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MOUNT NANSEN REMEDIATION PROJECT
SITE CHARACTERIZATION REPORT

Submitted to:

Assessment and Abandoned Mines
Energy Mines and Resources
Whitehorse, YT

Submitted by:

AMEC Environment & Infrastructure,
a Division of AMEC Americas Limited
Burnaby, BC

April 16, 2014

AMEC File: VM00605F

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EXECUTIVE SUMMARY

Introduction, Project Scope and Report Objective

Mount Nansen has been the site of mining exploration activity and/or active mining since the 1940s. The most extensive stage of mining occurred between November 1996 and February 1999 in the Brown-McDade Open Pit. It involved construction of the existing tailings dam and deposition of approximately 240,000 m^3 of tailings within the tailings impoundment. A waste rock storage area containing approximately 360,000 m^3 of waste rock was also created adjacent to the Brown-McDade Open Pit. Earlier periods of mining contributed to smaller amounts of tailings, some of which are still present near the mill site, and localized zones of waste rock at the mill site and elsewhere on the site. Other site infrastructure includes the mill and camp facilities as well as various ancillary structures, power lines and pipelines. In 1999, mining was halted because it was no longer economical, and sulphide ore was being mined in contravention of the water licence.

This remediation plan for the Mount Nansen site is comprised of the following:

- relocating the tailings and underlying affected soils from the existing tailings impoundment to the Open Pit;
- removing the main tailings dam and downstream seepage dam;
- relocating mineralized waste rock to the Open Pit;
- backfilling the Open Pit so that the tailings are located above the groundwater table and a stable final surface and topography is provided;
- developing a management method for the water currently in the Tailings Facility and Open Pit and for the short term seepage from the backfilled pit;
- covering the Open Pit area with an engineered low infiltration cover;
- quantifying the Open Pit connection to deeper groundwater, as it relates to current and potential long-term influences on groundwater movement into, or out of, the Pit;
- remediating the mill and camp areas;
- removing existing infrastructure (roads, power lines, pipelines, sediment ponds, ancillary buildings, etc.); and
- creating a remediated landscape that complements the natural topography and vegetation, including the reconstruction of Dome Creek through the current tailings impoundment area.

The purpose of the site characterization effort and this report is to consolidate all of the information on the site and its characteristics into one description that will then form the primary data input to the 30% Design Development Phase of the Mount Nansen Remediation Project (MNRP). In general terms, this site characterization report brings together investigative work that has been completed in the past at Mount Nansen with the findings of the 2013 Site Investigation (SI) program completed recently.

Site Setting

The report includes a section that describes:

- the physiographic setting of the site;
- surficial soils and vegetation conditions in both disturbed and undisturbed portions of the site;
- bedrock and surficial geology in the Mount Nansen area;
- an overview of permafrost conditions in and around the property;
- the seismic hazard assessment and analyses that apply to the site; and
- an overview of the terrain hazards on the property that will be relevant for design.

Hydrometeorology

The purpose of the hydrometeorology site characterization for the Mount Nansen Remediation Project was to estimate parameters that are representative of the site conditions. These hydrometeorology parameters will be used as inputs for engineering designs and environmental assessment. The report's hydrometeorology site characterization focuses on three parameters: precipitation, surface water flow and pond evaporation. The precipitation analyses estimated the following parameters for Mount Nansen site:

- monthly average precipitation and percentage distribution;
- annual average and annual precipitation for the different return periods; and
- peak short-term duration storms for the following return periods: 1 in 2-year, 1 in 5-year, 1 in 10-year, 1 in 25-year, 1 in 50-year, 1 in 100-year, 1 in 200-year and 1 in 1,000-year.

The surface flow analysis was performed to estimate the following parameters for Dome, Pony, Back and Victoria Creeks:

- monthly and annual flow;
- distribution of monthly flow; and
- typical hydrographs.

For evaporation, average monthly values were evaluated and provided.

Hydrogeology

The conceptual hydrogeological model that had been developed previously for the site was reviewed and expanded with the findings of the 2013 Site Investigation. The resulting modifications and/or refinements to the conceptual model are described below.

1. Pony Creek - in its upper reaches, is either a slightly losing or gaining stream, as the amount of groundwater exchanged was very low. Surface water ponds, created by exploration trenches, likely increase infiltration to shallow groundwater.
2. Pony Creek adjacent to the Open Pit, is documented as losing stream water to shallow groundwater, some of which reports to the Open Pit via the north pit wall.

3. Pony Creek upstream of the confluence with Back Creek had the greatest gaining seepage, indicating it to be a significant discharge area for groundwater to surface water.
4. Open Pit rock faulting – previously mapped as running through the Open Pit, extending north and south of the Open Pit footprint and described as a low conductive groundwater zones and barriers to flow and possibly also directing some water from Pony Creek into the pit. The 2013 data indicates that permafrost the greater constraint against deep groundwater moving east and south-east from the Open Pit area.
5. Open Pit rock mass – has a hydraulic conductivity in the order of 10^{-7} m/s. This value agrees with documented analyses of rock mass permeability that used pond level changes versus time (Gartner Lee, 2007).
6. Open Pit pond groundwater exchange – the 2010 to 2013 climatic and pit pond levels and piezometric elevation data for the underlying rock mass, shows the pond to be a surface water retention feature, with saturated hydraulic connection to the deep groundwater system, i.e. a leaky retention feature.
7. Open Pit climatic water balance – calculated the rate of water exchange between the pond and groundwater and derived an average seepage rate out of the Open Pit to be 0.2 L/s (Gartner Lee, 2007), for pit pond data in 2002 and 2003. Using August 2010 to June 2013, inclusive, climatic and pit pond data, a similar average of 0.2 L/s was derived.
8. Open Pit wintertime pond level recession – quantified the pond water outflow rate as being in the 0.3 L/s to 0.5 L/s range, applicable all year.
9. Open Pit pond relationship to groundwater – the pond is concluded as behaving as a surface water retention feature, water leaves the pit pond, as groundwater, at an average rate of 0.3 L/s, all year, applicable to a pond elevation range between 1,181 m and 1,184 m.
10. Open Pit underlying rock piezometric elevation range – elevations 1,166 m and 1,181 m, respectively, were interpreted as the current lower and upper bond values for the piezometric range, within the deeper rock mass underlying the Open Pit.
11. Open Pit underlying rock piezometric elevation range – pit pond level and corehole instrumentation data in 2014 will update the lower and upper bound piezometric range values of 1,166 m and 1,181 m.
12. Deep groundwater in the vicinity of the Open Pit appears to be recharging unconsolidated overburden in the central and lower reaches of Dome Creek and, to a lesser extent, the lower reaches of Pony Creek.
13. Deep groundwater discharging to shallow groundwater within Dome Creek and Pony Creek overburden, ultimately to surface water, is complex and currently influenced by relict permafrost surrounding the Open Pit.

The hydraulic relationship between the Open Pit pond and deep groundwater within underlying rock mass will continue to be refined in 2014, using the in-pit pond data logger and piezometric data from instrumentation and the monitoring well installed 50 m below the Open Pit floor.

The long-term effects of permafrost degradation will change this relationship to a currently undefined extent, as the following groundwater-related changes can be expected:

- shallow and deep groundwater will merge at greater locations, notably between the Open Pit and Dome Creek and between the Open Pit and Pony Creek;
- groundwater divides and permafrost barriers will move and/or disappear;
- surface runoff volumes will change. A greater ratio of precipitation will infiltrate giving less runoff, adding to shallow and deep groundwater. This will likely change piezometric elevations, groundwater gradients and flow directions; and
- deep groundwater flow paths will be less constrained, with more discharge to surface water at higher elevations than currently. The occurrences of spring-like groundwater flows will tend to increase, as permafrost degrades.

Geochemical Considerations

A significant geochemical characterization investigation was conducted at the Mount Nansen site to assess the potential for metal leaching and acid rock drainage (ML/ARD) from mine waste. Key site components in terms of potential sources of ML/ARD are the Brown-McDade waste rock pile, Brown-McDade pit, tailings impoundment. Results of the previous site investigations indicate that mine rocks and tailings were also identified in the other locations, such as haul roads and the mill area., adits, and waste rock/tailing used in the road or stored in the mill area.

Samples collected for ML/ARD assessment were tested for the following:

- Acid Base Accounting (ABA), which consists of the following analyses:
  - Modified Sobek neutralization potential (NP);
  - Sulphur species including Total Sulphur (S); Sulphate Sulphur; and Sulphide Sulphur;
  - Total Inorganic Carbon; and
  - Paste pH.
- elemental metals;
- total cyanide and weak acid dissociable (WAD) cyanide, and
- leachable metals.

Acid Base Accounting

The potential for a sample to generate acidity is defined by the neutralization potential ratio (NPR). The NPR is a ratio between neutralization potential (NP) and acid potential (AP). The AP is generally attributed to the oxidation of sulphide minerals and is calculated based on the sulphide sulphur content.

As an initial screening value, the NPR 2 is proposed to be used as a threshold value for separating potentially acid generating (PAG) rock from non-potentially acid generating (non-PAG) rock. The NPR 2 as a threshold value for PAG and non-PAG classification is referred to in the document entitled "*Prediction Manual for Drainage Chemistry from Sulphidic*

Geologic Materials" that was issued in 2009 by Mine Environment Neutral Drainage (MEND) as the updated guideline for ML/ARD characterization. This document provides an update to the Price 1997 document entitled "*Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia*. Based on ARD potential, the MEND 2009 guideline classifies mine rocks into three categories compared to four categories used in Price, 1997. The MEND, 2009 guideline states that a sample with NPR<1 is PAG, a sample with NPR>2 is non-PAG, and a sample with NPR between 1 and 2 is uncertain and capable of generating acid. These NPR criteria are also applied to tailings, but it is accepted in the industry that the NPR threshold between PAG and non-PAG tailings is usually less than 2, often in the range of 1.4 to 1.5.

Metal Content

There are no regulatory standards that apply directly to the elemental content of mine rock. For comparative purposes, the elemental content of mine rock was evaluated against average elemental crustal compositions, cited from Guidelines and Recommended Methods of ML/ARD (Price, 1997). Metal concentrations in soil samples were compared to the Yukon Contaminated Soil Regulation (CSR), OIC-2002/171, for park land (PL) use.

Leachable Metals

The results of leachable metal testing with the shake flask extraction (SFE) testing method were used as a geochemical screening tool to assess whether metal leaching could potentially occur from a sample. For comparison purposes, the SFE results were also reviewed in relation to the Canadian Environmental Quality Guidelines for fresh water aquatic life (CCME, 1999).

Site Wide Water Quality

The report's water quality section encompasses water quality (both surface water and groundwater), monitoring well headspace gas concentrations, and physical hydrogeology. Following a review of the mill process and a summary of the analytical data up to 2013, an interpretation of the current contaminant hydrogeology and biogeochemistry of the surface waters and groundwater is presented.

The water analytical results that were presented in the SI Data Report were evaluated against four sets of potentially applicable regulatory standards. The regulatory standards used for comparison were:

1. Metals Mining Effluent Regulation (MMER);
2. Site Water License;
3. Yukon Contaminated Sites Regulation (CSR) Fresh Water Aquatic Life standards; and
4. Canadian Water Quality Guidelines for Fresh Water Aquatic Life.

The data tables originally presented in the SI Data Report have been updated and expanded to include the evaluation against regulatory standards and for Quality Assurance and Quality Control (QA/QC).

The water quality assessment noted the following particular features of materials onsite that will influence elements of the remedial design:

- the tailings retain iron-cyanide complexes that are likely subject to photodegradation; the potential for free cyanide CN releases during excavation and relocation will need to be considered in the design;
- measurements of weak acid dissociable (WAD) cyanide in water do not correlate with metals such as copper; therefore, what has been measured as WAD cyanide is likely primarily an organic-cyanide complex rather than a metal-cyanide complex; this may have implications for water treatment requirements and design;
- it is hypothesized that the Inco process chemical sulphite is still present in the tailings and groundwater. This may be of significance as sulphite is being successfully used at other sites as an acid rock drainage (ARD) inhibitor; and
- groundwater in the tailings area appears to be “gassy” due to the formation of biogenic gases from the oxidation of organics cyanide and ammonia; this feature may have implications for the efficacy and design of any well point dewatering systems contemplated for the tailings.

Infrastructure Assessment

The infrastructure portion of the report provides an inventory of structures and materials that will need to be dismantled and/or demolished during remediation, and provides preliminary assessments and comments on likely disposition requirements/strategies for the waste streams generated by dismantling/demolition activity. Inventories, assessments and commentary are provided for the:

- Mill Area;
- Camp Area; and
- Miscellaneous Infrastructure.

Open Pit

The report provides assessments of the following components of the Brown-McDade Open Pit:

- pit walls: the nature and stability of the wall rock masses are characterized with respect to their likely influence on remedial designs and execution plans;
- geochemistry: the geochemical characteristics of the rocks comprising the pit walls are described;
- Pony Creek Adit: the history and current understanding of adit conditions are described with comments on the associated design implications as plans for the final configuration and use of the adit in the general pit containment scheme are developed;
- water balance: an update to the Open Pit water balance was developed to quantify the Open Pit pond groundwater exchange relationship; this balance derived the volume of groundwater apparently entering or leaving the Open Pit pond. For the period 2010 to 2013, inclusive, the climatic water balance method of quantifying groundwater indicated a loss of groundwater at an average rate of 0.2 L/s. A second method of quantifying water leaving the Open Pit pond as groundwater using measured wintertime pond level

declines gave an average rate of 0.4 L/s. An average of 0.3 L/s was used in water quality modelling (GoldSim), derived as an average of the two methods of groundwater quantification; and

- groundwater flow and permafrost regime: the 2013 site investigation data were used to update previous conceptual hydrogeological models involving groundwater flow and permafrost, in particular the understanding of shallow and deeper regional groundwater movement from the Open Pit area into the Dome Creek catchment. Previous assumptions regarding permafrost were updated using the vibrating wire piezometer data, which will continue to be used to refine permafrost presence, given its barrier effects with respect to groundwater movement.

Waste Rock Area

The main characteristics of the waste rock area located beside the Brown-McDade Open Pit include:

- Total waste rock volume of approximately 509,000 m^3 representing approximately 70% of the total volume of waste rock removed from the pit.
- Forty-seven of the 56 samples (84%) gathered from the lower south, southwest, and west areas have calculated neutralization potential ratios (NPR) greater than 2, indicating non potentially acid generating (non-PAG) conditions. Seven samples (13%) indicated "uncertain" potential for acid generation with NPR between 1 and 2, and two samples (4%) indicated PAG conditions. The material in these areas (approximately 200,000 m^3) may be suitable for storage outside the Open Pit.
- Elsewhere in the waste area, about half of the samples indicated non-PAG conditions, while 32% and 19% of the samples obtained indicated PAG and uncertain PAG conditions, respectively. It is likely not possible to separate PAG from non-PAG material in these areas and this material should be stored within the Open Pit.
- Most of the rock has naturally elevated levels of antimony, arsenic, bismuth, cadmium, lead and zinc as compared to the 10x average crustal abundance values.
- The low grade ore pile generally has PAG conditions comparable to the sulphide zone in the pit wall and should be contained within the Open Pit.
- The waste rock material is largely altered granodiorite with some unaltered granodiorite and altered feldspar porphyry. The geotechnical characteristics vary both spatially and horizontally. The material generally has greater than 50% gravel, cobbles and boulder sizes. The soil fraction consists predominantly of sand and gravel with trace fines. The oversize material varies from hard and strong to highly oxidized and very weak. Where it is geochemically suitable, the waste rock could be a source of general fill but is not a source of good quality durable cobbles or boulders.
- No frozen or free water was observed in the test pits or drill holes in the waste rock area. Seepage is only observed during the freshet period and in 2013 was found to have a neutral pH.

Tailings Storage Area

The main characteristics of the tailings storage facility include:

- Current tailings volume of approximately 250,000 m^3, most of which was deposited sub-aqueously.
- There is a significant region of tailings that is dominated by fined grained material characterized as sandy to clayey silt of medium to high plasticity. This fines-dominated area lies within the central region of the impoundment near the dam and has a maximum thickness in the order of 10 m. Within the fine tailings, there are lenses and zones of coarse tailings. Similarly, lenses and zones of fine tailings are present within the coarse tailings.
- The tailings appear to have peak strengths consistent with a normally consolidated material (i.e. peak undrained strength to effective strength ratio of about 0.2).
- The tailings are highly sensitive with very low residual strength and are prone to liquefaction under equipment loading, excavation, and other disturbances.
- Geochemical analyses indicate that the majority of the tailings are PAG and have high metal contents, particularly with regards to arsenic, iron, lead, manganese and zinc. The finer grained tailings tend to have higher concentrations of cyanide than the coarser grained tailings.
- The water level in the Tailings deposit is generally coincident with the pond level. There appears to be a significant downward gradient, particularly near the dam, with the insitu sand foundation appearing to act as an underdrain.
- The Tailings Facility has caused thaw of the permafrost in the foundation soils and there are no permanently frozen tailings. Permafrost appears to be present within several metres of the original ground surface on the south side of the Tailings Facility. The depth to permafrost beneath the tailings on the north side of the facility has not been determined but at one location is greater than 12 m below original ground. Permafrost thaw has extended 5 m into the foundation sands in the north terrace, downstream of the north tailings dam abutment.
- The foundation soils underlying the Tailings Facility consist generally of fine grained sand with organics overlying fine to medium sand and sand and gravels deposited by fluvial or glaciofluvial processes. Silt zones and layers have also been encountered in the Tailings Facility area as well as till from historic past glacial events. These soils are located below the water table and may be frozen depending on the location. The near surface sands are considered thaw stable. Two ice lenses of significant thickness were encountered at depths of 12 and 6.5 m below original ground and, therefore, the potential for ice rich material exists.
- The uppermost layer of foundation soil is contaminated by tailings pore water, characterized mainly by high arsenic levels. It is expected that this contamination will extend downward on the order of 1 m although testing during removal operations will be necessary to confirm this.

- There is a significant amount of seepage through the north terrace that likely originates from the diversion ditch. It is considered unlikely that seepage from Dome Creek is hydraulically connected to the seepage collection pond by a subsurface flow path into or under the tailings pond (EBA, 2012).
- The dam fill material is a poorly graded, fine to medium sand. With certain exceptions near the toe of the dam and on the south side of the dam, the material is generally compact and non-liquefiable. The fill is unfrozen with water levels several metres above the elevation of original ground.
- With the exception of two samples from one borehole, the dam fill was non-PAG with low metal leaching potential. All samples had elevated chromium contents and some had elevated arsenic levels. These elemental metal parameters may represent natural background conditions. This requires further assessment of available background soil geochemical data and potentially some additional field verification through shallow sampling. This should be done in support of the final site baseline characterization.

Mill Area

General Characterization

The mill area was created as a series of cut and fill benches which include insitu soils and waste rock material. A landfill is located to the south off the mill which was created by simply pushing material over from the top of the bank. East of the mill complex, there are three lined settling ponds (Pond 1, 2 and 3) that were historically used for tailings disposal. The clearing southeast of the mill complex is a historical explosives storage area. Northeast of the mill complex is the historical Huestis Adit area. Local overburden was pushed over the two portal areas obscuring the old workings.

The mill area soil has contaminant concentrations above the CSR-PL standards for metal, hydrocarbon and other contaminant parameters. The analytical results indicate that there is localized hydrocarbon contamination in the area. The larger hydrocarbon plume may extend from beneath the mill building 75 m northeast. The extent may be up to 50 m wide but it appears to be limited to the top metre. There may be a second hydrocarbon plume centred beneath the former landfill at the southeast end of the mill area. This is confined to the top 0.5 m below the garbage, and may extend up to 20 m in diameter.

Soils across the mill area (from approximately 20 m northwest of the mill building to 90 m southeast of the Warehouse Building) are contaminated with antimony, arsenic, cadmium, lead, and zinc. In general, the concentrations of these parameters decrease with depth below ground surface to bedrock or groundwater (approximately 4 mbgs at most locations). This pad area may have been built up with a blend of waste rock and non-contaminated material. Additionally, backfill contaminated with metals or unknown sources of metals have resulted in two localized areas of metals contamination. A former cyanide slurry spill has resulted in localized metals (and cyanide) contamination in the top 0.5 m of soil at BH-M-13-04 (Figure 45).

Potential glycol, chlorinated hydrocarbon, phenol, and PCB contamination within the mill building was not detected in soil samples collected adjacent to the building's footprint (BH-M-13-6, -7 and -8 were collected crossgradient and downgradient of the building). Analytical results provided no evidence of PCB contamination from the former landfill or the Transformer Storage Area. If such contamination does exist, it is likely localized.

There may be soil contaminated with hydrocarbons, metals, and other contaminants beneath the mill area buildings and infrastructure, including the current diesel storage area and garbage debris. These areas will need to be assessed during remediation.

Explosives Storage Area Characterization Summary

Overall, the results for the Explosives Storage Area indicate that pockets of soil in this area likely contain elevated nitrogen concentrations. Additionally, the elevated metals concentrations from the Explosives Storage Area indicate that it was likely constructed using waste rock.

Groundwater Flow and Huestis Adit

A preliminary groundwater flow plan was developed for the northwest portion of the mill area with proximity to the Huestis Adit. Groundwater elevations provided an indication of the shallow water table depth from which some extrapolation was possible, based on topographic mapping and depth to the shallow water table. Using this approach, groundwater contours and flow direction were interpreted for the Huestis Adit and mill area.

Roadways

There was concern that the soils in the roadway areas may be contaminated from the application of hydrocarbon materials to suppress dust during mine operation. Historic reports contained little information about hydrocarbon contamination along the roadways. The 2013 field screening of the samples from the roadways provided no evidence of widespread hydrocarbon contamination.

Geochemical characterization of local roads confirmed the presence of mine rock at the majority of the sampling locations. In general, the metal content in the road samples were within the range of metal contents observed from the waste rock samples. The majority of rock samples from the mine section of the haul road and the haul road berm were non-PAG, although PAG rock was identified at two sampling locations.

Former Ketza Shop

Previous investigations delineated hydrocarbon contamination within the Ketza Shop to depths of approximately 0.5 and 1.5 mbgs. The 2013 program indicated that hydrocarbon contamination is present in shallow (<0.5 mbgs) pockets in the Ketza Shop Area. Elevated metal levels are consistent across the Ketza Shop Area and are confined to the top 0.5 mbgs. Arsenic contamination generally decreases with depth. There is likely no cyanide contamination associated with the material beneath the shop.

Borrow Areas

The report characterizes conditions within sand borrow areas in the vicinity of the Tailings Storage Facility and at a potential offsite location some 25 km east of the site. The assessments identified no sources of fine grained borrow (i.e. potentially suitable for cover construction or reclamation) on the site or in its immediate vicinity. The borrow 25 km east of the site had some silty clay loam glaciolacustrine sediments that might be useable as fill.

Trenches and Clearings

There are numerous exploration trenches associated with the site that are visible as long linear features, typically clustered around a mineralized zone of interest. The trenches were created by pre-stripping the top 0.5 m of vegetation and soil with a bulldozer, and trenching from 1 to 3 m deep and side-casting this material with an excavator. During the 2013 site investigation, exposed nutrient poor substrates in the trenches were observed. If perpendicular to a slope, many of the exploration trenches have become preferential paths for water courses, which have resulted in formation of minor erosion rills.

The water quality of the trench runoff samples was compared against MMER effluent discharge criteria and CCME guidelines for the protection of aquatic life. Based on the water quality data, runoff from the exploration trenches is contributing at least some elevated metals to downstream water bodies.

1.0 PROJECT BACKGROUND AND SCOPE

1.1 Introduction

Mount Nansen has been the site of mining exploration activity and/or active mining since the 1940s. The site location is shown on Figure 1 and a current plan of the site is provided on Figure 2. The most extensive stage of mining occurred between November 1996 and February 1999 in the Brown-McDade Open Pit. It involved construction of the existing tailings dam and deposition of approximately 240,000 m^3 of tailings within the tailings impoundment. A waste rock storage area containing approximately 360,000 m^3 of waste rock was also created adjacent to the Brown-McDade Open Pit. Earlier periods of mining contributed to smaller amounts of tailings, some of which are still present near the mill site, and localized zones of waste rock at the mill site and elsewhere on the site. Other site infrastructure includes the mill and camp facilities as well as various ancillary structures, power lines and pipelines.

In 1999, mining was halted because it was no longer economical, and sulphide ore was being mined in contravention of the water licence. The company operating the Mount Nansen property was put into receivership in March 1999. The site is now managed by the Yukon Government through Assessment and Abandoned Mines (AAM).

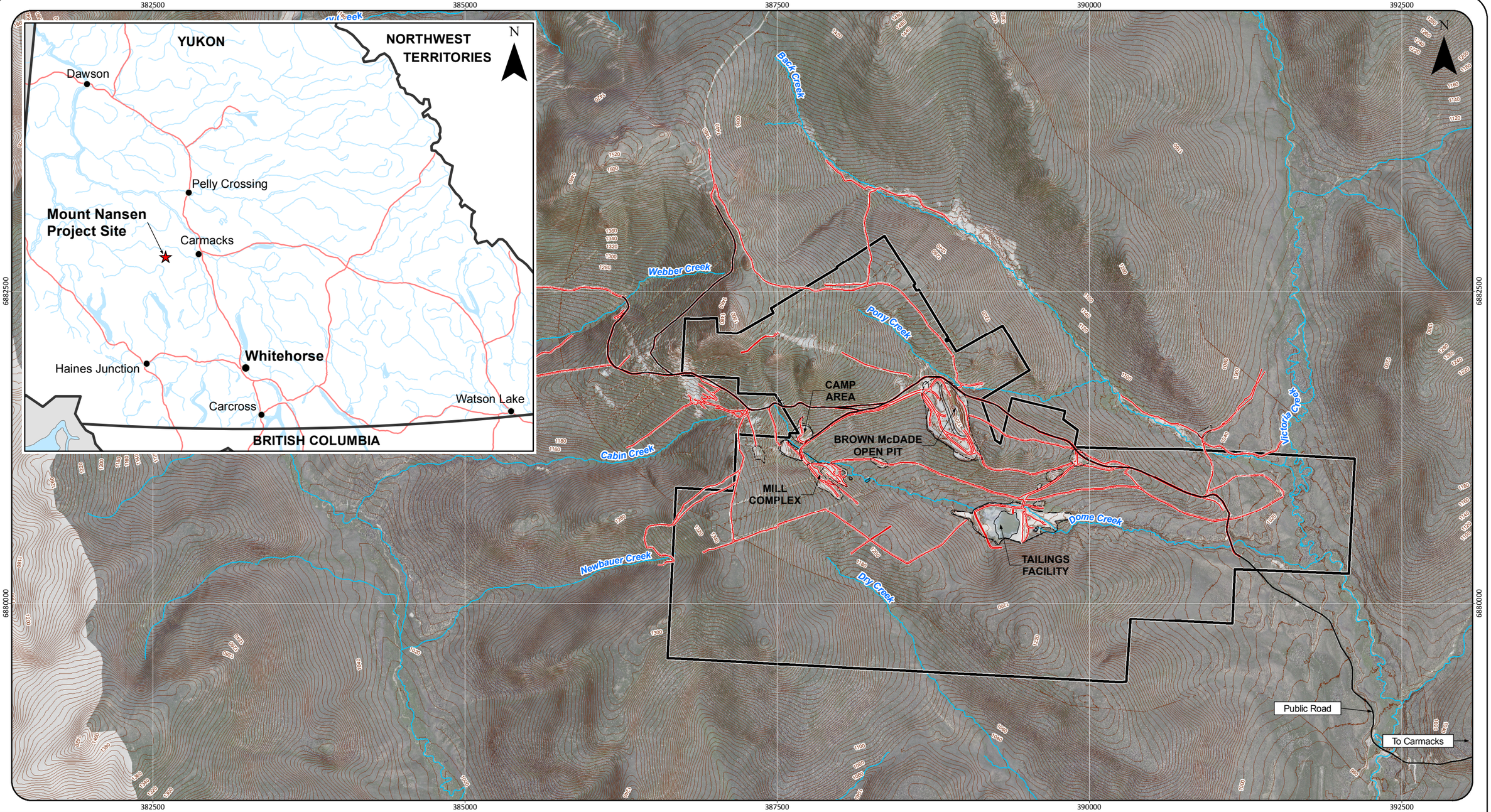
In support of site remediation, many studies and investigations have been carried out over the past decade to define the closure objectives and to explore various closure options. Detailed discussion of the closure objectives can be found in Yukon Government (2008) and are presented below.

1.2 Project Objectives and Scope

1.2.1 Objectives

The closure objectives for the Mount Nansen Remediation Project (MNRP) are as follows:

- protect human health and safety;
- protect and restore the environment including land, air, water, as well as fish and wildlife and their habitats;
- return the mine site to an acceptable state that reflects original, traditional, and pre-mining land use;
- maximize local, Yukon and First Nations benefits; and
- manage risk in a cost effective manner.



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

- Order in Council Boundary
- Contour (5 m)
- Disturbed Area
- Roads
- Streams

Associated Engineering — Global Perspective. Local Focus.

amec

Yukon Energy, Mines and Resources
Assessment and Abandoned Mines

MOUNT NANSEN REMEDIATION PROJECT

Figure 1

SITE CHARACTERIZATION REPORT

KEY MAP AND LOCATION PLAN

Scale 1:30,000
Metres
0 500 1,000

March 18, 2014

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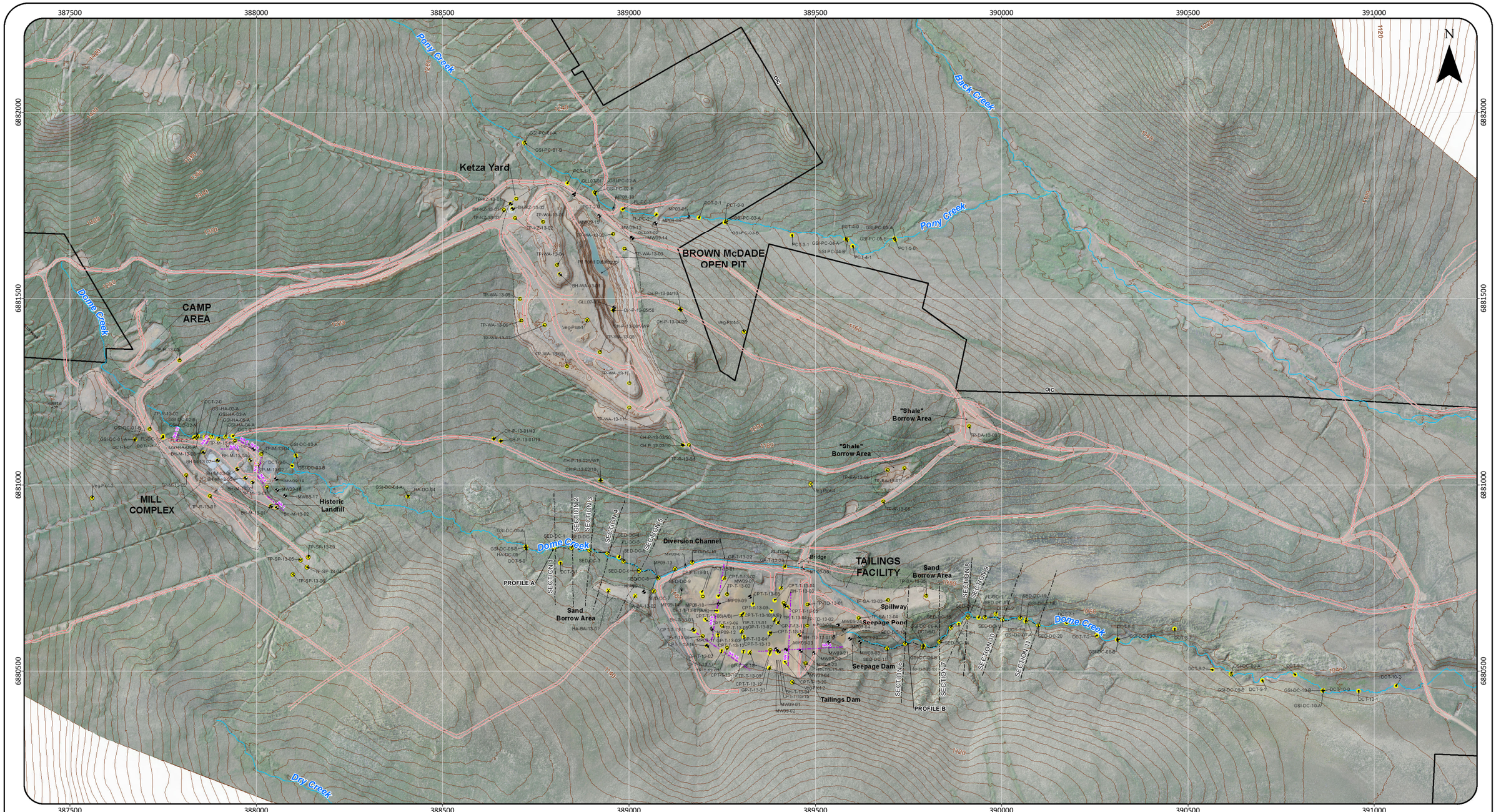

Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

- Borehole
- Hydrogeological
- CPT
- Geoprobe
- Grab Sample
- Hand Auger
- Mini Piezometer
- Temperature or Flow Measurement
- Test Pit
- 2013 Locations
- Order in Council Boundary
- Geophysics Lines
- Surveyed Sections
- Contour (5 m)
- Disturbed Area
- Roads
- Streams

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MOUNT NANSEN REMEDIATION PROJECT

Figure 2

SITE CHARACTERIZATION REPORT

OVERVIEW SITE PLAN

Scale 1:10,000

Metres

0 250 500

March 18, 2014

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1.2.2 Scope

The final remediation alternatives study (LORAX, 2011) presented technical information regarding four remediation options. The options were evaluated by representatives of Government of Yukon, Aboriginal Affairs and Northern Development Canada (AANDC) and the Little Salmon/Carmacks First Nation (LSCFN). Option 4, as described in LORAX (2011), has since been selected as the remediation option for the site. This remediation plan is comprised of the following:

- relocating the tailings and underlying affected soils from the existing tailings impoundment to the Open Pit;
- removing the main tailings dam and downstream seepage dam;
- relocating mineralized waste rock to the Open Pit;
- backfilling the Open Pit so that the tailings are located above the groundwater table and a stable final surface and topography is provided;
- developing a management method for the water currently in the Tailings Facility and Open Pit and for the short term seepage from the backfilled pit;
- covering the Open Pit area with an engineered low infiltration cover to substantially limit water contact within the tailings deposit;
- quantifying the Open Pit pond in terms of a long-term pond elevation, or elevation range, that is predicted to result after the climatic inputs (direct precipitation and runoff) that create most, possibly all, of the Open Pit pond, are minimized by the low infiltration Open Pit cover;
- remediating the mill area including building demolition, removing the rail tanker, restoring the water course, removing mineralized rock, removing hazardous waste, removing historic tailings, decommissioning historic settling ponds, providing compliant water quality and, if shown to be necessary, remediating the old landfill;
- remediating the camp area including demolishing existing buildings except those required for maintenance following closure, and removing hazardous waste;
- decommissioning all non-public roads, where not required for future monitoring;
- removing existing infrastructure (power lines, pipelines, sediment ponds, ancillary buildings, etc.);
- remediating hydrocarbon contaminated soils;
- remediating exploration trenches and disturbed areas as appropriate;
- decommissioning the Victoria Creek pump house and existing artesian well;
- reconstructing and reclaiming the Dome Creek channel and valley following removal of the tailings storage facility; and
- creating a remediated landscape that complements the natural topography and vegetation.

1.3 Project Development Status

1.3.1 30% Design Phase Objectives

The current phase of design development is referenced in AAM's process as the 30% Design Development phase. This phase is intended to:

- characterize the technical feasibility of Option 4;
- identify a base case design which can be further optimized and refined;
- provide bracketed predictions of the likely performance of the base case design (e.g. predicted ranges of downstream water quality relative to CCME criteria);
- provide a bracketed understanding of the risks associated with key project features and outcomes;
- characterize the nature and scale of uncertainties related to predictions of performance and risk;
- outline the basic elements of any adaptive management plans that may be needed to manage risks and uncertainties; and
- develop a project execution cost estimate with enough utility and reliability to support the next level of Partner decision making (generally equivalent to an AACE (Association for Advancement of Cost Engineering) Class 3 Estimate).

2.0 SITE CHARACTERIZATION PROGRAM

The purpose of the site characterization effort and this report is to consolidate all of the information on the site and its characteristics into one description that will then form the primary data input to the 30% Design Development Phase of the Mount Nansen Remediation Project (MNRP). In general terms, this site characterization report brings together investigative work that has been completed in the past at Mount Nansen with the findings of the 2013 Site Investigation (SI) program completed recently (AMEC, 2013).

2.1 Previous Investigations

Mining has occurred at the Mount Nansen site in various forms since the 1960s with the most intensive period occurring in the late 1990s. A significant amount of monitoring and assessment work has been done at the site over the years, both before and especially after mining. As much as possible the information available from these studies and particularly from previous investigation programs was reviewed by AMEC during development of the 2013 SI program. The previous investigations reviewed, and their influence on the 2013 SI program, are detailed in AMEC (2013a).

2.2 2013 Site Investigation Program

The 2013 site investigation program was developed in consideration of the work completed to date at the Mount Nansen site as summarized in the gap analysis and site investigation memos (AMEC, 2013a, 2013b). The intent of the program was to fill in information gaps where significant uncertainty and risk had been identified. Broadly, the key objectives were:

- to improve the tailings characterization, particularly as it relates to behaviour during relocation and placement;
- to improve the characterization of native materials under and around the Tailings Facility, in particular with regards to geochemistry and physical stability during remediation;

- to improve the understanding of hydrogeologic and thermal conditions around the Open Pit and particularly on the south side between the pit and Dome Creek;
- to expand the water quality dataset, particularly with respect to groundwater;
- to better understand the mill area soil contamination, flows and seepage;
- to improve estimates of the volumes of materials requiring containment in the Open Pit; and
- to provide the design team with confirmation of the onsite conditions and conceptual frameworks that have been developed to date.

A list of all of the subsurface investigations and installations completed in 2013 is summarized below.

- 35 boreholes (diamond, sonic and GeoProbe);
- 20 cone penetration tests;
- 40 test pits and four hand augers;
- 12 geophysics lines;
- 14 pairs of mini piezometers (on Dome Creek and Pony Creek);
- 5 single mini piezometers (at Huestis Adit);
- 8 monitoring wells; and
- 5 vibrating wire locations including two with nested installations.

The subsurface investigations were complemented by a sampling program which consisted of:

- 24 existing (pre-2013) groundwater mini-piezometer and well sample locations;
- 19 new (2013) groundwater locations sampled (27 new sampling locations installed but some were frozen or dry when sampling occurred);
- surface water sampling;
- 38 environmental soil samples;
- 95 soil samples for geotechnical testing;
- 156 soil samples for geochemical testing;
- 20 sediment samples;
- 21 samples of potentially hazardous material in the mill and development of hazardous material inventory;
- 14 seepage meter tests;
- 7 creek flow tests; and
- gas monitoring or well headspace and soil samples.

In addition to the investigations listed above, general site wide reconnaissance to support the development of reclamation concepts including observation of soils, vegetation, landforms and site aesthetics was completed. An initial visual assessment of the structures in the mill area and near the bunkhouse was also completed. In addition, general observations of the site conditions in consideration of possible geohazards and the potential for borrow material were carried out.

3.0 REPORT ORGANIZATION

The Site Characterization Report is organized with summary and more general characterization information presented in the main body followed by more detailed and/or supplemental information and data provided in appendices. The contents of the report sections and appendices are as follows:

Section 1.0: describes the project scope and current stage of project development.

Section 2.0: overview of the scope and objectives of the 2013 Site Investigation Program.

Section 4.0: provides a general physiographic introduction and description of the site.

Section 5.0: describes the scope and findings of the hydrological component of site characterization.

Section 6.0: describes the scope and findings of the hydrogeological component of site characterization.

Section 7.0: provides an overview of the geochemical issues that relate to the general site.

Section 8.0: describes the scope and findings of the water quality components (for both ground and surface water) of site characterization.

Section 9.0: provides an inventory of site infrastructure and a description of conditions that will be relevant for dismantling, demolition and disposition.

Section 10.0: first of a number of sections characterizing geotechnical, geochemical and/or contaminant conditions in specific site areas, in this case, the Open Pit.

Section 11.0: characterizes geotechnical and geochemical conditions of the various waste rock stockpiles in and around the Open Pit.

Section 12.0: characterizes geotechnical, hydrogeological, geochemical, contaminant and permafrost conditions in and around the Tailings Storage Facility.

Section 13.0: characterizes geotechnical, hydrogeological, geochemical, and contaminant conditions in the mill and explosives storage areas and describes the inventory of mill area hazardous materials.

Section 14.0: characterizes contaminant and geochemical conditions on site roadways and the former Ketza Shop Area.

Section 15.0: characterizes geotechnical and geochemical conditions in borrow areas on and near the site.

Section 16.0: provides a general inventory of exploration trenches on the site and characterizes representative geochemical conditions.

Appendix A: provides terrain maps.

Appendix B: provides an assessment of permafrost conditions within the study area.

Appendix C: provides supporting hydrological information and data.

Appendix D: provides water quality QA/QC information and data.

Appendix E: provides supporting geotechnical information and data.

Appendix F: provides supporting geochemical information and data.

Appendix G: provides site characterization QA/QC information and data.

4.0 SITE SETTING

4.1 Site Location and Physiography

The Mount Nansen site is located at approximately 62° 3' N, 137° 8' E in the Yukon Territory about 60 km west of the Village of Carmacks as shown in Figure 1. The project area is defined by the Order in Council (OIC) boundary and is approximately 12 km^2. It is accessed by a public gravel road that is maintained year-round. There is significant placer mining activity in the general area and within the watershed in which Mount Nansen is located.

The site is within the southern part of the Dawson Mountain Range of the Yukon Plateau-Central Ecoregion. It lies approximately 25 km west of the limits of the most recent Pleistocene glaciation (EBA, 2009) and within the discontinuous permafrost zone, near the southern boundary of continuous permafrost (Klohn, 1988). Site drainage has a rectilinear pattern, generally with low gradients to the east-southeast. Pony and Dome Creeks carry water offsite into Victoria Creek which feeds into the Neisling, the White and then the Yukon Rivers.

Mountain peaks in the vicinity of the site are all located to the north of the OIC limits and include Mount Nansen (1,827 masl), Mount Victoria (1,870 masl) and Mount McDade (1,499 masl). Locally, the topography at the site ranges from about 1,000 to 1,500 m with slopes typically in the gentle to moderate (5° to 25°) range. The landforms consist of rolling and rounded bedrock controlled hills and ridges oriented northwest-southeast with moderately incised valleys through which Pony and Dome Creeks flow. The slopes of the Dome Creek Valley range from 25 to 35% (14° to 19°).

4.2 Soils and Vegetation

Vegetation and soils observations are outlined in Table 1. Field plot locations are indicated in Figure 3. In addition to AMEC/AE's findings, Ecological Logistics & Research Ltd. (ELR) documented vegetation species lists for areas around the Mount Nansen site in undisturbed areas on behalf of the Yukon Government AAM (ELR, 2013). The ELR species lists are consistent with AMEC/AE's findings and were provided in a raw data format prior to the site investigation (ELR's plot locations are provided by way of Figure 1 in ELR (2013)). The ELR data could be used for direction for seed collection in the future or comparison to baseline conditions. Detailed descriptions of baseline conditions or undisturbed areas, disturbed areas and trial plantings are provided in the following sections.

In general, a review of background information and results of a site reconnaissance conducted in September 2013 indicated that disturbed areas are comprised of compacted, coarse rock with limited natural revegetation. In comparison, the species composition and soil development of undisturbed areas are dominated by forests that have established on colluvial materials on south facing slopes and shrub species that have developed on organic soils with a shallow permafrost table on the north facing slopes.

Table 1: Summit Plot Data for Site Investigation/Reconnaissance, September 2013

Plot #	UTM	Elevation (m)	General Location	Ecosystem	Slope	Aspect	Percent Vegetation Cover	Parent Material	Soil Characteristics	Drainage	Water Table (cm)	Permafrost Table (cm)	Comments
1	388888 E, 6881443 N	1214	Waste Rock Area	Anthropogenic	level	none	5-15%	Anthropogenic	80% coarse fragments (crushed gravel), sandy clay loam	Well	None	None	Natural revegetation varies. Sandy substrate is supporting higher density of vegetation growth
2	389438 E, 6880471 N	1105	South of Tailings Pond	Shrubby snow patch fen[1]	25%	North	100%	Organic veneer/ Eolian	20 cm poorly decomposed (fibric) material/ 45 cm sand,	Poor	30[2]	45[2]	Permafrost table at 35 cm upslope
3	387560 E, 6880965 N	1275	Adjacent to exploration line located west of site	Shrubby snow patch fen[1]	20%	Northeast (38°)	100%	Organic veneer/ Colluvium	12 cm poorly (fibric) to moderately (mesic) decomposed material/ 65 cm gravelly sandy loam	Imperfect to Poor	40[2]	65[2]	Comparison of ecotype for adjacent excavation line
4	389488 E, 6881001 N	1154	North of Tailings Pond	Forested upland	27%	Southeast (150°)	100%	Colluvium	Sandy clay loam, colluvial material	Well	None	None	Deep tephra (approximately 13 cm)
5	389309 E, 6881412 N	1219	East of Pit	Shrubby snow patch fen[1]	20%	Northeast (44°)	100%	Organic	Organic, moderately well to well decomposed (mesic to humic)	Poor	Frozen	30	Hummocky mounded terrain
6	391539 E, 6880871 N	1024	Victoria Creek Wellhouse	Forested Upland	level	none	70%	Eolian	Sand	Well	None	None	Victoria Creek Wellhouse
7	411006 E, 6886033 N	916	40 km east of site	Forested snow patch fen[1]	10%	Southeast (150°)	100%	Glaciolacustrine	Silty clay	Imperfect	30[2]	40[2]	Glaciated area

[1] Warner and Rubec, 1997.
[2] Water table and permafrost tables are measured below ground surface which is defined as the surface of the mineral layer. Any organic layers are considered above ground surface.

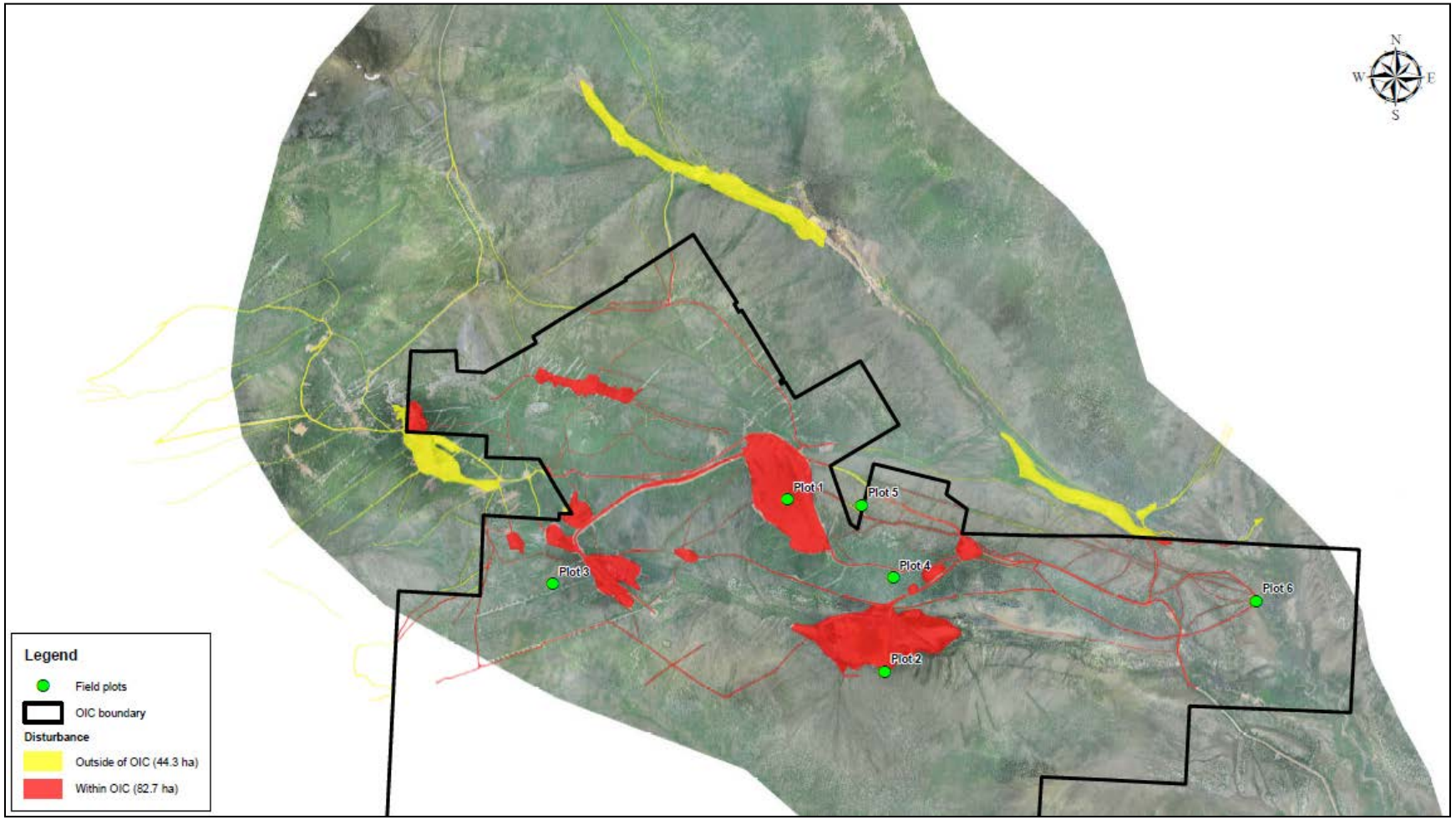


Figure 3: Reclamation Field Plot Locations

4.2.1 Baseline Conditions (Undisturbed)

The dominant vegetation on the south facing slopes are white spruce (*Picea glauca*) in the overstory, willow and Labrador tea (*Ledum groenlandacum*) in the understory, and crowberry (*Empetrum nigrum*), caribou lichens (*Cladina* spp.), and red-stemmed feather moss (*Pleurozium schreberi*) as the ground cover. Based on the size of the trees, the short growing period and poor nutrient regime, the trees are approximately 200 years old. There is no permafrost on these south facing slopes, resulting in much drier soil conditions. Soils are generally comprised of 10 cm of forest duff, over approximately 13 cm of tephra (volcanic ash). This is underlain by colluvial material consisting of a thin topsoil layer (2 cm) of dark brown sandy clay loam with approximately 10% angular coarse fragments. This is underlain by 13 cm of dark olive brown sandy clay loam with 10% coarse fragments grading to weathered bedrock with approximately 70% coarse fragment. Soils are considered moderately well drained (Table 1).

The dominant vegetation on north facing slopes consists of dwarf birch (*Betula glandulosa*), willow (*Salix sp.*), sedges (*Carex* sp.) and extensive moss cover. The presence of these hydrophilic species is primarily due to a shallow permafrost table that is approximately 30 to 60 cm below ground surface. The permafrost table results in a perched water table and poorly drained soils. The soils are comprised of approximately 20 cm of fibric (poorly decomposed) material over eolian sand (Table 1).

On the tops of the Tors, which are distinctive features of non-glaciated mountain tops outside of the OIC, there is little vegetation cover, with up to 25% exposed substrate. This is a natural occurrence due to poor moisture and nutrient regimes on the mountain peaks, as well as exposure to wind. What vegetation cover is established would be considered pioneer species, and is dominated by dryas (*Dryas* spp.), a nitrogen fixing plant.

4.2.2 Disturbed Areas

In disturbed areas within the OIC, the level and timing of disturbance varies, but the common theme is:

- waste rock and overburden surfaces are mainly comprised of compacted, coarse rock containing very little fines (typically less than 30%; Table 1);
- topsoil removal results in very poor natural revegetation; and
- naturally occurring revegetation in disturbed areas ranged from 0% to a maximum of 20% cover, averaging closer to 5% throughout the site disturbances.

Field observations for the disturbed areas are described below. The observations at Plot 1 in Table 1 are consistent with observations of disturbance areas throughout the Mount Nansen site.

Waste Rock and Overburden Areas

The substrates found in the waste rock/overburden areas surrounding the pit generally do not support vegetation growth. This is primarily due to poor moisture retention and nutrient conditions due to the coarse materials present. However, some small areas of natural revegetation were observed. These areas were generally characterized by small depressions (either natural or man-made). Vegetation establishment in depressions is due to a combination of factors including: accumulation of fines, moisture retention, seed trapping and germinating, and plant growth and decomposition resulting in organic matter build-up initiating moisture and nutrient retention. Nutrient cycling eventually supports more complex plant communities.

Exploration Trenches

There are numerous exploration trenches within the OIC that are visible as long linear features, typically clustered around a mineralized zone of interest (LORAX, 2011). The trenches were created by pre-stripping the top 0.5 m of vegetation and soil with a bulldozer, and trenching from 1 to 3 m deep and side-casting this material with an excavator (LORAX, 2011). The trenches are approximately 1 m wide and of variable length; however, detailed mapping or ground-truthing of the trenches has not been conducted to date.

During exploration, the soils and subsoils were side-cast with depths below ground surface measuring over 1 m, exposing the nutrient poor substrates. Many of the exploration trenches that travel perpendicular to the slope have become preferential paths for water courses, which have resulted in formation of minor erosion rills. Vegetation growth is generally very poor in the trench troughs; however, willow growth on side cast material is vigorous. On the slope to the west above the mill site, some of the trenches have been filled in with the side-cast material and show dense willow growth.

4.2.3 Trial Plantings

The trial plantings observed at three locations within the Mount Nansen site were unsuccessful, as shown in Table 2. The percent survival is approximately 5% or less at all sites. At one of these sites, specifically the exposed hill side above the mill, it is a convex surface with no microsites and it is very hard packed. This is consistent with the trial planting near Back Creek, except for one part of a row of planting at Back Creek where the substrate was mounded, loosening the soil and allowing a space for the cuttings to develop roots (hence the <5% or greater than 0% success). The plantings in the area south of the mine tailings were stuck into organic substrate that is blackened due to overflow from the tailings. The cuttings were inserted horizontally, but none of them were observed to have survived.

Table 2: Site Investigation of Trial Plantings at the Mount Nansen Site

Location	Species Planted	% Success	Comments
Below seepage pond	Willow and balsam poplar	0%	Blackened vegetation from tailings/ seepage pond overflow
Northwest of mill site	Balsam poplar	0%	Bare ground, very compacted
Adjacent to Back Creek	Willow and balsam poplar	<5%	Mounded location has some growth

4.3 Bedrock Geology

The Mount Nansen site lies within the Yukon Crystalline Terrain, south of the Yukon Clastic Terrain and west of the Whitehorse Trough (Tempelman-Kluit, 1986). The region is generally underlain by Mississippian aged metamorphic rocks which have been intruded by a series of plutonic suites. Most notably with respect to the project area, this includes the late Jurassic to early Triassic Dawson Range pluton which consists of granodiorite and diorite, and the mid-cretaceous Mount Nansen volcanic suite (Carlson, 1987; Stronshein, 2006). The bedrock in the southern part of the Mount Nansen site is dominated by biotite-quartz-feldspar schist, feldspar augen gneiss, amphibolite and minor quartzite and marble. The mineralization on the Mount Nansen property including the Brown McDade Open Pit within the Mount Nansen trend, a 3 km wide northwest trending corridor made up of various rock types. The geology within this trend is largely controlled by northwest trending faults on the flanks of and within the corridor (Hart and Langdon, 1997). The bedrock in the northeast portion of the OIC, in which the Brown-McDade Open Pit is located, consists of granodiorite and diorite, while the northwest corner of the site is underlain by andesitic flows, tuffs and agglomerate (Melling, 1995).

At the site, the lack of recent glaciation and relatively low rate of erosion since the Cretaceous period has contributed to development of weathering to depths of up to 30 to 75 m. With the exception of the Brown-McDade pit, areas of bedrock outcrop are sparse and subdued at the site. However, bedrock is typically exposed at or near surface in many of the shallow exploration trenches present at the site.

4.4 Surficial Geology

As a result of the absence of recent glaciation and the nature of the local bedrock, the surficial geology is dominated by thin (i.e. less than 5 m) colluvial deposits and patches of bedrock subcrop. This is reflected in the terrain map included in Appendix A which was based on EBA's 2009 regional mapping, refined within the OIC boundary based on a review of air photos and recent orthoimagery. Topsoil and organic material at the site is generally limited (typically less than 0.5 m although it can be thicker in valley bottoms) and is underlain by a thin layer of volcanic ash, which was deposited at least 2,000 years ago (Klohn, 1988).

Typically, the ridge tops and upper to mid valley slopes consist of a thin veneer of colluvium overlying bedrock with limited outcrops of fractured rock. The lower valley slopes include thicker colluvial deposits as well as colluvial fans and glaciofluvial terraces and low escarpments (EBA, 2009). The colluvium is typically a sand to sand and gravel, is angular, generally free draining and often unsaturated.

The valley bottoms have significant thicknesses of fluvial and glaciofluvial outwash deposits. In the lower regions of Dome Creek and other valleys, these deposits were eroded creating the terrace deposits described in Klohn (1988). The fluvial and glacialfluvial material ranges from a fine sand near surface with visible near horizontal laminations to coarser zones of sand and gravel, which may be present at depth. In localized areas at depth in the Dome Creek valley, silt to silty clay and till has been encountered (Klohn, 1988). The till is a remnant from earlier glacial advances. A more detailed discussion of the subsurface conditions at specific project areas is included in subsequent sections of this report.

There are extensive glacial deposits including glaciofluvial sands and gravels, glaciolacustrine silt and morainal deposits that start about 25 km west of the site. However, no significant source of fine-grained material has been located within closer proximity to the site.

The sampling on the background soil samples on the McDade property was performed in the previous exploration program conducted in 1987. A total of 76 soil samples were collected and analyzed for metal element. Soil samples were taken from B and C soil horizons in 0.5 m to 4.0 m deep trenches. Average gold and silver contents were 4 ppb and 0.2 ppm, respectively. The average arsenic background soil content was 30 ppm. The analysis results on the background soil samples indicated that the anomalous results were identified in the soil samples with arsenic concentration ranging from 100 ppm (weakly anomalous) to 400 ppm (strongly anomalous) and gold contents from 25 ppb (weakly anomalous) to 100 ppb (strongly anomalous).

Environment Dynamic Inc. (EDI) conducted the Terrestrial and Aquatic Effect Study in 2006 (EDI, 2006). This study included the assessment on the soil samples from the Mount Nansen site and also samples from the mineralized control area, located approximately 1 to 2 km northwest from the site. Five soil samples from the controlled area were analyzed for metal parameters.

Metal results in these background soils were compared to the CSR guideline value. Arsenic and cadmium contents in some soil samples exceeded the CSR guideline value for those two parameters. Arsenic concentrations in these controlled soil samples ranged from <10 to 141 mg/kg with an average value of 43 mg/.kg. The CSR guideline value for arsenic is 20 mg/kg. Cadmium contents ranged from <0.5 to 3.5 mg/kg with an average value of 1.4 mg/kg. The CSR guideline for cadmium is 2 mg/kg.

4.5 Permafrost

In support of general site characterization and also to assess the likely ground temperatures in the future so as to understand the influence that freezing or thawing may have on the remediation work, a series of thermal assessments were completed as presented in Appendix B. The limited Mount Nansen temperature data indicate a current mean annual air temperature of -1.5^{o}C. Note that this is somewhat warmer than the values reported in original design documentation. Climate data from regional weather stations were compared to data for

Mount Nansen and then used to extend the local record. Both Dawson City and Carmacks have shown clear warming trends since the 1960s, although there has been cooling recorded in the last decade. Applying the regional trends to the Mount Nansen data suggests that the mean annual temperature at the site in the 1960s was about -4^{o}C. This means that some of the existing permafrost may be a relic of cooler historic temperatures. If current warmer temperatures are sustained in the future, permafrost may not develop in reclaimed areas.

There is limited ground temperature data available at Mount Nansen and what is available is generally within the disturbed footprint. Ground temperatures at the site were, therefore, estimated via modelling efforts that incorporated soil type, slope aspect, vegetation, and snow cover. Based on this assessment, several draft permafrost maps have been produced and included in Appendix B. The predictions are complicated because of the near zero temperatures typical of the site which are significantly influenced by the latent heat of water during freezing and thawing processes. The ground temperature values indicated in the map legends reflect estimated temperatures for long term steady state conditions. Current conditions likely have not yet reached these stabilized temperatures and, therefore, relict permafrost could be present in the ground as indicated in the legend although the predicted temperatures are greater than 0^{o}C. Additional field truthing of the “district” boundaries as shown on the maps and current ground temperatures may be worthwhile, depending on the sensitivity of remediation goals and the intended use of the maps. Understanding the permafrost regime in and around the disturbed areas is considered adequate to support design of remediation efforts. Ground temperatures in undisturbed areas may be useful to support characterization of baseline conditions and may help to calibrate thermal models and predictions; however, they are not expected to significantly alter any design decisions.

With a mean annual air temperature of -4.0^{o}C, permafrost conditions would be expected in most areas of the Mount Nansen site except in areas with steep south facing slopes (refer to the 1967 map in Appendix B). Under these conditions, permafrost would re-establish in disturbed areas. Much of the ground though would be expected to be just below 0^{o}C. This is generally consistent with drilling results from the 80s. With warmer temperatures like those recorded since 2005, a trend to warmer ground temperatures would be expected (refer to the 2013 map in Appendix B), but would take many decades to occur. Should that warming continue further, the mean annual air temperatures would rise above 0^{o}C and permafrost could eventually disappear from the site completely. Under long term current temperature conditions, the coldest ground temperatures would be expected in flat or terrace areas with fluvial deposits and sparse forest and north facing slopes. Such areas are found within Dome Creek. Permafrost with temperatures near but below 0^{o}C would also be locally expected in the north facing and moderately sloped south facing slopes of Dome and Pony Creeks, depending on vegetation and snow cover. Permafrost may be absent in east and west facing slopes and steep south slopes.

4.6 Seismicity

Several seismic hazard assessments of the Mount Nansen site have been completed in support of dam safety assessments and assessment of various closure alternatives. Given that the current reclamation scope does not include a dam or any high consequence structures, reliance on previous assessments and current National Building Code (NBC) data were considered sufficient to define the seismicity of the site.

Probabilistic and deterministic studies were completed by the Pacific Geo-Science Center in 2000 (EBA, 2002, Appendix F). Because the assessment was being used to support assessment of a dam which was considered to have a high to very high consequence rating, per the 1999 Canadian Dam Association Guidelines that were applicable at the time, the maximum credible earthquake and the 10,000 year return period earthquake properties were evaluated. The major faults identified as significant seismic threats to Mount Nansen were the Fairweather, Denali and Tintina faults, located 254 km southwest, 125 km southwest and 132 km northeast of the site, respectively. The deterministic analyses indicated a maximum peak ground acceleration (PGA) of 0.13 g associated with a magnitude 8.7 earthquake on the Fairweather fault. The probabilistic analysis which followed the standard procedure of the Geological Survey of Canada's seismic risk calculation routine resulted in a PGA of 0.27 for a return period of 1:10,000 years and was associated with a local magnitude 7.5 seismic event, although the basis for the local earthquake magnitude value is unclear.

As a comparison to the previous work, and in consideration of the lower consequence, non-dam structures that will exist onsite post reclamation, the seismic hazard for the Mount Nansen Site from the current 2010 NBC information was reviewed (Natural Resources Canada, 2013). The comparison is shown in Table 3. The earthquake return period that should be used for design will depend on the scenario being analyzed.

Table 3: Probabilistic Seismic Hazard Analysis

Return Period		10,000	2,475	1,000	475	200	100
Probability of exceedance per annum			0.000404	0.001	0.0021	0.005	0.01
Probability of exceedance in 50 years (%)		0.5	2	5	10	22	40
2000 probabilistic assessment	PGA (g)[1]	0.27	0.17	0.119	0.096	0.075	0.058
	PHG (m/s)[1]	0.61	0.4	0.265	0.218	0.164	0.127
2010 Hazard assessment calculator for National Building Code of Canada	PGA (g)		0.11	0.079	0.06		0.034
	Sa(0.2) (g)		0.214	0.147	0.11		0.06
	Sa(0.5) (g)		0.138	0.102	0.079		0.044
	Sa(1.0) (g)		0.094	0.069	0.052		0.028
	Sa(2.0) (g)		0.056	0.042	0.032		0.017

Note: [1] Values for the 2,475 year return period earthquake are read from the graph provided in the 2000 assessment.

4.7 Terrain Hazards

Based on a general site reconnaissance and air photo review of the area excluding the Open Pit, there are no indications of existing large scale deep seated landslides at the Mount Nansen site. There are some areas where solufluction processes are evident on some of the hillslopes

and two areas northwest and west of the site, respectively, where there is evidence of local landslide activity as indicated on the terrain map. There are also some indications of localized surface erosion and rilling evident in some parts of the site where trenching has disrupted the natural pattern of surface water flow. However, none of these features appear likely to generate a large volume of debris or to pose significant risk to the main project areas. Additional disturbance of the ground, particularly in areas of marginally stable permafrost could, however, trigger further surface erosion. Equipment access and remediation of existing disturbed areas will, therefore, require consideration of this, in particular, for any work completed in the valleys.

The north facing slopes of the Dome Creek valley in the vicinity of the tailings dam and deposits are likely to be very sensitive to surficial thermal disturbance of the surface vegetation cover. Compression of the cover, or removal could potentially result in terrain instability due to thaw of surficial organic rich, potentially higher ice content soils under the vegetative cover. Tying-in slope reclamation works in disturbed areas with upslope natural terrain elements will require considerable care.

Generally, the slopes within the OIC boundary are not high or steep enough to generate a significant avalanche hazard. One potential exception to this is the slope immediately above the Pony Creek Adit. This slope above the adit has a steep gradient with a northeast aspect and thin vegetation cover, and is generally on the leeward side of the dominant wind direction. This geometry could cause a cornice or wind slab to build up creating a localized minor avalanche hazard.

5.0 SITE CLIMATE AND HYDROLOGY

5.1 Purpose and Objectives

The purpose of the hydrometeorology site characterization for the Mount Nansen Remediation Project is to estimate parameters that are representative of the site conditions. The hydrometeorology parameters will be used as inputs for engineering designs and environmental assessment.

This hydrometeorology site characterization focuses on three parameters: precipitation, surface water flow and pond evaporation. The objective of the precipitation analysis was to estimate the following parameters for the Mount Nansen site:

- monthly average precipitation and percentage distribution;
- annual average and annual precipitation for the different return periods; and
- peak short-term duration storms for the following return periods: 1 in 2-year, 1 in 5-year, 1 in 10-year, 1 in 25-year, 1 in 50-year, 1 in 100-year, 1 in 200-year and 1 in 1,000-year.

The surface flow analysis was performed with the objective of estimating the following parameters for Dome, Pony, Back and Victoria Creeks:

- monthly and annual flow;
- distribution of monthly flow; and
- typical hydrographs.

For evaporation analysis, only the average monthly was evaluated.

5.2 Previous Hydrometeorology Studies

This section presents the review of hydrometeorology parameters which have been estimated for the site from previous studies. Prior to presenting the previous parameters of Mount Nansen, the regional hydrometeorological setting of Mount Nansen is presented.

5.2.1 Regional Hydrometeorological Setting of Mount Nansen

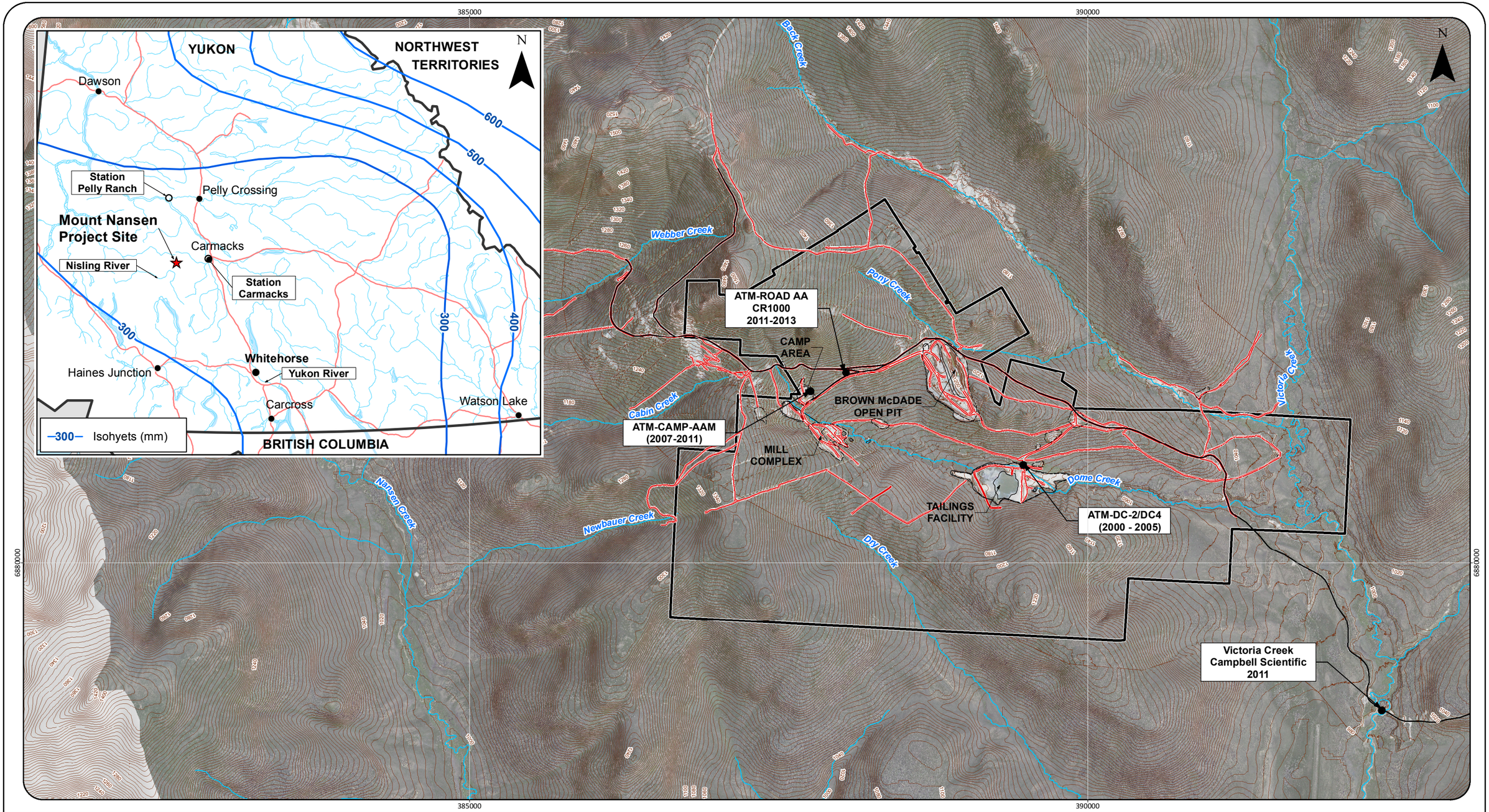
Figure 4 presents regional isohyets in the vicinity of Mount Nansen, developed by Environment Canada (1978). The Project site falls in an area with less variability of precipitation and with average annual precipitation of approximately 300 mm.

The Mount Nansen site is drained by Dome Creek to the south and Pony Creek to the north; both creeks flow east as shown in Figure 5. Pony Creek discharges into Back Creek which is a tributary of Victoria Creek. Dome Creek is also a tributary of Victoria Creek. Victoria Creek flows south into the Nisling River, which flows west into the White River (see Figure 5). The White River flows north into the Yukon River, which flows northwest into Alaska, then into the Bering Sea.

5.2.2 Precipitation

Previous Average Monthly and Annual Precipitation

Available previous monthly average precipitation for the Mount Nansen site was first estimated by Higgs (1994). Higgs used data from Carmacks to estimate monthly average precipitation for Mount Nansen as presented in Table 4. Average monthly rainfall for the site was estimated by Gartner Lee (2004) and Gomm Engineering (2011) also presented in Table 4. Both Gartner Lee and Gomm Engineering used Mount Nansen site data to estimate average monthly rainfall.



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

- Order in Council Boundary
- Contour (5 m)
- Disturbed Area
- Roads
- Streams
- Weather Stations

Associated Engineering — GLOBAL PERSPECTIVE. LOCAL FOCUS.

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Yukon Energy, Mines and Resources
Assessment and Abandoned Mines

MOUNT NANSEN REMEDIATION PROJECT
Figure 4

SITE CHARACTERIZATION REPORT

ISOHYETS AND LOCATION OF WEATHER STATIONS

Scale 1:30,000
Metres

0 500 1,000

March 18, 2014

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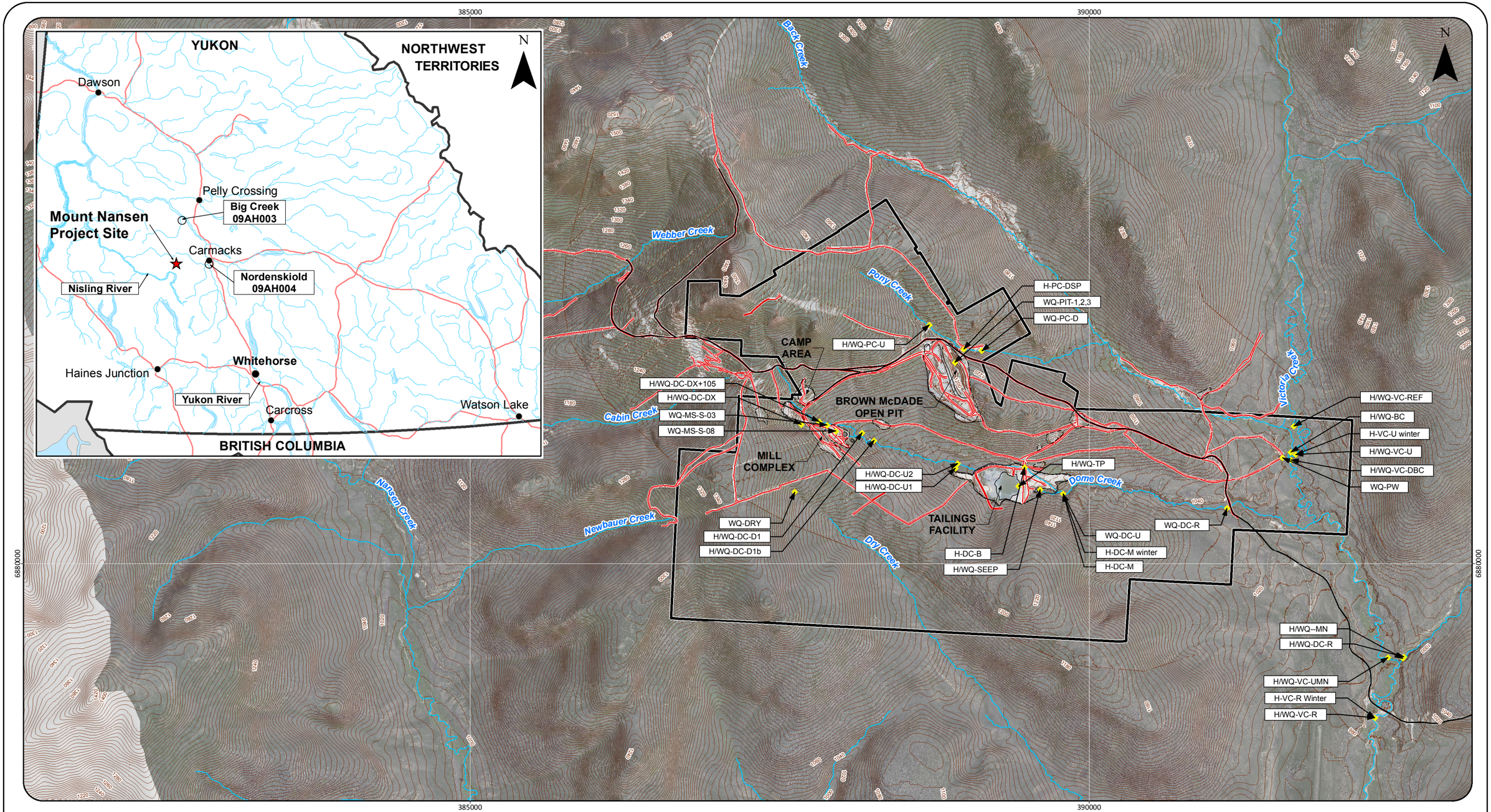

Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

- Order in Council Boundary
- Contour (5 m)
- Disturbed Area
- Roads
- Streams
- Hydrometric and/or Water Quality Stations

Associated Engineering — Global Perspective. Local Focus.

amec

Yukon Energy, Mines and Resources — Assessment and Abandoned Mines

MOUNT NANSEN REMEDIATION PROJECT

Figure 5

SITE CHARACTERIZATION REPORT

HYDROLOGICAL SETTING
REGIONAL HYDROMETRIC STATIONS
AND WATER QUALITY STATIONS

Scale 1:30,000
Metres

0 500 1,000

March 18, 2014

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Table 4: Previous Monthly Average Precipitation for Mount Nansen

Month	Higgs (1994) Precipitation Carmacks Data (1964 - 1991) (mm)	Gartner Lee (2004) Rainfall Mount Nansen 2000 - 2003 (mm)	Gomm (2011) Rainfall Mount Nansen 2000 - 2006 (mm)
January	17.5	0	0
February	12	0	0
March	6.8	0.2	0
April	6.6	1.8	46.1
May	19.6	24.3	34.1
June	33.7	37.2	68
July	53.8	60.3	61
August	38.5	47	38
September	30	33.5	13
October	18.7	6.5	0
November	17.9	0.3	0
December	14.9	0	0
Total	**270**	**211.1**	**260**

An average annual precipitation of 270 mm was estimated by Higgs (1994) by summing up average monthly precipitation in Table 4. Although snowfall was also measured at Mount Nansen in 2000 to 2005, Gartner Lee (2004) and Gomm (2011) only estimated monthly rainfall (April to October), hence annual precipitation was not estimated.

Previous Monthly and Annual Rainfall for Different Return Period

Table 5 presents the monthly and annual rainfall for different return periods for the Mount Nansen site from the various reports.

Table 5: Previous Monthly and Annual Rainfall for Different Return Periods

Month	Higgs (1994)/ Klohn-Crippen (1995)		Klohn-Crippen (1995)/ BYG (1995, 1998)		Higgs (1994)/ BYG (1995)		Gartner Lee (2004)					Gomm (2011)	
	10-Year Return Period Dry Year (mm)	200-Year Return Period Wet Year (mm)	10-Year Return Period Dry Year (mm)	200-Year Return Period Wet Year (mm)	200 Year Wet Year (mm)	10 Year Dry Year (mm)	5-Year Return Period (mm)	10-Year Return Period (mm)	20 - Year Return Period (mm)	50 - Year Return Period (mm)	100 - Year Return Period (mm)	Dry Year (mm)	Wet Year (mm)
January	14.0	25.9	13.0	26.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
February	10.0	18.5	8.9	18.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
March	8.0	14.8	5.0	10.3	0.0	0.0	0.2	0.3	0.3	0.3	0.3		
April	6.0	11.1	4.9	10.0	0.0	0.0	2.2	2.4	2.7	3.0	3.2	57.0	63.3
May	12.0	22.2	14.5	29.8	166.5	90.0	29.2	32.8	35.9	40.0	42.8	31.4	61.9
June	30.0	55.5	25.0	51.2	55.5	30.0	44.8	50.2	55.0	61.2	65.5	31.1	47.0
July	34.0	62.9	39.9	81.7	62.9	34.0	72.6	81.4	89.3	99.3	106.2	46.9	88.0
August	26.0	48.1	28.5	58.5	48.1	26.0	56.6	63.4	69.6	77.4	82.8	7.9	117.0
September	20.0	37.0	22.2	45.6	37.0	20.0	40.3	45.1	49.5	55.1	58.9	0.5	85.0
October	14.0	25.9	13.9	28.4	0.0	0.0	7.9	8.8	9.7	10.7	11.5	5.2	10.0
November	14.0	25.9	13.2	27.2	0.0	0.0	0.4	0.5	0.5	0.6	0.6		
December	12.0	22.2	11.0	22.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	200.0	370.0	200.0	410.0	370.0	200.0	254.2	284.9	312.5	347.6	371.8	180.0	472.2

Previous Short-term Extreme Storm Events

Short-term extreme storm events were estimated by Klohn-Crippen (1995) for Mount Nansen using Carmacks data as presented in Table 6. The return period of the storm events include 1:20 year, 1:200 year and the probable maximum precipitation (PMP).

Table 6: Previous Short-Term Extreme Storm Events

Duration	Klohn-Crippen (1995)/BYG (1995, 1998)		
	Rainfall (mm)		
	Return Period 1:20	Return Period 1:200	PMP
5 minutes	8.8	12.9	22.1
10 minutes	12	17.8	41.2
15 minutes	14.3	21.2	48.1
30 minutes	16.8	24.1	57.8
1 hour	18.8	26.9	86.1
2 hours	21.7	30	101
6 hours	26	35.5	124
12 hours	31.9	44	146
24 hours	35.7	49.2	170

Snow Course Studies

In addition to precipitation, snow course data was collected from 2000 to 2005 and in 2010 and 2011. Table 7 presents snow water equivalent (SWE) at the end of March from 2000 to 2005. In 2011 and 2012, snow course measurements were conducted at several locations at Mount Nansen as presented in Table 8. End of March SWE for different return periods by Gartner Lee (2004) is presented Table 9.

Table 7: Snow Water Equivalent (SWE) at the End of March (2000 to 2005)

Year	Gartner Lee (2006)	
	Depth (cm)	SWE (cm)
2000	38	6.8
2001	36	5.2
2002	45	7.1
2003	31	5.0
2004	n/a	10.5
2005	41	7.1

Table 8: Monthly SWE for 2010 and 2011

SC ID	Elevation (m)	EDI (2012)							
		Average SWE (cm)							
		Nov	Dec	Jan	Feb	Mar	Apr	Apr Mid	May
SC-DC-01	1015	2.3	6.3	8.4	8.1	7.5	18.5	15	7
SC-DC-02	1022	1.9	5.8	5.5	6.1	9.8	11.5	6.4	0
SC-DC-03	1034	2.4		7.4	8.1	10.2	12.2	9.4	11.5
SC-DC-04	1044	1.9		7.9	10.2	10	14	11.5	7
SC-DC-05	1068			8.5	8.4	8	15.6	16.1	9
SC-DC-06	1074	3.9	7.8	8.9	9.9	9.3	12.9	11	5
SC-DC-07	1104	3.1	6.5	8.4	8.6	10.3	14.1	12.1	7.6
SC-DC-08	1118	3	4.5	7.5	11.9	10.5	11.8	11.9	8.5
SC-DC-09	1181		7.5	8.4	8.8	10.5	13.1	10.5	5.5
SC-DC-10	1225		8	9.9	12.5	12.8	17.6	15.4	13.1
SC-NF-1	1117		8	7.6	12.4	11.4	14.2	10.9	11.6
SC-NF-2	1232		6.3	8.3	9.4	12.4	13.7	15.9	14.5
SC-SF-1	1134			7.6	9.2	10	9.6	0	0
SC-SF-2	1186		6.4	9	10.4	10	11.1	10.5	1.5
SC-WR-1	1191	0.3	6	3.3	5.3	2.3	3.8	0	0
SC-WR-2	1212	2.8	9.3	14.2	21.7	14.3	16.7	17.5	0
SC-WR-3	1214	3.3	5	5.2	7.3	6.7	10.2	6	0
SC-MET	1248		8.3	9.3	9.9	12.3	14.3	12	5.9
SC-AIR	986					10.5		10	
Average		**2.9**	**7.1**	**8.3**	**9.9**	**10.8**	**13.3**	**10.9**	**6**

Table 9: Estimated End of March SWE for Different Return Periods

Gartner Lee (2004), R-09	
Return Period (years)	**Snow Water Equivalent (cm)**
Mean Annual	7.3
5	8.7
10	9.7
20	10.6
50	11.8
50	12.6

5.2.3 Previous Evaporation

Average monthly and annual evaporation data for Mount Nansen from previous reports are presented in Table 10. Earlier values of evaporation, estimated in the reports in the 1990s are higher with an annual value of 454 mm; the latest value estimated in 2011 of 369 mm is lower. Higgs (1994) considered Pelly Ranch evaporation records as representative of the Mount Nansen area. LORAX (2011) took into account the differences in elevations between Pelly Ranch and Mount Nansen, reducing Pelly Ranch data by 19% (evaporation reduces by 10% for every increase of 350 m in elevation (Coulson et al., 1998). Evaporation has not been measured at any of the Mount Nansen weather stations.

Table 10: Previous Estimated Monthly and Annual Average Evaporation for Mount Nansen Site

Month	Higgs (1994, 1995); Klohn-Crippen (1995)/ BYG (1995, 1998) (mm)	LORAX (2011) (mm)
January	0	0
February	0	0
March	0	0
April	0	0
May	105	85
June	121	98
July	111	90
August	80	65
September	37	31
October	0	0
November	0	0
December	0	0
	454	369

Monthly evaporation for different return periods was also estimated by Gartner Lee (2004/2006) and is presented in Table 11. The average annual evaporation is similar to that estimated by LORAX (2011).

Table 11: Previous Estimated Monthly and Annual Average Evaporation for Different Return Periods (Gartner Lee, 2004, 2006)

Month	Annual (mm)	5-Year Return Period (mm)	10-Year Return Period (mm)	20 -Year Return Period (mm)	50 -Year Return Period (mm)	100 -Year Return Period (mm)
January						
February						
March						
April						
May	85	89	92	94	96	98
June	98	103	106	108	111	113
July	90	95	98	100	103	104
August	65	68	70	72	74	75
September	31	32	33	34	35	35
October						
November						
December						
Total	**369**	**387**	**399**	**408**	**419**	**425**

5.2.4 Surface Water Flow

Historical Measured Flow Data

Table 12 presents historical measured flow data for Victoria and Dome Creeks. Flow was manually measured on dates provided in the table in 1988 and 1994.

Table 12: Historical Measured Flow Data

Creek	Norecol Env. (1989) (R15), Higgs (1994) (R19)			
	Drainage Area (km^2)	Date	m^3/s	$L/s/km^2$
Victoria Upstream confluence at Minnesota Creek	82	May 26, 1988	0.976	11.9
		June 23, 1988	0.211	2.57
		September 22, 1988	0.277	3.38
Dome Upstream confluence at Victoria Creek	4.86	May 26, 1988	0.0169	3.48
		May 27, 1988	0.0153	3.15
		May 29, 1988	0.035	7.2
		June 2, 1988	0.0279	5.74
		June 12, 1988	0.0155	3.19
		July 4, 1988	0.0528	10.9
		August 4, 1988	0.0744	15.3
		September 22, 1988	0.0131	2.7
		September 11, 1994	0.00536	1.1
		September 12, 1994	0.0082	1.69

Table 13 presents previous monthly flow distribution of Victoria Creek, by Gomm Eng. (2011). The flow distribution is based on average flow measurements at the Nordenskiold River Water Survey Gauging Station shown in Figure 5.

Table 13: Previous Monthly Flow Distribution – Victoria Creek

Month	Gomm (2011)
	Monthly Flow Distribution (%)
January	1.2
February	0.6
March	0.7
April	5
May	25.9
June	18.7
July	12.8
August	11.3
September	11.2
October	7.2
November	3.4
December	2

Previous Typical Hydrographs

Previous typical hydrographs for Dome and Pony Creeks were evaluated by AECOM (2010) as presented in Figure 6 to Figure 10. The hydrographs cover the 2010 open water season from May to September and also present rainfall for the concurrent period.

Peak Flow Data

Peak flows for the Dome Creek diversion channel and the tailings storage facility estimated by various studies for various return periods are presented in Table 14.

Table 14: Previously Estimated Monthly Peak Flow

	Klohn-Crippen (1994, 1995), BYG (1995)	BKH (2001), EBA (2002, 2003)	Klohn-Crippen (1995)	AECOM (2010)
	Dome Creek Diversion Channel		Tailings Pond (without diversion)	
	2.26 (km^2) (1-hr event) (m^3/s)	3.1 (km^2) (m^3/s)	2.76 (km^2) (m^3/s)	3.3 (km^2) (6-hr-event) (m^3/s)
1 in 20 year	6.4	1.2		
1 in 200 year	9.1	3	11.1	
1 in 1,000 year				4
1 in 10,000 year				4.8
PMF			34	12.5

BK Hydrological Services (2001) concluded that the flood flows predicted by Klohn-Crippen (1995) for the diversion channel of 6.4 m^3/s (1 in 20 year) and 9.1 m^3/s (1 in 200 year) were excessive. BKH revised the design flows for the diversion channel to 1.2 m^3/s (1 in 20-year) and 3.0 m^3/s (1 in 200 year). Worley Parsons (2013), as part of the dam safety review, conducted preliminary hydrological modelling and concluded that the peak flow results were similar to those predicted by BKH and subsequently adopted by EBA (2002).

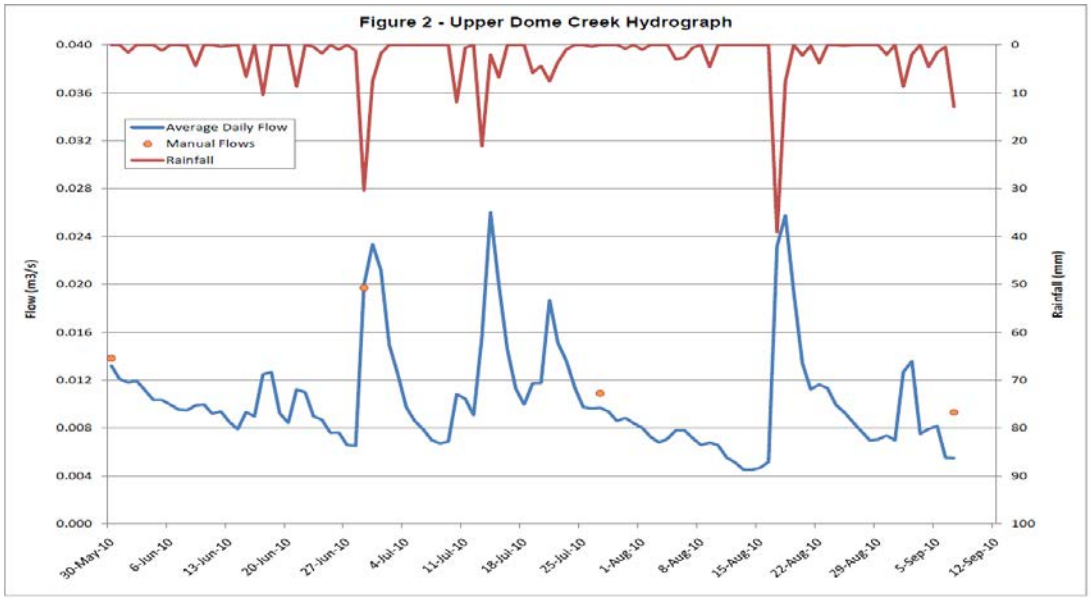


Figure 6: Upper Dome Creek Hydrograph - 2010

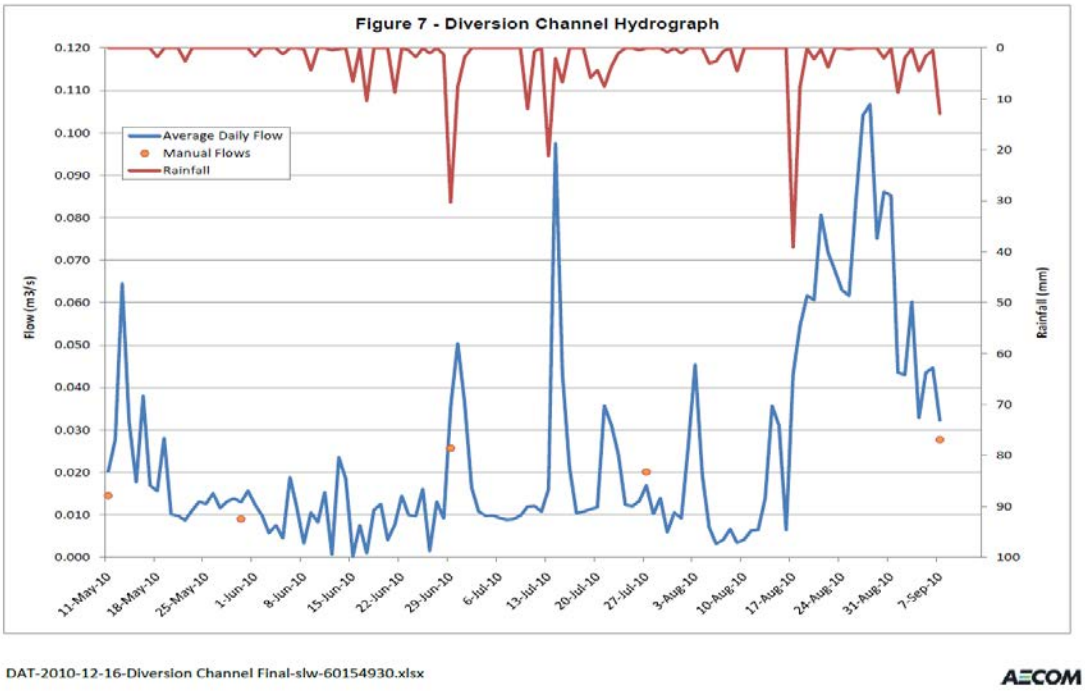


Figure 7: Dome Creek Diversion Channel Hydrograph - 2010

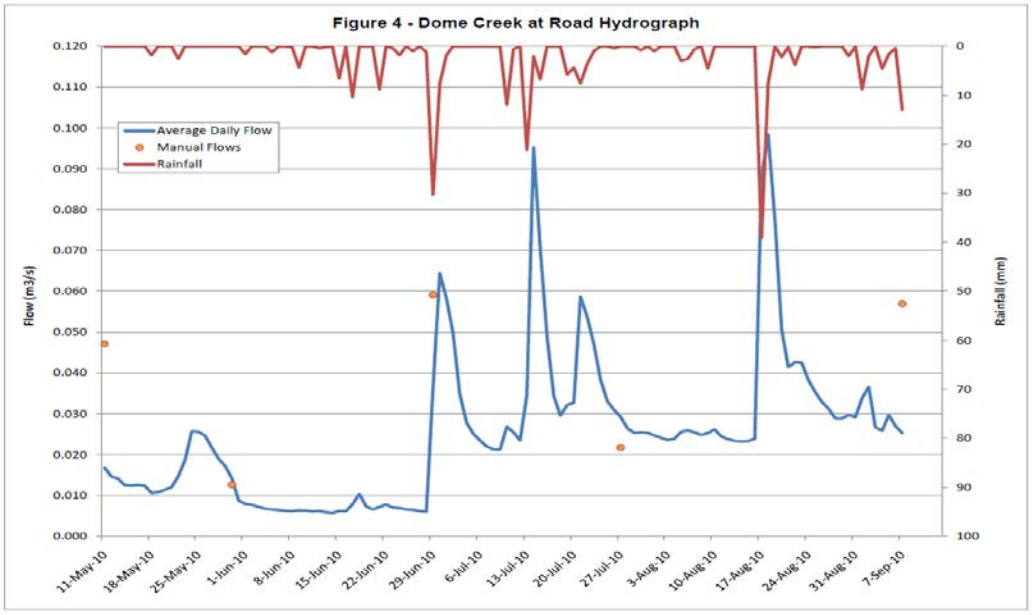


Figure 8: Dome Creek Diversion Channel Hydrograph - 2010

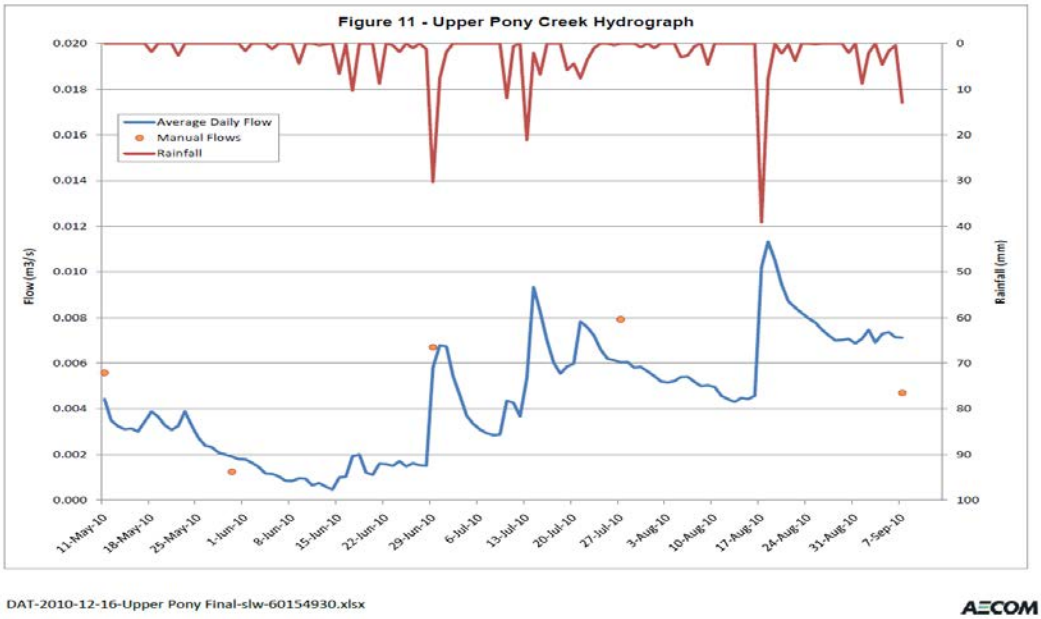


Figure 9: Upper Pony Creek Hydrograph - 2010

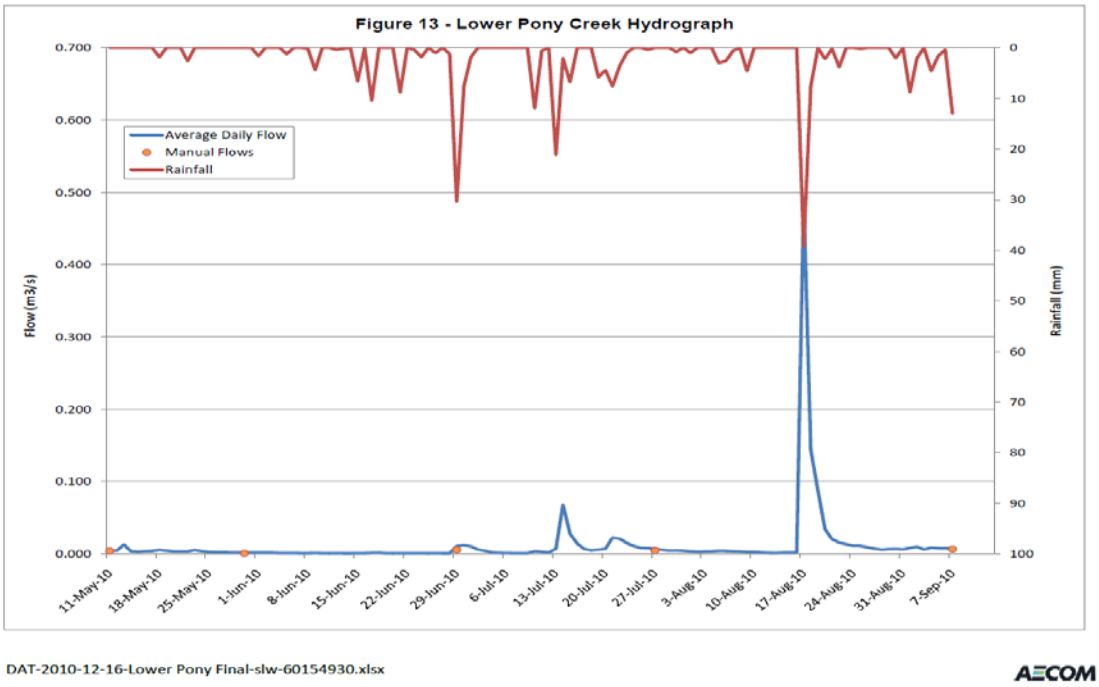


Figure 10: Lower Pony Creek Hydrograph - 2010

5.3 Precipitation Data Analysis

5.3.1 Available Data

The main sources of precipitation data relevant for hydrometeorology characterization for Mount Nansen are:

- Site Weather Station;
- Regional Weather Stations; and
- previous site studies (discussed in Section 5.2).

Site Weather Station Data

Site records indicate that three different weather stations have been installed and used for collecting data at Mount Nansen, including the current weather station. The first weather station operated from 2000 to 2005. The second weather station operated from 2007 to 2011. The current weather station was installed in 2011. Details of the three weather stations are presented in Table 15. Figure 4 shows the locations of the three weather stations at Mount Nansen.

Table 15: Details of Mount Nansen Weather Stations

Period of Record	Station Make	Data Interval	Latitude	Longitude	Elevation (m)[1]
2000-2005	Wx Weather station 2000-2005	Daily	62.04	-137.11°	-
2007-2011	HOBO	Hourly	-	-	-
2011-Current	Campbell Scientific	Hourly	62.05	-137.13	1265

Regional Precipitation Data

Regional weather stations relevant for Mount Nansen precipitation data analysis were selected based on the following criteria:

- within similar isohyets zone as the Mount Nansen or with similar annual precipitation (Figure 4);
- long periods of record;
- overlapping periods of record with the site weather stations; and
- stations that are still operational.

Based on the above criteria, the Carmacks and Pelly Ranch weather stations were found to be suitable sources for precipitation analysis for establishing parameters for the Mount Nansen Project. Details of the Carmacks and Pelly Ranch stations are presented in Table 16.

Table 16: Relevant Regional Weather Stations

Station	Province/ State	Distance from Mount Nansen Site (km)	Data Interval	Period of Record	Years of Data Available	Latitude	Longitude	Elevation (m)	Average Annual Precip (mm)
Regional Stations (Environment Canada)									
Carmacks	Yukon	60 km East	Daily	1964-2007	46	62°06'00.000"N	136°18'00.000"W	524.9	282
Pelly Ranch	Yukon	80 km North	Daily	1952-2013	62	62°49'00.000"N	137°22'00.000"W	454.2	310

Note: Average precipitation for Carmacks calculated from raw data 1963 to 2007, for Pelly Ranch 1971 to 2000 (Canadian Climate Normals)

Completeness of Available Data

Table 17 assesses the completeness of data collected at Mount Nansen, Carmacks and Pelly Ranch weather stations over the overlapping period of operation from 2000 to present.

[1] Elevation references are in metres above sea level (masl), unless otherwise specified.

Table 17: Completeness of Daily Precipitation Data Collected at Mount Nansen Weather Stations

Station/Period	Mount Nansen	Carmacks	Pelly Ranch
2000	Complete Year	Complete Year	Jan. 12 – Dec. 31
2001	Complete Year	Complete Year	Complete Year
2002	Complete Year	Complete Year	Complete Year
2003	Complete Year	Complete Year	Complete Year
2004	Complete Year	Complete Year	Complete Year
2005	Complete Year	Complete Year	Complete Year
2006	Complete Year	Jan. 1 – June 30	
2007	Apr. 10 – Dec. 31	Jan. 1 – Feb. 28	Jan. 1 – Oct. 12; Oct. 14 – Dec. 31
2008	Jan. 1 – Oct. 2	No data	Jan. 1 – Jan. 28; Feb. 1 – Feb. 5; Feb. 10 – Feb. 28; Mar. 1 – July 4; July 6 – Oct. 31; Dec. 1 – Dec. 31
2009	June 18 – Dec. 31	Note: Jan. 15 – Dec. 31	Jan. 1 – Jan. 7; Jan. 9 – Sep. 26; Sep. 27 – Dec. 31
2010	Complete Year	Complete Year	Jan. 1 – July 31
2011	Jan. 1 – June 3; Oct. 19 – Dec. 31	Complete Year	Feb. 1 – Dec. 31
2012	Jan. 1 – Dec. 21	Jan. 1 – Aug. 14	Jan. 1 – June 30; July 2 – Sep. 19; Sep. 21 – Oct. 31; Mar. 1 – July 4; Dec. 1 – Dec. 8; Dec. 11 – Dec. 17; Dec. 21 – Dec. 31
2013	Jan. 1 – Feb. 28 and Apr. 1 to Sept. 30	No data	Jan. 1 – Feb 15; Feb. 17 – Feb. 28; Apr. 1 – Aug. 31

5.3.2 Estimation Precipitation Parameters for Mount Nansen

In estimating precipitation parameters for Mount Nansen, a combination of data from Mount Nansen, Carmacks and Pelly Ranch weather stations were used. The record of Mount Nansen site data is too short (<15 years) to conduct independent statistical analyses and estimate site parameters. Data from Carmacks and Pelly Ranch were considered suitable to use in estimating parameters for Mount Nansen, because of reasonable correlations developed for the overlapping periods as shown in Table 18. In addition, the data record for Carmacks and Pelly Ranch is over a long period of time that provides statistically significant analyses for estimating parameters.

Table 18: Correlation Coefficient Between Mount Nansen; and Carmacks and Pelly Ranch

Years Complete Data	Carmacks/Mount Nansen	Pelly Ranch/Mount Nansen
2000	0.97	0.95
2002	0.96	0.95
2003	0.77	0.57
2004	0.76	0.32
2005	0.89	0.82
Average	**0.87**	**0.72**

Transposition Factors between Regional Station and Project

In order to use Carmacks and Pelly Ranch data at the Mount Nansen site, data were transferred using transposition factors. Transposition factors were estimated by calculating ratios of average data over the overlapping periods. Transposition factors are presented in Table 19. Transposition factors were calculated for snowfall, rainfall and precipitation.

Table 19: Transposition Factors of Between Mount Nansen and Carmacks and Pelly Ranch

Station	Transposition Factors		
	Rainfall	Snowfall	Precipitation
Carmacks	0.88	1.34	0.99
Pelly Ranch	0.88	1.81	1.10

Average Monthly and Annual Precipitation

The average monthly and annual representative precipitation data for Mount Nansen watershed were estimated using site data collected at Mount Nansen from 2000 to 2013. Where Mount Nansen data were missing over this period, Carmacks or Pelly Ranch data were used by applying transposition factors presented in Table 19. The resulting average monthly and annual precipitation and percentage distribution are presented in Table 20. Table 20 also presents long-term monthly and annual average data for Carmacks and Pelly Ranch.

Table 20: Mount Nansen Project Estimated Average Monthly and Annual Precipitation

Month	Mount Nansen	Carmacks	Pelly Ranch
January	11.9	17.5	18.9
February	6.3	11.7	14.4
March	9.1	8.1	10.8
April	15.9	6.4	11.1
May	23.0	22.5	25
June	55.2	34.7	38.2
July	65.6	53.7	55.2
August	47.4	40.5	39.5
September	36.1	30.8	29.8
October	18.0	20.5	24.8
November	10.8	19	23.4
December	11.2	16.5	19.3
Total	**310.6**	**281.9**	**310.3**

The currently estimated annual precipitation of 310.6 mm is higher than the previously estimated value of 270 (Higgs, 1994). The estimated value is within the expected regional value of 300 mm and is comparable to both Carmacks and Pelly Ranch as expected.

Annual Precipitation for Different Return Periods

In order to estimate annual precipitation for different return periods, the annual precipitation data for Carmacks from 1964 to 1984 were transposed to Mount Nansen. The data were then fitted to a statistical distribution using HYFRANPlus (Water Resources Publications, 2012). The data were found to fit a normal distribution. The wet and dry year values for annual precipitation for different return periods are presented in Table 21.

Table 21: Wet and Dry Annual Precipitation

	Return Period (years)	Mount Nansen
Wet Years	1000	646
	200	559
	100	522
	50	484
	20	434
	10	395
	5	355
Median	2	294
Dry years	5	249
	10	229
	20	215
	50	201
	100	192
	200	185
	1000	170

The estimated annual precipitation data for different return periods were higher than those previously estimated in Section 5.2.2. This is consistent with the higher average annual precipitation estimated in Section 5.2.2.

Short-term Extreme Storm Events

Short-term extreme storms for Mount Nansen were estimated through transposing the intensity duration frequency (IDF) relationship for Carmacks. The IDF for Carmacks was estimated by Environment Canada. A transposition factor of 0.77 was estimated by comparing annual daily peak rainfall between Mount Nansen and Carmacks as presented in Table 22. Although a transposition factor of 0.77 was calculated, to be conservative, a transposition factor of 0.99 (1.0) for precipitation presented in Table 20 was used for transposing short-term extreme storm events. This means that the short-term extreme storm events for Carmacks were adopted for Mount Nansen as presented in Table 23.

Table 22: Transposition Factors Between Mount Nansen and Carmacks Maximum Daily Rainfall

Year	Mount Nansen	Carmacks	Mount Nansen/ Carmacks
	Peak Daily Storm (mm)	Peak Daily Storm (mm)	Transposition Factor
2000	20	34	0.59
2002	19	19.4	0.98
2003	14	23	0.61
2004	19	25	0.76
2005	20	18.2	1.10
Average	**18**	**24**	**0.77**

Table 23: Short-term Extreme Storm Events for Mount Nansen

Duration	5 min	10 min	15 min	30 min	1 hr	2 hrs	6 hrs	12 hrs	24 hrs
Return Period	**(mm)**								
2	2.8	3.9	4.7	6.1	6.8	8.7	11.3	13.5	15.4
5	4.3	5.9	7.2	8.7	9.7	11.6	14.5	17.5	19.8
10	5.3	7.3	8.8	10.4	11.6	13.5	16.5	20.2	22.7
25	6.6	9	10.8	12.5	14	16	19.2	23.6	26.5
50	7.5	10.3	12.3	14.1	15.8	17.8	21.1	26.1	29.2
100	8.4	11.6	13.8	15.7	17.5	19.5	23.1	28.6	32
200	**9.4**	**12.8**	**15.1**	**17.3**	**19.2**	**21.4**	**25.1**	**31.1**	**34.6**
500	**10.6**	**14.4**	**17.1**	**19.3**	**21.5**	**23.8**	**27.7**	**34.4**	**38.2**
1000	**11.5**	**15.7**	**18.5**	**20.9**	**23.2**	**25.6**	**29.7**	**36.9**	**40.9**

The current short-term extreme storm events are lower than originally estimated by Klohn-Crippen (1995) as presented in Table 6.

5.4 Evaporation

Evaporation for the Mount Nansen site was estimated using regional data from Pelly Ranch as presented in Table 24. The data was adjusted for altitude and latitude. According to Coulson et al. (1998), evaporation rates decrease by approximately 10% for every 350 m of elevation increase. Evaporation also decreases by approximately 6% for each degree increase in latitude.

Table 24: Regional Monthly and Annual Lake Evaporation

Station	Pelly Ranch	Estimated for Mount Nansen
Month	**Lake Evaporation**	**Lake Evaporation**
January	0	0
February	0	0
March	0	0
April	0	0
May	109	90
June	120	100
July	112	93
August	81	67
September	39	32
October	0	0
November	0	0
December	0	0
Annual	**460**	**382**

The annual average evaporation is comparable to the value estimated by LORAX (2011); the only difference is that this current value is also adjusted for latitude.

5.5 Flow Data

The sources of data used for evaluating representative flow data for Mount Nansen site are:

- Mount Nansen flow data;
- regional hydrometric stations; and
- previous studies from Section 5.2.

5.5.1 Site Data

Site flow data for the Project have been collected for Mount Nansen from multiple flow stations as shown in Figure 5. Table 25 summarizes the stations where data have been collected onsite and the period of record.

Table 25: Mount Nansen Site Flow Monitoring Stations

Area	Station ID	Location	Longitude	Latitude	Drainage Area (km^2)
Pony Creek	H-PC-U	Upper Pony Creek	388709	6881930	0.84
	H-PC-DSP	Pony Creek Downstream of Pit	388986	6881734	1
Dome Creek	H-DC-DX	Dome Creek at DX	387674	6881127	0.2
	H-DCDX+105	Dome Creek at DX+105	387820	6881150	0.9
	H-DC-D1b	Dome Creek at D1b	388262	6881000	1.4
	H-DC-U1	Upper Dome Creek	388919	6880772	2.05
	H-DC-U2	Upper Dome Creek	388937	6880819	2.05
	H-DC-B	Diversion Channel at Bridge	389480	6880780	3.02
	H-DC-M	Middle Dome Creek	389788	6880565	3.26
	H-TP	Tailings Pond	389427	6880625	
	H-SEEP	Seepage Pond Outflow	389604	6880598	
	H-DC-R	Dome Creek at Road	392540	6879249	4.48
Back Creek	H-BC	Back Creek	391626	6880901	10.4
Minnesota Creek	H-MN	Minnesota Creek	392540	6879249	12.7
Victoria Creek	H-VC-REF	Victoria Creek Reference Site	391650	6881113	64
	H-VC-U	Upper Victoria Creek	391667	6880882	64.6
	H-VC-DBC	Victoria Creek Downstream of Back	391627	6880840	75
	H-VC-UMN	Victoria Creek Upstream of Minnesota Creek	392413	6879244	83.4
	H-VC-R	Victoria Creek at Road	392305	6878755	97.7

Of the flow data collected at Mount Nansen, digital (Excel tables) detailed hourly hydrograph data for 2011 were available for analysis. Data for April to June 2013 have been provided subsequently. For other years, point measurements are available digitally but the detailed hydrograph information is available only in graphical form or as hard copy or not available.

5.5.2 Regional Data

The closest regional flow monitoring stations to Mount Nansen are Nordenskiold River below Rowlinson Creek and Big Creek as shown in Figure 5. Table 26 presents details of these stations.

Table 26: Regional Flow Monitoring Stations

Station Name	WSC ID#	Drainage Area (km^2)	Latitude	Longitude	Period of Record	Current Status of the Station
Nordenskiold	09AH004	6,410	62°3’4”	136°16’49”	1982 - 2012	Active
Big Creek near the Mouth	09AH003	1,800	62°34’4”	137°0”34”	1974 - 2012	Active

5.5.3 Flow Data Analysis

Monthly average flow for Dome, Pony, Back, and Victoria Creeks; and Big Creek and Nordenskiold stations are presented in Table 27. Table 27 presents data in mm and $m^3/s/km^2$; both values represent yield of flow per unit area, making it easy to compare values from different catchment sizes. Of the Mount Nansen site flow data, Dome, Pony and Victoria, show very similar flow data. These three creeks are also very comparable to Big Creek flow data. Flow from Back Creek is generally higher than the other three creeks and flow in Nordenskiold is lower.

Table 27: Average Monthly and Annual Flows for Mount Nansen and Regional Stations - 2011

Location	Mount Nansen Runoff (mm)								Regional Runoff (mm)			
Station Name	Dome Creek (H-DC-R)		Pony Creek (H-PC-DSP)		Back Creek (H-BC)		Victoria Creek (H-VC-U)		Big Creek 09AH003		Nordenskiold 09AH004	
Drainage Area (km^2)	4.5		1		10.4		64.6		1,800		6410	
Year	mm	$m^3/s/km^2$	mm	$m^3/s/km^2$	mm	$m^3/s/km^2$	mm	$m^3/s/km^2$	mm	$m^3/s/km^2$	mm	$m3/s/km^2$
January									2	0.001	2	0.001
February									2	0.001	2	0.001
March									1	0.000	2	0.001
April									5	0.002	2	0.001
May									64	0.025	27	0.010
June	24	0.009	13	0.005	13	0.005	26	0.010	46	0.018	16	0.006
July	22	0.010	23	0.009	71	0.028	25	0.010	54	0.021	12	0.004
August	55	0.021			85	0.033	44	0.017	53	0.020	19	0.007
September	23	0.009	21	0.008	12	0.004	18	0.007	17	0.007	13	0.005
October			10	0.004	43	0.017	9	0.003	8	0.003	8	0.003
November							8	0.003	4	0.002	5	0.002
December							6	0.002	2	0.001	4	0.001
Annual										0.008	9	0.004

Note: 2011 data was used because at the time of the analysis, this was the only electronic flow data available

Daily hydrographs of Dome, Pony and Victoria Creeks and Big and Nordenskiold stations are compared in Figure 11 (Back Creek was not included in the daily hydrograph, because flow is significantly higher and to keep the graph simple).

Updated peak design flows for the site are presented in the “Mount Nansen Remediation Project 30% Design Phase Report”, AMEC (2014).

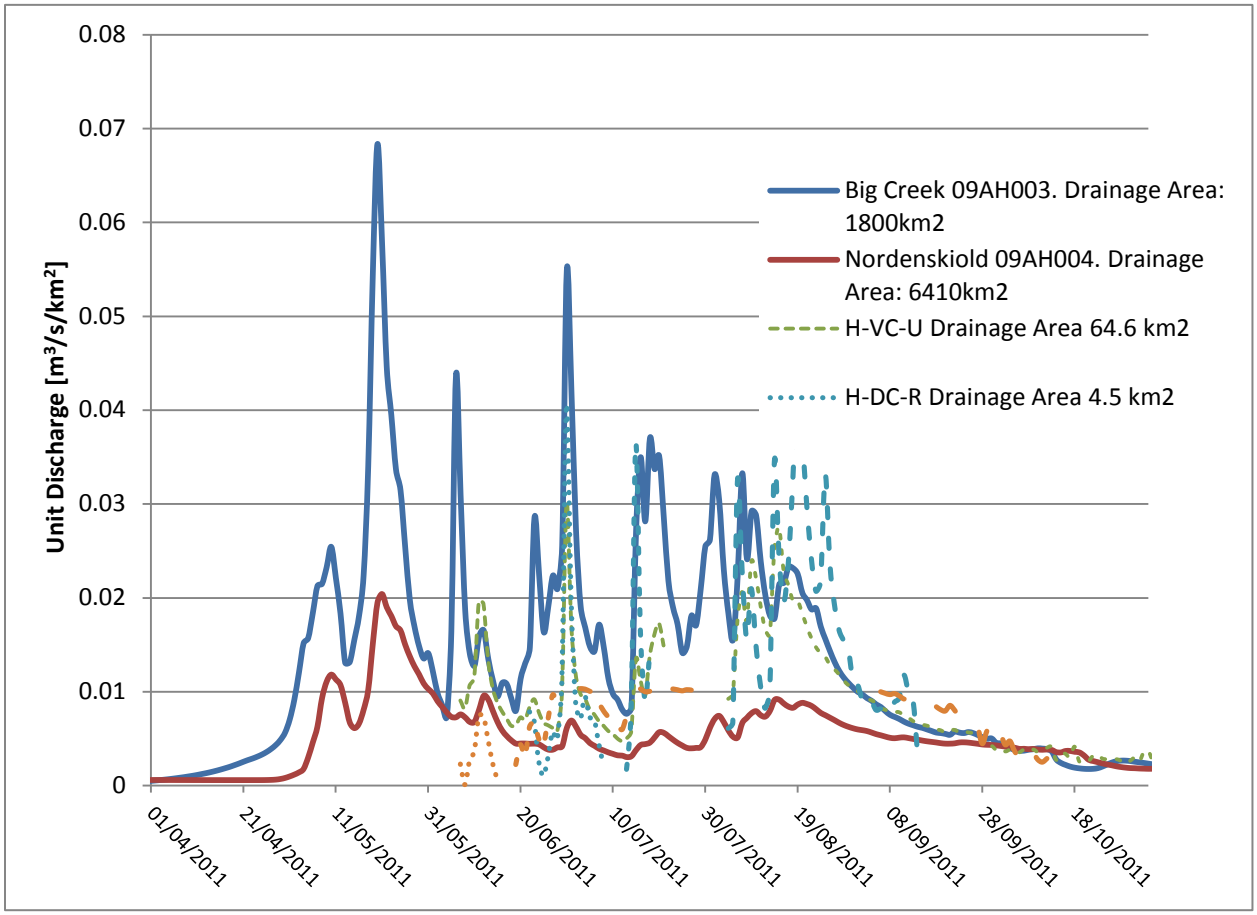


Figure 11: Typical Hydrograph of Mount Nansen and Regional Stations

6.0 HYDROGEOLOGICAL CONCEPTUAL MODEL

6.1 Pre-2013 Site Characterization Programs

Several site assessment programs, conducted between 2000 and 2009, have involved a component of hydrogeological characterization. For hydrogeological characterization purposes, the country rock at Mount Nansen had been previously documented (AECOM, 2010) to consist of four hydrogeological media types: overburden, shallow fractured rock, competent rock and tailings.

The pre-2013 field programs included the installation of shallow and intermediate depth groundwater monitor wells, the majority in 2007 and 2009, mostly to provide levels for shallow groundwater associated with Dome Creek, Pony Creek, the Mill and Tailings Pond areas. A small number of deeper monitor wells were installed into bedrock at locations in proximity to the north and northeast sides of the Open Pit, adjacent to the Mount Nansen Road. Two other bedrock monitor wells included one adjacent to the Pony Creek Adit entrance and one open borehole that was converted into a monitor well in the Open Pit floor.

6.2 Updated Hydrogeological Conceptual Model

The conceptual model developed over several years (AECOM, 2010) was reviewed and updated with the findings of the 2013 site investigation program, as follows.

1. Pony Creek - the September 2013 creek data suggests that, in its upper reaches, Pony Creek is either a slightly losing or gaining stream, as the amount of groundwater exchanged was very low. This was an end-of-season (September) determination and the amount of creek bed groundwater exchange is likely more pronounced when greater hydraulic heads are present during freshet and heavy rainfall. Surface water ponds, created by exploration trenches, likely increase infiltration to shallow groundwater.
2. Pony Creek adjacent to the Open Pit, is documented as losing stream water to shallow groundwater, some of which reports to the Open Pit via the north pit wall. A review of the hydrometric flow and level data for upper Pony Creek may quantify this north wall water component and any correlation between exploration trench ponding and seepage rates to the north wall.
3. In September 2013, the Pony Creek reach upstream of the confluence with Back Creek had the greatest gaining seepage, indicating it to be a significant discharge area for groundwater to surface water.
4. Open Pit rock faulting – several geological faults have been mapped as running through the Open Pit, extending north and south of the Open Pit footprint. These features have been described as a low conductive groundwater zones and barriers to flow and possibly also directing some water from Pony Creek into the pit. The 2013 vibrating wire piezometer temperature data indicate that permafrost is presently east and southeast of the Open Pit, as also verified by freeze-back observations of the groundwater monitoring wells constructed in the 2013 coreholes. Permafrost, therefore, appears to be the greater constraint against deep groundwater moving east and southeast from the Open Pit area.
5. Open Pit rock mass – has a hydraulic conductivity in the order of 10^{-7} m/s, as quantified by hydraulic packer testing of two coreholes into the Open Pit floor and east wall. This value agrees with documented analyses of rock mass permeability that used pond level changes versus time (Gartner Lee, 2007).
6. Open Pit pond groundwater exchange – the pond is documented as a possible perched water feature. From 2010 to 2013, climatic and pit pond levels and piezometric elevation data for the underlying rock mass shows the pond to be a surface water retention feature, with saturated hydraulic connection to the deep groundwater system, i.e. a leaky retention feature.
7. Open Pit climatic water balance – using precipitation, runoff, evaporation and pond level change data, calculated the rate of water exchange between the pond and groundwater and derived an average seepage rate out of the Open Pit to be 0.2 L/s (Gartner Lee, 2007) for pit pond data in 2002 and 2003. Using August 2010 to June 2013, inclusive, climatic and pit pond data, a similar average of 0.2 L/s was derived.
8. Open Pit wintertime pond level recession – the pond level data for August 2010 to June 2013, inclusive, included three wintertime pond level decline curves. These occur when climatic surface water inputs to the pond are not possible and Pony Creek north seepage inputs are negligible. As the pit pond does not freeze to bottom and water

continues to leave as groundwater, the latter was quantified in a more selective manner compared to water balance. This method quantified the pond water outflow rate as being in the 0.3 L/s to 0.5 L/s range, applicable all year.

9. Open Pit pond relationship to groundwater – the pond is concluded as behaving as a surface water retention feature, with saturated hydraulic connection to deep groundwater. Water leaves the pit pond, as groundwater, at an average rate of 0.3 L/s, all year, applicable to a pond elevation range between 1,181 m and 1,184 m, as recorded by the pond data logger from August 2010 to June 2013, inclusive.
10. Open Pit underlying rock piezometric elevation range – this corresponds to an equilibrium condition between the Open Pit pond and the surrounding and underlying deep groundwater, i.e. the long-term groundwater elevation in the Open Pit starting from an empty pit condition, with negligible climatic inputs and negligible Pony Creek water reporting to the north pit wall. An upper bound value for the piezometric range, within the deeper rock mass underlying the Open Pit, was derived from pond elevation wintertime minima of five winters, each exhibiting a linear decline. Elevation 1,181 m was interpreted as an indication of the upper bound value for the piezometric range, within the deeper rock mass underlying the Open Pit, applicable to the period of minimum pond storage in April-May each year. The vertical corehole constructed in the Open Pit floor gave a measured groundwater elevation of 1,166 m, in October 2013, shortly after completion of the well.
11. Open Pit underlying rock piezometric elevation range – pit pond level and corehole instrumentation data in 2014 will update the lower and upper bound piezometric range values of 1,166 m and 1,181 m, respectively, for the rock mass underlying the Open Pit. The implication of the upper bound value ‘daylighting’ between the pit base elevation of 1,174 m and the interim upper bound of 1,181 m, is that a hydraulic vertical gradient would exist, under which, groundwater would have the potential to enter the Open Pit.
12. Deep groundwater in the vicinity of the Open Pit appears to be recharging unconsolidated overburden in the central and lower reaches of Dome Creek and, to a lesser extent, the lower reaches of Pony Creek.
13. Deep groundwater discharging to shallow groundwater within Dome Creek and Pony Creek overburden, ultimately to surface water, is complex and currently influenced by relict permafrost surrounding the Open Pit.

The hydraulic relationship between the Open Pit pond and deep groundwater within underlying rock mass will continue to be refined in 2014, using the in-pit pond data logger and piezometric data from instrumentation and the monitoring well installed 50 m below the Open Pit floor. The refined piezometric elevation for the underlying rock mass is applicable to the current permafrost conditions.

A cross-section extending from Pony Creek, through the Open Pit, down to the Tailings Facility, is shown as Figure 12. Pony Creek is depicted adjacent to the Open Pit with a closed talik that currently limits groundwater-surface water exchange to when an active layer is absent. Permafrost is currently limiting water gains to Pony Creek upstream of the Open Pit for some distance uphill to the northwest. Adjacent to the Open Pit, Pony Creek appears to be a losing

stream with a component of creek water reporting to the Open Pit, observed in late fall as icing 'layers' on the north wall. This surface water contribution to the Open Pit will tend to increase in the long-term, as the closed talik degrades allowing Pony Creek water to recharge the overburden and deep groundwater adjacent to the Open Pit.

Figure 12 shows the Open Pit pond with its current pond level range of 1,181 m to 1,184 m that loses water as groundwater, at an average rate of 0.3 L/s, all year. The Open Pit is considered to act as a surface water retention feature, with a saturated hydraulic connection to underlying deep groundwater. The current equilibrium elevation between the Open Pit pond and deep groundwater, i.e. the pond level corresponding to zero climatic and north pit wall seepage inputs, is currently interpreted to be between elevation 1,166 m and 1,181 m. This equilibrium piezometric elevation may also vary seasonally and additional data in 2014 will help refine the lower bound and, possibly, the upper bound piezometric elevation. The latter is most discernible in years with a shorter freshet and dryer summer, as this minimizes pond storage and allows a longer period for declining pond levels in wintertime. If the upper bound piezometric value is concluded to be below elevation 1,175 m, the implication for water in the Open Pit as a pit pond, will be for that ponded water to always have a tendency to leave.

Bedrock in the order of 40 m depth in the area southwest of the Open Pit, that was the location for corehole CH-P-13-01, is under high artesian pressure. The nature of the confining layer was not determined although is speculated to have been the current presence of relict permafrost.

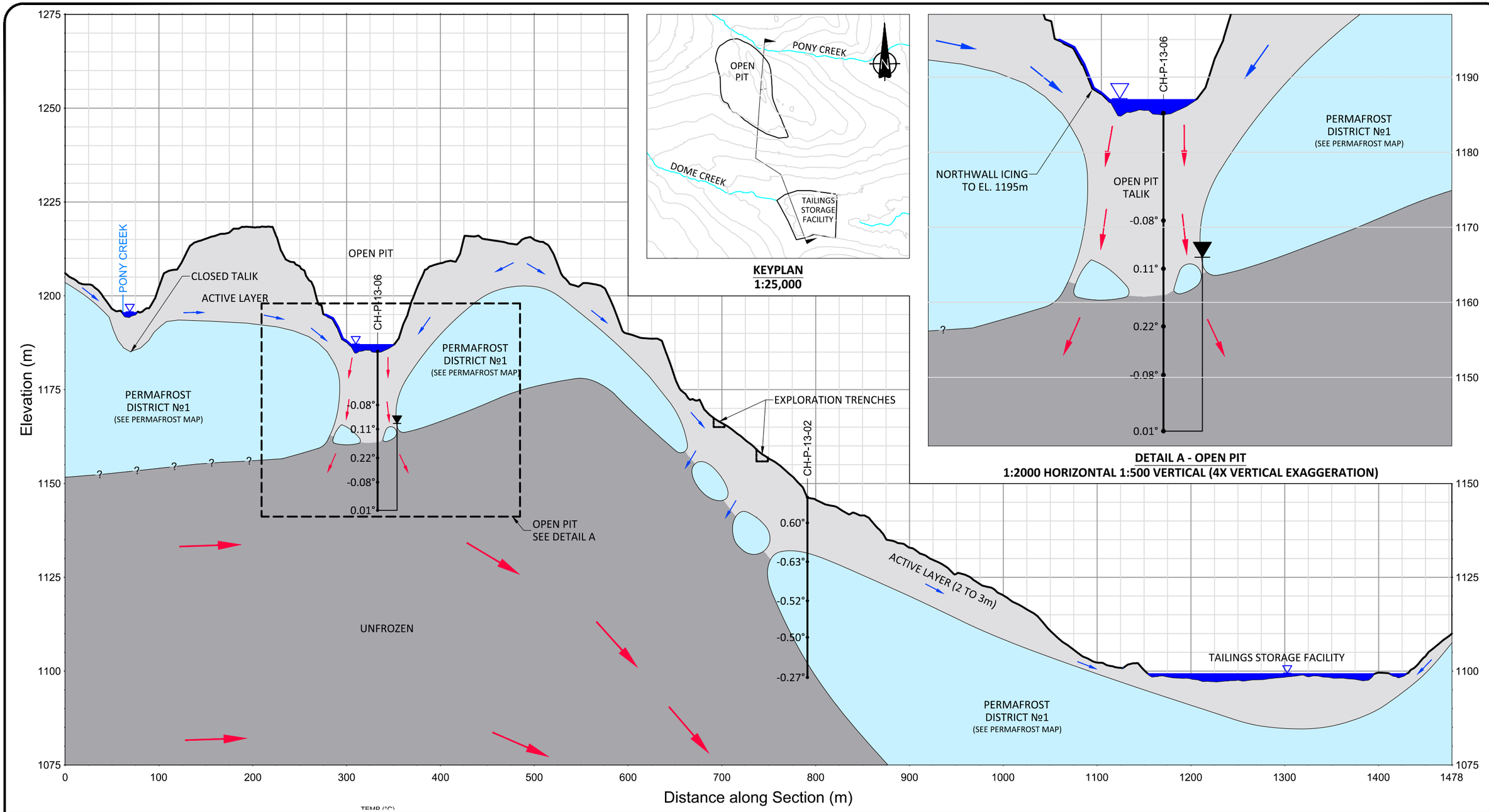
The long-term effects of permafrost degradation will change this relationship to a currently undefined extent, as the following groundwater-related changes can be expected:

- shallow and deep groundwater will merge at greater locations, notably between the Open Pit and Dome Creek and between the Open Pit and Pony Creek;
- groundwater divides and permafrost barriers will move and/or disappear;
- surface runoff volumes will change. A greater ratio of precipitation will infiltrate giving less runoff, adding to shallow and deep groundwater. This will likely change piezometric elevations, groundwater gradients and flow directions; and
- deep groundwater flow paths will be less constrained, with more discharge to surface water at higher elevations than currently. The occurrences of spring-like groundwater flows will tend to increase, as permafrost degrades.

6.3 2013 Hydrogeological Characterization

6.3.1 Corehole Logging

During September and October 2013, five coreholes were advanced vertically and one at 45° inclination to characterize the geology and hydrogeology of the rock mass in proximity to the Open Pit and the rock mass of the Open Pit floor. This was undertaken with five vertical coreholes to depths of 50 m below ground surface. One location inside the Open Pit was advanced at 45° inclination to intercept fracture zones associated with the fault, as mapped along the Open Pit east wall.



KEYPLAN
1:25,000

DETAIL A - OPEN PIT
1:2000 HORIZONTAL 1:500 VERTICAL (4X VERTICAL EXAGGERATION)

Data Source:
Datum: NAD 1983 CSRS UTM Zone 8N

LEGEND
ACTIVE LAYER FLOW
DEEP GROUNDWATER FLOW

Note: Groundwater and Ground Temperature data will be updated in 2014.

0m 40 80 120 160
1 : 4000 HORIZONTAL

0m 10 20 30 40
1 : 1000 VERTICAL (4x EXAGGERATION)

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MOUNT NANSEN REMEDIATION PROJECT
Figure 12

SITE CHARACTERIZATION REPORT

CONCEPTUAL HYDROGEOLOGICAL MODEL GROUNDWATER FLOW AND PERMAFROST

MARCH, 2014

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Corehole logs for the six coreholes cored in September 2013 are provided in the Site Investigation Data Report (AMEC, 2013). These logs give descriptions of the cored rock, including rock description and type, fracture type, infill type and thickness, rock strength and weathering. Signs of groundwater movement were also noted, where encountered, based on the presence of iron staining as an indication of oxygenated water circulating through the rock mass, originating from surface recharge.

From the corehole logs, it can be seen that the majority of the upper 30 to 40 m of bedrock surrounding the Open Pit is moderately to highly weathered. The logs also describe the rock as moderately to highly fractured, as quantified by low Solid Core Recovery (SCR) and Rock Quality Designation (RQD) values for the recovered core, per core run interval. These deep weathering profile observations are in agreement with the documented geological history of Mount Nansen, which escaped glaciation events that removed much of the weathered bedrock profile in other, lower-lying areas.

One major rock weakness zone, possibly a fault, was encountered at one corehole (CH-P-13-4), west of the Open Pit, between 35 to 37 m depth (elevation 1,190.5 to 1,188.5 m). This 2 metre thick zone was infilled with sand and soft clay that possessed a reddish-brown colour indicating oxygenated water movement to this depth in the host rock, at some time. This was the only logged encounter of a large-scale rock weakness zone. All other logs describe rock fracturing with fracture infill materials on a millimetre scale.

6.3.2 Corehole Hydraulic Conductivity Testing

A program of hydraulic testing of the rock mass was conducted during coring of the six coreholes in September 2013, to characterize the hydraulic conductivity of the rock mass. The testing involved single packer equipment, capable of both constant head and falling head type hydraulic conductivity testing, with a lower quantification threshold on the order of $1x10^{-9}$ m/s, i.e. the lowest measurable hydraulic conductivity with a corresponding 'no flow' comment in test logs.

A total of 32 packer tests were conducted involving sealing 5 m long test intervals of corehole wall. Water was either injected at a constant pressure to measure flow (constant head) or the packer equipment was filled and allowed to drain over time with the pressure change being measured (falling head). Packer testing was not possible in highly weathered and weaker rock portions of coreholes as the packer required competent and intact rock for a sufficient water pressure seal.

The results of the packer testing are summarized in Table 28, Coring Program - Hydraulic Conductivity Results Summary and also graphed versus depth in Figure 13, Coreholes - Hydraulic Conductivity Field Results Summary. The two coreholes advanced from the Open Pit floor (CH-P-13-5 and CH-P-13-6) were adjusted to a pre-mining elevation estimate to compare all hydraulic conductivity results to depth below surface grade, weathering profile. No obvious hydraulic conductivity spatial groupings or vertical trends are apparent in Figure 13.

Table HG1: Coring Program - Hydraulic Conductivity Results Summary

CH-P-13-02				CH-P-13-03				CH-P-13-04				CH-P-13-05				CH-P-13-06			
Depth (mbg)	**Permeability K (m/s)**	**$Log_{10}(K)$**	**Test Type (FH/CH)**	**Depth (mbg)**	**Permeability K (m/s)**	**$Log_{10}(K)$**	**Test Type (FH/CH)**	**Depth (mbg)**	**Permeability K (m/s)**	**$Log_{10}(K)$**	**Test Type (FH/CH)**	**Depth (mbg)**	**Permeability K (m/s)**	**$Log_{10}(K)$**	**Test Type (FH/CH)**	**Depth (mbg)**	**Permeability K (m/s)**	**$Log_{10}(K)$**	**Test Type (FH/CH)**
No test due to incompentent rock				7 - 13	1.20E-06	-5.92	Constant Head	10 - 16	-		No Flow	7 - 13	1.90E-07	-6.72	Constant Head	10 - 16	5.60E-08	-7.25	Falling Head
				13 - 19	1.30E-06	-5.89	Constant Head	16 - 22	-		No Flow	13 - 19	5.60E-08	-7.25	Falling Head	16 - 22	3.40E-08	-7.47	Falling Head
22 - 28	1.90E-08	-7.72	Falling head	19 - 25	9.90E-08	-7.00	Falling Head	22 - 28	-		No Flow	19 - 25	2.30E-08	-7.64	Falling Head	22 - 28	-	-	No Flow
28 - 34	2.00E-07	-6.70	Falling head	25 - 31	4.10E-07	-6.39	Constant Head	22 - 33.5	2.70E-08	-7.57	Falling Head	25 - 31	2.70E-07	-6.57	Constant Head	28 - 34	-	-	No Flow
34 - 40	1.30E-06	-5.89	Constant head	31 - 37	8.60E-08	-7.07	Falling Head	34 - 40	8.80E-09	-8.06	Falling Head	31 - 37	1.90E-07	-6.72	Constant Head	34 - 40	-	-	No Flow
40 - 50	-		No flow	37 - 43	1.30E-07	-6.89	Falling Head	40 - 50	-		No Flow	37 - 43	6.40E-08	-7.19	Falling Head	40 - 46	6.60E-07	-6.18	Constant Head
				43 - 50	1.10E-08	-7.96	Falling Head					43 - 50	2.10E-07	-6.68	Constant Head	46 - 52	-	-	No Flow
																52 - 60	1.40E-08	-7.85	Falling Head
Mean	1.70E-07	-6.77		**Mean**	1.86E-07	-6.73		**Mean**	1.54E-08	-7.81		**Mean**	1.08E-07	-6.97		**Mean**	6.48E-08	-7.19	
Median	2.00E-07	-6.70		**Median**	1.30E-07	-6.89		**Median**	1.79E-08	-7.81		**Median**	1.90E-07	-6.72		**Median**	4.50E-08	-7.36	

OVERALL VALUES				
	Mean (K)	1.04E-07	**Median (K)**	9.90E-08
	Mean (Log K)	-5.73	**Median (Log K)**	-6.72

Notes:
Packer Testing Results - Permeability Parameters (K) with depth (m/s)
FH = Falling Head Test CH = Constant Head Test
"-" no flow - No value calculated
Overburden or Heavily Weathered/Fractured Bedrock

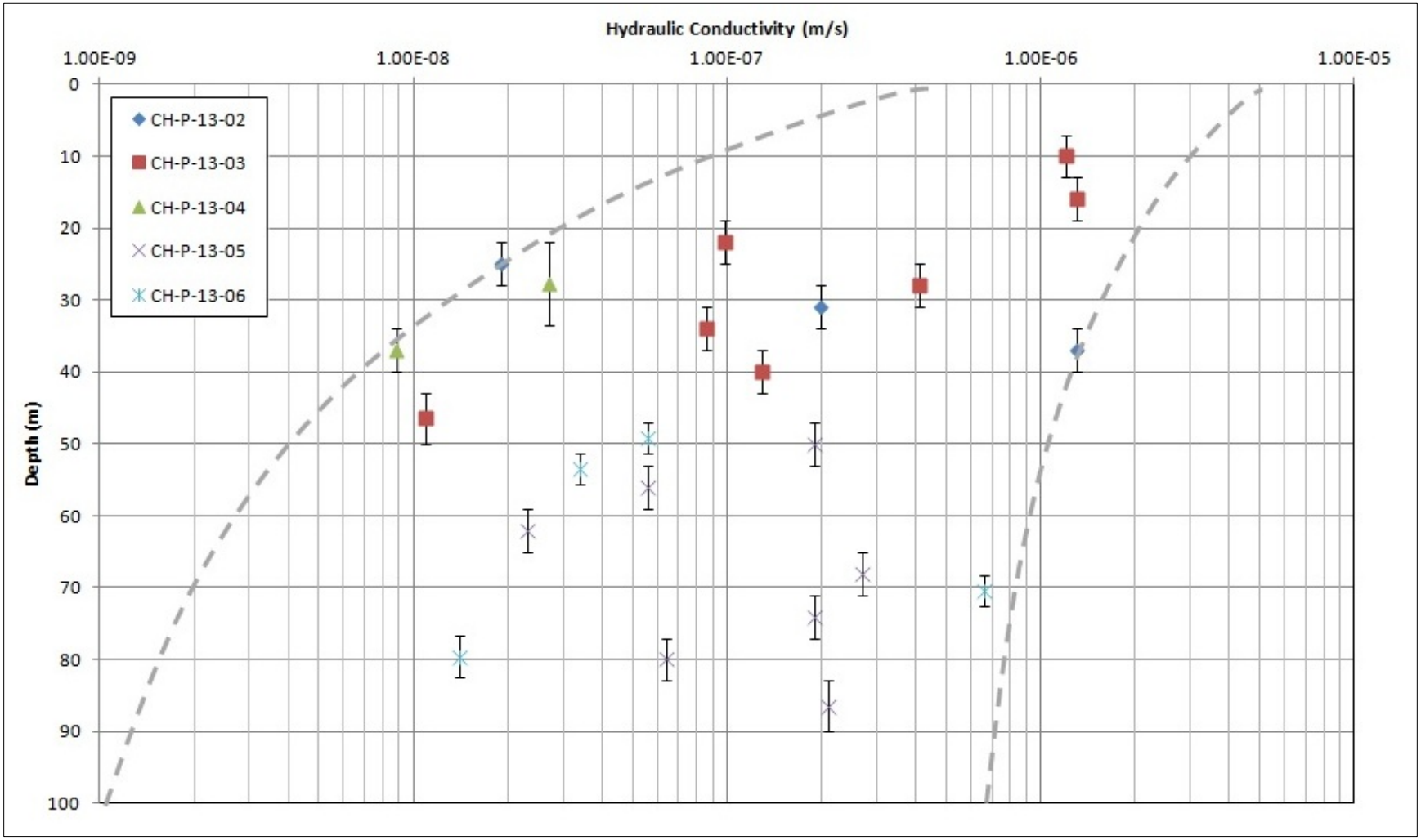


Figure 13: Coreholes - Hydraulic Conductivity Field Results Summary

Of the 32 tests summarized in Table 28, nine were recorded as 'no flow' and indicative of either a fully intact rock mass without conductive fractures, or indicative of permafrost presence, or both. A review of the hydraulic conductivity (K) values by individual coreholes gave a geometric mean K range from 1.5×10^{-8} m/s (CH-P-13-04) to 1.8×10^{-7} m/s (CH-P-13-03). The greatest hydraulic conductivity result, i.e. most conductive to water, was 1.3×10^{-6} m/s (13 m to 19 m depth in CH-P-13-03), southeast of the Open Pit. Of the 23 hydraulic tests not recorded as 'no flow', a geometric mean K of 1×10^{-7} m/s was derived.

A documented hydraulic conductivity analysis of the Open Pit rock mass used seasonal recession levels of the Open Pit lake to calculate a large-scale hydraulic conductivity applicable to the pit floor (Gartner Lee, 2007). This method determined the pit floor rock mass to have hydraulic conductivity in the order of 10^{-7} m/sec. The September 2013 packer testing in Corehole CH-P-13-5, cored vertically 50 m into the Open Pit floor, gave an average of 10^{-7} m/sec for hydraulic conductivity (geometric mean of seven tests).

Overall, highly conductive conduits for preferential groundwater movement were not detected during the 2013 packer testing program, at the tested locations and depths. The hydraulic conductivity of the rock mass in the Open Pit area and rock mass forming the Open Pit floor is considered to be at the lower end of the hydraulic conductivity scale, although not impermeable over long time periods. As noted, packer testing was not performed in rock zones that were too weak for the packer to obtain an effective pressure seal.

6.3.3 Instrumentation and Monitoring

With the exception of the first corehole (CH-P-13-1), vibrating wire type piezometers (VWPs) were installed into each corehole on completion and later connected to data loggers to record pressure and temperature readings from each piezometer. The VWPs were installed in two configurations, as follows:

(i) Coreholes CH-P-13-2 and CH-P-13-6
- string of five VWPs;
- VWPs at 10 m spacings; and
- VWPs attached to tremie piping and grouted in place.

(ii) Coreholes CH-P-13-3, CH-P-13-4 and CH-P-13-5
- PVC monitor well installed, to full corehole depth, with 3 m long intake screen;
- single VWP attached at the outside base of the PVC monitor well; and
- sand filter pack installed around well screen; remaining annulus grouted to surface.

Additionally, adjacent to the four coreholes located outside the Open Pit, a 10 m borehole was drilled into which a PVC monitor well was installed to full borehole depth. These 'companion' monitor wells were provided with 3 m long intake screens, intended to enable groundwater level measurement within the shallow, active layer.

Data from the VWP instrumentation was downloaded November 21 and 22, 2013 and provided initial readings for piezometric pressure (head) and temperature. The three PVC monitor wells installed into coreholes outside the Open Pit (CH-P-13-3 and CH-P-13-4) froze shortly after installation, indicating permafrost presence at all three locations. This was later confirmed with the VWP temperature data.

The PVC monitor well constructed into the Open Pit floor (CH-P-13-5), installed to 50 m below pit floor elevation, remained ice free. This was in agreement with the conceptual model of a fully-penetrating talik, below the Open Pit pond.

During coring of the first corehole (CH-P-13-1), extensive weathering of the bedrock was encountered, as shown in the lowest SCR and RQD values of all the coreholes. The degree of weathering decreased somewhat after 35 m depth below surface grade. At 40 m depth, flowing artesian conditions were suddenly encountered that necessitated the cessation of coring activities. Using the packer equipment, the flowing artesian condition was measured as being 1.2 L/sec and a shut-in pressure of 110 kPa (16 psi) was measured, equivalent to 11.25 m of water head above a hydrostatic condition.

Corehole CH-P-13-1 was plugged and sealed with cement. Instrumentation was not installed. The occurrence of flowing artesian conditions showed that the area surrounding this first corehole appears to be similarly influenced.

6.3.4 Dome Creek and Pony Creek Groundwater

The overall data objective of the groundwater-surface water interaction study was to characterize Dome Creek and Pony Creek in terms of identifying losing and gaining reaches of Dome and Pony Creeks and to quantify the rates of groundwater exchanging along these respective creek beds. The timing of the groundwater-surface water interaction study coincided with a period of lower surface water flows, shortly before winter freeze-up and, therefore, the time when relative groundwater contributions to surface water would be near a maximum.

This aspect of the hydrogeology of Mount Nansen was needed as input into the site-wide water quality modelling, in terms of quantifying the groundwater component contributing to Dome Creek and Pony Creek flows, i.e. as distinct from surface runoff. This input was needed for the integrated mine water quality model (GoldSim).

The specific data collection objectives for the creek groundwater-surface water interaction study included:

- Vertical hydraulic gradients - obtained from temporary creek bank drive-points, installed in pairs, shallow (A) to 1.5 m and deep (B) to 3 m below surface.
- Creek bed pore water temperature - obtained from a 0.5 m long probe and pilot hole tool, to obtain creek bed pore water temperature.

- Creek bed groundwater seepage rate (flux) - obtained from three seepage meters, connected to a water storage bag, for water gain or loss measurement, to derive a groundwater flow rate per unit time per unit area.

The vertical gradients were obtained using Solinst drive-point piezometers fitted with 0.15 m long screened tips. The creek bed porewater temperature survey used a Field Scout meter connected to a 0.5 m long temperature probe. Three seepage meters were custom-manufactured for the creek study (Oak Environmental), consisting of a low-profile, 0.099 m^2 area (14-inch diameter) metal tube, closed at the top, with a side port and tubing connected to a water storage bag. The change in water mass, either collecting in the bag (gaining creek segment) or leaving the bag (losing creek segment), was measured versus elapsed time to give the water mass change per unit time. Three seepage meters were used to enable simultaneous testing at different creek stations.

Fifteen creek study locations, or stations, were selected (10 on Dome Creek and five on Pony Creek), at which vertical gradient, creek bed porewater temperature and seepage meter flow data were collected. The temperature survey included several additional locations between the 15 stations, to increase the survey resolution. One station (DC-04) was deleted from the program due to shallow refusal of the drive-points, later determined to be frozen materials.

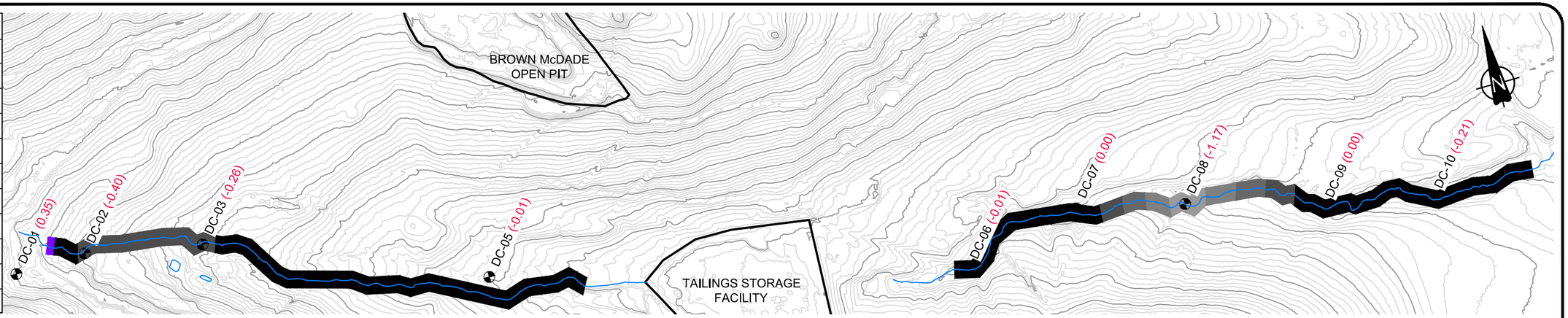
The September 2013 creek study data were plotted, using colour scales to represent the data magnitude and also direction, as shown on Figure 14 - Dome Creek - Groundwater-Surface Water Interaction and Figure 15 - Pony Creek - Groundwater-Surface Water Interaction. The signage conventions applied to vertical gradient and seepage flow in Figures 14 and 15, are as follows:

Vertical gradient - positive indicates upwards flow at the creek bed; and
- negative indicates downwards flow at the creek bed.

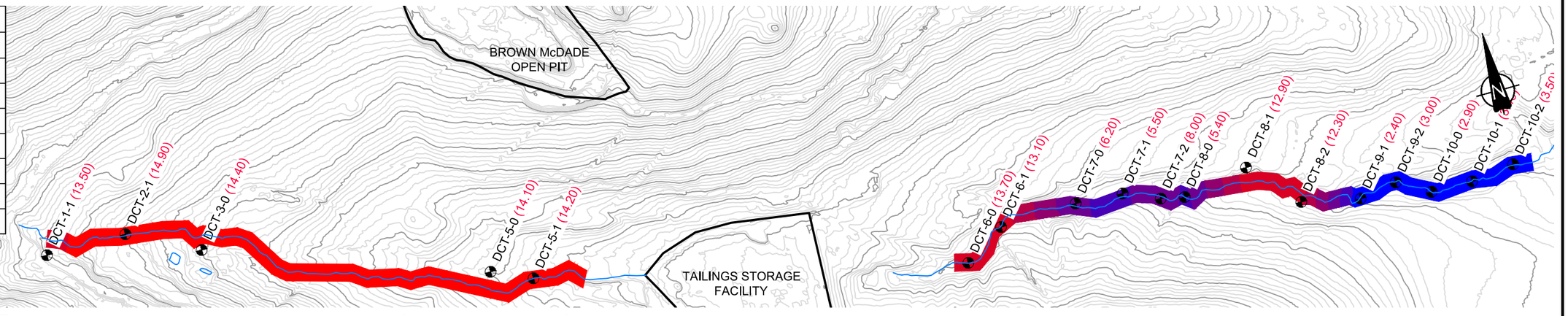
Seepage flow - positive indicates groundwater entering creek; and
- negative indicates groundwater leaving creek.

The September 2013 temperature survey indicated that the segments of Dome Creek upstream of the tailings pond and segments of Pony Creek upstream and adjacent to the Open Pit possessed relatively warm creek bed porewater, denoted in red on Figures 14 and 15, respectively. Downstream of the tailings pond, Dome Creek porewater became cooler and downstream of the Open Pit, Pony Creek porewater also became cooler, denoted in blue on Figures 14 and 15, respectively.

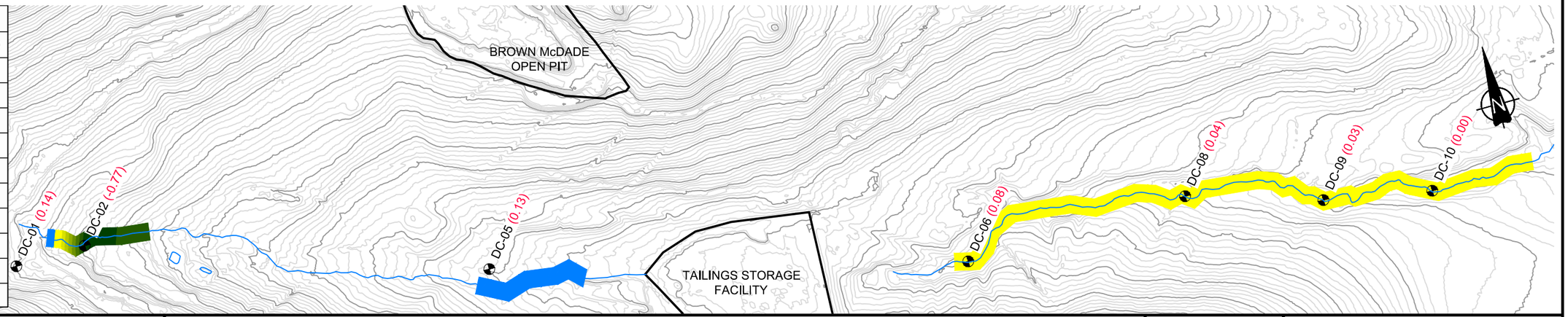
VERTICAL GRADIENT		
COLOR		VALUE
DOWNWARD		-2.00 TO -1.75
		-1.75 TO -1.50
		-1.50 TO -1.25
		-1.25 TO -1.00
		-1.00 TO -0.75
		-0.75 TO -0.50
		-0.50 TO -0.25
		-0.25 TO 0.00
UPWARD		0.00 TO 0.25
		0.25 TO 0.50



TEMPERATURE	
COLOR	VALUE (°C)
	2.0°C TO 4.0°C
	4.0°C TO 6.0°C
	6.0°C TO 8.0°C
	8.0°C TO 10.0°C
	10.0°C TO 12.0°C
	12.0°C TO 14.0°C
	14.0°C TO 16.0°C



CREEKBED SEEPAGE		
COLOR		VALUE (L/min/m²)
LOSING		-0.80 TO -0.700
		-0.70 TO -0.600
		-0.60 TO -0.500
		-0.50 TO -0.400
		-0.40 TO -0.300
		-0.30 TO -0.200
		-0.20 TO -0.100
		-0.10 TO 0.000
GAINING		0.00 TO 0.100
		0.10 TO 0.200



Data Source:
Datum: NAD 1983 CSRS UTM Zone 8N

AECOM Associated Engineering

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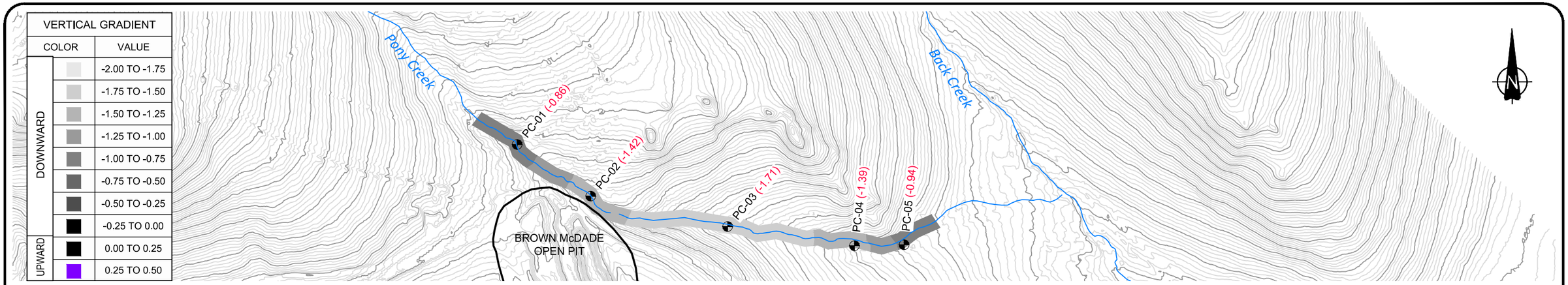
COREHOLES - HYDRAULIC CONDUCTIVITY FIELD RESULTS SUMMARY
Figure 14

DOME CREEK - GROUNDWATER-SURFACE WATER INTERACTION

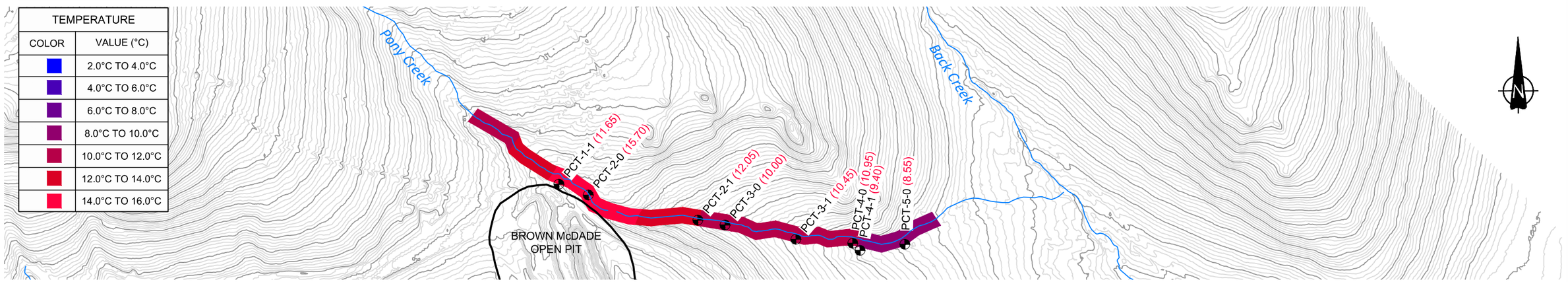
0m 100 200 300 400
1 : 10,000

MARCH, 2014

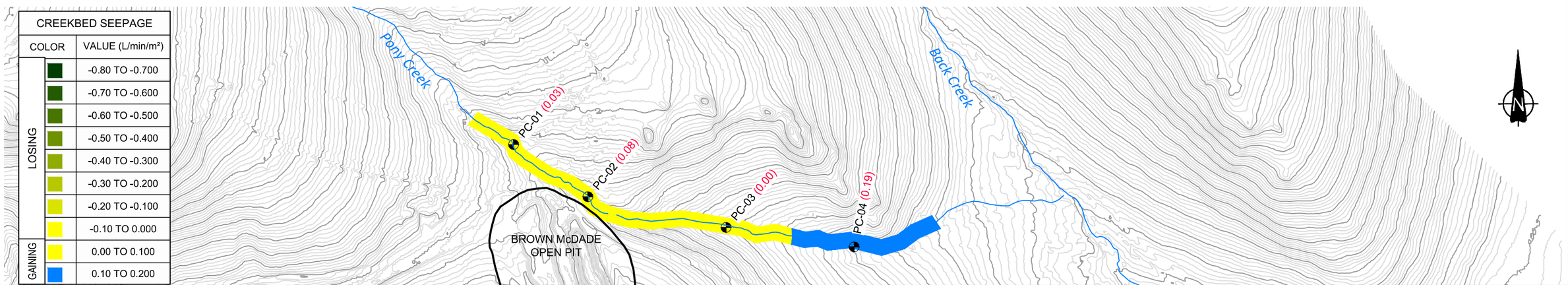
VERTICAL GRADIENT		
COLOR		VALUE
DOWNWARD		-2.00 TO -1.75
		-1.75 TO -1.50
		-1.50 TO -1.25
		-1.25 TO -1.00
		-1.00 TO -0.75
		-0.75 TO -0.50
		-0.50 TO -0.25
		-0.25 TO 0.00
UPWARD		0.00 TO 0.25
		0.25 TO 0.50



TEMPERATURE	
COLOR	VALUE (°C)
	2.0°C TO 4.0°C
	4.0°C TO 6.0°C
	6.0°C TO 8.0°C
	8.0°C TO 10.0°C
	10.0°C TO 12.0°C
	12.0°C TO 14.0°C
	14.0°C TO 16.0°C



CREEKBED SEEPAGE		
COLOR		VALUE (L/min/m²)
LOSING		-0.80 TO -0.700
		-0.70 TO -0.600
		-0.60 TO -0.500
		-0.50 TO -0.400
		-0.40 TO -0.300
		-0.30 TO -0.200
		-0.20 TO -0.100
		-0.10 TO 0.000
GAINING		0.00 TO 0.100
		0.10 TO 0.200



Data Source:
Datum: NAD 1983 CSRS UTM Zone 8N

MOUNT NANSEN REMEDIATION PROJECT
SITE CHARACTERIZATION
Figure 15

PONY CREEK - GROUNDWATER-SURFACE WATER INTERACTION

0m 100 200 300 400
1 : 10,000

MARCH, 2014

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C:\Users\karsten.rudolf\appdata\local\temp\AcPublish_13276\VM00605-002-Gw Sw Interaction.dwg – Figure 15 – Mar. 20, 2014 3:26pm – karsten.rudolf

The seepage meter tests provided a direct measure of groundwater exchange in the creek bed, indicating gaining or losing creek segments. For Dome Creek, these data showed a pattern of low, positive seepage rates and indicated gaining creek segments, with one notable exception near Huestis Adit (DC-02), which had the most negative seepage rate and loss from Dome Creek. For Pony Creek, the seepage meter data showed a pattern of low, positive seepage and gaining creek segments. Overall, the seepage meter data indicated that groundwater contributes to Dome Creek and Pony Creek at low rates.

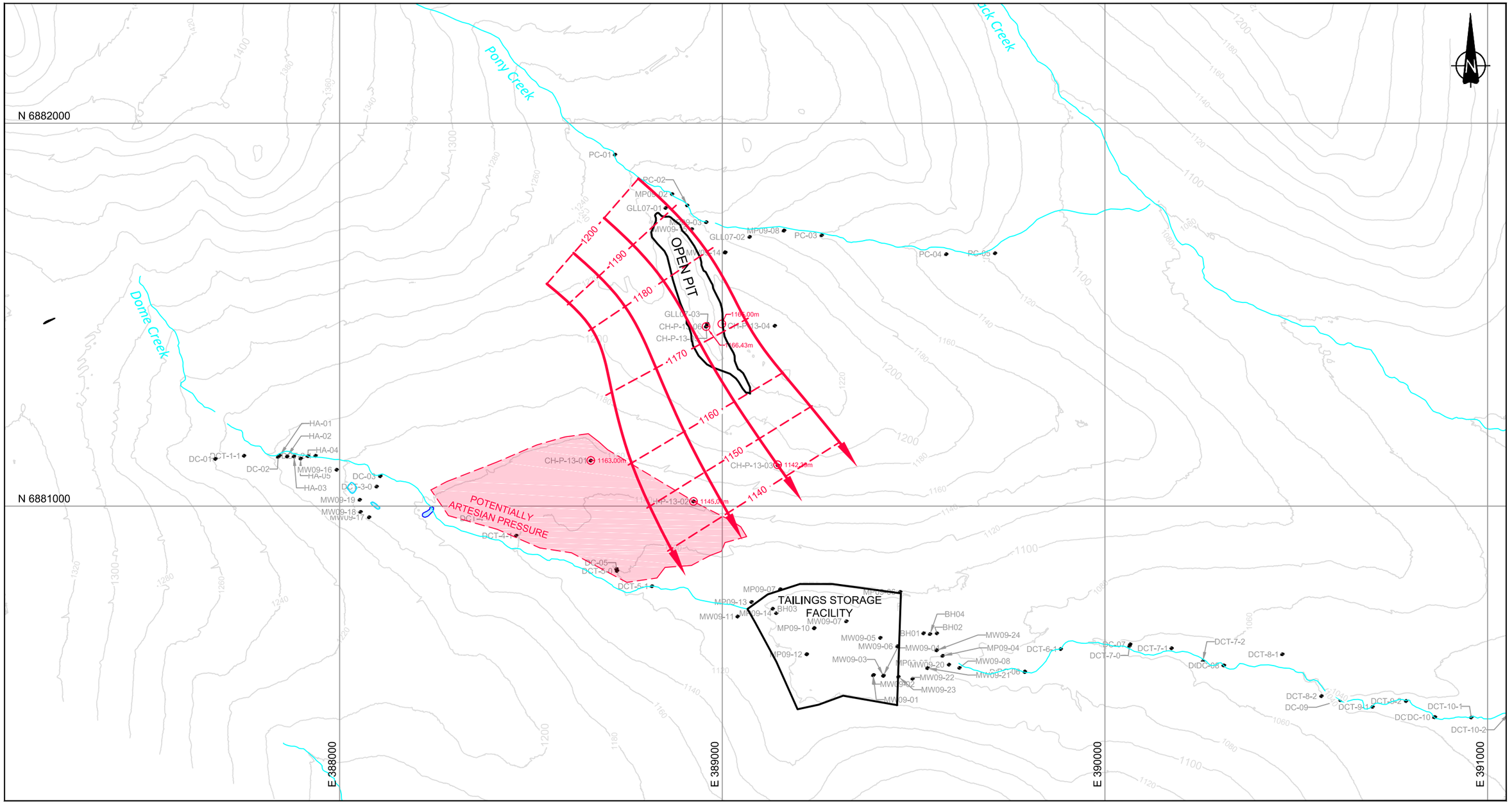
Vertical groundwater gradients, derived from the dual drive-point piezometers, were only somewhat consistent with the seepage meter results. The majority of creek stations gave negative, i.e. downward, groundwater directions indicative of losing creek water. This was at variance to the temperature survey and seepage meter findings. Only two stations had positive, i.e. upward, groundwater directions, corresponding to the most upstream station on Dome Creek (DC-01) and one station downstream of the tailings pond (DC-07). These findings may have been biased by the onset of freezing conditions that influenced the drive-point water levels.

6.4 Groundwater Elevations

Vibrating wire piezometer (VWP) 2013 readings of piezometric pressure (head) and groundwater levels measured from the deeper 2007 (Gartner Lee) and 2009 (AECOM) monitor wells, were used as a guide for an initial piezometric map of deep groundwater in the Open Pit area. These six data points for piezometric elevation around and within the Open Pit are shown on Figure 16 - Groundwater Elevations for Regional Flow.

It may be possible to add three other piezometric elevations locations to this map, when data loggers (installed November 2013) connected to single vibrating wire piezometers are downloaded and analyzed in 2014. These correspond to coreholes CH-P-13-03 (southeast of Open Pit), CH-P-13-04 (east of Open Pit) and CH-P-13-05 (Open Pit floor).

The previous hydrogeological conceptual model, in which the regional groundwater head was assumed to mimic topographic elevation minus 15 to 20 m, is not valid in the vicinity of corehole CH-P-13-01. Across this corehole area and nearby Dome Creek watershed, below elevation 1,168 m, the regional groundwater piezometric elevation is above surface grade, as shown on Figure 16. This created the high artesian pressure encountered at 40 m depth (11 m ‘head’ above surface grade), necessitating halting and sealing corehole CH-P-13-01, without instrumentation. The source for this artesian water was not determined in 2013, although can be speculated as being from one, or a combination of two sources. Firstly, deep groundwater from the recharge area on the higher hillside, northwest of the Open Pit and secondly Open Pit water that has hydraulic connection to deep groundwater, via the pit pond talik. One observation during 2013 that may help in resolving this uncertainty was the presence of a spring-like feature a short distance north and uphill of CH-P-13-01. Sampling and analysis of this ‘spring’ water in 2014 may help to indicate the artesian water origin.



Data Source:
Datum: NAD 1983 CSRS UTM Zone 8N

Note: Groundwater and Ground Temperature data will be updated in 2014.

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MOUNT NANSEN REMEDIATION PROJECT
Figure 16

SITE CHARACTERIZATION REPORT

GROUNDWATER ELEVATIONS FOR REGIONAL FLOW

0m 100 200 300 400
1 : 10000

MARCH, 2014

S:\Cadd\MISC\VM\VM00605\VM00605-001-Flownet.dwg – FIGURE 16 – Mar. 20, 2014 3:08pm – karsten.rudolf

A comparison of piezometric elevations between the vibrating wire instrumentation in nearby corehole CH-P-13-02 and the Open Pit corehole CH-P-13-05, may help identify hydraulic linkages between the Open Pit pond and deep groundwater in the artesian area, i.e. preferential groundwater pathways from the Open Pit pond, south and discharging into the Dome Creek watershed.

7.0 GEOCHEMICAL CONSIDERATIONS

A significant geochemical characterization investigation was conducted at the Mount Nansen site to assess the potential for metal leaching and acid rock drainage (ML/ARD) from mine waste. Key site components in terms of potential sources of ML/ARD are the Brown-McDade waste rock pile, Brown-McDade pit and tailings impoundment. Results of the previous site investigations indicate that mine rocks and tailings were also identified in the other locations, such as haul roads and the mill area. The 2013 Site Investigation Program (AMEC, 2013) was designed to fill the ML/ARD information gap that was identified during the gap analysis.

Samples collected for ML/ARD assessment were tested for the following:

- Acid Base Accounting (ABA), which consists of the following analyses:
  - Modified Sobek neutralization potential (NP);
  - Sulphur species including Total Sulphur (S), Sulphate Sulphur, and Sulphide Sulphur;
  - Total Inorganic Carbon; and
  - Paste pH.
- elemental metals;
- total cyanide and weak acid dissociable (WAD) cyanide, and
- leachable metals.

The following sections describe the assessment of ML/ARD tests in a regulatory context.

7.1 Acid Base Accounting

The potential for a sample to generate acidity is defined by the neutralization potential ratio (NPR). The NPR is a ratio between neutralization potential (NP) and acid potential (AP). The AP is generally attributed to the oxidation of sulphide minerals and is calculated based on the sulphide sulphur content.

As an initial screening value, the NPR 2 is proposed to be used as a threshold value for separating potentially acid generating (PAG) rock from non-potentially acid generating (non-PAG) rock. The NPR 2 as a threshold value for PAG and non-PAG classification is referred to in the document entitled "*Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials"* that was issued in 2009 by Mine Environment Neutral Drainage (MEND) as the updated guideline for ML/ARD characterization. This document provides an update to the Price 1997 document entitled "*Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia* .

Based on ARD potential, the MEND 2009 guideline classifies mine rocks into three categories compared to four categories used in Price, 1997. The MEND 2009 guideline states that a sample with NPR<1 is PAG, a sample with NPR>2 is non-PAG, and a sample with NPR between 1 and 2 is uncertain and capable of generating acid.

These NPR criteria are also applied to tailings, but it is accepted in the industry that the NPR threshold between PAG and non-PAG tailings is usually less than 2, often in the range of 1.4 to 1.5. However, site-specific studies are required to establish this value.

7.2 Metal Content

There are no regulatory standards that apply directly to the elemental content of mine rock. For comparative purposes, the elemental content of mine rock was evaluated against average elemental crustal compositions, cited from Guidelines and Recommended Methods of ML/ARD (Price, 1997). For screening purposes, samples with more than 10 times average crustal amount of each element were considered to be enriched in that element.

Metal concentrations in soil samples were compared to the Yukon Contaminated Soil Regulation, OIC-2002/171, for park land use.

7.3 Leachable Metals

The results of leachable metal testing with the shake flask extraction (SFE) testing method are used as a geochemical screening tool to assess whether metal leaching could potentially occur from a sample. They are not a direct measure of the expected drainage chemistry, but are used to indicate which elements may be readily leachable and can contribute as a contaminant.

For comparison purposes only, the SFE results were also reviewed in relation to the Canadian Environmental Quality Guidelines for fresh water aquatic life (CCME, 1999). These values are not directly comparable to leachates from source materials. This comparison is strictly for reference purposes and implies neither compliance nor non-compliance with the specific guideline. SFE results were considered elevated when concentrations were greater than allowed under the CCME guidelines. The elevated results indicate the sample could contribute the loadings of elevated parameters to the site water quality.

8.0 SITE WIDE WATER AND SEDIMENT QUALITY

8.1 Introduction

This section presents the interpretation of the site monitoring data that was presented in Appendix B7 of the Site Investigation (SI) Data Report (AMEC, 2013). This interpretation is based on the previous reports completed for the site and various scientific and engineering references as noted throughout this section.

This section encompasses water quality (both surface water and groundwater), monitoring well headspace gas concentrations, and physical hydrogeology. Section 8.2 presents various important considerations regarding water quality and provides the necessary context for the discussion that follows. The Inco process to manage cyanide is described in Section 8.3 to highlight the anticipated continued presence of iron-cyanide complexes on the tailings, and the hypothesized importance of the mill process chemical sulphite. Section 8.4 presents a summary of the analytical data compared to regulatory standards, a general characterization of surface water quality at various locations around the site and a description of sediment quality. Section 8.5 presents an evaluation of the possible continued presence of the mill process chemical sulphite and the potential role of sulphite as an ARD inhibitor.

In a companion appendix (Appendix D: Surface Water Quality Background Information, Quality Assurance and Quality Control), sampling and analytical Quality Assurance and Quality Control (QA/QC) are evaluated in terms of the variability of field duplicates and the variability observed between samples collected with standard and alternate preservations. Data and calculation tables relevant to this section are included in Appendix D. Geochemistry data plots summarizing the analytical data at the monitoring locations are also provided in Appendix D. Site drawings, borehole logs, and other data were presented in the SI Data Report.

8.2 Additional Water Quality Considerations

This subsection provides a summary of some considerations identified by AMEC in 2013 regarding the water quality of the site. This provides the necessary background to understand the relevance of various points that are discussed throughout this section and Appendix D.

Based on the data presented in the SI Data Report and previous reports by others, several components of the water quality interpretation for the site warrant consideration. These include:

1. Most of the cyanide added at the mill remains sorbed to the tailings as strong acid dissociable (SAD)-complexes (i.e. primarily iron-cyanide complexes). Approximately 6% of the nitrogen from the cyanide that was added during the ore processing has been measured discharging at the Seep. This is based on measured flow rates at the Seep, and the associated concentrations in the water for the various cyanide components (free cyanide, WAD-cyanide, SAD-cyanide, cyanate, thiocyanate) and the associated nitrogen containing breakdown products (ammonia, nitrate, nitrite).
2. The Inco process used at the site for cyanide oxidation does not address SAD-complexes, which remain on the tailings solids. As noted by CANMET (2001), the lack of cyanide released in their leaching tests is consistent with the cyanide being retained on the tailings as SAD-complexes. CANMET measured SAD-cyanide concentrations on the tailings of up to 160 mg/kg. Iron-cyanide complexes are subject to photodegradation when exposed to sunlight releasing free cyanide. This process is well known (Dzombak, 2006) and is used for the analysis of Total Cyanide where the sample is illuminated by UV light to release the cyanide from the solids for analysis.

3. The concentrations of the various cyanide species in surface water and groundwater are decreasing with time at all locations which are consistent with degradation of the remaining SAD-cyanide complexes by inorganic and biologically mediated reactions. Since 2006, approximately twice as much nitrogen has been discharged at the Seep as inorganic nitrogen breakdown products (i.e. ammonia, nitrate, and nitrite) than as the various cyanide species. This is consistent with the fact that most of the remaining cyanide is sorbed to the tailings solids as SAD-complexes.
4. The Inco process used sodium metabisulphite as the oxidizing agent in the cyanide oxidation process. This source of "liquid sulphur dioxide" hydrates to sulphite (SO_3^{2-}) in solution. The mass of sulphur discharged at the Seep equates to approximately 57% of the sulphur added at the mill as sodium metabisulphite and as copper sulphate. This compares with 6% of the nitrogen from cyanide.
5. Sulphite is used to oxidize cyanide in the Inco process, but sulphite can be oxidized to sulphate. Based on observed inconsistencies in various water quality parameters such as Total Alkalinity versus Total Inorganic Carbon, and the fact that ferrous iron (Fe^{2+}) did not precipitate from unpreserved dissolved metals samples, AMEC hypothesizes that potentially significant quantities of sulphite could still be present in the tailings and groundwater at the site. The laboratory analysis of sulphate typically involves Ion Chromatography (IC), and most laboratories cannot distinguish between sulphite and sulphate. Therefore, it is hypothesized that the reported sulphate concentrations could actually be a mixture of sulphite and sulphate. This is significant in that sulphite is an oxygen scavenger (sulphite oxidizes to sulphate), whereas sulphate is comparatively inert. Sulphite would be expected to still be present in the tailings area due to the limited oxygen recharge and high pH conditions. Sulphite is being successfully used at some sites as an Acid Rock Drainage (ARD) inhibitor. This is discussed further in Section 8.5.
6. The highest dissolved iron concentrations were observed in shallow drive points wells located downgradient of the tailings area along Dome Creek. The highest dissolved iron concentration (83 mg/L) was found in DC-10 which is the furthest location sampled from the tailings (approximately 1.4 km downgradient from the tailings dam crest). Comparable iron concentrations were also present in the unpreserved dissolved metals sample. Normally, these iron concentrations would not be present in unpreserved water samples due to oxidation of the iron by atmospheric oxygen. The lack of iron oxidation in the unpreserved water samples appears to indicate the presence of an oxygen scavenger such as sulphite which is preventing the oxidation and precipitation of the iron from the sample. This affect was noted in many of the groundwater samples, and thus the lack of iron oxidation in the unpreserved samples could also be due to lack of exposure of the unpreserved water to atmospheric oxygen.
7. Calculations show that the inferred presence of sulphite would account for the observed inconsistencies in the geochemical data. The presence of sulphite would explain the observed charge balance errors and the lack of iron oxidation in the unpreserved water samples. Sulphite can contribute to Total Alkalinity, which would result in an over estimation of carbonate alkalinity based on an acid titration. The potential significance of sulphite is discussed further in Section 8.5.

8. The mill process used the carbon-in-pulp (CIP) method to recover gold after cyanidation. The use of carbon for this process appears to be the source of significant concentrations of organic carbon in groundwater in the tailings area and downgradient along Dome Creek. There is also the possibility that natural sources such as organics beneath the tailings could be a source of organic carbon. This organic carbon will adsorb some metals and can also serve as a catalyst for various geochemical reactions. Cyanide concentrations measured as weak acid dissociable (WAD) cyanide are normally assumed to be related to metal-cyanide complexes, but the WAD cyanide measured in the Seep discharge does not correlate to copper-cyanide complexes (or other WAD metal-cyanide complexes). Therefore, it appears that WAD-cyanide analyses in water have been primarily measuring organic-cyanide complexes (Dzombak, 2006). This does not affect the interpretation of the site conditions, but it may have significance for water treatment where WAD organic-cyanide complexes may respond differently to treatment than WAD metal-cyanide complexes.
9. Several lines of evidence indicate that the groundwater in the tailings area is gassy due to the formation of biogenic gases from the oxidation of organics, cyanide, and/or ammonia. Bubbles can form in the aquifer when the sum of the partial pressures of the gases exceeds the confining pressure. The formation of nitrogen gas (N_2) would generate a higher partial pressure than the formation of methane (CH_4) or carbon dioxide (CO_2); therefore, the gases formed are inferred to be primarily nitrogen gas. Sulphite (SO_3^{2-}) can partition from water into the gas phase as sulphur dioxide (SO_2).

8.3 Inco Process Description

This section provides a description of the Inco process that was used during processing operations, and the associated influences and implications on current water chemistry. The mill used the Inco SO_2/Air process to oxidize cyanide in the tailings and tailings water prior to discharge to the tailings pond. The following discussion about the Inco process is primarily based on Mudder (2001) and Breuer (2011).

The patented Inco process is based upon conversion of free cyanide and WAD cyanides to cyanate using a mixture of SO_2 and air in the presence of a soluble copper catalyst at a controlled pH. The SO_2 required in the reaction was supplied as sodium metabisulphite ($Na_2S_2O_5$) in a liquid solution.

In the Inco process, the forms of cyanide are removed by different processes. One process involves the conversion of free cyanide and WAD cyanides to cyanate. Iron complexed cyanides are reduced to the ferrous state and precipitated as insoluble copper-iron-cyanide complexes. Residual metals liberated from the WAD cyanide complexes are precipitated as their hydroxides. Therefore, the Inco process oxidizes free cyanide and WAD cyanides to the less toxic form of cyanate, but most of the cyanide remains complexed onto iron in the tailings.

As of 2001, the Inco process has been used at over 80 mining operations worldwide. A primary application of the sulphur dioxide and air process is in treatment of tailings slurries, but it is also effective for the treatment of solutions for the oxidation of free and WAD cyanides.

This process description leads to an accounting of the mass of reactants used at the mill versus what has been measured as discharging from the tailings area. Report R05 prepared in 1988 by Melis Engineering Ltd. on behalf of BYG Natural Resources specifies the reagents that would be used at the site (Melis, 1988). Table 29 summarizes the annual reagent usage listed in this document, and Table 30 provides a summary of these values versus other mine sites (as listed in Mudder, 2001).

Table 29: Summary of Mill Reagent Usage as Specified in Report R05

Reagent	Formula	Molecular Weight (g/mol)	Design Consumption Rate (lb/ton)	Design Consumption Rate (kg/tonne)	Design Usage per Year (kg)
Sodium Cyanide	NaCN	49.02	2.2	1	100,000
Lime	CaO	56.08	10.3	4.6	460,000
Sodium Hydroxide	NaOH	40	0.4	0.18	18,000
Hydrochloric acid	HCl	36.46	0.4	0.18	18,000
Copper Sulphate	$CuSO_4*5H_2O$	249.7	0.6	0.27	27,000
Sodium Metabisulphite	$Na_2S_2O_5$	190.1	6	2.7	270,000

Table 30: Inco SO_2/Air Process Case Histories

Mine	Cyanide Concentration (mg/L)			Reagent Usage (g/g CN_T)		
	Before Feed	After Feed	% Removal	SO_2	Lime	Cu
Colosseum	364	0.4	99.9%	4.6	0.12	0.04
Ketza River	150	5	96.7%	6	0	0.3
Equity	175	2.3	98.7%	3.4	0	0.3
Casa Berardi	150	1	99.3%	4.5	--	0.1
Weatmin Premiere	150	0.2	99.9%	5.8	--	0.12
Golden Bear	205	0.3	99.9%	2.8	--	--
McBena (barren)	370	0.2	99.9%	4	4	0
Lynngold (pond)	106	0.6	99.4%	7	9	0.12
Mineral Hill (barren)	350	0.5	99.9%	6	9	0
Lac Shortt (pond)	10	0.5	95.0%	5	--	0
Citadel (barren)	350	5	98.6%	4	--	0
St. Andrew (pond)	15	1	93.3%	5	--	0.1
Average	**200**	**1.4**	**99.3%**	**4.8**	**3.7**	**0.1**
Mount Nansen				**3.6**	**8.7**	**0.13**

Legend:

	Tailings Slurry
	Solution

The reagent usage proposed in 1988 for Mount Nansen, as summarized in Table 29, is consistent with the reagent usage reported for other mines. As shown in Table 30, the design for the mill used 3.6 g of SO_2 per gram of cyanide oxidized. The theoretical usage of SO_2 in the process is 2.46 grams SO_2 per gram of WAD-cyanide oxidized, but in practice, the actual usage ranges from about 3.0 to 5.0 grams SO_2 per gram of WAD-cyanide oxidized.

The removal efficiency presented in Table 30 represents the cyanide concentration in the feedstock solution at the mill versus the cyanide concentration in the tailings liquid. An average of 99.3% efficiency is presented, but most of the cyanide remains as iron complexes on the tailings solids.

When the Inco process is applied to tailings liquids (i.e. homogeneous systems in chemistry terminology), all of the cyanide is converted to cyanate (i.e. it is stoichiometrically converted, see Breuer (2011)). However, cyanide reacts very strongly with iron to form SAD-cyanide complexes which are not affected by the Inco process. When the Inco process is applied to tailings slurries (i.e. heterogeneous systems), most of the cyanide will remain sorbed to the tailings solids as SAD-complexes.

8.3.1 Inco Process Chemistry

Free and weakly complexed metal cyanides (i.e. WAD-cyanides) are oxidized to cyanate by sulphur dioxide and air in the presence of a soluble copper catalyst.

$$CN^- + SO_2 + O_2 + H_2O \text{ ----> } OCN^- + SO_4^{2-} + 2H^+ \qquad (1)$$

Equation 1 shows sulphur dioxide (SO_2) reacting with cyanide (CN^-), oxygen and water in the presence of a copper catalyst to yield cyanate (OCN^-), sulphate (SO_4^{2-}) and acid (H^+). This is the standard description of the process as presented by Mudder (2001) which shows sulphur dioxide as the main reactant. More recent work by Breuer (2011) indicates that the reactant is actually sulphite which is formed by the hydration of sulphur dioxide as shown in Equation 2.

$$SO_2 + H_2O \text{ -----> } SO_3^{2-} + 2H^+ \qquad (2)$$

The reaction is normally carried out at a pH of about 8.0 to 9.0, and due to the formation of acid in the reactions, lime is normally required for pH control. Decreases in process performance can occur if the pH fluctuates outside this optimal range. The optimal pH must be determined experimentally, since maximum cyanide and metals removals occur at different pH values. Temperature has little effect on process performance between 5°C and 60°C.

Sodium metabisulphite ($Na_2S_2O_5$) was used as a source of sulphite for the Inco process at the site, and as mentioned in Section 8.2, there is evidence for the continued presence of sulphite in the groundwater in the tailings area and downgradient along Dome Creek. What has historically been reported as sulphate is likely a combination of sulphate and sulphite. Samples were not preserved in the field to prevent the oxidation of sulphite to sulphate as shown by Equation 3,

and the analytical method commonly used to quantify sulphate typically cannot separate these two compounds. Therefore, it is hypothesized that the use of sodium metabisulphite at the mill has resulted in the likely presence of significant but unquantified amounts of sulphite in the groundwater that have been misidentified as sulphate.

$$SO_3^{2-} + 0.5\ O_2 \text{ ------> } SO_4^{2-} \quad (3)$$

The soluble copper catalyst is normally added as a solution of copper sulphate pentahydrate ($CuSO_4$-$5H_2O$) to a level of about 10% to 20% of the initial WAD cyanide level.

Iron cyanide removal is initiated by reduction of iron from the ferric to the ferrous state according to the following reaction:

$$2Fe(CN)_6^{3-} + SO_2 + 2H_2O \text{ ----> } 2Fe(CN)_6^{4-} + 4H^+ + SO_4^{2-} \quad (4)$$

The ferrous cyanide complex is then removed through precipitation with either copper, nickel or zinc according to the following generalized reaction:

$$2(Metal)^{2+} + Fe(CN)_6^{4-} \text{ -----> } (Metal)_2Fe(CN)_6 \quad (5)$$

Trace metals remaining in solution following oxidation of the weakly complexed metal cyanides are precipitated as their hydroxides according to the following generalized reaction:

$$(Metal) +2 + 2OH- \text{ -----> } (Metal)(OH)2 \quad (solid) \quad (6)$$

The oxidation of thiocyanate (SCN), which is usually limited to 10% to 20% in the process, and the hydrolysis of cyanate (OCN^-) occur according to the following reactions:

$$SCN^- + 4SO_2 + 4O_2 + 5H_2O \text{ -----> } OCN^- + 10H^+ + 5\ SO_4^{2-} \quad (7)$$

$$OCN^- + H^+ + 2H_2O \text{ ----> } HCO_3^- + NH_4^+ \quad (8)$$

Generally, the best application of this process is with slurries containing low to moderately high initial levels of cyanide when treated cyanide levels of less than about 5 mg/L are required.

Ammonia, which is present as ammonium (NH_4^+) at these pHs, is known to be one of the main products of cyanide degradation. However, ammonia is itself subject to biodegradation by both aerobic and anaerobic micro-organisms. The widespread occurrence of anaerobic ammonia oxidation (Anammox) was discovered by microbiologists in the last two decades and this has ‘revolutionized’ the scientific understanding of the biogeochemistry of nitrogen. Processes affecting the degradation of cyanide have not been re-evaluated in light of the newly revised understanding of nitrogen biogeochemistry.

Table 31 summarizes the Advantages and Disadvantages of the Inco Process for cyanide destruction as presented in Table 6.33 of Mudder (2001).

Table 31: Advantages and Disadvantages of the Inco SO2/Air Process as listed in Table 6.33 of Mudder et al. (2001)

	Advantages
1	The process has been proven in numerous full-scale applications to yield low effluent cyanide and metals concentrations.
2	The process is effective in treating slurries as well as solutions.
3	The process is suitable for batch or continuous treatment.
4	All forms of cyanide are removed from solution, including the stable iron cyanide complexes.
5	Capital and operating costs are comparable with other chemical treatment processes.
	Disadvantages
1	If treating high levels of cyanide, the costs for reagents and electrical power can be high.
2	Cyanide is not recovered.
3	Undesirable levels of sulphate in the treated solution can result.
4	Additional treatment may be necessary for the removal of iron cyanide, thiocyanate, cyanate, ammonia, nitrate and/or metals for solutions to be discharged to the environment.

As shown in Table 31, Advantage #4 of the Inco process is that it removes all forms of cyanide from solution including stable iron-cyanide complexes. These are removed from solution, but iron-cyanide complexes remain sorbed to the tailings solids.

As shown in Table 31, Disadvantage #4 is that several water quality parameters are not addressed by this process and subsequent treatment may be required prior to discharge to the environment.

Another process used at the mill that is of relevance to the groundwater quality near the tailings was the use of the carbon-in-pulp (CIP) process to recover gold after cyanidation. This use of activated carbon to recover gold appears to have contributed to the high total organic carbon (TOC) concentrations that were noted by AMEC. Cyanide concentrations measured as weak acid dissociable (WAD) cyanide are normally assumed to be related to metal-cyanide complexes, but the WAD cyanide measured in the Seep discharge does not correlate to copper-cyanide complexes (or other WAD metal-cyanide complexes). Therefore, it appears that WAD-cyanide analyses in water have been primarily measuring organic-cyanide complexes (Dzombak, 2006). This does not affect the interpretation of the site conditions, but it may have significance for water treatment where WAD organic-cyanide complexes may respond differently to treatment than WAD metal-cyanide complexes.

Using the data presented in Table 29, the mass and concentration of reagents in the tailings is presented in Table 32. The calculated concentrations of sodium, calcium, cyanide, sulphur and copper added to the tailings are consistent with the measured concentrations for these parameters in the tailings as reported by CANMET (2002).

Table 32: Mass of Reagents Used at the Mill and Calculated versus Measured Concentrations in the Tailings

Mill Reagents			Mass and Concentration of Reagents Added to Tailings					
Reagent	Formula	Design Usage per Year (kg)	Reagent Concentration in Tailings (mg/kg)	**Sodium** Mass Added (kg/yr)	**Calcium** Mass Added (kg/yr)	**Cyanide** Mass Added (kg/yr)	**Sulphur** Mass Added (kg/yr)	**Copper** Mass Added (kg/yr)
Sodium Cyanide	NaCN	100,000	1000	47,000		53,000		
Lime	CaO	460,000	4600		330,000			
Sodium Hydroxide	NaOH	18,000	180	10,000				
Hydrochloric acid	HCl	18,000	180					
Copper Sulphate	$CuSO_4*5H_2O$	27,000	270				3,500	6,900
Sodium Metabisulfite	$Na_2S_2O_5$	270,000	2700	33,000			91,000	
Mill operated three days a week for a total volume processed of 100,000 m^3/year			**Totals (kg/year)**	**90,000**	**330,000**	**53,000**	**95,000**	**6,900**
			Concentration (mg/kg)	**900**	**3,300**	**530**	**950**	**69**
			Typical Tailings Concentrations (from Canmet 2002, Document R04)					
			Tailings Conc (mg/kg, Canmet Table C-1A, 2002)	Approx. 1,200 to 17,000 mg/kg	Approx 1-1.5% or 10,000 to 15,000 mg/kg	Approx 20 to 200 mg/kg as CN Total	Approx 0.7-4% or 7,000 to 40,000 mg/kg	Approx. 150 to 700 mg/kg

8.3.2 Seepage Flux Measurements

Using the spreadsheet provided by AAM in early December 2013, the volume of water discharged at the H/WQ-Seep location downstream of the Tailings Facility can be compared to the concentrations measured at the same location. The volume of water discharged times the concentration for various water quality parameters allows the calculation of the total mass of the water quality parameter that was discharged. This total mass discharged can then be compared to the mass of reagents used at the mill as presented in Table 29. Of the reagents listed in Table 32, water quality parameters are available to quantify the amount of sodium, calcium, sulphur and nitrogen discharged at the Seep.

The flux of water discharged in a time interval was determined using a 10-day moving average centred on a date with water chemistry data. Graphs of the water discharge and corresponding water chemistry are presented on Figure 17, attached, and the results are summarized in Table 29. The flow rate prior to 2006 was estimated at 60 L/min for these calculations. Concentrations during large time intervals in 2003 and 2009 with no analytical data were inferred from data in adjacent time periods.

Cyanides are presented in units of mg/L-N to allow direct comparison to the inorganic nitrogen data (ammonia, nitrate, nitrite). Inorganic nitrogen data is normally reported by laboratories as mg/L-N to allow direct comparison between nitrogen species. The total cyanide concentration as mg/L-N is calculated as follows:

$$\text{Total Cyanides as N} = (14.01\ \text{g/mol}) * [(CN^-)/26.02 + (WAD\text{-}CN)/26.02 + (SAD\text{-}CN)/26.02 + (OCN^-)/42.02 + (SCN^-)/58.08]$$

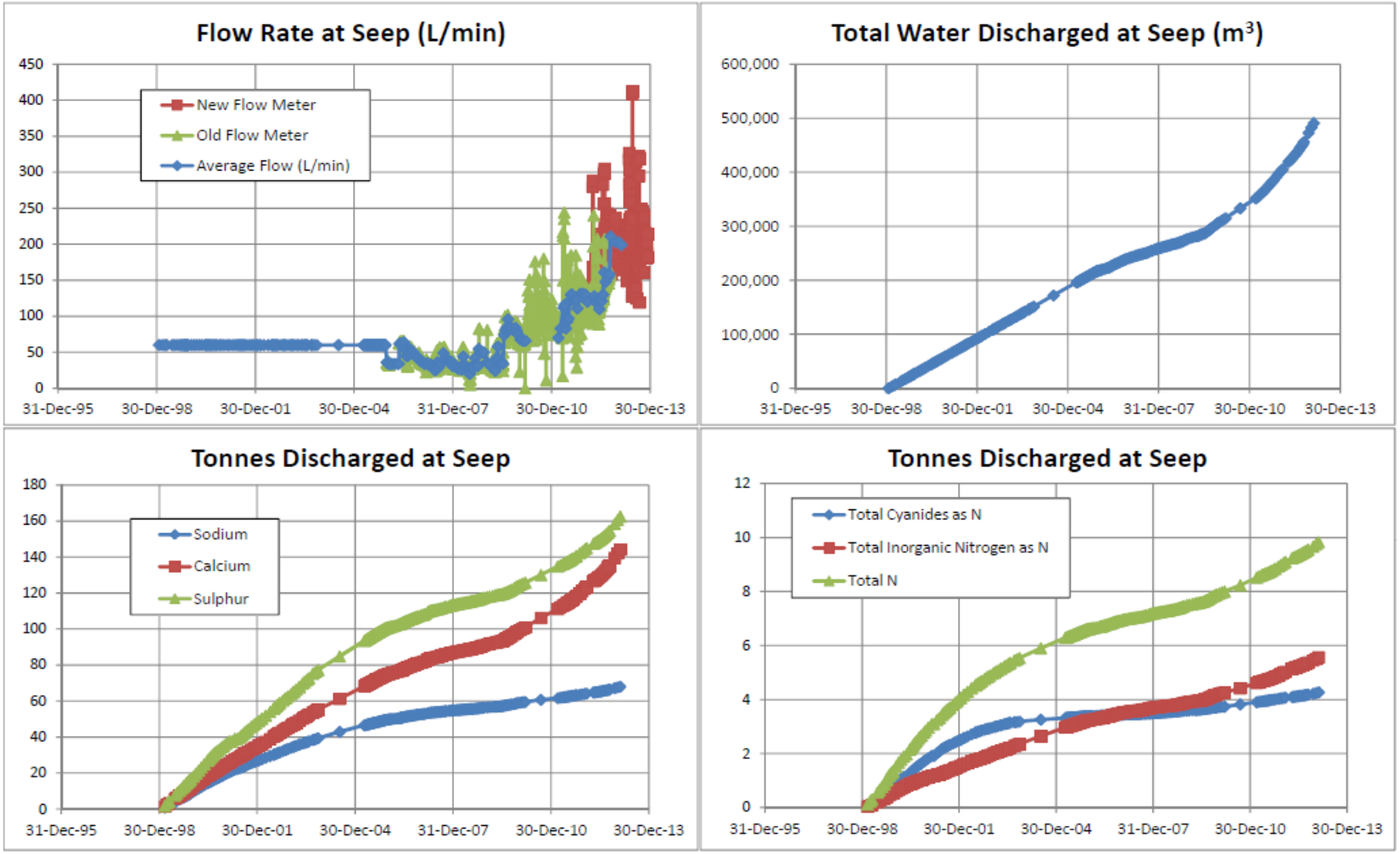


Figure 17: Seep Discharge Data

By calculating total cyanides as N, a direct comparison with the breakdown products (ammonia, nitrate, nitrite) can be completed as presented in Table 33. Total N is the sum of the various cyanide species (free cyanide, WAD-cyanide, SAD-cyanide, cyanate, thiocyanate) and the measured inorganic nitrogen species (ammonia, nitrate, nitrite).

Table 33: Calculation of Tonnes Discharged at Seep versus Reagent Addition at Mill

Parameter	Sodium	Calcium	Sulphur as S	Cyanides as N	Total Inorganic Nitrogen as N
Tonnes of Reagents Added at Mill (from Report R05)					
Mill (Tonnes/year)	90	330	95	53	
Total Mill (three years)	270	990	285	159	
Total Discharge (m^3)					
1999 to 2006	217,600				
2006 to 2013	273,200				
Total 1997 to 2013	490,800				
Tonnes Discharged at Seep					
1999 to 2006	49.7	75.0	100.9	3.4	3.2
2006 to 2013	18.3	69.2	61.6	0.9	2.3
Total 1997 to 2013	68.0	144.2	162.5	4.3	5.6
Tonnes Discharged as Percentage of Reagents added at Mill					
1999 to 2006	18.4%	7.6%	35.4%	4.2%	
2006 to 2013	6.8%	7.0%	21.6%	2.0%	
Total 1997 to 2013	25.2%	14.6%	57.0%	6.2%	
Average Concentrations (mg/L) 1999 to 2013					
Numerical Average	154	299	352	9.1	12.1
Flow Weighted Average	139	294	331	8.7	11.3

Assuming three years of operation at 100,000 m^3/year to produce 300,000 m^3 of tailings.
The design usage for sodium cyanide at the site was 1 kg of NaCN per tonne of ore.
Total Inorganic Nitrogen (i.e. ammonia, nitrate, nitrite) are breakdown products of cyanide degradation.
Note that sulphur present as thiocyanate is not included in this sulphate total.
Based on the concentrations of thiocyanate, including this would increase the total sulphur content by <2.5%.

The data and calculations presented on Figure 17 and summarized in Table 33 show that the equivalent of 57% of the sulphur added at the mill as sodium metabisulphite and copper sulphate has been measured in the discharge at the Seep. In comparison, 25% of the sodium, 15% of the calcium, and 6.2% of the nitrogen has been measured in the discharge at the Seep. These parameters were added as reagents at the mill, and are also naturally occurring; however, the fact that the percentage of the total N discharged is lower than the other three parameters is consistent with the fact that cyanide will be preferentially retained on the tailings solids as iron-cyanide complexes. Nitrogen gas will also be formed by the oxidation of ammonia which would also result in a lower estimate of the total mass of nitrogen discharged in the water at the Seep.

8.4 Water Analytical Results

8.4.1 Regulatory Standards and Data Tables

The water analytical results that were presented in Table 3 of the SI Data Report were evaluated against four sets of potentially applicable regulatory standards. The regulatory standards used for comparison purposes only were:

1. Site Water License;
2. Yukon Contaminated Sites Regulation (CSR) Fresh Water Aquatic Life standards;
3. Canadian Water Quality Guidelines for Fresh Water Aquatic Life; and
4. Metals Mining Effluent Regulation (MMER)

The data tables originally presented in the SI Data Report have been updated and are in Appendix D. Exceedances of the various regulatory standards in groundwater are shown in Table 34. Exceedances of the CCME standards are highlighted with a coloured background, and any exceedances of the other three regulatory standards are **bolded**. As expected, most of the exceedances of the CCME were noted as being for arsenic and cyanides. Other tabular summaries of water quality data are as follows:

- Table 35 presents surface water data with the same highlighting scheme;
- Table 36 presents data for geochemistry samples that are not compared to the regulatory standards;
- Table 37 summarizes the exceedances sorted by analytical parameter; and
- Table 38 summarizes the exceedances sorted by location.

8.4.2 Surface Water Quality Characterization

Surface water quality monitoring was performed at multiple locations across Mount Nansen (Figure 5). Mine property in areas encompasses Back Creek, Dome Creek, Minnesota Creek, Pony Creek and Victoria Creek. The following sections summarize the water quality from each station. Measured concentrations from water quality samples were compared to the CCME Aquatic Life guideline values to identify exceedances.

Dome Creek Water Quality Stations

Surface water quality along Dome Creek has been monitored at eight different monitoring stations. In order of decreasing distance from Victoria Creek, the water quality stations along Dome Creek are WQ-DC-DX, WQ-DC-DX+105, WQ-DC-D1, WQ-DC-D1b, , WQ-DC-U1, WQ-DC-U2, WQ-DC-U and WQ-DC-R, with WQ-DC-R closest to Victoria Creek.

<u>WQ-DC-DX</u>

The period of record for water quality sampling at WQ-DC-DX is from August 2007 to October 2013. A total of 54 samples were collected during this monitoring period. Only three samples were collected in 2007 and no samples were collected in 2010. WQ-DC-DX is located just upstream of the Mill Area.

Table 34: Groundwater Analytical Results 2013

Parameter	Reference Standards and/or Guidelines[1]				Location		MP09-04 Standard Preservation	MP09-04 ALTERNATE PRESERVATION #3 (UNPRESERVED)	MP09-05 STANDARD PRESERVATION	MP09-05 ALTERNATE PRESERVATION #3 (UNPRESERVED)	MP09-09 STANDARD PRESERVATION	MP09-09 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	MP09-09 ALTERNATE PRESERVATION #3 (UNPRESERVED)	MP09-10 STANDARD PRESERVATION	MP09-11 STANDARD PRESERVATION	FIELD DUP A STANDARD PRESERVATION	MP09-11 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	FIELD DUP A ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	MP09-11 ALTERNATE PRESERVATION #3 (UNPRESERVED)	FIELD DUP A ALTERNATE PRESERVATION #3 (UNPRESERVED)	MP09-12 STANDARD PRESERVATION	MP09-12 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	MP09-12 ALTERNATE PRESERVATION #3 (UNPRESERVED)	MW09-01 STANDARD PRESERVATION	MW09-01 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	MW09-01 ALTERNATE PRESERVATION #3 (UNPRESERVED)	MW09-02 STANDARD PRESERVATION	FIELD DUP B STANDARD PRESERVATION	MW09-02 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)
	CCME	Water License Standards	Yukon CSR	MMER	UNITS	Detection limit	18-Sep-13	18-Sep-13	18-Sep-13	18-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13
Physical Tests																														
Conductivity	-	-	-	-	uS/cm	2	1500	-	1950	-	457	-	-	495	1080	1120	-	-	-	-	929	-	-	1740	-	-	2750	2790	-
Hardness (as CaCO3)	-	-	-	-	mg/L	0.5	1160	1140	1290	1340	200	-	203	-	642	630	-	-	705	665	602	-	585	858	-	882	1860	1860	-
pH	6.5 to 9.0	6.5-8.5	-	-	pH	0.10	7.19	-	6.59	-	8.54	-	-	**9.15**	7.84	7.78	-	-	-	-	7.71	-	-	7.42	-	-	7.25	7.33	-
Anions and Nutrients																														
Alkalinity, Bicarbonate (as CaCO3)	-	-	-	-	mg/L	1	341	-	226	-	113	-	-	90.9	686	709	-	-	-	-	430	-	-	341	-	-	97.4	97.9	-
Alkalinity, Carbonate (as CaCO3)	-	-	-	-	mg/L	1	<1.0	-	<1.0	-	11.2	-	-	49.9	<1.0	<1.0	-	-	-	-	<1.0	-	-	<1.0	-	-	<1.0	<1.0	-
Alkalinity, Hydroxide (as CaCO3)	-	-	-	-	mg/L	1	<1.0	-	<1.0	-	<1.0	-	-	<1.0	<1.0	<1.0	-	-	-	-	<1.0	-	-	<1.0	-	-	<1.0	<1.0	-
Alkalinity, Total (as CaCO3)	-	-	-	-	mg/L	1	341	-	226	-	124	-	-	141	686	709	-	-	-	-	430	-	-	341	-	-	97.4	97.9	-
Ammonia, Total (as N)	0.12 - 231 [pH, T]	-	1.31-18.4 [pH]	-	mg/L	0.025	0.010	-	**9.410**	-	**3.21**	-	-	**3.23**	**4.40**	**4.02**	-	-	-	-	**4.67**	-	-	**12.8**	-	-	**10.3**	**9.86**	-
Chloride (Cl)	120	-	-	-	mg/L	5.0	<5.0	-	<10	-	2.3	-	-	2.8	<5.0	<5.0	-	-	-	-	<5.0	-	-	<5.0	-	-	<10	<10	-
Fluoride (F)	0.12		3.0	-	mg/L	0.20	<0.20	-	<0.40	-	**1.5**	-	-	**1.6**	**0.50**	**0.57**	-	-	-	-	**0.35**	-	-	<0.20	-	-	**0.75**	**0.73**	-
Nitrate (as N)	2.9	-	400	-	mg/L	0.050	0.166	-	0.26	-	0.010	-	-	0.033	<0.050	<0.050	-	-	-	-	0.056	-	-	<0.050	-	-	<0.10	0.16	-
Nitrite (as N)	0.060	-	1.0	-	mg/L	0.010	<0.010	-	0.041	-	0.0066	-	-	0.005	0.029	0.012	-	-	-	-	0.019	-	-	<0.010	-	-	0.024	0.031	-
Total Kjeldahl Nitrogen	-	-	-	-	mg/L	0.050	0.37	-	21.3	-	6.6	-	-	35	11	11	-	-	-	-	9.30	-	-	18	-	-	12	10	-
Sulfate (SO4)	-	-	1000	-	mg/L	5	783	-	**1220**	-	101	-	-	108	15	16	-	-	-	-	145	-	-	753	-	-	**1860**	**1890**	-
Sulphide as S	-	-		-	mg/L		-	-	-	-	<0.20	-	-	-	-	-	-	-	-	-	-	-	-	0.27	-	-	<0.020	-	-
Anion Sum	-	-	-	-	meq/L	-	23.1	-	30.0	-	4.7	-	-	-	14.1	14.5	-	-	-	-	11.6	-	-	22.5	-	-	40.8	41.3	-
Cation Sum	-	-	-	-	meq/L	-	23.6	-	33.4	-	5.2	-	-	-	15.0	14.7	-	-	-	-	13.3	-	-	23.1	-	-	41.7	41.4	-
Cation - Anion Balance	-	-	-	-	%	-	1.1	-	5.4	-	5.0	-	-	-	3.2	0.5	-	-	-	-	6.6	-	-	1.3	-	-	1.1	0.2	-
Cyanides																														
Cyanide, Weak Acid Diss	-	0.100	0.050	-	mg/L	0.0050	<0.0050	-	<0.0050	-	0.0058	**0.320**	-	0.0196	<0.0050	<0.0050	<0.0050	<0.0050	-	-	<0.0050	<0.0050	-	<0.0050	0.0100	-	<0.0050	<0.0050	0.0060
Cyanide, Total	-	0.3	-	1.5	mg/L	0.0050	0.011	-	0.0915	-	**2.37**	**0.324**	-	**2.07**	**0.901**	**0.909**	<0.0050	<0.0050	-	-	0.158	<0.0050	-	**0.506**	**0.512**	-	<0.0050	0.0072	0.0200
Thiocyanate (SCN)	-	-	-	-	mg/L	0.50	<0.50	-	2.87	-	0.99	<0.50	-	-	1.2	0.70	<0.50	<0.50	-	-	0.70	<0.50	-	7.1	9.0	-	<0.50	<0.50	<0.50
Thiocyanate (SCN) Alt Pres #1 (HNO3)							<0.50		2.9		<0.50				0.80	0.84					<0.50			7.4			<0.50	<0.50	
Cyanide, Free	0.0050	-	-	-	mg/L	0.0050	<0.0050	-	<0.0050	-	<0.0050	**0.28**	-	**0.0071**	<0.0050	<0.0050	<0.0050	<0.0050	-	-	<0.0050	<0.0050	-	<0.0050	<0.0050	-	<0.0050	<0.0050	<0.0050
Organic / Inorganic Carbon																														
Total Inorganic Carbon	-	-	-	-	mg/L	2.50	78.2	-	48.6	-	21.1	-	-	37.3	146	158	-	-	-	-	81.0	-	-	76.3	-	-	17.2	17.6	-
Total Organic Carbon	-	-	-	-	mg/L	5.00	2.17	-	104.00	-	28.50	-	-	52.50	62.80	61.10	-	-	-	-	19.60	-	-	76.00	-	-	6.31	6.35	-
Dissolved Metals																														
Aluminum (Al)-Dissolved	0.10	-	-	-	mg/L	0.0010	0.0023	<0.0010	0.0409	0.029	0.0021	-	<0.0020	-	0.0094	0.0082	-	-	0.0070	0.0061	0.0031	-	0.0029	0.042	-	0.031	<0.0020	0.0024	-
Antimony (Sb)-Dissolved	-	0.15	0.20	-	mg/L	0.00010	0.0018	0.0018	0.00052	0.00052	0.13	-	0.13	-	0.010	0.010	-	-	0.013	0.013	0.022	-	0.027	0.00081	-	0.00071	0.0040	0.0043	-
Arsenic (As)-Dissolved	-	0.15	0.050	0.75	mg/L	0.00010	0.0014	0.0014	**0.118**	**0.073**	**16**	-	**18**	-	**6.7**	**5.9**	-	-	**9.8**	**6.2**	**4.0**	-	**4.2**	**0.087**	-	**0.0671**	**11**	**10**	-
Barium (Ba)-Dissolved	-	1.0	10.0	-	mg/L	0.000050	0.092	0.095	0.115	0.11	0.0038	-	0.0037	-	0.15	0.14	-	-	0.16	0.12	0.21	-	0.20	0.12	-	0.11	0.0068	0.0069	-
Beryllium (Be)-Dissolved	-	-	0.053	-	mg/L	0.00010	<0.00020	<0.00010	<0.00020	<0.00020	<0.00020	-	<0.00020	-	<0.00010	<0.00010	-	-	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010	-	<0.00010	<0.00020	<0.00020	-
Bismuth (Bi)-Dissolved	-	-		-	mg/L	0.00050	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	-	<0.0010	-	<0.00050	<0.00050	-	-	<0.00050	<0.00050	<0.00050	-	<0.00050	<0.00050	-	<0.00050	<0.0010	<0.0010	-
Boron (B)-Dissolved	-	-	50.0	-	mg/L	0.010	<0.020	0.016	0.106	0.095	<0.020	-	<0.020	-	0.054	0.045	-	-	0.056	0.048	0.036	-	0.044	0.101	-	0.102	0.095	0.102	-
Cadmium (Cd)-Dissolved	0.000028 - 0.00045 [H]	0.02	0.0006	-	mg/L	0.00001	0.000104	0.000114	**0.000381**	**0.000315**	**0.000072**	-	**0.000077**	-	0.000112	0.000098	-	-	0.000085	0.000061	**0.000629**	-	**0.000634**	**0.000328**	-	**0.000319**	**0.000825**	**0.000948**	-
Calcium (Ca)-Dissolved				-	mg/L	0.050	310	295	428	451	76	-	77	-	132	129	-	-	146	135	132	-	125	257	-	269	476	463	-
Chromium (Cr)-Dissolved	0.0089	0.040	0.010	-	mg/L	0.00010	0.00050	0.00048	0.00092	0.00060	<0.00020	-	<0.00020	-	0.0018	0.0019	-	-	0.0019	0.0017	0.00080	-	0.00074	0.0017	-	0.0013	<0.00020	<0.00020	-
Cobalt (Co)-Dissolved	-	-	0.0090	-	mg/L	0.00010	0.00028	0.00036	**0.0152**	**0.015**	**0.015**	-	**0.018**	-	0.0035	0.0036	-	-	0.0036	0.0037	0.0015	-	0.0014	0.0058	-	0.0058	**0.012**	**0.012**	-
Copper (Cu)-Dissolved	0.002-0.004 [H]	0.20	0.090	0.45	mg/L	0.00020	0.0030	0.0032	0.00165	0.0015	**0.17**	-	***0.29***	-	0.0026	0.0021	-	-	0.0016	0.0017	0.0027	-	**0.0045**	0.00064	-	0.00091	0.00045	<0.00040	-
Iron (Fe)-Dissolved	0.30	1.0	-	-	mg/L	0.010	<0.010	<0.010	**56.1**	**53**	0.048	-	0.067	-	***8.8***	***7.8***	-	-	**4.8**	**6.5**	**3.5**	-	**2.7**	***28***	-	***28***	***19***	***17***	-
Lead (Pb)-Dissolved	0.0024-0.0070 [H]	0.10	0.16	0.30	mg/L	0.000050	<0.00010	<0.000050	0.00012	0.00013	0.0025	-	0.0022	-	0.0048	0.0029	-	-	0.0028	0.0024	**0.011**	-	**0.011**	0.00070	-	0.00056	0.00075	0.00092	-
Lithium (Li)-Dissolved	-	-	-	-	mg/L	0.00050	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	-	<0.0010	-	0.0050	0.0045	-	-	0.0045	0.0046	0.0021	-	0.0025	0.0014	-	0.0011	0.014	0.013	-
Magnesium (Mg)-Dissolved	-	-	-	-	mg/L	0.10	94	99	54.2	53	2.5	-	2.4	-	76	75	-	-	83	80	66	-	66	53	-	51	164	171	-
Manganese (Mn)-Dissolved	-	0.50	-	-	mg/L	0.000050	0.0023	0.0024	**10.70**	**12.1**	0.39	-	0.41	-	**6.0**	**6.2**	-	-	**6.6**	**5.5**	**3.2**	-	**3.1**	**5.8**	-	**6.0**	**16**	**16**	-
Mercury (Hg)-Dissolved	2.60E-05	-	1.00E-03	-	mg/L	1.00E-05	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-	<0.000010	-	<0.000010	<0.000010	-	-	<0.000010	<0.000010	<0.000010	-	<0.000010	<0.000010	-	<0.000010	<0.000010	<0.000010	-
Molybdenum (Mo)-Dissolved	0.073	-	10	-	mg/L	0.000050	0.00034	0.00036	0.00073	0.00073	0.015	-	0.013	-	0.010	0.0094	-	-	0.011	0.011	0.0022	-	0.0026	0.0012	-	0.0013	0.0077	0.0083	-
Nickel (Ni)-Dissolved	0.081-0.15 [H]	0.30	1.5	0.75	mg/L	0.00050	<0.0010	0.00059	0.0063	0.0052	0.0098	-	0.012	-	0.015	0.016	-	-	0.015	0.016	0.0055	-	0.0057	0.0029	-	0.0031	0.0040	0.0041	-
Phosphorus (P)-Dissolved	-	-	-	-	mg/L	0.050	<0.050	<0.050	<0.050	<0.25	0.43	-	0.45	-	0.086	0.082	-	-	0.072	0.063	0.097	-	0.083	0.12	-	<0.25	<0.050	<0.050	-
Potassium (K)-Dissolved	-	-	-	-	mg/L	0.10	2.65	2.6	8.5	8.4	11	-	10	-	8.7	8.6	-	-	9.1	10.0	5.9	-	5.9	10	-	11	29	28	-
Selenium (Se)-Dissolved	0.0010	-	0.010	-	mg/L	0.00010	0.00031	0.00023	0.00027	0.00034	0.00057	-	0.00067	-	0.00041	0.00038	-	-	0.00071	0.00049	0.00016	-	0.00027	0.00024	-	0.00049	<0.00020	<0.00020	-
Silicon (Si)-Dissolved	-	-	-	-	mg/L	0.050	5.1	5.0	6.4	6.3	15	-	16	-	10	9.9	-	-	11	11	10	-	9.7	7.0	-	7.1	8.0	8.2	-
Silver (Ag)-Dissolved	0.0001	0.1	0.015	-	mg/L	0.00001	<0.000020	<0.000010	<0.000020	0.000023	0.000056	-	0.000083	-	0.000019	0.00002	-	-	0.000028	0.000015	<0.000010	-	0.000021	0.00001	-	0.000015	<0.000020	<0.000020	-
Sodium (Na)-Dissolved	-	-	-	-	mg/L	0.050	8.9	9.1	76.1	78	16	-	17	-	21	22	-	-	23	23	11	-	9.9	70	-	69	32	32	-
Strontium (Sr)-Dissolved	-	-	-	-	mg/L	0.00020	0.97	0.98	1.09	1.14	0.23	-	0.23	-	0.84	0.79	-	-	0.91	0.85	0.80	-	0.92	0.74	-	0.74	0.87	0.89	-
Sulfur (S)-Dissolved	-		-	-	mg/L	0.50	260	240	408	426	58	-	38	-	7	7	-	-	8	8	56	-	51	237	-	245	616	632	-
Thallium (Tl)-Dissolved	0.0080	-	0.0030	-	mg/L	0.000010	<0.000020	<0.000010	0.000036	0.000037	<0.000020	-	<0.000020	-	<0.000010	<0.000010	-	-	0.000011	<0.000010	0.00011	-	0.00013	<0.000010	-	<0.000010	0.00038	0.00040	-
Tin (Sn)-Dissolved	-	-	-	-	mg/L	0.00010	<0.00020	<0.00010	<0.00020	<0.00020	<0.00020	-	<0.00020	-	0.00041	0.00019	-	-	0.00017	0.00013	<0.00010	-	<0.00010	<0.00010	-	<0.00010	<0.00020	<0.00020	-
Titanium (Ti)-Dissolved	-	-	1.0	-	mg/L	0.010	<0.020	<0.010	<0.020	<0.020	<0.020	-	<0.020	-	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	-	<0.010	<0.010	-	<0.010	<0.020	<0.020	-
Uranium (U)-Dissolved	0.015	-	3.0	-	mg/L	0.000010	0.013	0.013	0.00133	0.0013	0.0019	-	0.0022	-	0.00076	0.00075	-	-	0.00090	0.00087	0.00067	-	0.00076	0.00080	-	0.00081	0.0010	0.0011	-
Vanadium (V)-Dissolved	-	-	-	-	mg/L	0.0010	<0.0020	<0.0010	0.0026	<0.0020	<0.0020	-	<0.0020	-	0.0074	0.0071	-	-	0.0074	0.0060	0.0029	-	0.0025	0.0085	-	0.0064	<0.0020	<0.0020	-
Zinc (Zn)-Dissolved	0.030	0.30	2.4	0.75	mg/L	0.0010	0.0060	0.0073	0.0187	0.015	0.0052	-	0.0035	-	**0.031**	0.026	-	-	0.026	0.019	**0.059**	-	**0.061**	**0.47**	-	**0.42**	**0.42**	**0.45**	-

	Indicates concentration exceeds MMER standard. Note 1
Bold	Indicates concentrations exceeds lowest regulatory standard. Note 1

[H] indicates Hardness dependent standard.

[pH] indicates pH dependent standard.

Note 1. Standard and guidelines are shown for comparative purposes only. They are not intended to reflect what may or may not be the project regulatory criteria.

Table 34: Groundwater Analytical Results 2013

Parameter	Reference Standards and/or Guidelines[1] CCME	Water License Standards	Yukon CSR	MMER	FIELD DUP B ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	MW09-02 ALTERNATE PRESERVATION #3 (UNPRESERVED)	FIELD DUP B ALTERNATE PRESERVATION #3 (UNPRESERVED)	MW09-03 STANDARD PRESERVATION	MW09-03 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	MW09-03 ALTERNATE PRESERVATION #3 (UNPRESERVED)	MW09-04 STANDARD PRESERVATION	MW09-04 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	MW09-04 ALTERNATE PRESERVATION #3 (UNPRESERVED)	MW09-07 STANDARD PRESERVATION	MW09-07 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	MW09-07 ALTERNATE PRESERVATION #3 (UNPRESERVED)	MW09-08 STANDARD PRESERVATION	FIELD DUP C STANDARD PRESERVATION	MW09-08 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	FIELD DUP C ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	MW09-08 ALTERNATE PRESERVATION #3 (UNPRESERVED)	FIELD DUP C ALTERNATE PRESERVATION #3 (UNPRESERVED)	MW09-16 STANDARD PRESERVATION	MW09-16 ALTERNATE PRESERVATION #3 (UNPRESERVED)	MW09-17 STANDARD PRESERVATION	MW09-17 ALTERNATE PRESERVATION #3 (UNPRESERVED)	MW09-18 STANDARD PRESERVATION	MW09-18 ALTERNATE PRESERVATION #3 (UNPRESERVED)
					17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	18-Sep-13	18-Sep-13	18-Sep-13	18-Sep-13	18-Sep-13	18-Sep-13	18-Sep-13	18-Sep-13	18-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13
Physical Tests																											
Conductivity	-	-	-	-	-	-	-	2490	-	-	2480	-	-	1180	-	-	193	194	-	-	-	-	1420	-	2390	-	1970	-
Hardness (as CaCO3)	-	-	-	-	-	1930	1930	1520	-	1600	1610	-	1670	787	-	718	95	89	-	-	81	88	1050	1090	2010	2080	1890	1980
pH	6.5 to 9.0	6.5-8.5	-	-	-	-	-	7.45	-	-	7.77	-	-	***6.38***	-	-	6.51	**6.49**	-	-	-	-	6.89	-	6.94	-	7.01	-
Anions and Nutrients																											
Alkalinity, Bicarbonate (as CaCO3)	-	-	-	-	-	-	-	42	-	-	40	-	-	172	-	-	113	112	-	-	-	-	319	-	503	-	402	-
Alkalinity, Carbonate (as CaCO3)	-	-	-	-	-	-	-	<1.0	-	-	<1.0	-	-	<1.0	-	-	<1.0	<1.0	-	-	-	-	<1.0	-	<1.0	-	<1.0	-
Alkalinity, Hydroxide (as CaCO3)	-	-	-	-	-	-	-	<1.0	-	-	<1.0	-	-	<1.0	-	-	<1.0	<1.0	-	-	-	-	<1.0	-	<1.0	-	<1.0	-
Alkalinity, Total (as CaCO3)	-	-	-	-	-	-	-	42	-	-	40	-	-	172	-	-	113	112	-	-	-	-	319	-	503	-	402	-
Ammonia, Total (as N)	0.12 - 231 [pH, T]	-	1.31-18.4 [pH]	-	-	-	-	**7.72**	-	-	**8.75**	-	-	1.48	-	-	1.97	2.02	-	-	-	-	<0.005	-	<0.005	-	0.017	-
Chloride (Cl)	120	-	-	-	-	-	-	<10	-	-	<10	-	-	<5.0	-	-	<0.500	<0.500	-	-	-	-	<5.0	-	<10	-	<10	-
Fluoride (F)	0.12		3.0	-	-	-	-	**0.64**	-	-	**0.66**	-	-	<0.20	-	-	**0.17**	**0.18**	-	-	-	-	**0.20**	-	<0.40	-	<0.40	-
Nitrate (as N)	2.9	-	400	-	-	-	-	2.7	-	-	<0.10	-	-	0.48	-	-	0.014	<0.0050	-	-	-	-	0.20	-	0.11	-	0.23	-
Nitrite (as N)	0.060	-	1.0	-	-	-	-	**0.098**	-	-	<0.020	-	-	0.034	-	-	0.0028	0.0011	-	-	-	-	<0.010	-	<0.020	-	<0.020	-
Total Kjeldahl Nitrogen	-	-	-	-	-	-	-	9.9	-	-	9.9	-	-	3.4	-	-	3.1	2.8	-	-	-	-	0.33	-	0.28	-	0.24	-
Sulfate (SO4)	-	-	1000	-	-	-	-	**1660**	-	-	**1660**	-	-	624	-	-	<0.50	<0.50	-	-	-	-	747	-	**1580**	-	**1180**	-
Sulphide as S	-	-		-	-	-	-	-	-	-	-	-	-	0.026	-	-	0.074	0.069	-	-	-	-	-	-	-	-	-	-
Anion Sum	-	-	-	-	-	-	-	35.7	-	-	35.4	-	-	16.5	-	-	2.3	2.2	-	-	-	-	21.9	-	43.0	-	32.7	-
Cation Sum	-	-	-	-	-	-	-	34.6	-	-	36.3	-	-	19.0	-	-	4.2	4.1	-	-	-	-	21.6	-	40.8	-	38.4	-
Cation - Anion Balance	-	-	-	-	-	-	-	-1.5	-	-	1.3	-	-	7.2	-	-	29.2	28.7	-	-	-	-	-0.8	-	-2.5	-	8.0	-
Cyanides																											
Cyanide, Weak Acid Diss	-	0.100	0.050	-	<0.0050	-	-	<0.0050	<0.0050	-	<0.0050	<0.0050	-	<0.0050	<0.0050	-	<0.0050	<0.0050	<0.0050	<0.0050	-	-	<0.0050	-	<0.0050	-	<0.0050	-
Cyanide, Total	-	0.3	-	1.5	0.0093	-	-	0.0066	<0.0050	-	<0.0050	<0.0050	-	<0.0050	<0.0050	-	<0.0050	<0.0050	<0.0050	<0.0050	-	-	<0.0050	-	<0.0050	-	<0.0050	-
Thiocyanate (SCN)	-	-	-	-	<0.50	-	-	0.57	<0.50	-	0.56	<0.50	-	0.61	<0.50	-	<0.50	<0.50	<0.50	<0.50	-	-	<0.50	-	<0.50	-	<0.50	-
Thiocyanate (SCN) Alt Pres #1 (HNO3)								<0.50			<0.50			<0.50			<0.50	<0.50					<0.50		<0.50		<0.50	
Cyanide, Free	0.0050	-	-	-	<0.0050	-	-	<0.0050	<0.0050	-	<0.0050	<0.0050	-	<0.0050	<0.0050	-	<0.0050	<0.0050	<0.0050	<0.0050	-	-	<0.0050	-	<0.0050	-	<0.0050	-
Organic / Inorganic Carbon																											
Total Inorganic Carbon	-	-	-	-	-	-	-	7.94	-	-	7.40	-	-	31.1	-	-	24.1	23.6	-	-	-	-	78.7	-	59.7	-	80.6	-
Total Organic Carbon	-	-	-	-	-	-	-	11.90	-	-	5.92	-	-	31.40	-	-	24.50	28.40	-	-	-	-	6.08	-	5.70	-	5.75	-
Dissolved Metals																											
Aluminum (Al)-Dissolved	0.10	-	-	-	-	<0.0020	<0.0020	<0.0020	-	<0.0020	0.0031	-	<0.0020	0.041	-	0.031	0.094	0.090	-	-	0.090	0.092	0.0013	<0.0010	0.0022	<0.0020	<0.0020	<0.0020
Antimony (Sb)-Dissolved	-	0.15	0.20	-	-	0.0044	0.0046	**0.65**	-	**0.78**	**0.22**	-	**0.27**	0.0039	-	0.0052	0.00026	0.00026	-	-	0.00028	0.00026	0.061	0.059	0.00037	0.00040	0.00022	0.00021
Arsenic (As)-Dissolved	-	0.15	0.050	0.75	-	**9.2**	**12**	**3.6**	-	**3.8**	**1.4**	-	**1.0**	**0.512**	-	**0.42**	**0.38**	**0.36**	-	-	**0.37**	**0.39**	0.011	0.011	0.023	0.024	**0.061**	**0.065**
Barium (Ba)-Dissolved	-	1.0	10.0	-	-	0.0067	0.0070	0.0100	-	0.011	0.0071	-	0.0064	0.024	-	0.021	0.11	0.11	-	-	0.11	0.11	0.0127	0.012	0.0078	0.0086	0.0089	0.00919
Beryllium (Be)-Dissolved	-	-	0.053	-	-	<0.00020	<0.00020	<0.00020	-	<0.00020	<0.00020	-	<0.00020	<0.00020	-	<0.00020	<0.00010	<0.00010	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00020	<0.00020	<0.00020
Bismuth (Bi)-Dissolved	-	-		-	-	<0.0010	<0.0010	<0.0010	-	<0.0010	<0.0010	-	<0.0010	<0.0010	-	<0.0010	<0.00050	<0.00050	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.0010
Boron (B)-Dissolved	-	-	50.0	-	-	0.101	0.098	0.152	-	0.183	0.251	-	0.255	0.062	-	0.057	<0.010	<0.010	-	-	<0.010	<0.010	0.085	0.082	0.043	0.044	<0.020	<0.020
Cadmium (Cd)-Dissolved	0.000028 - 0.00045 [H]	0.02	0.0006	-	-	**0.00094**	**0.000908**	0.000318	-	0.000333	0.00005	-	0.000051	0.000127	-	**0.000208**	<0.000010	<0.000010	-	-	<0.000010	0.000016	**0.0194**	**0.0192**	<0.000020	<0.000020	0.000055	0.000053
Calcium (Ca)-Dissolved				-	-	495	492	487	-	515	479	-	507	247	-	220	29	27	-	-	24	26	249	249	365	378	366	374
Chromium (Cr)-Dissolved	0.0089	0.040	0.010	-	-	<0.00020	<0.00020	<0.00020	-	<0.00020	<0.00020	-	<0.00020	0.00075	-	0.00072	0.0012	0.0012	-	-	0.0011	0.0012	<0.00010	<0.00010	<0.00020	<0.00020	<0.00020	<0.00020
Cobalt (Co)-Dissolved	-	-	0.0090	-	-	**0.012**	**0.013**	0.0016	-	0.0017	0.0012	-	0.0013	**0.022**	-	**0.019**	0.00090	0.00089	-	-	0.00096	0.00096	0.00013	<0.00010	<0.00020	<0.00020	<0.00020	<0.00020
Copper (Cu)-Dissolved	0.002-0.004 [H]	0.20	0.090	0.45	-	<0.00040	0.00057	0.0037	-	0.0038	0.00079	-	<0.00040	**0.0069**	-	**0.0069**	0.00021	0.00020	-	-	<0.00020	<0.00020	**0.0057**	**0.0041**	0.00070	0.00095	0.00041	0.00041
Iron (Fe)-Dissolved	0.30	1.0	-	-	-	**15**	**1.1**	<0.010	-	<0.010	<0.010	-	<0.010	**4.0**	-	**3.2**	**36**	**36**	-	-	**38**	**34**	<0.010	<0.010	<0.010	<0.010	0.038	0.025
Lead (Pb)-Dissolved	0.0024-0.0070 [H]	0.10	0.16	0.30	-	0.00064	0.00075	0.00066	-	0.00073	**0.016**	-	0.0015	0.0015	-	0.0016	0.00016	0.0010	-	-	0.00011	0.00013	0.0062	0.0030	<0.00010	<0.00010	<0.00010	<0.00010
Lithium (Li)-Dissolved	-	-	-	-	-	0.013	0.0134	<0.0010	-	0.0014	0.0034	-	0.0033	0.0017	-	0.0013	<0.00050	<0.00050	-	-	<0.00050	<0.00050	0.0084	0.0081	0.017	0.017	0.016	0.016
Magnesium (Mg)-Dissolved	-	-	-	-	-	169	171	74	-	77	102	-	97	41	-	41	5.4	5.4	-	-	4.9	5.3	105	113	267	276	237	254
Manganese (Mn)-Dissolved	-	0.50	-	-	-	**16**	**17**	**1.2**	-	**1.3**	**2.8**	-	**2.6**	**16**	-	**14**	**2.3**	**2.2**	-	-	**2.2**	**2.3**	0.010	0.012	0.00052	0.00039	0.48	**0.52**
Mercury (Hg)-Dissolved	2.60E-05	-	1.00E-03	-	-	<0.000010	<0.000010	<0.000010	-	<0.000010	<0.000010	-	<0.000010	<0.000010	-	<0.000010	<0.000010	<0.000010	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Dissolved	0.073	-	10	-	-	0.0084	0.0081	0.0077	-	0.0089	0.0071	-	0.0072	0.00066	-	0.00059	0.000097	0.000090	-	-	0.000089	0.00011	0.00011	0.00016	<0.00010	<0.00010	<0.00010	<0.00010
Nickel (Ni)-Dissolved	0.081-0.15 [H]	0.30	1.5	0.75	-	0.0041	0.0042	0.0014	-	0.0014	<0.0010	-	<0.0010	0.022	-	0.019	<0.00050	<0.00050	-	-	<0.00050	<0.00050	0.0028	0.0027	<0.0010	<0.0010	<0.0010	0.0011
Phosphorus (P)-Dissolved	-	-	-	-	-	<0.10	<0.050	0.066	-	0.069	<0.050	-	<0.050	<0.050	-	<0.050	0.11	0.11	-	-	0.12	<0.25	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	-	-	-	-	-	26	30	40	-	42	41	-	41	11	-	11	1.4	1.4	-	-	1.2	1.3	6.0	6.0	7.0	7.3	6.9	6.9
Selenium (Se)-Dissolved	0.0010	-	0.010	-	-	<0.00020	<0.00020	<0.00020	-	<0.00020	<0.00020	-	<0.00020	<0.00020	-	<0.00020	0.00013	0.00014	-	-	0.00013	0.00017	<0.00010	0.00011	<0.00020	<0.00020	0.00033	0.00026
Silicon (Si)-Dissolved	-	-	-	-	-	8.1	7.8	10.0	-	10	8.2	-	7.2	10	-	9.2	9.6	9.6	-	-	9.7	9.1	5.2	5.3	4.8	5.0	4.8	4.8
Silver (Ag)-Dissolved	0.0001	0.1	0.015	-	-	<0.000020	<0.000020	0.000021	-	0.00003	<0.000020	-	<0.000020	0.00019	-	**0.000197**	<0.000010	<0.000010	-	-	<0.000010	0.000013	0.000026	0.000016	<0.000020	<0.000020	<0.000020	<0.000020
Sodium (Na)-Dissolved	-	-	-	-	-	31	33	61	-	64	51	-	57	48	-	44	1.4	1.4	-	-	1.4	1.5	6.9	7.6	11	12	10	11
Strontium (Sr)-Dissolved	-	-	-	-	-	0.91	0.91	1.19	-	1.41	1.24	-	1.26	0.61	-	0.55	0.12	0.12	-	-	0.12	0.12	0.51	0.47	1.12	1.14	1.05	1.08
Sulfur (S)-Dissolved	-		-	-	-	638	617	527	-	528	552	-	540	232	-	200	<0.50	1	-	-	<0.50	<2.5	241	227	493	484	458	455
Thallium (Tl)-Dissolved	0.0080	-	0.0030	-	-	0.00041	0.00040	<0.000020	-	<0.000020	<0.000020	-	<0.000020	<0.000020	-	<0.000020	<0.000010	<0.000010	-	-	<0.000010	<0.000010	0.00025	0.00027	0.00016	0.00017	0.00027	0.00026
Tin (Sn)-Dissolved	-	-	-	-	-	<0.00020	<0.00020	0.00046	-	0.00042	<0.00020	-	<0.00020	<0.00020	-	<0.00020	<0.00010	<0.00010	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)-Dissolved	-	-	1.0	-	-	<0.020	<0.020	<0.020	-	<0.020	<0.020	-	<0.020	<0.020	-	<0.020	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.020	<0.020	<0.020	<0.020
Uranium (U)-Dissolved	0.015	-	3.0	-	-	0.0011	0.0010	0.00040	-	0.00046	0.00014	-	0.00012	0.00072	-	0.00061	0.000093	0.000095	-	-	0.000088	0.000090	0.0029	0.0028	0.0090	0.0091	0.0085	0.0088
Vanadium (V)-Dissolved	-	-	-	-	-	<0.0020	<0.0020	<0.0020	-	<0.0020	<0.0020	-	<0.0020	<0.0020	-	<0.0020	0.0040	0.0038	-	-	0.0038	0.0041	<0.0010	<0.0010	<0.0020	<0.0020	<0.0020	<0.0020
Zinc (Zn)-Dissolved	0.030	0.30	2.4	0.75	-	**0.44**	**0.44**	**0.030**	-	**0.031**	**2.8**	-	**3.8**	**0.32**	-	**0.25**	0.0017	0.0019	-	-	<0.0010	<0.0010	**2.5**	**2.7**	0.0021	0.0033	0.0057	0.0041

	Indicates concentration exceeds MMER standard. Note 1
Bold	Indicates concentrations exceeds lowest regulatory standard. Note 1

[H] indicates Hardness dependent standard.

[pH] indicates pH dependent standard.

Note 1. Standard and guidelines are shown for comparative purposes only. They are not intended tc

Table 34: Groundwater Analytical Results 2013

Parameter	Reference Standards and/or Guidelines[1] CCME	Water License Standards	Yukon CSR	MMER	MW09-19 STANDARD PRESERVATION	FIELP DUP D STANDARD PRESERVATION	MW09-19 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	FIELP DUP D ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	MW09-19 ALTERNATE PRESERVATION #3 (UNPRESERVED)	FIELP DUP D ALTERNATE PRESERVATION #3 (UNPRESERVED)	MW09-21 STANDARD PRESERVATION	MW09-21 ALTERNATE PRESERVATION #3 (UNPRESERVED)	MW09-22 STANDARD PRESERVATION	MW09-22 ALTERNATE PRESERVATION #3 (UNPRESERVED)	MW09-23 STANDARD PRESERVATION	MW09-23 ALTERNATE PRESERVATION #3 (UNPRESERVED)	MW09-24 STANDARD PRESERVATION	MW09-24 ALTERNATE PRESERVATION #3 (UNPRESERVED)	GLL07-02 STANDARD PRESERVATION	GLL07-02 ALTERNATE PRESERVATION #3 (UNPRESERVED)	GLL07-03 ALTERNATE PRESERVATION #1 (SCN WITH HNO3)	GLL07-03 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	GLL07-03 ALTERNATE PRESERVATION #3 (UNPRESERVED)	W1410383-BH02 STANDARD PRESERVATION	W1410383-BH02 ALTERNATE PRESERVATION #3 (UNPRESERVED)	W1410383 BH03 STANDARD PRESERVATION	W1410383 BH03 ALTERNATE PRESERVATION #3 (UNPRESERVED)	DC-01
					19-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13	18-Sep-13	18-Sep-13	19-Sep-13	19-Sep-13	18-Sep-13	18-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13	18-Sep-13	18-Sep-13	20-Sep-13	20-Sep-13	28-Sep-13
Physical Tests																												
Conductivity	-	-	-	-	1650	1560	-	-	-	-	1240	-	1030	-	1960	-	808	-	329	-	-	-	-	920	-	807	-	456
Hardness (as CaCO3)	-	-	-	-	1410	1430	-	-	1460	1460	786	832	637	650	1540	1530	590	612	179	168	-	-	731	501	511	423	457	-
pH	6.5 to 9.0	6.5-8.5	-	-	6.84	6.83	-	-	-	-	6.52	-	**6.05**	-	6.84	-	7.41	-	6.55	-	-	-	-	7.65	-	**6.44**	-	7.79
Anions and Nutrients																												
Alkalinity, Bicarbonate (as CaCO3)	-	-	-	-	493	491	-	-	-	-	319	-	61	-	256	-	201	-	84	-	-	-	-	264	-	200	-	87
Alkalinity, Carbonate (as CaCO3)	-	-	-	-	<1.0	<1.0	-	-	-	-	<1.0	-	<1.0	-	<1.0	-	<1.0	-	<1.0	-	-	-	-	-	-	<1.0	-	<1.0
Alkalinity, Hydroxide (as CaCO3)	-	-	-	-	<1.0	<1.0	-	-	-	-	<1.0	-	<1.0	-	<1.0	-	<1.0	-	<1.0	-	-	-	-	-	-	<1.0	-	<1.0
Alkalinity, Total (as CaCO3)	-	-	-	-	493	491	-	-	-	-	319	-	61	-	256	-	201	-	84	-	-	-	-	-	-	200	-	87
Ammonia, Total (as N)	0.12 - 231 [pH, T]	-	1.31-18.4 [pH]	-	2.76	3.03	-	-	-	-	12.4	-	1.34	-	3.86	-	0.008	-	6.80	-	-	-	-	0.022	-	8.53	-	-
Chloride (Cl)	120	-	-	-	<5.0	<5.0	-	-	-	-	<5.0	-	<5.0	-	<10	-	<5.0	-	<0.50	-	-	-	-	<5.0	-	<5.0	-	1.8
Fluoride (F)	0.12		3.0	-	<0.20	**0.21**	-	-	-	-	<0.20	-	<0.20	-	<0.40	-	<0.20	-	0.053	-	-	-	-	<0.20	-	<0.20	-	0.091
Nitrate (as N)	2.9	-	400	-	0.15	0.14	-	-	-	-	<0.050	-	**3.7**	-	<0.10	-	**4.1**	-	0.70	-	-	-	-	0.81	-	<0.050	-	0.21
Nitrite (as N)	0.060	-	1.0	-	<0.010	<0.010	-	-	-	-	<0.010	-	**0.60**	-	<0.020	-	<0.010	-	<0.0010	-	-	-	-	<0.010	-	<0.010	-	0.0016
Total Kjeldahl Nitrogen	-	-	-	-	4.9	4.9	-	-	-	-	16	-	4.0	-	7.0	-	0.31	-	0.59	-	-	-	-	0.49	-	12	-	-
Sulfate (SO4)	-	-	1000	-	794	797	-	-	-	-	538	-	569	-	**1330**	-	327	-	98	-	-	-	-	368	-	269	-	175
Sulphide as S	-	-		-	0.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Anion Sum	-	-	-	-	26.4	26.4	-	-	-	-	17.6	-	13.4	-	32.9	-	11.1	-	3.8	-	-	-	-	13.0	-	9.6	-	-
Cation Sum	-	-	-	-	30.0	30.5	-	-	-	-	20.3	-	17.6	-	33.5	-	12.2	-	4.3	-	-	-	-	10.6	-	14.2	-	-
Cation - Anion Balance	-	-	-	-	6.4	7.1	-	-	-	-	7.2	-	13.7	-	1.0	-	4.5	-	6.1	-	-	-	-	-10.0	-	19.4	-	-
Cyanides																												
Cyanide, Weak Acid Diss	-	0.100	0.050	-	<0.0050	<0.0050	<0.0050	<0.0050	-	-	<0.0050	-	**0.053**	-	<0.0050	-	<0.0050	-	<0.0050	-	-	<0.0050	-	<0.0050	-	<0.0050	-	-
Cyanide, Total	-	0.3	-	1.5	<0.0050	<0.0050	<0.0050	<0.0050	-	-	0.008	-	0.178	-	0.0081	-	0.0270	-	<0.0050	-	-	<0.0050	-	<0.0050	-	<0.0050	-	-
Thiocyanate (SCN)	-	-	-	-	0.51	<0.50	<0.50	<0.50	-	-	1.1	-	0.57	-	<0.50	-	0.51	-	0.59	-	<0.50	<0.50	-	0.53	-	0.72	-	-
Thiocyanate (SCN) Alt Pres #1 (HNO3)					<0.50	<0.50					0.70		<0.50		<0.50		<0.50		<0.50					<0.50		0.73		
Cyanide, Free	0.0050	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	-	-	<0.0050	-	**0.050**	-	<0.0050	-	<0.0050	-	<0.0050	-	-	<0.0050	-	<0.0050	-	<0.0050	-	-
Organic / Inorganic Carbon																												
Total Inorganic Carbon	-	-	-	-	115	116	-	-	-	-	78.8	-	8.5	-	52.6	-	46.7	-	19.1	-	-	-	-	63.6	-	33.9	-	-
Total Organic Carbon	-	-	-	-	35.2	37.6	-	-	-	-	90.9	-	28.0	-	22.2	-	8.59	-	11.6	-	-	-	-	9.74	-	88.2	-	-
Dissolved Metals																												
Aluminum (Al)-Dissolved	0.10	-	-	-	0.0097	0.011	-	-	0.010	0.0074	**0.13**	0.088	0.042	0.024	0.019	0.016	0.0028	0.0014	0.011	0.011	-	-	<0.0010	0.0025	<0.0010	0.049	0.030	-
Antimony (Sb)-Dissolved	-	0.15	0.20	-	0.0002	0.0002	-	-	0.00023	0.00022	0.00018	0.00019	0.00017	0.00012	0.00042	0.00042	0.00020	0.00019	0.0006	0.00058	-	-	<0.00010	0.00021	0.00022	0.00041	0.00037	-
Arsenic (As)-Dissolved	-	0.15	0.050	0.75	**0.099**	**0.087**	-	-	**0.096**	**0.069**	**0.10**	**0.084**	0.007	0.004	0.011	0.010	0.002	0.002	0.001	0.001	-	-	<0.00010	0.0024	0.0028	**0.091**	**0.072**	-
Barium (Ba)-Dissolved	-	1.0	10.0	-	0.052	0.054	-	-	0.053	0.052	0.17	0.15	0.13	0.13	0.096	0.098	0.045	0.046	0.027	0.026	-	-	0.0094	0.12	0.13	0.30	0.25	-
Beryllium (Be)-Dissolved	-	-	0.053	-	<0.00010	<0.00010	-	-	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Bismuth (Bi)-Dissolved	-	-		-	<0.00050	<0.00050	-	-	<0.0010	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.00050	<0.00050	<0.00050	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-
Boron (B)-Dissolved	-	-	50.0	-	0.324	0.344	-	-	0.364	0.346	0.022	0.022	0.020	0.019	0.127	0.125	0.015	0.014	<0.010	<0.010	-	-	<0.010	0.015	0.015	0.017	0.017	-
Cadmium (Cd)-Dissolved	0.000028 - 0.00045 [H]	0.02	0.0006	-	<0.000010	<0.000010	-	-	<0.000020	<0.000010	0.000048	0.000057	0.000034	0.000023	0.000041	0.000066	0.000058	0.000057	**0.000205**	**0.00017**	-	-	**0.00448**	**0.000445**	**0.000395**	0.000022	0.00002	-
Calcium (Ca)-Dissolved				-	306	309	-	-	325	308	251	270	208	215	454	459	172	172	52	49	-	-	220	132	127	118	128	-
Chromium (Cr)-Dissolved	0.0089	0.040	0.010	-	0.00034	0.00037	-	-	0.00032	0.00032	0.0021	0.0016	0.00063	0.00036	0.00043	0.00046	0.00051	0.00049	0.00016	0.00013	-	-	<0.00010	0.00015	0.00016	0.00077	0.00056	-
Cobalt (Co)-Dissolved	-	-	0.0090	-	0.0021	0.0018	-	-	0.0020	0.0019	**0.014**	**0.014**	**0.012**	**0.010**	**0.020**	**0.021**	0.00068	0.00064	<0.00010	<0.00010	-	-	0.0070	0.00024	0.00014	0.0016	0.0018	-
Copper (Cu)-Dissolved	0.002-0.004 [H]	0.20	0.090	0.45	<0.00020	<0.00020	-	-	<0.00040	<0.00020	0.00040	0.00043	0.00151	0.0011	<0.00040	0.00063	**0.0084**	**0.0071**	0.0033	0.0029	-	-	<0.00020	0.0038	0.0032	0.00048	0.00028	-
Iron (Fe)-Dissolved	0.30	1.0	-	-	**14**	**15**	-	-	***14***	***11***	**52**	**51**	**51**	**43**	***19***	**18**	<0.010	<0.010	0.028	0.022	-	-	**3.8**	<0.010	<0.010	**83**	**73**	-
Lead (Pb)-Dissolved	0.0024-0.0070 [H]	0.10	0.16	0.30	<0.000050	0.000052	-	-	<0.00010	<0.000050	0.000071	0.00012	0.00043	0.000089	<0.00010	<0.00010	0.000073	<0.000050	0.00022	0.00012	-	-	<0.000050	<0.000050	<0.000050	0.00014	0.000058	-
Lithium (Li)-Dissolved	-	-	-	-	0.0094	0.010	-	-	0.0094	0.010	0.00064	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.00050	<0.00050	0.00051	-	-	0.016	0.00065	0.00059	<0.00050	0.00072	-
Magnesium (Mg)-Dissolved	-	-	-	-	157	161	-	-	159	167	38	38	29	27	100	93	39	44	12	11	-	-	44	41	47	31	33	-
Manganese (Mn)-Dissolved	-	0.50	-	-	**3.0**	**2.9**	-	-	**3.0**	**3.0**	**4.4**	**4.8**	**7.1**	**7.7**	**5.7**	**5.8**	0.0014	0.0011	0.0020	0.0018	-	-	**4.1**	0.15	0.11	**3.5**	**4.7**	-
Mercury (Hg)-Dissolved	2.60E-05	-	1.00E-03	-	<0.000010	<0.000010	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Molybdenum (Mo)-Dissolved	0.073	-	10	-	0.00013	0.00012	-	-	0.00014	0.00014	0.00030	0.00034	0.00011	0.000096	0.0034	0.0034	0.00034	0.00039	0.00010	0.00010	-	-	<0.000050	0.0013	0.0012	0.00055	0.00055	-
Nickel (Ni)-Dissolved	0.081-0.15 [H]	0.30	1.5	0.75	0.0015	0.0014	-	-	0.0021	0.0014	0.0019	0.0019	0.0013	0.0011	0.0022	0.0020	<0.00050	<0.00050	0.00073	0.00064	-	-	0.016	0.0012	0.00097	0.0014	0.0015	-
Phosphorus (P)-Dissolved	-	-	-	-	0.23	0.25	-	-	0.26	0.18	<0.050	<0.25	<0.050	<0.25	<0.050	<0.25	<0.050	<0.050	<0.050	<0.050	-	-	<0.050	<0.050	<0.050	0.12	<0.25	-
Potassium (K)-Dissolved	-	-	-	-	6.7	6.8	-	-	6.4	7.1	10	11	3.5	3.5	9.4	9.1	1.7	1.6	0.63	0.57	-	-	1.8	3.1	3.2	2.4	2.7	-
Selenium (Se)-Dissolved	0.0010	-	0.010	-	0.00034	0.00031	-	-	<0.00020	0.00022	00.00036	0.00039	0.00043	0.00039	<0.00020	<0.00020	0.00038	0.00054	<0.00010	<0.00010	-	-	<0.00010	0.00094	0.00117	0.00017	0.00023	-
Silicon (Si)-Dissolved	-	-	-	-	8.6	8.5	-	-	8.6	8.5	5.4	5.5	4.9	4.7	5.6	5.4	4.7	4.7	6.2	6.4	-	-	2.9	6.0	6.2	10	11	-
Silver (Ag)-Dissolved	0.0001	0.1	0.015	-	<0.000010	<0.000010	-	-	<0.000020	<0.000010	<0.000010	<0.000010	0.000026	0.00003	<0.000020	<0.000020	<0.000010	<0.000010	0.000023	0.00002	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Sodium (Na)-Dissolved	-	-	-	-	13	12	-	-	13	13	11	11	39	39	22	22	8.1	8.5	4.0	4.1	-	-	6.5	12	13	11	14	-
Strontium (Sr)-Dissolved	-	-	-	-	0.89	0.90	-	-	0.94	0.91	0.66	0.69	0.70	0.75	1.0	1.0	0.65	0.66	0.29	0.30	-	-	0.22	0.60	0.61	0.39	0.45	-
Sulfur (S)-Dissolved	-		-	-	294	310	-	-	312	300	162	171	214	217	428	427	117	112	33	31	-	-	224	84	78	64	66	-
Thallium (Tl)-Dissolved	0.0080	-	0.0030	-	<0.000010	<0.000010	-	-	<0.000020	<0.000010	0.000011	0.000014	<0.000010	<0.000010	<0.000020	<0.000020	<0.000010	<0.000010	<0.000010	<0.000010	-	-	0.000029	<0.000010	<0.000010	<0.000010	<0.000010	-
Tin (Sn)-Dissolved	-	-	-	-	<0.00010	<0.00010	-	-	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	-	-	<0.00010	0.00016	0.00010	<0.00010	<0.00010	-
Titanium (Ti)-Dissolved	-	-	1.0	-	<0.010	<0.010	-	-	<0.020	<0.010	<0.010	<0.010	<0.010	<0.010	<0.020	<0.020	<0.010	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	-
Uranium (U)-Dissolved	0.015	-	3.0	-	0.00098	0.00087	-	-	0.0010	0.00087	0.00056	0.00063	0.00037	0.00024	0.0017	0.0017	0.0097	0.0096	0.00028	0.00023	-	-	0.000013	0.0052	0.0050	0.00060	0.00078	-
Vanadium (V)-Dissolved	-	-	-	-	0.001000	<0.0010	-	-	<0.0020	<0.0010	0.007300	0.0053	0.0011	<0.0010	<0.0020	<0.0020	<0.0010	<0.0010	<0.0010	<0.0010	-	-	<0.0010	<0.0010	<0.0010	0.0025	0.0015	-
Zinc (Zn)-Dissolved	0.030	0.30	2.4	0.75	0.0023	0.0027	-	-	<0.0020	0.0015	0.0040	0.0034	0.0039	0.0030	**0.087**	**0.084**	0.0019	0.0021	0.021	0.019	-	-	**6.2**	0.0057	0.0015	0.0089	0.0029	-

	Indicates concentration exceeds MMER standard. Note 1
Bold	Indicates concentrations exceeds lowest regulatory standard. Note 1

[H] indicates Hardness dependent standard.

[pH] indicates pH dependent standard.

Note 1. Standard and guidelines are shown for comparative purposes only. They are not intended to

Table 34: Groundwater Analytical Results 2013

Parameter	Reference Standards and/or Guidelines[1] CCME	Water License Standards	Yukon CSR	MMER	DC-02	DC-02 (UNPRESERVED)	DC-03	DC-03 (UNPRESERVED)	DC-05	DC-05 (UNPRESERVED)	DC-06	DUP_01	DC-06 (UNPRESERVED)	DUP_01 (UNPRESERVED)	DC-07	DC-07 (UNPRESERVED)	DC-09	DC-09 (UNPRESERVED)	DC-10	DC-10 (UNPRESERVED)	PC-01	PC-01 (UNPRESERVED)	PC-02	PC-05	PC-05 (UNPRESERVED)	HA-01	HA-01 (UNPRESERVED)	HA-02	HA-02 (UNPRESERVED)
					27-Sep-13	28-Sep-13	30-Sep-13	30-Sep-13	30-Sep-13	30-Sep-13	28-Sep-13	28-Sep-13	28-Sep-13	28-Sep-13	28-Sep-13	28-Sep-13	28-Sep-13	28-Sep-13	29-Sep-13	29-Sep-13	30-Sep-13	30-Sep-13	27-Sep-13	30-Sep-13	30-Sep-13	29-Sep-13	29-Sep-13	29-Sep-13	29-Sep-13
Physical Tests																													
Conductivity	-	-	-	-	838	-	924	-	1280	-	1090	1090	-	-	474	-	459	-	666	-	362	-	334	285	-	865	-	774	-
Hardness (as CaCO3)	-	-	-	-	586	599	667	676	759	680	795	788	781	777	222	196	272	257	382	345	167	90	-	156	143	631	667	529	530
pH	6.5 to 9.0	6.5-8.5	-	-	6.99	-	7.68	-	7.27	-	7.35	7.35	-	-	7.05	-	**6.33**	-	**6.32**	-	6.99	-	7.90	7.25	-	7.22	-	**6.41**	-
Anions and Nutrients																													
Alkalinity, Bicarbonate (as CaCO3)	-	-	-	-	300	-	251	-	250	-	785	789	-	-	137	-	52	-	127	-	142	-	70	80	-	223	-	128	-
Alkalinity, Carbonate (as CaCO3)	-	-	-	-	<1.0	-	<1.0	-	<1.0	-	<1.0	<1.0	-	-	<1.0	-	<1.0	-	<1.0	-	<1.0	-	<1.0	<1.0	-	<1.0	-	<1.0	-
Alkalinity, Hydroxide (as CaCO3)	-	-	-	-	<1.0	-	<1.0	-	<1.0	-	<1.0	<1.0	-	-	<1.0	-	<1.0	-	<1.0	-	<1.0	-	<1.0	<1.0	-	<1.0	-	<1.0	-
Alkalinity, Total (as CaCO3)	-	-	-	-	300	-	251	-	250	-	785	789	-	-	137	-	52	-	127	-	142	-	70	80	-	223	-	128	-
Ammonia, Total (as N)	0.12 - 231 [pH, T]	-	1.31-18.4 [pH]	-	1.96	-	0.505	-	0.419	-	2.41	2.27	-	-	1.56	-	4.70	-	1.84	-	-	-	-	0.015	-	0.468	-	1.250	-
Chloride (Cl)	120	-	-	-	<5.0	-	<5.0	-	<5.0	-	7.8	7.8	-	-	1.5	-	0.5	-	2.0	-	2.0	-	0.7	0.5	-	<5.0	-	<5.0	-
Fluoride (F)	0.12		3.0	-	<0.20	-	**0.25**	-	**0.20**	-	**0.51**	**0.42**	-	-	**0.15**	-	0.041	-	**0.16**	-	**0.22**	-	**0.17**	0.073	-	**0.29**	-	<0.20	-
Nitrate (as N)	2.9	-	400	-	0.053	-	<0.050	-	<0.050	-	<0.050	<0.050	-	-	0.031	-	0.021	-	0.065	-	0.074	-	0.047	0.067	-	0.18	-	<0.050	-
Nitrite (as N)	0.060	-	1.0	-	<0.010	-	<0.010	-	<0.010	-	<0.010	<0.010	-	-	0.005	-	0.0018	-	0.0047	-	0.0064	-	0.003	0.002	-	0.021	-	<0.010	-
Total Kjeldahl Nitrogen	-	-	-	-	14	-	17	-	2.2	-	7.9	6.8	-	-	4.4	-	7.4	-	5.1	-	-	-	-	0.58	-	8.3	-	10	-
Sulfate (SO4)	-	-	1000	-	257	-	404	-	681	-	<5.0	<5.0	-	-	132	-	191	-	277	-	51	-	92	76	-	383	-	365	-
Sulphide as S	-	-		-																									
Anion Sum	-	-	-	-	11.4	-	13.4	-	19.2	-	15.9	16.0	-	-	5.6	-	5.0	-	8.4	-	4.0	-	-	3.2	-	12.5	-	10.1	-
Cation Sum	-	-	-	-	14.2	-	13.9	-	16.5	-	18.3	18.1	-	-	6.1	-	7.8	-	12.3	-	4.0	-	-	3.3	-	13.2	-	13.9	-
Cation - Anion Balance	-	-	-	-	11.1	-	1.8	-	-7.7	-	7.0	6.2	-	-	4.6	-	21.8%	-	18.9%	-	0.6	-	-	2.1	-	2.8	-	15.8	-
Cyanides																													
Cyanide, Weak Acid Diss	-	0.100	0.050	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	<0.0050	-	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-	-	<0.0050	-	<0.0050	-	<0.0050	-
Cyanide, Total	-	0.3	-	1.5	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	<0.0050	-	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-	-	<0.0050	-	<0.0050	-	<0.0050	-
Thiocyanate (SCN)	-	-	-	-	<0.50	-	<0.50	-	<0.50	-	<0.50	<0.50	-	-	<0.50	-	<0.50	-	0.66	-	<0.50	-	-	<0.50	-	<0.50	-	<0.50	-
Thiocyanate (SCN) Alt Pres #1 (HNO3)																													
Cyanide, Free	0.0050	-	-	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	<0.0050	-	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-	-	<0.0050	-	<0.0050	-	<0.0050	-
Organic / Inorganic Carbon																													
Total Inorganic Carbon	-	-	-	-	71.4	-	58.9	-	-	-	174	183	-	-	30.9	-	12.4	-	25.8	-	-	-	-	20.4	-	56.0	-	32.5	-
Total Organic Carbon	-	-	-	-	127.0	-	220.0	-	19.1	-	128.0	131.0	-	-	42.8	-	64.7	-	73.2	-	-	-	-	18.5	-	145	-	93.9	-
Dissolved Metals																													
Aluminum (Al)-Dissolved	0.10	-	-	-	0.017	<0.0010	0.0041	0.0019	0.0068	<0.0010	0.025	0.026	0.021	0.021	0.019	0.015	0.055	0.050	**0.237**	**0.212**	**0.107**	0.042	-	0.018	0.010	0.0049	0.0047	0.036	<0.0010
Antimony (Sb)-Dissolved	-	0.15	0.20	-	0.00065	0.00033	0.0039	0.0039	0.0029	0.0015	0.00065	0.00056	0.00085	0.00082	0.0017	0.0013	0.00081	0.00086	0.0025	0.0018	0.00094	0.00066	-	0.0011	0.0014	0.00097	0.0013	0.00055	0.00011
Arsenic (As)-Dissolved	-	0.15	0.050	0.75	**0.19**	0.014	0.0065	0.0065	0.044	0.014	**0.23**	**0.22**	**0.23**	**0.22**	**0.13**	**0.14**	**0.10**	**0.094**	**0.065**	0.043	0.013	0.0035	-	0.0025	0.0021	0.025	0.021	0.026	0.0013
Barium (Ba)-Dissolved	-	1.0	10.0	-	0.21	0.15	0.036	0.035	0.071	0.058	0.33	0.33	0.33	0.32	0.093	0.090	0.082	0.080	0.36	0.31	0.13	0.056	-	0.034	0.030	0.20	0.19	0.065	0.071
Beryllium (Be)-Dissolved	-	-	0.053	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bismuth (Bi)-Dissolved	-	-		-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Boron (B)-Dissolved	-	-	50.0	-	0.026	0.019	0.550	0.564	0.194	0.255	0.093	0.077	0.38	0.32	0.30	0.17	0.75	0.77	0.66	0.68	0.37	0.080	-	0.023	0.020	0.16	0.18	0.28	0.11
Cadmium (Cd)-Dissolved	0.000028 - 0.00045 [H]	0.02	0.0006	-	0.000086	<0.000010	**0.0017**	**0.00142**	0.000164	**0.000268**	<0.000010	0.000015	0.000018	<0.000010	**0.000122**	0.000011	0.000029	0.000014	**0.000281**	**0.000276**	**0.0003**	**0.000152**	-	**0.000251**	**0.000137**	<0.000010	<0.000010	0.000022	<0.000010
Calcium (Ca)-Dissolved				-	150	147	171	167	179	155	199	197	194	193	63	55	74	70	112	101	50	26	-	45	41	163	166	129	119
Chromium (Cr)-Dissolved	0.0089	0.040	0.010	-	0.00027	<0.00010	0.00071	0.00065	0.00060	0.00030	0.0018	0.0018	0.0024	0.0022	0.00094	0.00061	0.0022	0.0018	**0.0098**	0.00640	**0.0117**	0.00291	-	0.00045	<0.00010	0.00019	0.00015	0.00014	<0.00010
Cobalt (Co)-Dissolved	-	-	0.0090	-	0.0023	0.0017	0.0043	0.0043	**0.011**	**0.012**	0.0044	0.0043	0.0047	0.0048	0.0032	0.0030	0.0044	0.0039	**0.027**	**0.0242**	0.00312	0.00104	-	0.00031	0.00014	0.00060	0.00081	0.0075	0.0044
Copper (Cu)-Dissolved	0.002-0.004 [H]	0.20	0.090	0.45	0.00052	<0.00020	**0.10**	**0.074**	0.0023	**0.0048**	0.00063	0.00032	0.0012	0.0012	**0.0053**	0.0021	**0.015**	**0.011**	**0.043**	**0.034**	**0.12**	**0.041**	-	0.014	0.011	0.0011	0.0015	0.0026	0.00025
Iron (Fe)-Dissolved	0.30	1.0	-	-	**35**	**5.9**	0.04	0.044	**6.9**	**3.1**	**18**	**18**	**9.1**	**6.2**	**12**	**11**	**21**	**19**	**83**	**56**	***6.5***	***1.3***	-	0.057	0.029	**3.8**	**2.9**	**47**	**5.3**
Lead (Pb)-Dissolved	0.0024-0.0070 [H]	0.10	0.16	0.30	0.00028	<0.000050	0.00048	0.00051	0.00055	0.00025	0.000070	0.000059	0.00018	0.00017	0.0014	0.00040	0.0019	0.0014	**0.0099**	**0.0086**	**0.014**	**0.0029**	-	0.00043	0.00014	0.00010	0.00014	0.00022	<0.000050
Lithium (Li)-Dissolved	-	-	-	-	<0.00050	<0.00050	0.0046	0.0066	0.0036	0.0045	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.0012	<0.00050	0.0015	0.017	0.0068	<0.00050	<0.00050	-	<0.00050	<0.00050	0.0065	0.0064	<0.00050	<0.00050
Magnesium (Mg)-Dissolved	-	-	-	-	51	57	58	63	76	71	72	72	72	71	16	14	21	20	25	23	11	6.2	-	11	10	54	61	50	56
Manganese (Mn)-Dissolved	-	0.50	-	-	**4.2**	**4.0**	**3.5**	**3.5**	**4.6**	**4.3**	**5.8**	**5.5**	**5.7**	**5.6**	**1.2**	**1.1**	**1.8**	**1.8**	**9.8**	**9.4**	**0.93**	0.21	-	0.034	0.030	0.46	0.49	**9.9**	**9.5**
Mercury (Hg)-Dissolved	2.60E-05	-	1.00E-03	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	1.30E-05	<0.000010	<0.000010	<0.000010	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Dissolved	0.073	-	10	-	0.0043	0.0033	0.013	0.015	0.051	0.049	0.0085	0.0075	0.013	0.014	0.0064	0.0041	0.018	0.019	0.022	0.014	0.013	0.0047	-	0.0019	0.0016	0.0024	0.0031	0.0025	0.00043
Nickel (Ni)-Dissolved	0.081-0.15 [H]	0.30	1.5	0.75	0.015	0.012	0.057	0.057	**0.18**	**0.19**	0.022	0.021	0.034	0.034	0.023	0.018	0.041	0.037	0.11	0.091	0.042	0.017	-	0.010	0.0076	0.0046	0.0050	0.028	0.017
Phosphorus (P)-Dissolved	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.092	0.090	0.083	0.081	<0.050	<0.050	0.13	0.11	0.077	0.081	0.25	<0.050	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	-	-	-	-	3.9	3.9	4.4	4.2	5.8	5.2	3.4	3.3	4.5	4.4	3.2	2.7	3.1	2.9	7.8	5.7	1.2	0.40	-	0.88	0.75	4.0	4.3	3.9	3.7
Selenium (Se)-Dissolved	0.0010	-	0.010	-	<0.00010	<0.00010	0.00010	0.00012	<0.00010	0.00011	0.00051	0.00049	0.00066	0.00068	0.00014	0.00017	0.00013	0.00014	0.00045	0.00045	0.00010	<0.00010	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Silicon (Si)-Dissolved	-	-	-	-	9.0	7.9	7.5	7.6	7.5	7.3	8.8	8.7	8.4	8.1	6.9	7.0	8.2	8.2	9.6	8.6	9.9	8.2	-	5.7	5.8	6.1	6.4	7.2	6.0
Silver (Ag)-Dissolved	0.0001	0.1	0.015	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000014	<0.000010	<0.000010	0.000033	0.000026	0.000062	0.000055	0.000051	0.000013	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)-Dissolved	-	-	-	-	5.5	6.0	6.9	7.1	13	11	23	23	25	24	18	18	18	18	23	23	5.6	3.9	-	4.0	3.6	5.4	5.8	6.5	6.0
Strontium (Sr)-Dissolved	-	-	-	-	0.36	0.34	0.41	0.44	0.60	0.56	0.89	0.83	0.89	0.79	0.22	0.20	0.26	0.28	0.50	0.47	0.28	0.18	-	0.27	0.29	0.39	0.41	0.40	0.42
Sulfur (S)-Dissolved	-		-	-	98	91	137	126	183	147	2	2	2	2	43	37	76	69	101	91	22	20	-	27	23	131	126	126	119
Thallium (Tl)-Dissolved	0.0080	-	0.0030	-	<0.000010	<0.000010	0.000058	0.000054	0.000045	0.000038	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000020	0.000013	<0.000010	-	0.000014	0.000013	<0.000010	<0.000010	<0.000010	<0.000010
Tin (Sn)-Dissolved	-	-	-	-	<0.00010	<0.00010	0.00015	0.00016	<0.00010	<0.00010	<0.00010	0.00030	0.00010	<0.00010	<0.00010	<0.00010	0.00014	0.00013	0.00024	0.00016	0.00022	<0.00010	-	<0.00010	<0.00010	<0.00010	<0.00010	0.00011	<0.00010
Titanium (Ti)-Dissolved	-	-	1.0	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium (U)-Dissolved	0.015	-	3.0	-	0.00030	0.00021	0.0015	0.0016	0.0019	0.0012	0.00041	0.00034	0.0005	0.00049	0.00016	0.000089	0.00024	0.00019	0.00090	0.00072	0.00021	0.000053	-	0.00018	0.00015	0.00058	0.00091	0.00050	0.000094
Vanadium (V)-Dissolved	-	-	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0156	0.0152	0.0133	0.0128	0.0023	0.0024	0.0053	0.0047	0.0175	0.0141	<0.0010	<0.0010	-	<0.0010	<0.0010	0.0016	0.0012	0.0010	<0.0010
Zinc (Zn)-Dissolved	0.030	0.30	2.4	0.75	0.020	0.0063	**0.17**	**0.15**	**0.035**	**0.042**	0.0061	0.0073	0.0053	0.0052	0.019	0.015	**0.031**	0.019	**0.11**	**0.12**	**0.14**	**0.066**	-	0.017	0.0079	0.0064	0.0082	**0.049**	0.013

Indicates concentration exceeds MMER standard. Note 1

Bold Indicates concentrations exceeds lowest regulatory standard. Note 1

[H] indicates Hardness dependent standard.

[pH] indicates pH dependent standard.

Note 1. Standard and guidelines are shown for comparative purposes only. They are not intended to

Table 34: Groundwater Analytical Results 2013

	Reference Standards and/or Guidelines[1]				HA-03	HA-03 (UNPRESERVED)	HA-04	HA-04 (UNPRESERVED)	HA-05	HA-05 (UNPRESERVED)	DUP_02	DUP_02 (UNPRESERVED)	CH-13-03	CH-13-03 (UNPRESERVED)	CH-13-04	CH-13-04 (UNPRESERVED)	CH-13-05	CH-13-05 (UNPRESERVED)
Parameter	**CCME**	**Water License Standards**	**Yukon CSR**	**MMER**	29-Sep-13	29-Sep-13	29-Sep-13	29-Sep-13	29-Sep-13	29-Sep-13	29-Sep-13	29-Sep-13	30-Sep-13	30-Sep-13	30-Sep-13	30-Sep-13	30-Sep-13	30-Sep-13
Physical Tests																		
Conductivity	-	-	-	-	761	-	238	-	803	-	795	-	948	-	505	-	1820	-
Hardness (as CaCO3)	-	-	-	-	530	536	122	104	558	570	561	573	690	725	310	314	1460	1530
pH	6.5 to 9.0	6.5-8.5	-	-	6.59	-	**6.05**	-	6.87	-	6.82	-	7.45	-	7.53	-	**6.06**	-
Anions and Nutrients																		
Alkalinity, Bicarbonate (as CaCO3)	-	-	-	-	135	-	26	-	192	-	197	-	192	-	134	-	44.1	-
Alkalinity, Carbonate (as CaCO3)	-	-	-	-	<1.0	-	<1.0	-	<1.0	-	<1.0	-	<1.0	-	<1.0	-	<1.0	-
Alkalinity, Hydroxide (as CaCO3)	-	-	-	-	<1.0	-	<1.0	-	<1.0	-	<1.0	-	<1.0	-	<1.0	-	<1.0	-
Alkalinity, Total (as CaCO3)	-	-	-	-	135	-	26	-	192	-	197	-	192	-	134	-	44.1	-
Ammonia, Total (as N)	0.12 - 231 [pH, T]	-	1.31-18.4 [pH]	-	0.920	-	3.310	-	0.810	-	0.780	-	0.113	-	0.024	-	0.073	-
Chloride (Cl)	120	-	-	-	<5.0	-	<5.0	-	<5.0	-	<5.0	-	<5.0	-	2.7	-	<10	-
Fluoride (F)	0.12		3.0	-	<0.20	-	0.042	-	<0.20	-	<0.20	-	<0.20	-	0.079	-	<0.40	-
Nitrate (as N)	2.9	-	400	-	<0.050	-	0.028	-	<0.050	-	<0.050	-	0.31	-	0.16	-	**2.7**	-
Nitrite (as N)	0.060	-	1.0	-	<0.010	-	0.001	-	<0.010	-	<0.010	-	<0.010	-	0.007	-	0.029	-
Total Kjeldahl Nitrogen	-	-	-	-	13	-	17	-	1.7	-	2.0	-	1.5	-	0.86	-	0.55	-
Sulfate (SO4)	-	-	1000	-	384	-	86	-	365	-	359	-	491	-	169	-	**1430**	-
Sulphide as S	-	-		-														
Anion Sum	-	-	-	-	10.7	-	2.3	-	11.4	-	11.4	-	14.1	-	6.3	-	30.9	-
Cation Sum	-	-	-	-	12.9	-	4.0	-	13.1	-	13.0	-	14.5	-	6.6	-	30.1	-
Cation - Anion Balance	-	-	-	-	9.4	-	26.9	-	6.6	-	6.5	-	1.6	-	2.4	-	-1.2	-
Cyanides																		
Cyanide, Weak Acid Diss	-	0.100	0.050	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-
Cyanide, Total	-	0.3	-	1.5	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-
Thiocyanate (SCN)	-	-	-	-	<0.50	-	0.61	-	<0.50	-	<0.50	-	<0.50	-	<0.50	-	<0.50	-
Thiocyanate (SCN) Alt Pres #1 (HNO3)																		
Cyanide, Free	0.0050	-	-	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-	<0.0050	-
Organic / Inorganic Carbon																		
Total Inorganic Carbon	-	-	-	-	29.4	-	5.41	-	44.4	-	45.3	-	44.1	-	31.6	-	8.59	-
Total Organic Carbon	-	-	-	-	396	-	124	-	72	-	16.2	-	26.3	-	14.1	-	7.53	-
Dissolved Metals																		
Aluminum (Al)-Dissolved	0.10	-	-	-	0.0132	<0.0010	0.059	0.041	0.016	0.0049	0.014	0.0095	0.0085	0.0054	0.0079	0.0037	**0.46**	**0.35**
Antimony (Sb)-Dissolved	-	0.15	0.20	-	0.0011	0.00037	0.00067	0.00052	0.00068	0.00076	0.00084	0.00067	0.00242	0.00224	0.00090	0.00094	0.00040	0.00043
Arsenic (As)-Dissolved	-	0.15	0.050	0.75	0.013	0.0016	0.011	0.0077	**0.091**	0.037	**0.088**	**0.060**	0.0027	0.0028	0.0011	0.0012	0.00073	0.00066
Barium (Ba)-Dissolved	-	1.0	10.0	-	0.079	0.070	0.11	0.098	0.16	0.14	0.16	0.14	0.048	0.048	0.034	0.036	0.018	0.018
Beryllium (Be)-Dissolved	-	-	0.053	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00022	0.00021
Bismuth (Bi)-Dissolved	-	-		-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010
Boron (B)-Dissolved	-	-	50.0	-	0.72	0.34	0.16	0.10	0.05	0.057	0.039	0.067	0.021	0.020	<0.010	0.011	<0.020	<0.020
Cadmium (Cd)-Dissolved	0.000028 - 0.00045 [H]	0.02	0.0006	-	**0.000296**	0.00002	<0.000010	0.00001	0.000021	0.000028	0.000013	0.000027	**0.00108**	**0.000967**	**0.00058**	**0.000579**	**0.145**	**0.15**
Calcium (Ca)-Dissolved				-	135	129	36	31	148	143	148	144	164	167	71	66	428	444
Chromium (Cr)-Dissolved	0.0089	0.040	0.010	-	0.00084	<0.00010	0.00091	0.00081	0.00021	<0.00010	<0.00010	<0.00010	0.00057	0.00054	0.00028	0.00025	0.00026	0.00025
Cobalt (Co)-Dissolved	-	-	0.0090	-	0.0078	0.0039	0.00099	0.00063	0.0013	0.0014	0.0014	0.0016	0.0035	0.0034	0.0013	0.0012	0.0072	0.0075
Copper (Cu)-Dissolved	0.002-0.004 [H]	0.20	0.090	0.45	0.053	0.0021	0.0011	0.00036	0.00044	0.00025	0.00028	0.00060	**0.010**	**0.0080**	**0.013**	**0.011**	**0.42**	**0.43**
Iron (Fe)-Dissolved	0.30	1.0	-	-	**27**	**2.4**	**20**	**18**	**26**	**4.7**	**24**	**1.5**	0.017	<0.010	<0.010	<0.010	**1.5**	**0.4**
Lead (Pb)-Dissolved	0.0024-0.0070 [H]	0.10	0.16	0.30	0.0015	<0.000050	0.00012	<0.000050	0.00013	<0.000050	0.00012	0.000092	0.00028	0.000092	0.000086	0.000052	**0.011**	**0.0091**
Lithium (Li)-Dissolved	-	-	-	-	0.00066	0.00095	0.0016	0.0010	0.0014	0.00096	0.00099	0.00077	0.0082	0.0086	0.0061	0.0066	0.016	0.016
Magnesium (Mg)-Dissolved	-	-	-	-	47	52	7.5	6.4	46	52	46	52	68	75	32	36	95	103
Manganese (Mn)-Dissolved	-	0.50	-	-	**8.5**	**6.6**	**1.7**	**1.6**	**4.2**	**4.4**	**4.1**	**4.5**	**0.80**	**0.80**	0.21	0.20	**5.6**	**5.8**
Mercury (Hg)-Dissolved	2.60E-05	-	1.00E-03	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Dissolved	0.073	-	10	-	0.0048	0.0018	0.0012	0.00071	0.00093	0.00076	0.00081	0.00084	0.0058	0.0053	0.026	0.026	0.0013	0.0014
Nickel (Ni)-Dissolved	0.081-0.15 [H]	0.30	1.5	0.75	0.038	0.012	0.0091	0.0066	0.0082	0.0077	0.0085	0.0082	0.0085	0.0082	0.0034	0.0035	0.0080	0.009
Phosphorus (P)-Dissolved	-	-	-	-	<0.050	<0.050	0.18	0.22	0.071	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	-	-	-	-	3.6	2.8	0.36	0.30	2.1	2.1	2.1	2.1	5.8	5.9	3.1	2.9	2.4	2.6
Selenium (Se)-Dissolved	0.0010	-	0.010	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00020	0.00022	<0.00010	<0.00010	0.00032	0.00028
Silicon (Si)-Dissolved	-	-	-	-	7.6	6.7	11.4	11.7	7.5	6.8	7.5	6.6	5.6	5.8	5.5	5.7	4.7	4.9
Silver (Ag)-Dissolved	0.0001	0.1	0.015	-	0.000055	<0.000010	<0.000010	<0.000010	0.000012	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000020	<0.000020
Sodium (Na)-Dissolved	-	-	-	-	8.7	6.3	3.5	3.3	5.6	5.7	5.6	5.8	13	13	7.1	7.3	8.0	8.9
Strontium (Sr)-Dissolved	-	-	-	-	0.41	0.38	0.12	0.12	0.38	0.38	0.36	0.37	0.52	0.47	0.39	0.40	0.44	0.45
Sulfur (S)-Dissolved	-		-	-	129	117	35	28	123	113	123	111	169	164	60	53	472	468
Thallium (Tl)-Dissolved	0.0080	-	0.0030	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000022	0.00002	0.000015	0.000017	0.00023	0.00022
Tin (Sn)-Dissolved	-	-	-	-	0.00017	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.016	0.0072	0.0026	0.0020	0.0038	0.0032
Titanium (Ti)-Dissolved	-	-	1.0	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.020	<0.020
Uranium (U)-Dissolved	0.015	-	3.0	-	0.00044	0.00040	0.000042	0.000032	0.00016	0.00021	0.00019	0.00017	0.0020	0.0019	0.00091	0.00075	0.00020	0.00020
Vanadium (V)-Dissolved	-	-	-	-	<0.0010	<0.0010	0.0015	<0.0010	<0.0010	<0.0010	0.0011	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0020	<0.0020
Zinc (Zn)-Dissolved	0.030	0.30	2.4	0.75	**0.17**	0.021	0.0070	0.0035	**0.059**	**0.055**	**0.073**	**0.062**	**0.28**	**0.24**	**0.14**	**0.14**	**6.6**	**6.8**

	Indicates concentration exceeds MMER standard. Note 1
Bold	Indicates concentrations exceeds lowest regulatory standard. Note 1

[H] indicates Hardness dependent standard.

[pH] indicates pH dependent standard.

Note 1. Standard and guidelines are shown for comparative purposes only. They are not intended to

Table 35: Surface Water Analytical Results 2013

			Reference Standards and/or Guidelines[1]				SEEP STANDARD PRESERVATION	SEEP ALTERNATE PRESERVATION #1 (SCN WITH HN03)	SEEP ALTERNATE PRESERVATION #3 (UNPRESERVED)	OPEN PIT-UPPER STANDARD PRESERVATION	OPEN PIT-UPPER STANDARD PRESERVATION-RECIEVED 1-OCT-13	OPEN PIT-UPPER ALTERNATE PRESERVATION #1 (SCN WITH HNO3)	OPEN PIT-UPPER ALTERNATE PRESERVATION #3 (UNPRESERVED)	OPEN PIT-MIDDLE STANDARD PRESERVATION	OPEN PIT-MIDDLE ALTERNATE PRESERVATION #1 (SCN WITH HNO3)	OPEN PIT-MIDDLE ALTERNATE PRESERVATION #3 (UNPRESERVED)	OPEN PIT-BOTTOM STANDARD PRESERVATION	OPEN PIT-BOTTOM ALTERNATE PRESERVATION #1 (SCN WITH HNO3)	OPEN PIT-BOTTOM ALTERNATE PRESERVATION #3 (UNPRESERVED)
							17-Sep-13	17-Sep-13	17-Sep-13	18-SEP-13	18-SEP-13	18-SEP-13	18-SEP-13	18-SEP-13	18-SEP-13	18-SEP-13	18-SEP-13	18-SEP-13	18-SEP-13	18-SEP-13
Parameter	UNITS	Detection limit	**CCME Fresh Water Aquatic Life**	**Water License Standards**	**Yukon CSR Fresh Water Aquatic Life**	**MMER**	L1365603-41	L1365603-42	L1365603-44	L1368203-10	L1368203-18	L1368203-11	L1368203-12	L1368203-7	L1368203-8	L1368203-9	L1368203-4	L1368203-5	L1368203-6
Physical Tests																			
Conductivity	uS/cm	2.0	-	-	-	-	1630	-	-	1500	-	-	-	1500	-	-	1480	-	-
Hardness (as CaCO3)	mg/L	0.50	-	-	-	-	924	-	946	1140	-	-	1120	1120	-	1130	1110	-	1130
pH	pH	0.10	6.5 to 9.0	6.5-8.5	-	-	7.52	-	-	8.03	-	-	-	8.05	-	-	8.02	-	-
Anions and Nutrients																			
Alkalinity, Bicarbonate (as CaCO3)	mg/L	1.0	-	-	-	-	266	-	-										
Alkalinity, Carbonate (as CaCO3)	mg/L	1.0	-	-	-	-	<1.0	-	-										
Alkalinity, Hydroxide (as CaCO3)	mg/L	1.0	-	-	-	-	<1.0	-	-										
Alkalinity, Total (as CaCO3)	mg/L	1.0	-	-	-	-	266	-	-	160	-	-	-	158	-	-	158	-	-
Ammonia, Total (as N)	mg/L	0.025	1.5-7.3 [T, pH]	-	1.31-11.3 [pH]	-	3.94	-	-	<0.0050	-	-	-	<0.0050	-	-	0.0058	-	-
Chloride (Cl)	mg/L	5.0	120	-	-	-	<5.0	-	-	<5.0	-	-	-	<5.0	-	-	<5.0	-	-
Fluoride (F)	mg/L	0.20	0.12		3.0	-	<0.20	-	-	0.22	-	-	-	0.21	-	-	0.21	-	-
Nitrate (as N)	mg/L	0.050	2.9	-	400	-	1.21	-	-	<0.050	-	-	-	<0.050	-	-	<0.050	-	-
Nitrite (as N)	mg/L	0.010	0.060	-	1.0	-	0.029	-	-	<0.010	-	-	-	<0.010	-	-	<0.010	-	-
Total Kjeldahl Nitrogen	mg/L	0.050	-	-	-	-	5.69	-	-	0.093	-	-	-	0.087	-	-	0.096	-	-
Sulfate (SO4)	mg/L	5	-	-	1000	-	754	-	-	951	-	-	-	947	-	-	950	-	-
Sulphide as S	mg/L		-	-		-	<0.020	-	-										
Anion Sum	meq/L	-	-	-	-	-	21.1	-	-	23	-	-	-	22.9	-	-	23	-	-
Cation Sum	meq/L	-	-	-	-	-	21.2	-	-	23.4	-	-	-	23	-	-	22.7	-	-
Cation - Anion Balance	%	-	-	-	-	-	0.3	-	-	0.8	-	-	-	0.3	-	-	-0.5	-	-
Cyanides																			
Cyanide, Weak Acid Diss	mg/L	0.0050	-	0.100	0.050	-	0.0088	-	-	-	<0.0050	-	-	<0.0050	-	-	<0.0050	-	-
Cyanide, Total	mg/L	0.0050	-	0.3	-	1.5	0.0899	-	-	-	<0.0050	-	-	<0.0050	-	-	<0.0050	-	-
Thiocyanate (SCN)	mg/L	0.50	-	-	-	-	2.97	2.90	-	-	<0.50	<0.50	-	<0.50	<0.50	-	0.95	<0.50	-
Cyanide, Free	mg/L	0.0050	0.0050	-	-	-	**0.0053**	-	-	-	<0.0050	-	-	<0.0050	-	-	<0.0050	-	-
Organic / Inorganic Carbon																			
Total Inorganic Carbon	mg/L	2.5	-	-	-	-	57.5	-	-	-	36	-	-	34.4	-	-	33.8	-	-
Total Organic Carbon	mg/L	5.0	-	-	-	-	17.0	-	-	1.5	-	-	-	1.36	-	-	1.32	-	-
Total Metals																			
Aluminum (Al)-Total	mg/L	0.0010	0.10	-	-	-	0.0208	-	0.0220	0.0054	-	-	0.0079	0.0056	-	0.0159	0.0108	-	0.0446
Antimony (Sb)-Total	mg/L	0.00010	-	0.15	0.20	-	0.00070	-	0.00061	0.0037	-	-	0.00372	0.00361	-	0.00365	0.00364	-	0.00366
Arsenic (As)-Total	mg/L	0.0001	-	0.15	0.050	0.75	0.0487	-	0.0467	0.0116	-	-	0.0109	0.0114	-	0.0109	0.0114	-	0.0111
Barium (Ba)-Total	mg/L	0.000050	-	1.0	10.0	-	0.0682	-	0.0693	0.0121	-	-	0.0119	0.012	-	0.0121	0.012	-	0.0122
Beryllium (Be)-Total	mg/L	0.00010	-	-	0.053	-	<0.00010	-	<0.00010	<0.00010	-	-	<0.00010	<0.00010	-	<0.00010	<0.00010	-	<0.00010
Bismuth (Bi)-Total	mg/L	0.00050	-	-		-	<0.00050	-	<0.00050	<0.00050	-	-	<0.00050	<0.00050	-	<0.00050	<0.00050	-	<0.00050
Boron (B)-Total	mg/L	0.010	-	-	50.0	-	0.067	-	0.076	<0.010	-	-	<0.010	<0.010	-	<0.010	<0.010	-	<0.010
Cadmium (Cd)-Total	mg/L	1.00E-05	0.00022 - 0.00027 [H]	2.00E-02	6.00E-04	-	**5.44E-04**	-	**5.46E-04**	**2.82E-03**	-	-	**2.73E-03**	**2.76E-03**	-	**2.74E-03**	**2.69E-03**	-	**2.78E-03**
Calcium (Ca)-Total	mg/L	0				-	276	-	282	311	-	-	307	307	-	310	301	-	309
Chromium (Cr)-Total	mg/L	0.00010	0.0089	0.040	0.010	-	0.00056	-	0.00052	0.00024	-	-	0.00017	0.00019	-	0.00012	0.00017	-	0.00011
Cobalt (Co)-Total	mg/L	0.00010	-	-	0.0090	-	0.00738	-	0.00745	<0.00010	-	-	<0.00010	<0.00010	-	<0.00010	<0.00010	-	<0.00010
Copper (Cu)-Total	mg/L	0.00020	0.002-0.004 [H]	0.20	0.090	0.45	**0.00468**	-	**0.00479**	0.0021	-	-	0.00182	0.00197	-	0.00192	0.00195	-	0.00191
Iron (Fe)-Total	mg/L	0.0	0.30	1.0	-	-	**9.18**	-	**8.74**	0.037	-	-	0.026	0.036	-	0.028	0.048	-	0.032
Lead (Pb)-Total	mg/L	0.000050	0.0010-0.0070 [H]	0.10	0.16	0.30	0.000129	-	0.000103	0.000435	-	-	0.00034	0.000457	-	0.000357	0.000685	-	0.000424
Lithium (Li)-Total	mg/L	0.00050	-	-	-	-	0.00068	-	0.00080	0.00877	-	-	0.00874	0.00842	-	0.00856	0.00835	-	0.00861
Magnesium (Mg)-Total	mg/L	0.1	-	-	-	-	57.0	-	59.2	87.9	-	-	86.4	86.5	-	86.8	86.2	-	87.9
Manganese (Mn)-Total	mg/L	0.00	-	0.50	-	-	**5.60**	-	**5.61**	0.0535	-	-	0.0525	0.0521	-	0.0523	0.0525	-	0.0527
Mercury (Hg)-Total	mg/L	0.000010	0.000026	-	0.0010	-	<0.000010	-	<0.000010	<0.000010	-	-	<0.000010	<0.000010	-	<0.000010	<0.000050	-	<0.000010
Molybdenum (Mo)-Total	mg/L	0.000050	0.073	-	10	-	0.000914	-	0.00106	0.000149	-	-	0.000173	0.000164	-	0.00015	0.00019	-	0.000162
Nickel (Ni)-Total	mg/L	0.00050	0.025-0.15 [H]	0.30	1.5	0.75	0.00280	-	0.00275	<0.00050	-	-	<0.00050	<0.00050	-	<0.00050	<0.00050	-	<0.00050
Phosphorus (P)-Total	mg/L	0.050	-	-	-	-	<0.050	-	<0.050	<0.050	-	-	<0.050	<0.050	-	<0.050	<0.050	-	<0.050
Potassium (K)-Total	mg/L	0.10	-	-	-	-	5.76	-	5.93	3.89	-	-	3.72	3.79	-	3.76	3.71	-	3.8
Selenium (Se)-Total	mg/L	0.00010	0.0010	-	0.010	-	0.00020	-	0.00020	<0.00010	-	-	<0.00010	<0.00010	-	<0.00010	<0.00010	-	<0.00010
Silicon (Si)-Total	mg/L	0.050	-	-	-	-	6.56	-	6.67	2.96	-	-	2.86	2.87	-	2.9	2.84	-	2.9
Silver (Ag)-Total	mg/L	0.000010	0.00010	0.10	0.015	-	0.000025	-	0.000035	<0.000010	-	-	<0.000010	<0.000010	-	<0.000010	0.000012	-	0.000012
Sodium (Na)-Total	mg/L	0.050	-	-	-	-	37.5	-	38.3	11.7	-	-	11.7	11.5	-	11.5	11.2	-	11.5
Strontium (Sr)-Total	mg/L	0.00020	-	-	-	-	0.703	-	0.830	0.969	-	-	0.965	0.95	-	0.957	0.924	-	0.959
Sulfur (S)-Total	mg/L	1	-		-	-	249	-	254	331	-	-	327	326	-	329	320	-	330
Thallium (Tl)-Total	mg/L	0.00001	0.0080	-	0.0030	-	<0.000010	-	<0.000010	0.000079	-	-	0.000076	0.00008	-	0.000078	0.000076	-	0.000077
Tin (Sn)-Total	mg/L	0.00010	-	-	-	-	<0.00010	-	<0.00010	<0.00010	-	-	<0.00010	<0.00010	-	<0.00010	<0.00010	-	<0.00010
Titanium (Ti)-Total	mg/L	0.010	-	-	1.0	-	<0.010	-	<0.010	<0.010	-	-	<0.010	<0.010	-	<0.010	<0.010	-	<0.010
Uranium (U)-Total	mg/L	0.000010	0.015	-	3.0	-	0.00307	-	0.00361	0.00402	-	-	0.00402	0.00398	-	0.004	0.00398	-	0.00401
Vanadium (V)-Total	mg/L	0.0010	-	-	-	-	0.0019	-	0.0019	<0.0010	-	-	<0.0010	<0.0010	-	<0.0010	<0.0010	-	<0.0010
Zinc (Zn)-Total	mg/L	0.0010	0.030	0.30	2.4	0.75	0.0084	-	0.0084	**0.293**	-	-	**0.29**	**0.288**	-	**0.29**	**0.283**	-	**0.292**

Indicates concentration exceeds MMER standard.

Bold Indicates concentrations exceeds lowest regulatory standard.

[H] indicates Hardness dependent standard.

[pH] indicates pH dependent standard.

Note 1. Standard and guidelines are shown for comparative purposes only. They are not intended to reflect what may or may not be the project regulatory criteria.

Table 36: Leachate Analytical Results - Geochemistry Samples 2013

Parameter	UNITS	Sample ID	ORE LEACHATE	TAILINGS + ORG	TAILINGS SAND LEACHATE	WASTE ROCK + ORG	WASTE ROCK LEACHATE
		Date Sampled	18-SEP-13	18-SEP-13	18-SEP-13	18-SEP-13	18-SEP-13
		ALS Sample ID	L1368203-13	L1368203-14	L1368203-15	L1368203-16	L1368203-17
Physical Tests							
Conductivity	uS/cm		2570	1960	1640	2290	2750
Hardness (as CaCO3)	mg/L		2530	1800	1250	1980	2150
pH	pH		7.54	6.85	8.08	7.52	6.17
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	mg/L		28	65.3	27	35	77.5
Ammonia, Total (as N)	mg/L		-	-	-	-	-
Chloride (Cl)	mg/L		<10	<10	<5.0	<10	<10
Fluoride (F)	mg/L		<0.40	<0.40	0.28	<0.40	<0.40
Nitrate (as N)	mg/L		<0.10	<0.10	<0.050	<0.10	0.12
Nitrite (as N)	mg/L		<0.020	<0.020	<0.010	<0.020	<0.020
Total Kjeldahl Nitrogen	mg/L		-	-	-	-	-
Sulfate (SO4)	mg/L		2540	1670	1210	1950	2410
Sulphide as S	mg/L						
Anion Sum	meq/L		53.4	36	25.7	41.4	51.8
Cation Sum	meq/L		50.9	37.3	25.2	39.8	48.4
Cation - Anion Balance	%		-2.3	1.8	-1.1	-2	-3.3
Total Metals							
Aluminum (Al)-Total	mg/L		0.0872	0.0202	0.0073	0.605	0.059
Antimony (Sb)-Total	mg/L		0.0368	0.0134	0.0808	0.00801	<0.0010
Arsenic (As)-Total	mg/L		0.119	0.00373	0.00185	0.0503	0.0037
Barium (Ba)-Total	mg/L		0.0112	0.0219	0.0389	0.0536	0.0266
Beryllium (Be)-Total	mg/L		<0.00020	<0.00020	<0.00020	<0.00020	<0.0010
Bismuth (Bi)-Total	mg/L		<0.0010	<0.0010	<0.0010	<0.0010	<0.0050
Boron (B)-Total	mg/L		<0.020	0.036	<0.020	<0.020	<0.10
Cadmium (Cd)-Total	mg/L		0.0181	0.015	0.000924	0.00642	0.0304
Calcium (Ca)-Total	mg/L		400	566	445	445	477
Chromium (Cr)-Total	mg/L		0.00021	0.0002	<0.00020	0.0003	<0.0010
Cobalt (Co)-Total	mg/L		<0.00020	0.00562	0.00834	0.00028	0.0231
Copper (Cu)-Total	mg/L		0.0093	0.0051	0.0013	0.0175	<0.0050
Iron (Fe)-Total	mg/L		0.314	0.042	0.012	2.38	0.353
Lead (Pb)-Total	mg/L		0.0188	0.00034	<0.00010	0.0379	<0.00050
Lithium (Li)-Total	mg/L		0.0073	0.0141	0.0014	0.0038	0.0284
Magnesium (Mg)-Total	mg/L		357	86.7	38.6	191	263
Manganese (Mn)-Total	mg/L		0.625	5.17	0.00603	0.158	96.2
Mercury (Hg)-Total	mg/L		0.000015	<0.000010	<0.000010	0.000012	<0.000010
Molybdenum (Mo)-Total	mg/L		0.00011	0.00015	0.00094	0.00015	<0.00050
Nickel (Ni)-Total	mg/L		0.0011	0.0173	0.0035	<0.0010	0.098
Phosphorus (P)-Total	mg/L		<0.050	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Total	mg/L		6.3	31.3	4.78	5.42	37.1
Selenium (Se)-Total	mg/L		<0.00020	<0.00020	<0.00020	<0.00020	<0.0010
Silicon (Si)-Total	mg/L		5.56	6.23	4.74	2.8	8.89
Silver (Ag)-Total	mg/L		0.00039	<0.000020	<0.000020	0.000901	<0.00010
Sodium (Na)-Total	mg/L		2.26	4.17	0.96	1.43	6.83
Strontium (Sr)-Total	mg/L		0.698	1.4	0.448	0.714	1.48
Sulfur (S)-Total	mg/L		809	591	411	628	812
Thallium (Tl)-Total	mg/L		0.000135	0.000168	0.000036	0.000198	0.00037
Tin (Sn)-Total	mg/L		<0.00020	<0.00020	<0.00020	<0.00020	<0.0010
Titanium (Ti)-Total	mg/L		<0.020	<0.020	<0.020	<0.020	<0.10
Uranium (U)-Total	mg/L		0.000134	0.000272	0.000767	0.000749	<0.00010
Vanadium (V)-Total	mg/L		<0.0020	<0.0020	<0.0020	<0.0020	<0.010
Zinc (Zn)-Total	mg/L		1.24	1.16	0.0204	0.207	7.21
Dissolved Metals							
Dissolved Mercury Filtration Location	-		FIELD	FIELD	FIELD	FIELD	FIELD
Dissolved Metals Filtration Location	-		FIELD	FIELD	FIELD	FIELD	FIELD
Aluminum (Al)-Dissolved	mg/L		0.0046	0.0044	0.0071	0.003	0.011
Antimony (Sb)-Dissolved	mg/L		0.033	0.0155	0.0811	0.00246	0.0012
Arsenic (As)-Dissolved	mg/L		0.0987	0.00192	0.0017	0.00312	0.0034
Barium (Ba)-Dissolved	mg/L		0.01	0.022	0.0389	0.0116	0.0255
Beryllium (Be)-Dissolved	mg/L		<0.00020	<0.00020	<0.00020	<0.00020	<0.0010
Bismuth (Bi)-Dissolved	mg/L		<0.0010	<0.0010	<0.0010	<0.0010	<0.0050
Boron (B)-Dissolved	mg/L		<0.020	0.03	<0.020	<0.020	<0.10
Cadmium (Cd)-Dissolved	mg/L		0.0178	0.0219	0.000901	0.00528	0.00841
Calcium (Ca)-Dissolved	mg/L		411	568	437	468	453
Chromium (Cr)-Dissolved	mg/L		<0.00020	<0.00020	0.00029	<0.00020	<0.0010
Cobalt (Co)-Dissolved	mg/L		<0.00020	0.00497	0.00822	<0.00020	0.0369
Copper (Cu)-Dissolved	mg/L		0.00608	0.00418	0.00109	0.00206	0.0025
Iron (Fe)-Dissolved	mg/L		<0.010	0.0	0.0	<0.010	0.2
Lead (Pb)-Dissolved	mg/L		0.00022	<0.00010	<0.00010	<0.00010	<0.00050
Lithium (Li)-Dissolved	mg/L		0.0068	0.0144	0.0014	0.0035	0.0268
Magnesium (Mg)-Dissolved	mg/L		366.0	92.0	38.9	197.0	248.0
Manganese (Mn)-Dissolved	mg/L		0.60	7.99	0.00	0.06	109.00
Mercury (Hg)-Dissolved	mg/L		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Dissolved	mg/L		<0.00010	0.00019	0.00089	<0.00010	<0.00050
Nickel (Ni)-Dissolved	mg/L		0.001	0.0274	0.0033	<0.0010	0.097
Phosphorus (P)-Dissolved	mg/L		<0.050	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	mg/L		6.56	33.7	4.91	4.98	35.6
Selenium (Se)-Dissolved	mg/L		<0.00020	<0.00020	<0.00020	<0.00020	<0.0010
Silicon (Si)-Dissolved	mg/L		5.61	6.34	4.67	1.94	8.29
Silver (Ag)-Dissolved	mg/L		0.000032	<0.000020	<0.000020	<0.000020	<0.00010
Sodium (Na)-Dissolved	mg/L		2.25	4.07	0.96	1.4	6.69
Strontium (Sr)-Dissolved	mg/L		0.673	1.35	0.441	0.692	1.36
Sulfur (S)-Dissolved	mg/L		813	592	403	642	749
Thallium (Tl)-Dissolved	mg/L		0.000117	0.000184	0.000035	0.000091	0.00039
Tin (Sn)-Dissolved	mg/L		<0.00020	<0.00020	<0.00020	<0.00020	<0.0010
Titanium (Ti)-Dissolved	mg/L		<0.020	<0.020	<0.020	<0.020	<0.10
Uranium (U)-Dissolved	mg/L		0.000119	0.00032	0.000743	0.000638	0.00014
Vanadium (V)-Dissolved	mg/L		<0.0020	<0.0020	<0.0020	<0.0020	<0.010
Zinc (Zn)-Dissolved	mg/L		1.2	1.52	0.0185	0.11	7.42

Table 37: Summary of 2013 Water Quality Exceedances

Location	Reference Standards and/or Guidelines[1]	Total Number of 2013 Exceedances	Iron	Zinc	Arsenic	Maganese	Cadmium	pH	Fluoride	Copper	Ammonia	Cobalt	Sulphate	Lead	Aluminum	Antimony	Chromium	Nitrate	Cyanide (Total)	Cyanide (Free)	Nitrite	Cyanide-WAD	Nickel
Total Number of Exceedances		266	51	36	30	28	26	17	14	13	9	8	6	5	4	4	3	3	3	2	2	1	1
Percentage of Total			19%	14%	11%	11%	10%	6%	5%	5%	3%	3%	2%	2%	2%	2%	1%	1%	1%	1%	1%	0.4%	0.4%
MP09-05	CCME	2	x								x												
	Water License	0																					
	Yukon CSR	3	x			x						x											
	MMER	0																					
MP09-09	CCME	4					x			x	x							x					
	Water License	3			x					x												x	
	Yukon CSR	3			x					x		x											
	MMER	1			x																		
MP09-10	CCME	4						x	x		x									x			
	Water License	2						x											x				
	Yukon CSR	0																					
	MMER	1																	x				
MP09-11	CCME	4	x	x					x		x												
	Water License	2	x		x																		
	Yukon CSR	1			x																		
	MMER	1			x																		
MP09-12	CCME	6	x	x			x		x		x			x									
	Water License	2	x		x																		
	Yukon CSR	2			x		x																
	MMER	1			x																		
MW09-01	CCME	4	x	x			x				x												
	Water License	2	x																x				
	Yukon CSR	3		x	x	x																	
	MMER	0																					
MW09-02	CCME	5	x	x			x		x		x												
	Water License	3	x	x	x																		
	Yukon CSR	5			x	x	x					x	x										
	MMER	1			x																		
MW09-03	CCME	4		x					x		x										x		
	Water License	2			x											x							
	Yukon CSR	4			x	x							x			x							
	MMER	1			x																		
MW09-04	CCME	4		x					x		x			x									
	Water License	3		x	x											x							
	Yukon CSR	5		x	x	x							x			x							
	MMER	2		x	x																		
MP09-07	CCME	5	x	x			x	x		x													
	Water License	4	x	x	x			x															
	Yukon CSR	3			x	x						x											
	MMER	0																					

Table 37: Summary of 2013 Water Quality Exceedances

Location	Reference Standards and/or Guidelines[1]	Total Number of 2013 Exceedances	Iron	Zinc	Arsenic	Maganese	Cadmium	pH	Fluoride	Copper	Ammonia	Cobalt	Sulphate	Lead	Aluminum	Antimony	Chromium	Nitrate	Cyanide (Total)	Cyanide (Free)	Nitrite	Cyanide-WAD	Nickel
MW09-08	CCME	3	x					x	x														
	Water License	3	x		x			x															
	Yukon CSR	2			x	x																	
	MMER	0																					
MW09-16	CCME	4		x			x		x	x													
	Water License	1		x																			
	Yukon CSR	2		x			x																
	MMER	1		x																			
MW09-17	CCME	0																					
	Water License	0																					
	Yukon CSR	1											x										
	MMER	0																					
MW09-18	CCME	0																					
	Water License	0																					
	Yukon CSR	2				x							x										
	MMER	0																					
MW09-19	CCME	2	x						x														
	Water License	1	x																				
	Yukon CSR	1				x																	
	MMER	0																					
MW09-21	CCME	2	x												x								
	Water License	1	x																				
	Yukon CSR	2				x						x											
	MMER	0																					
MW09-22	CCME	5	x					x										x		x	x		
	Water License	2	x					x															
	Yukon CSR	1				x																	
	MMER	0																					
MP09-23	CCME	2	x	x																			
	Water License	1	x																				
	Yukon CSR	3				x						x	x										
	MMER	0																					
MW09-24	CCME	2								x								x					
	Water License	0																					
	Yukon CSR	0																					
	MMER	0																					
GLL07-02	CCME	1					x																
	Water License	0																					
	Yukon CSR	0																					
	MMER	0																					

Table 37: Summary of 2013 Water Quality Exceedances

Location	Reference Standards and/or Guidelines[1]	Total Number of 2013 Exceedances	Iron	Zinc	Arsenic	Maganese	Cadmium	pH	Fluoride	Copper	Ammonia	Cobalt	Sulphate	Lead	Aluminum	Antimony	Chromium	Nitrate	Cyanide (Total)	Cyanide (Free)	Nitrite	Cyanide-WAD	Nickel
GLL07-03	CCME	3	x	x			x																
	Water License	2	x	x																			
	Yukon CSR	3		x		x	x																
	MMER	1		x																			
W1410383-BH02	CCME	1					x																
	Water License	0																					
	Yukon CSR	0																					
	MMER	0																					
W1410383-BH03	CCME	2	x					x															
	Water License	1	x																				
	Yukon CSR	1				x																	
	MMER	0																					
DC-02	CCME	1	x																				
	Water License	2	x		x																		
	Yukon CSR	1				x																	
	MMER	0																					
DC-03	CCME	4		x			x		x	x													
	Water License	0																					
	Yukon CSR	3				x	x			x													
	MMER	0																					
DC-05	CCME	5	x	x			x		x														x
	Water License	1	x																				
	Yukon CSR	2				x						x											
	MMER	0																					
DC-06	CCME	2	x						x														
	Water License	2	x		x																		
	Yukon CSR	2			x	x																	
	MMER	0																					
DC-07	CCME	3	x				x			x													
	Water License	1	x																				
	Yukon CSR	2			x	x																	
	MMER	0																					
DC-09	CCME	4	x	x				x		x													
	Water License	2	x					x															
	Yukon CSR	2			x	x																	
	MMER	0																					
DC-10	CCME	9	x	x			x	x	x	x				x	x		x						
	Water License	2	x					x															
	Yukon CSR	3			x	x						x											
	MMER	0																					

Table 37: Summary of 2013 Water Quality Exceedances

Location	Reference Standards and/or Guidelines[1]	Total Number of 2013 Exceedances	Iron	Zinc	Arsenic	Maganese	Cadmium	pH	Fluoride	Copper	Ammonia	Cobalt	Sulphate	Lead	Aluminum	Antimony	Chromium	Nitrate	Cyanide (Total)	Cyanide (Free)	Nitrite	Cyanide-WAD	Nickel
PC-01	CCME	7	x	x			x			x				x	x		x						
	Water License	1	x																				
	Yukon CSR	3				x				x							x						
	MMER	0																					
PC-05	CCME	1					x																
	Water License	0																					
	Yukon CSR	0																					
	MMER	0																					
HA-01	CCME	2	x						x														
	Water License	1	x																				
	Yukon CSR	0																					
	MMER	0																					
HA-02	CCME	3	x	x				x															
	Water License	2	x					x															
	Yukon CSR	1				x																	
	MMER	0																					
HA-03	CCME	2		x			x																
	Water License	1	x																				
	Yukon CSR	1				x																	
	MMER	0																					
HA-04	CCME	1	x																				
	Water License	1	x																				
	Yukon CSR	1				x																	
	MMER	0																					
HA-05	CCME	2	x	x																			
	Water License	1	x																				
	Yukon CSR	2			x	x																	
	MMER	0																					
CH-13-03	CCME	2		x			x																
	Water License	0																					
	Yukon CSR	1				x																	
	MMER	0																					
CH-13-04	CCME	2		x			x																
	Water License	0																					
	Yukon CSR	0																					
	MMER	0																					
CH-13-05	CCME	6	x	x			x	x						x	x								
	Water License	4	x	x			x	x															
	Yukon CSR	3		x		x	x																
	MMER	1		x																			

Note 1. Standard and guidelines are shown for comparative purposes only. They are not intended to reflect what may or may not be the project regulatory criteria.

Table 38: Summary of 2011 CSR Groundwater Exceedances by Location

Total Number of Exceedances	Location	Parameters Exceeding Standards or Guidelines[1,2]
14	CH-13-05	Iron, zinc, manganese, cadmium, pH, lead, aluminum
14	DC-10	Iron, zinc, arsenic, manganese, cadmium, pH, fluoride, copper, cobalt, lead, aluminum, cadmium.
14	MW09-02	Iron, zinc, arsenic, manganese, cadmium, fluoride, ammonia, cobalt, slphate
14	MW09-04	Zinc, arsenic, manganese, fluoride, ammonia, sulphate, lead, antimony
12	MP09-07	Iron, zinc, arsenic, manganese, cadmium, pH, copper, cobalt
11	MP09-09	Arsenic, cadmium, copper, ammonia, cobalt, nitrate, WAD-cyanide
11	MP09-12	Iron, zinc, arsenic, cadmium, fluoride, ammonia, lead
11	MW09-03	Zinc, arsenic, manganese, fluoride, ammonia, sulphate, antimony, nitrite
11	PC-01	Iron, zinc, manganese, cadmium, copper, lead, aluminum, chromium
9	GLL07-03	Iron, zinc, manganese, cadmium
9	MW09-01	Iron, zinc, arsenic, manganese, cadmium, ammonia, total cyanide
8	DC-05	Iron, zinc, manganese, cadmium, fluoride, cobalt
8	DC-09	Iron, zinc, arsenic, manganese, pH, copper
8	MP09-11	Iron, zinc, arsenic, fluoride, ammonia, lead.
8	MW09-08	Iron, arsenic, manganese, pH, fluoride
8	MW09-16	Zinc, cadmium, fluoride, copper
8	MW09-22	Iron, manganese, pH, nitrate, free cyanide, nitrite
7	DC-03	Zinc, manganese, cadmium, fluoride, copper
7	MP09-10	pH, fluoride, ammonia, Total Cyanide, free cyanide
6	DC-06	Iron, arsenic, manganese, fluoride
6	DC-07	Iron, arsenic, manganese, cadmium, copper
6	HA-02	Iron, zinc, manganese, pH
6	MP09-23	Iron, zinc, manganese, cobalt, sulphate
5	HA-05	Iron, zinc, arsenic, manganese
5	MP09-05	Iron, manganese, ammonia, cobalt
5	MW09-21	Iron, manganese, cobalt, aluminum
4	DC-02	Iron, arsenic, manganese
4	HA-03	Iron, zinc, manganese, cadmium
4	MW09-19	Iron, manganese, fluoride
4	W1410383-BH03	Iron, manganese, pH
3	CH-13-03	Zinc, manganese, cadmium
3	HA-01	Iron, fluoride
3	HA-04	Iron, manganese
2	CH-13-04	Zinc, cadmium
2	MW09-18	Manganese, sulphate
2	MW09-24	Copper, nitrate
1	GLL07-02	Cadmium
1	MW09-17	Sulphate
1	PC-05	Cadmium
1	W1410383-BH02	Cadmium

Notes:

1. Parameters presented in order of the frequency of occurrence on Site (see Table 3H).

2. Results are compared to standard and guidelines for illustrative purposes only. They are not intended to reflect what may or may not be the project regulatory criteria.

All water quality samples collected at the WQ-DC–DX location reported pH values within the CCME guideline range (6.5 to 9.0). Numerous exceedances of CCME guideline values for arsenic, aluminum, iron, copper, lead and zinc were recorded as well. Silver and cadmium exceedances were few in number. Arsenic exceedances were recorded for 36 samples collected over the period of record. Around five to 10 samples collected in each monitoring year had arsenic contents higher than the CCME guideline value for arsenic. Approximately 80% of the WQ-DC-DX samples had exceedances in iron and aluminum. The exceedances occurred in every monitoring year. Copper, lead and zinc exceedances occurred in 14 samples, 10 samples, and eight samples, respectively. These exceedances almost occurred at each monitoring year with the exception of the year 2007 for lead, year 2009 for zinc, and year 2013 for copper. Silver and cadmium exceedances were few in number. Five samples collected over the monitoring period had silver exceedances. Three samples had cadmium concentrations above the CCME guideline value. All cadmium exceedances occurred in samples collected in 2009, 2012, and 2013.

Nitrate concentrations above the CCME guideline value were measured in five samples. These samples were collected from 2008 to 2011. No nitrite exceedances were recorded in 2012 and 2013.

WQ-DC-DX+105

WQ-DC-DX+105 is located in the mill area downstream of WQ-DC-DX. The period of record for water quality sampling at WQ-DC-DX is from November 2011 to February 2013. No samples were collected in 2010. A total of 31 samples were collected during this monitoring period.

The reported pH values of water quality samples collected at the WQ-DC–DX were within the CCME guideline range with the exception of one sample. The pH of one sample was close to the minimum pH value of the CCME guideline (pH 6.5).

Most CCME guideline exceedances at WQ-DC-DX+105 were for arsenic, cadmium and zinc followed by aluminum and iron, then copper, lead and nitrate. A onetime exceedance was identified for selenium and it was sampled in 2013. All samples collected over the period exceed the CCME guideline value of arsenic, cadmium and zinc. Approximately 50% of total samples had the iron and aluminum exceedances. The elevated aluminum and iron concentrations were measured in each year samples. Fewer exceedances occurred for copper and lead. Three samples collected in 2011 and two samples collected in 2013 had copper concentrations above the CCME guideline value. The elevated lead concentrations were measured in four samples collected during the monitoring period.

Concentrations of nitrite above the CCME guideline value were measured in five samples. All of these five samples were collected in 2011.

WQ-DC-D1

WQ WQ-DC-D1 is located downstream of the mill area. The period of record for water quality sampling at WQ-DC-DX is from July 2007 to October 2012. No samples were collected in 2010 and 2013. A total of 31 samples were collected during this monitoring period.

The reported pH values of water quality samples collected at the WQ-DC–01 were within the CCME guideline range (pH 6.5).

Most CCME guideline exceedances at WQ-DC-D1 were for arsenic, cadmium and zinc followed by aluminum and iron, then copper and lead. Selenium exceedances were measured in a few samples as well. Almost all of the 48 samples collected over the period of record had arsenic and cadmium concentrations above the CCME guideline value. Only three samples did not have elevated arsenic concentrations and these samples were collected in 2012. Two samples collected in 2008 also did not have elevated cadmium concentrations. All collected samples had zinc concentrations above the CCME guideline value. Twelve samples had the exceedances of the CCME guideline value for iron. These samples consist of two samples collected in 2008, four samples collected in 2009, and six samples collected in 2012. Copper concentrations above the CCME guideline value were reported in eight samples. The elevated copper concentrations were measured in one sample in 2008, one sample in 2009, three samples in 2011, and the other three samples in 2012. A total of five samples exceeded the CCME lead guideline value. These exceedances occurred in one of the 11 samples collected in 2009, two out of 12 samples collected in 2011, and two out of 15 samples collected in 2012. Rare exceedances were reported for selenium and silver. Two selenium exceedances were recorded in 2012 from a sample population of 15 and a single silver exceedance was recorded in 2012.

Fifteen samples had nitrite concentrations above the CCME guideline value. These exceedances were recorded in two samples in 2008, seven samples in 2009, one sample in 2001, and six samples in 2012.

WQ-DC-D1b

The period of record for water quality sampling at WQ-DC-D1b is from May 2012 to October 2013 and 14 samples were collected throughout. The location of WQ-DC-D1b is just downstream of WQ-DC-D1 immediately prior to a fork in Dome Creek.

No samples recorded pH values outside of the CCME guideline range (6.5 to 9.0).

All eight samples recorded concentrations that exceeded the guideline values for arsenic, cadmium, iron and zinc. A total of six samples recorded exceedances for aluminum. In addition, four samples collected in 2012 had lead concentrations above the CCME guideline value. Nitrite exceedance was reported in one sample collected in 2012.

WQ-DC-U1

The period of record for water quality sampling at WQ-DC-U1 is from May 2012 to October 2013 and a total of 19 samples were collected during this monitoring period. The location of WQ-DC-U1 is upstream of the tailings pond along one of the branches of Dome Creek downstream of WQ-DC-D1b.

One of the 19 samples recorded a pH outside of the CCME guideline range (6.5 to 9.0). The pH of one sample collected in November 2012 was 5.5. All WQ-DC-U1 samples had exceedances in arsenic and iron. Seven of 12 samples recorded exceedances in aluminum. Also, two of the 19 samples had copper and zinc concentrations above the CCME guideline values and all of these samples were collected in 2012.

Two samples collected in 2012 had nitrite concentrations above the CCME guideline value. No nitrite exceedances occurred in 2013.

WQ-DC-U2

WQ-DC-U2 is located upstream of the tailings pond along the alternate branch of Dome Creek downstream of WQ-DC-D1b. The water quality monitoring program was conducted from November 2011 to October 2013. A total of 20 samples were collected throughout this sampling period.

No samples recorded pH values outside of the CCME guideline range (6.5 to 9.0).

All 20 samples had concentrations that exceeded the CCME guideline values for arsenic, aluminum and iron. Exceedances of zinc were also measured in 19 samples. Cadmium and copper exceedances were recorded in 12 and nine samples, respectively. The copper exceedances only occurred in the samples collected in 2012. One of the 12 samples recorded an exceedance for selenium and this sample was collected in 2013.

Two samples that were collected in 2011 and one sample in 2013 recorded nitrite concentrations above the CCME guideline value.

WQ-DC-U

WQ-DC-U is located downstream of the tailings pond. The period of record for water quality sampling at WQ-DC-U is from May 2005 to October 2013. One hundred and forty-one samples were collected during this monitoring period.

Analysis of some metal parameters such as arsenic, silver, aluminum, cadmium, copper, lead, nickel, selenium, and thallium for the samples collected from 2005 to 2007 used the method detection limit values higher than the CCME guideline. When the results of those parameters were reported as MDL values, those results were not compared to CCME guideline values.

One out of 141 samples recorded pH values above the CCME guideline. The alkaline pH (11.1) was recorded in the sample collected in October 2005.

Most CCME guideline exceedances at WQ-DC-U were for arsenic, iron, zinc, and copper, followed by aluminum, nitrate and cadmium, then lead, nitrate and silver. Arsenic exceedances were identified in all samples with the exception of samples reported with a high MDL in 2005 to 2007. In addition, all 141 samples collected over the period of record reported iron concentrations that exceeded the CCME guideline value. Zinc concentrations above the CCME guideline value were identified in 40 samples from 2005 to 2013. Zinc exceedances occurred every year with number of exceedances ranging from two to nine samples. The highest number of exceedances was recorded in 2009. Fifteen samples collected from 2005 to 2007 and 34 samples collected from 2008 to 2013 had elevated copper concentrations above the CCME. Twenty-two of 70 samples collected from 2008 to 2013 had cadmium exceedances with number of exceedances ranging from three to seven samples each year. Fewer exceedances were recorded for lead and silver. Lead exceedances were recorded in 10 samples collected from years 2008 to 2013. The lead exceedances occurred every year with the exception of 2013 results. Four samples collected in 2009 to 2011 had silver concentrations above the CCME guideline value.

Seven of 141 samples collected over the period of record reported concentrations that exceeded the CCME guideline value for nitrate. These samples were collected in 2005, 2006, 2007 and 2011. Nitrite exceedances were reported in 33 samples collected from 2005 to 2009, and 2012. No nitrite exceedances were recorded in 2011 and 2013 samples.

WQ-DC-R

Station WQ-DC-R is downstream of WQ-DC-U positioned along Dome Creek just upstream of the Mount Nansen Road. It is the last WQ station before the confluence of Dome Creek with Victoria Creek. The water quality data of this station were available from January 1999 to October 2013. A total of 188 samples were collected during the monitoring period with around eight to 17 samples collected each year with the exception of 2005 and 2010. Thirty-six samples were collected in 2005 and no samples were collected in 2010.

Analysis of some metal parameters such as arsenic, silver, aluminum, cadmium, copper, lead, nickel, selenium, and thallium for the samples collected from 1995 to 2007 used the method detection limit values higher than the CCME guideline. When the results of those parameters were reported as MDL values, those results were not compared to CCME guideline values.

Only three out of 188 samples reported pH values outside of the CCME guideline range (6.5 to 9.0). The pH of two samples collected in 2009 and one sample collected in 2013 were slightly lower than the minimum pH of the CCME guideline.

Most CCME guideline exceedances at WQ-DC-U were for arsenic, iron, aluminum, lead, and copper, followed by zinc, cadmium, nitrite and cadmium, then, nitrate and silver. All collected samples had arsenic and iron concentrations above the CCME guideline values. Elevated aluminum, copper and lead concentrations were also reported in the majority of the samples. Aluminum, copper and lead exceedances were reported in 149 samples, 129 samples, and 97 samples, respectively. Numerous exceedances were also recorded for zinc and cadmium with zinc concentrations in 78 samples and cadmium concentrations in 44 samples above the respective CCME guideline values. Fewer exceedances were reported for silver and nitrate. Elevated silver concentrations were reported in nine samples. Five samples had nitrate concentrations above the CCME guideline values and all of these nitrate exceedances were reported in the samples collected between 2000 and 2005.

Forty-six samples collected over the period of record reported concentrations that exceeded the CCME guideline value for nitrite. Approximately 95% of exceedances occurred in the samples collected from 1999 to 2005. One exceedance was recorded in 2011 and another exceedance was reported in 2012.

Pony Creek Water Quality Stations

The surface water quality from Pony Creek has been monitored upstream (WQ-PC-U) and downstream of the pit (WQ-PC-D). A total of 55 water samples were collected from May 2008 to October 2013 for each station. No samples were collected in 2010.

WQ-PC-U

All water quality samples collected at the WQ-PC-U location reported pH values within the CCME guideline range (6.5 to 9.0).

The metal parameters that exceeded the CCME guideline in the WQ-PC-U were arsenic, aluminum, copper, iron, silver and lead. One sample collected on May 5, 2013 had anomalously high concentrations for arsenic, aluminum, iron, lead and zinc. Arsenic exceedances occurred in the samples collected in 2008 and 2009. Six out of 12 samples exceeded the CCME arsenic guideline value of 0.005 mg/L in 2009. One arsenic exceedance was reported in October 2008 and two other arsenic exceedances occurred in 2013. Arsenic concentrations above the CCME value were not recorded in the samples collected in 2011 and 2012. Elevated aluminum concentrations higher than the CCME guideline value were reported in some samples collected from WQ-PC-U in each year. Two out of 11 samples, three out of 12 samples, and three out of 11 samples collected in 2008, 2009 and 2011, respectively, had aluminum concentrations above the CCME value. Only one out of 13 samples in 2012 and one out of nine samples in 2013 exceeded the aluminum guideline value. Exceedances in the CCME guideline value for iron (0.3 mg/L) were reported in each year of water quality monitoring of WQ-PC-U. Two out of 11 samples and nine out of 12 samples reported exceedances in 2008 and 2009, respectively. Iron concentrations in five of 11 samples collected in 2011 were above the CCME guideline value. Elevated iron concentrations higher than the CCME guideline value were also measured in three of 13 samples in 2012 and two of nine samples in 2013. The rare exceedances

occurred for copper and silver in 2011 and 2013. One sample and two samples collected in 2011 had elevated copper and silver concentrations. The copper concentrations above the CCME value were measured in two samples in 2013 and one of these samples also had elevated silver. No copper and silver concentrations higher than the CCME guideline value were detected in the other samples.

WQ-PC-D

The pH of all water quality samples collected at the WQ-PC-D location was within the CCME guideline range (6.5 to 9.0).

The elevated concentrations above the CCME guideline value were measured for aluminum, arsenic, cadmium, copper, iron, lead, silver, and zinc. Exceedances were reported for arsenic, aluminum, cadmium, iron, and lead for each monitoring year. The highest number of samples that exceeded the CCME value of arsenic, aluminum, iron and lead occurred in 2009 with the exception of cadmium. All samples collected during the monitoring period had cadmium concentrations above the CCME value. Eight out of 11 samples reported exceedances for arsenic in 2008. All 12 samples collected in 2009 had arsenic concentrations above the CCME guideline value. Only two out of 10 samples and four of 12 samples reported arsenic exceedances in 2011 and 2012, respectively. The number of arsenic exceedances increased in 2013 with elevated arsenic concentrations measured in six of eight samples. From a total of 11 samples collected in 2008, seven samples reported aluminum exceedances and three samples had iron exceedances. Ten samples collected in 2009 reported aluminum and iron concentrations above the CCME guideline values. The number of exceedances decreased in 2011, 2012 and 2013 for aluminum and iron. Six out of 11 samples in 2011, three out of 12 samples in 2012, and three of eight samples in 2013 reported exceedances in aluminum. Only two iron exceedances occurred in 2011, 2012, and 2013. Nine of 12 samples collected in 2009 reported lead exceedances. Only one of 11 samples collected in 2011, one of 12 samples collected in 2012, and one of eight samples collected in 2013 reported lead concentrations above the CCME guideline value. Silver exceedances were measured in the samples collected in 2008 and 2009. One in 11 samples collected in 2008 and four out of 12 samples collected in 2009 had silver concentrations above the CCME guideline value (0.0001 mg/L). Silver concentrations in all samples collected in 2011, 2012, and 2013 were below the CCME guideline value. All samples collected throughout the entire period of record reported exceedances in copper except for two, once in 2011 and once in 2012. All samples also had zinc concentrations above the CCME guideline value (0.3 mg/L) with the exception of one sample collected in 2011, one sample collected in 2012, and two samples collected in 2013.

In summary, a comparison of Pony Creek samples collected upstream and downstream of the pit shows a degraded downstream water quality. Copper and zinc exceedances were reported in nearly all downstream samples compared to no exceedances upstream of the pit. A higher proportion of exceedances in arsenic, aluminum and lead were reported downstream of the pit compared to upstream.

Back Creek Water Quality Stations

The surface water quality from Back Creek has been monitored from May 2008 to October 2013. There were no samples collected in 2010. A total of 52 samples were collected during this monitoring period. The location of the water quality monitoring station (WQ-BC) was downstream of the confluence of Pony Creek and Back Creek and immediately upstream of the confluence of Victoria Creek and Back Creek. It represents the segment of Back Creek that is impacted by the water quality reporting from Pony Creek.

All water quality samples collected at the WQ-PC-D location reported pH values within the CCME guideline range (6.5 to 9.0).

Several metal parameters such as arsenic, aluminum, cadmium, iron, copper, lead, molybdenum, nickel, thallium, silver, and zinc exceeded the CCME guideline values. These exceedances occurred in each monitoring year with the exception of molybdenum, nickel, and thallium. Nitrite concentrations above the CCME guideline value were also measured in some samples. Arsenic concentrations measured in samples collected in 2009, 2011 2013, and 2012 were generally higher than the arsenic concentrations measured in the samples collected in 2008. Only two of 11 samples collected in 2008 reported arsenic concentrations that exceeded the CCME guideline value of 0.005 mg/L. All 11 samples collected in 2009, eight of 10 samples collected in 2011, 11 of 14 samples collected in 2012 reported arsenic concentrations above the CCME value. Fewer arsenic exceedances occurred in 2013 with concentrations from three of eight samples higher than the CCME guideline value. Most of the collected samples had aluminum concentrations higher than the CCME guideline value. All samples collected in 2009 and 2011 exceeded the CCME guideline value for aluminum. Every sample collected in 2012 and 2013 had aluminum concentrations above the CCME guideline value except one sample in 2012 and one sample in 2013. Eight of 11 samples collected in 2008 also reported aluminum concentrations that exceeded the CCME guideline value. The cadmium concentrations above the CCME guideline value were reported in two of 11 samples collected in 2008 and five out of 11 samples collected in 2009. Also, six of 10 samples collected in 2011, six of 14 samples collected in 2012, and three of eight samples collected in 2013 exceeded the CCME guideline values for cadmium. Five of 11 samples collected in 2008 exceeded the CCME guideline value for copper. More samples collected from 2009 to 2012 had the elevated copper concentrations. Eight of 11 samples collected in 2009, ten of 11 samples collected in 2011, and eight of 14 samples collected in 2012 reported copper exceedances. Copper concentrations above the CCME guideline value were measured in four of eight samples in 2013. Iron concentrations in all samples collected in 2008 to 2012 except one (collected April 18, 2012) exceeded the CCME guideline value of 0.3 mg/L. In addition, four of eight samples collected in 2013 also had iron exceedances. Two of 11 samples collected in 2008 reported concentrations above the CCME lead guideline value. More samples had lead concentrations above the CCME guideline value in 2009, 2011, 2012 and, 2013 with the number of exceedances ranging from three to 11 samples each year. Approximately 18% of samples collected in 2008 and 2009 and 30% of samples collected in 2011 had silver concentrations above the CCME guideline value. In addition, two out of 14 samples collected in 2012 reported exceedances as well. No silver exceedances occurred in the samples collected in 2013. Only two of 11 samples collected in 2008 exceeded

the CCME zinc guideline value. More zinc exceedances were reported from 2009 to 2012 samples. Four of 11 samples, seven of 11 samples, and five of 14 samples collected in 2009, 2011, and 2012, respectively, reported zinc concentrations higher than the CCME guideline value. Four of eight samples collected in 2013 also had zinc concentrations above the CCME zinc guideline value. One sample collected on August 18, 2011 had a molybdenum concentration higher than the CCME guideline value (0.073 mg/L), otherwise no exceedances were reported throughout the entire period of record. Nickel exceedances were reported in two samples collected in 2011.

Nitrite concentrations above the CCME guideline value (0.06 mg/L) were measured in three samples collected in 2012. No nitrite exceedances were reported in the samples collected in 2008, 2009, 2011 and 2013.

Based on exceedances of CCME guideline values, the majority of Back Creek (WQ-BC) had elevated arsenic, aluminum, cadmium, iron, copper, lead and zinc concentrations. The source of arsenic, aluminum, copper and zinc metals are likely from Pony Creek since these parameters were identified as parameters of concern downstream of the pit. Some of the iron and lead is likely discharged from Pony Creek, although sources upstream of Pony Creek along Back Creek seem to contribute to these parameters. Cadmium exceedances were not reported along any stretch of Pony Creek; hence the exceedances observed in Back Creek downstream of the confluence with Pony Creek suggests that an upstream source could be affected by the water quality at the WQ-BC.

Minnesota Creek Water Quality Stations

WQ- MN

The surface water quality from upstream Minnesota Creek has been monitored at station WQ-MN. The water quality records of this station were available from April 2012 to October 2013. A total of 24 water samples were collected from this station. Nine samples were collected in 2012 and 15 samples were collected in 2013.

The water pH below the minimum range of the CCME guideline value was recorded in two samples collected in 2012 and five samples collected in 2013.

No exceedances were reported for almost all metals. Concentrations above the CCME guideline values were only recorded for copper and cadmium. Two samples collected in 2012 had elevated copper concentrations, while three samples collected in 2013 had cadmium exceedances.

In summary, the pH water of several samples was slightly lower than the minimum limit of the CCME guideline. However, the metal exceedances were rare for WQ-MN samples and the limited exceedances only occurred for copper and cadmium parameters.

Victoria Creek Water Quality Stations

The surface water quality from upstream Victoria Creek has been monitored at Victoria Reference (WQ-VC-Ref) and Victoria Upstream (WQ-VC-U). The WQ-VC-U is located immediately prior to the confluence with Back Creek, while the WQ-VC-Ref is located further upstream of the WQ-VC-U. Both the WQ-VC-Ref and the WQ-VC-U are not impacted by mining activity associated with Mount Nansen.

WQ-VC-Ref

The WQ-VC-Ref station has been monitored from October 2007 and the data are available up to October 2013. A total of 59 samples were collected during the monitoring period. Around nine to 14 samples were collected every year with the exception of years 2007 and 2008. Only one sample was collected in 2007 and three samples were collected in 2008.

All samples had neutral pH with reported pH values within the CCME guideline range with the exception of one sample. The pH of one sample collected on May 16, 2012 was 5.7.

Most CCME guideline exceedances at WQ-VC-Ref were for copper, aluminum and iron, followed by lead and cadmium. Fewer exceedances occurred for zinc, arsenic, and nitrite. A total of 27 samples had elevated copper concentrations and these samples were collected from years 2008 to 2013. The highest copper exceedances occurred in 2012 which around 79% of samples or 11 of 14 samples had elevated copper concentrations. The aluminum and iron concentrations above the CCME guideline values were measured in 19 and 17 samples, respectively. The aluminum and iron exceedances mostly occurred in the samples collected in 2012 and 2013. Several exceedances were reported for lead and cadmium. Lead exceedances occurred in 12 samples collected in 2008, 2009, 2012, and 2013. Elevated cadmium concentrations were measured in seven samples during the monitoring year with the exception of year 2011. Only three samples had zinc exceedances and those samples were collected in 2009, 2012, and 2013. Arsenic concentrations above the CCME guideline value were measured in one sample collected in 2012 and one sample collected in 2013.

Nitrite concentrations higher than the CCME guideline value were detected in two samples, which one sample was collected in 2009 and the other sample was collected in 2012.

WQ-VC-U

The surface water quality monitoring program in the WQ-VC-U was started in 2005. A total of 171 samples were collected up to October 2013. The samples collected from 2005 to 2007 were analyzed using the MDL value higher than the CCME guideline for metal parameters such as aluminum, arsenic, cadmium, copper, lead, nickel and silver parameters. When the results were reported less than the MDL value, the data were not compared to the CCME guideline Therefore, only the results from year 2008 to 2013 (90 samples) were compared to the CCME guideline for those parameters.

The WQ-VC-U station is most elevated with concentrations of iron, copper and aluminum. Fewer exceedances occurred for arsenic, cadmium, lead, and nitrite. Thirty-four samples had iron and copper concentrations above the CCME guideline values. These samples had been collected from years 2005 to 2013. Less number of samples (24 samples) had aluminum exceedances. Arsenic exceedances occurred in four samples collected between 2008 and 2012. Five samples collected in the same period had cadmium and lead concentrations higher than the CCME guideline values.

Elevated nitrate concentrations were measured in two samples collected in 2009 and the other two samples collected in 2012.

WQ-VC-DBC

The WQ-VC-DBC station was monitored for two years starting in 2012. A total of 32 samples were collected from this station. The station is located downstream of the confluence of Victoria Creek with Back Creek.

The measured pH values of all samples were within the CCME guideline range with the exception of one sample. The pH of the sample collected on May 16, 2012 was 5.6.

Most CCME guideline exceedances at WQ-VC-DBC were for cadmium and iron, followed by aluminum, copper, and arsenic. Fewer exceedances occurred for zinc and lead. Sixteen samples had elevated cadmium and iron concentrations with more than 60% of these samples collected in 2013. The aluminum and copper exceedances were reported in 11 samples. Around 50% aluminum exceedances occurred in 2013's samples, while the copper exceedances were mostly measured in the samples collected in 2012. Arsenic concentrations above the CCME guideline value were reported in five samples collected in 2012 and three samples collected in 2013. In addition, zinc and lead exceedances were measured in the WQ-VC-DBC samples. Three samples had zinc exceedances and two samples had lead concentrations higher than the CCME lead guideline value.

The sources of elevated metal concentrations at the WQ-VC-DBC are likely from Back Creek (WQ-BC) and also the upstream Victoria Creek station (WQ-BC-U) since the exceedances of those metal parameters were also observed at those two stations.

WQ-VC-UMN

Station WQ-VC-UMN is positioned just upstream of the confluence of Victoria Creek with Minnesota Creek. The station also provides a snapshot for the water quality of Victoria Creek downstream of the confluence with Dome Creek. The period of record for water quality monitoring at WQ-VC-UMN was from November 2011 to September 2013. A total of 34 samples were collected during this monitoring period with only one sample collected in 2011.

Only one sample had the pH values lower than the minimum limit of the CCME guideline value. This sample was collected in May 2012.

Most CCME guideline exceedances at WQ-DC-U were for aluminum, iron, and copper, followed by lead, arsenic, and cadmium, arsenic, and then, nitrite. No zinc exceedance was reported. Six samples had arsenic concentrations above the CCME guideline value for arsenic. Four of these exceedances occurred in 2012 and the other two exceedances were reported in 2013. Numerous exceedances were recorded for aluminum, iron and copper. Seventeen samples and 16 samples had aluminum and iron exceedances, respectively. These exceedances were reported for the samples collected in 2012 and 2013. Copper concentrations above the CCME guideline value were measured in 13 samples. Fewer exceedances were reported for lead and cadmium. Seven of 34 samples collected over the period of record exceeded the CCME guideline value for lead. Five of these samples were collected in 2012 and two other samples collected in 2013. Three samples were reported to have cadmium concentrations above the CCME guideline value in which two samples were collected in 2012 and one sample was collected in 2013.

Two exceedances occurred for nitrite and all of these samples were collected in 2012.

WQ-VC-R

Station WQ-VC-R is positioned downstream of the confluence of Victoria Creek and Minnesota Creek. The period of record for water quality monitoring at station WQ-VC-R is from April 1999 to September 2013. A total of 228 water samples were analyzed during the monitoring period. No data were collected in 2010.

Only three samples had the pH values lower than the minimum limit of the CCME guideline value. Two samples were collected in 2012 and the other sample was collected in 2013.

The samples collected from 1999 to 2007 were analyzed using the MDL value higher than the CCME guideline for metal parameters such as aluminum, arsenic, cadmium, copper, lead, nickel and silver, and thallium. The results were not compared to the CCME when less than MDL values were reported as results.

Most CCME guideline exceedances at WQ-DC-R were for iron, copper and aluminum, followed by lead, cadmium, arsenic, selenium, and zinc, then silver, nitrite, nitrate and thallium. Eighteen samples reported concentrations that exceeded the CCME guideline value for arsenic. These exceedances were not included in the 140 samples collected in 1999 to 2007 which had concentrations below the MDL for arsenic (0.02 or 0.2 mg/L) and the MDL exceeds the CCME guideline value. Iron, copper, and aluminum exceedances were reported in 105 samples, 92 samples, and 77 samples, respectively. Numerous exceedances were also recorded for lead and cadmium. Lead concentrations in 28 samples and cadmium concentrations in 20 samples were above the respective CCME guideline values. Fewer exceedances were reported for selenium, zinc, and silver. Selenium concentrations above the CCME guideline value were reported in 14 samples and these samples were mainly collected from 1999 to 2007. Zinc concentrations above the CCME guideline value were reported in 13 samples. Elevated silver concentrations were reported in nine samples. One sample collected in 2011 had thallium exceedances.

Only one exceedance was recorded for nitrate, and two exceedances were reported for nitrite. The nitrate exceedance was recorded in one sample collected in 2000 while the nitrite exceedances were measured in one sample collected in 2000 and another sample was collected in 2002.

Non-Creek Water Quality Stations

Pit

The period of record for water quality monitoring of the pit lake is available from December 2005 to July 2013. The monitoring water quality stations are located at the top section (WQ-PIT1), the middle section (WQ-PIT2), and the bottom section (WQ-PIT3). In total, 54 samples were collected for each water quality station during the monitoring period. Around eight to 11 samples were collected every year with the exception of years 2005, 2006 and 2010. Only one sample was collected in each year for 2009 and 2010, and three samples were collected in 2010.

No samples reported pH values outside of the CCME guideline range (pH 6.5 to 9.0).

Samples collected in 2005, 2006, and 2007 were analyzed for arsenic, cadmium, iron, and lead and the MDL exceeded the CCME guideline value. Due to this reason, the analysis results that reported lower than the MDL were not compared to the CCME.

Arsenic, cadmium, and zinc had the highest exceedances when the concentrations were compared to the CCME guideline. All samples had arsenic, cadmium and zinc concentrations above the CCME guideline values. The number of exceedances is also quite significant for copper which the copper concentrations above the CCME guideline were measured in 36 samples from the top section, 39 samples from the middle section, and 39 samples from the bottom section. Fewer exceedances were reported for lead. A total of 34 samples had lead concentrations above the CCME guideline value with nine samples of the top section, seven samples of the middle section, and 15 samples of the bottom section. Eighteen samples from the bottom section had iron exceedances. However, only one sample from the middle section and no sample from the top pit section had concentrations above the CCME value for iron. Exceedances also occurred for aluminum and silver parameters. Aluminum exceedances measured in one sample from the top section, one sample from the middle section, and seven samples from the bottom section. Seven samples with silver exceedances consist of two samples from the top section, two samples from the middle section, and five samples from the bottom section.

Nitrate and nitrite exceedances were reported throughout the monitoring period. Six samples from the top section and one sample from the middle section had nitrate concentrations above the CCME guideline value. A total of 19 samples had nitrite exceedances which consisted of three samples from the top section, eight samples from the middle section, and the other eight samples from the bottom section.

Tailings Pond

The period of record for water quality monitoring of the tailings pond (WQ-TP) was from January 1999 to September 2013. The tailings pond is positioned along Dome Creek downstream of WQ-DC-U1 and WQ-DC-U2. A total of 233 samples were collected during the monitoring period.

No samples reported pH values outside of the CCME guideline range (pH 6.5 to 9.0).

The samples collected from 1999 to 2007 were analyzed using the MDL value higher than the CCME guideline for metal parameters such as aluminum, arsenic, cadmium, copper, lead, nickel and silver, and thallium. The exceedances were not counted when the high MDL value reported as results.

All samples collected over the period of record exceeded the CCME guideline value for arsenic, cadmium, and copper. Numerous exceedances were recorded for iron, zinc, silver, lead and aluminum. Iron concentrations of 199 samples, and zinc concentrations of 190 samples were above the respective CCME guideline values. Silver concentrations of 100 samples were above the CCME guideline value. The lead exceedances were measured in 98 samples. Aluminum concentrations of 60 samples were also recorded higher than the CCME guideline value. Seven samples over the period of record exceeded the CCME guideline value for nickel. These samples were collected in 1999 and 2001. Ten samples also recorded silver concentrations above the CCME guideline value. One sample collected in 1999 exceeded the CCME guideline value for molybdenum.

Thirty-one samples reported nitrate concentrations above the CCME guideline value for nitrate. Nitrite exceedances were measured in 123 samples.

SEEP

The period of record for water quality monitoring of the seepage pond (SEEP) was from January 1999 to September 2013. The SEEP is located downstream of the seepage pond. A total of 265 samples were collected during the monitoring period. No samples were collected in 2010.

Two samples had pH values above the maximum pH of the CCME and the pH values of the other two samples were lower than the minimum pH of the CCME guideline value.

All samples collected over the period of record exceeded the CCME guideline value for arsenic and iron, and numerous exceedances were recorded for copper and cadmium. Copper concentrations of 197 samples and cadmium concentrations of 156 samples were above the respective CCME guideline values. Fewer exceedances occurred for zinc, silver, aluminum and lead. The zinc and silver exceedances were measured in 60 samples and 48 samples, respectively. In addition, 34 samples had aluminum exceedances and 20 samples had lead exceedances. Nickel concentrations above the CCME guideline value were measured in 13 samples.

Nitrate and nitrite exceedances were common in the samples. Seventy samples reported nitrate concentrations above the CCME guideline value. Nitrite exceedances were measured in 176 samples.

8.4.3 Dome Creek Sediment Quality Characterization

Nine sediment samples from the Dome Creek area were collected by members of the Little Salmon Carmacks First Nations. The first sample was collected from Dome Creek where the public road intersects. The rest of the samples were collected along Dome Creek upstream of the road intersection at 100 m intervals. Acid-base accounting (ABA) and metals analysis (aqua regia digestion with ICP-MS finish) was performed on the samples in October 2013.

In general, the paste pH was relatively low; values ranged from 4.2 to 6.1 with a median of 4.7. Total sulphur ranged from 0.02 to 0.94% with an average of 0.1%. The NP was low and ranged from negligible to 6 kg $CaCO_3$/t. Also, the Carb NP was low with the majority of samples reporting a negligible Carb NP. The ratio of NP to Maximum Potential Acidity (MPA) ranged from negligible to 6.4. The MPA was calculated from the total sulphur contents.

The concentrations of metals in the samples were compared to the CSR-PL values. Metals in samples #2 and #3 were much higher relative to other samples. Arsenic, cadmium, silver and zinc concentrations in samples #2 and #3 were above the CSR guideline values. In addition, the zinc concentration in sample #2 was higher than the CSR-PL guideline value. The other four samples (samples #1, #6, #7, and #9) had arsenic concentrations that were higher than the CSR guideline value. All samples had barium concentrations above the CSR guideline value.

The highest arsenic content was measured in sample #2 with concentrations above 10,000 mg/kg. As a comparison, arsenic contents in the recent tailings samples from the tailings pond ranged from 1,650 to 5,620 mg/kg. Arsenic results suggest that sample #2 may contain tailings material.

During the 2013 site investigation, AMEC collected 20 samples from Dome Creek. The location of each of these samples is presented in Figure 2. These sediment samples were collected within 500 m upstream (10 samples) and downstream (10 samples) of the tailings storage facility. The samples were submitted to ALS for metals and cyanide testing. Results are presented in Appendix D-2 of the Site Investigation Report.

Total cyanide in all samples was below the CSR guideline value. Ten samples had arsenic concentrations above the CSR guideline value (20 mg/kg). High arsenic concentrations were measured in samples DC-11 to DC-20. The highest arsenic concentration was measured in sample DC-11 (926 mg/kg). The DC-11 is located downstream of the tailings dam (upstream diversion channel discharge. The concentration of cadmium in sample DC-11 was also above the CSR guideline value (2 mg/kg).

In addition to the high metals measured in some of the sediment samples, there is a zone of blackened vegetation on the south bank of Dome Creek downstream of the tailings seepage pond. As reported by EDI (2006), the area is approximately 4 to 6 m wide and begins about 75 to 100 m downstream of the seepage dam, extending 150 m to 200 m downstream. Sampling from 2006 indicated elevated metals in the vegetation and the upper soil horizons. The deeper soils, however, appeared to have lower metals concentrations.

8.4.4 Evaluation of Trends in Cyanide Chemistry

The measured concentrations of the various cyanide species in groundwater near the Tailings Dam are continuing to decrease with time. As shown on Figure 18, the total concentration of the various nitrogen containing species near the Tailings Dam decreased from 2011 to 2013. These values include organic nitrogen as measured by Total Kjeldahl Nitrogen (TKN), which also measures ammonia. Organic nitrogen values were not included in the accounting presented in Table 33 as it is not clear what is being measured as organic nitrogen by the measurement of TKN minus the concentration of ammonia. Therefore, to prevent double counting of cyanide species, organic nitrogen as measured by the TKN test was not included in the accounting. Note that the 2013 TKN concentration reported for MP09-10 of 35.2 mg/L may be an order of magnitude too high based on the 2011 results at this location, and the fact that ammonia at this location was 3.23 mg/L in 2013.

Figure 18 clearly shows a decreasing trend in cyanide and inorganic nitrogen species concentrations from 2011 to 2013. This is consistent with the continued slow oxidation of cyanide that remains sorbed to the tailings solids as SAD-cyanide. This oxidation of SAD-cyanide is also indicated by the observation that the concentration of Total Inorganic Nitrogen discharged at the Seep since 2006 is approximately double that of the concentration of the various cyanide species.

8.5 Sulphite

Sulphite is hypothesized to be present in the mine tailings due to the use of sodium metabisulphite as part of the Inco Process (discussed in Section 8.3). This is potentially significant as sulphite is used at other sites as an inhibitor to prevent the formation of Acid Rock Drainage (ARD). As presented by Hao and Dick (2000), sulphite can prevent ARD by scavenging oxygen to prevent pyrite oxidation. There are no refereed publications where sulphite is used at mine sites as an ARD inhibitor, but layering of sulphite and pyrite containing coal waste is being used successfully to prevent ARD at sites in Ohio (Warren Dick, University of Ohio, Personal Communication).

The mill used sodium metabisulphite ($Na_2S_2O_5$) as part of the Inco process to oxidize free cyanide and WAD-cyanide to cyanate (OCN^-). Sodium metabisulphite hydrates to form sulphite (SO_3^{2-}) in water. Sulphite is an oxygen scavenger because it is readily oxidized to sulphate according to Equation 3.

$$SO_3^{2-} + 0.5\ O_2 \text{ ------> } SO_4^{2-} \qquad (3)$$

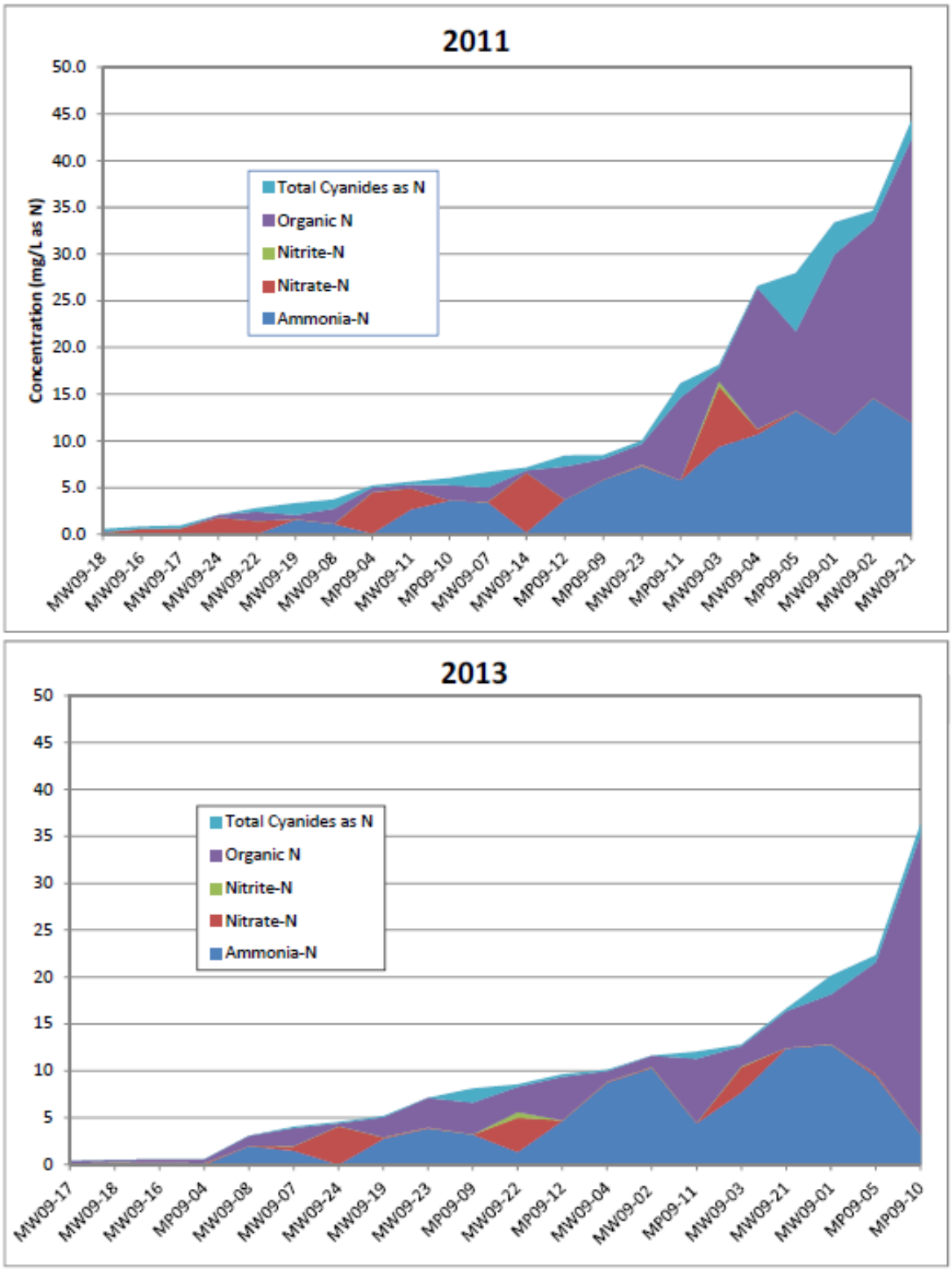


Figure 18: Concentration of Nitrogen Species Sorted by Increasing Total Nitrogen Content

As shown in Table 29 in Section 8.3, the design usage at the mill was 270 tonnes of $Na_2S_2O_5$ per year. This equates to 91 tonnes per year of sulphur or 340 tonnes of sulphite over three years of mill operation at 100,000 m^3/year to produce 300,000 m^3 of tailings. If the porosity of the saturated tailings is 40%, and assuming no discharge of groundwater or geochemical reactions to consume or discharge the added sulphite, the 120,000 m^3 of groundwater could have an upper bound concentration of 2,800 mg/L of sulphite. This is equivalent to 35 mmol/L (millmoles per litre) of sulphur, and if quantified as sulphate, this concentration of sulphur would be 3,360 mg/L. Therefore, the amount of sulphite added at the mill is comparable to the amount of sulphur that has been observed in the groundwater (i.e. the concentrations are of the same order of magnitude).

As discussed in Appendix D on Alternate Preservation #3, the persistence of dissolved iron (Fe^{2+}) in unpreserved water samples is considered indicative of the presence of an oxygen scavenger (such as sulphite) that prevents the oxidation of iron by atmospheric oxygen. Detailed calculations that were used to infer the presence of sulphite in the groundwater near the tailings area are presented in Appendix D in Table D8. As shown in Table D8, the amount of sulphite required to account for the lack of iron oxidation in the unpreserved samples is typically <5% of the total sulphur content. Other calculations in Table D8 show that the charge balance errors observed for various water samples can also be explained by the presence of sulphite in the water.

Sulphite was not directly measured in any of the water sampling that has been completed to date as it was not identified as a potential contaminant of concern and was not expected to be present. Sulphate (SO_4^{2-}) is normally the dominant sulphur ion in groundwater, and it is the formation of sulphuric acid (H_2SO_4) from the oxidation of sulphide minerals that results in ARD. However, reduced sulphur species are likely present in the groundwater. These other species include the fully reduced sulphide, partially oxidized polysulphides, thiosulphate, sulphite, and numerous other sulphur species. These reduced sulphur species are difficult to sample and analyze, and are often overlooked, as they are readily oxidized to sulphate by atmospheric oxygen.

The sulphur species measured in 2013 by AMEC were sulphate, dissolved sulphur, and sulphide. While most of the dissolved sulphur was accounted for by the measured sulphate concentrations, there are discrepancies that indicate the presence of a reduced sulphur compound such as sulphite. Furthermore, the analysis of sulphate typically involves Ion Chromatography (IC), which often cannot distinguish between sulphite and sulphate. Some IC setups can distinguish sulphite from sulphate, but this is normally not done for routine environmental monitoring. The analytical laboratory (ALS) reviewed the ion chromatography data for a submission of groundwater samples in 2013 from the tailings area and a sulphite peak was visible in two of the groundwater samples (MP09-09 and MP09-10). These samples were not preserved to prevent the oxidation of sulphite to sulphate, and the sulphite peaks were not quantified.

Another consideration accounted for in Table C8 is the fact that while sulphate does not affect acid titratable alkalinity measurements, sulphite does. For each 10 mg/L of sulphite present at a pH of about 8.5, when titrated to an analytical endpoint of pH= 4.5, the apparent acid buffering capacity, expressed as calcite equivalents, is 25 mg/L of Total Alkalinity. Total Alkalinity is quantified as calcite equivalents ($CaCO_3$), but it also measures other titratable ions aside from carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-). Comparison of Total Inorganic Carbon (TIC) versus Total Alkalinity shows that other species aside from carbon are contributing to the measured alkalinity at most sampling locations.

The only locations where the calculations presented on Table C8 fail are where the total amount of sulphur is very low such as at MW09-08 and DC-06. The lack of sulphur at these locations was previously inferred to be due to sulphate reduction to sulphide; however, field testing for sulphide in 2013 indicated that essentially no sulphide is present at most locations onsite, including MW09-08 and DC-06. The low sulphur concentrations in the groundwater at these locations are inconsistent with the high sulphate concentrations near the tailings dam crest and groundwater transport of dissolved species downgradient along Dome Creek. It is notable that sulphite dissolved in water will release sulphur dioxide (SO_2) when acidified according to Equations 9 and 10, and this mechanism could explain the lack of sulphur downgradient of the tailings dam.

$$SO_3^{2-} + 2H^+ \text{ ----> } H_2SO_3 \qquad (9)$$

$$H_2SO_3 \text{ ----> } H_2O + SO_2 \qquad (10)$$

In summary, based on the discussion presented above, and the data and calculations in Tables 29 and 33 (in Section 8.3) and Table C8, the continued presence of sulphite in the water at the site is inferred based on the following considerations:

- the mill used the equivalent of 340 tonnes of sulphite as part of the Inco process;
- standard laboratory analyses cannot distinguish sulphite from sulphate;
- the lack of iron oxidation in unpreserved water samples for metals analysis may indicate the presence of an oxygen scavenger such as sulphite;
- sulphite can contribute to acid buffering capacity as measured by the Total Alkalinity measurement which measures the amount of acid needed to lower the sample pH to 4.5. Comparison of Total Inorganic Carbon (TIC) versus Total Alkalinity shows that other species aside from carbon are contributing to the measured alkalinity at most sampling locations;
- the calculated amounts of sulphite needed to prevent the oxidation of iron in the unpreserved water samples are plausible;
- the calculated amounts of sulphite needed to account for the observed charge balance errors are also plausible;
- the only locations where the sulphite calculations presented in Table C8 are implausible is where the sulphate and dissolved sulphur concentrations are very low such as at MW09-08 and DC-06 which are both located immediately downgradient of the seepage pond; and
- sulphite can de-gas from water as sulphur dioxide according to Equations 9 and 10.

The calculated values of sulphite that would be required to account for the inconsistencies in the observed water chemistry are plausible. Therefore, it is hypothesized that sulphite is persisting in the water at the site, and the reported concentrations of sulphate are actually a combination of sulphate and sulphite.

Sulphite is being used to inhibit ARD formation at coal waste sites in Ohio, and the continued presence of sulphite at Mount Nansen would be expected based on the conditions in the mine tailings (saturated tailings, high pH). The presence of sulphite in the groundwater or tailings solids would not be accounted for by the routine geochemical sampling and testing, but the existing water quality observations and geochemical testing results are consistent with the continued presence of sulphite. The hypothesized presence of sulphite in the tailings and groundwater could be confirmed or refuted with targeted sampling and analysis.

9.0 INFRASTRUCTURE ASSESSMENT

9.1 Mill Area

9.1.1 Overview

Mining on the Mount Nansen properties has occurred since the min-1940s through several changes in ownership and development. The mill complex was most recently upgraded in 1998 and comprises several inter-connected steel buildings of varying size and shape, all in fairly good condition situated on a levelled site.

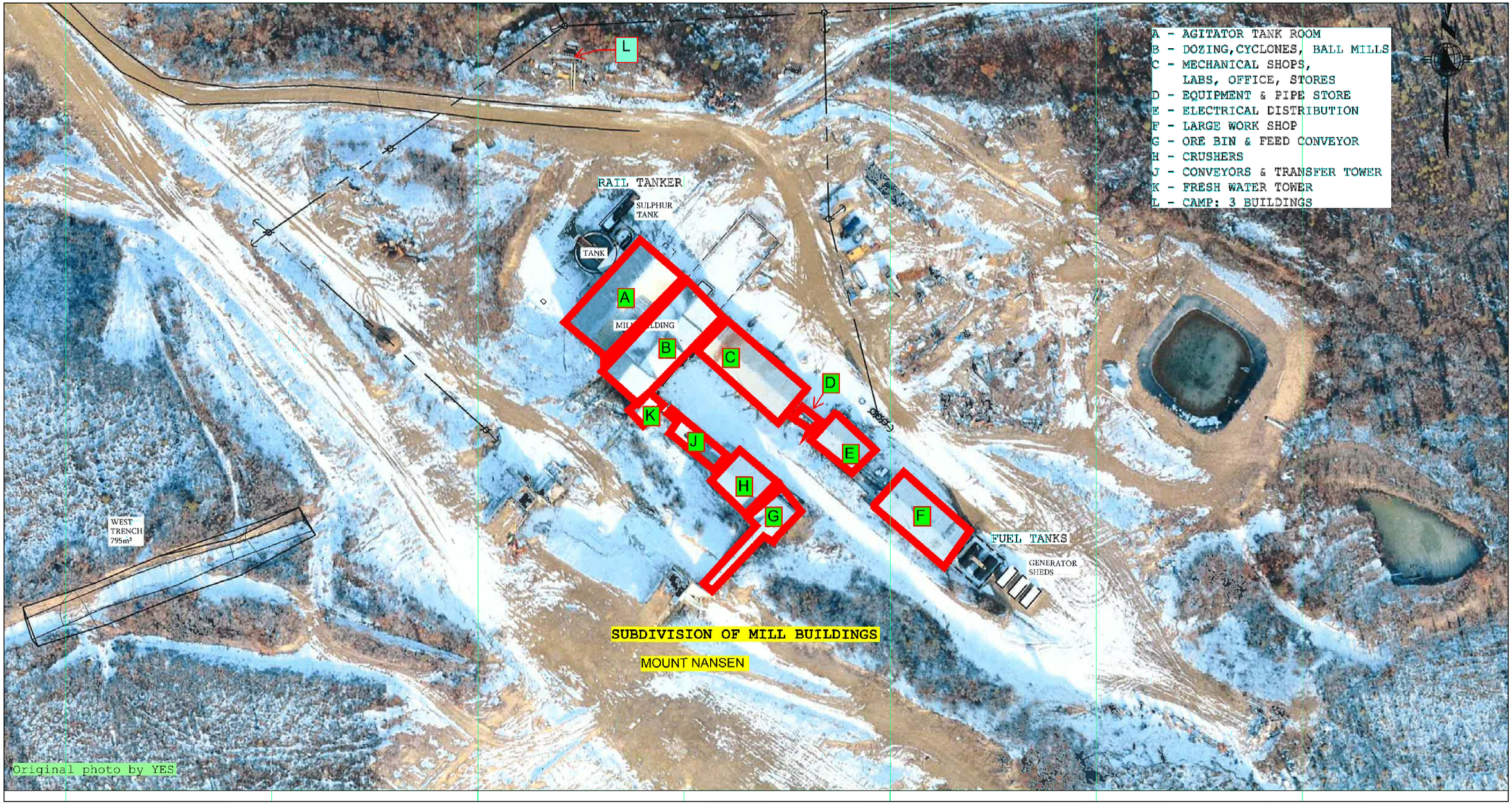
The current condition and design of the various building components renders the mill feasible for substantial diversion of the demolished waste to recycling or reuse. A preliminary estimate is that 80% of the total waste stream could typically be diverted to either re-sale or recycle to a smelter or crusher. Due to the remoteness of the site, this diversion rate may be optimistic and further assessment is required to verify the feasibility of cost-effective diversion. Alternatively, all waste would be buried onsite in a manner that minimizes volume and environmental impact.

Dimensional surveys were completed of the building complex during early December 2013 by Underhill Geomatics, to enable the estimation of deconstruction waste quantity and cost.

Figure 19 shows the subdivided location of the mill complex, with the summarized Structural Characterization in Table 39 for the areas A to K. Figure 20 views show selected views representing the character of the mill building complex.

9.1.2 Structural Assessment

A summary of the features and deconstruction aspects of each building area in the mill is given in Table 34.



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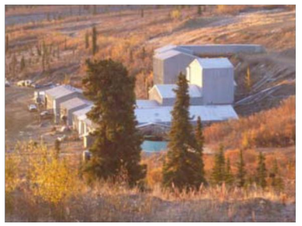
MOUNT NANSEN REMEDIATION PROJECT
Figure 19

SITE CHARACTERIZATION REPORT

SUBDIVISION OF MILL BUILDINGS

MARCH 17, 2014

Mill Complex Random Views



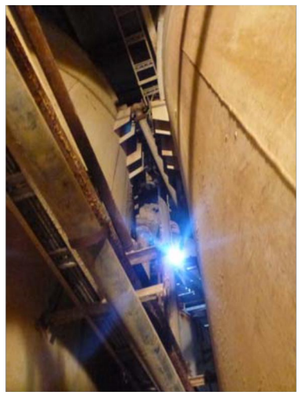
1 - Mill complex looking east

2 - Looking west at Buildings B and C

3 - View of mill looking west at Buildings B, C, and D

4 - Interior Building E MCC

5 - Mill upper terrace, looking west at Buildings J, K, B, and C



6 - Agitator tanks in Building A

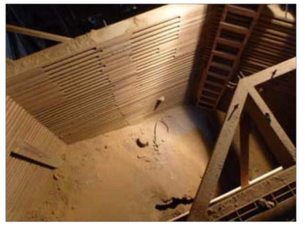
7 - Walkways over agitator tanks in Building A

8 - Interior of Building B, ball mill floor

9 - Looking east at Buildings G, H, and J from upper terrace

10 - Cabling and water pipe from Building B and K

11 - South entry to Building K (fresh water tank room)



12 - Wood stave ore bin in Building G

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MOUNT NANSEN REMEDIATION PROJECT
Figure 20

SITE CHARACTERIZATION REPORT

MILL COMPLEX RANDOM VIEWS

MARCH 17, 2014

Table 39: Structural Characterization – Mill Complex

Area (see Figure 19)	Structure Format, Materials & Content	Deconstruction Aspects	Potentially Hazardous Materials
A – Agitator tank farm	High profiled building with steel portal framing (painted), sub framing, steel sheet roof and side cladding (galvanized), fibreglass insulation, grated steel walkways and ladders (painted), cable racks without cabling (galvanized), closely arranged large and smaller process steel tanks (eroded paint coating), concrete floor-on-grade with containment curbs around tanks, PVC and steel piping, miscellaneous left-over components like mixers from partly- stripped process equipment. Most pumps, electric motors and heavy cabling already removed. Detailed inventory not available. Level site.	Top-down sequence to remove building envelope, expose large tanks for removal. Large open-top agitator tanks have low probability for salvage due to poor condition (dents, damaged paint, bulky format for transport). Foresee insitu destruction of large tanks by flame cutting for recycling to smelter. Smaller open-top and closed tanks could be salvaged by dragging off the foundations for transporting away.	Concrete floors-on-grade saturated with wet process sludge. Generally very wet environment from sustained ground water seepage on floor emanating from south embankment. Spilled granular lime on floors.
B - Chemical dosing, electrolyte heating, cyanide feeding, cyclone feeders, ball mills, ore bins, MCC room, office	Similar to A, without large agitator tanks but with several smaller steel vessels. Add mezzanine floor (3-level) with concrete retaining walls. Heavy upstand concrete foundations of ball mills (mill mechanicals already removed) on upper mezzanine. Two very large wood stave fine ore feed bins in tower section. Small wood framed office and MCC room. Exterior covered insulated pipe box structure down south embankment 15 m long.	Similar to A. Concrete retaining walls which bound the three mezzanines to be crushed and processed with floors and plinths. Crushed concrete to be tested for contaminants before applying as recycled fill.	Similar to A; however, dry floors on upper mezzanines. Hydrocarbon saturation of concrete of mill foundations and surrounding floor on upper mezzanine. Possible cyanide contamination on floors, mid mezzanine and lower. Small stockpile of bagged sodium metabisulphide on upper mezzanine.
C - Refinery flux store, labs, office, mechanical work shop, supplies stores	Low-profile steel portal framed and steel cladded building with fibreglass insulation, including wood framed partition walls between workshop, stores, office and laboratories. No ceilings. Roof sheeting and some wall cladding damaged operations and ice build-up. Concrete floors with storey-height concrete retaining wall south side.	Clear interior content and wood/steel; removing exterior cladding; lift portal framing off foundations; demolish and crush concrete floors, foundations and retaining wall. Deconstruct this section before B. Retaining wall to remain until H, J and K are deconstructed, to	Possible hydrocarbons in floor concrete at stores. Small volumes of asbestos onsite, identified in older parts. This includes the gaskets in the furnace and some wall board.

Area (see Figure 19)	Structure Format, Materials & Content	Deconstruction Aspects	Potentially Hazardous Materials
		prevent possible embankment failure under wet conditions. Severe damage on areas of roof and side steel cladding, operational damage and ice damage.	
D - Store for mining pipes and equipment	Similar to C.	Similar to C.	Similar to C.
E – Electrical distribution room	Similar to C. Contains substantial electrical control board with instrumentation and heavy cabling.	Similar to C.	Similar to C.
F – Main Workshop	Similar to C. Contains bridge crane and roll-up doors, concrete floor with embedded steel rails. Only building in complex electrically-energized.	Similar to C.	Similar to C.
G – Ore bin & conveyor 4	High profiled building with steel portal framing (painted), sub framing, steel sheet roof and side cladding (galvanized), fibreglass insulation, grated steel walkways and ladders. High concrete foundation walls. Houses large wood stave bin for coarse ore. Conveyor feed system with wood substructure.	Top-down sequence to remove building envelope, expose large ore bin for piece-meal deconstruction of wood. Can combine with H.	No hazardous materials.
H – Jaw & Cone crushers	Similar to G. Contains crusher equipment.	Top down, alternatively collapse by controlled blasting of foundations and pull-over with bulldozer after removal of crushers and conveyors.	No hazardous materials.
J – Conveyor transfer tower	High profiled small footprint building with steel framing (painted), sub framing, steel sheet roof and side cladding (galvanized), fibreglass insulation, grated steel walkways and ladders, high concrete foundation walls. Conveyors on wood trestles.	Top down, alternatively collapse by controlled blasting of foundations and pull-over with bulldozer after removal of conveyors.	No hazardous materials.

Area (see Figure 19)	Structure Format, Materials & Content	Deconstruction Aspects	Potentially Hazardous Materials
K – Fresh water tower	High profiled building with steel framing (painted), sub framing, steel sheet roof and side cladding (galvanized), grated steel walkways and ladders. On stilts. Concrete stair down south embankment, exterior.	Top down, alternatively collapse by controlled blasting of foundations and pull-over with bulldozer after removal of steel tank.	No hazardous materials.
Fuel Tanks – next to Workshop F	1.2 m high concrete bund wall and floor, with two steel tanks for diesel fuel.	Salvage tanks; demolish and crush concrete for recycling as fill onsite, provided no contamination with hydrocarbons.	Hydrocarbons
Generator sheds	Three steel shipping containers.	Dismantle for reuse or resale. Generators for resale.	No hazardous materials.

9.1.3 Electrical Assessment

Heavy cabling in the mill has largely been removed. Residual electrical equipment includes control and instrumentation cabinets (MCC) in buildings B and C, switchgear and distribution equipment (e.g. cable racks and conduits and lighting). These items have low salvage value, and they are lumped together as ‘building content’ for inclusion under the inventory of the main deconstruction contract.

External electrical infrastructure is discussed under Section 9.3 Miscellaneous Infrastructure.

9.1.4 Mechanical Assessment

Mechanical equipment in the mill complex includes the following:

- conveyor systems without the rubber belts (which have been removed);
- miscellaneous valves and piping, in steel, PVC and HDPE;
- ventilation ducting and fans; and
- crushers in building H (jaw and cone crushers).

These items have salvage value. They are lumped together under ‘building content’ for inclusion in the inventory of the main deconstruction contract.

9.2 Camp Area and Miscellaneous Small Buildings

9.2.1 Structural Assessment

Overview

The various wooden buildings appear to be older than the mill complex, assumed to date from the 1940s. They are generally of light wood frame construction of varying size and shape, and were in poor to reasonable functional condition. The Bunkhouse was in good condition with recent interior renovations.

The feasibility of deconstruction with diversion to recycling or reuse is considered limited to poor. A preliminary estimate is that 25% of the total waste stream could be diverted to either re-sale or recycle, with 0% from small pump stations.

Dimensional surveys were completed of all buildings during early December 2013 by Underhill Geomatics to enable the estimation of deconstruction waste quantity and cost.

Figure 21 is a compilation of the miscellaneous buildings showing six wood structures. The Structural Characterization summary of the features and deconstruction aspects of each building is given in Table 40. Figure 22 shows the location of pumphouses and the road bridge.

9.2.2 Electrical Assessment

These buildings contain small electrical distribution boards and cabling for appliances and lighting. In the case of the Pumphouses and the Electrical Transfer Station, the supply is expected to be of a higher rating than the Bunkhouse and Cookhouse.

9.2.3 Mechanical Assessment

Other than domestic plumbing, there is no mechanical component in these buildings, except for pumps and valves in the two Pumphouses which are fitted with a well pump of unknown depth and power rating. A compact water purification system is installed in the Cookhouse.

Electrical and mechanical equipment are typically lumped together under ‘building content’ for inclusion in the inventory of the main deconstruction contract.

Compilation of Miscellaneous Buildings

11 - Victoria Creek Wellhouse

12 - Victoria Creek Wellhouse Interior

13 - Seepage Pond Pump House

14 - Cookhouse Exterior

15 - Cookhouse Interior

16 - Camp Shed

17 - Bunkhouse

18 - Bunkhouse foundation wall

19 - Electrical Transfer Station (ETS)

20 - Interior of ETS

Data Source:
Datum: NAD 1983 CSRS UTM Zone 8N

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MOUNT NANSEN REMEDIATION PROJECT
Figure 21

SITE CHARACTERIZATION REPORT

COMPILATION OF MISCELLANEOUS BUILDINGS

MARCH 17, 2014

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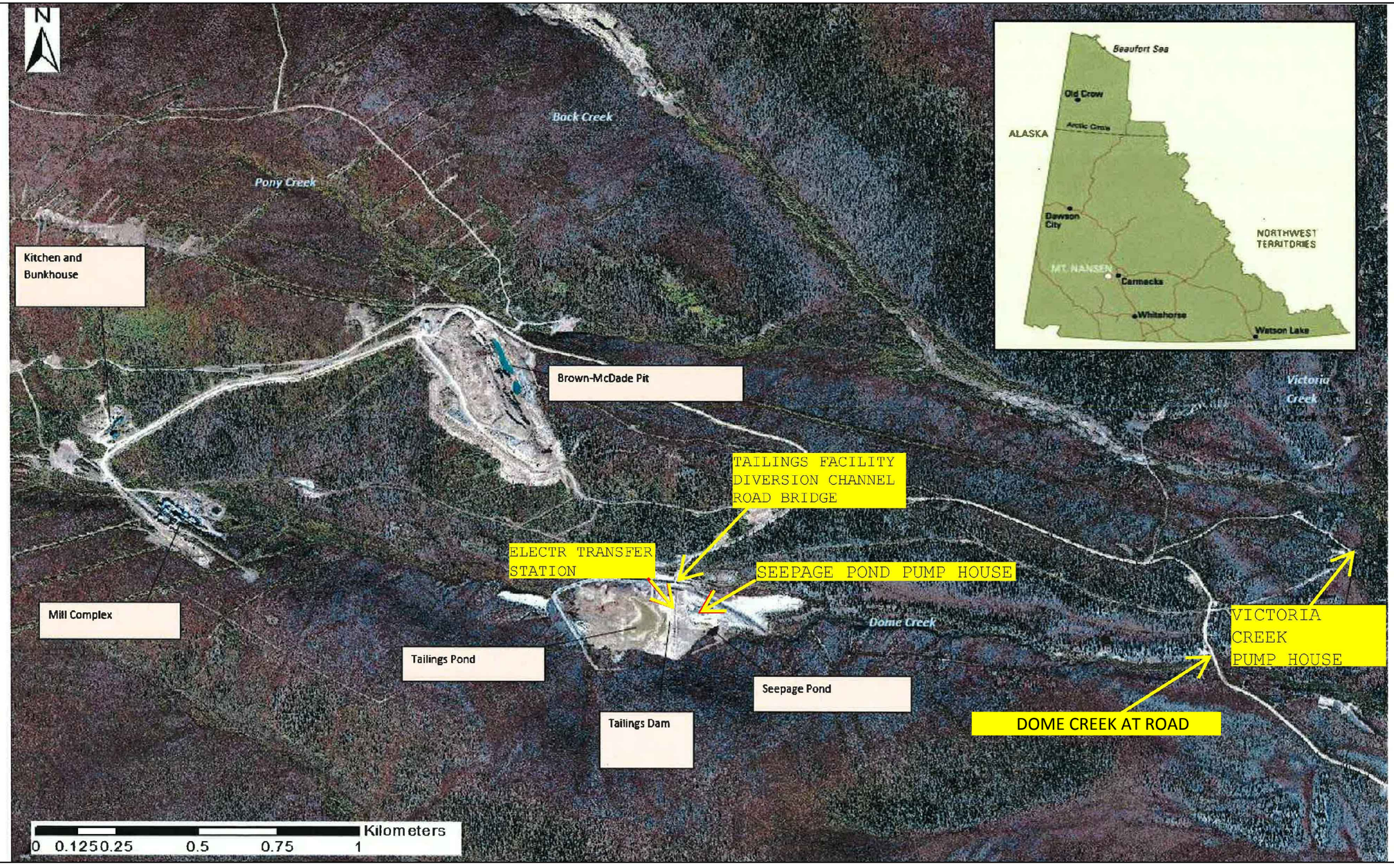

Data Source:
Datum: NAD 1983 CSRS UTM Zone 8N

MOUNT NANSEN REMEDIATION PROJECT
Figure 22

SITE CHARACTERIZATION REPORT

SITE VIEW
MOUNT NANSEN SITE

MARCH 17, 2014

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Table 40: Structural Characterization – Camp Area & Miscellaneous Small Buildings

Building (see Figure 20)	Structure Format, Materials & Content	Deconstruction Aspects	Potentially Hazardous Materials
Bunkhouse	Wood frame, wood sided, pitched steel covered roof, gypsum board partitioned interiors, vinyl covered floors laminated ceiling beams, wood doors and PVC windows, roof ventilator, fluorescent lighting and multiple wall outlets, residential style plumbing with kitchen and washrooms in good condition, concrete foundation walls. Sloping site. Electrically energized.	Piece-meal deconstruction. Remove steel roofing, doors, windows and plumbing fittings for recycling. Gypsum walling and vinyl flooring likely to hazardous disposal. Push-over with dozer and dispose of wood. Laminated ceiling beams have salvage value. Concrete foundation walls crushed and recycled as fill onsite.	Possible asbestos in floor covering, lead paint, PCB's in fluorescent lights. Requires verification.
Cookhouse-kitchen	Wood frame, wood sided, pitched steel covered roof, gypsum board partitioned interiors, vinyl covered floors, wood doors and steel windows, fluorescent lighting and multiple wall outlets, residential style plumbing with kitchen and washrooms in fair condition, large walk-in freezer. A compact water purification system is installed. Stainless steel hooded gas burning stoves and stainless steel wash troughs. Concrete foundation walls. Sloping site. Electrically energized.	Similar to Bunkhouse, without laminated beams.	Similar to Bunkhouse.
Camp Shed	Simple wood frame, wood sided, pitched asphalt roof, no partition walls, wood doors and window, fluorescent lighting and wall outlets. Concrete floor and foundation walls. Level site. Electrically energized.	Piece-meal deconstruction. Remove steel roofing, doors, windows and plumbing fittings for recycling. Push-over with dozer and dispose of wood. Concrete floor and foundations crushed and recycled as fill onsite.	Lead paint, PCBs in fluorescent lights. Hydrocarbons on floor. Requires verification

Building (see Figure 20)	Structure Format, Materials & Content	Deconstruction Aspects	Potentially Hazardous Materials
Victoria Creek Wellhouse	Wood frame, wood sided, pitched asphalt covered roof, gypsum board partitioned interiors, vinyl covered floors laminated ceiling beams, wood door, fluorescent lighting and multiple wall outlets, concrete foundation walls. Sloping site.	Piece-meal removal of pump and electrical fittings including control panels and cabling. Push-over with dozer and dispose of wood, which has no salvage value left. Concrete foundation walls crushed and recycled as fill onsite. The well will be decommissioned per standard practices: • remove down-well pumping equipment; • cut down casing to below the to-be-restored, final land grade; • tremie cement from well base to below the final land grade, leaving no down-well voids. The wellhouse area will be regraded and reclaimed as appropriate.	Lead paint, PCBs in fluorescent lights. Hydrocarbons on floor. Requires verification.
Seepage pond pumphouse	Wood frame, wood sided, steel roof, gypsum board partitioned interiors, vinyl covered floors laminated ceiling beams, wood doors and PVC windows, fluorescent lighting and multiple wall outlets, concrete foundation walls. Sloping site.	Similar to Victoria Creek Wellhouse. The concrete encasement of the well shaft will remain and capped off with cementitious grout.	Similar to Victoria Creek Wellhouse.
Electrical Transfer Station at Tailings Dam	Wood frame, wood sided, steel roof, gypsum board partitioned interiors, vinyl covered floors laminated ceiling beams, wood doors and PVC windows, fluorescent lighting and multiple wall outlets, concrete foundation walls. Sloping site.	Similar to Victoria Creek Wellhouse.	Similar to Victoria Creek Wellhouse.

9.3 Miscellaneous Infrastructure

9.3.1 Electrical Grid

The electrical grid consists primarily of a posted overland feeder line, fitted with pole mounted transformers at branches to the Victoria Creek pump station, the camp site, the mill and a branch to the transfer station for small pump stations.

A buried cable line (high current to crushers) between buildings E and H at the mill could be retrieved and the excavations reinstated. No hazmat implications are foreseen.

9.3.2 Underground Piping

No onsite inspections were conducted to characterize underground piping or cabling. Information for a desk study was gathered from an 'As-built' sketch by BYG Natural Resources dated April 1998 summarized as follows, and depicted on Figure 23:

- Seven pipe lines in the vicinity of the mill complex are designated PL-1 to PL-7. Most are presumably water, fresh and other. Only pipe PL-7 is not buried. Materials and potential hazmat content are not available. Coated steel, ductile iron, PVC and HDPE materials could be expected.
- Line PL-2 is apparently a 4" steel drain under the access road coming from the camp site.
- The origin of the fresh water line PL-1 is unknown (where it traverses west of the camp site). Similarly, the origin of PL-4 along the main access road is unknown.

It is foreseen that pipes will be removed only where day-lighting is above grade and exposed.

The salvage value of pipes will depend on hazmat conditions and the pipe material. Clean HDPE and steel pipes will have some salvage value.

With reference to Figure 23, it is recommended that where pipes are visible and accessible, a hazardous material assessment be undertaken to identify potential further action. Further action would be complete or partial removal of a line from the site.

9.3.3 Culverts

Six culverts were identified, presumably corrugated pipe. Culvert disposition will be a function of the general site reclamation plan, as follows:

- culverts should remain if the road alignment is not reclaimed back to the natural grade and slope; and
- culverts are removed and backfilled together with the remediation of the road alignment to resemble natural grade.

9.3.4 Bridges

As part of the decommissioning of the diversion ditch, the existing minor bridge crossing of the Dome Creek diversion ditch will be removed. The 9.4 m span steel girder/wood deckbridge resting on concrete lock blocks can be deconstructed efficiently. It was recently repaired and could be salvaged for reuse if required. The gravel foundation bases under lock blocks can be removed or recontoured to blend with the immediate surroundings. No hazardous material impacts are foreseen.

Within the OIC there is also a culvert crossing of Dome Creek downstream of the Tailings Facility. This will not be decommissioned as it is part of the public road.

Data Source:
Datum: NAD 1983 CSRS UTM Zone 8N

MOUNT NANSEN REMEDIATION PROJECT
Figure 23

SITE CHARACTERIZATION REPORT

MISCELLANEOUS INFRASTRUCTURE

MARCH 17, 2014

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9.3.5 Roads

Roads are all surfaced with granular soil and gravel. All roads are in fair to good, trafficable condition with little evidence of drainage scouring and erosion damage of the shoulders or local site.

Two options will be considered for remediation: (a) Road alignment is not reclaimed back to the natural grade and slope; however, ripped and vegetated, with local trenching to facilitate natural drainage and prevent scouring developing in to ditch formations; and (b) Complete reclamation of road alignment, by cut and fill back to the natural grade with vegetation and riprap scour prevention, including shaping of natural gullies.

10.0 OPEN PIT

10.1 Pit Walls

The Brown-McDade Pit has been characterized significantly by many reports as part of pre-mining assessments. An extensive assessment of the current conditions of the Open Pit has also been recently completed (EBA, 2012). General visual observations indicated that the 2012 report appears consistent with conditions in 2013. The pit wall characterization summarized below is, therefore, based on these reports. For additional detail, reference should be made to EBA (2012).

The Brown-McDade Pit is situated within some of the altered granitic intrusions located along a 3 km wide, northwest-trending corridor, referred to as the Mount Nansen Trend. This corridor is essentially a horst, bordered by primary, north-northwest-trending, normal faults, and cross-cut by east-northeast trending (secondary) strike-slip faults. The interaction between the primary and secondary faults has additionally produced a swarm of closely-spaced tensile cracks, which are consistently oriented north-northeast, and responsible for the mineralization. The most common form of mineralization is associated with quartz, carbonate and sulphide veins; it is most pronounced in the southern three quarters of the pit. Since the Mount Nansen Trend escaped the most recent Pleistocene glaciations, the weaker, altered and weathered rocks were preserved.

The main jointing patterns in the Brown-McDade Pit are parallel to the aforementioned tectonic features. The secondary joint set, associated with the direction of the aforementioned strike-slip faults, has a northeasterly strike and is subvertical. The combination of these two orthogonal joint sets is responsible for the blocky appearance of the pit walls. The pit is a 400 m long elongated excavation, not more than 30 m wide at the base. Five portal locations exist within the pit walls. Only one of these, the Pony Creek Adit, is understood to be of any significant length and is the only one which daylights from the pit and is discussed subsequently. If the other short portals collapse, it has been suggested that this could result in a network of cracks that could create a localized secondary permeability conduit for groundwater seepage water from the pit.

While the benches along the east wall were excavated taking advantage of the steeply dipping (70° to 80°) primary joints, the same discontinuity pattern produced a consistent toppling failure mode for the west wall, and consequently far more instabilities. Generally, a fair to good rock mass exists along the southernmost three quarters of the east wall. In this area, only localized rock fall hazards exist. Since the fragments are generally small and tabular or blocky, they are more likely to slide than roll. Hence, they generally do not pose a rollout hazard. The northernmost 100 m of the east wall is more heavily jointed and also weathered; consequently the catch berms here are filled with gravel-sized talus.

The rock mass along the west wall is more severely weathered and jointed and, therefore, of poor to very poor quality. Added to this is the toppling failure mode, which continuously opens up new cracks where the freeze-thaw process produces ravelling of gravel-sized fragments. This is most pronounced in the northwest sector of the pit. Here, the rock mass is also weak enough to allow shallow slide-type failures.

10.2 Geochemical Characterization

The Brown-McDade Zone is located at the southeasterly end of the belt and measures 500 m in length by 200 m in width. Quartz veins and associated feldspar porphyry dykes are developed in the hanging wall of a strong fault (Footwall Fault), which strikes 160° and dips 50 to 70° to the southwest. The fault cuts obliquely across a contact between granodiorite and metamorphic rocks and is most highly mineralized where granodiorite forms both walls (Higgs, 1994).

The strongest veins occur in a 3 to 40 m wide band directly adjacent to the Footwall Fault. Weaker subsidiary structures are common further out on the hanging wall. The highest assays are normally found within the quartz veins. Adjacent fractured or gougy wallrocks are often weakly to moderately mineralized. Near-surface sulphide minerals were converted to limonite and other oxides by supergene weathering. The oxidation gradually diminishes with increasing depth. The depth of total oxidation ranges from 5 m at the north end of the zone to at least 75 m at the south end.

Primary sulphide minerals in the Brown-McDade Zone, in approximate order of abundance, are pyrite, arsenopyrite, sphalerite, galena and sulfosalts (Norecol Environmental Consultants, 1989).

10.2.1 Geochemical Investigation Program

The initial geochemical study on the Brown-McDade Pit wall consisted of 13 samples collected by BYG Natural Resources Inc. in 1997. In 2000, Conor Pacific selected four samples from the northern area of the lower pit wall and two samples from the southern area of the lower pit wall (Conor Pacific, 2000). A total of 14 samples were collected along several benches of the pit wall in 2009 by Altura (Altura, 2009, 2009b, 2009c). The 2009 samples were collected as composites over an interval of several tens of metres from the north and east sides of the upper and lower pit walls. Samples from all programs underwent a suite of ABA testing, elemental metal, and leachable metal as summarized in Table 41.

Table 41: Summary of Geochemical Tests of Pit Wall Rock Samples (1997, 2000, 2009)

Pit Section	No. of Samples	Geochemistry Testing		
		ABA	Metal	Leachable Metal
Upper Pit Wall - Oxide Zone	19	19	19	5
Lower Pit Wall - Sulphide Zone	14	14	14	6
Total	**33**	**33**	**33**	**11**

10.2.2 Geochemical Characterization of Pit Wall Rock

The rock samples from the pit wall were grouped into the oxide zone of the Upper Pit Wall and the sulphide zone of the Lower Pit Wall. The statistical summary of ABA testing results is presented in Table 42.

Paste pH values ranged from 5.9 to 8.1, with a median pH of 7.1 for all rock samples from the oxide zone. The paste pH for sulphide zone rock samples was lower compared to the paste pH of oxide zone rock samples, with values between 2.4 and 7.6.

For the oxide zone rock samples, the concentrations of total sulphur ranged from less than 0.1% to 2.4%, with a median of 0.3%. Sulphate concentrations were low and varied from 0.01% to 0.08%. Sulphide was the major sulphur species in the oxide zone rock samples. The sulphur content from the sulphide zone varied from 0.02% to 36.2%. Sulphate content ranged from 0.01% to 2.2%. Sulphide was also the major sulphur species for the sulphide zone rock samples.

Table 42: Summary of Acid Base Accounting Results for Pit Wall Rock Samples

Sample	Paste pH	TIC	S(T)	$S(SO_4)$	Calculated $S(S^{-2})$	Carb NP	AP	NP	NPR
		%				kg $CaCO_3$/t			
Upper Pit Wall - Oxide Zone (n=19)									
Count	19	6	19	19	19	6	19	19	19
Minimum	5.9	0.0	0.1	0.01	0.01	0.01	0.3	-4.4	0.03
Maximum	8.1	0.6	2.4	0.8	2.2	0.6	67.8	76.5	120
Mean	7.0	0.3	0.5	0.1	0.4	0.3	13.3	20.7	1.6
Standard Deviation	0.7	0.2	0.6	0.2	0.5	0.2	16.1	22.8	3.3
Median	7.1	0.3	0.3	0.0	0.2	0.3	6.4	13.7	2.1
10^{th} Percentile	6.1	0.1	0.1	0.0	0.1	0.1	2.6	-2.1	0.1
25^{th} Percentile	6.5	0.1	0.1	0.0	0.1	0.1	3.5	3.2	0.6
75^{th} Percentile	7.6	0.5	0.7	0.1	0.6	0.5	20.1	38.2	2.4
90^{th} Percentile	7.7	0.6	1.0	0.2	0.8	0.6	26.4	47.6	3.5
Lower Pit Wall - Sulphide Zone (n=14)									
Count	14	14	14	14	14	14	14	14	14
Minimum	2.4	0.01	0.02	0.01	0.02	0.01	0.6	-30.5	0.0002
Maximum	7.9	3.8	36.2	2.2	34.0	3.8	1064	54.3	13.4
Mean	5.9	0.8	5.3	0.7	4.7	0.8	145	17.1	0.1
Standard Deviation	1.9	1.1	10.2	0.7	9.7	1.1	304	23.7	3.3
Median	6.7	0.4	1.6	0.4	1.2	0.4	36.3	23.9	0.7
10^{th} Percentile	3.0	0.0	0.1	0.03	0.1	0.01	2.1	-8.5	0.002
25^{th} Percentile	4.3	0.0	0.5	0.2	0.2	0.04	7.4	1.8	0.1
75^{th} Percentile	7.3	1.0	3.2	1.2	1.7	1.0	54.5	30.0	2.6
90^{th} Percentile	7.6	2.2	15.3	1.6	14.3	2.2	447.8	44.4	5.4

The median NP for the oxide zone rock samples was 13.7 kg $CaCO_3$/t, which was less than the median NP for the sulphide zone rock samples of 23.9 kg $CaCO_3$/t. The median NP attributed to carbonate minerals (Carb NP) was low for both zones, and was 0.3 kg $CaCO_3$/t for the oxide zone and 0.4 kg $CaCO_3$/t for the sulphide zone. This indicates that very few carbonate minerals are present to provide neutralization capacity for any acidic reaction products.

The NPR of the oxide zone rock samples ranged from 0 to 120. The average and median NPR values were 1.6 and 2.1, respectively, with 13 of 19 samples having an NPR less than two, and eight of 19 samples having an NPR less than one (Figure 24). The mean and median NPR of the sulphide zone rock samples ranged from 0.0002 to 13.4 with mean median values of 0.1 and 0.7, respectively. Approximately 57% (eight of 14 samples) of the sulphide zone samples had NPR less than 2, and seven samples had NPR less than 1 (Figure 24).

The elemental analysis results indicated that elevated concentrations of antimony, arsenic, bismuth, cadmium, copper, lead, and zinc occurred in both oxide and sulphide zone samples. The statistical summary of the elevated metal parameters is presented in Table 43.

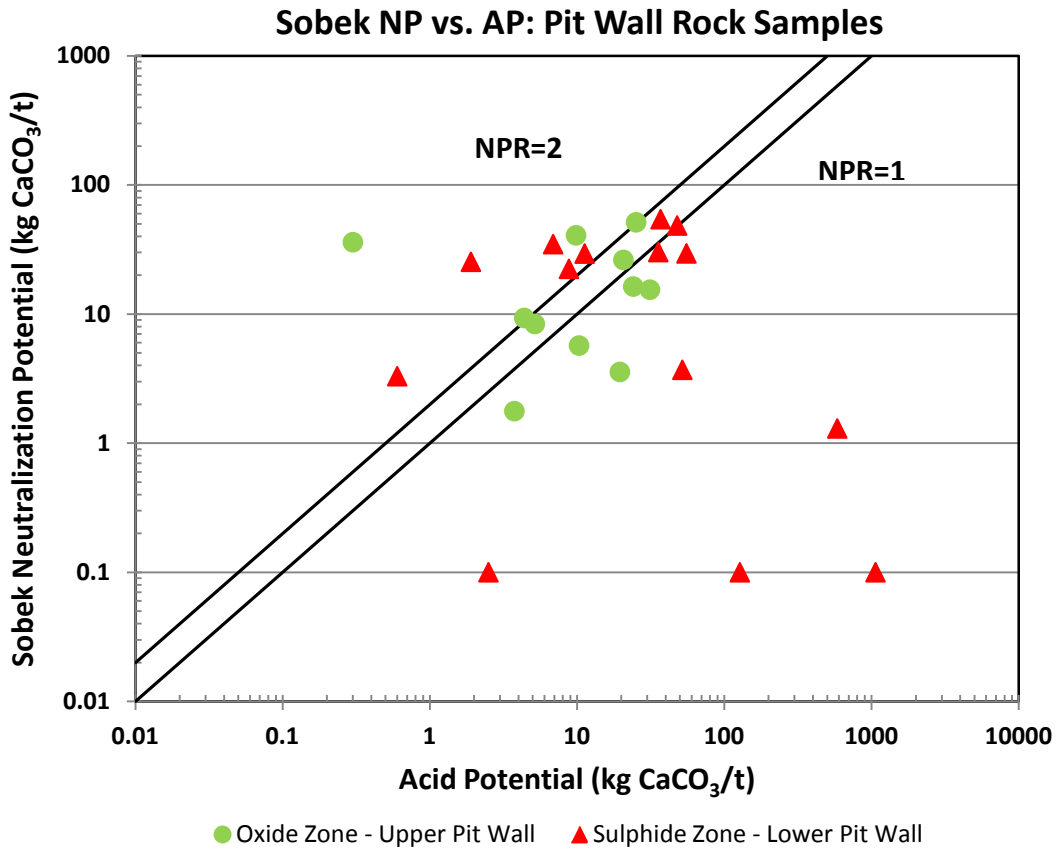


Figure 24: Comparison of AP vs. NP for Pit Wall Rock Samples

Table 43: Summary of Selected Elemental Metal Results for Pit Wall Rock Samples

Statistic	As	Bi	Cd	Cu	Pb	Sb	Zn
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
10 Times Average Crustal Abundance	18	0.085	1.5	600	140	2	700
Upper Pit Wall - Oxide Zone (n=19)							
Count	19	6	19	19	19	19	19
Minimum	5.0	0.1	0.2	4	8.8	1	19.0
Maximum	3,331	16.1	55.9	1315	782.0	141	10,200
Mean	481.1	4.9	14.0	230	196.4	31	1,819
Standard Deviation	888.6	5.7	14.5	319	193.9	34	2,348
Median	129.0	3.2	9.7	110	103.0	21	968
10th Percentile	30.6	1.3	1.5	15	49.4	9	309
25th Percentile	82.0	2.6	4.2	49	77.5	15	708
75th Percentile	359.4	4.3	15.9	291	276.6	31	1,846
90th Percentile	1055.3	10.4	31.5	517	416.7	52	3,655
Lower Pit Wall - Sulphide Zone (n=14)							
Count	14	8	14	14	14	14	14
Minimum	39.0	2.5	4.0	28	18.0	5	112
Maximum	2,655	233.8	175.3	22846	12,524	1336	10,380
Mean	812.6	37.7	25.7	1851	1,743	177	1,874
Standard Deviation	820.1	79.6	43.4	6046	3,398	343	2,505
Median	449.1	7.6	14.5	204	451.7	52	1,209
10th Percentile	179.9	3.3	9.5	43	108.2	19	544
25th Percentile	281.9	4.7	11.0	124	299.0	28	1,063
75th Percentile	925	18.1	17.7	365	1,195	181	1,806
90th Percentile	2,094	88.2	25.1	673	4,281	233	1,892

Approximately 90% of oxide zone rock samples had elevated concentrations of antimony, arsenic, and cadmium and all samples had elevated bismuth content. Zinc enrichment was identified in around 74% of oxide zone samples. A lower number of oxide zone samples, approximately 52%, were enriched in lead. Elevated copper content was detected only in one sample from the oxide zone.

All sulphide zone samples had elevated concentrations of arsenic, bismuth, cadmium and antimony. Lead and zinc enrichment also occurred in 86% of sulphide zone samples. One sulphide zone sample had an extremely high copper concentration (around 2.2%).

The complete results of the SFE testing on oxide and sulphide zone samples are presented in Table GC-1 in Appendix F.

Leachates from oxide zone samples had pH values ranging from 6.3 to 7.8. Concentrations of arsenic, copper, and zinc were above CCME freshwater aquatic life guidelines for at least one sample from the oxide zone.

The pH of two sulphide zone samples was acidic (values around 2.4). The metal concentrations in the leachate from the sulphide zone samples were generally higher compared to the metal concentrations in the leachate from the sulphide zone. Short-term leachate test results of

sulphide zone samples exhibited high antimony, arsenic, copper, lead, manganese and zinc concentrations. The leachate from these samples also had high sulphate concentrations, ranging from 2,762 mg/L to 10,211 mg/L.

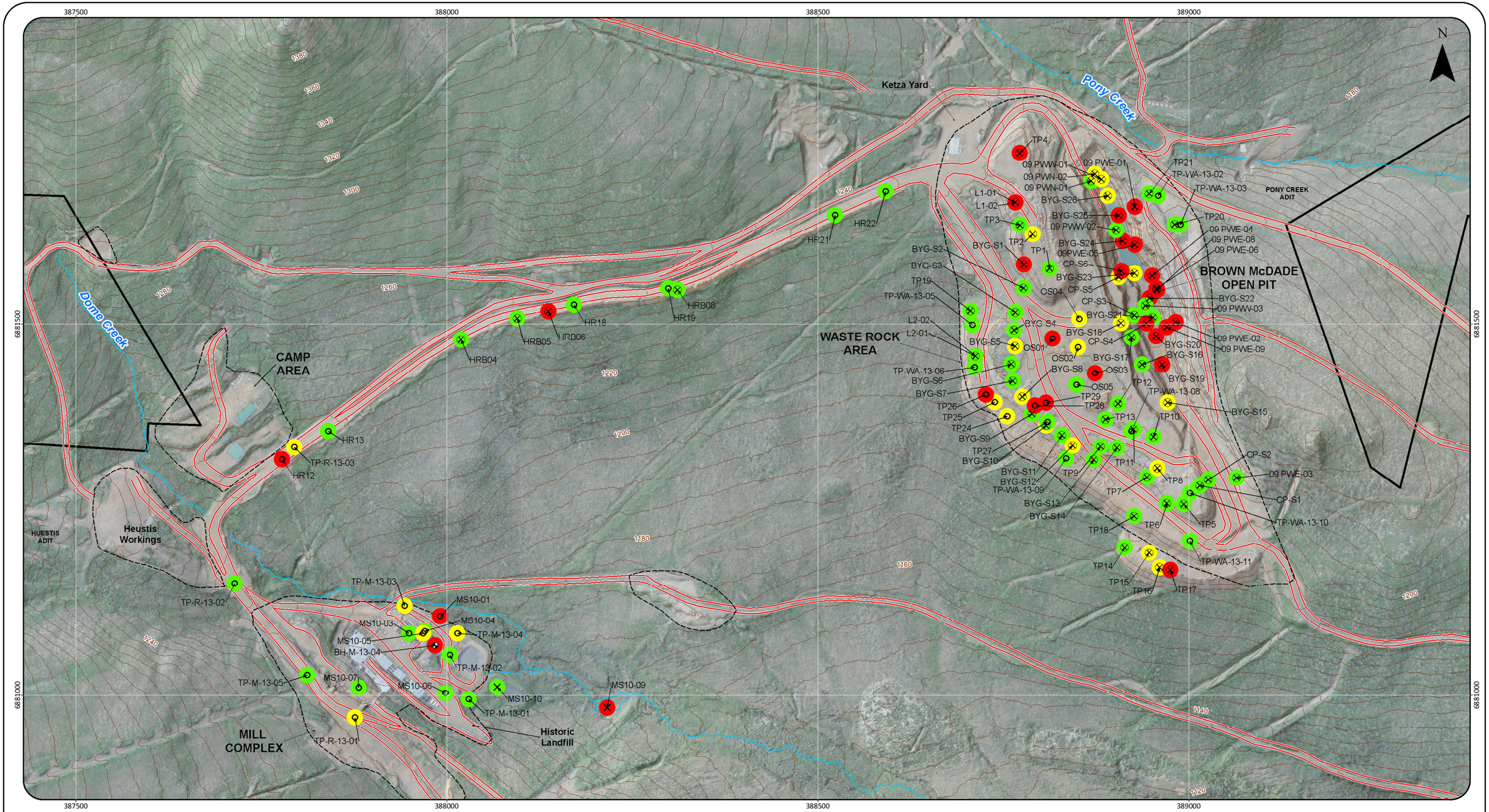
In summary, PAG and non-PAG rock was identified in both the oxide zone and the sulphide zone as presented in Figure 25. Antimony, arsenic, cadmium, copper, lead manganese and zinc are the main metals of concern for the pit wall. The sulphide zone on the lower pit wall contains oxidation products that could lead to low pH and high metal leachate concentrations.

10.3 Pony Creek Adit

The Pony Creek Adit was an original exploration adit that had been developed in the 1960s. The current condition of the Pony Creek Adit remains in doubt.

This horizontal tunnel was advanced from a portal on the west bank of the Pony Creek, heading in a northwesterly direction toward the Mount Nansen orebody over a distance of 165 m. It was subsequently intersected by the Brown-McDade Pit, where it currently daylights at about elevation 1,185 m in the east wall. It must have been mined using conventional, non-mechanized drill and blast methods based on its approximate cross-sectional dimensions of 2 m (height) x 1.8 m (width). The adit is situated entirely within intrusive rock (granodiorite), with the degree of alteration increasing significantly as it approaches the orebody.

The adit was inspected and mapped by SRK Consulting in September 2005 (and reported in May 2006). Overburden was encountered for the first 5 m; hence, this part of the excavation was supported with timber. From 5 to 23 m, the rock is weathered and from 110 to 165 m, the adit intersects the altered zone surrounding the orebody. Conditions were described as blocky and poor at these extremities. Fair to good conditions prevail from 31 to 110 m. Only a narrow strip with favourable ground conditions, from 27 to 31 m, was encountered. This location of favourable conditions is where SRK recommended the construction of a 0.5 m thick, steel-reinforced concrete bulkhead, anchored into the surrounding rock mass by means of 20 mm x 1.2 m full-column-grouted steel dowels (0.6 m embedded length). Penetrating grout was specified at the roof contact to provide a tight seal, while an embedded pipe with a valve was included in the design to allow for the drainage of water, should this be necessary for whatever reason. Lastly, a 1 m high dam was proposed southeast of the barrier to pond any water that might seep past through or past it, to provide an option to pump it back into the pit, if necessary. No as-built drawing for the SRK bulkhead has been located.



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

ARD Classification
- PAG
- non-PAG
- Uncertain

Testhole
- Borehole
- Grab Sample
- Hand Auger
- Test Pit

- Order in Council Boundary
- Contour (5 m)
- Disturbed Area
- Roads
- Streams

Associated Engineering — Global Perspective. Local Focus.

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Yukon Energy, Mines and Resources — Assessment and Abandoned Mines

MOUNT NANSEN REMEDIATION PROJECT
Figure 25

SITE CHARACTERIZATION REPORT

OPEN PIT, WASTE ROCK AREA GEOCHEMISTRY

Scale 1:5,000
Metres
0 100 200

March 18, 2014

S:\PROJECTS\VM00605 - Mount Nansen\GIS\Mapping\VM00605_0020c_11x17_SiteCharacterizationReport_Geochem_MillPitLocations.mxd

There is some significant uncertainty related to the bulkhead in the Pony Creek Adit. Gartner Lee (2007) stated that "the Pony Creek Adit has been plugged". In their overall pit assessment of December 2012, EBA Engineering expressed some seemingly contradictory statements regarding the adit. On the one hand, they mentioned that, since "there do not appear to be any significant changes since 2006" to the adit, they "have no reason to question the adequacy of SRK's design". Within the same report, however, they indicated that they had never entered the adit to visit the site of the proposed bulkhead. Based on a lack of construction documentation in LORAX (2011), they concluded that "the SRK bulkhead had not been constructed", but that clay and fine-grained materials may have been placed near the adit exposure within the pit wall as a substitute. It is unclear where the clay or fine-grained materials may have been sourced. It is not clear how the adit was accessed to place material even assuming it was available. Irrespective of the nature or existence of any barricade or bulkhead, their report mentioned that gradual collapse of the adit might result in an increased secondary permeability in the strata which, in turn, could accelerate the contamination of the groundwater table.

Once the role of the Pony Creek Adit in the reclaimed pit configuration has been confirmed, the appropriate confirmation of the condition of the adit should be made. This would include visual observation and will require planning to ensure the safety of entry into a potentially unstable confined space.

10.4 Groundwater Exchange from Water Balance

An update to the previous Open Pit water balance (Gartner Lee, 2007) was developed to quantify the current pond water exchanging with groundwater. The method is based on water accounting to derive groundwater exchanging (entering or leaving) the Open Pit pond.

The water balance accounts for inflow and outflow volumes for the pit pond. The period of data used for the water balance was from October 8, 2010 to June 30, 2013. Daily data were available for the open pit pond level, and monthly data for the other parameters for the water balance analysis.

The water balance parameters were as follows:

- Surface Water Inflow:
  - direct precipitation, within the pit perimeter, P; and
  - surface runoff (factored for sublimation), entering as pit wall runoff, R.
- Surface Water Outflow:
  - evaporation, E (assumed to be the only surface water outflow).
- Net Surface Water Inflow:
  - P + R - E
- Pond Level Change:
  - pond water level change, factored for area, giving pit volume change, PV.
- Net Groundwater Exchange:
  - P + R - E - PV

Daily values for Net groundwater exchange were derived as the residual after summing Net Surface Water Inflow and Pond Level Change. Figure 26 shows the groundwater component of the Open Pit pond to have a net loss over time, i.e. water predominantly leaves as groundwater. For the period 2010 to 2013, inclusive, the average rate of water loss from the Open Pit pond was quantified as being 0.2 L/s (1 m^3/d to 2 m^3/d).

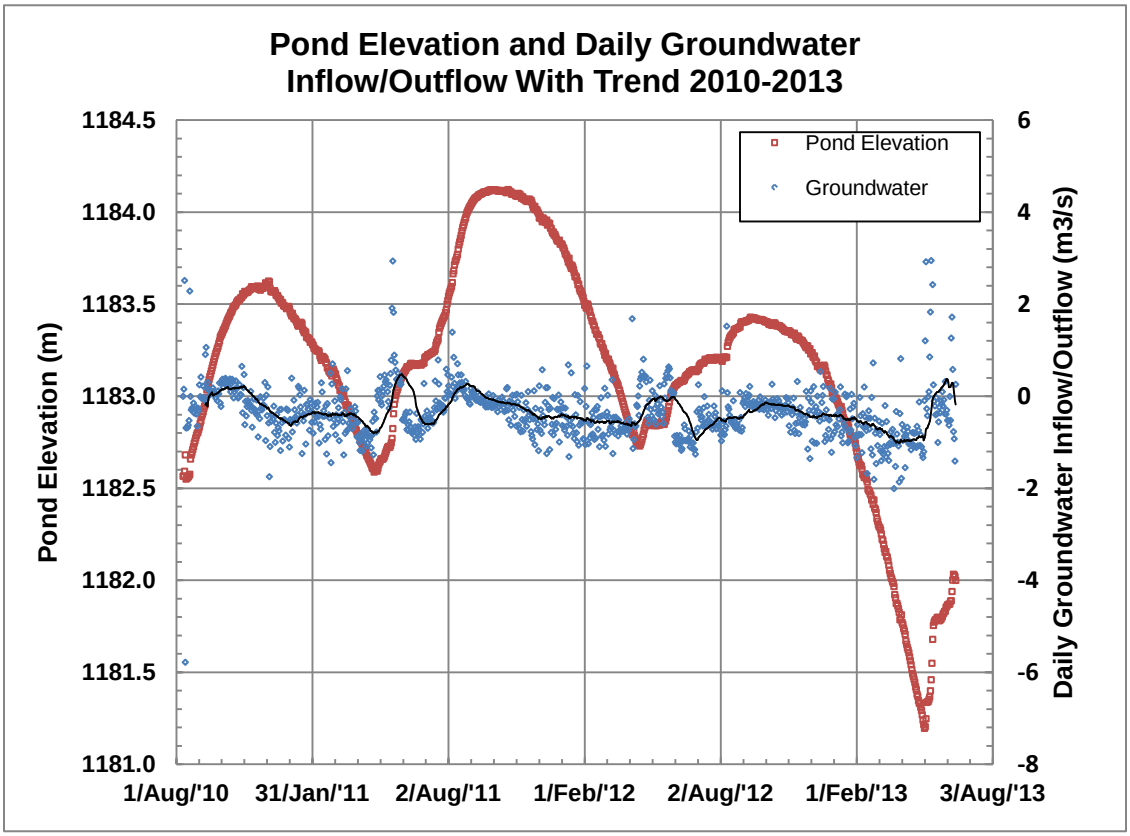


Figure 26: Pond Elevation and Daily Groundwater Inflow/Outflow With Trend 2010-2013

10.5 Groundwater Exchange from Winter Recession Curve Analyses

The average derived from the three wintertime pond elevation declines is greater than that quantified from water balance methods (0.2 L/s), which contain an unquantified, although previously assumed low, bias from Pony Creek seepage. The pit pond decline method of evaluating groundwater outflow is unaffected by this bias and is also more selective for quantifying groundwater exchange, compared to the water balance method, arising from the different measurement scales, i.e. metres of pit pond elevation range versus millimetre summations of surface water inputs and evaporative losses.

Pit pond level data, as recorded by the in-pond data logger, provided pond levels from August 2010 to June 2013, inclusive, which included three wintertime periods and pond level recession curves. These pond level data were analyzed to identify the following:

- the pond elevation relationship to groundwater inflow/outflow daily rates, as derived from water balance, i.e. the pond water 'head' dependency, if any; and
- the time relationship to groundwater inflow/outflow daily rates, as derived from water balance, i.e. seasonal dependency, if any.

The pond elevation and pond water temperature data are shown on Figure 27, as variables compared to daily groundwater inflow (positive values) and daily groundwater outflow (negative values). Note, the conversion for in-pond logger data from water level to elevation is not final; therefore, the pond elevations that follow are subject to possible minor adjustment.

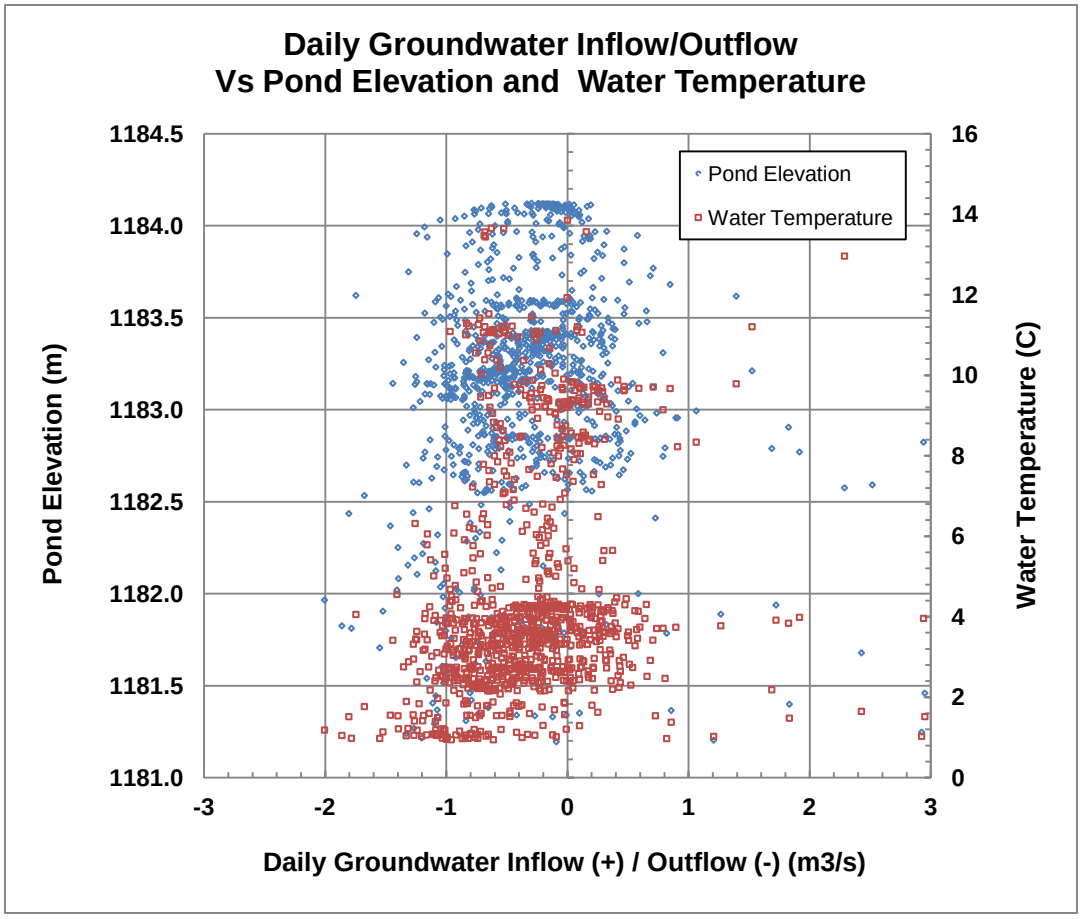


Figure 27: Daily Groundwater Inflow/Outflow vs. Pond Elevation and Water Temperature

Figure 27 indicates the following:

- a correlation between the pond elevation and groundwater inflow/outflow values is not apparent, inferring the groundwater exchange with the Open Pit pond is not significantly controlled by pond elevation, i.e. water 'head', applicable to the range of pond level data, i.e. pond elevations 1,181 to 1,184 m; and
- a cluster of groundwater outflow points is associated with cooler water temperatures, inferring that the daily groundwater inflow/outflow component is more discernible in the wintertime data.

The annual periodicity of pond storage increases from the addition of water from the freshet, direct precipitation and runoff within the Open Pit catchment area, as shown on Figure 26, which shows pond elevation and daily groundwater inflow/outflow data for the 2010 to 2013 data period.

Annual pond elevation peaks for the August 2010 to June 2013 data period, occurred from September to November, followed by pond elevation declines with high linearity, through winter until the commencement of the following annual freshet and other surface sources. As the pit pond does not freeze to bottom, daily water levels were recorded for the three year data period.

One additional water source, not quantified to-date, with a bearing on the water balance is groundwater originating from Pony Creek that moves, via shallow rock, into the Open Pit. This was first documented in 2004, observed as wintertime icing on the north pit wall above the pond level. This Pony Creek seepage water reports to the north pit wall and potentially biases (positively) the derived groundwater inflow/outflow parameter, i.e. introducing an additional surface input that decreases the apparent groundwater outflow.

The linear declines in wintertime pond elevation, when the pit walls were frozen, were used to more selectively quantify groundwater leaving the Open Pit pond. Figure 28 shows pond elevation and water temperature for the data period and the linear wintertime pond elevation declines.

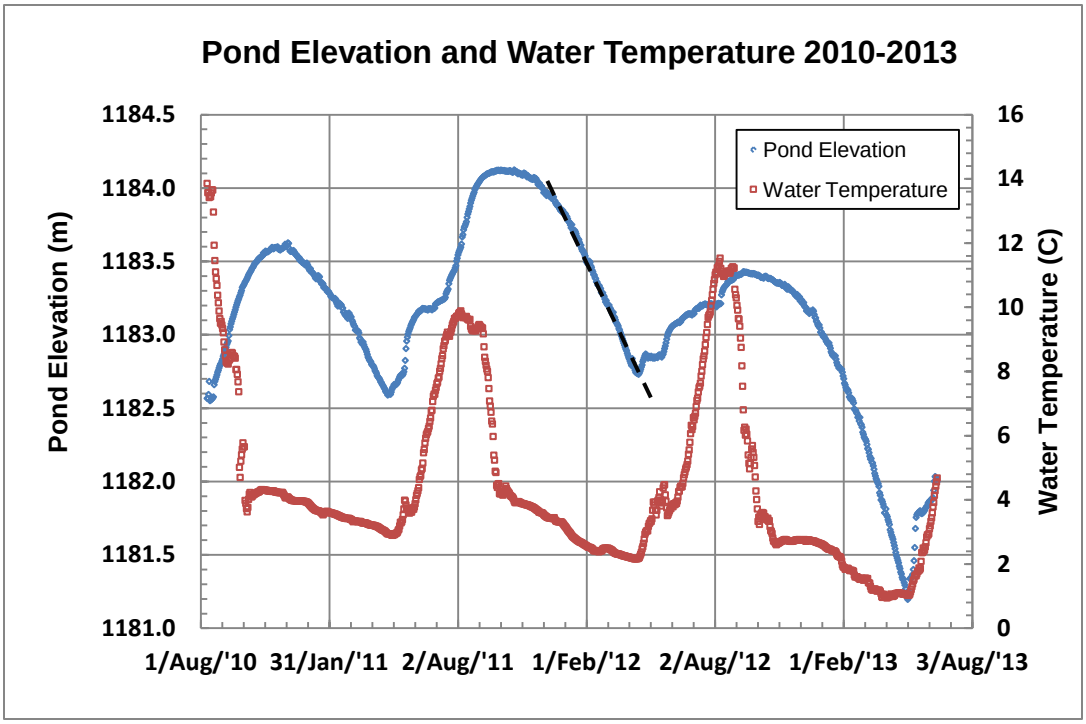


Figure 28: Pond Elevation and Water Temperature 2010 to 2013

Data points were picked for each of the linear pond elevation declines, corresponding to the winters of 2010/2011, 2011/2012 and 2012/2013. These gradient values were factored for pond area and time to derive rates for groundwater loss, as shown in Table 44.

Table 44: Wintertime Pit Pond Groundwater Outflow Rates

Data Period	Groundwater Outflow Volumes and Rates		
	m^3	m^3/day	L/s
February 25, 2011 to April 24, 2011	1,627	28.0	0.32
January 30, 2012 to April 11, 2012	2,603	36.2	0.42
February 10, 2013 to May 3, 2013	4,555	55.5	0.64
			Average 0.46 L/s

On this basis, elevation 1,181 m was interpreted as an indication of the upper bound value for the piezometric range, within the deeper rock mass underlying the open pit, applicable to the period of minimum pond storage in April-May.

10.6 Deep Groundwater Piezometric Elevation Range

Currently, it appears that the Open Pit acts as surface water retention feature, with pond water leaving at an average rate of 0.3 L/s, all year, occurring within the pond elevation 'head' range of 1,181 m to 1,184 m. The 1,181 m pond level minima, as previously described, represents an upper bound value for long-term pit pond elevation design, corresponding to a groundwater-only pond without any surface water input or non-groundwater losses, i.e. a pit pond in equilibrium

with deep groundwater within the rock mass underlying the pond. The 1,181 m value is based on five wintertime pond level recession curves, to which the 2013-2014 wintertime minima elevation will be added.

Quantifying a lower bound piezometric elevation, within the deep rock mass underlying the Open Pit, was the objective of instrumentation installed into CH-P-13-05, involving a conventional, short-screen, monitor well and a companion vibrating wire piezometer attached to the monitor well base, installed to 50 m depth (elevation 1,135 m), below the Open Pit floor. Monitor well and piezometer data are being interpreted to include the April to May pond elevation (head') minima and the September to November pond elevation ('head') maxima. With these data, annual and seasonal changes in piezometric elevations and vertical groundwater gradient can be quantified and the implications evaluated for a long-term groundwater condition of the Open Pit.

To-date, the CH-P-13-05 monitor well has provided a measured groundwater elevation of 1,166 m (October 2013) shortly after completion of the well. Additional measurements are planned in the monitoring program for 2014. Data from the companion vibrating wire piezometer for November 2013 to 2014, will update the groundwater elevation of 1,166 m. The latter currently provides a lower bound value for the piezometric range, within the deeper rock mass underlying the Open Pit, applicable to the period of maximum pond storage in September-November 2013.

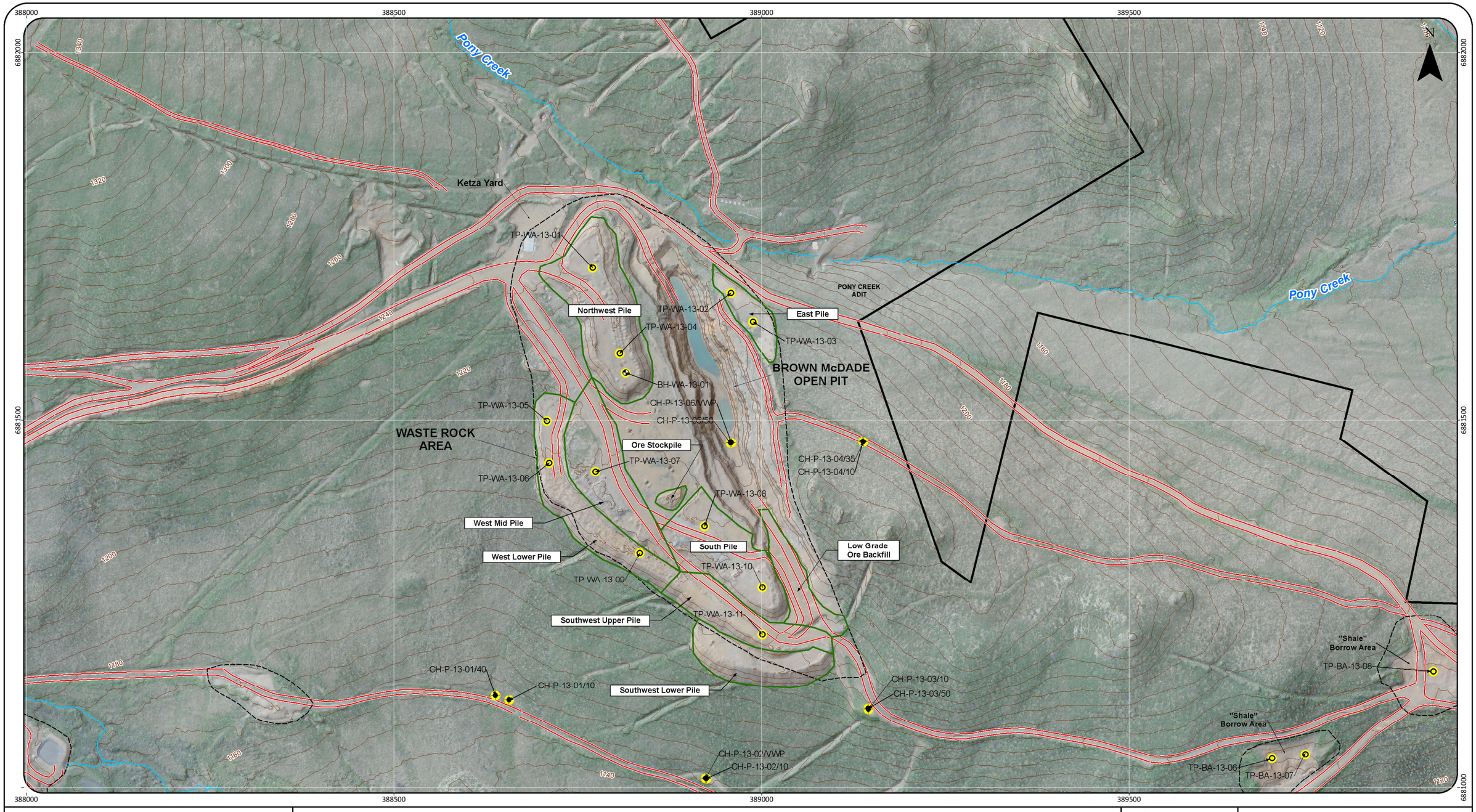
In summary, the rock mass underlying the Open Pit is currently understood to have a lower and upper bound piezometric range of 1,166 m and 1,181 m, respectively, which will be refined with 2014 data to refine this range and also to assess seasonal change. The implications of the upper bound value 'daylighting' between the pit base elevation of 1,174 m and interim upper bound value of 1,181 m, is that a hydraulic vertical gradient would exist, under which, groundwater would have the potential to enter the Open Pit.

11.0 WASTE ROCK AREA

11.1 Geotechnical Characterization

Prior to the 2013 investigations, limited quantitative geotechnical characterization of the waste rock had been completed. The 2013 site investigation advanced 11 test pits and one sonic drillhole through the waste rock area as shown in Figure 29. There was no discernible separation of waste rock types within the waste rock area.

The particle size distribution was spatially variable both vertically and horizontally. The soil portion of the waste rock was generally sand and gravel. Silt and clay sized particles were typically less than 10% passing 0.075 mm, with some areas up to 20%. Particles greater than 25 mm were typically not sampled due to size and were visually estimated to comprise between 30 to 70% or the mass of the material. Boulders and cobbles were encountered with a maximum particle size of 2 m diameter. Some large boulders were noted on the top of the waste dumps, and at the toe of the dumps. Refer to Appendix E1 for a summary of the sieve results from samples of the soil matrix gathered from the waste area.



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

- Borehole
- Hydrogeological
- CPT
- Geoprobe
- Grab Sample
- Hand Auger
- Mini Piezometer
- Measures
- Test Pit
- 2013 Locations
- Order in Council Boundary
- Contour (5 m)
- Disturbed Area
- Roads
- Streams
- Waste Pile Area

Associated Engineering — GLOBAL PERSPECTIVE. LOCAL FOCUS.

amec

Yukon Energy, Mines and Resources
Assessment and Abandoned Mines

MOUNT NANSEN REMEDIATION PROJECT
Figure 29

SITE CHARACTERIZATION REPORT

OPEN PIT, WASTE ROCK AREA GEOTECHNICAL

Scale 1:5,000
Metres
0 100 200

March 18, 2014

S:\PROJECTS\VM00605 - Mount Nansen\GIS\Mapping\VM00605_0021b_11x17_SiteCharacterizationReport_Geotechnical_PitDetail.mxd

The soil encountered was mostly oxidized with a red, orange or yellow colour. Approximately a quarter of the material was brown coloured and likely had a low level of oxidation. Section 11.1 discusses the geochemical results for the waste rock material. The particles were typically sub angular, where the asperities were typically broken down. Oversized material, rock fragments greater than 1", was typically greater than 50% by weight. Boulders and cobbles consisted of both meta-sedimentary and igneous rocks. Generally, the meta-sedimentary rocks were hard and broke after several blows with a rock hammer. In areas where the rocks were red and highly oxidized, they crumbled with one rock hammer blow. Igneous rocks generally were not as hard and were more oxidized than the meta-sedimentary rocks. They typically crumbled with one blow with a rock hammer, and in some areas, crumbled to the touch. The sand and silt sized particles were typically of the same oxidation level as the surrounding cobble and boulder sized particles.

The density of the waste rock was variable. In areas where the haul road currently is, or adjacent to the road, the waste rock was typically dense and difficult to excavate. In areas on the edge of the piles where there was likely little truck traffic, the waste rock was compact and easy to excavate. The excavator had difficulties when large cobbles to boulders were encountered. In these instances, the test pit would collapse, or refusal was met. Significant sloughing occurred during excavation of the test pits. Typically upon completion of a 5 m hole, the width on surface would be approximately 5 m forming a 0.5H:1V slope. Some test pits would slough at the bottom of the excavation, while the material above it would be intact, resulting in overhanging areas of the test pit.

The structure of the waste rock soil was also variable. Horizontal layers of varying colours were observed, typically in areas adjacent to the access roads within the waste dump. In contrast, there was no obvious layering or other soil structure observed in the test pits completed near the edge of waste rock piles. This likely reflects the fact that there was little trafficking or compaction near the edges and the material is a result of dumping to angle of repose.

No free water was encountered in the 2013 test pits or drill hole. The waste rock was usually damp to moist. Seepage exiting the waste rock toe has been noted during freshet. Original ground was encountered only in the east pile and in the drillhole advanced in the northwest pile.

In northern regions, open highly porous gravel or rock embankments (typically with particle sizes greater than 3 cm) can develop convective cooling causing permafrost to agrade and/or be locally colder (e.g. Goering, 2002). The waste rock at Mount Nansen, however, has a soil matrix that in comparison to open work embankments has relatively high fines content (refer to AMEC, 2013 for detailed results). This cooling phenomenon is, therefore, not expected in the Mount Nansen waste rock area. This is generally supported by the conditions observed onsite. With two possible exceptions, permafrost was not encountered in the test pits or drill hole. TP-WA-13-08 and 09 may have intersected permafrost approximately at 4.0 m and 2.0 m depth, respectively.

The waste rock area was split into nine regions, based on Altura (2009) (R73). The geometry of the nine regions has been approximated from the 2012 LiDAR survey, and an estimate of original ground based on the investigation data and available historical project information as summarized in Table 45 and discussed subsequently.

Table 45: Approximate Geometric Dimensions of Waste Area

Pile ID[1]	Test Pit / Boreholes Complete	Footprint Size (m²)	Height (m) [1]	Slopes (°)
Northwest Pile	TP-WA-13-01 TP-WA-13-04 BH-WA-13-01	20,100	5-12	35
East Pile	TP-WA-13-02 TP-WA-13-03	4,300	2-8	33
West Mid Pile	TP-WA-13-07	14,500	5-10	35
West Lower Pile	TP-WA-13-05 TP-WA-13-06 TP-WA-13-09	14,400	5-12	35
Ore Stockpile	-	900	2-3	25
South Pile	TP-WA-13-08 TP-WA-13-10	14,800	2-12	35
Southwest Upper Pile	TP-WA-13-11	10,200	7-12	35
Southwest Lower Pile	-	9,600	2-13	35
Low Grade Ore Backfill	-	6,350	5-10	N/A

Note: [1] Waste rock division and height per Altura (2009).

11.1.1 Northwest Pile

- The Northwest Pile is estimated to be the largest waste rock pile onsite. The northern side of the pile is several metres tall near the former Ketza Shop, and is a maximum of 12 m high on the south side. The east side is set back approximately 20 m from the rim of the Open Pit. Several dozen windrow piles of waste are on the western side of the platform.
- BH-WA-13-01 encountered waste rock for approximately 9 m depth. Weathered bedrock was present below. The sonic drillhole did not encounter the groundwater table or competent bedrock.

11.1.2 East Pile

- The East Pile is estimated to be one of the smallest piles onsite, located between the east edge of the pit, and the public access road. Two test pits completed intersected a thin layer of organics and vegetation at a depth of approximately 2 m, more oxidized sand and gravel for another metre, then original ground with vegetation and sand below. The East Pile may have had two stages of waste rock placed, allowing vegetation to establish between the cycles. Altura (2009) states that the first stage of waste rock stripped from the pre-development phase was placed on the East Pile.

11.1.3 West Mid Pile and West Lower Pile

- Test pits TP-WA-13-05 to 07 had some portions of dense soil difficult to dig, possibly from existing haul roads in the area. Boulders and windrow piles were regraded to allow access for the excavator. Approximately half of the boulders broke into a few pieces when the excavator picked up with its thumb.

11.1.4 South, Southwest Upper and Lower Pile

- Three test pits were completed in this area. Boulders up to 1 m were noted, and the rock was variably weathered.

11.1.5 Low Grade Ore Backfill

- The stockpiles of low grade ore that remained at the mill area following the end of milling operations was placed at the southern end of the Brown-McDade Pit several years ago. The area outlined is based on identifying the fill placed between the 2004 pit survey and the 2012 LiDAR survey.
- There is some material placed on an upper bench at the north end of the pit which is understood to have been low grade ore from the Pony Creek Adit area.

11.2 Geochemical Characterization

11.2.1 Waste Rock Area

Approximately 740,000 m^3 of waste rock was generated during the operation of the Brown-McDade Pit (Altura, 2009). AMEC's estimate of the total waste rock volume in the waste rock area near the Brown-McDade Open Pit is 598,800 m^3 over an area of 89,000 m^2 as presented by sector in Table 46. This estimate is 17% greater than the 2009 estimate (Altura, 2009), split about evenly between PAG and NAG, but is still less than the total removed from the Open Pit. It is acknowledged that some waste rock was utilized in other areas of the site (e.g. for road construction) and this is the reason for discrepancy between volume estimates.

Waste rock from the Brown-McDade Pit was classified into three waste rock types consisting of altered granodiorite, altered feldspar porphyry, and unaltered granodiorite (Conor Pacific, 2000). The majority of Brown-McDade waste rock (approximately 70%) was estimated to be altered granodiorite. Around 20% and 10% of the waste rock was estimated to be altered porphyry and unaltered granodiorite, respectively.

The old ore stockpile was located in the central part of the Brown-McDade waste rock pile. Based on the topographic survey conducted in 2009, it was estimated that approximately 1,800 m^3 of ore was stored in the old ore stockpile.

Table 46: Summary of Volumes in the Waste Rock Pile

Sector	Estimated Volume (m^3)
Northwest	156,400
East	20,000
South	81,600
Southwest upper	75,500
Southwest Lower	46,500
West lower	86,000
West mid	129,900
Old ore stockpile	1,800
Total	**597,700**

Geochemical Sampling Program

The ML/ARD characterization of the waste rock pile occurred over multiple sampling programs during the 1985 to 2009 period. Pre-operation sampling in 1985, 1989 and 1994 was conducted on drill core samples that involved 43 rock samples.

All the pre-operation samples were analyzed for ABA. Elemental metal analyses and whole rock analyses were conducted on 37 samples that were collected during the 1994 sampling program. In addition, five composite samples were prepared from the 37 core samples collected in 1994. Elemental metal, whole rock analyses and leachable metal testing were performed on these composite samples.

The initial geochemistry sampling on the waste rock pile occurred in 1996 where 14 samples were collected from the westernmost portion of the waste rock pile existing at that time. In 2007, six samples were collected from the northwest waste rock pile. ABA and elemental metal analyses were performed on all samples.

A more comprehensive geochemical characterization of the waste rock pile continued in 2008 and 2009. During the 2008 characterization program, 21 test pits were excavated in the various sectors of the waste rock pile and 34 samples were collected. The test pit depths ranged from 1 m to 1.2 m. In addition, two lysimeters were installed in the northwest sectors of the waste rock pile.

In 2009, a trench 13 m long, 2 m wide and 1.6 m deep was excavated in the southwest upper waste rock pile. As part of the 2009 geochemistry program, five test pits were completed in the old ore stockpile. Seven samples were collected from those test pits and tested for elemental metals and leachable metals. Six samples were also tested for ABA.

Non-potentially acid generating (non-PAG) rock was identified in certain sections of the waste rock pile during the 1985 to 2009 investigation programs. However, most of the non-PAG samples were collected from near surface. In 2013, AMEC completed seven test pits in the west lower, southwest upper, southwest lower, and east sections of the waste rock pile where the

non-PAG waste rock samples were identified from the previous characterization programs. The objective of these test pits was to collect deeper samples at the non-PAG locations to improve understanding of the distribution and volume of non-PAG rock that could be used for reclamation or other purposes. Twenty samples were selected for geochemical tests.

Geochemical Characterization of Waste Rock

ABA and PAG/non-PAG Distributions

The results from the previous studies that were conducted post mining were incorporated in the present geochemical analysis in order to increase the size of the available database. A summary of all ABA results for the waste rock pile since 1996 is presented in Table 47.

Table 47: Summary of Acid Base Accounting Results for Waste Rock Pile Samples

Sample	Paste pH	TIC	S(T)	$S(SO_4)$	Calculated $S(S^{-2})$	Carb NP	AP	NP	NPR	Carb NPR
		%				kg $CaCO_3$/t				
Count	113	99	110	112	111	99	113	113	113	89
Minimum	3.94	0.01	0.01	0.01	0.00	0.8	0.2	0.0	0.0	0.0
Maximum	8.41	1.36	10.50	1.24	9.86	113.3	318.8	90.0	166.0	169.4
Mean	7.44	0.32	0.78	0.24	0.53	26.4	16.6	25.2	13.1	12.1
Standard Deviation	0.79	0.28	1.51	0.29	1.40	23.6	44.7	19.6	25.5	27.7
Median	7.70	0.28	0.34	0.11	0.15	23.3	4.7	22.6	4.0	2.6
10^{th} Percentile	6.26	0.02	0.05	0.01	0.01	1.7	0.3	3.2	0.7	0.0
25^{th} Percentile	7.33	0.07	0.16	0.03	0.05	5.8	1.3	9.6	1.6	0.7
75^{th} Percentile	7.87	0.48	0.76	0.35	0.37	39.6	10.9	35.9	10.0	5.9
90^{th} Percentile	8.09	0.62	1.64	0.71	1.10	51.5	33.8	48.3	31.7	34.5

Paste pH was measured for 113 samples, the majority of which were neutral to alkaline. Paste pH ranged from 3.9 to 8.4 with a median of 7.4.

Total sulphur was measured for 110 samples with an average of 0.78%. Sulphate sulphur was measured in 112 samples with an average of 0.24%. Sulphate sulphur represents a minor fraction of the total sulphur. Sulphide sulphur was calculated by the difference between total sulphur and sulphate sulphur. Sulphide sulphur ranged from 0 to 9.86% with an average of 0.53%.

Neutralization potential was measured both as Sobek NP and Carb NP in 113 waste rock pile samples. The results of both methods were comparable, with Sobek NP averaging 25.2 kg $CaCO_3$/t and Carb NP averaging of 26.4 kg $CaCO_3$/t.

The NPR ranged from 0 to 166 with an average of 13.1 for 113 waste rock pile samples (Figure 30). Fifteen percent of the waste rock pile samples had NPR <1 and were classified as PAG. The majority of PAG samples (eight of 17) were from the northwest sector of the dump. Three PAG samples were from the west mid-level of the dump. Two PAG samples came from the east sector of the dump and two more from the old ore stockpile. Two PAG samples were also from the lower sector of the dump (one west and one southwest).

Seventeen percent of the waste rock pile samples were between NPR 1 and 2 and were classified as having an uncertain potential for acid generation. Five of the 'uncertain' samples were from the west mid-level of the dump. The west lower, southwest lower, northwest and old ore stockpile sectors of the dump each had three samples with uncertain acid generating potential. The south and east sectors of the dump each had one 'uncertain' sample.

The remaining 68% of the waste rock pile samples had NPR >2 and were classified as non-PAG.

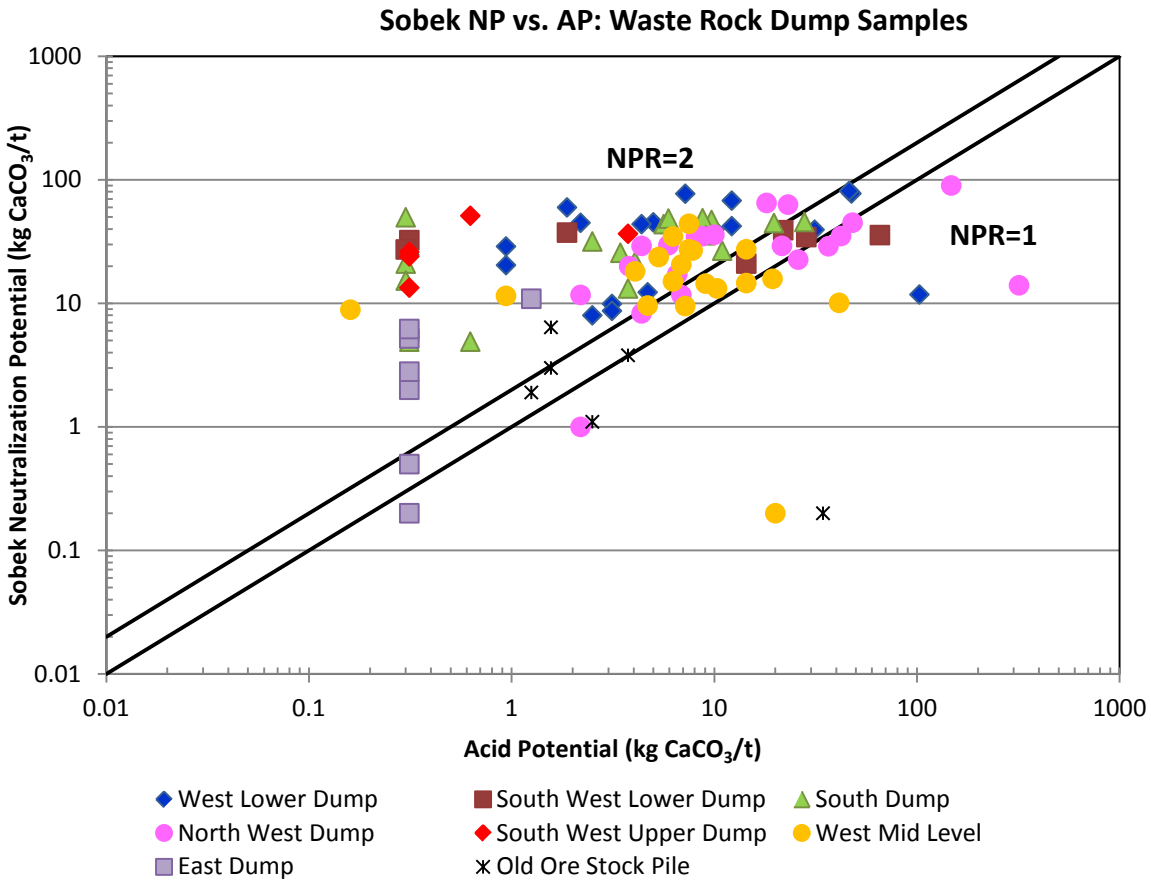


Figure 30: Comparison of AP vs. NP for Waste Rock Pile Samples

The distribution of PAG and non-PAG rock in the waste rock area is summarized in Table 48 and presented in Figure 25.

Table 48: Summary of PAG and non-PAG Rock in Waste Rock Pile Samples

Sector	Number of Samples	PAG (NPR<1)		Uncertain (1<NPR<2)		non-PAG	
		n	%	n	%	n	%
West lower	26	1	3.8	3	11.5	22	84.6
Southwest lower	13	1	7.7	3	23.1	9	69.2
South	17	0	---	1	5.9	16	94.1
Northwest	21	8	38.1	3	14.3	10	47.6
West mid level	19	4	21.1	4	21.1	11	57.9
East	8	2	25.0	1	12.5	5	62.5
Old ore stockpile	6	3	50.0	2	33.3	1	16.7

The recent sampling program confirms the presence of non-PAG rock at deeper locations in the south and west lower sectors of the waste dump. The majority of west lower and south sectors of the waste rock pile was non-PAG, so they can be stored outside of the pit if required. The remaining waste rock area sectors are estimated to have PAG and non-PAG waste rock in comparable amounts. Unless the non-PAG rock is concentrated in certain locations of these dump sectors, it is likely that segregation of non-PAG rock from PAG rock will be difficult. Thus the waste rock from these remaining sectors will likely require relocation into the pit. The ore stockpile, which mainly consists of PAG rock, will also require transfer to the pit.

Metal Contents

The statistical summary of those metal parameters with relatively elevated concentrations is presented in Table 49. For statistical purposes, the results from the old ore stockpile samples were analyzed separately from the samples of the other sectors of the waste rock area. The elemental analysis results indicated that elevated concentrations of antimony, arsenic, bismuth, cadmium, copper, lead, and zinc occurred in waste rock area and the old ore stockpile when compared to the 10x average crustal abundance values.

Approximately 98% of samples from waste rock area sectors had elevated concentrations of antimony, arsenic, bismuth, and cadmium. Lead enrichment was identified in around 82% of samples. Approximately 73% of samples were also enriched in zinc. Elevated copper content was detected in only two samples.

All samples from the old ore stockpile sector had elevated antimony, arsenic, bismuth, cadmium and lead concentrations. Zinc enrichment was detected in six of seven samples.

Table 49: Summary of Selected Elemental Metal Results for Waste Rock Area Samples

Statistic	As	Bi	Cd	Cu	Pb	Sb	Zn
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
10 times average crustal	18	0.085	1.5	600	140	2	700
Waste Rock Area Sectors (n=108)							
Count	108	94	108	108	108	108	108
Minimum	6.0	0.1	0.1	3.9	14.0	2.0	48.0
Maximum	9,280	65.9	93.1	2630	2,516	647	6,623
Mean	707	7.1	15.5	173	491	58.5	1,360
Standard Deviation	1110	11.1	13.7	274	492	83.9	1,033
Median	495	3.3	12.4	109	346	33.5	1,135
10^{th} Percentile	73	0.4	2.0	23	65	7.3	336
25^{th} Percentile	182	0.9	6.3	40	154	11.7	662
75^{th} Percentile	858	8.6	21.6	234	611	66.8	1,759
90^{th} Percentile	1,224	17.4	31.4	349	1077	142	2,579
Old Ore Stockpile (n=7)							
Count	7	7	7	7	7	7	7
Minimum	198	1	6	30	202	16	484
Maximum	5,197	51	47	202	3,482	562	3,765
Mean	2,445	23	17	159	1,809	255	1,416
Standard Deviation	1,592	15	14	61	957	165	1,073
Median	2,103	25	14	183	1,800	242	1,170
10^{th} Percentile	1,156	9	8	93	1,012	107	697
25^{th} Percentile	1,822	15	10	144	1,590	179	900
75^{th} Percentile	2,943	26	15	191	1,943	288	1,256
90^{th} Percentile	4,325	36	28	196	2,586	406	2,261

Leachate and Seepage Characterizations

The SFE testing was conducted on 16 samples collected from the waste rock pile in 2008 and the results are presented in Table GC-2 in Appendix F. Leachates of the SFE testing on 16 samples exhibited neutral pH ranging from 6.82 to 8.12, with the exception of one sample. A pH of 2.96 was measured in the leachate of one sample collected from northwest sector of the waste rock pile with sulphate concentration of 1,294 mg/L. The low pH sample also had elevated aluminum, copper, iron, manganese, silver, and zinc above the CCME guideline value for those parameters.

Around 60% of the samples with neutral pH were elevated in arsenic and zinc concentrations. The arsenic and zinc concentrations ranged from 0.00009 to 0.0304 mg/L and 0.001 to 3.29 mg/L, respectively. These results suggest leachate from the waste rock material could contribute in arsenic and zinc loadings to the local watershed.

In May 2013, two seepage samples from the waste rock dump were collected and tested for water quality. The first sampling point was located near the bottom of the west lower waste rock pile and the second sampling point was lysimeter 2 at the west lower pile. The purpose of sampling runoff water was to aid in developing the geochemical source term for the waste rock piles.

A summary of the results is presented in Table 50. The water quality of the samples was compared against CCME guidelines for the protection of aquatic life. The seepage of the waste rock pile and the leachate from the lysimeter L2 had sulphate, total arsenic, total copper, and total zinc concentrations greater than the CCME guidelines. Total manganese concentrations in the waste rock pile seepage and total iron concentrations in the lysimeter L2 were also above the CCME values for those two parameters.

Based on the water quality data, seepage from the waste rock pile is contributing some elevated sulphate and metals concentration to the local watershed.

Table 50: Summary of Water Quality Results for Seepage from Waste Rock Pile

Parameters	Unit	CCME	Waste Rock Pile 01	L2
			May 16, 2013	May 22, 2013
Physical Tests				
Conductivity	(µS/cm)		2,090	296
Hardness (as $CaCO_3$)	(mg/L)	-	1,450	170
pH	Units	6.5-9.0	7.88	*7.57*
Anions and Nutrients				
Acidity (as $CaCO_3$)	(mg/L		5.2	5.0
Alkalinity, Total (as $CaCO_3$)	(mg/L)		94.6	37.2
Chloride (Cl)	(mg/L)		<10	<0.50
Fluoride (F)	(mg/L)		<0.40	0.188
Nitrate (as N)	(mg/L)		9.85	0.0563
Nitrite (as N)	(mg/L)		<0.020	<0.0010
Sulphate (SO_4)	(mg/L)	100	**1,290**	**133**
Metals				
Aluminum (Al)-Dissolved	(mg/L)	0.1	<0.0050	0.0434
Antimony (Sb)-Total	(mg/L)	0.02	0.00247	0.00340
Arsenic (As)-Total	(mg/L)	0.005	**0.00616**	**0.0316**
Barium (Ba)-Total	(mg/L)		<0.020	<0.020
Beryllium (Be)-Total	(mg/L)		<0.0010	<0.0010
Boron (B)-Total	(mg/L)		<0.10	<0.10
Cadmium (Cd)-Total	(mg/L)		0.0268	0.00128
Calcium (Ca)-Total	(mg/L)		308	47.0
Chromium (Cr)-Total	(mg/L)		<0.0010	<0.0010
Cobalt (Co)-Total	(mg/L)		<0.00030	<0.00030
Copper (Cu)-Total	(mg/L)	0.004	**0.0168**	**0.0073**
Iron (Fe)-Total	(mg/L)	0.3	0.194	**0.675**
Lead (Pb)-Total	(mg/L)	0.007	0.00672	0.0178
Lithium (Li)-Total	(mg/L)		<0.0050	<0.0050
Magnesium (Mg)-Total	(mg/L)		176	11.5
Manganese (Mn)-Total	(mg/L)	0.2	**0.258**	0.0646
Mercury (Hg)-Total	(mg/L)	0.000026	<0.000010	<0.000010
Molybdenum (Mo)-Total	(mg/L)	0.073	<0.0010	<0.0010
Nickel (Ni)-Total	(mg/L)	0.15	0.0024	<0.0010
Potassium (K)-Total	(mg/L)		2.4	<2.0
Selenium (Se)-Total	(mg/L)	0.001	0.00106	<0.00010
Silver (Ag)-Total	(mg/L)	0.0001	0.000126	0.000277

Parameters	Unit	CCME	Waste Rock Pile 01	L2
			May 16, 2013	May 22, 2013
Sodium (Na)-Total	(mg/L)		5.1	<2.0
Thallium (Tl)-Total	(mg/L)	0.0008	<0.00020	<0.00020
Tin (Sn)-Total	(mg/L)		<0.00050	<0.00050
Titanium (Ti)-Total	(mg/L)		0.013	<0.010
Uranium (U)-Total	(mg/L)		0.00155	0.00022
Vanadium (V)-Total	(mg/L)		<0.0020	0.0011
Zinc (Zn)-Total	(mg/L)	0.03	**2.51**	**0.0639**

Note: Bold values exceed CCME water quality guidelines for the protection of freshwater aquatic life. Italicized values exceed MMER effluent discharge criteria.

11.2.2 Low Grade Ore Backfill

Geochemical Investigation Program

In 2009, Altura conducted a geochemistry program for the ore materials located at the south end of the Brown-McDade Pit (Altura, 2009b). These materials were relocated from the ore stockpile at the upper platform of the mill area in the fall of 2008 and were originally produced from the ore zone in the south end of the Brown-McDade Pit.

Nine samples from nine test pits were completed during the site investigation in 2009 (Table 51). The test pit locations are presented in Figure 25. The depths ranged from 0.8 m to 1.4 m. Elemental metal analyses were performed on all samples. In addition, seven samples were selected for ABA testing and six samples were tested for leachable metals using the shake flask extraction (SFE) test method.

Table 51: Summary of Geochemical Tests of Low Grade Backfill Samples

Test Pit	Number of Samples	Geochemistry Testing		
		ABA	Metal	Leachable Metal
OB1	1	1	1	
OB2	1		1	
OB3	1		1	
OB4	1	1	1	1
OB5	1	1	1	1
OB7	1	1	1	1
OB8	1	1	1	1
OB9	1	1	1	1
OB10	1	1	1	1
Total	**9**	**7**	**9**	**6**

Geochemical Characterization of Low Grade Ore Backfill

ABA and PAG/non-PAG Distributions

Summary statistics for ABA results for seven low grade ore (LGO) backfill samples are presented in Table 52. Paste pH values were neutral. Total sulphur ranged from 0.2 to 1.8% with an average of 1.3%. Sulphate sulphur had an average of 0.7% and sulphide sulphur was averaged 0.6%. This indicates that almost half of the total sulphur is potentially available for acid generating reactions.

Table 52: Summary of Acid Base Accounting Results for Low Grade Ore Backfill Rock Samples

Sample	Paste pH	TIC	S(T)	$S(SO_4)$	Calculated $S(S^{-2})$	Carb NP	AP	NP	NPR
		%				kg $CaCO_3$/t			
Count	7	7	7	7	7	7	7	7	7
Minimum	6.0	0.1	0.2	0.1	0.1	4.2	1.9	4.4	0.2
Maximum	7.4	0.2	1.8	1.0	1.1	20.0	33.1	17.3	9.2
Mean	6.6	0.1	1.3	0.7	0.6	10.7	19.2	10.3	0.5
Standard Deviation	0.5	0.1	0.6	0.3	0.4	5.6	11.4	4.9	3.3
Median	6.4	0.1	1.6	0.8	0.7	10.0	22.2	11.1	0.5
10^{th} Percentile	6.0	0.1	0.4	0.3	0.1	5.2	3.9	5.1	0.2
25^{th} Percentile	6.2	0.1	1.0	0.6	0.4	6.7	13.4	6.3	0.3
75^{th} Percentile	6.4	0.1	1.6	0.8	0.7	10.0	22.2	11.1	0.5
90^{th} Percentile	7.0	0.2	1.7	0.8	0.8	13.8	25.3	13.4	1.3

The Carb NP and Sobek NP values were both low with averages of 10.7 kg $CaCO_3$/t and 10.3 kg $CaCO_3$/t, respectively. This indicates there the rock has low neutralization capacity.

The NPR ranged from 0.2 to 9.2 with an average of 0.5. Sobek NP is plotted against AP in Figure 31. Five of seven samples had an NPR <1; hence, the majority of the LGO backfill samples are considered to be PAG. One sample had an NPR = 1.3 and is classified as having an uncertain potential for acid generation. One sample is non-PAG with an NPR >2 (NPR = 9.2).

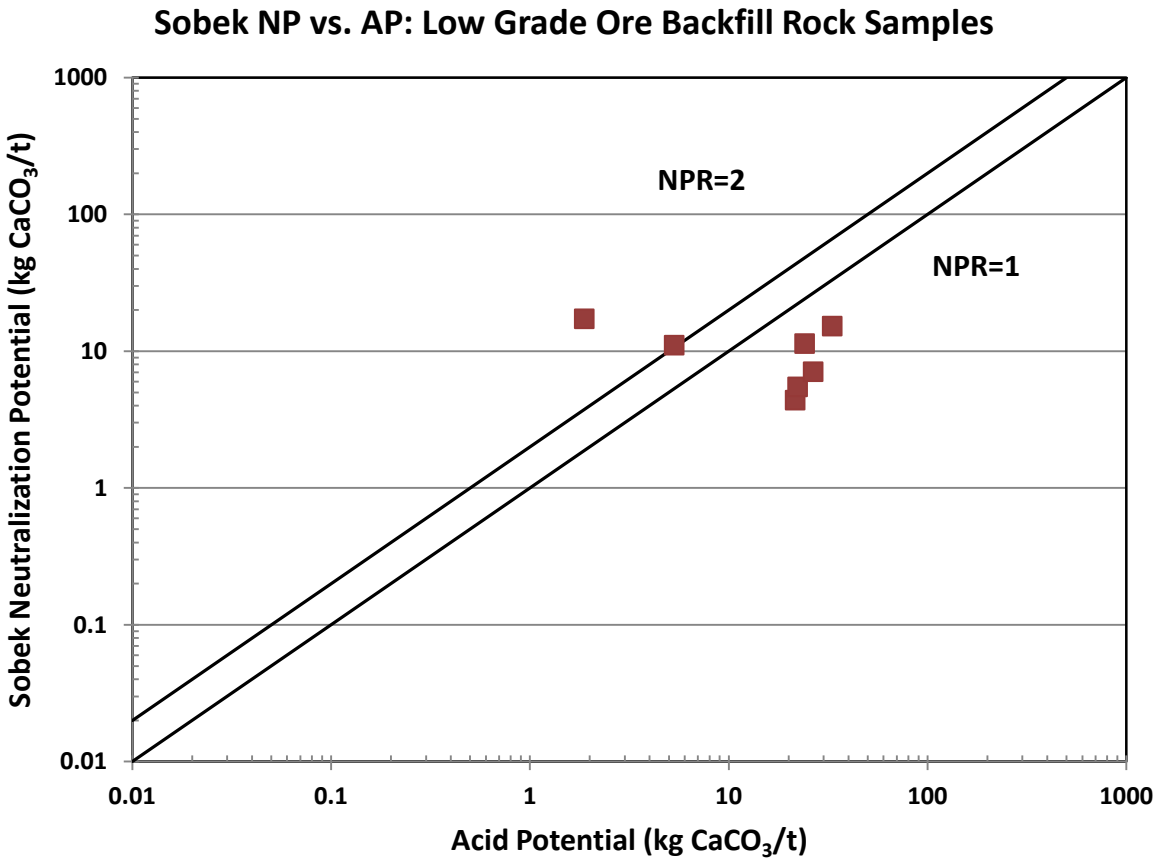


Figure 31: Comparison of AP vs. NP for Low Grade Ore Backfill Rock Samples

Metal Contents

The multi-element geochemistry analyses of nine low grade ore backfill samples are presented in Table 53. Concentrations of select metals (antimony, arsenic, bismuth, cadmium, lead, and zinc) generally exceeded 10x the average crustal abundance values.

Table 53: Summary of Selected Elemental Metal Results for Low Grade Ore Backfill Rock Samples

Statistic	As	Bi	Cd	Pb	Sb	Zn
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
10 Times Average Crustal Abundance	18	0.085	1.5	140	2	700
Count	9	9.0	9.0	9	9	9
Minimum	522	0.4	5.4	602	18	578
Maximum	3,444	42.1	41.7	2,804	441	3,330
Mean	1,909	20.6	19.7	1,782	193	1,588
Standard Deviation	891	13.9	9.7	678	132	752
Median	1,980	16.4	17.7	1,752	185	1,423
10^{th} Percentile	1,098	5.3	12.9	1,205	51	1,080
25^{th} Percentile	1,257	14.0	17.5	1,381	118	1,361
75^{th} Percentile	1,980	16.4	17.7	1,752	185	1,423
90^{th} Percentile	2,502	32.1	19.8	2,149	254	1,543

Leachate Characteristics

Leachates of the SFE testing on six samples exhibited neutral pH raging from 6.6 to 7.3, which were within the pH range for CCME guidelines. Sulphate concentrations ranged from 568 to 1,240 mg/L. As an indication of the leachate quality, the results were compared to CCME guidelines for the protection of aquatic life for reference only. Antimony, cadmium, copper, lead and manganese concentrations were greater than CCME guidelines for at least one sample. All arsenic concentrations were greater than the CCME guideline of 0.005 mg/L, with results ranging from 0.0132 to 0.035 mg/L. High zinc concentrations were measured in the leachate of some samples with a maximum concentration of 2.46 mg/L as compared to the CCME guideline of 0.03 mg/L. The maximum manganese concentration measured was 15.6 mg/L, which is relatively high, but there is no CCME guideline for this parameter. The SFE results suggest leachate from the ore material could potentially contribute in arsenic, antimony, cadmium, copper, and lead loadings to the local watershed. The complete results of the SFE testing are presented in Table GC-2 in Appendix F.

In summary, the low grade ore backfill material is PAG and contains elevated metals. The geochemical characterization of low grade ore backfill is comparable with the sulphide zone in the pit wall.

12.0 TAILINGS STORAGE FACILITY

12.1 General

The Tailings Facility is located about 600 m south of the Open Pit and consists of a tailings dam approximately 270 m in length, a seepage collection pond, an emergency spillway and a diversion channel. The diversion channel diverts Dome Creek around the north side of the facility and includes a cutoff ditch along the western perimeter of the impoundment. The impounded tailings cover an area that is roughly 250 m wide (north-south) by 280 m long (east-west).

A number of field investigations have been completed within the Tailings Facility area since the 1980s. The purpose of the investigations has been to characterize and assess the facility for various reasons including foundation/subgrade conditions, tailings characterization, groundwater/seepage analysis and borrow exploration.

Figure 32 illustrates the location of test holes advanced and near surface grab samples taken from within the Tailings Facility. Many of the investigations consisted of shallow sampling events and much of the sampling was related to chemical assessment of the solids and porewater.

Figure 33 illustrates the location of the functioning instrumentation installed within the Tailings Facility.

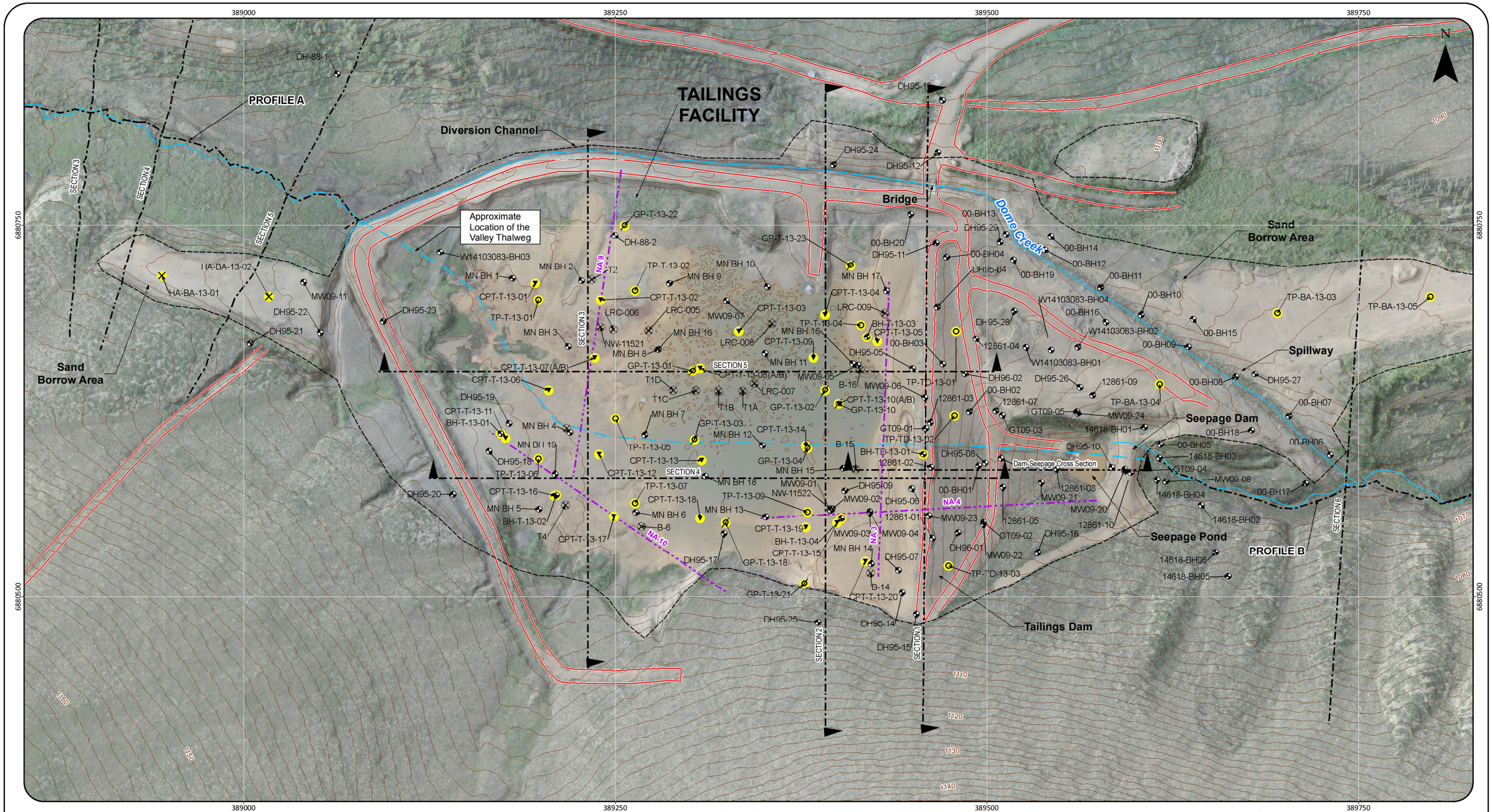
12.2 Tailings Characterization

12.2.1 General

Tailings deposition started on October 16, 1996 and occurred continuously until November 30, 1997 when operations were temporarily ceased due to high water volumes in the tailings pond and an inability to meet water quality discharge criteria. Milling was resumed in February 1998 and continued until February 26, 1999 when operations were permanently shutdown.

During operation of the Tailings Facility, tailings were initially discharged from the upstream face of the dam. As the impoundment was filled, discharge points were moved to maximize the storage capacity and produce tailings beaches with the flattest slope possible. The number of discharge points is unknown. Large volumes of water quickly accumulated within the impoundment as a result of surface runoff and higher than anticipated seepage rates from the diversion ditch (Conor Pacific, 2000). During operation, water was typically close to the crest of the dam (Brodie, 1998) and it is, therefore, likely that a significant portion of the tailings were deposited subaqueously, resulting in a very loose, sensitive state. Towards the end of operations, sulphide rich ore was mined although it was not part of the mine plan or water license. It is estimated that 10,000 m^3 of sulphide rich tailings were deposited mainly at the north end of the west side of the Tailings Facility (Brodie, 1998).

Characterization of the Mount Nansen tailings has involved various static, kinetic and chemical tests on tailings as well as testing of the geotechnical properties. The static tests include particle size distribution, acid-base accounting, metals, water soluble constituents, and insitu substrate characterization. Details regarding tailings volume and characterization are described in the following sections.



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

- Borehole
- CPT
- Geoprobe
- Grab Sample
- Hand Auger
- Mini Piezometer
- Test Pit
- 2013 Locations
- Order in Council Boundary
- Geophysics Lines
- Surveyed Sections
- Contour (2 m)
- Disturbed Area
- Roads
- Streams

Note:
Refer to Figures 36 to 38 for sections.

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MOUNT NANSEN REMEDIATION PROJECT
Figure 32

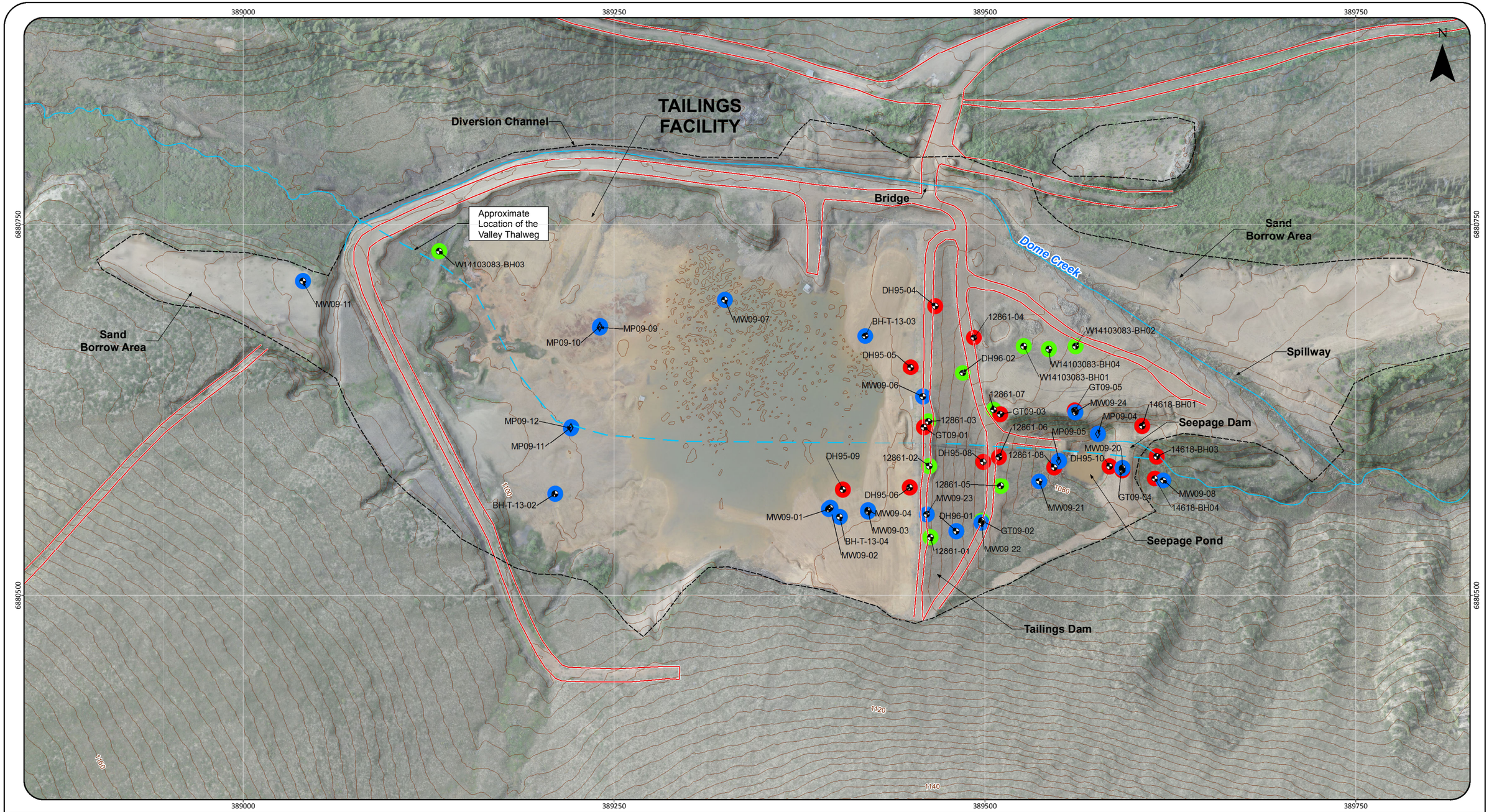
SITE CHARACTERIZATION REPORT

TAILINGS FACILITY
HISTORICAL INVESTIGATION LOCATIONS

Scale 1:2,500
Metres
0 50 100

March 18, 2014

S:\PROJECTS\VM00605 - Mount Nansen\GIS\Mapping\VM00605_0018b_11x17_SiteCharacterizationReport_HistoricLocations_TSFDetail.mxd



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

- Borehole
- Mini Piezometer
- Piezometer
- Thermistor
- Thermistor/Piezometer
- Order in Council Boundary
- Contour (2 m)
- Disturbed Area
- Roads
- Streams

Note: Piezometers include mini piezometer (MP), monitoring well (MW), and pneumatic installations
All DH95 installations and DH96-02 are no longer functioning

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Assessment and Abandoned Mines

MOUNT NANSEN REMEDIATION PROJECT
Figure 33

SITE CHARACTERIZATION REPORT

TAILINGS FACILITY
INSTRUMENTATION LOCATIONS

Scale 1:2,500
Metres

0 50 100

April 3, 2014

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12.2.2 Total Tailings Volume

The estimated total volume of tailings stored within the TSF is approximately 243,000 m^3. An isopach of tailings thickness is included in Figure 34. The volume estimate and isopach are based on the existing surveys; original ground surface (surveyed by Klohn Crippen in 1996) and the 2012 LiDAR survey and correlated with recent drilling results. Allowing for some consolidation, it also appears generally consistent with the reported tailings volume of 258,174 m^3 that was deposited to the end of 1998 (Conor Pacific, 2000).

In order to generate an updated volume estimate, the following was utilized:

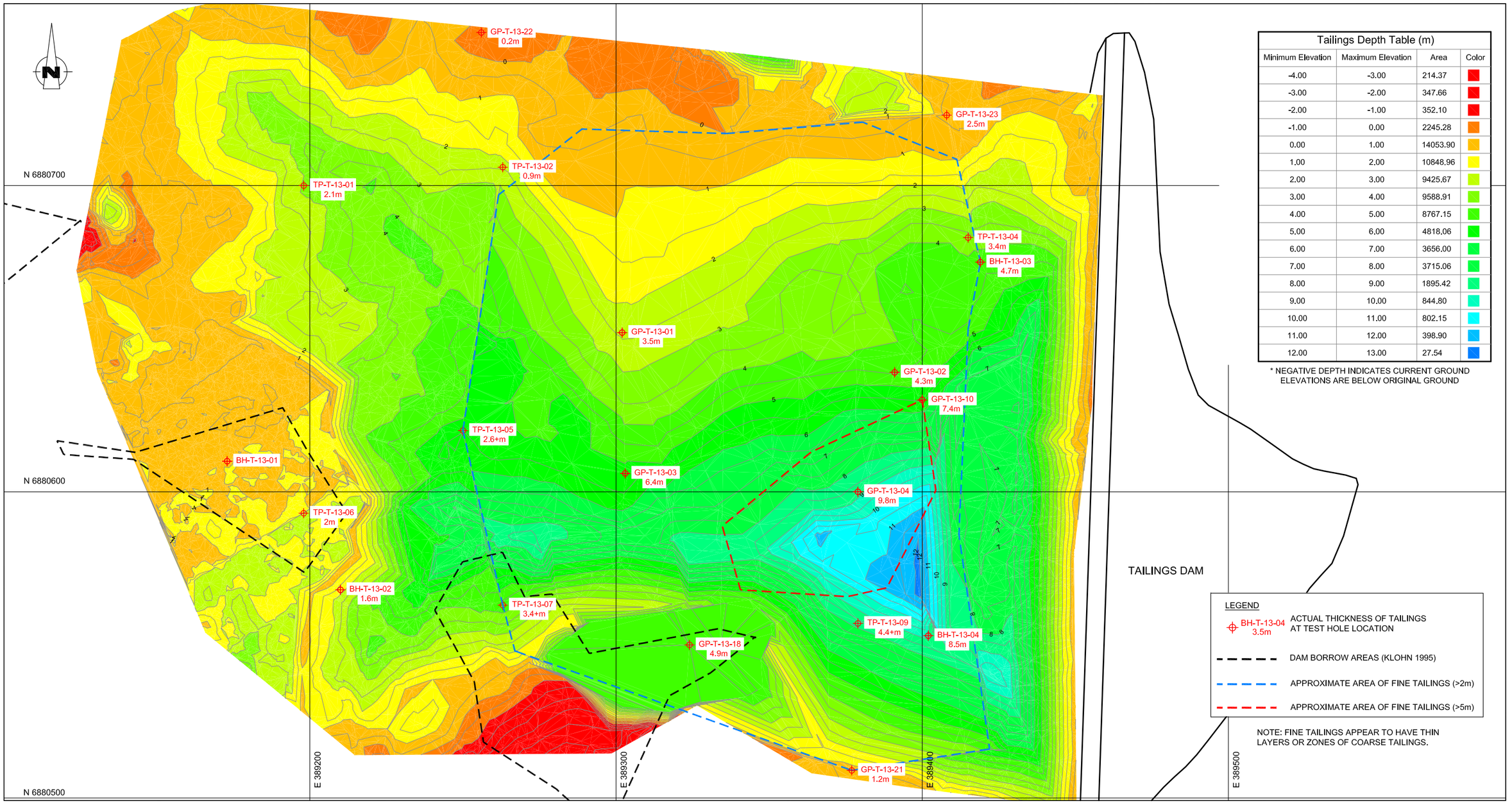
- a projected upstream dam surface based on as-built surveys by Klohn Crippen in 1996;
- a pond elevation of 1,095.8 m taken from the October 2013 readings;
- an approximated tailings surface below the pond based on 2013 test hole data; and
- approximate tailings surfaces in the dam fill borrow areas based on 2013 test hole data.

There are a number of uncertainties associated with the volume estimation and calculation. For example, upper and bottom tailings surfaces were created based on results from the 2013 test hole data, producing surfaces beneath the pond and also where there are borrow areas cut below the original ground (i.e. southwest corner of the impoundment). These surfaces were approximated due to the lack of recent bathymetric and excavated borrow surveys. Based on the data used to create the surface, it is reasonable to assume a variance for the total estimated volume of tailings between ±11,000 to 23,000 m^3. Improved modelling may be able to be completed in the next phase of design to potentially improve this accuracy; however, it would take a significant investigative effort to drastically improve the volume predictions. This investigative effort would be costly and would not provide a benefit consistent with the cost and effort required.

Fill comprising the dam's upstream toe berm was included in the total tailings estimate (approximately 5,800 m^3). It is understood that the berm is not lined with geosynthetics and is, therefore, likely contaminated with tailings.

A rough comparison of the tailings surface on the 2012 LiDAR survey and the 2001 YES survey was carried out. Results from the comparison generally show a lower tailings surface in the central region of the impoundment in 2012 relative to 2001, likely indicating that the tailings have undergone some degree of consolidation in this area.

The isopach in Figure 34 illustrates the estimated depth of tailings throughout the impoundment, and identifies approximate borrow areas and actual tailings depths recorded during the 2013 field investigation. The isopach also provides an indication of where there are significant thicknesses of fine dominated tailings. The distribution of fines and coarse tailings is discussed further in Section 12.2.3.



Tailings Depth Table (m)			
Minimum Elevation	Maximum Elevation	Area	Color
-4.00	-3.00	214.37	
-3.00	-2.00	347.66	
-2.00	-1.00	352.10	
-1.00	0.00	2245.28	
0.00	1.00	14053.90	
1.00	2.00	10848.96	
2.00	3.00	9425.67	
3.00	4.00	9588.91	
4.00	5.00	8767.15	
5.00	6.00	4818.06	
6.00	7.00	3656.00	
7.00	8.00	3715.06	
8.00	9.00	1895.42	
9.00	10.00	844.80	
10.00	11.00	802.15	
11.00	12.00	398.90	
12.00	13.00	27.54	

* NEGATIVE DEPTH INDICATES CURRENT GROUND ELEVATIONS ARE BELOW ORIGINAL GROUND

LEGEND

BH-T-13-04 3.5m — ACTUAL THICKNESS OF TAILINGS AT TEST HOLE LOCATION

DAM BORROW AREAS (KLOHN 1995)

APPROXIMATE AREA OF FINE TAILINGS (>2m)

APPROXIMATE AREA OF FINE TAILINGS (>5m)

NOTE: FINE TAILINGS APPEAR TO HAVE THIN LAYERS OR ZONES OF COARSE TAILINGS.

Data Source:

SOPACH IS BASED ON THE ORIGINAL GROUND SURVEY (KLOHN 1996), 2012 LIDAR AND TAILINGS SURFACES INFERRED FROM 2013 TESTHOLES.

Datum: NAD 1983 CSRS UTM Zone 8N

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MOUNT NANSEN REMEDIATION PROJECT
Figure 34

SITE CHARACTERIZATION REPORT

2013 TAILINGS ISOPACH

0m 10 20 30 40 50
SCALE (m)

MARCH 17, 2014

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Comparison of the 2013 isopach with the isopach created by YES in 2001 indicate that they are in general agreement, showing that the thickest tailings lie immediately upstream of the dam (approximately 12 m) while the thinnest deposits (approximately 1 to 2 m) lie along the north and west areas of the impoundment. Refusal depths from the 2013 CPT testing also correspond to the anticipated thickness of tailings and depths to original ground.

12.2.3 Geotechnical Properties

Based on a review of historical and recent field investigation data, the tailings at Mount Nansen are generally characterized as 70% coarse tailings and 30% fine tailings. Deposits of finer tailings have been found to exist in the central region of the impoundment and also as lenses elsewhere in the impoundment. Within the fine dominated tailings area, lenses and zones of coarser tailings are expected. The coarse tailings dominate the deposit around this central region and are also present as lenses within the central region.

A summary of the measured geotechnical tailings parameters are presented in the following sections.

Particle Size Distribution

Figure 35 presents a compilation of all of the particle size distributions measured on tailings samples at the Mount Nansen site with the samples used for subsequently more specialized testing highlighted. Plots in Appendix E1 present the particle size analyses with all borehole names for reference to specific investigation programs and locations. The majority of tailings are characterized as silt and sand, and silty sand as presented in the tailings sieves in Appendix E1. These are considered to be coarse tailings for this assessment.

For the purposes of this report, the term fine tailings is generally defined as containing greater than 45% fines (particle size passing the 0.075 µm sieve) and/or visually classified as clayey silt, silty clay to clay within existing test hole logs. Based on the sieve plots presented in Appendix E1, it can be seen that the tailings characterization within the fines region ranges from silty clay, clay and silt, silt, and sand and silt. Results from the 2013 CPT testing within the fines region also correspond with the characterization of finer tailings. The CPT results in the finer tailings generally yield higher pore pressures and higher friction ratios with increasing depth indicating the presence of a finer material with decreasing permeability.

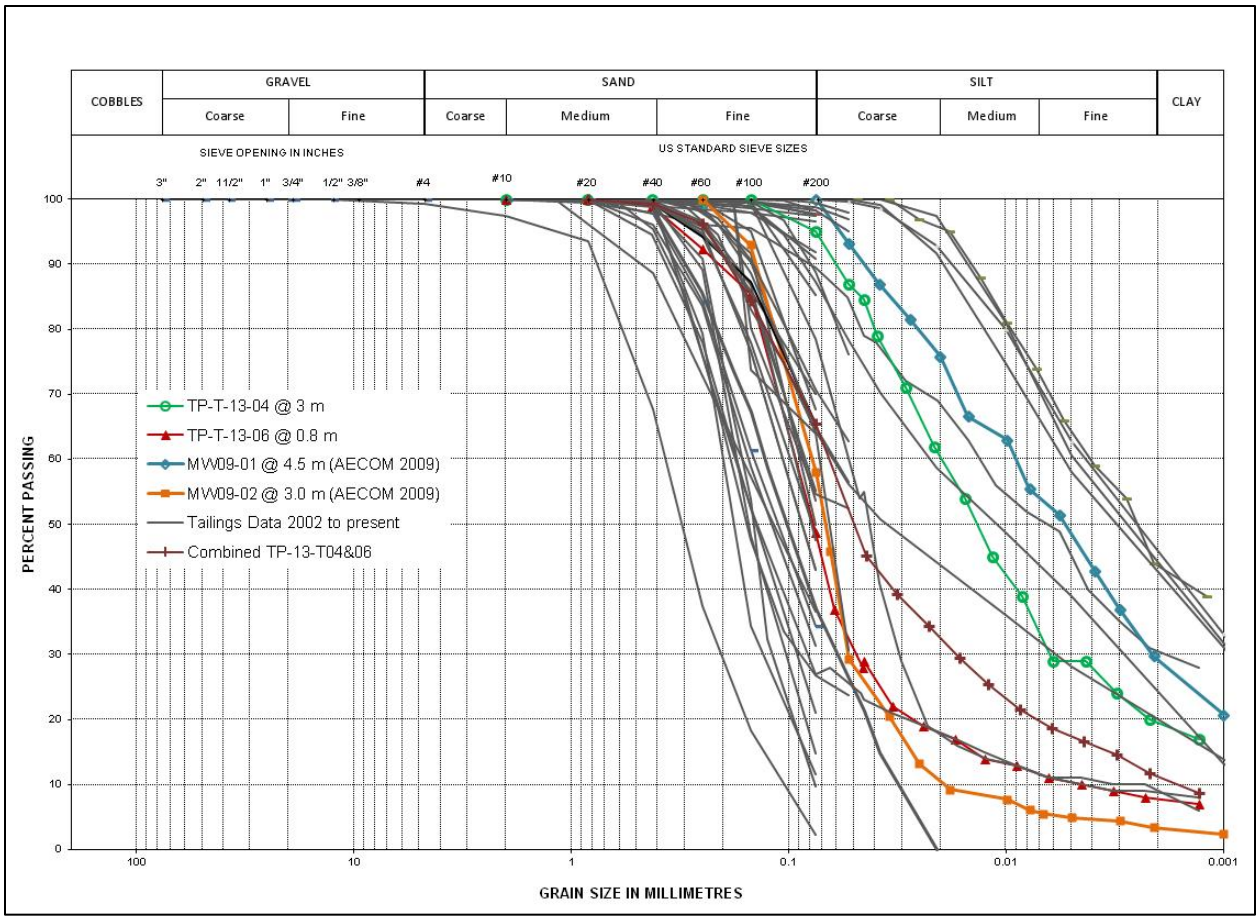
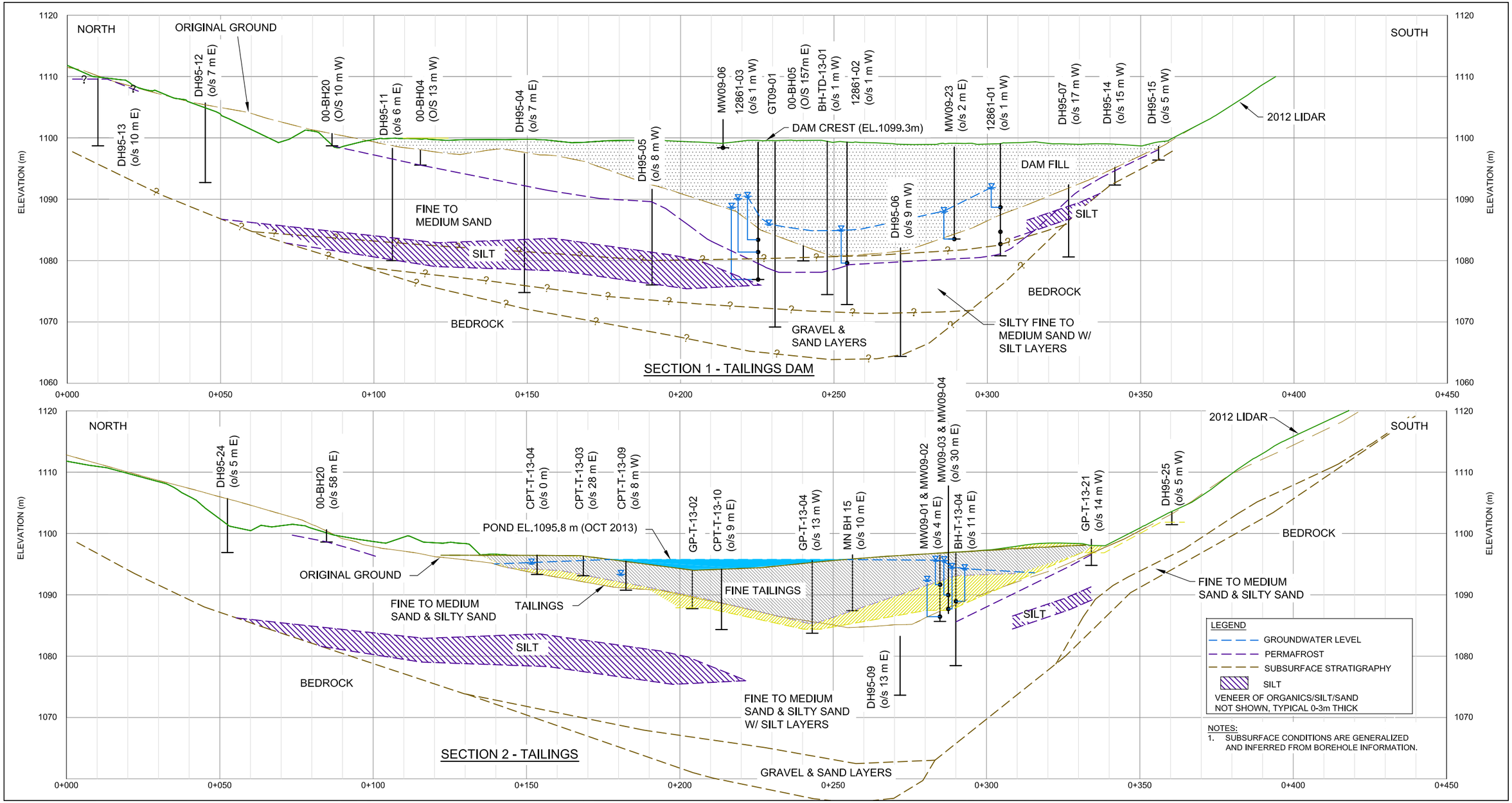


Figure 35: Tailings Particle Size Distribution

Distribution of Tailings and Phreatic Surface

There exists a significant region within the central region of the impoundment of the tailings pond that can be characterized dominantly as fine tailings. Within this central area, there are portions with coarser tailings above and/or below the main fine tailings unit. Given depositional processes and observations of the core samples, it is also likely that there are seams and lenses of coarser tailings within the fine tailings unit. Outside of this central area, layers or zones of fine tailings were encountered, but generally in thicknesses of less than 2 m. The central region (including fine and coarse tailings) covers approximately 29,000 m^2 (40% of the total tailings surface area). The fine tailings in this central region range from 2 to 10 m in thickness and do not comprise the full thickness of tailings over the entire area. An outline of the regions where fine tailings are inferred to exist in thickness greater than 2 m and 5 m and are shown on Figure 34. The inferred fines distribution based on AMEC's observations in 2013 and assessment of the historical information is shown in cross sections in Figures 36, 37 and 38. The section locations are shown in Figure 32.



Data Source:
Datum: NAD 1983 CSRS UTM Zone 8N

MOUNT NANSEN REMEDIATION PROJECT
Figure 36

SITE CHARACTERIZATION REPORT

SECTIONS (SHEET 1 OF 3)

0m 10 20 30 40 50
HORIZONTAL (m)
0m 5 10 15 20 25
VERTICAL (m)

MARCH 17, 2014

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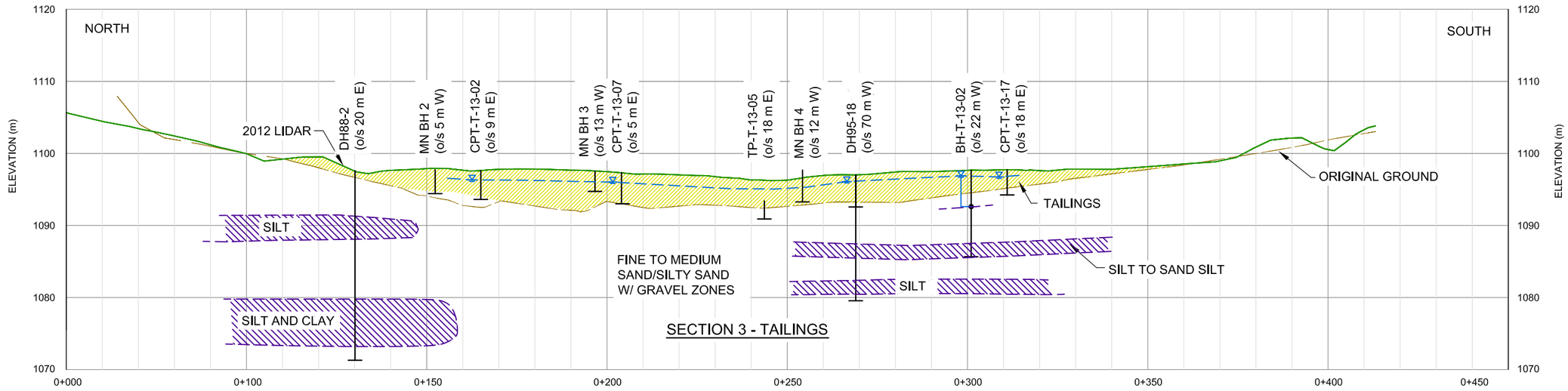

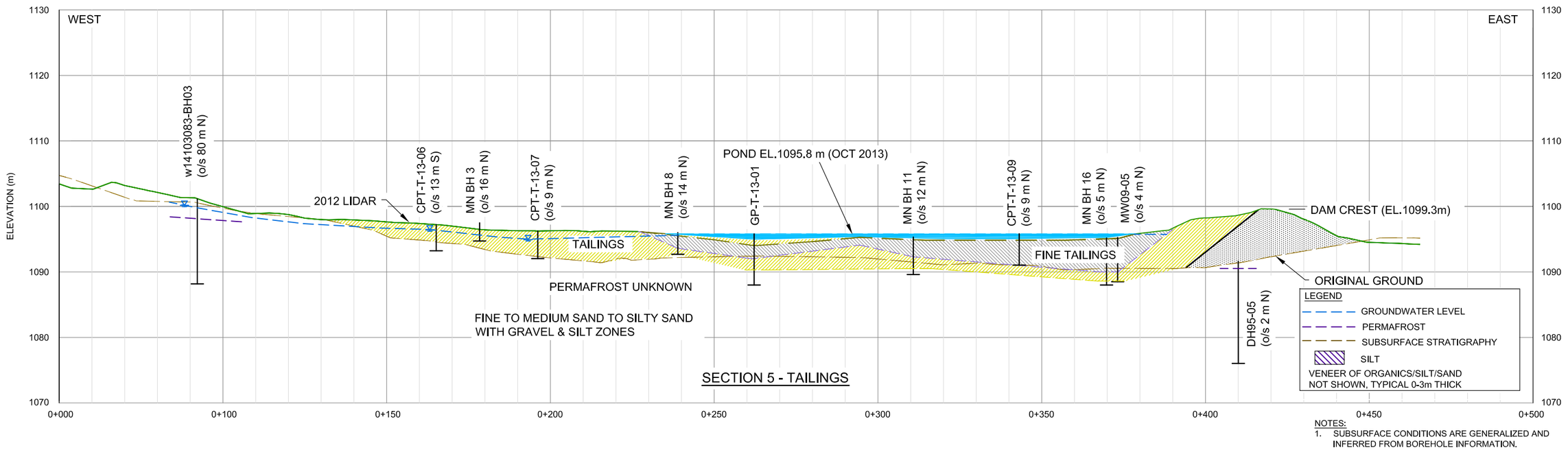

NOTES:
1. SUBSURFACE CONDITIONS ARE GENERALIZED AND INFERRED FROM BOREHOLE INFORMATION.

Data Source:
Datum: NAD 1983 CSRS UTM Zone 8N

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MOUNT NANSEN REMEDIATION PROJECT
Figure 37

SITE CHARACTERIZATION REPORT

SECTIONS (SHEET 2 OF 3)

0m 10 20 30 40 50
HORIZONTAL (m)
0m 5 10 15 20 25
VERTICAL (m)

MARCH 17, 2014

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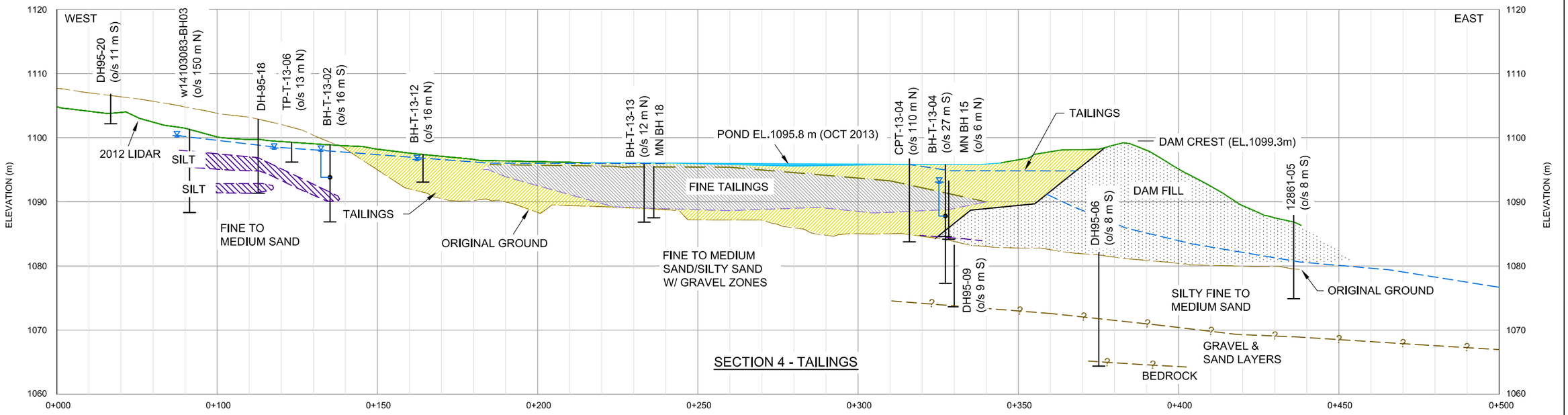


DAM - SEEPAGE DAM SECTION

NOTES:
1. SUBSURFACE CONDITIONS ARE GENERALIZED AND INFERRED FROM BOREHOLE INFORMATION.

Data Source:
Datum: NAD 1983 CSRS UTM Zone 8N

MOUNT NANSEN REMEDIATION PROJECT
Figure 38

SITE CHARACTERIZATION REPORT

SECTIONS (SHEET 3 OF 3)

0m 10 20 30 40 50
HORIZONTAL (m)
0m 5 10 15 20 25
VERTICAL (m)

MARCH 17, 2014

S:\PROJECTS\VM00605 – Mount Nansen\Drawings\Site Characterization Report\Figures 36,37,38.dwg – Figure 38 – Mar. 17, 2014 4:42pm – yuan.chen

Piezometers within the Tailings Facility are situated within the tailings, dam fill and the insitu subgrade material. The CPT pore pressure measurements also provided indications of water levels within the tailings. These are shown in the cross sections presented in Figures 36, 37 and 38.

Groundwater level measurements and CPT dissipation data tend to indicate lower pore pressures in the sand foundation corresponding to downward gradients between the tailings and underlying sand. This underdrainage appears to be continuous under the tailings dam, especially in the north abutment, and continues downstream of the dam. Some seepage appears to be intercepted by the toe seepage collection pond, but it is possible that seepage also exists in Dome Creek further downstream. During the summer months, water levels within the tailings appear to be connected to the pond level as shown in the cross sections. Water levels may drop during the winter months as seepage continues to occur while surface waters are frozen.

Atterberg Limits

Atterberg Limits testing gives numerical values to soil plastic and liquid limits, thus classifying the type of fine-grained soil. Plots of the Atterberg Limits test results on the tailings are presented in Appendix E1.

The plasticity index results indicate that the tailings at Mount Nansen range from non-plastic to highly plastic. Samples tested within the fine tailings region yielded plasticity index results ranging from 14 to 22, generally classifying as silts and clays with medium to high plasticity. Liquid and plastic limits for these samples ranged between 23 and 53 and 23 and 37, respectively. Insitu moisture contents suggest that the tailings exist in a state near the liquid limit. This is consistent with the low strength of the tailings. Samples tested within the coarser region classified as non-plastic silt and sand. According to CANMET (2003), the mineralogy of the tailings is heterogeneous with coarser tailings generally containing more quartz and less sericite than the finer tailings.

Moisture Content, Specific Gravity and Insitu Density

A summary of moisture content, specific gravity and standard proctor lab testing results are presented in Appendix E1.

Moisture contents determined from the tailings ranged between 11 to 52% with an overall average of 27%. Moisture contents plotted by depth for three test holes completed in 2013 are presented in Appendix E1. It should be noted that the tests plotted were from onsite laboratory testing that was available only for the sonic drill program. The results are, therefore, skewed towards areas of coarser tailings. The moisture content of the fine tailings is likely typically near the upper end of the range reported.

Specific gravity lab results range from 2.6 to 2.9 with an average of 2.8. Results are based on 2013 field investigation data as well as test data referenced from AECOM (2009).

Maximum Standard Proctor dry densities from two tests were 1,665 and 1,700 kg/m^3 (SPDD) with optimum moisture contents of 21 and 18%, respectively. The lower SPDD was associated with the finer tailings while the higher SPDD is for coarser tailings.

For coarse tailings, reported insitu wet densities (AECOM, 2007) and those calculated from water contents measured onsite (AMEC, 2013) typically range from 1,150 to 2,050 kg/m^3 (AECOM, 2009). It is possible that disturbance occurred during sampling resulting in a densified sample and resulting in a higher measured density or lower measured moisture content. Assuming the average measured moisture content is reasonably representative of saturated insitu conditions, the calculated tailings the void ratio ranged for the coarse tailings is 0.9 to 1.0 for the measured specific gravities. This value is consistent with the upper range of reported void ratios for typical spigotted sand tailings from hard rock mining (Vick, 1990). This corresponds to dry densities in the order of 1,350 to 1,530 kg/m^3 and is generally consistent with the reported saturated densities.

For fine tailings, reported insitu wet densities (Golder, 2010 and AECOM, 2009) generally range from 1,150 to 1,500 kg/m^3 with one associated moisture content of 51%. Moisture contents measured in 2013 (AMEC, 2013) indicate a range of moisture contents between about 37 and 52% for tailings with greater than 90% fines. Void ratios calculated from the measured specific gravity and moisture contents (assumed to represent saturated conditions) typically associated with the finer tailings range between 1.1 and 1.5. This is consistent with somewhat higher than typical gold slimes void ratios which are reported to be in the order of 1.1 to 1.2 (Vick, 1990).

Seepage Properties

Historical testing of tailings hydraulic conductivity (k) has been completed in the field through slug tests and in the lab on reconstituted and blended samples. The 2013 program supplemented these tests with one larger sized constant head column test (10 cm diameter by 10 cm tall) and evaluation of CPT dissipation tests. The measured values are summarized in Table 54 and range from 3.4x10^{-5} m/s to 1.6x10^{-7} m/s for coarse tailings and 2.04x10^{-6} m/s to 1.8x10^{-8} m/s for fine tailings.

The results from field slug tests are orders of magnitude higher than the laboratory tests. The CPT estimated values typically fall within the upper range of the laboratory tests. This may reflect an issue of scale with the slug tests influenced by the largest volume of material and potentially reflecting the influence of sand seams and structures within the insitu tailings. It is also possible that the slug tests have not tested the finest material that is present in the Tailings Facility and in the areas of finest tailings, field hydraulic conductivity values could approach the CPT and laboratory values.

Table 54: Summary of Hydraulic Conductivity Testing

Sample ID	Soil Type	Field or Lab Test	Hydraulic Conductivity, *k* (m/s)	Reference
COARSE TAILINGS				
MW09-02	Silty Sand Tailings)	Field	3.4E-05	EBA, 2012
MW09-02	Silty Sand Tailings)	Field	1.0E-06	AECOM, 2009
MW09-04	Silty Sand (Tailings)	Field	7.1E-07	EBA, 2012
Trial 1	Silty Sand (Tailings)	Lab	8.4E-06	LORAX, 2010
Trial 2	Tailings	Lab	8.1E-06	LORAX, 2010
CPT-T-13-15 - 5.1 m	Sand, fine to medium, some silt	Field	1.6E-07	AMEC, 2013
FINE TAILINGS				
Clay Tailings - Trial 1	Clay (Tailings)	Lab	1.8E-08	LORAX, 2010
Clay Tailings - Trial 2	Clay (Tailings)	Lab	1.1E-07	LORAX, 2010
MW09-06	Clay (Tailings)	Field	2.0E-06	AECOM, 2009
CPT-T-13-10(B) - 7.7 m	Clayey silt, trace sand	Field	7.8E-08	AMEC, 2013
CPT-T-13-3 - 2.8 m	Silt to silty sand	Field	1.2E-08	AMEC, 2013
CPT-T-13-13 - 8.2 m	Tailings (no physical sample)	Field	1.2E-08	AMEC, 2013
CPT-T-13-18 - 6.2 m	Tailings (no physical sample)	Field	5.9E-09	AMEC, 2013
CPT-T-13-14 - 3.5 m	Silt some clay	Field	8.9E-08	AMEC, 2013
CPT-T-13-14 - 5.5 m	Silt some clay	Field	1.5E-08	AMEC, 2013
CPT-T-13-14 - 8.0 m	Silt some clay	Field	2.7E-08	AMEC, 2013
CPT-T-13-12 - 3.8 m	Tailings (no physical sample)	Field	8.0E-08	AMEC, 2013
COMBINED TAILINGS				
Combined TP-T-13-04&06	Sandy silt with some clay	Lab	1.2E-08	AMEC, 2013
Mixed Tailings	Sand and Silt, some Clay (Tailings)	Lab	9.8E-09	LORAX, 2010
Mixed Tailings	Sand and Silt, some Clay (Tailings)	Lab	3.8E-08	LORAX, 2010
Mixed Tailings	Sand and Silt, some Clay (Tailings)	Lab	3.2E-09	LORAX, 2010
Mixed Tailings - Trial 1	Sandy Silt, some Clay (Tailings)	Lab	4.8E-10	LORAX, 2010
Mixed Tailings - Trial 2	Sandy Silt, some Clay (Tailings)	Lab	5.2E-09	LORAX, 2010
Mixed Tailings - Trial 3	Sandy Silt, some Clay (Tailings)	Lab	2.6E-08	LORAX, 2010
Coarse & Fine (combined)	Tailings	Lab	1.0E-08	Golder, 2010
CPT-T-13-8(A) - 4.1 m	Fine Sand and Silt	Field	3.9E-09	AMEC, 2013
CPT-T-13-19 - 5.8 m	Tailings (no physical sample)	Field	1.6E-07	AMEC, 2013

Soil-water characteristic curves (SWCC) have been measured for the tailings deposit based on field samples and are included in Figure 39. The particle size distributions of the samples selected for SWCC testing are highlighted in Figure 35. The 2013 results were completed on samples with similar gradations as the 2009 tests with one fine sample and one typical to coarse sample testing in each program. The results from both tests match closely. The samples were prepared at void ratios of 1.0 and 1.2 for the fine tailings and 0.9 for the typical to coarse tailings. These values are fairly consistent with the insitu void ratio in the Tailings Facility. As expected, the typical to coarse tailings samples have relatively steep SWCCs with an air entry value of around 3 to 4 kPa and a reach moisture content approaching residual values at suctions of around 100 kPa. The residual volumetric moisture content for the coarser samples was not measured but is less than 15% (corresponding to a gravimetric water content of less than about 10%). The fine samples have a much flatter SWCC with an air entry value in the order of 20 to 50 kPa. Residual volumetric moisture content for the fine tailings is in the order of 6% but requires a suction of 7,000 to 8,000 kPa.

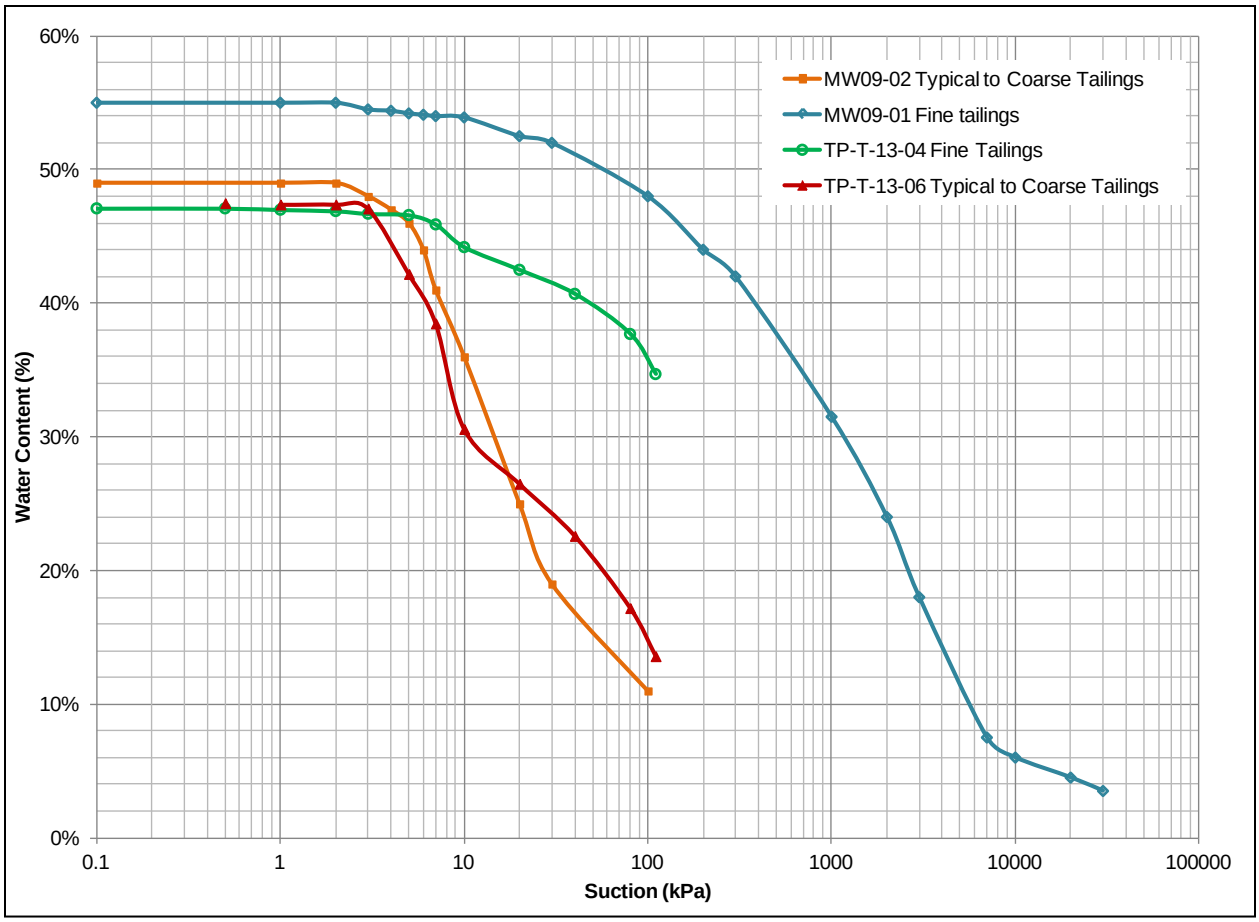


Figure 39: Tailings Soil Water Characteristic Curves

Strength and Sensitivity

The strength and sensitivity of the insitu tailings deposit has been assessed via interpretation of the CPT data as well as observations made during the site investigation.

The CPT tip resistance measured in the tailings was typically less than 5 bar (1 bar = 100 kPa) although there were some zones and layers with increased tip resistance up to 20 or 30 bar. These zones were associated with decreased dynamic pore pressures and were likely reflective of coarser tailings and/or insitu material. Generic correlations to estimate undrained strength (Su) with an assumed Nkt factor of 15 were applied to the CPT tip resistance. This is appropriate in zones where excess pore pressures were observed. The calculated undrained strength in these materials typically increased with depth in the tailings corresponding to an undrained strength – effective stress ratio (Su/p') of around 0.2. This is generally consistent with a normally consolidated fine-grained deposit.

The sleeve friction values measured from CPT testing within the tailings is very low (indeed lower than the accuracy of the transducer (see CPT interpretation in Appendix E2)). This is not atypical for tailings deposits (e.g. Cone Tec 2010 and general experience) and is a function of the high sensitivity and low remoulded strength of the tailings. This interpretation is consistent with the loss of strength and water on surface that was observed when tailings were subjected to equipment loading. It is further supported by the observations that after sampling and transportation of samples to another location, the condition of a number of the samples appeared to change into a liquefied or semi-solid state.

Consolidation Properties

One dimensional oedometer tests were completed on samples of fine and typical to coarse tailings (AMEC, 2013). The intent of the testing was to assess the consolidation and collapse properties of the tailings when placed in the backfilled pit. Two series of tests were, therefore, completed. Two conventional saturated oedometer tests were completed on samples of fine and typical to coarse tailings, respectively, that were prepared at 86% Standard Proctor dry density. Another set of oedometer tests were run with initially unsaturated loading conditions to an applied vertical pressure of 250 kPa. At that point, the samples were flooded and once conditions stabilized, loading was continued under saturated conditions to a final vertical load of 1,000 kPa.

The results of the tests are included in Figure 40. It can be seen that under unsaturated loading, the slope of the void ratio – e log p' curve is much flatter than under saturated conditions. Upon flooding, however, collapse of the soil structure occurs and the shape consolidation curve is similar for both tests. The different response of unsaturated and saturated tailings to an applied load increment is also evident in the results (refer to the complete lab results in AMEC, 2013). The saturated material exhibits the classic behaviour where primary consolidation dominates the behaviour. Unsaturated loading, however, appears to be dominated by what would conventionally be termed secondary or creep behaviour with continually increasing deformation as the grains rearrange. Collapse or ongoing settlement of tailings placed in an unsaturated state must, therefore, be considered in the design. The various test results also highlight the non-uniqueness of the consolidation curve for sand dominated materials.

For the saturated loading stages, coefficient of consolidation (c_v) values ranging between 3 and 19 m^2/yr and coefficient of volume compressibility (m_v) values of between $5x10^{-3}$ and $1x10^{-1}$ m^2/MN were calculated with no significant difference between the fine and coarse tailings. This is generally consistent with published data (e.g. Vick, 1990 and AECOM, 2009b).

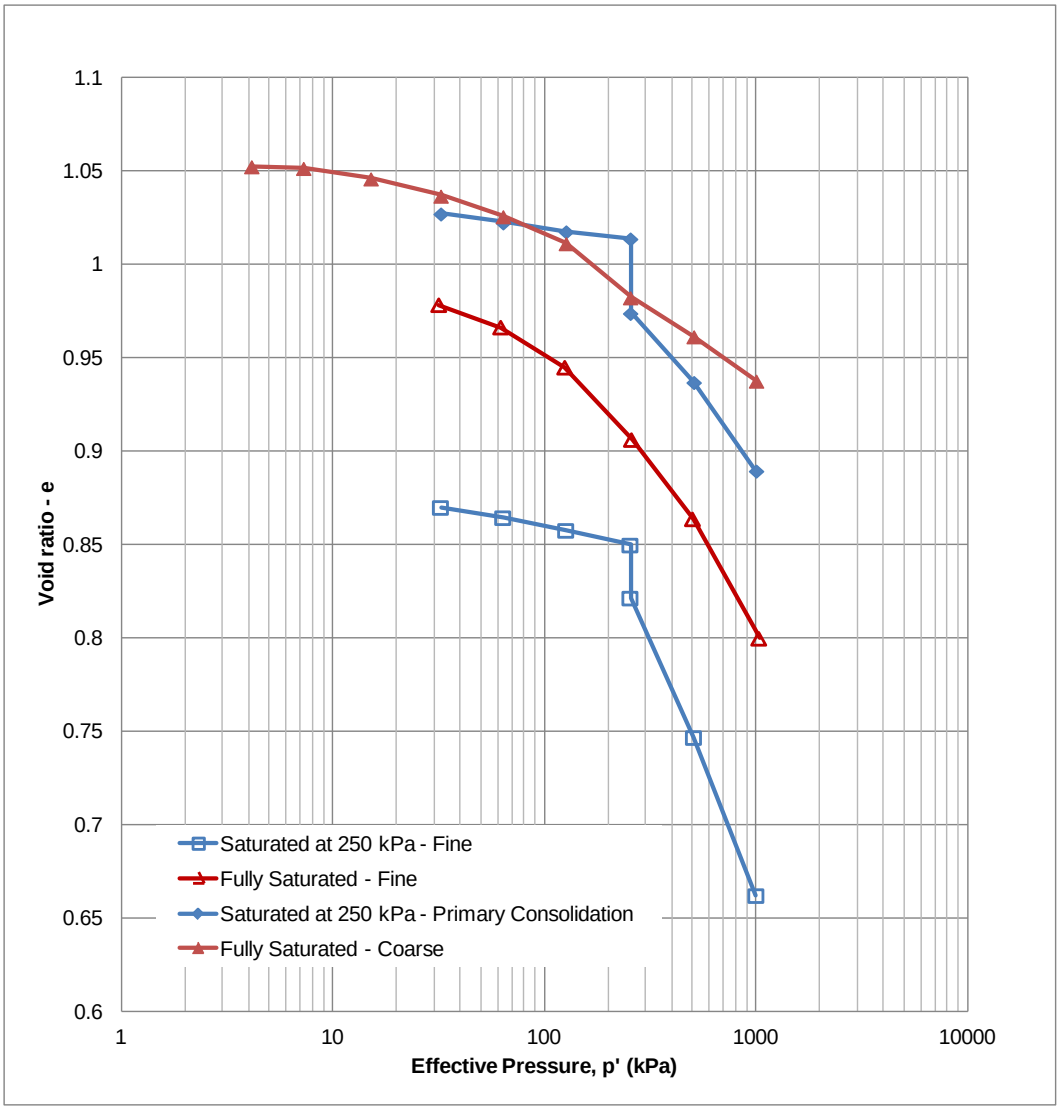


Figure 40: Results of Oedometer Tests on Tailings

12.2.4 Geochemical Properties

CANMET classified the tailings impoundment into four main types of tailings based on apparent contrasts in mineralogy, colour and texture observed during field core logging. The types of tailings are oxide rich silt, oxide rich clayey silt, sulphide rich silt and sulphide clayey silt. Based on the sum of core lengths, it was estimated the impoundment tailings are comprised of 35% oxide silt, 29.8% oxide clay, 16.5% sulphidic silt and 18.7% sulphidic clay (CANMET, 2002). Sulphide-rich tailings are more widespread in the western half (particularly the southwestern quadrant) of the impoundment

Geochemical Sampling Program

Field sampling of the Mount Nansen tailings impoundment occurred on multiple occasions within the decade following mine abandonment in 1999. Solid phase samples were collected from the tailings impoundment area by Conor Pacific in 1999 (Conor Pacific, 2000), by Kwong et al. in 2001 (CANMET, 2002), and by LORAX Environmental in 2009 (LORAX, 2011). The purpose of each field program was to characterize the geochemistry of the tailings in the impoundment area in order to better predict the ML/ARD potential. The 2009 program included kinetic tests in addition to the static tests to characterize the reactivity of the tailings.

AMEC collected five tailings samples from the tailings impoundment area in 2013, which were submitted to the laboratory for metal and cyanide analysis.

The specific geochemical tests conducted on all tailings samples since 1999 are summarized in Table 55.

Table 55: Summary of Geochemical Testing of Tailings Samples

Test	Conor Pacific	CANMET MMSL	LORAX	AMEC	Total
	1999	2001	2009	2013	
Static Tests					
Acid-Base Accounting	6	40	26	-	72
Multi-elemental Chemistry					
Metals	6	110	26	5	147
Cyanides	-	58	-	5	63
Mineralogy					
XRD	-	36	6	-	42
Petrography	-	38	-	-	38
SEM-EDX	-	12	-	-	12
Shake Flask Extraction	6	-	9	-	15
Kinetic Tests					
Humidity Cells	-	-	6	-	6
Kinetic Field Bins	-	-	2	-	2

Geochemical Characterization of Tailings

<u>ABA Accounting and PAG/non-PAG Distributions</u>

ABA results from the Conor Pacific tailings characterization study (Conor Pacific, 2000) are discussed below. The total and sulphide sulphur content of five of the six tailings samples ranged from 3.0 to 6.8% by weight, and the sixth sample contained negligible sulphide. As a result, exposed tailings along the western edge of the impoundment are inferred to be sulphide-rich. A high carbonate content was confirmed in each of the six tailings samples (average inorganic carbon = 2.0 weight %). The corresponding Carb NP concentrations ranged from 20.2 to 57.7 kg $CaCO_3$/t. Slightly lower Sobek NP concentrations were reported, and ranged from 16.6 to 38.7 kg $CaCO_3$/t (average = 31.1 kg $CaCO_3$/t). Excess carbon and lime in the former water treatment process (WTP) would have contributed to the higher observed Carb NP

concentrations. The NPR reported for the five samples with high sulphur content ranged from 0.1 to 0.4; hence these tailings samples are classified as being potentially acid generating (PAG) according to MEND (2009).

ABA results from the CANMET tailings characterization study on the four tailings types confirmed that the impounded tailings are PAG (CANMET, 2002). The modified ABA approach was applied to 40 tailings samples at BC Research Inc. Total inorganic carbon analysis confirmed the presence of carbonate minerals in most tailings samples. However, Carb NP was often lower than the modified Sobek NP, which suggests that some of the carbonates contain iron or manganese. The iron/manganese carbonate minerals do not provide acid neutralization capacity.

Large variations in ABA parameters were observed within each of the four tailings types. The tailings produced from oxide zone ore were relatively depleted of carbonates, meaning they contained little neutralizing capacity. Sulphide sulphur concentrations were lowest in the fine-grained tailings, especially the oxide clay tailings.

ABA results of the LORAX tailings characterization study supported previous findings that the tailings in the Mount Nansen tailings impoundment are generally PAG (LORAX, 2011). The median sulphide concentration for 26 tailings samples was 0.7% and ranged from 0.02 to 6.7%. The median Carb NP was 29.2 kg $CaCO_3$/t and ranged from 0.63 to 66.7 kg $CaCO_3$/t. The median Sobek NP was lower than Carb NP suggesting that non carbonate minerals such as silicate may be present in the tailings samples. The silicate minerals have low contribution to acid neutralization capacity. The median NPR was 0.8 and ranged from 0.1 to 13.5.

The NPR of all 72 tailings samples ranged from 0.1 to 13.5 as shown in Figure 41. The majority of samples have NPR <1. Figure 42 shows the distribution of PAG and non-PAG in the tailings impoundment.

Metals Content

A total of 147 tailings samples collected from the Mount Nansen tailings impoundment during the different testing programs were tested for metals content. Arsenic concentrations ranged from 14 to 7,081 mg/kg.

The reported results of the metal content analyses performed by Conor Pacific (2000), CANMET (2002) and LORAX (2011) indicate elevated concentrations of antimony, arsenic, copper, iron, lead, and zinc. Clayey tailings are more enriched in arsenic, iron, lead, manganese, and zinc. The sulphide zone tailings are only slightly higher in total S content compared to the oxide zone tailings regardless of grain size. Oxide clayey tailings are preferentially enriched in antimony, arsenic, lead, and silver. Oxide silt tailings are depleted in calcium, strontium, and zinc. The tailings can be differentiated from the underlying native sediments by total sulphur and metal enrichment including antimony, arsenic, copper, iron, lead, manganese, silver, and zinc and also depletion of calcium, magnesium, and sodium.

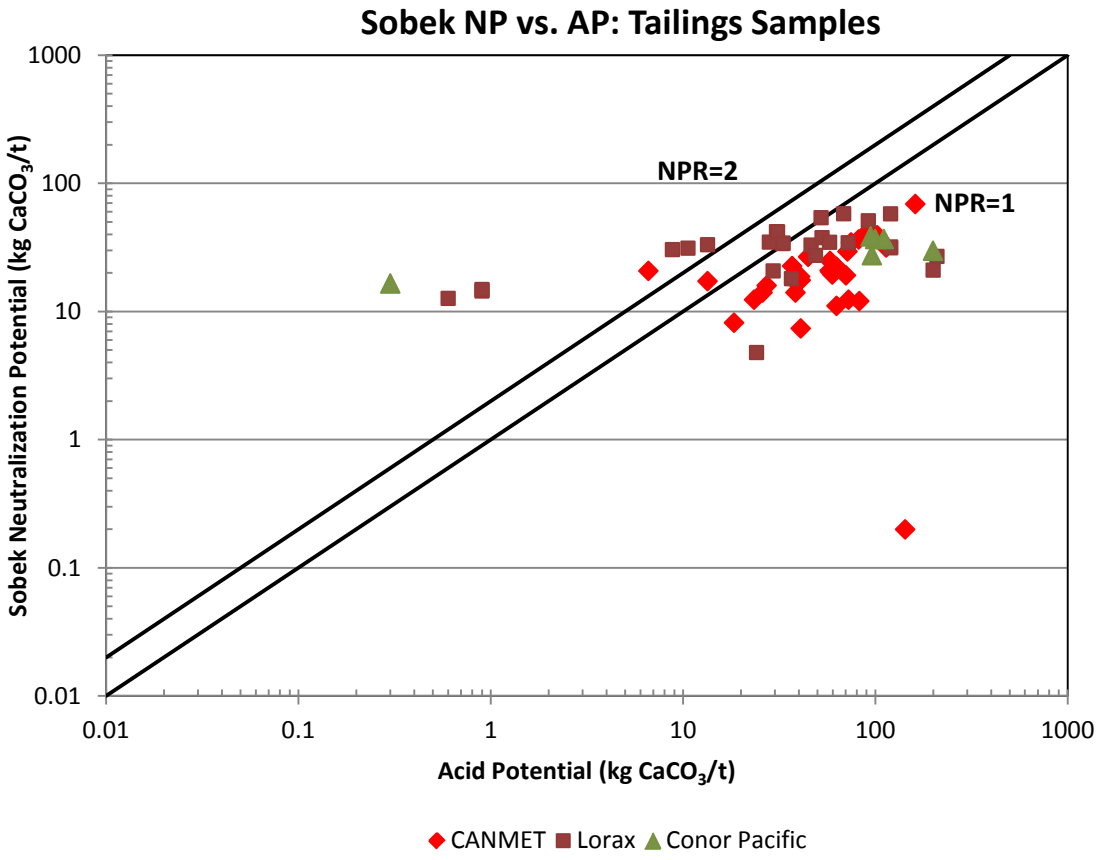
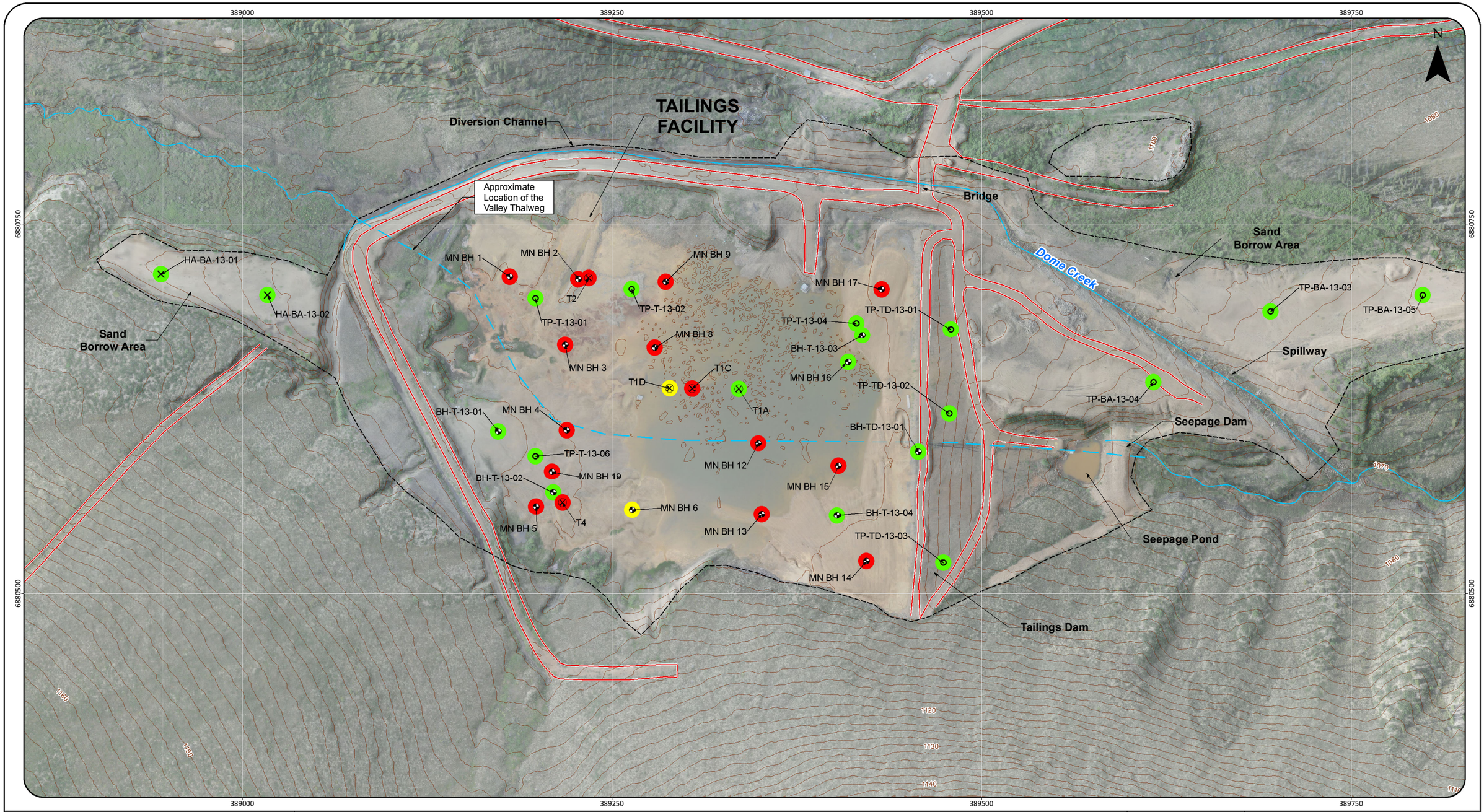


Figure 41: Comparison of AP vs. NP for Tailings Samples



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

ARD Classification
- PAG
- non-PAG
- Uncertain

Testhole
- Borehole
- Grab Sample
- Hand Auger
- Test Pit

- Order in Council Boundary
- Contour (2 m)
- Disturbed Area
- Roads
- Streams

Associated Engineering — Global Perspective. Local Focus.

amec

Yukon Energy, Mines and Resources — Assessment and Abandoned Mines

MOUNT NANSEN REMEDIATION PROJECT
Figure 42

SITE CHARACTERIATION REPORT

TAILINGS FACILITY GEOCHEMISTRY

Scale 1:2,500
Metres
0 50 100

March 18, 2014

S:\PROJECTS\VM00605 - Mount Nansen\GIS\Mapping\VM00605_0020c_11x17_SiteCharacterizationReport_Geochem_TSFLocations.mxd

Test pit tailings samples collected from the Mount Nansen tailings impoundment by AMEC in 2013 were characterized for metals content. Metal concentrations in the tailings were high and the results are presented in Table 56. The results fall within the range of tailings concentrations reported by Conor Pacific, CANMET and LORAX (Conor Pacific, 2000; CANMET, 2002; LORAX, 2011).

Table 56: Metal and Cyanide Testing Results of 2013 Tailings Test Pit Samples

Sample ID	Comparison Guidelines		TP-T-13-02 (GS2 1.0M)	TP-T-13-04 (GS1 1.0M)	TP-T-13-04 (GS5 3.0-3.1M)	TP-T-13-06 (GS1 0.8M)
	Average Concentration (Continental Crustal)**	Yukon Contaminated Site Regulation O.I.C. (2002/171)				
Cyanides						
Cyanide, Weak Acid Dissolved	N/A	10	0.156	0.192	<0.050	0.083
Cyanide, Total	N/A	N/A	54.1	36.8	0.233	6.92
Metals						
Antimony (Sb)	0.2	20	436	415	529	164
Arsenic (As)	1.8	20	3450	5620	4990	1650
Barium (Ba)	425	500	137	62.3	201	75.6
Beryllium (Be)	3	4	0.51	<0.20	0.31	0.25
Cadmium (Cd)	0.15	2	42.2	21	12.3	20
Chromium (Cr)	102	NA	11.1	5.6	11	9.49
Cobalt (Co)	25	50	5.85	2.49	3.55	5.71
Copper (Cu)	60	150	485	386	157	192
Lead (Pb)	14	250	2550	2300	2620	974
Mercury (Hg)	85	15	0.397	0.23	0.641	0.179
Molybdenum (Mo)	1.2	10	1.77	1	1.6	0.97
Nickel (Ni)	84	100	5.52	1.76	4.53	5.14
Selenium (Se)	0.05	3	0.36	0.96	0.54	<0.20
Silver (Ag)	75	20	32.8	39.7	37	20.4
Thallium (Tl)	9.6		1.28	0.857	2.01	0.565
Tin (Sn)	2.3	50	<2.0	<2.0	<2.0	<2.0
Uranium (U)	2.7		0.968	0.548	0.629	0.551
Vanadium (V)	120	200	21.3	12.7	23	19.6
Zinc (Zn)	70	300	2890	685	1060	1470

Mount Nansen tailings samples from the impoundment were measured for total cyanide in the CANMET study (CANMET, 2002). Total cyanide content ranged between 5 and 165 mg/kg with high values generally associated with the fine-grained tailings.

Test pit tailings samples collected from the Mount Nansen tailings impoundment by AMEC in 2013 were also characterized for cyanide content (WAD and Total). WAD CN ranged from 0.05 to 0.5 mg/kg with an average concentration of 0.2 mg/kg. The WAD cyanide concentrations in tailings were below the WAD cyanide standard in the CSR-PL, which is 10 mg/kg for park land use. Total cyanide concentrations ranged from 0.23 to 58.9 mg/kg, with an average concentration of 31.4 mg/kg. The minimum total cyanide content was lower compared to the minimum total cyanide concentration previously reported by CANMET (CANMET, 2002). This is reasonable as cyanide degrades naturally and there were 11 years between studies.

The static testing results indicate the tailings are PAG. The results from the kinetic testing done on the tailings samples suggest that it will take less than 25 years for tailings to become acidic in laboratory conditions, and as low as 6.4 years in the silty-sand tailings (LORAX, 2011). The ARD lag time for the tailings is expected to be longer for field conditions.

12.3 Tailings and Seepage Dam Characterization

The tailings and seepage dams have been investigated and assessed many times since the original construction in 1996, both in support of developing reclamation options and to comply with required dam safety reviews. The characterization presented below is summarized from this previous work, in particular Klohn (1995), Klohn (1996), EBA (2002a), EBA (2002b), EBA (2003), EBA (2004), EBA (2013a), and EBA (2013b). With the exception of geochemical testing, new analyses were not been completed for the dam in 2013.

12.3.1 Dam Construction

The main tailings dam is an earth fill structure constructed from sand borrow sourced from the nearby valley deposits. At its maximum, the dam was designed to be 21.5 m tall but the maximum as-built height is reported to be 18.5 m. Much of the dam on the north side overlies terrace deposits and has a typical height of about 4 m. The dam crest is at an elevation of 1,099.8 m[2], is 6 m wide and approximately 270 m in length. As shown in Figure 38, it has an upstream slope of 2.5H:1V and a downstream slope of 3.5H:1V.

An upstream toe berm was constructed in the deepest part of the valley bottom to an elevation of approximately 1,089 m with a maximum width of 20 m and an upstream slope of 2H:1V. The primary means of seepage control was intended to be a 50 m wide beach against the dyke. An upstream geosynthetic clay liner (GCL) was included as a secondary seepage control measure. At the upstream toe of the dam, the GCL was terminated in a trench and where the upstream toe berm exists, the GCL was extended underneath the length of the berm. The GCL was not keyed into any impermeable unit. Thus, and as some thermal degradation of permafrost beneath the dam and tailings deposit is to be expected, under-seepage from the tailings under the dam and towards the dam toe is to be expected.

Erosion protection was placed on the crest and upstream and downstream slopes. The most significant observations during construction were that foundation stripping was not completed to the extent proposed and organics were left in place, in particular, over a large portion of the south abutment. In addition, compaction of the sand fill was not well documented and may not have met the construction specification in some areas.

[2] There has been a change in mine datum over the life of the project and design documentation indicates a crest elevation of 1,151.5 m.

Significantly more water was retained behind the dam than was envisioned and it appears that the 50 m beach was either not achieved or maintained. An emergency downstream toe berm and north terrace buttress was constructed in July/August 1997 (nine months after initial deposition into the tailings pond) to control seepage and piping in response to a series of observations that included:

- heavy seepage and sand boils at the downstream toe;
- much of the lower dam slope was saturated and soft;
- seepage from the north abutment terrace where it intersected the dam toe and associated sloughing; and
- a significant erosion channel along the south abutment of the dam.

The toe berm was not formally designed but rather was field designed to provide loading to control piping and for filtration. Construction was carried out in several phases and there is no complete construction record for the toe berm or terrace buttress. Generally it seems that the toe berm consists of a gravel toe drain/anchor trench, a sand bedding layer, a geotextile overlain by a rock fill buttress about 6 m wide. The materials were placed without compaction control, in particular some of the initial layers which had to be dumped into place because the dam face was too soft to traffic. The main rock fill placement was likely subjected to construction equipment traffic. It should also be noted that although standing vegetation was removed, the north terrace buttress was placed directly over the organic mat.

The seepage collection dam is located approximately 40 m downstream of the toe of the dam. It was reconstructed in 2000 because of significant physical and environmental deficiencies. The rebuilt seepage collection dam is a sand fill structure with upstream and downstream slopes of 2.5H:1V. It has a maximum height of 4 m. There is an upstream PVC liner that is keyed into permafrost and refreezing of the key trench and maintenance of permafrost conditions are promoted by horizontal thermosyphons.

The diversion spillway was also upgraded in 2000/2001 in order to handle a 1 in 200 year flow.

12.3.2 Dam Performance

As indicated by the construction history, the initial performance of the tailings dam and seepage dam was poor. There was significant seepage on the face of the tailings dam and from the abutments and there was also a significant amount of seepage around the seepage collection dam. This is not surprising considering that there were several issues of concern related to the construction of the tailings dam and tailings deposition and facility operation did not occur as envisioned by the designers. The emergency measures that were implemented and the reduced pond levels that have been maintained in the pond in recent years appear to have generally mitigated the major issues regarding seepage. Recent dam inspections indicate that both the dam and seepage dam are in stable condition. There is still some seepage occurring as outlined below:

- downwards seepage gradients in the tailings and insitu deposits of the north abutment upstream of the dam, indicating that there must be active seepage paths under the dam;

- intermittent seepage at the toe of the main tailings dam;
- several intermittent seepage zones on the downstream toe of the seepage collection dam; and
- zone of seepage (i.e. not a single concentrated location) from the toe of the sand terraces on the north side of the seepage collection pond.

The seepage is reported to be free of fines and although warranting continuous observation for changing conditions, is not considered to be a significant immediate concern, but will require technical management/control during dam removal.

The dam has experienced some settlement and deformation. Limited deformation of the dam face has occurred in a generally east to southeast direction typically ranging between 15 mm to 35 mm. It appears that most of this deformation occurred early in the life of the dam. Settlement of the dam crest has occurred with the largest settlements occurring in the southern portion of the dam. In this area, AECOM (2008) report ongoing settlement which had accumulated to 265 mm at one location. No significant horizontal movement of the crest has been measured. In addition, a zone of cracking and local subsidence has historically been observed on the downstream face of the dam near the south abutment. This was an area where an erosion channel had appeared in 1996/97. This area was repaired by the mine operator and it is suspected that loose fill was placed in the area. The cracking and subsidence has not worsened since 2002.

Interestingly, although more settlement has been measured on the south side of the dam, this portion of the dam has not recorded the greatest amount of permafrost thaw. Permafrost thaw has been measured to typical depths of 1.5 to 2.5 m below the original depth of permafrost with a maximum of about 4.5 m on the south abutment and in the valley bottom. There are no active thermistors in the dam crest on the north half of the dam but there are several along the toe and in the terrace just downstream of the north abutment. These instruments as well as drilling completed in 2000 indicate that 5 to 6 m of permafrost has thawed. Construction activities associated with the Seepage Dyke in the fall of 2000 indicated that thawing had “proceeded 18 m laterally into the north slope as well as 5.4 m vertically below the toe of the slope” (EBA, 2002a). None of the dam fill has frozen. Inferred permafrost levels through the valley bottom and along the dam crest are shown in Figures 36 and 38, respectively.

The piezometric levels in the dam were constant or dropping until about 2008. Since then, there have been measured increases in water pressures, which may indicate increased seepage through the dam (EBA, 2013a). AMEC understands that the tailings pond was pumped dry at some point in the mid to late 2000s and the pond has been filling since that time. Pond elevation data for this period does not appear to be available; however, it is difficult to assess the effect of pond level on the measured pore water pressures. Water levels under the crest of the dam are variable but tend to be higher in the southern portion of the dam than the northern portion. It has been suggested that this is due to the lesser tailings thickness against the north side of the dam and also because of the large amount of thaw that has occurred in the north abutment, which effectively acts as a drain. The phreatic surface in the toe berm is more constant, although still

slightly lower in the north side of the dam. Water levels are generally near surface in the toe berm area as evidenced by the intermittent seepage and occasional ice formation that is observed. The inferred phreatic surface through the dam in the valley bottom is shown in Figure 36 and under the crest of the dam in Figure 38.

12.3.3 Geotechnical Properties of Fill

The dam was constructed mostly from sand borrowed from locations within the tailings impoundment and from the sand borrow areas upstream and downstream of the facility. There are few reported test results in the construction documentation regarding the gradation or compaction of the dam fill. Consistent with recent observations of the borrow area, it was reported that the dam fill material was quite consistent and is a poorly graded fine to medium sand with between 5 and 12% fines and no significant amount of gravel. A limited amount of sand (about 2,000 m^3) obtained from the spillway excavation had up to 30% gravel (Klohn, 1996). It was also reported that there was also some material excavated from the diversion ditch that contained boulder sizes and small frozen pieces that was included in the dam fill.

Twenty-six compaction tests are reported in the construction report. With two exceptions, they indicated achieved dry densities of 1,674 kg/m^3 to 1,776 kg/m^3 corresponding to a minimum of 97% of the maximum Standard Proctor dry density. Reported areas where compaction was not achieved were the initial pad directly above the insitu subgrade, some upstream slope areas and lower portions of the north abutment.

A limited number of SPTs have been completed in the dam fill as part of dam safety assessments. The values ranged from 10 to 40 blows per 300 mm. The higher values are typically associated with older drill programs and some of the range in values may be explained by differences in hammer energy. CPTs have also been advanced through dam fills and were used to assess liquefaction potential (EBA, 2002). The assessment indicated that the dam fills were in general compact and non-liquefiable except at one location on the south side of the dam where a 0.8 m thick zone was considered to be potentially liquefiable.

12.3.4 Geochemical Properties of Fill

The geochemical sampling program was conducted during the 2013 site investigation program to assess ML/ARD potential of dam fill materials. No geochemical characterization was previously performed on the tailings dam materials. One borehole and three test pits were completed in the tailings dam (Figure 42). The depth of test pits ranged from 3.5 m to 5.1 m, while the depth of the borehole was around 17 m. Twenty-one samples were selected for ABA and elemental metal analyses. Nine samples also underwent leachable metal analyses.

The geochemistry testing conducted on dam fill samples is summarized in Table 57.

Table 57: Summary of Geochemistry Tests for Dam Fill Material and Underlying Soil Samples

Borehole ID	No. of Samples	Geochemistry Testing		
		ABA	Metal	Leachable Metal
TP-TD-13-01	4	4	4	2
TP-TD-13-02	4	4	4	2
TP-TD-13-03	6	6	6	2
BH-TD-13-01	7	7	7	3
Total	**21**	**21**	**21**	**9**

ABA Accounting and PAG/non-PAG Distributions

The total sulphur content in the samples was relatively low, ranging from below the method detection limit (MDL) (0.01%) to 0.15%. Median (0.01%) and average values (0.02%) of total sulphur were at or near the method detection limit of 0.01%. The highest sulphur content (0.15%) was identified in the sample collected from the 4.5 m to 4.6 m depth interval in TP-TD-03. The Sobek NP values of samples were low and ranged from negligible to 13.3 kg $CaCO_3$/t. The tailings dam samples exhibited low Carb NP values (≤5.8 kg $CaCO_3$/t). The summary of ABA results is presented in Table 58.

Table 58: Summary of Acid Base Accounting Results for Dam Fill Samples

Sample	Paste pH	TIC	S(T)	$S(SO_4)$	Calculated $S(S^{-2})$	Carb NP	AP	NP	NPR	Carb NPR
		%				kg $CaCO_3$/t				
Count	21	21	21	21	21	21	21	21	21	21
Minimum	5.5	0.01	0.01	0.01	0.01	0.8	0.3	0.0	0.02	1.8
Maximum	8.6	0.07	0.15	0.17	0.03	5.8	0.9	13.2	24.3	16.7
Mean	8.0	0.02	0.02	0.02	0.01	1.4	0.3	3.2	9.2	4.2
Standard Deviation	0.7	0.02	0.03	0.03	0.00	1.5	0.2	2.8	6.1	4.0
Median	8.2	0.01	0.01	0.01	0.01	0.8	0.3	2.3	7.7	2.7
10^{th} Percentile	7.5	0.01	0.01	0.01	0.01	0.8	0.3	1.7	5.7	2.7
25^{th} Percentile	7.9	0.01	0.01	0.01	0.01	0.8	0.3	2.1	7.0	2.7
75^{th} Percentile	8.4	0.01	0.01	0.01	0.01	0.8	0.3	3.1	10.3	2.7
90^{th} Percentile	8.6	0.05	0.03	0.01	0.01	4.2	0.3	6.4	21.1	9.3

The NPR values in the samples ranged from 0.02 to 23.36 with a median value of 8.55 (Figure 43). Only two samples had an NPR<2, which would be classified as PAG according to MEND criteria. Both samples were collected from TP-T-03. One sample was taken from the 4.4 to 4.5 m depth interval where a salt-like mineral was observed. The other sample contained moist organic material which was collected from the 4.5 to 4.6 m depth interval. Samples collected from the same test pit at shallower and deeper locations were classified as non-PAG material. The distribution of PAG and non-PAG of the dam fill material is presented on Figure 42.

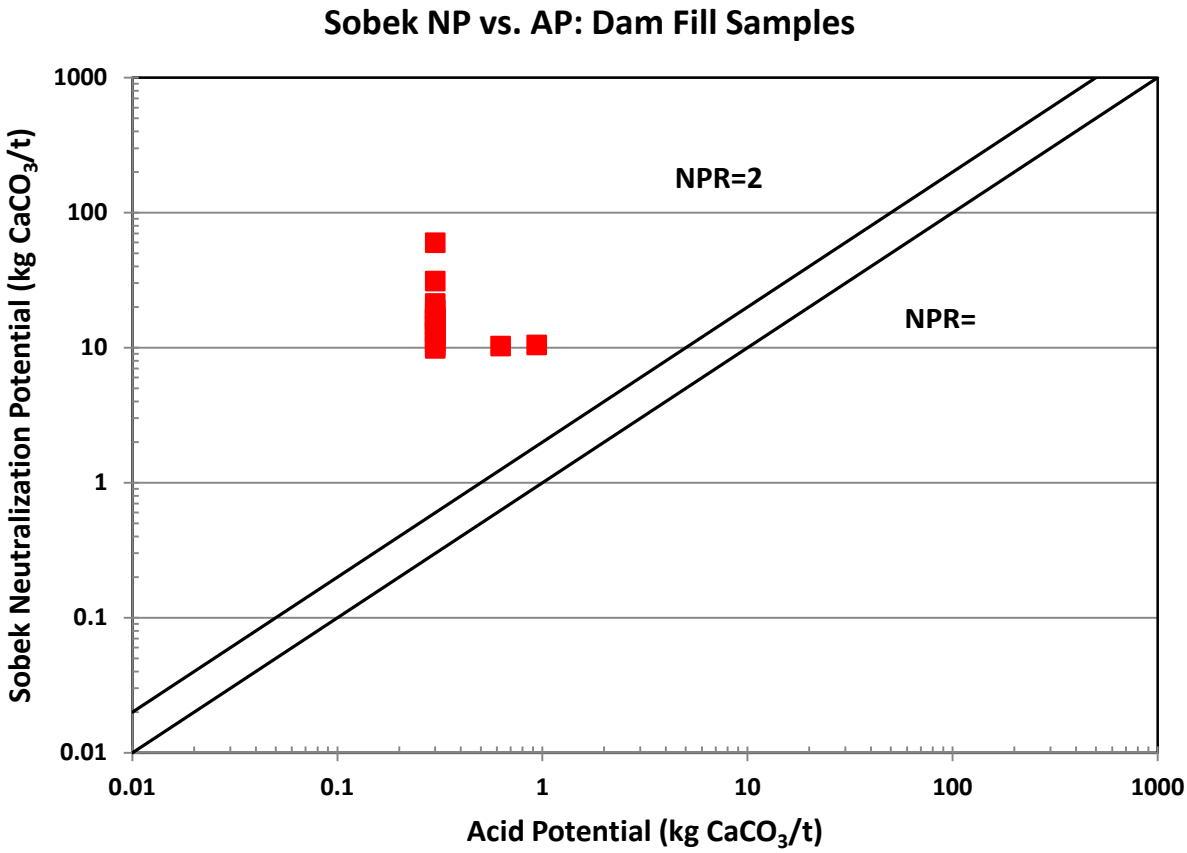


Figure 43: Comparison of AP vs. NP for Dam Fill Material Samples

Metal Contents

The strong acid digestion method with ICP-MS was used in the elemental metal testing. Results were compared to average crustal concentrations, and were considered elevated where concentrations were greater than ten times the crustal average. The metal testing results of dam fill samples were also compared to the CSR – PL values. Results for selected parameters are summarized in Table 59 and the complete metal results are given in Appendix F.

Table 59: Summary of Selected Elemental Metal Results for Dam Fill Samples

Statistic	As	Ba	Bi	Cu	Sb	Zn
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
10 times average crustal content	18	4,250	0.085	600	2	700
CSR-PL	20	500	N/A	90	20	150
Count	21	21	21	21	21	21
Minimum	6	814	0.06	5.1	0.78	25
Maximum	58	1,380	4.31	137	3.26	232
Mean	14.1	1,085	0.28	17.7	1.33	43
Standard Deviation	12	133	0.92	29.7	0.61	44
Median	11	1,100	0.08	7.5	1.16	34
10^{th} Percentile	7	933	0.07	5.7	0.80	26
25^{th} Percentile	7	1,050	0.07	6.6	0.94	29
75^{th} Percentile	13	1,140	0.09	11.2	1.45	38
90^{th} Percentile	28	1,170	0.13	31.2	1.94	45

Metal concentrations were generally lower in the dam fill samples. Arsenic, bismuth, and cadmium were enriched metal parameters. All samples had elevated bismuth content. Arsenic and cadmium content were elevated in four and two samples, respectively. The remaining elemental metals had relatively low concentrations.

Arsenic and barium were above the CLR-PL values. Arsenic contents in the four dam fill samples were above the CSR-PL regulation value (20 mg/L). Copper content in one sample exceeded the CSR-PL value of copper (90 mg/kg), while the other samples had zinc content above the CSR-PL value (150 mg/kg).

Leachate Characterization

The SFE testing results show all samples exhibited neutral pH ranging from 7.35 to 7.49, with the exception of one sample measuring a pH of 5.67. This low pH sample also had a high sulphur content. For reference, the CCME minimum guideline for pH is 6. In general, the aluminum concentration in samples marginally exceeded the CCME surface water guideline for receiving waters (0.01 mg/L). The copper concentration in four samples was higher than the CCME copper guideline of 0.004 mg/L, with results ranging from 0.0042 mg/L to 0.0078 mg/L. The sample with the highest sulphur content also had a high manganese concentration of 17.3 mg/L and a sulphate concentration of 445 mg/L, which were above CCME freshwater aquatic life guidelines for these parameters. The SFE testing results are shown in Table GC-4 in Appendix F.

In summary, the dam fill material is generally non-PAG material with low metal leaching potential. However, one location (TP-TD-03) contained oxidized material with sulphur and metal concentrations above typical values for the dam fill material. Arsenic concentrations in some samples were above the CSR-PL, while all samples had chromium contents above the CSR-PL value. These elemental metal parameters could be naturally elevated in the Mount Nansen area. As discussed in Section 4.4, the results of metal contents in soil background indicate arsenic contents above the CSR-PL value were measured in the background soil samples.

12.4 Insitu Soils

12.4.1 Geotechnical Characterization

The naturally occurring or insitu soils encountered in the Tailings Facility consist generally of fine grained sand with organics overlying fine to medium sand and sand and gravels. Silt zones and layers have also been encountered in the Tailings Facility area. These soils are located below the water table and may be frozen depending on the location.

Generalized inferred subsurface geology is included in the cross sections in Figures 36, 37 and 38. Some continuity has been assumed between the silt zones reported at discrete borehole locations and it is possible that there was a depositional event that introduced a silt layer in the valley that was subsequently eroded in the middle. There are cases where boreholes have been carried out by different consultants within close proximity to each other and in one log, the material is described as a silt and in the other, it is described as a sand. The main conclusion from the availably is that the silt material is likely of relatively low plasticity and variable, particularly with regards to sand content and is not reported to be ice rich. One borehole from 1988 located near the old thalweg intersected a pocket of clay at a depth of 18 m.

Appendix E1 contains graphs summarizing the particle size distribution, moisture content and Atterberg limit results for the insitu soils encountered below the tailings dam, and below the tailings deposit from the investigation completed to support the dam design and from the recent 2013 investigations. Cross sections illustrating the subsurface stratigraphy across Dome Creek valley at the dam centreline and down the length of Dome Creek Valley are shown in Figures 36 and 38, respectively. The geotechnical parameters of the insitu soils underlying the Tailings Facility are very similar to those encountered in the borrow area and tailings dam fill.

Fine Grained Sand with Organics

Test pits and drill holes completed in the Tailings Facility generally first intersected a layer of dark coloured fine grained sand with organics below the tailings. This soil unit is typically 0.5 to 2 m in thickness and underlies the majority of the Tailings Facility. The structure of the unit typically consists of 0.05 to 1.0 m thick layers of sand mixed with organics amongst the fine to medium sand described below. The spacing of the layers generally increases from a near solid unit near the tailings interface, to becoming thin layers 1 m apart at depth.

The soil is dominantly sand and has trace to no gravel. The amount of fine particles passing the #200 sieve is variable, generally between 20 and 40%, but ranges up to greater than 90%. It is distinguishable by its dark brown to black colour, and smells of decomposing vegetation. Trace small vegetation fibres are present. The moisture content is typically about 20% as shown in Appendix E1. Four laboratory tests indicated the organics content is 1 to 5% (laboratory results are included in AMEC, 2013). The material is non to low plastic based on visual classification and one Atterberg limit that indicated the sample was a low plastic clay although it had greater than 90% fines.

Fine to Medium Sand

Fine to medium grained sand dominates the insitu soil encountered in the Tailings Facility area and is located below the fine grained soil with organics, and above the gravel and sand. The unit appears to be up to approximately 10 m deep although the base of the unit was not identified in all investigation locations. The gradation is dominantly fine grained sand with about 10% medium grained sand. It is blue to grey coloured. This soil has a variable amount of silt sized particles, from 0 to 40% passing the #200 sieve as shown in the graphs in Appendix E1. The moisture content was typically 20 to 30% as shown in Appendix E1, and the three samples tested for Atterberg Limits have non-plastic results.

Figure 36 presents the inferred subsurface stratigraphy beneath the dam crest per the tailings dam design report (Klohn, 1995). It distinguished between a fine to medium sand, and a silty fine to medium sand. Such a distinction was not made farther upstream as shown in Figure 38 although silty sand to silt layers of limited thickness were encountered. The sand, silty sand, and silt are likely of glaciofluvial and/or fluvial origin and are treated herein as a single unit. Near the top contact, the unit typically has trace 1 mm to 10 cm thick layers of dark brown to black fine grained sand with organics described above. Measurements of insitu density from 1995, prior to development of the Tailings Facility, indicated a typical range of bulk density between about 1,760 kg/m^3 and 2,055 kg/m^3 with a median value of 1,925 kg/m^3. Reported coefficient of consolidation values (cv) from Klohn 1995 ranged from a minimum value of 1x10^{-7} cm^2/s (3x10^{-4} m^2/yr) from a fines dominated material at low confining stress to 1x10^{-2} cm^2/s (30 m^2/yr) for a sand at high confining stress.

In 2013, the fine to medium sand unit was encountered in a frozen state in the southern half of the Tailings Facility and thawed over the depth of investigation in the northern half of the facility.

Gravel and Sand

Beneath the sand deposits in the Tailings Facility/Dome Creek area is a gravel and sand unit. This unit most likely overlies bedrock and may include weathered bedrock. Only a few drill holes in the Tailings Facility area have intersected this soil unit. It appears to be approximately 10 m below the original ground surface below most of the Tailings Facility. TP-T-13-01 intersected the unit at approximately 2 m depth in the northwest portion of the Tailings Facility. In the past, drill rigs had difficulty drilling through this soil, especially when combined with permafrost.

This unit consists of approximately 50% gravel and 50% sand. Trace silt was noted. TP-T-13-01 found a large amount of cobbles and a boulder at 2 m depth. One sieve for this material is included in Appendix E1. The sand and gravel encountered was wet to saturated with a measured moisture content of 20%.

Permafrost

Drill holes completed in the 1990s encountered permafrost several metres below the insitu ground surface. In areas outside the impounded tailings, with the exception of the north terrace downstream of the dam, investigations in the 2000s have also shown permafrost within several metres of ground surface. In 2013, within the area covered by tailings, permafrost was encountered within the depth of investigation only in the southern portion of the Tailings Facility. It was encountered in all of the fine to medium sand, and gravel and sand units discussed above beginning a few metres below the top of insitu soil. On the northern side of the Tailings Facility near the dam, 2013 drill holes and test pits did not encounter permafrost. Permafrost is indicated by the existing thermistor installed just inside the diversion ditch at the very western edge of the Tailings Facility. No permafrost was encountered in the tailings dam fill or tailings material.

When permafrost was encountered, the soil was typically well bonded to the ice and did not break when hand force was applied. Reflections off the ice were seen when frozen core was freshly broken apart There was no excess ice taking space more than the natural void space. The permafrost was, therefore, typically logged as non visible, well bonded with no excess ice (Nbn classification according to ASTM D4083). Small 1 mm ice crystals were seen with the naked eye generally only amongst the organics layers. Ice lenses 0.15 m and 0.70 m thick were observed in BH-T-13-01 and 02, respectively, at depths of approximately 12 m and 6.5 m below original ground. Up to 100% moisture content was measured in the ice lenses as shown in the moisture content graphs included in Appendix E1.

When the frozen core was retrieved from the sonic drill rig, the outer centimetre was typically thawed from the drilling action. The core was hard and required a hammer to break apart. When the frozen core was left at the drill site overnight to thaw, it retained its shape and didn't fall apart in the core box. The insitu sands are, therefore, generally considered to be thaw stable. When the thawed core was transported to the core racks in the back of a pickup truck, the majority of the core retained its shape. Some pieces that started with a higher moisture content fell apart and liquefied when transported.

12.4.2 Geochemical Characterization of Insitu Soils

Geochemical Sampling Program

The previous geochemical investigation in the tailings impoundment included samples of the insitu soil underlying the tailings impoundment. Insitu soil analysis was conducted to assess the extent of the downward migration of tailings-associated contaminants in order to estimate the amount of material to be included in the remediation plan. CANMET included nine insitu soil samples in the geochemical testing program in 2001. LORAX collected an additional eight samples of the insitu soil from 0 to 1 m below the tailings surface at the east end of the tailings pond in 2001. During the 2013 site investigation, AMEC sampled the insitu soil from four test pits and one borehole in the tailings pond. In total, 30 insitu soil samples were submitted to the lab for the geochemical testing. Test pit and borehole locations are presented in Figure 42.

ABA Accounting and PAG/non-PAG Distributions

A summary of ABA results for the insitu soils is presented in Table 60. The statistical summary was performed with the available data for 48 samples collected during separate investigations, for which only nine had sulphur speciation data (LORAX, 2011). The paste pH was neutral to alkaline with values that ranged from 6.1 to 8.8 and a median of 8.0.

Table 60: Summary of Acid Base Accounting Results for Insitu Soil Samples

Sample	Paste pH	TIC	S(T)	$S(SO_4)$	Calculated $S(S^{-2})$	Carb NP	AP	NP	NPR
		%				kg $CaCO_3$/t			
Count	39	39	48	48	48	39	39	39	39
Minimum	6.1	0.01	0.01	0.01	0	0.70	0.20	0.20	0.13
Maximum	8.8	0.99	2.7	1.3	1.2	36.7	36.6	34.9	116
Mean	7.8	0.19	0.21	0.10	0.10	10.3	3.2	11.2	26.6
Standard Deviation	0.75	0.26	0.52	0.24	0.26	11.3	8.7	10.7	32.9
Median	8.0	0.09	0.04	0.02	0.01	5.0	0.31	5.8	11.0
10^{th} Percentile	6.7	0.01	0.01	0.01	0.01	0.80	0.30	1.7	0.56
25^{th} Percentile	7.4	0.01	0.01	0.01	0.01	0.80	0.30	3.0	5.2
75^{th} Percentile	8.3	0.28	0.075	0.045	0.03	18.4	0.94	21.4	34.0
90^{th} Percentile	8.6	0.51	0.43	0.18	0.20	25.5	3.2	26.8	82.5

Total sulphur was measured in 48 samples and the values ranged from 0.01 to 2.7% with an average of 0.21%. Sulphate sulphur values had a mean of 0.1%. Sulphate sulphur represents a relatively small fraction of the total sulphur. Sulphide sulphur ranged from 0 to 1.2% with an average of 0.1%.

Neutralization potential was measured both as Sobek NP and Carb NP in 39 insitu soil samples. Results for both methods were comparable. Sobek NP averaged 11.2 kg $CaCO_3$/t and Carb NP averaged 10.3 kg $CaCO_3$/t.

NPR ranged from 0.13 to 116 with an average of 26.6. A plot of NP vs. AP indicates that six of the native sediment samples have NPR <1 and are classified as potentially acid generating (PAG). The remaining 32 samples are non-PAG (NPR >2). Seventeen of the samples recorded AP values below method detection limits, and this is demonstrated by an apparent vertical line in the NP vs. AP plot (Figure 44).

Metal Contents

A summary of the multi-elemental analysis results for historic samples and 2013 samples is presented in Table 61, including samples from CANMET. The high metal concentrations were mainly measured in the samples collected by CANMET since some samples were collected from the tailings transition zone. One sample collected by AMEC is likely included the tailings transition zone and is identified by high metal concentrations compared to other insitu soil samples.

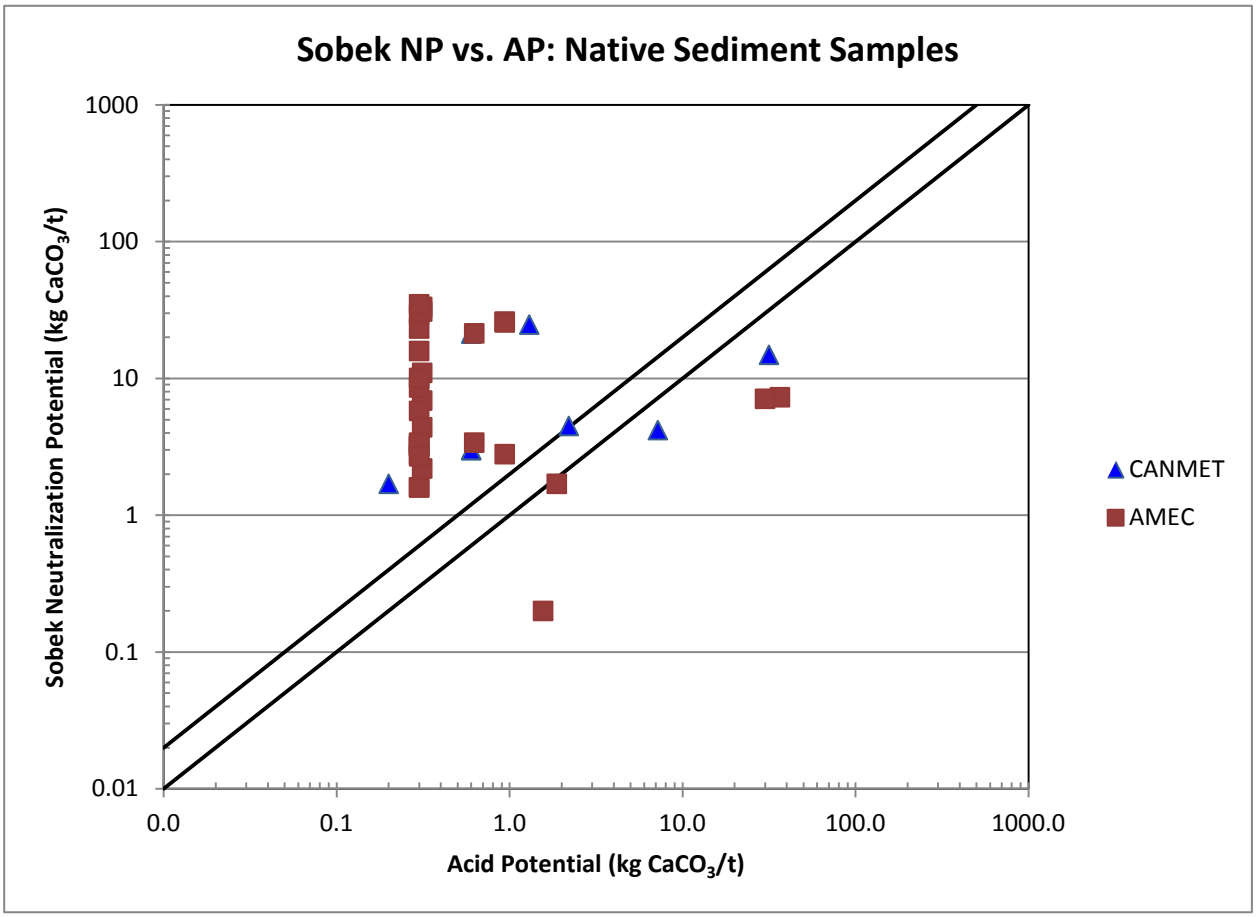


Figure 44: Comparison of AP vs. NP for Insitu Soil Samples

Table 61: Summary of Multi-Elemental Analysis Results for Insitu soil Samples

Statistic	Antimony	Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Zinc
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
10x Crustal Average	2	18	4250	1.5	1020	600	140	700
CSR-PL	20	15	500	1.5	60	90	100	150
Historical data (n=32)								
Count	30	32	32	28	32	32	32	32
Minimum	2.0	14.0	60	0.21	8.1	7.4	15.2	22.5
Maximum	706	5,005	1,210	101	91.2	428	4,780	1,360
Mean	190	1,483	753	8.9	51.2	121	1,366	451
Standard Deviation	264	1,804	444	20.4	19.3	138	1,844	513
Median	18.4	313	1,015	1.9	52	51.0	123	173
10^{th} Percentile	3.0	23.6	106	0.39	28.6	11.0	20.1	43.3
25^{th} Percentile	5.5	88.7	160	0.68	36.2	13.0	28.0	67.4
75^{th} Percentile	310	3,493	1,083	4.4	65.0	205	3,893	925
90^{th} Percentile	683	4,051	1,136	31.0	68.2	391	4,128	1,319
2013 data (n=30)								
Count	30	30	30	30	30	30	30	30
Minimum	0.68	5.0	625	0.09	55.0	5.0	10.4	26.0
Maximum	677	3,790	1,780	21.6	197	366	1,960	1,370
Mean	42.2	282	987	1.5	112	36.1	147	137
Standard Deviation	148	878	233	4.7	31.2	74.0	475	299
Median	2.3	21	976	0.23	111	14.3	17.4	43.5
10^{th} Percentile	0.80	5.9	724	0.13	82.7	6.9	11.4	31.9
25^{th} Percentile	1.0	8.3	892	0.15	95.3	8.8	12.2	36.3
75^{th} Percentile	5.4	48.3	1,098	0.40	126	25.6	24.8	75.3
90^{th} Percentile	12.9	271	1142	1.2	141	45	63	126

Arsenic and antimony were only two elevated metal parameters. Approximately 60% of samples had elevated arsenic and antimony contents.

The metal testing results of insitu soil samples were also compared to the CSR – PL values. Barium concentrations were above the CSR-PL value for approximately 95% of samples collected in 2013. In addition, 18 samples from 2013 program also had arsenic concentrations above the CSR-PL value. Concentrations of antimony, cadmium, copper, silver, and zinc in the sample from the transition zone also exceeded the CSR-PL values for those parameters.

Fifteen insitu soil samples collected from the upper layer by AMEC in 2013 were also characterized for cyanide content (WAD and Total). WAD CN contents in all samples were below method detection limit (MDL) of 0.001 mg/kg. The total cyanide contents in all samples were also below MDL of 0.001 mg/kg, with exception two samples collected from the transition zone. The total cyanide contents were 0.002 and 0.003 mg/kg in two samples collected from the transition zone.

Leachate Characterization

Results of the leachable tests on insitu soil samples are presented in Table GC-5 in Appendix F. Leachates from 11 samples exhibited circum neutral to slightly alkaline pH in the range of pH 6.3 to a maximum of pH 8.3.

One sample from BH-T-13-04 had a relatively high sulphate concentration of 1,073 mg/L. Concentrations of some metal parameters such as arsenic and manganese were also elevated in the leachate from this sample. Arsenic and manganese concentrations were 1.24 mg/L and 2.76 mg/L, respectively.

All insitu soil samples from BH-T-13-01 and BH-T-13-02 had low arsenic concentrations ranging from 6 to 50 mg/kg. For BH-T-13-03, TP-T-13-02, and TP-T-13-04, arsenic concentrations in the samples directly underlying the tailings were relatively higher than arsenic concentrations in the deeper interval, suggesting some arsenic migration from the overlying tailings.

Arsenic concentrations in the first two interval samples from TP-T-13-04 were high with values of 3,350 mg/kg and 3,790 mg/kg. The sulphur content in these samples was also high and they were classified as PAG. Based on the sulphur and arsenic contents, these samples were likely mixed with tailings and not simply insitu soil. The arsenic concentrations from the underlying samples were much lower with values ranging from 5 to 21 mg/kg.

Based on the existing results, it can be summarized that the uppermost layer of insitu soil is contaminated by the tailings. Detailed inspection and geochemical testing are required to identify the extent of contaminated soil when the tailings relocation is conducted.

12.4.3 Reclamation Suitability

Select samples of native material from near the original ground were identified for testing with regards to reclamation issues to investigate its suitability as a substrate or reclamation material. Samples were tested for the following parameters.

- pH;
- electrical conductivity (EC);
- sodium absorption ratio (SAR); and
- cation exchange capacity (CEC).

The results of analysis are indicated in Table 62.

Table 62: Results of Substrate Testing at the Tailings Facility

Sample ID / Parameter	Units	BH-T-13-01 ARD-01	BH-T-13-01 ARD-01	BH-T-13-02 ARD-02	BH-T-13-03 ARD-02	BH-T-13-03 ARD-04	BH-T-13-04 ARD-04	TP-T-13-04 ARD-01	BH-T-13-04 (Duplicate) ARD-04
pH		8.31	7.38	7.41	7.78	8.38	8.07	6.22	8.19
Electrical Conductivity	µS/cm	198	148.9	117.1	122.6	78.9	125.4	343	119.3
SAR		0.05	0.01	0.04	0.11	0.03	0.52	0.11	
CEC	meq/100 g	5.71	6.87	6.13	5.51	5.79	5.82	16.76	-

Laboratory results indicate that pH, EC and SAR are all within acceptable levels for reclamation and plant establishment. Liming may be required to neutralize basic soil conditions for optimal plant growth.

The CEC is a measurement of the soils ability to bind or hold exchangeable cations; or a measure of soil fertility. Results indicate that the potential borrow material has a low CEC, ranging from 5.51 to 6.87 meq/100 g, which is typical for sandy materials. One sample had moderate fertility at 16.76 meq/100 g, but otherwise all other samples had low fertility. A review of borehole logs indicates that the sample with moderate soil fertility was collected in an area of buried organic material.

A review of total metal results (Section 15) indicates that some of the potential sand borrow is contaminated with heavy metals, particularly arsenic and zinc. If the sand borrow is used as a reclamation material, it is imperative that contaminated material is separated from clean material and handled separately. Further characterization of contaminated soils may be necessary to accurately delineate the contaminated material.

In summary, all parameters, with the exception of some heavy metals, are within normal concentrations for soils and are within levels considered suitable for reclamation purposes. However, low fertility results indicate that if this material is used for reclamation purposes, it should be augmented with commercial fertilizer and/or a soil amendment with high organic matter content.

12.5 Current Permafrost and Seepage Regime

The Tailings Facility has had an impact on the local permafrost and seepage regime. Inferred shallow water levels and permafrost levels are included in Figures 36, 37 and 38. There is limited data to quantify the extent of thaw that has occurred beneath the main part of the impoundment because the tailings surface is inaccessible to heavy equipment that would penetrate to sufficient depths.

Generally, permafrost appears to be within a couple of metres of the ground surface south of the impoundment and also at the west end. Frozen ground was encountered within the insitu soils beneath the tailings on the west side of the pond on what was the south side of Dome Creek Valley at a depth of 3.5 to 4 m below insitu ground indicating 2 to 3 m of permafrost thaw. Near the dam on the south side of the facility, permafrost was encountered at a depth of 3 m below original ground. The permafrost level then rises with distance downstream from the crest of the dam.

On the north side of the impoundment near the dam, upstream of the north terrace where significant thaw of the ground has been documented, thawed soils were encountered over the full investigation depth of BH-T-13-03, which extended 12 m into insitu materials. A thermistor located west of the Tailings Facility on the north side of the original Dome Creek Valley, but downstream of the diversion ditch (W14103083-01 BH03) indicates permafrost at a depth of

3 m. The amount of thaw is a function of inter-related effects of original vegetation cover, original slope aspect and seepage. The increased thaw observed in the northeast part of the facility is likely partly a function of the southern exposure and seepage from the diversion ditch.

Seepage is occurring from the Tailings Facility through the thawed sandy foundation soils, which appear to act as an underdrain. Downward gradients have been measured between the tailings unit and the insitu soils upstream of the dam. It appears that there may be some upward gradients measured in the toe area of the dam which would be consistent with the rising water levels within the dam.

There is also a significant amount of seepage through the north terrace that likely originates from the diversion ditch (EBA, 2012). A similar mechanism may be occurring upstream of the tailings dam where significant thawed soils were observed. Significant seepage was also noted near the top of insitu soil in test pit TP-13-01 and 02 located in the northwest corner of the facility. It is not considered likely that seepage from Dome Creek and the tailings deposits is hydraulically connected to the seepage collection pond by a subsurface flow path into or under the tailings pond (EBA, 2012).

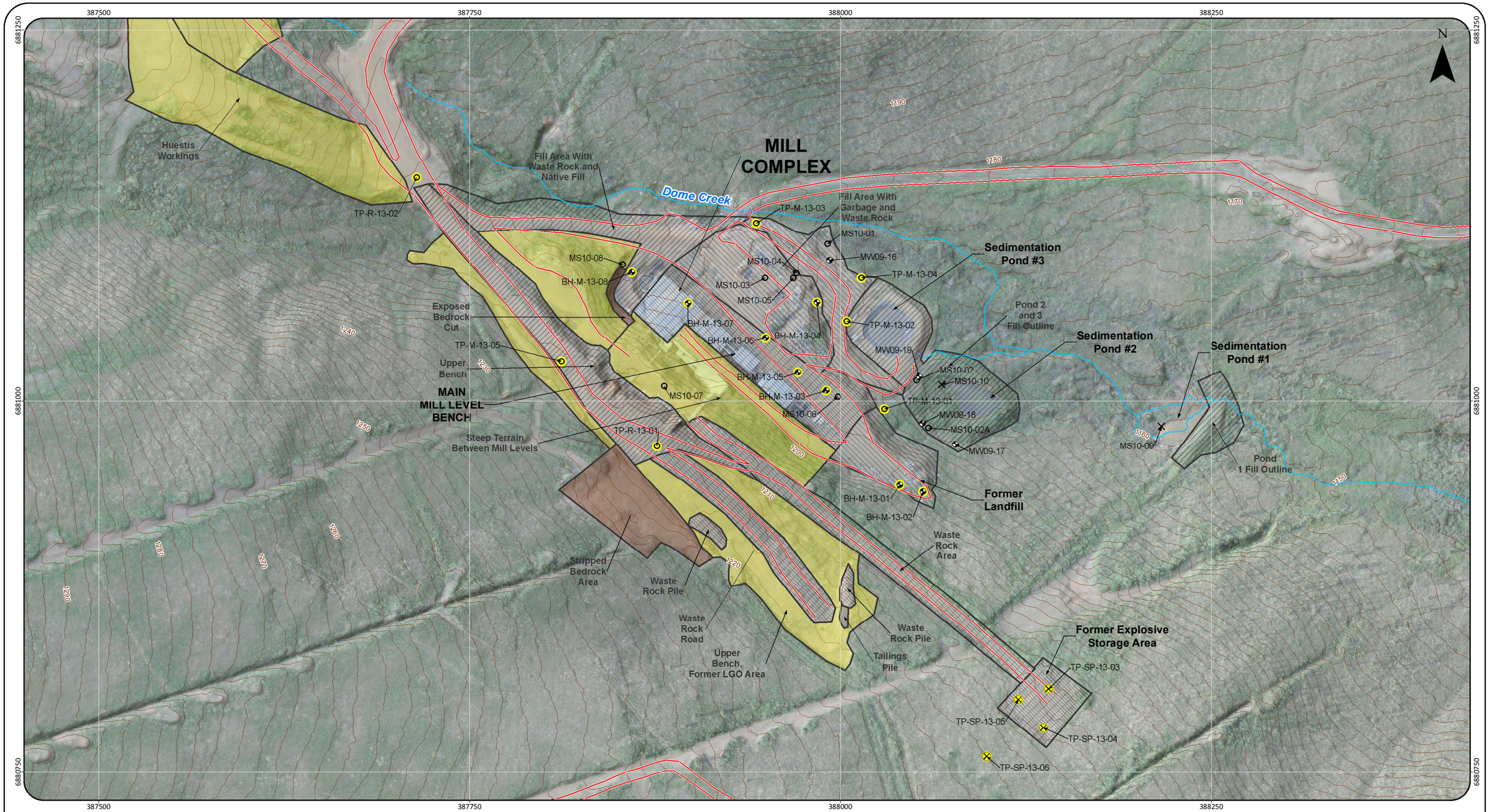
13.0 MILL AREA

13.1 General Characterization

The general mill area is shown in Figure 45. It was created as a series of cut and fill benches which include insitu soils and waste rock material. A landfill is located to the south off the mill which was created by simply pushing material over from the top of the bank. The landfill does not appear to have been lined and does not have an engineered cover nor has it been regraded to improve drainage.

East of the mill complex, there are three lined settling ponds (Ponds 1, 2 and 3) with respective areas of 800 m^2, 450 m^2 and 500 m^2 that were historically used for tailings disposal. The tailings from Ponds 2 and 3 structures were removed and reprocessed as part of the most recent mining activity. The westernmost pond (Pond 3) was used during the 1990 milling operations for water supply and for cyanide treatment. It is estimated that 2,000 tonnes of tailings remains in Pond 1. There is also indication that there are small volumes of tailings near Pond 2 and elsewhere within the general mill area (LORAX, 2011).

The clearing southeast of the mill complex is a historical explosives storage area. Northeast of the mill complex is the historical Huestis Adit area. Local overburden was pushed over the portal area obscuring the old workings.



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

- Borehole
- Grab Sample
- Hand Auger
- Test Pit
- 2013 Locations
- Order in Council Boundary
- Contour (2 m)
- Roads
- Streams

Soil Type

- Bedrock
- Bedrock Shallow, Shallow Native/Waste Rock
- Tailings
- Waste Rock
- Waste Rock and Native Fill
- Waste Rock/Ore and Garbage

Associated Engineering — Global Perspective. Local Focus.

amec

Yukon Energy, Mines and Resources
Assessment and Abandoned Mines

MOUNT NANSEN REMEDIATION PROJECT
Figure 45

SITE CHARACTERIZATION REPORT

MILL AREA FILL PLAN

Scale 1:2,500
Metres
0 50 100

March 18, 2014

S:\PROJECTS\VM00605 - Mount Nansen\GIS\Mapping\VM00605_0026b_11x17_SiteCharacterizationReport_MillAreaFillPlan.mxd

A general reconnaissance of the mil area was completed to confirm the distribution of materials that had been previously reported. This was supplemented by assessment of available imagery. The general distribution of material is presented schematically in Figure 45 and summarized in the following:

- Bedrock Exposures:
  - The upper bench southwest of the mill buildings had exposures of bedrock. The bedrock was characterized as a meta-sedimentary rock. The material stripped from here likely was used for the fill slope nearby.
  - A small bedrock exposure was noted west of the clarifier tank along the cut slope.
- Shallow bedrock, covered with a layer of insitu and/or waste rock:
  - The upper bench south of the mill area has a large clearing. Small areas of exposed bedrock are noted. Sparse vegetation grows on rocky soil. This area may have been used to store the low grade ore (LGO) before it was moved to the Brown-McDade Pit. Cobbles to sand sized particles are on surface, and some particles are oxidized red coloured. Some of the LGO and insitu soil are likely mixed on surface. There are two small piles of waste rock piled in this area, and a small section of sandy tailings in the southeast corner. The centre area along the former road contains waste rock.
  - Along the south side of the road leading to the upper bench. This road was likely built from cut and fill from the insitu soil. Along the sides of the road are small berms less than 1 m high of what appears to be waste rock.
  - West of the mill complex. Shallow bedrock was noticed in the cut slopes around the clarifier tank, and minimal disturbance was noted. Small amounts of garbage and debris are littered near the southeast road.
  - South of the mill complex, along the intermediate benches of the workings. This area is quite steep, and has areas of timber cribbing, and small areas of exposed bedrock. Fill (from insitu or waste rock) was likely used for the access roads.
  - The surface Huestis workings to the northwest of the mill complex have shallow bedrock and minor fill. It is understood from AAM that a dozer pushed overburden from above to build a platform. It appears that areas of the access road to the area have waste rock on surface.
- Waste rock/ore and soil fill:
  - The access road along the upper bench of the mill complex likely was initially made from the overburden stripped from the nearby bedrock exposure to build the platform for the filler bins. Areas on surface are stained red and are likely a mix of insitu soil and ore. Likely as the trucks went to this level to dump ore to the filler bins, some ore spilled out, or was used to build up the platform.
  - The fill around Ponds 1, 2 and 3 are likely a combination of waste rock and soil.
  - Exposed soil around Pond 3 was moderately oxidized and angular, with low fines. The outline around the ponds was taken from LiDAR bare earth shading, as vegetation has grown over it, and field observation was difficult. It is not known what the fill is for Ponds 1 and 2; however, AAM suggests that the berms were constructed from soil excavated from the pond.

- Waste rock/ore:
  - Two small piles were noted on the upper levels of the mill complex.
  - The access road to the north of the mill complex has a moderately thick amount of fill placed. Oxidized red waste rock combined with some soil was noted. Garbage is found on surface in areas. LiDAR was used to estimate the toe of the slope to the north side of the road.
  - The main mill level bench likely consists dominantly of waste rock/ore. Test holes and boreholes in front of the buildings have noted some garbage and oxidized rock. The 2013 site investigation test pits and drill holes suggest the contamination extends to bedrock or groundwater.
  - The access road on the upper bench, and the access road leading to the former explosives storage area consist of waste rock.
- Garbage, waste rock/ore fill, thick fill (yellow shade):
  - The landfill area to the south of the mill site encountered approximately 2 m of garbage from the drill holes. Lots of debris is noted on surface and on the fill slopes. Small amounts of sandy tailings were noted.
  - The area to the northeast of the mill complex is likely a mixture of garbage, waste rock/ore and some soil fill. Large amounts of metal debris are on surface.

The following is a summary of field observations pertaining to the mill infrastructure items:

- Pond 1 is surrounded by vegetation, and the water surface is covered with algae and vegetation. The water appears stagnant, and the level has likely decreased since it was in operation;
- Pond 2 is also surrounded by vegetation. No water appears to flow into the pond, or out of the pond. The water is somewhat clear, and the bottom of the pond is covered in a thick layer of algae. It appears the water level has decreased by approximately 0.3 m from the maximum level;
- Pond 3 is lined with a synthetic liner and surrounded by a waste rock berm. A small overflow pipe is on the southeast side of the pond, leading to a larger 1 m diameter culvert, which spills to some rock armouring between Pond 2 and Pond 3;
- a drainage swale was cut by DES while AMEC and AE were onsite on the lower bench leading approximately from BH-M-13-04 to the north side of Pond 3;
- existing building foundations were noted near BH-M-13-04. Existing foundations were also noted on the upper north bench of the mill complex as the filler bins;
- an approximate location of the Huestis Adit is outlined in the figure, based on historical photos of the area, and geophysics completed by Kryotec Arctic Innovation Inc.; and
- the former explosives area is located approximately 200 m southeast of the mill complex in a clearing.

13.2 Geotechnical Characterization

Subsurface investigation at the mill area has largely been limited to the upper 5 to 10 m with the exception of two holes drilled in the late 1980s near Dome Creek upstream and downstream of the mill area. Within the disturbed areas, the near surface material is dominated by granular fill

soils consisting mainly of sand, gravel and cobbles. Fills are expected to be up to approximately 5 m thick based on an assessment of the current and original topography. The insitu soils in the area are similar to the insitu soils described in the tailings area (Section 12.4). They are dominantly sandy fluvial deposits near the valley bottom and colluvial deposits farther upslope. Where there is no disturbance or where it was not cleared prior to fill placement, there is a veneer of organics, silt and silty fine sand. This unit is typically expected to be less than 1 to 2 m thick except possibly near Pond 1 which is located closer to the valley bottom where the thickness may increase. Underlying the surficial veneer is fine to medium sand to silty sand, and sand and gravel deposits with occasional silt layers or zones.

In the vicinity of Ponds 2 and 3, a gravelly sand to gravel unit has been encountered within about 1 m of original ground. It should be noted that borehole MW09-18 (AECOM, 2009) indicated a potential 1 m thickness of tailings uphill from Pond 2; however, subsequent investigations by Altura in 2010 (Altura, 2010) suggested that the unit is likely an insitu sand deposit. Shallow bedrock (6 m depth) may be present uphill of Pond 2 as indicated by MW09-17 (AECOM, 2009); however, it is also possible that drill refusal was caused by gravel, bobbles and/or permafrost.

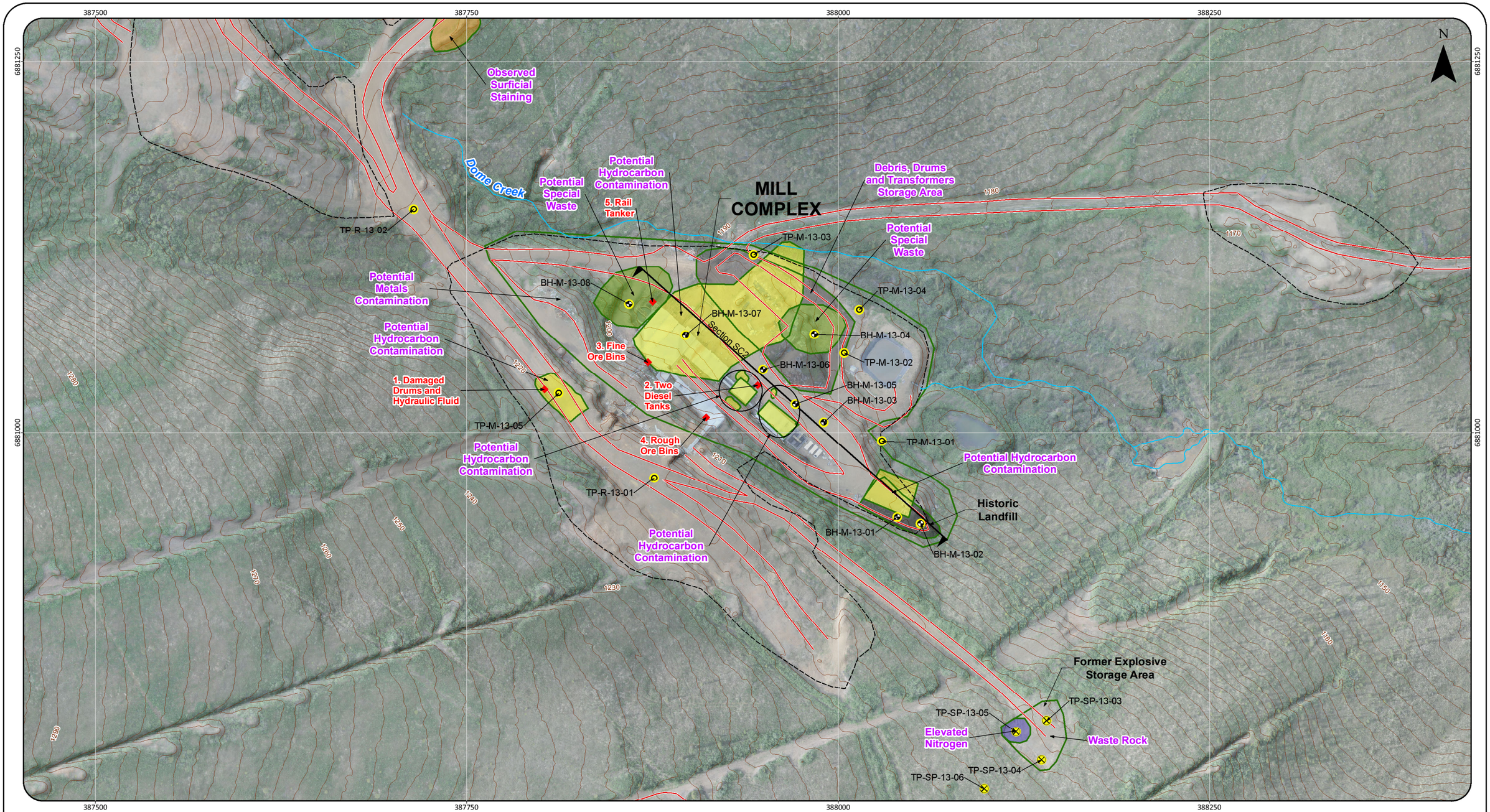
Permafrost has only been encountered in two recent investigations near the mill, specifically in MS10-09 near Pond 1 and in BH-M-13-06 where a pocket of fine grained material was encountered. The 1980 drilling indicates that any visible ice was typically encountered within the organics near surface. With depth there were very infrequent visible ice inclusions several millimetres in thickness.

Various seepages have been encountered in the test pits that have been excavated, mainly through fill material. The groundwater level, however, appears to be several metres below original ground.

13.3 Environmental Soil Assessment

Methods for collection and analyses of soil samples in the mill area are summarized in Section 2 of the Site Investigation Data Report (AMEC, 2013).

Soil samples were collected from eight boreholes (BH-M-13-01, BH-M-13-02, BH-M-13-03, BH-M-13-04, BH-M-13-05, BH-M-13-06, BH-M-13-07, and BH-M-13-08) and five test pits (TP-M-13-01, TP-M-13-02, TP-M-13-03, TP-M-13-04, and TP-M-13-05) in the mill area (Figure 46). Cobble and bedrock was encountered at approximately 3 to 4 metres below ground surface (mbgs) in this area, and groundwater was frequently encountered near 4 mbgs (Figure 47). Field screening was conducted and select soil samples were analyzed for potential contaminants of concern (PCOCs) including hydrocarbons, metals, and other parameters. The field screening results are presented in Section 3.4.2 of the Site Investigation Data Report, and are also listed in the Borehole Logs in Appendix A of the same report. Analytical results for soil samples collected from the mill area for hydrocarbons, metals, and other parameters are reported below and are summarized in Tables 63, 64 and 65, respectively. The laboratory reports are provided in Appendix D of the Site Investigation Data Report.



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

- Borehole
- Grab Sample
- Test Pit
- 2013 Locations
- Order in Council Boundary
- Contour (2 m)
- Disturbed Area
- Roads
- Streams

Site Characterization

- Debris, Drums and Transformers Storage Area
- Elevated Nitrogen
- Landfill
- Observed Surficial Staining
- Potential Hydrocarbon Contamination
- Potential Special Waste

Associated Engineering — Global Perspective. Local Focus.

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MOUNT NANSEN REMEDIATION PROJECT
Figure 46

SITE CHARACTERIZATION REPORT

CONCEPTUAL MODEL FOR SITE CHARACTERIZATION
PLAN VIEW, MILL AREA

Scale 1:2,500
Metres
0 50 100

March 18, 2014

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NORTHWEST

SOUTHEAST

GROUND

BH-M-13-08

BH-M-13-07

TP-M-13-04
BH-M-13-04
BH-M-13-06

BH-M-13-05

BH-M-13-03

BH-M-13-01

BH-M-13-02

HYDROCARBONS

Pb / CN
SPECIAL WASTE

UNKNOWN
SOURCE OF
METALS
CONTAMINATION

LANDFILL
WASTE

METALS

As
SPECIAL WASTE

ESTIMATED
BEDROCK

ESTIMATED
BEDROCK

?

DEPTH (m) BELOW SURFACE

0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5

Data Source:
Refer to Figure 46 for Cross-Section Alignment

Datum: NAD 1983 CSRS UTM Zone 8N

Legend:

CONFIRMED BOUNDARY
- SPECIAL WASTE
- HYDROCARBONS
- LANDFILL WASTE
- METALS

UNCONFIRMED BOUNDARY
- SPECIAL WASTE
- HYDROCARBONS
- LANDFILL WASTE
- METALS

0m 0.5 1.0 1.5m
(VERTICAL, APPROX.)

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MOUNT NANSEN REMEDIATION PROJECT
Figure 47

SITE CHARACTERIZATION REPORT

Conceptual Model for Site Characterization Cross-Section, Mill Area

0m 10 20 30 40m

MARCH 17, 2014

S:\PROJECTS\VM00605 – Mount Nansen\Drawings\Site Characterization Report\Figures 47,52.dwg – SC2 – Mar. 17, 2014 5:53pm – yuan.chen

Table 63. 2013 soil hydrocarbon analytical results compared to standards, Mt. Nansen, YT

	Sample ID	BH-M-13-01	BH-M-13-01	BH-M-13-01	BH-M-13-02	BH-M-13-05	BH-M-13-04	BH-M-13-04	BH-M-13-05	BH-M-13-07	BH-M-13-07	BH-M-13-07	BH-M-13-08	BH-M-13-08	BH-M-13-08	BH-M-13-08	TP-M-13-04	BH-KZ-13-02	BH-KZ-13-02	BH-KZ-13-01	BH-KZ-13-01
	Depth (mbgs)	1.1-1.5	1.6-2.0	2.1-2.5	3.1-3.5	0.0-0.5	0.0-0.5	1.1-1.5	1.1-1.5	0.0-0.5	0.6-1.0	1.1-1.5	0.0-0.5	2.6-3.0	3.1-3.5	3.6-4.0	2.1-2.5	0.0-0.5	1.1-1.5	0.0-0.5	0.6-1.0
	Date Sampled	09/10/2013	09/10/2013	09/10/2013	09/09/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	9/13/2013	09/10/2013	09/10/2013	09/09/2013	09/09/2013
Group	**Analyte**	**Units**	**CSR-PL**																		
Physical	Moisture	%	-	13.2	11.2	11.8	13.5	7.73	7.1	13.9	4.53	11.9	15.2	15.8	20	14.9	8.05	15	17.7	7.23	5.28	4.16	12.3
	pH (1:2 soil:water)	pH	-	7.61	7.95	7.83	8.61	7.44	7.74	7.61	7.82	7.91	8.29	8.34	7.71	7.74	7.66	7.64	7.05	7.22	6.1	7.08	5.71
Volatile Organic Compounds	Volatile Hydrocarbons (VH6-10)	mg/kg	-	<100	-	-	<100	<100	<100	<100	<100	320	660	<100	<100	<100	<100	<100	<100	<100	-	1610	<100
	VPH (C6-C10)	mg/kg	200	<100	-	-	<100	<100	<100	<100	<100	320	660	<100	<100	<100	<100	<100	<100	<100	-	1210	<100
	Benzene	mg/kg	0.04	<0.040	-	-	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	-	<0.40	<0.040
	Ethylbenzene	mg/kg	1	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	1.36	0.131	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	-	7.19	<0.050
	Methyl t-butyl ether (MTBE)	mg/kg	-	<0.20	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-	<0.20	<0.20
	Styrene	mg/kg	5	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	-	0.12	<0.050
	Toluene	mg/kg	1.5	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	-	31.6	<0.050
	ortho-Xylene	mg/kg	-	0.061	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	-	144	<0.050
	meta- & para-Xylene	mg/kg	-	0.124	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.060 *	1.47	0.139	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	-	215	<0.050
	Xylenes	mg/kg	5	0.185	-	-	<0.075	<0.075	<0.075	<0.075	<0.075	<0.078	1.47	0.139	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	-	359	<0.075
Extractable Petroleum Hydrocarbons	EPH10-19	mg/kg	1000	970	<200	<200	<200	<200	<200	<200	<200	4600	7330	470	<200	<200	210	<200	210	630	<200	2120	<200
	EPH10-19 (sg)	mg/kg	1000	-	-	-	-	-	-	<200	-	-	-	-	-	-	-	-	<200	-	-	-	-
	EPH19-32	mg/kg	1000	1630	<200	<200	<200	<200	<200	260	<200	1030	940	<200	<200	<200	<200	<200	<200	17700	230	21200	460
	EPH19-32 (sg)	mg/kg	1000	-	-	-	-	-	-	210	-	-	-	-	-	-	-	-	<200	-	-	-	-
	LEPH	mg/kg	1000	970	-	-	<200	<200	<200	<200	<200	4600	7330	470	<200	<200	210	<200	210	630	<200	2110	<200
	HEPH	mg/kg	1000	1630	-	-	<200	<200	<200	260	<200	1030	940	<200	<200	<200	<200	<200	<200	17700	230	21200	460
Polycyclic Aromatic Hydrocarbons	Acenaphthene	mg/kg	-	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.090 *	<0.60 *	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.20 *	<0.050
	Acenaphthylene	mg/kg	-	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.060 *	<0.30 *	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.050	<0.050
	Anthracene	mg/kg	-	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.060 *	<0.15 *	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.080 *	<0.050
	Benz(a)anthracene	mg/kg	1	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.050	<0.050
	Benzo(a)pyrene	mg/kg	1	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.050	<0.050
	Benzo(b)fluoranthene	mg/kg	1	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.20 *	<0.050	<0.20 *	<0.050
	Benzo(g,h,i)perylene	mg/kg	-	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.35 *	<0.050	0.226	<0.050
	Benzo(k)fluoranthene	mg/kg	1	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.20 *	<0.050	<0.060 *	<0.050
	Chrysene	mg/kg	-	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.070 *	<0.050	<0.060 *	<0.050
	Dibenz(a,h)anthracene	mg/kg	1	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.070 *	<0.050	<0.050	<0.050
	Fluoranthene	mg/kg	-	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.060 *	<0.050 *	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.070 *	<0.050
	Fluorene	mg/kg	-	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	0.188	0.902	0.071	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.20 *	<0.050
	Indeno(1,2,3-c,d)pyrene	mg/kg	1	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.080 *	<0.050	<0.050	<0.050
	2-Methylnaphthalene	mg/kg	-	0.076	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	0.61	14.3	0.847	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	4.94	<0.050
	Naphthalene	mg/kg	5	<0.080 *	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.30 *	3.05	<0.20 *	<0.050	<0.050	<0.050	<0.050	0.211	<0.050 *	<0.050	6.51	<0.050
	Phenanthrene	mg/kg	5	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.20 *	1.15	0.077	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050 *	<0.050	0.269	<0.050
	Pyrene	mg/kg	10	0.215	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	0.949	1.35	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.483	<0.050	0.563	<0.050

* indicates that the result is qualified
- indicates no data

CSR - PL = Yukon Government (YG). 2002. Contaminated Sites Regulation – Yukon Environment Act Schedules 1 and 2 for Park Land Use [O.I.C. 2002/171]

CSR-PL exeedences are highlighted and underlined

Table 64. 2013 metals soil analytical results compared to standards, Mt. Nansen, YT

	Sample ID	BH-M-13-01	BH-M-13-01	BH-M-13-01	BH-M-13-02	BH-M-13-02	BH-M-13-04	BH-M-13-04	BH-M-13-04	BH-M-13-05	BH-M-13-05	BH-M-13-05	BH-M-13-05	BH-M-13-05	BH-M-13-05	BH-M-13-07	BH-M-13-07	BH-M-13-07	BH-M-13-07	BH-M-13-08	BH-M-13-08	BH-M-13-08	BH-M-13-08
	Depth (mbgs)	1.1-1.5	1.6-2.0	2.1-2.5	1.6-2.0	3.1-3.5	0.0-0.5	0.0-0.5	1.1-1.5	0.0-0.5	0.6-1.0	1.1-1.5	1.6-2.0	2.1-2.5	3.1-3.5	0.0-0.5	0.6-1.0	1.1-1.5	2.6-3.0	0.0-0.5	2.6-3.0	3.1-3.5	3.6-4.0
	Date Sampled	09/10/2013	09/10/2013	09/10/2013	09/09/2013	09/09/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013
Group	**Analyte**	**Units**	**CSR-PL**	**HWHRM**																			
Physical	Moisture	%	-	-	13.2	11.2	11.8	-	13.5	-	7.1	13.9	7.73	6	4.53	6.48	-	-	11.9	15.2	15.8	-	20	14.9	8.05	15
	pH (1:2 soil:water)	pH	-	-	7.61	7.95	7.83	-	8.61	7.67	7.74	7.61	7.44	7.82	7.82	7.89	7.94	5.81	7.91	8.29	8.34	8.09	7.71	7.74	7.66	7.64
Metals	Antimony (Sb)	mg/kg	20	-	36.8	30.9	67	-	4.22	-	558	125	135	146	94	28.3	21.1	6.76	107	3.35	0.71	12.8	128	1730	165	131
	Arsenic (As)	mg/kg	20	-	502	355	1190	20.1	56.2	-	9350	2570	1450	1730	1480	423	443	93.3	1050	71.7	27.2	187	1840	80700	16400	8770
	Barium (Ba)	mg/kg	500	-	166	194	234	-	98.5	-	106	141	169	135	131	120	136	150	154	60.6	47.3	53.1	218	116	80.5	141
	Beryllium (Be)	mg/kg	4	-	0.33	0.36	0.41	-	0.39	-	0.43	0.49	0.53	0.43	0.49	0.39	0.39	0.3	0.38	<0.20	<0.20	0.26	0.52	0.34	<0.20	0.41
	Cadmium (Cd)	mg/kg	1.5	-	2.03	1.84	4.04	-	0.269	-	41.7	26.2	10.5	11.4	10.1	3.55	5.1	0.266	11.8	0.176	0.082	0.755	9.54	24.3	2.49	4.04
	Chromium (Cr)	mg/kg	60	-	16.4	14.6	21.3	-	16.3	-	13.2	19	11.1	10.5	11.9	10.3	15.8	16.9	31.2	10.3	9.9	13.3	17	2.64	1.7	2.4
	Cobalt (Co)	mg/kg	50	-	10.9	12	15.9	-	10.1	-	11.4	16.5	17.3	11	13.1	11.1	11.5	7.91	8.28	3.86	3.17	6.62	10.2	0.99	0.66	1.05
	Copper (Cu)	mg/kg	90	-	74.6	80.3	108	-	30	-	326	159	52.4	72.4	80	36.1	38.4	21.3	94.4	8.8	5.31	21.4	499	383	38.6	32.7
	Lead (Pb)	mg/kg	100	-	203	132	407	-	11.8	-	4250	524	1980	1310	585	139	210	9.79	658	10.6	4.2	35.4	791	9340	1550	2050
	Mercury (Hg)	mg/kg	15	-	<0.050	<0.050	0.074	-	0.058	-	0.177	0.083	0.136	0.082	0.062	<0.050	<0.050	<0.050	0.083	<0.050	<0.050	<0.050	0.164	0.876	0.199	0.144
	Molybdenum (Mo)	mg/kg	10	-	1.03	<0.50	<0.50	-	0.65	-	1.11	1.1	0.94	1.62	1.14	0.82	1.07	0.53	2.22	<0.50	<0.50	<0.50	1.67	0.97	1.3	0.72
	Nickel (Ni)	mg/kg	100	-	9.6	8.67	11.7	-	8.1	-	10.9	12.1	21	8.16	8.73	7.35	11.9	9.01	16.9	6.93	6.03	8.58	13.2	1.01	0.73	0.94
	Selenium (Se)	mg/kg	3	-	0.32	0.32	0.42	-	0.27	-	1.15	0.61	0.57	0.39	0.36	0.27	0.48	0.33	0.61	<0.20	<0.20	0.29	0.55	2.25	0.9	0.91
	Silver (Ag)	mg/kg	20	-	3.8	2.17	6.41	-	0.39	-	64	5.11	9.84	11.9	9.37	6.53	7.65	0.44	17.3	0.13	<0.10	0.59	14.2	53.4	10.9	9.52
	Thallium (Tl)	mg/kg	-	-	0.375	0.326	0.401	-	0.362	-	0.942	0.64	0.539	0.366	0.345	0.279	0.303	0.24	0.524	0.075	0.052	0.253	0.688	7.39	1.74	5.21
	Tin (Sn)	mg/kg	50	-	<2.0	<2.0	<2.0	-	<2.0	-	4.7	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
	Uranium (U)	mg/kg	-	-	0.398	0.391	0.448	-	0.862	-	0.773	1.24	0.538	0.86	0.541	0.443	0.525	0.617	0.711	0.685	0.384	0.586	0.944	3.33	0.457	0.437
	Vanadium (V)	mg/kg	200	-	73.8	85.8	110	-	85.4	-	48.7	63.1	45.2	45.7	43.3	49.8	57	57.9	52.8	25.6	22.2	52.1	56.9	20.1	12.1	15.2
	Zinc (Zn)	mg/kg	150	-	222	180	326	-	95.7	-	2440	1180	843	818	731	324	234	61.6	853	40.4	23.6	92.7	781	677	131	236
	Chromium, Trivalent	mg/kg	60	-	16.4	-	-	-	16.2	-	13.2	18.7	10.9	10.3	11.8	10.2	-	-	30.8	10.3	9.9	-	17	2.64	1.67	2.4
	Hexavalent Chromium	mg/kg	60	-	<0.10	-	-	-	<0.10	-	<0.10	0.23	0.1	0.18	0.13	<0.10	-	-	0.33	<0.10	<0.10	-	<0.10	<0.10	<0.10	<0.10
Leachable Metals	1st Preliminary PH	pH	-	-	8.65	-	-	-	-	-	8.94	-	-	-	9.3	-	-	-	9.37	9.18	-	-	-	8.26	8.22	-
	2nd Preliminary PH	pH	-	-	1.61	-	-	-	-	-	1.69	-	-	-	1.67	-	-	-	1.61	1.61	-	-	-	1.61	1.61	-
	Final pH	pH	-	-	5.08	-	-	-	-	-	5.22	-	-	-	5.42	-	-	-	5.26	4.98	-	-	-	5.03	4.94	-
	Extraction Solution Initial pH	pH	-	-	4.94	-	-	-	-	-	4.94	-	-	-	4.92	-	-	-	4.94	4.92	-	-	-	4.93	4.92	-
	Aluminum (Al)	mg/L	-	-	-	-	-	-	-	*0.0181*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Antimony (Sb)	mg/L	-	-	<1.0	-	-	-	-	*0.905*	<1.0	-	-	-	<1.0	-	-	-	<1.0	<1.0	-	-	-	<1.0	<1.0	-
	Arsenic (As)	mg/L	-	2.5	<1.0	-	-	-	-	*0.375*	<1.0	-	-	-	<1.0	-	-	-	<1.0	<1.0	-	-	-	**6.1**	**5**	-
	Barium (Ba)	mg/L	-	100	<2.5	-	-	-	-	*0.0328*	<2.5	-	-	-	<2.5	-	-	-	<2.5	<2.5	-	-	-	<2.5	<2.5	-
	Beryllium (Be)	mg/L	-	-	<0.025	-	-	-	-	*< 0.00002*	<0.025	-	-	-	<0.025	-	-	-	<0.025	<0.025	-	-	-	<0.025	<0.025	-
	Bismuth (Bi)	mg/L	-	-	-	-	-	-	-	*< 0.00001*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Boron (B)	mg/L	-	500	<0.50	-	-	-	-	*0.0168*	<0.50	-	-	-	<0.50	-	-	-	<0.50	<0.50	-	-	-	<0.50	<0.50	-
	Cadmium (Cd)	mg/L	-	0.5	<0.050	-	-	-	-	*0.00144*	0.341	-	-	-	0.084	-	-	-	0.173	<0.050	-	-	-	<0.050	<0.050	-
	Calcium (Ca)	mg/L	-	-	77.6	-	-	-	-	*52.2*	174	-	-	-	404	-	-	-	265	52.6	-	-	-	81.8	42.1	-
	Chromium (Cr)	mg/L	-	5	<0.25	-	-	-	-	*< 0.0005*	<0.25	-	-	-	<0.25	-	-	-	<0.25	<0.25	-	-	-	<0.25	<0.25	-
	Cobalt (Co)	mg/L	-	-	<0.050	-	-	-	-	*0.000113*	<0.050	-	-	-	0.209	-	-	-	<0.050	<0.050	-	-	-	<0.050	<0.050	-

Table 64. 2013 metals soil analytical results compared to standards, Mt. Nansen, YT

	Sample ID	TP-M-13-04	TP-M-13-04	TP-M-13-04	TP-M-13-04	TP-M-13-05	BH-KZ-13-02	BH-KZ-13-02	BH-KZ-13-02	BH-KZ-13-01	BH-KZ-13-01	BH-KZ-13-01	BH-KZ-13-01	BH-KZ-13-01	TP-SP-13-03	TP-SP-13-04	TP-SP-13-05	TP-SP-13-06	TP-R-13-01	TP-R-13-02	TP-R-13-03
	Depth (mbgs)	0.0-0.5	2.1-2.5	3.1-3.5	4.6-5.0	0.6-1.0	0.0-0.5	1.1-1.5	2.1-2.5	0.0-0.5	0.6-1.0	1.1-1.5	2.1-2.5	3.1-3.5	0.1-0.2	0.1-0.2	0.1-0.2	0.1-0.2	0.6-1.0	0.0-0.5	0.6-1.0
	Date Sampled	9/13/2013	9/13/2013	9/13/2013	9/13/2013	9/13/2013	09/10/2013	09/10/2013	09/10/2013	09/09/2013	09/09/2013	09/09/2013	09/09/2013	09/09/2013	09/11/2013	09/11/2013	09/11/2013	09/11/2013	09/12/2013	09/12/2013	09/12/2013
Group	Analyte	Units	CSR-PL	HWHRM																	
Physical	Moisture	%	-	-	-	17.7	-	-	-	7.23	5.28	-	4.16	12.3	-	-	-	-	-	-	-	-
	pH (1:2 soil:water)	pH	-	-	7.82	7.05	6.2	6.05	7.86	7.22	6.1	7.86	7.08	5.71	6.6	-	-	8.26	7.72	8.58	5.86	7.43	7.83	7.82
Metals	Antimony (Sb)	mg/kg	20	-	-	20.9	40.6	19.7	-	33.9	5.45	2.75	25.9	2.61	4.58	-	-	9.17	1.69	3.91	0.29	-	-	-
	Arsenic (As)	mg/kg	20	-	-	380	454	203	-	525	83.9	13.2	276	98.7	98.2	139	147	104	9.89	31.7	3.56	-	-	-
	Barium (Ba)	mg/kg	500	-	-	144	125	110	-	86.3	200	105	166	385	202	-	-	366	306	460	43	-	-	-
	Beryllium (Be)	mg/kg	4	-	-	0.46	0.43	0.27	-	0.27	0.41	0.35	0.38	0.66	0.41	-	-	0.44	0.47	0.8	<0.20	-	-	-
	Cadmium (Cd)	mg/kg	1.5	-	-	1.95	4.75	1.23	-	0.857	0.25	0.094	4.17	0.137	0.264	-	-	0.306	0.108	0.358	<0.050	-	-	-
	Chromium (Cr)	mg/kg	60	-	-	18.4	14.6	16	-	8.77	8.28	4.94	28.8	29	8.98	-	-	24.5	8.48	82	8.71	-	-	-
	Cobalt (Co)	mg/kg	50	-	-	11	8.69	7.02	-	4.26	5.37	7.33	6.47	7.55	7.08	-	-	19.5	14.7	26.9	3.52	-	-	-
	Copper (Cu)	mg/kg	90	-	-	33.9	31.7	22.6	-	18.9	9.81	8.2	70.9	21.4	36.6	-	-	49.1	49	25.8	8.54	-	-	-
	Lead (Pb)	mg/kg	100	-	-	103	208	137	-	270	27.2	5.64	231	15.6	16.5	-	-	56.1	2.89	16.7	1.46	-	-	-
	Mercury (Hg)	mg/kg	15	-	-	0.08	0.074	0.054	-	<0.050	<0.050	<0.050	0.071	<0.050	<0.050	-	-	<0.050	0.064	<0.050	<0.050	-	-	-
	Molybdenum (Mo)	mg/kg	10	-	-	0.7	0.71	<0.50	-	0.57	<0.50	<0.50	5.13	0.65	2.62	-	-	<0.50	<0.50	<0.50	<0.50	-	-	-
	Nickel (Ni)	mg/kg	100	-	-	11.1	9.63	9.69	-	6.7	5.6	4.2	11.2	16.4	6.53	-	-	10.7	4.9	40.6	3.31	-	-	-
	Selenium (Se)	mg/kg	3	-	-	0.56	0.47	0.49	-	<0.20	<0.20	<0.20	<0.20	0.25	<0.20	-	-	0.35	<0.20	<0.20	<0.20	-	-	-
	Silver (Ag)	mg/kg	20	-	-	1.12	2.07	1.05	-	2.31	0.2	<0.10	2.35	0.16	0.12	-	-	1.49	0.1	0.36	0.11	-	-	-
	Thallium (Tl)	mg/kg	-	-	-	0.45	0.387	0.262	-	0.144	0.098	0.053	0.235	0.172	0.155	-	-	0.425	0.295	0.32	<0.050	-	-	-
	Tin (Sn)	mg/kg	50	-	-	<2.0	<2.0	<2.0	-	<2.0	<2.0	<2.0	5.2	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	<2.0	-	-	-
	Uranium (U)	mg/kg	-	-	-	0.804	0.743	1.45	-	0.405	0.32	0.18	0.579	0.808	0.4	-	-	0.321	0.457	0.272	0.156	-	-	-
	Vanadium (V)	mg/kg	200	-	-	64.7	55.8	39.5	-	25.2	26.7	25.1	39.9	57.8	28	-	-	131	97.1	127	36	-	-	-
	Zinc (Zn)	mg/kg	150	-	-	159	301	117	-	170	29.1	23.9	307	59.7	46.8	-	-	117	97.1	110	16.7	-	-	-
	Chromium, Trivalent	mg/kg	60	-	-	18.4	-	-	-	8.58	-	-	28.7	28.8	-	-	-	-	-	-	-	-	-	-
	Hexavalent Chromium	mg/kg	60	-	-	<0.10	-	-	-	0.19	-	-	0.13	0.23	-	-	-	-	-	-	-	-	-	-
Leachable Metals	1st Preliminary PH	pH	-	-	-	-	-	-	-	8.08	-	-	7.28	-	-	-	-	-	-	-	-	-	-	-
	2nd Preliminary PH	pH	-	-	-	-	-	-	-	1.58	-	-	1.58	-	-	-	-	-	-	-	-	-	-	-
	Final pH	pH	-	-	-	-	-	-	-	5.03	-	-	4.95	-	-	-	-	-	-	-	-	-	-	-
	Extraction Solution Initial pH	pH	-	-	-	-	-	-	-	4.94	-	-	4.92	-	-	-	-	-	-	-	-	-	-	-
	Aluminum (Al)	mg/L	-	-	*0.0343*	-	-	-	*0.105*	-	-	-	-	-	-	-	-	-	-	-	-	*0.0440*	*0.0340*	*0.0362*
	Antimony (Sb)	mg/L	-	-	*0.110*	-	-	-	*0.0013*	<1.0	-	-	<1.0	-	-	-	-	-	-	-	-	*0.0065*	*0.0107*	*0.0026*
	Arsenic (As)	mg/L	-	2.5	*0.131*	-	-	-	*0.0021*	<1.0	-	-	<1.0	-	-	-	-	-	-	-	-	*0.0092*	*0.0215*	*0.0031*
	Barium (Ba)	mg/L	-	100	*0.0150*	-	-	-	*0.0401*	<2.5	-	-	<2.5	-	-	-	-	-	-	-	-	*0.0586*	*0.0188*	*0.0152*
	Beryllium (Be)	mg/L	-	-	*< 0.00002*	-	-	-	*< 0.00002*	<0.025	-	-	<0.025	-	-	-	-	-	-	-	-	*< 0.00002*	*< 0.00002*	*< 0.00002*
	Bismuth (Bi)	mg/L	-	-	*< 0.00001*	-	-	-	*< 0.00001*	-	-	-	-	-	-	-	-	-	-	-	-	*0.00002*	*< 0.00001*	*< 0.00001*
	Boron (B)	mg/L	-	500	*0.0172*	-	-	-	*0.0073*	<0.50	-	-	<0.50	-	-	-	-	-	-	-	-	*0.0048*	*0.0154*	*0.0063*
	Cadmium (Cd)	mg/L	-	0.5	*0.000294*	-	-	-	*0.000003*	<0.050	-	-	<0.050	-	-	-	-	-	-	-	-	*0.000147*	*0.000098*	*0.000286*
	Calcium (Ca)	mg/L	-	-	*29.8*	-	-	-	*8.73*	30.6	-	-	41.2	-	-	-	-	-	-	-	-	*25.6*	*39.4*	*42.7*
	Chromium (Cr)	mg/L	-	5	*< 0.0005*	-	-	-	*< 0.0005*	<0.25	-	-	<0.25	-	-	-	-	-	-	-	-	*< 0.0005*	*< 0.0005*	*< 0.0005*
	Cobalt (Co)	mg/L	-	-	*0.000070*	-	-	-	*0.000078*	<0.050	-	-	<0.050	-	-	-	-	-	-	-	-	*0.000084*	*0.000135*	*0.000087*

Table 64. 2013 metals soil analytical results compared to standards, Mt. Nansen, YT

	Sample ID	BH-M-13-01	BH-M-13-01	BH-M-13-01	BH-M-13-02	BH-M-13-02	BH-M-13-04	BH-M-13-04	BH-M-13-04	BH-M-13-05	BH-M-13-05	BH-M-13-05	BH-M-13-05	BH-M-13-05	BH-M-13-05	BH-M-13-07	BH-M-13-07	BH-M-13-07	BH-M-13-07	BH-M-13-08	BH-M-13-08	BH-M-13-08	BH-M-13-08
	Depth (mbgs)	1.1-1.5	1.6-2.0	2.1-2.5	1.6-2.0	3.1-3.5	0.0-0.5	0.0-0.5	1.1-1.5	0.0-0.5	0.6-1.0	1.1-1.5	1.6-2.0	2.1-2.5	3.1-3.5	0.0-0.5	0.6-1.0	1.1-1.5	2.6-3.0	0.0-0.5	2.6-3.0	3.1-3.5	3.6-4.0
	Date Sampled	09/10/2013	09/10/2013	09/10/2013	09/09/2013	09/09/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013
Group	Analyte	Units	CSR-PL	HWHRM																					
	Copper (Cu)	mg/L	-	-	0.168	-	-	-	-	*0.0065*	1.23	-	-	-	<0.050	-	-	-	0.084	<0.050	-	-	-	0.278	<0.050	-
	Iron (Fe)	mg/L	-	-	1	-	-	-	-	*0.021*	0.34	-	-	-	<0.15	-	-	-	2.91	23.4	-	-	-	0.58	0.64	-
	Lead (Pb)	mg/L	-	5	<0.25	-	-	-	-	*0.00516*	**6.22**	-	-	-	0.27	-	-	-	2.67	<0.25	-	-	-	<0.25	<0.25	-
	Lithium (Li)	mg/L	-	-	-	-	-	-	-	*0.004*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Magnesium (Mg)	mg/L	-	-	14	-	-	-	-	*14.7*	19.5	-	-	-	13.8	-	-	-	7.41	4.03	-	-	-	18.5	12.4	-
	Manganese (Mn)	mg/L	-	-	-	-	-	-	-	*0.0189*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mercury (Hg)	mg/L	-	0.1	<0.0010	-	-	-	-	*0.02*	<0.0010	-	-	-	<0.0010	-	-	-	<0.0010	<0.0010	-	-	-	<0.0010	<0.0010	-
	Molybdenum (Mo)	mg/L	-	-	-	-	-	-	-	*0.00266*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Nickel (Ni)	mg/L	-	-	<0.25	-	-	-	-	*0.0004*	<0.25	-	-	-	<0.25	-	-	-	<0.25	<0.25	-	-	-	<0.25	<0.25	-
	Phosphorus (P)	mg/L	-	-	-	-	-	-	-	*0.014*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Potassium (K)	mg/L	-	-	-	-	-	-	-	*4.21*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Selenium (Se)	mg/L	-	1	<1.0	-	-	-	-	*0.00041*	<1.0	-	-	-	<1.0	-	-	-	<1.0	<1.0	-	-	-	<1.0	<1.0	-
	Silicon (Si)	mg/L	-	-	-	-	-	-	-	*2.56*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Silver (Ag)	mg/L	-	5	<0.050	-	-	-	-	*0.00036*	<0.050	-	-	-	<0.050	-	-	-	<0.050	<0.050	-	-	-	<0.050	<0.050	-
	Sodium (Na)	mg/L	-	-	-	-	-	-	-	*1.32*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Strontium (Sr)	mg/L	-	-	-	-	-	-	-	*0.150*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sulphur (S)	mg/L	-	-	-	-	-	-	-	*47.8*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Thallium (Tl)	mg/L	-	-	<1.0	-	-	-	-	*0.00021*	<1.0	-	-	-	<1.0	-	-	-	<1.0	<1.0	-	-	-	<1.0	<1.0	-
	Tin (Sn)	mg/L	-	-	-	-	-	-	-	*0.00087*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Titanium (Ti)	mg/L	-	-	-	-	-	-	-	*0.0003*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Uranium (U)	mg/L	-	-	-	-	-	-	-	*0.000411*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Vanadium (V)	mg/L	-	-	<0.15	-	-	-	-	*0.00029*	<0.15	-	-	-	<0.15	-	-	-	<0.15	<0.15	-	-	-	<0.15	<0.15	-
	Zinc (Zn)	mg/L	-	-	1.05	-	-	-	-	*0.038*	19.8	-	-	-	3.21	-	-	-	4.69	<0.50	-	-	-	1.75	0.8	-
	Zirconium (Zr)	mg/L	-	-	-	-	-	-	-	*0.00014*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* indicates that the result is qualified

\- indicates no data

CSR - PL = Yukon Government (YG). 2002. Contaminated Sites Regulation – Yukon Environment Act Schedules 1 and 2 for Park Land Use [O.I.C. 2002/171]

CSR-PL exeedences are highlighted and underlined

HWHRM = Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (SOR/2005-149)

HWHRM exceedences are highlighted and underlined

Leachable metals through TCLP Extraction Procedure or, *if italisized, through the SFE Method*

Table 64. 2013 metals soil analytical results compared to standards, Mt. Nansen, YT

	Sample ID	TP-M-13-04	TP-M-13-04	TP-M-13-04	TP-M-13-04	TP-M-13-05	BH-KZ-13-02	BH-KZ-13-02	BH-KZ-13-02	BH-KZ-13-01	BH-KZ-13-01	BH-KZ-13-01	BH-KZ-13-01	BH-KZ-13-01	TP-SP-13-03	TP-SP-13-04	TP-SP-13-05	TP-SP-13-06	TP-R-13-01	TP-R-13-02	TP-R-13-03
	Depth (mbgs)	0.0-0.5	2.1-2.5	3.1-3.5	4.6-5.0	0.6-1.0	0.0-0.5	1.1-1.5	2.1-2.5	0.0-0.5	0.6-1.0	1.1-1.5	2.1-2.5	3.1-3.5	0.1-0.2	0.1-0.2	0.1-0.2	0.1-0.2	0.6-1.0	0.0-0.5	0.6-1.0
	Date Sampled	9/13/2013	9/13/2013	9/13/2013	9/13/2013	9/13/2013	09/10/2013	09/10/2013	09/10/2013	09/09/2013	09/09/2013	09/09/2013	09/09/2013	09/09/2013	09/11/2013	09/11/2013	09/11/2013	09/11/2013	09/12/2013	09/12/2013	09/12/2013
Group	Analyte	Units	CSR-PL	HWHRM																	
	Copper (Cu)	mg/L	-	-	*0.0016*	-	-	-	*0.0014*	<0.050	-	-	<0.050	-	-	-	-	-	-	-	*0.0033*	*0.0010*	*0.0008*
	Iron (Fe)	mg/L	-	-	*0.020*	-	-	-	*0.095*	0.41	-	-	4.01	-	-	-	-	-	-	-	*0.101*	*0.022*	*0.016*
	Lead (Pb)	mg/L	-	5	*0.00105*	-	-	-	*0.00013*	<0.25	-	-	<0.25	-	-	-	-	-	-	-	*0.00202*	*0.00045*	*0.00032*
	Lithium (Li)	mg/L	-	-	*< 0.001*	-	-	-	*< 0.001*	-	-	-	-	-	-	-	-	-	-	-	*0.001*	*< 0.001*	*0.002*
	Magnesium (Mg)	mg/L	-	-	*5.90*	-	-	-	*1.68*	4.72	-	-	5.07	-	-	-	-	-	-	-	*5.25*	*6.25*	*6.10*
	Manganese (Mn)	mg/L	-	-	*0.0024*	-	-	-	*0.0105*	-	-	-	-	-	-	-	-	-	-	-	*0.0262*	*0.0030*	*0.0054*
	Mercury (Hg)	mg/L	-	0.1	*< 0.01*	-	-	-	*< 0.01*	<0.0010	-	-	<0.0010	-	-	-	-	-	-	-	*< 0.01*	*< 0.01*	*< 0.01*
	Molybdenum (Mo)	mg/L	-	-	*0.00120*	-	-	-	*0.00035*	-	-	-	-	-	-	-	-	-	-	-	*0.00008*	*0.00023*	*0.00044*
	Nickel (Ni)	mg/L	-	-	*0.0003*	-	-	-	*0.0004*	<0.25	-	-	<0.25	-	-	-	-	-	-	-	*0.0007*	*0.0002*	*0.0002*
	Phosphorus (P)	mg/L	-	-	*0.014*	-	-	-	*< 0.009*	-	-	-	-	-	-	-	-	-	-	-	*0.011*	*0.026*	*< 0.009*
	Potassium (K)	mg/L	-	-	*3.29*	-	-	-	*1.09*	-	-	-	-	-	-	-	-	-	-	-	*4.32*	*3.67*	*3.14*
	Selenium (Se)	mg/L	-	1	*0.00041*	-	-	-	*0.00020*	<1.0	-	-	<1.0	-	-	-	-	-	-	-	*0.00014*	*0.00009*	*0.00009*
	Silicon (Si)	mg/L	-	-	*2.16*	-	-	-	*2.01*	-	-	-	-	-	-	-	-	-	-	-	*3.58*	*2.46*	*2.38*
	Silver (Ag)	mg/L	-	5	*< 0.00001*	-	-	-	*< 0.00001*	<0.050	-	-	<0.050	-	-	-	-	-	-	-	*0.00001*	*< 0.00001*	*< 0.00001*
	Sodium (Na)	mg/L	-	-	*0.64*	-	-	-	*0.80*	-	-	-	-	-	-	-	-	-	-	-	*1.77*	*1.09*	*2.21*
	Strontium (Sr)	mg/L	-	-	*0.0669*	-	-	-	*0.0308*	-	-	-	-	-	-	-	-	-	-	-	*0.0721*	*0.0865*	*0.150*
	Sulphur (S)	mg/L	-	-	*21.1*	-	-	-	*3.57*	-	-	-	-	-	-	-	-	-	-	-	*28.6*	*28.8*	*32.5*
	Thallium (Tl)	mg/L	-	-	*0.00004*	-	-	-	*< 0.00002*	<1.0	-	-	<1.0	-	-	-	-	-	-	-	*0.00004*	*< 0.00002*	*< 0.00002*
	Tin (Sn)	mg/L	-	-	*< 0.00001*	-	-	-	*< 0.00001*	-	-	-	-	-	-	-	-	-	-	-	*< 0.00001*	*< 0.00001*	*< 0.00001*
	Titanium (Ti)	mg/L	-	-	*0.0004*	-	-	-	*0.0025*	-	-	-	-	-	-	-	-	-	-	-	*0.0013*	*0.0004*	*0.0002*
	Uranium (U)	mg/L	-	-	*0.000156*	-	-	-	*0.000022*	-	-	-	-	-	-	-	-	-	-	-	*0.000008*	*0.000142*	*0.000159*
	Vanadium (V)	mg/L	-	-	*0.00032*	-	-	-	*0.00062*	<0.15	-	-	<0.15	-	-	-	-	-	-	-	*0.00027*	*0.00017*	*0.00012*
	Zinc (Zn)	mg/L	-	-	*0.006*	-	-	-	*0.001*	1.62	-	-	1.15	-	-	-	-	-	-	-	*0.006*	*0.003*	*0.004*
	Zirconium (Zr)	mg/L	-	-	*0.00005*	-	-	-	*0.00003*	-	-	-	-	-	-	-	-	-	-	-	*0.00007*	*0.00003*	*0.00002*

* indicates that the result is qualified

\- indicates no data

CSR - PL = Yukon Government (YG). 2002. Contaminated Sites Regulation – Yukon Environment Act Schedules 1 and 2 for Park Land Use [O.I.C. 2002/171]

CSR-PL exeedences are highlighted and underlined

HWHRM = Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (SOR/2005-149)

HWHRM exceedences are highlighted and underlined

Leachable metals through TCLP Extraction Procedure or, *if italisized, through the SFE Method*

Table 65. 2013 soil other parameter analytical results compared to standards, Mt. Nansen, YT

	Sample ID	BH-M-13-01	BH-M-13-02	BH-M-13-05	BH-M-13-04	BH-M-13-04	BH-M-13-04	BH-M-13-05	BH-M-13-07	BH-M-13-07	BH-M-13-07	BH-M-13-08	BH-M-13-08	BH-M-13-08	BH-M-13-08
	Depth (mbgs)	1.1-1.5	3.1-3.5	0.0-0.5	0.0-0.5	0.0-0.5	1.1-1.5	1.1-1.5	0.0-0.5	0.6-1.0	1.1-1.5	0.0-0.5	2.6-3.0	3.1-3.5	3.6-4.0
	Date Sampled	09/10/2013	09/09/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013
Group	Analyte	Units	CSR SOIL PL													
Physical	Moisture	%	-	13.2	13.5	7.73	-	7.1	13.9	4.53	11.9	15.2	15.8	20	14.9	8.05	15
	pH (1:2 soil:water)	pH	-	7.61	8.61	7.44	7.67	7.74	7.61	7.82	7.91	8.29	8.34	7.71	7.74	7.66	7.64
Cyanide	Cyanide, Weak Acid Diss	mg/kg	-	-	-	-	-	<0.050	<0.050	-	-	<0.050	-	-	-	<0.050	-
	Cyanide, Total	mg/kg	50	-	-	-	-	29.6	<0.050	-	-	<0.050	-	-	-	<0.050	-
Carbon	Total Organic Carbon	%	-	0.97	<0.10	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen	Available Ammonium-N	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total Kjeldahl Nitrogen	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Nitrate+Nitrite-N	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Nitrate-N	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Nitrite-N	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Volatile Organic Compounds	Volatile Hydrocarbons (VH6-10)	mg/kg	-	<100	<100	<100	-	<100	<100	<100	320	660	<100	<100	<100	<100	<100
	VPH (C6-C10)	mg/kg	200	<100	<100	<100	-	<100	<100	<100	320	660	<100	<100	<100	<100	<100
	Benzene	mg/kg	0.04	<0.040	<0.040	<0.040	-	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
	Bromodichloromethane	mg/kg	-	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	Bromoform	mg/kg	-	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	Carbon Tetrachloride	mg/kg	5	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	Chlorobenzene	mg/kg	1	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	Dibromochloromethane	mg/kg	-	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	Chloroethane	mg/kg	-	<0.10	<0.10	-	-	-	-	-	-	-	-	-	-	-	-
	Chloroform	mg/kg	5	<0.10	<0.10	-	-	-	-	-	-	-	-	-	-	-	-
	Chloromethane	mg/kg	-	<0.10	<0.10	-	-	-	-	-	-	-	-	-	-	-	-
	1,2-Dichlorobenzene	mg/kg	1	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	1,3-Dichlorobenzene	mg/kg	1	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	1,4-Dichlorobenzene	mg/kg	1	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	1,1-Dichloroethane	mg/kg	5	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	1,2-Dichloroethane	mg/kg	5	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	1,1-Dichloroethylene	mg/kg	5	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	cis-1,2-Dichloroethylene	mg/kg	5	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	trans-1,2-Dichloroethylene	mg/kg	5	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	Dichloromethane	mg/kg	5	<0.30	<0.30	-	-	-	-	-	-	-	-	-	-	-	-
	1,2-Dichloropropane	mg/kg	5	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	cis-1,3-Dichloropropylene	mg/kg	5	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	trans-1,3-Dichloropropylene	mg/kg	5	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	Ethylbenzene	mg/kg	1	<0.050	<0.050	<0.050	-	<0.050	<0.050	<0.050	<0.050	1.36	0.131	<0.050	<0.050	<0.050	<0.050
	Methyl t-butyl ether (MTBE)	mg/kg	-	<0.20	<0.20	<0.20	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
	Styrene	mg/kg	5	<0.050	<0.050	<0.050	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	1,1,1,2-Tetrachloroethane	mg/kg	-	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	1,1,2,2-Tetrachloroethane	mg/kg	-	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	Tetrachloroethylene	mg/kg	5	0.153	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	Toluene	mg/kg	1.5	<0.050	<0.050	<0.050	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	1,1,1-Trichloroethane	mg/kg	5	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	1,1,2-Trichloroethane	mg/kg	5	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	Trichloroethylene	mg/kg	0.15	0.015	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
	Trichlorofluoromethane	mg/kg	-	<0.10	<0.10	-	-	-	-	-	-	-	-	-	-	-	-

Table 65. 2013 soil other parameter analytical results compared to standards, Mt. Nansen, YT

	Sample ID	BH-M-13-01	BH-M-13-02	BH-M-13-05	BH-M-13-04	BH-M-13-04	BH-M-13-04	BH-M-13-05	BH-M-13-07	BH-M-13-07	BH-M-13-07	BH-M-13-08	BH-M-13-08	BH-M-13-08	BH-M-13-08
	Depth (mbgs)	1.1-1.5	3.1-3.5	0.0-0.5	0.0-0.5	0.0-0.5	1.1-1.5	1.1-1.5	0.0-0.5	0.6-1.0	1.1-1.5	0.0-0.5	2.6-3.0	3.1-3.5	3.6-4.0
	Date Sampled	09/10/2013	09/09/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013
Group	Analyte	Units	CSR SOIL PL													
	Vinyl Chloride	mg/kg	-	<0.10	<0.10	-	-	-	-	-	-	-	-	-	-	-
	ortho-Xylene	mg/kg	-	0.061	<0.050	<0.050	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	meta- & para-Xylene	mg/kg	-	0.124	<0.050	<0.050	-	<0.050	<0.050	<0.050	<0.060 *	1.47	0.139	<0.050	<0.050	<0.050	<0.050
	Xylenes	mg/kg	5	0.185	<0.075	<0.075	-	<0.075	<0.075	<0.075	<0.078	1.47	0.139	<0.075	<0.075	<0.075	<0.075
Glycols	Diethylene Glycol	mg/kg	-	<10	<10	-	-	-	-	-	-	-	-	-	-	-	-
	Ethylene Glycol	mg/kg	1500	<10	<10	-	-	-	-	-	-	-	-	-	-	-	-
	1,2-Propylene Glycol	mg/kg	-	<10	<10	-	-	-	-	-	-	-	-	-	-	-	-
Chlorinated Hydrocarbons	1,2-Dichlorobenzene	mg/kg	1	<0.010	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
	1,3-Dichlorobenzene	mg/kg	1	<0.010	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
	1,4-Dichlorobenzene	mg/kg	1	<0.010	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
	Hexachlorobenzene	mg/kg	2	<0.010	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
	Hexachlorobutadiene	mg/kg	-	<0.010	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
	Hexachlorocyclohexane (Total)	mg/kg	-	<0.30 *	<0.050	-	-	-	-	-	-	-	-	-	-	-	-
	Hexachloroethane	mg/kg	-	<0.010	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
	Pentachlorobenzene	mg/kg	2	<0.010	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,4-Tetrachlorobenzene	mg/kg	2	<0.010	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,5-Tetrachlorobenzene	mg/kg	2	<0.010	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,4,5-Tetrachlorobenzene	mg/kg	2	<0.010	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3-Trichlorobenzene	mg/kg	2	<0.020 *	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,4-Trichlorobenzene	mg/kg	2	<0.010	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
	1,3,5-Trichlorobenzene	mg/kg	2	<0.010	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
	2,4,5-Trichlorotoluene	mg/kg	-	<0.20 *	<0.010	-	-	-	-	-	-	-	-	-	-	-	-
Phenols	4-Chloro-3-methylphenol	mg/kg	-	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	2-Chlorophenol	mg/kg	0.5	<0.030 *	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	3-Chlorophenol	mg/kg	0.5	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	4-Chlorophenol	mg/kg	0.5	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	2,3-Dichlorophenol	mg/kg	0.5	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	2,4 & 2,5-Dichlorophenol	mg/kg	-	<0.050 *	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	2,6-Dichlorophenol	mg/kg	0.5	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	3,4-Dichlorophenol	mg/kg	0.5	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	3,5-Dichlorophenol	mg/kg	0.5	<0.060 *	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	2,4-Dimethylphenol	mg/kg	1	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	o-Cresol	mg/kg	1	<0.030 *	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	m-Cresol	mg/kg	1	<0.030 *	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	p-Cresol	mg/kg	1	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	Pentachlorophenol	mg/kg	0.15	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	Phenol	mg/kg	1	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,4,5-Tetrachlorophenol	mg/kg	0.5	<0.030 *	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,4,6-Tetrachlorophenol	mg/kg	0.5	<0.030 *	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,5,6-Tetrachlorophenol	mg/kg	0.5	<0.030 *	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,4-Trichlorophenol	mg/kg	0.5	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,5-Trichlorophenol	mg/kg	0.5	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,6-Trichlorophenol	mg/kg	0.5	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
	2,4,5-Trichlorophenol	mg/kg	0.5	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-

Table 65. 2013 soil other parameter analytical results compared to standards, Mt. Nansen, YT

	Sample ID	BH-M-13-01	BH-M-13-02	BH-M-13-05	BH-M-13-04	BH-M-13-04	BH-M-13-04	BH-M-13-05	BH-M-13-07	BH-M-13-07	BH-M-13-07	BH-M-13-08	BH-M-13-08	BH-M-13-08	BH-M-13-08
	Depth (mbgs)	1.1-1.5	3.1-3.5	0.0-0.5	0.0-0.5	0.0-0.5	1.1-1.5	1.1-1.5	0.0-0.5	0.6-1.0	1.1-1.5	0.0-0.5	2.6-3.0	3.1-3.5	3.6-4.0
	Date Sampled	09/10/2013	09/09/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013
Group	Analyte	Units	CSR SOIL PL													
	2,4,6-Trichlorophenol	mg/kg	0.5	<0.020	<0.020	-	-	-	-	-	-	-	-	-	-	-	-
PCBs	PCB-1016	mg/kg	-	<0.020	<0.020	-	-	-	-	<0.020	-	-	-	-	-	-	-
	PCB-1221	mg/kg	-	<0.020	<0.020	-	-	-	-	<0.020	-	-	-	-	-	-	-
	PCB-1232	mg/kg	-	<0.020	<0.020	-	-	-	-	<0.020	-	-	-	-	-	-	-
	PCB-1242	mg/kg	-	<0.020	<0.020	-	-	-	-	<0.020	-	-	-	-	-	-	-
	PCB-1248	mg/kg	-	<0.020	<0.020	-	-	-	-	<0.020	-	-	-	-	-	-	-
	PCB-1254	mg/kg	-	<0.020	<0.020	-	-	-	-	<0.020	-	-	-	-	-	-	-
	PCB-1260	mg/kg	-	<0.020	<0.020	-	-	-	-	<0.020	-	-	-	-	-	-	-
	PCB-1262	mg/kg	-	<0.020	<0.020	-	-	-	-	<0.020	-	-	-	-	-	-	-
	PCB-1268	mg/kg	-	<0.020	<0.020	-	-	-	-	<0.020	-	-	-	-	-	-	-
	Total Polychlorinated Biphenyls	mg/kg	5	<0.020	<0.020	-	-	-	-	<0.020	-	-	-	-	-	-	-
	2,3,7,8-TCDD	pg/g	-	0.97 *	<0.27 *	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,7,8-PeCDD	pg/g	-	3.21 *	<0.19 *	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,4,7,8-HxCDD	pg/g	-	2.40 *	<0.11 *	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,6,7,8-HxCDD	pg/g	-	4.44 *	<0.12 *	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,7,8,9-HxCDD	pg/g	-	4.00 *	<0.11 *	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,4,6,7,8-HpCDD	pg/g	-	26	<0.18 *	-	-	-	-	-	-	-	-	-	-	-	-
	OCDD	pg/g	-	36.9	<0.16 *	-	-	-	-	-	-	-	-	-	-	-	-
	Total-TCDD	pg/g	-	82.3	<0.27	-	-	-	-	-	-	-	-	-	-	-	-
	Total TCDD # Homologues		-	13	0	-	-	-	-	-	-	-	-	-	-	-	-
	Total-PeCDD	pg/g	-	84.1	<0.19	-	-	-	-	-	-	-	-	-	-	-	-
	Total PeCDD # Homologues		-	7	0	-	-	-	-	-	-	-	-	-	-	-	-
	Total-HxCDD	pg/g	-	75.9	<0.12	-	-	-	-	-	-	-	-	-	-	-	-
	Total HxCDD # Homologues		-	4	0	-	-	-	-	-	-	-	-	-	-	-	-
	Total-HpCDD	pg/g	-	60.7	<0.18	-	-	-	-	-	-	-	-	-	-	-	-
	Total HpCDD # Homologues		-	2	0	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,7,8-TCDF	pg/g	-	9.5	<0.21 *	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,7,8-PeCDF	pg/g	-	11.3	<0.12 *	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,4,7,8-PeCDF	pg/g	-	21	<0.11 *	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,4,7,8-HxCDF	pg/g	-	17.7	<0.10 *	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,6,7,8-HxCDF	pg/g	-	16.2	<0.095 *	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,7,8,9-HxCDF	pg/g	-	2.70 *	<0.13 *	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,4,6,7,8-HxCDF	pg/g	-	20.7	<0.094 *	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,4,6,7,8-HpCDF	pg/g	-	69.7	<0.11 *	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,4,7,8,9-HpCDF	pg/g	-	3.4 *	<0.17 *	-	-	-	-	-	-	-	-	-	-	-	-
	OCDF	pg/g	-	15.0 *	<0.24 *	-	-	-	-	-	-	-	-	-	-	-	-
	Total-TCDF	pg/g	-	370	<0.21	-	-	-	-	-	-	-	-	-	-	-	-
	Total TCDF # Homologues		-	19	0	-	-	-	-	-	-	-	-	-	-	-	-
	Total-PeCDF	pg/g	-	314	<0.12	-	-	-	-	-	-	-	-	-	-	-	-
	Total PeCDF # Homologues		-	12	0	-	-	-	-	-	-	-	-	-	-	-	-
	Total-HxCDF	pg/g	-	179	<0.13	-	-	-	-	-	-	-	-	-	-	-	-
	Total HxCDF # Homologues		-	9	0	-	-	-	-	-	-	-	-	-	-	-	-
	Total-HpCDF	pg/g	-	92.2	<0.17	-	-	-	-	-	-	-	-	-	-	-	-
	Total HpCDF # Homologues		-	4	0	-	-	-	-	-	-	-	-	-	-	-	-

Table 65. 2013 soil other parameter analytical results compared to standards, Mt. Nansen, YT

	Sample ID	BH-M-13-01	BH-M-13-02	BH-M-13-05	BH-M-13-04	BH-M-13-04	BH-M-13-04	BH-M-13-05	BH-M-13-07	BH-M-13-07	BH-M-13-07	BH-M-13-08	BH-M-13-08	BH-M-13-08	BH-M-13-08
	Depth (mbgs)	1.1-1.5	3.1-3.5	0.0-0.5	0.0-0.5	0.0-0.5	1.1-1.5	1.1-1.5	0.0-0.5	0.6-1.0	1.1-1.5	0.0-0.5	2.6-3.0	3.1-3.5	3.6-4.0
	Date Sampled	09/10/2013	09/09/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013	09/10/2013
Group	Analyte	Units	CSR SOIL PL													
	13C12-2,3,7,8-TCDD	%	-	88	56	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,7,8-PeCDD	%	-	82	49	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,4,7,8-HxCDD	%	-	100	83	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,6,7,8-HxCDD	%	-	92	70	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,4,6,7,8-HpCDD	%	-	84	64	-	-	-	-	-	-	-	-	-	-	-
	13C12-OCDD	%	-	81	53	-	-	-	-	-	-	-	-	-	-	-
	13C12-2,3,7,8-TCDF	%	-	88	59	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,7,8-PeCDF	%	-	82	52	-	-	-	-	-	-	-	-	-	-	-
	13C12-2,3,4,7,8-PeCDF	%	-	78	51	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,4,7,8-HxCDF	%	-	92	63	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,6,7,8-HxCDF	%	-	84	68	-	-	-	-	-	-	-	-	-	-	-
	13C12-2,3,4,6,7,8-HxCDF	%	-	85	72	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,7,8,9-HxCDF	%	-	95	66	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,4,6,7,8-HpCDF	%	-	81	66	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,4,7,8,9-HpCDF	%	-	87	60	-	-	-	-	-	-	-	-	-	-	-
	37Cl4-2,3,7,8-TCDD (Cleanup)	%	-	96	78	-	-	-	-	-	-	-	-	-	-	-
	Lower Bound PCDD/F TEQ	pg/g	-	17.7	0	-	-	-	-	-	-	-	-	-	-	-
	Mid Point PCDD/F TEQ	pg/g	-	19.6	0.299	-	-	-	-	-	-	-	-	-	-	-
	Higher Bound PCDD/F TEQ	pg/g	-	19.6	0.598	-	-	-	-	-	-	-	-	-	-	-
	Volume Nanopure Water	mL	-	-	-	-	750	-	-	-	-	-	-	-	-	-
	Sample Weight	g	-	-	-	-	250	-	-	-	-	-	-	-	-	-
Miscellaneous	Redox	mV	-	-	-	-	317	-	-	-	-	-	-	-	-	-
Parameters	Conductivity	uS/cm	-	-	-	-	389	-	-	-	-	-	-	-	-	-
	Total Acidity (to pH 8.3)	mg CaCO3/L	-	-	-	-	3.7	-	-	-	-	-	-	-	-	-
	Alkalinity	mg CaCO3/L	-	-	-	-	50.1	-	-	-	-	-	-	-	-	-
	Sulphate	mg/L	-	-	-	-	109	-	-	-	-	-	-	-	-	-
	Major Anions	meq/L	-	-	-	-	1.12	-	-	-	-	-	-	-	-	-
	Major Cations	meq/L	-	-	-	-	0.00	-	-	-	-	-	-	-	-	-
Ion Balance	Difference	meq/L	-	-	-	-	1.12	-	-	-	-	-	-	-	-	-
	Balance (%)	%	-	-	-	-	100.0%	-	-	-	-	-	-	-	-	-

* indicates that the result is qualified

- indicates no data

CSR - PL = Yukon Government (YG). 2002. Contaminated Sites Regulation – Yukon Environment Act Schedules 1 and 2 for Park Land Use [O.I.C. 2002/171]

CSR-PL exeedences are highlighted and underlined

Table 65. 2013 soil other parameter analytical results compared to standards, Mt. Nansen, YT

	Sample ID	TP-M-13-04	TP-M-13-04	TP-M-13-05	BH-KZ-13-02	BH-KZ-13-01	BH-KZ-13-01	TP-SP-13-03	TP-SP-13-04	TP-SP-13-05	TP-SP-13-06	TP-R-13-01	TP-R-13-02	TP-R-13-03
	Depth (mbgs)	0.0-0.5	2.1-2.5	0.6-1.0	0.0-0.5	0.0-0.5	0.6-1.0	0.1-0.2	0.1-0.2	0.1-0.2	0.1-0.2	0.6-1.0	0.0-0.5	0.6-1.0
	Date Sampled	9/13/2013	9/13/2013	09/12/2013	09/10/2013	09/09/2013	09/09/2013	09/11/2013	09/11/2013	09/11/2013	09/11/2013	09/12/2013	09/12/2013	09/12/2013
Group	Analyte	Units	CSR SOIL PL												
Physical	Moisture	%	-	-	17.7	-	7.23	4.16	12.3	-	-	-	-	-	-	-
	pH (1:2 soil:water)	pH	-	7.82	7.05	7.86	7.22	7.08	5.71	8.26	7.72	8.58	5.86	7.43	7.83	7.82
Cyanide	Cyanide, Weak Acid Diss	mg/kg	-	-	<0.050	-	<0.050	<0.10 *	<0.050	-	-	-	-	-	-	-
	Cyanide, Total	mg/kg	50	-	<0.050	-	<0.050	-	-	-	-	-	-	-	-	-
Carbon	Total Organic Carbon	%	-	-	-	-	-	-	-	0.15	<0.10	<0.10	2.5	-	-	-
Nitrogen	Available Ammonium-N	mg/kg	-	-	-	-	-	-	-	1.8	1.1	3.3	1.8	-	-	-
	Total Kjeldahl Nitrogen	%	-	-	-	-	-	-	-	<0.020	<0.020	<0.020	0.142	-	-	-
	Nitrate+Nitrite-N	mg/kg	-	-	-	-	-	-	-	<2.0	<2.0	<2.0	<4.0 *	-	-	-
	Nitrate-N	mg/kg	-	-	-	-	-	-	-	<2.0	<2.0	<2.0	<4.0 *	-	-	-
	Nitrite-N	mg/kg	-	-	-	-	-	-	-	<0.40	<0.40	<0.40	<0.80 *	-	-	-
Volatile Organic Compounds	Volatile Hydrocarbons (VH6-10)	mg/kg	-	-	<100	-	<100	1610	<100	-	-	-	-	-	-	-
	VPH (C6-C10)	mg/kg	200	-	<100	-	<100	1210	<100	-	-	-	-	-	-	-
	Benzene	mg/kg	0.04	-	<0.040	-	<0.040	≤0.40	<0.040	-	-	-	-	-	-	-
	Bromodichloromethane	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Bromoform	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Carbon Tetrachloride	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	Chlorobenzene	mg/kg	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	Dibromochloromethane	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Chloroethane	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Chloroform	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	Chloromethane	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2-Dichlorobenzene	mg/kg	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,3-Dichlorobenzene	mg/kg	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,4-Dichlorobenzene	mg/kg	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,1-Dichloroethane	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2-Dichloroethane	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,1-Dichloroethylene	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	cis-1,2-Dichloroethylene	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	trans-1,2-Dichloroethylene	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	Dichloromethane	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2-Dichloropropane	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	cis-1,3-Dichloropropylene	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	trans-1,3-Dichloropropylene	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ethylbenzene	mg/kg	1	-	<0.050	-	<0.050	7.19	<0.050	-	-	-	-	-	-	-
	Methyl t-butyl ether (MTBE)	mg/kg	-	-	<0.20	-	<0.20	<0.20	<0.20	-	-	-	-	-	-	-
	Styrene	mg/kg	5	-	<0.050	-	<0.050	0.12	<0.050	-	-	-	-	-	-	-
	1,1,1,2-Tetrachloroethane	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,1,2,2-Tetrachloroethane	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Tetrachloroethylene	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	Toluene	mg/kg	1.5	-	<0.050	-	<0.050	31.6	<0.050	-	-	-	-	-	-	-
	1,1,1-Trichloroethane	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,1,2-Trichloroethane	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	Trichloroethylene	mg/kg	0.15	-	-	-	-	-	-	-	-	-	-	-	-	-
	Trichlorofluoromethane	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 65. 2013 soil other parameter analytical results compared to standards, Mt. Nansen, YT

	Sample ID	TP-M-13-04	TP-M-13-04	TP-M-13-05	BH-KZ-13-02	BH-KZ-13-01	BH-KZ-13-01	TP-SP-13-03	TP-SP-13-04	TP-SP-13-05	TP-SP-13-06	TP-R-13-01	TP-R-13-02	TP-R-13-03
	Depth (mbgs)	0.0-0.5	2.1-2.5	0.6-1.0	0.0-0.5	0.0-0.5	0.6-1.0	0.1-0.2	0.1-0.2	0.1-0.2	0.1-0.2	0.6-1.0	0.0-0.5	0.6-1.0
	Date Sampled	9/13/2013	9/13/2013	09/12/2013	09/10/2013	09/09/2013	09/09/2013	09/11/2013	09/11/2013	09/11/2013	09/11/2013	09/12/2013	09/12/2013	09/12/2013
Group	Analyte	Units	CSR SOIL PL												
	Vinyl Chloride	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-
	ortho-Xylene	mg/kg	-	-	<0.050	-	<0.050	144	<0.050	-	-	-	-	-	-	-
	meta- & para-Xylene	mg/kg	-	-	<0.050	-	<0.050	215	<0.050	-	-	-	-	-	-	-
	Xylenes	mg/kg	5	-	<0.075	-	<0.075	359	<0.075	-	-	-	-	-	-	-
Glycols	Diethylene Glycol	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ethylene Glycol	mg/kg	1500	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2-Propylene Glycol	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorinated Hydrocarbons	1,2-Dichlorobenzene	mg/kg	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,3-Dichlorobenzene	mg/kg	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,4-Dichlorobenzene	mg/kg	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	Hexachlorobenzene	mg/kg	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	Hexachlorobutadiene	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Hexachlorocyclohexane (Total)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Hexachloroethane	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pentachlorobenzene	mg/kg	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,4-Tetrachlorobenzene	mg/kg	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,5-Tetrachlorobenzene	mg/kg	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,4,5-Tetrachlorobenzene	mg/kg	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3-Trichlorobenzene	mg/kg	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,4-Trichlorobenzene	mg/kg	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,3,5-Trichlorobenzene	mg/kg	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,4,5-Trichlorotoluene	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenols	4-Chloro-3-methylphenol	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2-Chlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	3-Chlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	4-Chlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,3-Dichlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,4 & 2,5-Dichlorophenol	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,6-Dichlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	3,4-Dichlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	3,5-Dichlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,4-Dimethylphenol	mg/kg	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	o-Cresol	mg/kg	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	m-Cresol	mg/kg	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	p-Cresol	mg/kg	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pentachlorophenol	mg/kg	0.15	-	-	-	-	-	-	-	-	-	-	-	-	-
	Phenol	mg/kg	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,4,5-Tetrachlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,4,6-Tetrachlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,5,6-Tetrachlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,4-Trichlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,5-Trichlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,6-Trichlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,4,5-Trichlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 65. 2013 soil other parameter analytical results compared to standards, Mt. Nansen, YT

	Sample ID	TP-M-13-04	TP-M-13-04	TP-M-13-05	BH-KZ-13-02	BH-KZ-13-01	BH-KZ-13-01	TP-SP-13-03	TP-SP-13-04	TP-SP-13-05	TP-SP-13-06	TP-R-13-01	TP-R-13-02	TP-R-13-03
	Depth (mbgs)	0.0-0.5	2.1-2.5	0.6-1.0	0.0-0.5	0.0-0.5	0.6-1.0	0.1-0.2	0.1-0.2	0.1-0.2	0.1-0.2	0.6-1.0	0.0-0.5	0.6-1.0
	Date Sampled	9/13/2013	9/13/2013	09/12/2013	09/10/2013	09/09/2013	09/09/2013	09/11/2013	09/11/2013	09/11/2013	09/11/2013	09/12/2013	09/12/2013	09/12/2013
Group	Analyte	Units	CSR SOIL PL													
	2,4,6-Trichlorophenol	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
PCBs	PCB-1016	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PCB-1221	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PCB-1232	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PCB-1242	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PCB-1248	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PCB-1254	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PCB-1260	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PCB-1262	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PCB-1268	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total Polychlorinated Biphenyls	mg/kg	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,7,8-TCDD	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,7,8-PeCDD	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,4,7,8-HxCDD	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,6,7,8-HxCDD	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,7,8,9-HxCDD	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,4,6,7,8-HpCDD	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OCDD	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total-TCDD	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total TCDD # Homologues		-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total-PeCDD	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total PeCDD # Homologues		-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total-HxCDD	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total HxCDD # Homologues		-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total-HpCDD	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total HpCDD # Homologues		-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,7,8-TCDF	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,7,8-PeCDF	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,4,7,8-PeCDF	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,4,7,8-HxCDF	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,6,7,8-HxCDF	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,7,8,9-HxCDF	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2,3,4,6,7,8-HxCDF	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,4,6,7,8-HpCDF	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1,2,3,4,7,8,9-HpCDF	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OCDF	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total-TCDF	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total TCDF # Homologues		-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total-PeCDF	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total PeCDF # Homologues		-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total-HxCDF	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total HxCDF # Homologues		-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total-HpCDF	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total HpCDF # Homologues		-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 65. 2013 soil other parameter analytical results compared to standards, Mt. Nansen, YT

	Sample ID	TP-M-13-04	TP-M-13-04	TP-M-13-05	BH-KZ-13-02	BH-KZ-13-01	BH-KZ-13-01	TP-SP-13-03	TP-SP-13-04	TP-SP-13-05	TP-SP-13-06	TP-R-13-01	TP-R-13-02	TP-R-13-03
	Depth (mbgs)	0.0-0.5	2.1-2.5	0.6-1.0	0.0-0.5	0.0-0.5	0.6-1.0	0.1-0.2	0.1-0.2	0.1-0.2	0.1-0.2	0.6-1.0	0.0-0.5	0.6-1.0
	Date Sampled	9/13/2013	9/13/2013	09/12/2013	09/10/2013	09/09/2013	09/09/2013	09/11/2013	09/11/2013	09/11/2013	09/11/2013	09/12/2013	09/12/2013	09/12/2013
Group	Analyte	Units	CSR SOIL PL													
	13C12-2,3,7,8-TCDD	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,7,8-PeCDD	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,4,7,8-HxCDD	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,6,7,8-HxCDD	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,4,6,7,8-HpCDD	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13C12-OCDD	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13C12-2,3,7,8-TCDF	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,7,8-PeCDF	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13C12-2,3,4,7,8-PeCDF	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,4,7,8-HxCDF	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,6,7,8-HxCDF	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13C12-2,3,4,6,7,8-HxCDF	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,7,8,9-HxCDF	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,4,6,7,8-HpCDF	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13C12-1,2,3,4,7,8,9-HpCDF	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	37Cl4-2,3,7,8-TCDD (Cleanup)	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Lower Bound PCDD/F TEQ	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mid Point PCDD/F TEQ	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Higher Bound PCDD/F TEQ	pg/g	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Volume Nanopure Water	mL	-	750	-	750	-	-	-	-	-	-	-	750	750	750
	Sample Weight	g	-	250	-	250	-	-	-	-	-	-	-	250	250	250
Miscellaneous	Redox	mV	-	351	-	345	-	-	-	-	-	-	-	366	361	357
Parameters	Conductivity	uS/cm	-	209	-	61	-	-	-	-	-	-	-	203	260	287
	Total Acidity (to pH 8.3)	mg CaCO3/L	-	3.6	-	3.0	-	-	-	-	-	-	-	3.8	3.4	3.8
	Alkalinity	mg CaCO3/L	-	38.8	-	24.3	-	-	-	-	-	-	-	4.0	42.1	36.6
	Sulphate	mg/L	-	58	-	10	-	-	-	-	-	-	-	82	77	96
	Major Anions	meq/L	-	0.88	-	0.57	-	-	-	-	-	-	-	0.16	0.95	0.84
	Major Cations	meq/L	-	0.00	-	0.00	-	-	-	-	-	-	-	0.00	0.00	0.00
Ion Balance	Difference	meq/L	-	0.88	-	0.57	-	-	-	-	-	-	-	0.16	0.95	0.84
	Balance (%)	%	-	100.0%	-	100.0%	-	-	-	-	-	-	-	100.0%	100.0%	100.0%

* indicates that the result is qualified

- indicates no data

CSR - PL = Yukon Government (YG). 2002. Contaminated Sites Regulation – Yukon Environment Act Schedules 1 and 2 for Park Land Use [O.I.C. 2002/171]

CSR-PL exeedences are highlighted and underlined

13.3.1 Hydrocarbons

Historical Data

There are several possible sources of hydrocarbon contamination at the mill area, some presented in historical information which we have reviewed from previous reports (AMEC, 2013a).

Documented Spills - Conor Pacific Environmental Technologies Inc. (Conor Pacific) completed a historical data review and an Environmental Site Assessment in 2000. Of the four documented spills that Conor Pacific reported on at the site, two involved hydrocarbons:

- in 1996, approximately 10,000 L of diesel fuel was spilled at an unknown location. The remediation activities at the time consisted of absorbing fuel with matting, volatilizing excess fuel, and diverting Dome Creek away from the spill location. Nothing further is known about this spill; and
- a hydrocarbon spill occurred in May 1997, but no details were available. Conor Pacific followed up this historical data review by analyzing one soil sample (GS3) that was collected northwest of the mill building. This sample contained elevated concentrations of extractable petroleum hydrocarbons (EPH10-19 and EPH19-32), indicating that Light and Heavy Extractable Petroleum Hydrocarbons (LEPH and HEPH) at this location likely exceed the Contaminated Sites Regulation – Parkland Land use (CSR–PL) standards (YG, 2002). This exceedance is not confirmed at this time, as EPH10-19 and EPH 19-32 are not equivalent to LEPH and HEPH, respectively. However, they are the main constituents of LEPH and HEPH.

Contamination Adjacent to the Former Landfill - During an inventory of hazardous materials conducted by EBA in 2011, a 205 L drum of waste oil was observed in the former landfill. It was suggested that there might also be more (buried, discarded) hydrocarbon sources in the former landfill.

Stained Soil at the Transformer Storage Area - In a 2006 report, KWEC identified 12 transformers in the storage area at the eastern edge of the mill yard. Seven of these contained oil, and staining was observed in the soil surrounding these transformers.

Contamination inside the Mill Building - A 2011 report by EBA identified hydrocarbon sludge inside the mill building. The extent of this contamination is unknown. Given that fuel has historically been stored in and around this building, other undocumented contamination from inside the mill building is a potential concern.

Stained Soil at the Warehouse - The report by KWEC (2006) documented soil staining near the warehouse in a storage area that contained 161 drums of various chemicals. Laboratory analyses of the drum contents indicated that some drums contained waste oil, diesel fuel, and motor oil. In addition, EBA (2011) observed soil staining in a 91 m^2 area inside the warehouse building.

Contamination at the Generator Building - In 2011, EBA observed three drains inside the Generator Building that contained grease or oil. The same report identified soil staining in an area approximately 455 m^2 inside and surrounding the generator building. There were likely additional undocumented sources of hydrocarbon contamination from this building.

Contamination at the Upper Mill Area - The report by EBA (2011) also noted staining at the upper mill area. This was in an approximately 300 m^2 area of soil along the road to the Semi Autogeneous Grinding (SAG) Building. Additionally, potential hydrocarbons were identified in the basin of the upper mill building. The quantity of the hydrocarbon-contaminated material was unknown; however, EBA determined that it was unlikely for water ingress at this location.

Contamination near the Diesel Containment - The report by EBA (2011) documented a 1 m^2 area of soil staining near the diesel containments southeast of the mill building.

2013 Fieldwork Results

Field screening results indicated volatile organic compound (VOC) vapour concentrations of zero parts per million (ppm) for samples from all depths in boreholes (BH-M-13-01, BH-M-13-02, BH-M-13-03, BH-M-13-05, and BH-M-13-06) and test pits (TP-M-13-01, TP-M-13-02, TP-M-13-04, and TP-M-13-05). Field screening from BH-M-13-08 and TP-M-13-03 revealed measurable VOC concentrations between 0 and 50 ppm, and field screening from BH-M-13-04 and BH-M-13-07 revealed some VOC concentrations in excess of 50 ppm.

Of the six boreholes and one test pit from the mill area, only samples from boreholes BH-M-13-01 and BH-M-13-07 had hydrocarbon concentrations in excess of the CSR–PL standards (Table 62). These exceedances of hydrocarbon parameters are detailed below:

- a sample from BH-M-13-01 at 1.1–1.5 mbgs exceeded the CSR–PL standards for HEPH. This sample had an HEPH concentration of 1,630 mg/kg, which exceeds the standard of 1,000 mg/kg;
- a sample from BH-M-13-07 at 0.0 to 0.5 mbgs exceeded the CSR–PL standards for three parameters. The volatile petroleum hydrocarbon (VPH; 320 mg/kg) exceeded the standard (200 mg/kg), LEPH (4,600 mg/kg) exceeded the standard (1,000 mg/kg), and HEPH (1,030 mg/kg) exceeded the standard (1,000 mg/kg); and
- a sample from BH-M-13-07 at 0.6–1.0 mbgs exceeded the CSR–PL standards for three parameters. VPH (660 mg/kg) exceeded the standard (200 mg/kg), ethylbenzene (1.36 mg/kg) exceeded the standard (1 mg/kg), and LEPH (7,330 mg/kg) exceeded the standard (1,000 mg/kg).

Analyses of soil collected and screened to assess for contamination in the former Transformer Storage Area (BH-M-13-04), adjacent to the current Diesel Containment area (BH-M-13-03), near the Warehouse Building (BH-M-13-05) and near the Generator Building (BH-M-13-06), did not identify hydrocarbon contamination. These results do not verify the absence of hydrocarbon contamination at sites identified as possible contamination sources in historic reports; rather, they indicate that potential existing contamination at these locations does not extend to the

sampled locations. There is potential for hydrocarbon contamination beneath the footprints of the Warehouse Building and Generator Building, around the exterior of the Generator Building, and extending to the 2013 sampling points.

Discussion - Hydrocarbons

Previous reports document hydrocarbon contamination and staining at the mill area (EBA, 2011; KWEC, 2006; Conor Pacific, 2000). The analytical results from the 2013 fieldwork summarized above indicate there is hydrocarbon contamination at two of the identified locations in the mill area (BH-M-13-01 and BH-M-13-07).

Contamination at BH-M-13-01 was detected between 1.1 and 1.5 mbgs (Figure 20). This borehole is in the former landfill site, where a waste oil drum and staining was observed by EBA (2011). The source of this contamination may have been the waste oil drum or other hydrocarbon substances that were disposed of in the landfill. No contamination was detected in borehole BH-M-13-02 (approximately 15 m southeast of BH-M-13-01). We believe that there is a localized plume of hydrocarbon contamination in the top 0.5 m of soil (below the landfill materials) as observed in BH-M-13-01. This may extend to a 15 m radius around BH-M-13-01. Groundwater at this location was encountered at a shallow depth (approximately 2.6 mbgs), but is not believed to be contaminated with HEPHs because soil below 1.5 mbgs had <200 mg/kg of HEPH. Additionally, groundwater analytical results from the wells approximately 25 m downgradient of the former landfill (MW09-17 and -18) do not vary significantly from other wells onsite. As such, there is no indication that potential contamination from the landfill may extend to these wells.

At borehole BH-M-13-07, contamination was detected in the top 1.0 m of soil (Figure 20). Given the proximity of this borehole to the mill building, the source of this contamination may have been a spill inside or adjacent to the mill building. The exact location of the historic spills described by Conor Pacific (2000) is unknown; therefore, we were unable to determine whether these exceedances are traceable to one of these spills. There may be a hydrocarbon plume that extends from beneath the mill building 75 m to the northeast. This plume was detected in BH- M-13-07. The extent may be up to 50 m wide but it appears to be limited to the top metre.

Subsurface investigations were not carried beneath building footprints (Warehouse Building, Generator Building, Transformer Storage Area, or Diesel Containment) so as to limit structural stability hazards and because those areas will require contaminant investigations upon building removal. However, field observations and analytical results from nearby boreholes and test pits completed in 2013 in the mill area (BH-M-13-03, BH-M-13-05, BH-M-13-06, and TP-M-13-01) showed no indications of hydrocarbon contamination. We conclude that the staining and potential contamination observed at these locations has not migrated significantly from their previously documented locations.

Screening results from the area of staining on the Upper Mill road indicated no detectable hydrocarbon contamination of the soil. This could mean that hydrocarbons are present but do not exceed CSR-PL standards, or that any existing hydrocarbon contamination is not volatile (i.e. no polycyclic aromatic hydrocarbons [PAHs] or HEPHs present).

Other samples from the mill area (TP-M-13-02, TP-M-13-03, and TP-M-13-05) were screened for hydrocarbons and results indicated no concerns. Some samples (BH-M-13-02, BH-M-13-04, BH-M-13-05, BH-M-13-07, and BH-M-13-08) and test pit (TP-M-13-04) were below the CSR–PL standards for hydrocarbons. These results indicate that the two historic hydrocarbon spills were not likely in these areas.

Samples from the mill area exhibited no exceedances of the Hazardous Waste and Hazardous Recyclable Materials Regulations (HWHRM) standards (GC 1999) for hydrocarbons.

13.3.2 Metals

Historical Data

Two possible sources of metals contamination are suggested for the mill area (AMEC, 2013).

Contamination from inside the Mill Building - In 2008, KWEC conducted a Phase II Environmental Site Assessment of the mill area (KWEC, 2008) that involved collection and analysis of 49 samples from inside the mill building. Thirty-two of those samples had parameters that exceeded the CSR Industrial Land Use standards. Many of the exceedances were for metals.

Use of Tailings or Waste Rock - Metals contamination has been observed in the soil of the mill area in the past (Conor Pacific, 2000). There is a general concern that the mill area was constructed on waste rock or tailings materials, which likely explains such metals exceedances.

2013 Fieldwork Results

Samples from every borehole and test pit from the mill area had signs of rust staining, and samples from every test pit except TP-M-13-02 also contained pyrite. Twenty-four samples from six boreholes (BH-M-13-01, BH-M-13-02, BH-M-13-04, BH-M-13-05, BH-M-13-07, and BH-M-13-08) and test pit TP-M-13-04 were submitted for total metals analysis (Figure 19). Nine of those samples (from five boreholes and two test pits) were also analyzed for leachable metals. Metals concentrations exceeded the CSR–PL in each of the total metals samples in three of samples analyzed for leachable metals, concentrations exceeded the HWHRM standards (GC, 1999; Table 63). A summary of individual metals that exceeded the relevant standards is provided below.

The observed CSR-PL standard exceedances were as follows:

- Antimony exceeded the CRS-PL standard (15 mg/kg) at six locations tested (BH-M-13-01, BH-M-13-04, BH-M-13-05, BH-M-13-07, BH-M-13-08, and TP-M-13-04) and in 17 of the samples. The exceedances ranged from 20.9 mg/kg to 1,730 mg/kg;
- Arsenic exceeded the CRS-PL standard (20 mg/kg) at every location tested and in all 24 samples. Arsenic concentrations ranged from 20.1 mg/kg to 80,700 mg/kg. The median concentration was 478 mg/kg and the standard deviation was 16,157 mg/kg;
- Cadmium exceeded the CRS-PL standard (1.5 mg/kg) at six locations (BH-M-13-01, BH-M-13-04, BH-M-13-05, BH-M-13-07, BH-M-13-08, and TP-M-13-04) and in 17 samples. Cadmium exceedances ranged from 1.84 mg/kg to 41.7 mg/kg;
- Copper exceeded the CRS-PL standard (90 mg/kg) at four locations (BH-M13-01, BH-M13-04, BH-M13-07 and BH-M13-08) and in six samples. Copper exceedances ranged from 94.4 mg/kg to 499 mg/kg;
- Lead exceeded the CRS-PL standard (100 mg/kg) at six locations (BH-M-13-01, BH-M-13-04, BH-M-13-05, BH-M-13-07, BH-M-13-08, and TP-M-13-04) and in 18 samples. Lead exceedances ranged from 132 mg/kg to 9,340 mg/kg;
- Silver exceeded the CRS-PL standard (20 mg/kg) at two locations (BH-M-13-04 and BH-M-13-04) at depths of 0.0-0.5 and 2.6-3.0 mbgs, respectively. Silver exceedances ranged from 53.4 mg/kg to 64 mg/kg; and
- Zinc exceeded the CRS-PL standard (150 mg/kg) at six locations (BH-M-13-01, BH-M-13-04, BH-M-13-05, BH-M-13-07, BH-M-13-08, and TP-M-13-04) and in 16 samples. Zinc exceedances ranged from 159 mg/kg to 2,440 mg/kg.

No CRS-PL standard exceedances were observed for the following metals:

- barium;
- beryllium;
- chromium;
- cobalt;
- mercury;
- molybdenum;
- nickel;
- selenium;
- thallium;
- tin;
- uranium; and
- vanadium.

Three samples exceeded the HWHRM standards for metals:

- Lead at BH-M-13-04 (sample depth 0.0 to 0.5 mbgs) exceeded the HWHRM standard (5 mg/L) with a concentration of 6.22 mg/L; and
- Arsenic at BH-M-13-08 (sample depths 2.6 to 3.0 mbgs and 3.1 to 3.5 mbgs) exceeded the HWHRM standard (2.5 mg/L) with concentrations of 6.1 and 5.0 mg/L, respectively.

No HWHRM standard exceedances were observed for the following metals:

- barium;
- boron;
- cadmium;
- chromium;
- mercury;
- nickel;
- selenium; and
- silver.

Discussion - Metals

Across the mill area, soils are contaminated with antimony, arsenic, cadmium, lead, and zinc. In general, the concentrations of these parameters decreased with depth below ground surface. Exceptions were at BH-M-13-01, BH-M-13-02, BH-M-13-05 and BH-M-13-08 (Figure 20; Table 63).

Concentrations of metals detected at BH-M-13-01 and BH-M-13-02 were generally highest at 2.1 to 2.5 mbgs. Sampling observations suggested the presence of garbage in the top metre of soil; however, the analytical results indicate that garbage extends to 2.0 mbgs at these locations. At greater depths, the metal concentrations generally decreased, and we observed the same at other mill area locations.

Concentrations of metals detected at BH-M-13-05 were generally highest at 0.6 to 1.0 mbgs. The reason for this is unclear, but it indicates that the soil at this location may have an upper layer of backfill or perhaps a buried contaminant source.

Concentrations of metals detected at BH-M-13-08 were generally highest at 2.6-3.0 mbgs, and the arsenic levels detected at 2.6 to 3.5 mbgs exceeded the HWHRM standards for this metal. The reason for this is unclear, but it indicates that the soil at this location may have an upper layer of backfill or perhaps a buried contaminant source.

Concentrations of lead were inconsistently high when compared to other sample locations from the mill area (above the HWHRM standards) at BH-M-13-04 from 0.0 to 0.5 mbgs. This indicates that this area may have been backfilled with contaminated material or there may be a local contaminant source.

13.3.3 Other Parameters

Historical Data

Historical reports indicate several possible sources of contamination with cyanide, polychlorinated biphenyls (PCBs), phenols, and chlorinated hydrocarbon in the mill area (AMEC, 2013).

Contamination from inside the Mill Building - The Phase II Environmental Site Assessment by KWEC (2008) identified contaminants in the form of various chemicals (including cyanide) in the mill building. There is concern that these contaminants may have contaminated the soil beneath this building and beyond its footprint.

Previous Spills - Conor Pacific (2000) compiled a list of documented spills at the site, including information about potential sources of contamination with materials other than metals and hydrocarbons:

- in November 1996, an estimated 2,046 L of cyanide slurry spilled onto the mill yard. The slurry froze in place and was removed from the site with heavy machinery and disposed of in the Tailings Facility; and
- on June 25, 1998, 15 L of anti-freeze spilled onto the ground near the Generator Building. Sand and soil was placed over the pooled anti-freeze, and approximately 2 m^3 of contaminated soil and sand was removed from this area.

Historic Landfill - A former landfill area is visible at the southeast end of the mill area. The 2011 study by EBA identified the following potential contaminant sources within the footprint of this former landfill:

- one refrigerator containing an unknown quantity of refrigerant;
- one freezer containing an unknown quantity of refrigerant; and
- 13 equipment batteries.

Transformer Storage Area - Transformers are stored away from the mill yard, northeast of the mill building (Figure 20). In 2000, Conor Pacific collected and analyzed soil from the Transformer Storage Area and found PCB levels above the laboratory detection limits but below CSR–PL standards. In 2006, KWEC confirmed that PCBs were present in two of the 12 transformers that were being stored at the mill area. There is concern that nearby soil may be contaminated with PCBs.

2013 Fieldwork Results

Samples from BH-M-13-01 (1.1 to 1.5 mbgs) and BH-M-13-02 (3.1 to 3.5 mbgs) (Figure 20) were analyzed for glycols, chlorinated hydrocarbons, phenols, and PCBs. The sample from BH-M-13-05 at 1.1 to 1.5 mbgs was also analyzed for PCBs. None of the results exceeded the CSR–PL standards for these parameters.

Cyanide parameters were analyzed in five samples from the mill area (BH-M-13-04 at 0.0 to 0.5 mbgs and 1.1 to 1.5 mbgs, BH-M-13-07 at 0.6 to 1.0 mbgs, BH-M-13-08 at 3.1 to 3.5 mbgs, and TP-M-13-05 at 2.1 to 2.5 mbgs; Figure 19). Most concentrations were below the CSR–PL standard for strong acid dissociable cyanide (50 mg/kg). The only exception was in BH-M-13-04 (at 0.0–0.5 mbgs), with a total cyanide concentration of 29.6 mg/kg.

Discussion

Potential glycol, chlorinated hydrocarbon, phenol, and PCB contamination within the mill building's footprint (KWEC, 2008) does not appear to extend northeast (downgradient) or northwest of that footprint.

Our results suggest that the cyanide slurry spill identified in the Conor Pacific (2000) report may have occurred near BH-M-13-04, and that localized contamination from this spill remains, at least in the top 0.5 m (Figure 20).

No non-hydrocarbon and non-metal contamination from the former landfill or the Transformer Storage Area was identified. Any contamination from these sources is likely localized.

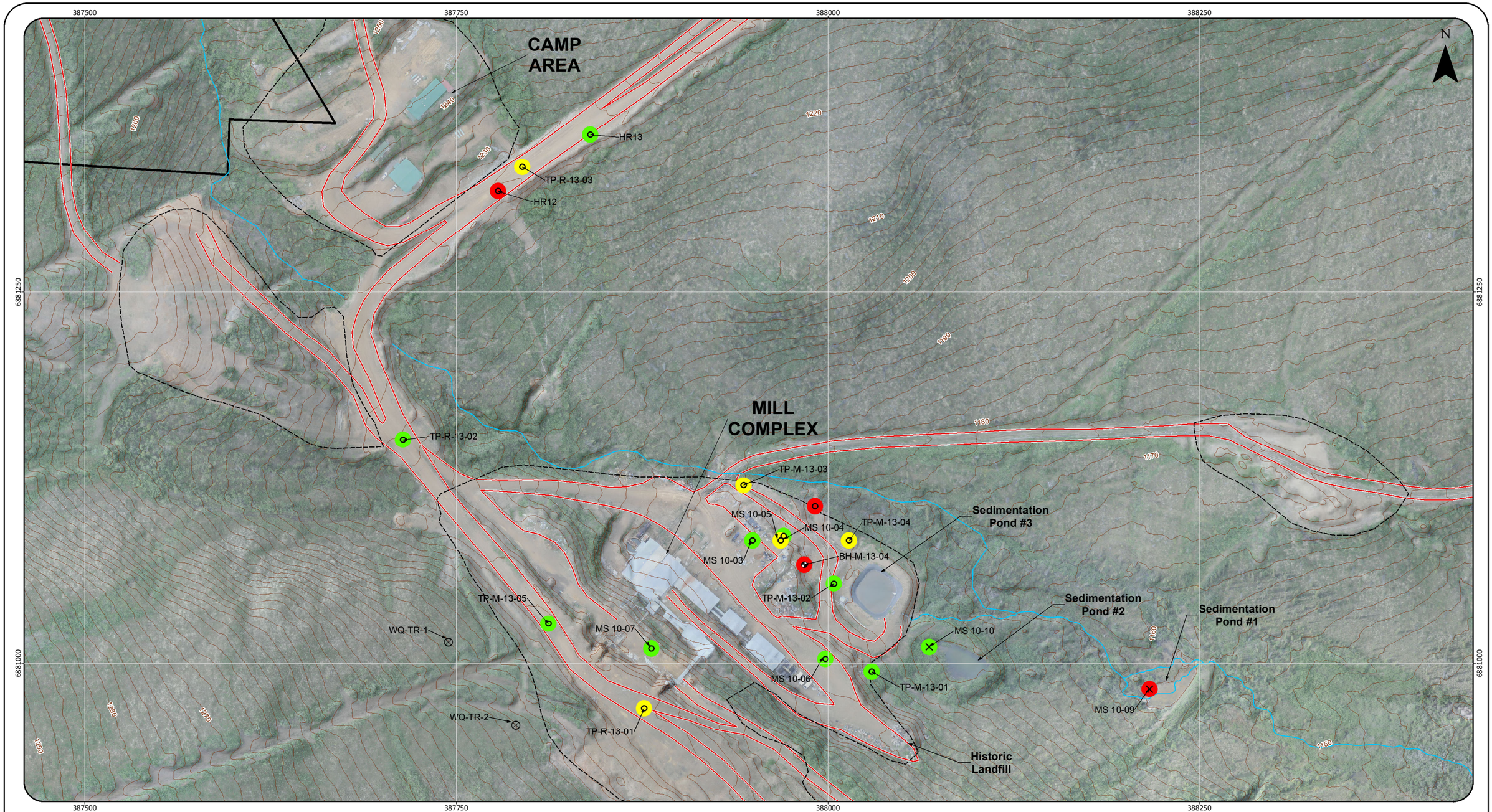
13.4 Geochemical Characterization

In 2010, Altura conducted a geochemistry sampling program for the mill area to identify the mine rock and tailings that were historically stored or used for construction. Eight trenches were completed around the immediate mill area. A total of nine samples were collected from the trenches and these samples were mainly selected from altered materials (Altura, 2010).

During the 2013 site investigation, eight boreholes and five test pits were completed in the mill area to delineate the areas of mine rock or tailings and also to identify any other contaminated material (Figure 48). After reviewing the borehole/test pit logs, 18 samples were selected for ABA and metal analysis, and three samples underwent SFE tests. Nineteen additional samples were also submitted for total metal analysis, but only for the parameters related to the CSR-PL.

There are a number of areas within the Mount Nansen mill area that were suspected or confirmed to contain tailings. Three ponds in particular were suspected as tailings storage locations (Higgs, 1994). Two of the ponds (Ponds 1 and 2) are earthen berm structures and overgrown with vegetation. The third pond (Pond 3) was lined with a geomembrane in the 1990s (Brodie Consulting, 1998). Historical tailings were reportedly relocated from the pond prior to lining but some of the historical tailings may remain under the liner.

Three core samples were collected from the sedimentation Ponds 1 and 2 by Altura in 2010. Pond 1 sediment was sampled to a depth of 40 cm, while sediment from Pond 2 was collected to a depth of 75 cm. A composite sample from Pond 1 was made using sediment from depths of 5 to 40 cm. Two composite samples were made from Pond 2 sediment: one sample using sediment from depths of 16 to 45 cm; and one sample using sediment from depths of 45 to 75 cm. Sediment samples were tested for ABA and metals content.



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

ARD Classification
- PAG
- non-PAG
- Uncertain

Testhole
- Borehole
- Grab Sample
- Hand Auger
- Test Pit

- Order in Council Boundary
- Contour (2 m)
- Disturbed Area
- Roads
- Streams

Associated Engineering — Global Perspective. Local Focus.

amec

Yukon Energy, Mines and Resources — Assessment and Abandoned Mines

MOUNT NANSEN REMEDIATION PROJECT
Figure 48

SITE CHARACTERIZATION REPORT

MILL AREA GEOCHEMISTRY

Scale 1:2,500
Metres
0 50 100

March 18, 2014

S:\PROJECTS\VM00605 - Mount Nansen\GIS\Mapping\VM00605_0020c_11x17_SiteCharacterizationReport_Geochem_MillLocations.mxd

13.4.1 Geochemical Testing Results of Mill Area

ABA Accounting and PAG/non-PAG Distributions

A summary of the ABA results for the 29 samples collected from the mill area is presented in Table 66. The summary includes the data from samples collected during year 2010 investigation program. The sample population does not include three core samples collected from the ponds, which are discussed separately. The paste pH ranged from 2.9 to 8.5 with a median value of 7.5. The majority of the samples were neutral to alkaline. The single acidic sample (MS-10-05A) appears to be a statistical outlier.

Table 66: Summary of Acid Base Accounting Results for Mill Area Samples

Sample	Paste pH	TIC	S(T)	$S(SO_4)$	Calculated $S(S^{-2})$	Carb NP	AP	NP	NPR
		%				kg $CaCO_3$/t			
Count	29	29	29	29	29	29	29	29	29
Minimum	2.9	0.01	0.1	0.01	0.03	0.80	0.94	1.2	0.09
Maximum	8.5	1.6	4.1	1.2	4.0	134	125	128	23.3
Mean	7.2	0.28	0.7	0.12	0.53	23.6	16.5	26.8	1.6
Standard Deviation	1.0	0.39	0.9	0.24	0.82	32.9	25.5	30.0	6.0
Median	7.5	0.14	0.3	0.04	0.21	11.7	6.6	16.8	2.6
10^{th} Percentile	6.4	0.02	0.1	0.01	0.04	1.5	1.3	2.1	0.67
25^{th} Percentile	6.7	0.03	0.1	0.02	0.06	2.5	1.9	13.4	1.02
75^{th} Percentile	6.7	0.03	0.1	0.02	0.06	2.5	1.9	13.4	1.02
90^{th} Percentile	6.7	0.03	0.1	0.02	0.06	2.5	1.9	13.4	1.02

Total sulphur ranged from 0.1 to 4.1% with an average concentration of 0.9%. Sulphate sulphur ranged from 0.01 to 1.2% with an average of 0.12%. Sulphate sulphur represents a relatively minor fraction of the total sulphur. Sulphide sulphur ranged from 0.03 to 4.0% with an average of 0.53%. Sulphide is the main source of sulphur for the majority of the rock types.

Neutralization potential was measured both as Sobek NP and carbonate NP (Carb NP). Sobek NP averaged 26.8 kg $CaCO_3$/t and Carb NP averaged 23.6 kg $CaCO_3$/t.

The NP vs. AP plot shows that six samples have NPR <1 and are classified as potentially acid generating (PAG), eight samples have NPR between 1 and 2 and are classified as having an uncertain potential for acid generation, while the remaining 15 mill area samples are non-PAG (NPR >2).

The distribution of PAG and non-PAG material in the mill area is presented on Figure 48. The majority of the PAG or uncertain samples were clustered in the northeast or east section of the mill area, which is comprised of waste rock and native fill material.

Metal Contents

A summary of the metal analysis results for 29 samples collected from the mill area is presented in Table 67.

Table 67: Summary of Selected Metal Results for Mill Area Samples

Statistic	Antimony	Arsenic	Cadmium	Lead	Zinc
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
10 times average crustal content	2.0	18	1.5	140	700
Count	29	29	29	29	29
Minimum	4.8	26.0	0.24	15.0	68.6
Maximum	1,530	6,769	69.1	10,000	4,560
Mean	177	1,687	13.4	1,042	963
Standard Deviation	344	2,341	17.5	2,074	1,112
Median	35.6	408	3.9	144	404
10^{th} Percentile	6.2	43.0	0.37	20.4	86.2
25^{th} Percentile	11	86.0	0.45	27.0	103
75^{th} Percentile	11	86.0	0.45	27.0	103
90^{th} Percentile	11	86.0	0.45	27.0	103

All samples were elevated in antimony and arsenic when compared to the 10x average crustal abundance values. Half the samples had elevated cadmium and lead concentrations. Although the median zinc concentration was less than the 10x average crustal abundance value of 700 mg/kg, the mean concentration was elevated at 964 mg/kg.

Leachate Characterization

Leachate samples from the SFE testing had neutral pH which ranged from 7.6 to 7.8. One sample collected from TP-M1-3-04 had leachate with high antimony and arsenic concentrations of 0.905 mg/L and 0.038 mg/L, respectively. The complete SFE testing results are presented in Table GC6 in Appendix F.

In summary, results of the geochemistry testing of samples from the test pits of TP-M-13-03, TP-M-13-04 and MS-10-01 located in the mill lower platform area confirm the presence of waste rock or ore. PAG rock was identified at MS10 to a depth of approximately 1.5 m, at TP-M-13-03 for the first 1 m, and also at TP- M13-04 from around 1.1 to 2 m below ground surface. The PAG rock at TP-M13-04 also contained a high arsenic concentration of approximately 6,500 mg/kg. Elevated arsenic concentrations were still identified at deeper locations within TP- M13-04 (2 to 5 m) with concentrations ranging from 200 to 380 mg/kg.

PAG rock was identified in the mill platform area where borehole BH-M-13-04 and test pits MS-10-04 and MS-10-5 are located. The sample from BH-M-13-04 at a depth of 1.5 m also had a high arsenic concentration.

The metal testing results indicate high arsenic concentrations in the samples from boreholes BH-M-13-05 (0 to 2.5 m), BH-M-13-07 (0 to 0.5 m), and BH-M-13-08 (0 to 4 m), suggesting the location contains or contained waste rock or ore.

13.4.2 Geochemical Characterization of Pond Core Samples

The results of the ABA analysis indicate high sulphide sulphur content for Pond 1 (2.26%) compared to Pond 2 (0.04 to 0.06%). The Sobek NP was higher in Pond 1 as well (40.9 kg $CaCO_3$/t) compared to Pond 2 (15.2 to 16.8 kg $CaCO_3$/t). The Carb NP was marginally higher than Sobek NP for the Pond 1 sample (44.2 kg $CaCO_3$/t > 40.9 kg $CaCO_3$/t). However, in both Pond 2 composite samples, the Sobek NP was at least 2.6 times higher than the Carb NP, indicating a non-carbonate mineral contribution to NP (i.e. silicates). The NPR of the Pond 1 sample was 0.56 and it was classified as PAG. Both sediment samples from Pond 2 had NPR greater than 2 and were classified as non-PAG.

Samples from Ponds 1 and 2 had elevated arsenic and antimony concentrations. The arsenic concentration in the Pond 1 sample was higher than 10,000 mg/L, suggesting the presence of tailings. The results of the metals analyses show that concentrations in Pond 2 are much less compared to concentrations in Pond 1. However, the arsenic content in Pond 2 was still higher than the CSR-PL value of 15 mg/kg.

13.5 Geophysical Survey

The methods for the geophysical survey are summarized in Section 2 of the Site Investigation Data Report (AMEC, 2013).

Induced polarization results were reviewed to help delineate metals contamination. Since the original plan for the Site Investigation did not include a geophysical survey, analytical results were only comparable to one sampling location (BH-M-13-01) adjacent to the induced polarization lines. This one comparison point provides insufficient information to correlate analytical and induced polarization results; With further soil sampling along the geophysical survey lines, it would be possible to use this data to evaluate the limits of contamination. This data would reduce uncertainty of costing for remedial works. However, it is not recommended due to the cost versus benefit of collecting this data prior to remedial works. The main reasons for this are:

1. soil sampling after contaminated soil removal should to be carried out, even if the area is previously delineated; and
2. remedial planning for Mount Nansen is not significantly affected by this material as it is a small volume (relative to the total volume of materials needing relocation during remediation) and the concentration of contaminants have been observed to allow the material to be placed in the Open Pit (as they are below special waste standards).

13.6 Hazardous Materials Assessment

The methods for the hazardous materials assessment are summarized in Section 2 of the Site Investigation Data Report (AMEC, 2013).

A historical search of hazardous materials at the mill area revealed potential contamination from landfill seepage and from use of waste rock or tailings as infill. The search also identified specific concerns related to storage of hazardous materials from the milling process.

During the 2013 Site Investigation, the mill building (Figure 19) was found to contain a list of milling process chemicals in their original packaging:

- solvents;
- fuel;
- lubricants;
- batteries;
- compressed gases (three cylinders);
- flocculants;
- sodium metabisulphite; and
- ferric chloride.

Potential concerns inside the mill building were as follows:

- 12 sacks of lime, some of which had partially spilled onto the floor;
- six above-ground storage tanks (ASTs) (Tanks 1 through 6) inside a bermed area;
- the bermed area, which contained water, and approximately 50 m^3 of sludge and solids, which are likely from refined process sludge; and
- one tank reported to contain mill process sludge on the mill's floor beneath the tank.

Hazardous materials outside and beyond the mill building footprint were as follows (Figure 20):

- a rail (tanker) car reportedly containing sulphur dioxide remains adjacent to the mill building. This tank was tested and confirmed to be empty;
- three ASTs containing diesel (southeast end of mill area);
- two partially full diesel tanks (northeast of mill building);
- propane bottles (northeast of mill building);
- ore bins (northeast of mill building); and
- metal drums in apparent poor condition and containing hydraulic fluid, oil, grease, dirt, rags, and rain water along the road to the SAG building (southwest of mill building).

The hazardous material releases noted in the mill building are of environmental concern because the surface water runoff from upgradient of the mill building was observed flowing over the mill building floor adjacent to the observed lime spill and the bermed area around Tanks 1-6. This water appears to have flowed over the berm and into the contained area. Additionally, the mill building floor is concrete, slab on grade. This material is porous and not an effective barrier for hazardous materials. For this reason, contamination from inside the mill building could have travelled to the soil beneath the building footprint. Consistent pH levels of 7.0 to 8.6 in surrounding soils suggest that lime from inside the mill has not contaminated the surrounding soil. In contrast to this, elevated metals concentrations detected in borehole BH-M-13-08 indicate that process sludge from inside the mill might have contaminated surrounding soils; however, this is only one possible explanation for the high metal concentrations in this borehole.

The metal drum storage southwest of the mill building (on the SAG Road) was investigated through sampling at TP-M-13-05. Field screening results indicated potential hydrocarbon contaminants to a depth of 2.0 mbgs. In 2011, EBA identified damaged drums at this location. They tested the contents of the drums and identified it as hydraulic fluid. From this past information and field results, this area is likely contaminated with hydrocarbons (dominantly HEPH) down to a depth of approximately 2 mbgs.

Otherwise, it is believed that the hazardous materials stored in the mill area beyond the mill building footprint are not contributing to non-metals and non-hydrocarbon contamination. The ASTs appear in good condition and there was no staining observed on the soils adjacent to these.

13.7 Mill Area Characterization Summary

The mill area soil has contaminant concentrations above the CSR-PL standards for metal, hydrocarbon and other contaminant parameters.

The analytical results indicate that there is localized hydrocarbon contamination in the area. The larger hydrocarbon plume may extend from beneath the mill building 70 m northeast to near the historic polishing pond. The extent may be up to 50 m wide but it appears to be limited to the top metre. There may be a second hydrocarbon plume centred beneath the former landfill at the southeast end of the mill area. This is confined to the top 0.5 m below the garbage, and may extend up to 20 m in diameter (Figure 20).

Soils across the mill area (from approximately 20 m northwest of the mill building to 90 m southeast of the Warehouse Building) are contaminated with antimony, arsenic, cadmium, lead, and zinc. In general, the concentrations of these parameters decrease with depth below ground surface to bedrock or groundwater (approximately 4 mbgs at most locations). This pad area may have been built up with a blend of waste rock and non-contaminated material. Additionally, backfill contaminated with metals or unknown sources of metals have resulted in two localized areas of metals contamination. A former cyanide slurry spill has resulted in localized metals (and cyanide) contamination in the top 0.5 m of soil at another location (Figure 20).

Potential glycol, chlorinated hydrocarbon, phenol, and PCB contamination within the mill building footprint does not appear to extend northeast (downgradient) or northwest of that footprint. Analytical results suggested there was no potential PCB contamination from the former landfill or the Transformer Storage Area. If such contamination does exist, it is likely localized.

There may be soil contaminated with hydrocarbons, metals, and other contaminants beneath the mill area buildings and infrastructure, including the current diesel storage area and garbage debris. These areas will need to be assessed upon remediation.

13.8 Explosives Storage Area

Methods for collection and analyses of soil samples from the Explosives Storage Area are summarized in Section 2 of the Site Investigation Data Report (AMEC, 2013).

Soil samples were analyzed for PCOCs, including metals and other parameters, from four grab sample locations (TP-M-13-03, TP-M-13-04, TP-M-13-05, and TP-M-13-06) from the Explosives Storage Area (Figure 19). Analytical results for soil samples collected from the Explosives Storage Area for metals, and other parameters are reported below and are summarized in Tables 63 and 64, respectively. The laboratory reports are provided in Appendix D of the Site Investigation Data Report.

13.8.1 Explosives Related Parameters

Historical Data

AMEC/AE could not find any reports that provided historical information about the Explosives Storage Area other than a description of its use. Improper storage of explosives can lead to environmental contamination, with parameters of concern such as nitrogen compounds and total organic carbon (TOC). In addition to potential explosives-related contamination, there is concern that this area might have been infilled with waste rock or tailings. For this reason, samples from this location were also tested for metals (Section 13.7.2 below).

2013 Fieldwork Results

No field screening was conducted for samples from the Explosives Storage Area. Three samples from this area (TP-M-13-03, TP-M-13-04 and TP-M-13-05) were submitted for nitrogen and TOC analyses. One sample from the surrounding area (TP-M-13-06) was also submitted for background testing of these parameters. Because there are no CSR-PL standards for nitrogen compounds or TOC in soil, the concentrations in samples from the Explosives Storage Area were compared to those in the background sample.

Concentrations of available ammonium (as N) in the three Explosives Storage Area samples were between 1.1 and 3.3 mg/kg, similar to the 1.8 mg/kg in the background sample (Table 64). Total Kjeldahl nitrogen (TKN) concentrations in the three samples were below laboratory detection limits, whereas TKN in the background sample was detectable (0.142 mg/kg). Nitrate and nitrite concentrations were below laboratory detection limits in all three Explosives Storage Area samples as well as the background sample.

The TOC concentration at TP-SP-13-04 was 0.15 mg/kg, whereas levels in both other samples from the Explosives Storage Area were <0.10 mg/kg. The TOC concentration in the background sample (2.5 mg/kg) was higher than that in all three test samples.

Discussion – Explosives-related Parameters

The results indicate that pockets of soil in the Explosives Storage Area may have elevated nitrogen concentrations (e.g. soil in the vicinity of TP-SP-13-05). Results also suggest a possible lack of available organic carbon in the soil of the Explosives Storage Area. This might be explained by explosives storage and/or the fact that the area remains clear of vegetation, which is a source of carbon. Presence of vegetation also reduces the available nitrogen in soil.

13.8.2 Metals

Historical Data

There is concern that the soil in the Explosives Storage Area is contaminated with metals because waste rock was likely used to build the pad area, although historical information from previous reports contain little information about metals concentrations detected in this area.

2013 Fieldwork Results

As noted, no field screening was done for samples from the Explosives Storage Area. Three samples from the Explosives Area were submitted for total metals analysis (TP-M-13-03, TP-M-13-04, and TP-M-13-05) and one sample (TP-M-13-06) was also submitted for total metals from a background area. Metals results in two samples exceeded the CSR–PL standards. The metals results summarized in Table 63 were as follows:

- total arsenic in TP-SP-13-03 (104 mg/kg) and TP-SP-13-05 (31.7 mg/kg) exceeded the CSR-PL standard (20 mg/kg);
- total chromium in TP-SP-13-05 (82 mg/kg) exceeded the CSR–PL standard (60 mg/kg);
- TP-SP-13-05 had elevated concentrations of barium, (460 mg/kg), cobalt (26.9 mg/kg), and nickel (40.6 mg/kg) compared to other samples collected during the program. These concentrations were below the respective CSR-PL standards; and
- the metals concentrations in soil samples from TP-SP-13-04 and TP-SP-13-06 were below applicable CSR–PL standards.

Discussion - Metals

The analytical results indicate that the surface soil of the Explosives Storage Area is contaminated with metals. Most concentrations observed were consistent with those observed elsewhere at the Mount Nansen Site and likely reflect the use of waste rock as infill. The elevated concentrations of barium, cobalt, and nickel at TP-SP-13-05 were unusual, and the cause of the higher concentrations in these parameters is inconclusive.

13.8.3 Explosives Storage Area Characterization Summary

Overall, the results for the Explosives Storage Area indicate that pockets of soil in this area likely contain elevated nitrogen concentrations. Additionally, the elevated metals concentrations from the Explosives Storage Area indicate that it was likely constructed using waste rock.

13.9 Groundwater Flow and Huestis Adit

A preliminary groundwater flow plan was developed for the northwest portion of the mill area with proximity to Huestis Adit. Five drive-point piezometers were installed close to the determined location for this former portal and lowest point of drainage from the underground workings.

Groundwater elevations from the five drive-points provided an indication of the shallow water table depth from which some extrapolation was possible, based on topographic mapping and depth to the shallow water table. Using this approach, groundwater contours and flow direction were interpreted, as shown on Figure 49 - Groundwater Flow Huestis Adit and Mill Area.

14.0 ROADWAYS AND FORMER KETZA SHOP

14.1 Roadways

Methods for collection and analyses of soil samples from the Roadway Areas are summarized in Section 2 of the Site Investigation Data Report (AMEC, 2013).

Soil samples were screened and collected from five test pits within the road right-of-way (TP-R-13-01, TP-R-13-02, TP-R-13-03, TP-R-13-04, and TP-R-13-05) (Figures 19 and 48). Field screening results are presented in Section 3.4.2 of the Site Investigation Data Report and the Borehole Logs are in Appendix A of that report. Based on field screening results, select soil samples were analyzed for PCOCs (i.e. hydrocarbons and metals). Analytical results for soil samples collected from the Roadway Areas for hydrocarbons and metals are reported below and are summarized in Tables 62, 63 and 64. The laboratory reports are provided in Appendix D of the Site Investigation Data Report.

14.1.1 Hydrocarbons

There is concern that the soil in the Roadway Areas may be contaminated from the application of hydrocarbon materials to suppress dust during mine operation. Historic reports contain little information about hydrocarbon contamination along the roadways.

Five test pits were advanced along the roadways (TP-R-13-01, TP-R-13-02, TP-R-13-03, TP-R-13-04, and TP-R-13-05). The VOC concentrations in all samples from these test pits were 0 ppm (Appendix D of the Site Investigation Data Report). These field results indicate low potential for hydrocarbon contamination; therefore, samples from these locations were not analyzed at the laboratory.

Because the field screening of the samples from the roadways suggested no hydrocarbon contamination, we believe there is a low likelihood that the roadways have widespread hydrocarbon contamination.

N 6881200

N 6881100

E 387700

E 387800

E 387900

E 388000

1196

1194

1192

1190

DCT-1-1

DC-01

DC-02

HA-01 1195.53m

HA-02 1195.15m

HA-03 1193.90m

HA-04 1189.47m

HA-05 1192.05m

DCT-2-1

DOME CREEK

MW09-16

MW09-19

MILL AREA

Data Source:
Datum: NAD 1983 CSRS UTM Zone 8N

Note: Groundwater and Ground Temperature data will be updated in 2014.

Associated Engineering — GLOBAL PERSPECTIVE. LOCAL FOCUS.

amec

Yukon
Energy, Mines and Resources
Assessment and Abandoned Mines

MOUNT NANSEN REMEDIATION PROJECT
SITE CHARACTERIZATION
Figure 49

GROUNDWATER FLOW
HUESTIS ADIT AND MILL AREA

0m 10 20 30 40
1 : 1000

MARCH, 2014

S:\Cadd\MISC\VM\VM00605\VM00605-003-Mill Area.dwg – Figure 46 – Mar. 20, 2014 3:13pm – karsten.rudolf

14.1.2 Metals

There is concern that the roadways might have been constructed using waste rock which has elevated metals. Historical data obtained from our review of previous reports provide little information regarding metals contamination along the roadways.

Field screening identified rust staining in samples from all five test pits. In addition, pyrite was observed in all of the samples from TP-R-13-03 and TP-R-13-05, and in some samples from TP-R-13-01 and TP-R-13-02. According to the Special Waste Regulation (YG, 1995), no analysis for leachable metals in these sample was warranted.

Samples from three roadway test pits (TP-R-13-01, TP-R-13-02, and TP-R-13-03) were analyzed for leachable metals using the shake flask extraction method. This method is not the approved analytical method for comparison to HWHRM standards (the required analyses is the Toxicity Characteristic Leachate Procedure). For this reason, the results from the shake flask analyses cannot be compared to the HWHRM; however, they do provide general information about the mobility of these parameters in soils. Based on arsenic content in these samples, metals contamination is indicated to approximately 1 mbgs. These analytical results indicate that the surface soil of the roadways is contaminated with metals. These elevated metals levels are likely consistent with the metals contamination observed elsewhere at the Mount Nansen Site and likely reflect the use of waste rock as infill.

14.1.3 Geochemical Characterization

A geochemical rock characterization of the haul road from the mine to the mill was conducted by Altura in 2009. During this 2009 site investigation program, five test pits were excavated at the haul road at the Mill Section near the crusher feeder and the other 14 test pits were excavated at a section of the Haul Road from the mine area (Altura, 2009c). Test pit depths ranged from 1.2 m to 1.6 m. In addition, grab samples were also collected from nine sampling points on the haul road berm.

Geochemical testing was conducted on five samples from the test pits on the Mill Section Haul Road, nine samples from the Mine Section Haul Road, and 10 samples from the Haul Road berm. All of these samples underwent elemental metal analysis and the majority of samples also had field paste pH and conductivity measurements. ABA and SFE testing were performed only on seven selected samples from Mine Haul Road test pits and four samples collected from the Haul Road berm. The laboratory geochemical testing program was performed on fine-grained samples; therefore, only the minus ¼ inch fraction of samples was tested.

The geochemistry program conducted in 2013 was intended to assess the acid potential of material from Mill Section Haul Road. Three test pits were completed and nine samples were selected for the geochemical testing. Table 68 summarizes the geochemical testing conducted on samples from the Haul Road.

Table 68: Summary of Geochemical Tests of Haul Road Rock Samples

Location	Investigator	Year	Number of Samples	Geochemistry Testing		
				ABA	Metal	Leachable Metal
Mill Section	Altura	2009	5		5	
	AMEC	2013	9	9	9	3
Mine Section	Altura	2009	15	7	15	6
Berm	Altura	2009	10	4	10	4
		Total	**39**	**20**	**39**	**13**

A summary of the ABA results for the Haul Road is presented in Table 69 and the metal testing results are summarized in Table 70. The NP vs. AP distribution for the Haul Road samples is presented graphically in Figure 50. Results are discussed based on the haul road sections including Mill Section, Mine Section and Haul Road Berm.

Table 69: Summary of Acid Base Accounting Results for Haul Road Samples

Sample	Paste pH	TIC	S(T)	$S(SO_4)$	$S(S^{-2})$	Carb NP	AP	NP	NPR	Carb NPR
		%				kg $CaCO_3$/t				
Haul Road _ Mill Section (n=9)										
Count	9	9	9	9	9	9	9	9	9	9
Minimum	6.5	0.0	0.09	0.01	0.03	0.8	0.9	4.4	0.9	0.2
Maximum	8.1	0.3	0.52	0.12	0.49	22.5	15.3	25.2	5.4	5.3
Mean	7.5	0.1	0.30	0.06	0.24	10.7	7.5	14.5	1.9	1.4
Standard Deviation	0.5	0.1	0.15	0.04	0.16	8.7	4.9	7.8	1.7	1.7
Median	7.6	0.1	0.27	0.05	0.23	8.3	7.2	15.6	2.2	1.2
10^{th} Percentile	6.9	0.0	0.14	0.01	0.09	0.8	2.9	4.7	1.2	0.4
25^{th} Percentile	7.5	0.0	0.18	0.04	0.11	1.7	3.4	6.4	1.4	0.5
75^{th} Percentile	7.7	0.2	0.40	0.07	0.36	18.3	11.3	20.2	3.5	1.9
90^{th} Percentile	7.8	0.2	0.50	0.10	0.42	19.8	13.1	22.9	5.2	3.6
Haul Road - Mine Section (n=7)										
Count	7	7	7	7	7	7	7	7	7	7
Minimum	5.8	0.0	0.03	0.01	0.02	0.8	0.6	3.2	0.2	0.1
Maximum	8.4	0.3	1.18	0.43	0.75	27.5	23.4	33.0	52.8	44.0
Mean	7.0	0.1	0.30	0.10	0.20	10.6	6.3	14.3	2.3	1.7
Standard Deviation	1.0	0.1	0.42	0.15	0.28	11.5	8.6	12.4	18.5	16.0
Median	6.6	0.0	0.08	0.06	0.03	3.3	0.9	7.7	8.2	3.6
10^{th} Percentile	6.0	0.0	0.04	0.01	0.02	1.3	0.6	4.1	1.0	0.8
25^{th} Percentile	6.3	0.0	0.07	0.02	0.02	1.7	0.6	5.0	3.0	1.3
75^{th} Percentile	7.7	0.2	0.35	0.08	0.29	19.6	9.1	23.2	8.9	3.2
90^{th} Percentile	8.1	0.3	0.75	0.23	0.52	25.5	16.3	30.9	28.5	19.8
Haul Road - Berm (n=4)										
Count	4	4	4	4	4	4	4	4	4	4
Minimum	6.3	0.0	0.05	0.03	0.02	3.3	0.6	6.4	0.3	0.3
Maximum	7.7	0.3	1.28	0.25	1.09	23.3	34.1	22.7	10.2	6.2
Mean	7.2	0.1	0.48	0.13	0.35	11.3	11.0	13.4	1.2	1.0
Standard Deviation	0.6	0.1	0.55	0.11	0.50	8.6	15.5	6.8	4.4	2.9
Median	7.4	0.1	0.30	0.12	0.15	9.2	4.7	12.2	2.6	2.0
10^{th} Percentile	6.6	0.1	0.10	0.03	0.05	4.6	1.6	8.0	0.9	0.6
25^{th} Percentile	7.0	0.1	0.18	0.04	0.10	6.5	3.0	10.4	1.8	1.1
75^{th} Percentile	7.6	0.2	0.60	0.21	0.41	14.0	12.7	15.1	7.1	5.6
90^{th} Percentile	7.7	0.2	1.01	0.23	0.82	19.6	25.5	19.7	9.0	6.0

Table 70: Summary of Selected Metal Results for Haul Road Rock Samples

Section	Statistic	As	Bi	Cd	Pb	Sb	Zn
	10 times average crustal	18	0.085	1.5	140	2	700
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Haul - Mill	Count	14	14	14	14	14	14
	Minimum	25	0.08	0.25	9.60	5.1	95
	Maximum	822	3.70	15.30	466.00	119.0	1230
	Mean	247	0.94	4.55	171.77	34.3	430
	Standard Deviation	235	1.11	4.76	158.36	31.3	375
	Median	166	0.38	2.61	117.50	27.1	269
	10^{th} Percentile	41	0.10	0.30	13.10	8.5	105
	25^{th} Percentile	79	0.13	1.12	23.15	11.7	142
	75^{th} Percentile	312	1.46	7.26	305.00	47.1	734
	90^{th} Percentile	542	2.31	11.01	377.82	63.2	915
Haul - Mine	Count	15	15	15	15	15.0	15
	Minimum	20	0.40	1.30	26.50	3.0	149
	Maximum	899	11.20	29.00	692.80	119.7	2193
	Mean	371	2.59	8.94	288.87	28.7	752
	Standard Deviation	256	2.97	6.86	172.84	29.5	501
	Median	301	1.80	7.00	263.10	17.8	625
	10^{th} Percentile	84	0.50	3.62	83.74	5.8	328
	25^{th} Percentile	215	0.60	5.10	199.55	10.1	470
	75^{th} Percentile	555	3.15	10.35	353.90	38.0	862
	90^{th} Percentile	699	5.68	15.62	483.34	48.2	1219
Road - Berm	Count	10	10	10	10	10.0	10
	Minimum	220	0.60	6.50	183.50	18.0	688
	Maximum	3920	25.70	43.80	6036.30	236.7	3171
	Mean	984	11.36	17.83	1169.15	80.8	1384
	Standard Deviation	1117	9.46	12.49	1761.60	74.8	780
	Median	618	9.00	14.25	504.45	36.5	1074
	10^{th} Percentile	254	2.58	6.86	214.91	25.9	751
	25^{th} Percentile	308	3.38	9.13	463.45	29.7	937
	75^{th} Percentile	1214	17.83	18.80	1052.45	131.8	1619
	90^{th} Percentile	1629	24.08	36.69	1978.47	165.5	2297

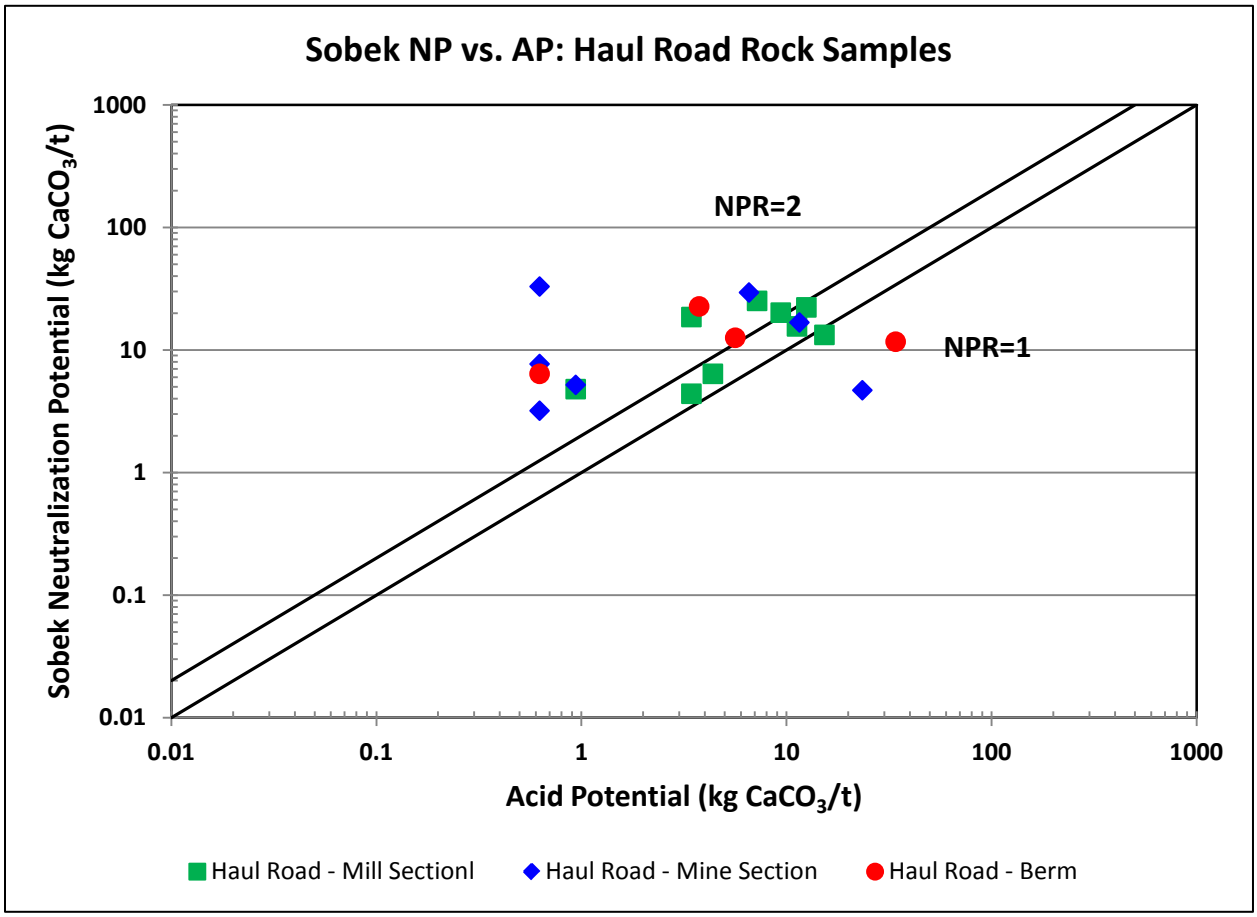


Figure 50: Comparison of AP vs. NP for Haul Road Samples

Haul Road - Mill Section

The paste pH was neutral to alkaline with pH values that ranged from 6.5 to 8.1 with a median of 7.5.

Total sulphur ranged from 0.09 to 0.52% with an average of 0.3%. Sulphate sulphur was relatively low ranging from 0.01 to 0.12% with an average of 0.04%. Sulphide is the main source of sulphur for the majority of the samples with an average value of 0.24%.

The NP of the mill section samples was determined by both Sobek NP and carbonate NP (Carb NP). Sobek NP averaged 18 kg $CaCO_3$/t and Carb NP averaged 14.5 kg $CaCO_3$/t.

The NPR ranged from 0.9 to 15.8 with an average of 2.5. One sample had an NPR <1 and was classified as PAG. Six samples had NPR values between 1 and 2 and were classified as having an uncertain potential for acid generation. Five samples had NPR >2 and were non-PAG.

Fourteen samples were tested for metal concentrations. All samples had elevated concentrations of arsenic and antimony. Seven, four and three samples were enriched in cadmium, lead, and zinc, respectively, when compared to the 10 times crustal abundance values.

Leachates from the three samples collected during the 2013 sampling program exhibited neutral pH ranging from 7.4 to 7.8. Dissolved metal concentrations were generally low. The arsenic concentration in one sample was relatively high compared to the other samples with a concentration of 0.0216 mg/L. For comparison purposes, the CCME freshwater aquatic life guideline is 0.005 mg/L. The SFE testing results are presented in Table GC7 in Appendix F.

Haul Road – Mine Section

Seven samples were collected from the mine section of the Haul Road for ABA analysis. The paste pH was mostly neutral to alkaline except for one acidic sample. The paste pH results ranged from 5.8 to 8.4 with a median value of 6.6.

Total sulphur ranged from 0.03 to 1.18% with an average of 0.3%. Sulphate concentrations were low with an average of 0.1%. Sulphide is the major sulphur species with an average of 0.2%.

Sobek NP averaged 14.3 kg $CaCO_3$/t and Carb NP averaged 10.6 kg $CaCO_3$/t. The Sobek NP and Carb NP of samples were relatively low indicating the materials had a limited acid neutralization capacity.

The NPR values ranged from 0.2 to 52.8 with an average of 2.3. One sample had an NPR <1 and was classified as PAG. One sample had NPR between 1 and 2 and was classified as having an uncertain acid generating potential. Five samples were classified as non-PAG with NPR >2. The NP vs. AP distribution for the Haul Road Mine Section samples is plotted in Figure 50.

Fifteen samples collected from the Mine Section of the Haul Road were analyzed for metals. As previously stated, enrichment is defined as equal to or higher than 10x the average crustal abundance. All samples were enriched in arsenic, bismuth and antimony. The majority of samples were enriched in cadmium and lead, while seven samples were enriched in zinc.

Short-term leachate tests completed on six samples had relatively low metal concentrations with the exception of arsenic. Four samples had arsenic concentrations less than the CCME guideline for freshwater aquatic life (0.005 mg/L), but two leachate samples had concentrations of 0.0156 mg/L and 0.0278 mg/L.

Haul Road - Berm

Four Haul Road samples were collected from the berm for ABA analysis. The paste pH was neutral with values that ranged from 6.3 to 7.7 with a median of 7.4.

Total sulphur ranged from 0.05 to 1.28% with an average of 0.48%. Sulphate sulphur contents were low with an average of 0.13%. Sulphide was the primary form of the sulphur in the majority of the samples. The average sulphide sulphur content was 0.35%.

Samples exhibited low Sobek NP with an average of 13.4 kg $CaCO_3$/t and low Carb NP with an average of 11.3 kg $CaCO_3$/t.

The NPR ranged from 0.3 to 10.2 with an average of 1.2. One sample had NPR <1 and was classified as PAG. The remaining three berm samples were non-PAG (NPR >2). The NP vs. AP distribution for the Haul Road berm samples is presented graphically in Figure 50.

Ten samples collected from the Haul Road berm were analyzed for multi-element content. The term elevated is defined as 10x or higher than the average crustal abundance, and the concentrations of antimony, arsenic, cadmium, lead and zinc were elevated in all 10 samples.

Four of the 10 samples were submitted for SFE tests and the results are presented in Table GC7 in Appendix F. The elevated zinc concentration of 1.61 mg/L was identified in the leachate from the solid sample with high zinc content. Arsenic concentration in this leachate was 0.0128 mg/L which was relatively higher compared to arsenic concentrations in the leachates from other samples.

Summary of Haul Road Rock Geochemical Characterization

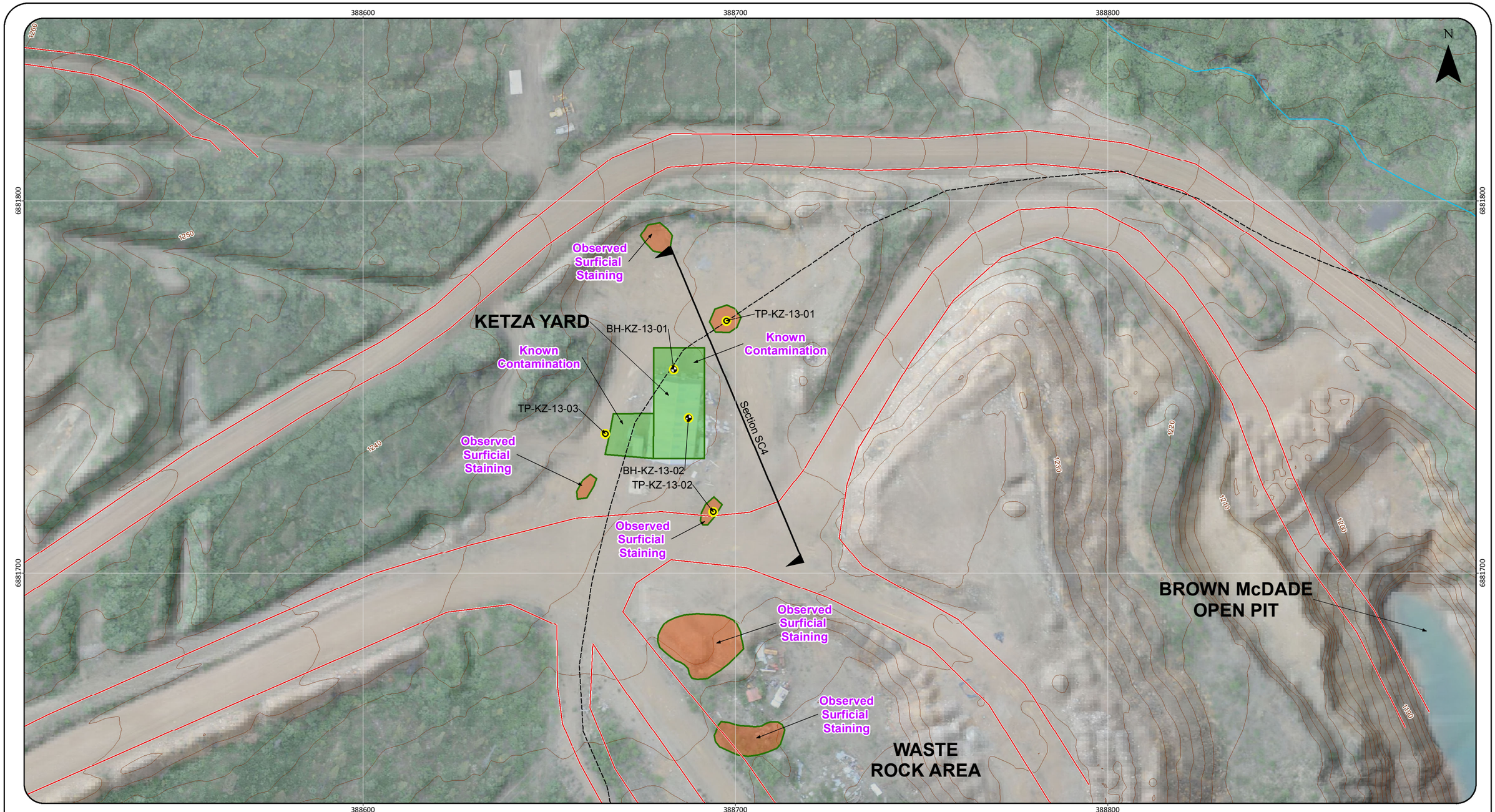
The geochemical characterization results confirm the presence of mine rock in the Haul Road at the majority of the sampling locations. In general, the metal content in the road samples were within the range of metal contents observed from the waste rock samples. All the recent completed test pits contain the waste rock material. The waste rock was identified at TP-R-13-01 up to 1 m depth, while the waste rock was also detected at the deeper locations for TP-R-13-02 (1.5 m) and TP-R-13-03 (2 m).

The distribution of PAG and non-PAG rock is presented in Figure 25. The majority of rock samples from mine section of the Haul Road and the Haul Road berm were non-PAG, although PAG rock was also identified at two sampling locations. The Mill Section of the Haul Road contains mainly uncertain PAG rock with NPR between 1 and 2.

14.2 Ketza Shop Area

Methods for collection and analyses of soil samples from the Ketza Shop Area (Figure 51) are summarized in Section 2 of the Site Investigation Data Report (AMEC, 2013).

Soil samples were collected from two boreholes (BH-KZ-13-01 and BH-KZ-13-02) and three test pits (TP-KZ-13-01, TP-KZ-13-02, and TP-KZ-13-03) in this area (Figure 51). Field screening was conducted on each sample, and selected samples were analyzed for PCOCs, specifically hydrocarbons, metals, and other parameters.



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

- Borehole
- Test Pit
- 2013 Locations
- Order in Council Boundary
- Contour (2 m)
- Disturbed Area
- Roads
- Streams

Site Characterization

- Known Contamination
- Observed Surficial Staining

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MOUNT NANSEN REMEDIATION PROJECT

Figure 51

SITE CHARACTERIZATION REPORT

CONCEPTUAL MODEL FOR SITE CHARACTERIZATION
PLAN VIEW, KETZA YARD AREA

Scale 1:1,000
Metres

0 25 50

March 18, 2014

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Field screening results are presented in Section 3.4.2 and Appendix A of the Site Investigation Data Report. Analytical results for soil samples collected from the Ketza Shop Area for metals, and other parameters are reported below and are summarized in Tables 62, 63 and 64. The laboratory reports are provided in Appendix D of the Site Investigation Data Report.

14.2.1 Hydrocarbons

Historic Data

Previous studies have documented soil staining and hydrocarbon contamination in the Ketza Shop Area (Conor Pacific, 2000; EBA, 2011; EBA, 2012). Analytical results from EBA (2012) confirmed contamination within the footprint of the old Ketza Shop and near the AST directly southwest of the shop, and these areas were adequately delineated by EBA. Soil staining was also observed (but not delineated) near a waste oil container south of the Ketza Shop and near equipment stored north of the shop. The extent of the staining was estimated to be 3 m^2 and 10 m^2, respectively (EBA, 2012).

2013 Fieldwork Results

Field screening results indicated VOC concentrations of 0 ppm (Appendix D of the Site Investigation Data Report) for the samples from all three test pits at the Ketza Shop. These findings indicated low potential for hydrocarbon contamination; therefore, samples from these locations were not analyzed at the laboratory.

At the time of the 2013 fieldwork, the Ketza Shop and its AST had been demolished and removed from the site. The two boreholes advanced in this area (BH-KZ-13-01 and BH-KZ-13-02) were within the footprint of the former Ketza Shop.

The VOC concentrations in BH-KZ-13-01 were above 50 ppm for samples collected from the top 1.0 mbgs, and the sample from 0.0 to 0.5 mbgs had a methane concentration of 1,720 ppm. Although VOC concentrations at BH-KZ-13-02 were low, soil staining was observed to 1.0 mbgs. Samples from both of these locations were analyzed for hydrocarbon PCOCs.

The sample from BH-KZ-13-01 at 0.0 to 0.5 mbgs exceeded the CSR–PL standards for VPH, ethylbenzene, toluene, xylenes, LEPH, and HEPH. Levels in the sample below this (BH-KZ-13-01 at 0.6 to 1.0 mbgs) did not exceed the standards for any hydrocarbon parameters.

The sample from BH-MZ-13-02 at 0.0 to 0.5 mbgs exceeded the standards for HEPH. Levels in the sample below this (BH-KZ-13-02 at 0.6 to 1.0 mbgs) did not exceed the standards for any hydrocarbon parameters.

None of the results exceeded HWHRM standards.

Discussion - Hydrocarbons

EBA (2012) delineated hydrocarbon contamination to depths of approximately 0.5 and 1.5 mbgs in the footprint of the Ketza Shop. The 2013 fieldwork indicates that other hydrocarbon contamination is shallow and generally confined to the top 0.5 m (see Figure 52). This is consistent with the results reported by EBA (2012).

The methane observed at BH-KZ-13-01 during field screening might be associated with the insitu degradation of hydrocarbons.

Test pit TP-KZ-13-01 was advanced at the location of a small surface stain that was observed during the 2013 fieldwork. Field screening results indicated no contamination at this location.

Test pit TP-KZ-13-02 was within 5 m of the soil staining from the waste oil drum south of the Ketza Shop. No indications of contamination were observed in samples from this test pit. Our findings support the conclusions of EBA (2012), that contamination at this location is likely shallow, localized and affects approximately 5 m^3 of soil.

Test pit TP-KZ-13-03 was advanced at the location of an overflowing waste oil drum that was onsite at the time of the 2013 fieldwork. The location of this drum is different from that of the waste oil drum noted by EBA (2012), and it is unclear whether this is the same drum. Our field results did not indicate any contaminated soil at this location.

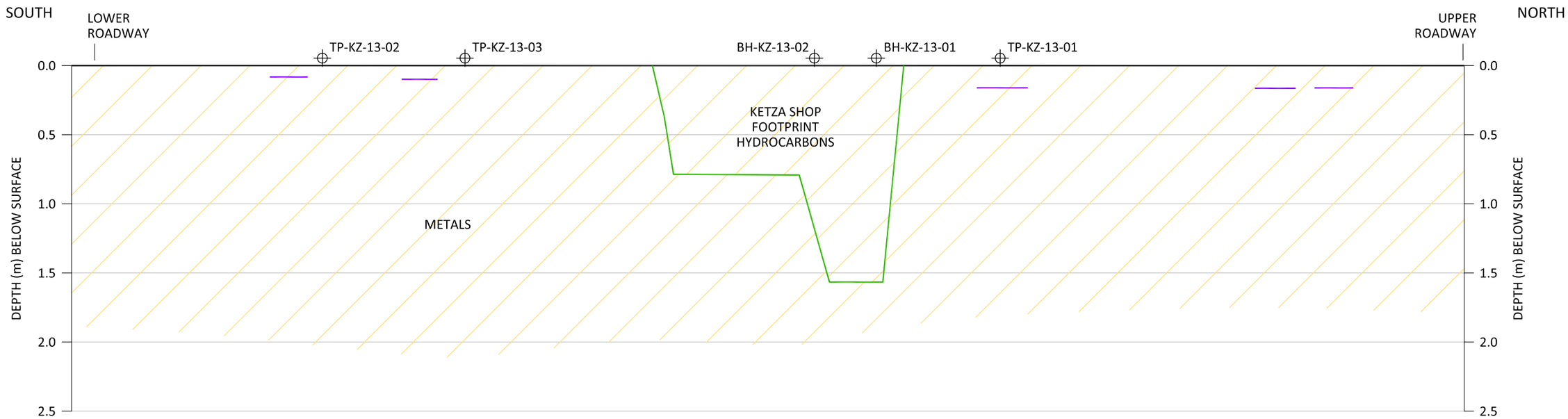
During the 2013 fieldwork, no visible staining or hydrocarbon odours were noted in the area where EBA (2012) had identified staining from equipment stored north of the Ketza Shop footprint. Consequently, this was not identified as an area of concern during the 2013 fieldwork. If contamination remains and is not observable from the surface, then it is likely localized and small volume, as EBA concluded.

14.2.2 Metals

The previous report by EBA (2012) documented metals contamination in the soil of the Ketza Shop Area. Further studies were recommended to characterize the metals concentrations prior to remediation. There is concern that the Ketza Shop Area has been backfilled using waste rock and tailings material with high metals concentrations.

Field screening identified rust staining in samples from the two boreholes and three test pits at the Ketza Shop Area. Additionally, pyrite was observed in the top 1.0 mbgs of TP-KZ-13-02.

Six samples from BH-KZ-13-01 and BH-KZ-13-02 were analyzed for total metals (Table 63). Two of these samples (BH-KZ-13-01 at 2.1 to 2.5 mbgs and at 3.1 to 3.5 mbgs) were only analyzed for arsenic.



Data Source:
Refer to Figure 51 for Cross-Section Alignment

Datum: NAD 1983 CSRS UTM Zone 8N

Legend:

CONFIRMED BOUNDARY

OBSERVED SURFICIAL STAINING
HYDROCARBON CONTAMINATION
METALS CONTAMINATION

0m 0.5 1.0 1.5m
(VERTICAL, APPROX.)

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MOUNT NANSEN REMEDIATION PROJECT
Figure 52

SITE CHARACTERIZATION REPORT

Conceptual Model for Site Characterization Cross-Section, Ketza Shop Area

0m 10 20 30 40m

MARCH 17, 2014

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All but one sample had metals concentrations that exceeded applicable CSR–PL standards. A summary of the exceedances is presented below.

- Arsenic concentrations in all six samples from the Ketza Shop Area exceeded the CSR-PL standard (20 mg/kg). The exceedances ranged from 83.9 mg/kg to 523 mg/kg;
- Antimony concentrations in two of the four samples tested exceeded the CSR-PL standard (15 mg/kg). The concentration in BH-KZ-13-01 at 0.0 to 0.5 mbgs was 25.9 mg/kg, and that in BH-KZ-13-02 at 0.0 to 0.5 mbgs was 33.9 mg/kg;
- Cadmium concentrations in one of the four samples exceeded the CSR-PL standard (1.5 mg/kg). The concentration in BH-KZ-13-01 at 0.0 to 0.5 mbgs was 4.17 mg/kg;
- Lead concentrations in two of the four samples exceeded the CSR-PL standard (100 mg/kg). The concentration in BH-KZ-13-01 at 0.0 to 0.5 mbgs was 231 mg/kg, and the concentration in BH-KZ-13-02 at 0.0 to 0.5 mbgs was 270 mg/kg; and
- Zinc concentrations in two of the four samples exceeded the CSR-PL standard (150 mg/kg). The concentration in BH-KZ-13-01 at 0.0 to 0.5 was 307 mg/kg, and the concentration in BH-KZ-13-02 at 0.0 to 0.5 was 170 mg/kg.

According to the Special Waste Regulation (YG, 1995), no analysis of these samples for leachable metals was warranted.

Other than arsenic, all detected metals exceedances were within the top 0.5 m of soil. Field screening results and observations indicate that metals contamination is relatively consistent across the soil of the Ketza Shop Area.

14.2.3 Other Parameters

There is concern that the shop may have been built on tailings or waste rock materials that contain cyanide. Therefore, a sample from borehole BH-KZ-13-01 at 0.0 to 1.0 mbgs was analyzed for weak acid dissociable cyanide and a sample from borehole BH-KZ-13-02 at 0.0 to 0.5 mbgs was analyzed for weak acid dissociable and total cyanide (Table 64). All concentrations were below laboratory detection limits and applicable CSR–PL standards. These analytical results do not indicate cyanide contamination in the soils of the Ketza Shop Area

14.2.4 General Ketza Shop Area Characterization Summary

EBA (2012) delineated hydrocarbon contamination within the Ketza Shop to depths of approximately 0.5 and 1.5 mbgs. The 2013 fieldwork results indicate that hydrocarbon contamination is present in shallow (<0.5 mbgs) pockets in the Ketza Shop Area. Levels of metals contamination are consistent across the Ketza Shop Area and are confined to the top 0.5 mbgs. Arsenic contamination generally decreases with depth. Possible cyanide contamination in the Ketza Shop Area (from the potential placement of tailings) was investigated and the analytical results indicated that there is no cyanide contamination associated with the material beneath the shop.

15.0 BORROW AREAS

15.1 Onsite Sand Borrow Area

Sand borrow areas surround the Tailings Facility, and were used in the 1990s for construction of the tailings dam and supporting earth structures as shown in Figure 32. Presently, there are two exposed sand borrow areas around the periphery of the Tailings Facility. There were three additional sand borrow areas used in dam construction that are now covered with tailings.

Appendix E1 contains the summary of the sand borrow area sieves completed in the various sand borrow areas. Three sieves were performed on the borrow upstream of the Tailings Facility in 2013. The soil is dominantly fine-grained sand with less than 10% passing the #200 sieve. To date, no sieves have been completed for the downstream sand borrow area, but visually observation suggests the gradation is similar to the upstream borrow, with trace 10% fines. Trace 25 to 75 mm diameter rocks were encountered in the borrow material, with no soil of gradation between the fine sand and coarse gravel. These rocks were angular, oxidized red coloured on surface, and generally hard to break.

Structure was evident within the test pits. Thin 0.5 mm to 2 mm thick dark coloured laminations spread from 5 mm to 10 mm apart are present throughout most of the area. The unfrozen soil is generally loose to compact in density and easy to excavate. The test pits sloughed significantly such that where a 5 m test pit would be 9 m in diameter on surface. The top 1 m to 2 m would be vertical, and the lower 3 m to 5 m would slough to approximately 1 Horizontal:1 Vertical slopes in the test pit.

Permafrost was encountered approximately 4 to 5 m depth in the downstream Tailings Facility borrow. The permafrost was well bonded with no excess ice (Nbn classification). MW09-11 drilled by AECOM in 2009 indicated permafrost at 4.2 m depth at the time of drilling in the upstream borrow area.

The depth to groundwater was approximately 3 m depth in the downstream borrow area. MW09-11 drilled by AECOM in 2009 indicated groundwater at approximately 2 m depth at the time of drilling in the upstream borrow area. Above the groundwater table, the soil is typically dry to damp. Moisture content tests performed by Klohn indicated a moisture content of approximately 15 to 30%.

No useful sources of fine grained borrow suitable for a low permeability cover have been identified at the site, or in the vicinity.

15.2 Offsite

Approximately 25 km east of the Mount Nansen site, within 1 km of the Mount Nansen Road, is a glaciolacustrine deposit (EBA, 2009). During the September 2013 site visit, AMEC/AE completed soil tests pits in this area. The soils are comprised of silty clay loam glaciolacustrine sediments located in the western margins of the Pleistocene glaciation. A permafrost table was encountered at approximately 40 cm below ground surface (Table 1). The location of this material is approximately 800 m from the Mount Nansen Road, through undulating terrain. This area was forested with trees that are upwards of 200 years.

15.3 Geochemical Characterization

15.3.1 Geochemical Sampling Program

Borrow areas were identified and previously utilized for the tailings dam; however, geochemical characterization was not performed on those borrow materials. To understand the geochemistry of the borrow material, soil samples were selected from the completed test pits and submitted for geochemical testing.

Three pits were excavated at the sand borrow area located downstream of the tailings pond and two hand augers were advanced in the sand borrow area upstream of the tailings storage facility. Three locations were also excavated at the shale area near the road during the 2013 site investigation program. A total of 22 samples were selected for geochemical testing. Twelve samples were collected from depths of 1 m to 5 m in three test pits located in the sand borrow area downstream of the tailings pond. Six samples from two hand auger pits in the sand area upstream of the tailings storage facility were also submitted for geochemical testing. Samples from the hand auger pits were collected at depths ranging from 1 m to 3 m. Four samples were selected from three test pits in the shale borrow area located near the road. Due to hard ground conditions which limited the excavation depth, the shale borrow area test pits were relatively shallow, with a maximum depth of approximately 1 m[3].

All samples were analyzed for ABA and 20 samples underwent elemental metals testing. Nine of 22 samples were selected for leachable metals analysis using the SFE testing method.

The summary of the geochemistry sampling program on the borrow areas is presented on Table 71.

[3] The intent of the test pits was to assess the ripability of the material with the small excavator and generally qualitatively assess the potential for competent gravel borrow; deep test pits were not expected.

Table 71: Summary of Geochemical Tests for the Borrow Material Areas

Location	Borehole ID	Number of Samples	Geochemistry Testing		
			ABA	Metal	Leachable Metal
Sand Material – Upstream of Tailings Pond	HA-BA-13-01	3	3	2	1
	HA-BA-13-02	3	3	2	1
Sand Material – Downstream of Tailings Pond	TP-BA-13-03	4	4	4	2
	TP-BA-13-04	4	4	4	2
	TP-BA-13-05	4	4	4	2
Shale Material – Near the Road	TP-BA-13-06	1	1	1	
	TP-BA-13-07	2	2	2	1
	TP-BA-13-08	1	1	1	
Total		**22**	**22**	**20**	**9**

15.3.2 Geochemical Testing Results of Borrow Material

The summary of the ABA testing results is presented in Table 72. All borrow material samples had consistent neutral to alkaline paste pH value that ranged from 7.16 to 9.13. Total sulphur contents were consistently low throughout all of the samples with values ranging from lower than the MDL (<0.01%) to 0.09%. With the exception of one sample, the Sobek NP and Carb-NP of all samples were generally low with values less than 10 kg $CaCO_3$/t. One sample had Sobek NP and Carb NP of 31.5 kg $CaCO_3$/t and 53.3 kg $CaCO_3$/t, respectively.

Table 72: Summary of Acid Base Accounting Results for Borrow Material Samples

Sample	Paste pH	TIC	S(T)	$S(SO_4)$	Calculated $S(S^{-2})$	Carb NP	AP	NP	NPR	Carb NPR
		%				kg $CaCO_3$/t				
Count	22	22	22	22	22	22	22	22	22	22
Minimum	7.16	0.01	<0.01	<0.01	<0.01	0.80	0.31	1.40	4.48	2.56
Maximum	9.13	0.64	0.08	0.09	0.01	53.3	0.31	31.5	100.8	170.7
Mean	8.63	0.06	0.02	0.01	0.01	5.37	0.31	6.85	21.9	17.2
Standard Deviation	0.52	0.13	0.02	0.02	0.00	10.92	0.00	6.00	19.20	34.93
Median	8.76	0.03	0.01	0.01	0.01	2.50	0.31	5.10	16.32	8
10^{th} Percentile	8.01	0.01	0.01	0.01	0.01	0.80	0.31	3.13	10.02	2.56
25^{th} Percentile	8.52	0.02	0.01	0.01	0.01	1.67	0.31	4.33	13.84	5.33
75^{th} Percentile	9.03	0.07	0.01	0.01	0.01	5.83	0.31	8.63	27.60	18.67
90^{th} Percentile	9.07	0.08	0.02	0.01	0.01	6.58	0.31	9.44	30.21	21.07

All NPR results were greater than 2 with values ranging from 4.5 to 100.8. Based on these results, all borrow materials were classified as non-PAG material according to MEND criteria (Figure 53). Distribution of PAG and non-PAG at the potential borrow area is presented on Figures 42 and 54.

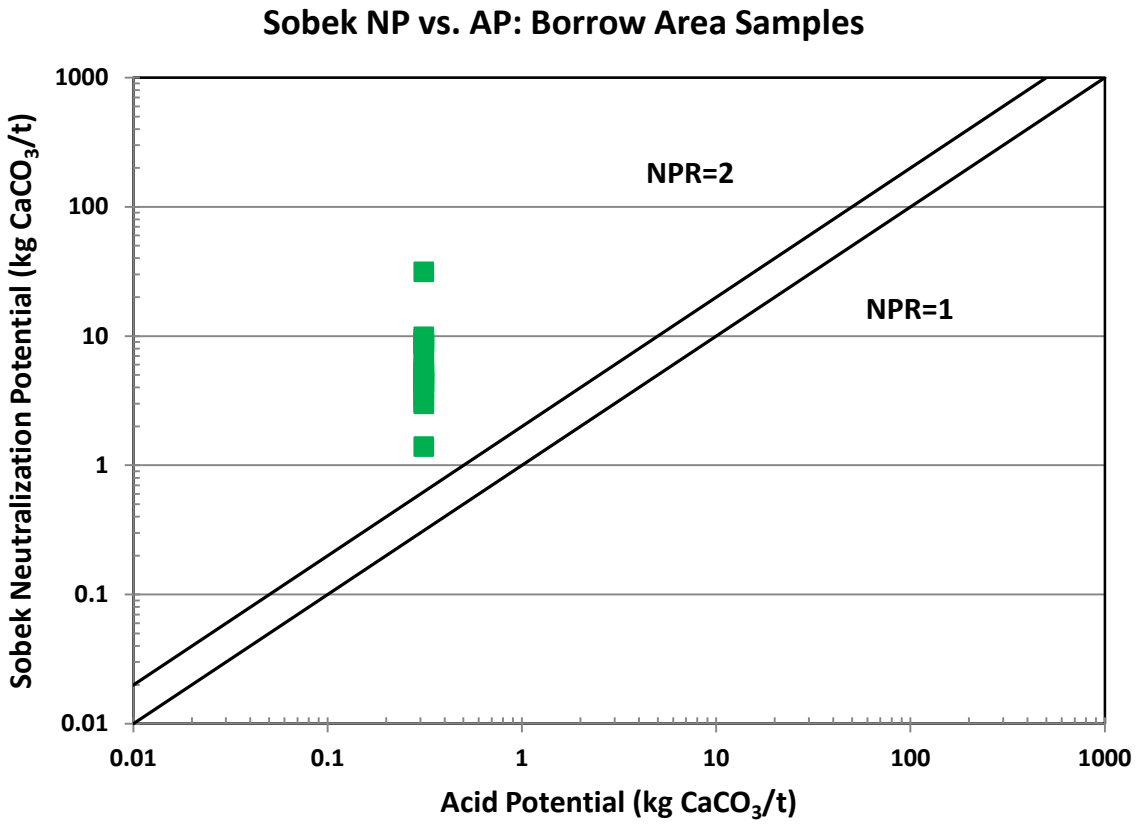
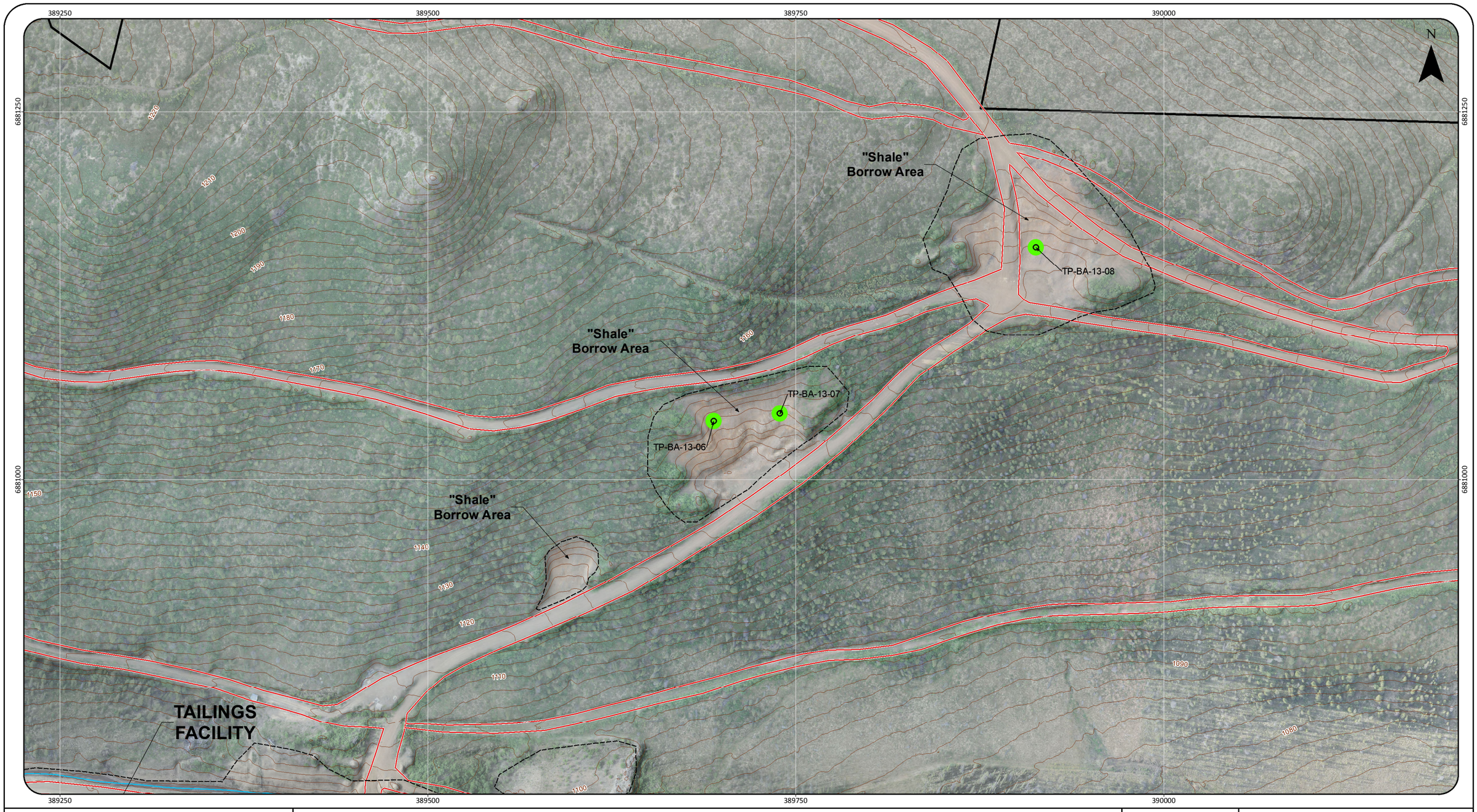


Figure 53: Comparison of AP vs. NP for Borrow Material Samples



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

ARD Classification

- PAG
- Non-PAG
- Uncertain

Testhole

- Test Pit

- Order in Council Boundary
- Contour (2 m)
- Disturbed Area
- Roads
- Streams

Associated Engineering — Global Perspective. Local Focus.

amec

Yukon Energy, Mines and Resources
Assessment and Abandoned Mines

MOUNT NANSEN REMEDIATION PROJECT
Figure 54

SITE CHARACTERIZATION REPORT

TAILINGS FACILITY
GEOCHEMISTRY SHALE BORROW AREA

Scale 1:2,500
Metres
0 50 100

March 18, 2014

S:\PROJECTS\VM00605 - Mount Nansen\GIS\Mapping\VM00605_0020c_11x17_SiteCharacterizationReport_Geochem_ShaleBorrowLocations.mxd

The elemental content for the borrow material samples were determined by strong acid digestion followed by an ICP-MS scan. Results of the metal testing from 20 samples of borrow material were compared to average crustal concentrations and were considered elevated if they were greater than ten times the crustal average. In addition, metal concentrations in samples were compared to the CSR-PL.

The summary of testing for the selected parameters was presented in Table 73. Complete results are given in Appendix F.

Table 73: Summary of Acid Base Selected Metal Results for Borrow Material Samples

Statistic	As	Ba	Bi	Cd	Cr	Mo	Sb	Zn
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
10 times average crustal content	18	4,250	0.085	1.5	1,020	12	2	700
CSR-PL	15	500	N/A	1.5	60	10	20	150
Count	20	20	20	20	20	20	20	20
Minimum	4	1,040	0.06	0.09	73	3.9	0.8	25
Maximum	310	2,270	0.43	4.56	213	15.6	18.4	452
Mean	60.7	1,212	0.137	0.7	120	5.9	5.1	95
Standard Deviation	78	275	0.108	1.21	32	2.5	5.5	129
Median	21.5	1,140	0.09	0.22	113	5.5	2.8	42
10^{th} Percentile	5	1,060	0.07	0.11	99	4.2	0.8	28
25^{th} Percentile	11	1,085	0.07	0.12	107	5	1.1	31
75^{th} Percentile	91.8	1,183	0.153	0.39	118	5.7	6.7	66
90^{th} Percentile	165.3	1,284	0.292	2.75	168	6.9	11.8	271

All samples had elevated bismuth content. Arsenic enrichment was identified in eight of 13 samples from the sand borrow downstream of the tailings pond and two of three samples from the shale borrow area. One sample from the sand borrow downstream of the tailings pond had cadmium and molybdenum enrichment. Elevated cadmium was detected in two samples from the shale borrow area. In general, metal concentrations were lower in samples at the sand borrow upstream of the tailings pond than in other samples.

Barium concentrations in all samples from sand and shale borrow areas were above the CRS-PL values. One sample from the sand borrow downstream of the tailings pond and all three samples from the shale borrow area also had zinc concentrations greater than the CSR-PL value (150 mg/kg). Arsenic concentrations above the CSR-PL value (20 mg/kg) were reported in eight of 13 samples from the sand borrow downstream of the tailings pond and two samples from the shale borrow area. Molybdenum concentrations in one sample from the sand borrow downstream of the tailings pond were above the CSR-PL value (10 mg/kg). Cadmium concentrations in two samples from the shale borrow area and concentrations in one sample from the sand borrow downstream of the tailings pond exceeded the CSR-PL value of 1.5 mg/kg.

Leachates of borrow material samples exhibited neutral pH in the range of pH 7.15 to 7.83. Dissolved metal concentrations in the SFE leachates were generally low. Arsenic concentrations ranged from 0.001 to 0.0141 mg/L. Arsenic concentrations in the leachates from

four samples of the sand borrow downstream of the tailings pond were above the CCME value of 0.005 mg/L. The maximum arsenic concentration was identified on the sample from TP-BA-13-03 at 3.5 to 3.6 m depth interval. The summary of SFE testing is presented in Table GC8 in Appendix F.

In summary, the identified borrow materials were non-PAG. The metal contents were generally low; however, arsenic and barium contents in these soil samples were higher than the CSR-PL values for those parameters. Metal data in the background soil indicated that the elevated arsenic contents above the CSR-PL value were also measured in the background soil.

16.0 TRENCHES AND CLEARINGS

16.1 General Inventory and Description

There are numerous exploration trenches within the OIC that are visible as long linear features, typically clustered around a mineralized zone of interest (LORAX, 2011). The trenches were created by pre-stripping the top 0.5 m of vegetation and soil with a bulldozer, and trenching from 1 to 3 m deep and side-casting this material with an excavator (LORAX, 2011). The trenches are approximately 1 m wide and of variable length; however, detailed mapping or ground-truthing of the trenches has not been conducted to date. During the September 2013 site investigation, exposed nutrient poor substrates in the trenches were observed. If perpendicular to a slope, many of the exploration trenches have become preferential paths for watercourses, which have resulted in formation of minor erosion rills.

16.2 Geochemical Characterization

In May 2013, the runoff water from exploration trenches was sampled and tested for water quality. The first sampling point is named Trench above Mill Road 01 and the other sampling point is named Trench above Mill Road 02 (Figure 48). The purpose of sampling runoff water is to aid in developing the geochemical source term for the exploration trenches.

A summary of the results is presented in Table 74. The water quality of the samples was compared against MMER effluent discharge criteria and CCME guidelines for the protection of aquatic life.

Table 74: Summary of Water Quality Results for Runoff Samples from Trenches Area

Parameters	Unit	CCME	Trench Above Mill Road 01	Trench Above Mill Road 02
			May 22, 2013	May 23, 2013
Physical Tests				
Conductivity	(µS/cm)		27.2	24.1
Hardness (as $CaCO_3$)	(mg/L)	-	14.0	14.7
pH	Units	6.5-9.0	6.93	***5.82***
Anions and Nutrients				
Acidity (as $CaCO_3$)	(mg/L		4.3	11.3
Alkalinity, Total (as $CaCO_3$)	(mg/L)		10.5	7.6
Chloride (Cl)	(mg/L)		<0.50	<0.50
Fluoride (F)	(mg/L)		0.020	<0.02
Nitrate (as N)	(mg/L)		0.0217	0.0191
Nitrite (as N)	(mg/L)		<0.001	<0.001
Sulphate (SO_4)	(mg/L)	100	1.91	<0.50
Metals				
Aluminum (Al)-Dissolved	(mg/L)	0.1	**0.252**	**0.560**
Antimony (Sb)-Total	(mg/L)	0.02	0.0011	0.00055
Arsenic (As)-Total	(mg/L)	0.005	**0.0206**	0.00444
Barium (Ba)-Total	(mg/L)		0.041	0.045
Beryllium (Be)-Total	(mg/L)		<0.001	<0.001
Boron (B)-Total	(mg/L)		<0.10	<0.10
Cadmium (Cd)-Total	(mg/L)		0.000074	0.000143
Calcium (Ca)-Total	(mg/L)		4.94	4.40
Chromium (Cr)-Total	(mg/L)		0.0019	<0.001
Cobalt (Co)-Total	(mg/L)		0.00119	0.00032
Copper (Cu)-Total	(mg/L)	0.004	**0.0057**	**0.0058**
Iron (Fe)-Total	(mg/L)	0.3	**3.0**	**0.50**
Lead (Pb)-Total	(mg/L)	0.007	0.0023	0.0013
Lithium (Li)-Total	(mg/L)		<0.01	<0.01
Magnesium (Mg)-Total	(mg/L)		1.47	0.90
Manganese (Mn)-Total	(mg/L)	0.2	0.13	0.04
Mercury (Hg)-Total	(mg/L)	0.000026	0.000015	**0.000026**
Molybdenum (Mo)-Total	(mg/L)	0.073	<0.001	<0.001
Nickel (Ni)-Total	(mg/L)	0.15	0.0015	0.0018
Potassium (K)-Total	(mg/L)		<2.0	<2.0
Selenium (Se)-Total	(mg/L)	0.001	<0.0001	<0.0001
Silver (Ag)-Total	(mg/L)	0.0001	0.000075	0.000060
Sodium (Na)-Total	(mg/L)		<2.00	<2.00
Thallium (Tl)-Total	(mg/L)	0.0008	<0.0002	<0.0002
Tin (Sn)-Total	(mg/L)		<0.001	<0.001
Titanium (Ti)-Total	(mg/L)		0.082	0.012
Uranium (U)-Total	(mg/L)		<0.0002	<0.0002
Vanadium (V)-Total	(mg/L)		0.0072	0.0011
Zinc (Zn)-Total	(mg/L)	0.03	0.013	0.012

Bold values exceed CCME water quality guidelines for the protection of freshwater aquatic life.

The Trench above Mill Road 01 sample had elevated dissolved aluminum, total arsenic, total copper and total iron concentrations greater than the CCME guidelines. The Trench above Mill Road 02 sample had dissolved aluminum, total copper and total iron concentrations greater than the CCME guidelines, in addition to pH below the relevant guideline and a total mercury concentration equal to the relevant guideline. All concentrations were less than MMER discharge criteria.

Based on the water quality data, runoff from the exploration trenches is contributing some elevated metals to downstream water bodies that should be considered in the site water quality modelling and trench reclamation assessment.

17.0 LIMITATIONS AND CLOSURE

This report was prepared exclusively for Assessment and Abandoned Mines, Energy Mines and Resources by AMEC Environment & Infrastructure, a wholly owned subsidiary of AMEC Americas Limited. The quality of information, conclusions and estimates contained herein is consistent with the level of effort involved in AMEC services and based on: i) information available at the time of preparation, ii) data supplied by outside sources, and iii) the assumptions, conditions and qualifications set forth in this report. This report is intended to be used by Assessment and Abandoned Mines, Energy Mines and Resources only, subject to the terms and conditions of its contract with AMEC. Any other use of, or reliance on, this report by any third party is at that party's sole risk.

Yours truly,

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16 April 2014

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AMEC ENVIRONMENT & INFRASTRUCTURE
SIGNATURE
Date 16 April 2014
PERMIT NUMBER PP130
Association of Professional Engineers of Yukon

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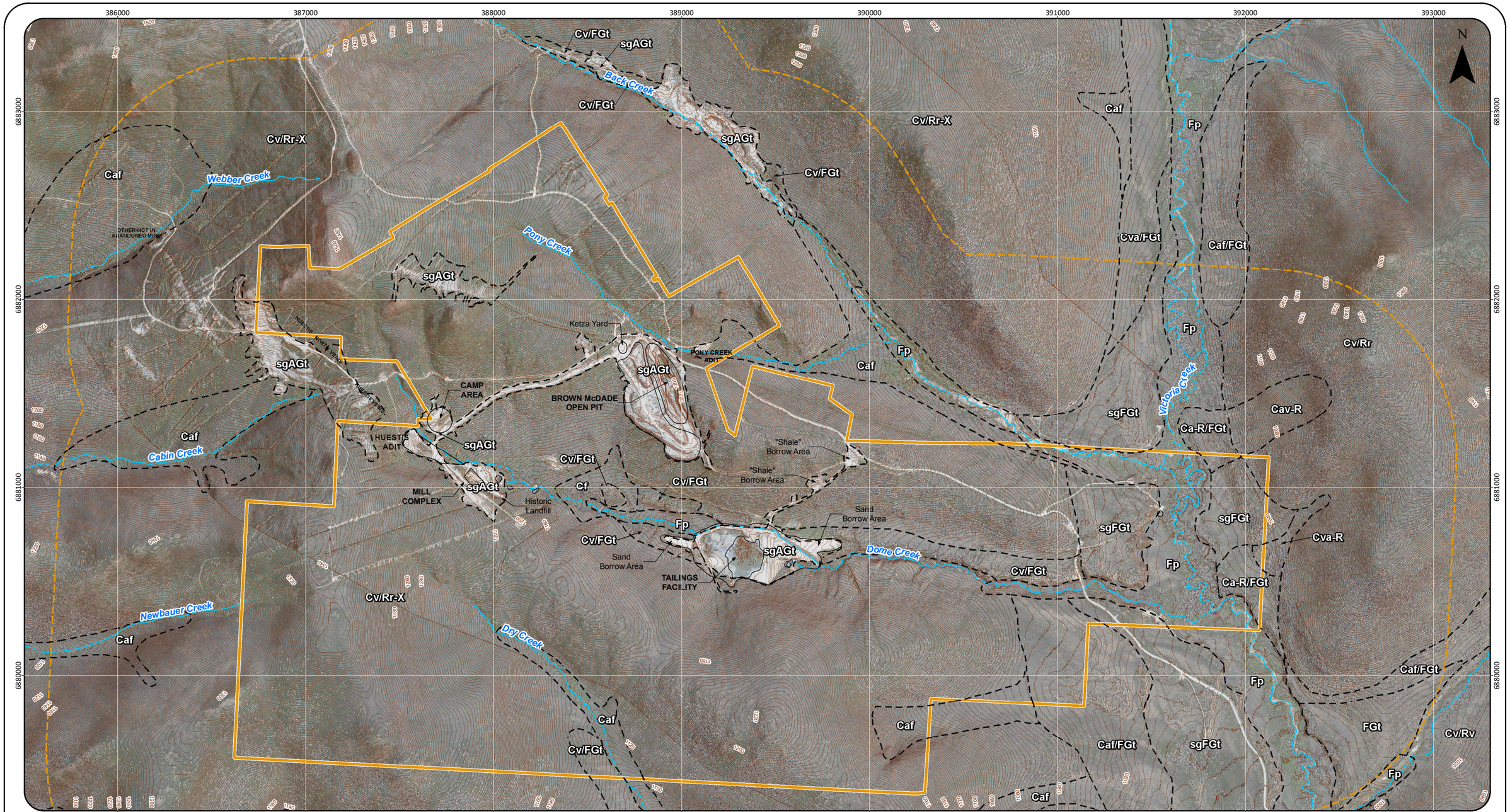
APPENDIX A

Terrain Map



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Terrain mapping/polygons are generally based on regional scale mapping conducted by EBA (2009), supplemented with additional detailed mapping based on review of LiDAR imagery and stereo airphotos A28154-113-117 and 144-145.

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

- Local Study Area
- Order in Council Boundary
- Terrain Polygon
- Contour (2 m)
- Streams

Terrain Unit Symbol

surficial material → sgFGt - Rb ← geomorphological process sub-class
texture →
surface expression →
geomorphological process

Cv/FGt indicates that Cv overlies FGt

Materials

A	Anthropogenic	Areas of cuts and/or fills in soil and bedrock where the original ground topography has been modified by human activity
C	Colluvium	Products of gravitational slope movements, materials derived from local bedrock and major deposits derived from drift, includes talus and landslide deposits. Includes up to 20% bedrock
F	Fluvial Sediments	Silts, sands and gravels transported and deposited by streams and rivers; floodplains, terraces and alluvial fans
FG	Glaciofluvial Sediments	Sands and gravels transported and deposited by meltwater streams; includes kames, eskers and outwash plains
R	Bedrock	Outcrops and bedrock within a few centimetres of the surface Includes up to 20% colluvium

Texture

s	Sand	62.5 micro-m - 2mm
g	Gravel	Mixture of pebbles (p), cobbles (k), boulders (b) and up to 20% of sand

Geomorphological Processes

R	Lanslide	Landslide
X	Permafrost processes	Processes related to the presence of permafrost, permafrost aggradation and degradation

Surface Expression

a	Apron	Soil of variable thickness over bedrock, typically thin at upper elevations and thickening downslope, often transitional to veneer or fan
f	Fan	A fan-shaped surface that is a sector of a cone, slopes 3-15deg (5-27%)
p	Plain	Flatlying terrain with very low relief (0-3° slope)
r	Ridge	Linear rises with many slopes >15°
t	Terrace(s)	Stepped topography and benchlands
v	Veneer	Thin deposits of soil (<1-2m) derived from underlying material (soil or bedrock) with topography controlled by the underlying material

Associated Engineering — Global Perspective. Local Focus.

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Assessment and Abandoned Mines

MOUNT NANSEN REMEDIATION PROJECT
Figure A1

SITE CHARACTERIZATION REPORT

TERRAIN MAPPING

Scale 1:20,000
Metres
0 500 1,000

March 18, 2014

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APPENDIX B

Permafrost Assessment

B. Evolution and Prediction of Permafrost Within Study Area from 1967 to 2050

B.1 Introduction

In support of site characterization efforts for the Mount Nansen site, a permafrost map showing existing conditions is required. Prediction of the permafrost conditions for various periods has also been completed to understand the thermal regime in support of design activities. This assessment involved the following steps:

1. identification of terrain districts based on aerial photograph interpretation. The air photographs used for the interpretation are shown on the sketch titled Mount Nansen Select Air photo Flight Lines;
2. determination and calculation of the surface conditions and soil physical and thermal parameters for each of the identified terrain districts for various periods of the mine activity and closure. The surface conditions and soil properties are required for assessment of the mean annual soil temperature, permafrost thickness, active layer thickness, and seasonal frost penetration thickness;
3. analytical and numerical calculations of the thermal soil parameters listed above for various periods of the mine activity and closure; and
4. transferring the results of the analytical and numerical calculations for various periods of the time to the map of identified terrain districts and development of the legend for the maps.

B.2 Aerial Photograph Interpretation

The purpose of the aerial photograph interpretation was to identify terrain districts which differ from each other by morphological features (slope steepness and aspect) vegetation (spruce forest, tall willow shrubs, dwarf shrubs, moss, cereal grass), and soil origin and composition. Identification of terrain units in a 3-dimensional format was carried out with the use of SOKKIA mirror stereoscope MS16 with magnification of 1.5. Contact prints of black and white aerial photographs scale 1:20,000, taken on September 30, 1994 were interpreted. Figure B-1 shows the interpreted study area. The following inferred characteristics were analyzed during the air photo interpretation: slope aspect and gradient, overburden thickness, and vegetation type. A site visit was made prior to completing this work, however, only for the purposes of a general reconnaissance. Data from the existing thermistors have also been evaluated and considered in this assessment. The area covered by thermistors is limited, however, and is concentrated in the disturbed area around the Tailings Facility. Specific field reconnaissance to ground truth the permafrost conditions has been undertaken as part of the aerial photograph interpretation. Hence, if a ground truth reconnaissance will be carried out in the near future, some deviations and variations of site-specific conditions to the results of the interpretation may be found.

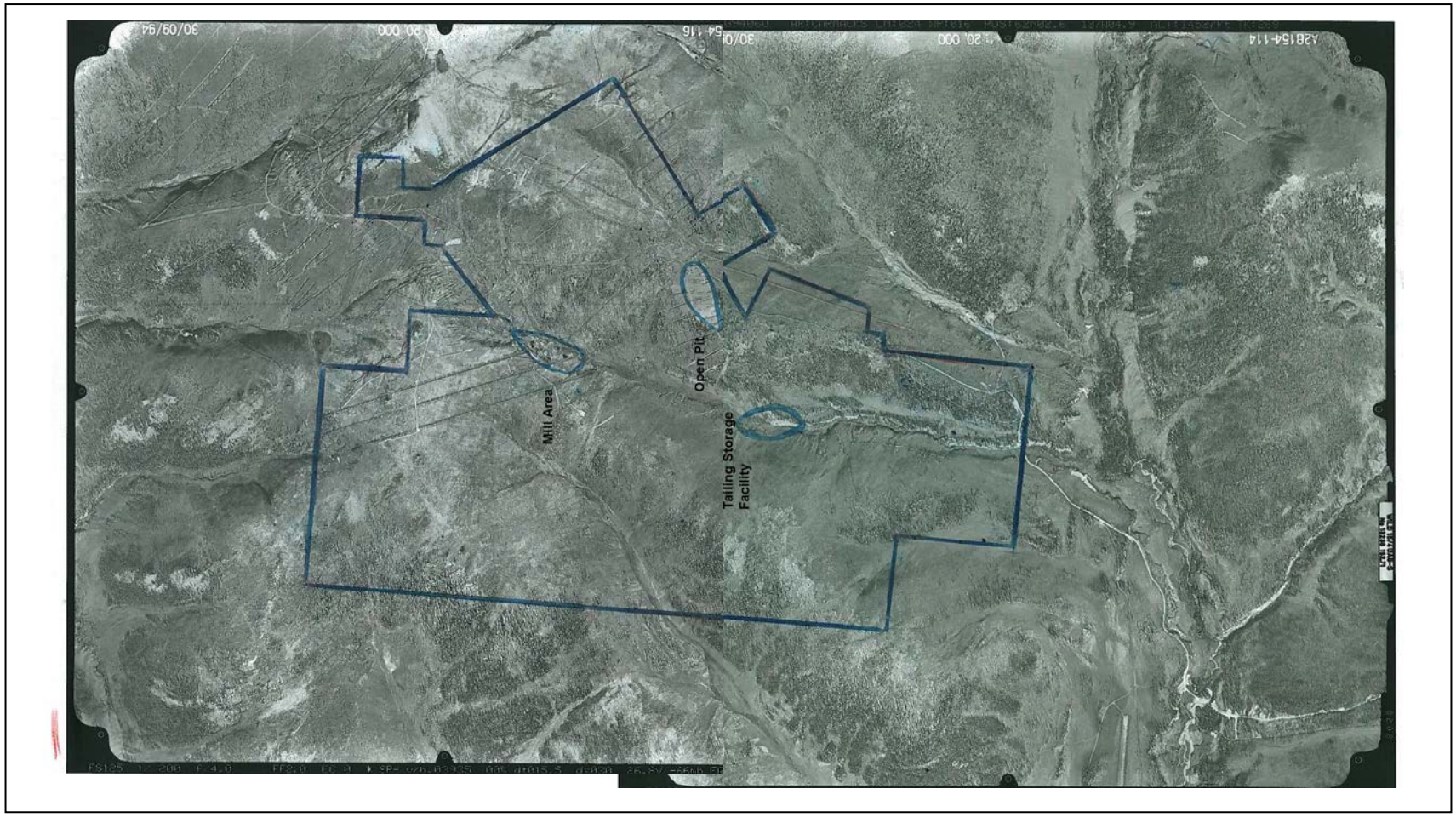

Figure B-1: Interpreted Study Area

B.2.1 Identified Terrain Districts

Eleven terrain districts were identified on the aerial photographs. The origin of the deposits present on steep and medium steep slopes is colluvium, while on gently sloping terrain the deposits are interpreted to consist mainly of eluvium and drift bed. Fluvial sediments were identified within floodplains and upper/lower terraces of creeks. A very brief characterization for each of the identified terrain districts is provided below and comprises part 1 of the legend to the permafrost maps.

1. Medium steep (15-20 degrees) south facing slope. Thickness of the overburden is likely in the range of 5 m to 10 m. Surficial soils mainly comprise sand and gravel. Vegetation consists of open or medium dense spruce forest with shrubs, and ground vegetation is mainly thick moss (sphagnum) cover.
2. Steep south facing slope. Thickness of the overburden is likely less than 5 m. Surficial soils mainly comprise sand and gravel. Vegetation consists of sparse tall willows, dwarf shrubs, various mosses (sphagnum is not dominant), and cereal grasses.
3. Medium steep north facing slope. Thickness of the overburden is likely in the range of 5 m to 10 m. Surficial soils mainly comprise sand and gravel. Vegetation mainly consists of dwarf shrubs, various mosses, and cereal grasses.
4. Steep north facing slope. Thickness of the overburden is likely less than 5 m. Surficial soils mainly comprise sand and gravel. Vegetation mainly consists of dwarf shrubs, various mosses, and cereal grasses.
5. Medium steep east and west facing slope. Thickness of the overburden is likely in the range of 5 m to 10 m. Surficial soils mainly comprise sand and gravel. Vegetation consists of open or medium dense spruce forest with shrubs, and ground vegetation is mainly various mosses.
6. Medium steep east and west facing slope. Thickness of the overburden is likely in the range of 5 m to 10 m. Surficial soils mainly comprise sand and gravel. Vegetation consists of sparse tall willows, dwarf shrubs, various mosses (sphagnum is not dominant), and cereal grasses.
7. Relatively flat surface. Thickness of the overburden is likely in the range of 5 m to 10 m. Surficial soils mainly comprise sand, gravel and a little silt. Vegetation mainly consists of dwarf shrubs, various mosses, and cereal grasses.
8. Relatively flat surface. Thickness of the overburden is likely in the range of 5 m to 10 m. Surficial soils mainly comprise sand, gravel and a little silt. Vegetation consists mainly of open spruce forest with shrubs, and ground vegetation is mainly moss (sphagnum) and cereal grasses.
9. Relatively flat surface at hill summits. Thickness of the overburden is likely less than 5 m. Surficial soils mainly consist of gravel and rock fragments with a little to some sand. Vegetation mainly consists of dwarf shrubs, various mosses, and cereal grasses.
10. Creek floodplain. Thickness of the overburden is likely in the range of 5 m to 10 m or more. Surficial soils presented mainly by sand with some silt. Vegetation consists of insulated spruces, dwarf shrubs, various mosses and cereal grasses.

11. Creek upper and lower terraces. Thickness of the overburden is likely in the range of 5 m to 10 m. Surficial soils presented mainly by sand with some silt. Vegetation consists of open spruce forest, dwarf shrubs and moss (predominantly sphagnum).

B.3 Surface Conditions and Surficial Soil Properties

Calculations were made to estimate the following parameters:

- mean annual soil temperature;
- permafrost and active layer thickness; and
- seasonal frost penetration depth.

Key input parameters for the calculations, include the mean monthly air temperatures and snow depth (mean monthly or maximum for the winter). Characterization of the historical mean monthly temperatures, annual air temperatures and snow thicknesses for Carmacks and Dawson were calculated from data obtained from the website of Government of Canada (2013). Historical mean monthly temperatures and annual air temperatures for the Mount Nansen weather station were provided to AMEC by the Government of Yukon, Assessment and Abandoned Mines, Mount Nansen Weather Data. The maximum snow thickness for the Mount Nansen area was obtained from EDI, 2012. The near future air temperatures were predicted based on information in Maxwell, 1997. A comparison of the results from this approach with the future air temperatures suggested in CSA 2009 is discussed subsequently.

B.3.1 Present Air Temperatures and Snow Cover (2013)

Temperature records for the Mount Nansen weather station were analyzed from year 2000 to 2010. Due to absence of temperature records for year 2006 and 2007, the mean annual air temperatures for these years were calculated by interpolating the mean annual air temperatures for Carmacks and Dawson. Figure B-2 shows the mean annual air temperatures (MAAT) for Mount Nansen from year 2000 to 2010. The monthly air temperatures and MAAT for the Mount Nansen weather station are also tabulated in Table B-1. The burgundy colour indicates the interpolated values for 2006 and 2007 for which the mean monthly air temperatures were adjusted to correspond to the mean annual air temperatures of -3.6ºC and -3.4ºC, respectively.

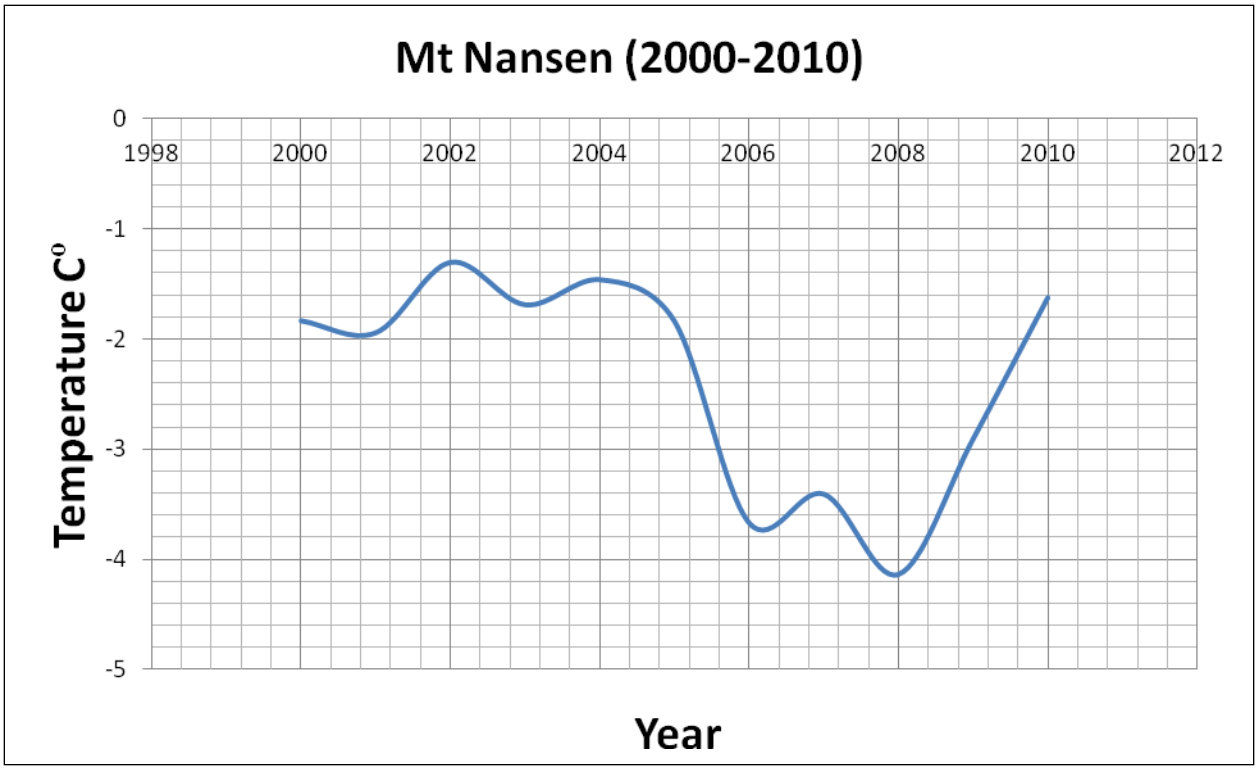

Figure B-2: Mean Annual Air Temperatures for Mount Nansen Weather Station (2000-2010)

Table B-1: Mean Monthly Air Temperature for Study Area

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
2000	-11	-9.0	-6.8	-3.95	2.8	10.5	11.1	8.0	2.6	-2.0	-9.6	-14.3	-1.80
2001	-7.1	-11.8	-8.8	-2.10	2.6	11.1	10.8	11.4	4.9	-4.0	-11.5	-18.7	-1.90
2002	-13	-11.4	-13.3	-6.0	5.0	10.2	12	8.7	5.4	0.9	-3.70	-10.9	-1.30
2003	-14	-9.0	-10.7	-0.9	4.1	8.9	13.4	9.9	2.7	0.5	-9.6	-15.8	-1.70
2004	-22	-8.1	-11.3	-0.7	7.2	15.2	13.1	12.3	1.9	-3.1	-8.8	-13.5	-1.50
2005	-18	-12.3	-4.5	0.8	8.4	11.8	11.1	10.6	5.2	-2.4	-17.3	-15.8	-1.90
2006	-26.4	-20.9	-17.0	-3.5	9.3	18.62	20.8	17.1	6.7	-5.4	-16.3	-26.8	-3.60
2007	-19.9	-15.8	-12.8	-2.6	6.9	14.01	15.7	13.0	5.1	-9.6	-5.6	-29.2	-3.40
2008	-26	-23.3	-13.9	-1.0	8.5	13.8	13.2	9.9	4.7	-8.0	-10.1	-17.3	-4.13
2009	-18	-14.8	-13.1	-2.6	3.7	7.9	14.3	9.2	4.5	-3.20	-12.3	-10.0	-2.90
2010	-13	-7.6	-7.5	-1.3	6.6	9.2	11.1	10.6	3.7	-3.20	-8.80	-18.8	-1.6

Table B-2 presents the calculated mean monthly air temperatures for 2013. These values were used for analyzing the past and future air temperatures and prediction of the soil thermal parameters. The freezing and thawing indexes for 2013 were calculated to be equal 70°C-months and 45.5°C-months, respectively.

Table B-2: Mean Monthly Air Temperatures for Study Area (2013)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
-17.5	-7.8	-9.4	-1.0	6.9	12.2	12.1	11.4	2.8	-3.2	-8.8	-16.2	-1.5

Snow cover data for Mt Nansen was available for the 2011/2012 winter season. Environmental Dynamics Inc. (2012) stated that the maximum snow thickness accumulated within the study area at the end of winter is approximately 66 cm.

B.3.2 Past Air Temperatures and Snow Cover (1967)

Due to the absence of historical climate data for the study area, available air temperatures and snow thickness data for the Towns of Carmacks and Dawson which are in relatively close range to the study area were analyzed to assess the past air temperatures and snow thickness in the study area. In order to eliminate short term fluctuations of the air temperature, annual values for averages of the 10 year mean annual temperatures (10 year slides) were prepared to analyze the air temperature changes in the Towns of Carmacks and Dawson from 2013 to approximately 1967 (Figures B-3 and B-4).

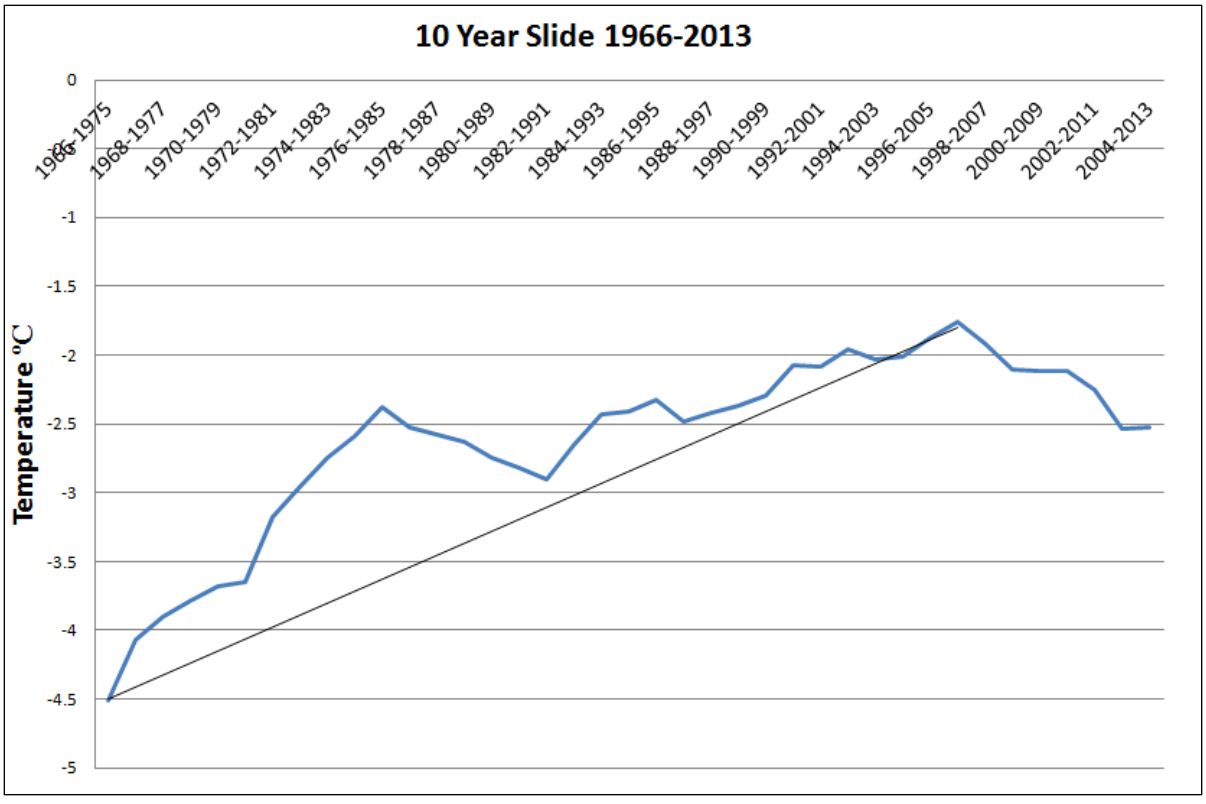

Figure B-3: Mean Annual Temperatures for 10 Year Slide and Assessed Warming Trend (Carmacks, 1966-2013)

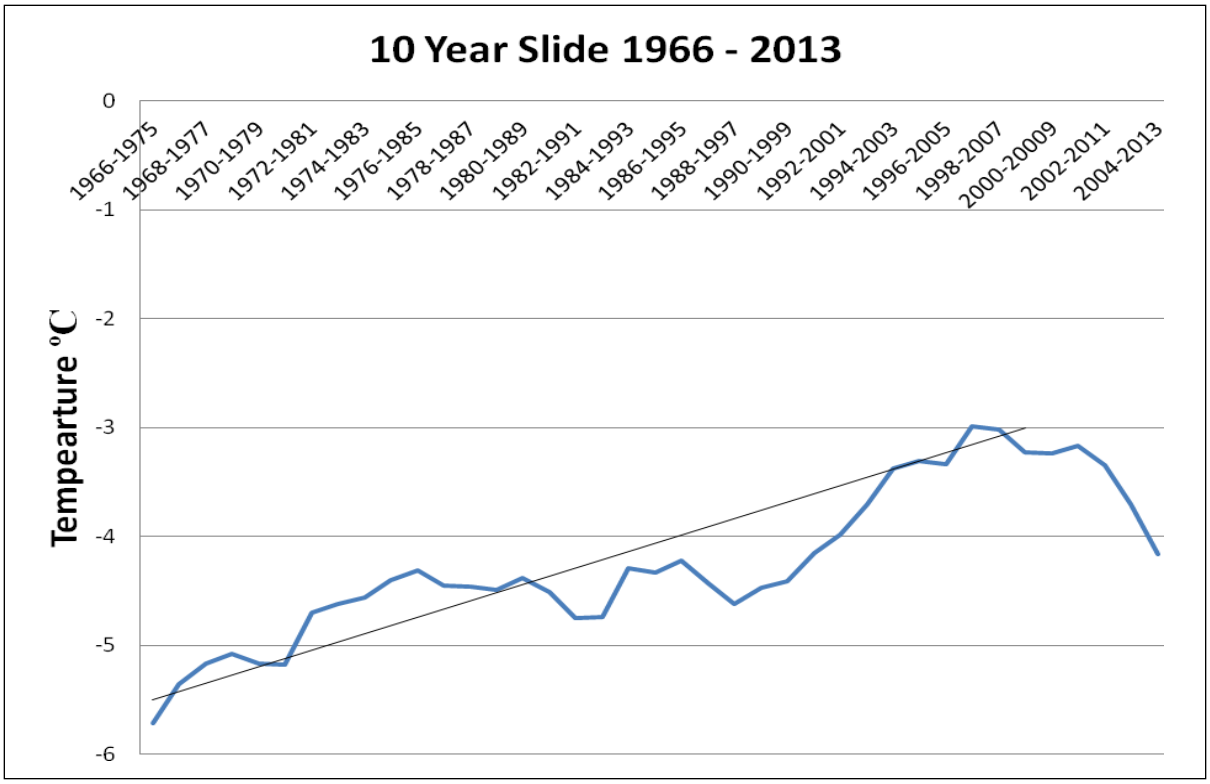

Figure B-4: Mean Annual Temperatures for 10 Year Slide and Assessed Warming Trend (Dawson, 1966-2013)

Figures B-3 and B-4 show a warming trend for the period of time from about 1966 to the present days of about 2.5°C for both Dawson and Carmacks. Based on this assessment, it was estimated that the warming trend for the study area could also be approximately 2.5°C, meaning that the mean annual air temperature within the study area in 1967 would be approximately -4°C (-1.5°C plus -2.5°C).

Figure B-3 expresses historical mean annual air temperatures for Dawson, Carmacks from year 1967 to 2013 and for the recent data from Mount Nansen. The figure also includes the extrapolated warming trends. It can be seen that the data for the Mount Nansen site aligns well with the data from Dawson and Carmacks, and for assessment of the warming trend for Mount Nansen from year 1967 to 2013.

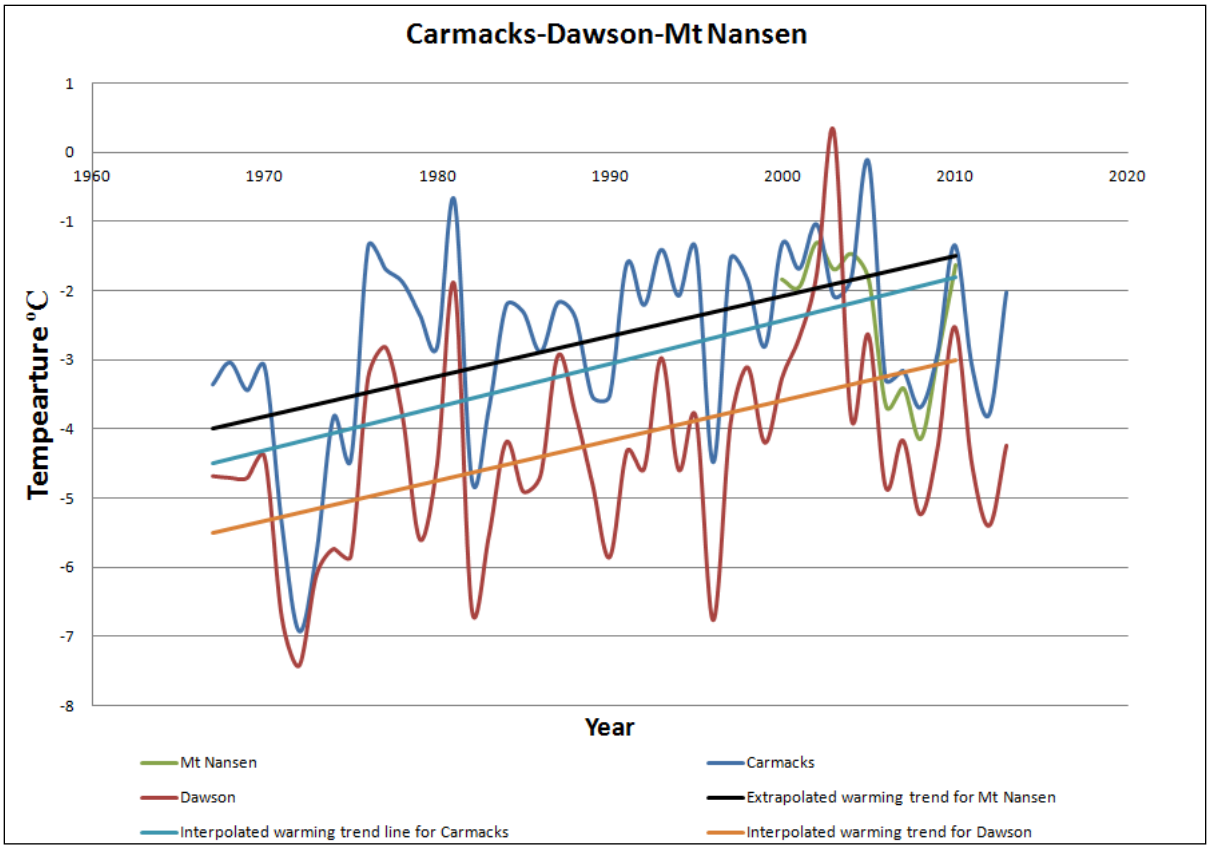

Figure B-5: Mean Annual Air Temperatures for Carmacks, Dawson and Mount Nansen Weather Stations

For determination of the mean monthly air temperatures within the study area in 1967, calculations of the mean annual winter temperatures in 2013 and 1967 for the Carmacks weather station were carried out. It was determined that the mean winter air temperatures were -15°C and -19.5°C for 2013 and 1967, respectively. This gives a ratio of 1.3 for the 1967 vs. 2013 mean winter air temperature. The 1.3 coefficient was applied to the mean monthly winter temperatures within the study area for 2013 (Table B-2) to calculate the mean monthly winter temperatures for the study area in 1967. The mean monthly summer temperatures then were reduced proportionally to obtain the mean annual air temperature within the study area of -4°C. The estimated mean monthly air temperatures for the study area for 1967 are shown in Table B-3. The corresponding freezing and thawing indexes for 1967 were calculated to be equal 83°C-months and 35°C-months, respectively.

Table B-3: Mean Monthly Air Temperatures for Study Area (1967)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
-22.7	-10.1	-12.2	-1.3	5.3	9.4	9.3	8.8	2.2	-4.2	-11.4	-21.1	-4

Snow cover data for the Carmacks and Dawson weather stations were also analyzed. Figures B-6 and B-7 show mean winter snow thicknesses and trends in snow thickness change for the Carmacks and Dawson weather stations. It can be seen in the figures that the trends indicate negligible change in the snow thickness for a period of 40 years for Carmacks and 100 years for Dawson. Based on this, it was concluded that, likely, no noticeable change in the snow thickness was observed within the study area for a long period of time, say, from the early 20th century to the present days. It was assumed in calculations of the mean annual ground temperature and seasonal frost penetration that the maximum snow thickness within the study area in the past was equal to the present maximum snow thickness (approximately 66 cm).

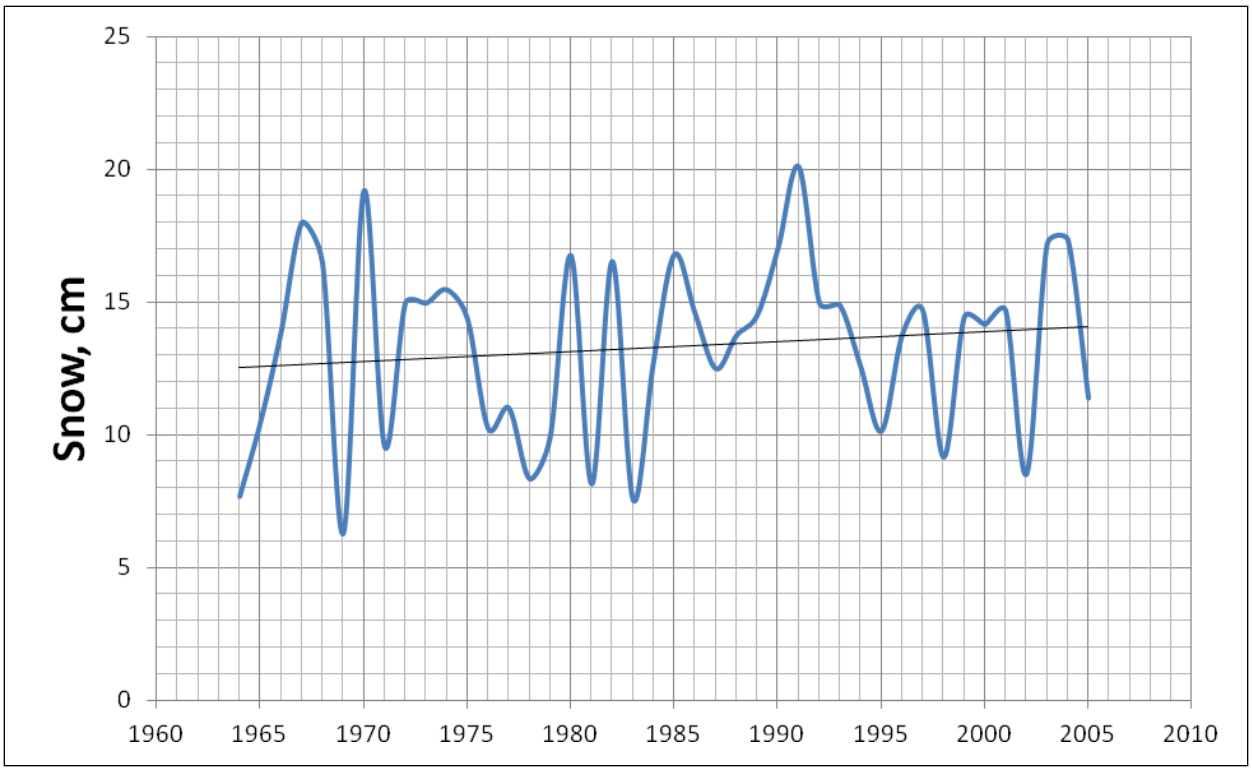

Figure B-6: Average Snow Thickness and Trend of Snow Thickness Change for Carmacks Weather Station (1964-2005)

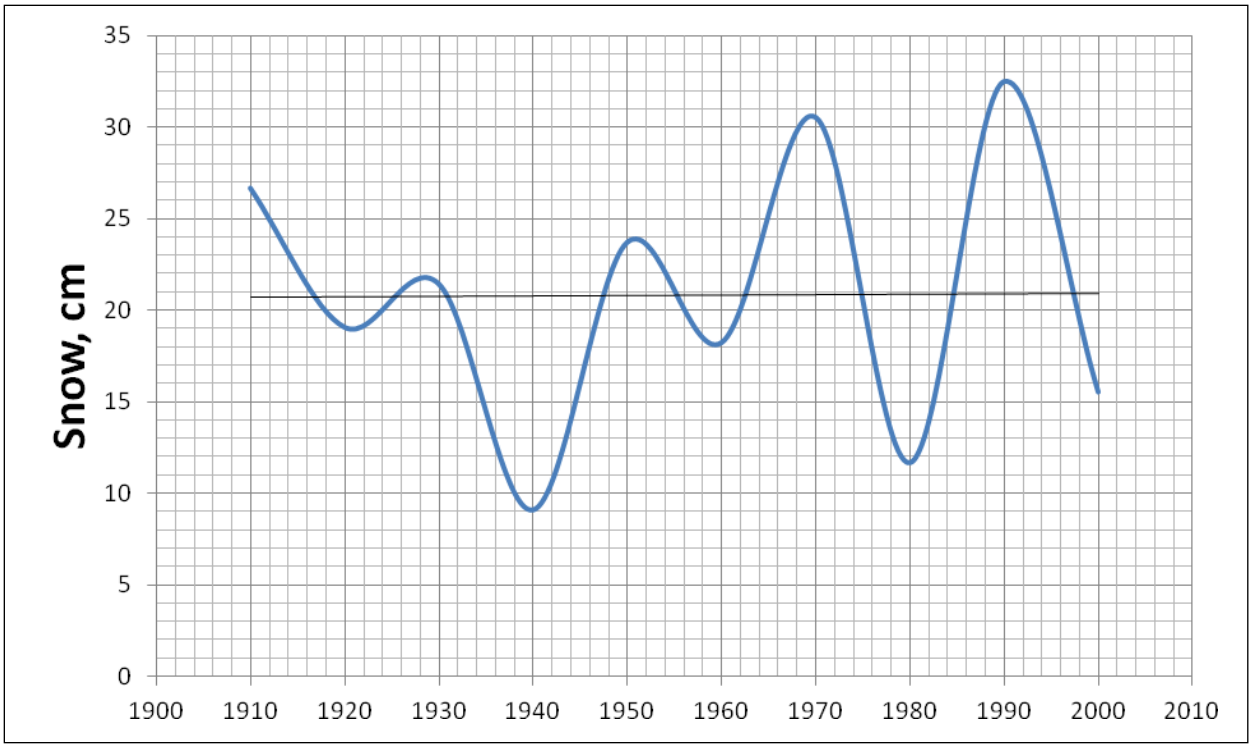

Figure B-7: Average Snow Thickness and Trend of Snow Thickness Change for Dawson Weather Station (1910-2005)

B.3.3 Future Air Temperatures and Snow Cover (2050)

Prediction of the future mean monthly and annual air temperatures was undertaken with the use of data in Maxwell, 1997. The report assesses potential changes in air temperatures for the period of time from 1992 to 2100 (108 years) assuming that the content of carbon dioxide will be doubled for the given period of time, and that CO_2 in the atmosphere is the major cause of future temperature changes. Recent IPCC AR5 report 2013 does acknowledge that other factors may affect climate. Therefore, it is considered that the future predictions based on the 1997 basis may be very conservative.

The above-mentioned report has an assessment of the increase of the seasonal air temperature for the study area from 1992 to 2100 as follows: March-May at 4^{o}C (rate 0.037^{o}C/year); June-August at 6^{o}C (rate 0.056^{o}C/year); September-November at 4^{o}C (rate 0.037^{o}C/year); and December-February at 3.5^{o}C (rate 0.032^{o}C/year). Based on the above calculated rates, the increase of the seasonal air temperature for 37 years (2013 to 2050) was calculated as follows: March-May at 1.3^{o}C; June-August at 2^{o}C; September-November at 1.3^{o}C; and December-February at 1.2^{o}C. Applying these increases to the present mean monthly air temperatures for the study area (Table B-2), the mean monthly air temperatures for 2050 were calculated (Table B-4 below). The freezing and thawing indexes for 2050 were calculated to be equal 55.5^{o}C-months and 54.5^{o}C-months, respectively.

Table B-4: Mean Monthly Air Temperatures for 2050

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
-16.3	-6.6	-8.1	0.3	8.2	14.2	14.1	13.4	4.1	-1.9	-7.5	-15.0	-0.1

These predictions from Maxwell, 1997 are essentially the same as the temperatures that would be estimated for the year 2050 using the more recent CSA (2009) guidelines. For times greater than 40 years into the future, the temperatures estimated using the CSA guidelines start to increase more rapidly than the Maxwell, 1997 estimates.

Based on the analysis of the historical snow data in Section B.3.3, it was concluded that, likely, there will be no noticeable change in the snow thickness within the study area in the near future. It was assumed in the calculations of the mean annual ground temperature and seasonal frost penetration for 2050 that the maximum snow thickness within the study area in the past was equal to the present maximum snow thickness (approximately 66 cm).

B.3.4 Influence of Slope Aspect on Air Temperature

In the past, based on data for incoming short wave solar radiation (direct and diffused), and outgoing long wave solar radiation, Dr. Tchekhovski, one of the authors of the present report, calculated the ratio of the radiation balance at the horizontal surface to the south/north facing slopes (approximately 20 degrees steep) in summer months for various latitudes of the planet. These ratios for the 62 degrees latitude (approximate latitude of the study area) are provided in Table B-5 below.

Table B-5: Radiation Balance Ratio for South and North Slopes

Slope	April	May	June	July	August	September
South	1.15	1.07	1.04	1.05	1.11	1.22
North	0.68	0.84	0.86	0.86	0.76	0.53

Further assessment of these data has demonstrated that the mean monthly air temperatures on slopes during summer months will be warmer (south slope) or colder (north slope) following to the ratios provided in Table B-5. The assessment should be considered as a rough approach assuming that other parameters responsible for the air temperature such as convective heat transfer at the surface, and evaporation and condensation are in the same range for various terrain districts identified within the study area.

B.3.5 Influence of Vegetation

Moss vegetation provides considerable insulating effect to the ground temperature in summer time. The insulating effect of the moss vegetation was applied in the model for prediction of the mean annual ground temperature and thickness of the active layer as thermal resistance. Published field test results (Tchekhovski, A. and V. Tchernyadiev, 1983) have demonstrated that the maximum thermal resistance (approximately 0.45 $h*m*^{o}C/W$) is provided by sphagnum moss covers. Other types of mosses and lichen have considerably less thermal resistance

which on average is about 0.23 h*m*^{o}C/W. Due to insufficient data on extent of various moss covers over the study area, and limited data obtained by Dr. A. Tchekhovski during a short field reconnaissance in spring 2013, the thermal resistance of a sphagnum moss cover (0.45 h*m*^{o}C/W) was considered to be applicable for forest areas, while for open areas, the thermal resistance of the ground vegetation was taken as 0.23 h*m*^{o}C/W.

Conifer treed areas were considered as shaded areas meaning that an n-factor method was not used to calculate the surface temperature. Some portion of the snowfall (approximately 10 to 20%) in a medium dense conifer forest will be accumulated on tree crowns reducing the insulating effect of the snow.

B.3.6 Influence of Snow

A snow cover provides considerable insulating effect to the ground temperature in winter time. The insulating effect of the snow cover was applied in the model for prediction the mean annual ground temperature and thickness of the seasonal frost penetration as thermal resistance. It is a well-known fact that the thermal conductivity of snow varies with temperature. The thermal conductivity increases with temperature, resulting in a decrease of the snow thermal resistance for a given snow thickness. Tchekhovski, A. and V. Tchernyadiev (1983) demonstrated that for the maximum snow thickness of approximately 66 cm, the average winter thermal resistance of snow is approximately 1.3 h*m*^{o}C/W for winter air temperatures consistent with the 1967 estimated temperatures within the study area. Exceptions were made only for treed south facing slope where the thermal resistance was reduced down to 1.1 h*m*^{o}C/W due to snow on the tree crowns and open south facing slopes where the thermal resistance was reduced to 1.2 h*m*^{o}C/W due to for the potential of warmer winter air temperatures at south facing slopes.

Due to warming of winter temperatures in 2013 and 2050, the thermal resistance of the snow cover for the study area was decreased at approximately 20% for 2013 and additional 20% for 2050.

B.3.7 Surficial Soil and Bedrock Properties

Surficial deposits within the study area consist generally of colluvium on slopes, eluvium and drift beds at relatively flat surfaces and hill summits, and fluvial deposits in creek valleys. Remnants of glacial fluvial deposits can be found also near toes of the slopes. Analysis of aerial photographs and results of drilling suggest that the thickness of the overburden in the majority of the terrain districts is likely in the range of 5 m to 10 m. Based on indicators of outcrops on the aerial photographs, the thickness of the overburden on the steep slopes and hill summits is likely less than 5 m.

The study area is dominated by coarse (granular) surficial materials. Within the majority of the terrain units, surficial material consists of a mixture sand and gravel. Some admixture of silt likely can be found in eluvial and drift beds materials within the relatively flat terrains and at hill summits. Based on results of the field reconnaissance undertaken by Dr. A. Tchekhovski in

spring 2013, it was found that fluvial deposits within the Dome Creek Valley are sandier in comparison with colluvium of the slopes which are more gravelly. Bulk density and moisture content was assumed to be within a typical range for the identified soil types.

The thermal properties of the identified overburden soils were selected based on limited published data and were calculated based on methodology provided in Esch, D.C., 2004. Table B-6 below summarizes the assumed physical and thermal parameters of the overburden soils identified within the study area.

Bedrock within the study area consists predominantly of metamorphic rock with inclusion of sedimentary, volcanic and intrusive rocks. Predominant metamorphic rocks are amphibolites, chlorite-biotite schist, and gneiss. Table B-6 provides assumed physical and thermal properties of the bedrock.

Table B-6: Physical and Thermal Properties of Overburden Soils and Bedrock

Terrain Districts	Soil	Dry Density, kg/m^3	Moisture Content, %	Thermal Conductivity, W/m/^{o}C		Heat Capacity, MJ/m^3/^{o}C	
				frozen	unfrozen	frozen	unfrozen
1 and 3	Sand and gravel	1600	10	1.2	1.4	1.800	2.156
2, 4, 5, and 6	Sand and gravel	1500	5	1.0	0.9	1.570	1.675
7 and 8	Sand, gravel, a little silt	1800	15	2.6	2.3	2.261	2.512
9	Gravel, rock fragments, some sand	1700	15	2.3	2.0	2.135	2.491
10	Sand, some silt	1800	20	2.8	2.6	2.408	3.161
11	Sand, some silt	1800	10	2.2	2.0	2.031	2.408
Bedrock	Amphibolites, schist, and gneiss	2800	2	2.9	2.9	2.512	2.512

B.4 Evolution of Mean Annual Ground Temperature

Nomographs for an express calculation of the mean annual ground temperature were published in Tchekhovski, A., and V. Tchernyadiev, 1983. Creation of the nomographs was based on numerous calculations of the mean annual ground temperature by the method of physical modeling. The input parameters required for the express calculations are: freezing index at the snow surface, thawing index at the ground vegetation surface, thermal resistance of snow cover, and thermal resistance of the ground vegetation.

For calculation of the thawing index on the ground vegetation surface in summer time, an n-factor of 1.2 was applied to the thawing indexes provided in Sections B.3.1, B.3.2, and B.3.3. However, for shaded areas (forest), the thawing indexes in Sections B.3.1, B.3.2, and B.3.3 were used. Further evolution of the thawing indexes included incorporation of influence of the slope aspect as it was discussed in Section B.3.4.

Due to low or negligible values of the radiation balance in winter time, the freezing index on the snow surface was taken as stated in Sections B.3.1, B.3.2, and B.3.3 irrespectively of the slope face and for both shaded and open terrain districts.

Thermal resistances of the snow cover and ground vegetation were selected/calculated as was discussed in Sections B.3.5 and B.3.6. Table B-7 below provides a summary of the freezing and thawing indexes, snow and vegetation thermal resistances used for calculation the mean annual ground temperature for 1967, 2013, and 2050. The characteristics of the districts listed in Table B-7 were discussed in Section B.2.1 and are summarized in Table B-8 as well as on the appended permafrost maps.

Table B-7: Input Parameters Used for Calculation of Mean Annual Ground Temperature

Terrain District	Freezing Index, ^{o}C - month			Thawing Index, ^{o}C - month			Snow Thermal Resistance, h*m*^{o}C/W			Ground Vegetation Thermal Resistance, h*m*^{o}C/W		
	1967	2013	2050	1967	2013	2050	1967	2013	2050	1967	2013	2050
1	83.0	65.0	55.5	40.0	50.0	62.0	1.3	1.0	0.8	0.5	0.5	0.5
2	83.0	65.0	55.5	48.0	61.9	74.0	1.4	1.1	0.9	0.25	0.25	0.25
3	83.0	65.0	55.5	34.0	44.2	52.0	1.5	1.2	1.0	0.25	0.25	0.25
4	83.0	65.0	55.5	34.0	44.2	52.0	1.5	1.2	1.0	0.25	0.25	0.25
5	83.0	65.0	55.5	42.0	54.5	65.0	1.5	1.2	1.0	0.25	0.25	0.25
6	83.0	65.0	55.5	42.0	54.5	65.0	1.5	1.2	1.0	0.25	0.25	0.25
7	83.0	65.0	55.5	42.0	54.5	65.0	1.5	1.2	1.0	0.25	0.25	0.25
8	83.0	65.0	55.5	35.0	45.4	54.3	1.5	1.2	1.0	0.5	0.5	0.5
9	83.0	65.0	55.5	42.0	54.5	65.0	1.5	1.2	1.0	0.25	0.25	0.25
10	83.0	65.0	55.5	42.0	54.5	65.0	1.5	1.2	1.0	0.25	0.25	0.25
11	83.0	65.0	55.5	42.0	54.5	54.3	1.5	1.2	1.0	0.25	0.25	0.25

Calculations of the mean annual ground temperature were carried out for single values of the input parameters and soil physical and thermal properties. However, the legend to the Permafrost Maps show a range of the mean annual ground temperatures for identified terrain districts. The range of the temperatures was based on our assessment of expected variations for the input parameters and soil properties. The results of calculations for the given input parameters (Table B-7) are provided in the legends included on the Permafrost Maps in the appended Figures (B1, B2 and B3).

The legend shows that in 1967, the predominant majority of the study area had permafrost at temperature ranging from about -2.5^{o}C to about -0^{o}C. It can be estimated that permafrost occupied approximately 90 to 95% of the study area. The minimum permafrost temperatures in a range from -2.5^{o}C to -1.5^{o}C likely could be found within treed areas (south facing slopes, relatively flat terrain and upper and lower creek terraces. The cold permafrost temperatures were due mainly to thick sphagnum moss layer and/or reduced thickness of the snow cover in the conifer forest (Terrain District 1). The north facing slopes have also relatively cold permafrost temperature in a range from -1.5^{o}C to -0.5^{o}C. This range of the temperatures is a result of insufficient warming of the north slopes in summer time. Five terrain districts (5, 6, 7, 9, and 10) were predicted to have ground temperature in a range from -0.5^{o}C to -0^{o}C in 1967.

These terrain units are characterized by the maximum insulating effect of the snow cover, and relatively low insulating effect due to the moss cover. The calculations indicate that open south facing slope (terrain district 2) may have had mean annual ground temperature above 0°C. In 1967, this terrain district is characterized by the maximum surface temperatures in summer time and relatively low insulating effect of the moss cover.

The range of the mean annual ground temperature calculated for 2013 is shown in the legend of Map B2. As outlined above, the calculated ground temperatures are for the temperature and resistance values presented in Table B-7 and, therefore, reflect steady state conditions. Since climate is not steady state, it could take many years for the predicted conditions to develop. The legend, therefore, includes potential relict permafrost thicknesses which represent permafrost that was formed during past colder temperatures and that has remained at site. Permafrost is most likely to be encountered in the treed areas or at the north facing slopes. The minimum permafrost temperature (-0.5°C to -1.0°C) likely can be found in treed areas of the relatively flat terrain (district 8) and upper and lower creek terraces (district 11). The mean annual ground temperature for south facing treed slope and north facing slopes (medium and steep) may be in a range from -0.5°C to +0.5°C. Such range of the mean annual ground temperatures means that within the given terrain districts (1, 3, and 4) permafrost can be encountered immediately under the active layer, or at some depth, representing relict permafrost of the previous cold climate, or no permafrost can be found within some local areas.

Table B-8: General Characterization of Identified Districts

District No.	Morphology	Soil Origin and Composition to 10 m	Vegetation
1	medium steep south facing slope	colluvium, sand and gravel	spruce forest, moss
2	steep south facing slope	colluvium over bedrock at about 5 m depth, sand and gravel	shrubs, tall willows, patched moss, cereal grass
3	medium steep north facing slope	colluvium, sand and gravel	shrubs, moss, cereal grass
4	steep north facing slope	colluvium over bedrock at about 5 m depth, sand and gravel	shrubs, moss, cereal grass
5	medium steep east & west facing slopes	colluvium, sand and gravel	medium dense or sparse spruce forest, moss
6	medium steep east & west facing slopes	colluvium, sand and gravel	shrubs, tall willows, patched moss, cereal grass
7	relatively flat surface	eluvium and drift beds, sand, silt, rock fragments	shrubs, moss, cereal grass
8	relatively flat surface	eluvium and drift beds, sand, silt, rock fragments	sparse spruce forest, moss, cereal grass
9	relatively flat mounts summits	eluvium over bedrock at about 5 m depth, sand, rock fragments	sparse shrubs, moss
10	creek flood plan	fluvial, sand	shrubs, moss, cereal grass
11	creek upper and lower terraces	fluvial, sand	sparse spruce forest, moss

Results of ground temperature measurements undertaken by AMEC in 2013 around the Open Pit and data on ground temperatures in the vicinity of the tailings dam in general confirm results of the ground temperature prediction. Where permafrost is measured in the thermistors, it is generally warm permafrost near 0^{o}C. For instance, the following ground temperature conditions were found in the four wells advanced around the Open Pit: well CHP-13-01 (district 5, may have permafrost above the artesian water); CHP-13-02 (district 3, relict permafrost from about 15 m depth); CHP-13-03 (districts 1 or 3, likely relict permafrost from about 5 m depth); CHP-13-04 (district 1, permafrost).

At steady state conditions predicted for 2050, as shown on Figure B3 the mean annual ground temperatures within the study area will be likely above 0^{o}C within all of the identified terrain districts. The range of the ground temperatures is predicted to be from 2.0^{o}C to 0.5^{o}C. The legend also shows that relict permafrost perhaps can be encountered within terrain districts 1, 3, 4, 8, and 11. The permafrost temperature of the relict permafrost is usually in a range from about -0^{o}C to -0.1^{o}C.

B.5 Evolution of Active Layer Thickness and Frost Penetration Depth

The modified Stefan's equation was used for calculation of the active layer thickness and depth of the seasonal frost penetration. Modification of the well-known Stefan's equation included incorporation of the integral soil temperature to a depth of approximately 7 to 10 m where no seasonal changes of soil temperature are expected. Similar to the express method for calculation, the modified Stefan's equation also was published in Tchekhovski, A., and V. Tchernyadiev, et al., 1983.

For calculation of the active layer thickness, the method requires the following input parameters:

- thawing index (Table B-7);
- thermal resistance of vegetation (Table B-7);
- thawing period (Tables B-2, B-3, and B-4); and
- soil physical and thermal properties (Table B-6).

For calculation of the seasonal frost penetration depth, the method requires:

- freezing index (Table B-7);
- thermal resistance of snow (Table B-7);
- freezing period (Tables B-2, B-3, and B-4); and
- soil physical and thermal properties (Table B-6).

Calculations of the active layer thickness and seasonal frost penetration were carried out for single values of the input parameters and soil physical and thermal properties. However, the legend on the Permafrost Maps show a range of the calculated depths for identified terrain districts. The range of the calculated depths was based on our assessment of the expected variations for the input parameters and soil properties. The results of calculations for the given input parameters (Table B-7) are provided the legends included on the Permafrost Maps and discussed below.

The legend shows that in 1967, the range of the active layer thickness within the study area was from 1.5 to 2.5 m. The minimum thickness of the active layer (1.5 to 2 m) was predicted for flat areas near the hill summits and for creek flood plains. The relatively shallow active layer within these terrain units is due mainly to the assumed high moisture content (15% for terrain district 9 and 20% for terrain district 10). The second thinnest active layer (1.7 to 2.2 m) was predicted for treed south facing slope (terrain district 1). The moisture content of surficial soils within this district was assessed as relatively low (10%). However, the relatively shallow active layer in Terrain District 1 is due to the considerable insulating effect of sphagnum preventing thaw in the summer time. The maximum active layer thickness (2 to 2.5 m) was predicted for east/west and north facing slopes and upper/lower creek terraces. The deep thaw within these terrain districts is mainly a result of low moisture content ranging from 5 to 10%. The calculations of the seasonal frost penetration depth were also carried for the terrain district 1 where the mean annual ground temperature was predicted to be above 0^{o}C (terrain district with no permafrost). It was found that the seasonal frost penetration depth within this district would be in a range from 2 to 2.5 m.

For 2013, the active layer thickness was calculated for the five terrain districts which were calculated to have non relict permafrost. The maximum predicted thickness of the active layer (2 to 2.5 m) was calculated for south and north facing slopes (terrain districts 1, 3, and 4) with low moisture content surficial soils (5 to 10%). The seasonal frost penetration depth within the terrain districts with no permafrost or with relict permafrost may vary, depending mainly on snow accumulation and moisture content, from 1 m to 3.0 m. The minimum frost penetration is expected within areas with considerable snow accumulation and relatively high soil moisture content. In contrast, the maximum frost penetration usually can be encountered within areas where snow blow out occurs or within areas of shallow bedrock having low moisture content.

Due to warmer winter temperatures in 2050, the seasonal frost penetration depth in 2050 is predicted to be less, and likely will not exceed a depth of 2 m even for slopes where moisture content of surficial materials is low (5 -10%). As shown in the legend on Figure B3, a seasonal frost penetration depth of approximately 1.5 m is predicted in all of the identified terrain districts.

B.6 Evolution of Permafrost Thickness

Permafrost thickness for year 1967 was calculated based on predicted mean annual permafrost temperature and geothermal gradient of 0.02^{o}C/m considered to be an average value for the planet. For calculation of the permafrost thickness for 2013 and 2050, a one-dimensional version of SIMPTEMP software (developed in-house by AMEC) was implemented. The program uses the finite element method to compute a numerical solution for the heat transfer problem. Physical/mathematical algorithms used in the SIMPTEMP model have been published and the simulation process has been verified against well-known analytical solutions and with numerical solutions produced by other commercial/non-commercial geothermal modeling software. AMEC has successfully used the SIMPTEMP program for a variety of geothermal applications over the last 15 years.

Thermal properties of the overburden and bedrock were incorporated in the computer model in accordance with data shown in Table B-7. The modelling was completed for all terrain districts which had permafrost in 1967. The boundary temperatures on the top of the model mesh were equal to the mean annual ground temperatures shown in the legends for the permafrost maps. The simulation time was 83 years (from 1967 to 2050).

Figure B2 indicates that under constant 2013 conditions, permafrost may be absent within terrain districts 5, 6, 7, 9, and 10. This is because the initial permafrost thickness within these districts was predicted to be only 12.5 m in 1967. Due to warming up of the permafrost temperature, the permafrost thickness was reduced to 2 to 3 m within districts 3 and 4 (permafrost thickness was 50 m in these districts in 1967). Due to greater heat inertia within terrains 1, 8, and 11 from the thick initial permafrost conditions (predicted to be 100 m), only a 1 m reduction of the permafrost thickness is predicted. The local areas in districts 1, 3, and 4 may have the mean annual ground temperature above 0^{o}C. However, relict permafrost may be encountered within such areas. It was predicted that the permafrost table can be located at a depth 5 m to 20 m below the ground surface.

It was predicted that dramatic reduction of permafrost area may occur within the study area in the middle of the 21st century (2050), if further climate warming occurs in accordance with the predictions in Section B.3.3. The legend in Figure B3 shows that frozen soils within the study area likely can be found only at depths of 8 m to 18 m. However, location of the permafrost bottom will not be changed considerably, again due to heat inertia of frozen materials.

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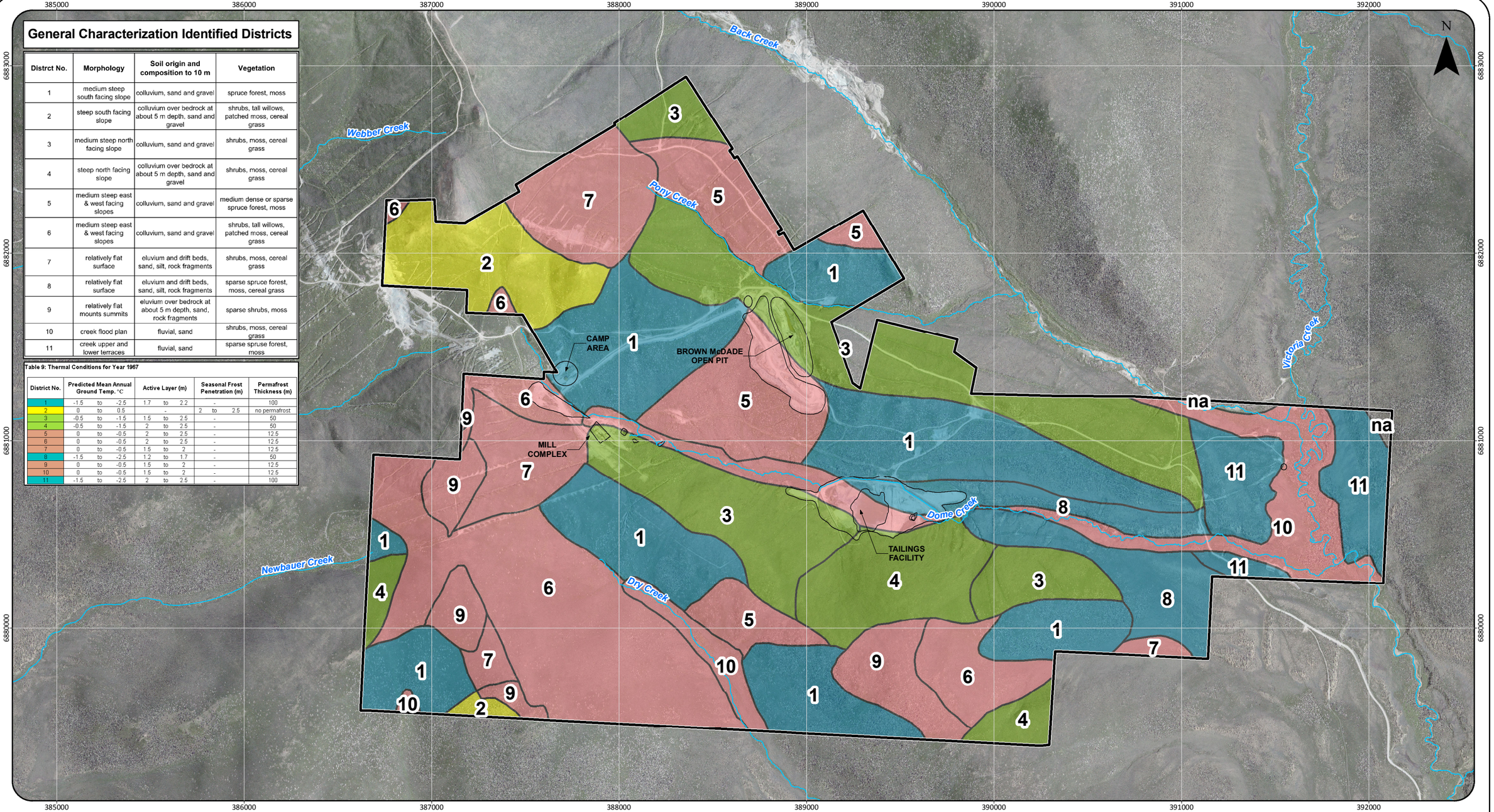
General Characterization Identified Districts

Distrct No.	Morphology	Soil origin and composition to 10 m	Vegetation
1	medium steep south facing slope	colluvium, sand and gravel	spruce forest, moss
2	steep south facing slope	colluvium over bedrock at about 5 m depth, sand and gravel	shrubs, tall willows, patched moss, cereal grass
3	medium steep north facing slope	colluvium, sand and gravel	shrubs, moss, cereal grass
4	steep north facing slope	colluvium over bedrock at about 5 m depth, sand and gravel	shrubs, moss, cereal grass
5	medium steep east & west facing slopes	colluvium, sand and gravel	medium dense or sparse spruce forest, moss
6	medium steep east & west facing slopes	colluvium, sand and gravel	shrubs, tall willows, patched moss, cereal grass
7	relatively flat surface	eluvium and drift beds, sand, silt, rock fragments	shrubs, moss, cereal grass
8	relatively flat surface	eluvium and drift beds, sand, silt, rock fragments	sparse spruce forest, moss, cereal grass
9	relatively flat mounts summits	eluvium over bedrock at about 5 m depth, sand, rock fragments	sparse shrubs, moss
10	creek flood plan	fluvial, sand	shrubs, moss, cereal grass
11	creek upper and lower terraces	fluvial, sand	sparse spruce forest, moss

Table 9: Thermal Conditions for Year 1967

District No.	Predicted Mean Annual Ground Temp. °C	Active Layer (m)	Seasonal Frost Penetration (m)	Permafrost Thickness (m)
1	-1.5 to -2.5	1.7 to 2.2	-	100
2	0 to 0.5	-	2 to 2.5	no permafrost
3	-0.5 to -1.5	1.5 to 2.5	-	50
4	-0.5 to -1.5	2 to 2.5	-	50
5	0 to -0.5	2 to 2.5	-	12.5
6	0 to -0.5	2 to 2.5	-	12.5
7	0 to -0.5	1.5 to 2	-	12.5
8	-1.5 to -2.5	1.2 to 1.7	-	50
9	0 to -0.5	1.5 to 2	-	12.5
10	0 to -0.5	1.5 to 2	-	12.5
11	-1.5 to -2.5	2 to 2.5	-	100



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

- Order in Council Boundary
- Streams

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MOUNT NANSEN REMEDIATION PROJECT
Figure B1

SITE CHARACTERIZATION REPORT

PERMAFROST MAP
THERMAL CONDITIONS FOR YEAR 1967

Scale 1:20,000
Metres

0 500 1,000

March 19, 2014

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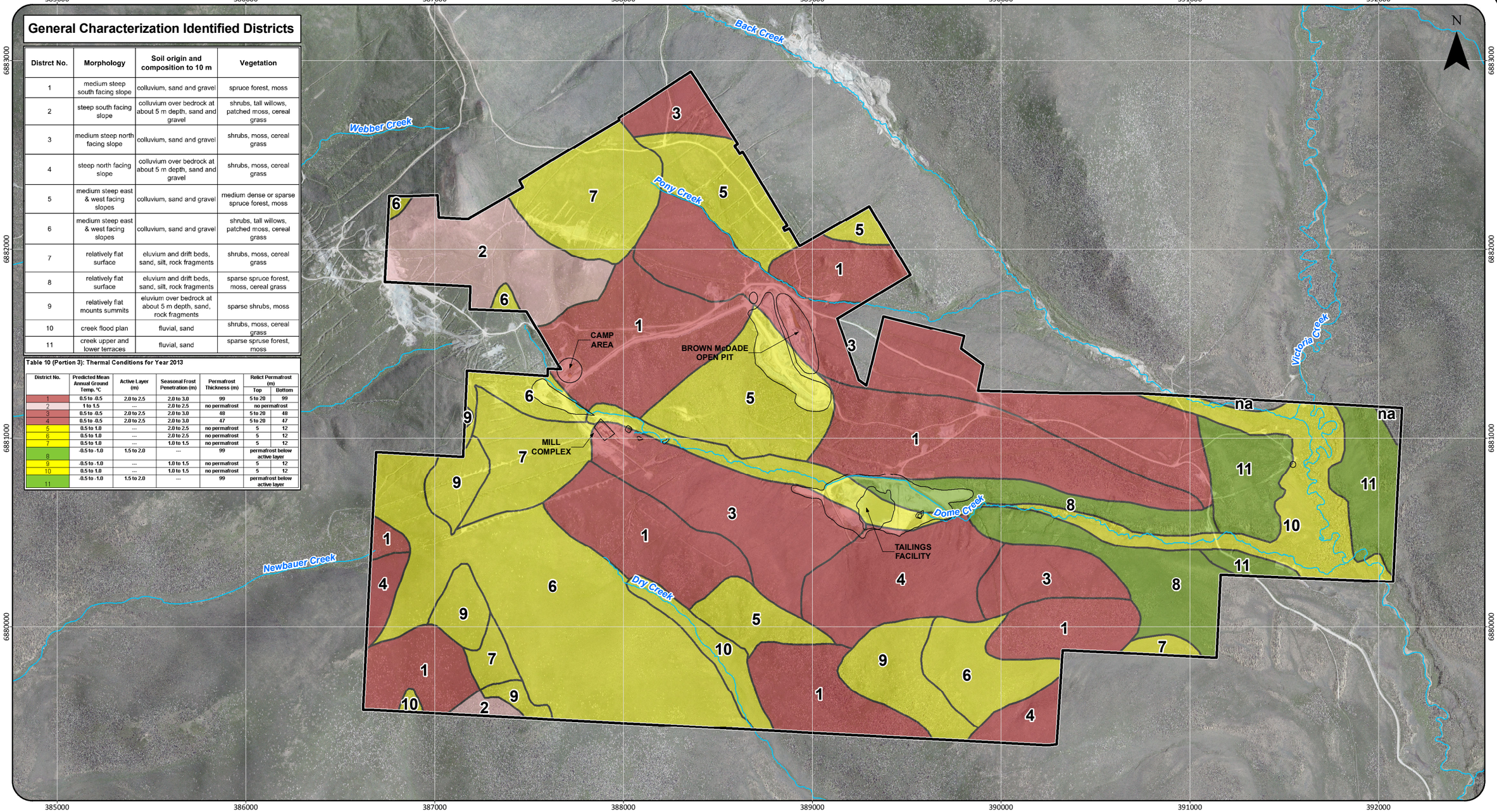
General Characterization Identified Districts

Distrct No.	Morphology	Soil origin and composition to 10 m	Vegetation
1	medium steep south facing slope	colluvium, sand and gravel	spruce forest, moss
2	steep south facing slope	colluvium over bedrock at about 5 m depth, sand and gravel	shrubs, tall willows, patched moss, cereal grass
3	medium steep north facing slope	colluvium, sand and gravel	shrubs, moss, cereal grass
4	steep north facing slope	colluvium over bedrock at about 5 m depth, sand and gravel	shrubs, moss, cereal grass
5	medium steep east & west facing slopes	colluvium, sand and gravel	medium dense or sparse spruce forest, moss
6	medium steep east & west facing slopes	colluvium, sand and gravel	shrubs, tall willows, patched moss, cereal grass
7	relatively flat surface	eluvium and drift beds, sand, silt, rock fragments	shrubs, moss, cereal grass
8	relatively flat surface	eluvium and drift beds, sand, silt, rock fragments	sparse spruce forest, moss, cereal grass
9	relatively flat mounts summits	eluvium over bedrock at about 5 m depth, sand, rock fragments	sparse shrubs, moss
10	creek flood plan	fluvial, sand	shrubs, moss, cereal grass
11	creek upper and lower terraces	fluvial, sand	sparse spruce forest, moss

Table 10 (Portion 3): Thermal Conditions for Year 2013

District No.	Predicted Mean Annual Ground Temp. °C	Active Layer (m)	Seasonal Frost Penetration (m)	Permafrost Thickness (m)	Relict Permafrost (m)	
					Top	Bottom
1	0.5 to -0.5	2.0 to 2.5	2.0 to 3.0	99	5 to 20	99
2	1 to 1.5	---	2.0 to 2.5	no permafrost	no permafrost	
3	0.5 to -0.5	2.0 to 2.5	2.0 to 3.0	48	5 to 20	48
4	0.5 to -0.5	2.0 to 2.5	2.0 to 3.0	47	5 to 20	47
5	0.5 to 1.0	---	2.0 to 2.5	no permafrost	5	12
6	0.5 to 1.0	---	2.0 to 2.5	no permafrost	5	12
7	0.5 to 1.0	---	1.0 to 1.5	no permafrost	5	12
8	-0.5 to -1.0	1.5 to 2.0	---	99	permafrost below active layer	
9	-0.5 to -1.0	---	1.0 to 1.5	no permafrost	5	12
10	0.5 to 1.0	---	1.0 to 1.5	no permafrost	5	12
11	-0.5 to -1.0	1.5 to 2.0	---	99	permafrost below active layer	



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

- Order in Council Boundary
- Streams

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MOUNT NANSEN REMEDIATION PROJECT
Figure B2

SITE CHARACTERIZATION REPORT

PERMAFROST MAP
THERMAL CONDITIONS FOR YEAR 2010-2013

Scale 1:20,000
Metres

0 500 1,000

March 19, 2014

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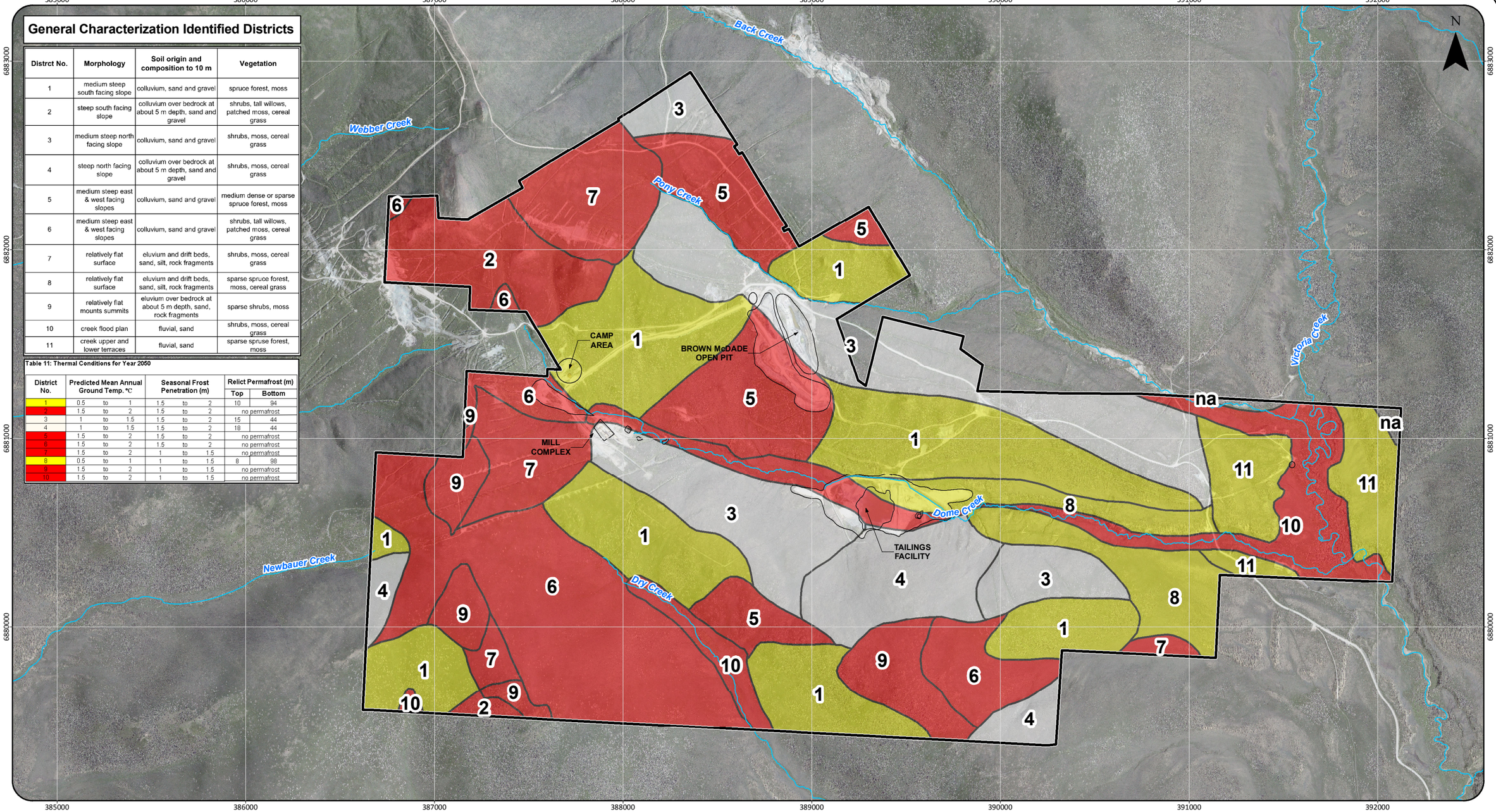
General Characterization Identified Districts

Distrct No.	Morphology	Soil origin and composition to 10 m	Vegetation
1	medium steep south facing slope	colluvium, sand and gravel	spruce forest, moss
2	steep south facing slope	colluvium over bedrock at about 5 m depth, sand and gravel	shrubs, tall willows, patched moss, cereal grass
3	medium steep north facing slope	colluvium, sand and gravel	shrubs, moss, cereal grass
4	steep north facing slope	colluvium over bedrock at about 5 m depth, sand and gravel	shrubs, moss, cereal grass
5	medium steep east & west facing slopes	colluvium, sand and gravel	medium dense or sparse spruce forest, moss
6	medium steep east & west facing slopes	colluvium, sand and gravel	shrubs, tall willows, patched moss, cereal grass
7	relatively flat surface	eluvium and drift beds, sand, silt, rock fragments	shrubs, moss, cereal grass
8	relatively flat surface	eluvium and drift beds, sand, silt, rock fragments	sparse spruce forest, moss, cereal grass
9	relatively flat mounts summits	eluvium over bedrock at about 5 m depth, sand, rock fragments	sparse shrubs, moss
10	creek flood plan	fluvial, sand	shrubs, moss, cereal grass
11	creek upper and lower terraces	fluvial, sand	sparse spruce forest, moss

Table 11: Thermal Conditions for Year 2050

District No.	Predicted Mean Annual Ground Temp. °C			Seasonal Frost Penetration (m)			Relict Permafrost (m)	
							Top	Bottom
1	0.5	to	1	1.5	to	2	10	94
2	1.5	to	2	1.5	to	2	no permafrost	
3	1	to	1.5	1.5	to	2	15	44
4	1	to	1.5	1.5	to	2	18	44
5	1.5	to	2	1.5	to	2	no permafrost	
6	1.5	to	2	1.5	to	2	no permafrost	
7	1.5	to	2	1	to	1.5	no permafrost	
8	0.5	to	1	1	to	1.5	8	98
9	1.5	to	2	1	to	1.5	no permafrost	
10	1.5	to	2	1	to	1.5	no permafrost	



Data Source:

Roads, trails, streams, waterbodies, watercourses and infrastructure areas digitized using 2008 Quickbird imagery (courtesy of Yukon Geomatics) and spatial data provided by Yukon government.

Heli LIDAR Data Survey and Imagery, 2012

Datum: NAD 1983 CSRS UTM Zone 8N

Legend

- Order in Council Boundary
- Streams

Associated Engineering — GLOBAL PERSPECTIVE. LOCAL FOCUS.

amec

Yukon
Energy, Mines and Resources
Assessment and Abandoned Mines

MOUNT NANSEN REMEDIATION PROJECT
Figure B3

SITE CHARACTERIZATION REPORT

PERMAFROST MAP
THERMAL CONDITIONS FOR YEAR 2050

Scale 1:20,000
Metres

0 500 1,000

March 19, 2014

S:\PROJECTS\VM00605 - Mount Nansen\GIS\Mapping\VM00605_9003b_11x17_permafrost_2050.mxd

APPENDIX C

Site Hydrology

APPENDIX C1

Summary of Previous Hydrological Parameters

Table C1 - Summary of Previous Hydrologic Parameters

No	Data	BYG, 2003 (R15)	Klohn-Crippen, 1994 (R13)	T.W.Higgs, 1994 (R19)	Higgs, 1995	BYG, 1995	Klohn-Crippen, 1995	Klohn-Crippen 1995	BYG, 1998	EBA Eng. 2002	EBA Eng. 2003	Gartner Lee, 2004 (R09)	Gartner Lee, 2006	Gomm Eng. 2011//AECOM 2010	AECOM, 2011	EDI, 2012	Lorax, 2011	EDI, 2012	Summary	Note
					R20	R40	R47	R48	R115	R12	R11		R25	R97, R89???	R78	R86	R88	R71		
1	**Daily Precipitation**																*Mt Nansen : 2000 to 2009, and Carmack:1964 to 2006, Missing data used the near station*	*Hourly/Daily rainfall data for 2010 to 2012 from Mt Nanson sites (from Camp and Road) and EMR client at Victoria Creek for missing data in summer 2011. Graph only*	*Mt Nansen : 2000 to 2012, and Carmack:1964 to 2006, Missing data used the near station*	*Daily precipitation data are not available in the report R88 and only shown as graph in R71*
2	**Monthly Precipitation**											*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002 - See* ***Table 1***	*From Mt Nansen Site 2000 to 2005 - See* ***Table 1***	*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002 - See* ***Table 1***					*From Mt Nansen: 2000 to 2003; From Carmack Station, Period 1964 to 2006*	*Monthly precipitaion record for each year are not available in the report. Missing appendix C of R09 that may contain the data.*
	Mean year (mm)			*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 1***	*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***	*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***					*Dry year: 1976*						
	200 year wet year (mm)			*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 1***	*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***	*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***					*Wet year: 2000*						
	10 year dry year (mm)			*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 1***	*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***	*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***					*Average year: 2006*						
3	**Monthly Average Precipitation**																		*From Mt Nansen: 2000 to 2003; From Carmack Station, Period 1964 to 2006*	*Only for certain return period/typical years*
4	**Annual Average Precipitation**											*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002 - See* ***Table 1***	*From Mt Nansen Site 2000 to 2005 - See* ***Table 1***	*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002 - See* ***Table 1***					*From Mt Nansen: 2000 to 2003; From Carmack Station, Period 1964 to 2006*	*Annaul precipitaion record for each year are not available in the report. Missing appendix C of R09 that may contain the data.*
	Mean year (mm)	*271*		*271*	*271*	*271*	*271*		*271*											
	200 year wet year (mm)	*370*		*370*	*370*	*370*	*370*		*370*											
	10 year dry year (mm)	*200*		*200*	*200*	*200*	*200*		*200*											
5	**Monthly Distribution**											*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002), Carmack 1964 to 2002) - See* ***Table 4***							*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002*	
6	**Short Duration Rainfall**					*From Carmack Station, Period 1963 to 1991 - See* ***Table 2***		*From Carmack Station, Period 1963 to 1991 - See* ***Table 2***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 2***										*From Carmack Station, Period 1963 to 1991*	*Only for certain return period*
	1 in 2 year																			
	1 in 5 year																			
	1 in 10 year				*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***	*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***											
	1 in 25 year																			
	1 in 50 year																			
	1 in 100 year																			
	1 in 200 year			*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 1***	*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***	*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***	*From Carmack Station, Period 1963 to 1991 - See* ***Table 1***											
	1 in 1000 year																			
7	**PMP**																			
	1 hour (mm)	*63*	*63*	*63*			*63*	*63*												
	6 hours (mm)	*76*	*76*	*76*			*76*	*76*												
	24 hours (mm)	*108*	*108*	*108*			*108*	*108*												
8	**One Hour Intensity**																			
	In 200 year			*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 3***			*From Mt Nansen Site and Carmack Station, Period not stated - See* ***Table 3***												*From Mt Nansen Site and Carmack Station, Period not stated*	*Only for 200 year*
9	**Annual Precipitation for return period**																			
	1 in 2 year																			

Table C1 - Summary of Previous Hydrologic Parameters

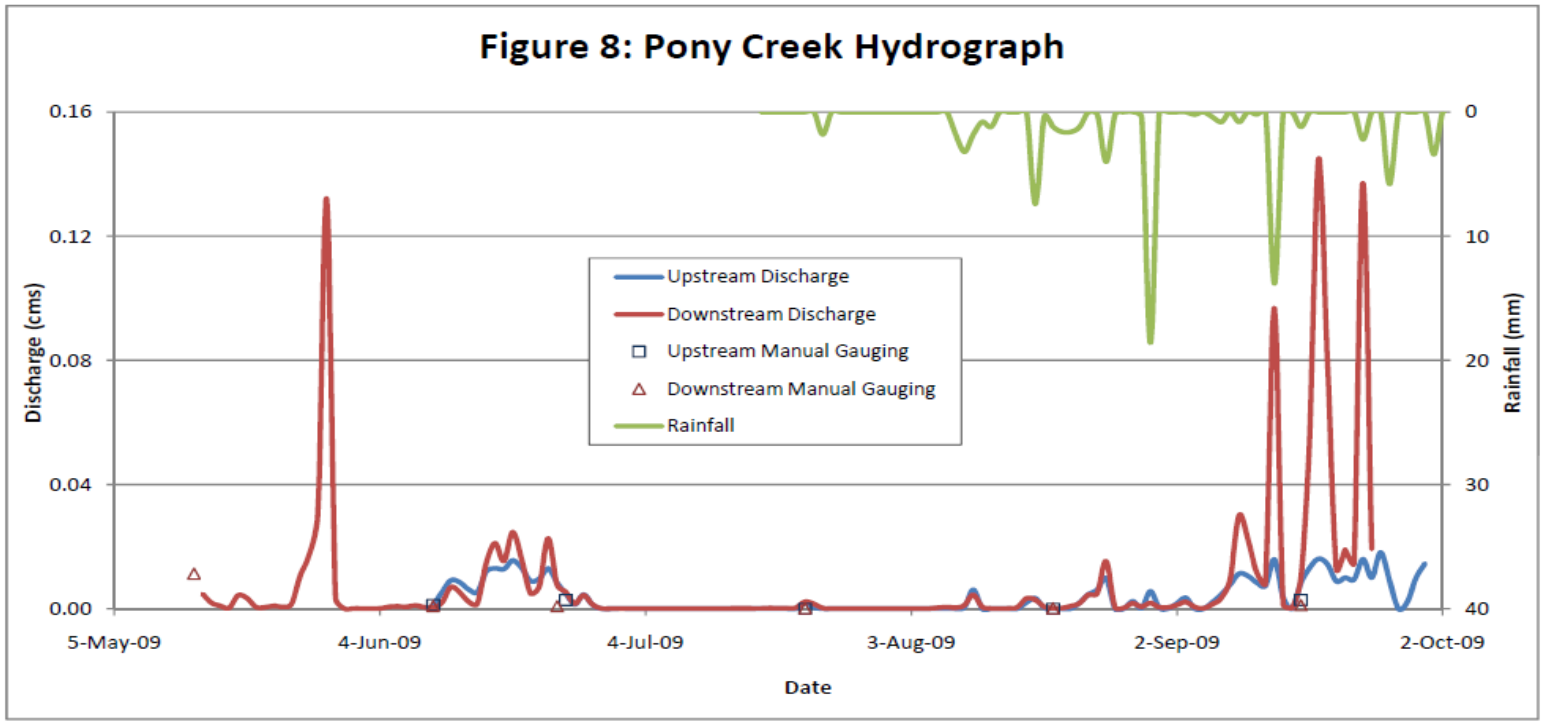
No	Data	BYG, 2003 (R15)	Klohn-Crippen, 1994 (R13)	T.W.Higgs, 1994 (R19)	Higgs, 1995	BYG, 1995	Klohn-Crippen, 1995	Klohn-Crippen 1995	BYG, 1998	EBA Eng. 2002	EBA Eng. 2003	Gartner Lee, 2004 (R09)	Gartner Lee, 2006	Gomm Eng. 2011//AECOM 2010	AECOM, 2011	EDI, 2012	Lorax, 2011	EDI, 2012	Summary	Note
					R20	R40	R47	R48	R115	R12	R11	Gartner Lee, 2004 (R09)	R25	R97, R89???	R78	R86	R88	R71		
	1 in 5 year											*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002 - See **Table 1***							*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002*	
	1 in 10 year											*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002 - See **Table 1***							*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002*	
	1 in 25 year											*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002 - See **Table 1***							*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002*	
	1 in 50 year											*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002 - See **Table 1***							*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002*	
	1 in 100 year											*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002 - See **Table 1***							*From Mt Nansen Station 2000 to 2003 but the table's foot note stated for 2000 to 2002, Carmack 1964 to 2002*	
	1 in 200 year																			
	1 in 1000 year																			
10	Monthly evaporation			*From Pelly Ranch, Period not stated - See **Table 5***	*From Pelly Ranch, Period not stated - See **Table 5***		*From Pelly Ranch, 17 to 28 year of Period 1951 to 1990 - See **Table 5***	*From Pelly Ranch, 17 to 28 year of Period 1951 to 1990 - See **Table 5***				*From Pelly Ranch, Period not stated - See **Table 5***	*From Pelly Ranch, Period not stated - See **Table 5***	*From Pelly Ranch, Period ? - 2006 See **Table 5***			*From Pelly Ranch, 1965 to 1995*		*From Pelly Ranch, Period 1965(?) - 2006*	*Monthly data for each year are not available in the report*
11	Monthly Evaporation Distribution											*From Pelly Ranch, Period not stated - See **Table 5***	*From Pelly Ranch, Period not stated - See **Table 5***				*From Pelly Ranch, 1965 to 1995*		*From Pelly Ranch, Period 1965(?) - 2006*	
12	Annual Evaporation	*From Pelly Ranch, Period not stated: 452.9 mm*		*From Pelly Ranch, Period not stated: 452.9 mm*	*From Pelly Ranch, Period not stated: 452.9 mm*									*From Pelly Ranch, Period ? To 2006: 369 mm*			*From Pelly Ranch, 1965 to 1995: 369 mm*		*From Pelly Ranch, Period 1965(?) - 2006*	
13	**Yearly (at end of March) SWE**											*From Snow Survey by Yukon Environment for 2000 to 2003 - See **Table 6***	*From Snow data supplied by Yukon Environment for different reurn period - See **Table 7***						*From Yukon Environment 2000 to 2005*	
	Annual SWE															*Victoria Strip, 1976 - 2012 - Graph only*			*Victoria Strip, 1976 - 2012*	*Graph only*
14	**Average monthly SWE**															*October 2011 to May 2012, See **Table 8***			*October 2011 to May 2012*	
15	Daily SWE/Snow Depth															*YG-09Ca-Sc1 - See **Table 9***			*Certain dates from February to April 2012*	
																27-Feb-12				
																26-Mar-12				
																25-Apr-12				
																EDI-SC-AIR				
																06-Mar-12				
																17-Apr-12				
16	Average monthly snow depth														*2010 - March, April, May, See **Table 10***	*October 2011 to May 2012, See **Table 10***			*October 2011 to May 2012*	
17	Hourly snow depth														*Mt Nansen - Graph only, October 19 2011 to May 15 2012*				*October 2011 to May 2012*	*Database available*
18	Average monthly snow density															*October 2011 to May 2012, See **Table 11***			*October 2011 to May 2012*	
19	Snowmelt distribution													*Snowmelt factor: 82% from April 15 to 30, and 18% from May 1 to 7*						
20	Average monthly air temperature														*2010 - Graph only*	*October 2011 to May 2012, See **Table 12***	*From Mt Nansen Station 2000 to 2005 and Carmack Station: 2000 to 2005 - See **Table 13***		*October 2011 to May 2012; and 2000 to 2005*	
21	Average monthly wind speed															*October 2011 to May 2012, See **Table 12***			*October 2011 to May 2012*	

Table C1 - Summary of Previous Hydrologic Parameters

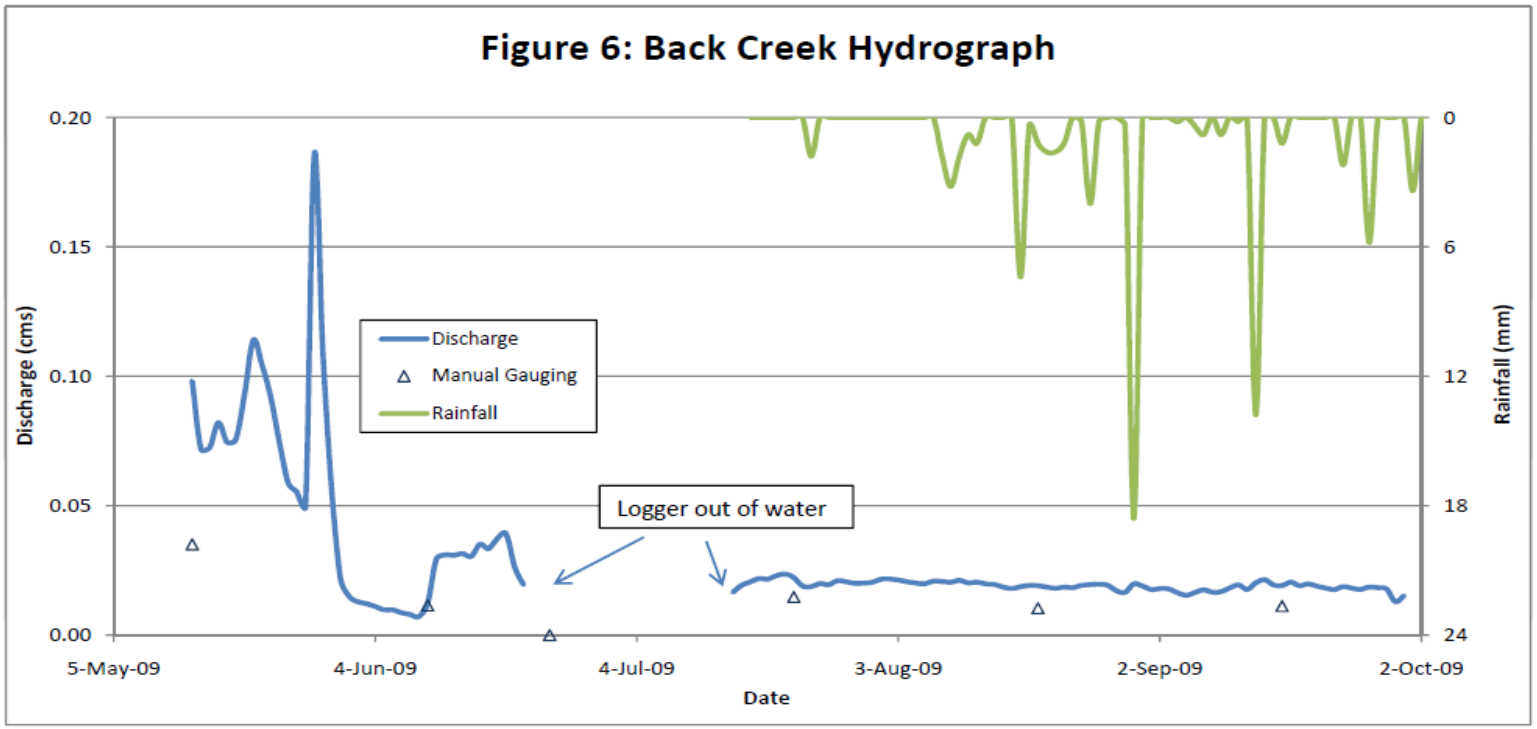
No	Data	BYG, 2003 (R15)	Klohn-Crippen, 1994 (R13)	T.W.Higgs, 1994 (R19)	Higgs, 1995	BYG, 1995	Klohn-Crippen, 1995	Klohn-Crippen 1995	BYG, 1998	EBA Eng. 2002	EBA Eng. 2003	Gartner Lee, 2004 (R09)	Gartner Lee, 2006	Gomm Eng. 2011//AECOM 2010	AECOM, 2011	EDI, 2012	Lorax, 2011	EDI, 2012	Summary	Note
					R20	R40	R47	R48	R115	R12	R11		R25	R97, R89???	R78	R86	R88	R71		
22	Hourly temperature															Mt Nansen October 19 2011 to May 15 2012 - Graph only			October 2011 to May 2012	Graph only
23	Hourly Wind speed															Mt Nansen October 19 2011 to May 15 2012 - Graph only			October 2011 to May 2012	Graph only
24	Runoff coeeficient	Dry years: 0.6 and wet years: 0.8													Summer months: 0.6 and Spring months: 0.8					
25	Daily Flow	Victoria Creek, 1988 and Dome Creek, 1988 - See **Table 14**		Victoria Creek, 1988 and Dome Creek, 1988, 1994 - See **Table 14**											2010 - Hydrograph only (Upper Dome Creek, Dome Creek at Road, Diversion Channel, Back Creek, Victoria Creek, Upper Pony Creek, Lower Pony Creek)				2010	Hydrograph and Rating Curve only
25	Monthly Flow																		Synthetic historical flow based on Mt Nansen and Carmack Station Jan 1963 to Feb 2007	
26	Monthly Flow Distribution																			
	Victoria Creek													Based on flow measured at the Water Survey Gauging station - See **Table 15**					For Victoria Creek	
27	Peak flow																			
	Diversion channel		Peak discharge 9.1 m3/s based 200 year return period 1 hour storm and area of 2.26 km2			Peak discharge 6.4 m3/s based 20 year return period 1 hour storm and area of 2.3 km2	Peak discharge 9.1 m3/s based 200 year return period 1 hour storm and area of 2.26 km2	Peak discharge 6.4 m3/s based 20 year return period 1 hour storm and area of 2.3 km2	Peak discharge 6.4 m3/s based 20 year return period 1 hour storm and area of 2.3 km2	Peak flow of 1.2 m3/s for 20 yr storm event and 3 m3/s for 200 yr storm	Peak flow of 1.2 m3/s for 20 yr storm event and 3 m3/s for 200 yr storm								For diversion channel	
	Tailings Pond						Pond flow w/o diversion channel 11.1 m3/s based 200 year return period 1 hour storm and area of 2.26 km2; Peak PMF of 34 m3/s with runfoff coefficient of 0.7, and PMP of 63 mm and area of 2.76 km2													
	Peak flow short term duration													Peak Flow and Volume for 1000 year and 10000 year for various duration based on runoff coefficient of 0.7 See Table 16						
	1 in 2 year																			
	1 in 5 year																			
	1 in 10 year																			
	1 in 25 year																			
	1 in 50 year																			
	1 in 100 year																			
	1 in 200 year																			
	1 in 1000 year													Peak Flow of 6 hrs duration: 4 m3/s for for 1000 year, 4.8 m3/s for 10000 year, 12.5 m3/y for PMF and 6.8 m3/s for IDF						
	1 in 10000 year													Peak Flow of 6 hrs duration: 4 m3/s for for 1000 year, 4.8 m3/s for 10000 year, 12.5 m3/y for PMF and 6.8 m3/s for IDF						
	Monthly Average Precipitation																			
	Annual Average Precipitation																			
	Monthly Distribution																			

APPENDIX C2

2009 and 2010 Hydrographs



12359_DTAB_CS_All Sites_09Dec01_eh_v7.xls



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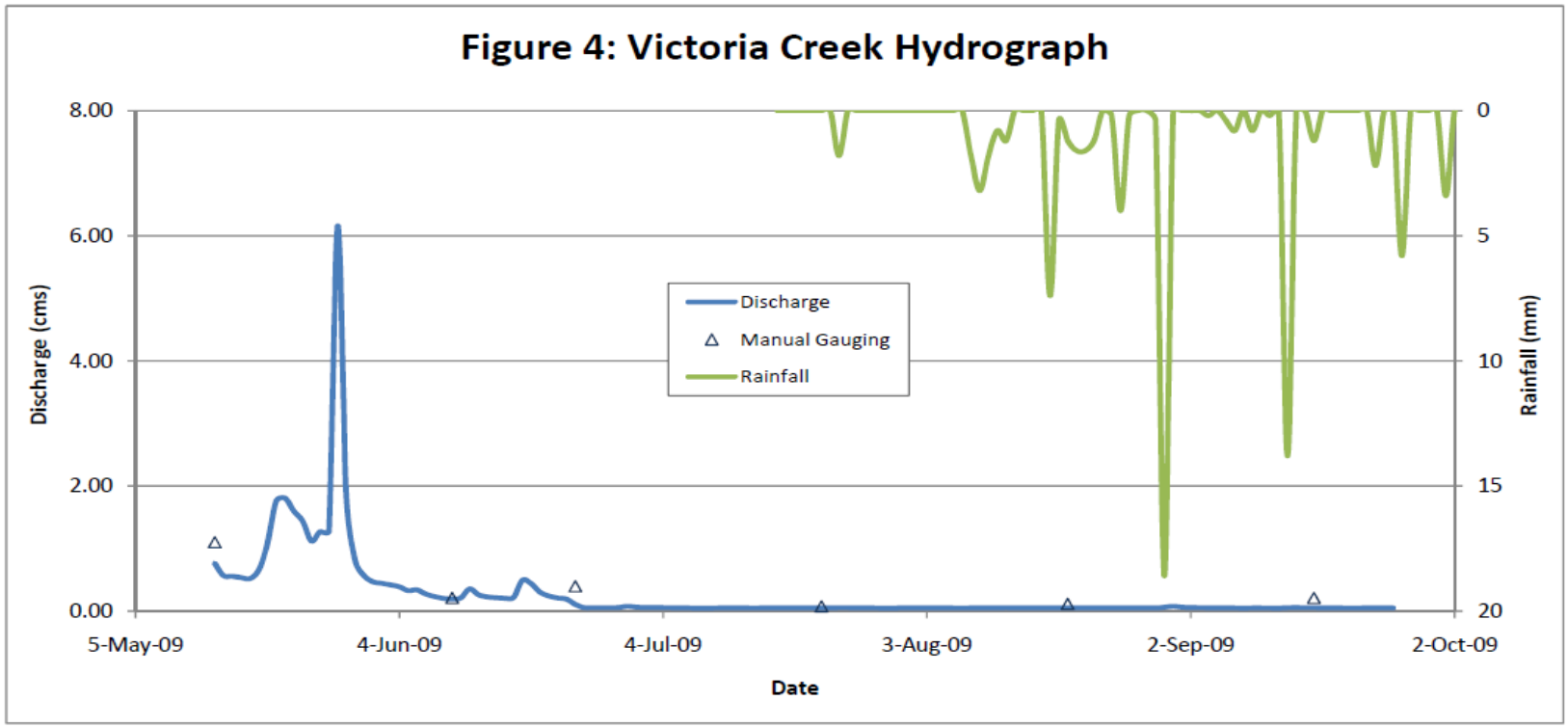
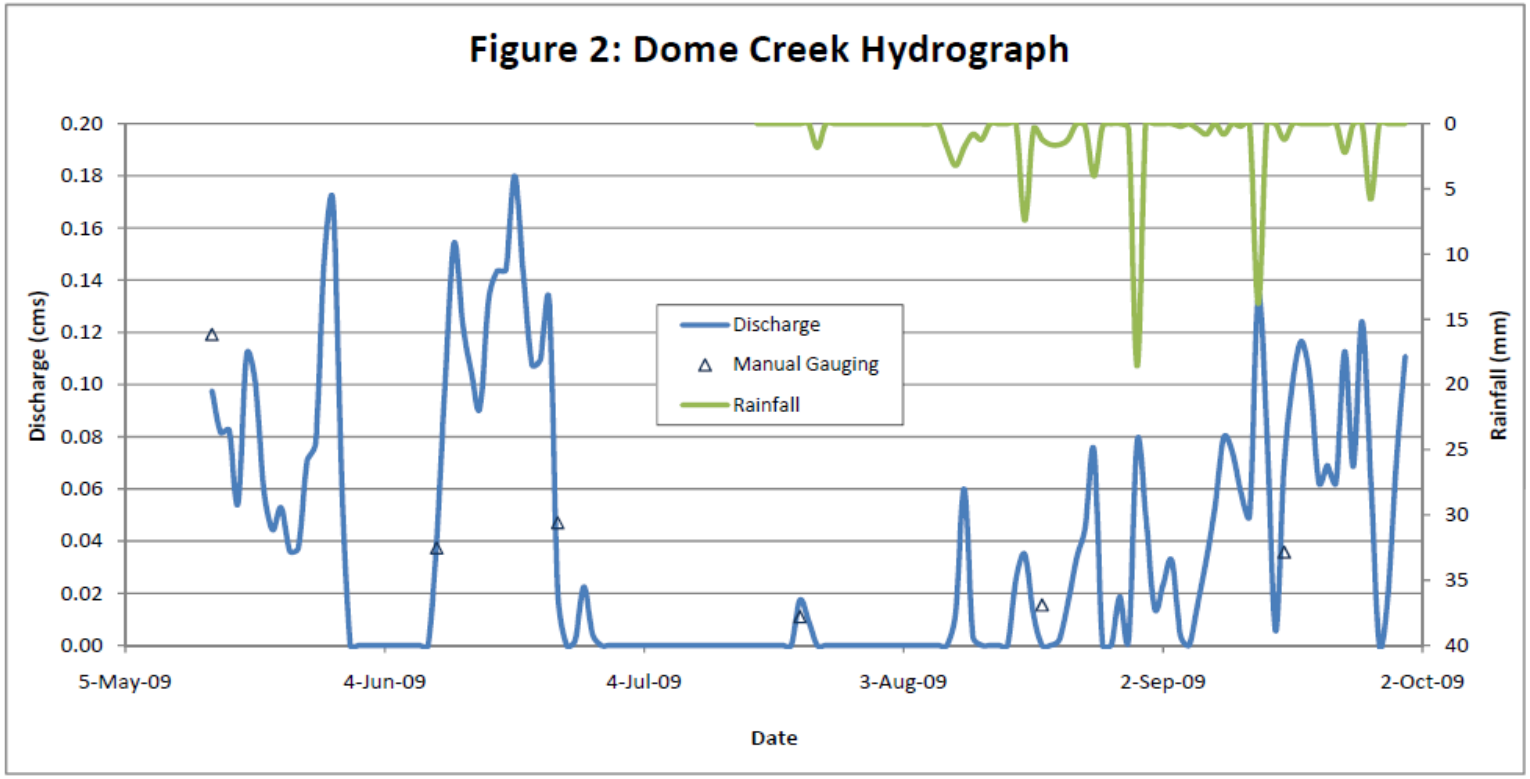
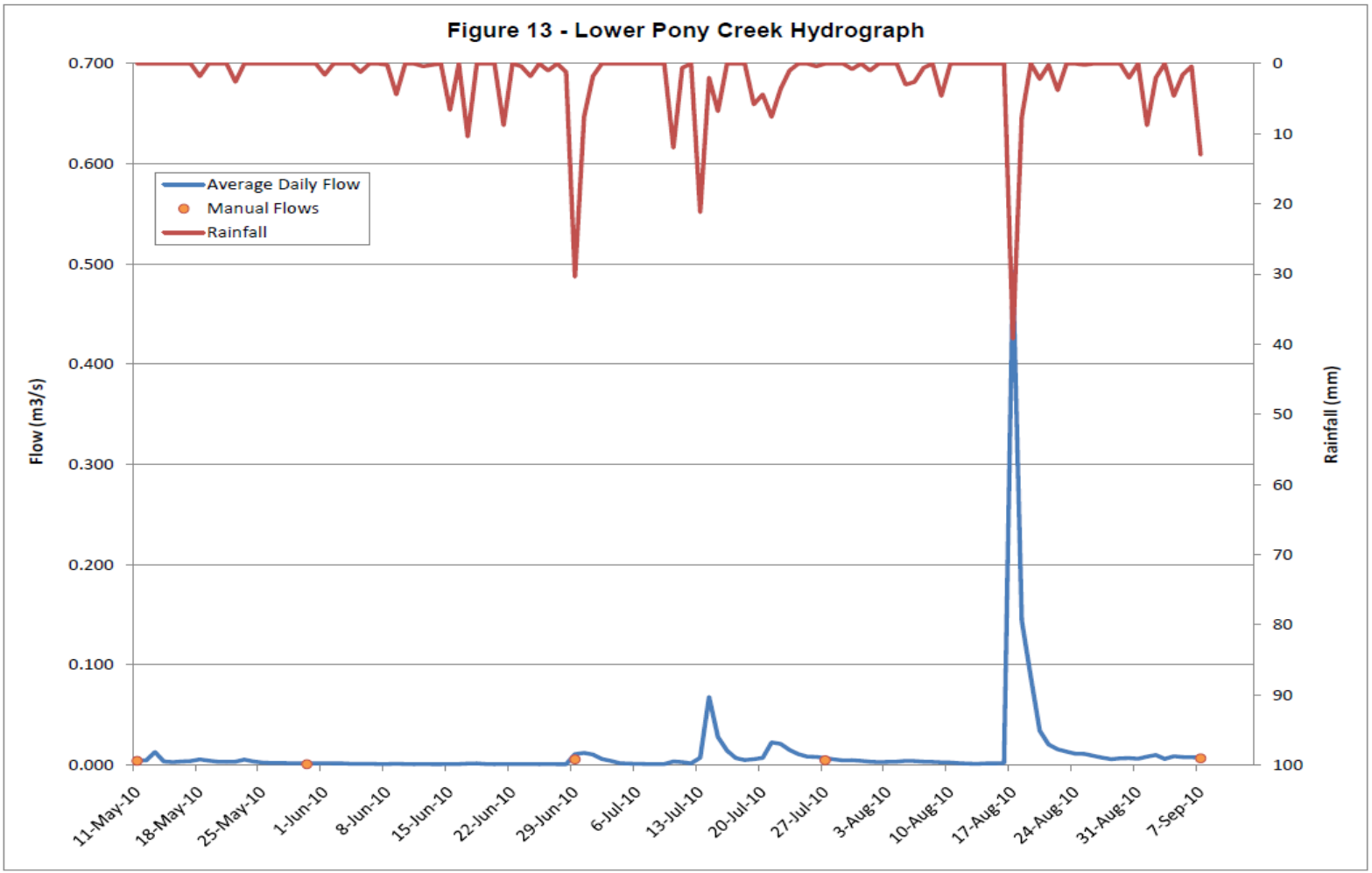


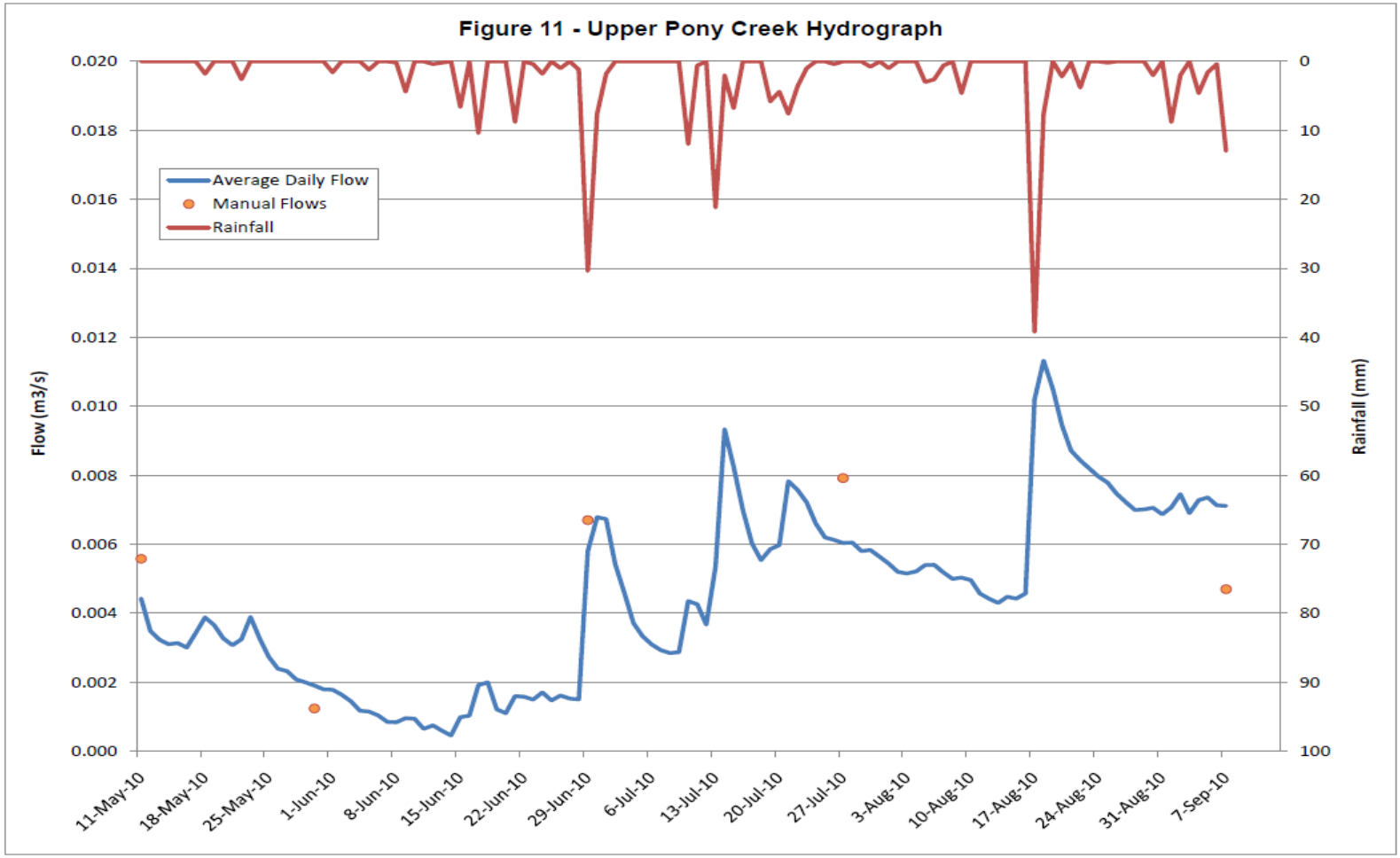
Figure 4: Victoria Creek Hydrograph
8.00
6.00
4.00
2.00
0.00
Discharge (cms)
0
5
10
15
20
Rainfall (mm)
Discharge
Manual Gauging
Rainfall
5-May-09
4-Jun-09
4-Jul-09
3-Aug-09
2-Sep-09
2-Oct-09
Date



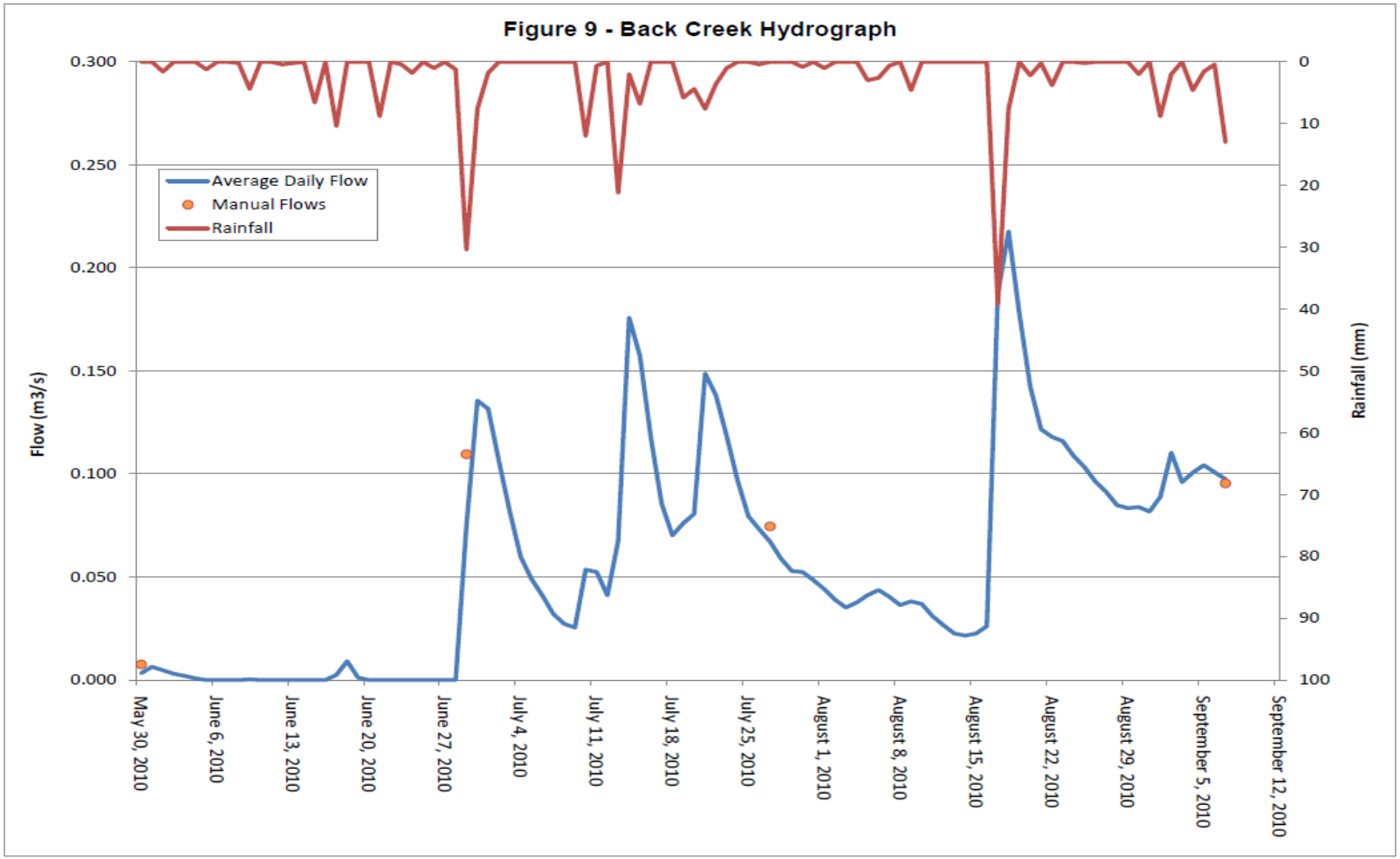
112359_DTAB_CS_All Sites_09Dec01_eh_v7.xls



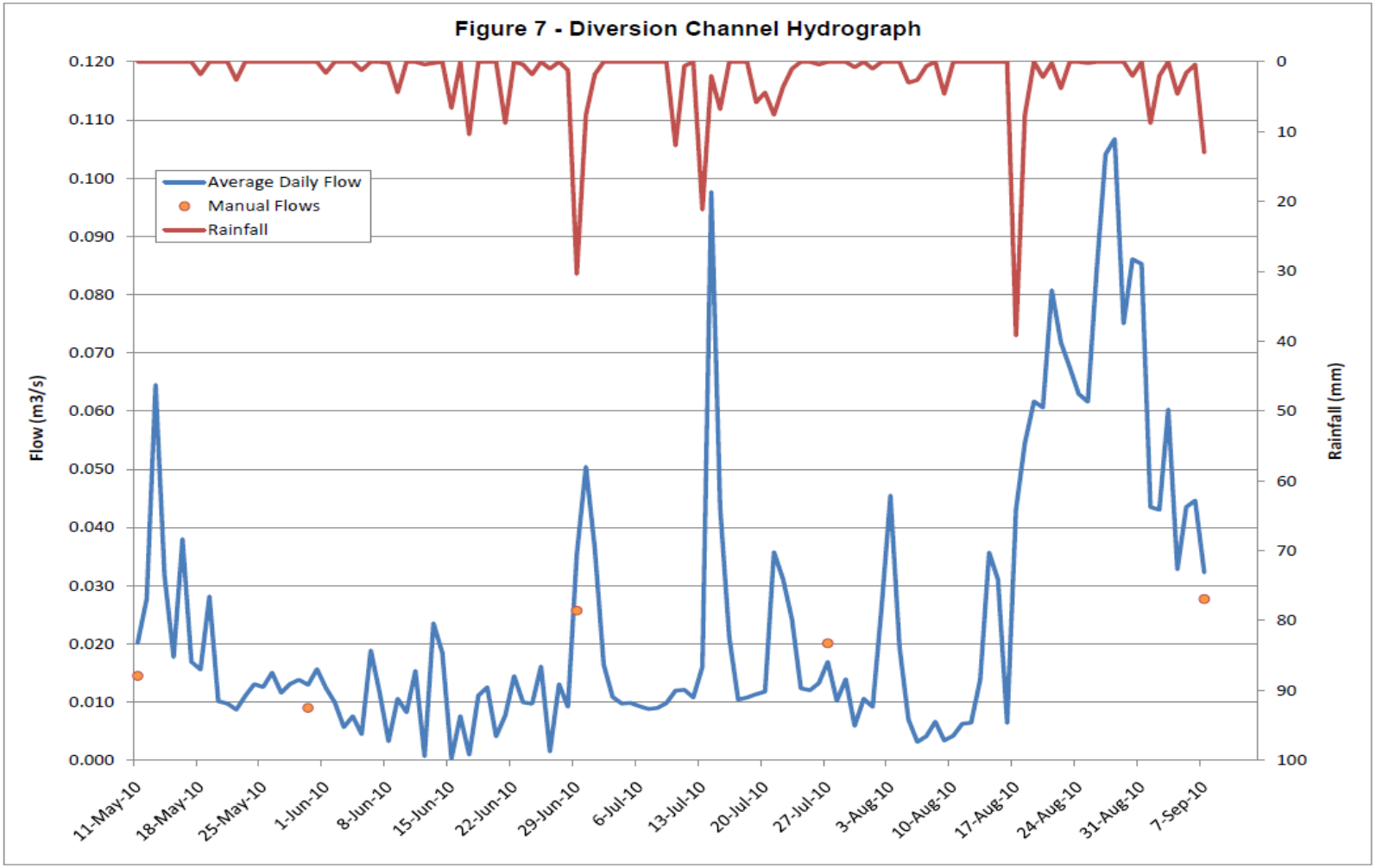
DAT-2010-12-16-Lower Pony Final-slw-60154930.xlsx



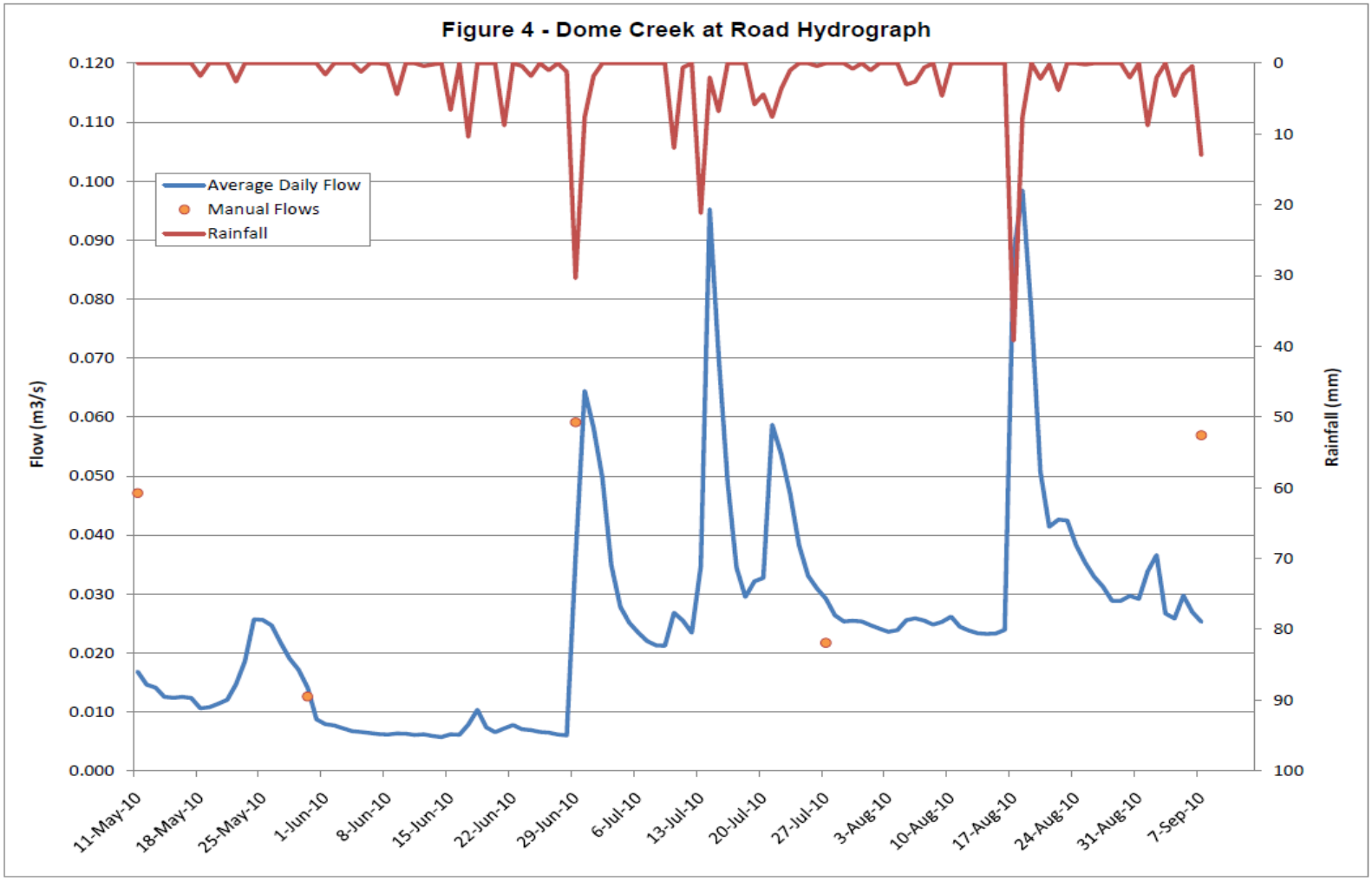
DAT-2010-12-16-Upper Pony Final-slw-60154930.xlsx



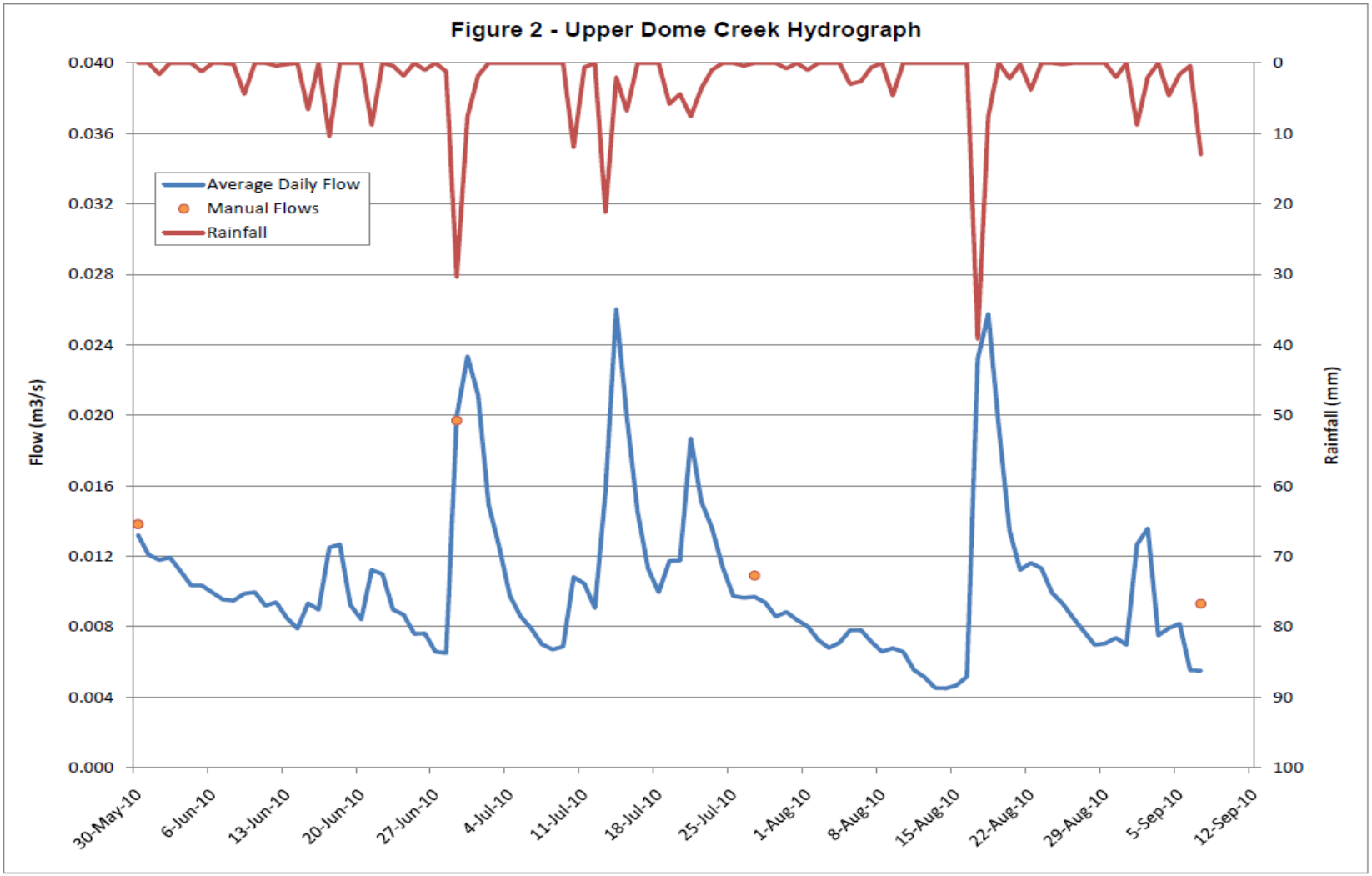
DAT-2010-12-16- Back Creek Final-slw-60154930.xlsx



DAT-2010-12-16-Diversion Channel Final-slw-60154930.xlsx



DAT-2010-12-16-Dome at Road Final-slw-60154930.xlsx



DAT-2010-12-16- Upper Dome Final-slw-60154930.xlsx

APPENDIX D

Surface Water Quality Assurance/Quality Control

D. Quality Assurance and Quality Control (QA/QC) for Surface Water Quality Assessments

D.1 Sampling and Analysis

Quality Assurance and Quality Control (QA/QC) were provided by having experience staff using defensible sampling methods. All sample collection was completed according to the methods documented in the SI Data Report.

Most of the chemical analyses were completed by ALS Environmental in Whitehorse, YT, and Burnaby, BC. Additional water analyses for dissolved gases were completed by the AMEC Chemistry Laboratory in Edmonton, AB (i.e. volatile organic carbon, VOCs), and in Dr. Lisa Stein's laboratory in the Biological Sciences department at the University of Alberta (i.e. methane and nitrous oxide). ALS and AMEC are accredited by the Canadian Association for Laboratory Accreditation (CALA) for the analyses completed.

Three alternate preservations were applied to evaluate potential sampling biases related to the expected presence of sulphide in the groundwater.

D.2 QA/QC

Tables C1 to C5 provide evaluations of the data generated by three Alternate Preservations and field duplicates. The data is evaluated using Relative Percent Difference (RPD) which is the difference in concentration divided by the average concentration; therefore, an RPD of 200% is the maximum possible. Because analytical error increases near the detection limit, RPDs are not calculated unless both concentrations are more than five times the method detection limit (MDL). However, when one result is less than five times the MDL, and the other result is more than 10 times the MDL, then the RPD was calculated.

Tables C1 to C4 present the data from the three Alternate Preservations that were applied to evaluate the potential effect of sulphide on analytical results for cyanide species and arsenic. Table C3 Summary reduces the data from Table C4 for Alternate Preservation #3.

Table C3 presents the field duplicate data.

Table 38 provides an evaluation of sulphite as an explanation for inconsistencies that were identified in the water analytical data. This is discussed in the section on Alternate Preservation #3 and in the section on Sulphite Calculations.

D.3 Alternate Preservation #1

Alternate Preservation #1 used nitric acid (HNO_3) to preserve thiocyanate samples rather than sodium hydroxide (NaOH) which is the standard preservative that has been applied historically for thiocyanate samples. As discussed in the SI Data Report, when sulphide (H_2S or HS^-), or

other partially oxidized forms of sulphide such as polysulphide (S_8) are present in a water sample containing free cyanide, the addition of NaOH as a preservative can quickly convert free cyanide to thiocyanate. This mechanism creates a negative bias for free cyanide (CN^-) and a positive bias for the less toxic thiocyanate (SCN^-). The laboratory, ALS, recently switched from using NaOH as the preservative for thiocyanate samples to address this problem.

The results on Table C1 show that this change in preservative had essentially no effect on the measured thiocyanate results. Therefore, this suggests that there are minimal sulphides or polysulphides present in the groundwater.

Based on these results, the switch of preservative from NaOH to HNO_3 for thiocyanate samples should be continued.

D.4 Alternate Preservation #2

Alternate Preservation #2 used the addition of lead acetate in the field to water samples for cyanide analyses to remove sulphide prior to preservation with NaOH. The method used was described in the SI Data Report, and is based on the approach detailed by ALS Australia in two fact sheets from 2012.

Most locations did not have significant sulphide concentrations when measured in the field using a Chemetric field test kit for sulphide, and Alternate Preservation #2 was not applied at all locations.

The results on Table C2 show that most locations sampled with Alternate Preservation #2 had non-detectable concentrations for the various cyanide species, and the use of this alternate method did not change the measured results. However, at three locations on the up-gradient side of the tailings pond (i.e. MP09-09, MP09-11 and MP09-12) the removal of sulphide changed the measured cyanide species concentrations significantly. At all three of these locations, the measured thiocyanate concentration went down, but only at MP09-09 did the free cyanide concentration increase. Alternately, the Total Cyanide concentration (which measures both WAD and SAD-cyanides) decreased with the application of Alternate Preservation #2. The addition of lead acetate to the water samples formed significant amounts of precipitate which was allowed to settle out from the water sample prior to the collection of filtered samples for cyanide analyses. It appears that this precipitate removed some of the Total Cyanide.

Based on these results, the removal of sulphide using lead acetate should be considered necessary only when sampling for free cyanide when sulphide is present.

D.5 Alternate Preservation #3

Alternate Preservation #3 was the use of no preservative for dissolved metals samples. This was done to evaluate the potential effect on dissolved arsenic concentrations. When present in a water sample with sulphide, arsenic is stable in solution at neutral pH, but the addition of acid

promotes the precipitation of arsenic sulphides which removes arsenic from the water sample. Therefore, the standard dissolved metals sampling procedure creates a potential negative bias for arsenic when sulphide is present. As shown by Smeja and Wilkins (2003)[4], the negative bias for arsenic can be very significant.

Normally, dissolved metals samples are preserved with nitric acid primarily to prevent the oxidation of dissolved ferrous iron (Fe^{2+}) to ferric iron (Fe^{3+}) in the form of red-orange precipitates ($Fe(OH)_3$) which are referred to as iron oxyhydroxides. This oxidation of iron produces acid which consumes alkalinity. This can result in an electrical charge balance error as the iron concentration (i.e. cation) is measured correctly, but the alkalinity value (i.e. anion) is depressed by the production of acid from iron oxidation in the unpreserved bottle that is used for the alkalinity titration. This charge balance error due to iron precipitation can be accounted for by increasing the measured alkalinity by an amount corresponding to the acid produced by the iron oxidation. Using units of milliequivalents to account for the weight and charge of the various ions, it can be shown that for each 10 mg/L of iron that precipitates, 17.9 mg/L of total alkalinity (expressed as $CaCO_3$) is consumed.

The detailed evaluation of the effect of Alternate Preservation #3 is presented on Table C3, and a summary is presented on Table C4 Summary. Of the metals with exceedances of the various regulatory standards as noted on Tables C6 and C7, significant variability (RPD >20%) was noted in some samples for arsenic, cadmium and iron.

Some of the arsenic concentrations measured at the up-gradient side of the Tailings Dam area increased significantly when the samples were collected without preservation. At MP09-11, the measured arsenic concentration in the preserved sample was 6.65 mg/L and the unpreserved sample had an arsenic concentration nearly 40% higher at 9.75 mg/L. Several arsenic results were lower in the unpreserved samples, which is consistent with the fact that arsenic (and other metals) will sorb strongly to iron oxyhydroxides, which means they will tend to be measured at lower concentrations in the unpreserved sample. However, at most locations, the differences observed for the various metal concentrations were minor.

The most notable result identified by Alternate Preservation #3 was the lack of iron oxidation in the unpreserved samples, identified by the difference in the iron concentrations between the preserved and unpreserved samples (see Table C1 through C4). This is considered unusual because at these concentrations (tens of mg/L) the dissolved iron (Fe^{2+}) would be expected to be oxidized by atmospheric oxygen in the unpreserved sample. This lack of iron oxidation could be considered indicative of the presence of an oxygen scavenger such as sulphite. This affect was noted in many of the groundwater samples, and thus the lack of iron oxidation in the unpreserved samples could also be due lack of exposure of the unpreserved water to atmospheric oxygen.

[4] Smeja and Wilkins. 2003.

Table C8 presents an evaluation of the concentration of sulphite that would be needed to prevent the oxidation of iron in the unpreserved water samples. These calculations show that the presence of sulphite can be inferred in the groundwater at sufficient concentrations to account for the noted lack of iron oxidation. This is discussed further in the Sulphite Calculations section.

Based on these results, future sampling of groundwater or surface water for metals should include both preserved and unpreserved samples to evaluate the effect on arsenic, cadmium and iron concentrations.

D3.6 Data Validation

Data validation for the 2013 data and the historical data set consisted of evaluating electrical charge balance and the internal consistency of various analytical parameters for each sampling event at each location. Water must be electrically neutral and charge balance is presented on the data tables as presented by the laboratory, or as calculated by AMEC. The charge balance from ALS differs from the charge balance calculated by AMEC as there are various formulas to evaluate this data. AMEC calculated charge balance as the sum of cations divided by the sum of anions. The cation and anion concentrations are quoted in meq/L (milliequivalents per litre) which accounts for the weight and electrical charge on a given ion.

As shown on the data tables, many of the water samples had poor electrical charge balances which can be explained by the presence of other electrically charged species that have not been fully accounted for by these chemical analyses. These results are considered indicative of the presence of sulphite, and this is discussed further in the section on Sulphite Calculations.

When large variations from expected analytical values are identified, the source of the error is investigated and corrected. as needed. For example, some of the highest historical analytical results for cyanides in the Tailings Pond and Seep were identified as being 10 times higher than the norm. The data for WAD-cyanide on 29 June 2000 was reported as 1,140 mg/L, but this elevated value for cyanide did not have a correspondingly elevated value for iron or copper to match this high WAD-cyanide result. Therefore, this WAD-cyanide value has been corrected to 114.0 mg/L to match the historical trends. Factor of 10 errors such as these are simply dilution errors that can occur during the chemical analysis.

Having calculated the electrical charge balance and the relative contribution of the individual major ions to the total ion concentration, Ion Percentage graphs were then prepared for each location with sufficient data (i.e. more than one sampling event).

The Ion Percentage graphs are presented in Addendum 1. Various biogeochemical processes can be identified by the use of Ion Percentage graphs, and this is discussed further in a subsequent section.

Table D1: Relative Percent Difference (RPD) Calcualtions for Alternate Preservation #1 Thiocyanate

		Sample ID	Thiocyanate (SCN)
		Units	mg/L
		Detection limit	0.50
	Date Sampled		
MP09-04 Standard Preservation	18-Sep-13		<0.005
MP09-04 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
MP09-05 STANDARD PRESERVATION	18-Sep-13		2.87
MP09-05 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			2.89
		RPD	0.69%
MP09-09 STANDARD PRESERVATION	17-Sep-13		0.99
MP09-09 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
MP09-11 STANDARD PRESERVATION	17-Sep-13		1.18
FIELD DUP A STANDARD PRESERVATION			0.7
		RPD	n/a
MP09-11 ALTERNATE PRESERVATION #1 (SCN WITH HN03)	17-Sep-13		0.8
FIELD DUP A ALTERNATE PRESERVATION #1 (SCN WITH HN03)			0.84
		RPD	n/a
MP09-12 STANDARD PRESERVATION	17-Sep-13		0.7
MP09-12 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
MW09-01 STANDARD PRESERVATION	17-Sep-13		7.11
MW09-01 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			7.38
		RPD	3.73%
MW09-02 STANDARD PRESERVATION	17-Sep-13		<0.50
FIELD DUP B STANDARD PRESERVATION			<0.50
		RPD	n/a
MW09-02 ALTERNATE PRESERVATION #1 (SCN WITH HN03)	17-Sep-13		<0.50
FIELD DUP B ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
MW09-03 STANDARD PRESERVATION	17-Sep-13		0.57
MW09-03 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
MW09-04 STANDARD PRESERVATION	17-Sep-13		0.56
MW09-04 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
MW09-07 STANDARD PRESERVATION	18-Sep-13		0.61
MW09-07 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
MW09-08 STANDARD PRESERVATION	18-Sep-13		<0.50
FIELD DUP C STANDARD PRESERVATION			<0.50
		RPD	n/a
MW09-08 ALTERNATE PRESERVATION #1 (SCN WITH HN03)	18-Sep-13		<0.50
FIELD DUP C ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
MW09-16 STANDARD PRESERVATION	19-Sep-13		<0.50
MW09-16 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
MW09-17 STANDARD PRESERVATION	19-Sep-13		<0.50
MW09-17 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
MW09-18 STANDARD PRESERVATION	19-Sep-13		<0.50
MW09-18 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
MW09-19 STANDARD PRESERVATION	19-Sep-13		0.51
FIELP DUP D STANDARD PRESERVATION			<0.50
		RPD	n/a
MW09-19 ALTERNATE PRESERVATION #1 (SCN WITH HN03)	19-Sep-13		<0.50
FIELP DUP D ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
MW09-21 STANDARD PRESERVATION	19-Sep-13		1.11
MW09-21 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			0.7
		RPD	n/a
MW09-22 STANDARD PRESERVATION	18-Sep-13		0.57
MW09-22 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
MW09-23 STANDARD PRESERVATION	19-Sep-13		<0.50
MW09-23 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
MW09-24 STANDARD PRESERVATION	18-Sep-13		0.51
MW09-24 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			<0.50
		RPD	n/a
GLL07-02 STANDARD PRESERVATION	19-Sep-13		0.59
GLL07-02 ALTERNATE PRESERVATION #1 (SCN WITH HNO3)			<0.50
		RPD	n/a
GLL07-03 STANDARD PRESERVATION	19-Sep-13		<0.50
GLL07-03 ALTERNATE PRESERVATION #1 (SCN WITH HNO3)			<0.50
		RPD	n/a
W1410383-BH02 STANDARD PRESERVATION	18-Sep-13		0.53
W1410383-BH02 ALTERNATE PRESERVATION #1 (SCN WITH HNO3)			<0.50
		RPD	n/a
W1410383 BH03 STANDARD PRESERVATION	20-Sep-13		0.72
W1410383 BH03 ALTERNATE PRESERVATION #1 (SCN WITH HN03)			0.73
		RPD	n/a

Table D2: Relative Percent Difference (RPD) Calcualtions for Alternate Preservation #2 Cyanides

Sample ID	Date Sampled	Cyanide, Weak Acid Diss	Cyanide, Total	Thiocyanate (SCN)	Cyanide, Free
Units		mg/L	mg/L	mg/L	mg/L
Detection limit		0.01	0.01	0.50	0.01
MP09-09 STANDARD PRESERVATION	17-Sep-13	0.0058	2.37	0.99	<0.0050
MP09-09 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)		0.320	0.324	<0.50	0.278
RPD		n/a	151.9%	n/a	200.0%
MP09-11 STANDARD PRESERVATION	17-Sep-13	<0.0050	0.90	1.18	<0.0050
MP09-11 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)		<0.0050	<0.0050	<0.50	<0.0050
RPD		n/a	200.0%	n/a	n/a
FIELD DUP A ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	17-Sep-13	<0.0050	<0.0050	<0.50	<0.0050
RPD		n/a	n/a	n/a	n/a
MP09-12 STANDARD PRESERVATION	17-Sep-13	<0.0050	0.16	0.70	<0.0050
MP09-12 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)		<0.0050	<0.0050	<0.50	<0.0050
RPD		n/a	200.0%	n/a	n/a
MW09-01 STANDARD PRESERVATION	17-Sep-13	<0.0050	0.51	7.11	<0.0050
MW09-01 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)		0.0100	0.512	8.99	<0.0050
RPD		n/a	1.2%	23.4%	n/a
MW09-02 STANDARD PRESERVATION	17-Sep-13	<0.0050	<0.0050	<0.50	<0.0050
MW09-02 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)		0.0060	0.0200	<0.50	<0.0050
RPD		n/a	n/a	n/a	n/a
FIELD DUP B ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	17-Sep-13	<0.0050	0.01	<0.50	<0.0050
RPD		n/a	n/a	n/a	n/a
MW09-03 STANDARD PRESERVATION	17-Sep-13	<0.0050	0.01	0.57	<0.0050
MW09-03 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)		<0.0050	<0.0050	<0.50	<0.0050
RPD		na/	na/	na/	na/
MW09-04 STANDARD PRESERVATION	17-Sep-13	<0.0050	<0.0050	0.56	<0.0050
MW09-04 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)		<0.0050	<0.0050	<0.50	<0.0050
RPD		n/a	n/a	n/a	n/a
MW09-07 STANDARD PRESERVATION	18-Sep-13	<0.0050	<0.0050	0.61	<0.0050
MW09-07 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)		<0.0050	<0.0050	<0.50	<0.0050
RPD		n/a	n/a	n/a	n/a
MW09-08 STANDARD PRESERVATION	18-Sep-13	<0.0050	<0.0050	<0.50	<0.0050
MW09-08 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)		<0.0050	<0.0050	<0.50	<0.0050
RPD		n/a	n/a	n/a	n/a
FIELD DUP C ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	18-Sep-13	<0.0050	<0.0050	<0.50	<0.0050
RPD		n/a	n/a	n/a	n/a
MW09-19 STANDARD PRESERVATION	19-Sep-13	<0.0050	<0.0050	0.51	<0.0050
MW09-19 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)		<0.0050	<0.0050	<0.50	<0.0050
RPD		n/a	n/a	n/a	n/a
FIELP DUP D ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)	19-Sep-13	<0.0050	<0.0050	<0.50	<0.0050
RPD		n/a	n/a	n/a	n/a
GLL07-03 STANDARD PRESERVATION	19-Sep-13	<0.0050	<0.0050	<0.50	<0.0050
GLL07-03 ALTERNATE PRESERVATION #2 (SULPHIDE REMOVED)		<0.0050	<0.0050	<0.50	<0.0050
RPD		n/a	n/a	n/a	n/a

Table D3: Relative Percent Difference (RPD)
Calculations for Alternate Preservation #3
Dissolved Metals

Sample ID	UNITS	Detection limit	MP09-04 Standard Preservation	MP09-04 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MP09-05 STANDARD PRESERVATION	MP09-05 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MP09-09 STANDARD PRESERVATION	MP09-09 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MP09-11 STANDARD PRESERVATION	MP09-11 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	FIELD DUP A ALTERNATE PRESERVATION #3 (UNPRESERVED)
Date Sampled			18-Sep-13	18-Sep-13		18-Sep-13	18-Sep-13		17-Sep-13	17-Sep-13		17-Sep-13			17-Sep-13
Dissolved Metals															
Aluminum (Al)-Dissolved	mg/L	0.0010	0.0023	<0.0010	n/a	0.0409	0.0286	-35.4%	0.0021	<0.0020	n/a	0.0094	0.0070	-29.3%	0.0061
Antimony (Sb)-Dissolved	mg/L	0.00010	0.0018	0.00184	0.5%	0.00052	0.00052	0.0%	0.127	0.130	2.3%	0.0101	0.0132	26.6%	0.0129
Arsenic (As)-Dissolved	mg/L	0.0001	0.00144	0.00144	0.0%	0.118	0.0728	-47.4%	16	17.7	10.1%	6.65	9.75	37.8%	6.2
Barium (Ba)-Dissolved	mg/L	0.000050	0.09220	0.0954	3.4%	0.115	0.110	-4.4%	0.00381	0.00371	-2.7%	0.145	0.155	6.7%	0.123
Beryllium (Be)-Dissolved	mg/L	0.00010	<0.00020	<0.00010	n/a	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a	<0.00010	<0.00010	n/a	<0.00010
Bismuth (Bi)-Dissolved	mg/L	0.00050	<0.0010	<0.00050	n/a	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a	<0.00050	<0.00050	n/a	<0.00050
Boron (B)-Dissolved	mg/L	0.010	<0.020	0.016	n/a	0.106	0.095	-10.9%	<0.020	<0.020	n/a	0.054	0.056	3.6%	0.048
Cadmium (Cd)-Dissolved	mg/L	0.000010	0.000104	0.000114	9.2%	0.000381	0.000315	-19.0%	0.000072	0.000077	6.7%	0.000112	0.000085	-27.4%	0.000061
Calcium (Ca)-Dissolved	mg/L	0.05	310	295	-5.0%	428	451	5.2%	76	77	1.7%	132	146	10.1%	135
Chromium (Cr)-Dissolved	mg/L	0.00010	000	0.00048	-4.1%	0.00092	0.00060	-42.1%	<0.00020	<0.00020	n/a	0.00182	0.00186	2.2%	0.00173
Cobalt (Co)-Dissolved	mg/L	0.00010	0.00028	0.00036	25.0%	0.0152	0.0154	1.3%	0.0153	0.0181	16.8%	0.00350	0.00355	1.4%	0.00374
Copper (Cu)-Dissolved	mg/L	0.00020	0.00298	0.00320	7.1%	0.00165	0.00150	-9.5%	0.171	0.285	50.0%	0.00255	0.00162	-44.6%	0.00172
Iron (Fe)-Dissolved	mg/L	0.01	<0.010	<0.010	n/a	56.1	53.4	-4.9%	0.05	0.1	33.0%	8.8	4.8	-59.9%	6.5
Lead (Pb)-Dissolved	mg/L	0.000050	<0.00010	<0.000050	n/a	0.00012	0.00013	8.0%	0.00252	0.00215	-15.8%	0.00480	0.00276	-54.0%	0.00241
Lithium (Li)-Dissolved	mg/L	0.00050	<0.0010	<0.00050	n/a	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a	0.00504	0.00445	-12.4%	0.00455
Magnesium (Mg)-Dissolved	mg/L	0.1	93.6	99.0	5.6%	54.2	52.6	-3.0%	2.5	2.4	-4.9%	76.1	82.6	8.2%	79.7
Manganese (Mn)-Dissolved	mg/L	0.00005	0.00	0.00	4.2%	10.70	12.10	12.3%	0.39	0.41	4.5%	6.02	6.56	8.6%	5.54
Mercury (Hg)-Dissolved	mg/L	0.000010	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010
Molybdenum (Mo)-Dissolved	mg/L	0.000050	0.00034	0.000358	5.2%	0.00073	0.00073	0.0%	0.0145	0.0134	-7.9%	0.00996	0.0109	9.0%	0.0108
Nickel (Ni)-Dissolved	mg/L	0.00050	<0.0010	0.00059	n/a	0.0063	0.0052	-19.1%	0.0098	0.0120	20.2%	0.0154	0.0146	-5.3%	0.0164
Phosphorus (P)-Dissolved	mg/L	0.050	<0.050	<0.050	n/a	<0.050	<0.25	n/a	0.430	0.449	4.3%	0.086	0.072	n/a	0.063
Potassium (K)-Dissolved	mg/L	0.10	2.65	2.60	-1.9%	8.50	8.40	-1.2%	11.2	10.2	-9.3%	8.71	9.11	4.5%	9.99
Selenium (Se)-Dissolved	mg/L	0.00010	0.00	0.00023	-29.6%	0.00027	0.00034	23.0%	0.00057	0.00067	16.1%	0.00041	0.00071	53.6%	0.00049
Silicon (Si)-Dissolved	mg/L	0.050	5.08000	5.02	-1.2%	6.38	6.30	-1.3%	14.9	16.2	8.4%	10.0	10.8	7.7%	10.5
Silver (Ag)-Dissolved	mg/L	0.000010	<0.000020	<0.000010	n/a	<0.000020	0.000023	n/a	0.000056	0.000083	38.8%	0.000019	0.000028	38.3%	0.000015
Sodium (Na)-Dissolved	mg/L	0.050	8.9	9.11	2.3%	76.1	78.0	2.5%	15.8	17.2	8.5%	21.4	22.5	5.0%	22.7
Strontium (Sr)-Dissolved	mg/L	0.00020	0.97	0.979	1.0%	1.09	1.14	4.5%	0.234	0.226	-3.5%	0.836	0.907	8.1%	0.854
Sulfur (S)-Dissolved	mg/L	0.50	260	240	-8.0%	408	426	4.3%	58	38	-41.0%	7	8	11.9%	8
Thallium (Tl)-Dissolved	mg/L	0.00001	<0.000020	<0.000010	n/a	0.000036	0.000037	2.7%	<0.000020	<0.000020	n/a	<0.000010	0.000011	n/a	<0.000010
Tin (Sn)-Dissolved	mg/L	0.00010	<0.00020	<0.00010	n/a	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a	0.00041	0.00017	n/a	0.00013
Titanium (Ti)-Dissolved	mg/L	0.010	<0.020	<0.010	n/a	<0.020	<0.020	n/a	<0.020	<0.020	n/a	<0.010	<0.010	n/a	<0.010
Uranium (U)-Dissolved	mg/L	0.000010	0.0131	0.0128	-2.3%	0.00133	0.00126	-5.4%	0.00194	0.00215	10.3%	0.000760	0.000904	17.3%	0.000865
Vanadium (V)-Dissolved	mg/L	0.0010	<0.0020	<0.0010	n/a	0.0026	<0.0020	n/a	<0.0020	<0.0020	n/a	0.0074	0.0074	0.0%	0.0060
Zinc (Zn)-Dissolved	mg/L	0.0010	0.006	0.0073	19.5%	0.0187	0.0151	-21.3%	0.0052	0.0035	-39.1%	0.0313	0.0258	-19.3%	0.0188

Table D3: Relative Percent Difference (RPD)
Calculations for Alternate Preservation #3
Dissolved Metals

Sample ID	UNITS	Detection limit	RPD	MP09-12 STANDARD PRESERVATION	MP09-12 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MW09-01 STANDARD PRESERVATION	MW09-01 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MW09-02 STANDARD PRESERVATION	MW09-02 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	FIELD DUP B ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD
Date Sampled				17-Sep-13	17-Sep-13		17-Sep-13	17-Sep-13		17-Sep-13	17-Sep-13		17-Sep-13	
Dissolved Metals														
Aluminum (Al)-Dissolved	mg/L	0.0010	4.9%	0.0031	0.0029	n/a	0.0422	0.0311	-30.3%	<0.0020	<0.0020	n/a	<0.0020	n/a
Antimony (Sb)-Dissolved	mg/L	0.00010	3.7%	0.0220	0.0269	20.0%	0.00081	0.00071	-13.2%	0.00397	0.00440	10.3%	0.00462	15.1%
Arsenic (As)-Dissolved	mg/L	0.0001	-7.8%	3.98	4.15	4.2%	0.087	0.0671	-25.8%	11	9.15	-18.4%	11.7	6.2%
Barium (Ba)-Dissolved	mg/L	0.000050	-18.0%	0.208	0.195	-6.5%	0.116	0.110	-5.3%	0.00676	0.00671	-0.7%	00.0	3.1%
Beryllium (Be)-Dissolved	mg/L	0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00020	<0.00020	n/a	<0.00020	n/a
Bismuth (Bi)-Dissolved	mg/L	0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.0010	<0.0010	n/a	<0.0010	n/a
Boron (B)-Dissolved	mg/L	0.010	-12.3%	0.036	0.044	n/a	0.101	0.102	1.0%	0.095	0.101	6.1%	0.098	3.1%
Cadmium (Cd)-Dissolved	mg/L	0.000010	0.1%	0.000629	0.000634	0.8%	0.000328	0.000319	-2.8%	0.000825	0.000940	13.0%	0.001	9.6%
Calcium (Ca)-Dissolved	mg/L	0.05	2.9%	132	125	-5.4%	257	269	4.6%	476	495	3.9%	492	3.3%
Chromium (Cr)-Dissolved	mg/L	0.00010	-1.3%	0.00080	0.00074	-7.8%	0.00168	0.00131	-24.7%	<0.00020	<0.00020	n/a	<0.00020	n/a
Cobalt (Co)-Dissolved	mg/L	0.00010	3.8%	0.00147	0.00142	-3.5%	0.00582	0.00579	-0.5%	0.0119	0.0122	2.5%	0.0125	4.9%
Copper (Cu)-Dissolved	mg/L	0.00020	0.8%	0.00273	0.00448	48.5%	0.00064	0.00091	34.8%	0.00045	<0.00040	n/a	0.0006	n/a
Iron (Fe)-Dissolved	mg/L	0.01	-48.2%	3.5	2.7	-25.9%	27.9	28.3	1.4%	18.6	15.0	-21.4%	1.1	-177.7%
Lead (Pb)-Dissolved	mg/L	0.000050	1.8%	0.0105	0.0111	5.6%	0.000696	0.000562	-21.3%	0.00075	0.00064	-15.8%	0.00	0.0%
Lithium (Li)-Dissolved	mg/L	0.00050	1.8%	0.00206	0.00248	18.5%	0.00141	0.00106	-28.3%	0.0140	0.0131	-6.6%	0.01340	-4.4%
Magnesium (Mg)-Dissolved	mg/L	0.1	6.0%	66.3	66.4	0.2%	52.6	50.9	-3.3%	164.0	169.0	3.0%	171.0	4.2%
Manganese (Mn)-Dissolved	mg/L	0.00005	-10.5%	3.23	3.10	-4.1%	5.84	5.98	2.4%	16.30	15.90	-2.5%	16.50	1.2%
Mercury (Hg)-Dissolved	mg/L	0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	n/a
Molybdenum (Mo)-Dissolved	mg/L	0.000050	2.8%	0.00217	0.00260	18.0%	0.00123	0.00133	7.8%	0.00767	0.00836	8.6%	0.00811	5.6%
Nickel (Ni)-Dissolved	mg/L	0.00050	-57.7%	0.00547	0.00569	3.9%	0.00289	0.00308	6.4%	0.0040	0.0041	2.5%	0.00420	4.9%
Phosphorus (P)-Dissolved	mg/L	0.050	n/a	0.097	0.083	-15.6%	0.119	<0.25	n/a	<0.050	<0.10	n/a	<0.050	n/a
Potassium (K)-Dissolved	mg/L	0.10	18.4%	5.94	5.88	-1.0%	10.4	10.5	1.0%	29.0	25.5	-12.8%	30	3.4%
Selenium (Se)-Dissolved	mg/L	0.00010	0.1%	0.00016	0.00027	51.2%	0.00024	0.00049	n/a	<0.00020	<0.00020	n/a	<0.00020	n/a
Silicon (Si)-Dissolved	mg/L	0.050	6.4%	10.1	9.67	-4.4%	7.04	7.08	0.6%	7.99	8.12	1.6%	7.76	-2.9%
Silver (Ag)-Dissolved	mg/L	0.000010	0.0%	<0.000010	0.000021	n/a	0.000010	0.000015	n/a	<0.000020	<0.000020	n/a	<0.000020	n/a
Sodium (Na)-Dissolved	mg/L	0.050	7.8%	10.8	9.91	-8.6%	69.9	69.1	-1.2%	32.3	31.4	-2.8%	33	2.1%
Strontium (Sr)-Dissolved	mg/L	0.00020	2.7%	0.800	0.920	14.0%	0.744	0.742	-0.3%	0.872	0.910	4.3%	00.9	3.7%
Sulfur (S)-Dissolved	mg/L	0.50	14.0%	56	51	-8.8%	237	245	3.3%	616	638	3.5%	617	0.2%
Thallium (Tl)-Dissolved	mg/L	0.00001	n/a	0.000108	0.000125	14.6%	<0.000010	<0.000010	n/a	0.000381	0.000408	6.8%	0.000399	4.6%
Tin (Sn)-Dissolved	mg/L	0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00020	<0.00020	n/a	<0.00020	n/a
Titanium (Ti)-Dissolved	mg/L	0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.020	<0.020	n/a	<0.020	n/a
Uranium (U)-Dissolved	mg/L	0.000010	0.2%	0.000670	0.000764	13.1%	0.000804	0.000812	1.0%	0.00101	0.00106	4.8%	0.00103	2.0%
Vanadium (V)-Dissolved	mg/L	0.0010	-26.9%	0.0029	0.0025	-14.8%	0.0085	0.0064	-28.2%	<0.0020	<0.0020	n/a	<0.0020	n/a
Zinc (Zn)-Dissolved	mg/L	0.0010	42.8%	0.0585	0.0614	4.8%	0.469	0.422	-10.5%	0.417	0.435	4.2%	0.44	5.4%

Table D3: Relative Percent Difference (RPD)
Calculations for Alternate Preservation #3
Dissolved Metals

Sample ID	UNITS	Detection limit	MW09-03 STANDARD PRESERVATION	MW09-03 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MW09-04 STANDARD PRESERVATION	MW09-04 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MW09-07 STANDARD PRESERVATION	MW09-07 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MW09-08 STANDARD PRESERVATION	MW09-08 ALTERNATE PRESERVATION #3 (UNPRESERVED)
Date Sampled			17-Sep-13	17-Sep-13		17-Sep-13	17-Sep-13		18-Sep-13	18-Sep-13		18-Sep-13	18-Sep-13
Dissolved Metals													
Aluminum (Al)-Dissolved	mg/L	0.0010	<0.0020	<0.0020	n/a	0.0031	<0.0020	n/a	0.0414	0.0310	n/a	0.0938	0.0900
Antimony (Sb)-Dissolved	mg/L	0.00010	0.654	0.777	17.2%	0.222	0.268	18.8%	0.0039	0.00522	27.9%	0.00026	0.00028
Arsenic (As)-Dissolved	mg/L	0.0001	3.55	3.78	6.3%	1.42	1.04	-30.9%	0.512	0.418	-20.2%	0.377	0.369
Barium (Ba)-Dissolved	mg/L	0.000050	0.00998	0.0106	6.0%	0.00705	0.00644	-9.0%	0.024	0.0205	-14.1%	0.107	0.106
Beryllium (Be)-Dissolved	mg/L	0.00010	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a	<0.00010	<0.00010
Bismuth (Bi)-Dissolved	mg/L	0.00050	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a	<0.00050	<0.00050
Boron (B)-Dissolved	mg/L	0.010	0.152	0.183	18.5%	0.251	0.255	1.6%	0.062	0.057	-8.4%	<0.010	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.000010	0.000318	0.000333	4.6%	0.000050	0.000051	2.0%	0.00013	0.000208	48.4%	<0.000010	<0.000010
Calcium (Ca)-Dissolved	mg/L	0.05	487	515	5.6%	479	507	5.7%	247	220	-11.6%	29	24
Chromium (Cr)-Dissolved	mg/L	0.00010	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a	000	0.00072	-4.1%	0.00119	0.00114
Cobalt (Co)-Dissolved	mg/L	0.00010	0.00155	0.00165	6.3%	0.00119	0.00126	5.7%	0.02180	0.0192	-12.7%	0.00090	0.00096
Copper (Cu)-Dissolved	mg/L	0.00020	0.00369	0.00380	2.9%	0.00079	<0.00040	n/a	0.0069	0.00687	-0.9%	0.00021	<0.00020
Iron (Fe)-Dissolved	mg/L	0.01	<0.010	<0.010	n/a	<0.010	<0.010	n/a	4.0	3.2	-22.3%	35.9	38.4
Lead (Pb)-Dissolved	mg/L	0.000050	0.00066	0.00073	10.1%	0.0162	0.00152	-165.7%	0.00	0.00162	9.7%	0.000155	0.000109
Lithium (Li)-Dissolved	mg/L	0.00050	<0.0010	0.0014	n/a	0.0034	0.0033	-3.0%	0.00170	0.0013	-26.7%	<0.00050	<0.00050
Magnesium (Mg)-Dissolved	mg/L	0.1	73.7	77.1	4.5%	102.0	97.0	-5.0%	41.4	41.3	-0.2%	5.4	4.9
Manganese (Mn)-Dissolved	mg/L	0.00005	1.21	1.26	4.0%	2.77	2.62	-5.6%	15.60	13.80	-12.2%	2.26	2.21
Mercury (Hg)-Dissolved	mg/L	0.000010	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010
Molybdenum (Mo)-Dissolved	mg/L	0.000050	0.00768	0.00889	14.6%	0.00708	0.00722	2.0%	0.00066	0.00059	-11.2%	0.000097	0.000089
Nickel (Ni)-Dissolved	mg/L	0.00050	0.0014	0.0014	0.0%	<0.0010	<0.0010	n/a	0.02180	0.0192	-12.7%	<0.00050	<0.00050
Phosphorus (P)-Dissolved	mg/L	0.050	0.066	0.069	n/a	<0.050	<0.050	n/a	<0.050	<0.050	n/a	0.107	0.120
Potassium (K)-Dissolved	mg/L	0.10	39.5	41.8	5.7%	41.2	41.3	0.2%	11.4	10.7	-6.3%	1.36	1.21
Selenium (Se)-Dissolved	mg/L	0.00010	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a	0.00013	0.00013
Silicon (Si)-Dissolved	mg/L	0.050	9.95	10.3	3.5%	8.21	7.16	-13.7%	10.1	9.22	-9.1%	9.57	9.67
Silver (Ag)-Dissolved	mg/L	0.000010	0.000021	0.000030	n/a	<0.000020	<0.000020	n/a	00.0	0.000197	3.6%	<0.000010	<0.000010
Sodium (Na)-Dissolved	mg/L	0.050	60.6	63.9	5.3%	51.1	56.7	10.4%	48.300000	44.4	-8.4%	1.41	1.43
Strontium (Sr)-Dissolved	mg/L	0.00020	1.19	1.41	16.9%	1.24	1.26	1.6%	00.6	0.554	-10.3%	0.119	0.120
Sulfur (S)-Dissolved	mg/L	0.50	527	528	0.2%	552	540	-2.2%	232	200	-14.8%	<0.50	<0.50
Thallium (Tl)-Dissolved	mg/L	0.00001	<0.000020	<0.000020	n/a	<0.000020	<0.000020	n/a	<0.000020	<0.000020	n/a	<0.000010	<0.000010
Tin (Sn)-Dissolved	mg/L	0.00010	0.00046	0.00042	n/a	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a	<0.00010	<0.00010
Titanium (Ti)-Dissolved	mg/L	0.010	<0.020	<0.020	n/a	<0.020	<0.020	n/a	<0.020	<0.020	n/a	<0.010	<0.010
Uranium (U)-Dissolved	mg/L	0.000010	0.000395	0.000456	14.3%	0.000143	0.000121	-16.7%	0.000718	0.000607	-16.8%	0.000093	0.000088
Vanadium (V)-Dissolved	mg/L	0.0010	<0.0020	<0.0020	n/a	<0.0020	<0.0020	n/a	<0.0020	<0.0020	n/a	0.0040	0.0038
Zinc (Zn)-Dissolved	mg/L	0.0010	0.0300	0.0313	4.2%	2.78	3.78	30.5%	0.316	0.245	-25.3%	0.0017	<0.0010

Table D3: Relative Percent Difference (RPD)
Calculations for Alternate Preservation #3
Dissolved Metals

Sample ID	UNITS	Detection limit	RPD	FIELD DUP C ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MW09-16 STANDARD PRESERVATION	MW09-16 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MW09-17 STANDARD PRESERVATION	MW09-17 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MW09-18 STANDARD PRESERVATION	MW09-18 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD
Date Sampled				18-Sep-13		19-Sep-13	19-Sep-13		19-Sep-13	19-Sep-13		19-Sep-13	19-Sep-13	
Dissolved Metals														
Aluminum (Al)-Dissolved	mg/L	0.0010	-4.1%	0.0923	-2.6%	0.0013	<0.0010	n/a	0.0022	<0.0020	n/a	<0.0020	<0.0020	n/a
Antimony (Sb)-Dissolved	mg/L	0.00010	n/a	0.00026	0.0%	0.0610	0.0591	-3.2%	0.00037	0.00040	n/a	0.00022	0.00021	n/a
Arsenic (As)-Dissolved	mg/L	0.0001	-2.1%	0.386	3.2%	0.0106	0.0106	0.0%	0.0225	0.0243	7.7%	0.0613	0.0649	5.7%
Barium (Ba)-Dissolved	mg/L	0.000050	-0.9%	0.109	2.6%	0.0127	0.0123	-3.2%	0.00781	0.00860	9.6%	0.0089	0.00919	3.8%
Beryllium (Be)-Dissolved	mg/L	0.00010	n/a	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a
Bismuth (Bi)-Dissolved	mg/L	0.00050	n/a	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a
Boron (B)-Dissolved	mg/L	0.010	n/a	<0.010	n/a	0.085	0.082	-3.6%	0.043	0.044	2.3%	<0.020	<0.020	n/a
Cadmium (Cd)-Dissolved	mg/L	0.000010	n/a	0.000016	n/a	0.0194	0.0192	-1.0%	<0.000020	<0.000020	n/a	0.000055	0.000053	-3.7%
Calcium (Ca)-Dissolved	mg/L	0.05	-17.6%	26	-14.1%	249	249	0.0%	365	378	3.5%	366	374	2.2%
Chromium (Cr)-Dissolved	mg/L	0.00010	-4.3%	0.00122	-0.3%	<0.00010	<0.00010	n/a	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a
Cobalt (Co)-Dissolved	mg/L	0.00010	6.5%	0.00096	0.4%	0.00013	<0.00010	n/a	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a
Copper (Cu)-Dissolved	mg/L	0.00020	n/a	<0.00020	n/a	0.00571	0.00413	-32.1%	0.00070	0.00095	n/a	0.00041	0.00041	n/a
Iron (Fe)-Dissolved	mg/L	0.01	6.7%	33.7	-8.1%	<0.010	<0.010	n/a	<0.010	<0.010	n/a	0.0	0.0	-41.3%
Lead (Pb)-Dissolved	mg/L	0.000050	-34.8%	0.000126	0.0%	0.00623	0.00302	-69.4%	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a
Lithium (Li)-Dissolved	mg/L	0.00050	n/a	<0.00050	n/a	0.00840	0.00808	-3.9%	0.0169	0.0171	1.2%	0.016	0.0164	2.5%
Magnesium (Mg)-Dissolved	mg/L	0.1	-8.9%	5.3	-2.3%	105.0	113.0	7.3%	267.0	276.0	3.3%	237.0	254.0	6.9%
Manganese (Mn)-Dissolved	mg/L	0.00005	-2.2%	2.27	0.6%	0.01	0.01	11.9%	0.00	0.00	-28.6%	0.48	0.52	8.0%
Mercury (Hg)-Dissolved	mg/L	0.000010	n/a	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Molybdenum (Mo)-Dissolved	mg/L	0.000050	n/a	0.000107	10.2%	0.000108	0.000163	40.6%	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a
Nickel (Ni)-Dissolved	mg/L	0.00050	n/a	<0.00050	n/a	0.00279	0.00272	-2.5%	<0.0010	<0.0010	n/a	<0.0010	0.0011	n/a
Phosphorus (P)-Dissolved	mg/L	0.050	11.5%	<0.25	n/a	<0.050	<0.050	n/a	<0.050	<0.050	n/a	<0.050	<0.050	n/a
Potassium (K)-Dissolved	mg/L	0.10	-11.7%	1.27	-9.7%	6.01	5.96	-0.8%	6.95	7.27	4.5%	6.86	6.94	1.2%
Selenium (Se)-Dissolved	mg/L	0.00010	n/a	0.00017	27.9%	<0.00010	0.00011	n/a	<0.00020	<0.00020	n/a	0.00	0.00026	-23.7%
Silicon (Si)-Dissolved	mg/L	0.050	1.0%	9.10	-6.6%	5.21	5.29	1.5%	4.75	4.97	4.5%	4.76000	4.84	1.7%
Silver (Ag)-Dissolved	mg/L	0.000010	n/a	0.000013	n/a	0.000026	0.000016	-47.6%	<0.000020	<0.000020	n/a	<0.000020	<0.000020	n/a
Sodium (Na)-Dissolved	mg/L	0.050	1.4%	1.45	3.7%	6.88	7.56	9.4%	11.2	11.7	4.4%	10.4	10.8	3.8%
Strontium (Sr)-Dissolved	mg/L	0.00020	0.8%	0.115	-4.4%	0.509	0.466	-8.8%	1.12	1.14	1.8%	01.1	1.08	2.8%
Sulfur (S)-Dissolved	mg/L	0.50	n/a	<2.5	n/a	241	227	-6.0%	493	484	-1.8%	458	455	-0.7%
Thallium (Tl)-Dissolved	mg/L	0.00001	n/a	<0.000010	n/a	0.00025	0.000267	6.6%	0.000157	0.000165	5.0%	0.000265	0.000262	-1.1%
Tin (Sn)-Dissolved	mg/L	0.00010	n/a	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a
Titanium (Ti)-Dissolved	mg/L	0.010	n/a	<0.010	n/a	<0.010	<0.010	n/a	<0.020	<0.020	n/a	<0.020	<0.020	n/a
Uranium (U)-Dissolved	mg/L	0.000010	-5.5%	0.000090	0.0%	0.00291	0.00284	-2.4%	0.00902	0.00910	0.9%	0.00853	0.00882	3.3%
Vanadium (V)-Dissolved	mg/L	0.0010	n/a	0.0041	2.5%	<0.0010	<0.0010	n/a	<0.0020	<0.0020	n/a	<0.0020	<0.0020	n/a
Zinc (Zn)-Dissolved	mg/L	0.0010	n/a	<0.0010	n/a	2.49	2.69	7.7%	0.0021	0.0033	44.4%	0.0057	0.0041	n/a

Table D3: Relative Percent Difference (RPD)
Calculations for Alternate Preservation #3
Dissolved Metals

Sample ID	UNITS	Detection limit	MW09-19 STANDARD PRESERVATION	MW09-19 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	FIELP DUP D ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MW09-21 STANDARD PRESERVATION	MW09-21 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MW09-22 STANDARD PRESERVATION	MW09-22 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MW09-23 STANDARD PRESERVATION
Date Sampled			19-Sep-13	19-Sep-13		19-Sep-13		19-Sep-13	19-Sep-13		18-Sep-13	18-Sep-13		19-Sep-13
Dissolved Metals														
Aluminum (Al)-Dissolved	mg/L	0.0010	0.0097	0.0100	3.0%	0.0074	-16.0%	0.128	0.0877	-37.4%	0.0421	0.0235	-56.7%	0.0194
Antimony (Sb)-Dissolved	mg/L	0.00010	0.0002	0.00023	n/a	0.00022	n/a	0.000	0.00019	n/a	0.00017	0.00012	n/a	0.00042
Arsenic (As)-Dissolved	mg/L	0.0001	0.0994	0.0955	-4.0%	0.0687	-54.9%	0.104	0.0837	-21.6%	0.00727	0.00393	-59.6%	0.0108
Barium (Ba)-Dissolved	mg/L	0.000050	0.0518	0.0530	2.3%	0.0516	-0.4%	0.166	0.148	-11.5%	0.132	0.126	-4.7%	0.0958
Beryllium (Be)-Dissolved	mg/L	0.00010	<0.00010	<0.00020	n/a	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00020
Bismuth (Bi)-Dissolved	mg/L	0.00050	<0.00050	<0.0010	n/a	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.0010
Boron (B)-Dissolved	mg/L	0.010	0.324	0.364	11.6%	0.346	7.7%	0.022	0.022	n/a	0.020	0.019	n/a	0.127
Cadmium (Cd)-Dissolved	mg/L	0.000010	<0.000010	<0.000020	n/a	<0.000010	n/a	0.000	0.000057	n/a	0.000034	0.000023	-38.6%	0.000041
Calcium (Ca)-Dissolved	mg/L	0.05	306	325	6.0%	308	0.9%	251	270	7.3%	208	215	n/a	454
Chromium (Cr)-Dissolved	mg/L	0.00010	000	0.00032	n/a	0.00032	-6.1%	0.00	0.00157	-26.5%	0.00063	0.00036	-54.5%	0.00043
Cobalt (Co)-Dissolved	mg/L	0.00010	0.00206	0.00204	-1.0%	0.00188	19.1%	0.01350	0.0135	0.0%	0.0117	0.0102	-13.7%	0.0199
Copper (Cu)-Dissolved	mg/L	0.00020	<0.00020	<0.00040	n/a	<0.00020	n/a	0.0004	0.00043	7.2%	0.00151	0.00107	-34.1%	<0.00040
Iron (Fe)-Dissolved	mg/L	0.01	14.1	14.4	2.1%	11.3	-28.1%	52.1	50.9	-2.3%	51.3	42.8	-18.1%	18.8
Lead (Pb)-Dissolved	mg/L	0.000050	<0.000050	<0.00010	n/a	<0.000050	n/a	00.0	0.000120	n/a	0.000428	0.000089	-131.1%	<0.00010
Lithium (Li)-Dissolved	mg/L	0.00050	0.00944	0.0094	-0.4%	0.0104	15.4%	0.000640	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.0010
Magnesium (Mg)-Dissolved	mg/L	0.1	157.0	159.0	1.3%	167.0	8.3%	38.4	38.2	-0.5%	28.6	27.2	-5.0%	99.7
Manganese (Mn)-Dissolved	mg/L	0.00005	2.97	2.99	0.7%	3.01	1.8%	4.36	4.77	9.0%	7.09	7.72	8.5%	5.65
Mercury (Hg)-Dissolved	mg/L	0.000010	<0.000010	<0.000010	n/a	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010
Molybdenum (Mo)-Dissolved	mg/L	0.000050	0.000127	0.00014	n/a	0.000141	n/a	0.000304	0.000338	10.6%	0.000113	0.000096	-16.3%	0.00338
Nickel (Ni)-Dissolved	mg/L	0.00050	0.001450	0.0021	36.6%	0.00140	-0.1%	0.001860	0.00190	2.1%	0.00125	0.00112	-11.0%	0.0022
Phosphorus (P)-Dissolved	mg/L	0.050	0.22800	0.26	13.1%	0.183	-22.4%	<0.050	<0.25	n/a	<0.050	<0.25	n/a	<0.050
Potassium (K)-Dissolved	mg/L	0.10	6.690	6.41	-4.3%	7.09	7.9%	10.2	10.6	3.8%	3.53	3.48	-1.4%	9.43
Selenium (Se)-Dissolved	mg/L	0.00010	0.00	<0.00020	n/a	0.00022	n/a	00.0	0.00039	n/a	0.00043	0.00039	n/a	<0.00020
Silicon (Si)-Dissolved	mg/L	0.050	8.60000	8.56	-0.5%	8.53	-1.1%	5.40000	5.47	1.3%	4.90	4.72	-3.7%	5.57
Silver (Ag)-Dissolved	mg/L	0.000010	<0.000010	<0.000020	n/a	<0.000010	n/a	<0.000010	<0.000010	n/a	0.000026	0.000030	14.3%	<0.000020
Sodium (Na)-Dissolved	mg/L	0.050	12.8	12.9	0.8%	13.0	2.1%	10.9	10.6	-2.8%	39.1	38.6	-1.3%	21.6
Strontium (Sr)-Dissolved	mg/L	0.00020	0.89	0.935	5.5%	0.914	4.2%	0.66	0.689	4.5%	0.700	0.750	6.9%	1.00
Sulfur (S)-Dissolved	mg/L	0.50	294	312	5.9%	300	2.6%	162	171	5.4%	214	217	1.4%	428
Thallium (Tl)-Dissolved	mg/L	0.00001	<0.000010	<0.000020	n/a	<0.000010	n/a	0.000011	0.000014	n/a	<0.000010	<0.000010	n/a	<0.000020
Tin (Sn)-Dissolved	mg/L	0.00010	<0.00010	<0.00020	n/a	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00020
Titanium (Ti)-Dissolved	mg/L	0.010	<0.010	<0.020	n/a	<0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.020
Uranium (U)-Dissolved	mg/L	0.000010	0.000976	0.000999	2.3%	0.000872	-1.6%	0.000562	0.000633	11.9%	0.000366	0.000244	-40.0%	0.00173
Vanadium (V)-Dissolved	mg/L	0.0010	0.001000	<0.0020	n/a	<0.0010	n/a	0.007300	0.0053	-31.7%	0.0011	<0.0010	n/a	<0.0020
Zinc (Zn)-Dissolved	mg/L	0.0010	0.0023	<0.0020	n/a	0.0015	-42.1%	0.0040	0.0034	n/a	0.0039	0.0030	n/a	0.0873

Table D3: Relative Percent Difference (RPD)
Calculations for Alternate Preservation #3
Dissolved Metals

Sample ID	UNITS	Detection limit	MW09-23 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	MW09-24 STANDARD PRESERVATION	MW09-24 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	GLL07-02 STANDARD PRESERVATION	GLL07-02 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	GLL07-03 STANDARD PRESERVATION	GLL07-03 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	W1410383-BH02 STANDARD PRESERVATION	W1410383-BH02 ALTERNATE PRESERVATION #3 (UNPRESERVED)
Date Sampled			19-Sep-13		18-Sep-13	18-Sep-13		19-Sep-13	19-Sep-13		19-Sep-13	19-Sep-13		18-Sep-13	18-Sep-13
Dissolved Metals															
Aluminum (Al)-Dissolved	mg/L	0.0010	0.0162	-18.0%	0.0028	0.0014	n/a	0.0109	0.0113	3.6%	0.0213	<0.0010	n/a	0.0025	<0.0010
Antimony (Sb)-Dissolved	mg/L	0.00010	0.00042	n/a	0.00020	0.00019	n/a	0.0006	0.00058	0.0%	<0.00010	<0.00010	n/a	0.00021	0.00022
Arsenic (As)-Dissolved	mg/L	0.0001	0.0104	-3.8%	0.00163	0.00152	-7.0%	0.00127	0.00121	-4.8%	0.00044	<0.00010	n/a	0.00243	0.00278
Barium (Ba)-Dissolved	mg/L	0.000050	0.0976	1.9%	0.0451	0.0463	2.6%	0.02690	0.0264	-1.9%	0.00956	0.00939	-1.8%	0.124	0.127
Beryllium (Be)-Dissolved	mg/L	0.00010	<0.00020	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010
Bismuth (Bi)-Dissolved	mg/L	0.00050	<0.0010	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050
Boron (B)-Dissolved	mg/L	0.010	0.125	-1.6%	0.015	0.014	-6.9%	<0.010	<0.010	n/a	<0.010	<0.010	n/a	0.015	0.015
Cadmium (Cd)-Dissolved	mg/L	0.000010	0.000066	n/a	0.000058	0.000057	-1.7%	0.000205	0.000170	-18.7%	0.00437	0.00448	2.5%	0.000445	0.000395
Calcium (Ca)-Dissolved	mg/L	0.05	459	1.1%	172	172	0.0%	52	49	-6.8%	226	220	-2.7%	132	127
Chromium (Cr)-Dissolved	mg/L	0.00010	0.00046	n/a	0.00051	0.00049	-4.0%	00.0	0.00013	-20.7%	<0.00010	<0.00010	n/a	0.00015	0.00016
Cobalt (Co)-Dissolved	mg/L	0.00010	0.0205	3.0%	0.00068	0.00064	-6.1%	<0.00010	<0.00010	n/a	0.00685	0.00695	1.4%	0.00024	0.00014
Copper (Cu)-Dissolved	mg/L	0.00020	0.00063	n/a	0.00844	0.00708	-17.5%	0.00331	0.00287	-14.2%	0.00030	<0.00020	n/a	0.00377	0.00317
Iron (Fe)-Dissolved	mg/L	0.01	17.8	-5.5%	<0.010	<0.010	n/a	0.0	0.0	-24.0%	18.9	3.8	-133.8%	<0.010	<0.010
Lead (Pb)-Dissolved	mg/L	0.000050	<0.00010	n/a	0.000073	<0.000050	n/a	0.00022	0.00012	-56.0%	0.000053	<0.000050	n/a	<0.000050	<0.000050
Lithium (Li)-Dissolved	mg/L	0.00050	<0.0010	n/a	<0.00050	<0.00050	n/a	<0.00050	0.00051	n/a	0.0173	0.0158	-9.1%	0.00065	0.00059
Magnesium (Mg)-Dissolved	mg/L	0.1	93.0	-7.0%	38.7	44.4	13.7%	12.0	11.4	-5.1%	41.8	44.2	5.6%	41.3	46.8
Manganese (Mn)-Dissolved	mg/L	0.00005	5.81	2.8%	0.00144	0.00112	-25.0%	0.00201	0.00184	-8.8%	4.08	4.12	1.0%	0.15	0.11
Mercury (Hg)-Dissolved	mg/L	0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010
Molybdenum (Mo)-Dissolved	mg/L	0.000050	0.00335	-0.9%	0.000337	0.000387	13.8%	0.000101	0.000095	-6.1%	0.000368	<0.000050	n/a	0.00128	0.00123
Nickel (Ni)-Dissolved	mg/L	0.00050	0.0020	-9.5%	<0.00050	<0.00050	n/a	0.000730	0.00064	n/a	0.0160	0.0161	0.6%	0.00124	0.00097
Phosphorus (P)-Dissolved	mg/L	0.050	<0.25	n/a	<0.050	<0.050	n/a	<0.050	<0.050	n/a	<0.050	<0.050	n/a	<0.050	<0.050
Potassium (K)-Dissolved	mg/L	0.10	9.07	-3.9%	1.68	1.61	-4.3%	0.63	0.57	-10.0%	1.80	1.80	0.0%	3.14	3.15
Selenium (Se)-Dissolved	mg/L	0.00010	<0.00020	n/a	0.00038	0.00054	34.8%	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	0.00094	0.00117
Silicon (Si)-Dissolved	mg/L	0.050	5.35	-4.0%	4.71	4.70	-0.2%	6.22	6.35	2.1%	3.04	2.85	-6.5%	5.96	6.18
Silver (Ag)-Dissolved	mg/L	0.000010	<0.000020	n/a	<0.000010	<0.000010	n/a	0.00	0.000020	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010
Sodium (Na)-Dissolved	mg/L	0.050	21.9	1.4%	8.06	8.45	4.7%	4.020000	4.08	1.5%	6.33	6.45	1.9%	12.2	12.5
Strontium (Sr)-Dissolved	mg/L	0.00020	1.00	0.0%	0.651	0.663	1.8%	0.29	0.298	1.7%	0.239	0.223	-6.9%	0.603	0.611
Sulfur (S)-Dissolved	mg/L	0.50	427	-0.2%	117	112	-4.4%	33	31	-5.0%	234	224	-4.4%	84	78
Thallium (Tl)-Dissolved	mg/L	0.00001	<0.000020	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	0.000030	0.000029	-3.4%	<0.000010	<0.000010
Tin (Sn)-Dissolved	mg/L	0.00010	<0.00020	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	0.00016	0.00010
Titanium (Ti)-Dissolved	mg/L	0.010	<0.020	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010
Uranium (U)-Dissolved	mg/L	0.000010	0.00173	0.0%	0.00969	0.00958	-1.1%	0.000275	0.000228	-18.7%	0.000096	0.000013	n/a	0.00517	0.00498
Vanadium (V)-Dissolved	mg/L	0.0010	<0.0020	n/a	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a	<0.0010	<0.0010
Zinc (Zn)-Dissolved	mg/L	0.0010	0.0840	-3.9%	0.0019	0.0021	10.0%	0.0205	0.0187	-9.2%	6.36	6.19	-2.7%	0.0057	0.0015

Table D3: Relative Percent Difference (RPD)
Calculations for Alternate Preservation #3
Dissolved Metals

Sample ID	UNITS	Detection limit	RPD	W1410383 BH03 STANDARD PRESERVATION	W1410383 BH03 ALTERNATE PRESERVATION #3 (UNPRESERVED)	RPD	DC-02	DC-02 (UNPRESERVED)	RPD	DC-03	DC-03 (UNPRESERVED)	RPD	DC-05	DC-05 (UNPRESERVED)	RPD	DC-06	DUP_01	RPD
Date Sampled				20-Sep-13	20-Sep-13		27-Sep-13	28-Sep-13		30-Sep-13	30-Sep-13		30-Sep-13	30-Sep-13		28-Sep-13	28-Sep-13	
Dissolved Metals																		
Aluminum (Al)-Dissolved	mg/L	0.0010	n/a	0.0487	0.0303	-46.6%	0.017	<0.0010	n/a	0.0041	0.0019	n/a	0.0068	<0.0010	n/a	0.025	0.026	3.1%
Antimony (Sb)-Dissolved	mg/L	0.00010	n/a	0.00041	0.00037	n/a	0.00065	0.00033	-65.3%	0.0039	0.0039	1.8%	0.0029	0.0015	-63.7%	0.00065	0.00056	-14.9%
Arsenic (As)-Dissolved	mg/L	0.0001	13.4%	0.0914	0.0724	-23.2%	0.19	0.014	-172.9%	0.0065	0.0065	-0.2%	0.044	0.014	-101.5%	0.23	0.22	-0.9%
Barium (Ba)-Dissolved	mg/L	0.000050	2.4%	0.296	0.252	-16.1%	0.21	0.15	-35.8%	0.036	0.035	-2.6%	0.071	0.058	-20.5%	0.33	0.33	-0.9%
Beryllium (Be)-Dissolved	mg/L	0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a
Bismuth (Bi)-Dissolved	mg/L	0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a
Boron (B)-Dissolved	mg/L	0.010	n/a	0.017	0.017	n/a	0.026	0.019	-31.1%	0.550	0.564	2.5%	0.194	0.255	27.2%	0.093	0.077	-18.8%
Cadmium (Cd)-Dissolved	mg/L	0.000010	-11.9%	0.000022	0.000020	-9.5%	0.000086	<0.000010	n/a	0.0017	0.0014	-17.9%	0.00016	0.00027	48.1%	<0.000010	0.000015	n/a
Calcium (Ca)-Dissolved	mg/L	0.05	-3.9%	118	128	8.1%	150	147	-2.0%	171	167	-2.4%	179	155	-14.4%	199	197	-1.0%
Chromium (Cr)-Dissolved	mg/L	0.00010	n/a	0.00077	0.00056	-31.6%	0.00027	<0.00010	n/a	0.00071	0.00065	-8.8%	0.00060	0.00030	n/a	0.0018	0.0018	0.6%
Cobalt (Co)-Dissolved	mg/L	0.00010	n/a	0.00159	0.00175	9.6%	0.0023	0.0017	-33.4%	0.0043	0.0043	-0.7%	0.011	0.012	11.4%	0.0044	0.0043	-3.0%
Copper (Cu)-Dissolved	mg/L	0.00020	-17.3%	0.00048	0.00028	n/a	0.00052	<0.00020	n/a	0.10	0.074	-29.4%	0.0023	0.0048	68.9%	0.00063	0.00032	n/a
Iron (Fe)-Dissolved	mg/L	0.01	n/a	82.7	72.8	-12.7%	35	5.9	-141.8%	0.042	0.044	4.7%	6.9	3.1	-74.4%	18	18	-2.8%
Lead (Pb)-Dissolved	mg/L	0.000050	n/a	0.000138	0.000058	-81.6%	0.00028	<0.000050	n/a	0.00048	0.00051	6.7%	0.00055	0.00025	-76.1%	0.000070	0.000059	-17.1%
Lithium (Li)-Dissolved	mg/L	0.00050	n/a	<0.00050	0.00072	n/a	<0.00050	<0.00050	n/a	0.0046	0.0066	36.6%	0.0036	0.0045	23.6%	<0.00050	<0.00050	n/a
Magnesium (Mg)-Dissolved	mg/L	0.1	12.5%	31.1	33.0	5.9%	51	57	9.6%	58	63	7.1%	76	71	-6.5%	72	72	-1.1%
Manganese (Mn)-Dissolved	mg/L	0.00005	-24.8%	3.53	4.68	28.0%	4.2	4.0	-5.6%	3.5	3.5	-0.6%	4.6	4.3	-5.6%	5.8	5.5	-5.2%
Mercury (Hg)-Dissolved	mg/L	0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Molybdenum (Mo)-Dissolved	mg/L	0.000050	-4.0%	0.000553	0.000552	-0.2%	0.0043	0.0033	-25.1%	0.013	0.015	9.3%	0.051	0.049	-4.0%	0.0085	0.0075	-12.1%
Nickel (Ni)-Dissolved	mg/L	0.00050	-24.4%	0.00139	0.00146	4.9%	0.015	0.012	-24.1%	0.057	0.057	0.9%	0.18	0.19	4.3%	0.022	0.021	-6.0%
Phosphorus (P)-Dissolved	mg/L	0.050	n/a	0.124	<0.25	n/a	<0.050	<0.050	n/a	<0.050	<0.050	n/a	<0.050	<0.050	n/a	0.092	0.090	n/a
Potassium (K)-Dissolved	mg/L	0.10	0.3%	2.40	2.70	11.8%	3.9	3.9	-0.3%	4.4	4.2	-3.7%	5.8	5.2	-10.8%	3.4	3.3	-5.1%
Selenium (Se)-Dissolved	mg/L	0.00010	21.8%	0.00017	0.00023	n/a	<0.00010	<0.00010	n/a	0.00010	0.00012	n/a	<0.00010	0.00011	n/a	0.00051	0.00049	n/a
Silicon (Si)-Dissolved	mg/L	0.050	3.6%	10.3	10.6	2.9%	9.0	7.9	-13.7%	7.5	7.6	1.9%	7.5	7.3	-2.8%	8.8	8.7	-2.1%
Silver (Ag)-Dissolved	mg/L	0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Sodium (Na)-Dissolved	mg/L	0.050	2.4%	11.4	14.4	23.3%	5.5	6.0	8.3%	6.9	7.1	3.7%	13	11	-17.1%	23	23	-0.4%
Strontium (Sr)-Dissolved	mg/L	0.00020	1.3%	0.388	0.453	15.5%	0.36	0.34	-6.6%	0.41	0.44	7.5%	0.60	0.56	-7.6%	0.89	0.83	-7.7%
Sulfur (S)-Dissolved	mg/L	0.50	-7.5%	64	66	2.2%	98	91	-7.1%	137	126	-8.4%	183	147	-21.8%	2	2	-4.9%
Thallium (Tl)-Dissolved	mg/L	0.00001	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	0.000058	0.000054	-7.1%	0.000045	0.000038	n/a	<0.000010	<0.000010	n/a
Tin (Sn)-Dissolved	mg/L	0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	0.00015	0.00016	6.5%	<0.00010	<0.00010	n/a	<0.00010	0.00030	n/a
Titanium (Ti)-Dissolved	mg/L	0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a
Uranium (U)-Dissolved	mg/L	0.000010	-3.7%	0.000597	0.000782	26.8%	0.00030	0.00021	-33.7%	0.0015	0.0016	3.9%	0.0019	0.0012	-44.4%	0.00041	0.00034	n/a
Vanadium (V)-Dissolved	mg/L	0.0010	n/a	0.0025	0.0015	n/a	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a	0.0156	0.0152	-2.6%
Zinc (Zn)-Dissolved	mg/L	0.0010	n/a	0.0089	0.0029	n/a	0.020	0.0063	-103.4%	0.17	0.15	-9.4%	0.035	0.042	18.4%	0.0061	0.0073	17.9%

Table D3: Relative Percent Difference (RPD) Calculations for Alternate Preservation #3 Dissolved Metals

Sample ID	UNITS	Detection limit	DC-06 (UNPRESERVED)	DUP_01 (UNPRESERVED)	RPD	DC-07	DC-07 (UNPRESERVED)	RPD	DC-09	DC-09 (UNPRESERVED)	RPD	DC-10	DC-10 (UNPRESERVED)	RPD	PC-01	PC-01 (UNPRESERVED)	RPD	PC-05	PC-05 (UNPRESERVED)	RPD
Date Sampled			28-Sep-13	28-Sep-13		28-Sep-13	28-Sep-13		28-Sep-13	28-Sep-13		29-Sep-13	29-Sep-13		30-Sep-13	30-Sep-13		30-Sep-13	30-Sep-13	
Dissolved Metals																				
Aluminum (Al)-Dissolved	mg/L	0.0010	0.021	0.021	0.0%	0.019	0.015	-25.6%	0.055	0.050	-10.6%	0.237	0.212	-11.1%	0.107	0.042	-87.4%	0.018	0.010	-58.5%
Antimony (Sb)-Dissolved	mg/L	0.00010	0.00085	0.00082	-3.6%	0.0017	0.0013	-29.7%	0.00081	0.00086	6.0%	0.0025	0.0018	-33.3%	0.00094	0.00066	-35.0%	0.0011	0.0014	17.7%
Arsenic (As)-Dissolved	mg/L	0.0001	0.23	0.22	-1.3%	0.13	0.14	3.7%	0.10	0.094	-9.6%	0.065	0.043	-42.2%	0.013	0.0035	-112.7%	0.0025	0.0021	-18.2%
Barium (Ba)-Dissolved	mg/L	0.000050	0.33	0.32	-2.8%	0.093	0.090	-3.7%	0.082	0.080	n/a	0.36	0.31	-16.1%	0.13	0.056	-79.7%	0.034	0.030	-10.9%
Beryllium (Be)-Dissolved	mg/L	0.00010	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a
Bismuth (Bi)-Dissolved	mg/L	0.00050	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a
Boron (B)-Dissolved	mg/L	0.010	0.38	0.32	-16.9%	0.30	0.17	-54.9%	0.75	0.77	2.2%	0.66	0.68	4.0%	0.37	0.080	-129.4%	0.023	0.020	n/a
Cadmium (Cd)-Dissolved	mg/L	0.000010	0.000018	<0.000010	n/a	0.00012	0.000011	-166.9%	0.000029	0.000014	n/a	0.00028	0.00028	-1.8%	0.00030	0.00015	-65.5%	0.00025	0.00014	-58.8%
Calcium (Ca)-Dissolved	mg/L	0.05	194	193	-0.5%	63	55	-13.0%	74	70	-5.8%	112	101	-10.3%	50	26	-63.5%	45	41	-9.6%
Chromium (Cr)-Dissolved	mg/L	0.00010	0.0024	0.0022	-6.9%	0.00094	0.00061	-42.6%	0.0022	0.0018	-19.3%	0.0098	0.00640	-41.6%	0.0117	0.00291	-120.3%	0.00045	<0.00010	n/a
Cobalt (Co)-Dissolved	mg/L	0.00010	0.0047	0.0048	1.3%	0.0032	0.0030	-6.8%	0.0044	0.0039	-11.4%	0.027	0.0242	-10.2%	0.00312	0.00104	-100.0%	0.00031	0.00014	-75.6%
Copper (Cu)-Dissolved	mg/L	0.00020	0.0012	0.0012	3.3%	0.0053	0.0021	-86.7%	0.015	0.011	-30.9%	0.043	0.034	-22.3%	0.12	0.041	-99.5%	0.014	0.011	-27.6%
Iron (Fe)-Dissolved	mg/L	0.01	9.1	6.2	-37.1%	12	11	-0.9%	21	19	-8.4%	83	56	-39.2%	*6.5*	*1.3*	-134.5%	0.057	0.029	n/a
Lead (Pb)-Dissolved	mg/L	0.000050	0.00018	0.00017	-6.5%	0.0014	0.00040	-111.5%	0.0019	0.0014	-31.0%	0.0099	0.0086	-13.8%	0.014	0.0029	-132.1%	0.00043	0.00014	-100.2%
Lithium (Li)-Dissolved	mg/L	0.00050	<0.00050	<0.00050	n/a	<0.00050	0.0012	n/a	<0.00050	0.0015	n/a	0.017	0.0068	-83.9%	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a
Magnesium (Mg)-Dissolved	mg/L	0.1	72	71	-1.3%	16	14	-11.5%	21	20	-5.3%	25	23	-8.8%	11	6.2	-52.2%	11	10	-6.6%
Manganese (Mn)-Dissolved	mg/L	0.00005	5.7	5.6	-1.8%	1.2	1.1	-8.8%	1.8	1.8	0.6%	9.8	9.4	-4.1%	0.93	0.21	-127.6%	0.034	0.030	-11.0%
Mercury (Hg)-Dissolved	mg/L	0.000010	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	0.000013	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Molybdenum (Mo)-Dissolved	mg/L	0.000050	0.013	0.014	8.3%	0.0064	0.0041	-43.9%	0.018	0.019	2.7%	0.022	0.014	-42.9%	0.013	0.0047	-94.3%	0.0019	0.0016	-15.7%
Nickel (Ni)-Dissolved	mg/L	0.00050	0.034	0.034	-1.8%	0.023	0.018	-22.7%	0.041	0.037	-11.1%	0.11	0.091	-21.8%	0.042	0.017	-84.2%	0.010	0.0076	-29.9%
Phosphorus (P)-Dissolved	mg/L	0.050	0.083	0.081	n/a	<0.050	<0.050	n/a	0.13	0.11	-13.1%	0.077	0.081	n/a	0.25	<0.050	n/a	<0.050	<0.050	n/a
Potassium (K)-Dissolved	mg/L	0.10	4.5	4.4	-2.7%	3.2	2.7	-17.8%	3.1	2.9	-6.6%	7.8	5.7	-31.7%	1.2	0.40	-97.4%	0.88	0.75	-16.0%
Selenium (Se)-Dissolved	mg/L	0.00010	0.00066	0.00068	3.0%	0.00014	0.00017	n/a	0.00013	0.00014	7.4%	0.00045	0.00045	n/a	0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a
Silicon (Si)-Dissolved	mg/L	0.050	8.4	8.1	-3.3%	6.9	7.0	0.9%	8.2	8.2	0.5%	9.6	8.6	-10.5%	9.9	8.2	-18.8%	5.7	5.8	2.6%
Silver (Ag)-Dissolved	mg/L	0.000010	<0.000010	0.000014	n/a	<0.000010	<0.000010	n/a	0.000033	0.000026	n/a	0.000062	0.000055	-12.0%	0.000051	0.000013	-118.8%	<0.000010	<0.000010	n/a
Sodium (Na)-Dissolved	mg/L	0.050	25	24	-2.1%	18	18	-2.2%	18	18	1.1%	23	23	0.9%	5.6	3.9	-35.3%	4.0	3.6	-10.4%
Strontium (Sr)-Dissolved	mg/L	0.00020	0.89	0.79	-11.4%	0.22	0.20	-8.2%	0.26	0.28	6.8%	0.50	0.47	-6.2%	0.28	0.18	-42.6%	0.27	0.29	5.7%
Sulfur (S)-Dissolved	mg/L	0.50	2	2	n/a	43	37	-15.7%	76	69	-10.2%	101	91	-10.3%	22	20	-8.7%	27	23	-12.9%
Thallium (Tl)-Dissolved	mg/L	0.00001	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	0.000020	n/a	0.000013	<0.000010	n/a	0.000014	0.000013	-7.4%
Tin (Sn)-Dissolved	mg/L	0.00010	0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	0.00014	0.00013	n/a	0.00024	0.00016	n/a	0.00022	<0.00010	n/a	<0.00010	<0.00010	n/a
Titanium (Ti)-Dissolved	mg/L	0.010	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a
Uranium (U)-Dissolved	mg/L	0.000010	0.0005	0.00049	-9.8%	0.00016	0.000089	-54.1%	0.00024	0.00019	n/a	0.00090	0.00072	-22.1%	0.00021	0.000053	-120.0%	0.00018	0.00015	-23.7%
Vanadium (V)-Dissolved	mg/L	0.0010	0.0133	0.0128	-3.8%	0.0023	0.0024	n/a	0.0053	0.0047	n/a	0.0175	0.0141	-21.5%	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a
Zinc (Zn)-Dissolved	mg/L	0.0010	0.0053	0.0052	-1.9%	0.019	0.015	-26.9%	0.031	0.019	-48.4%	0.11	0.12	8.8%	0.14	0.066	-74.5%	0.017	0.0079	-72.6%

Table D3: Relative Percent Difference (RPD)
Calculations for Alternate Preservation #3
Dissolved Metals

Sample ID	UNITS	Detection limit	HA-01	HA-01 (UNPRESERVED)	RPD	HA-02	HA-02 (UNPRESERVED)		HA-03	HA-03 (UNPRESERVED)	RPD	HA-04	HA-04 (UNPRESERVED)	RPD	HA-05	HA-05 (UNPRESERVED)	RPD	DUP_02	DUP_02 (UNPRESERVED)	RPD
Date Sampled			29-Sep-13	29-Sep-13		29-Sep-13	29-Sep-13		29-Sep-13	29-Sep-13		29-Sep-13	29-Sep-13		29-Sep-13	29-Sep-13		29-Sep-13	29-Sep-13	
Dissolved Metals																				
Aluminum (Al)-Dissolved	mg/L	0.0010	0.0049	0.0047	n/a	0.036	<0.0010	n/a	0.0132	<0.0010	n/a	0.059	0.041	-35.6%	0.016	0.0049	-105.8%	0.014	0.0095	-39.7%
Antimony (Sb)-Dissolved	mg/L	0.00010	0.00097	0.0013	32.0%	0.00055	0.00011	n/a	0.0011	0.00037	-95.8%	0.00067	0.00052	-25.2%	0.00068	0.00076	11.1%	0.00084	0.00067	-22.5%
Arsenic (As)-Dissolved	mg/L	0.0001	0.025	0.021	-13.9%	0.026	0.0013	-181.5%	0.013	0.0016	-158.3%	0.011	0.0077	-34.8%	0.091	0.037	-84.6%	0.088	0.060	-36.9%
Barium (Ba)-Dissolved	mg/L	0.000050	0.20	0.19	-6.8%	0.065	0.071	9.2%	0.079	0.070	-12.7%	0.11	0.098	-7.6%	0.16	0.14	-12.5%	0.16	0.14	-12.5%
Beryllium (Be)-Dissolved	mg/L	0.00010	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a
Bismuth (Bi)-Dissolved	mg/L	0.00050	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a
Boron (B)-Dissolved	mg/L	0.010	0.16	0.18	14.9%	0.28	0.11	-86.1%	0.72	0.34	-72.7%	0.16	0.10	-45.6%	0.05	0.057	7.3%	0.039	0.067	52.8%
Cadmium (Cd)-Dissolved	mg/L	0.000010	<0.000010	<0.000010	n/a	0.000022	<0.000010	n/a	0.00030	0.000020	n/a	<0.000010	0.000010	n/a	0.000021	0.000028	n/a	0.000013	0.000027	n/a
Calcium (Ca)-Dissolved	mg/L	0.05	163	166	1.8%	129	119	-8.1%	135	129	-4.5%	36	31	-15.7%	148	143	-3.4%	148	144	-2.7%
Chromium (Cr)-Dissolved	mg/L	0.00010	0.00019	0.00015	n/a	0.00014	<0.00010	n/a	0.00084	<0.00010	n/a	0.00091	0.00081	-11.6%	0.00021	<0.00010	n/a	<0.00010	<0.00010	n/a
Cobalt (Co)-Dissolved	mg/L	0.00010	0.00060	0.00081	29.8%	0.0075	0.0044	-53.5%	0.0078	0.0039	-66.9%	0.00099	0.00063	-44.4%	0.0013	0.0014	7.2%	0.0014	0.0016	11.6%
Copper (Cu)-Dissolved	mg/L	0.00020	0.0011	0.0015	32.0%	0.0026	0.00025	n/a	0.053	0.0021	-185.0%	0.0011	0.00036	-103.4%	0.00044	0.00025	-55.1%	0.00028	0.00060	72.7%
Iron (Fe)-Dissolved	mg/L	0.01	3.8	2.9	-26.4%	47	5.3	-159.8%	27	2.4	-167.8%	20	18	-13.3%	26	4.7	-138.9%	24	1.5	-177.0%
Lead (Pb)-Dissolved	mg/L	0.000050	0.00010	0.00014	36.0%	0.00022	<0.000050	n/a	0.0015	<0.000050	n/a	0.00012	<0.000050	n/a	0.00013	<0.000050	n/a	0.00012	0.000092	n/a
Lithium (Li)-Dissolved	mg/L	0.00050	0.0065	0.0064	-1.2%	<0.00050	<0.00050	n/a	0.00066	0.00095	n/a	0.0016	0.0010	-45.0%	0.0014	0.00096	-34.5%	0.00099	0.00077	-25.0%
Magnesium (Mg)-Dissolved	mg/L	0.1	54	61	12.5%	50	56	11.5%	47	52	11.1%	7.5	6.4	-15.9%	46	52	12.1%	46	52	10.6%
Manganese (Mn)-Dissolved	mg/L	0.00005	0.46	0.49	6.1%	9.9	9.5	-4.2%	8.5	6.6	-24.9%	1.7	1.6	-8.5%	4.2	4.4	4.2%	4.1	4.5	9.4%
Mercury (Hg)-Dissolved	mg/L	0.000010	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Molybdenum (Mo)-Dissolved	mg/L	0.000050	0.0024	0.0031	27.8%	0.0025	0.00043	-141.6%	0.0048	0.0018	-91.4%	0.0012	0.00071	-50.5%	0.00093	0.00076	-20.7%	0.00081	0.00084	3.9%
Nickel (Ni)-Dissolved	mg/L	0.00050	0.0046	0.0050	7.9%	0.028	0.017	-46.0%	0.038	0.012	-101.2%	0.0091	0.0066	-32.1%	0.0082	0.0077	-6.3%	0.0085	0.0082	-3.7%
Phosphorus (P)-Dissolved	mg/L	0.050	<0.050	<0.050	n/a	<0.050	<0.050	n/a	<0.050	<0.050	n/a	0.18	0.22	21.9%	0.071	<0.050	n/a	<0.050	<0.050	n/a
Potassium (K)-Dissolved	mg/L	0.10	4.0	4.3	5.5%	3.9	3.7	-7.1%	3.6	2.8	-26.5%	0.36	0.30	-18.2%	2.1	2.1	-1.9%	2.1	2.1	1.4%
Selenium (Se)-Dissolved	mg/L	0.00010	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a
Silicon (Si)-Dissolved	mg/L	0.050	6.1	6.4	4.7%	7.2	6.0	-19.2%	7.6	6.7	-13.0%	11.4	11.7	2.6%	7.5	6.8	-9.9%	7.5	6.6	-13.2%
Silver (Ag)-Dissolved	mg/L	0.000010	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	0.000055	<0.000010	n/a	<0.000010	<0.000010	n/a	0.000012	<0.000010	n/a	<0.000010	<0.000010	n/a
Sodium (Na)-Dissolved	mg/L	0.050	5.4	5.8	8.0%	6.5	6.0	-7.7%	8.7	6.3	-32.6%	3.5	3.3	-6.1%	5.6	5.7	1.6%	5.6	5.8	3.5%
Strontium (Sr)-Dissolved	mg/L	0.00020	0.39	0.41	5.5%	0.40	0.42	3.9%	0.41	0.38	-8.4%	0.12	0.12	-5.1%	0.38	0.38	0.5%	0.36	0.37	1.6%
Sulfur (S)-Dissolved	mg/L	0.50	131	126	-3.9%	126	119	-5.7%	129	117	-9.8%	35	28	-22.6%	123	113	-8.5%	123	111	-10.3%
Thallium (Tl)-Dissolved	mg/L	0.00001	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Tin (Sn)-Dissolved	mg/L	0.00010	<0.00010	<0.00010	n/a	0.00011	<0.00010	n/a	0.00017	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a
Titanium (Ti)-Dissolved	mg/L	0.010	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a
Uranium (U)-Dissolved	mg/L	0.000010	0.00058	0.00091	45.1%	0.00050	0.000094	-136.5%	0.00044	0.00040	-7.8%	0.000042	0.000032	-27.0%	0.00016	0.00021	22.2%	0.00019	0.00017	-11.0%
Vanadium (V)-Dissolved	mg/L	0.0010	0.0016	0.0012	n/a	0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a	0.0015	<0.0010	n/a	<0.0010	<0.0010	n/a	0.0011	<0.0010	n/a
Zinc (Zn)-Dissolved	mg/L	0.0010	0.0064	0.0082	24.7%	0.049	0.013	-114.2%	0.17	0.021	-155.0%	0.0070	0.0035	n/a	0.059	0.055	n/a	0.073	0.062	n/a

Table D3: Relative Percent Difference (RPD) Calculations for Alternate Preservation #3 Dissolved Metals

Sample ID	UNITS	Detection limit	CH-13-03	CH-13-03 (UNPRESERVED)	RPD	CH-13-04	CH-13-04 (UNPRESERVED)	RPD	CH-13-05	CH-13-05 (UNPRESERVED)	RPD
Date Sampled			30-Sep-13	30-Sep-13		30-Sep-13	30-Sep-13		30-Sep-13	30-Sep-13	
Dissolved Metals											
Aluminum (Al)-Dissolved	mg/L	0.0010	0.0085	0.0054	-44.6%	0.0079	0.0037	-72.4%	0.46	0.35	-27.6%
Antimony (Sb)-Dissolved	mg/L	0.00010	0.00242	0.00224	-7.7%	0.00090	0.00094	4.3%	0.00040	0.00043	7.2%
Arsenic (As)-Dissolved	mg/L	0.0001	0.0027	0.0028	1.8%	0.0011	0.0012	12.1%	0.00073	0.00066	-10.1%
Barium (Ba)-Dissolved	mg/L	0.000050	0.048	0.048	1.0%	0.034	0.036	6.5%	0.018	0.018	4.5%
Beryllium (Be)-Dissolved	mg/L	0.00010	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a	0.00022	0.00021	n/a
Bismuth (Bi)-Dissolved	mg/L	0.00050	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	<0.0010	<0.0010	n/a
Boron (B)-Dissolved	mg/L	0.010	0.021	0.020	n/a	<0.010	0.011	n/a	<0.020	<0.020	n/a
Cadmium (Cd)-Dissolved	mg/L	0.000010	0.0011	0.00097	-11.0%	0.00058	0.00058	-0.2%	0.15	0.15	3.4%
Calcium (Ca)-Dissolved	mg/L	0.05	164	167	1.8%	71	66	-7.6%	428	444	3.7%
Chromium (Cr)-Dissolved	mg/L	0.00010	0.00057	0.00054	-5.4%	0.00028	0.00025	-11.3%	0.00026	0.00025	n/a
Cobalt (Co)-Dissolved	mg/L	0.00010	0.0035	0.0034	-3.2%	0.0013	0.0012	-8.6%	0.0072	0.0075	4.0%
Copper (Cu)-Dissolved	mg/L	0.00020	0.010	0.0080	-22.2%	0.013	0.011	-12.7%	0.42	0.43	3.3%
Iron (Fe)-Dissolved	mg/L	0.01	0.017	<0.010	n/a	<0.010	<0.010	n/a	1.5	0.4	-110.8%
Lead (Pb)-Dissolved	mg/L	0.000050	0.00028	0.000092	-101.3%	0.000086	0.000052	n/a	0.011	0.0091	-18.7%
Lithium (Li)-Dissolved	mg/L	0.00050	0.0082	0.0086	5.3%	0.0061	0.0066	8.2%	0.016	0.016	4.4%
Magnesium (Mg)-Dissolved	mg/L	0.1	68	75	9.0%	32	36	12.3%	95	103	8.3%
Manganese (Mn)-Dissolved	mg/L	0.00005	0.80	0.80	0.0%	0.21	0.20	-5.9%	5.6	5.8	4.9%
Mercury (Hg)-Dissolved	mg/L	0.000010	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Molybdenum (Mo)-Dissolved	mg/L	0.000050	0.0058	0.0053	-8.5%	0.026	0.026	-2.3%	0.0013	0.0014	14.1%
Nickel (Ni)-Dissolved	mg/L	0.00050	0.0085	0.0082	-3.6%	0.0034	0.0035	2.3%	0.0080	0.009	8.4%
Phosphorus (P)-Dissolved	mg/L	0.050	<0.050	<0.050	n/a	<0.050	<0.050	n/a	<0.050	<0.050	n/a
Potassium (K)-Dissolved	mg/L	0.10	5.8	5.9	1.0%	3.1	2.9	-4.7%	2.4	2.6	8.0%
Selenium (Se)-Dissolved	mg/L	0.00010	0.00020	0.00022	n/a	<0.00010	<0.00010	n/a	0.00032	0.00028	-13.3%
Silicon (Si)-Dissolved	mg/L	0.050	5.6	5.8	3.3%	5.5	5.7	2.5%	4.7	4.9	2.7%
Silver (Ag)-Dissolved	mg/L	0.000010	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000020	<0.000020	n/a
Sodium (Na)-Dissolved	mg/L	0.050	13	13	-3.9%	7.1	7.3	3.8%	8.0	8.9	11.1%
Strontium (Sr)-Dissolved	mg/L	0.00020	0.52	0.47	-10.2%	0.39	0.40	2.0%	0.44	0.45	2.7%
Sulfur (S)-Dissolved	mg/L	0.50	169	164	-3.0%	60	53	-13.8%	472	468	-0.9%
Thallium (Tl)-Dissolved	mg/L	0.00001	0.000022	0.00002	n/a	0.000015	0.000017	12.5%	0.00023	0.00022	n/a
Tin (Sn)-Dissolved	mg/L	0.00010	0.016	0.0072	-74.2%	0.0026	0.0020	-25.3%	0.0038	0.0032	-14.9%
Titanium (Ti)-Dissolved	mg/L	0.010	<0.010	<0.010	n/a	<0.010	<0.010	n/a	<0.020	<0.020	n/a
Uranium (U)-Dissolved	mg/L	0.000010	0.0020	0.0019	-9.8%	0.00091	0.00075	-19.0%	0.00020	0.00020	1.5%
Vanadium (V)-Dissolved	mg/L	0.0010	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a	<0.0020	<0.0020	n/a
Zinc (Zn)-Dissolved	mg/L	0.0010	0.28	0.24	-15.4%	0.14	0.14	0.0%	6.6	6.8	3.3%

Table D4 Summary: Relative Percent Difference (RPD) Calculations for Alternate Preservation #3 Dissolved Metals

Sample ID	Positve values indicate unpreserved value is higher				RPD +/- 10%	
	Max	Min	Median	Mean	Count Positive	Count Negative
Aluminum (Al)-Dissolved	4.9%	-105.8%	-28.4%	-30.0%	0	26
Antimony (Sb)-Dissolved	32.0%	-95.8%	0.5%	-5.8%	10	23
Arsenic (As)-Dissolved	**37.8%**	**-181.5%**	**-7.8%**	**-26.6%**	**4**	**41**
Barium (Ba)-Dissolved	9.6%	-79.7%	-2.7%	-5.8%	0	45
Beryllium (Be)-Dissolved	0.0%	0.0%				
Bismuth (Bi)-Dissolved	0.0%	0.0%				
Boron (B)-Dissolved	52.8%	-129.4%	1.3%	-11.1%	5	25
Cadmium (Cd)-Dissolved	**48.4%**	**-166.9%**	**-1.7%**	**-10.6%**	**3**	**26**
Calcium (Ca)-Dissolved	10.1%	-63.5%	-1.0%	-3.4%	1	44
Chromium (Cr)-Dissolved	2.2%	-120.3%	-8.8%	-19.9%	0	25
Cobalt (Co)-Dissolved	29.8%	-100.0%	0.4%	-6.9%	6	35
Copper (Cu)-Dissolved	72.7%	-185.0%	-14.2%	-16.6%	6	25
Iron (Fe)-Dissolved	**33.0%**	**-177.7%**	**-24.9%**	**-50.5%**	**1**	**35**
Lead (Pb)-Dissolved	36.0%	-165.7%	-18.7%	-40.6%	2	27
Lithium (Li)-Dissolved	36.6%	-83.9%	-2.1%	-7.0%	4	20
Magnesium (Mg)-Dissolved	13.7%	-52.2%	3.2%	1.0%	8	38
Manganese (Mn)-Dissolved	28.0%	-127.6%	-0.3%	-4.4%	3	43
Mercury (Hg)-Dissolved	0.0%	0.0%				
Molybdenum (Mo)-Dissolved	40.6%	-141.6%	-0.1%	-9.6%	8	32
Nickel (Ni)-Dissolved	36.6%	-101.2%	-3.6%	-11.3%	2	36
Phosphorus (P)-Dissolved	21.9%	-22.4%	4.3%	0.0%	3	4
Potassium (K)-Dissolved	18.4%	-97.4%	-1.9%	-5.4%	2	44
Selenium (Se)-Dissolved	53.6%	-29.6%	16.1%	13.2%	7	6
Silicon (Si)-Dissolved	8.4%	-19.2%	0.1%	-2.0%	0	46
Silver (Ag)-Dissolved	38.8%	-118.8%	1.8%	-10.4%	3	5
Sodium (Na)-Dissolved	23.3%	-35.3%	1.7%	0.1%	3	43
Strontium (Sr)-Dissolved	16.9%	-42.6%	1.7%	-0.2%	3	43
Sulfur (S)-Dissolved	14.0%	-41.0%	-4.9%	-5.3%	2	41
Thallium (Tl)-Dissolved	14.6%	-7.4%	4.6%	3.1%	2	9
Tin (Sn)-Dissolved	6.5%	-74.2%	-20.1%	-27.0%	0	4
Titanium (Ti)-Dissolved	0.0%	0.0%			0	0
Uranium (U)-Dissolved	45.1%	-136.5%	-2.3%	-10.5%	8	35
Vanadium (V)-Dissolved	2.5%	-31.7%	-14.8%	-14.1%	0	9
Zinc (Zn)-Dissolved	44.4%	-155.0%	-2.7%	-15.7%	7	28

Indicates parameters of potential concern with significant variability.

Note: Dissolved metals samples are preserved with nitric acid primarily to prevent the oxidation of iron which results in the precipiation of iron oxyhydroxides (Fe(OH)3 solids which can remove other metals from the water. Alternate Preservation #3 was to evaluate a potential negative bias for arsenic.

Arsenic and cadmium concentrations can be lowered by the precipiation of iron oxyhydroxides. However, arsenic and cadmium concentrations increased at some locations in the unpreserved samples. The addition of nitric acid to a water sample containing arsenic and sulphide can result in a negative bias for arsenic as arsenic sulphide minerals are precipitated from the water. It appears that this process may also apply to cadmium.

Therefore, arsenic and cadmium concentrations that increased in the unpreserved samples are considered more representative of the Site conditions.

Table D5: Duplicates

Sample ID	UNITS	Detection limit	MP09-11 STANDARD PRESERVATION	FIELD DUP A STANDARD PRESERVATION	RPD	MW09-02 STANDARD PRESERVATION	FIELD DUP B STANDARD PRESERVATION	RPD	MW09-08 STANDARD PRESERVATION	FIELD DUP C STANDARD PRESERVATION	RPD	MW09-19 STANDARD PRESERVATION	FIELP DUP D STANDARD PRESERVATION	RPD
Date Sampled			17-Sep-13	17-Sep-13		17-Sep-13	17-Sep-13		18-Sep-13	18-Sep-13		19-Sep-13	19-Sep-13	
Physical Tests														
Conductivity	uS/cm	2.0	1080	1120	3.6%	2750	2790	1.4%	193	194	0.5%	1650	1560	-5.6%
Hardness (as CaCO3)	mg/L	0.50	642	630	-1.9%	1860	1860	0.0%	95.0	89.2	-6.3%	1410	1430	1.4%
pH	pH	0.10	7.84	7.78	-0.8%	7.25	7.33	1.1%	6.51	6.49	-0.3%	6.84	6.83	-0.1%
Anions and Nutrients														
Alkalinity, Bicarbonate (as CaCO3)	mg/L	1.0	686	709	3.3%	97.4	97.9	0.5%	113	112	-0.9%	493	491	-0.4%
Alkalinity, Carbonate (as CaCO3)	mg/L	1.0	<1.0	<1.0	n/a	<1.0	<1.0	n/a	<1.0	<1.0	n/a	<1.0	<1.0	n/a
Alkalinity, Hydroxide (as CaCO3)	mg/L	1.0	<1.0	<1.0	n/a	<1.0	<1.0	n/a	<1.0	<1.0	n/a	<1.0	<1.0	n/a
Alkalinity, Total (as CaCO3)	mg/L	1.0	686	709	3.3%	97.4	97.9	0.5%	113	112	-0.9%	493.00	491.00	-0.4%
Ammonia, Total (as N)	mg/L	0.025	4.40	4.02	-9.0%	10.3	9.86	-4.4%	1.97	2.02	2.5%	2.76	3.03	9.3%
Chloride (Cl)	mg/L	5.0	<5.0	<5.0	n/a	<10	<10	n/a	<0.50	<0.50	n/a	<5.0	<5.0	n/a
Fluoride (F)	mg/L	0.20	0.50	0.57	n/a	0.75	0.73	n/a	0.170	0.181	n/a	<0.20	0.21	n/a
Nitrate (as N)	mg/L	0.050	<0.050	<0.050	n/a	<0.10	0.16	n/a	0.0138	<0.0050	n/a	0.15	0.14	n/a
Nitrite (as N)	mg/L	0.010	0.029	0.012	n/a	0.024	0.031	n/a	0.0028	0.0011	n/a	<0.010	<0.010	n/a
Total Kjeldahl Nitrogen	mg/L	0.050	11.2	10.5	-6.5%	11.5	10.4	-10.0%	3.05	2.83	-7.5%	4.90	4.85	-1.0%
Sulfate (SO4)	mg/L	5	15	16	n/a	1860	1890	1.6%	<0.50	<0.50	n/a	794.00	797.00	0.4%
Sulphide as S	mg/L		-	-	n/a	<0.020	-	n/a	0.074	0.069	-7.0%	0.18	-	n/a
Anion Sum	meq/L	-	14.1	14.5	2.8%	40.8	41.3	1.2%	2.28	2.24	-1.8%	26.40	26.40	0.0%
Cation Sum	meq/L	-	15.0	14.7	-2.0%	41.7	41.4	-0.7%	4.16	4.05	-2.7%	30.00	30.50	1.7%
Cation - Anion Balance	%	-	3.2	0.5	n/a	1.1	0.2	n/a	29.2	28.7	n/a	6.40	7.10	n/a
Cyanides														
Cyanide, Weak Acid Diss	mg/L	0.0050	<0.0050	<0.0050	n/a	<0.0050	<0.0050	n/a	<0.0050	<0.0050	n/a	<0.0050	<0.0050	n/a
Cyanide, Total	mg/L	0.0050	0.901	0.909	0.9%	<0.0050	0.0072	n/a	<0.0050	<0.0050	n/a	<0.0050	<0.0050	n/a
Thiocyanate (SCN)	mg/L	0.50	1.18	0.70	n/a	<0.50	<0.50	n/a	<0.50	<0.50	n/a	0.51	<0.50	n/a
Cyanide, Free	mg/L	0.0050	<0.0050	<0.0050	n/a	<0.0050	<0.0050	n/a	<0.0050	<0.0050	n/a	<0.0050	<0.0050	n/a
Organic / Inorganic Carbon														
Total Inorganic Carbon	mg/L	2.5	146	158	7.9%	17.2	17.6	2.3%	24.1	23.6	-2.1%	115.00	116.00	0.9%
Total Organic Carbon	mg/L	5.0	62.8	61.1	-2.7%	6.31	6.35	n/a	24.5	28.4	14.7%	35.20	37.60	6.6%
Dissolved Metals														
Aluminum (Al)-Dissolved	mg/L	0.0010	0.0094	0.0082	-13.6%	<0.0020	0.0024	n/a	0.0938	0.0904	-3.7%	0.0097	0.0105	7.9%
Antimony (Sb)-Dissolved	mg/L	0.00010	0.0101	0.0104	2.9%	0.00397	0.00429	7.7%	0.00026	0.00026	n/a	0.0002	0.0002	n/a
Arsenic (As)-Dissolved	mg/L	0.0001	6.65	5.86	-12.6%	11	10.2	-7.5%	0.377	0.362	-4.1%	0.0994	0.0867	-13.6%
Barium (Ba)-Dissolved	mg/L	0.000050	0.145	0.136	-6.4%	0.00676	0.00687	1.6%	0.107	0.107	0.0%	0.0518	0.0541	4.3%
Beryllium (Be)-Dissolved	mg/L	0.00010	<0.00010	<0.00010	n/a	<0.00020	<0.00020	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a
Bismuth (Bi)-Dissolved	mg/L	0.00050	<0.00050	<0.00050	n/a	<0.0010	<0.0010	n/a	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a
Boron (B)-Dissolved	mg/L	0.010	0.054	0.045	n/a	0.095	0.102	7.1%	<0.010	<0.010	n/a	0.324	0.344	6.0%
Cadmium (Cd)-Dissolved	mg/L	0.000010	0.000112	0.000098	-13.3%	0.000825	0.000948	13.9%	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Calcium (Ca)-Dissolved	mg/L	0.05	132	129	-2.3%	476	463	-2.8%	29	27	-8.2%	306.00	309.00	1.0%
Chromium (Cr)-Dissolved	mg/L	0.00010	0.00182	0.00191	4.8%	<0.00020	<0.00020	n/a	0.00119	0.00121	1.7%	0.00034	0.00037	n/a
Cobalt (Co)-Dissolved	mg/L	0.00010	0.00350	0.00356	1.7%	0.0119	0.0124	4.1%	0.00090	0.00089	-1.1%	0.00206	0.00183	-11.8%
Copper (Cu)-Dissolved	mg/L	0.00020	0.00255	0.00214	-17.5%	0.00045	<0.00040	n/a	0.00021	0.00020	n/a	<0.00020	<0.00020	n/a
Iron (Fe)-Dissolved	mg/L	0.01	8.8	7.8	-12.8%	18.6	17.1	-8.4%	35.9	36.1	0.6%	14.1	14.7	4.2%
Lead (Pb)-Dissolved	mg/L	0.000050	0.00480	0.00286	**-50.7%**	0.00075	0.00092	**20.4%**	0.000155	0.00102	n/a	<0.000050	00.0	n/a
Lithium (Li)-Dissolved	mg/L	0.00050	0.00504	0.00447	-12.0%	0.0140	0.0130	-7.4%	<0.00050	<0.00050	n/a	0.00944	0.010100	6.8%
Magnesium (Mg)-Dissolved	mg/L	0.1	76.1	74.5	-2.1%	164.0	171.0	4.2%	5.4	5.4	0.2%	157.0	161.0	2.5%
Manganese (Mn)-Dissolved	mg/L	0.00005	6.02	6.18	2.6%	16.30	16.00	-1.9%	2.26	2.18	-3.6%	2.97	2.87	-3.4%
Mercury (Hg)-Dissolved	mg/L	0.000010	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Molybdenum (Mo)-Dissolved	mg/L	0.000050	0.00996	0.00940	-5.8%	0.00767	0.00825	7.3%	0.000097	0.000090	-7.5%	0.000127	0.000123	-3.2%
Nickel (Ni)-Dissolved	mg/L	0.00050	0.0154	0.0157	1.9%	0.0040	0.0041	2.5%	<0.00050	<0.00050	n/a	0.001450	0.001410	-2.8%
Phosphorus (P)-Dissolved	mg/L	0.050	0.086	0.082	n/a	<0.050	<0.050	n/a	0.107	0.107	n/a	0.22800	0.25300	10.4%
Potassium (K)-Dissolved	mg/L	0.10	8.71	8.61	-1.2%	29.0	28.1	-3.2%	1.36	1.36	0.0%	6.690	6.840	2.2%
Selenium (Se)-Dissolved	mg/L	0.00010	0.00041	0.00038	-7.6%	<0.00020	<0.00020	n/a	0.00013	0.00014	n/a	0.00034	0.00031	n/a
Silicon (Si)-Dissolved	mg/L	0.050	10.0	9.85	-1.5%	7.99	8.16	2.1%	9.57	9.55	-0.2%	8.60000	8.51000	-1.1%
Silver (Ag)-Dissolved	mg/L	0.000010	0.000019	0.000020	5.1%	<0.000020	<0.000020	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Sodium (Na)-Dissolved	mg/L	0.050	21.4	21.8	1.9%	32.3	31.6	-2.2%	1.41	1.41	0.0%	12.8	12.4	-3.2%
Strontium (Sr)-Dissolved	mg/L	0.00020	0.836	0.789	-5.8%	0.872	0.894	2.5%	0.119	0.118	-0.8%	0.89	0.90	1.8%
Sulfur (S)-Dissolved	mg/L	0.50	7	7	0.7%	616	632	2.6%	<0.50	1	n/a	294.00	310.00	5.3%
Thallium (Tl)-Dissolved	mg/L	0.00001	<0.000010	<0.000010	n/a	0.000381	0.000402	5.4%	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Tin (Sn)-Dissolved	mg/L	0.00010	0.00041	0.00019	n/a	<0.00020	<0.00020	n/a	<0.00010	<0.00010	n/a	<0.00010	<0.00010	n/a
Titanium (Ti)-Dissolved	mg/L	0.010	<0.010	<0.010	n/a	<0.020	<0.020	n/a	<0.010	<0.010	n/a	<0.010	<0.010	n/a
Uranium (U)-Dissolved	mg/L	0.000010	0.000760	0.000750	-1.3%	0.00101	0.00106	4.8%	0.000093	0.000095	2.1%	0.000976	0.00087	-11.5%
Vanadium (V)-Dissolved	mg/L	0.0010	0.0074	0.0071	-4.1%	<0.0020	<0.0020	n/a	0.0040	0.0038	n/a	0.001000	<0.0010	n/a
Zinc (Zn)-Dissolved	mg/L	0.0010	0.0313	0.0260	-18.5%	0.417	0.454	8.5%	0.0017	0.0019	n/a	0.0023	0.0027	n/a

Table D6: Summary of 2013 Water Quality Exceedances

Location	Comparative Standards [1]	Total Number of 2013 Exceedances	Iron	Zinc	Arsenic	Maganese	Cadmium	pH	Fluoride	Copper	Ammonia	Cobalt	Sulphate	Lead	Aluminum	Antimony	Chromium	Nitrate	Cyanide (Total)	Cyanide (Free)	Nitrite	Cyanide-WAD	Nickel
Total Number of Exceedances		266	51	36	30	28	26	17	14	13	9	8	6	5	4	4	3	3	3	2	2	1	1
Percentage of Total			19%	14%	11%	11%	10%	6%	5%	5%	3%	3%	2%	2%	2%	2%	1%	1%	1%	1%	1%	0.4%	0.4%
MP09-05	CCME	2	x								x												
	Water License	0																					
	Yukon CSR	3	x			x						x											
	MMER	0																					
MP09-09	CCME	4					x			x	x							x					
	Water License	3			x					x												x	
	Yukon CSR	3			x					x		x											
	MMER	1			x																		
MP09-10	CCME	4						x	x		x									x			
	Water License	2						x											x				
	Yukon CSR	0																					
	MMER	1																	x				
MP09-11	CCME	4	x	x					x		x												
	Water License	2	x		x																		
	Yukon CSR	1			x																		
	MMER	1			x																		
MP09-12	CCME	6	x	x			x		x		x			x									
	Water License	2	x		x																		
	Yukon CSR	2			x		x																
	MMER	1			x																		
MW09-01	CCME	4	x	x			x				x												
	Water License	2	x																x				
	Yukon CSR	3		x	x	x																	
	MMER	0																					
MW09-02	CCME	5	x	x			x		x		x												
	Water License	3	x	x	x																		
	Yukon CSR	5			x	x	x					x	x										
	MMER	1			x																		
MW09-03	CCME	4		x					x		x										x		
	Water License	2			x											x							
	Yukon CSR	4			x	x							x			x							
	MMER	1			x																		
MW09-04	CCME	4		x					x		x			x									
	Water License	3		x	x											x							
	Yukon CSR	5		x	x	x							x			x							
	MMER	2		x	x																		
MP09-07	CCME	5	x	x			x	x		x													
	Water License	4	x	x	x			x															
	Yukon CSR	3			x	x						x											
	MMER	0																					

Table D6: Summary of 2013 Water Quality Exceedances

Location	Comparative Standards [1]	Total Number of 2013 Exceedances	Iron	Zinc	Arsenic	Maganese	Cadmium	pH	Fluoride	Copper	Ammonia	Cobalt	Sulphate	Lead	Aluminum	Antimony	Chromium	Nitrate	Cyanide (Total)	Cyanide (Free)	Nitrite	Cyanide-WAD	Nickel
MW09-08	CCME	3	x					x	x														
	Water License	3	x		x			x															
	Yukon CSR	2			x	x																	
	MMER	0																					
MW09-16	CCME	4		x			x		x	x													
	Water License	1		x																			
	Yukon CSR	2		x			x																
	MMER	1		x																			
MW09-17	CCME	0																					
	Water License	0																					
	Yukon CSR	1											x										
	MMER	0																					
MW09-18	CCME	0																					
	Water License	0																					
	Yukon CSR	2				x							x										
	MMER	0																					
MW09-19	CCME	2	x						x														
	Water License	1	x																				
	Yukon CSR	1				x																	
	MMER	0																					
MW09-21	CCME	2	x												x								
	Water License	1	x																				
	Yukon CSR	2				x						x											
	MMER	0																					
MW09-22	CCME	5	x					x										x		x	x		
	Water License	2	x					x															
	Yukon CSR	1				x																	
	MMER	0																					
MP09-23	CCME	2	x	x																			
	Water License	1	x																				
	Yukon CSR	3				x						x	x										
	MMER	0																					
MW09-24	CCME	2								x								x					
	Water License	0																					
	Yukon CSR	0																					
	MMER	0																					
GLL07-02	CCME	1					x																
	Water License	0																					
	Yukon CSR	0																					
	MMER	0																					

Table D6: Summary of 2013 Water Quality Exceedances

Location	Comparative Standards [1]	Total Number of 2013 Exceedances	Iron	Zinc	Arsenic	Maganese	Cadmium	pH	Fluoride	Copper	Ammonia	Cobalt	Sulphate	Lead	Aluminum	Antimony	Chromium	Nitrate	Cyanide (Total)	Cyanide (Free)	Nitrite	Cyanide-WAD	Nickel
GLL07-03	CCME	3	x	x			x																
	Water License	2	x	x																			
	Yukon CSR	3		x		x	x																
	MMER	1		x																			
W1410383-BH02	CCME	1					x																
	Water License	0																					
	Yukon CSR	0																					
	MMER	0																					
W1410383-BH03	CCME	2	x					x															
	Water License	1	x																				
	Yukon CSR	1				x																	
	MMER	0																					
DC-02	CCME	1	x																				
	Water License	2	x		x																		
	Yukon CSR	1				x																	
	MMER	0																					
DC-03	CCME	4		x			x		x	x													
	Water License	0																					
	Yukon CSR	3				x	x			x													
	MMER	0																					
DC-05	CCME	5	x	x			x		x														x
	Water License	1	x																				
	Yukon CSR	2				x						x											
	MMER	0																					
DC-06	CCME	2	x						x														
	Water License	2	x		x																		
	Yukon CSR	2			x	x																	
	MMER	0																					
DC-07	CCME	3	x				x			x													
	Water License	1	x																				
	Yukon CSR	2			x	x																	
	MMER	0																					
DC-09	CCME	4	x	x				x		x													
	Water License	2	x					x															
	Yukon CSR	2			x	x																	
	MMER	0																					
DC-10	CCME	9	x	x			x	x	x	x				x	x		x						
	Water License	2	x					x															
	Yukon CSR	3			x	x						x											
	MMER	0																					

Table D6: Summary of 2013 Water Quality Exceedances

Location	Comparative Standards [1]	Total Number of 2013 Exceedances	Iron	Zinc	Arsenic	Maganese	Cadmium	pH	Fluoride	Copper	Ammonia	Cobalt	Sulphate	Lead	Aluminum	Antimony	Chromium	Nitrate	Cyanide (Total)	Cyanide (Free)	Nitrite	Cyanide-WAD	Nickel
PC-01	CCME	7	x	x			x			x				x	x		x						
	Water License	1	x																				
	Yukon CSR	3				x				x							x						
	MMER	0																					
PC-05	CCME	1					x																
	Water License	0																					
	Yukon CSR	0																					
	MMER	0																					
HA-01	CCME	2	x						x														
	Water License	1	x																				
	Yukon CSR	0																					
	MMER	0																					
HA-02	CCME	3	x	x				x															
	Water License	2	x					x															
	Yukon CSR	1				x																	
	MMER	0																					
HA-03	CCME	2		x			x																
	Water License	1	x																				
	Yukon CSR	1				x																	
	MMER	0																					
HA-04	CCME	1	x																				
	Water License	1	x																				
	Yukon CSR	1				x																	
	MMER	0																					
HA-05	CCME	2	x	x																			
	Water License	1	x																				
	Yukon CSR	2			x	x																	
	MMER	0																					
CH-13-03	CCME	2		x			x																
	Water License	0																					
	Yukon CSR	1				x																	
	MMER	0																					
CH-13-04	CCME	2		x			x																
	Water License	0																					
	Yukon CSR	0																					
	MMER	0																					
CH-13-05	CCME	6	x	x			x	x						x	x								
	Water License	4	x	x			x	x															
	Yukon CSR	3		x		x	x																
	MMER	1		x																			

Note 1 - Standards are presented for comparative purposes only, they are not intended to indicate regulatory standards that may apply.

Table D7: Summary of 2011 CSR Groundwater Exceedances by Location

Total Number of Exceedances	Location	Parameters Exceeding Regulatory Standards
14	CH-13-05	Iron, zinc, manganese, cadmium, pH, lead, aluminum
14	DC-10	Iron, zinc, arsenic, manganese, cadmium, pH, fluoride, copper, cobalt, lead, aluminum, cadmium.
14	MW09-02	Iron, zinc, arsenic, manganese, cadmium, fluoride, ammonia, cobalt, slphate
14	MW09-04	Zinc, arsenic, manganese, fluoride, ammonia, sulphate, lead, antimony
12	MP09-07	Iron, zinc, arsenic, manganese, cadmium, pH, copper, cobalt
11	MP09-09	Arsenic, cadmium, copper, ammonia, cobalt, nitrate, WAD-cyanide
11	MP09-12	Iron, zinc, arsenic, cadmium, fluoride, ammonia, lead
11	MW09-03	Zinc, arsenic, manganese, fluoride, ammonia, sulphate, antimony, nitrite
11	PC-01	Iron, zinc, manganese, cadmium, copper, lead, aluminum, chromium
9	GLL07-03	Iron, zinc, manganese, cadmium
9	MW09-01	Iron, zinc, arsenic, manganese, cadmium, ammonia, total cyanide
8	DC-05	Iron, zinc, manganese, cadmium, fluoride, cobalt
8	DC-09	Iron, zinc, arsenic, manganese, pH, copper
8	MP09-11	Iron, zinc, arsenic, fluoride, ammonia, lead.
8	MW09-08	Iron, arsenic, manganese, pH, fluoride
8	MW09-16	Zinc, cadmium, fluoride, copper
8	MW09-22	Iron, manganese, pH, nitrate, free cyanide, nitrite
7	DC-03	Zinc, manganese, cadmium, fluoride, copper
7	MP09-10	pH, fluoride, ammonia, Total Cyanide, free cyanide
6	DC-06	Iron, arsenic, manganese, fluoride
6	DC-07	Iron, arsenic, manganese, cadmium, copper
6	HA-02	Iron, zinc, manganese, pH
6	MP09-23	Iron, zinc, manganese, cobalt, sulphate
5	HA-05	Iron, zinc, arsenic, manganese
5	MP09-05	Iron, manganese, ammonia, cobalt
5	MW09-21	Iron, manganese, cobalt, aluminum
4	DC-02	Iron, arsenic, manganese
4	HA-03	Iron, zinc, manganese, cadmium
4	MW09-19	Iron, manganese, fluoride
4	W1410383-BH03	Iron, manganese, pH
3	CH-13-03	Zinc, manganese, cadmium
3	HA-01	Iron, fluoride
3	HA-04	Iron, manganese
2	CH-13-04	Zinc, cadmium
2	MW09-18	Manganese, sulphate
2	MW09-24	Copper, nitrate
1	GLL07-02	Cadmium
1	MW09-17	Sulphate
1	PC-05	Cadmium
1	W1410383-BH02	Cadmium

Note: Parameters presented in order of the frequency of occurrence on Site (see Table 3H).

Table D8: Evaluation of Sulphite as Explanation for Charge Balance Errors and Lack of Iron Oxidation

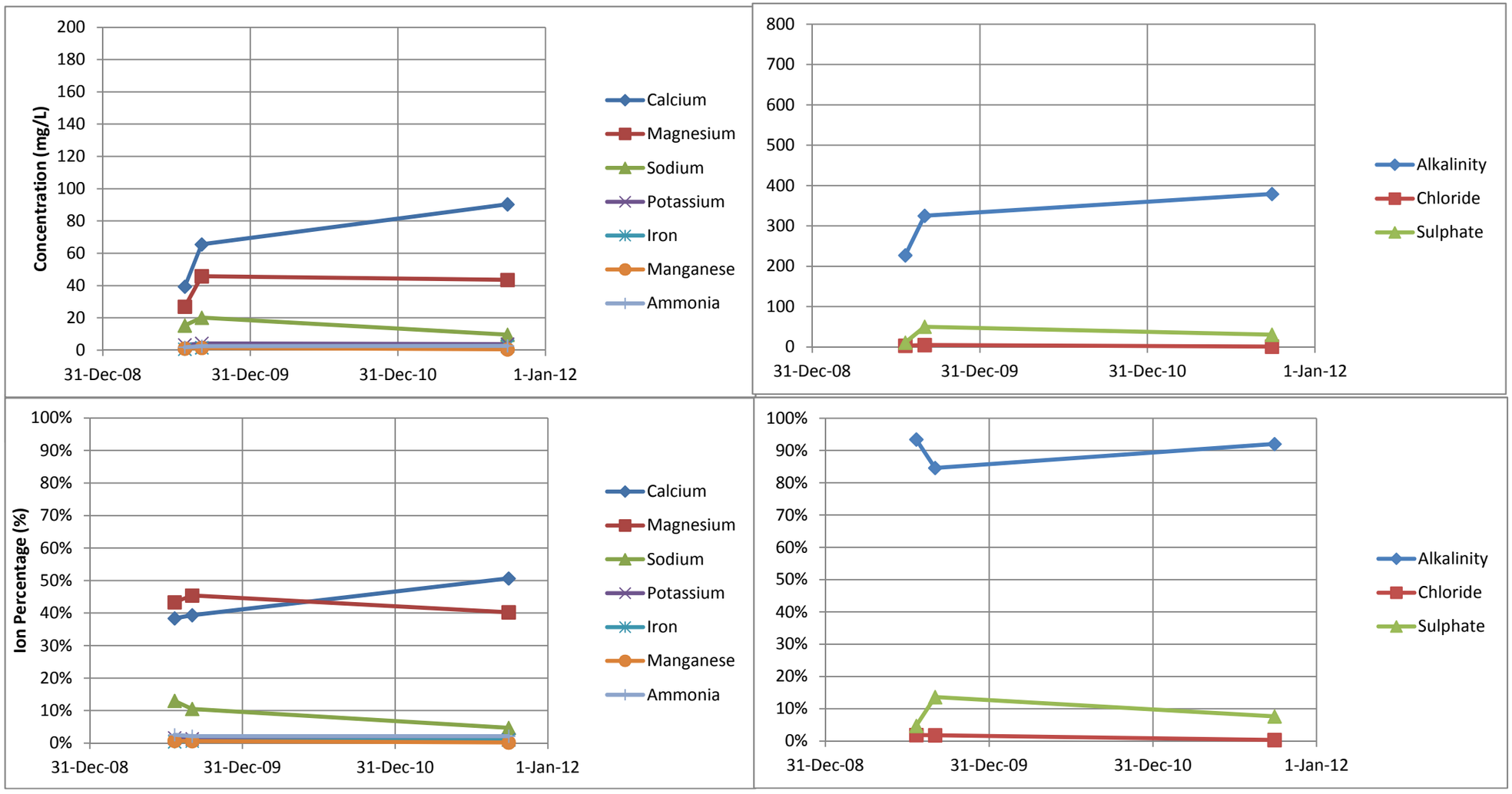
Parameter or Calculation Description	UNITS	MP09-04 Standard Preservation	MP09-05 STANDARD PRESERVATION	MP09-09 STANDARD PRESERVATION	MP09-10 STANDARD PRESERVATION	MP09-10 STANDARD PRESERVATION	MP09-11 STANDARD PRESERVATION	FIELD DUP A STANDARD PRESERVATION	MP09-12 STANDARD PRESERVATION	MW09-01 STANDARD PRESERVATION	MW09-02 STANDARD PRESERVATION	FIELD DUP B STANDARD PRESERVATION	MW09-03 STANDARD PRESERVATION	MW09-04 STANDARD PRESERVATION	MW09-07 STANDARD PRESERVATION	MW09-08 STANDARD PRESERVATION	FIELD DUP C STANDARD PRESERVATION	MW09-16 STANDARD PRESERVATION	MW09-17 STANDARD PRESERVATION	MW09-18 STANDARD PRESERVATION	MW09-19 STANDARD PRESERVATION	FIELP DUP D STANDARD PRESERVATION	MW09-21 STANDARD PRESERVATION
Date Sampled		18-Sep-13	18-Sep-13	17-Sep-13	17-Sep-13	19-SEP-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	17-Sep-13	18-Sep-13	18-Sep-13	18-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13	19-Sep-13
pH	pH	7.19	6.59	8.54	9.15	8.68	7.84	7.78	7.71	7.42	7.25	7.33	7.45	7.77	6.38	6.51	6.49	6.89	6.94	7.01	6.84	6.83	6.52
Anion Sum	meq/L	23.1	30.0	4.72	5.1	5.4	14.1	14.5	11.6	22.5	40.8	41.3	35.7	35.4	16.500	2.28	2.24	21.9	43.0	32.7	26.4	26.4	17.6
Cation Sum	meq/L	23.6	33.4	5.22	-	5.6	15.0	14.7	13.3	23.1	41.7	41.4	34.6	36.3	19.0	4.16	4.05	21.6	40.8	38.4	30.0	30.5	20.3
Balance (Cation/Anion)	%	102.2%	111.3%	110.6%	-	103.6%	106.4%	101.4%	114.7%	102.7%	102.2%	100.2%	96.9%	102.5%	115.2%	182.5%	180.8%	98.6%	94.9%	117.4%	113.6%	115.5%	115.3%
Total Organic Carbon (TOC)	mg/L	2.2	104	28.5	52.5	-	62.8	61.1	19.6	76	6.31	6.35	11.9	5.92	31.4	24.5	28.4	6.08	5.7	5.8	35	38	90.9
Total Inorganic Carbon (TIC)	mg/L	78.2	48.6	21.1	37.3	-	146	158	81	76.3	17.2	17.6	7.94	7.4	31.1	24.1	23.6	78.7	59.7	80.6	115	116	78.8
Alkalinity, Total (as CaCO3)	mg/L	341.0	226	124.0	141.0	98.1	686.0	709.0	430.0	341.0	97.40	97.90	41.7	40.00	172.0	113.0	112.0	319.00	503.0	402.0	493	491	319.0
Iron (Fe)-Dissolved	mg/L	<0.010	56.10	0.05	-	0.30	8.81	7.75	3.49	27.90	18.60	17.10	<0.010	<0.010	3.98	35.90	36.10	<0.010	<0.010	0.04	14.10	14.70	52.10
Sulphate as SO4	mg/L	783	1220	101	108	161	15	16	145	753	1860	1890	1660	1660	624	0.5	<0.50	747	1580	1180	794	797	538
Sulfur (S)-Dissolved	mg/L	260.0	408.0	57.9	63.0	63.0	7.4	7.4	55.8	237.0	616.0	632.0	527.0	552.0	232.0	0.5	0.5	241.0	493.0	458.0	294.0	310.0	162.0
Sulphate as S (32.05/98.06)	0.33	261.3	407.2	33.7	36.0	53.7	5.1	5.3	48.4	251.3	620.8	630.8	554.0	554.0	208.3			249.3	527.3	393.8	265.0	266.0	179.6
Calculations Based on Alkalinity and Charge Balance																							
Anions Needed to Reach 100% Charge Balance	meq/L	0.5	3.4	0.5	0.3	0.2	0.9	0.2	1.7	0.6	0.9	0.1	-1.1	0.9	2.5	1.9	1.8	-0.3	-2.2	5.7	3.6	4.1	2.7
Increase in Alkalinity Needed to Reach 100% Charge Balance	mg/L	25.0	170.1	25.0	12.8	9.9	45.0	10.0	85.1	30.0	45.0	5.0	-55.0	45.0	125.1	94.1	90.6	-15.0	-110.1	285.2	180.1	205.2	135.1
TIC as CaCO3 Alkalinity (50.04/12.01)	4.17	325.8	202	87.9	155.4	155.4	608.3	658.3	337.5	317.9	71.66	73.33	33.1	30.83	129.6	100.4	98.3	327.91	248.7	335.8	479	483	328.3
Alkalinity, Total (as CaCO3)	mg/L	341.0	226	124.0	141.0	141.0	686.0	709.0	430.0	341.0	97.40	97.90	41.7	40.00	172.0	113.0	112.0	319.00	503.0	402.0	493	491	319.0
Difference (Measured Alk - TIC*4.17)	mg/L	15.2	23.5	36.1	-14.4	-14.4	77.7	50.7	92.5	23.1	25.7	24.6	8.6	9.2	42.4	12.6	13.7	-8.9	254.3	66.2	13.9	7.7	-9.3
Missing Alkalinity as CaCO3	**mg/L**	**40**	**194**	**61**	**-2**	**-5**	**123**	**61**	**178**	**53**	**71**	**30**	**-46**	**54**	**168**	**107**	**104**	**-24**	**144**	**351**	**194**	**213**	**126**
Calculation of Minimum Sulphite Needed to Prevent Iron Oxidation in Unpreserved Bottle																							
Iron Retained in Solution	mg/L	0.01	56.1	0.05	0.3	0.3	8.8	7.8	3.5	27.9	3.6	16.0	0.01	0.01	4.0	35.9	36.1	0.01	0.01	0.04	14.1	14.7	50.9
Sulphite Needed to Prevent Iron Oxidation in Unpreserved Bottle	mg/L	0.01	39.8	0.03	0.2	0.2	6.3	5.5	2.5	19.8	2.6	11.4	0.01	0.01	2.8	25.5	25.6	0.01	0.01	0.03	10.0	10.4	36.1
Calcite Consumed by Fe Oxidation in Unpreserved Bottle	1.79	0.02	100.42	0.09	0.54	0.54	15.77	13.87	6.25	49.94	6.44	28.64	0.02	0.02	7.12	64.26	64.62	0.02	0.02	0.07	25.24	26.31	91.11
Missing Alkalinity Remaining After Including Fe Oxidation	**mg/L**	**40.2**	**93.2**	**61.0**	**-2.2**	**-5.1**	**107.0**	**46.8**	**171.3**	**3.2**	**64.3**	**0.9**	**-46.4**	**54.2**	**160.4**	**42.4**	**39.6**	**-23.9**	**144.2**	**351.3**	**168.8**	**186.5**	**34.7**
Calculation of Required Sulphite Concentrations																							
Sulphate as SO4	mg/L	783	1220	101	108	161	15	16	145	753	1860	1890	1660	1660	624	<0.50	<0.50	747	1580	1180	794	797	538
Sulphate as S (32.05/98.06)	0.33	261.3	407.2	33.7	36.0	53.7	5.1	5.3	48.4	251.3	620.8	630.8	554.0	554.0	208.3			249.3	527.3	393.8	265.0	266.0	179.6
Sulfur (S)-Dissolved	mg/L	260.0	408.0	57.9	63.0	63.0	7.4	7.4	55.8	237.0	616.0	632.0	527.0	552.0	232.0	0.5	0.5	241.0	493.0	458.0	294.0	310.0	162.0
Total S Minus Sulphate as S	mg/L	-1	1	24	27	9	2	2	7	-14	-5	1	-27	-2	24	1	1	-8	-34	64	29	44	-18
Alkalinity, Total (as CaCO3)	mg/L	341.0	226	124.0	141.0	98.1	686.0	709.0	430.0	341.0	97.40	97.90	41.7	40.00	172.0	113.0	112.0	319.00	503.0	402.0	493	491	319.0
Missing Alkalinity Remaining After Including Fe Oxidation	mg/L	40.2	93.2	61.0	-2.2	-1.2	107.0	46.8	171.3	3.2	64.3	0.9	-46.4	54.2	160.4	42.4	39.6	-23.9	144.2	351.3	168.8	186.5	34.7
Minimum Sulphite as S to Prevent Fe Oxidation	mg/L	0.0	16.0	0.0	0.1	0.1	2.5	2.2	1.0	7.9	1.0	4.6	0.0	0.0	1.1	10.2	10.3	0.0	0.0	0.0	4.0	4.2	14.5
Titratable Sulphite as S to Equal Missing Alkalinity	mg/L	6.4	14.9	9.8	-0.4	0.0	17.1	7.5	27.4	0.5	10.3	0.1	-7.4	8.7	25.7	6.8	6.3	-3.8	23.1	56.3	27.0	29.9	5.6
Titratable Sulphite as SO_3 to Equal Missing Alkalinity	**mg/L**	**16.1**	**37.3**	**24.4**	**-0.9**	**0.0**	**42.8**	**18.8**	**68.6**	**1.3**	**25.8**	**0.4**	**-18.6**	**21.7**	**64.2**	**17.0**	**15.9**	**-9.6**	**57.7**	**140.7**	**67.6**	**74.7**	**13.9**
Percentage of Acid Titratable Alkalinity Due to Sulphite	%	11.8%	41.3%	49.3%	-1.6%	0.0%	15.6%	6.6%	39.9%	0.9%	66.1%	1.0%	-111.5%	135.6%	93.4%	37.6%	35.4%	-7.5%	28.7%	87.5%	34.3%	38.0%	10.9%
Minimum Percentage of S as Sulphite to Prevent Fe Oxidation	%	0.0%	3.9%	0.02%	0.1%	0.14%	34.0%	29.7%	1.8%	3.3%	0.2%	0.7%	0.0%	0.0%	0.5%	2041.9%	2013.0%	0.0%	0.0%	0.0%	1.4%	1.3%	8.9%
Percentage of S as Sulphite to Explain Missing Alkalinity	**%**	**2.5%**	**3.7%**	**16.9%**	**-0.6%**	**0.0%**	**232.4%**	**101.1%**	**49.2%**	**0.2%**	**1.7%**	**0.0%**	**-1.4%**	**1.6%**	**11.1%**	**1358.4%**	**1244.4%**	**-1.6%**	**4.7%**	**12.3%**	**9.2%**	**9.6%**	**3.4%**
Minimum Percentage of S as Sulphate	**%**	**97.5%**	**96.3%**	**83.1%**	**100.6%**	**100.0%**	**-132.4%**	**-1.1%**	**50.8%**	**99.8%**	**98.3%**	**100.0%**	**101.4%**	**98.4%**	**88.9%**	**-1258.4%**	**-1144.4%**	**101.6%**	**95.3%**	**87.7%**	**90.8%**	**90.4%**	**96.6%**

Indicates Laboratory Reported Value
Indicates value inserted at MDL for non-detect results
Indicates substantial charge balance error.
Indicates notable result
Indicates discrepancy due to low Dissolved Sulphur Content

Table D8: Evaluation of Sulphite as Explanation for Charge Balance Errors and Lack of Iron Oxidation

Parameter or Calculation Description	UNITS	MW09-22 STANDARD PRESERVATION	MW09-23 STANDARD PRESERVATION	MW09-24 STANDARD PRESERVATION	GLL07-02 STANDARD PRESERVATION	W1410383-BH02 STANDARD PRESERVATION	W1410383 BH03 STANDARD PRESERVATION	DC-02	DC-03	DC-05	DC-06	DUP_01	DC-07	DC-09	DC-10	PC-05	HA-01	HA-02	HA-03	HA-04	HA-05	DUP_02	CH-13-03	CH-13-04	CH-13-05
Date Sampled		18-Sep-13	19-Sep-13	18-Sep-13	19-Sep-13	18-Sep-13	20-Sep-13	27-Sep-13	30-Sep-13	30-Sep-13	28-Sep-13	28-Sep-13	28-Sep-13	28-Sep-13	29-Sep-13	30-Sep-13	29-Sep-13	29-Sep-13	29-Sep-13	29-Sep-13	29-Sep-13	29-Sep-13	30-Sep-13	30-Sep-13	30-Sep-13
pH	pH	6.05	6.84	7.41	6.55	7.65	6.44	6.99	7.68	7.27	7.35	7.35	7.05	6.33	6.32	7.25	7.22	6.41	6.59	6.05	6.87	6.82	7.45	7.53	6.06
Anion Sum	meq/L	13.4	32.9	11.1	3.78	9.6	12.9	11.40	13.40	19.20	15.90	16.00	5.55	5.03	8.38	3.19	12.50	10.10	10.70	2.30	11.40	11.40	14.10	6.29	30.90
Cation Sum	meq/L	17.6	33.5	12.2	4.26	10.6	14.2	14.2	13.9	16.5	18.3	18.1	6.09	7.84	13.8	3.33	13.2	13.9	12.9	3.98	13.1	13.0	14.5	6.60	30.1
Balance (Cation/Anion)	%	131.3%	101.8%	109.9%	112.7%	110.4%	109.8%	124.6%	103.7%	85.9%	115.1%	113.1%	109.7%	155.9%	164.7%	104.4%	105.6%	137.6%	120.6%	173.0%	114.9%	114.0%	102.8%	104.9%	97.4%
Total Organic Carbon (TOC)	mg/L	28	22.2	8.59	11.6	9.74	88.2	127	220	19.1	128	131	42.8	64.7	73.2	18.5	145	93.9	396	124	71.5	16.2	26.3	14.1	7.53
Total Inorganic Carbon (TIC)	mg/L	8.5	52.6	46.7	19.1	63.6	33.9	71.4	58.9	-	174	183	30.9	12.4	25.8	20.4	56	32.5	29.4	5.41	44.4	45.3	44.1	31.6	8.59
Alkalinity, Total (as CaCO3)	mg/L	61.4	256.0	201.00	83.9	264.0	200	300	251	250.0	785	789	137.0	51.6	127.0	79.6	223	128.0	135	026	192.0	197.0	192.0	134.0	44.10
Iron (Fe)-Dissolved	mg/L	51.30	18.80	<0.010	0.03	<0.010	82.70	34.80	0.04	6.86	18.20	17.70	11.50	21.00	82.90	0.06	3.77	47.20	27.20	20.00	26.10	24.10	0.02	<0.010	1.53
Sulphate as SO4	mg/L	569	1330	327	98	368	269	257	404	681	<5.0	<5.0	132	191	277	76	383	365	384	86	365	359	491	169	1430
Sulfur (S)-Dissolved	mg/L	214.0	428.0	117.0	32.5	83.9	64.2	97.5	137.0	183.0	1.7	1.6	43.3	76.1	101.0	26.5	131.0	126.0	129.0	35.0	123.0	123.0	169.0	60.4	472.0
Sulphate as S (32.05/98.06)	0.33	189.9	443.9	109.1	32.8	122.8	89.8	85.8	134.8	227.3	#VALUE!		44.1	63.7	92.4	25.3	127.8	121.8	128.2	28.5	121.8	119.8	163.9	56.4	477.3
Calculations Based on Alkalinity and Charge Balance																									
Anions Needed to Reach 100% Charge Balance	meq/L	4.2	0.6	1.1	0.5	1.0	1.3	2.8	0.5	-2.7	2.4	2.1	0.5	2.8	5.4	0.1	0.7	3.8	2.2	1.7	1.7	1.6	0.4	0.3	-0.8
Increase in Alkalinity Needed to Reach 100% Charge Balance	mg/L	210.2	30.0	55.0	24.0	50.2	63.2	140.1	25.0	-135.1	120.1	105.1	27.0	140.6	271.2	7.0	35.0	190.2	110.1	84.1	85.1	80.1	20.0	15.5	-40.0
TIC as CaCO3 Alkalinity (50.04/12.01)	4.17	35.4	219.2	194.58	79.6	265.21	141.3	297	245	245	725	762	128.8	51.7	107.5	85.0	233	135.4	123	023	185.0	188.7	183.7	131.7	35.79
Alkalinity, Total (as CaCO3)	mg/L	61.4	256.0	201.00	83.9	264.0	200	300	251	250.0	785	789	137.0	51.6	127.0	79.6	223	128.0	135	026	192.0	197.0	192.0	134.0	44.10
Difference (Measured Alk - TIC*4.17)	mg/L	26.0	36.8	6.4	4.3	-1.2	58.8	2.5	5.6	5.6	60.0	26.5	8.3	-0.1	19.5	-5.4	-10.3	-7.4	12.5	3.1	7.0	8.3	8.3	2.3	8.3
Missing Alkalinity as CaCO3	**mg/L**	**236**	**67**	**61**	**28**	**49**	**122**	**143**	**31**	**-130**	**180**	**132**	**35**	**141**	**291**	**2**	**25**	**183**	**123**	**87**	**92**	**88**	**28**	**18**	**-32**
Calculation of Minimum Sulphite Needed to Prevent Iron Oxidation																									
Iron Retained in Solution	mg/L	42.8	18.8	0.01	0.6	0.01	72.8	5.9	0.04	6.9	9.1	11.5	11.5	21.0	55.7	0.06	2.9	5.3	2.4	17.5	4.7	1.5	0.01	0.01	1.5
Sulphite Needed to Prevent Iron Oxidation in Unpreserved Bottle	mg/L	30.4	13.3	0.00	0.4	0.01	51.7	4.2	0.03	4.9	6.5	8.1	8.2	14.9	39.5	0.04	2.1	3.7	1.7	12.4	3.3	1.0	0.01	0.01	1.1
Calcite Consumed by Fe Oxidation in Unpreserved Bottle	1.79	76.61	33.65	0.01	1.01	0.02	130.31	10.61	0.08	12.28	16.32	20.51	20.59	37.59	99.70	0.10	5.17	9.43	4.26	31.33	8.43	2.63	0.02	0.02	2.74
Missing Alkalinity Remaining After Including Fe Oxidation	**mg/L**	**159.5**	**33.2**	**61.5**	**27.3**	**48.9**	**-8.4**	**132.0**	**30.5**	**-141.8**	**163.8**	**111.1**	**14.7**	**103.0**	**191.0**	**1.5**	**19.5**	**173.3**	**118.3**	**55.8**	**83.6**	**85.7**	**28.3**	**17.8**	**-34.5**
Calculation of Required Sulphite Concentrations																									
Sulphate as SO4	mg/L	569	1330	327	98	368	269	257	404	681	<5.0	<5.0	132	191	277	76	383	365	384	86	365	359	491	169	1430
Sulphate as S (32.05/98.06)	0.33	189.9	443.9	109.1	32.8	122.8	89.8	85.8	134.8	227.3	#VALUE!		44.1	63.7	92.4	25.3	127.8	121.8	128.2	28.5	121.8	119.8	163.9	56.4	477.3
Sulfur (S)-Dissolved	mg/L	214.0	428.0	117.0	32.5	83.9	64.2	97.5	137.0	183.0	1.7	1.6	43.3	76.1	101.0	26.5	131.0	126.0	129.0	35.0	123.0	123.0	169.0	60.4	472.0
Total S Minus Sulphate as S	mg/L	24	-16	8	0	-39	-26	12	2	-44	#VALUE!	2	-1	12	9	1	3	4	1	6	1	3	5	4	-5
Alkalinity, Total (as CaCO3)	mg/L	61.4	256.0	201.00	83.9	264.0	200	300	251	250.0	785	789	137.0	51.6	127.0	79.6	223	128.0	135	026	192.0	197.0	192.0	134.0	44.10
Missing Alkalinity Remaining After Including Fe Oxidation	mg/L	159.5	33.2	61.5	27.3	48.9	-8.4	132.0	30.5	-141.8	163.8	111.1	14.7	103.0	191.0	1.5	19.5	173.3	118.3	55.8	83.6	85.7	28.3	17.8	-34.5
Minimum Sulphite as S to Prevent Fe Oxidation	mg/L	12.2	5.3	0.0	0.2	0.0	20.7	1.7	0.0	2.0	2.6	3.3	3.3	6.0	15.8	0.0	0.8	1.5	0.7	5.0	1.3	0.4	0.0	0.0	0.4
Titratable Sulphite as S to Equal Missing Alkalinity	mg/L	25.6	5.3	9.8	4.4	7.8	-1.3	21.1	4.9	-22.7	26.2	17.8	2.4	16.5	30.6	0.2	3.1	27.8	19.0	8.9	13.4	13.7	4.5	2.9	-5.5
Titratable Sulphite as SO_3 to Equal Missing Alkalinity	**mg/L**	**63.9**	**13.3**	**24.6**	**10.9**	**19.6**	**-3.4**	**52.9**	**12.2**	**-56.8**	**65.6**	**44.5**	**5.9**	**41.2**	**76.5**	**0.6**	**7.8**	**69.4**	**47.4**	**22.3**	**33.5**	**34.3**	**11.3**	**7.1**	**-13.8**
Percentage of Acid Titratable Alkalinity Due to Sulphite	%	260.2%	13.0%	30.6%	32.6%	18.6%	-4.2%	44.1%	12.2%	-56.8%	20.9%	14.1%	10.7%	199.8%	150.6%	1.9%	8.8%	135.6%	87.8%	218.2%	43.6%	43.6%	14.7%	13.3%	-78.2%
Minimum Percentage of S as Sulphite to Prevent Fe Oxidation	%	5.7%	1.2%	0.0%	0.5%	0.0%	32.2%	1.7%	0.0%	1.1%	156.2%	206.3%	7.6%	7.8%	15.7%	0.1%	0.6%	1.2%	0.5%	14.2%	1.1%	0.3%	0.0%	0.0%	0.1%
Percentage of S as Sulphite to Explain Missing Alkalinity	**%**	**11.9%**	**1.2%**	**8.4%**	**13.5%**	**9.3%**	**-2.1%**	**21.7%**	**3.6%**	**-12.4%**	**1580.4%**	**1126.3%**	**5.4%**	**21.7%**	**30.3%**	**0.9%**	**2.4%**	**22.0%**	**14.7%**	**25.5%**	**10.9%**	**11.2%**	**2.7%**	**4.7%**	**-1.2%**
Minimum Percentage of S as Sulphate	**%**	**88.1%**	**98.8%**	**91.6%**	**86.5%**	**90.7%**	**102.1%**	**78.3%**	**96.4%**	**112.4%**	**-1480.4%**	**-1026.3%**	**94.6%**	**78.3%**	**69.7%**	**99.1%**	**97.6%**	**78.0%**	**85.3%**	**74.5%**	**89.1%**	**88.8%**	**97.3%**	**95.3%**	**101.2%**

Indicates Laboratory Reported Value
Indicates value inserted at MDL for non-detect results
Indicates substantial charge balance error.
Indicates notable result
Indicates discrepancy due to low Dissolved Sulphur Content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140
120
100
80
60
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20
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31-Dec-09
31-Dec-10
1-Jan-12
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia
800
700
600
500
400
300
200
100
0
Alkalinity
Chloride
Sulphate
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70%
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50%
40%
30%
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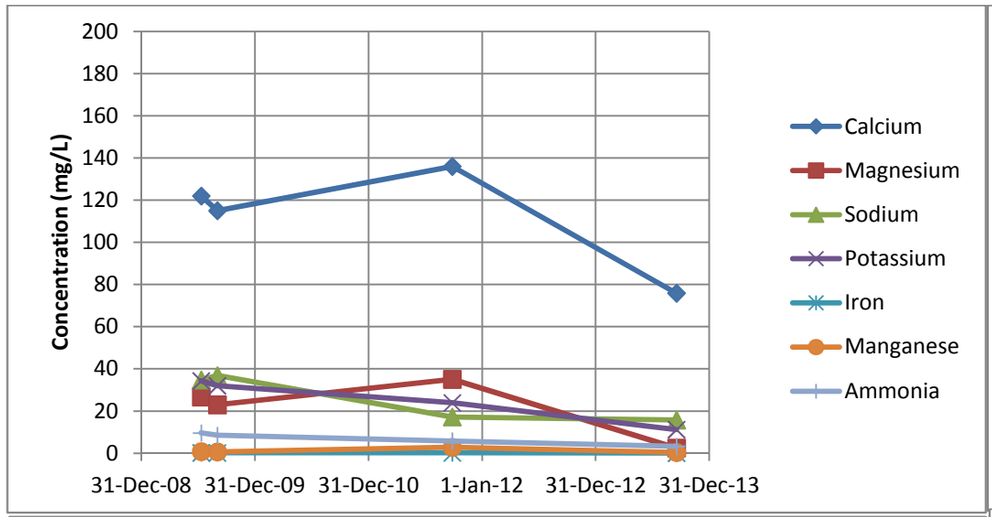
10%
0%

MW09-11


Concentration (mg/L)
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160
140
120
100
80
60
40
20
0
31-Dec-08
31-Dec-09
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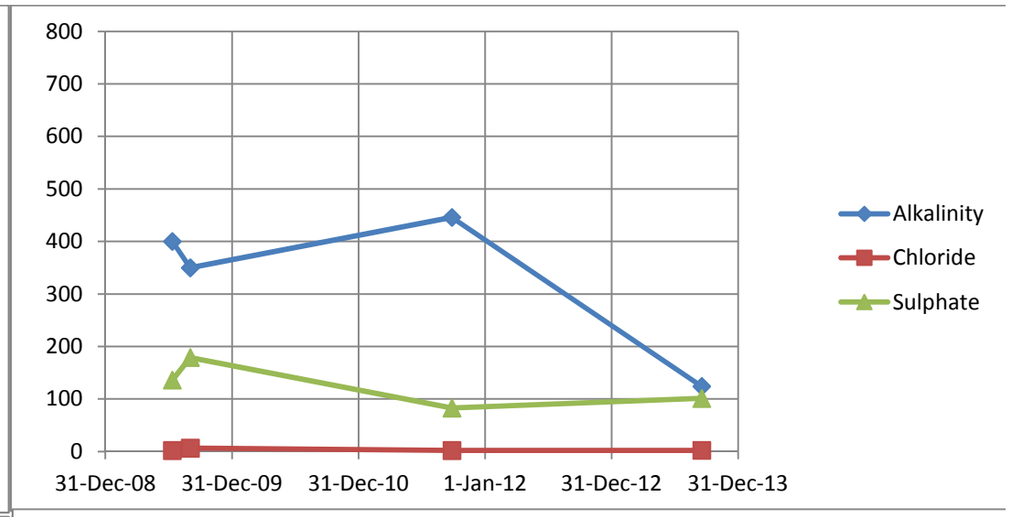
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia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700
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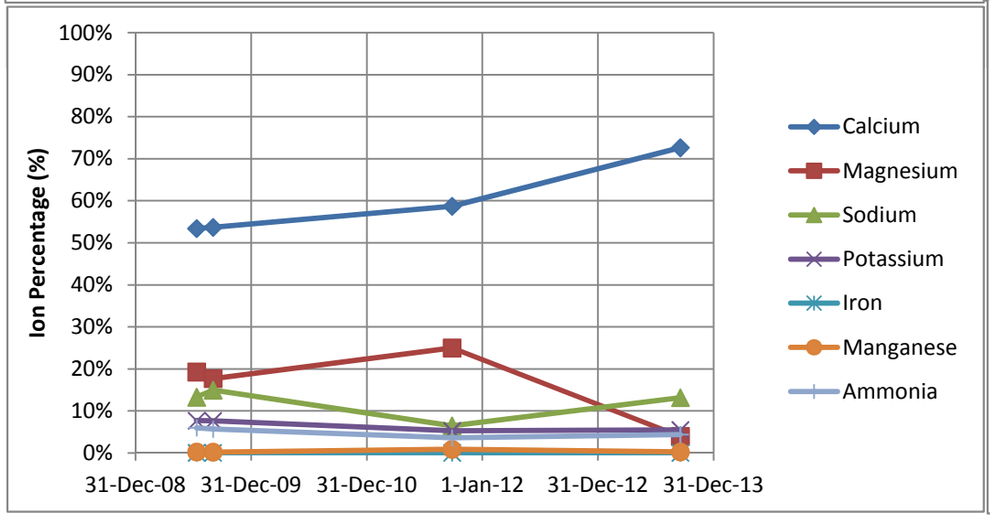
500
400
300
200
100
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Alkalinity
Chloride
Sulphate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80%
70%
60%
50%
40%
30%
20%
10%
0%
31-Dec-08
31-Dec-09
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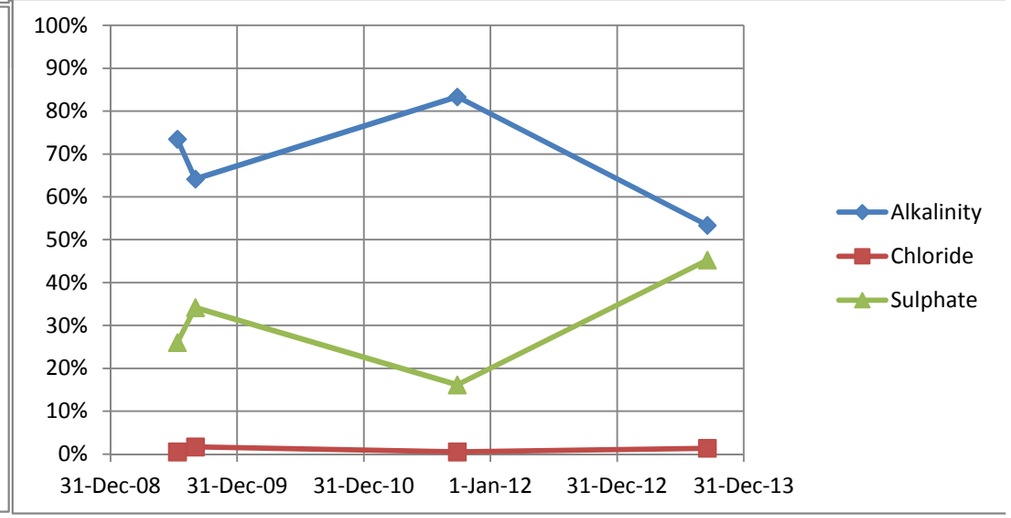
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia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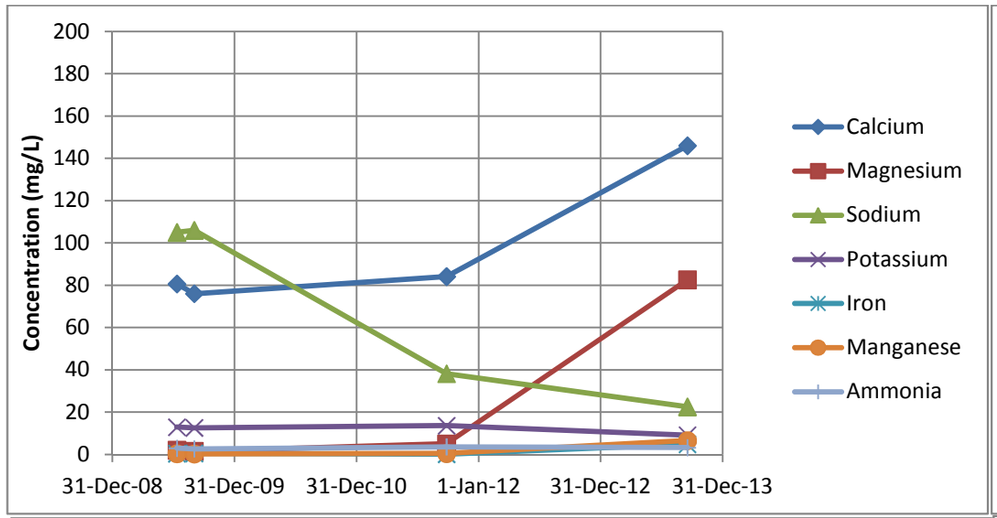
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Alkalinity
Chloride
Sulphate

MP09-09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160
140
120
100
80
60
40
20
0
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31-Dec-09
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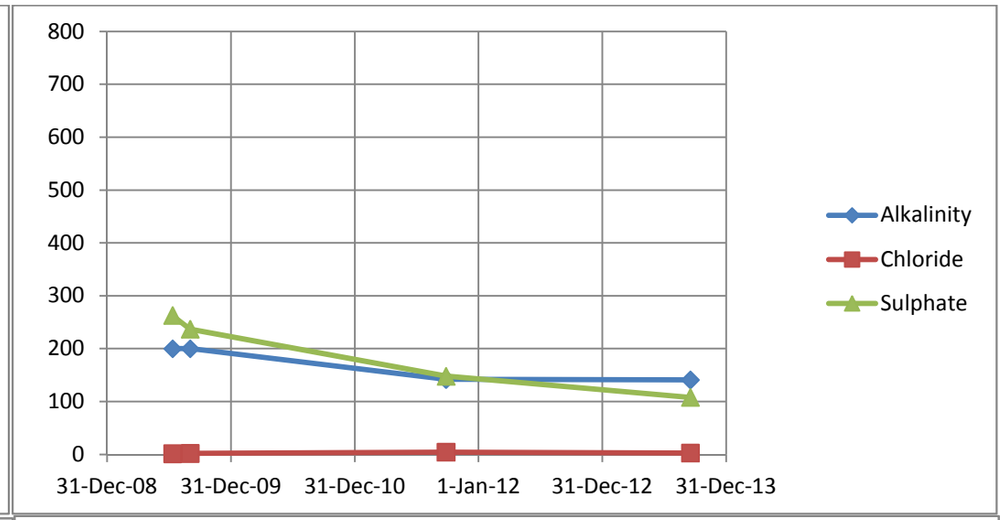
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia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700
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500
400
300
200
100
0
31-Dec-08
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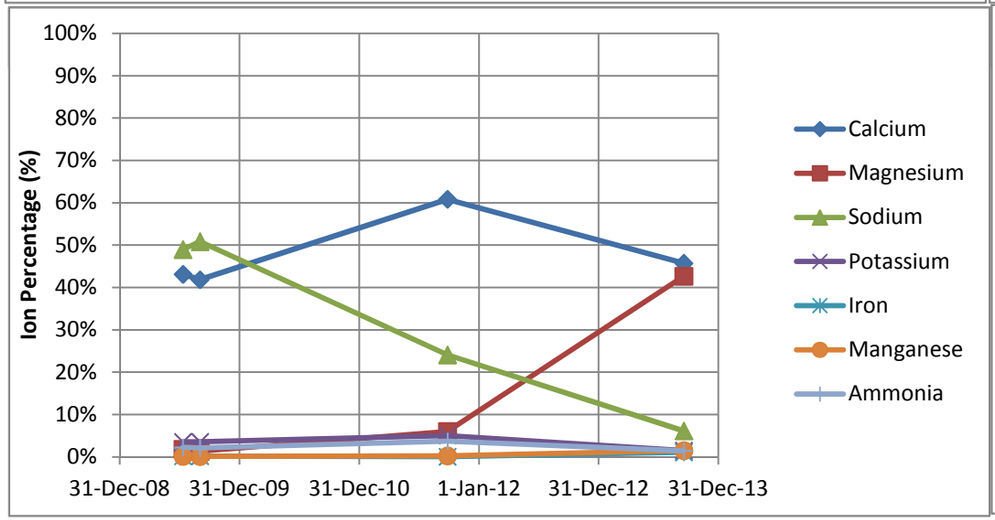
1-Jan-12
31-Dec-12
31-Dec-13
Alkalinity
Chloride
Sulphate


Ion Percentage (%)
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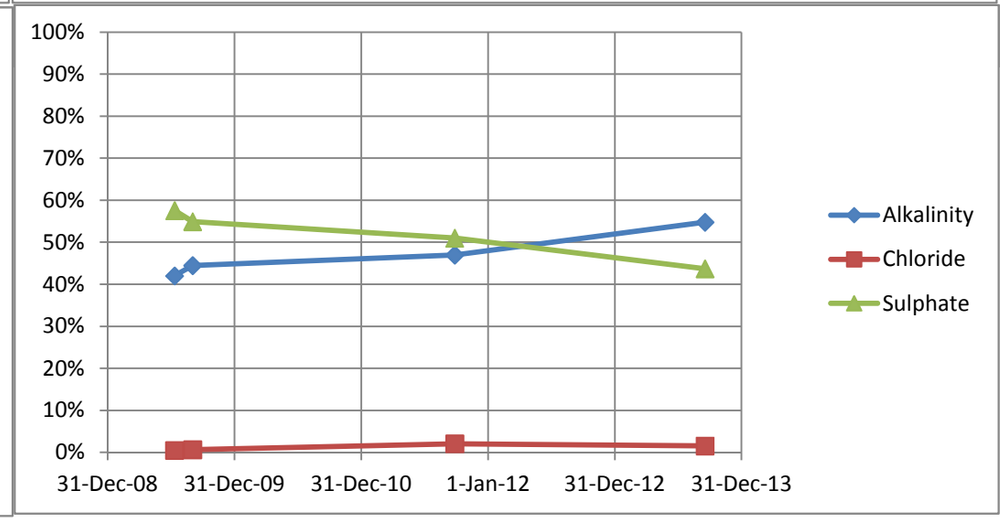
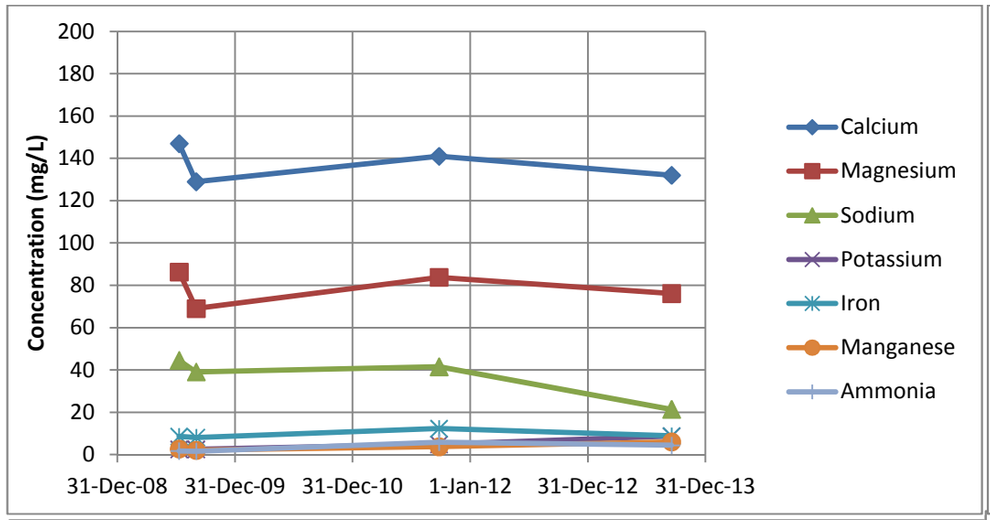
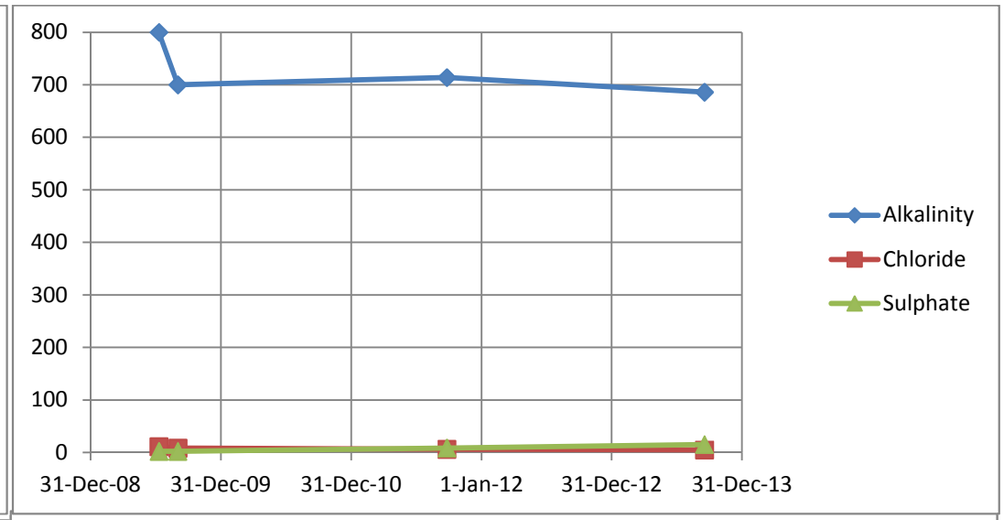
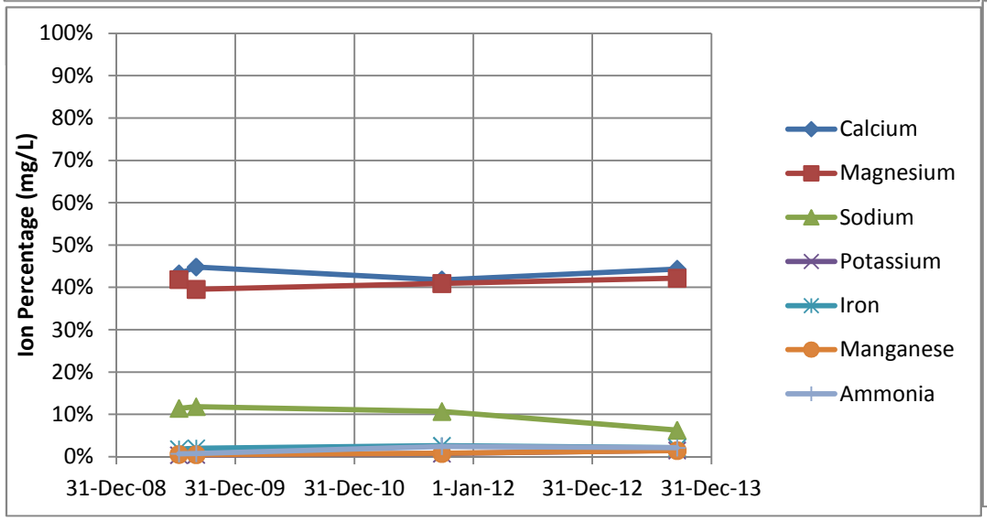
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia

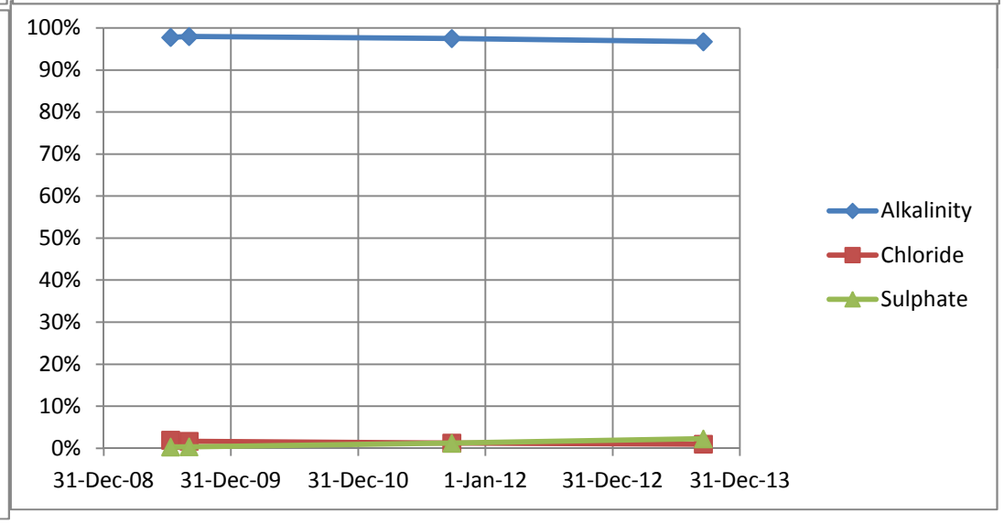

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Alkalinity
Chloride
Sulphate

MP09-10

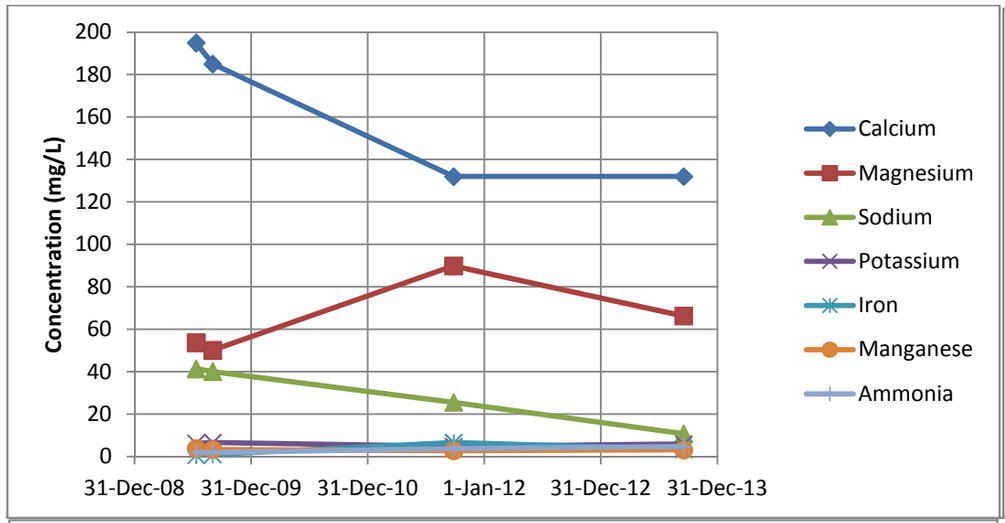

Concentration (mg/L)
200
180
160
140
120
100
80
60
40
20
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia

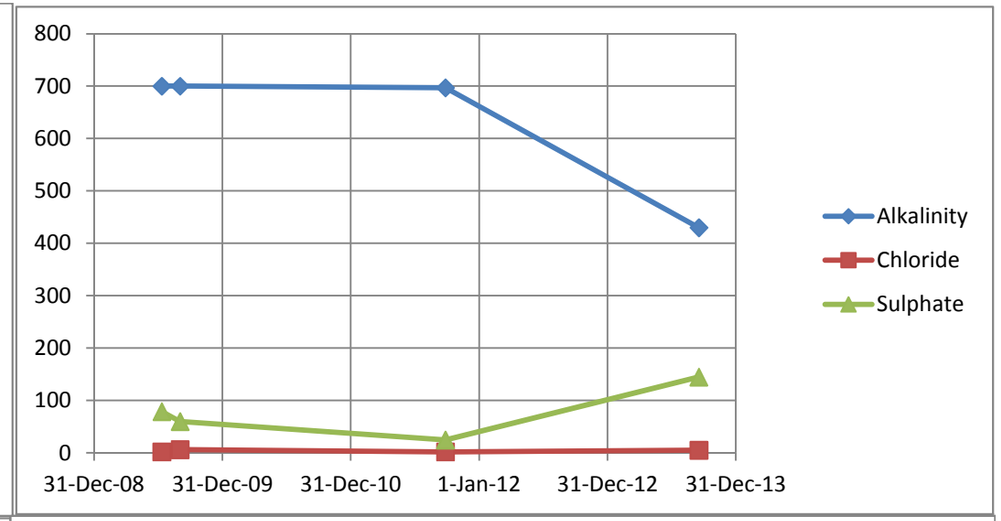

800
700
600
500
400
300
200
100
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Alkalinity
Chloride
Sulphate

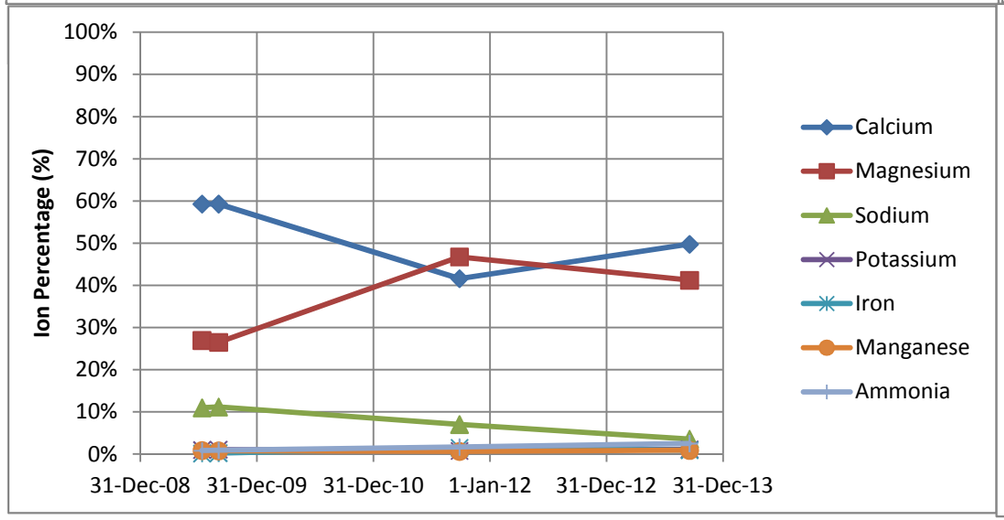

Ion Percentage (mg/L)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia

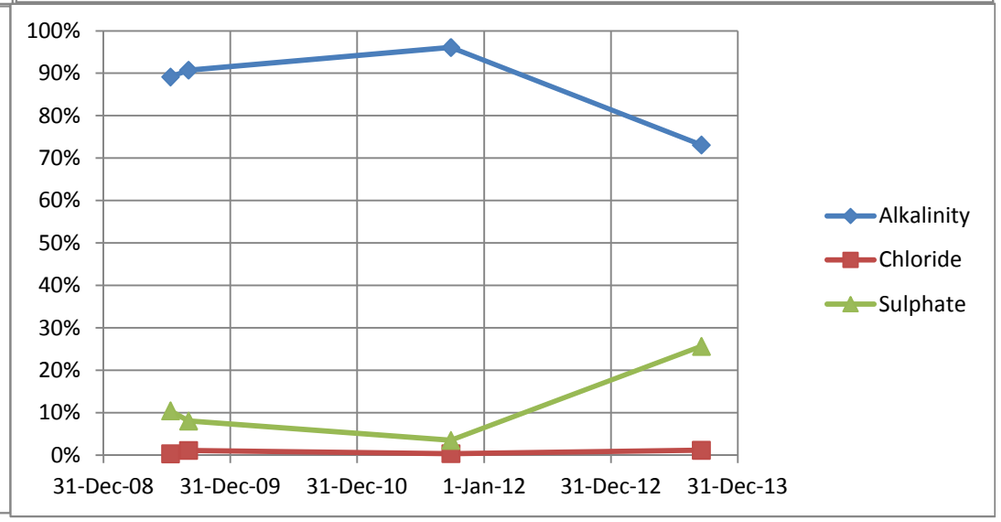

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Alkalinity
Chloride
Sulphate

MP09-11

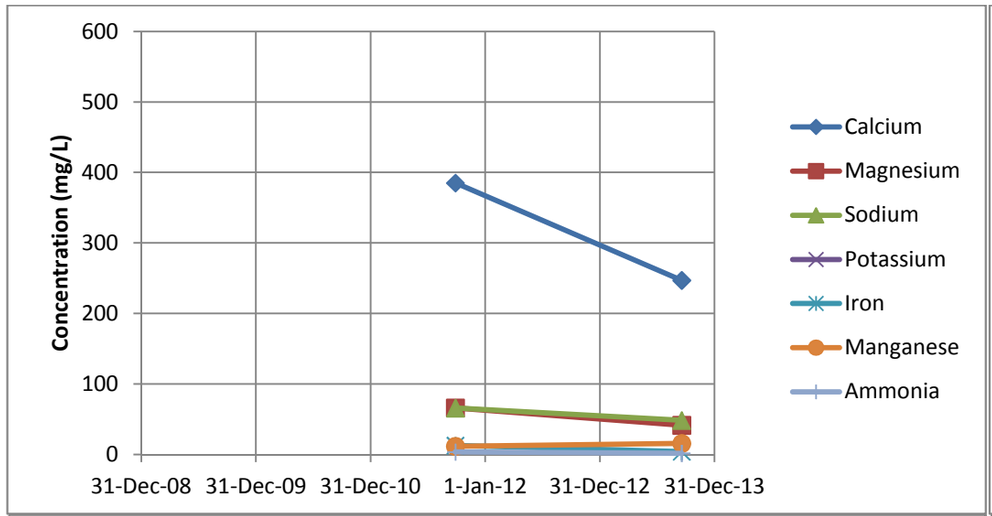

Concentration (mg/L)
200
180
160
140
120
100
80
60
40
20
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia

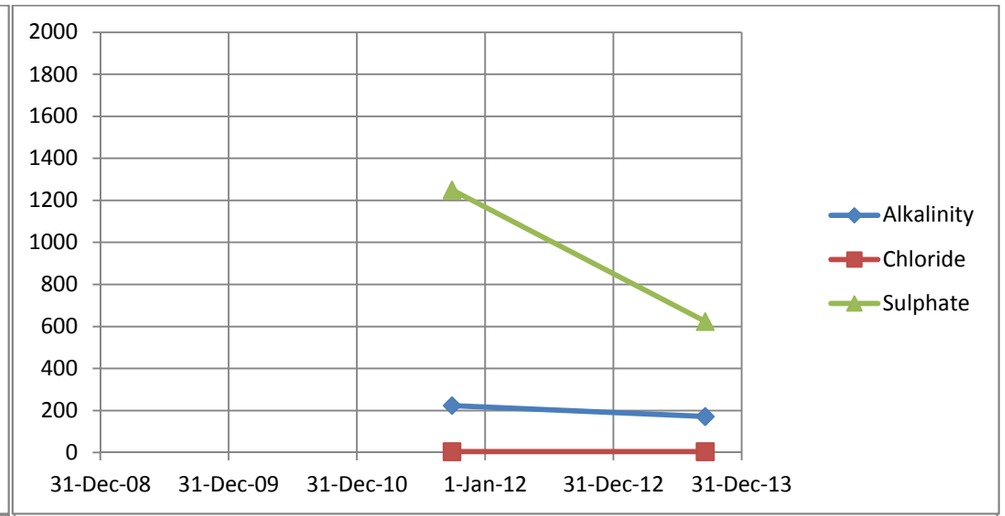

800
700
600
500
400
300
200
100
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Alkalinity
Chloride
Sulphate

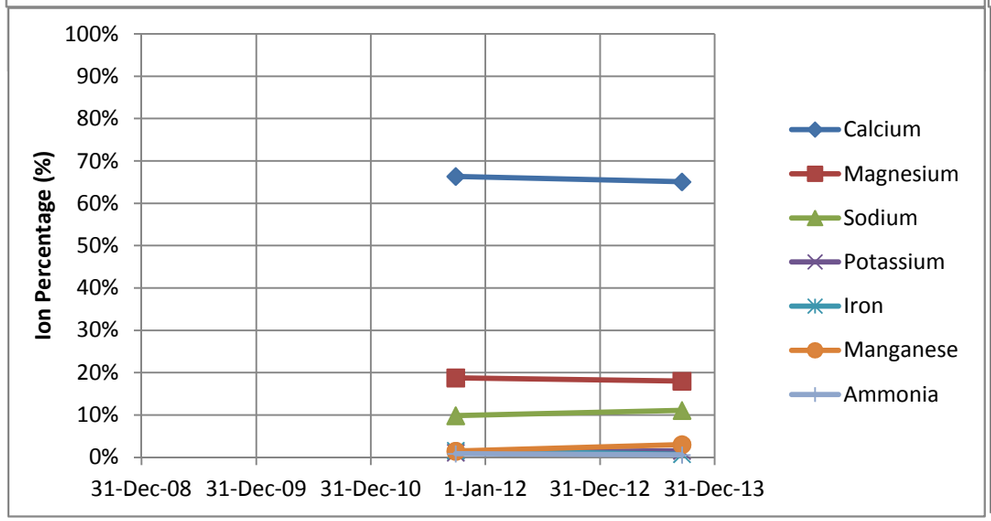

Ion Percentage (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia

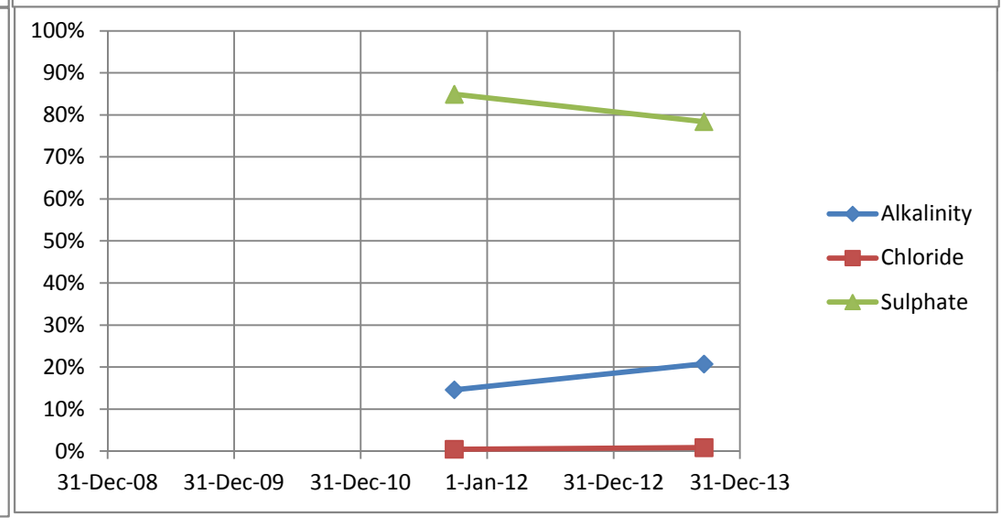

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Alkalinity
Chloride
Sulphate

MP09-12

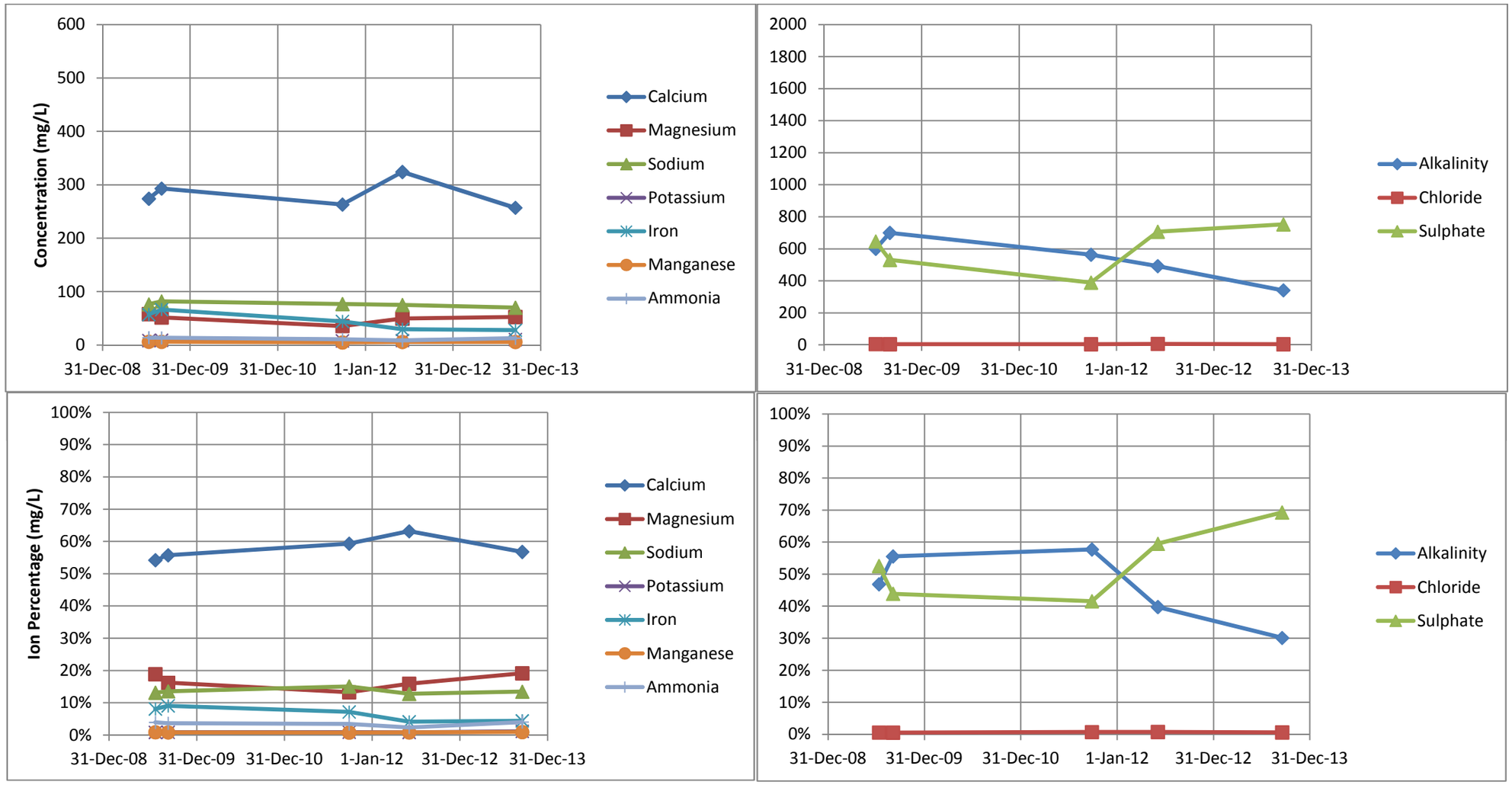

Concentration (mg/L)
600
500
400
300
200
100
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia


2000
1800
1600
1400
1200
1000
800
600
400
200
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Alkalinity
Chloride
Sulphate

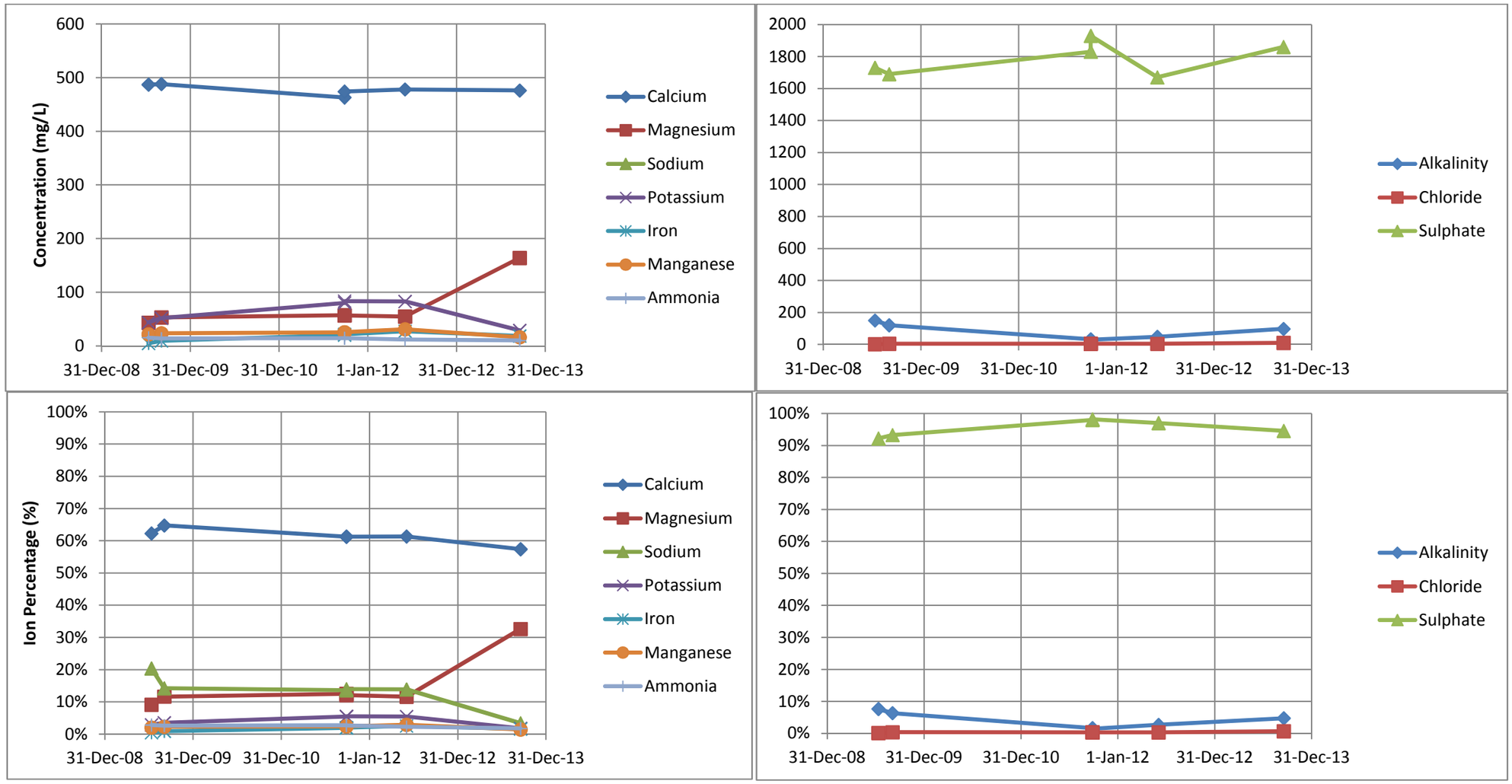

Ion Percentage (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Alkalinity
Chloride
Sulphate

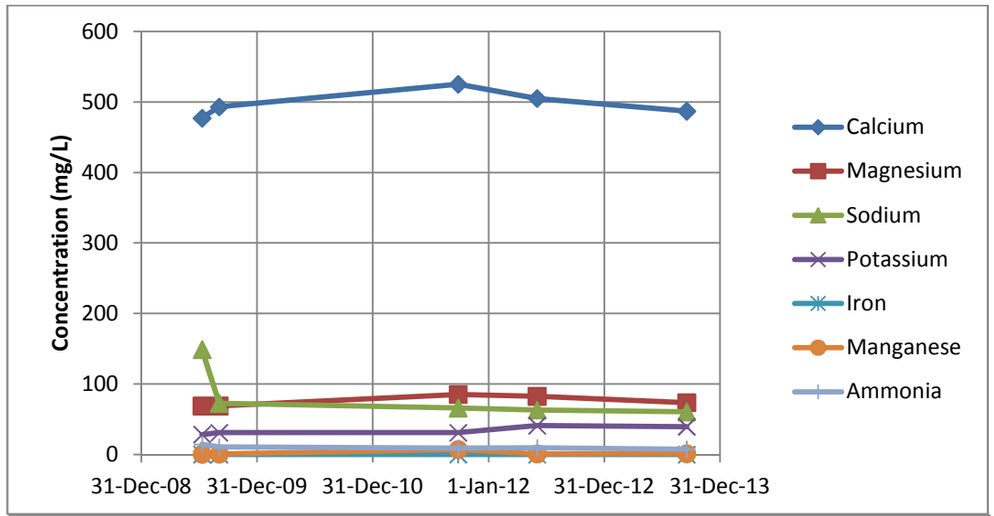
MW09-07

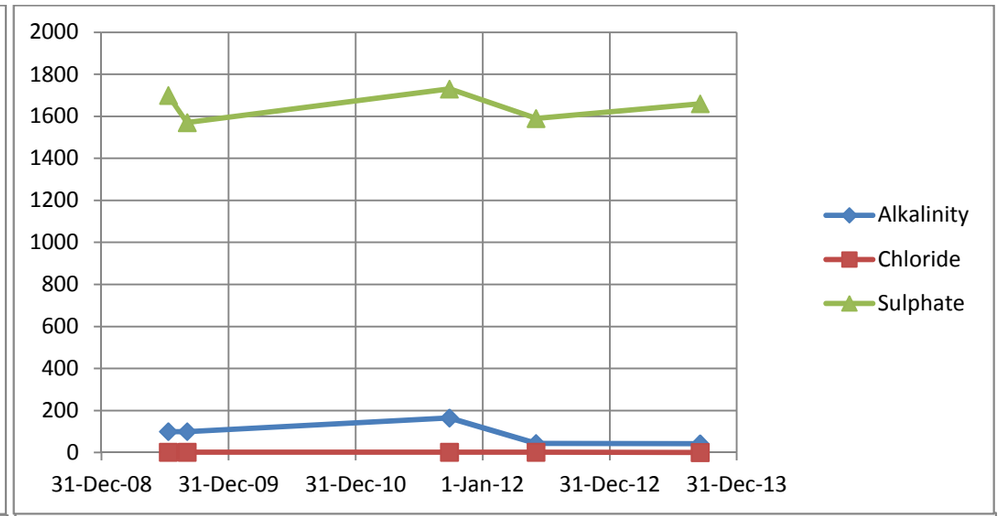

Concentration (mg/L)
600
500
400
300
200
100
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Alkalinity
Chloride
Sulphate
Ion Percentage (mg/L)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

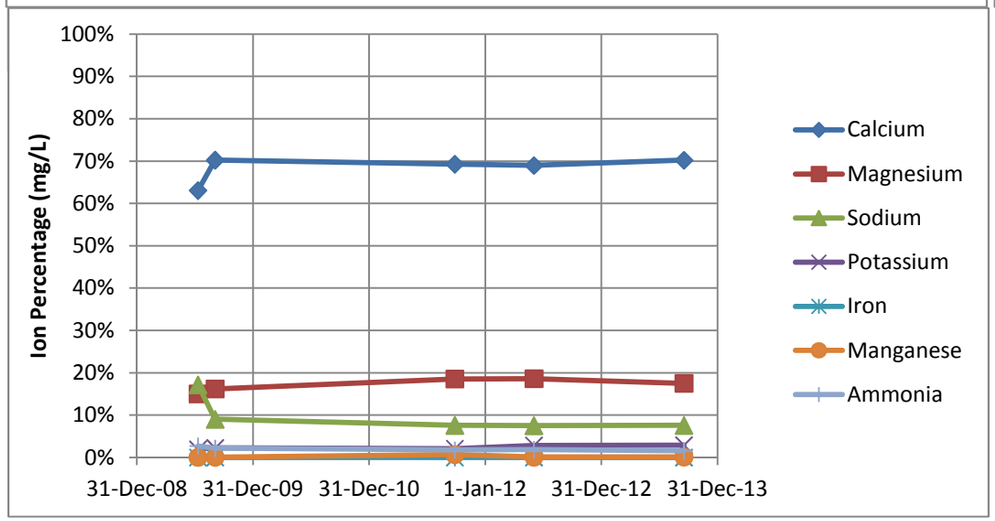
MW09-1

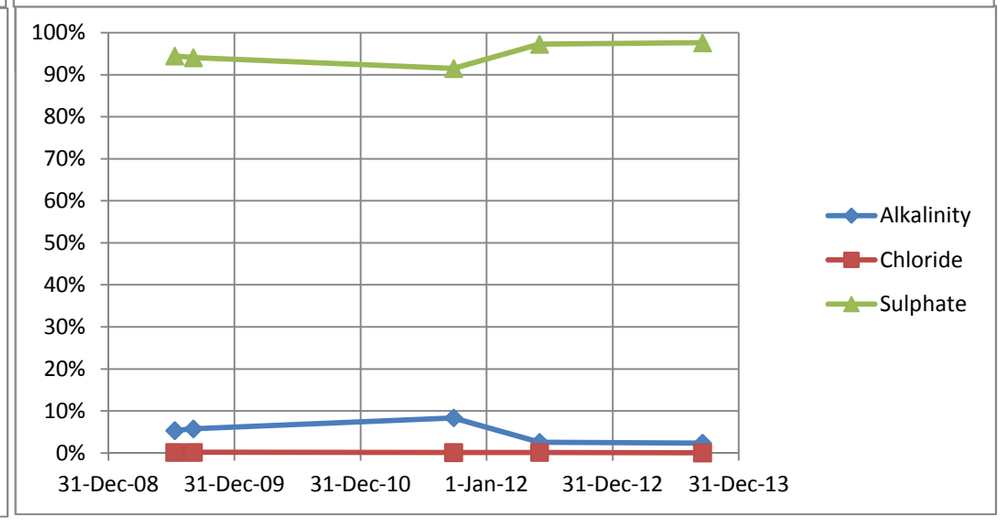

Concentration (mg/L)
600
500
400
300
200
100
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Alkalinity
Chloride
Sulphate
Ion Percentage (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

MW09-2

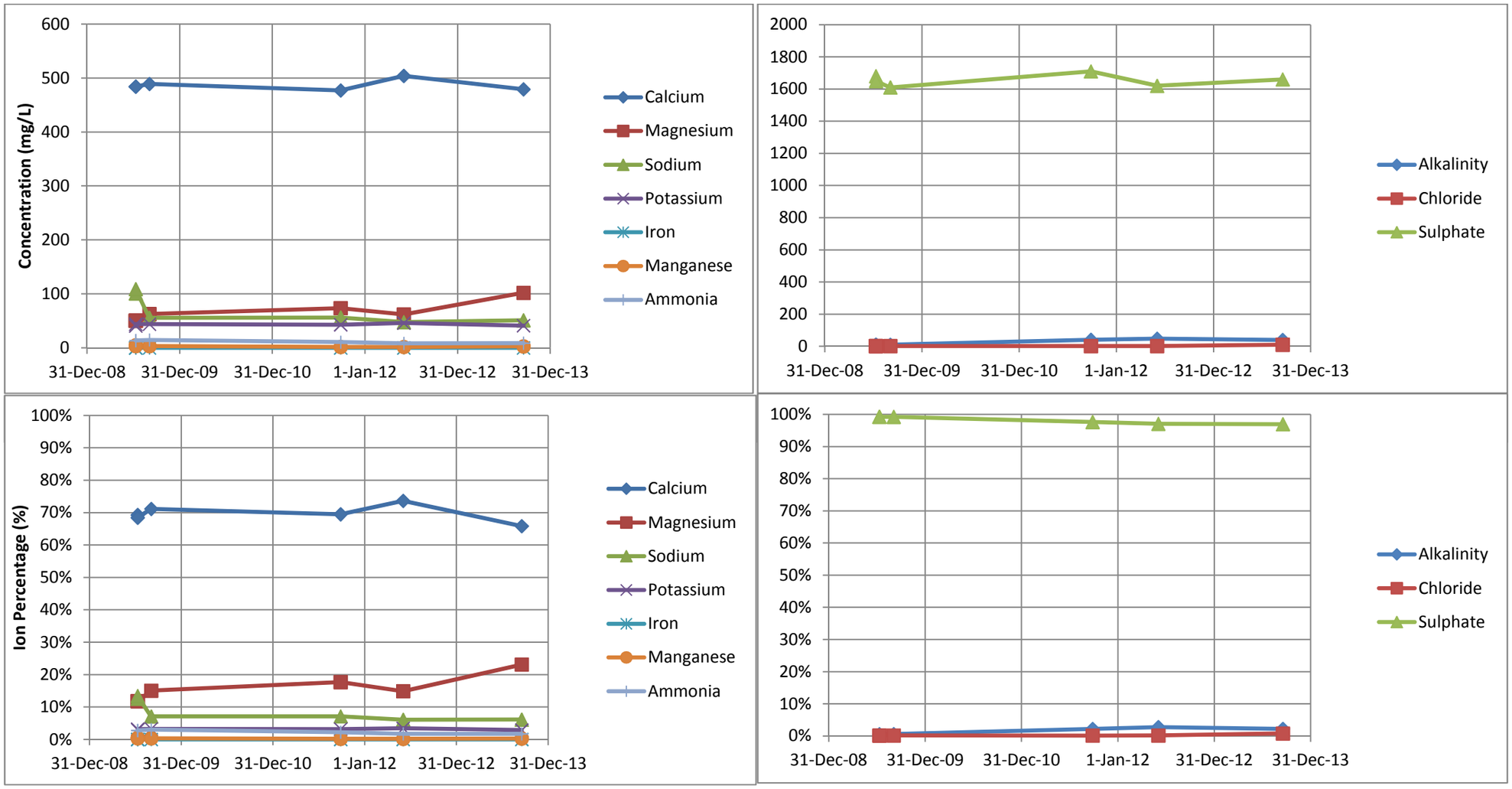

Concentration (mg/L)
600
500
400
300
200
100
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia


2000
1800
1600
1400
1200
1000
800
600
400
200
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Alkalinity
Chloride
Sulphate

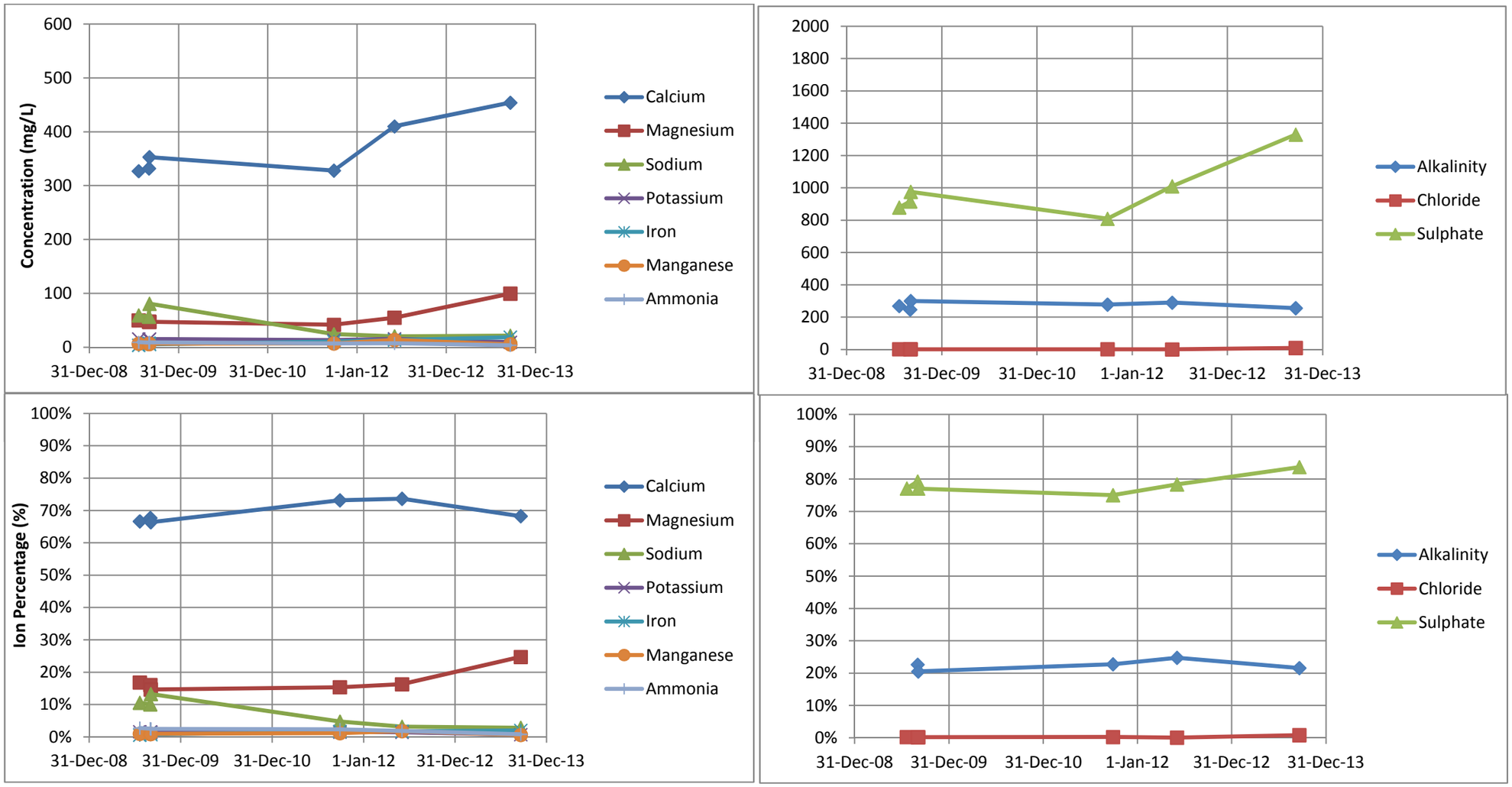

Ion Percentage (mg/L)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Alkalinity
Chloride
Sulphate

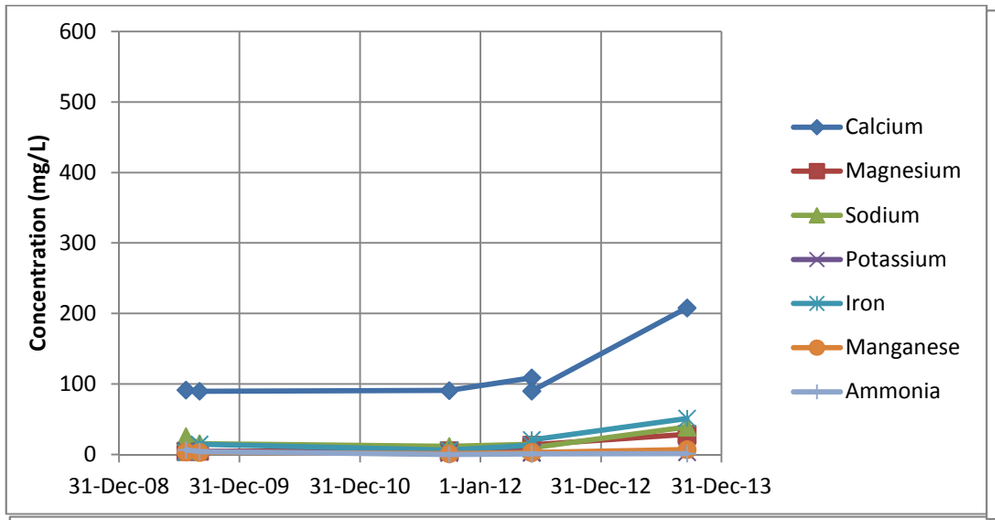
MW09-3

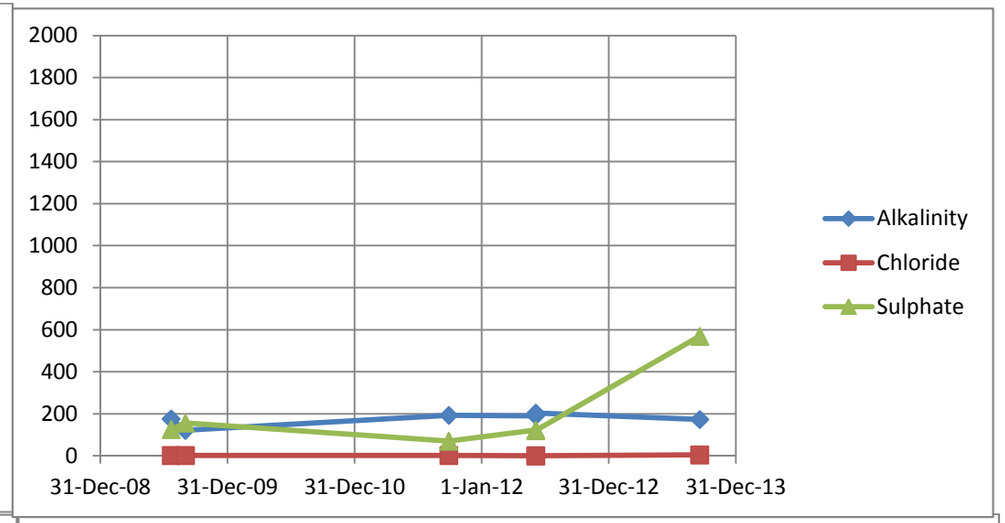

Concentration (mg/L)
600
500
400
300
200
100
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Alkalinity
Chloride
Sulphate
Ion Percentage (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

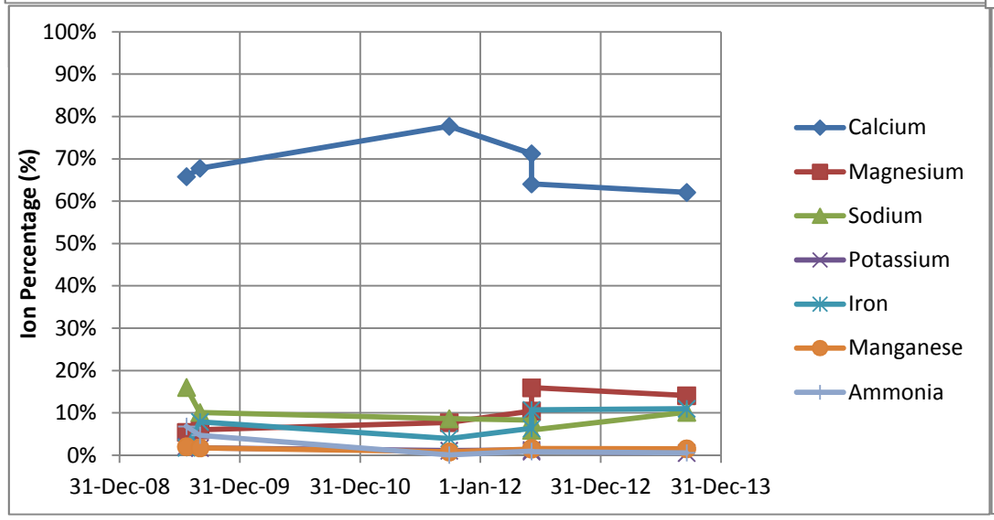
MW09-4

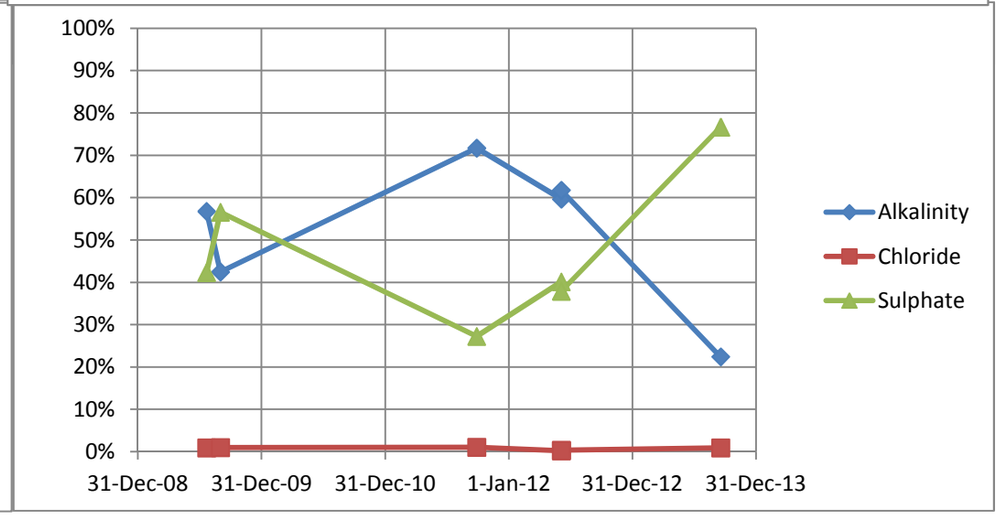

Concentration (mg/L)
600
500
400
300
200
100
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Alkalinity
Chloride
Sulphate
Ion Percentage (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

MW09-23

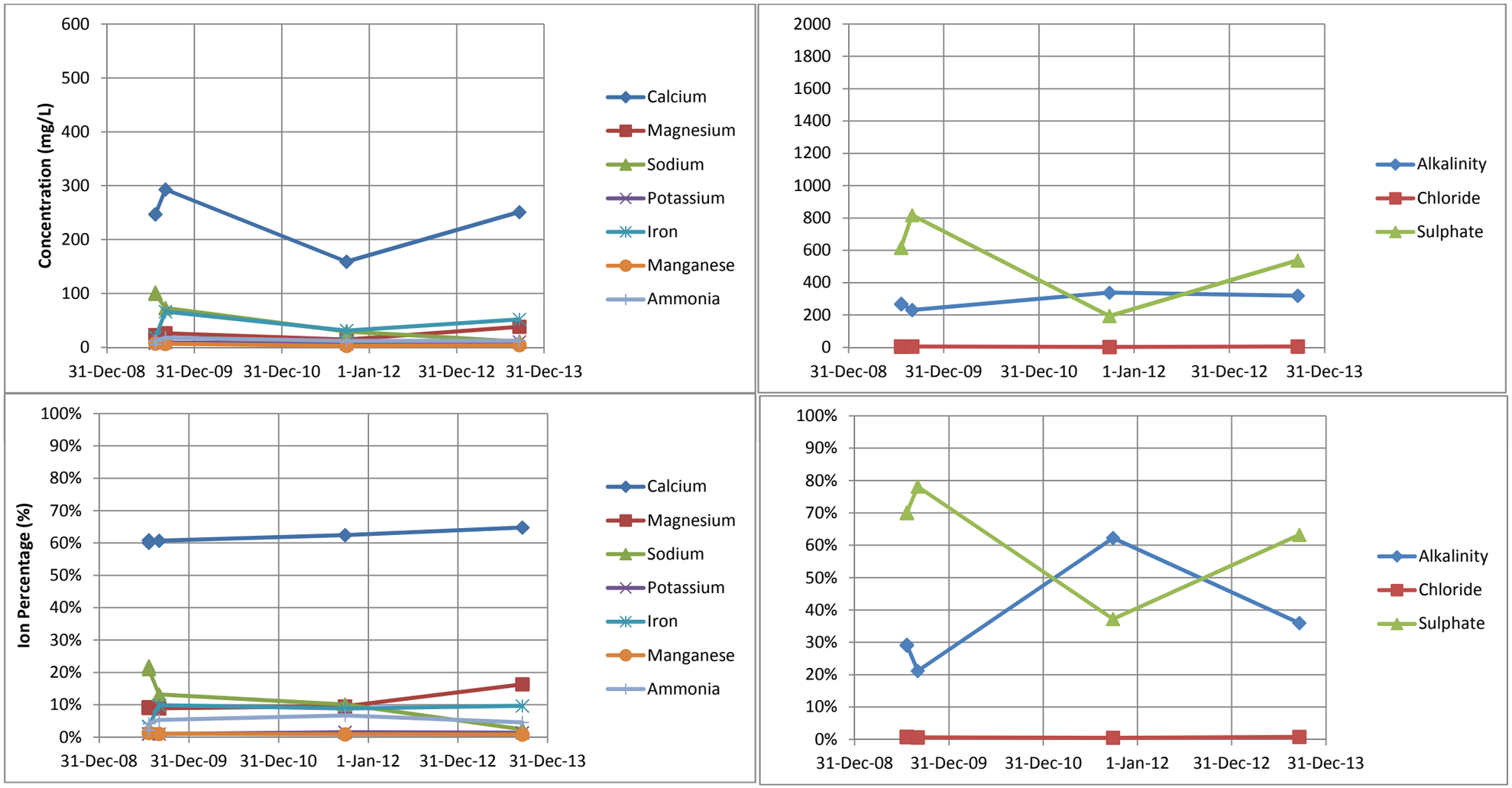

600
500
400
300
200
100
0
Concentration (mg/L)
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia


2000
1800
1600
1400
1200
1000
800
600
400
200
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Alkalinity
Chloride
Sulphate

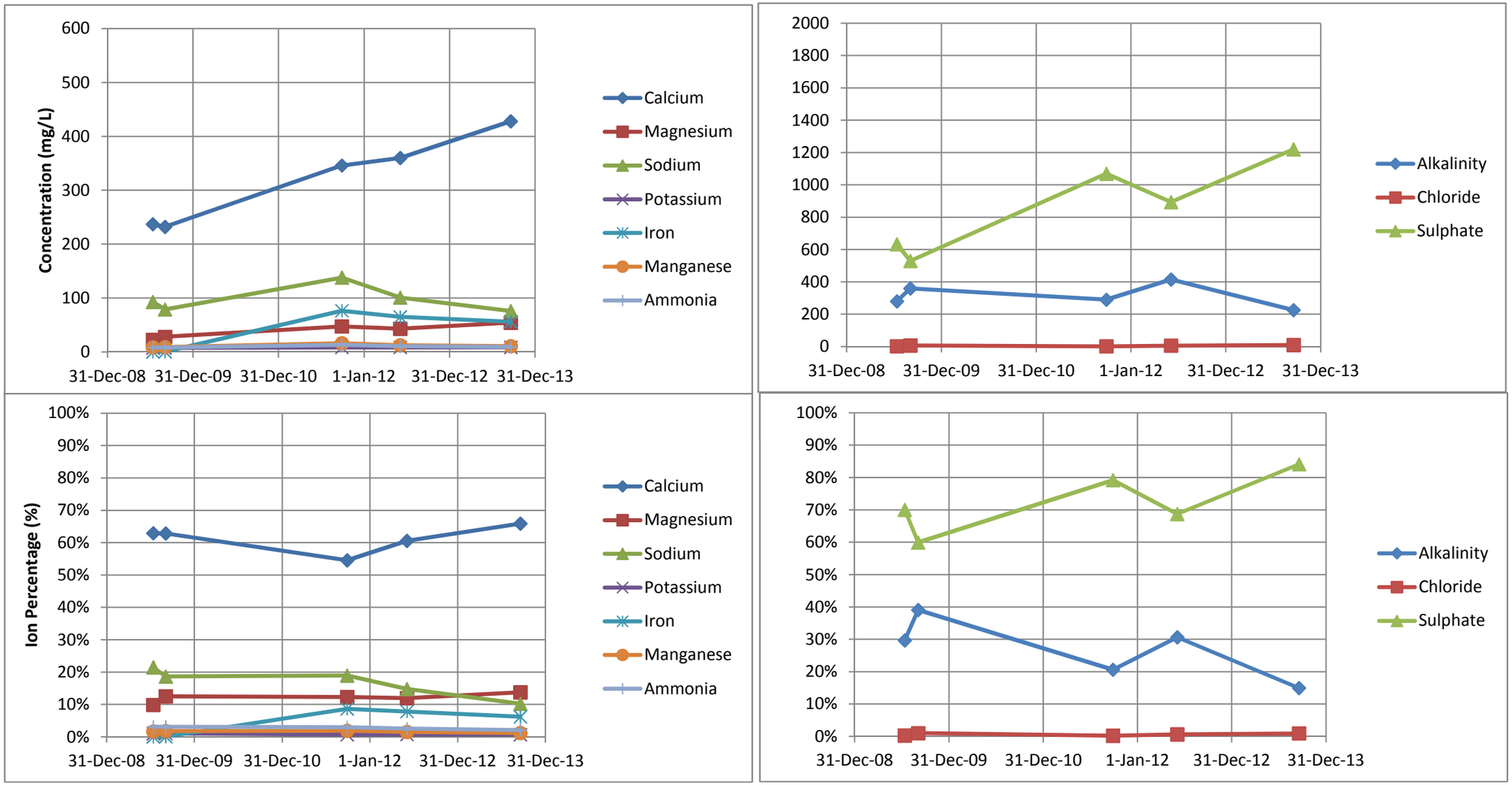

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Ion Percentage (%)
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Alkalinity
Chloride
Sulphate

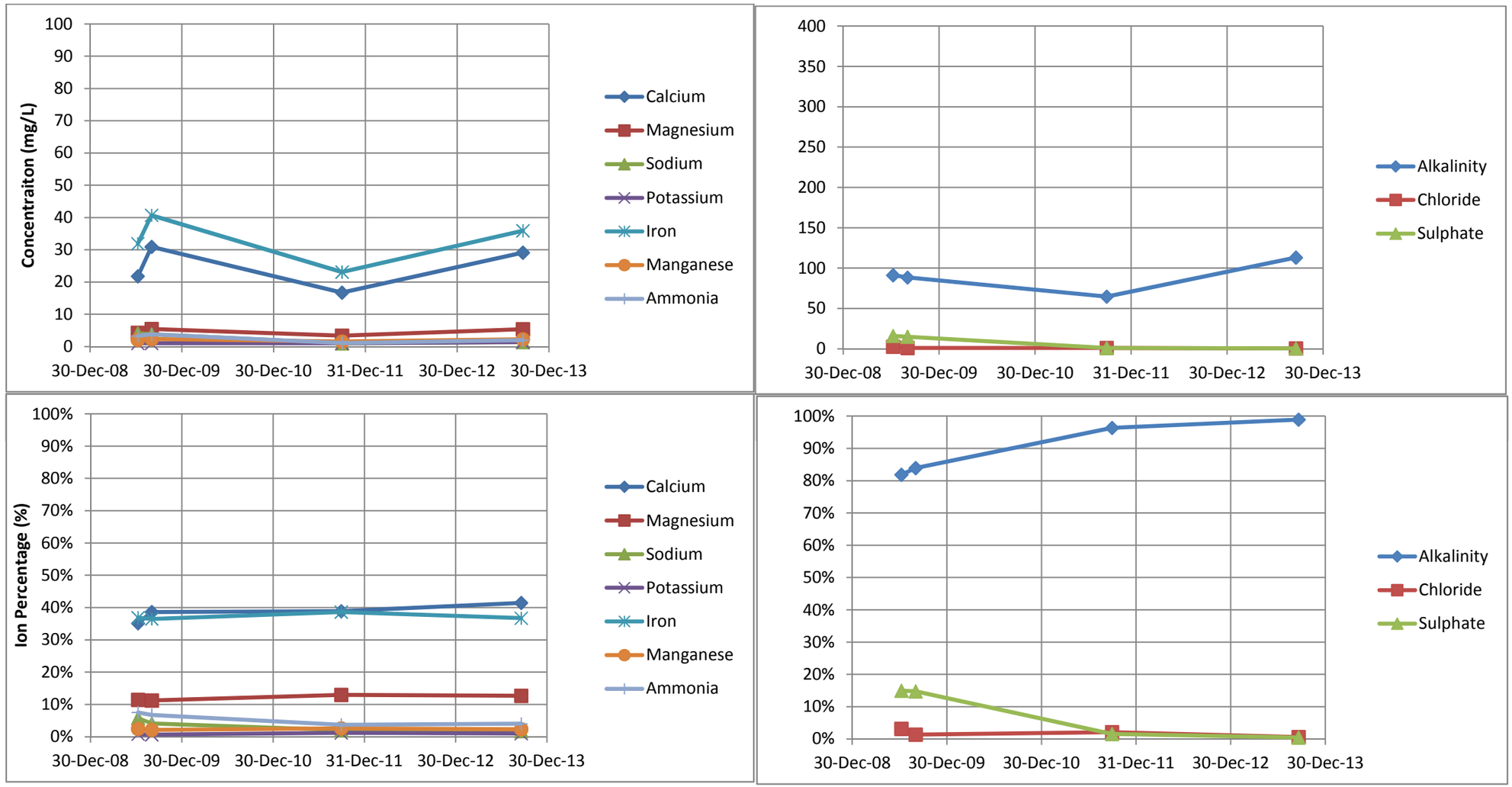
MW09-22


Concentration (mg/L)
600
500
400
300
200
100
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Alkalinity
Chloride
Sulphate
Ion Percentage (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

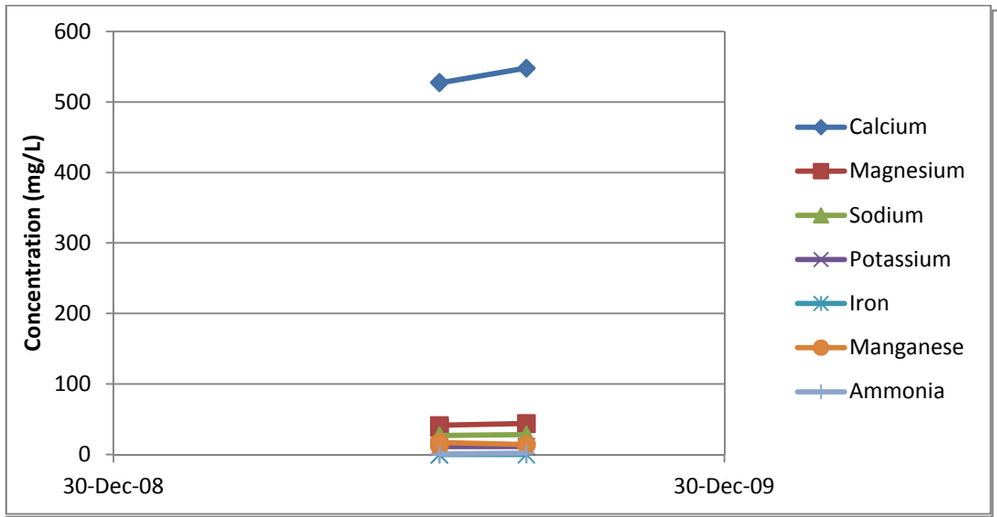
MW09-21

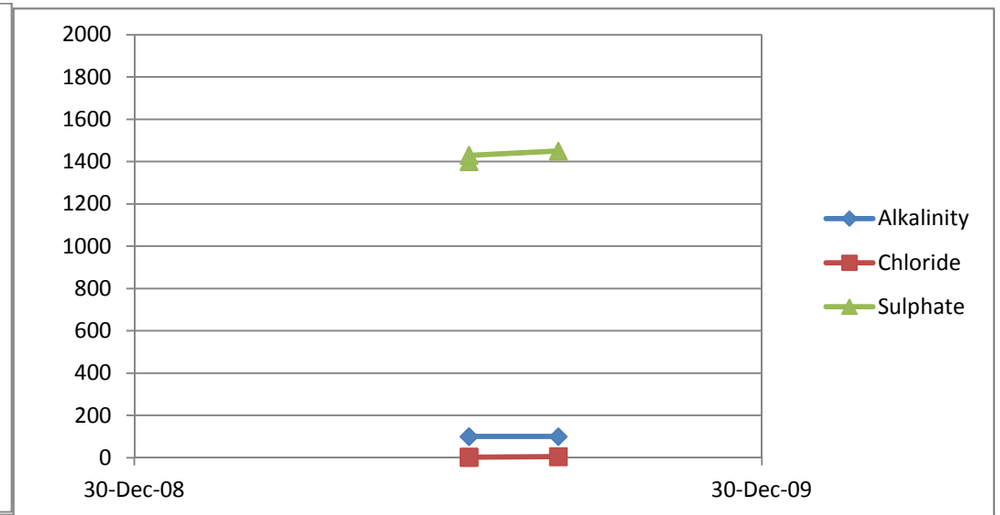

Concentration (mg/L)
600
500
400
300
200
100
0
31-Dec-08
31-Dec-09
31-Dec-10
1-Jan-12
31-Dec-12
31-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Alkalinity
Chloride
Sulphate
Ion Percentage (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

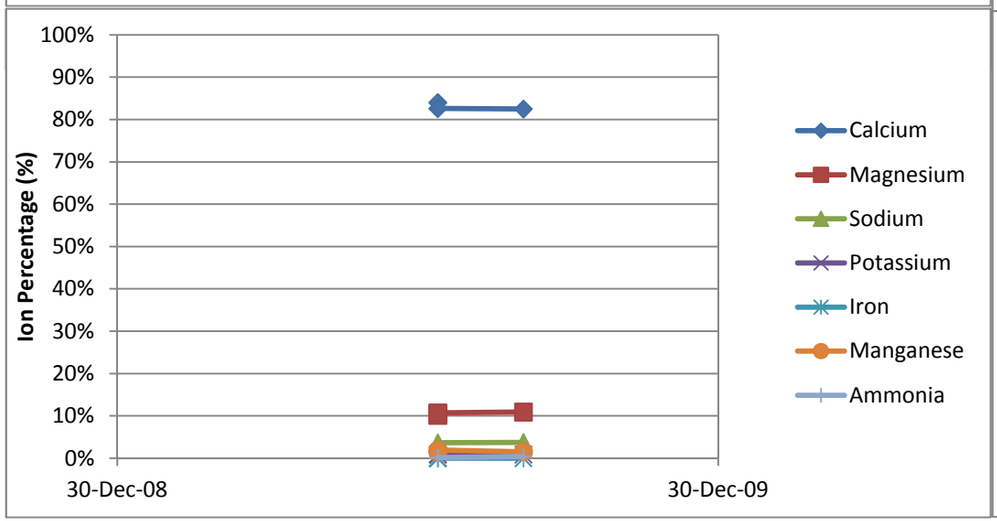
MP09-5

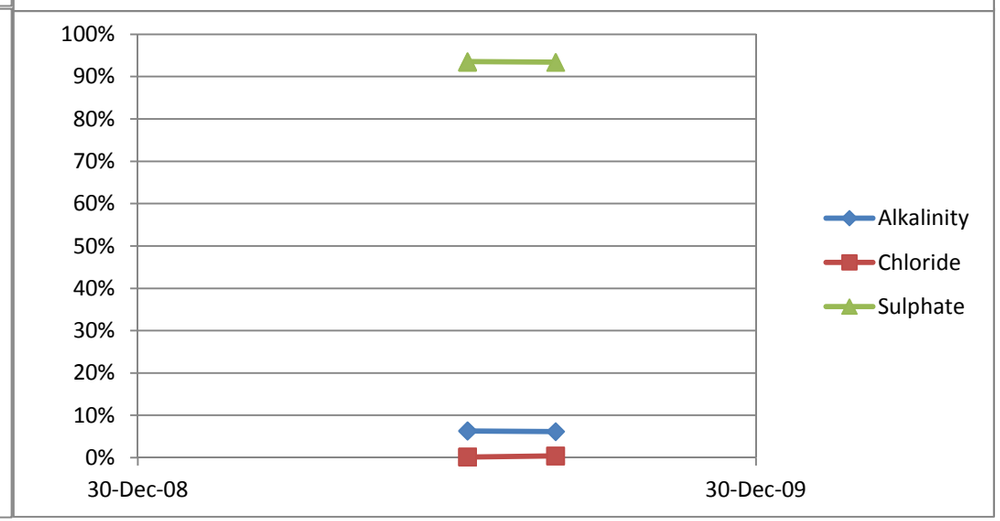

Concentraiton (mg/L)
100
90
80
70
60
50
40
30
20
10
0
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia
400
350
300
250
200
150
100
50
0
Alkalinity
Chloride
Sulphate
Ion Percentage (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

MW09-08

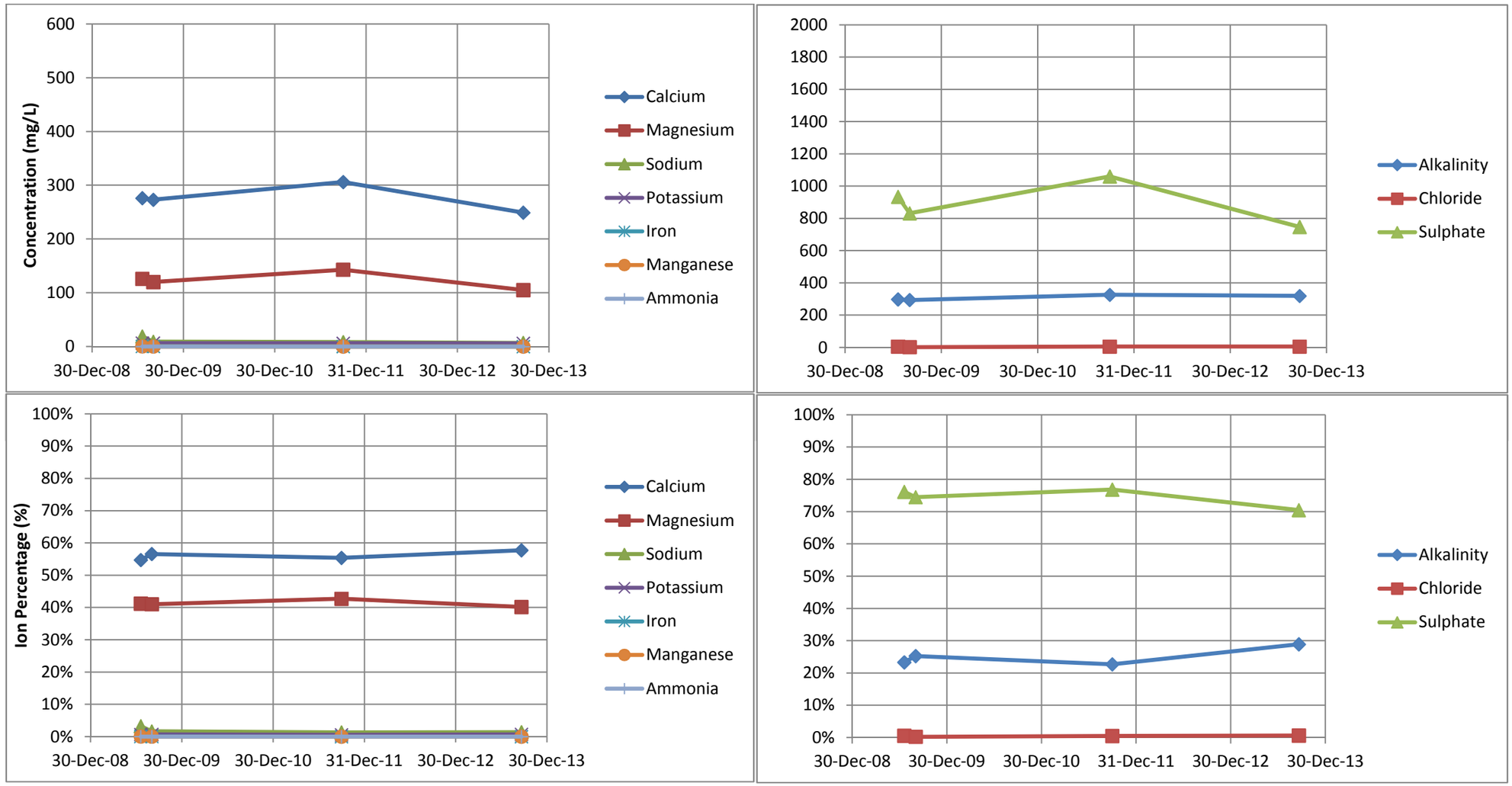

600
500
400
300
200
100
0
Concentration (mg/L)
30-Dec-08
30-Dec-09
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia


2000
1800
1600
1400
1200
1000
800
600
400
200
0
30-Dec-08
30-Dec-09
Alkalinity
Chloride
Sulphate

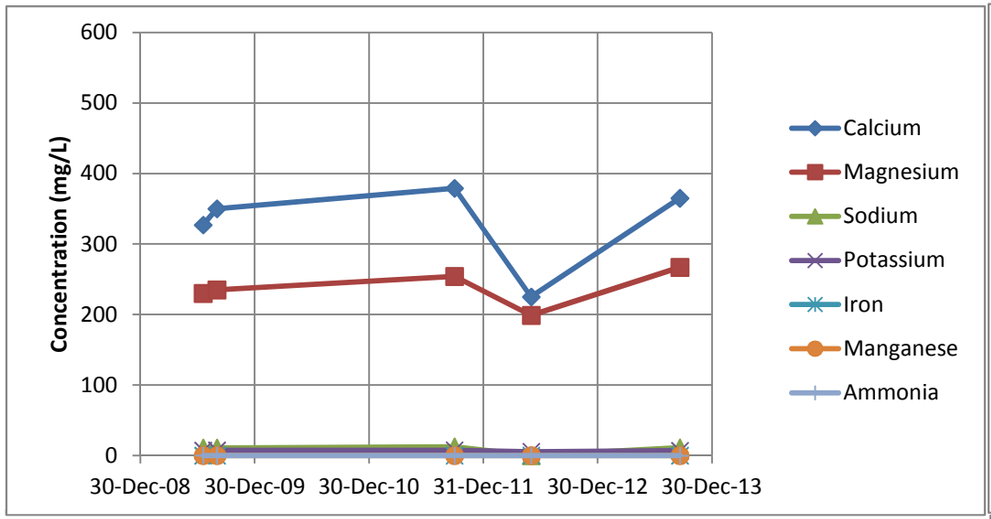

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Ion Percentage (%)
30-Dec-08
30-Dec-09
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia

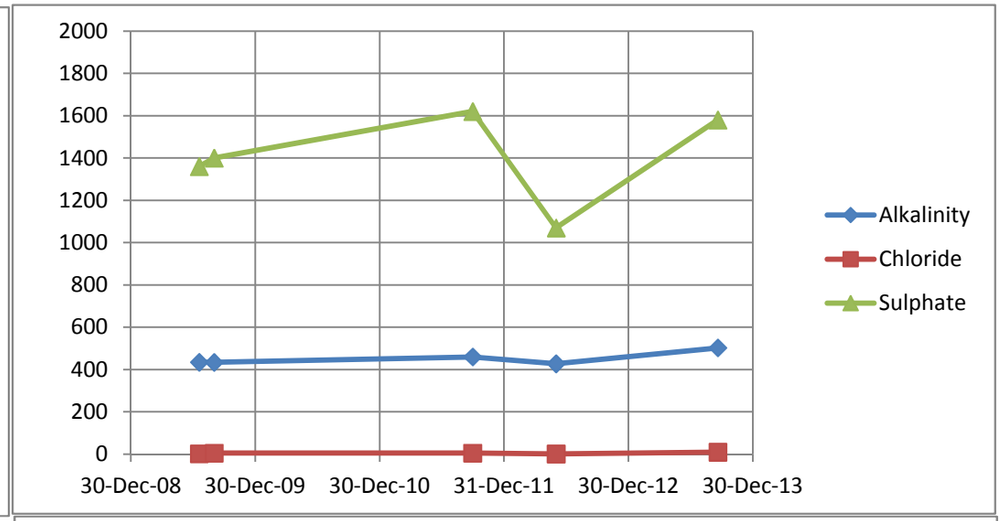

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
30-Dec-08
30-Dec-09
Alkalinity
Chloride
Sulphate

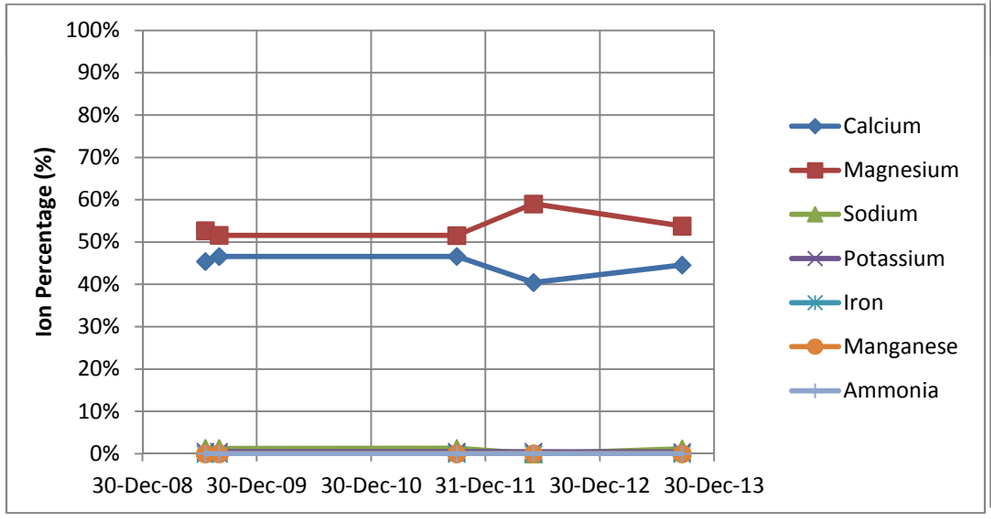
MW09-6

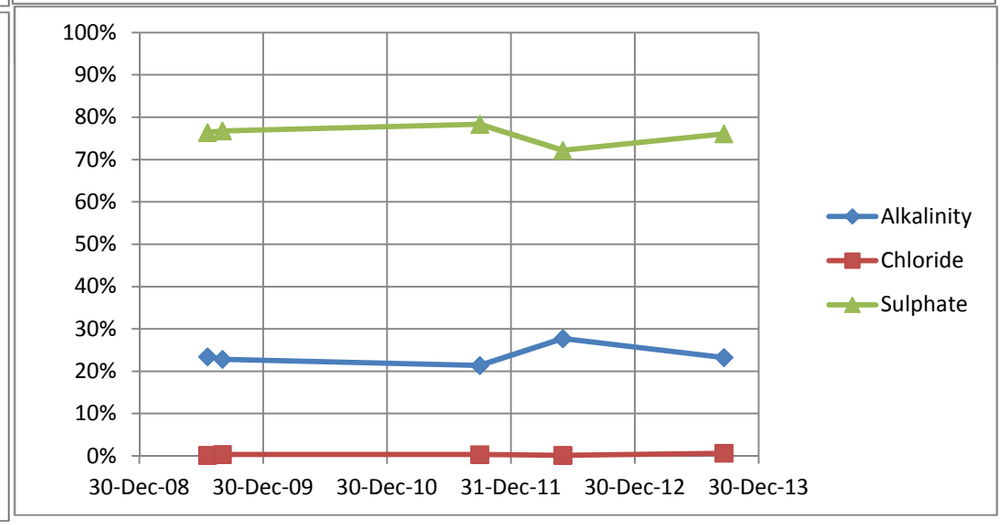

Concentration (mg/L)
600
500
400
300
200
100
0
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Alkalinity
Chloride
Sulphate
Ion Percentage (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

MW09-16

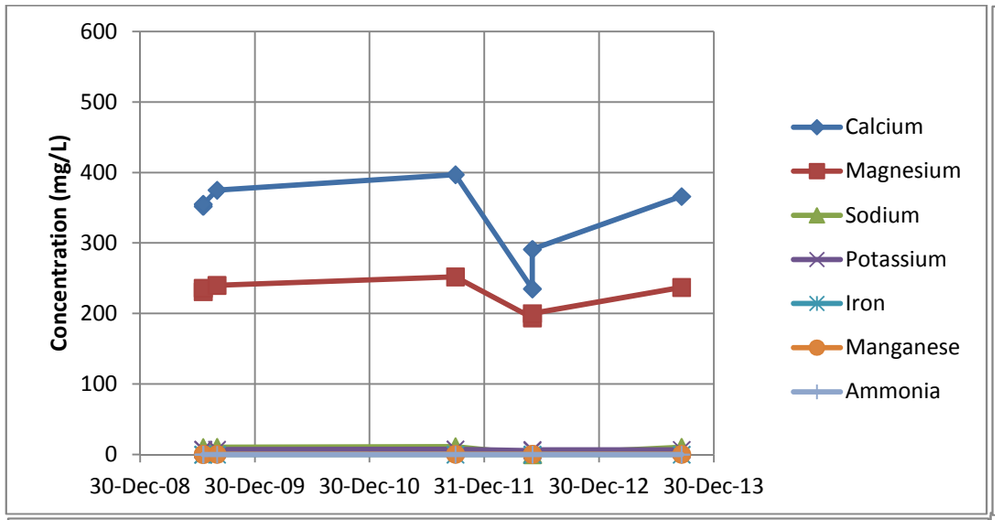

Concentration (mg/L)
600
500
400
300
200
100
0
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia

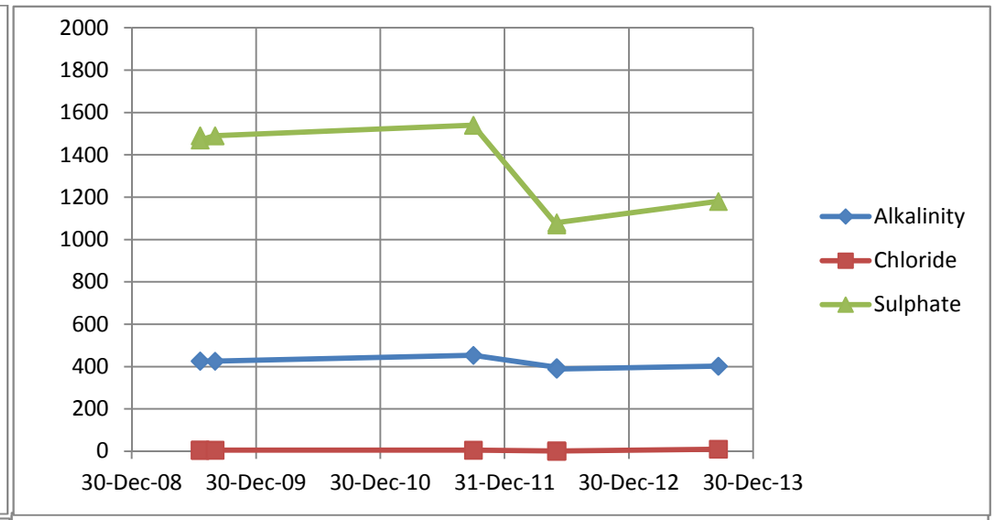

2000
1800
1600
1400
1200
1000
800
600
400
200
0
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Alkalinity
Chloride
Sulphate

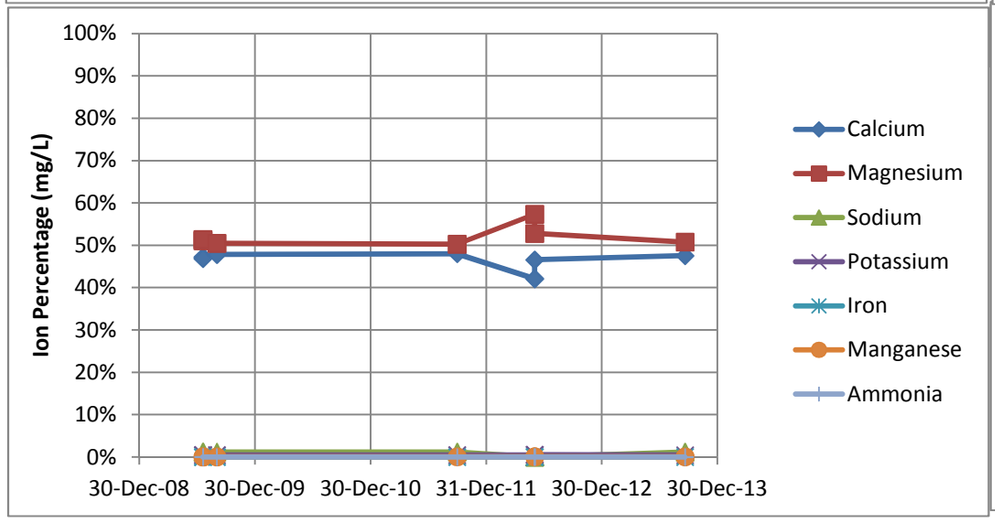

Ion Percentage (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia

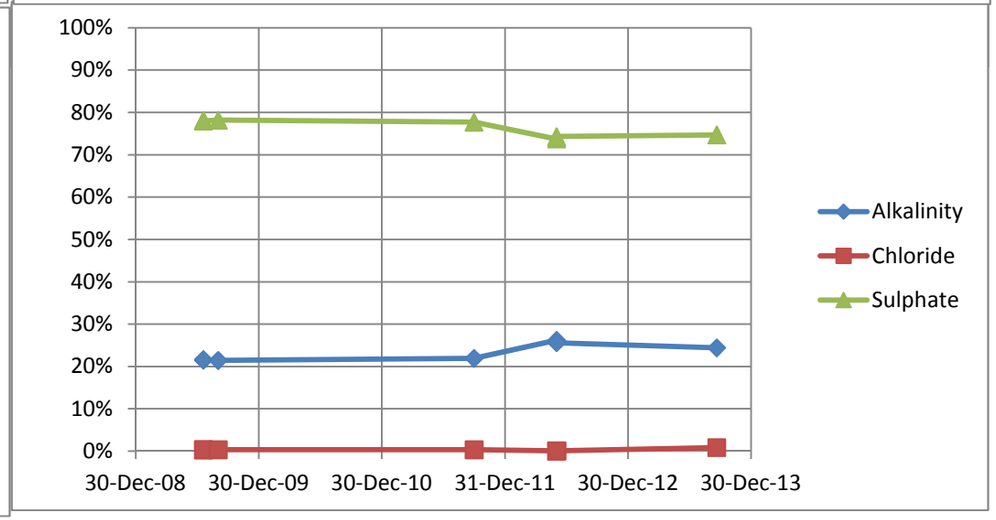

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Alkalinity
Chloride
Sulphate

MW09-17

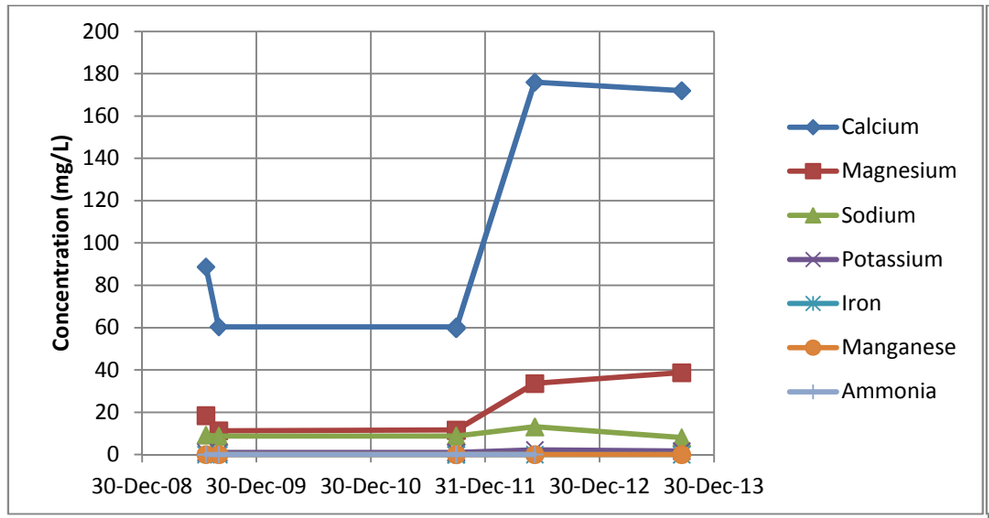

Concentration (mg/L)
600
500
400
300
200
100
0
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia

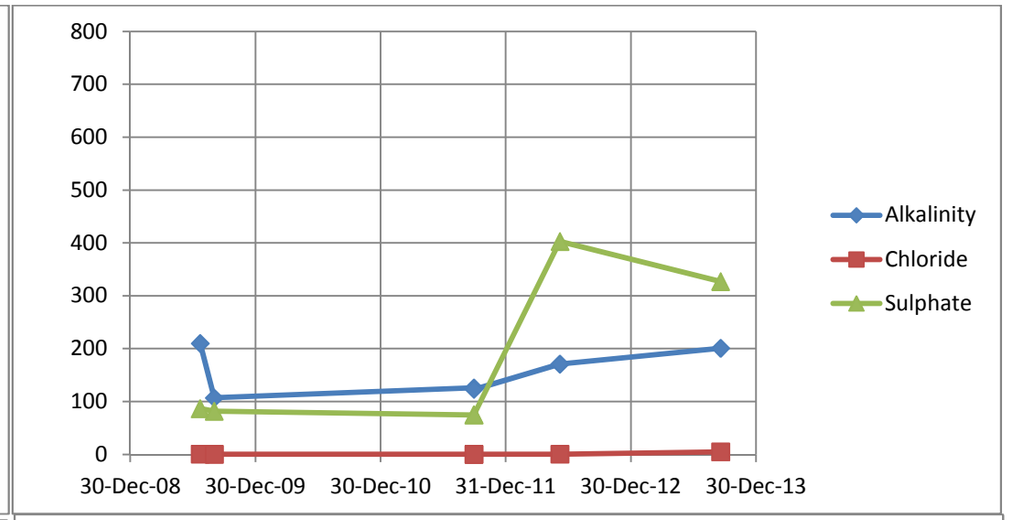

2000
1800
1600
1400
1200
1000
800
600
400
200
0
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Alkalinity
Chloride
Sulphate

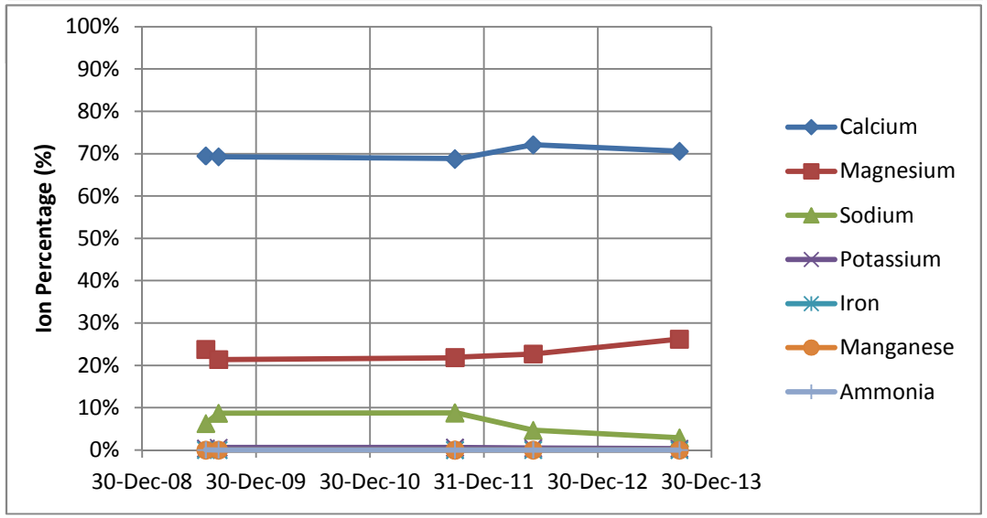

Ion Percentage (mg/L)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia

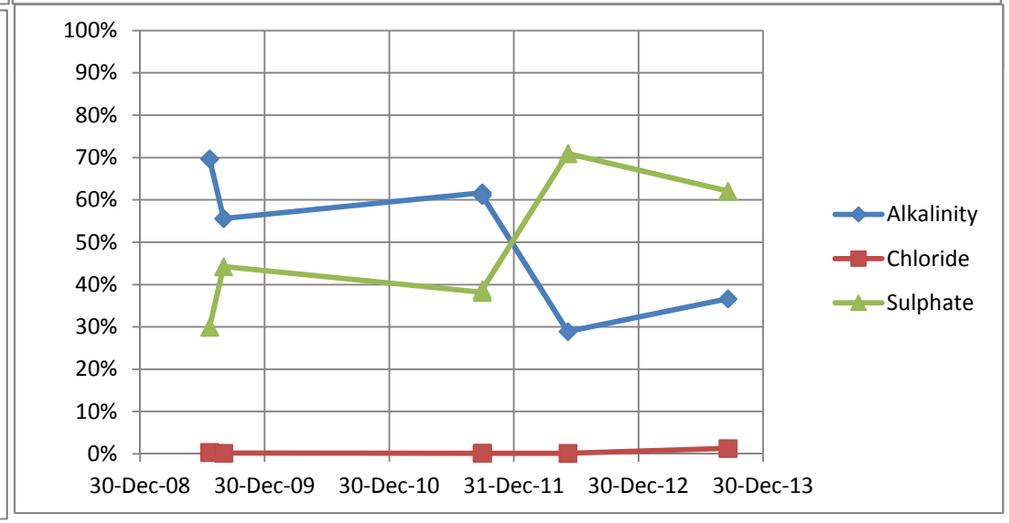

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Alkalinity
Chloride
Sulphate

MW09-18

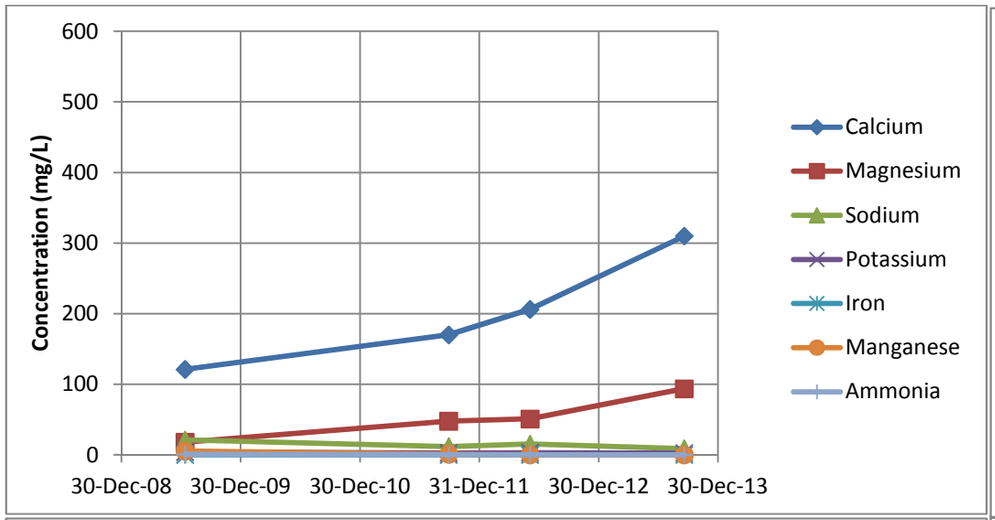

Concentration (mg/L)
200
180
160
140
120
100
80
60
40
20
0
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia

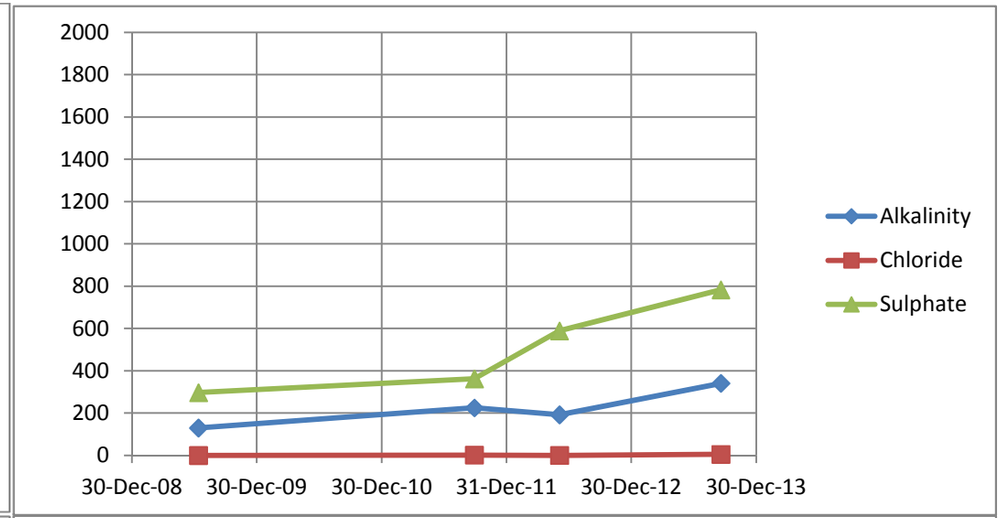

800
700
600
500
400
300
200
100
0
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Alkalinity
Chloride
Sulphate

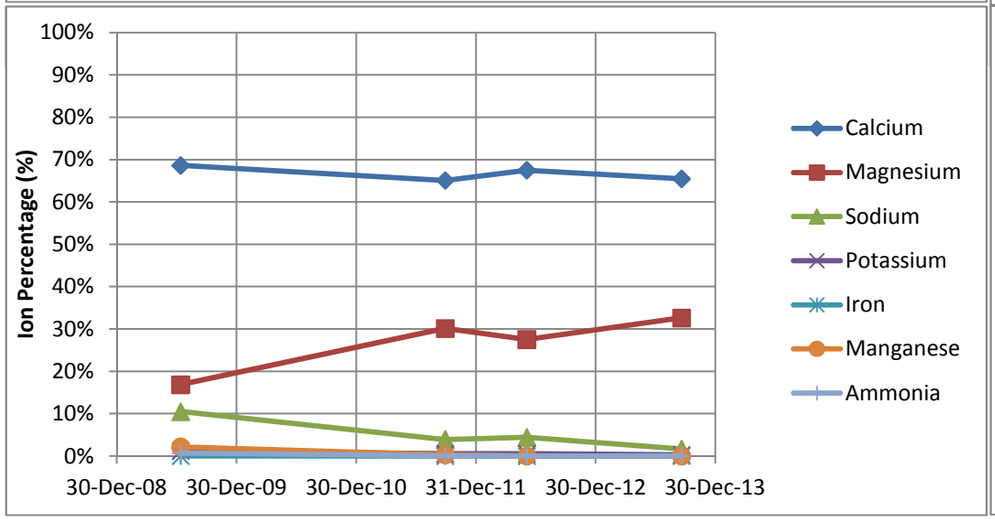

Ion Percentage (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia

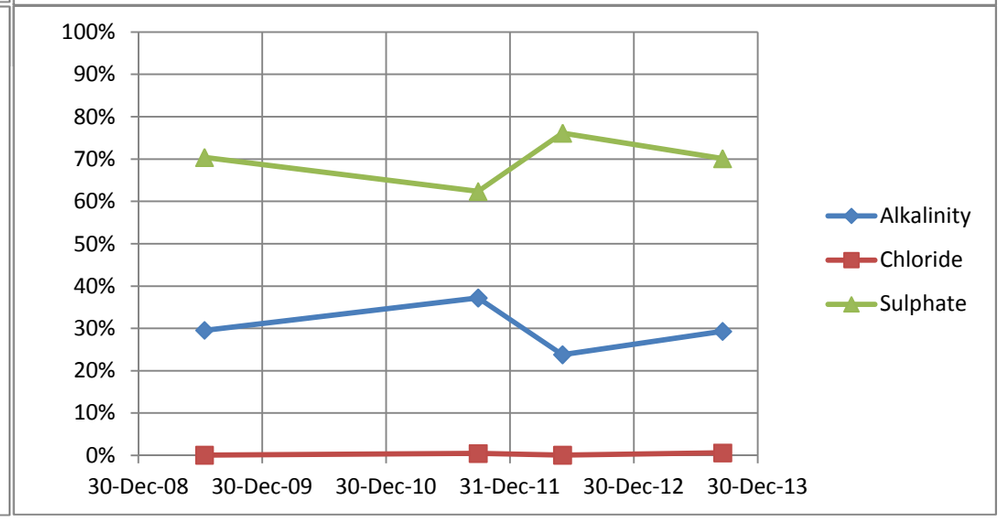

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Alkalinity
Chloride
Sulphate

MW09-24


600
500
400
300
200
100
0
Concentration (mg/L)
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia


2000
1800
1600
1400
1200
1000
800
600
400
200
0
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Alkalinity
Chloride
Sulphate


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Ion Percentage (%)
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Calcium
Magnesium
Sodium
Potassium
Iron
Manganese
Ammonia


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
30-Dec-08
30-Dec-09
30-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
Alkalinity
Chloride
Sulphate

MP09-04

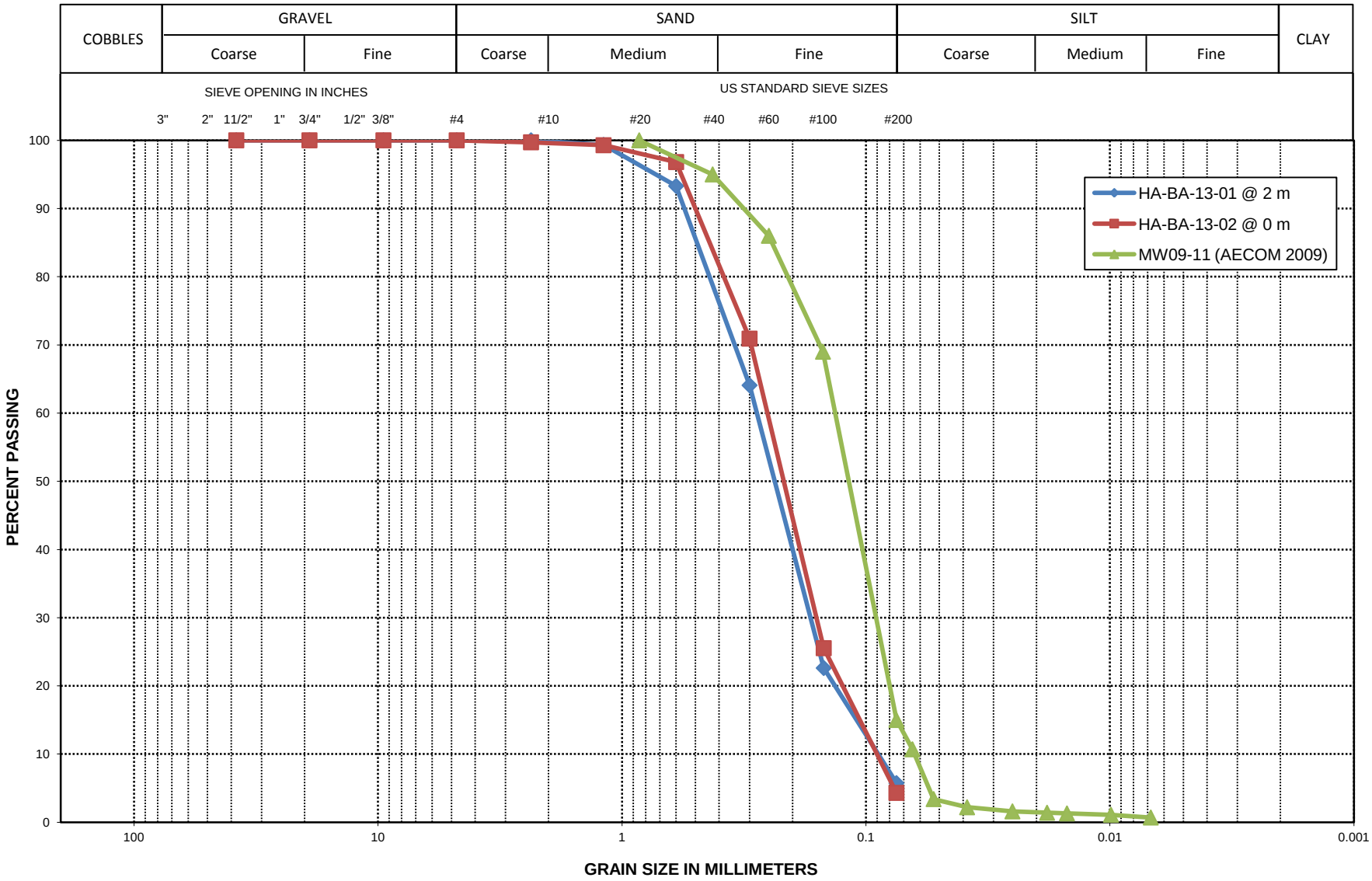
APPENDIX E

Geotechnical Data and Information

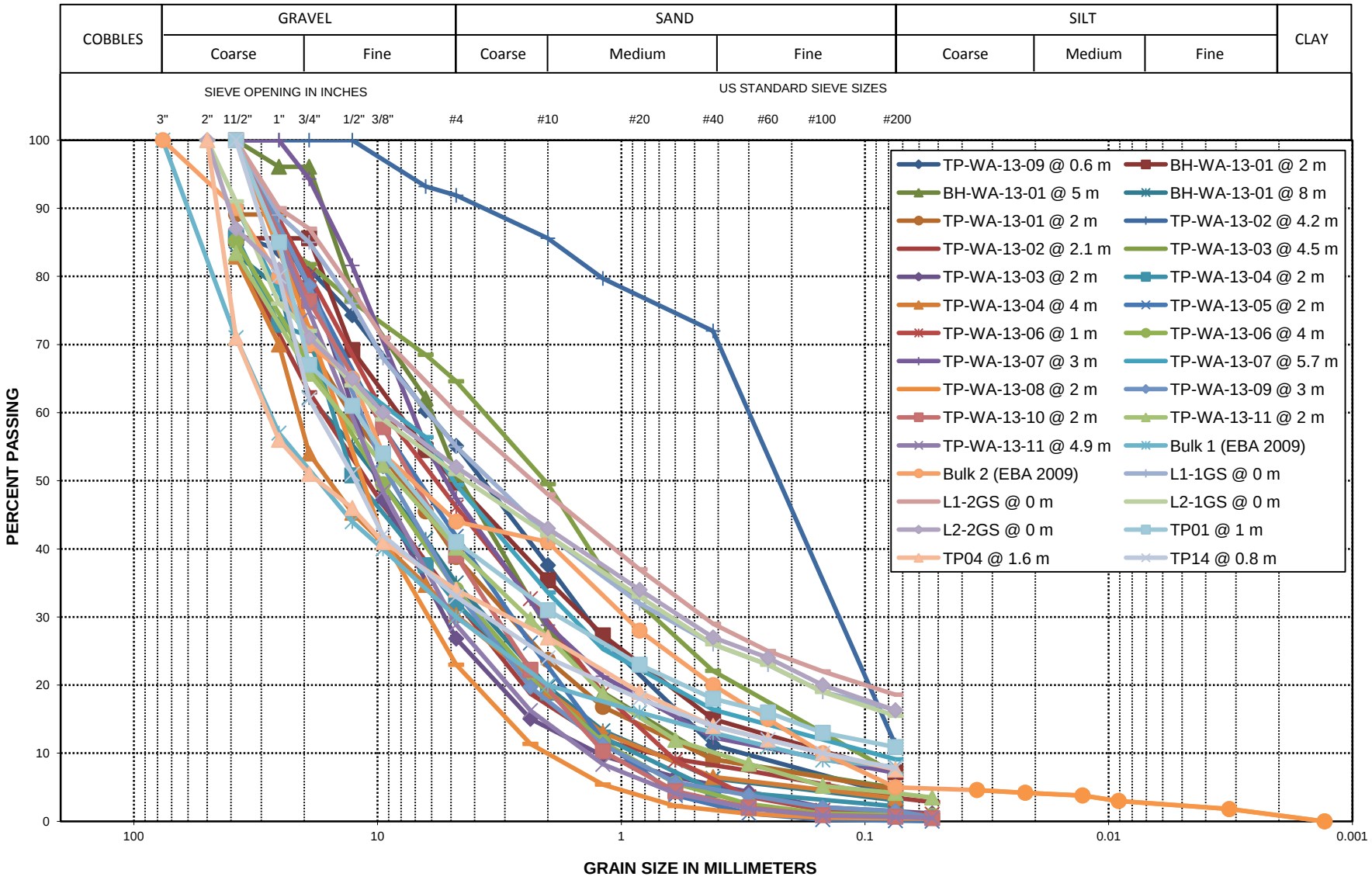
APPENDIX E1

Lab Testing Summary

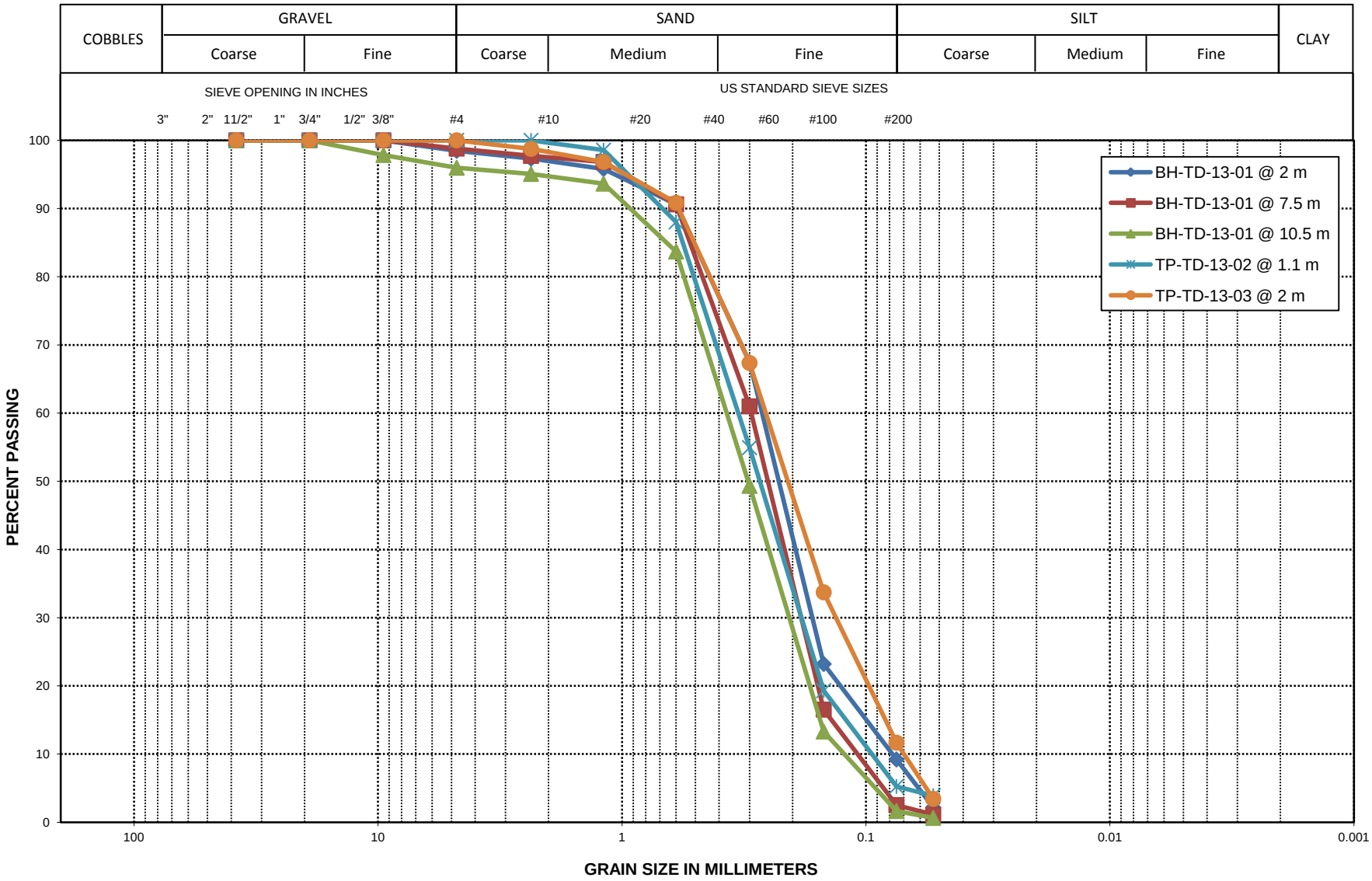
Borrow Area - Sand Sieve Results



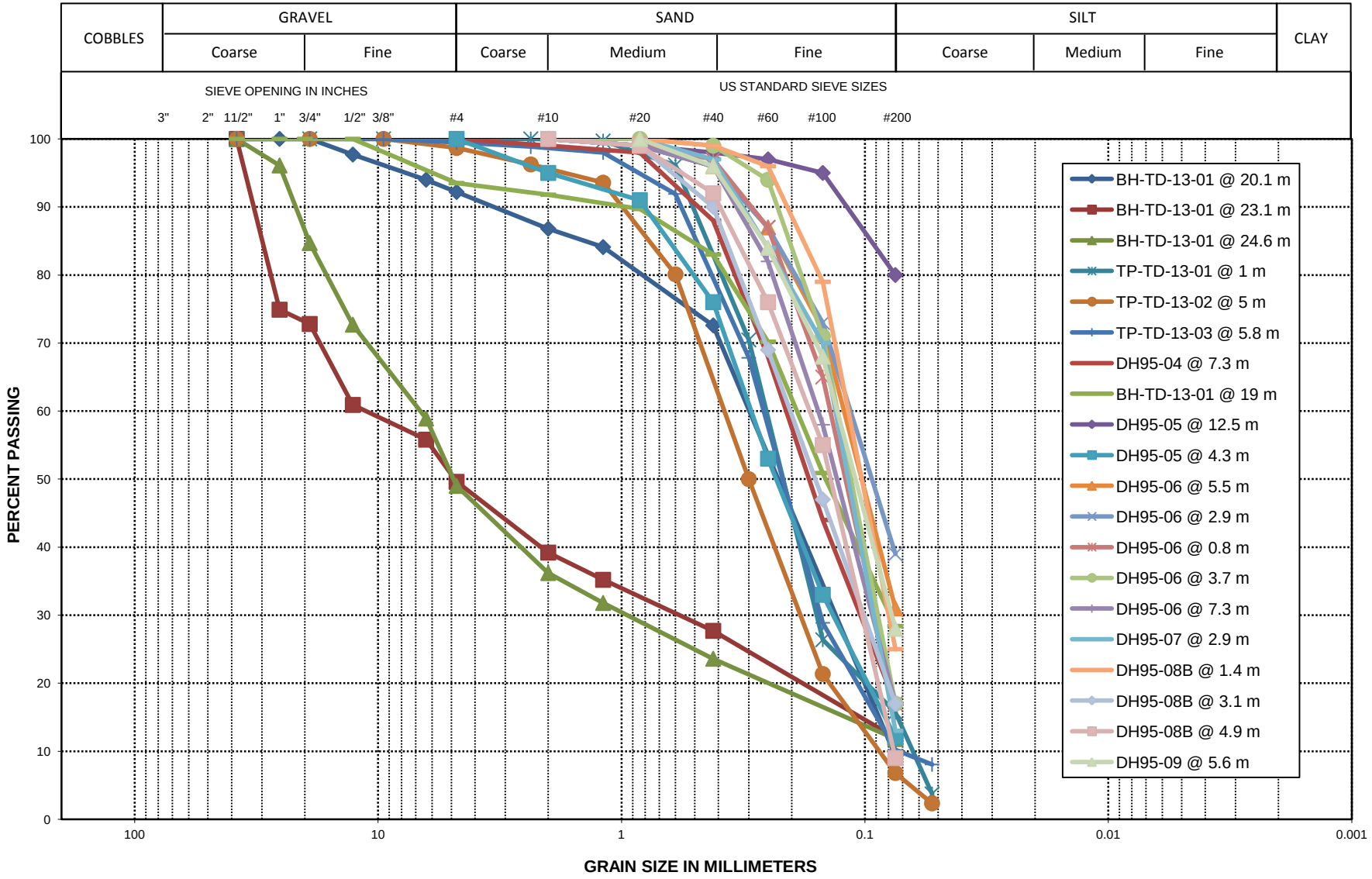
Waste Area - Waste Rock Sieve Results



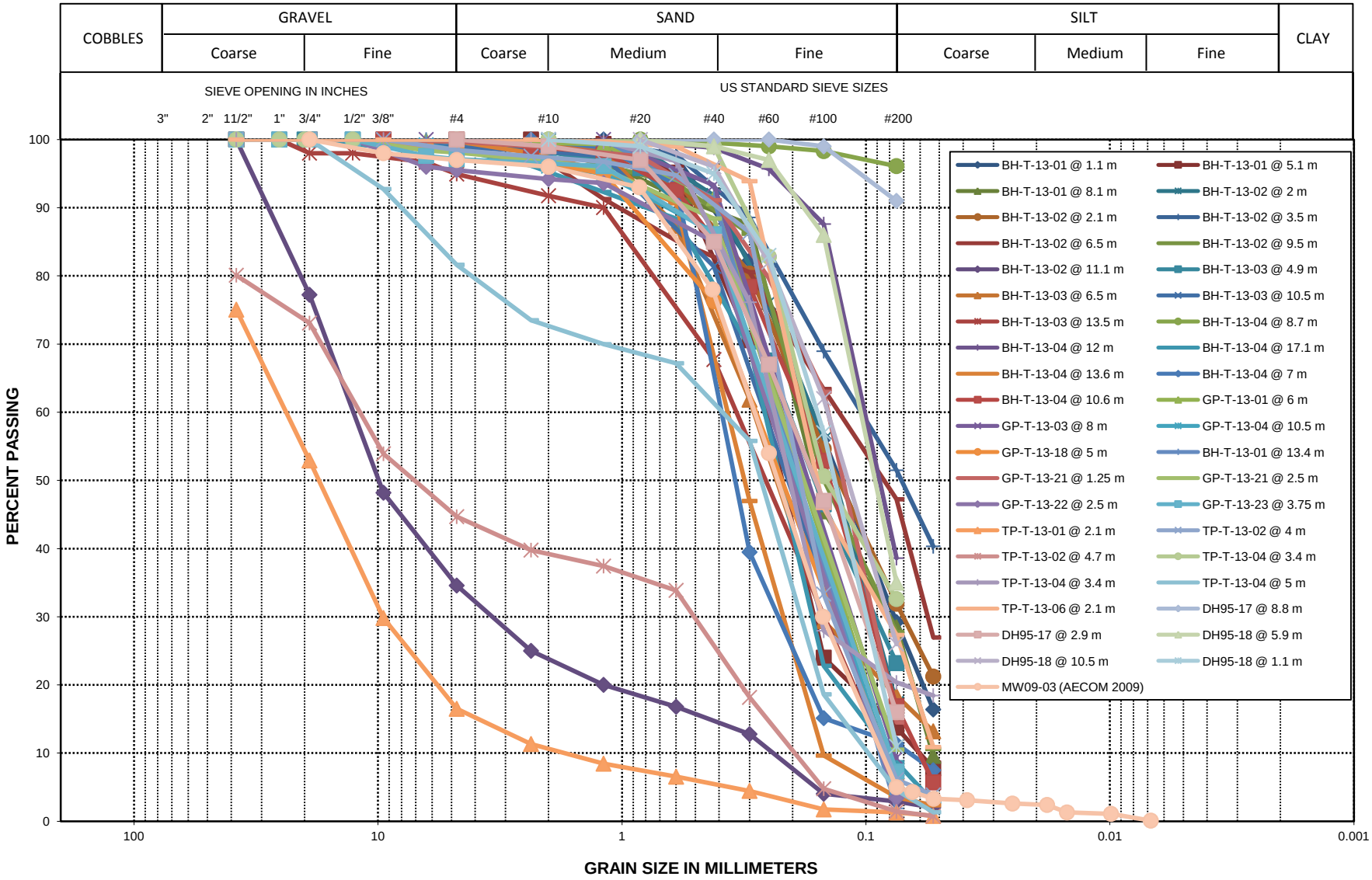
Tailings Facility - Dam Fill Sieve Results



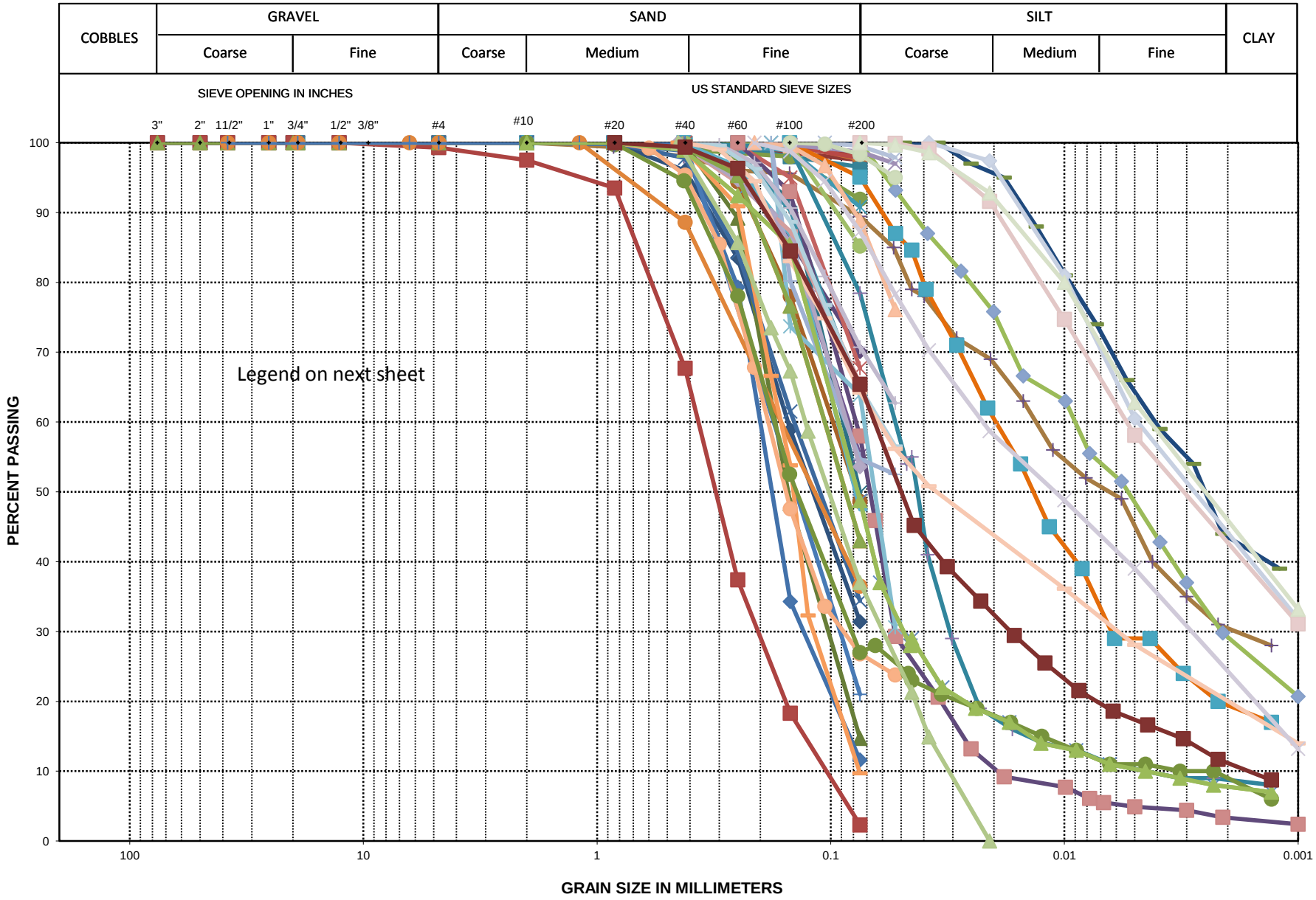
Tailings Facility - In Situ Soil Below Dam Sieve Results



Tailings Facility - In Situ Soil Below Tailings Sieve Results



Tailings Facility - Tailings Sieve Results

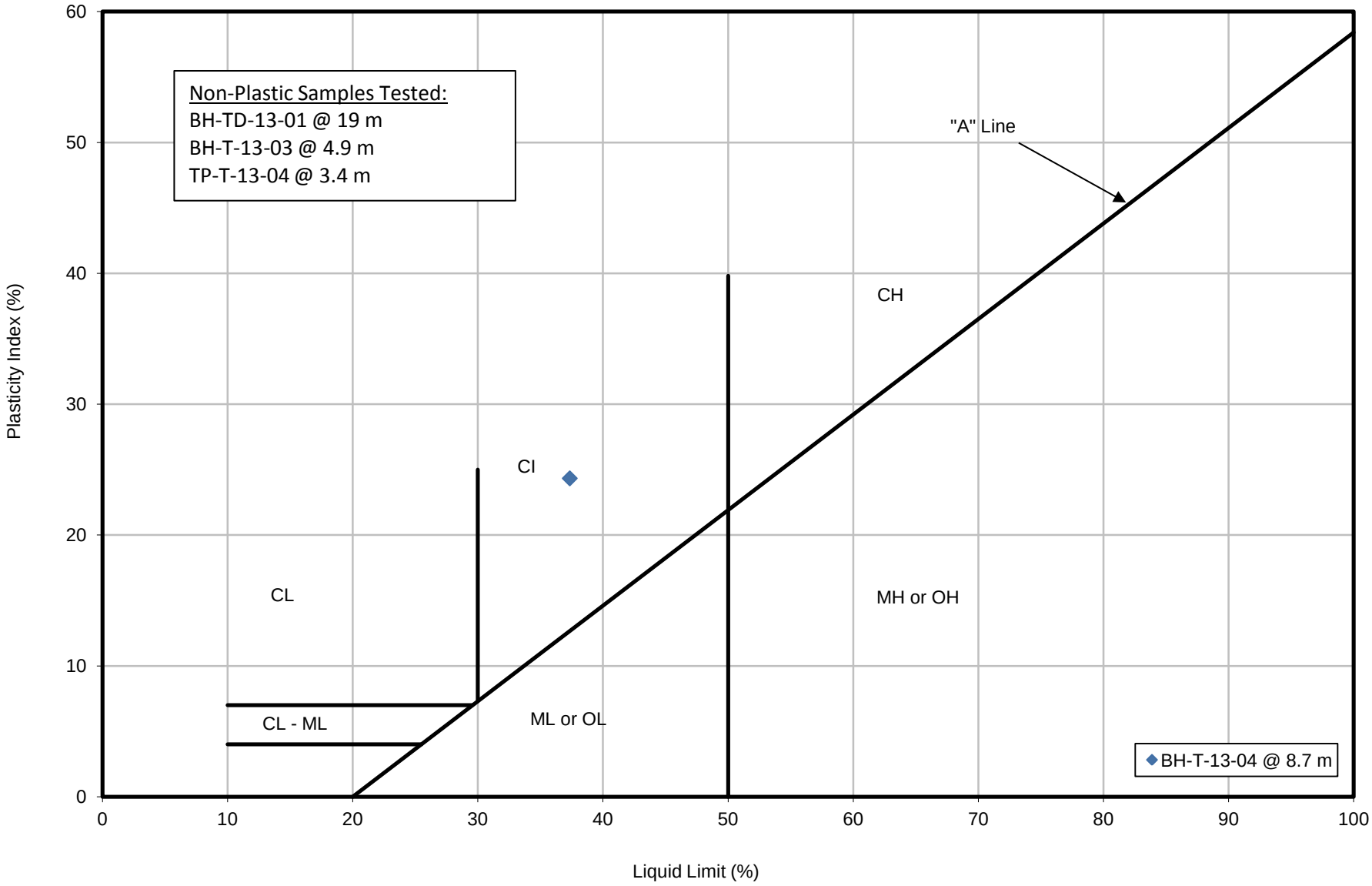


Tailings Facility - Tailings Sieve Results

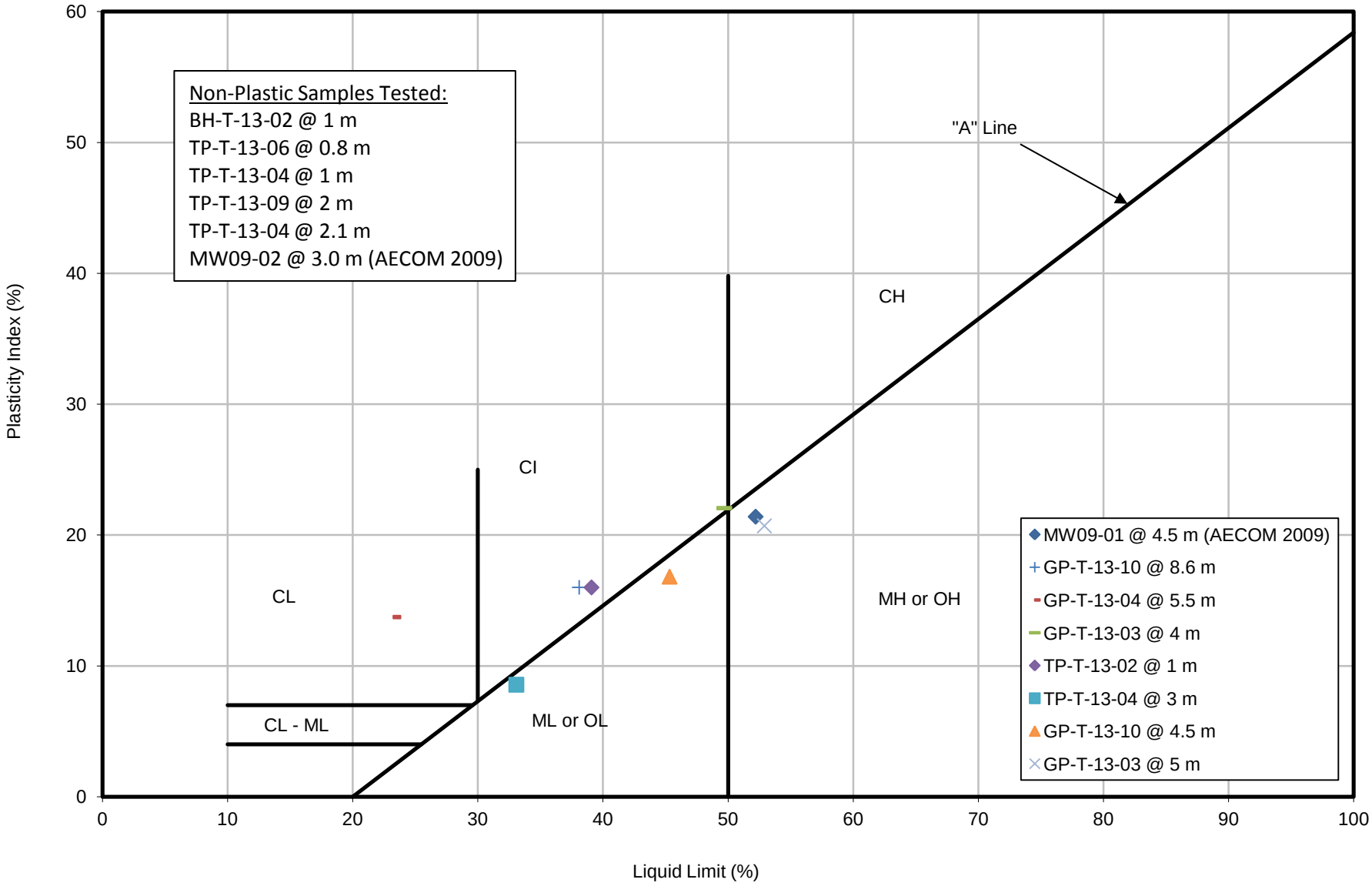
COBBLES	GRAVEL		SAND			SILT			CLAY
	Coarse	Fine	Coarse	Medium	Fine	Coarse	Medium	Fine	
	SIEVE OPENING IN INCHES			US STANDARD SIEVE SIZES					

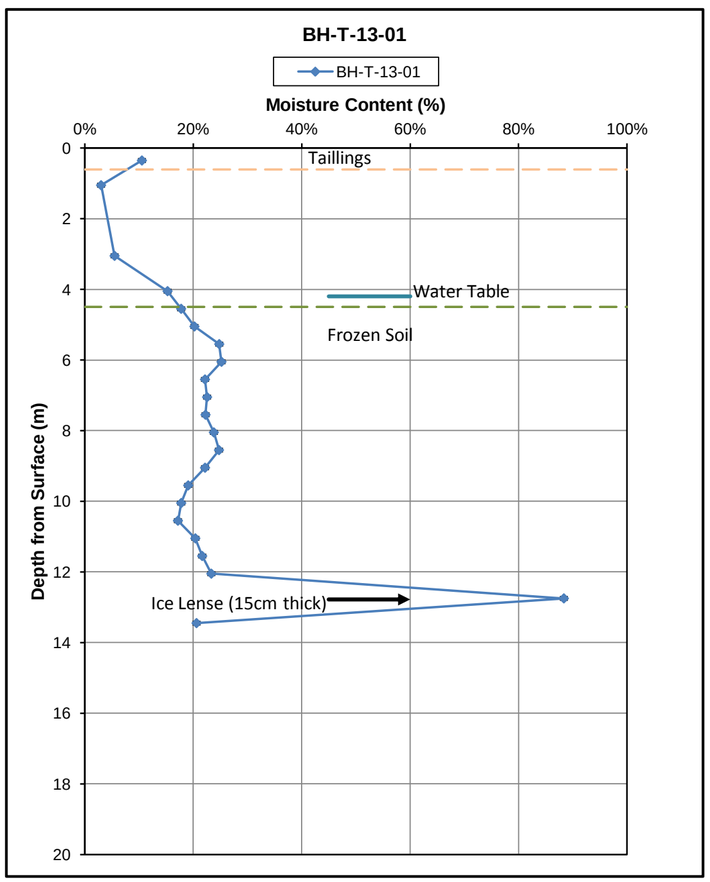
- BH-T-13-03 @ 4 m
- GP-T-13-03 @ 4 m
- GP-T-13-03 @ 6 m
- GP-T-13-10 @ 4.5 m
- GP-T-13-10 @ 8.6 m
- TP-T-13-02 @ 1 m
- TP-T-13-04 @ 2.1 m
- TP-T-13-04 @ 3 m
- TP-T-13-06 @ 0.8 m
- TP-T-13-09 @ 2 m
- TP-T-13-09 @ 4 m
- MW09-02 @ 3.0 m (AECOM 2009)
- T2&T5 (Lorax 2010)
- Bin 4 (Lorax 2010)
- MNBH 11-02 @ 2.5 (CANMET 2002)
- Batch O - clayey silt (CANMET 2002)
- SMIX - silt (CANMET 2002)
- SOMIX - T (CANMET 2002)
- Batch O - T (CANMET 2002)
- MN1401 - T (CANMET 2002)
- BH-T-13-04 @ 2.5 m
- GP-T-13-10 @ 8.6 m
- TP-T-13-04 @ 2.5 m
- TP-T-13-06 @ 0.8 m
- TP-T-13-09 @ 3 m
- MW09-02 @ 3.0 m (AECOM 2009)
- OMIX - silt (CANMET 2002)
- BH-T-13-02 @ 1 m
- Bin 4 (Clayey Silt/Sand + Native Org) (Lorax 2010)
- GP-T-13-01 @ 4 m
- GP-T-13-03 @ 5 m
- GP-T-13-04 @ 5.5 m
- GP-T-13-10 @ 8.5 m
- TP-T-13-01 @ 1 m
- TP-T-13-04 @ 1 m
- TP-T-13-04 @ 3 m
- TP-T-13-06 @ 0.8 m
- TP-T-13-07 @ 3 m
- TP-T-13-09 @ 2 m
- MW09-01 @ 4.5 m (AECOM 2009)
- T1&T4 (Lorax 2010)
- T3&T6 (Lorax 2010)
- Bin 4 - Clayey Silt (Lorax 2010)
- MNBH 14-01 @ 1 (CANMET 2002)
- Batch S - clayey silt (CANMET 2002)
- SOMIX - silt (CANMET 2002)
- MN 1102 - T (CANMET 2002)
- Batch S - T (CANMET 2002)
- BH-T-13-02 @ 1 m
- GP-T-13-03 @ 5 m
- GP-T-13-18 @ 0 m
- TP-T-13-05 @ 1 m
- TP-T-13-09 @ 1 m
- MW09-01 @ 4.5 m (AECOM 2009)
- Bin 4 - Sand (Lorax 2010)
- US Bureau of Standards
- TP-T-13-06 @ 0.8 m
- Combined TP-13-T04&06

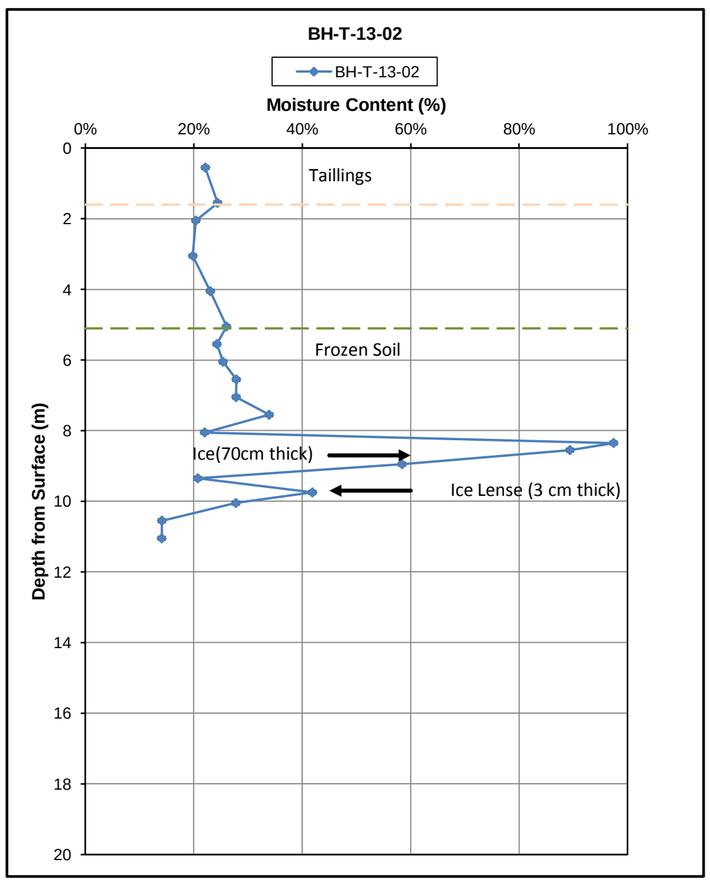
Tailings Facility - In Situ Soil Atterberg Limits Results

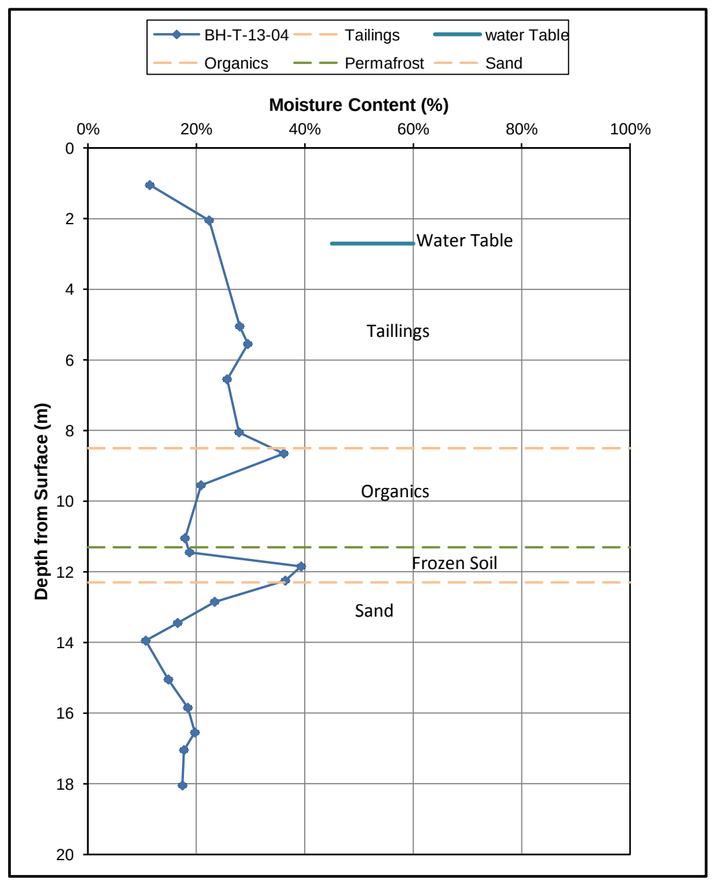


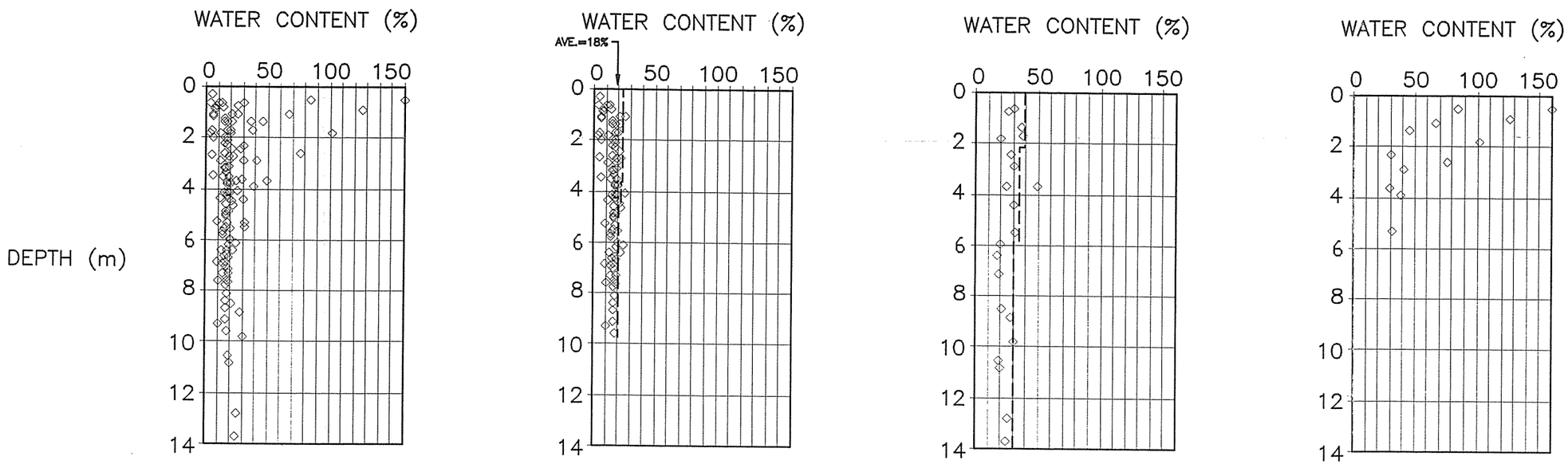
Tailings Facility - Tailings Atterberg Limits Results




BH-T-13-01
BH-T-13-01
Moisture Content (%)
0%
20%
40%
60%
80%
100%
Depth from Surface (m)
0
2
4
6
8
10
12
14
16
18
20
Taillings
Water Table
Frozen Soil
Ice Lense (15cm thick)


BH-T-13-02
BH-T-13-02
Moisture Content (%)
0%
20%
40%
60%
80%
100%
Depth from Surface (m)
0
2
4
6
8
10
12
14
16
18
20
Taillings
Frozen Soil
Ice(70cm thick)
Ice Lense (3 cm thick)


BH-T-13-04
Tailings
water Table
Organics
Permafrost
Sand
Moisture Content (%)
0%
20%
40%
60%
80%
100%
Depth from Surface (m)
0
2
4
6
8
10
12
14
16
18
20
Water Table
Taillings
Organics
Frozen Soil
Sand



ALL SOILS

SAND

SILTY SAND

(IDENTIFIED IN HOLES DH95-05, 06, 07, 09, 10, 17, 18, 19)

PEAT & SOILS WITH ORGANIC INCLUSIONS

(IDENTIFIED IN HOLES DH95-06, 07, 08, 09 10, 15)

NOTES:
1. SOIL TYPES DETERMINED FROM VISUAL DESCRIPTION SHOWN ON DRILL HOLE LOGS

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

TO BE READ WITH KLOHN CRIPPEN REPORT DATED _____

KLOHN-CRIPPEN

CLIENT: B.Y.G. NATURAL RESOURCES INC.

PROJECT: MT. NANSEN GOLD PROJECT

TITLE: WATER CONTENT PROFILES WITH DEPTH

DATE OF ISSUE: JULY 95

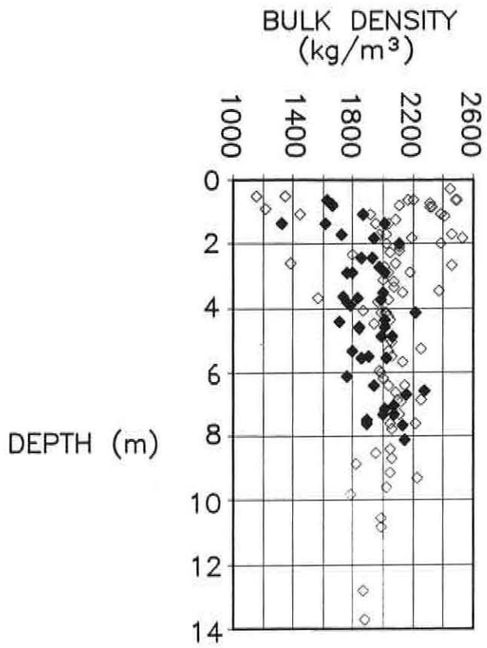
APPROVED

PROJECT No.: PM 5314.05

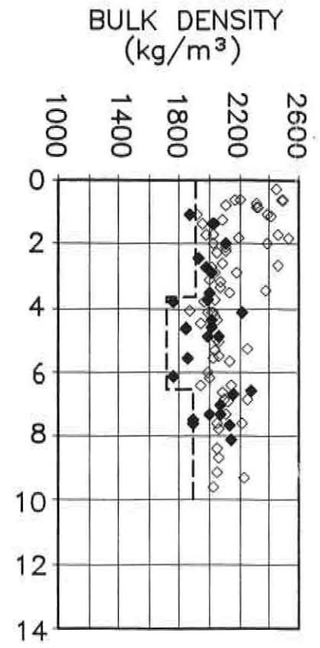
DWG. No.: FIGURE A2-1

REV.

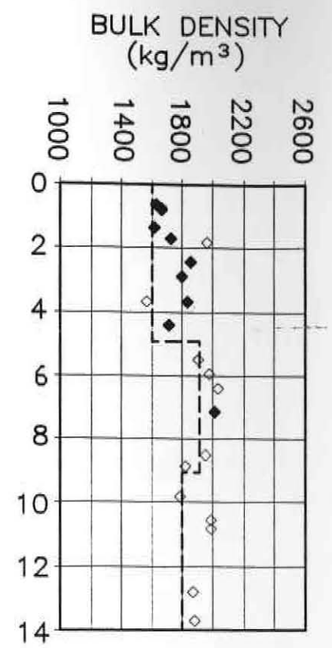
5314w009.DWG



ALL SOILS

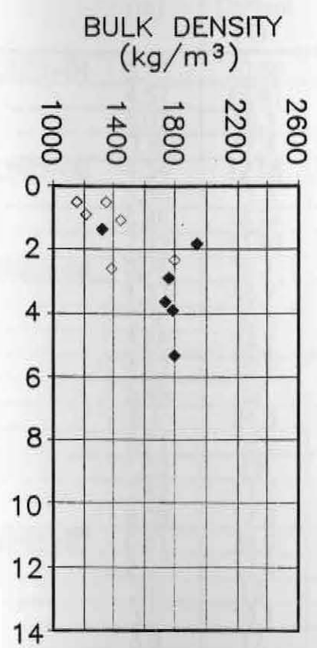


SAND



SILTY SAND

(IDENTIFIED IN HOLES DH95–05, 06, 07, 09, 10, 17, 18, 19)



PEAT & SOILS WITH ORGANIC INCLUSIONS

(IDENTIFIED IN HOLES DH95–06, 07, 08, 09 10, 15)

LEGEND

◆ MEASURED

◇ ESTIMATED

NOTES:

1. SOIL TYPES DETERMINED FROM VISUAL DESCRIPTION SHOWN ON DRILL HOLE LOGS
2. THE DATA SHOWN IS COMBINED FROM MEASURED FROZEN BULK DENSITIES AND ESTIMATED DENSITIES FROM MEASURED WATER CONTENTS WITH AN ASSUMED SATURATION OF 90%.

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TO BE READ WITH KLOHN CRIPPEN REPORT DATED _____

KLOHN-CRIPPEN

CLIENT: B.Y.G. NATURAL RESOURCES INC.

PROJECT: MT. NANSEN GOLD PROJECT

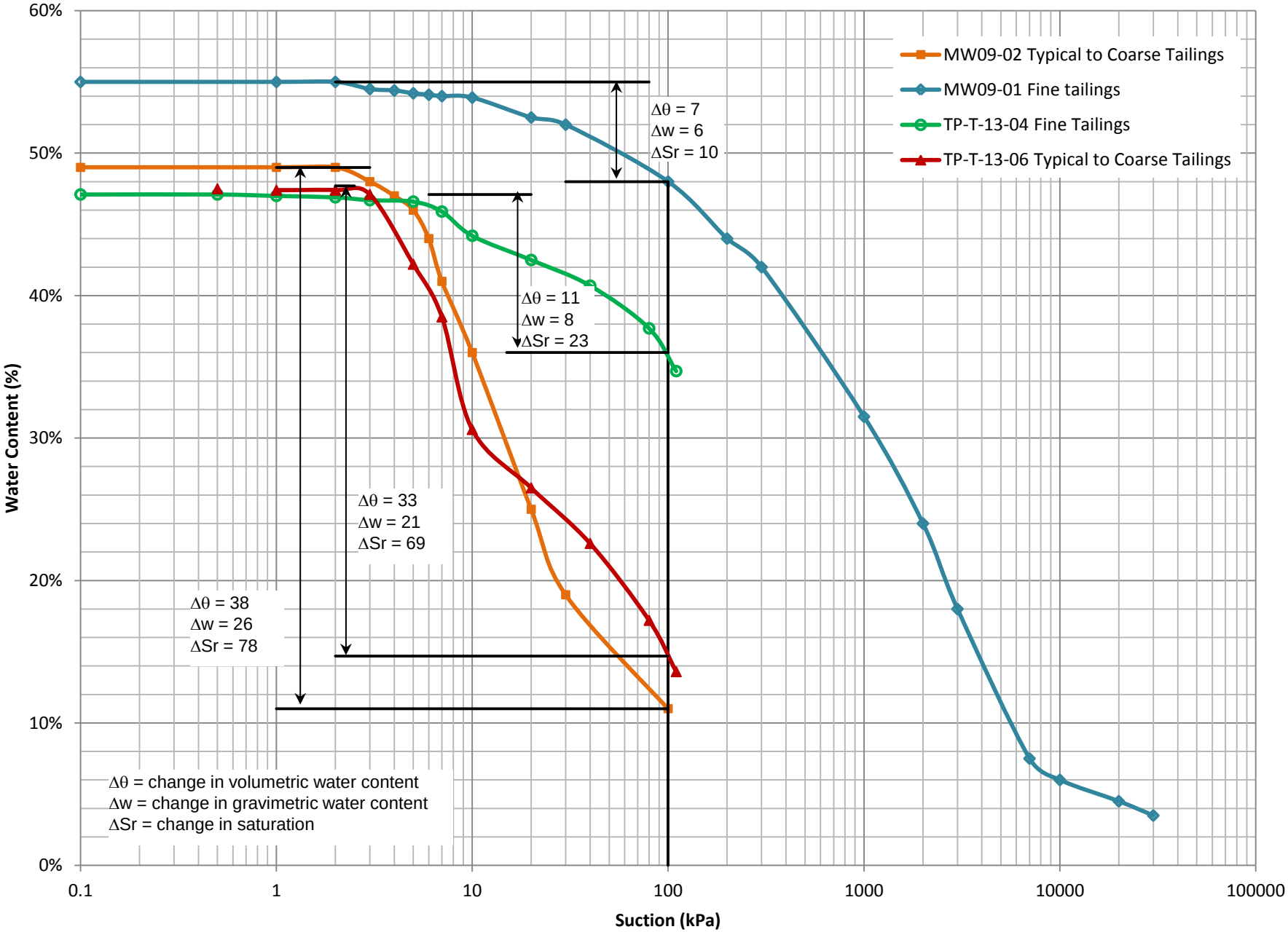
TITLE: FROZEN BULK DENSITY PROFILES WITH DEPTH

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
JULY 95	PM 5341.05	FIGURE A2-3	

APPROVED

5341w011.DWG

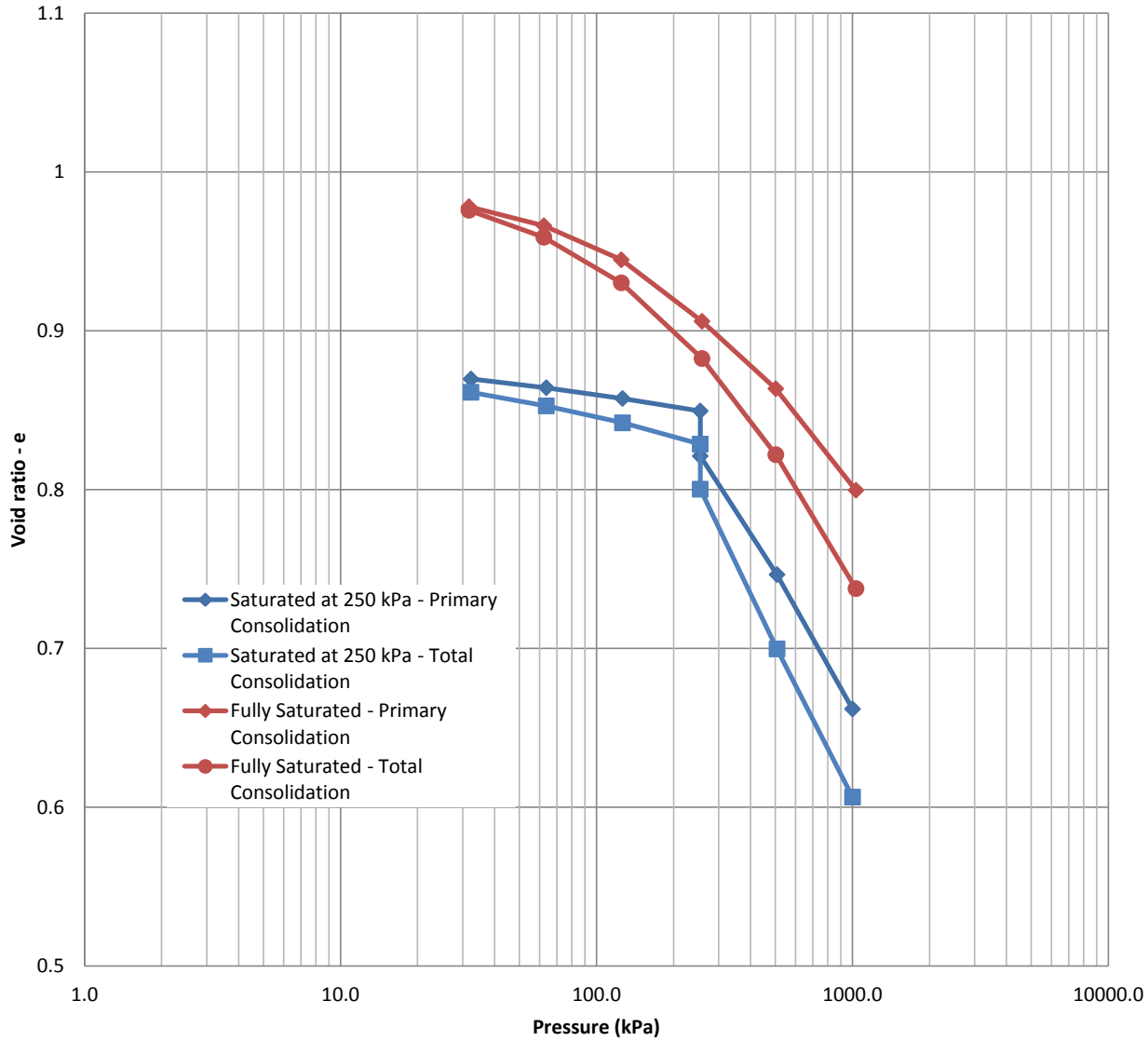
Soil Water Characteristic Plot

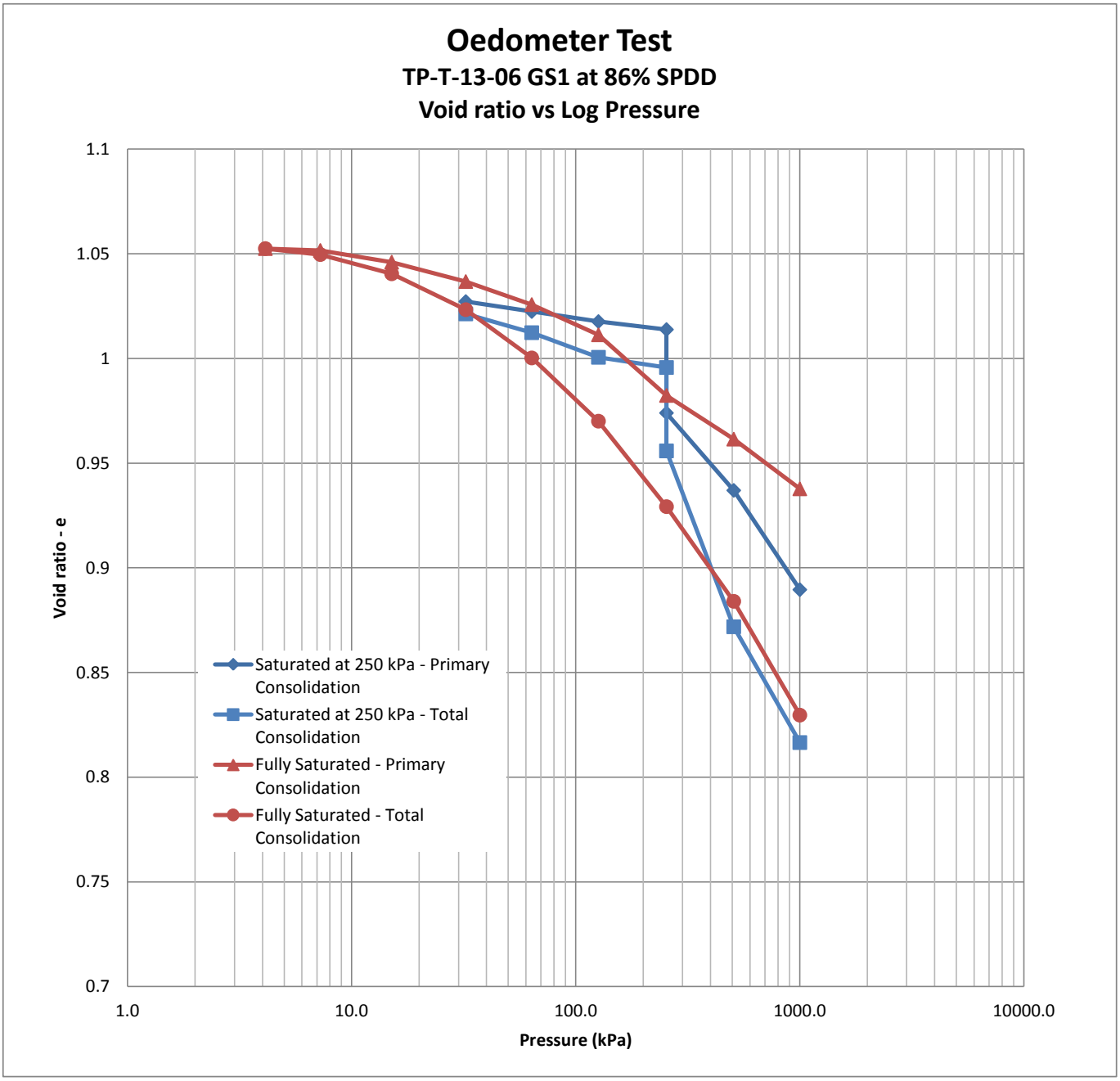


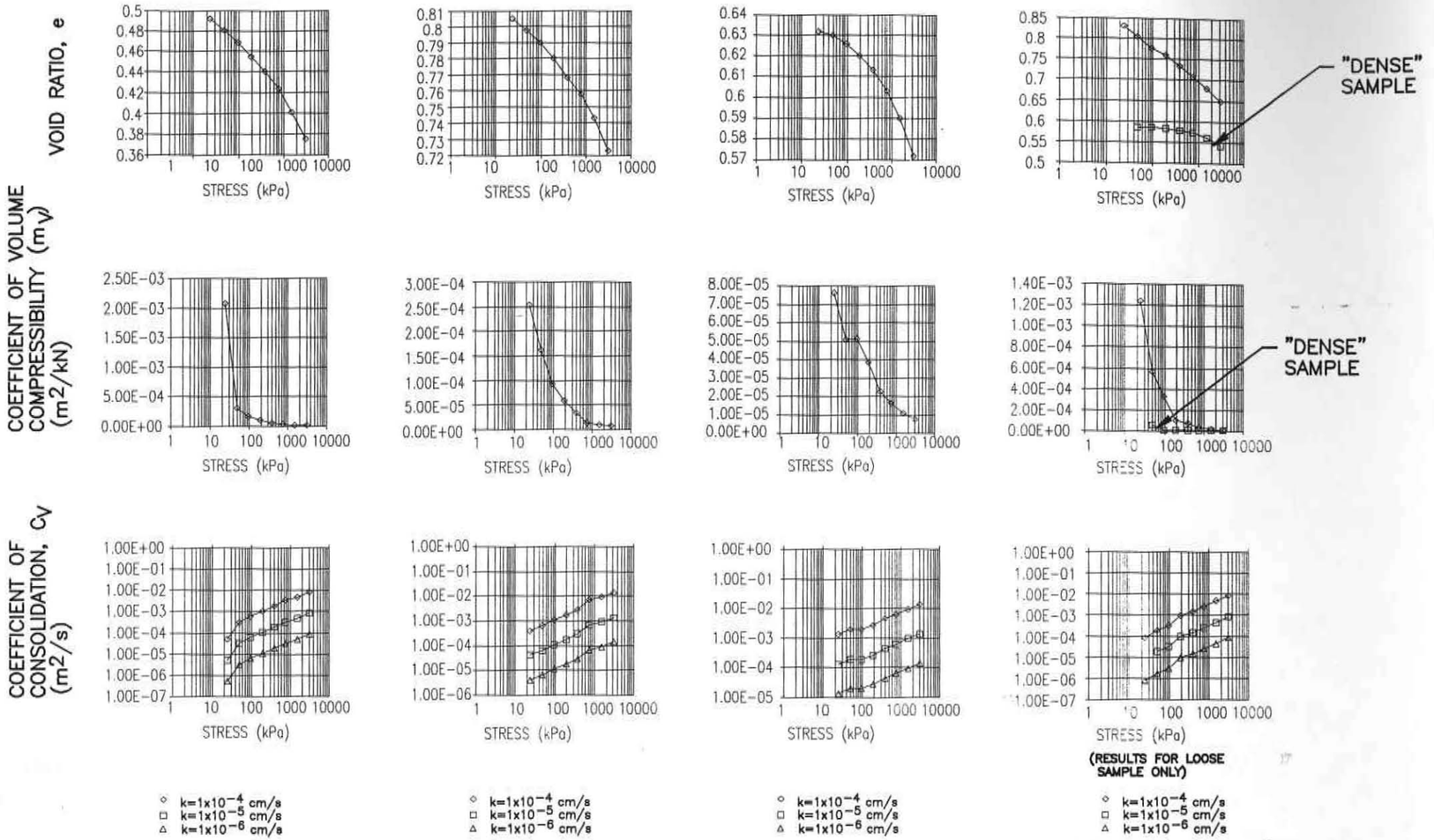
Oedometer Test:

TP-T-13-04 GS5 at 86% SPDD

Void ratio vs Log Pressure




Oedometer Test
TP-T-13-06 GS1 at 86% SPDD
Void ratio vs Log Pressure
Void ratio - e
1.1
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
1.0
10.0
100.0
1000.0
10000.0
Pressure (kPa)
Saturated at 250 kPa - Primary Consolidation
Saturated at 250 kPa - Total Consolidation
Fully Saturated - Primary Consolidation
Fully Saturated - Total Consolidation



DH95–05(12.5m)

SAND = 20%
FINES = 80%

DH95–06(3.7m)

SAND = 82%
FINES = 18%

DH95–08B(1.4m)

SAND = 75%
FINES = 25%

DH95–08B(3.1m)

SAND = 83%
FINES = 17%

MEASURED k = 5.5x10^{-5} cm/s
(IN DENSE STATE)

NOTE:

1. ALL SAMPLES, EXCEPT AS NOTED ON DH95–08B(3.1m) WERE PLACED IN A LOOSE CONDITION IN THE OEDOMETER RING PRIOR TO SATURATION.

TO BE READ WITH KLOHN CRIPPEN REPORT DATED _____

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KLOHN-CRIPPEN

CLIENT: B.Y.G. NATURAL RESOURCES INC.

PROJECT: MT. NANSEN GOLD PROJECT

TITLE: OEDOMETER TEST RESULTS

DATE OF ISSUE: JULY 1995
APPROVED:

PROJECT No.: PM 5314.05

DWG. No.: FIGURE A2–4

REV.:

5314w022.DWG

APPENDIX E2

CPT Information

Mount Nansen Remediation Project
2013 Site Investigation Data Report
Appendix C5

Summary of CPT Locations and Dissipation Tests

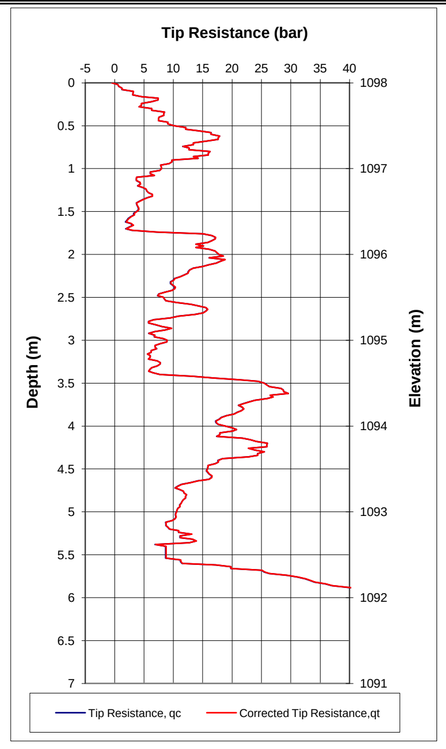
CPT ID	Easting	Northing	CPT Conducted on Pond Surface	Elevation of Top of CPT Trace	CPT Total Depth	Dissipitation Test Depth	[1] Dissipation Achieved	Estimated Hydrostatic Pore Pressure
	UTM Zn 8 NAD 83	UTM Zn 8 NAD 83	Y/N	(m)	(m)	(m)	%	(m)
CPT-T-13-1	389,196	6,880,711	N	1098	5.92	1.9	123.89%	1
						5.4	-10.78%	4.4
CPT-T-13-2	389,240	6,880,700	N	1097.3	3.92	1.9	46.36%	1
CPT-T-13-3	389,333	6,880,679	Y	1096.1	3.4	2.8	88.31%	2.5
CPT-T-13-4	389,391	6,880,690	Y	1096.1	2.98	3	-1.24%	2.7
CPT-T-13-5	389,426	6,880,672	N	1099.7	4.96	3	-6.13%	2
CPT-T-13-6	389,205	6,880,639	N	1097.2	4.02	1.5	44.55%	0.5
CPT-T-13-7(A)	389,236	6,880,661	N	1096.6	4.16	4.10	-4021.19%	3
CPT-T-13-7(B)	389,236	6,880,661	N	1096.6	1.94	2	34.46%	1
CPT-T-13-8(A)	389,307	6,880,654	Y	1096.1	4.06	4.1	55.81%	3.8
CPT-T-13-8(B)	389,307	6,880,654	Y	1096.1	4.04	4.1	39.85%	3.8
CPT-T-13-9	389,383	6,880,661	Y	1096.1	4.88	4.8	-0.46%	4.6
CPT-T-13-10(A)	389,400	6,880,630	Y	1096.1	8.7	Not Completed		
CPT-T-13-10(B)	389,400	6,880,630	Y	1096.1	7.64	2.9	20.51%	2.7
						7.7	68.49%	7.5
CPT-T-13-11	389,176	6,880,607	N	1101.1	0.48	Not Completed		
CPT-T-13-12	389,239	6,880,596	N	1097.2	4.32	3.8	64.95%	2.8
CPT-T-13-13	389,308	6,880,592	Y	1096.1	8.18	4.2	7.80%	3.2
						7.2	26.94%	6.9
						8.2	70.58%	7.9
CPT-T-13-14	389,378	6,880,602	Y	1096.1	9.72	3.5	51.44%	3.3
						5.5	94.91%	5.3
						8	95.02%	7.7
CPT-13-15	389,399	6,880,550	N	1096.8	8.56	5.1	100.62%	3.4
CPT-T-13-16	389,209	6,880,568	N	1098.6	4.66	Not Completed		
CPT-T-13-17	389,249	6,880,554	N	1097.3	3.4	2	46.98%	1
CPT-T-13-18	389,307	6,880,553	Y	1096.1	6.6	6.2	53.77%	5.9
CPT-T-13-19	389,378	6,880,547	N	1096.7	7.66	3.8	8.45%	2.7
						5.8	99.37%	4.5
CPT-T-13-20	389,418	6,880,524	N	1099.7	6.8	Not Completed		

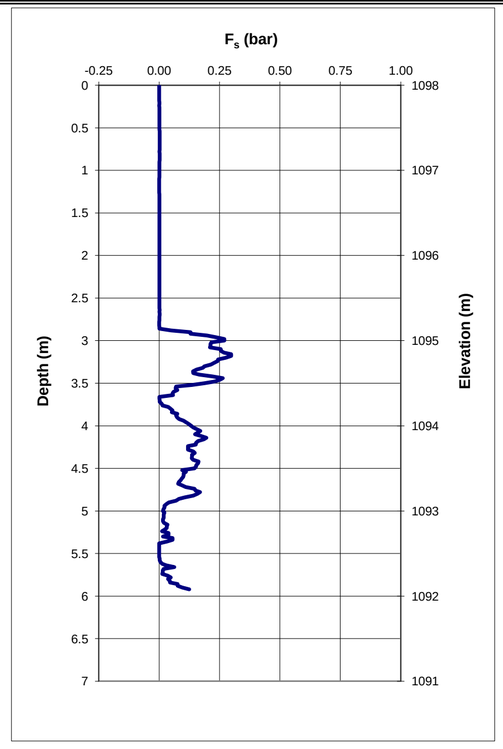
NOTES:

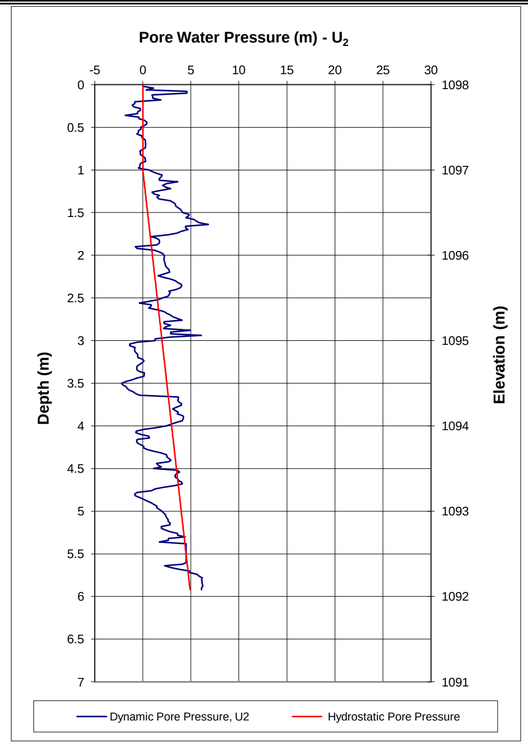
1. Dissipation Cells Highlighted Grey did not Reach Equilibrium or had Pore Pressure Below Hydrostatic (-ve values) and therefore data for these tests is not included.

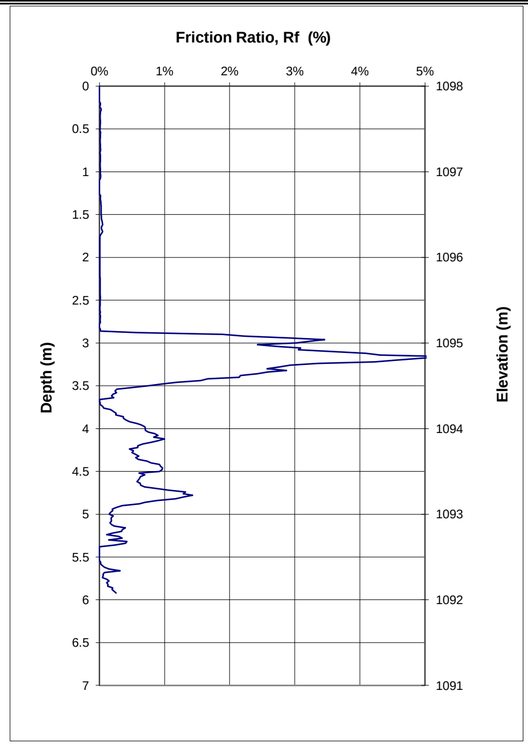
CPT-T-13-01

Tailings









PROJECT: VM00605E

CPT DATE: October 7, 2013 Prepared by: Ewelina Halyno

DATE: March 7, 2014 Reviewed by: Renata Wood

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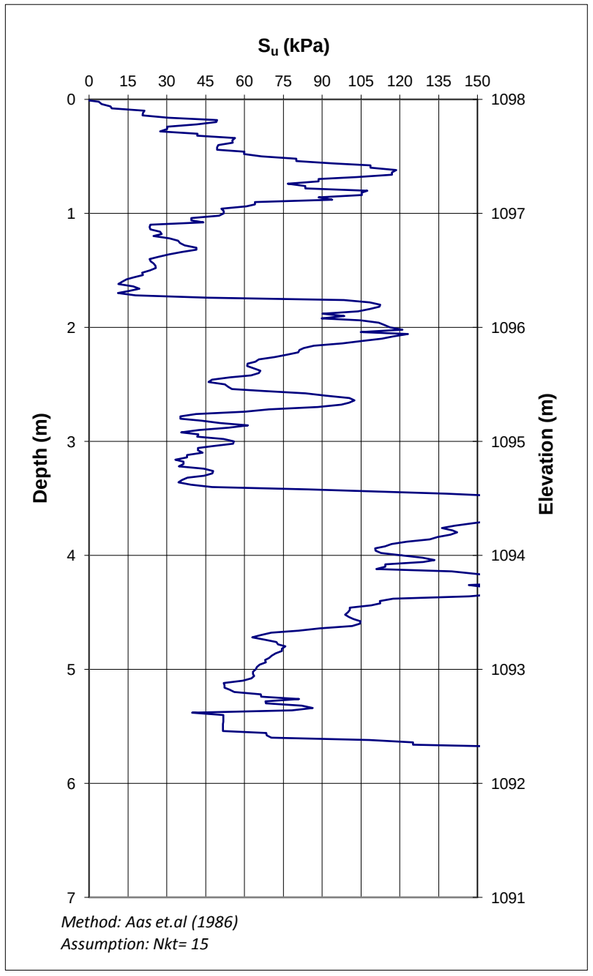
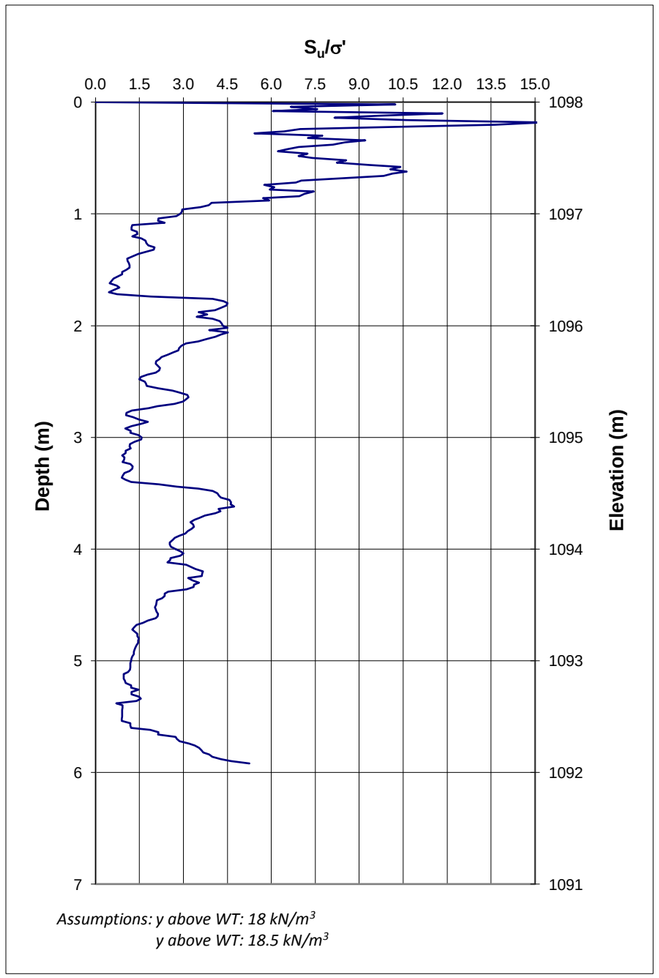
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-01

CPT-T-13-01



Method: Aas et.al (1986)
Assumption: Nkt= 15



Assumptions: y above WT: 18 kN/m³
y above WT: 18.5 kN/m³

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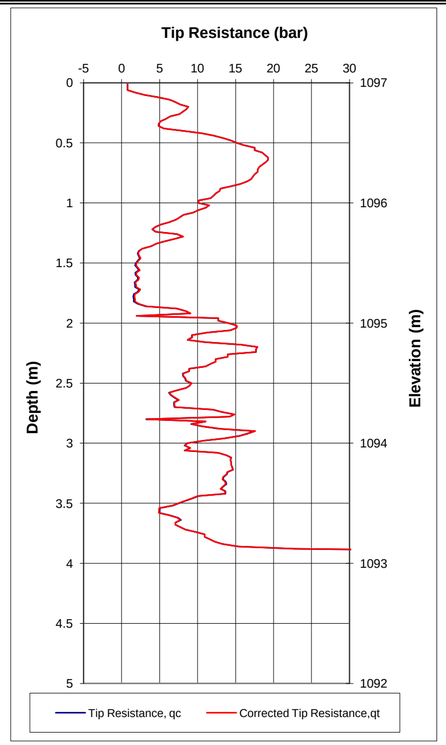
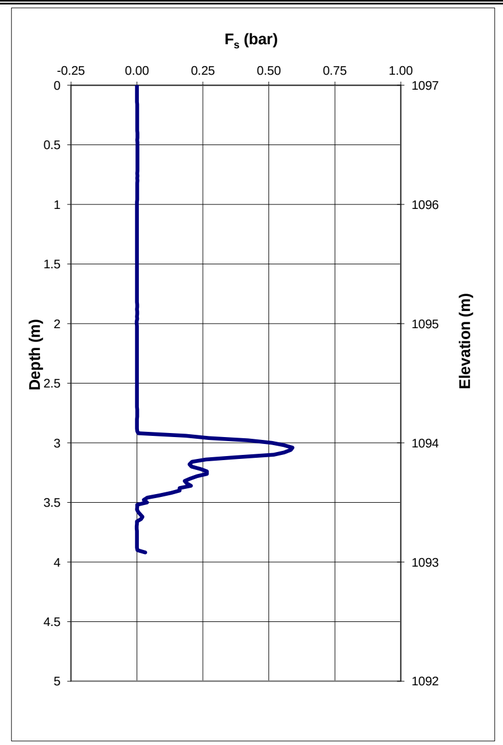
MOUNT NANSEN
CPT INTERPERTATION

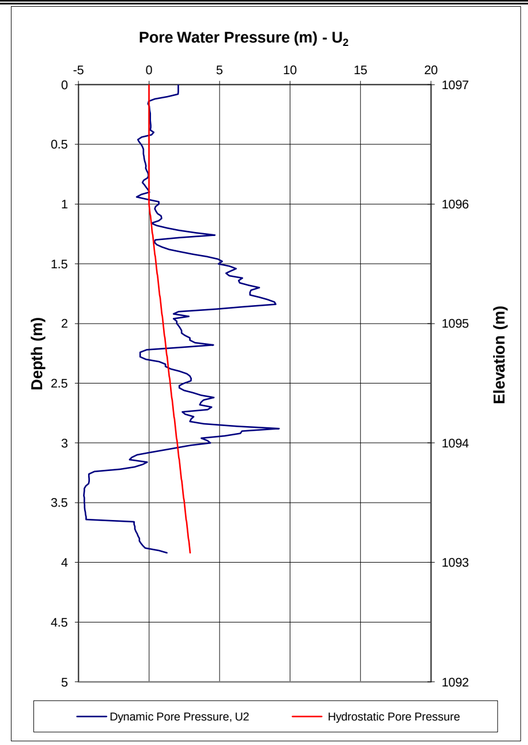
CPT-T-13-01

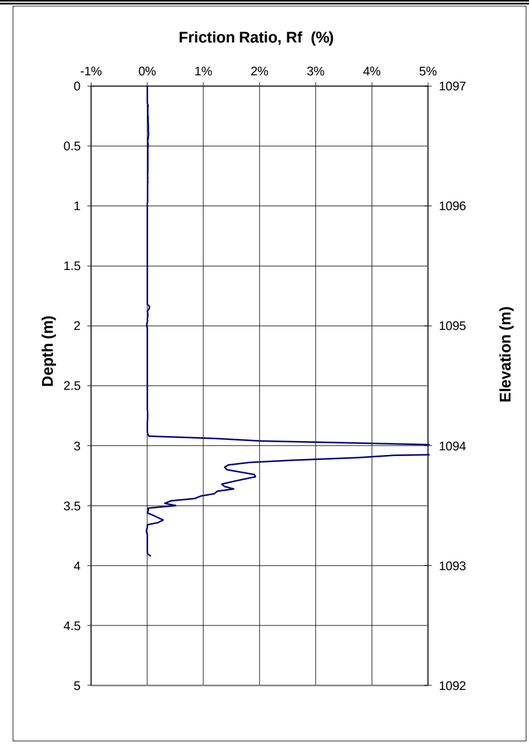
CPT-T-13-02

Tailings









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CPT DATE: October 7, 2013 Prepared by: Ewelina Halyno

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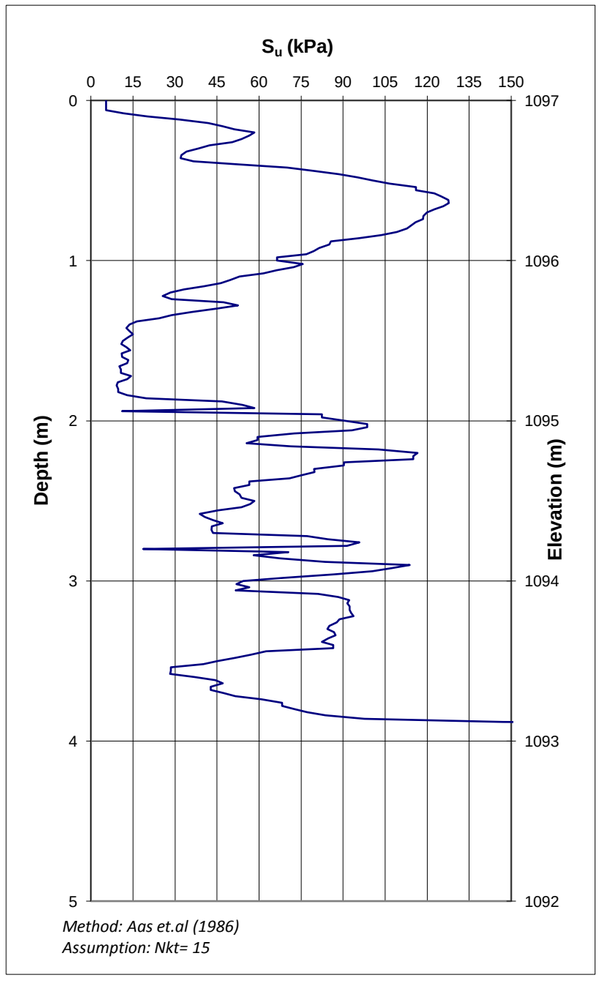
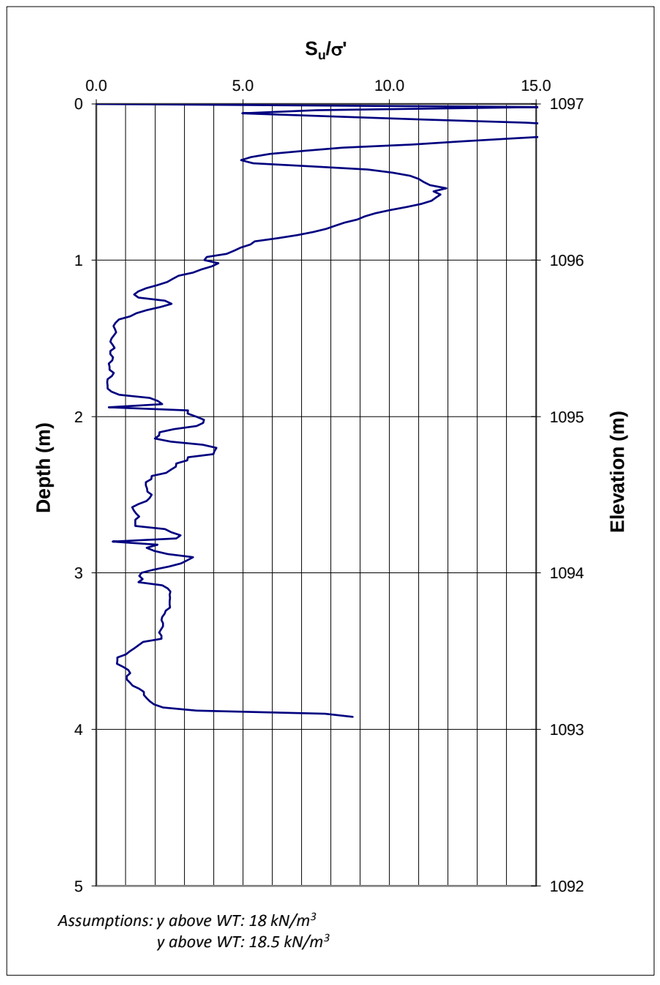
CPT INTERPERTATION

CPT-T-13-02

CPT-T-13-02



Method: Aas et.al (1986)
Assumption: Nkt= 15



Assumptions: y above WT: 18 kN/m^3
y above WT: 18.5 kN/m^3

PROJECT: VM00605E

CPT DATE: October 7, 2013 Prepared by: Ewelina Halyno
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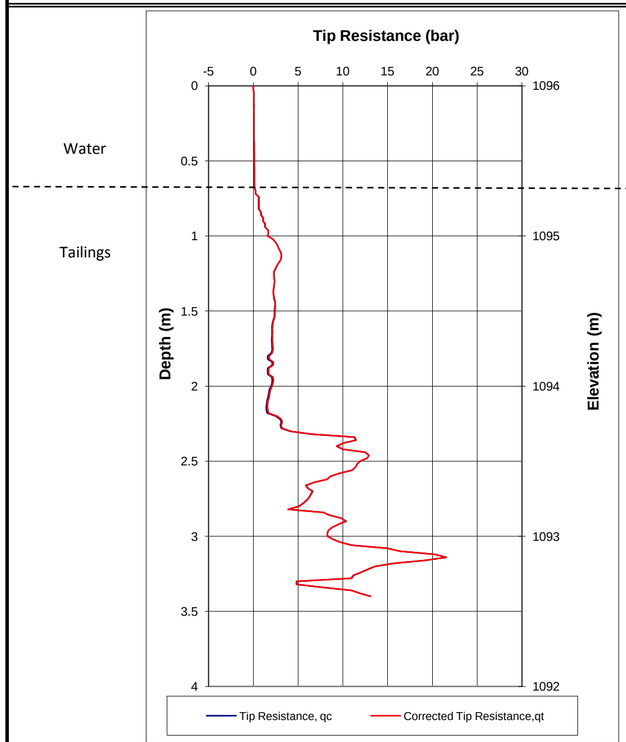
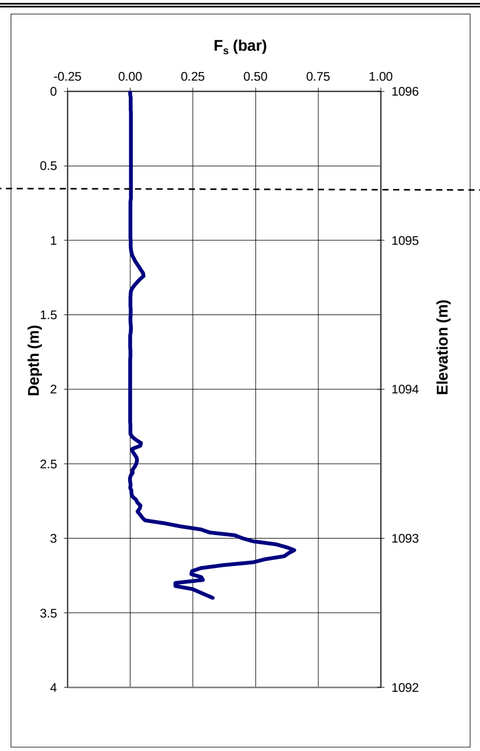
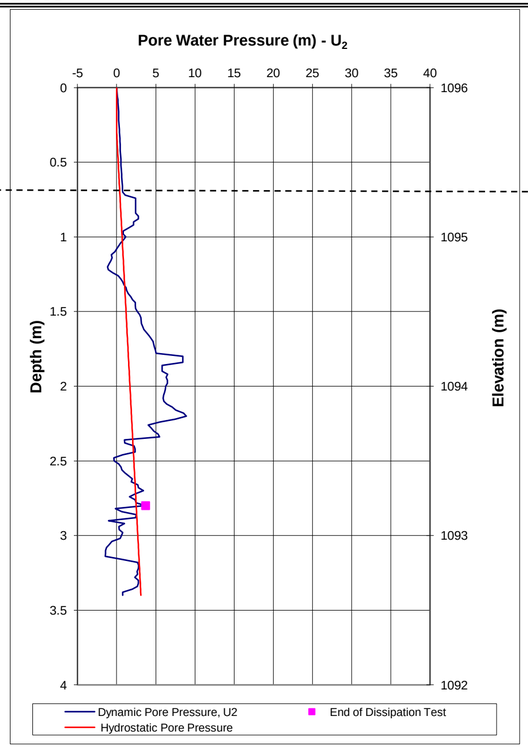
CPT INTERPERTATION

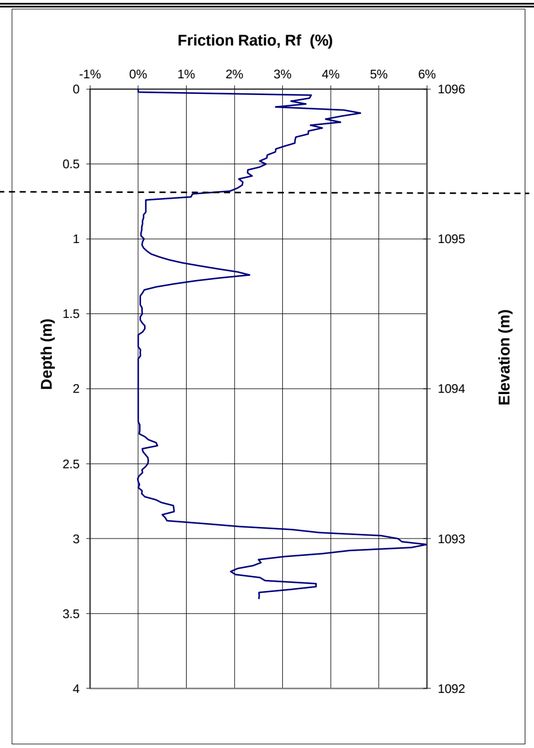
CPT-T-13-02

CPT-T-13-03









PROJECT: VM00605E

NOTE:

CPT DATE: October 4, 2013 Prepared by: Ewelina Halyno

DATE: March 7, 2014 Reviewed by: Renata Wood

1. Depth Measured Relative to Barge Deck Elevation

2. Pond Elevation of 1095.8m Provided by AAM

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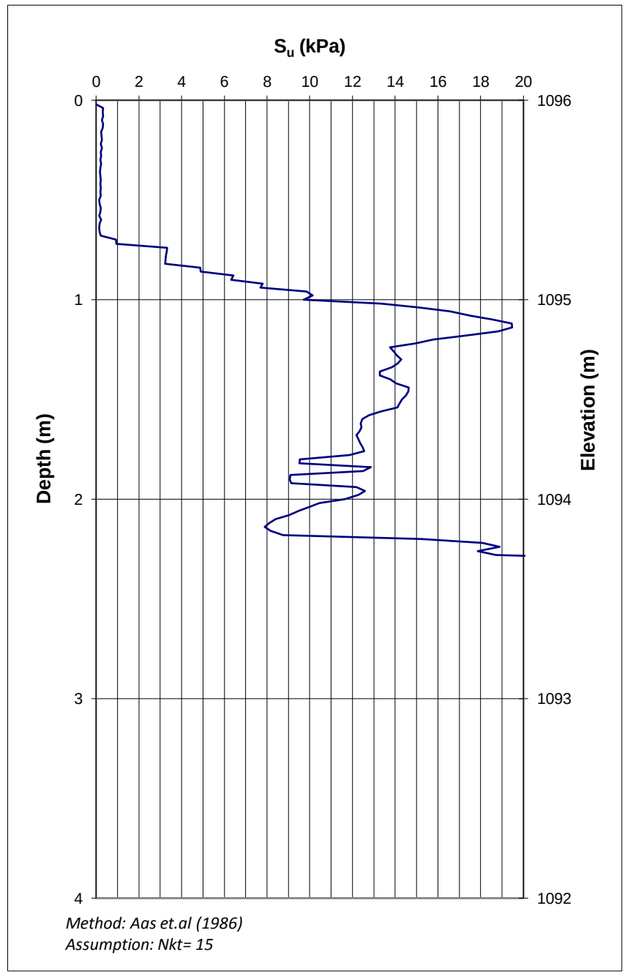
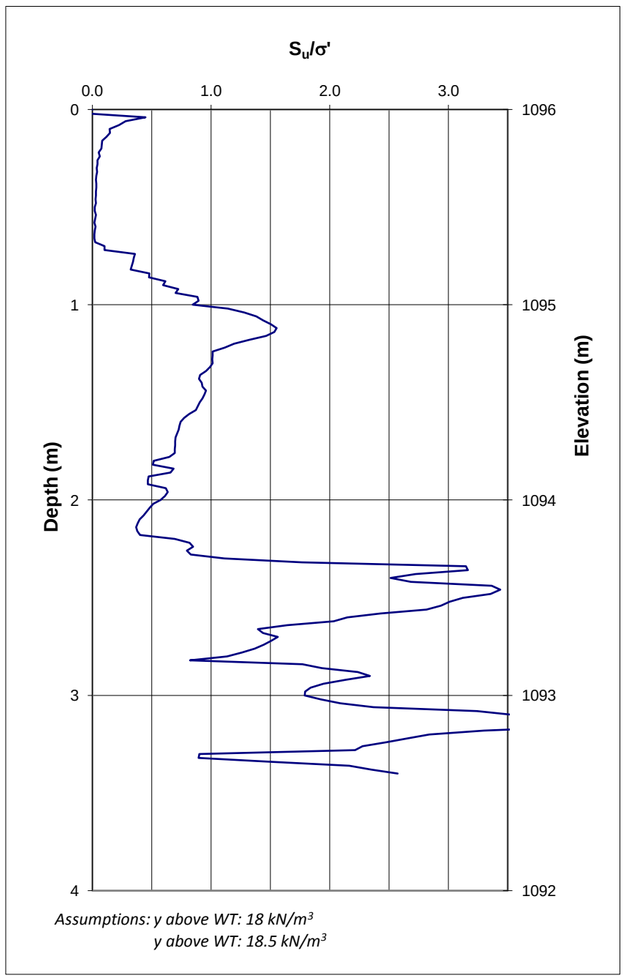
CPT INTERPERTATION

CPT-T-13-03

CPT-T-13-03



Method: Aas et.al (1986)
Assumption: Nkt= 15



Assumptions: y above WT: 18 kN/m^3
y above WT: 18.5 kN/m^3

PROJECT: VM00605E

CPT DATE:	October 4, 2013	Prepared by:	Ewelina Halyno
DATE:	March 7, 2014	Reviewed by:	Renata Wood

NOTE:

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2. Pond Elevation of 1095.8m Provided by AAM

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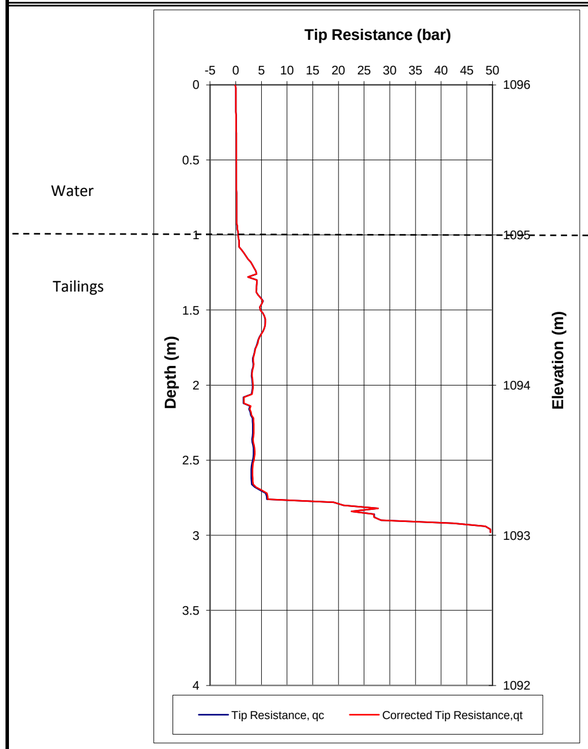
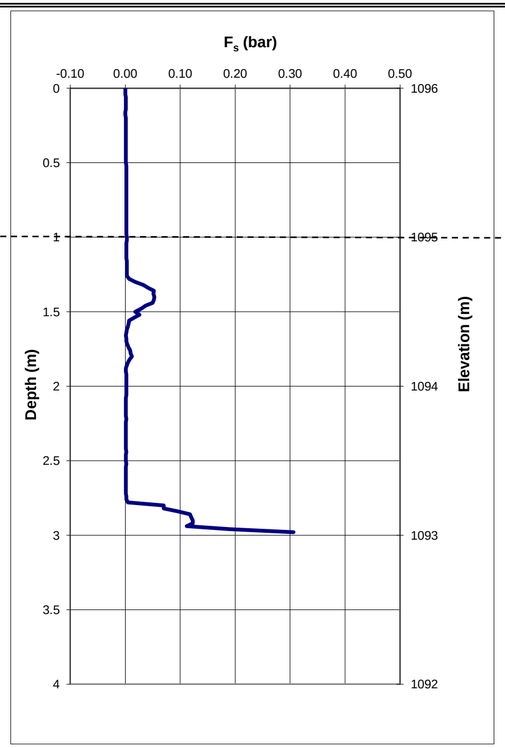
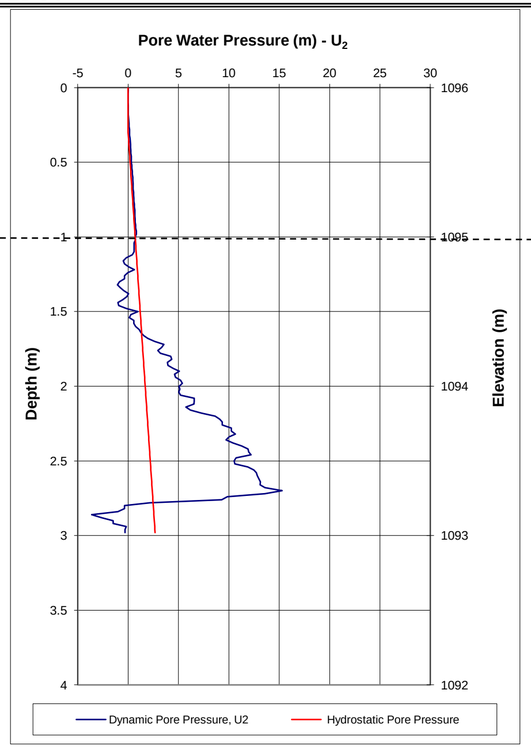
MOUNT NANSEN
CPT INTERPERTATION

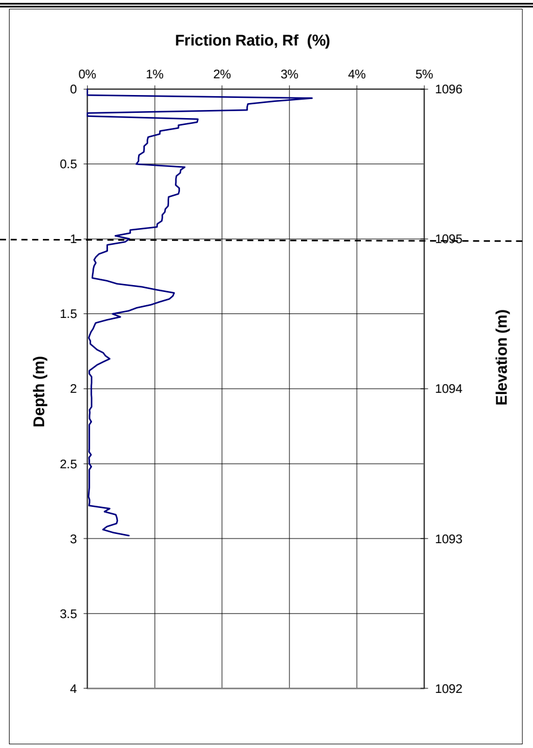
CPT-T-13-03

CPT-T-13-04









PROJECT: VM00605E

CPT DATE: October 4, 2013 Prepared by: Ewelina Halyno

DATE: March 7, 2014 Reviewed by: Renata Wood

NOTE:

1. Depth Measured Relative to Barge Deck Elevation
2. Pond Elevation of 1095.8m Provided by AAM

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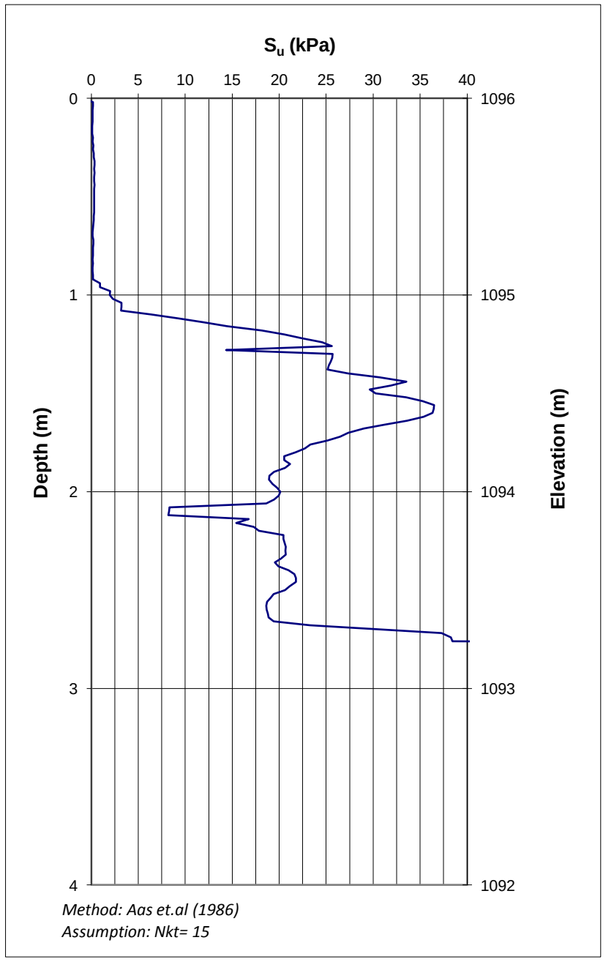
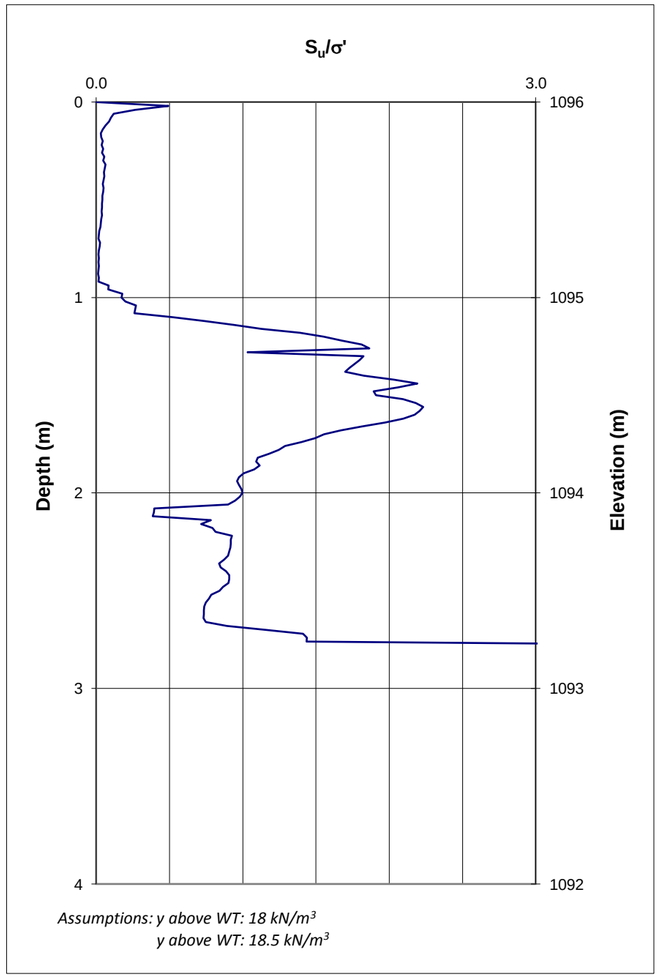
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-04

CPT-T-13-04





PROJECT: VM00605E

CPT DATE:	October 4, 2013	Prepared by:	Ewelina Halyno
DATE:	March 7, 2014	Reviewed by:	Renata Wood

NOTE:

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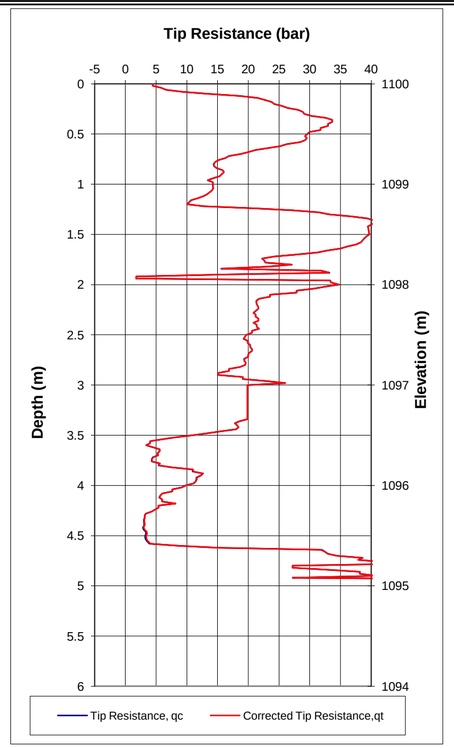
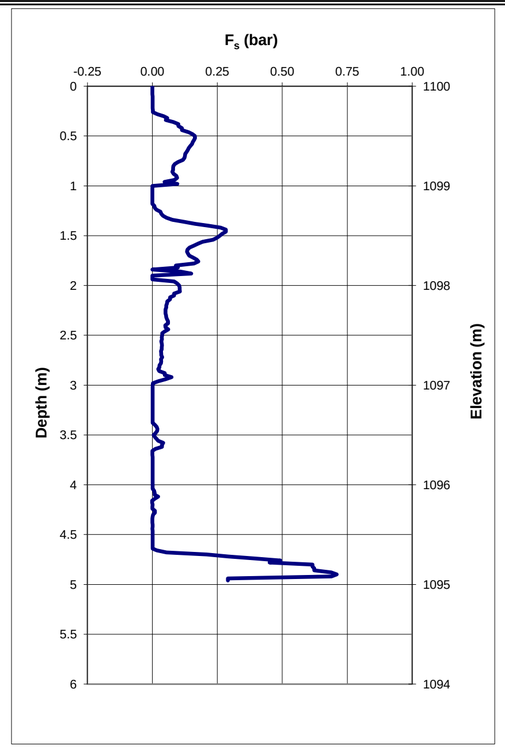
MOUNT NANSEN
CPT INTERPERTATION

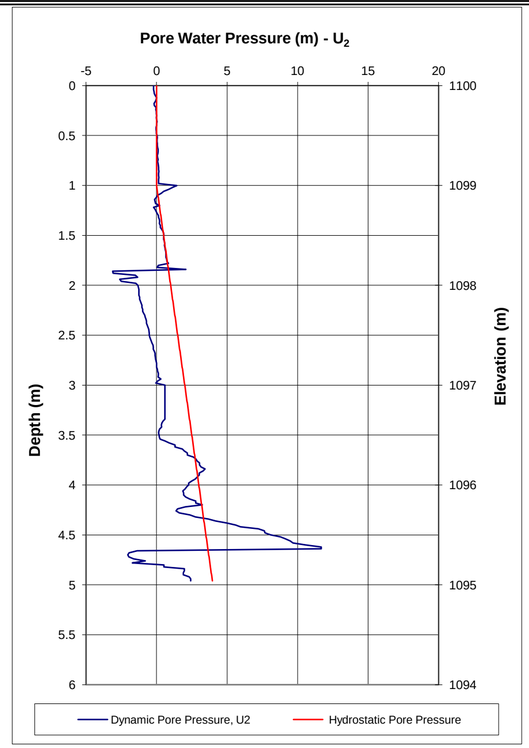
CPT-T-13-04

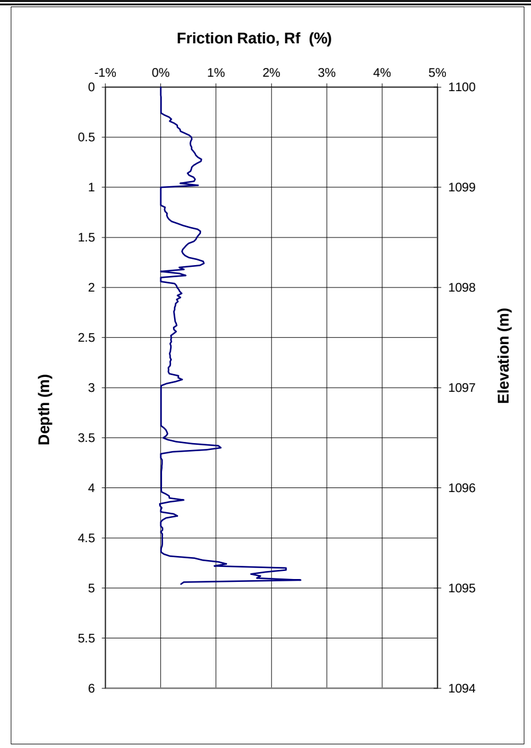
CPT-T-13-05

Tailings









PROJECT: VM00605E

CPT DATE: October 7, 2013 Prepared by: Ewelina Halyno

DATE: March 7, 2014 Reviewed by: Renata Wood

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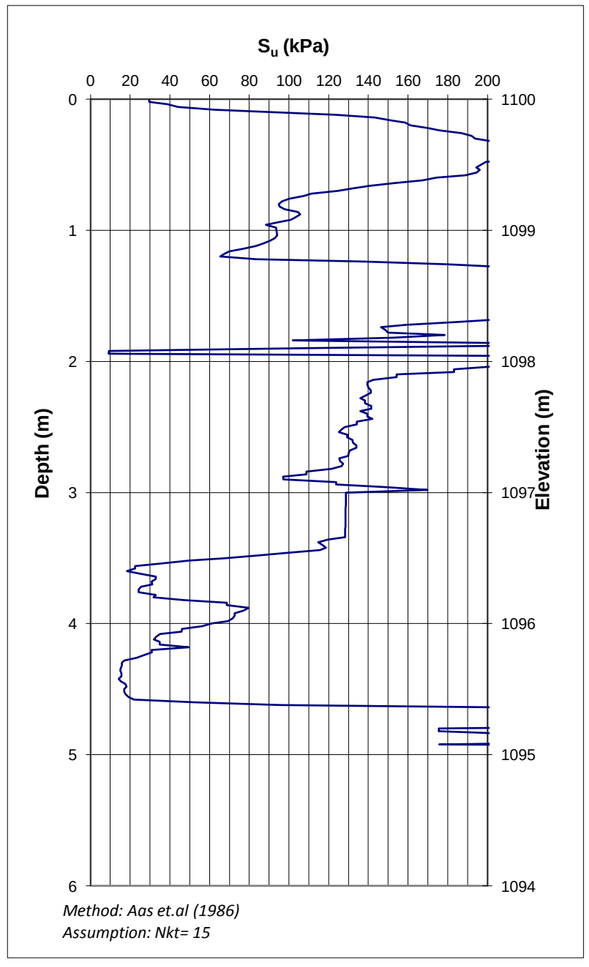
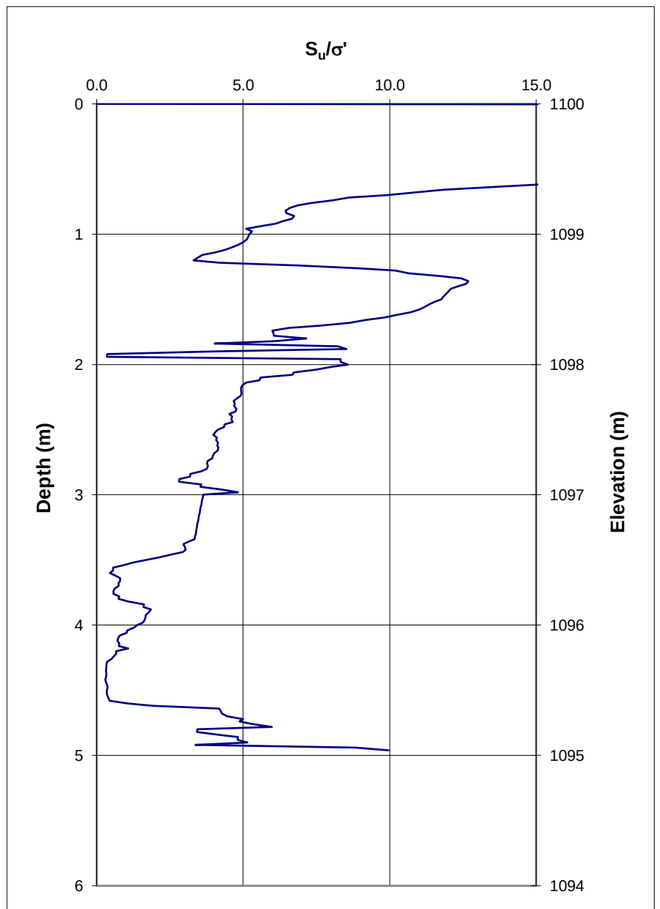
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-05

CPT-T-13-05



Method: Aas et.al (1986)
Assumption: Nkt= 15



Assumptions: y above WT: 18 kN/m³
y above WT: 18.5 kN/m³

PROJECT:	VM00605E			
	CPT DATE:	October 7, 2013	Prepared by:	Ewelina Halyno
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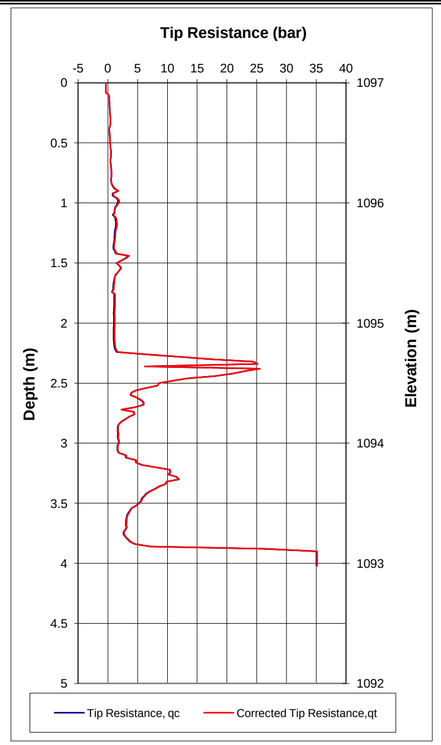
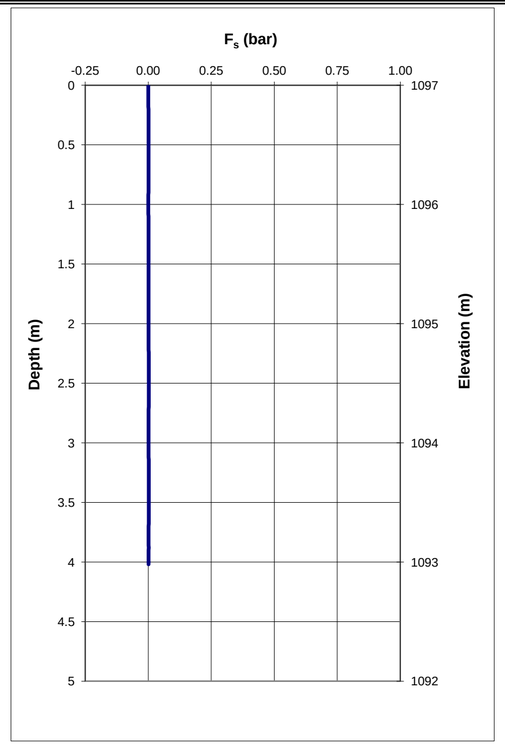
MOUNT NANSEN
CPT INTERPERTATION

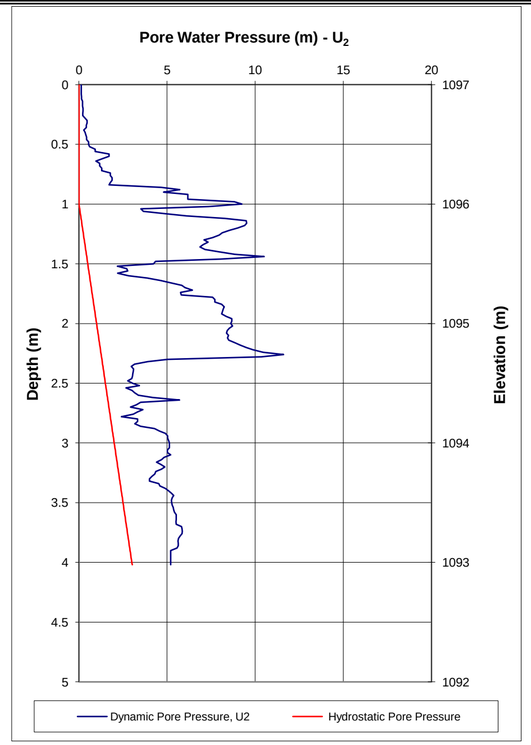
CPT-T-13-05

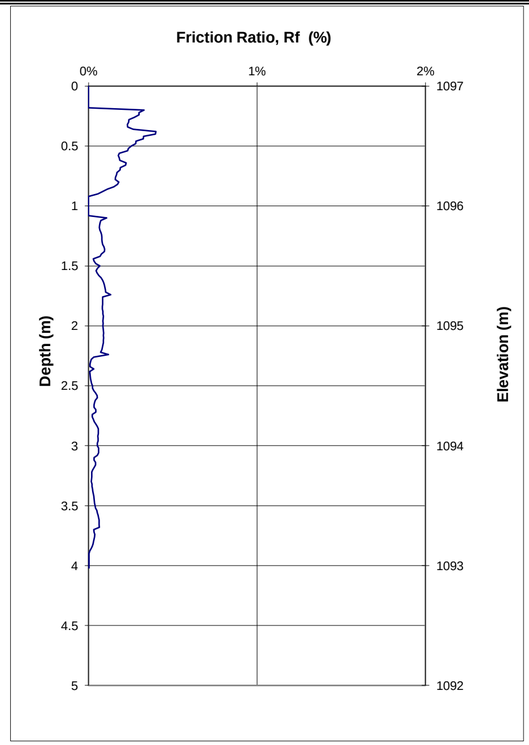
CPT-T-13-06

Tailings









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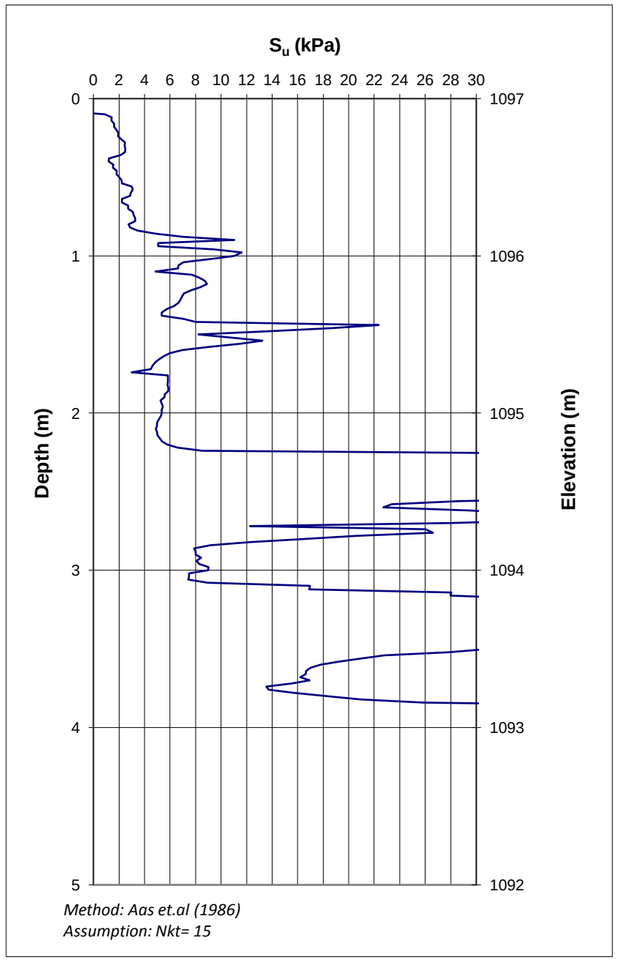
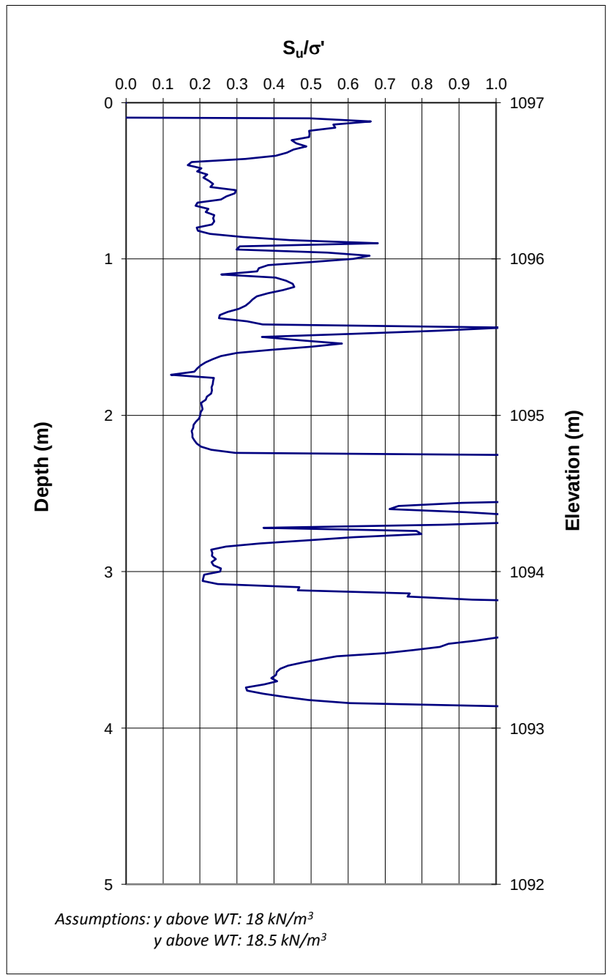
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-06

CPT-T-13-06





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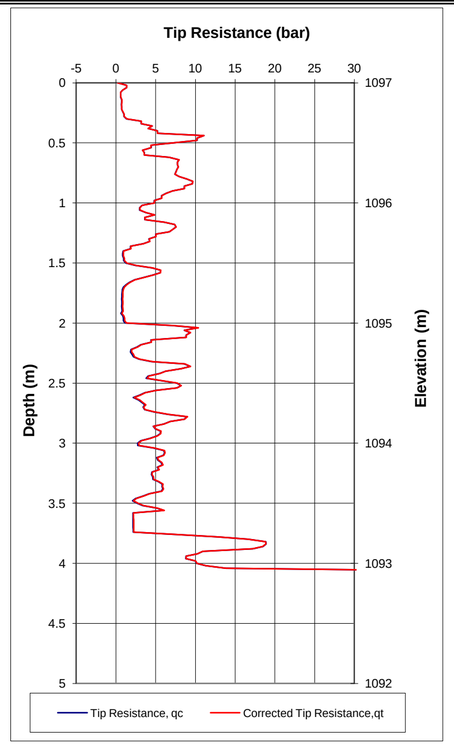
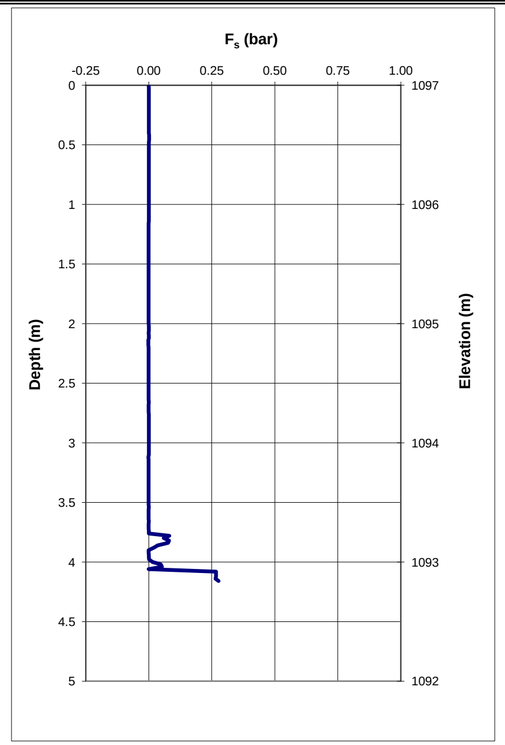
MOUNT NANSEN
CPT INTERPERTATION

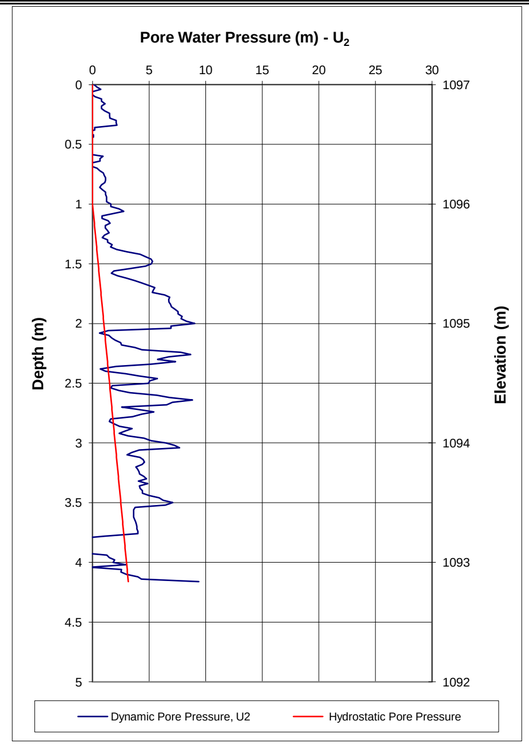
CPT-T-13-06

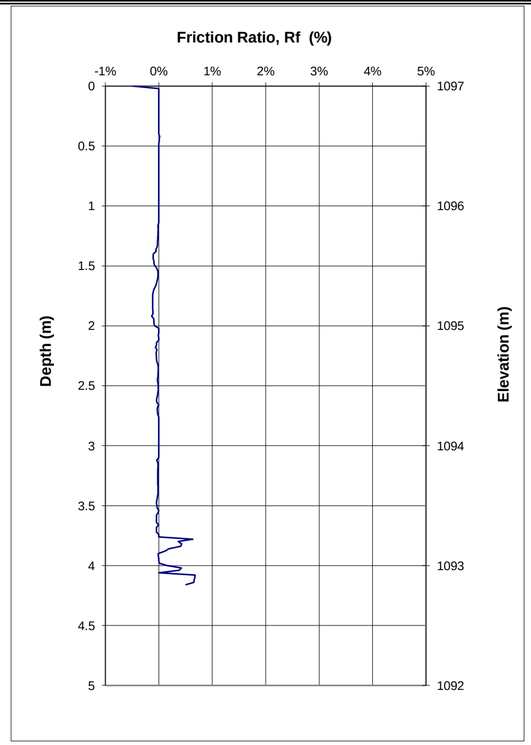
CPT-T-13-07 (A)

Tailings









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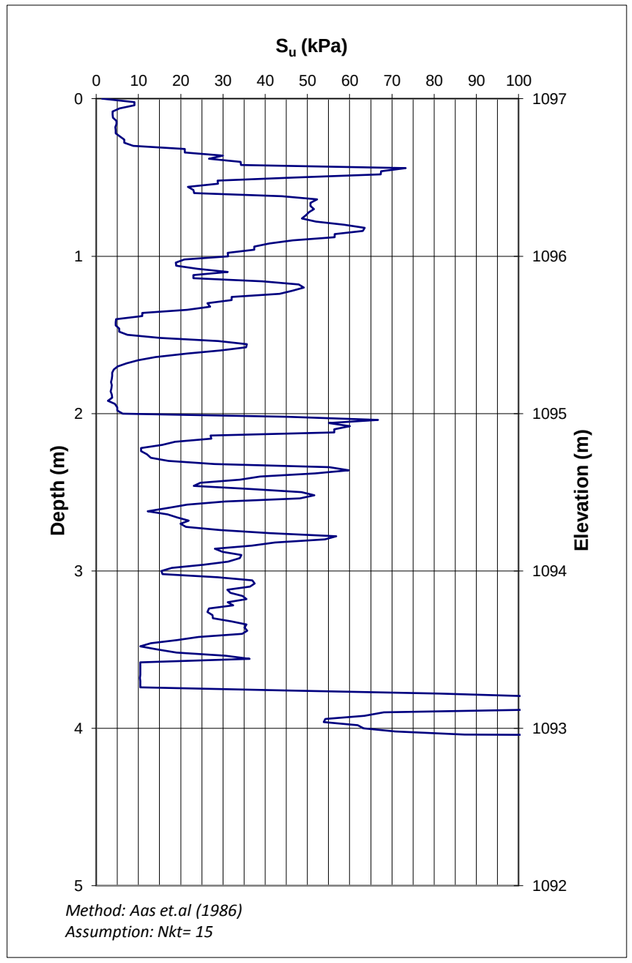
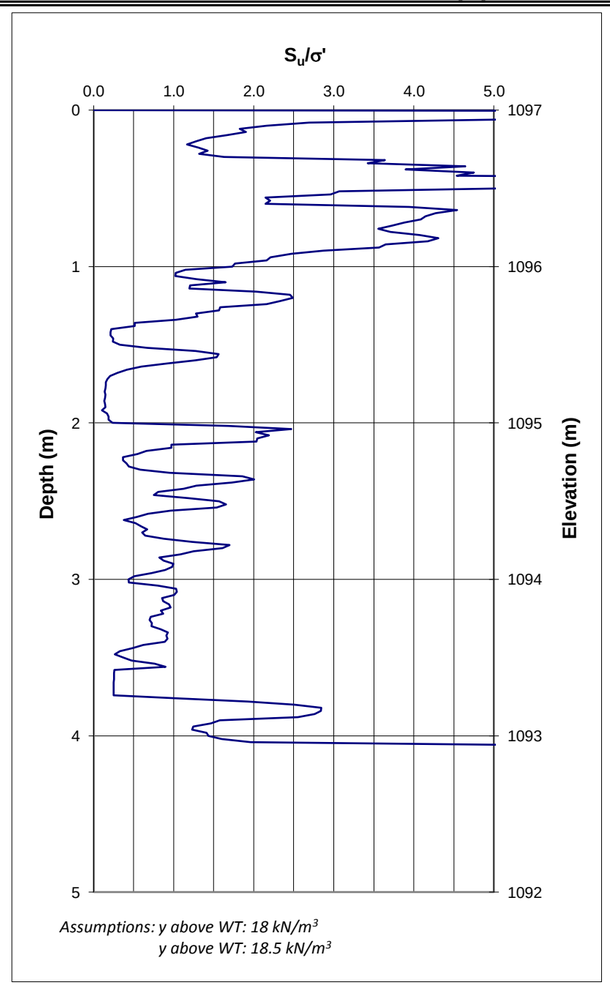
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-07 (A)

CPT-T-13-07 (A)



Method: Aas et.al (1986)
Assumption: Nkt= 15



Assumptions: y above WT: 18 kN/m³
y above WT: 18.5 kN/m³

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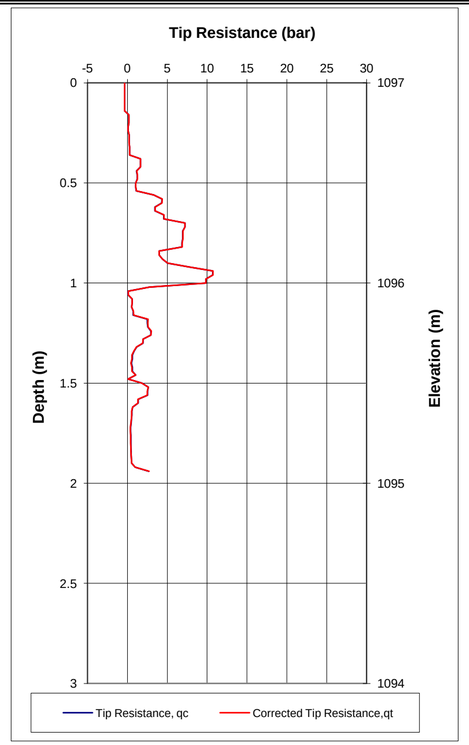
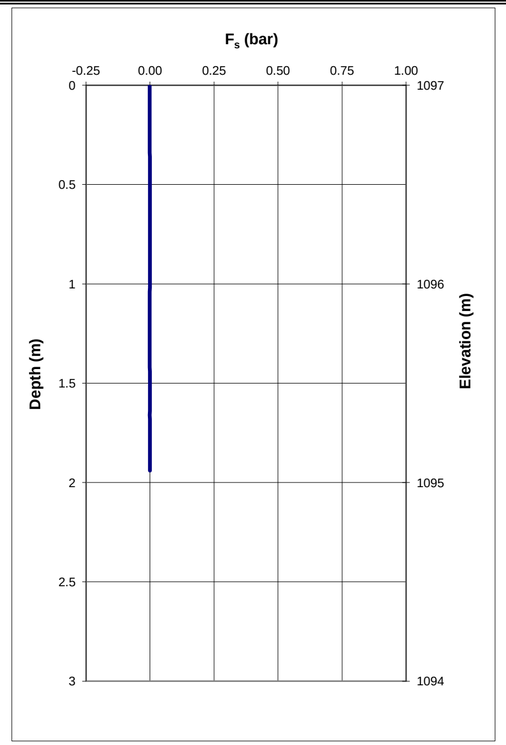
MOUNT NANSEN
CPT INTERPERTATION

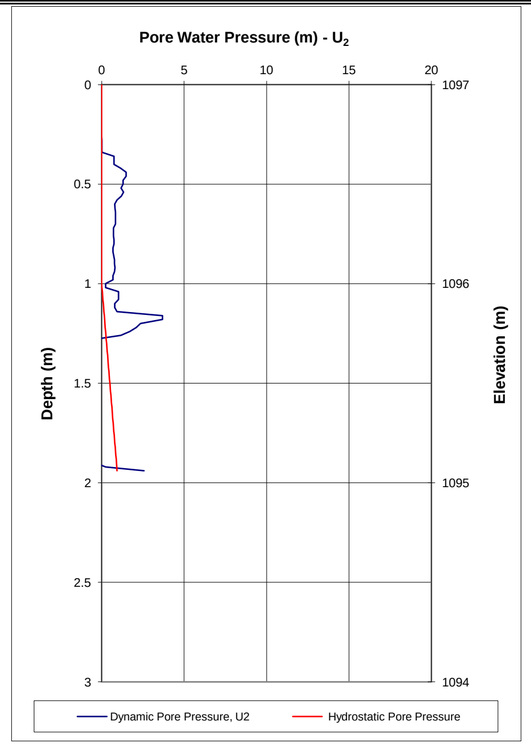
CPT-T-13-07 (A)

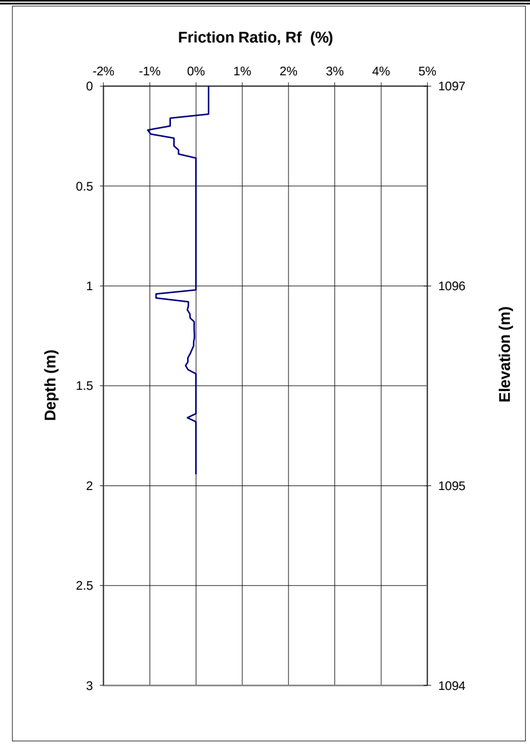
CPT-T-13-07 (B)

Tailings









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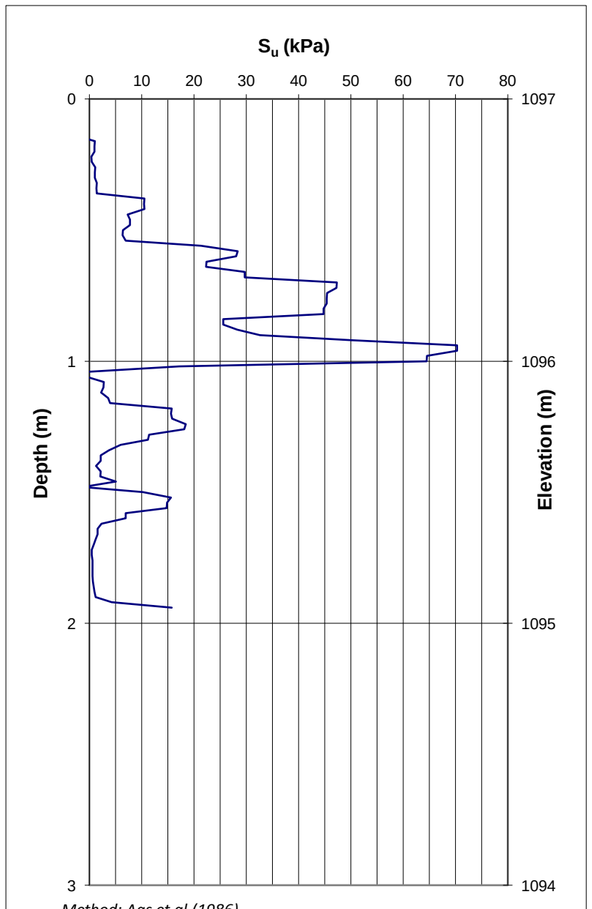
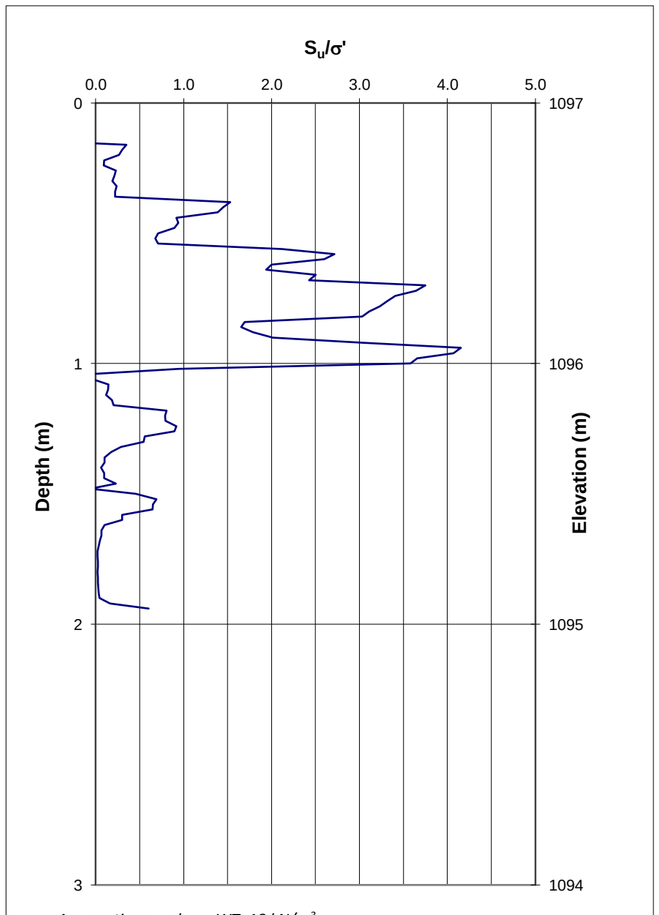
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-07 (B)

CPT-T-13-07 (B)



Method: Aas et.al (1986)
Assumption: Nkt= 15



Assumptions: y above WT: 18 kN/m³
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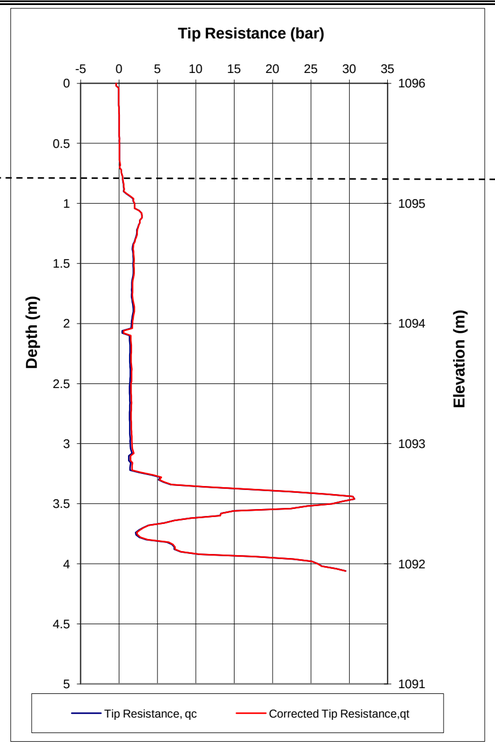
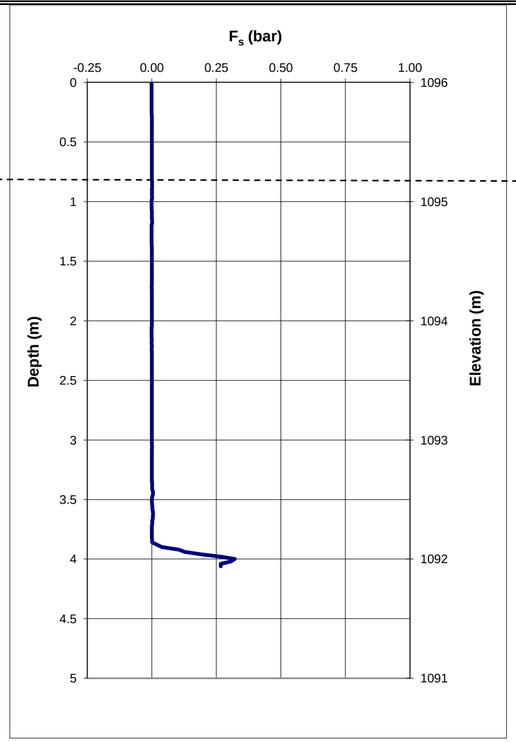
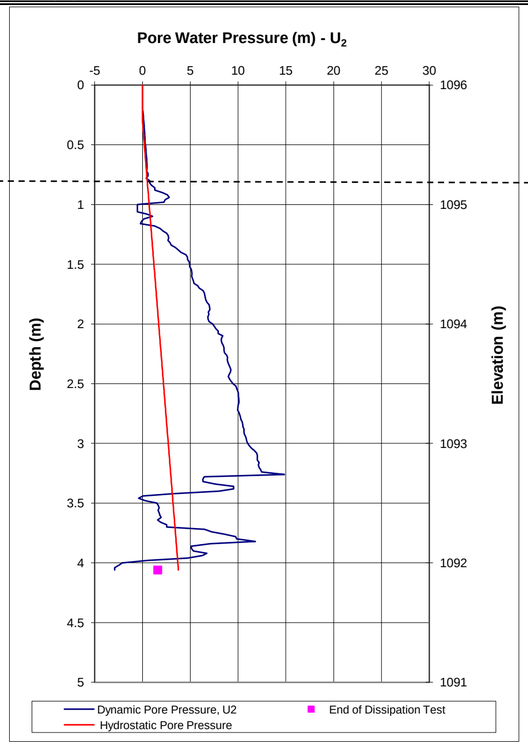
CPT INTERPERTATION

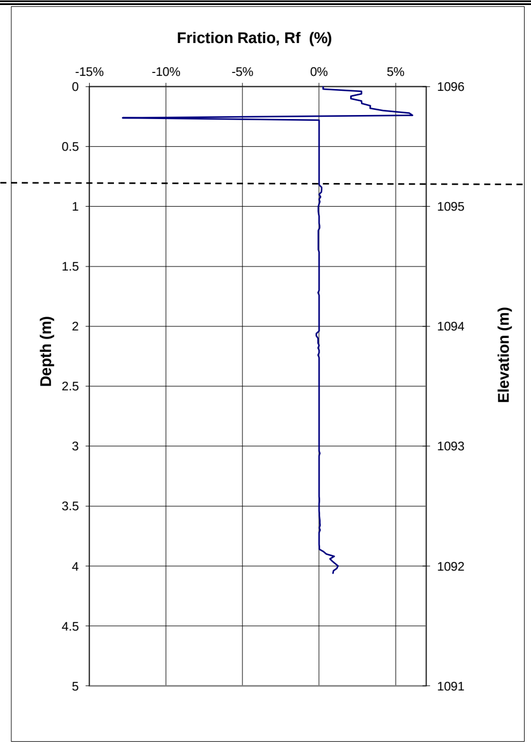
CPT-T-13-07 (B)

CPT-T-13-08 (A)









PROJECT: VM00605E

CPT DATE: October 4, 2013 Prepared by: Ewelina Halyno

DATE: March 7, 2014 Reviewed by: Renata Wood

NOTE:

1. Depth Measured Relative to Barge Deck Elevation

2. Pond Elevation of 1095.8m Provided by AAM

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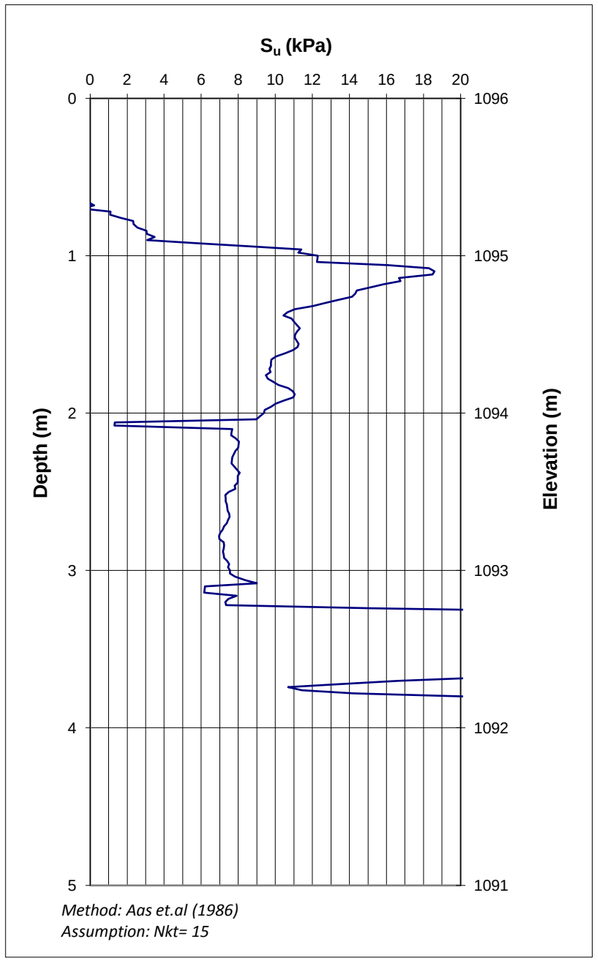
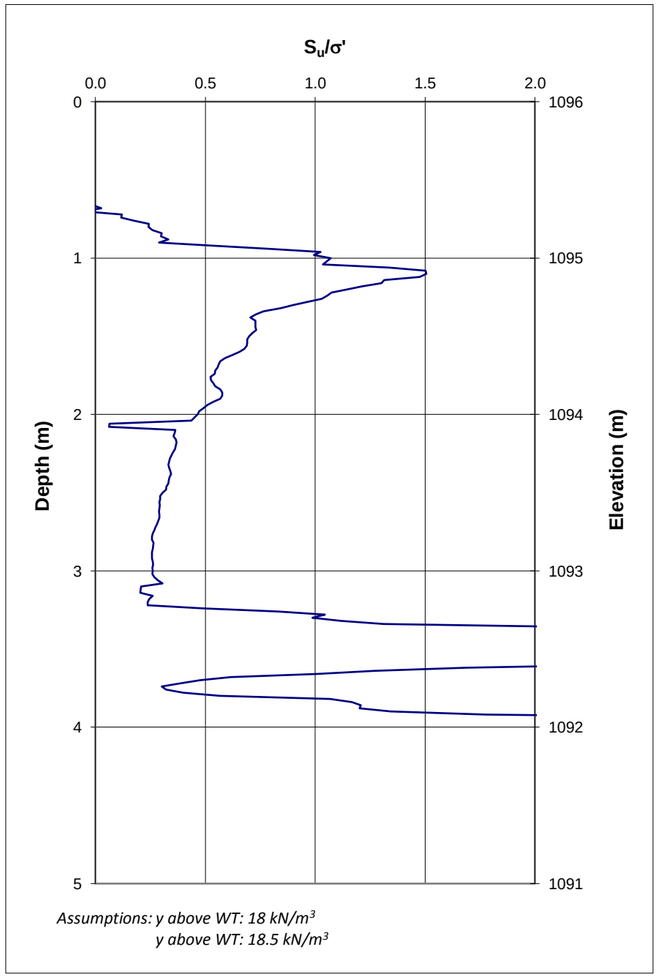
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-08 (A)

CPT-T-13-08 (A)





PROJECT: VM00605E

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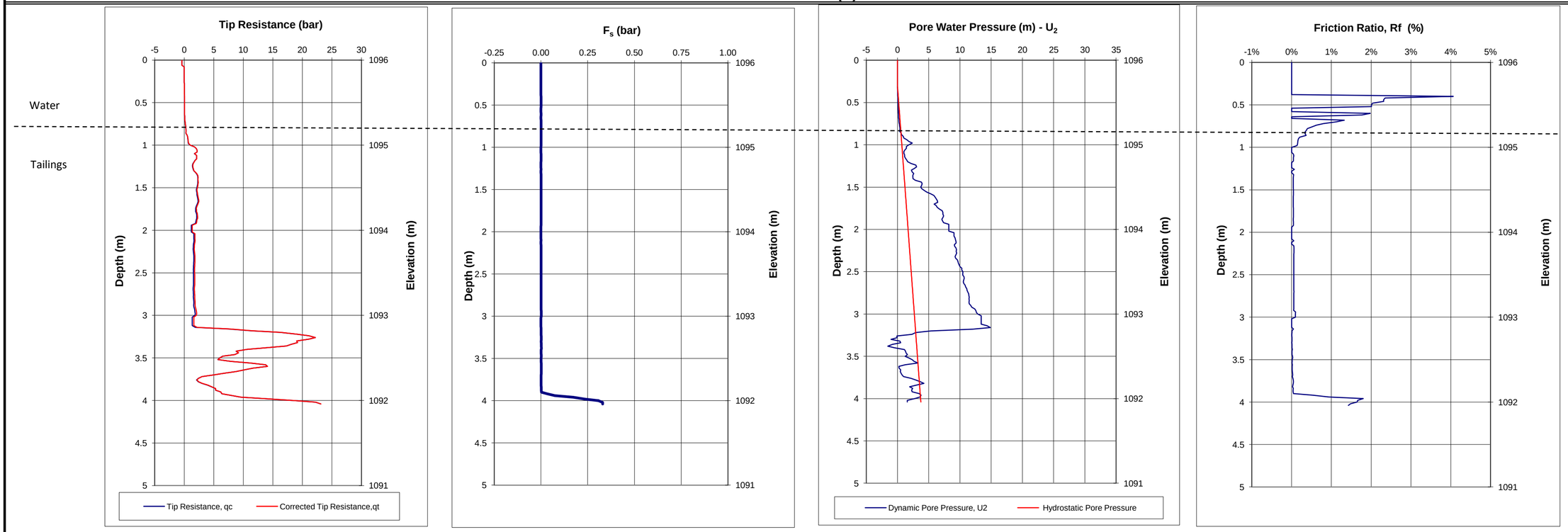
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-08 (A)

CPT-T-13-08 (B)



PROJECT: VM00605E

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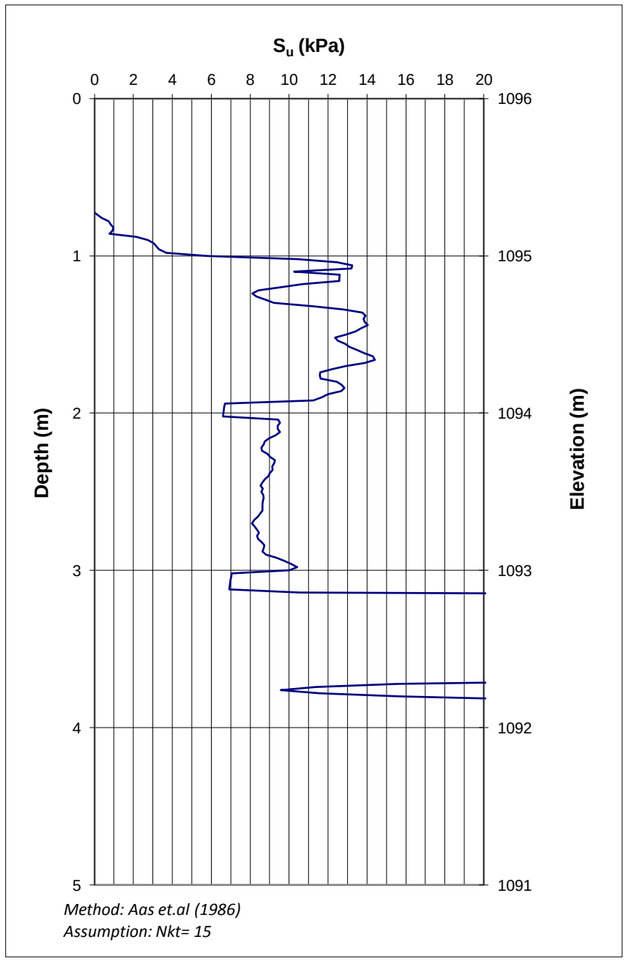
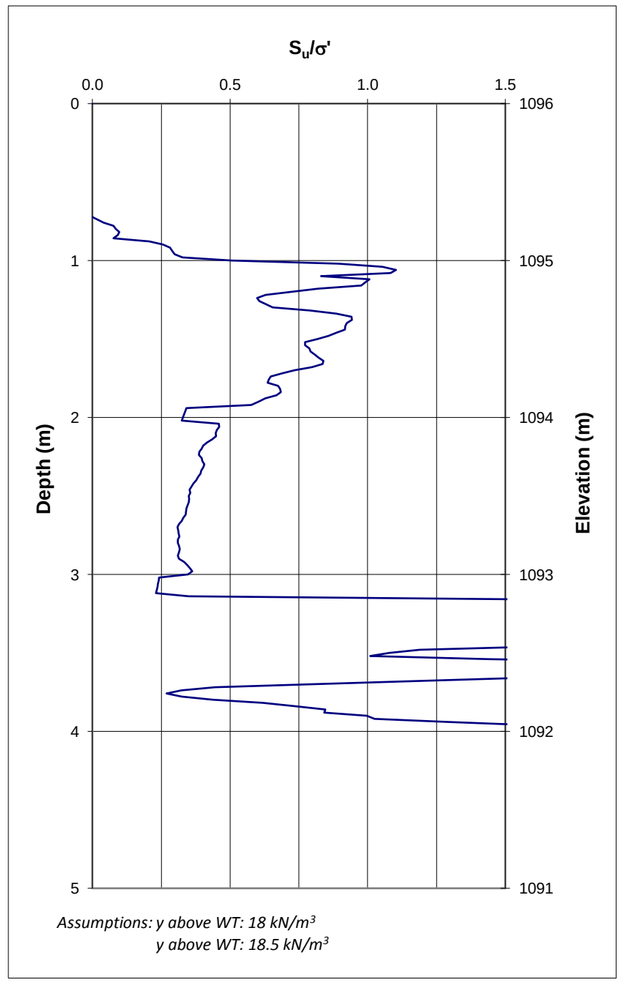
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-08 (B)

CPT-T-13-08 (B)





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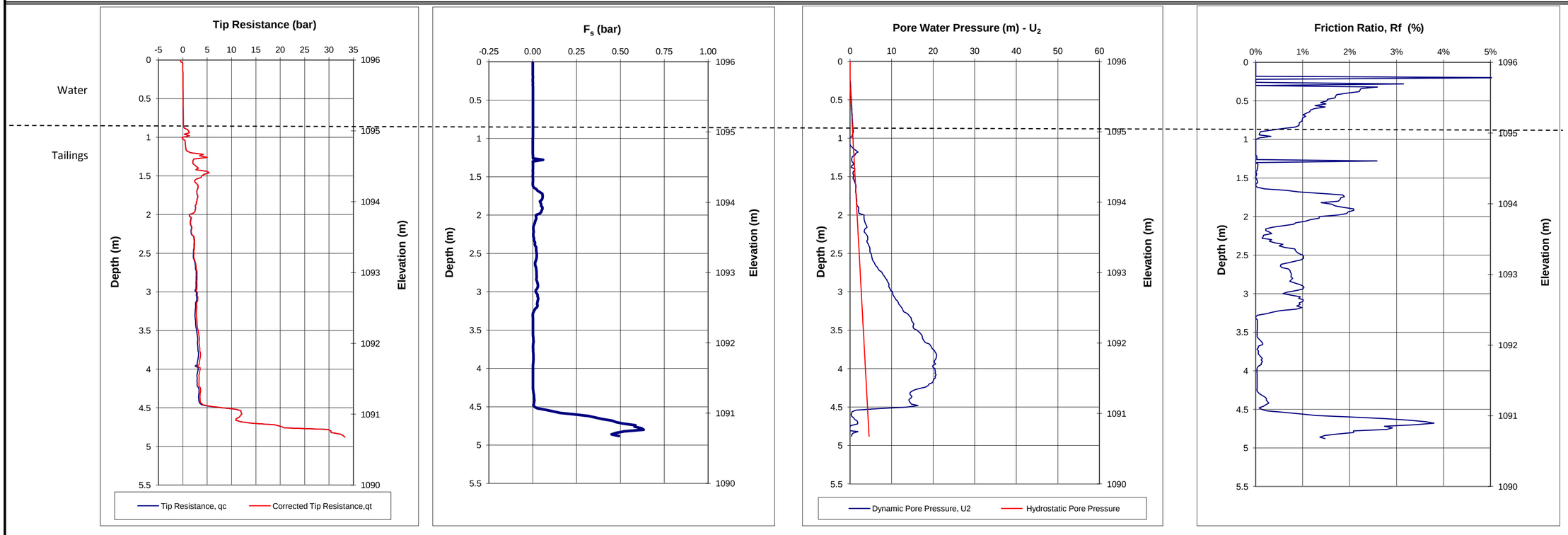
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-08 (B)

CPT-T-13-09



PROJECT: VM00605E

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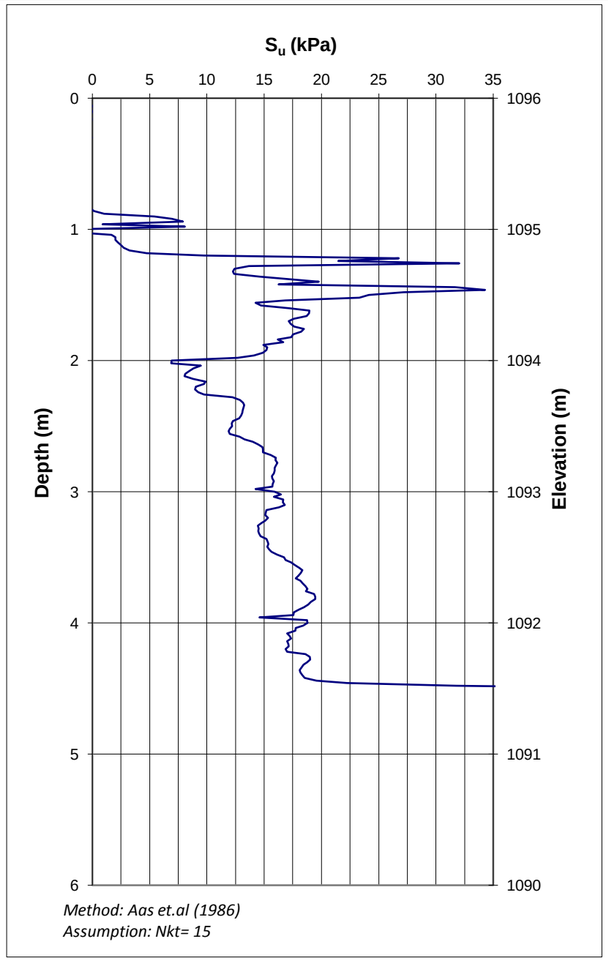
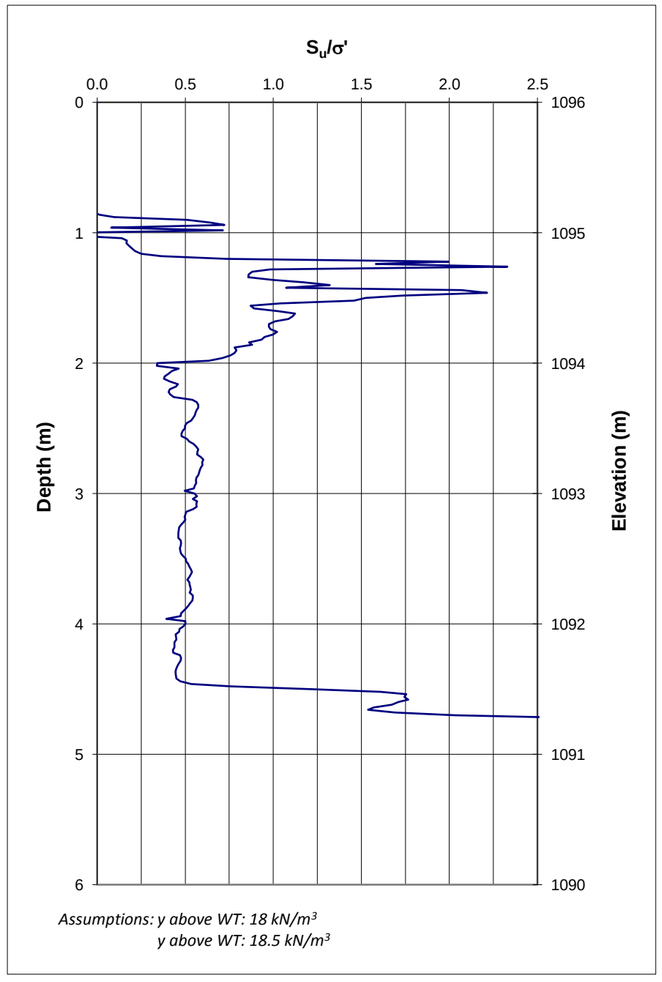
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-09

CPT-T-13-09





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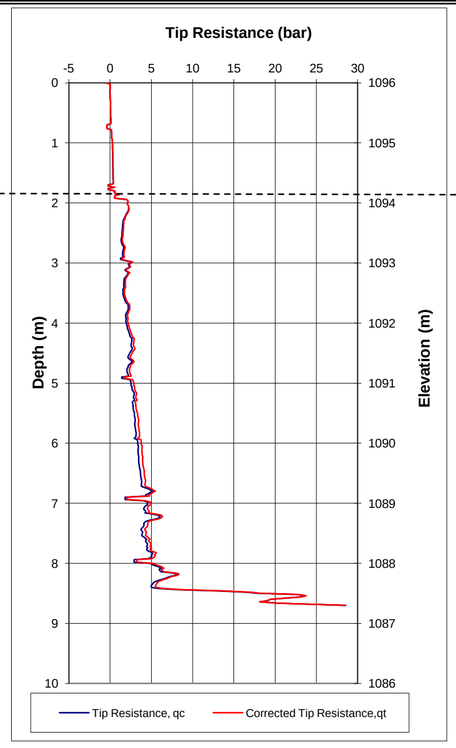
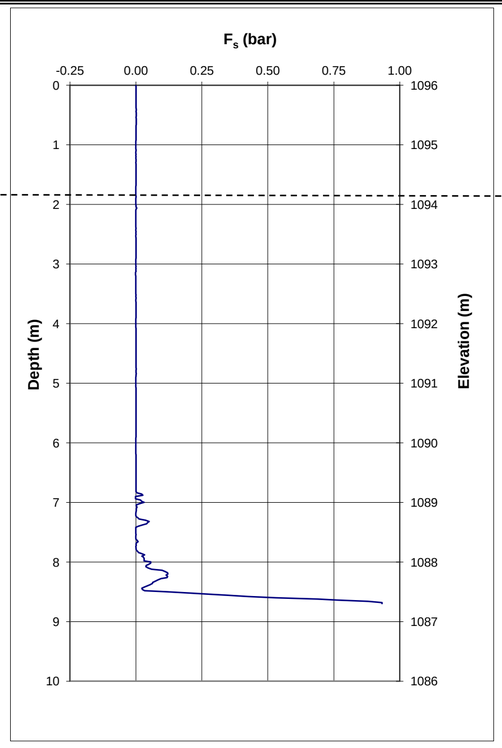
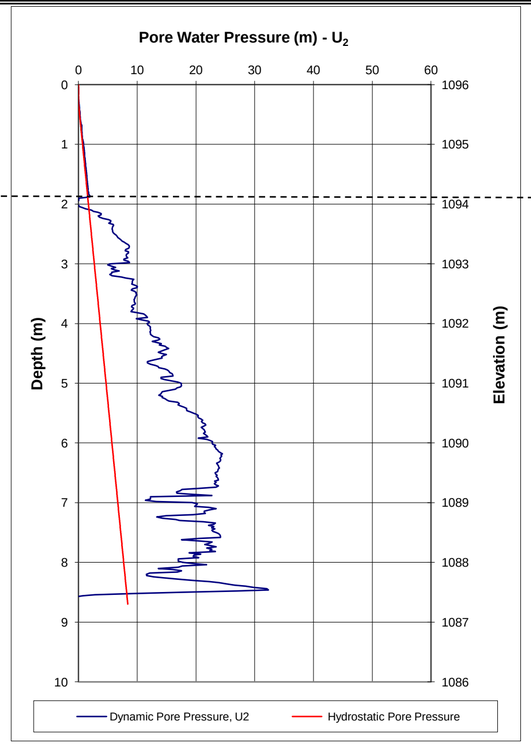
MOUNT NANSEN
CPT INTERPERTATION

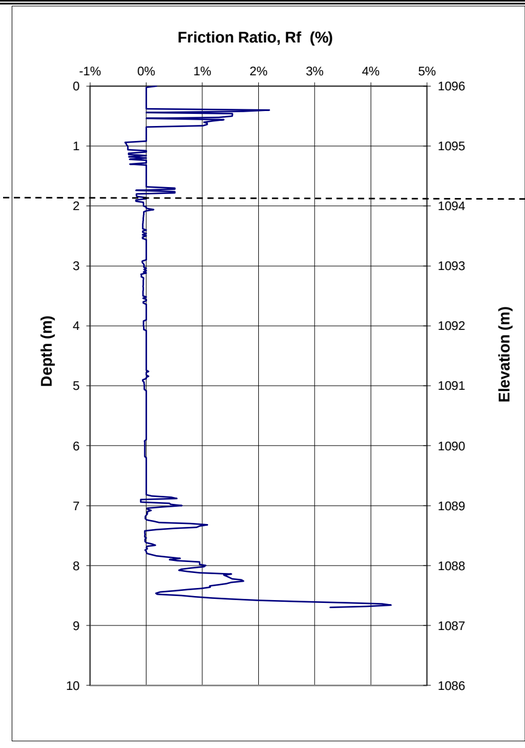
CPT-T-13-09

CPT-T-13-10 (A)









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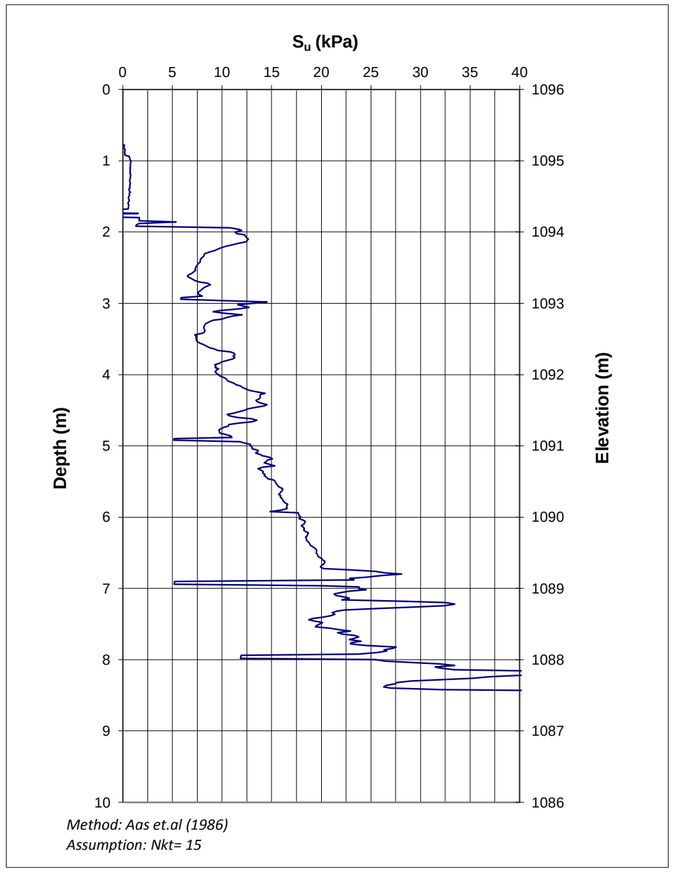
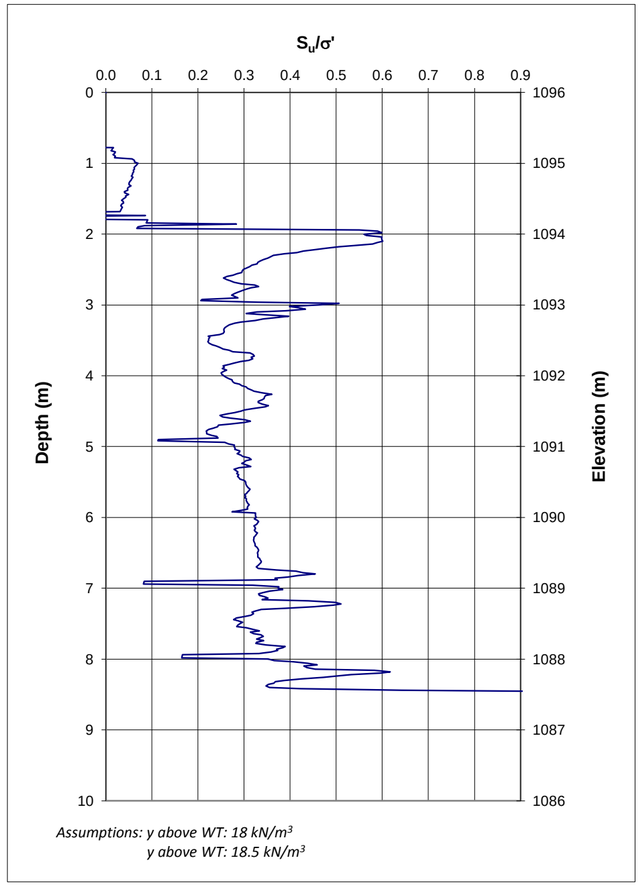
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-10 (A)

CPT-T-13-10 (A)





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CPT DATE: October 4, 2013
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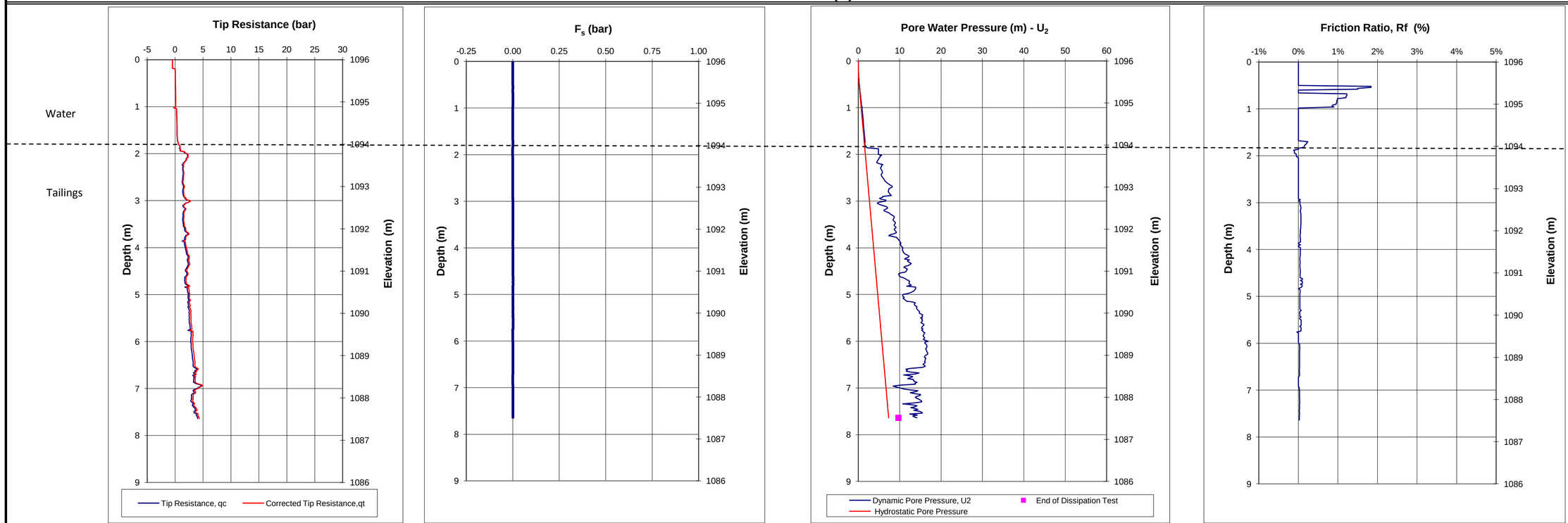
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-10 (A)

CPT-13-10 (B)



PROJECT: VM00605E

NOTE:

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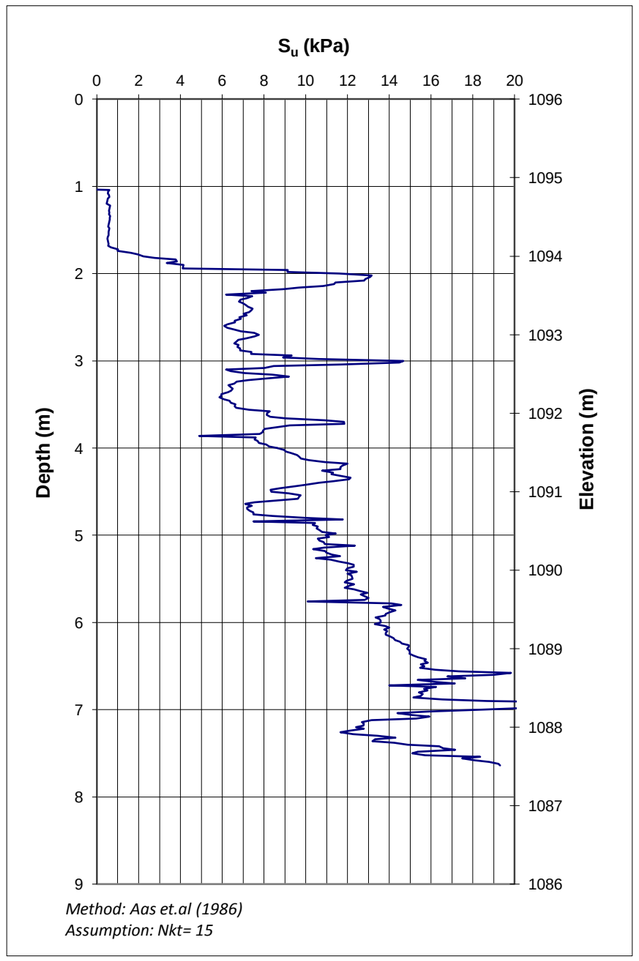
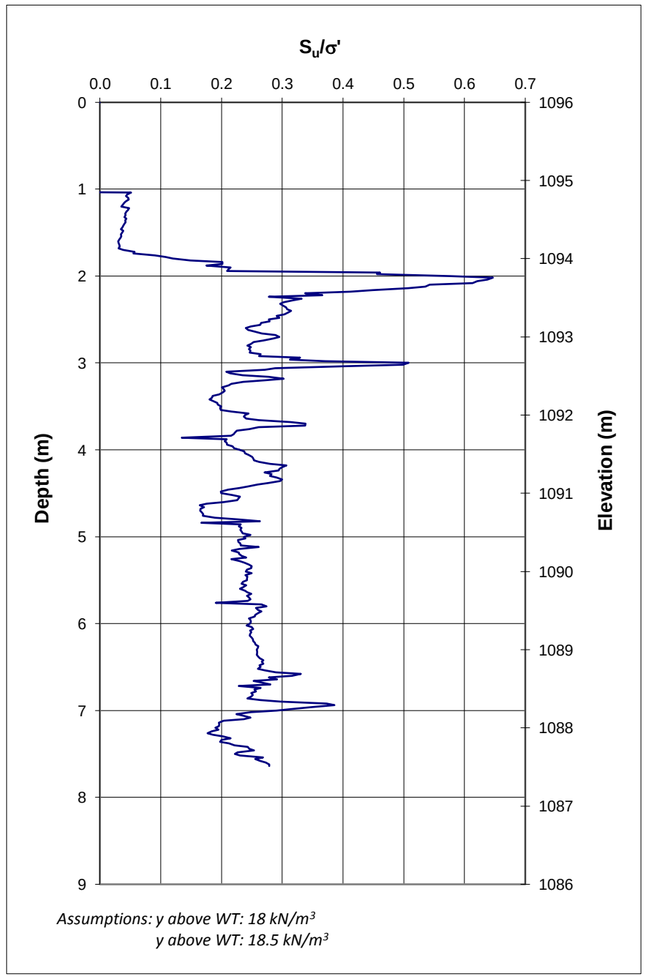
MOUNT NANSEN
CPT INTERPERTATION

CPT-13-10 (B)

CPT-13-10 (B)





PROJECT: VM00605E

CPT DATE:	October 4, 2013	Prepared by:	Ewelina Halyno
DATE:	March 7, 2014	Reviewed by:	Renata Wood

NOTE:

1. Depth Measured Relative to Barge Deck Elevation

2. Pond Elevation of 1095.8m Provided by AAM

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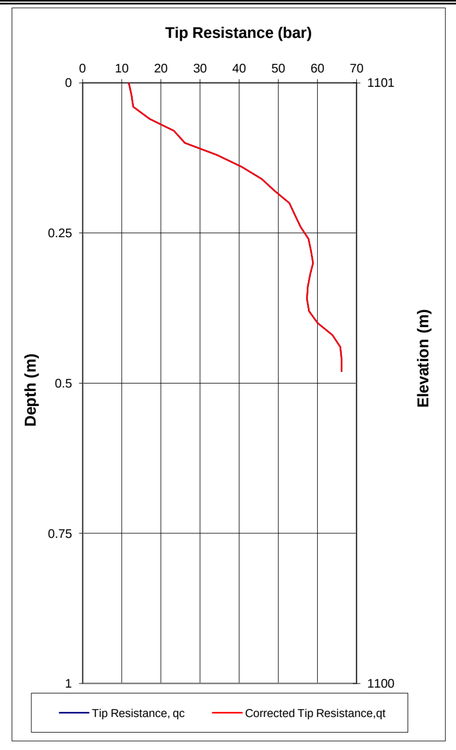
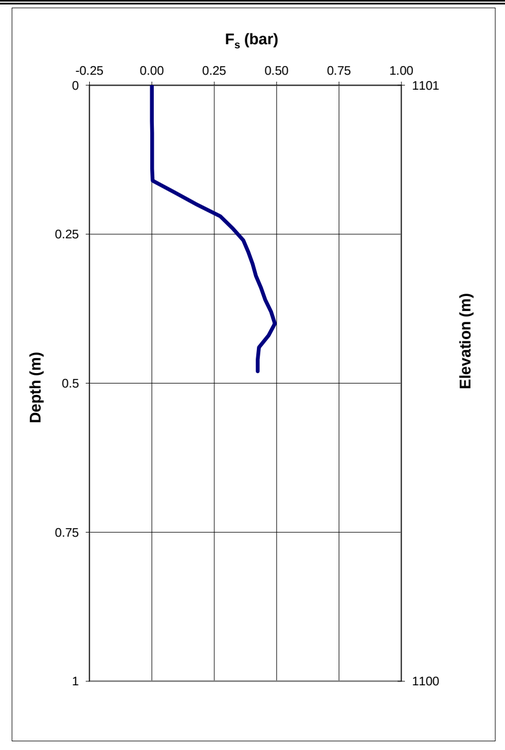
MOUNT NANSEN
CPT INTERPERTATION

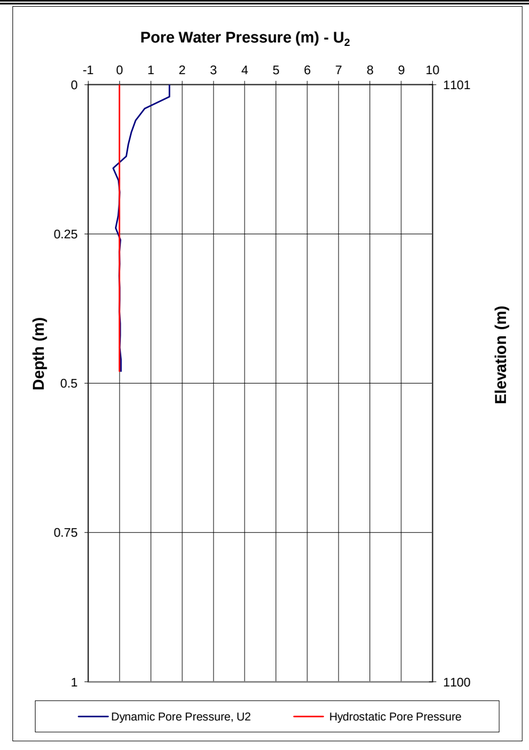
CPT-13-10 (B)

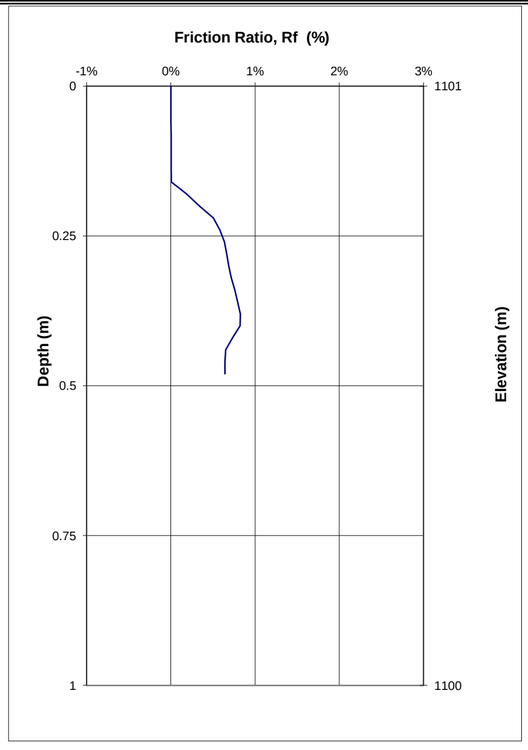
CPT-T-13-11

Tailings









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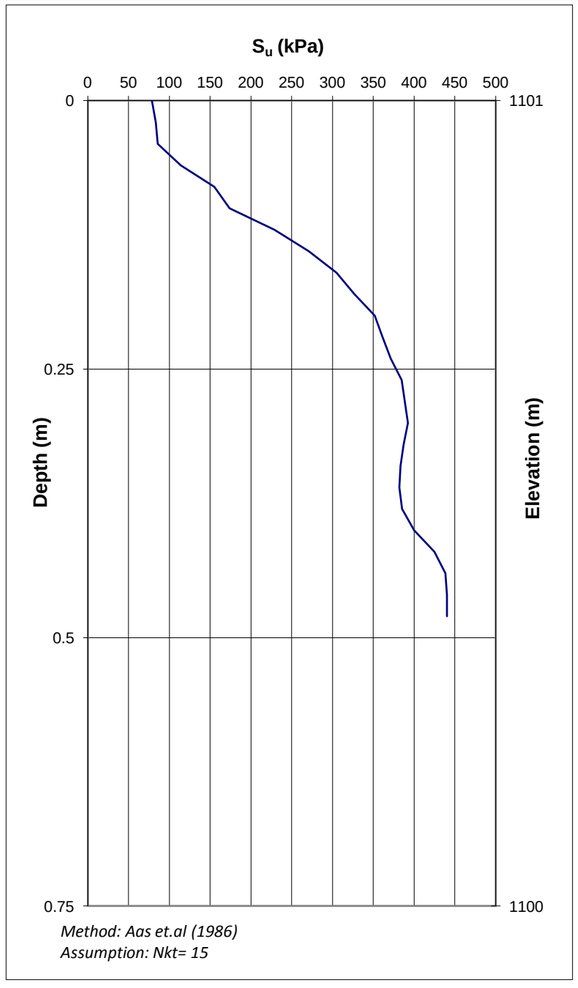
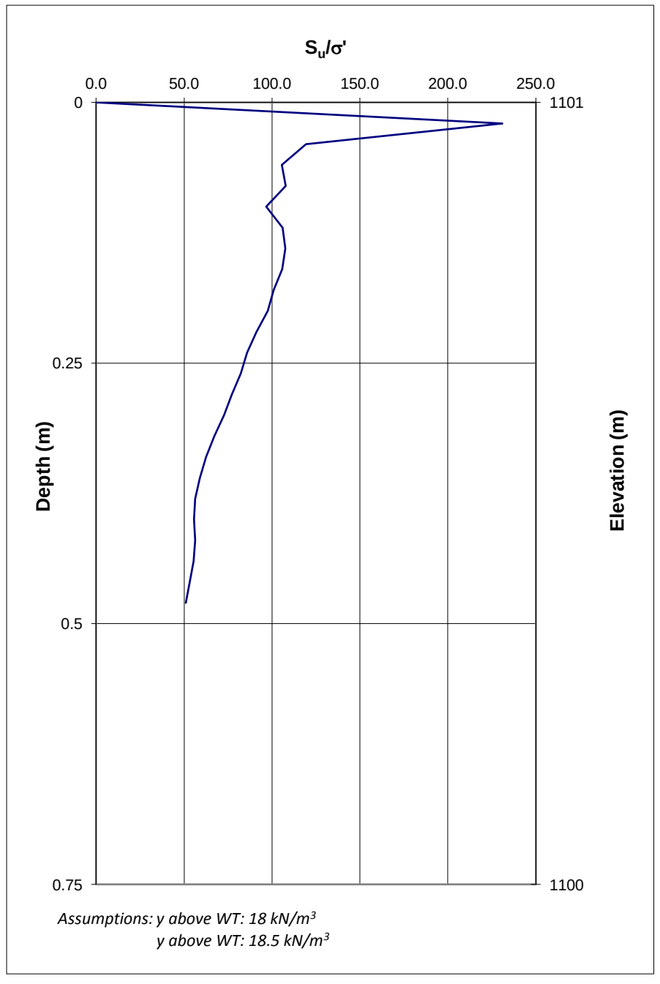
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-11

CPT-T-13-11



Method: Aas et.al (1986)
Assumption: Nkt= 15



Assumptions: y above WT: 18 kN/m³
y above WT: 18.5 kN/m³

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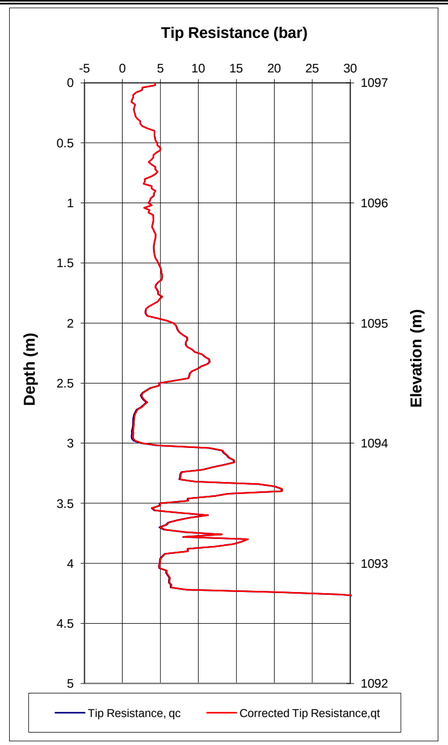
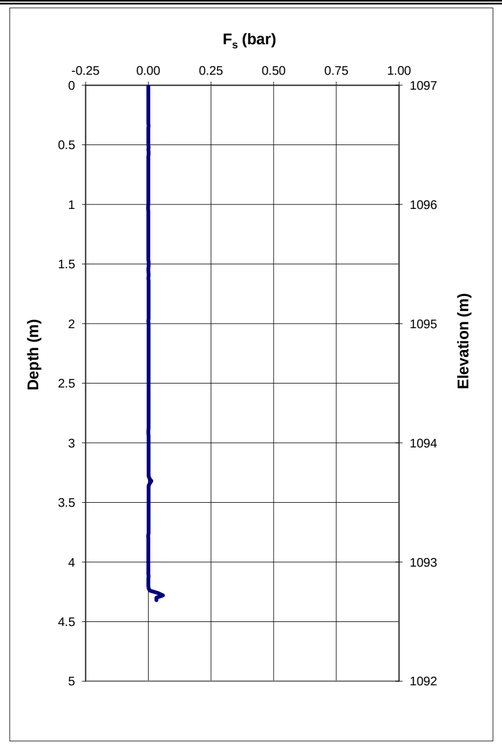
MOUNT NANSEN
CPT INTERPERTATION

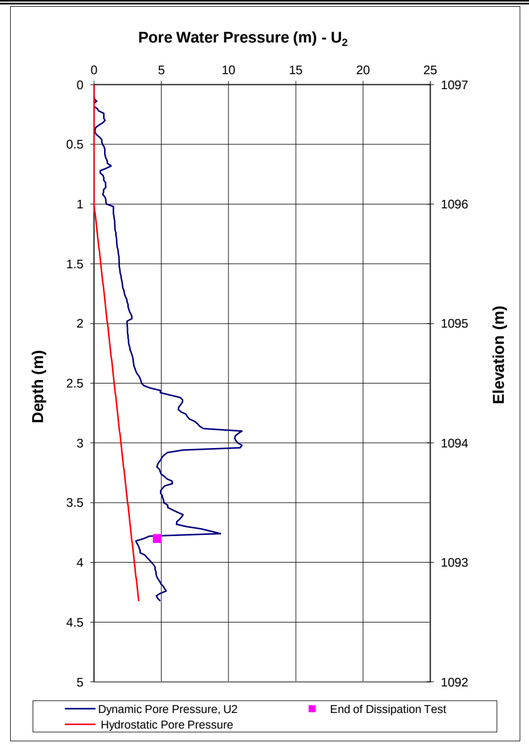
CPT-T-13-11

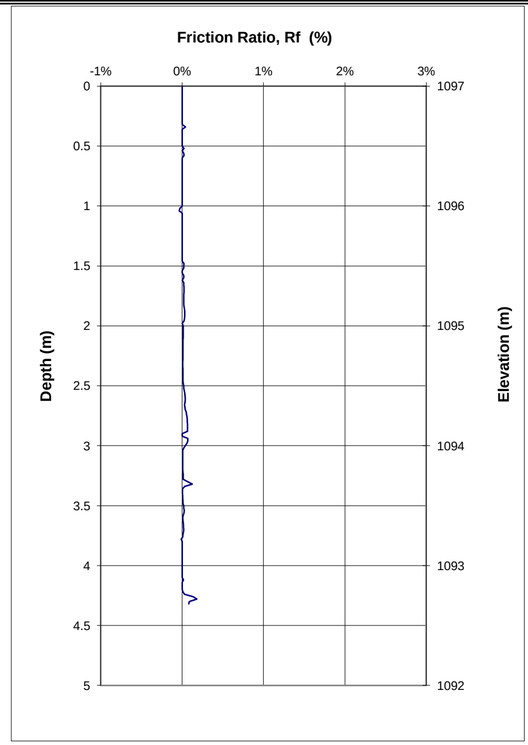
CPT-T-13-12

Tailings









PROJECT: VM00605E

CPT DATE: October 6, 2013 Prepared by: Ewelina Halyno

DATE: 07/03/201 Reviewed by: Renata Wood

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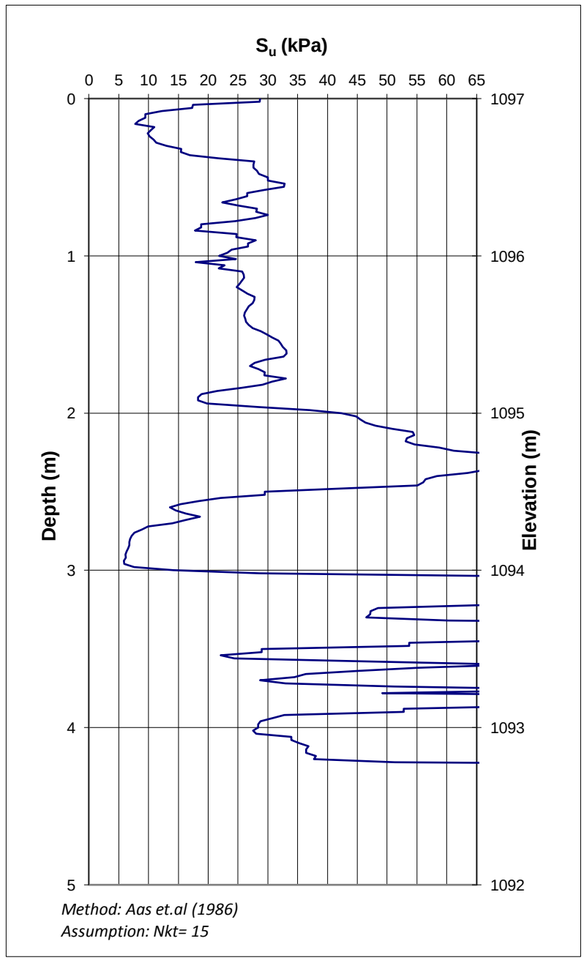
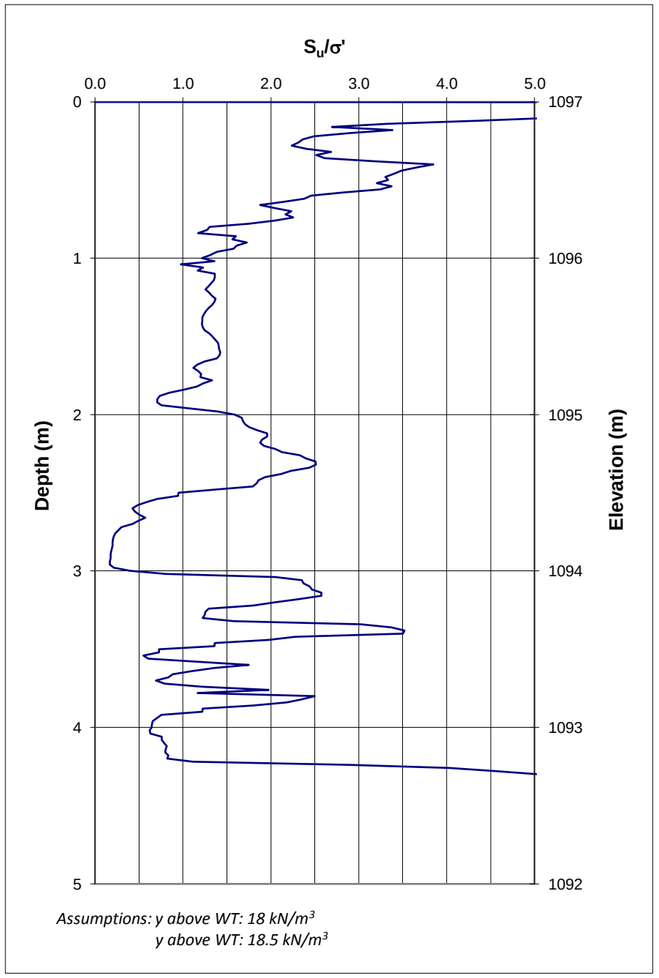
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-12

CPT-T-13-12



Method: Aas et.al (1986)
Assumption: Nkt= 15



Assumptions: y above WT: 18 kN/m³
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PROJECT: VM00605E

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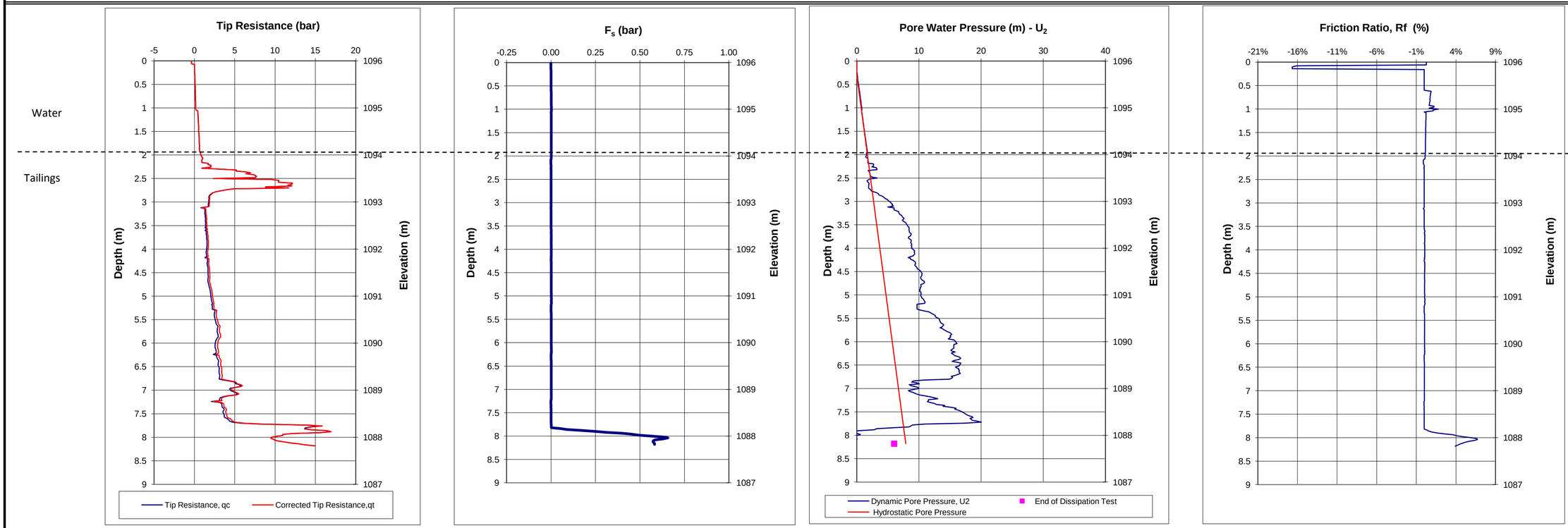
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-12

CPT-T-13-13



PROJECT: VM00605E

NOTE:

CPT DATE: October 4, 2013 Prepared by: Ewelina Halyno

DATE: March 7, 2014 Reviewed by: Renata Wood

1. Depth Measured Relative to Barge Deck Elevation
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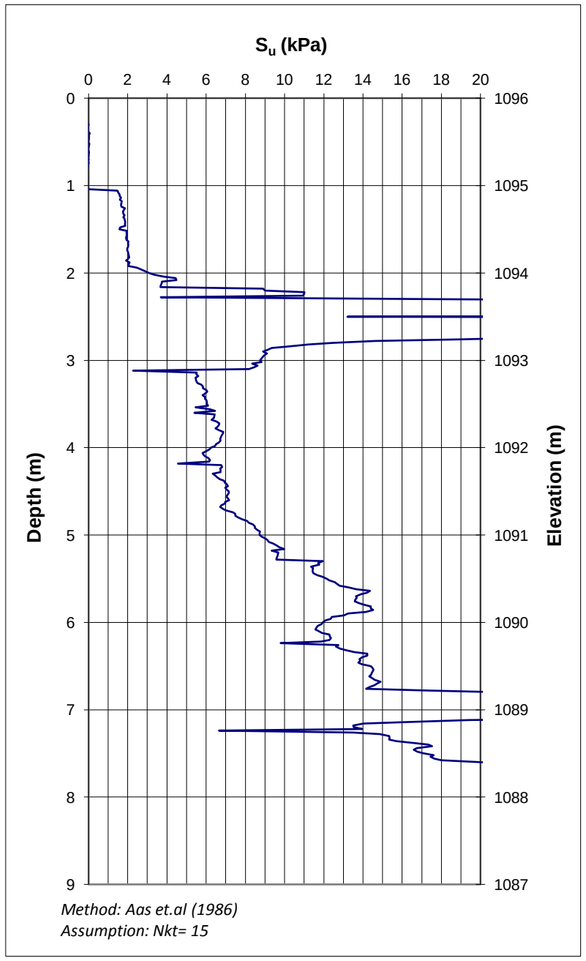
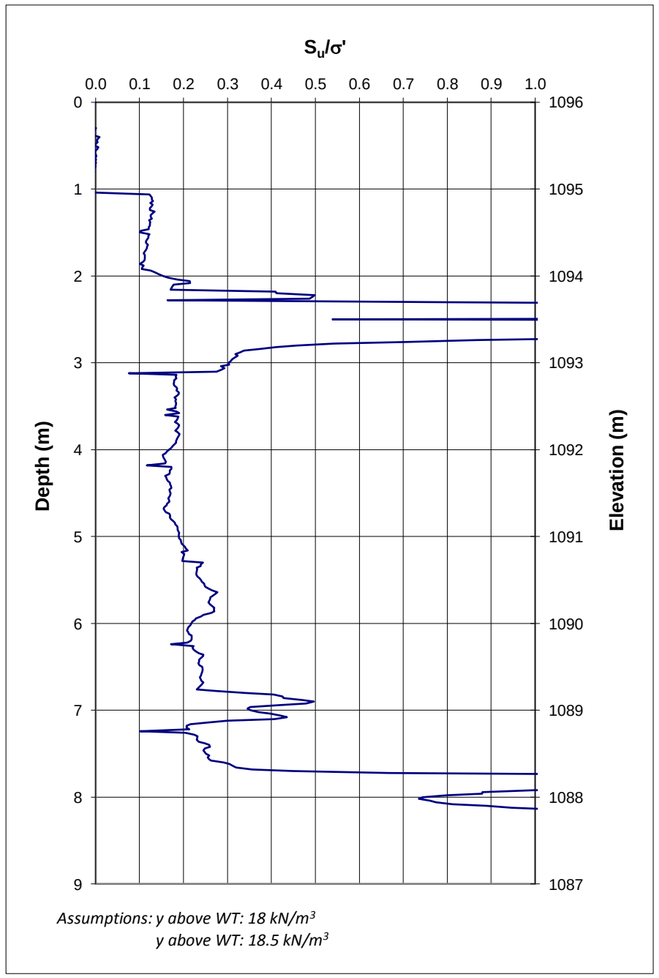
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-13

CPT-T-13-13





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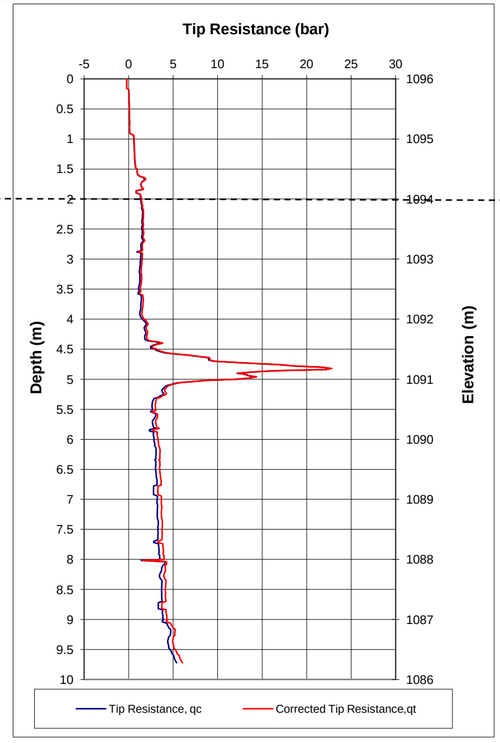
MOUNT NANSEN
CPT INTERPERTATION

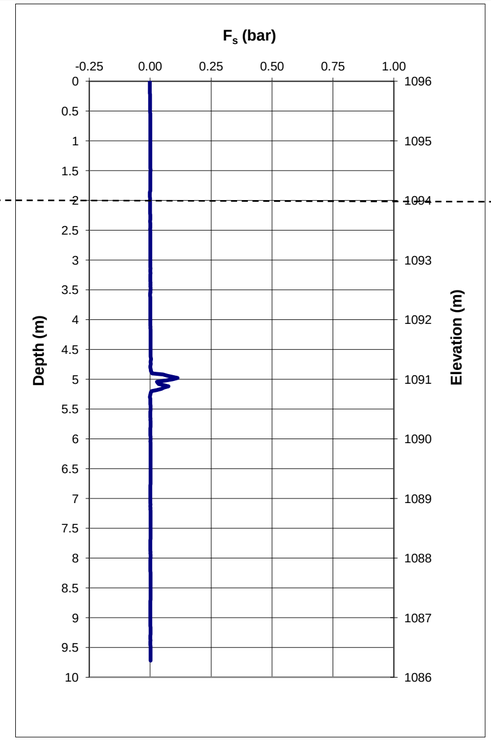
CPT-T-13-13

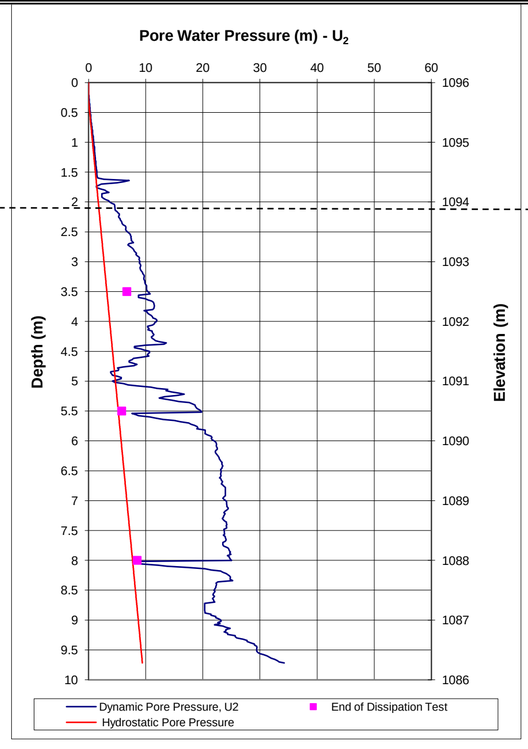
CPT-T-13-14

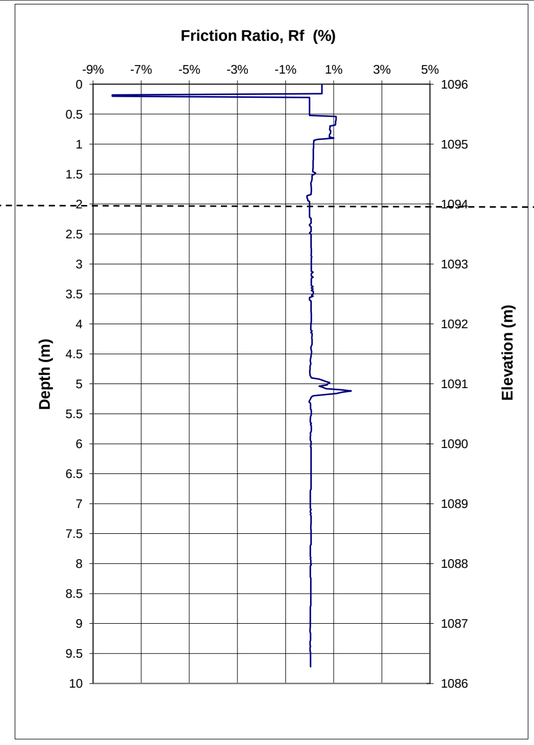
Water

Tailings









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CPT DATE: October 6, 2013 Prepared by: Ewelina Halyno

DATE: March 7, 2013 Reviewed by: Renata Wood

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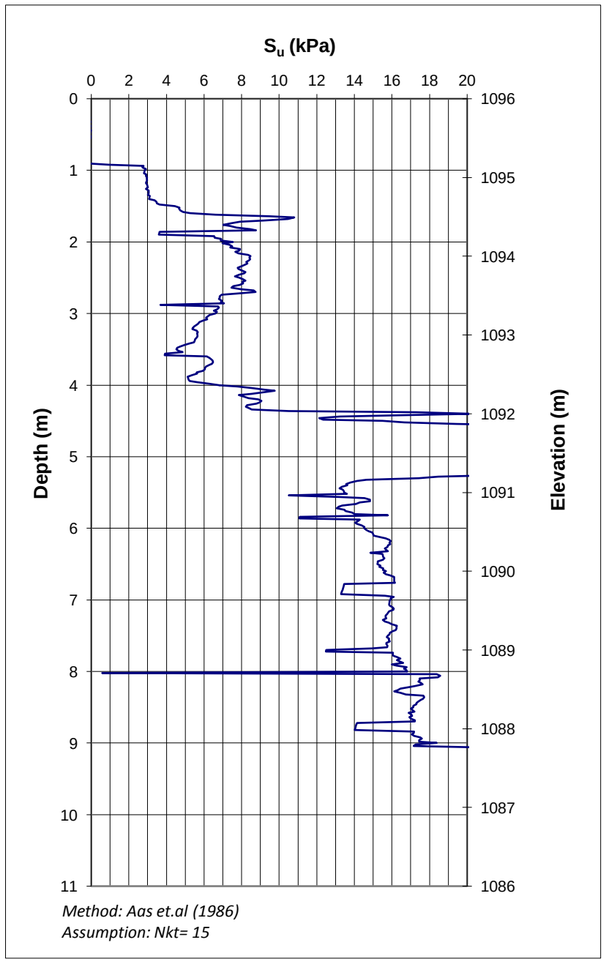
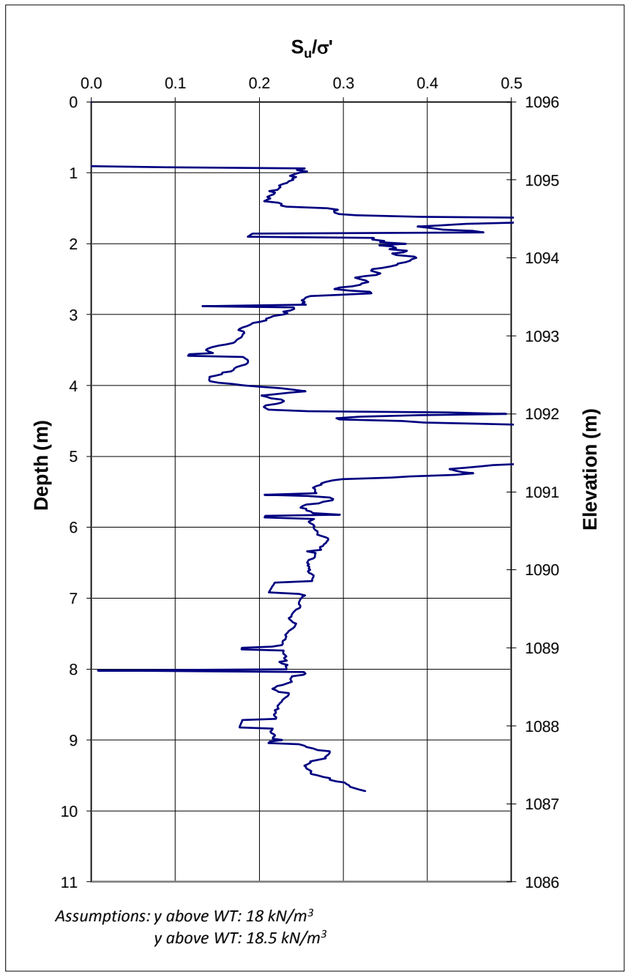
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-14

CPT-T-13-14



Method: Aas et.al (1986)
Assumption: Nkt= 15



Assumptions: y above WT: 18 kN/m³
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PROJECT: VM00605E

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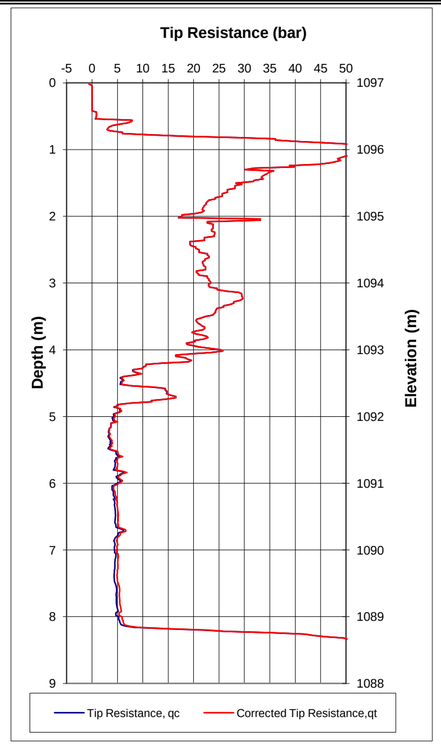
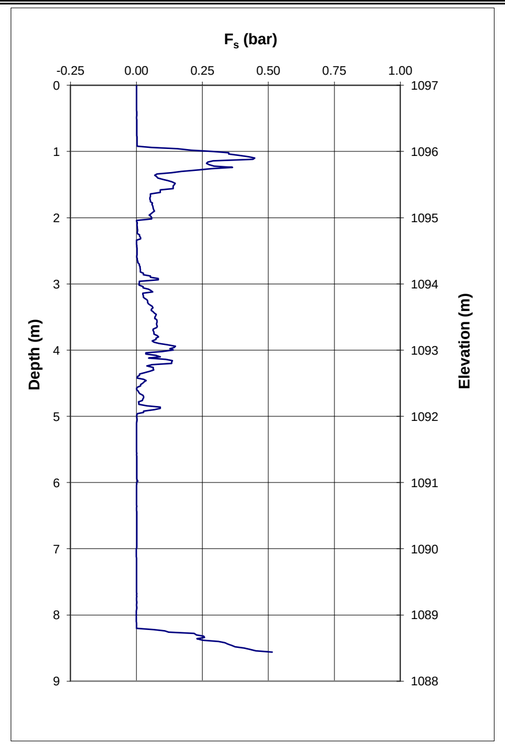
MOUNT NANSEN
CPT INTERPERTATION

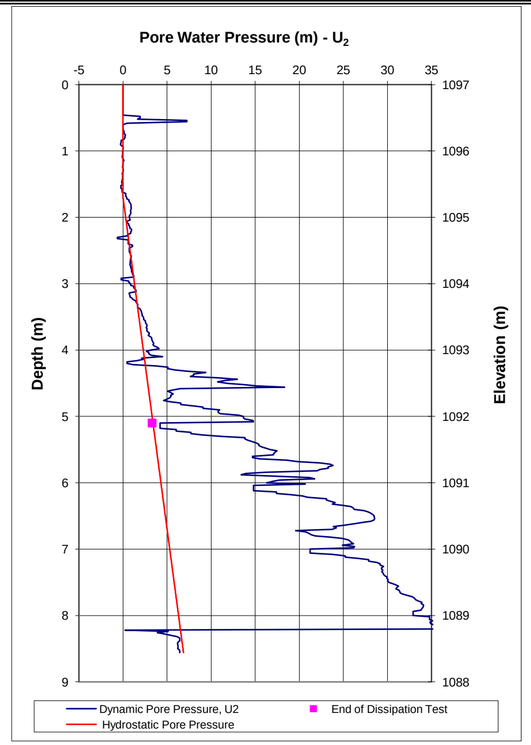
CPT-T-13-14

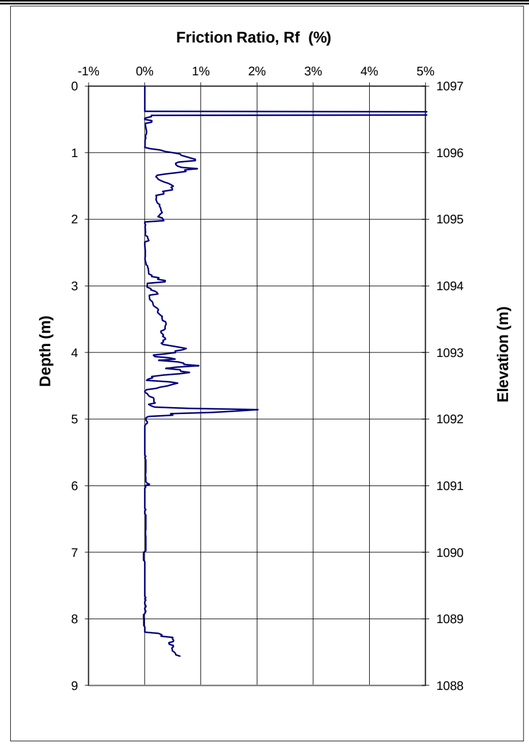
CPT-T-13-15

Tailings









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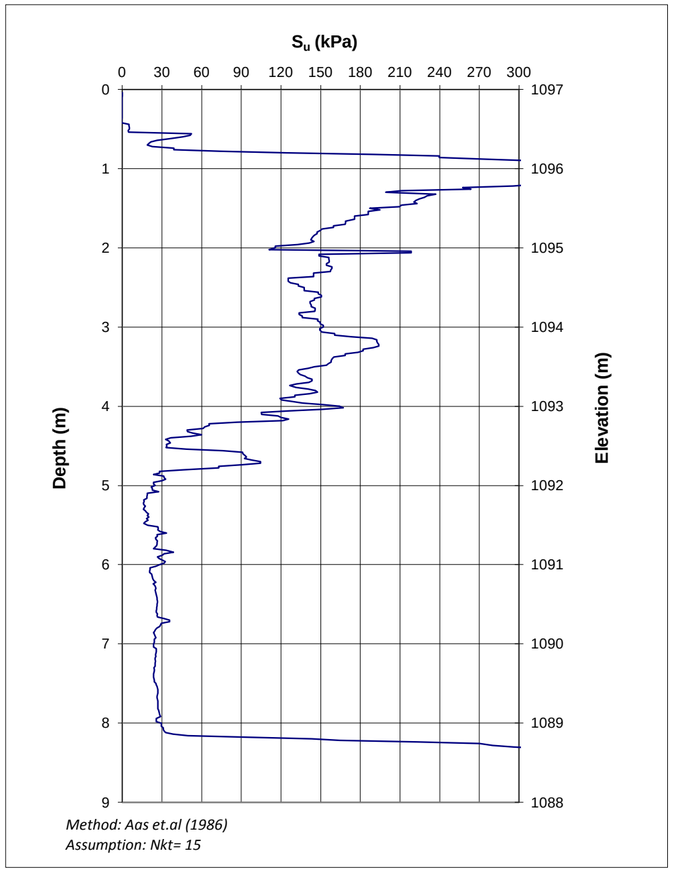
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-15

CPT-T-13-15



Method: Aas et.al (1986)
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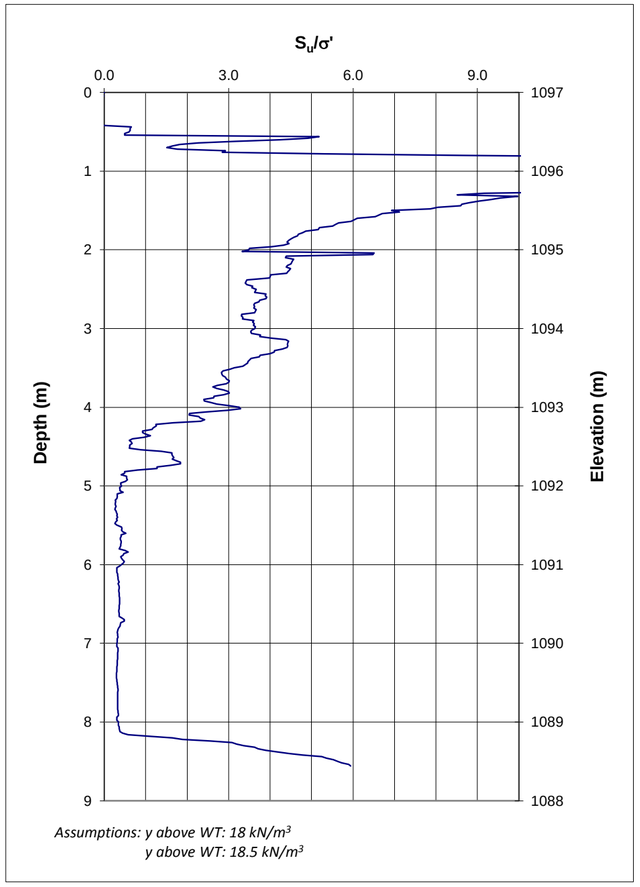

Assumptions: y above WT: 18 kN/m³
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CPT DATE: October 7, 2013
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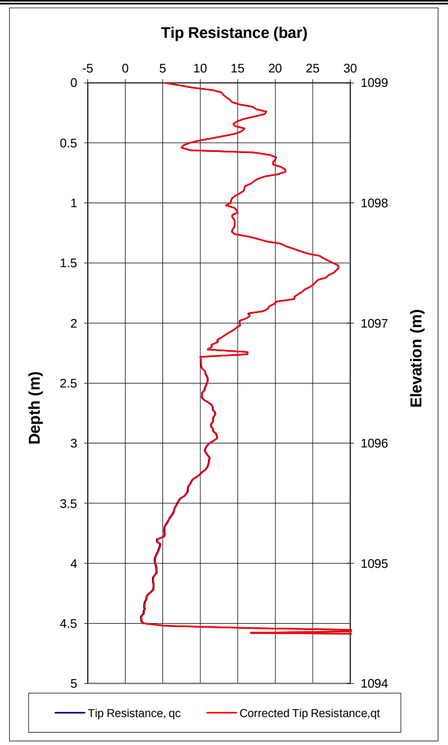
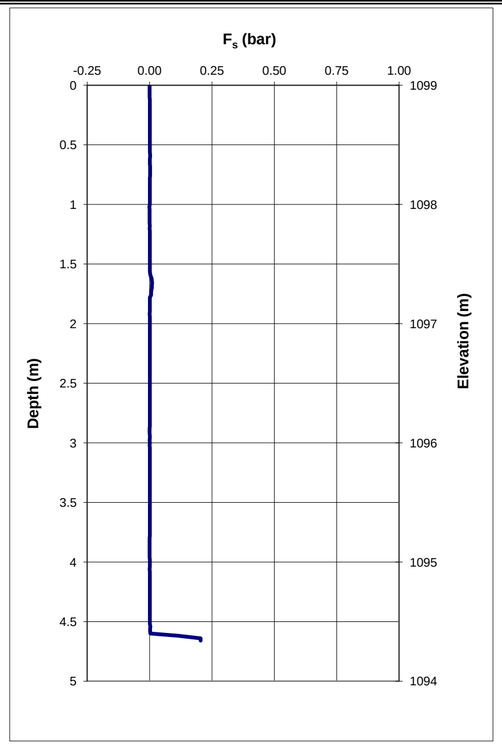
MOUNT NANSEN
CPT INTERPERTATION

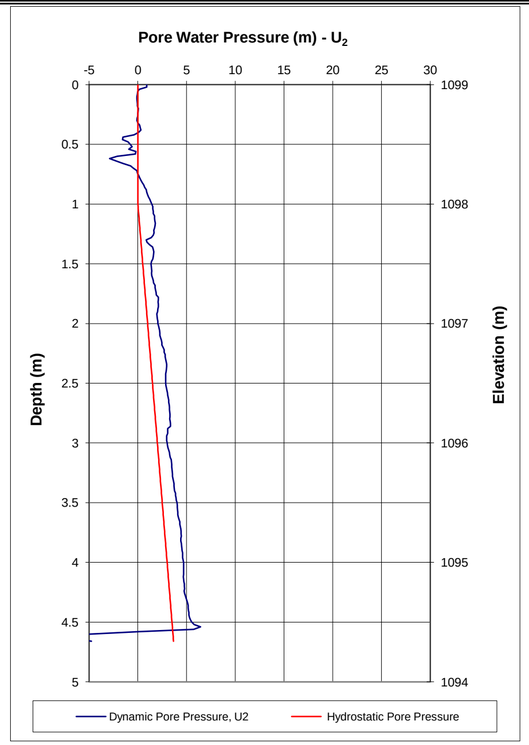
CPT-T-13-15

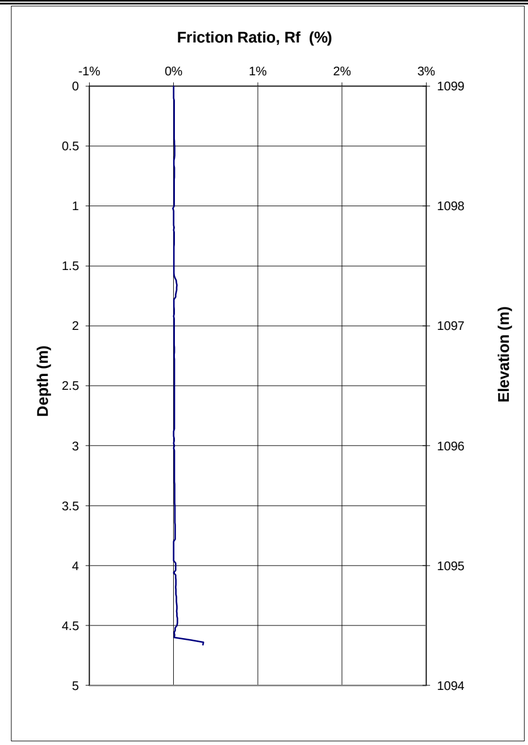
CPT-T-13-16

Tailings









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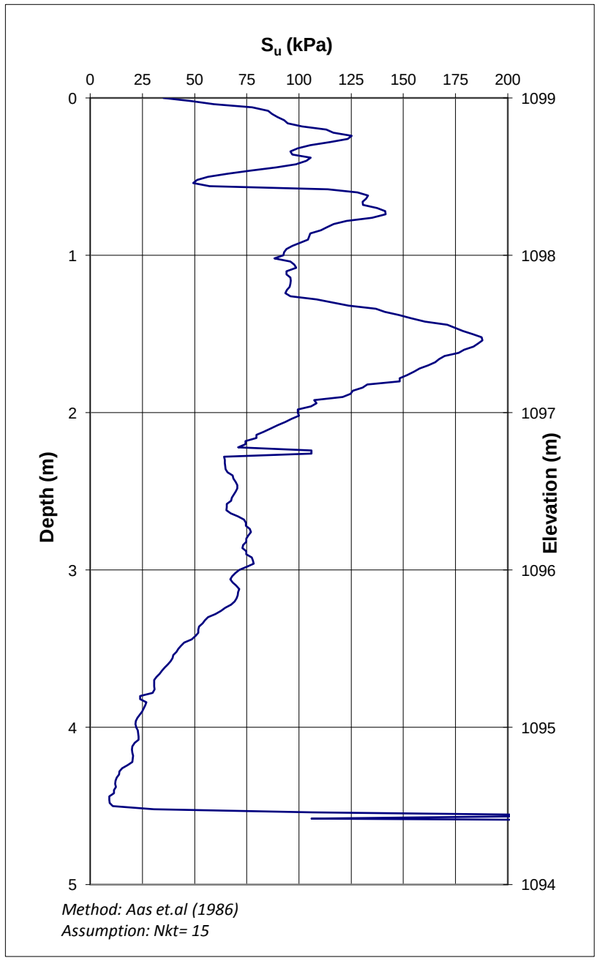
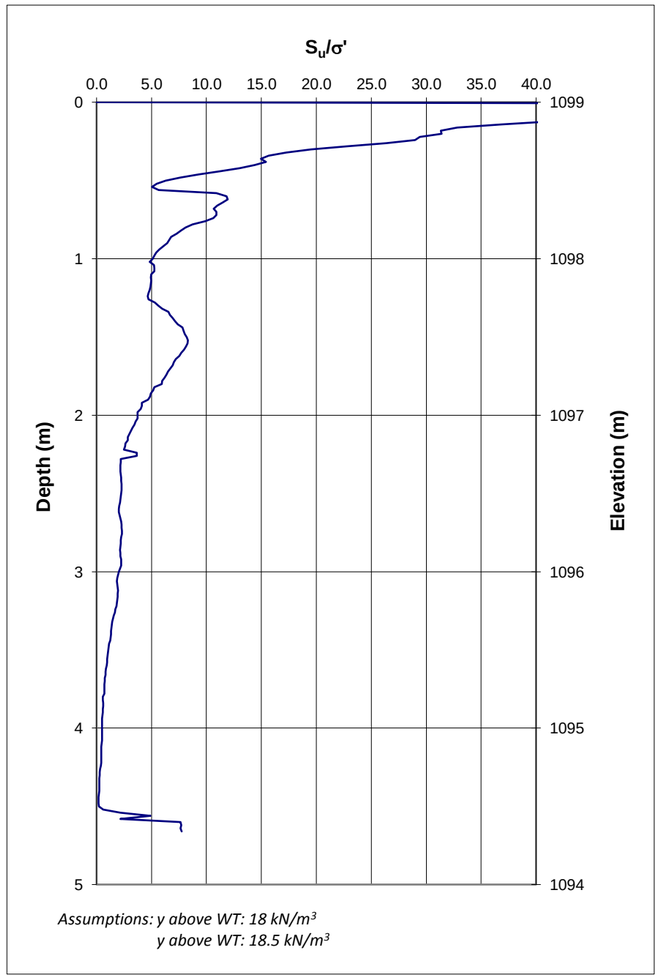
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-16

CPT-T-13-16



Method: Aas et.al (1986)
Assumption: Nkt= 15



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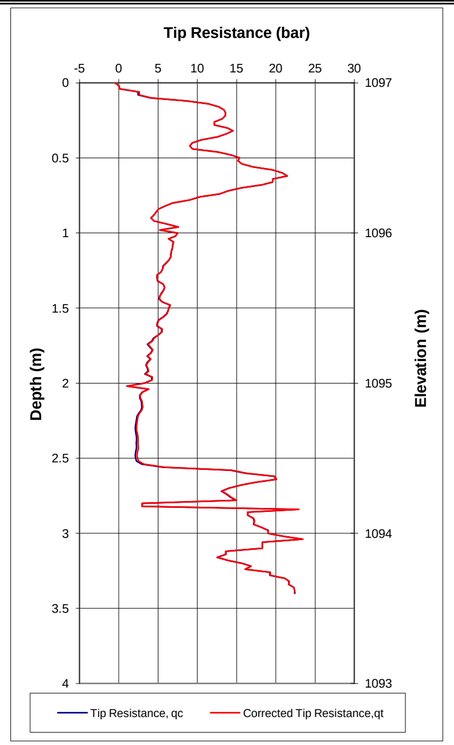
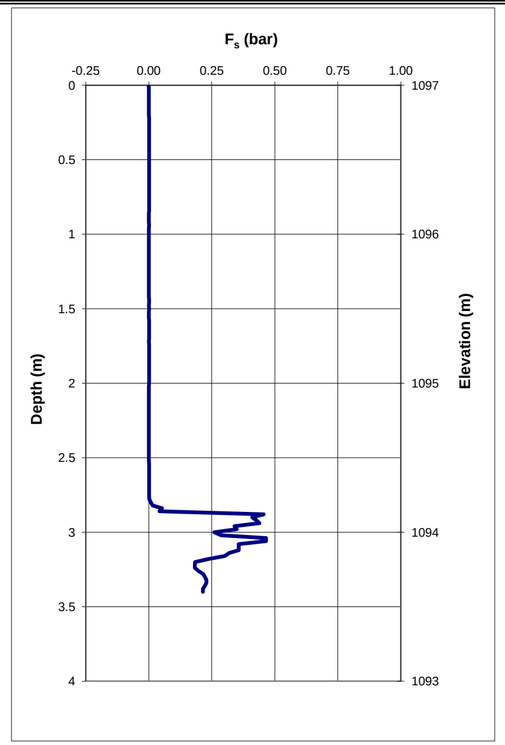
MOUNT NANSEN
CPT INTERPERTATION

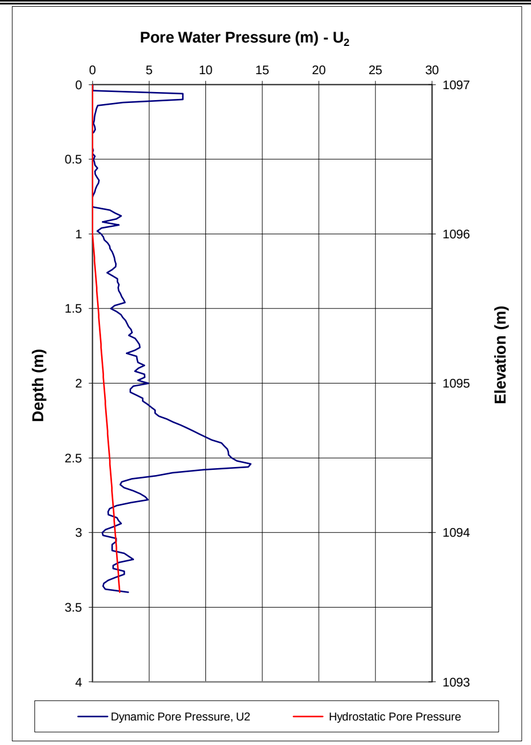
CPT-T-13-16

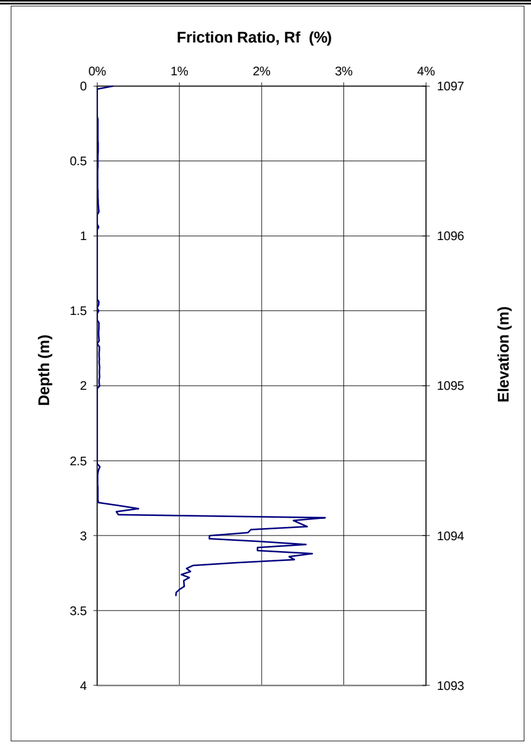
CPT-T-13-17

Tailings









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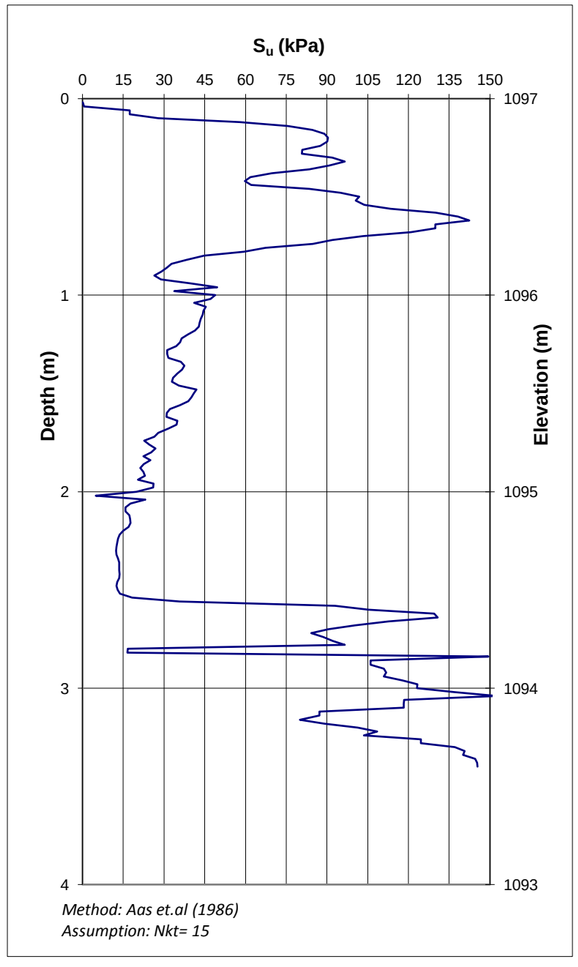
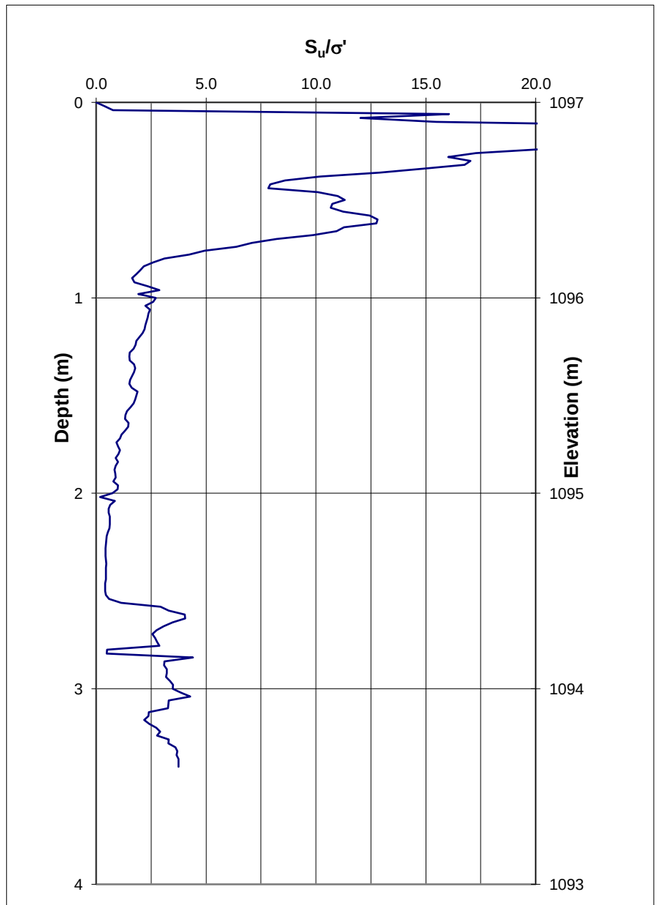
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-17

CPT-T-13-17



Method: Aas et.al (1986)
Assumption: Nkt= 15



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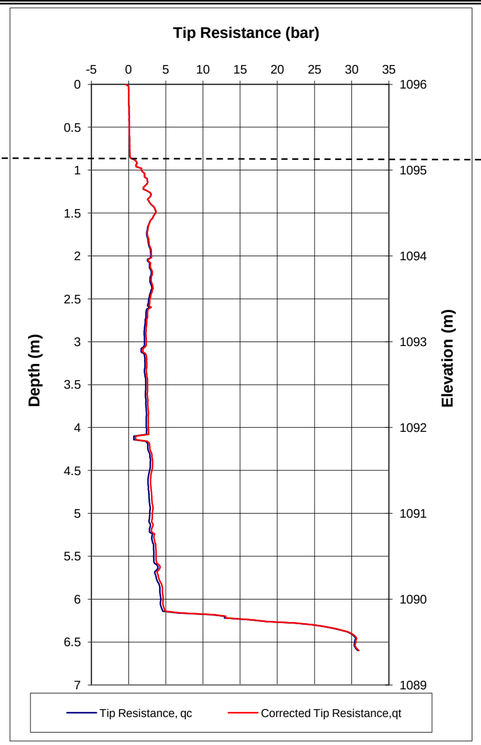
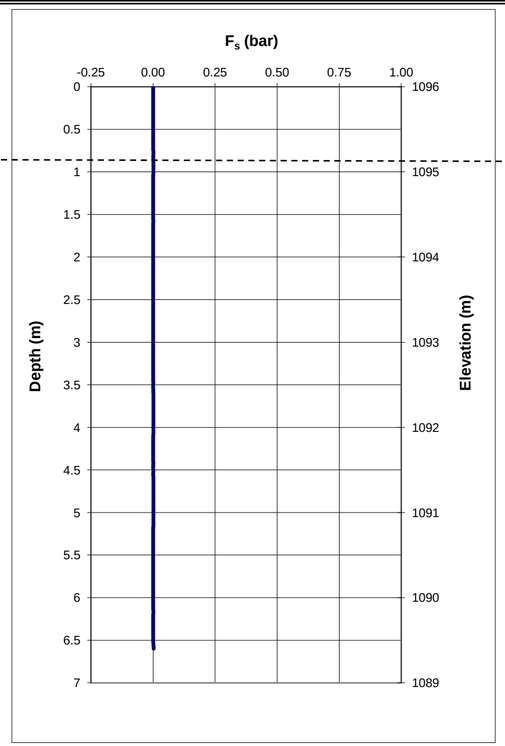
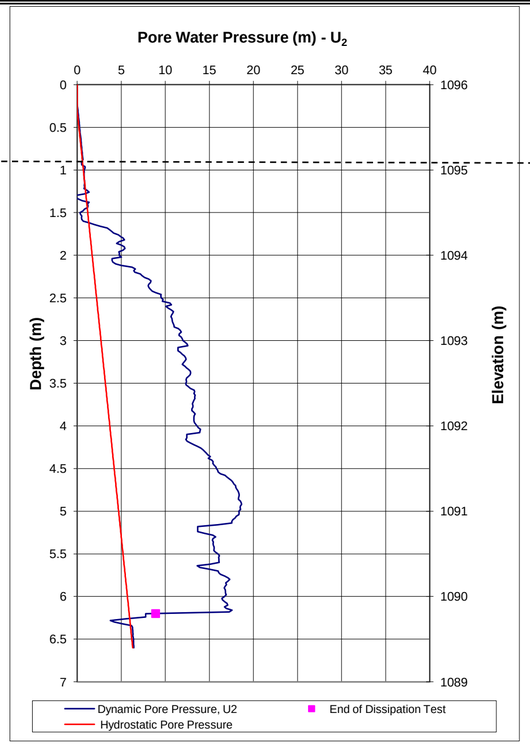
MOUNT NANSEN
CPT INTERPERTATION

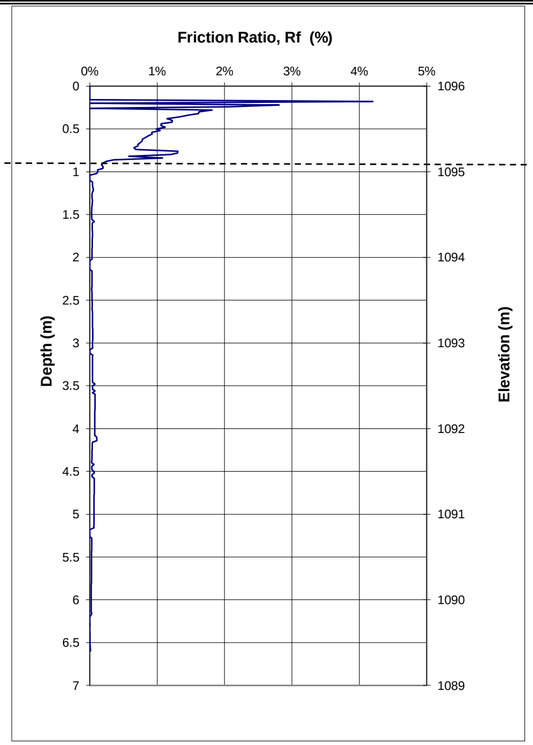
CPT-T-13-17

CPT-T-13-18









PROJECT: VM00605E

CPT DATE: October 4, 2013 Prepared by: Ewelina Halyno

DATE: March 7, 2014 Reviewed by: Renata Wood

NOTE:

1. Depth Measured Relative to Barge Deck Elevation
2. Pond Elevation of 1095.8m Provided by AAM

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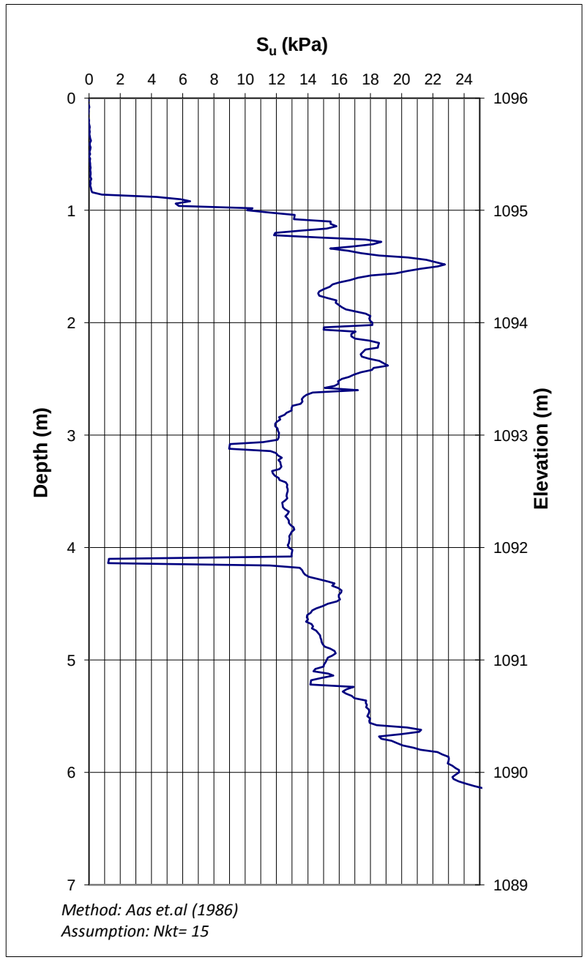
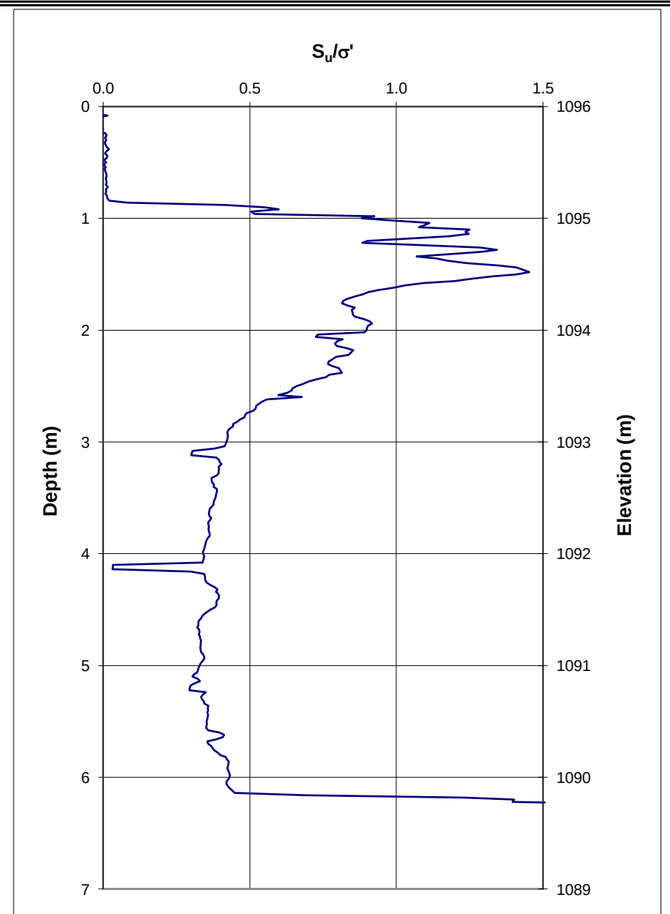
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-18

CPT-T-13-18



Method: Aas et.al (1986)
Assumption: Nkt= 15



Assumptions: y above WT: 18 kN/m^3
y above WT: 18.5 kN/m^3

PROJECT: VM00605E

CPT DATE: October 4, 2013 Prepared by: Ewelina Halyno

DATE: March 7, 2014 Reviewed by: Renata Wood

NOTE:

1. Depth Measured Relative to Barge Deck Elevation
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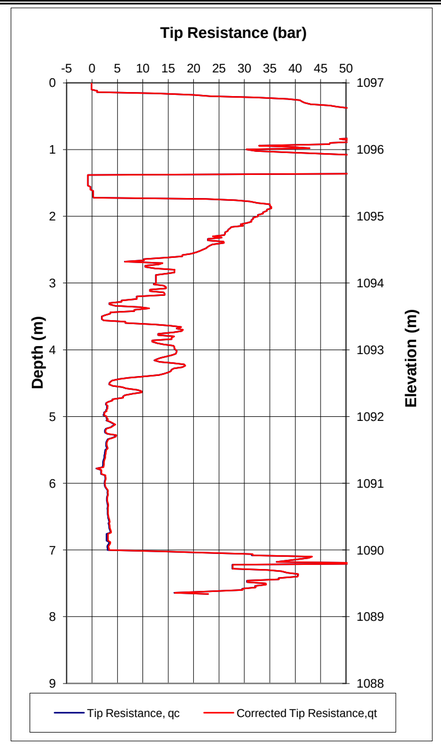
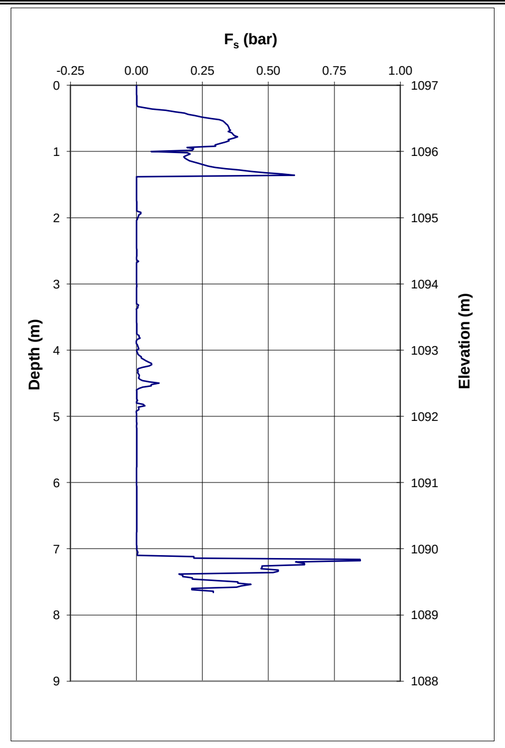
MOUNT NANSEN
CPT INTERPERTATION

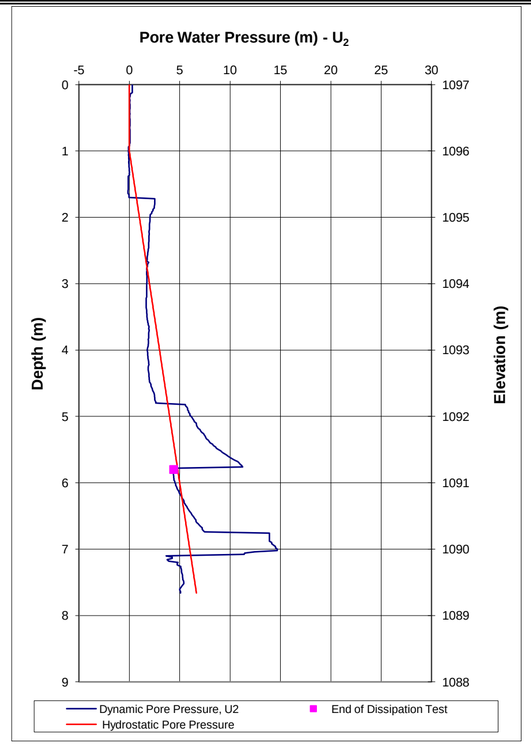
CPT-T-13-18

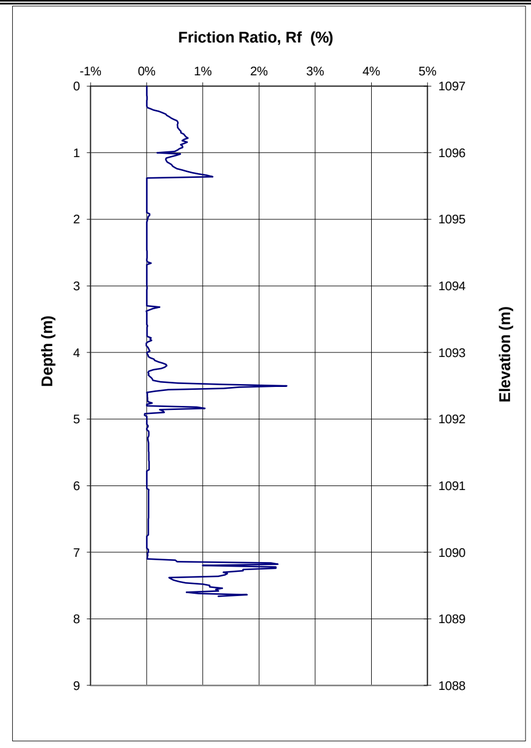
CPT-T-13-19

Tailings









PROJECT: VM00605E

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DATE: March 7, 2014 Reviewed by: Renata Wood

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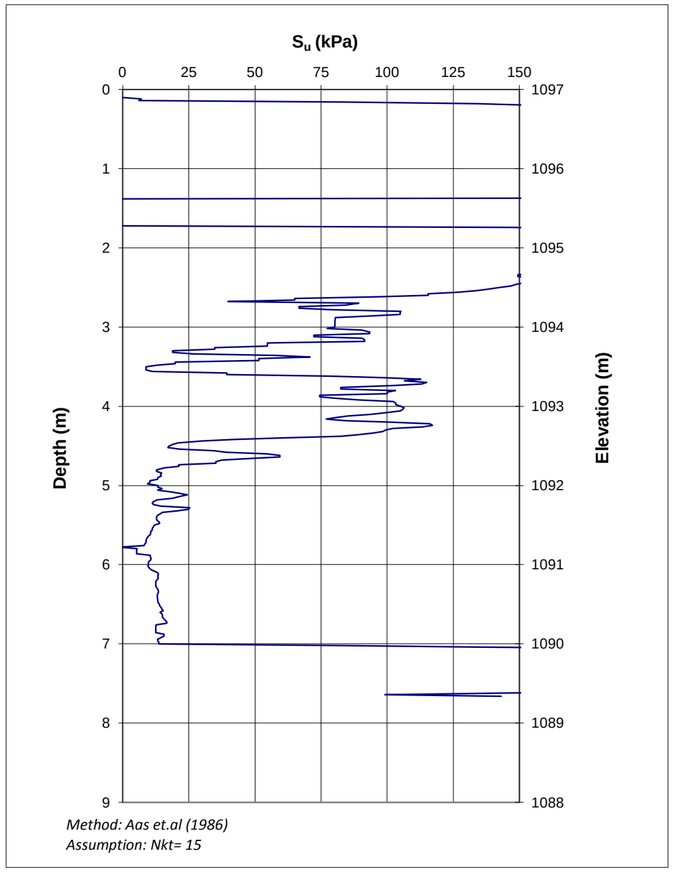
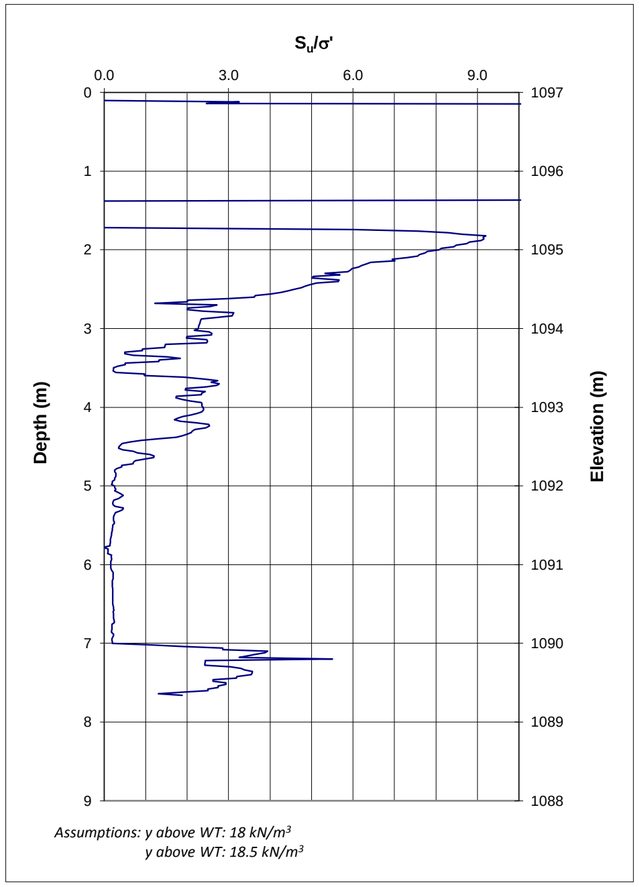
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-19

CPT-T-13-19



Method: Aas et.al (1986)
Assumption: Nkt= 15



Assumptions: y above WT: 18 kN/m³
y above WT: 18.5 kN/m³

PROJECT: VM00605E
CPT DATE: October 7, 2013
DATE: March 7, 2014

Prepared by: Ewelina Halyno
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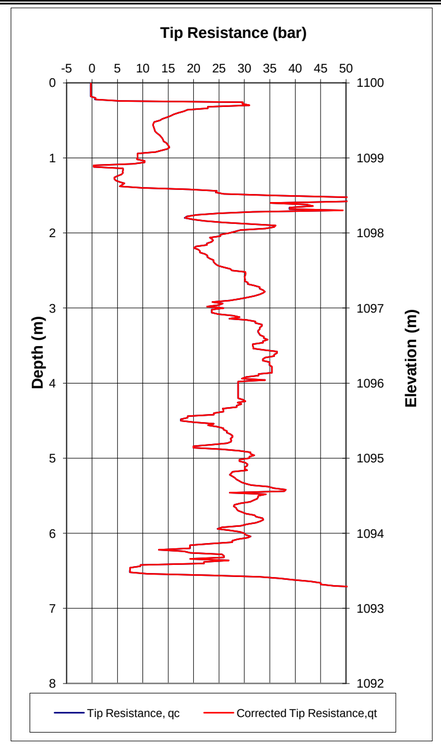
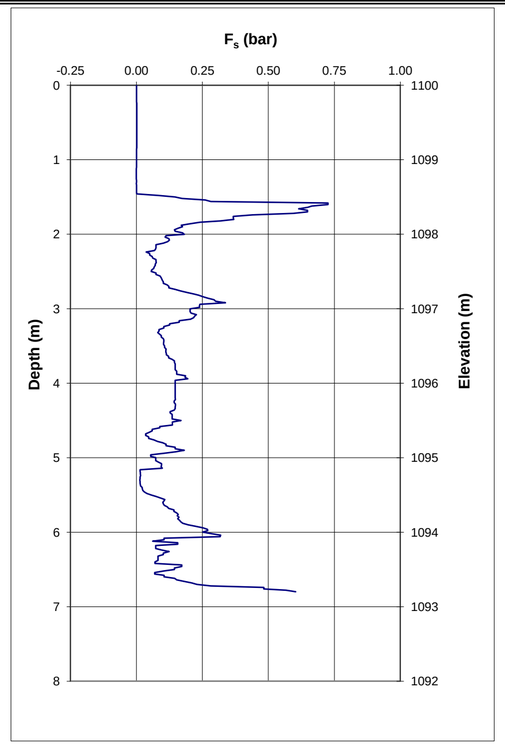
MOUNT NANSEN
CPT INTERPERTATION

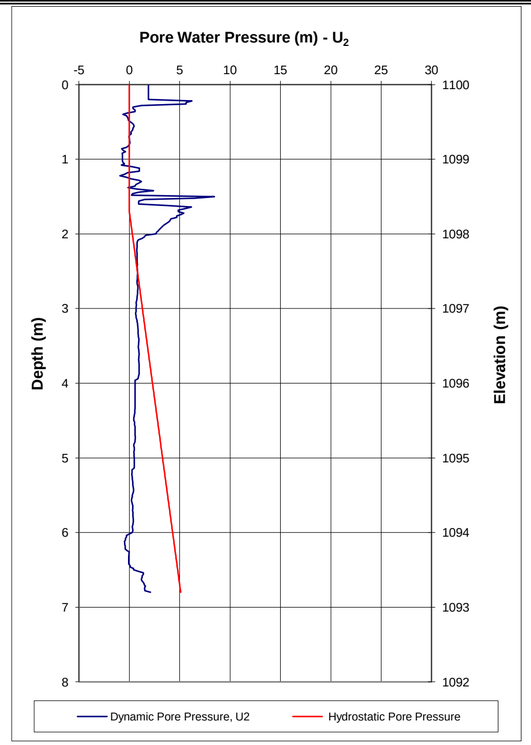
CPT-T-13-19

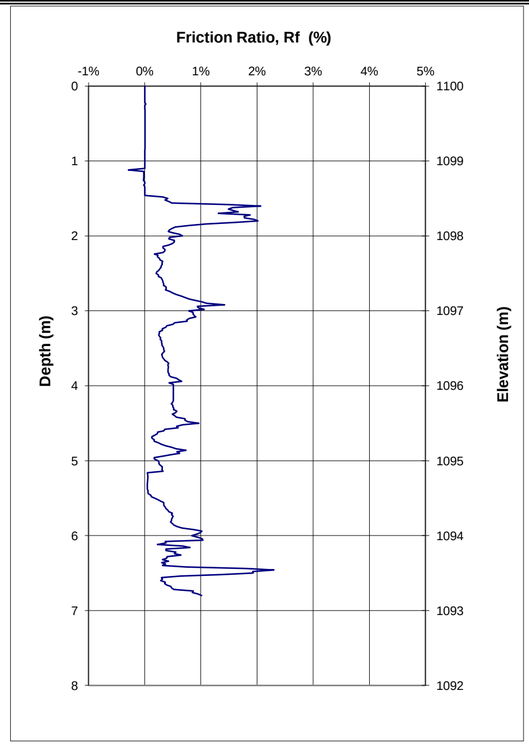
CPT-T-13-20

Tailings









PROJECT: VM00605E

CPT DATE: October 7, 2013 Prepared by: Ewelina Halyno

DATE: March 7, 2014 Reviewed by: Renata Wood

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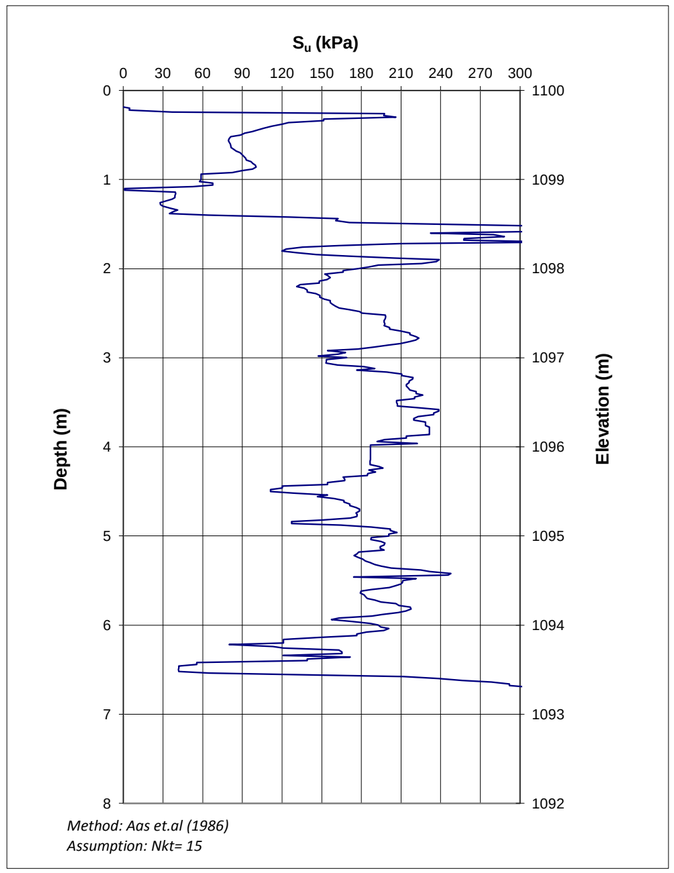
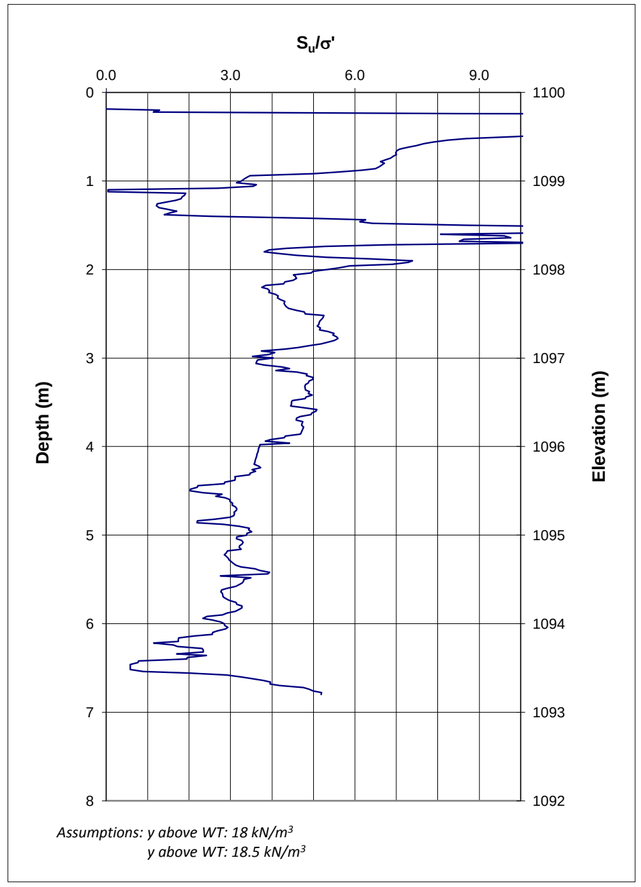
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-20

CPT-T-13-20





PROJECT: VM00605E

CPT DATE: October 7, 2013

DATE: March 7, 2014

Prepared by: Ewelina Halyno

Reviewed by: Renata Wood

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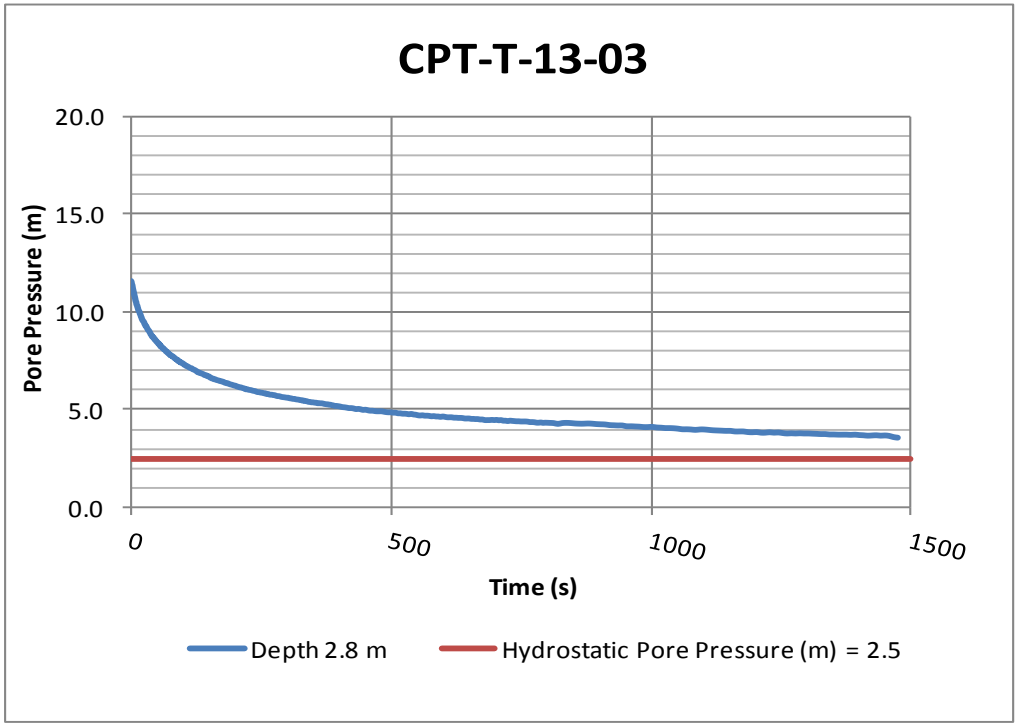
MOUNT NANSEN
CPT INTERPERTATION

CPT-T-13-20



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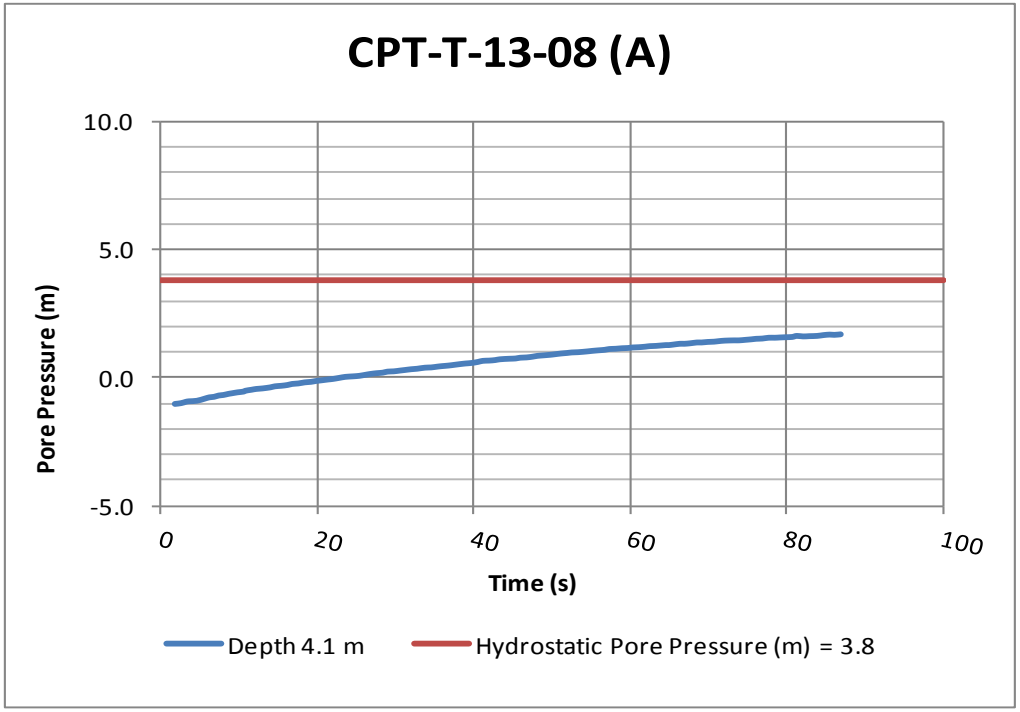
		DEPTH 3:	N/A		

DATE:	Feb-14
CPT DATE:	4-Oct-13
PROJECT NO:	VM00605E
FIGURE NO:	1



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DATE:	Feb-14
CPT DATE:	4-Oct-13
PROJECT NO:	VM00605E
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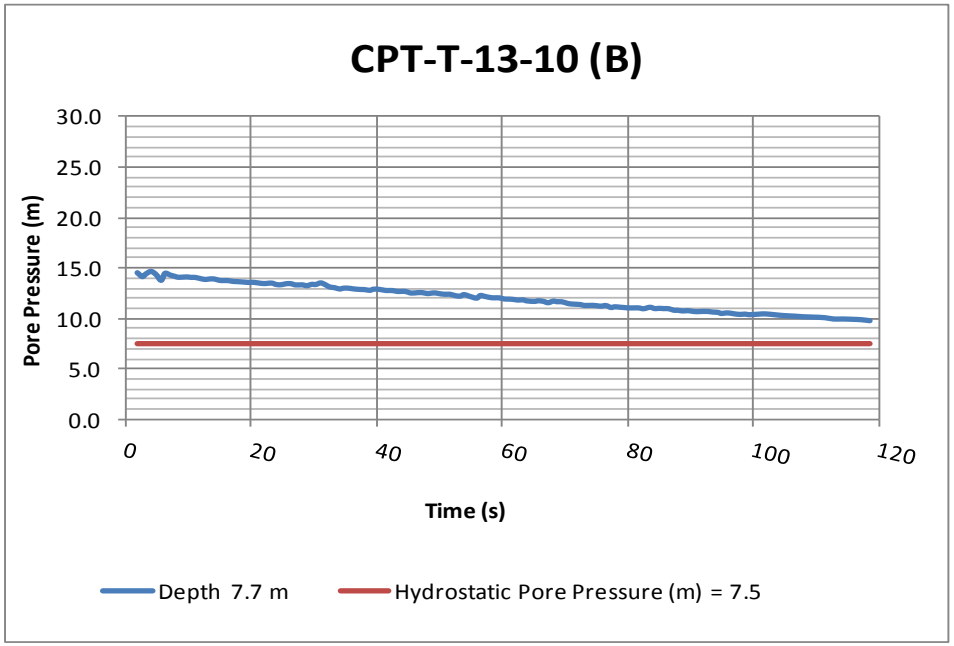

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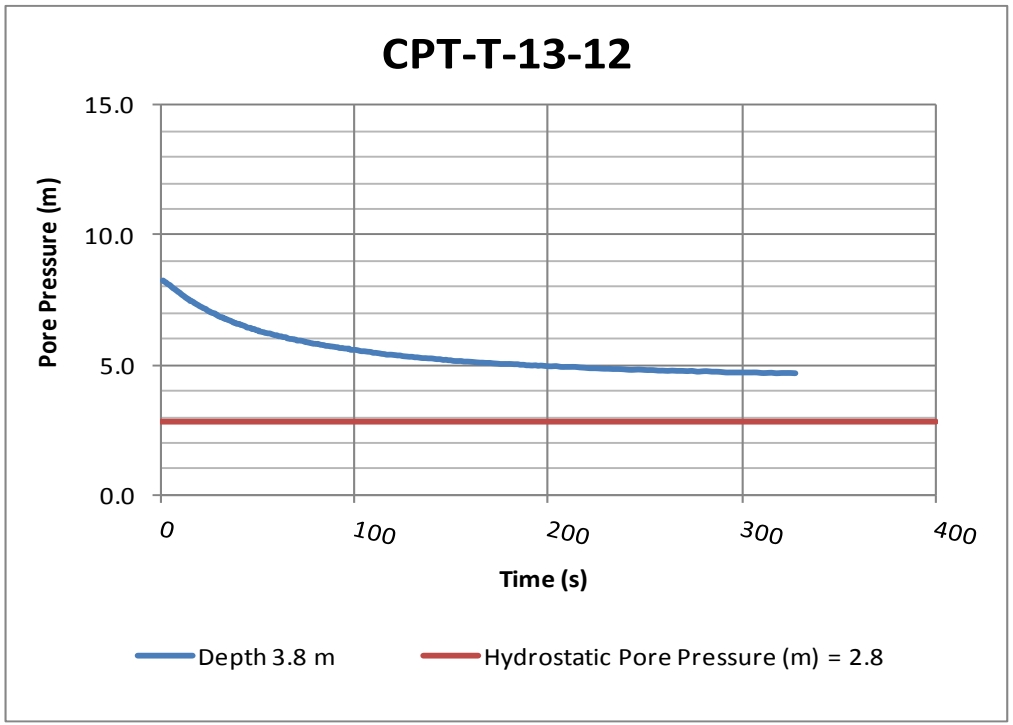
DATE:	Feb-14
CPT DATE:	4-Oct-13
PROJECT NO:	VM00605E
FIGURE NO:	3



CLIENT	Yukon Energy, Mines and Resources	DWN BY:	EH	PROJECT	MOUNT NANSEN CPT INTERPERTATION	DATE:	Feb-14
		CHK'D BY:	RW			CPT DATE:	6-Oct-13
Associated Engineering / amec / Yukon Energy, Mines and Resources		DEPTH 1:	3.8m	TITLE	CPT-T-13-12 Dissipation	PROJECT NO:	VM00605E
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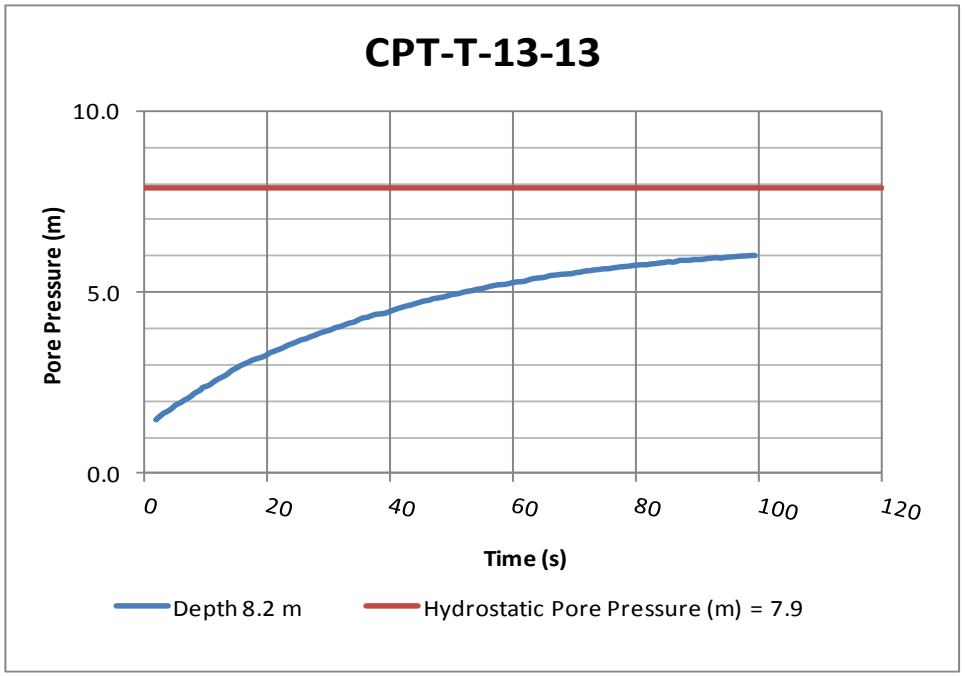
		DEPTH 3:	N/A				



CLIENT	Yukon Energy, Mines and Resources	DWN BY: EH	PROJECT	MOUNT NANSEN CPT INTERPERTATION	DATE: Feb-14
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Associated Engineering / amec / Yukon Energy, Mines and Resources		DEPTH 1: 8.2m	TITLE	CPT-T-13-13 Dissipation	PROJECT NO: VM00605E
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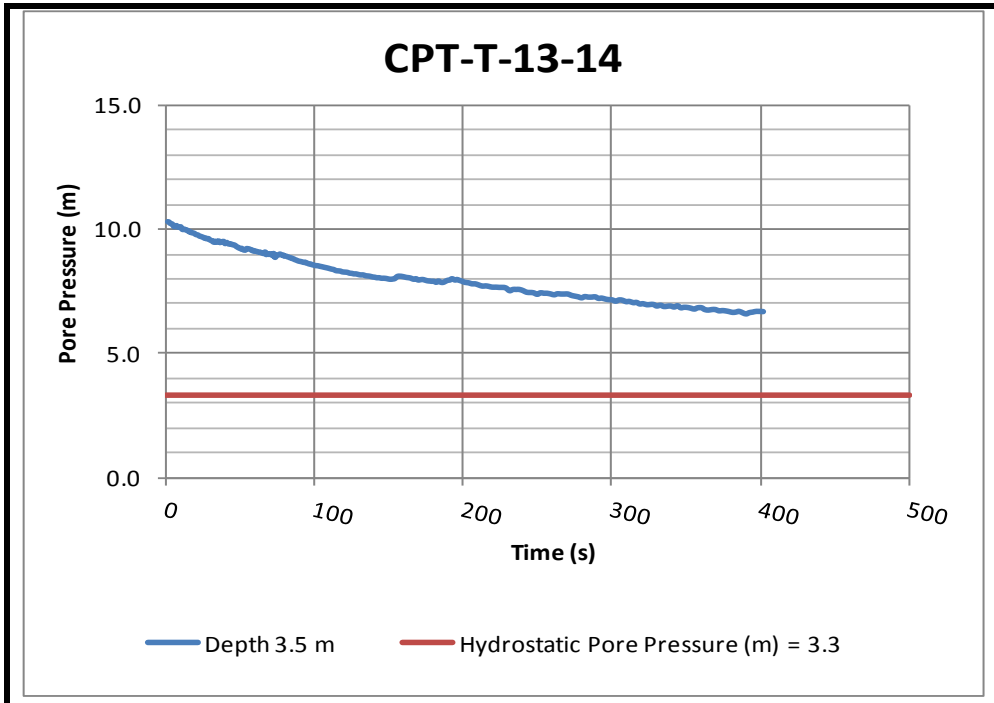
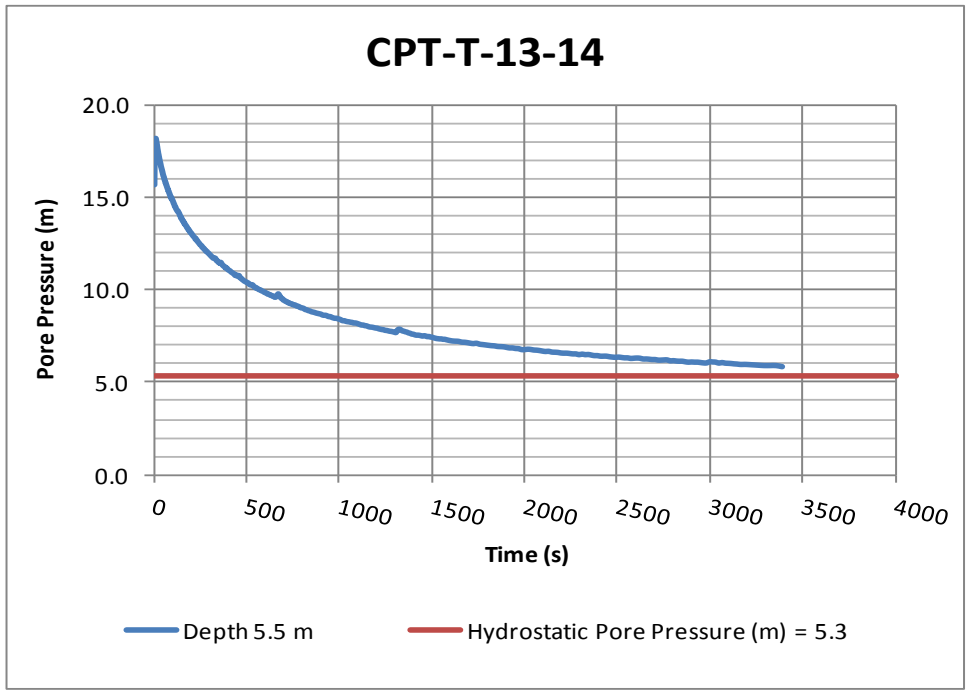
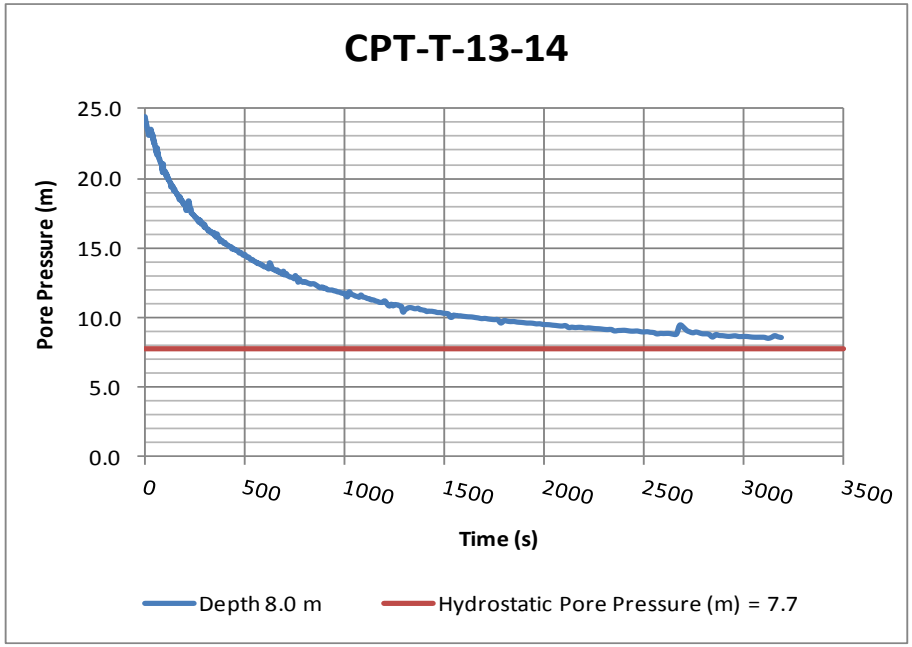
		DEPTH 3: N/A			







CLIENT: Yukon Energy, Mines and Resources	DWN BY: EH	PROJECT: MOUNT NANSEN CPT INTERPERTATION	DATE: Feb-14		
	CHK'D BY: RW		CPT DATE: 6-Oct-13		
Associated Engineering / amec / Yukon Energy, Mines and Resources	DEPTH 1: 3.5m	TITLE: CPT-T-13-14 Dissipation	PROJECT NO: VM00605E		
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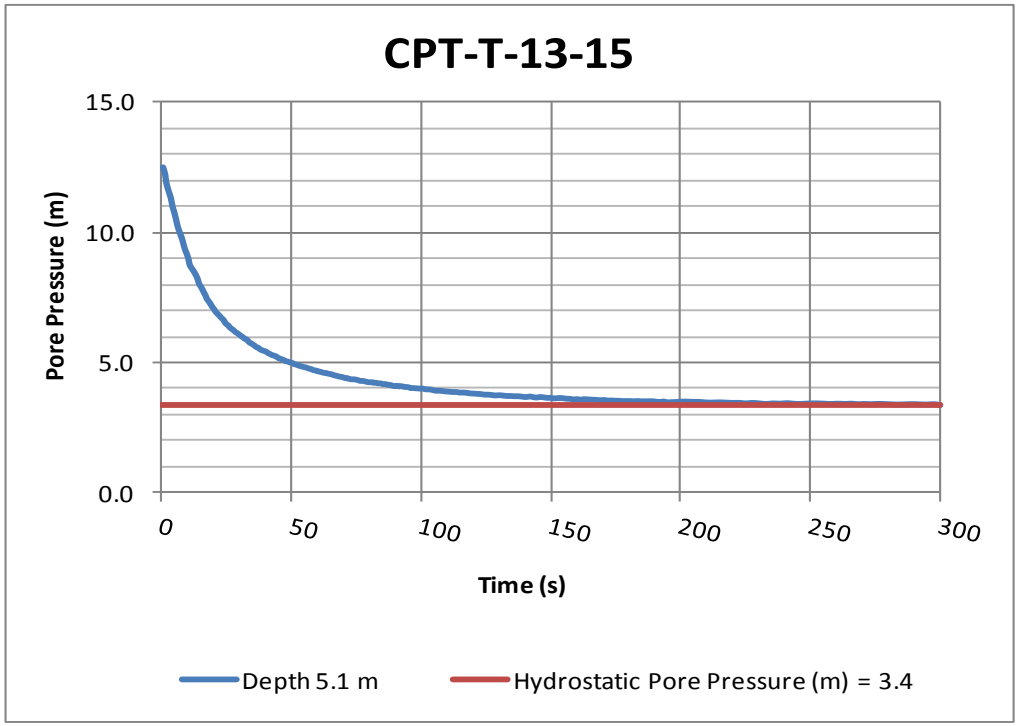
	DEPTH 3: 8.0m				



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Associated Engineering / amec / Yukon Energy, Mines and Resources		DEPTH 1:	5.1m	TITLE	CPT-T-13-15 Dissipation	PROJECT NO:	VM00605E
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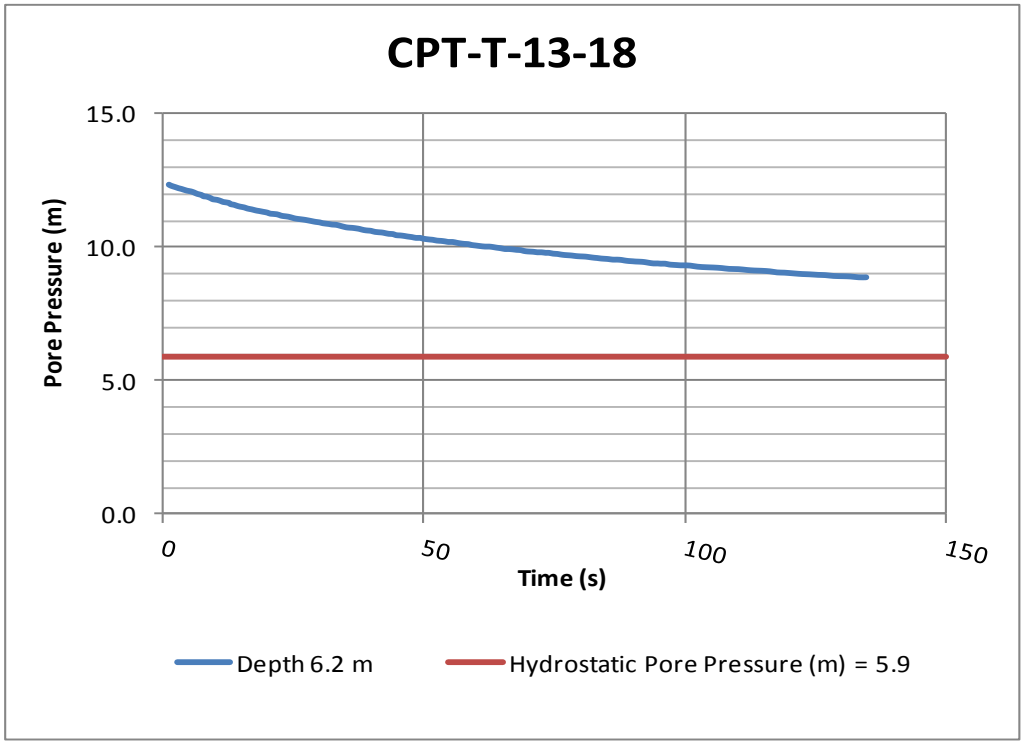
		DEPTH 3:	N/A				



CLIENT	Yukon Energy, Mines and Resources	DWN BY:	EH	PROJECT	MOUNT NANSEN CPT INTERPERTATION	DATE:	Feb-14
		CHK'D BY:	RW			CPT DATE:	4-Oct-13
Associated Engineering / amec / Yukon Energy, Mines and Resources		DEPTH 1:	6.2m	TITLE	CPT-T-13-18 Dissipation	PROJECT NO:	VM00605E
		DEPTH 2::	N/A			FIGURE NO:	8
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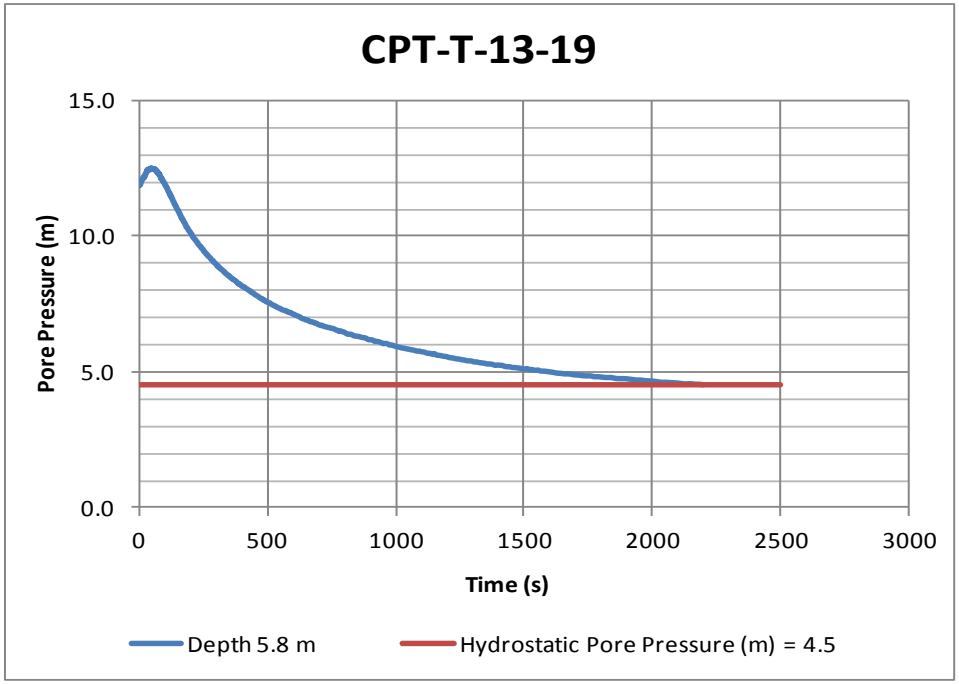

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Associated Engineering / amec / Yukon Energy, Mines and Resources		DEPTH 1:	5.8m	TITLE	CPT-T-13-19 Dissipation	PROJECT NO:	VM00605E
		DEPTH 2::	N/A			FIGURE NO:	9
		DEPTH 3:	N/A				

APPENDIX F

Geochemistry Tables

Table F1: Shake Flask Extraction - Pitwall

		Pitwall													Compariosn Guideline
Sample ID	**Units**	**PWN-02**	**PWN-02**	**PWE-01**	**PWE-02**	**PWE-03**	**PWE-04**	**PWE-05**	**PWE-06**	**PWE-08**	**PWE-09**	**PWW-01**	**PWW-02**	**PWW-03**	**CCME,Water Quality Guideline For Protection Aquatic Life**
Sample #		PWN-02a (-1/4")	PWN-02b (-1/4")	PWE-01 (-1/4")	PWE-02 (-1/4")	PWE-03 (-1/4")	PWE-04 (-1/4")	PWE-05 (-1/4")	PWE-06 (-1/4")	PWE-08 (-1/4")	PWE-09 (-1/4")	PWW-01 (-1/4")	PWW-02 (-1/4")	PWW-03 (-1/4")	
Fraction		Fine (-1/"4")	Fine (-1/"4")	Fine (-1/"4")	Fine (-1/"4")	Fine (-1/"4")	Fine (-1/"4")	Fine (-1/"4")	Fine (-1/"4")	Fine (-1/"4")	Fine (-1/"4")	Fine (-1/"4")	Fine (-1/"4")	Fine (-1/"4")	
Sector		North - Upper	North - Upper	East - Upper	East - Upper	East - Upper	East - Lower	East - Lower	East - Lower	East - Lower	East - Lower	West - Lower	West - Lower	West - Lower	
Parameter		SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	
Volume Nanopure Water	mL	1500	1500	1500	1500	1500	1500	1500	750	1500	1500	1500	1500	1500	
Sample Weight	g	500	500	500	500	500	500	500	250	500	500	500	500	500	
pH		7.75	7.75	6.34	7.64	7.76	4.19	7.48	2.48	2.37	5.26	7.71	7.55	7.63	**6.5-9.0**
Redox	mV	258	258	323	305	298	438	293	443	519	289	236	254	258	
Conductivity	uS/cm	338	338	43	80	72	3333	2486	5410	3490	880	1168	1542	1062	
Acidity (to pH 4.5)	mg CaCO3/L						10.4		2675.0	1800.0					
Total Acidity (to pH 8.3)	mg CaCO3/L	6.4	6.4	5.0	4.6	3.9	181.7	19.1	9750.0	2975.0	60.1	7.4	8.0	6.7	
Alkalinity	mg CaCO3/L	52.1	52.1	2.5	42.6	41.4		49.6			1.5	30.6	36.7	26.5	
Sulphate	mg/L	104	104	13	3	1	2762	1444	10211	3980	439	624	913	552	
Ion Balance															
Major Anions	meq/L	3.21	3.21	0.32	0.91	0.83	57.54	31.07	215.60	84.73	9.17	13.61	19.75	12.03	
Major Cations	meq/L	3.58	3.58	0.41	0.85	0.77	52.20	35.69	281.93	102.60	10.03	14.48	20.22	13.08	
Difference	meq/L	-0.37	-0.37	-0.09	0.07	0.05	5.34	-4.62	-66.33	-17.86	-0.86	-0.87	-0.47	-1.05	
Balance (%)	%	-5.4%	-5.4%	-11.8%	3.9%	3.4%	4.9%	-6.9%	-13.3%	-9.5%	-4.5%	-3.1%	-1.2%	-4.2%	
Dissolved Metals															
Hardness CaCO3	mg/L	175	175	13.8	39.6	35.7	2330	1720	2190	1740	440	704	994	646	-
Aluminum Al	mg/L	0.0033	0.0033	0.0246	0.0251	0.0369	**7.12**	0.002	**67.9**	**127**	1.68	0.0044	0.0032	0.0045	**0.005 if pH<6.5; 0.1 if pH≥6.5**
Antimony Sb	mg/L	0.00626	0.00626	0.00367	0.00091	0.00179	0.003	0.0122	0.348	0.028	0.0002	0.00333	0.00215	0.00094	
Arsenic As	mg/L	**0.0129**	**0.0129**	0.00478	**0.00747**	**0.0141**	**0.0987**	0.005	**60**	**17.1**	0.0018	0.00077	0.00195	0.001	**0.005**
Barium Ba	mg/L	0.0445	0.0445	0.0287	0.0118	0.0312	0.0005	0.0146	0.001	0.002	0.0175	0.0302	0.02	0.00512	
Beryllium Be	mg/L	0.00001	0.00001	0.00001	0.00001	0.00001	0.0061	0.00005	0.009	0.0201	0.0009	0.00001	0.00001	0.00001	
Bismuth Bi	mg/L	0.000005	0.000005	0.000006	0.000005	0.000005	0.00005	0.00003	0.0156	0.0003	0.00003	0.000005	0.000005	0.000005	
Boron B	mg/L	0.05	0.05	0.05	0.05	0.05	0.5	0.3	**3**	**3**	0.3	0.05	0.05	0.05	**1.5**
Cadmium Cd	mg/L	**0.00119**	**0.00119**	**0.0018**	**0.000033**	**0.000026**	**0.481**	**0.0555**	**4.79**	**1.29**	**0.333**	**0.00144**	**0.00547**	**0.00163**	**0.00004 to 0.00037 [H]**
Calcium Ca	mg/L	52.7	52.7	3.92	13.2	12.9	487	444	438	439	141	166	217	162	
Chromium Cr	mg/L	0.0001	0.0001	0.0001	0.0002	0.0001	0.001	0.0005	0.043	0.034	0.0005	0.0001	0.0001	0.0001	
Cobalt Co	mg/L	0.000055	0.000055	0.000044	0.000009	0.000126	0.245	0.00829	0.321	0.589	0.00166	0.000027	0.000085	0.000016	
Copper Cu	mg/L	0.00323	0.00323	**0.0056**	**0.001**	**0.00422**	**2.9**	**0.0176**	**120**	**19.6**	**0.447**	0.00258	0.00191	0.00091	**0.002 to 0.004 [H]**
Iron Fe	mg/L	0.002	0.002	0.026	0.015	0.025	**1.25**	0.022	**3880**	**793**	0.038	0.002	0.003	0.002	**0.3**
Lead Pb	mg/L	0.000184	0.000184	0.000371	0.000337	0.00037	0.00122	0.00481	**0.0582**	**0.0129**	0.00093	0.000339	0.000141	0.000088	**0.001 to 0.007 [H]**
Lithium Li	mg/L	0.0013	0.0013	0.0016	0.0005	0.0005	0.04	0.011	0.08	0.053	0.026	0.0023	0.003	0.0024	
Magnesium Mg	mg/L	10.6	10.6	0.96	1.64	0.88	271	147	267	156	21.2	70.5	110	58.8	
Manganese Mn	mg/L	0.0734	0.0734	0.0374	0.00128	0.00265	94	21.5	96.1	92.5	7.25	0.00859	0.25	0.0123	
Mercury Hg	ug/L	0.02	0.02	0.01	0.02	0.02	0.1	**0.33**	**0.5**	**0.5**	**0.32**	0.01	0.02	0.02	**0.0026**
Molybdenum Mo	mg/L	0.0011	0.0011	0.00005	0.00035	0.00155	0.0005	0.0003	0.003	0.003	0.0003	0.00102	0.00031	0.00015	**0.073**
Nickel Ni	mg/L	0.0004	0.0004	0.00069	0.00016	0.00036	0.0934	0.0071	0.044	0.132	0.0111	0.00052	0.00042	0.00019	**0.025 to 0.15 [H]**
Phosphorus P	mg/L	0.006	0.006	0.016	0.01	0.107	0.02	0.01	4.86	11.7	0.01	0.005	0.003	0.004	
Potassium K	mg/L	2.35	2.35	1.34	1.43	1.28	0.99	6.59	0.5	0.5	4.78	5.02	5.16	4.32	
Selenium Se	mg/L	0.00024	0.00024	0.00005	0.00006	0.00013	0.0006	0.0014	**0.009**	**0.002**	0.0002	0.0002	0.00018	0.00016	**0.001**
Silicon Si	mg/L	1.67	1.67	3.64	1.94	2.9	4.32	1.88	5	5	6.11	1.38	1.35	1.02	
Silver Ag	mg/L	0.000005	0.000005	0.000018	0.000007	0.000012	0.00015	0.0003	0.0012	0.0004	0.00005	0.000006	0.000005	0.000005	**0.0001**
Sodium Na	mg/L	0.37	0.37	2.24	0.35	0.58	2.61	8.74	0.5	0.5	1.09	6.17	4.8	1.04	
Strontium Sr	mg/L	0.181	0.181	0.0257	0.0405	0.0371	0.465	1.04	0.428	0.217	0.0997	0.623	0.683	0.295	
Sulphur (S)	mg/L	44	44	5	3	3	868	577	3490	1410	166	242	337	216	
Thallium Tl	mg/L	0.000036	0.000036	0.000011	0.000006	0.000006	0.00006	0.00026	0.0001	0.0001	0.00031	0.000049	0.000063	0.000045	**0.0008**
Tin Sn	mg/L	0.00001	0.00001	0.00001	0.00001	0.00001	0.0001	0.00005	0.0183	0.0016	0.00005	0.00001	0.00001	0.00001	
Titanium Ti	mg/L	0.0005	0.0005	0.0005	0.0005	0.0005	0.005	0.003	0.03	0.03	0.003	0.0005	0.0005	0.0005	
Uranium U	mg/L	0.000255	0.000255	0.000003	0.000128	0.000092	0.00714	0.00027	0.0063	0.0413	0.00059	0.000365	0.000398	0.000157	
Vanadium V	mg/L	0.0002	0.0002	0.0002	0.0002	0.0005	0.002	0.001	0.365	0.027	0.001	0.0002	0.0002	0.0002	
Zinc Zn	mg/L	**0.0485**	**0.0485**	**0.114**	0.0012	0.0015	**33.2**	**2.6**	**371**	**93.2**	**20.5**	0.0179	**0.0484**	0.0243	**0.03**
Zirconium Zr	mg/L	0.0001	0.0001	0.0001	0.0001	0.0001	0.001	0.0005	0.005	0.005	0.0005	0.0001	0.0001	0.0001	

Note:

Bold font indicates CCME exceedances

Table F2: Shake Flask Extraction - Low Grade Ore Backfill

Pit Ramp (LGO)								Compariosn Guideline
Site	**Units**	**OB04**	**OB05**	**OB07**	**OB08**	**OB09**	**OB10**	**CCME,Water Quality Guideline For Protection Aquatic Life**
Fraction		Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	
Sector		Ore Backfill	Ore Backfill	Ore Backfill	Ore Backfill	Ore Backfill	Ore Backfill	
Parameter		SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	
Volume Nanopure Water	mL	750	750	750	750	750	750	
Sample Weight	g	250	250	250	250	250	250	
pH		6.68	7.48	6.74	6.74	7.33	7.33	**6.5-9.0**
Redox	mV	338	332	347	347	315	315	
Conductivity	uS/cm	1609	1008	1742	1742	1861	1861	
Acidity (to pH 4.5)	mg CaCO3/L							
Total Acidity (to pH 8.3)	mg CaCO3/L	6.8	5.2	7.7	7.7	9.8	9.8	
Alkalinity	mg CaCO3/L	5.7	26.3	8.5	8.5	10.1	10.1	
Sulphate	mg/L	1125	586	1101	1101	1240	1240	
Ion Balance								
Major Anions	meq/L	23.55	12.74	23.11	23.11	26.04	26.04	
Major Cations	meq/L	21.70	12.28	24.29	24.29	26.82	26.82	
Difference	meq/L	1.86	0.46	-1.19	-1.19	-0.78	-0.78	
Balance (%)	%	4.1%	1.8%	-2.5%	-2.5%	-1.5%	-1.5%	
Dissolved Metals								
Hardness CaCO3	mg/L	1060	606	1190	1190	1300	1300	-
Aluminum Al	mg/L	0.002	0.0038	0.006	0.006	0.005	0.005	**0.005 if pH<6.5; 0.1 if pH≥6.5**
Antimony Sb	mg/L	0.0132	0.0173	0.0228	0.0228	0.0359	0.0359	
Arsenic As	mg/L	**0.0106**	**0.0387**	**0.0212**	**0.0212**	**0.0201**	**0.0201**	**0.005**
Barium Ba	mg/L	0.0131	0.0193	0.0103	0.0103	0.0144	0.0144	
Beryllium Be	mg/L	0.00005	0.00001	0.00005	0.00005	0.00005	0.00005	
Bismuth Bi	mg/L	0.00003	0.000009	0.00003	0.00003	0.00003	0.00003	
Boron B	mg/L	0.3	0.05	0.3	0.3	0.3	0.3	**1.5**
Cadmium Cd	mg/L	**0.0192**	**0.00195**	**0.0383**	**0.0383**	**0.0449**	**0.0449**	**0.00004 to 0.00037 [H]**
Calcium Ca	mg/L	337	205	365	365	394	394	
Chromium Cr	mg/L	0.0005	0.0001	0.0005	0.0005	0.0005	0.0005	
Cobalt Co	mg/L	0.00021	0.00002	0.00145	0.00145	0.00353	0.00353	
Copper Cu	mg/L	0.0027	0.00203	0.0031	0.0031	0.0055	0.0055	**0.002 to 0.004 [H]**
Iron Fe	mg/L	0.006	0.007	0.022	0.022	0.012	0.012	**0.3**
Lead Pb	mg/L	0.0009	0.00013	0.00054	0.00054	0.00174	0.00174	**0.001 to 0.007 [H]**
Lithium Li	mg/L	0.005	0.0013	0.006	0.006	0.008	0.008	
Magnesium Mg	mg/L	54.4	22.6	67.4	67.4	77.2	77.2	
Manganese Mn	mg/L	3.16	0.00649	9.24	9.24	15.6	15.6	
Mercury Hg	ug/L	0.05	0.01	0.05	0.05	0.05	0.05	**0.0026**
Molybdenum Mo	mg/L	0.0003	0.00042	0.0003	0.0003	0.0003	0.0003	**0.073**
Nickel Ni	mg/L	0.0016	0.00039	0.0042	0.0042	0.0073	0.0073	**0.025 to 0.15 [H]**
Phosphorus P	mg/L	0.01	0.011	0.01	0.01	0.01	0.01	
Potassium K	mg/L	5.49	5.02	3.94	3.94	4.12	4.12	
Selenium Se	mg/L	0.0002	0.00008	0.0003	0.0003	0.0004	0.0004	**0.001**
Silicon Si	mg/L	2.98	2.94	1.81	1.81	1.73	1.73	
Silver Ag	mg/L	0.00003	0.000005	0.00004	0.00004	0.00005	0.00005	**0.0001**
Sodium Na	mg/L	2.78	1.19	0.69	0.69	1	1	
Strontium Sr	mg/L	0.348	0.275	0.336	0.336	0.424	0.424	
Sulphur (S)	mg/L	373	214	411	411	464	464	
Thallium Tl	mg/L	0.00011	0.000059	0.00014	0.00014	0.0002	0.0002	**0.0008**
Tin Sn	mg/L	0.00005	0.00001	0.00005	0.00005	0.00005	0.00005	
Titanium Ti	mg/L	0.003	0.0005	0.003	0.003	0.003	0.003	
Uranium U	mg/L	0.00001	0.000085	0.00001	0.00001	0.00001	0.00001	
Vanadium V	mg/L	0.001	0.0002	0.001	0.001	0.001	0.001	
Zinc Zn	mg/L	**0.591**	0.0203	**1.83**	**1.83**	**2.45**	**2.45**	**0.03**
Zirconium Zr	mg/L	0.0005	0.0001	0.0005	0.0005	0.0005	0.0005	

Note:

Bold font indicates CCME exceedances

Table F3: Shake Flask Extraction - Waste Rock Dump

Waste Rock Dump															Compariosn Guideline
Sample ID	**Units**	**L1**			**L2**			**TP-1**			**TP-4**				**CCME,Water Quality Guideline For Protection Aquatic Life**
Sample_#	**mL**	L1-1	L1-2	L1-3	L2-1	L2-2	L2-3	TP-1 0.45-1.0m	TP-1 1.0-2.0m	TP-1 1.5m	TP-4 0.15-0.3m	TP-4 0.6-0.8m	TP-4 1.6-1.8m	TP-4 1.5m	
SGS CEMI Sample		L1-1 (-1/4")	L1-2 (-1/4")	L1-3 (-1/4")	L2-1 (-1/4")	L2-2 (-1/4")	L2-3 (-1/4")	TP-1 0.45-1.0m (-1/4")	TP-1 1.0-2.0m (-1/4")	TP-1 1.5m (-1/4")	TP-4 0.15-0.3m (-1/4")	TP-4 0.6-0.8m (-1/4")	TP-4 1.6-1.8m (-1/4")	TP-4 1.5m (-1/4")	
Fraction		Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	
Sector		NW Dump	NW Dump	NW Dump	W Lower Dump	W Lower Dump	W Lower Dump	NW Dump	NW Dump	NW Dump	NW Dump N Lobe	NW Dump N Lobe	NW Dump N Lobe	NW Dump N Lobe	
Material Type		Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	
Parameter		SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	
Volume Nanopure Water	**mL**	750	750	750	750	750	750	750	750	750	750	750	750	750	
Sample Weight	**g**	250	250	250	250	250	250	250	250	250	250	250	250	250	
pH		6.95	7.42	7.42	8.08	8.01	8.09	7.56	7.44	**6.38**	7.89	7.21	7.81	**2.96**	**6.5-9.0**
Redox		256	253	347	315	320	222	339	345	371	333	434	399	543	
Conductivity	**mV**	2588	2599	2496	289	360	274	514	1542	562	176	1040	675	2120	
Acidity (to pH 4.5)	**mg CaCO3/L**													200	
Total Acidity (to pH 8.3)	**mg CaCO3/L**	6.4	5.9	5.4	2.9	2.6	2.3	5.3	6.3	11.8	4.3	5.1	4.2	450.0	
Alkalinity	**mg CaCO3/L**	17.1	20.2	20.6	69.3	64.7	73.7	54.8	32.1	2.8	63.7	24.1	48.5		
Sulphate	**mg/L**	1784	1752	1316	68	109	61	213	968	284	27	569	312	1294	
Ion Balance															
Major Anions	**meq/L**	37.51	36.90	27.83	2.80	3.56	2.74	5.53	20.81	5.97	1.84	12.34	7.47	26.96	
Major Cations	**meq/L**	38.48	37.52	27.27	2.80	3.70	2.71	5.68	21.29	5.69	1.91	13.12	8.02	25.15	
Difference	**meq/L**	-0.97	-0.62	0.56	0.01	-0.14	0.04	-0.14	-0.48	0.29	-0.07	-0.79	-0.55	1.81	
Balance (%)	**%**	-1.3%	-0.8%	1.0%	0.1%	-1.9%	0.7%	-1.3%	-1.1%	2.5%	-2.0%	-3.1%	-3.5%	3.5%	
Dissolved Metals															
Hardness CaCO3	**mg/L**	1920	1870	1360	134	179	130	276	1060	263	92.2	650	395	876	-
Aluminum Al	**mg/L**	0.013	0.018	0.001	0.0057	0.004	0.0039	0.013	0.0059	**0.0122**	0.0112	0.0066	0.0045	**12.9**	**0.005 if pH<6.5; 0.1 if pH≥6.5**
Antimony Sb	**mg/L**	0.0037	0.0034	0.0025	0.00231	0.0022	0.00188	0.0003	0.00927	0.00798	0.0162	0.0101	0.00085	0.0014	
Arsenic As	**mg/L**	0.0025	0.0031	0.0037	**0.00768**	**0.00655**	**0.00724**	0.00013	0.00546	**0.0304**	0.00653	**0.0289**	0.00094	**0.01**	**0.005**
Barium Ba	**mg/L**	0.0045	0.004	0.0067	0.00652	0.00666	0.00468	0.00059	0.00429	0.00715	0.0429	0.00603	0.0131	0.0251	
Beryllium Be	**mg/L**	0.00005	0.00005	0.00005	0.00001	0.00001	0.00001	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00903	
Bismuth Bi	**mg/L**	0.00003	0.00003	0.00003	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.00003	
Boron B	**mg/L**	0.3	0.3	0.3	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.3	**1.5**
Cadmium Cd	**mg/L**	**0.0208**	**0.0167**	**0.0138**	**0.000292**	0.000384	**0.00022**	**0.000413**	**0.00372**	**0.00973**	**0.000559**	**0.00341**	**0.000448**	**0.526**	**0.00004 to 0.00037 [H]**
Calcium Ca	**mg/L**	616	602	492	33.5	46	30.8	56.2	330	79.8	25.1	216	111	299	
Chromium Cr	**mg/L**	0.0005	0.0005	0.0005	0.0002	0.0001	0.0001	0.0006	0.0007	0.0001	0.0001	0.0002	0.0001	0.0027	
Cobalt Co	**mg/L**	0.00034	0.00026	0.0002	0.000014	0.000005	0.000005	0.00001	0.000014	0.000634	0.000006	0.000015	0.000017	0.175	
Copper Cu	**mg/L**	0.0016	0.0016	0.0039	0.00203	0.00132	0.00111	0.00086	0.00104	**0.133**	**0.00538**	**0.00189**	0.00088	**1.53**	**0.002 to 0.004 [H]**
Iron Fe	**mg/L**	**0.015**	**0.013**	0.008	0.003	0.002	0.001	0.001	0.006	0.004	0.002	0.009	0.004	**28.1**	**0.3**
Lead Pb	**mg/L**	0.00034	0.00022	0.00004	0.000031	0.000038	0.000023	0.000679	0.000018	0.000056	0.000887	0.00003	0.000045	**0.064**	**0.001 to 0.007 [H]**
Lithium Li	**mg/L**	0.008	0.007	0.005	0.003	0.0033	0.0031	0.0028	0.0058	0.0079	0.0018	0.0057	0.0031	0.033	
Magnesium Mg	**mg/L**	92.3	89.2	32.2	12.3	15.6	12.9	32.9	56.5	15.5	7.2	26.9	28.7	31.5	
Manganese Mn	**mg/L**	2.17	1.5	1.54	0.00113	0.00147	0.00048	0.0005	0.0132	2.73	0.00231	0.00458	0.00165	72.6	
Mercury Hg	**mg/L**	0.05	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.05	**0.0026**
Molybdenum Mo	**mg/L**	0.0003	0.0003	0.0003	0.00034	0.00024	0.00019	0.00015	0.00007	0.00005	0.00172	0.00025	0.00084	0.0003	**0.073**
Nickel Ni	**mg/L**	0.0009	0.0009	0.0009	0.00015	0.00019	0.00023	0.00034	0.00041	0.00313	0.00023	0.00044	0.00041	0.0497	**0.025 to 0.15 [H]**
Phosphorus P	**mg/L**	0.01	0.01	0.01	0.003	0.003	0.003	0.002	0.003	0.007	0.004	0.007	0.002	0.01	
Potassium K	**mg/L**	5.05	4.79	2.45	3.51	3.92	3.44	3.03	2.71	3.04	1.96	4.03	3.45	0.19	
Selenium Se	**mg/L**	0.0006	0.0005	0.0002	0.00004	0.00004	0.00004	0.00017	0.00044	0.00023	0.00007	0.0001	0.00006	0.0004	**0.001**
Silicon Si	**mg/L**	1.36	1.33	0.835	1.59	1.66	1.65	0.633	1.12	3.36	1.08	1.53	2.54	5.58	
Silver Ag	**mg/L**	0.00003	0.00003	0.00003	0.000005	0.000005	0.000005	0.000005	0.000005	0.000224	0.000017	0.000035	0.000015	0.0106	**0.0001**
Sodium Na	**mg/L**	0.41	0.41	0.19	0.51	0.5	0.46	2.06	2.37	3.35	0.32	0.66	0.7	0.18	
Strontium Sr	**mg/L**	0.608	0.545	0.402	0.12	0.153	0.116	0.59	0.602	0.0895	0.114	0.425	0.286	0.406	
Sulphur (S)	**mg/L**	609	605	437	25	40	22	77	360	98	10	215	118	435	
Thallium Tl	**mg/L**	0.00019	0.00016	0.00014	0.000032	0.000032	0.000025	0.000017	0.000065	0.00007	0.000042	0.000109	0.000032	0.0005	**0.0008**
Tin Sn	**mg/L**	0.00005	0.00006	0.00005	0.00003	0.00002	0.00001	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001	0.00005	
Titanium Ti	**mg/L**	0.003	0.003	0.003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.003	
Uranium U	**mg/L**	0.00028	0.0002	0.0001	0.000131	0.000186	0.000115	0.000911	0.00124	0.000004	0.000076	0.000085	0.000307	0.0199	
Vanadium V	**mg/L**	0.001	0.001	0.001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.001	
Zinc Zn	**mg/L**	**0.268**	**0.198**	**0.183**	0.0046	0.0057	0.0029	0.013	0.0544	**3.29**	0.0125	0.0689	0.0046	**28.5**	**0.03**
Zirconium Zr	**mg/L**	0.0005	0.0005	0.0005	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0005	

Note:
Bold font indicates CCME exceedances

Table F3: Shake Flask Extraction - Waste Rock Dump (continue)

Waste Rock Dump											Compariosn Guideline
Sample ID	**Units**	**TP-5**	**TP-6**	**TP-8**	**TP-9**	**TP-13**	**TP-14**			**TP-18**	**CCME,Water Quality Guideline For Protection Aquatic Life**
Sample_#	**mL**	TP-5 1.0 m	TP-6 1.0m	TP-8 0.10m	TP-9 1.0m	TP-13 1.0m	TP-14 0.1-0.3m	TP-14 0.8-1.0m	TP-14 1.8-2.0m	TP-18 1.0m	
SGS CEMI Sample		TP-5 1.0m (-1/4")	TP-6 1.0m (-1/4")	TP-8 0.1m (-1/4")	TP-9 1.0m (-1/4")	TP-13 1.0m (-1/4")	TP-14 0.1-0.3m (-1/4")	TP-14 0.8-1.0m (-1/4")	TP-14 1.8-2.0m (-1/4")	TP-18 1.0m (-1/4")	
Fraction		Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	
Sector		S Dump	S Dump	S Dump	S Dump	S Dump	SW Lower Dump	SW Lower Dump	SW Lower Dump	SW Upper Dump	
Material Type		Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	
Parameter		SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	
Volume Nanopure Water	**mL**	750	750	750	750	750	750	750	750	750	
Sample Weight	**g**	250	250	250	250	250	250	250	250	250	
pH		7.58	7.73	7.62	8.08	7.95	8.01	8.12	8.11	7.87	**6.5-9.0**
Redox		411	402	412	384	397	390	393	400	409	
Conductivity	**mV**	2025	1281	2132	162	284	136	135	160	79	
Acidity (to pH 4.5)	**mg CaCO3/L**										
Total Acidity (to pH 8.3)	**mg CaCO3/L**	5.5	4.3	5.2	2.4	2.9	1.9	1.7	1.8	1.8	
Alkalinity	**mg CaCO3/L**	36.6	40.1	36.6	66.3	60.2	73.9	72.7	72.6	36.9	
Sulphate	**mg/L**	1430	790	1550	18	90	3	3	11	4	
Ion Balance											
Major Anions	**meq/L**	30.52	17.26	33.02	1.70	3.08	1.54	1.52	1.68	0.82	
Major Cations	**meq/L**	29.65	17.12	32.27	1.84	3.19	1.63	1.61	1.84	0.90	
Difference	**meq/L**	0.88	0.14	0.75	-0.14	-0.11	-0.09	-0.10	-0.15	-0.08	
Balance (%)	**%**	1.5%	0.4%	1.1%	-3.8%	-1.8%	-2.7%	-3.0%	-4.4%	-4.5%	
Dissolved Metals											
Hardness CaCO3	**mg/L**	1470	849	1610	88.5	156	78.7	77.9	88.1	41.9	-
Aluminum Al	**mg/L**	0.0055	0.005	0.0069	0.0074	0.0066	0.0124	0.0099	0.0085	0.0163	**0.005 if pH<6.5; 0.1 if pH≥6.5**
Antimony Sb	**mg/L**	0.00185	0.00159	0.0389	0.00122	0.00117	0.00112	0.00078	0.00106	0.00097	
Arsenic As	**mg/L**	**0.0166**	0.00391	**0.0247**	0.00222	**0.00695**	0.00476	**0.00513**	0.00261	**0.0177**	**0.005**
Barium Ba	**mg/L**	0.00955	0.00916	0.00534	0.0241	0.00877	0.0915	0.0405	0.077	0.0042	
Beryllium Be	**mg/L**	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	
Bismuth Bi	**mg/L**	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	
Boron B	**mg/L**	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	**1.5**
Cadmium Cd	**mg/L**	**0.00144**	**0.000886**	**0.00366**	**0.000187**	**0.000236**	0.000023	0.000041	0.000031	0.00002	**0.00004 to 0.00037 [H]**
Calcium Ca	**mg/L**	484	324	585	26	45.7	23	23.8	27.2	13.2	
Chromium Cr	**mg/L**	0.0004	0.0002	0.0001	0.0003	0.0001	0.0004	0.0003	0.0004	0.0008	
Cobalt Co	**mg/L**	0.000022	0.000019	0.000036	0.000012	0.000015	0.000012	0.000008	0.000015	0.000008	
Copper Cu	**mg/L**	0.00058	0.00072	0.00144	0.00129	0.00049	0.00035	0.00131	0.00075	0.00138	**0.002 to 0.004 [H]**
Iron Fe	**mg/L**	0.009	**0.01**	**0.011**	0.004	0.004	0.005	0.005	0.003	0.007	**0.3**
Lead Pb	**mg/L**	0.000074	0.000061	0.000073	0.00007	0.000052	0.000016	0.000026	0.000025	0.000049	**0.001 to 0.007 [H]**
Lithium Li	**mg/L**	0.0037	0.0026	0.0059	0.0017	0.0035	0.0013	0.0016	0.0018	0.0008	
Magnesium Mg	**mg/L**	64.3	10	35.6	5.72	10.1	5.19	4.51	4.92	2.14	
Manganese Mn	**mg/L**	0.00183	0.00319	0.0123	0.00081	0.00283	0.00072	0.00045	0.00209	0.00052	
Mercury Hg	**mg/L**	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	**0.0026**
Molybdenum Mo	**mg/L**	0.0001	0.00014	0.00055	0.00166	0.0001	0.00307	0.00206	0.00139	0.00722	**0.073**
Nickel Ni	**mg/L**	0.00044	0.00045	0.00075	0.00046	0.00062	0.00024	0.00028	0.00118	0.00029	**0.025 to 0.15 [H]**
Phosphorus P	**mg/L**	0.013	0.008	0.008	0.012	0.01	0.011	0.013	0.006	0.065	
Potassium K	**mg/L**	7.04	4.3	5.14	1.95	2.28	1.65	1.75	1.84	1.23	
Selenium Se	**mg/L**	0.00008	0.00005	0.00008	0.00005	0.00005	0.00005	0.00006	0.00005	0.0002	**0.001**
Silicon Si	**mg/L**	1.92	1.85	1.88	1.99	2.6	2.09	2.22	2.24	2.83	
Silver Ag	**mg/L**	0.000005	0.000005	0.000006	0.000007	0.000007	0.000005	0.000005	0.000005	0.000005	**0.0001**
Sodium Na	**mg/L**	0.51	0.36	0.46	0.43	0.5	0.22	0.2	0.61	0.74	
Strontium Sr	**mg/L**	0.603	0.267	0.751	0.13	0.11	0.0774	0.069	0.0817	0.0295	
Sulphur (S)	**mg/L**	526	291	569	7	33	3	3	5	3	
Thallium Tl	**mg/L**	0.00016	0.00012	0.000157	0.000028	0.000022	0.000014	0.000013	0.000013	0.000005	**0.0008**
Tin Sn	**mg/L**	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00002	0.00001	0.00001	
Titanium Ti	**mg/L**	0.0006	0.0006	0.0006	0.0007	0.0006	0.0005	0.0005	0.0006	0.0007	
Uranium U	**mg/L**	0.000294	0.000353	0.00124	0.000285	0.000099	0.000254	0.000331	0.000174	0.000157	
Vanadium V	**mg/L**	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	
Zinc Zn	**mg/L**	0.031	0.0125	0.0586	0.0041	0.0032	0.0012	0.0021	0.0013	0.0014	**0.03**
Zirconium Zr	**mg/L**	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	

Note:

Bold font indicates CCME exceedances

Table F3: Shake Flask Extraction - Waste Rock Dump (continue)

Waste Rock Dump								Compariosn Guideline
Sample ID	**Units**	**TP-18**	**TP-19**	**OS-1**		**LW**	**W**	**CCME,Water Quality Guideline For Protection Aquatic Life**
Sample_#	**mL**	TP-18 1.0m	TP-19 1.0m	OS-1-1	OS-1-2	LW-Fine-02	W-Fine-01	
SGS CEMI Sample		TP-18 1.0m (-1/4")	TP-19 1.0m (-1/4")	OS-1-1 (-1/4")	OS-1-2 (-1/4")	LW-Fine-02 (-1/4")	W-Fine-01 (-1/4")	
Fraction		Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	Fine (-1/4")	
Sector		SW Upper Dump	W Lower Dump	Ore Stockpile	Ore Stockpile	W Lower Dump	W Mid Level	
Material Type		Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	Rock Pile	
Parameter		SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	SFE_3:1	
Volume Nanopure Water	**mL**	750	750	750	750	750	600	
Sample Weight	**g**	250	250	250	250	250	200	
pH		7.87	7.61	**5.04**	**4.75**	7.96	6.87	**6.5-9.0**
Redox		409	434	513	478	375	429	
Conductivity	**mV**	79	1703	90	656	126	744	
Acidity (to pH 4.5)	**mg CaCO3/L**							
Total Acidity (to pH 8.3)	**mg CaCO3/L**	1.8	4.1	7.2	21.5	1.8	3.0	
Alkalinity	**mg CaCO3/L**	36.9	36.8	0.8	-0.2	75.1	7.3	
Sulphate	**mg/L**	4	1220	27	372	3	530	
Ion Balance								
Major Anions	**meq/L**	0.82	26.15	0.58	7.75	1.56	11.19	
Major Cations	**meq/L**	0.90	25.87	0.58	7.72	1.62	10.24	
Difference	**meq/L**	-0.08	0.28	0.00	0.03	-0.06	0.95	
Balance (%)	**%**	-4.5%	0.5%	0.2%	0.2%	-1.7%	4.4%	
Dissolved Metals								
Hardness CaCO3	**mg/L**	41.9	1290	22.8	382	76.9	507	-
Aluminum Al	**mg/L**	0.0163	0.0048	**0.0718**	**0.194**	0.0111	0.0108	**0.005 if pH<6.5; 0.1 if pH≥6.5**
Antimony Sb	**mg/L**	0.00097	0.00124	0.00054	0.00083	0.00127	0.00191	
Arsenic As	**mg/L**	**0.0177**	0.00226	**0.0165**	0.00656	**0.0187**	**0.0058**	**0.005**
Barium Ba	**mg/L**	0.0042	0.0068	0.00067	0.00198	0.102	0.0505	
Beryllium Be	**mg/L**	0.00001	0.00001	0.00004	0.00016	0.00001	0.00001	
Bismuth Bi	**mg/L**	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	
Boron B	**mg/L**	0.05	0.05	0.05	0.05	0.05	0.05	**1.5**
Cadmium Cd	**mg/L**	0.00002	**0.00285**	**0.00427**	**0.0483**	0.000043	**0.0107**	**0.00004 to 0.00037 [H]**
Calcium Ca	**mg/L**	13.2	471	6.92	147	22.7	191	
Chromium Cr	**mg/L**	0.0008	0.0002	0.0001	0.0001	0.0003	0.0001	
Cobalt Co	**mg/L**	0.000008	0.000022	0.00015	0.00109	0.000009	0.000023	
Copper Cu	**mg/L**	0.00138	0.00093	**0.0395**	**0.179**	0.00195	0.00212	**0.002 to 0.004 [H]**
Iron Fe	**mg/L**	0.007	0.008	0.002	0.008	0.003	0.004	**0.3**
Lead Pb	**mg/L**	0.000049	0.000109	0.000053	0.000241	0.000025	0.00003	**0.001 to 0.007 [H]**
Lithium Li	**mg/L**	0.0008	0.005	0.0045	0.0051	0.001	0.0018	
Magnesium Mg	**mg/L**	2.14	26.8	1.33	3.47	4.92	7.17	
Manganese Mn	**mg/L**	0.00052	0.0032	0.285	12.4	0.00107	0.0815	
Mercury Hg	**mg/L**	0.01	0.01	0.01	0.88	0.01	0.01	**0.0026**
Molybdenum Mo	**mg/L**	0.00722	0.00011	0.00005	0.00005	0.0009	0.00006	**0.073**
Nickel Ni	**mg/L**	0.00029	0.00042	0.00101	0.0113	0.00022	0.00054	**0.025 to 0.15 [H]**
Phosphorus P	**mg/L**	0.065	0.007	0.009	0.008	0.007	0.007	
Potassium K	**mg/L**	1.23	5.88	3.79	3.24	1.86	3.98	
Selenium Se	**mg/L**	0.0002	0.00004	0.00004	0.00007	0.00005	0.00005	**0.001**
Silicon Si	**mg/L**	2.83	1.68	1.89	2.72	1.79	2.51	
Silver Ag	**mg/L**	0.000005	0.000005	0.00106	0.000151	0.000005	0.000005	**0.0001**
Sodium Na	**mg/L**	0.74	0.36	0.55	0.35	0.79	0.31	
Strontium Sr	**mg/L**	0.0295	0.433	0.00115	0.249	0.0757	0.21	
Sulphur (S)	**mg/L**	3	455	12	149	3	178	
Thallium Tl	**mg/L**	0.000005	0.00009	0.000245	0.000118	0.000008	0.000056	**0.0008**
Tin Sn	**mg/L**	0.00001	0.00002	0.00002	0.00001	0.00001	0.00001	
Titanium Ti	**mg/L**	0.0007	0.0008	0.0006	0.001	0.0007	0.0007	
Uranium U	**mg/L**	0.000157	0.000422	0.000012	0.000115	0.000211	0.000007	
Vanadium V	**mg/L**	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	
Zinc Zn	**mg/L**	0.0014	0.0656	**0.571**	**5.73**	0.0017	0.192	**0.03**
Zirconium Zr	**mg/L**	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	

Note:
Bold font indicates CCME exceedances

Table F4: Shake Flask Extraction - Dam Fill Material

Dam Fill Material										Compariosn Guideline
Sample ID	**Units**	**TP-TD-13-01**	**BH-TD-13-01**	**TP-TD-13-01**	**BH-TD-13-01**	**BH-TD-13-01**	**TP-TD-13-02**	**TP-TD-13-02**	**TP-TD-13-03**	**CCME,Water Quality Guideline For Protection Aquatic Life**
		ARD-02	**ARD-03**	**ARD-04**	**ARD-06**	**ARD-10**	**ARD-01**	**ARD-03**	**ARD-05**	
Parameter										
Volume Nanopure Water	mL	750	750	750	750	750	750	750	750	
Sample Weight	g	250	250	250	250	250	250	250	250	
pH		7.70	7.94	7.72	7.41	7.67	7.35	7.49	5.67	**6.5-9.0**
Redox	mV	337	337	321	319	357	352	287	278	
Conductivity	uS/cm	6	40	32	28	49	20	33	1008	
Acidity (to pH 4.5)	mg CaCO3/L	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
Total Acidity (to pH 8.3)	mg CaCO3/L	3.7	3.7	2.4	2.4	3.9	3.5	2.8	7.6	
Alkalinity	mg CaCO3/L	2.9	20.3	10.0	10.7	10.9	8.4	12.5	1.3	
Sulphate	mg/L	4	4	8	4	7	3	2	445	
Ion Balance										
Major Anions	meq/L	0.14	0.49	0.37	0.30	0.36	0.23	0.29	9.30	
Major Cations	meq/L	0.13	0.44	0.35	0.29	0.52	0.34	0.53	10.77	
Difference	meq/L	0.01	0.05	0.02	0.00	-0.15	-0.11	-0.23	-1.48	
Balance (%)	%	5.3%	5.3%	2.2%	0.4%	-17.5%	-19.4%	-28.7%	-7.4%	
Dissolved Metals										
Hardness CaCO3	mg/L	3.4	15.8	12.3	11.1	9.13	13.1	20.1	489	-
Aluminum Al	mg/L	**0.148**	**0.237**	**0.201**	0.0827	**0.381**	**0.280**	**0.259**	**0.189**	**0.005 if pH<6.5; 0.1 if pH≥6.5**
Antimony Sb	mg/L	< 0.0002	0.0013	0.0004	0.0020	0.0005	< 0.0002	0.0017	0.0009	
Arsenic As	mg/L	0.0008	0.0044	0.0033	0.0031	0.0027	0.0014	0.0007	0.0038	**0.005**
Barium Ba	mg/L	0.00732	0.017	0.0208	0.0115	0.023	0.0145	0.0250	0.0839	
Beryllium Be	mg/L	0.00002	< 0.00002	< 0.00002	< 0.00002	0.00002	< 0.00002	0.00006	0.00002	
Bismuth Bi	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00010	0.00018	0.00013	
Boron B	mg/L	0.0053	0.0149	0.0148	0.0065	0.0145	0.0057	0.0100	0.138	**1.5**
Cadmium Cd	mg/L	0.000035	0.000016	0.000018	0.000026	0.000018	< 0.000003	**0.000294**	**0.000520**	**0.00004 to 0.00037 [H]**
Calcium Ca	mg/L	1.20	4.93	3.91	3.56	3.23	4.40	7.06	172	
Chromium Cr	mg/L	0.0007	< 0.0005	< 0.0005	< 0.0005	0.0008	0.0008	0.0025	0.0010	
Cobalt Co	mg/L	0.000237	0.000183	0.000150	0.000098	0.00104	0.000345	0.00330	0.115	
Copper Cu	mg/L	0.0166	0.0035	0.0047	0.0042	0.0078	0.0069	0.0062	0.0106	**0.002 to 0.004 [H]**
Iron Fe	mg/L	0.069	0.212	0.211	0.060	0.305	0.196	0.242	0.166	**0.3**
Lead Pb	mg/L	0.00008	0.00023	0.00020	0.00009	0.00031	0.00043	0.00025	0.00046	**0.001 to 0.007 [H]**
Lithium Li	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	
Magnesium Mg	mg/L	0.092	0.840	0.629	0.530	0.257	0.511	0.594	14.6	
Manganese Mn	mg/L	0.0130	0.0097	0.0161	0.0053	0.0129	0.0100	0.0078	17.3	
Mercury Hg	ug/L	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01	**0.0026**
Molybdenum Mo	mg/L	0.00029	0.00138	0.00097	0.00100	0.00155	0.00174	0.00059	0.00745	**0.073**
Nickel Ni	mg/L	0.0004	< 0.0001	0.0007	0.0004	0.0003	0.0006	0.0029	0.0207	**0.025 to 0.15 [H]**
Phosphorus P	mg/L	0.018	0.013	0.019	0.018	0.022	0.021	0.038	0.086	
Potassium K	mg/L	0.329	0.777	0.751	0.643	0.685	0.509	0.521	3.39	
Selenium Se	mg/L	0.00009	0.00020	0.00030	0.00021	0.00017	0.00021	0.00039	0.00023	**0.001**
Silicon Si	mg/L	2.21	2.36	2.76	2.27	2.24	1.83	1.73	10.5	
Silver Ag	mg/L	0.00001	< 0.00001	< 0.00001	< 0.00001	0.00009	< 0.00001	< 0.00001	< 0.00001	**0.0001**
Sodium Na	mg/L	0.72	1.54	1.17	1.30	5.94	0.54	1.59	5.16	
Strontium Sr	mg/L	0.0064	0.0260	0.0163	0.0142	0.0172	0.0203	0.0278	0.553	
Sulphur (S)	mg/L	0.17	0.82	1.44	0.59	3.04	0.36	0.90	174	
Thallium Tl	mg/L	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	0.00006	0.00033	**0.0008**
Tin Sn	mg/L	< 0.00001	0.00002	< 0.00001	0.00008	0.00003	< 0.00001	0.00091	0.00012	
Titanium Ti	mg/L	0.0020	0.0068	0.0062	0.0018	0.0113	0.0066	0.0069	0.0019	
Uranium U	mg/L	0.000066	0.000058	0.000067	0.000035	0.000063	0.000127	0.00454	0.000730	
Vanadium V	mg/L	0.00065	0.00166	0.00381	0.00117	0.00169	0.00145	0.00202	0.00042	
Zinc Zn	mg/L	0.001	0.002	0.001	0.002	0.002	0.003	0.004	0.016	**0.03**
Zirconium Zr	mg/L	0.00098	0.00026	0.00040	0.00022	0.00063	0.00100	0.00078	0.00080	

Note:

Bold font indicates CCME exceedances

Table F5: Shake Flask Extraction - Native Soil

		Native Soil												Compariosn Guideline
Sample ID	**Units**	**BH-T-13-01**	**BH-T-13-01**	**BH-T-13-02**	**BH-T-13-02**	**BH-T-13-03**	**BH-T-13-03**	**BH-T-13-04**	**BH-T-13-04**	**TP-T-13-02**	**TP-T-13-03**	**TP-T-13-04**	**TP-T-13-06**	**CCME,Water Quality Guideline For Protection Aquatic Life**
		ARD-01	**ARD-05**	**ARD-01**	**ARD-04**	**ARD-02**	**ARD-06**	**ARD-02**	**ARD-04**	**ARD-02**	**ARD-02**	**ARD-02**	**ARD-02**	
Parameter														
Volume Nanopure Water	mL	750	750	750	750	750	750	750	750	750	750	750	750	
Sample Weight	g	250	250	250	250	250	250	250	250	250	250	250	250	
pH		8.00	7.98	7.52	8.30	7.62	7.48	7.49	8.00	**6.33**	8.04	7.19	8.07	**6.5-9.0**
Redox	mV	347	344	350	311	349	304	335	320	259	303	330	317	
Conductivity	uS/cm	420	272	347	417	192	128	2089	227	418	77	213	159	
Acidity (to pH 4.5)	mg CaCO3/L	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
Total Acidity (to pH 8.3)	mg CaCO3/L	5.9	5.3	5.7	7.0	4.6	2.9	8.8	5.2	8.6	2.1	2.9	1.9	
Alkalinity	mg CaCO3/L	38.9	103.0	13.2	119.9	6.1	16.6	34.0	36.1	1.6	39.5	3.9	58.8	
Sulphate	mg/L	156	26	133	84	63	32	1072	20	145	3	58	10	
Ion Balance														
Major Anions	meq/L	4.03	2.60	3.04	4.15	1.44	1.00	23.01	1.14	3.05	0.85	1.29	1.38	
Major Cations	meq/L	4.14	3.07	3.33	4.59	1.70	1.16	26.74	2.01	3.31	0.89	1.77	1.55	
Difference	meq/L	-0.11	-0.46	-0.29	-0.45	-0.26	-0.16	-3.72	-0.87	-0.26	-0.04	-0.48	-0.16	
Balance (%)	%	-1.3%	-8.2%	-4.6%	-5.1%	-8.3%	-7.6%	-7.5%	-27.7%	-4.1%	-2.4%	-15.8%	-5.6%	
Dissolved Metals														
Hardness CaCO3	mg/L	195	123	160	195	71.7	48.8	1280	95.2	156	40.3	65.6	74.2	-
Aluminum Al	mg/L	0.0294	0.172	0.112	0.101	0.155	0.0744	0.0111	0.0299	0.0566	**0.228**	0.0997	0.0219	**0.005 if pH<6.5; 0.1 if pH≥6.5**
Antimony Sb	mg/L	0.0065	0.0035	0.0046	0.0073	0.0013	0.0063	0.465	0.0075	0.0033	0.0007	0.0007	0.0013	
Arsenic As	mg/L	**0.0166**	**0.0183**	**0.0087**	**0.0475**	0.0023	**0.0160**	**1.24**	**0.0072**	**0.0133**	0.0013	0.0046	0.0022	**0.005**
Barium Ba	mg/L	0.0519	0.0626	0.0904	0.112	0.069	0.0542	0.015	0.077	0.087	0.0219	0.0648	0.0437	
Beryllium Be	mg/L	0.00002	0.00008	< 0.00002	0.00014	< 0.00002	< 0.00002	< 0.00002	< 0.00002	0.00003	0.00004	< 0.00002	< 0.00002	
Bismuth Bi	mg/L	0.00002	0.00044	0.00001	0.00030	0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00009	< 0.00001	< 0.00001	
Boron B	mg/L	0.0162	0.0280	0.0843	0.0934	0.0183	0.0160	0.126	0.0245	0.0531	0.0094	0.0273	0.0224	**1.5**
Cadmium Cd	mg/L	0.000030	0.000087	0.000055	0.000219	**0.000215**	0.000045	**0.00343**	0.000058	0.000119	0.000038	**0.000303**	0.000012	**0.00004 to 0.00037 [H]**
Calcium Ca	mg/L	36.3	34.1	36.3	51.9	21.2	15.5	479	32.5	45.7	13.9	23.6	22.5	
Chromium Cr	mg/L	< 0.0005	0.0038	0.0006	0.0042	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0014	0.0009	< 0.0005	< 0.0005	
Cobalt Co	mg/L	0.000501	0.00391	0.00203	0.00452	0.000892	0.000261	0.00951	0.00120	0.00431	0.000646	0.000902	0.000245	
Copper Cu	mg/L	**0.0077**	**0.0325**	**0.0100**	**0.0325**	**0.0126**	0.0029	**0.0117**	0.0080	0.0035	0.0134	**0.0035**	**0.0042**	**0.002 to 0.004 [H]**
Iron Fe	mg/L	0.016	**1.25**	0.103	**1.38**	0.132	0.068	0.025	0.046	**0.415**	0.188	0.108	0.046	**0.3**
Lead Pb	mg/L	0.00007	0.00067	0.00057	0.00102	0.00037	0.00039	0.00048	0.00045	0.00015	0.00026	0.00023	0.00004	**0.001 to 0.007 [H]**
Lithium Li	mg/L	0.002	0.002	< 0.001	0.004	< 0.001	< 0.001	0.008	< 0.001	0.008	< 0.001	< 0.001	0.001	
Magnesium Mg	mg/L	25.4	9.09	16.8	15.9	4.52	2.44	20.6	3.43	10.1	1.37	1.59	4.34	
Manganese Mn	mg/L	0.0265	0.126	0.365	0.134	0.578	0.0181	2.76	0.0729	0.435	0.0112	0.146	0.0548	
Mercury Hg	ug/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.14	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	**0.0026**
Molybdenum Mo	mg/L	0.00170	0.0362	0.00656	0.0403	0.00163	0.00512	0.00816	0.00332	0.00038	0.00091	0.00039	0.0108	**0.073**
Nickel Ni	mg/L	0.0014	0.0104	0.0015	0.0099	0.0004	0.0004	0.0008	< 0.0001	0.0049	0.0010	0.0009	0.0014	**0.025 to 0.15 [H]**
Phosphorus P	mg/L	0.032	0.106	0.021	0.240	< 0.009	0.014	0.054	0.020	0.016	0.025	< 0.009	0.016	
Potassium K	mg/L	2.69	3.83	1.59	2.74	2.74	2.04	16.4	1.82	1.89	0.668	4.96	1.32	
Selenium Se	mg/L	0.00050	0.00099	0.00026	0.00125	0.00008	0.00031	0.00079	0.00066	0.00073	0.00029	0.00013	0.00098	**0.001**
Silicon Si	mg/L	1.62	2.23	2.51	2.68	2.78	2.57	4.45	1.26	2.54	1.56	1.44	0.85	
Silver Ag	mg/L	< 0.00001	< 0.00001	< 0.00001	0.00006	< 0.00001	< 0.00001	0.00005	< 0.00001	< 0.00001	0.00009	0.00004	< 0.00001	**0.0001**
Sodium Na	mg/L	3.71	10.3	1.22	12.1	3.45	3.07	12.3	1.31	2.57	0.80	7.16	0.79	
Strontium Sr	mg/L	0.170	0.136	0.287	0.216	0.0810	0.0682	0.653	0.129	0.200	0.0490	0.0606	0.0841	
Sulphur (S)	mg/L	57.3	11.7	50.0	30.3	22.3	12.8	421	10.4	64.1	0.68	23.8	4.35	
Thallium Tl	mg/L	< 0.00002	< 0.00002	< 0.00002	0.00009	< 0.00002	< 0.00002	0.00037	< 0.00002	< 0.00002	< 0.00002	0.00005	< 0.00002	**0.0008**
Tin Sn	mg/L	0.00001	< 0.00001	0.00007	0.00006	0.00003	0.00018	< 0.00001	0.00002	< 0.00001	< 0.00001	< 0.00001	< 0.00001	
Titanium Ti	mg/L	0.0006	0.0144	0.0040	0.0128	0.0056	0.0015	0.0003	0.0010	0.0023	0.0065	0.0019	0.0006	
Uranium U	mg/L	0.000275	0.00327	0.000043	0.00142	0.000027	0.000032	0.000598	0.000217	0.000061	0.000232	0.000037	0.00132	
Vanadium V	mg/L	0.00390	0.00740	0.00688	0.00789	0.00063	0.00081	0.00021	0.00098	0.00244	0.00189	0.00034	0.00068	
Zinc Zn	mg/L	0.003	0.004	0.004	0.004	0.005	0.001	0.019	0.002	0.018	0.003	0.002	< 0.001	**0.03**
Zirconium Zr	mg/L	0.00004	0.00207	0.00047	0.00209	0.00022	0.00004	0.00003	0.00006	0.00012	0.00035	0.00033	0.00005	

Note:
Bold font indicates CCME exceedances

Table F6: Shake Flask Extraction - Mill Area

Mill					Compariosn Guideline
Sample ID	**Units**	**BH-M-13-04**	**TP-M-13-04**	**TP-M-13-05**	**CCME,Water Quality Guideline For Protection Aquatic Life**
		ARD-01	**ARD-01**	**ARD-02**	
Parameter					
Volume Nanopure Water	mL	750	750	750	
Sample Weight	g	250	250	250	
pH		7.67	7.82	7.86	**6.5-9.0**
Redox	mV	317	351	345	
Conductivity	uS/cm	389	209	61	
Acidity (to pH 4.5)	mg CaCO3/L	#N/A	#N/A	#N/A	
Total Acidity (to pH 8.3)	mg CaCO3/L	3.7	3.6	3.0	
Alkalinity	mg CaCO3/L	50.1	38.8	24.3	
Sulphate	mg/L	109	58	10	
Ion Balance					
Major Anions	meq/L	3.27	1.98	0.69	
Major Cations	meq/L	3.98	2.09	0.65	
Difference	meq/L	-0.71	-0.11	0.04	
Balance (%)	%	-9.8%	-2.6%	3.1%	
Dissolved Metals					
Hardness CaCO3	mg/L	191	98.6	28.7	-
Aluminum Al	mg/L	0.0181	0.0343	**0.105**	**0.005 if pH<6.5; 0.1 if pH≥6.5**
Antimony Sb	mg/L	0.905	0.110	0.0013	
Arsenic As	mg/L	**0.375**	**0.131**	0.0021	**0.005**
Barium Ba	mg/L	0.0328	0.0150	0.0401	
Beryllium Be	mg/L	< 0.00002	< 0.00002	< 0.00002	
Bismuth Bi	mg/L	< 0.00001	< 0.00001	< 0.00001	
Boron B	mg/L	0.0168	0.0172	0.0073	**1.5**
Cadmium Cd	mg/L	**0.00144**	**0.000294**	0.000003	**0.00004 to 0.00037 [H]**
Calcium Ca	mg/L	52.2	29.8	8.73	
Chromium Cr	mg/L	< 0.0005	< 0.0005	< 0.0005	
Cobalt Co	mg/L	0.000113	0.000070	0.000078	
Copper Cu	mg/L	**0.0065**	0.0016	0.0014	**0.002 to 0.004 [H]**
Iron Fe	mg/L	0.021	0.020	0.095	**0.3**
Lead Pb	mg/L	0.00516	0.00105	0.00013	**0.001 to 0.007 [H]**
Lithium Li	mg/L	0.004	< 0.001	< 0.001	
Magnesium Mg	mg/L	14.7	5.90	1.68	
Manganese Mn	mg/L	0.0189	0.0024	0.0105	
Mercury Hg	ug/L	0.02	< 0.01	< 0.01	**0.0026**
Molybdenum Mo	mg/L	0.00266	0.00120	0.00035	**0.073**
Nickel Ni	mg/L	0.0004	0.0003	0.0004	**0.025 to 0.15 [H]**
Phosphorus P	mg/L	0.014	0.014	< 0.009	
Potassium K	mg/L	4.21	3.29	1.09	
Selenium Se	mg/L	0.00041	0.00041	0.00020	**0.001**
Silicon Si	mg/L	2.56	2.16	2.01	
Silver Ag	mg/L	0.00036	< 0.00001	< 0.00001	**0.0001**
Sodium Na	mg/L	1.32	0.64	0.80	
Strontium Sr	mg/L	0.150	0.0669	0.0308	
Sulphur (S)	mg/L	47.8	21.1	3.57	
Thallium Tl	mg/L	0.00021	0.00004	< 0.00002	**0.0008**
Tin Sn	mg/L	0.00087	< 0.00001	< 0.00001	
Titanium Ti	mg/L	0.0003	0.0004	0.0025	
Uranium U	mg/L	0.000411	0.000156	0.000022	
Vanadium V	mg/L	0.00029	0.00032	0.00062	
Zinc Zn	mg/L	0.038	0.006	0.001	**0.03**
Zirconium Zr	mg/L	0.00014	0.00005	0.00003	

Note:

Bold font indicates CCME exceedances

Table F7: Shake Flask Extraction - Haul Road

Haul Road					Compariosn Guideline
Sample ID	**Units**	**TP-R-13-01**	**TP-R-13-02**	**TP-R-13-03**	**CCME,Water Quality Guideline For Protection Aquatic Life**
		ARD-02	**ARD-01**	**ARD-02**	
Parameter					
Volume Nanopure Water	mL	750	750	750	
Sample Weight	g	250	250	250	
pH		7.43	7.83	7.82	**6.5-9.0**
Redox	mV	366	361	357	
Conductivity	uS/cm	203	260	287	
Acidity (to pH 4.5)	mg CaCO3/L	#N/A	#N/A	#N/A	
Total Acidity (to pH 8.3)	mg CaCO3/L	3.8	3.4	3.8	
Alkalinity	mg CaCO3/L	4.0	42.1	36.6	
Sulphate	mg/L	82	77	96	
Ion Balance					
Major Anions	meq/L	1.79	2.45	2.73	
Major Cations	meq/L	1.90	2.62	2.81	
Difference	meq/L	-0.11	-0.18	-0.08	
Balance (%)	%	-3.1%	-3.5%	-1.4%	
Dissolved Metals					
Hardness CaCO3	mg/L	85.5	124	132	-
Aluminum Al	mg/L	0.0440	0.0340	0.0362	**0.005 if pH<6.5; 0.1 if pH≥6.5**
Antimony Sb	mg/L	0.0065	0.0107	0.0026	
Arsenic As	mg/L	**0.0092**	**0.0215**	0.0031	**0.005**
Barium Ba	mg/L	0.0586	0.0188	0.0152	
Beryllium Be	mg/L	< 0.00002	< 0.00002	< 0.00002	
Bismuth Bi	mg/L	0.00002	< 0.00001	< 0.00001	
Boron B	mg/L	0.0048	0.0154	0.0063	**1.5**
Cadmium Cd	mg/L	0.000147	0.000098	**0.000286**	**0.00004 to 0.00037 [H]**
Calcium Ca	mg/L	25.6	39.4	42.7	
Chromium Cr	mg/L	< 0.0005	< 0.0005	< 0.0005	
Cobalt Co	mg/L	0.000084	0.000135	0.000087	
Copper Cu	mg/L	**0.0033**	0.0010	0.0008	**0.002 to 0.004 [H]**
Iron Fe	mg/L	0.101	0.022	0.016	**0.3**
Lead Pb	mg/L	0.00202	0.00045	0.00032	**0.001 to 0.007 [H]**
Lithium Li	mg/L	0.001	< 0.001	0.002	
Magnesium Mg	mg/L	5.25	6.25	6.10	
Manganese Mn	mg/L	0.0262	0.0030	0.0054	
Mercury Hg	ug/L	< 0.01	< 0.01	< 0.01	**0.0026**
Molybdenum Mo	mg/L	0.00008	0.00023	0.00044	**0.073**
Nickel Ni	mg/L	0.0007	0.0002	0.0002	**0.025 to 0.15 [H]**
Phosphorus P	mg/L	0.011	0.026	< 0.009	
Potassium K	mg/L	4.32	3.67	3.14	
Selenium Se	mg/L	0.00014	0.00009	0.00009	**0.001**
Silicon Si	mg/L	3.58	2.46	2.38	
Silver Ag	mg/L	0.00001	< 0.00001	< 0.00001	**0.0001**
Sodium Na	mg/L	1.77	1.09	2.21	
Strontium Sr	mg/L	0.0721	0.0865	0.150	
Sulphur (S)	mg/L	28.6	28.8	32.5	
Thallium Tl	mg/L	0.00004	< 0.00002	< 0.00002	**0.0008**
Tin Sn	mg/L	< 0.00001	< 0.00001	< 0.00001	
Titanium Ti	mg/L	0.0013	0.0004	0.0002	
Uranium U	mg/L	0.000008	0.000142	0.000159	
Vanadium V	mg/L	0.00027	0.00017	0.00012	
Zinc Zn	mg/L	0.006	0.003	0.004	**0.03**
Zirconium Zr	mg/L	0.00007	0.00003	0.00002	

Note:

Bold font indicates CCME exceedances

Table F8: Shake Flask Extraction - Borrow Area

		Borrow Material									Compariosn Guideline
Sample ID	**Units**	**HA-BA-13-01**	**HA-BA-13-02**	**TP-BA-13-03**	**TP-BA-13-03**	**TP-BA-13-04**	**TP-BA-13-04**	**TP-BA-13-05**	**TP-BA-13-05**	**TP-BA-13-07**	**CCME,Water Quality Guideline For Protection Aquatic Life**
		2-3 m	**0-1 m**	**ARD-01**	**ARD-03**	**ARD-01**	**ARD-03**	**ARD-02**	**ARD-04**	**ARD-02**	
Parameter											
Volume Nanopure Water	mL	750	750	750	750	750	750	750	750	750	
Sample Weight	g	250	250	250	250	250	250	250	250	250	
pH		7.76	7.81	7.53	7.56	7.15	7.60	7.35	7.64	7.83	**6.5-9.0**
Redox	mV	331	329	333	335	338	351	345	350	353	
Conductivity	uS/cm	78	72	39	48	12	55	23	74	72	
Acidity (to pH 4.5)	mg CaCO3/L	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
Total Acidity (to pH 8.3)	mg CaCO3/L	2.2	2.1	2.3	2.4	2.5	2.2	2.6	2.6	2.9	
Alkalinity	mg CaCO3/L	38.3	34.3	20.3	24.3	5.1	26.7	9.8	31.3	38.9	
Sulphate	mg/L	3	3	<2	<2	3	<2	<2	5	4	
Ion Balance											
Major Anions	meq/L	0.83	0.75	0.41	0.49	0.16	0.53	0.20	0.73	0.86	
Major Cations	meq/L	0.83	0.76	0.40	0.51	0.13	0.57	0.23	0.74	0.77	
Difference	meq/L	0.00	-0.01	0.00	-0.03	0.04	-0.04	-0.04	-0.01	0.09	
Balance (%)	%	0.0%	-0.9%	0.3%	-2.8%	12.1%	-3.4%	-8.5%	-0.8%	5.3%	
Dissolved Metals											
Hardness CaCO3	mg/L	38.5	35.3	18.4	23.1	5.0	26.2	9.8	33.5	35.4	-
Aluminum Al	mg/L	0.0622	**0.105**	0.0677	0.0750	0.0357	0.0873	0.0145	0.0933	0.0419	**0.005 if pH<6.5; 0.1 if pH≥6.5**
Antimony Sb	mg/L	0.0012	0.0012	0.0007	0.0010	0.0005	0.0004	0.0044	0.0014	0.0002	
Arsenic As	mg/L	0.0039	0.0039	**0.0114**	**0.0141**	0.0041	**0.0086**	0.0034	**0.0086**	0.0010	**0.005**
Barium Ba	mg/L	0.0182	0.0249	0.0160	0.0161	0.00375	0.00941	0.00791	0.0279	0.00167	
Beryllium Be	mg/L	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
Bismuth Bi	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	
Boron B	mg/L	0.0174	0.0132	0.0071	0.0160	0.0075	0.0113	0.0066	0.0074	0.0049	**1.5**
Cadmium Cd	mg/L	0.000006	0.000009	< 0.000003	0.000033	0.000008	0.000014	0.000005	0.000022	0.000007	**0.00004 to 0.00037 [H]**
Calcium Ca	mg/L	12.2	11.8	6.66	7.13	1.45	8.73	3.40	10.9	11.7	
Chromium Cr	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
Cobalt Co	mg/L	0.000061	0.000084	0.000060	0.000075	0.000047	0.000098	0.000034	0.000121	0.000042	
Copper Cu	mg/L	**0.0024**	**0.0036**	**0.0016**	**0.0029**	**0.0027**	0.0020	0.0027	**0.0038**	< 0.0005	**0.002 to 0.004 [H]**
Iron Fe	mg/L	0.037	0.070	0.058	0.083	0.033	0.055	0.020	0.074	0.014	**0.3**
Lead Pb	mg/L	0.00004	0.00011	0.00010	0.00035	0.00010	0.00010	0.00007	0.00018	< 0.00002	**0.001 to 0.007 [H]**
Lithium Li	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	
Magnesium Mg	mg/L	1.94	1.44	0.417	1.29	0.327	1.06	0.322	1.54	1.49	
Manganese Mn	mg/L	0.0058	0.0066	0.0025	0.0083	0.0043	0.0192	0.0025	0.0098	0.0005	
Mercury Hg	ug/L	< 0.01	0.02	0.02	0.02	0.02	0.02	0.02	< 0.01	< 0.01	**0.000026**
Molybdenum Mo	mg/L	0.00089	0.00160	0.00037	0.00075	0.00043	0.00047	0.00121	0.00157	0.00572	**0.073**
Nickel Ni	mg/L	0.0003	0.0004	0.0003	0.0004	0.0008	0.0002	0.0003	0.0006	0.0001	**0.025 to 0.15 [H]**
Phosphorus P	mg/L	0.052	0.032	0.057	0.036	0.019	0.052	0.010	0.026	0.011	
Potassium K	mg/L	1.32	1.32	0.565	0.940	0.385	0.824	0.729	1.12	2.23	
Selenium Se	mg/L	0.00040	0.00046	0.00020	0.00069	0.00011	0.00073	0.00056	0.00095	0.00026	**0.001**
Silicon Si	mg/L	2.49	1.74	2.40	2.19	1.74	2.50	1.73	1.69	2.28	
Silver Ag	mg/L	< 0.00001	< 0.00001	< 0.00001	0.00002	0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	**0.0001**
Sodium Na	mg/L	0.58	0.48	0.53	0.62	0.46	0.62	0.40	0.96	0.23	
Strontium Sr	mg/L	0.0593	0.0508	0.0206	0.0285	0.0073	0.0241	0.0110	0.0446	0.0548	
Sulphur (S)	mg/L	0.52	0.58	0.25	0.34	0.22	0.39	0.31	1.25	0.51	
Thallium Tl	mg/L	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	**0.0008**
Tin Sn	mg/L	0.00004	0.00002	0.00004	0.00001	0.00007	0.00001	0.00002	< 0.00001	< 0.00001	
Titanium Ti	mg/L	0.0014	0.0027	0.0018	0.0015	0.0009	0.0023	0.0003	0.0022	0.0002	
Uranium U	mg/L	0.000338	0.000281	0.000018	0.000037	0.000022	0.000100	0.000006	0.000158	0.000087	
Vanadium V	mg/L	0.00512	0.00335	0.00186	0.00255	0.00067	0.00622	0.00071	0.00222	0.00013	
Zinc Zn	mg/L	< 0.001	0.001	0.002	0.002	< 0.001	< 0.001	< 0.001	0.001	< 0.001	**0.03**
Zirconium Zr	mg/L	0.00003	0.00005	0.00004	0.00006	0.00010	0.00003	0.00002	0.00005	< 0.00001	

Note:

Bold font indicates CCME exceedances

APPENDIX G

Site Characterization QA/QC

SITE CHARACTERIZATION QUALITY ASSURANCE AND QUALITY CONTROL

To assess the quality of the sampling and analytical results, field duplicates were analyzed for the Program at a rate of approximately 13% of the total number of samples collected. The collection and analysis of the duplicate samples provided information on the combined (field and analytical) precision of the sampling and analytical program. The individual analytical results for each analyte in each sample of the duplicate pair were compared, and the relative percent difference (RPD) for each analyte pair was calculated as follows:

$$RPD = \left(\frac{(a-b)}{\left(\frac{a+b}{2} \right)} \right) \times 100$$

where a and b are duplicate pair values in identical units. An RPD of 25% or less is generally considered acceptable, whereas an RPD greater than 25% may indicate a problem with either sampling or analysis (BC MOE 2003). This limit may vary somewhat depending on the analysis involved and the concentration of the analyte. The RPD also tends to increase as the result approaches the detection limit. Therefore, use of this threshold is restricted to duplicate pair values that are both five-fold higher than their detection limit.

RPDs calculated from sample duplicates were found to indicate good reproducibility, with an average of 17.1% (ranging from 0 to 88.4% RPD; Table SC4). Where RPDs were above detection limits, they were found to generally improve with concentration. In all cases, the highest value of a duplicate pair was used for interpretation purposes. Variability between samples of a duplicate pair did not affect interpretations of the results. Results of laboratory QA/QC samples were generally found to be within tolerances, supporting the acceptable accuracy and precision of all analytical data.

Table G1. 2013 soil analytical QAQC results, Mt. Nansen, YT

Sample	BH-M-13-02			BH-M-13-05			BH-M-13-07			BH-M-13-08			TP-SP-13-03		
Depth (mbgs)	1.1-1.5	Dup 05	RPD	1.1-1.5	Dup 01	RPD	2.6-3.0	Dup 02	RPD	2.6-3.0	Dup 03	RPD	0.1-0.2	Dup 04	RPD
Analyte															
pH (in pH units)	6.1	6.58	7.6	7.82	8	2.3	8.09	8.18	1.1	7.74	7.74	0.0	8.26	8.33	0.8
Antimony (Sb)	5.45	6.88	23.2	94	83	12.4	12.8	13	1.6	1730	930	**60.2**	9.17	9.11	0.7
Arsenic (As)	83.9	83.6	0.4	1480	1120	**27.7**	187	187	0.0	80700	43800	**59.3**	104	106	1.9
Barium (Ba)	200	192	4.1	131	162	21.2	53.1	66.2	22.0	116	88.2	27.2	366	405	10.1
Beryllium (Be)	0.41	0.5	19.8	0.49	0.51	4.0	0.26	0.25	3.9	0.34	0.28	19.4	0.44	0.47	6.6
Cadmium (Cd)	0.25	0.273	8.8	10.1	10.5	3.9	0.755	0.954	23.3	24.3	12.6	**63.4**	0.306	0.329	7.2
Chromium (Cr)	8.28	21.4	**88.4**	11.9	12.6	5.7	13.3	15.1	12.7	2.64	2.31	13.3	24.5	45.7	**60.4**
Cobalt (Co)	5.37	5.71	6.1	13.1	13.8	5.2	6.62	6.64	0.3	0.99	1.08	8.7	19.5	20	2.5
Copper (Cu)	9.81	18.9	**63.3**	80	70.7	12.3	21.4	23	7.2	383	193	**66.0**	49.1	49	0.2
Lead (Pb)	27.2	22	21.1	585	445	**27.2**	35.4	37.8	6.6	9340	5870	**45.6**	56.1	60.2	7.1
Mercury (Hg)	0.05	0.05	0.0	0.062	0.068	9.2	0.05	0.05	0.0	0.876	0.608	**36.1**	0.05	0.05	0.0
Molybdenum (Mo)	0.5	0.5	0.0	1.14	1.22	6.8	0.5	0.5	0.0	0.97	1.24	24.4	0.5	0.75	**40.0**
Nickel (Ni)	5.6	8.17	**37.3**	8.73	9.85	12.1	8.58	8.93	4.0	1.01	1.1	8.5	10.7	17.2	**46.6**
Selenium (Se)	0.2	0.2	0.0	0.36	0.39	8.0	0.29	0.31	6.7	2.25	1.6	**33.8**	0.35	0.3	15.4
Silver (Ag)	0.2	0.18	10.5	9.37	10.8	14.2	0.59	0.82	**32.6**	53.4	39	**31.2**	1.49	1.57	5.2
Thallium (Tl)	0.098	0.11	11.5	0.345	0.369	6.7	0.253	0.231	9.1	7.39	4.45	**49.7**	0.425	0.472	10.5
Tin (Sn)	2	2	0.0	2	2	0.0	2	2	0.0	2	2	0.0	2	2	0.0
Uranium (U)	0.32	0.403	23.0	0.541	0.562	3.8	0.586	0.455	**25.2**	3.33	1.71	**64.3**	0.321	0.411	24.6
Vanadium (V)	26.7	40.1	**40.1**	43.3	43.6	0.7	52.1	55.8	6.9	20.1	12.4	**47.4**	131	138	5.2
Zinc (Zn)	29.1	42.5	**37.4**	731	748	2.3	92.7	94.4	1.8	677	407	**49.8**	117	127	8.2
Maximum RPD			88.4			27.7			32.6			66.0			60.4
Minimum RPD			0.0			0.0			0.0			0.0			0.0
Average RPD			20.1			9.3			8.2			**35.4**			12.7

Notes:
RPD = Relative Percent Difference
RPDs >25% are noted in bold
Units are mg/kg, unless otherwise noted