MGM Energy – 2016 Environmental Site Monitoring Report

Site: Umiak N-16 Wellsite and Sump

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Prepared for:
MGM Energy Corporation
Calgary, Alberta

Prepared by:
KAVIK-STANTEC Inc.
Inuvik, NT

Water License N7L1-1797 and Land Use Permit N2003A0035

KAVIK-STANTEC

Executive Summary

The Umiak N-16 Wellsite (the Wellsite Area) and Umiak N-16 Sump (the Sump Area) are located within the Inuvialuit Settlement Region (ISR), Northwest Territories (NT). The Wellsite Area is located approximately 122 km northwest of Inuvik and contains a wellhead and surrounding land to the Wellsite Area boundary. The Sump Area is located approximately 11 km southeast of the Wellsite Area and contains a drilling sump and four thermistor cables and metal protective casings (the data loggers were previously removed in 2010 and the instruments are no longer recording data).

On August 22, 2016 two KAVIK-STANTEC assessors and one MGM representative visited both the Wellsite Area and the Sump Area to conduct the 2016 environmental monitoring and reclamation program (the 2016 program). The 2016 program was the second year that KAVIK-STANTEC conducted monitoring of the Wellsite Area and Sump Area.

The 2016 program produced the following findings regarding the Wellsite Area and Sump Area:

Wellsite Area:

- Two ice-wedges were observed within 5 m of the wellhead. The troughs - approximately 0.30 m wide, 0.30 m deep and 10 to 20 m long - had no standing water present and showed no signs of erosion.
- An active retrogressive thaw slump was observed approximately 300 m east from the wellhead and not affecting the integrity of the Wellsite Area.
- No conditions that warranted soil or water sampling were observed; therefore, no sampling was conducted.
- Vegetation cover within most of the Wellsite Area was meeting Land Use Permit N2003A0035 requirements for vegetation health and 70% cover. Vegetation growing in the sandy, gravelly material around the wellhead culvert had approximately 57% cover. This area was seeded as part of the 2016 program with approximately 0.5 kg of seed mix consisting of violet wheatgrass (*Agropyron violaceum/Elymus alaskanus)*, polargrass (*Arctagrostis latifolia*) and tufted hairgrass (*Deschampsia caespitosa*).
- An invasive species, scentless chamomile (*Tripleurospermum inodorum*) was observed to be growing immediately south of the wellhead. At the time of the site visit, the infestation area was approximately 200 m^2 area with a 10% cover of scentless chamomile plants, which is considered a moderate infestation.

Sump Area:

- The slopes along the sump were observed to be stable, with no physical evidence of recent surface erosion, stress or new tension cracks.
- Previous monitoring events completed at the sump identified elevated salinity in soil south of the sump.

- Eight soil samples were collected off-site of the Sump Area. The pH values in several of the samples were outside of the applicable guidelines; however, only one sample collected approximately 110 m south of the sump had a pH that was below reference data. Although the type of material sampled (peat) is consistent with low pH, due to the limited reference data available, KAVIK-STANTEC could not confirm that the low pH is related to natural conditions.
- Six standing water samples were collected (two within 50 m of the sump perimeter and four reference samples). The analytical results of water samples collected during current and historical monitoring programs suggest that a migration of drilling fluid has occurred, which has resulted in higher electrical conductivity (EC) values in samples collected to the north and south of the sump. Results from the 2016 samples collected north of the sump suggested that impacts potentially relating to sump contents were present. Notably, the concentration of dissolved chloride and potassium in standing water samples collected to the north and south of the sump was elevated in comparison with the historical and 2016 reference concentrations.
- No vegetation issues were observed on the sump. The sump has greater than 70% vegetation cover, which met Land Use Permit N2003A0035 requirements.
- Impacted vegetation was identified in two areas south of the Sump Area, including one to the south and one to the southwest. Results of soil and standing water samples collected proximate to the southern impacted area suggest that concentrations of potassium and chloride may be affecting vegetation growth in these areas. Soil samples collected from one of the impacted vegetation areas also had pH values below the applicable guideline.
- Invasive plants were not observed.

Based on the findings of the 2016 program, the following recommendations are provided for 2017:

Parameter	Recommendations
Ground temperature monitoring	• Remove the remaining ground temperature equipment from the Sump Area.
Terrain and permafrost	• Monitor the ice-wedges present next to the wellhead and sump. • Monitor the retrogressive thaw slump for signs of activity; delineate the headwall so that a retrogression rate can be assessed.
Soil and Water Sampling	• Complete reference sampling in the area surrounding the sump. • Collect additional soil samples in vicinity of the observed elevated conductivities to confirm the findings of past electromagnetic (EM) surveys.
Wellsite Area Reclamation	• Conduct vegetation monitoring on the lightly vegetated area around the wellhead culvert to determine if there is establishment of the grass seed that was applied in 2016 and increased growth and density of the currently established grasses. • Findings of the monitoring will determine if additional treatments will be required.

Parameter	Recommendations
Sump Area Reclamation	• Conduct vegetation monitoring of the impacted vegetation areas south of the sump to delineate the currently identified areas, monitor for changes, and locate new areas. Monitoring should include vegetation species composition and cover, plant establishment and growth and overall vegetation health. Also conduct vegetation monitoring at non-impacted reference sites in surrounding areas for comparison of vegetation cover and species composition. • Findings of the vegetation monitoring could be used to determine if impacted vegetation areas can be left on their own to naturally develop a self-sustaining vegetation cover, or if phytoremediation/reclamation treatments would be required in 2018.
Invasive plants	• Monitor invasive plant infestation (scentless chamomile) in native grass seeded area immediately south of the wellhead. • Carry out control treatments including pulling plants, storing in garbage bags, and disposing offsite in the Inuvik landfill. Monitoring and control treatment should be carried out in the summer of 2017 prior to seed ripening. • Study potential alternative treatments, such as herbicide application or biocontrol (i.e., control of invasive plants using insects, parasites, and pathogens), that would provide more effective and longer term control.

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Abbreviations

µS/cm ..... microseimens per centimetre
AEP ..... Alberta Environment and Parks
CCME ..... Canadian Council of the Ministers of the Environment
cm ..... centimetre
CSQG ..... Canadian Soil Quality Guideline
CWQG ..... Canadian Water Quality Guideline
dS/m ..... deciseimens per metre
EC ..... electrical conductivity
EM ..... electromagnetic
GNWT ..... Government of the Northwest Territories
ha ..... hectare
INAC ..... Indigenous and Northern Affairs Canada
ISO ..... International Organization for Standardization
ISR ..... Inuvialuit Settlement Region
IWB ..... Inuvialuit Water Board
KAVIK-STANTEC ..... KAVIK-STANTEC Inc.
kg ..... kilogram
km ..... kilometre
m ..... metre
m^2 ..... square metre
Maxxam ..... Maxxam Analytics Inc.
mbgs ..... metres below ground surface
mg/L ..... milligram per litre
MGM ..... MGM Energy Corporation
NEB ..... National Energy Board
NT ..... Northwest Territories
NWTWB ..... Northwest Territories Water Board
PAL ..... Protection of Aquatic Life
PCOC ..... potential contaminants of concern
PHC ..... petroleum hydrocarbon
PVC ..... polyvinyl chloride
QA/QC ..... quality assurance/quality control
RPD ..... relative percent difference
SAR ..... sodium adsorption ratio
Site ..... Umiak N-16 Wellsite Area and Sump Area

Glossary

Term	Definition
active layer	The layer of ground that is subject to annual thawing and freezing in areas underlain by permafrost
biocontrol	Biocontrol or biological control is a method of invasive plant control which uses the invasive plant's natural enemies such as insects, parasites and pathogens to reduce the invasive plant population below a desired level. It is the long-term, self-sustaining treatment method for managing invasive plants.
control transect	Refers to the location of active layer measurements taken away from the sump, along a straight line located in undisturbed terrain 50 to 100 m away from the sump.
ice-wedge	A massive, generally wedge-shaped body with its apex pointing downward, composed of foliated or vertically banded, commonly white, ice
Impacted vegetation area	A vegetated area having lower vegetation cover, displaying poor vegetation condition or health or extensive bare areas potentially due to poor soil nutrient conditions, high/low pH levels, electrical conductivity (EC)/ sodium absorption ratio (SAR) exceedances, petroleum hydrocarbon (PHC) exceedances or other soil chemistry factors.
permafrost	Soil or rock, and included ice and organic material, that remains frozen for at least two consecutive years.
reclamation	The process of reconverting disturbed land to its former or other productive uses.
remediation	The removal, reduction, or neutralization of substances, wastes or hazardous material from a site to reduce the potential for adverse effects on the environment now or in the future.

reference samples	A reference site is selected in the landscape to serve as a comparison to a disturbed area being reclaimed. These sites are normally equivalent in landscape characteristics with the key difference being the reference site has not been subjected to disturbance from development. Reference samples (e.g., water or soil) can be taken as a comparison with samples collected in the disturbed area being reclaimed. Reference sampling provides the background, or naturally occurring conditions, that are then compared with the site undergoing reclamation to evaluate whether conditions are similar.
retrogressive thaw slump	A slope failure resulting from thawing of ice-rich permafrost.
routine chemistry parameters	Laboratory analysis of conductivity, pH and major cations

1 INTRODUCTION

In 2016, KAVIK-STANTEC Inc. (KAVIK-STANTEC) was retained by MGM Energy Corp. (MGM) to complete environmental monitoring and reclamation activities at the Umiak N-16 Wellsite Area and Sump Area located in the Inuvialuit Settlement Region (ISR) of the Northwest Territories (NT). KAVIK-STANTEC also completed an environmental monitoring program at the Umiak N-16 Wellsite Area and Sump Area in 2015 (the 2015 program). Further details can be found in the reports titled *MGM Energy Corporation – 2015 Environmental Site Monitoring Report Site: Umiak N-16 Wellsite* (KAVIK-STANTEC 2016a) and *MGM Energy Corporation – 2015 Environmental Site Monitoring Report Site: Umiak N-16 Sump* (KAVIK-STANTEC 2016b). The 2016 environmental monitoring and reclamation program (the 2016 program) scope of work was developed in consideration of the recommendations and outcomes of the 2015 program, as well as discussions between the regulators, MGM and KAVIK-STANTEC.

1.1 Scope of Work

The objective of this report is to provide the findings of the 2016 program, which consisted of the following activities (where practicable):

- Observing conditions at the wellsite and sump, including observations related to the terrain conditions (including terrain stability), vegetation condition and vegetation health
- Collecting soil and/or water samples
- Interpreting laboratory results and site observations relative to guidelines and reclamation objectives.

1.2 Site Description

The Wellsite Area is located at 69° 25' 53.112" N and 134° 18' 55.512" W, approximately 122 km north of Inuvik, NT (Figure A-1 and A-2, Appendix A). The Wellsite Area spans an area of approximately 2.25 ha and encompasses the wellhead location and surrounding land to the site boundary (Photo B-1, Appendix B). The site is located on top of a gently rolling hill, and is reflective of the surrounding topography with hills sloping down to lakes. Unnamed lakes lie in all directions around the site, with the closest one located approximately 230 m southeast of the wellsite (Photo B-1, Appendix B). The layout of the Wellsite Area is illustrated in Figures A-2, Appendix A.

The Sump Area is located at 69° 25' 53.096" N and 134° 19' 6.016" W, approximately 11 km southeast of the Wellsite Area (Figure A-1, Appendix A). The sump is approximately 120 m long by 40 m wide (dimensions of the sump are from previous monitoring reports and have not been field verified by KAVIK-STANTEC) (Photo B-2, Appendix B) and is located in an area where well-developed ice-wedges are present. The ice-wedges are especially visible from the air and from a network of polygons that are visible all around the perimeter of the sump (Photo B-2, Appendix B). The layout of the Sump Area is illustrated in Figures A-4, Appendix A.

2 REGULATORY FRAMEWORK

In April 2014, the Government of the Northwest Territories (GNWT) assumed the responsibility for the regulation of oil and gas activities within the Northwest Territories. However, the National Energy Board (NEB) remains the regulator of oil and gas activities within the ISR (GNWT 2013). Since the Site is under federal jurisdiction, federal guidelines have been provided for comparison purposes.

For parameters and media where federal criteria do not exist, KAVIK-STANTEC has presented criteria from other jurisdictions for comparison.

Historically, the Umiak N-16 Wellsite Area and Sump Area were operated under the Inuvialuit Water Board Water (IWB) (formerly the Northwest Territories Water Board) Water License N7L1-1797 (NWTWB 2003) and Indigenous and Northern Affairs Canada (formerly Indian and Northern Affairs Canada) Land Use Permit N2003A0035 (INAC 2003a). As a requirement of the water license and land use permit, MGM is required to submit annual reports to the IWB.

2.1 Soil Assessment

The 2016 analytical results for soil were compared to the following guidelines:

- Canadian Council of the Ministers of the Environment (CCME) Canadian Soil Quality Guidelines (CSQG) (CCME 1999a)
- Government of Alberta, Alberta Environment and Parks (AEP) Tier 1 Soil and Groundwater Remediation Guidelines (AEP 2016)

2.1.1 Canadian Council of the Ministers of the Environment Canadian Soil Quality Guidelines

The CCME CSQG for the Protection of Environmental and Human Health (1999a, updated 2007 and thereafter updated and accessed online) are risk-based and are typically used as a preliminary means of evaluating soil. The soil quality guidelines consider land use with different guidelines for agricultural, residential/parkland, commercial and industrial sites. In addition to land use, the guidelines are dependent on soil type (i.e., coarse versus fine grained) and depth for some types of analysis.

For the parameters analyzed during the 2016 program, the guidelines are not dependent on soil type or depth. Based on the anticipated future land use of the Site, the analytical results have been compared with the residential/parkland land use guidelines.

2.1.2 Alberta Tier 1 Soil and Groundwater Remediation Guidelines

The guidelines for the assessment and remediation of soil and groundwater for contaminated sites in Alberta are the Alberta Tier 1 Soil and Groundwater Remediation Guidelines (AEP 2016). The guidelines provide limits for select parameters in soil and groundwater and are intended to maintain, improve, and/or

protect environmental quality and human health. These guidelines include numerical values for the assessment of soil and groundwater in the context of natural, agricultural, residential/parkland, commercial, and industrial land uses. The Tier 1 Guidelines are generic, and were developed to be protective of most sites and are to be used without modification.

Soil remediation guidelines for electrical conductivity (EC) and sodium adsorption ratio (SAR) presented in *"Table 4 – Alberta Tier 1 Salt Remediation Guidelines"* of the Alberta Tier 1 guidelines were adopted from a previous guideline document produced by the Government of Alberta, the *Salt Contamination Assessment and Remediation Guidelines* (AENV 2001). Guidelines are presented for both surface and subsoil conditions; with topsoil guidelines being applied to the L, F, H, O, and A horizons or equivalent surficial material where the horizons are not present. As specified in the guidelines, the purpose of the Tier 1 guideline is to "return the site to the same rating category as the non-contaminated soils of the same type".

Both surface and subsoil guidelines (where available) were used for comparison with the analytical results.

2.2 Standing Water Assessment

The 2016 analytical results for standing water were compared with the CCME Canadian Water Quality Guidelines (CWQG) for the Protection of Aquatic Life (PAL). The CCME CWQG (1999b, updated 2007 and thereafter updated and accessed online) are risk-based and are typically used as a means of evaluating surface water quality results. These guidelines are not regulatory criteria or limits, and consequently guideline comparisons in this document are provided for context only.

Water samples were collected from areas of standing water located on or near the site. Therefore, the water samples were compared with the freshwater guidelines.

Although standing water is not necessarily an aquatic habitat, the CCME CWQG were used to evaluate water quality. These were applied as a guideline only and limited conclusions can be made as to the quality of the standing water, which is a temporary feature with a limited volume of water.

2.3 Reference Data

For soluble parameters in soil (chloride, calcium, magnesium, sodium, potassium, sulphate) and selected dissolved parameters in water (sulphate, calcium, magnesium, sodium, and potassium) no criteria are presented in the regulatory guidelines described above. As such, the results of these parameters were compared with the concentrations detected in reference samples collected at the site. This includes historical reference sample data collected during previous monitoring programs and reference data collected during the 2016 program, when available. The salinity analysis completed during the previous monitoring programs included the analysis of leachable calcium, chloride, magnesium, sodium, potassium and sulphate. The results of these analyzes were reported as soluble concentrations (mg/L).

Selected parameters have also been presented to facilitate the comparison of exceedances identified during the 2016 program with the reference values. In the case of N-16, these included:

- Soil – pH
- Water – pH, dissolved iron, and dissolved chloride

Reference data in this report will only be presented for the Sump Area because no pre-disturbance or reference soil and water samples were collected associated with the Wellsite Area; therefore, no data are available for comparison.

For the Sump Area, the reference data available for comparison included reference soil data from two soil samples collected in 2006 and 2007, and reference standing water data from four water samples collected in 2006, 2007, 2009, and 2015. The reference data (including sample numbers, parameters, results, and sample locations) for the 2016 program are discussed in Sections 4, 5 and 6. The approximate locations of the historical reference samples are outlined in Table 2-1 below.

Table 2-1 Reference Soil and Water Sample Locations at the N-16 Sump Area

Type of Sample	Date	Sample	Approximate Location
Soil	2006	N16-S12	45 m east of the sump
	2007	N16-07- S5	50 m west of the sump
Water	2006	N16-W10	50 m north of the sump
	2007	N16-07- W2	130 m south of the sump
	2009	N16-09-W04	120 m southwest from the sump
	2015	N16-15-08	100 m east of the sump

For comparison purposes, KAVIK-STANTEC has outlined the ranges of each parameter below for their respective sample type (i.e., soil or water). The reference data are presented for comparison purposes only and are not to be interpreted as regulatory criteria. The data are presented as ranges, and illustrate the minimum and maximum concentrations detected in the reference samples collected at the site.

Soil[1]

- pH – 3.9 to 4.3
- Soluble chloride – 10 mg/L to 50 mg/L
- Soluble calcium – 14 mg/L to 26 mg/L
- Soluble magnesium – 4 mg/L to 13 mg/L
- Soluble sodium – 13 mg/L to 24 mg/L
- Soluble potassium – 4 mg/L to 9 mg/L
- Soluble sulphate – 15 mg/L to 32 mg/L

[1] (KAVIK-AXYS 2006, MGM 2007)

Water[2]

- pH – 5.52 to 6.32
- Dissolved Chloride – 16 mg/L to 52 mg/L
- Dissolved Iron – 0.39 mg/L to 1.50 mg/L
- Dissolved Sulphate – <0.5 mg/L to 0.7 mg/L
- Dissolved Calcium – 7.1 mg/L to 13 mg/L
- Dissolved Magnesium – 3.5 mg/L to 6.6 mg/L
- Dissolved Manganese – 0.02 mg/L to 0.082 mg/L
- Dissolved Sodium – 5.7 mg/L to 13 mg/L
- Dissolved Potassium – <0.3 mg/L to 0.7 mg/L

[2] (KAVIK-AXYS 2006, MGM 2007, KAVIK-AXYS 2009, KAVIK-STANTEC 2016b)

3 METHODS

3.1 Site Observations

Monitoring of the Site was conducted in accordance with the Northern Land Use Guidelines (INAC 2003b) and the Protocol for the Monitoring of Drilling-Waste Disposal Sumps, Inuvialuit Settlement Region (NWTWB 2006). The monitoring program was designed to report the status of the following items:

- Presence of surface wastes
- Presence of surface spills
- Terrain conditions
- Presence of standing water
- Vegetation establishment, cover and condition
- Invasive plant (weed) presence
- Wildlife signs or use at site
- Soil conditions (physical and chemical) (i.e., physical signs of erosion, surficial staining, salt crusts).
- Erosion and drainage issues
- Erosion control methods in place and effectiveness
- Requirements for additional assessment, remediation, or reclamation.

Upon arrival at each of the sites, the field team visually assessed the site for the above-listed items and observed the conditions of the drilling operation disturbances in the immediate vicinity of the Site only. Site conditions were assessed and documented on field forms.

3.2 Terrain Conditions

Local terrain conditions were assessed from the air and from the ground. The observations consisted of identifying potential changes to the ground surface (e.g., the presence of new depression(s) or the increase in size and depth of existing depression(s)) as well as identifying features and/or geologic processes potentially indicative of unstable terrain (e.g., tension cracks, gullies, slumping).

Indications of permafrost were observed and noted. These observations consisted of identifying potential indicators of permafrost degradation (e.g., thaw settlement). Visual observations, measurements, and characterizations were conducted for the Sump Area and surrounding terrain (i.e., approximately 100 m around the perimeter of the sump).

Figure 3-1 outlines the features of a typical sump, and is similar to the sump located at the site.

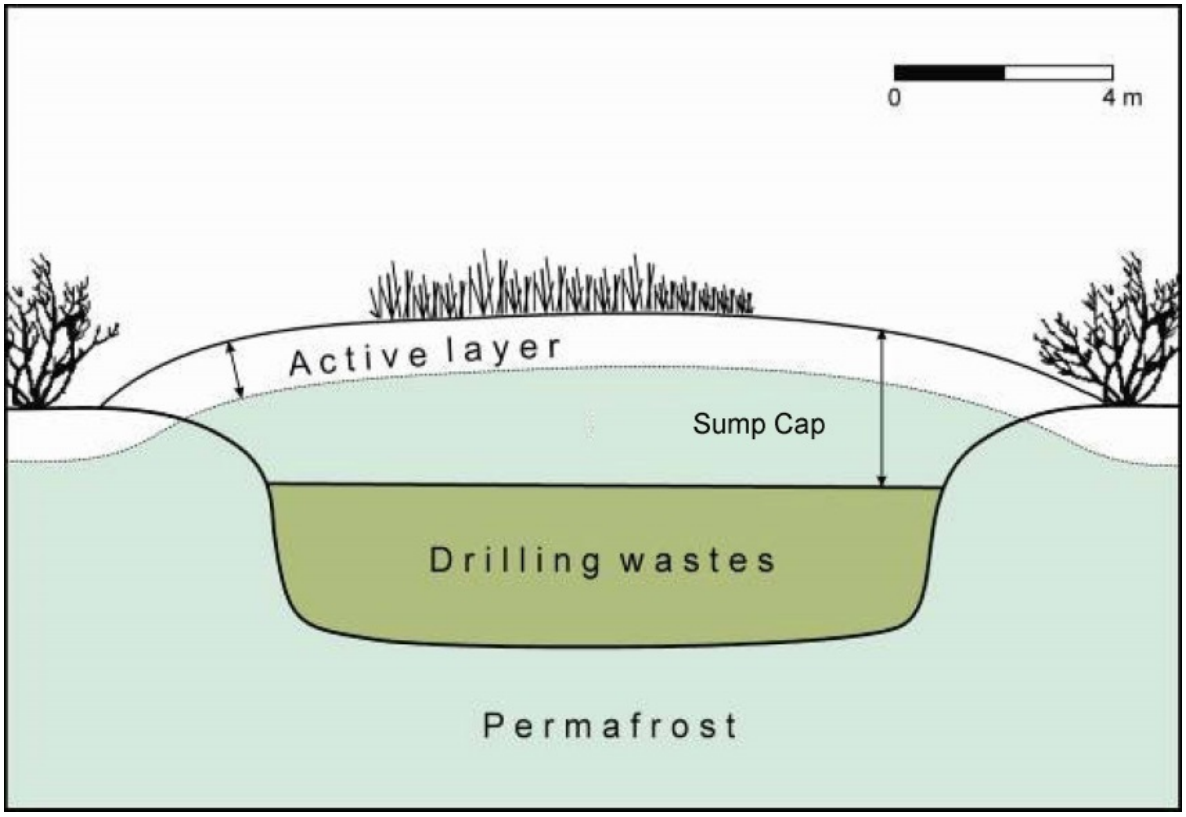

Figure 3-1 Configuration of a sump to encapsulate drilling wastes in permafrost (from Jenkins et al. 2008, Fig. 1)

3.2.1 Active Layer Monitoring

One of the parameters measured to characterize local permafrost ground condition is the thickness of the active layer. The active layer is defined as the surface layer of soil or organic material subject to annual freezing and thawing. Measurements are taken by pushing a steel rod vertically into the ground until reaching frozen ground.

Active layer measurements were collected at the sump during the 2016 site visit. The data presented in Section 4.2.3 represents active layer depths at the time of the site visit and may not necessarily indicate the maximum active layer depth that could be obtained during the year (this depth generally occurs in the fall). The control transect is in the same general location as previous years (i.e., at an undisturbed area located approximately 40 m west of the sump).

3.3 Soil and Water Assessment

Soil and water sampling was completed, as necessary, in response to either an information gap identified during the 2015 program, or evidence that triggered sample collection during the 2016 program. Evidence that would trigger the collection of samples included:

- The presence of a hydrocarbon-like sheen on the surface of standing water

- Crust formation on exposed soil surfaces
- Discolored vegetation
- Lack of vegetation
- Discolored soil surfaces (e.g., staining)
- Standing water as identified within 50 m (as per the Protocol for the Management of Drilling-Waste Disposal Sumps (NWTWB 2006)).

During the 2016 program, soil and water samples were collected by an MGM representative who was provided with KAVIK-STANTEC's sampling methods outlined in Appendix C.

Once collected, the soil and standing water samples were analyzed for potential contaminants of concern (PCOCs) associated with the site. The list of PCOCs was developed considering the historical activities completed at the site. Although KAVIK-STANTEC does not know the exact nature of the products within the sump, the constituents of brine-based drilling mud typically include potassium chloride, bentonite, cellulose polymers, lignosulphonates, and sodium hydroxide (Piteau Engineering Ltd. 1988, Kokelj and GeoNorth 2002). Considering this information, the PCOCs at the Site are salinity parameters.

3.3.1 Soil and Water Sampling

Prior to the completion of the 2016 site visit, a work plan was developed based on the findings of the 2015 program (KAVIK-STANTEC 2016a, b). The work plan identified the following activities:

1. Collection of reference water samples from standing water in the undisturbed area surrounding the Sump Area
2. Collection of soil samples from areas downgradient (north and south) of the sump to investigate the extent of salinity impacts
3. Collection of standing water within 50 m of the sump (if observed)
4. Collection of additional samples based on site conditions observed during the site visit (i.e., presence of a hydrocarbon-like sheen).

During the 2016 site visit, soil and water samples were collected as per items 1,2,4 and 4. Additional sampling completed at the sites included the collection of soil and water samples in an area of impacted vegetation located south of the Sump Area. Since no other areas of concern were observed, no other samples were collected at the Wellsite Area or the Sump Area (i.e., item 4).

The soil and water sampling locations are presented on figures in Appendix A. The sampling methods are provided in Appendix C. Analytical results are summarized in Tables F-1 and F-2 in Appendix F. Laboratory certificates of analysis are provided in Appendix G.

3.3.1.1 Standing Water Sampling

REFERENCE WATER SAMPLES NEAR THE SUMP AREA

Limited reference sampling has previously been completed at the Sump Area. As a result, the 2015 program recommended the collection of reference water sampling in undisturbed areas near the sump (KAVIK-STANTEC 2016b). Three reference water samples (N-16_Sump_W2, N-16_Sump_W3 and N-16_Sump_W6) were collected from areas of standing water located in topographical lows located north and south of the Sump Area (Figure A-4, Appendix A). The water samples were submitted for laboratory analysis of routine chemistry parameters.

The sample results are provided in Section 4.4.2.1 and discussed in Section 5.4.1.

STANDING WATER WITHIN 50 M OF THE SUMP

Two water samples (N-16_Sump_W1 and N-16_Sump_W4) were collected to monitor salinity levels in standing water located within 50 m of the sump (Figure A-4, Appendix A). The water samples collected were submitted for laboratory analysis of routine chemistry parameters (conductivity, pH and major cations).

The sample results are presented in Section 4.4.2.2 and discussed in Section 5.4.2.

In addition to the collection of water samples, a handheld YSI multimeter was used to collect EC values in standing water near the sump. The EC values were are on Figure A-6, Appendix A.

IMPACTED VEGETATION AREA

During the 2016 site visit, an area of impacted vegetation was observed south of the Sump Area (Figure A-4, Appendix A). One water sample (N-16_Sump_W5) was collected from the area located approximately 50 m south of the sump (identified as V3-01) and submitted for laboratory analysis of routine chemistry parameters (conductivity, pH and major cations).

The sample results are presented in Section 4.4.2.3 and discussed in Section 5.4.2.

3.3.1.2 Soil Sampling

SUMP SALINITY IMPACT ASSESSMENT

The work plan for the 2016 program included the collection of soil samples from areas located down-gradient from the sump (north and south) to determine the extent of the salinity impacts present. Previous soil sampling identified elevated saline conditions south of the sump (KAVIK-STANTEC 2016b). Upon completion of the 2015 program, KAVIK-STANTEC recommended soil samples be collected to confirm if the saline conditions have decreased from natural attenuation processes. Eight soil samples were collected from four boreholes advanced north and south of the sump (Figure A-4, Appendix A). Samples were collected at two depth intervals (0.00 to 0.25 mbgs and 0.25 to 0.50 mbgs) in each of the boreholes

advanced and submitted for salinity analysis (conductivity, pH, EC, SAR, and soluble parameters). Samples N-16_Sump_SS1_0-0.25, N-16_Sump_SS1_0.25-0.5, N-16_Sump_SS2_0-0.25, and N-16_Sump_SS2_0.25-0.50, were collected from areas north of the sump, samples N-16_Sump_SS3_0-0.25, N-16_Sump_SS3_0.25-0.5, N-16_Sump_SS5_0-0.25, and N-16_Sump_SS5_0.25-0.50 were collected south of the sump (Figure A-4, Appendix A).

Two of the boreholes, N-16_Sump_SS2 and N-16_Sump_SS5, were advanced approximately 90 m and 100 m, respectively away from the sump. The soil samples collected from these boreholes were collected to confirm the northern and southern boundaries of the salinity impacts surrounding the sump. In the case of borehole N-16_Sump_SS5, the location of borehole was placed at the same location as a reference water sample (N-16_Sump_W6) (Figure A-4, Appendix A). The soil samples were submitted for laboratory analysis of salinity parameters (conductivity, pH, EC, SAR and soluble parameters).

The sample results are presented in Section 4.3.2.1 and discussed in Section 5.3.2.

IMPACTED VEGETATION AREA

During the 2016 site visit, an area of impacted vegetation was observed south of the Sump Area (Figure A-4, Appendix A). Two soil samples (N-16_Sump_SS4_0.0-0.25 and N-16_Sump_SS4_0.25-0.5) were collected from the area located approximately 50 m south of the sump (identified as V3-01) and submitted for laboratory analysis of salinity parameters (conductivity, pH, EC, SAR, and soluble parameters). In the case of borehole N-16_Sump_SS4, the location of borehole was placed at the same location as a reference water sample (N-16_Sump_W5) (Figure A-4, Appendix A).

The sample results are presented in Section 4.3.2.2 and discussed in Section 5.3.2.

3.3.2 Data Interpretation

KAVIK-STANTEC compared the sample results with the applicable regulatory criteria. For parameters where no criteria were available, the concentrations were compared with the reference concentrations presented in Section 2.3.

3.3.3 Quality Assurance / Quality Control Program Methods

Maxxam Analytics Inc. (Maxxam) was used for the chemical analyzes (soil and standing water, where applicable). The laboratory is accredited to the International Organization for Standardization (ISO) Standard 17025 through the Standards Council of Canada.

Maxxam has quality assurance/quality control (QA/QC) protocols for instrument calibration, laboratory duplicates, matrix spikes, method blanks, process recovery and surrogate spikes. The laboratory follows Standard Operating Procedures, which specify time limitations, sample preparation and preservation, data production and reporting, among other activities. As part of its quality assurance program, Maxxam analyzed quality control samples, including duplicates, blanks and spike samples. The laboratory QA/QC results are provided in the certificates of analysis in Appendix G.

3.4 Reclamation Assessment

Typically, a reclamation assessment of the site would include the following:

- Condition of vegetation (see Table D-1, Appendix D)
- Presence of invasive plant species
- Signs of wildlife use
- The assessment of any erosion issues or the condition of any installed erosion control structures

However, based on the finding of the 2015 program, most of the sites met Land Use Permit N2003A0035 (INAC 2003a) requirements and did not require further assessment as part of the 2016 program. Therefore, 2016 reclamation monitoring focused on areas at the site that did not meet land use permit requirements including:

- Documentation and assessment of vegetation conditions in the impacted vegetation areas at the sump.
- Documentation of invasive plant presence and signs of wildlife use at each site.

Table D-1, Appendix D provides a summary of the reclamation assessment methods used for the assessment of the site features.

4 RESULTS

The Wellsite Area and Sump Areas were monitored on August 22, 2016 by two KAVIK-STANTEC assessors and one MGM representative. The observations and findings of the 2016 site visit are detailed below. Site figures are provided in Appendix A. Photographs showing site conditions as of August 22, 2016 are provided in Appendix B.

2016 represents the seventh year of monitoring after the required minimum 5-year monitoring program for the sump as stipulated in *Part H Conditions Applying to Abandonment and Restoration* of the Northwest Territories Board Water License No. N7L1-1797 (NWTWB 2003).

4.1 On-Site Material

4.1.1 Wellsite Area

The Wellsite Area contained a wellhead with a protective culvert, steel well marker post and sign (Photo B-1; Appendix B).

No other surface structures, materials, or waste were observed at the site during the 2016 site visit.

4.1.2 Sump Area

The Sump Area contained a drilling sump that had approximate dimensions of 120 m long by 40 m wide. Four thermistor cables and metal protective casings were present at the site (Photo B-2; Appendix B); however, the data loggers were previously removed in 2010 and the instruments are no longer recording data (KAVIK-AXYS 2010).

No other surface structures, materials, or waste were observed at the site during the 2016 site visit.

4.2 Terrain Conditions

4.2.1 Wellsite Area

The Wellsite Area had a slope gradient that ranged from 0% to 5 % with a south aspect (188°). Field observations identified two ice-wedges within 5 m of the wellhead. The locations of the ice-wedges were visible from the characteristic morphology where a shallow linear depression referred to as a trough is located above the wedges. A diagram of ice-wedges forming a network of polygons is provided below (Figure 4-1). Troughs of two interconnecting ice-wedges were visible less than 5 m southeast of the wellhead (Photo B-1, Appendix B). The features consisted of shallow linear depressions approximately 0.30 m wide, 0.30 m deep and 10 to 20 m long. No standing water was present within the troughs at the time of the 2016 site visit (Photos B-3, Appendix B).

A retrogressive thaw slump was present outside of the Wellsite Area, approximately 300 m east from the wellhead with observed erosion (Figure A-3, Appendix A; Photos B-4, Appendix B). The landslide was located on a 2% to 20% slope marking the northern shore of a small lake and was approximately 3.20 ha in size. Field observations indicated that the landslide was formed of three separate units; i.e., one large suspended landslide (i.e., an inactive landslide that still has the potential to move, but currently stationary or without measurable displacement for over five years) and two smaller active landslides (i.e., landslides that were currently moving).

The slumps had a typical bowl-shape, each comprised of two main elements: 1) a vertical or near-vertical headwall, and 2) a gently sloping slump floor (generally 5 to 20%). A diagram of retrogressive thaw slump is provided below (Figure 4-2). Several meters of massive ice was visible along the headwalls of the two active slumps (approximately 5 m in the west slump and approximately 8 m in the east slump) (Photos B-5, Appendix B). Viscous flows of water-saturated, fine-grained soils were observed along the slump floors.

No erosion issues were observed immediately adjacent to the Wellsite Area during the 2016 site visit. The two linear depressions assumed to be related to ice-wedges troughs showed no signs of undergoing erosion.

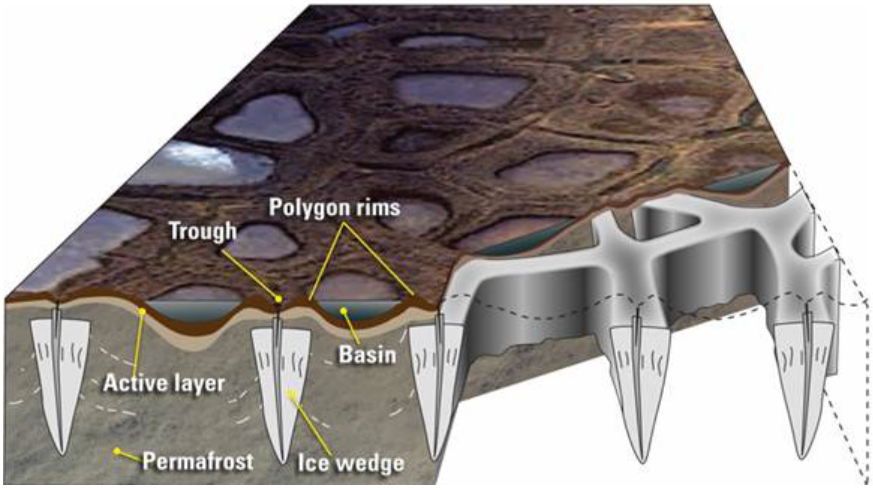

Figure by R. Mitchell/Inkworks for U.S. Fish and Wildlife Service

Figure 4-1 Schematic illustrating formation of ice wedges in permafrost.

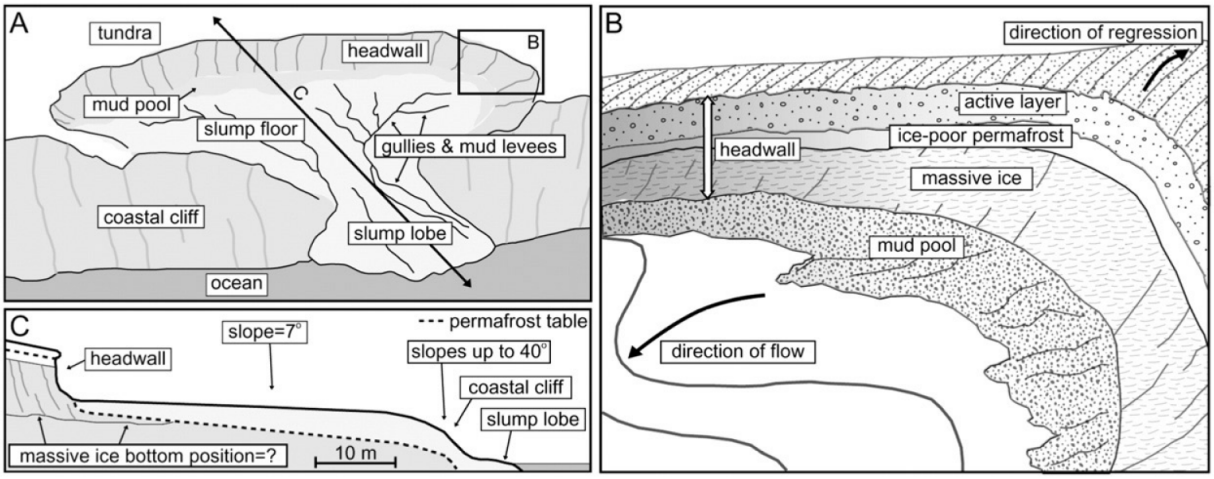

Figure 4-2 Schematic illustration of a retrogressive thaw slump (Lantuit and Pollard 2008)

4.2.2 Sump Area

The surface of the sump (referred to as the sump top) was observed to be flat to gently undulating (less than 2% slope gradient), while the slopes marking the perimeter of the sump ranged from 20% to 60%. The sump cap itself appeared to be stable with no visual signs of erosion and/or evidence of subsidence or settling. No tension cracks were observed at the surface of the sump, although the vegetation might have hid some tension cracks.

The slopes marking the perimeter of the sump appeared to be stable, with no physical evidence of recent surface erosion, stress or new tension cracks. Depressions matching the location of ice-wedges overlapped by the sump cap were visible along the lower slope; however, there were no indications that size of the depressions has increased from those observed during the 2015 site visit.

4.2.3 Active Layer Measurements

Figure A-5 (Appendix A) shows the location and value of each individual active layer measurement. Maximum, minimum and average active layer thicknesses for the 2009/2016 period are presented in Table E-1 (Appendix E) and are summarized as follows:

- Active layer depths of the sump cap ranged from 91 to 125 cm and averaged 106 cm.
- Active layer depths around the perimeter of the sump ranged from 37 to 108 cm and averaged 54 cm.
- The average active layer depths measured along the control transect ranged from 28 cm to 43 cm and averaged 37 cm.

4.3 Soil Assessment

Soil sampling locations are presented on Figure A-4 in Appendix A. Table F-1 of Appendix F summarizes the analytical results of soil samples collected at the sites. The laboratory certificate of analysis is provided in Appendix G. Sample results are summarized in the sections below.

4.3.1 Wellsite Area

At the time of the 2016 site visit, no conditions that warranted sampling were observed (Section 3.3). Therefore, soil samples were not collected at the Wellsite Area and analysis was not completed.

4.3.2 Sump Area

4.3.2.1 Salinity Impact Assessment

The analytical results of the soil samples collected from four boreholes around the Sump Area (N-16_Sump_SS1, N-16_Sump_SS2, N-16_Sump_SS3, and N-16_Sump_SS5) indicated the following:

- The pH values detected were all outside of the acceptable CCME guideline range (6 to 8), with the values ranging from 4.52 to 5.39 in the samples collected north of the sump, and 3.87 to 5.07 in samples collected south of the sump.
- The EC and SAR values detected in each of the samples collected were below the CCME guidelines and were classified as "good" under the AEP criteria. The EC values ranged from 0.13 to 0.55 dS/m in the northern samples, and 0.12 to 0.82 dS/m in the southern samples. The SAR values ranged from 0.73 to 1.20 in the northern samples, and 0.90 to 1.80 in the southern samples.
- All other parameters analyzed were within the applicable criteria.

A summary of the soil exceedances identified at the Sump Area are provided in Table 4-1 below.

Table 4-1 Summary of Soil Exceedances Around the Sump Area

Sample ID	Parameter	Unit	Depth (mbgs)	Reported Value	Guidelines	
					CCME	AEP
N-16_Sump_SS1_0-0.25	pH	No Unit	0.00 – 0.25	**5.39**	6 to 8	6 to 8.5
N-16_Sump_SS1_0.25-0.5			0.25 – 0.50	**5.24**		
N-16_Sump_SS2_0-0.25			0.0 – 0.25	**4.60**		
N-16_Sump_SS2_0.25-0.5			0.25 – 0.50	**4.52**		
N-16_Sump_SS3_0-0.25			0.00 – 0.25	**4.29**		
N-16_Sump_SS3_0.25-0.5			0.25 – 0.50	**4.28**		
N-16_Sump_SS5_0-0.25			0.00 – 0.25	**3.87**		
N-16_Sump_SS5_0.25-0.5			0.25 – 0.50	**4.18**		

NOTES:
CCME CCME CSQG, residential /parkland land use
AEP Alberta Environment & Parks (AEP). 2016. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. Table 4: Alberta Tier 1 Salt Remediation Guidelines for Top Soil (horizons A, L, F, H, and O horizons or the equivalent where these horizons are not present)
5.39 pH value exceeds the CCME criteria
3.87 pH value exceeds the CCME criteria and the reference pH values presented in Section 2.3.

CCME does not provide guidelines for soluble parameters in soil. As such, KAVIK-STANTEC has compared the analytical results of these parameters with the reference data previously collected at the sump (outlined in Section 2.3). The results indicated the following:

- Concentrations of soluble chloride ranged from 10 to 120 mg/L. The concentrations detected in five samples (N-16_Sump_SS1_0-0.25, N-16_Sump_SS1_0.25-0.5, N-16_Sump_SS2_0-0.25, N-16_Sump_SS3_0-0.25, N-16_Sump_SS3_0.25-0.5) were high compared with the historical reference data (10 to 50 mg/L). The other samples collected in this area had concentrations below the reference data.
- Concentrations of soluble calcium ranged from 2.8 to 51 mg/L. The concentrations detected in five samples (N-16_Sump_SS1_0-0.25, N-16_Sump_SS1_0.25-0.5, N-16_Sump_SS2_0-0.25, N-16_Sump_SS3_0-0.25, N-16_Sump_SS3_0.25-0.5) were high compared with the historical reference data (14 to 26 mg/L). The other samples collected in this area had concentrations below the historical reference concentrations.
- Concentrations of soluble magnesium ranged from less than the laboratory reportable detection limit (<1.0 mg/L) to 18 mg/L. The concentrations detected in two samples (N-16_Sump_SS1_0-0.25 and N-16_Sump_SS3_0-0.25) were high compared with the historical reference data (4 to 13 mg/L). The other samples collected in this area had concentrations below the historical reference concentrations.
- Concentrations of soluble sodium ranged from 11 to 30 mg/L. The concentrations detected in three samples (N-16_Sump_SS1_0-0.25, N-16_Sump_SS1_0.25-0.5, N-16_Sump_SS3_0.25-0.5) were high compared with the historical reference data (13 to 24 mg/L). The other samples collected in this area had concentrations below the historical reference concentrations.

- Concentrations of soluble potassium ranged from less than the laboratory reportable detection limit (1.3 mg/L) to 8.7 mg/L. Results were consistent with the historical reference data (4 to 9 mg/L).
- Concentrations of soluble sulphate ranged from 9.1 to 100 mg/L. The concentrations detected in four samples (N-16_Sump_SS1_0-0.25, N-16_Sump_SS2_0-0.25, N-16_Sump_SS3_0-0.25, N-16_Sump_SS3_0.25-0.5) were high compared with the historical reference data (15 to 32 mg/L). The other samples collected in this area had concentrations below the historical reference concentrations.

4.3.2.2 Impacted Vegetation Area

The analytical results of the two soil samples collected from the borehole at the area of impacted vegetation (V3-01) (N-16_Sump_SS4) indicated the following:

- The pH values detected was 5.06 and 5.07, outside of the acceptable CCME and AEP guideline range (6 to 8).
- The EC values were 0.79 and 0.82 dS/m, and SAR values were 0.92 and 1.2. The EC and SAR values detected in each of the samples collected were below the CCME guidelines and were classified as "good" under the AEP criteria.
- All other parameters analyzed were within the applicable criteria.

A summary of the soil exceedances identified at the impacted vegetation area around the Sump Area are provided in Table 4-2 below.

Table 4-2 Summary of Soil Exceedances in the Impacted Vegetation Area V3-01 Around the Sump Area

Sample ID	Parameter	Unit	Depth (mbgs)	Reported Value	Guidelines	
					CCME	AEP
N-16_Sump_SS4_0-0.25	pH	No Unit	0.00 – 0.25	**5.06**	6 to 8	6 to 8.5
N-16_Sump_SS4_0.25-0.5	pH		0.25 – 0.50	**5.07**		

NOTES:
CCME CCME CSQG, residential /parkland land use
AEP Alberta Environment & Parks (AEP). 2016. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. Table 4: Alberta Tier 1 Salt Remediation Guidelines for Top Soil (horizons A, L, F, H, and O horizons or the equivalent where these horizons are not present)
5.06 pH value exceeds the CCME criteria

The CCME does not provide guidelines for soluble parameters in soil. As such, KAVIK-STANTEC has compared the analytical results of these parameters in the two samples (N-16_Sump_SS4_0-0.25, and N-16_Sump_SS4_0.25-0.5) with the reference data previously collected at the sump (outlined in Section 2.3). The results indicated the following:

- Concentrations of soluble chloride were 93 and 130 mg/L, respectively. Results were high compared to the historical reference data (10 to 50 mg/L).
- Concentrations of soluble calcium were 35 and 40 mg/L, respectively. Results were high compared to the historical reference data (14 to 26 mg/L).

- Concentrations of soluble magnesium were 9.5 and 11 mg/L, respectively. The results were consistent with the historical reference data (4 to 13 mg/L).
- Concentrations of soluble sodium were 26 and 30 mg/L, respectively. Results were high compared to the historical reference data (13 to 24 mg/L).
- Concentrations of soluble potassium were 100 and 110 mg/L, respectively. Results were high compared to the historical reference data (4 to 9 mg/L).
- Concentrations of soluble sulphate were 120 and 150 mg/L, respectively. Results were high compared to the historical reference data (15 to 32 mg/L).

4.4 Standing Water Assessment

Water sampling locations are presented on Figure A-4 in Appendix A. Table F-2 of Appendix F summarizes the analytical results of soil samples collected at the Site. The laboratory certificate of analysis is provided in Appendix G. Sample results are summarized in the sections below.

4.4.1 Wellsite Area

At the time of the 2016 site visit, no conditions that warranted sampling were observed. Water samples were therefore not collected and laboratory analysis was not completed.

4.4.2 Sump Area

In-situ field measurements of EC were collected from standing water in vicinity of the Sump Area. The recorded EC ranged from 84 µs/cm in standing water located south of the sump (approximately 35 m south of sample N-16_Sump_W6) to 10,060 µs/cm in the standing water located approximately 75 m southwest of the sump (Figure A-6, Appendix A).

A distinctive sheen was observed at the surface of several of the ice-wedge troughs located both in contact with the sump perimeter and several meters away from the sump. The sheen did not present a shiny or hydrocarbon-like surface, but rather consisted of a thin layer of grayish to brown foam (Photo B-13, Appendix B). Based on field observations, it was determined that the sheen was not likely associated with hydrocarbons but more likely due to natural organic substances in the water, which will create brown colouration (organic acids) that as they decay release compounds known as surfacants that mix with water and creates bubbles.

4.4.2.1 Reference Water Samples

The analytical results of the three water samples (N-16_Sump_W2; N-16_Sump_W3; N-16_Sump_W6) collected from areas of standing water north and south of the Sump Area indicated the following:

- Two of the samples (N-05_Sump_W3 and N-05_Sump_W6) had pH values of 5.42 and 5.55; below the CCME range (6.5 to 9).

- Concentrations of dissolved iron exceeded the CCME guideline in each of the samples collected, ranging from 1.90 /L to 12 mg/L.
- All other parameters analyzed were below the applicable criteria.

A summary of the water exceedances in reference water samples collected at the Sump Area are provided in Table 4-3 below.

Table 4-3 Summary of Exceedances in Reference Water Samples collected Near the Sump Area

Sample ID	Parameter	Unit	Reported Value	CCME PAL
N-05_Sump_W2	Dissolved Iron	mg/L	**3.1**	0.3[B]
N-16_Sump_W3	pH	No Unit	**5.55**	6.5-9.0[A]
	Dissolved Iron	mg/L	**12**	0.3[B]
N-16_Sump_W6	pH	No Unit	**5.42**	6.5-9.0[A]
	Dissolved Iron	mg/L	**1.9**	0.3[B]

Notes:
CCME PAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life (PAL)
A Short term guideline
B Long term guideline
5.55 Reported value exceeds the CCME Guideline
3.1 Reported value exceeds the CCME guideline and the historical reference data outlined in Section 2.3.

The CCME PAL does not provide guidelines for EC or dissolved parameters (calcium, magnesium, manganese, potassium, and sodium). As such, KAVIK-STANTEC compared the 2016 data to the reference sample results. The results indicated the following:

- The EC values detected in the three reference samples ranged from 150 to 250 µs/cm. The EC value in one sample (N-16_Sump_W6) was high compared to the reference data (75 to 210 µs/cm).
- Concentrations of dissolved sulphate in the three reference samples were below the laboratory reportable detection limit (<0.5 mg/L). Results were consistent with the historical reference data (less than the laboratory reportable detection limit (<0.5 mg/L) to 0.7 mg/L)
- Concentrations of dissolved calcium in the three reference samples ranged from 16 to 22 mg/L. Results were high compared with the historical reference data (7.1 to 13 mg/L).
- Concentrations of dissolved magnesium in the three reference samples ranged from 9.3 to 9.8 mg/L. Results were high compared with the historical reference data (3.5 to 6.6 mg/L).
- Concentrations of dissolved manganese in the three reference samples ranged from 0.078 to 0.43 mg/L. Results were high compared with the historical reference data (0.02 to 0.082 mg/L).
- Concentrations of dissolved potassium in the three samples ranged from 0.33 to 5.0 mg/L. Results were high compared with the historical reference data (<0.3 mg/L to 0.7 mg/L).

4.4.2.2 Standing Water within 50 m of the Sump

Two water samples were collected from standing water in vicinity of the sump, including one north of the sump (N-16_Sump_W1) and one sample south of the sump (N-16_Sump_W4) (Figure A-4, Appendix A). A summary of the analytical results is provided below:

- One of the samples (N-16_Sump_W4) had a pH value of 5.93; below the CCME range (6.5 to 9).
- The concentrations of dissolved chloride exceeded the CCME guideline in both samples collected. The highest concentration of dissolved chloride was detected in sample N-16_Sump_W4 (970 mg/L).
- Concentrations of dissolved iron exceeded the CCME guideline in each of the samples collected, ranging from 1.2 mg/L to 2.4 mg/L.
- All other parameters analyzed were below the applicable criteria.

A summary of the exceedances in water samples collected within 50 m of the sump are provided in Table 4-4 below.

Table 4-4 Summary of Exceedances in Water Samples Collected within 50 m of the Sump at N-16

Sample ID	Parameter	Unit	Reported Value	CCME PAL
N-16_Sump_W1	Dissolved Chloride	mg/L	**190**	640[A]/120[B]
	Dissolved Iron	mg/L	**1.2**	0.3[B]
N-16_Sump_W4	pH	No Unit	**5.93**	6.5-9.0[A]
	Dissolved Chloride	mg/L	**970**	640[A]/120[B]
	Dissolved Iron	mg/L	**2.4**	0.3[B]

NOTES:
CCME PAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life (PAL)
A Short term guideline
B Long term guideline
5.93 Concentration exceeds the CCME Guideline
190 Reported value exceeds the CCME guideline and the historical reference data outlined in Section 2.3.

The CCME PAL does not provide guidelines for EC or dissolved parameters (sulphate, calcium, magnesium, manganese, potassium, and sodium). As such, KAVIK-STANTEC compared the 2016 data with the reference sample results (both historical and the 2016 reference data). The results indicated the following:

- The EC values in the two samples were 1,200 µs/cm in the northern sample (N-16_Sump_W1) and 4,100 µs/cm in the southern sample (N-16_Sump_W4). Results were high compared to the historical and 2016 reference data (the historical reference data ranged from 75 to 210 µs/cm; the 2016 reference data ranged from 150 to 250 µs/cm).
- Concentrations of dissolved sulphate in the samples ranged from 110 to 500 mg/L. Results were high compared to the historical and 2016 reference data (the historical reference data ranged from less

than the laboratory reportable detection limit (<0.5 mg/L) to 0.7 mg/L; the 2016 reference data were less than the laboratory reportable detection limit).

- Concentrations of dissolved calcium in the samples ranged from 130 to 430 mg/L. Results were high compared to the historical and 2016 reference data (the historical data ranged from 7.1 to 13 mg/L; the 2016 reference data ranged from 16 to 22 mg/L).
- Concentrations of dissolved magnesium in the samples ranged from 48 to 120 mg/L. Results were high compared to the historical and 2016 reference data (the historical data ranged from 3.5 to 6.6 mg/L; the 2016 reference data ranged from 9.3 to 9.8 mg/L).
- Concentrations of dissolved manganese in the samples ranged from 0.83 to 5.8 mg/L. Results were high compared to the historical and 2016 reference data (the historical data ranged from 0.020 to 0.082 mg/L; the 2016 reference data ranged from 0.078 to 0.43 mg/L).
- Concentrations of dissolved potassium in the samples ranged from 29 to 220 mg/L. Results were high compared with the historical and 2016 reference data (the historical data ranged from less than the laboratory reportable detection limit (<0.3 to 0.7 mg/L; the 2016 reference data ranged from 0.33 to 5.0 mg/L). The highest concentration of dissolved potassium was detected in sample N-16_Sump_W4 (220 mg/L) which was approximately 44 times the concentration detected in the 2016 reference sample.
- Concentrations of dissolved sodium in the samples ranged from 31 to 91 mg/L. Results were high compared with the historical and 2016 reference samples (the historical data ranged from 5.7 to 13 mg/L; the 2016 reference data ranged from 8.2 to 18 mg/L).

4.4.2.3 Impacted Vegetation Area

The analytical results of the water sample collected from the impacted vegetation at location V3-01 (N-16_Sump_W5) indicated the following:

- The pH value was 6.56, within the accepted range outlined by the CCME (6.5 to 9).
- The concentrations of dissolved chloride (180 mg/L) and dissolved iron (1.6 mg/L) exceeded CCME guideline.
- All other parameters analyzed were below the applicable criteria.

A summary of the water exceedances of N-16_Sump_W5 area are presented in Table 4-5 below.

Table 4-5 Summary of Exceedances at Impacted Vegetation Area V3-01

Sample ID	Parameter	Unit	Reported Value	CCME PAL
N-16_Sump_W5	Dissolved Chloride	mg/L	**180**	640[A]/120[B]
	Dissolved Iron	mg/L	**1.6**	0.3[B]

Sample ID	Parameter	Unit	Reported Value	CCME PAL

NOTES:
CCME PAL Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life (PAL)
A Short term guideline
B Long term guideline
180 Reported value exceeds the CCME guideline and the historical reference data outlined in Section 2.3.

The CCME PAL does not provide guidelines for EC or dissolved parameters (sulphate, calcium, magnesium, manganese, potassium, and sodium). As such, KAVIK-STANTEC compared the 2016 data with the reference sample results (both historical and the 2016 reference data). The results indicated the following:

- The EC value was 700 µs/cm. Results were high compared to the historical and 2016 reference data (the historical data ranged from 75 to 210 µs/cm; the 2016 reference data ranged from 150 to 250 µs/cm).
- The concentration of dissolved sulphate was 10 mg/L, which was high compared with the historical and 2016 reference data (the historical data ranged from less than the laboratory reportable detection limit (<0.5 to 0.7 mg/L; the 2016 reference were less than the laboratory reportable detection limit).
- The concentration of dissolved calcium was 41 mg/L, which was high compared with the historical and 2016 reference data (the historical data ranged from 7.1 to 13 mg/L; the 2016 reference data ranged from 16 to 22 mg/L).
- The concentration of dissolved magnesium was 13 mg/L, which was high compared with the historical and 2016 reference data (the historical data ranged from 3.5 to 6.6 mg/L; the 2016 reference data ranged from 9.3 to 9.8 mg/L).
- The concentration of dissolved manganese was 0.20 mg/L. Except for one reference sample collected in 2016, results were high compared with the historical and 2016 reference data (the historical data ranged from 0.02 to 0.082 mg/L; the 2016 reference data ranged from 0.078 to 0.43 mg/L).
- The concentration of dissolved potassium was 71 mg/L, which was high compared with the historical and 2016 reference data (the historical data ranged from less than the laboratory reportable detection limit (0.3 to 0.7 mg/L; the 2016 reference data ranged from 0.33 to 5.0 mg/L).
- The concentration of dissolved sodium was 27 mg/L, which was high compared with the historical and 2016 reference data (the historical data ranged from 5.7 to 13 mg/L; the 2016 reference data ranged from 8.2 to 18 mg/L).

4.5 Reclamation Assessment

The results of the reclamation assessment of the sites are highlighted in the sections below. Appendix E provides the site monitoring tables for the sites.

4.5.1 Vegetation Establishment

4.5.1.1 Wellsite Area

At the time of the 2016 site visit, the Wellsite Area had minimal topsoil and vegetation disturbance by lease preparation operations, which resulted in mixture of native low/dwarf shrubs, forbs, sedges, and mosses re-establishing in most of the area (Photo B-1, Appendix B). Vegetation cover conditions during the 2016 site visit were observed to be similar to conditions observed in 2015 in both species composition and percent cover (Figure A-2, Appendix A).

At the time of the 2016 site visit, the area to the south of the wellhead was well vegetated with the seeded native grasses, predominantly tufted hairgrass (*Deschampsia caespitosa*) with minor amounts of polargrass (*Arctagrostis latifolia*) and violet wheatgrass (*Agropyron violaceum/Elymus alaskanus*); trace amounts of the native forbs arnica (*Arnica sp*.) and coltsfoot (*Petasites sp*.) were present (Photo B-6 and B-7, Appendix B). Vegetation cover conditions in the area to the south of the wellhead were observed to be similar to conditions observed in 2015 in both species composition and percent cover.

A small area containing sandy gravelly material with lower density plant cover was observed immediately surrounding the wellhead culvert. This lightly vegetated area consisted of previously seeded native grasses (Priddis 2014) and naturally established forbs and was approximately 3 m^2 in area (Photo B-8, Appendix B). At the time of the 2016 site visit, the native grass and forb cover was approximately 57% and consisted of tufted hairgrass (*Deschampsia caespitosa*) and violet wheatgrass (*Agropyron violaceum/Elymus alaskanus*) and low amounts of the native forb fireweed (*Epilobium angustifolium*); plant heights were up to approximately 0.40 m.

Table E-2 (Appendix E), summarizes the vegetation coverage observed in the lightly vegetated area around the wellhead culvert. Table E-3 (Appendix E) lists the plant species composition observed.

4.5.1.2 Sump Area

Vegetation observed on the Sump Area in the 2016 site visit consisted primarily of native grasses including tufted hairgrass (*Deschampsia caespitosa*), sheep fescue (*Festuca ovina*), creeping red fescue *(Festuca rubra*), rocky mountain fescue (*Festuca saximontana*), alpine bluegrass (*Poa alpina*) and bluegrass (*Poa sp.*). Naturally established native shrub and forb species also observed included alpine bearberry (*Arctostaphylos alpina*), broad leaved willowherb (*Epilobium latifolium*), small bog cranberry (*Oxycoccus microcarpus*), cloudberry (*Rubus chamaemorus*), net veined willow (*Salix reticulata*), and willows (*Salix sp*.). Vegetation cover conditions on the sump during the 2016 site visit were observed to be similar to conditions observed in 2015 in both species composition and percent cover (Photos B-2, B-9, and B-10, Appendix B). Vegetation conditions observed during 2016 in the undisturbed area

surrounding the sump was found to remain unchanged from conditions observed in the 2015 program (KAVIK-STANTEC 2016b). The majority of this area remains well vegetated with the naturally established native vegetation.

Vegetation displaying either dead, withered or yellowing foliage.with lower density plant cover were observed approximately 50 m south of the sump (Impacted vegetation location V3-01) and 70 m southwest of the sump (Impacted vegetation location V2-03) (Photo B-9, Appendix B) (Figure A-4, Appendix A). These impacted vegetation areas consisted predominantly of naturally established native plant species adapted to lower soil pH conditions; the V3-01 impacted vegetation area was approximately 10 m^2 in area and the V2-03 impacted vegetation area was approximately 60 m^2 in area (Photos B-11 to B-14, Appendix B). At the time of the 2016 site visit, the native vegetation cover was approximately 70% for the V3-01 impacted vegetation area and 40% for the V2-03 impacted vegetation area. Vegetation litter, consisting primarily of dead cottongrass, was approximately 25% and 5% cover for the V3-01 and V2-03 impacted vegetation areas, respectively. Vegetation species observed in both areas consisted of alpine bearberry (*Arctostaphylos alpina),* dwarf birch (*Betula glandulosa*), sedges *(Carex sp.),* crowberry (*Empetrum nigrum*), cottongrass (*Eriophorum sp*.), cloudberry (*Rubus chamaemorus*), willow (*Salix sp*.), bog cranberry (*Vaccinium vitis idaea*), lichens and mosses; plant heights ranged from approximately 0.10 to 0.40 m.

Table E-2 (Appendix E), summarizes the vegetation coverage observed in the lightly vegetated area around the wellhead culvert Table E-3 (Appendix E) lists the plant species composition observed.

4.5.2 Vegetation Condition and Health

Overall, vegetation health and condition was observed to be good throughout the Wellsite Area and Sump Area at the time of the 2016 site visit. There was no evidence of plant disease and plant foliage was green and robust based on visual assessments. The sump top and slope areas had accumulations of leaf/stem litter from previous years' grass plant growth, but this did not appear to be impacting overall plant health/condition. An exception was the two impacted vegetation areas located south of the Sump Area (Figure A-4, Appendix A).

Impacted vegetation areas were observed south of the Sump Area (impacted vegetation location V3-01; impacted vegetation location V2-03) adjacent to waterbodies in topographical low areas (Figure A-4, Appendix A). The vegetation in those areas appears to be in similar condition to that observed in previous monitoring programs (KAVIK-STANTEC 2013, KAVIK-STANTEC 2016b). In addition, these areas were detected to have low pH values, and elevated concentrations of dissolved parameters (calcium, chloride, magnesium, sodium, sulphate, potassium) (Sections 4.3.2.2 and 4.4.2.3). Tussock cottongrass and sedges were the most impacted species that were observed, displaying either dead or withered and yellowing foliage. Species that are more tolerant of low pH conditions such as alpine bearberry, dwarf birch, crowberry, cloudberry, willow, bog cranberry, lichens and mosses appeared in good health and condition. The vegetation in impacted vegetation location V2-03 was the most affected out of the two areas (Photos B-11 to B-14, Appendix B).

4.5.3 Invasive Plants

Scentless chamomile (*Tripleurospermum inodorum*) plants were observed during the 2016 site visit growing in the area immediately south of the wellhead at the Wellsite Area (Coordinates: Latitude: 69°25'53.304" N; Longitude: 134°19'6.366" W.). The scentless chamomile plants observed were growing individually and in small groups in the native grass seeded area around the wellhead (Photo B-6 and B-7, Appendix B). The infestation area was approximately 200 m^2 in size; however, scentless chamomile cover was only approximately 10% within the infestation area at the time of monitoring. Table E-4 (Appendix E) provides details on the invasive plant species observed growing in the site area. Invasive plant locations are shown on Figure A-2 (Appendix A).

No invasive plant species were observed at the Sump Area during the 2016 site visit.

4.5.4 Signs of Wildlife Use

Wildlife was observed near the sites at the time of the 2016 site visit. Approximately 10 geese (species not identified) were observed flying over the Wellsite Area and approximately 50 geese (species not identified) were observed flying over the Sump Area.

Wildlife signs of use were also observed at the sites. Bird droppings were observed on the wellhead and an animal den hole entrance was observed in the northeastern corner of the sump. In addition, goose and reindeer or caribou (*Rangifer spp.*) droppings were present throughout the Sump Area.

4.6 Laboratory Quality Assurance / Quality Control (QA/QC) Program Results

As part of the QA/QC program, KAVIK-STANTEC reviewed Maxxam's Quality Assurance report and the laboratory certificates of analysis to confirm if any issues or concerns were identified.

Maxxam's National Guidelines (Maxxam undated) used for performing QA/QC on laboratory duplicates state that no duplicate pair should have an relative percent difference (RPD) greater than 60% for soil and 40% for water.

The review of Maxxam's Quality Assurance Report did not identify any QC samples (i.e., matrix spikes, method blanks, spiked blanks) that were outside the acceptable QC limits set by the laboratory.

For this sampling program, two notes were included on the laboratory certificates of analysis. These included:

- Detection limits raised due to dilution to bring analyte within calibrated range
- Dissolved greater than total. Results within acceptable limits of precision.

The notes provided by the laboratory do not impact the reliability of the data. No other data quality issues were identified by the laboratory.

5 DISCUSSION

During the 2015 program, KAVIK-STANTEC developed a decision tree to assist in identifying appropriate remediation / reclamation recommendations. Inputs included parameter concentrations from laboratory testing, site observations, and past efforts. This decision tree was carried forward for the 2016 program and can be found in Appendix H.

5.1 On-Site Materials

5.1.1 Wellsite Area

No changes relative to on-site materials were observed at the Wellsite Area during the 2016 site visit.

5.1.2 Sump Area

During the 2010 site assessment, it was discovered that the thermistor strings had been forcefully removed from the data loggers and that some of the connectors had been torn from the thermistor strings (KAVIK-AXYS 2010). Animals were assumed to be the source of the damage and the data loggers were removed from the site. The remaining equipment was not in working order and assumed to be unrepairable.

It is stated in the Environmental Inspection Report received from the NWTWB; following their August 15, 2016 site visit (NWTWB 2016), that all thermistor casings and cables that are no longer operational should be removed from the site. The polyvinyl chloride (PVC) tubing and the steel pipes supporting the protective casings are frozen in the permafrost. Removing them will require digging down to the base of the active layer and cutting up the uppermost section of the pipes (four in total). The lower portions of the PVC tubing and steel pipes will remain on site. Minor to no ground disturbance would be generated while removing the equipment.

5.2 Terrain and Permafrost

5.2.1 Wellsite Area

Two shallow linear depressions located next to the wellhead are assumed to be related to the presence of ice-wedges. Although ice-wedges are more common and more easily recognisable in lowland basin, the occurrence of ice-wedges on hilltops or hill slopes do occur (Burn and O'Neil 2015).

The retrogressive thaw slump located east of the wellhead is active. One of the main processes observed during the 2016 site visit consisted of the thermal erosion of the massive ice exposed along the head wall. This melting and associated erosion leads to successive micro-failures (generally less than a cubic meter at the time) and flow of water-saturated sediments.

The review of the Project Description submitted in support of the Burnt Lake Drilling Program (Encana 2004) included a figure of the site, onto which the retrogressive thaw slump is visible. The feature itself, however, is not discussed in the report. Furthermore, the feature is one of over 2,000 landslides mapped over the Mackenzie Delta Region by the Geological Survey of Canada in 2001 (feature #330 of the Mackenzie Landslide Database; Aylsworth et al. 2001). As part of this airphoto interpretation exercise, the landslide was classified as being composed of multiple, coalescing landslides assumed to have initiated prior to 1985. Recent studies on thaw slumps in the Mackenzie Valley (Baolin 2011) suggest that maximum retrogression rate of landslides monitored along the northern portion of the Mackenzie Valley can be as high as 15 m/year. Based on this maximum retrogression rate alone, it would take approximately 20 years for the slump to reach the wellhead. Local site conditions and topography, however, do not suggest that the current slump will extend to the west as far as the wellhead (Photo B-4, Appendix B).

No erosion issues were observed in the Wellsite Area during the 2016 site visit.

5.2.2 Sump Area

The sump cap does not exhibit characteristics to suggest that the sump is currently degrading (e.g., new tension cracks or area characterized by subsidence).

No erosion issues were observed at the Sump Area during the 2016 site visit.

5.2.3 Active Layer Measurements

Comparison of the active layer thicknesses measured in 2015 and 2016 showed a similar range of values at the three survey locations in both years (i.e., sump top, sump perimeter and control transect) (Figure A-5, Appendix A). Review of past and current active layer measurements at the N-16 Sump (i.e., 2008 to 2016, with the exception of 2013 and 2014) showed annual variations generally in the order of 2 to 10 cm; however, the data do not indicate that the active layer has significantly increased since 2010 (KAVIK-STANTEC 2016b).

A series of factors control annual variations, including (but not limited to) air temperature, snow cover, the amount of summer rainfall, the presence of surface water, local soil characteristics and vegetation conditions. The complex relationship between topography, vegetation, snow cover, water ponding and their effect on the depth of the active layer at the surface and along the perimeter of a sump has been documented by others (Johnstone and Kokelj 2008).

5.3 Soil Assessment

5.3.1 Reference Data

Since no reference samples were previously collected at the Wellsite Area, only the Sump Area had reference data available for soil parameters. The reference data included two historical reference soil samples. No reference samples were collected during the 2016 program. Additional data is required to

appropriately characterize the background conditions at the site. This would include the collection of samples in the area surrounding the sump.

5.3.2 Sump Area

Previous monitoring events completed at the site identified elevated salinity in the area south of the sump (KAVIK-STANTEC 2012). The results of the 2012 program suggested that there impacts from the sump; however, it could not be determined if the impacts were associated with a migration of sump contents or minor surface spillage (KAVIK-STANTEC 2012). Since the 2012 report, no soil sampling has been completed in this area. As such, the source and extent of the salinity impacts in this area remain unknown. Upon completion of the 2015 program, KAVIK-STANTEC recommended that soil samples be collected to confirm the presence of salinity impacts and determine if natural attenuation processes have occurred to reduce the salinity impacts in this area (KAVIK-STANTEC 2016b).

Upon comparison of the soil exceedances at the sump, pH values in several of the samples were outside of the acceptable range outlined by the CCME. However, only one sample collected approximately 110 m south of the sump had a pH that was below the reference data. As there are only two historical reference samples to compare to, KAVIK-STANTEC cannot confirm that the low pH is related to the type of material sampled (peat material).

Since the sump contents consist of potassium chloride-containing drilling waste, the principal parameters that were evaluated to identify concerns relating to the migration of sump contents were soluble potassium and soluble chloride. The data collected in 2012 show that the highest concentrations of soluble potassium and soluble chloride were detected in samples collected south of the sump. The concentrations of soluble potassium were approximately double the concentration detected in the 2016 sample (537 mg/L versus the 2012 concentration of 220 mg/L). The concentration of chloride detected in the 2016 samples, however, were significantly higher than the 2012 sample (990 mg/L versus 595 mg/L). Comparing the 2012 versus 2016 sample locations, it is apparent that the samples collected in 2016 were located to the west of the 2012 sample location. Therefore, KAVIK-STANTEC cannot confirm the extent of the impacts or that natural attenuation processes are occurring in this area.

Soil data from the impacted vegetation area south of the sump suggest that the migration of sump contents may be occurring. Concentrations of several soluble parameters (chloride, calcium, sodium, potassium, and sulphate) were high compared to the reference data. Elevated concentrations of soluble parameters appear to be having an adverse impact on vegetative regrowth, such as dead or withered and yellowing foliage (see Section 4.5.2).

The results from the samples collected north of the sump suggest that impacts potentially relating to sump contents are present. Notably, the concentration of dissolved chloride appears elevated in comparison with the historical and 2016 reference concentrations. However, due to the lack of salinity impacts in the other samples collected north of the sump, the data suggest that the impacts are localized.

5.4 Standing Water Assessment

5.4.1 Reference Data

Since no reference samples were previously collected at the Wellsite Area, only the Sump Area had reference data for standing water parameters. Reference data included four historical reference samples and three 2016 reference samples. The locations of each of the reference water samples are greater than 50 m from the sump. Therefore, additional reference water data are not required at the sump. If, during future monitoring programs, water samples are collected at the Wellsite Area, additional reference water data should be collected to appropriately characterize the natural conditions in the area.

5.4.2 Sump Area

Upon review of the exceedances noted at the site, low pH values were detected in one of the three standing water samples (N-16_Sump_W4) collected within 50 m of the sump. In comparison with the historical reference data and the 2016 reference data, the pH values detected in the samples are generally consistent. Considering the pH values detected in the reference samples and the type of soils found at the site (i.e., poorly drained organic soils), the low pH value is considered to be naturally occurring.

The key indicator for the presence of sump-affected water outside of the sump perimeter is the presence of dissolved potassium and dissolved chloride in some of the samples. The concentrations of dissolved potassium and dissolved chloride in the samples collected to the north and south of the sump were higher than the concentrations detected in the historical and 2016 reference samples. At one location south of the sump (N-16_Sump_W4), the concentration of dissolved potassium has decreased between the 2015 and 2016 programs (KAVIK-STANTEC 2016b). However, the high concentrations of dissolved chloride in the sample suggest that there may be some impact from the material stored within the sump. The elevated concentrations of dissolved chloride and dissolved potassium detected in one of the samples collected north of the sump (N-16_Sump_W1) also suggest some level of impact from the sump.

The analytical results of samples collected during current and historical monitoring programs suggest that a migration of drilling fluid has occurred, which has resulted in higher EC values in samples collected to the north and south of the sump. The latest electromagnetic (EM) survey conducted at the site in 2014 (Worley Parsons 2015) indicated that the elevated EC zones present away from the sump are potentially associated with inorganic impacts (i.e., salts). This especially is the case for the area located south of the sump. The results of the EC measurements completed during the 2016 site visit concurs with the highest EC reading detected in an area of standing water located southwest of the sump.

Impacted vegetation was identified in two areas south of the sump, including one to the south (V3-01) and one to the southwest (V2-03). Soil and standing water samples were collected proximate to the southern impacted area; results suggest that concentrations of potassium and chloride may be affecting vegetation growth in these areas (see Section 4.5.2).

5.5 Reclamation

5.5.1 Wellsite Area

Vegetation cover conditions in the Wellsite Area outside of the wellhead were similar to conditions observed in 2015 in both species composition and percent cover (KAVIK-STANTEC 2016a); the site had minimal topsoil and vegetation disturbance, likely due to lease preparation operations being conducted in the winter months, which has resulted in native vegetation re-establishing in the area. No vegetation issues were observed during the 2016 site visit. The vegetation cover in this portion of the site met INAC Land Use Permit N2003A0035 (INAC 2003a) requirements for vegetation health and 70% cover. The vegetation species observed were native shrubs and forbs which are characteristic of the vegetation cover for the Tundra Plains Mackenzie Delta Low Arctic North Ecoregion (ECG 2012).

Vegetation growing in the area directly south of the wellhead consisted of a dense stand of native grasses seeded in previous reclamation treatments (Priddis 2014). At the time of the 2016 site visit, vegetation cover conditions were observed to be similar to conditions observed in 2015 in both species composition and percent cover (KAVIK-STANTEC 2016a); the area was well vegetated with the seeded native grasses. Vegetation cover at the in this area met INAC Land Use Permit N2003A0027 (INAC 2003a) requirements for 70% cover and health.

Vegetation growing in the sandy, gravelly material around the wellhead culvert consisted of a low density stand of previously seeded native grasses and naturally established native forb species (Priddis 2014); vegetation cover around the wellhead culvert was approximately 57%, which is insufficient to meet INAC Land Use Permit N2003A0027 (INAC 2003a) requirements. The sandy gravelly material is not representative of the fine-grained soils present throughout most of Richards Island (ECG 2012) and was likely deposited at this location at the time of wellhead installation. Following completion of vegetation monitoring tasks at the Wellsite Area, the lightly vegetated area surrounding the wellhead culvert was seeded with native grasses in an effort to increase the density of the current grass cover. Native grass species applied included violet wheatgrass, polargrass and tufted hairgrass (approximately 0.5 kg of seed mix). The grass seed was obtained from stock that was in storage in the MGM seacan trailers in Inuvik.

5.5.2 Sump Area

Vegetation growing on the sump was similar to conditions observed in 2015 in both species composition and percent cover (KAVIK-STANTEC 2016b); it was dominated by a dense stand of native grasses growing throughout the sump that were applied in previous reclamation treatments between 2007 and 2010 (MGM 2007, Priddis 2014). No vegetation issues were observed during the 2016 site visit. The seeded grass cover was well established, in good condition and appeared to be self-sustaining; the vegetation cover in this portion of the sump met INAC Land Use Permit N2003A0035 (INAC 2003a) requirements (KAVIK-STANTEC 2016b) for vegetation health and 70 %cover.

With the exception of two areas to the south of the sump, vegetation conditions in the majority of the undisturbed area surrounding the Sump Area remained unchanged from conditions observed in the 2015 program (KAVIK-STANTEC 2016b). This area remained well vegetated with the naturally established

native shrubs and forbs which are characteristic of the vegetation cover for the Tundra Plains Mackenzie Delta Low Arctic North Ecoregion (ECG 2012) and currently meets land use permit requirements.

Vegetation growing in the impacted vegetation locations south of the Sump Area (V3-01 and V2-03) consisted predominantly of short/dwarf shrub species including dwarf birch, crowberry, cloudberry, willows, bog cranberry, lichens, and mosses. The presence of these types of plants are likely a response to the ground conditions present at these locations, consisting of hummocky, organic, peat-dominated ground material, which tends to have low pH levels and low nutrient levels. Vegetation cover in the V3-01 impacted vegetation location was approximately 70%, which met INAC Land Use Permit N2003A0035 (INAC 2003a). Vegetation cover in the V2-03 impacted vegetation area was approximately 40%, which is insufficient to meet the land use permit requirements. The above-listed plants that were growing at this location were well established, in good condition, and appear to be self-sustaining. However, large sections of litter (consisting primarily of dead cottongrass and sedges) and bare sections were also present, which is indicative of responses to changes in soil and water conditions. These areas have typically been correlated with the highest elevated apparent conductivities in historical EM surveys, which had been confirmed with soil and water laboratory testing (KAVIK-STANTEC 2016b) and with soil and water testing conducted in 2016. Laboratory analyzes of the soil material and water indicates low pH values, and elevated concentrations of dissolved parameters (chloride, potassium), which are likely affecting vegetation health and conditions in these impacted vegetation locations. Tussock cottongrass and sedges were the most impacted species that were observed, displaying either dead or withered and yellowing foliage.

5.5.3 Invasive Plants

Invasive plants present at the Wellsite Area consisted of scentless chamomile plants growing individually and in small groups in the native grass seeded area immediately south of the wellhead. At the time of the 2016 site visit, the infestation area was approximately 200 m^2 area with a 10% cover of scentless chamomile plants, which can be considered a moderate infestation. Based on previous monitoring reports (Priddis 2014), the infestation has increased in area and density, but yearly manual control treatments carried out to date have restrained the invasive plant population. However, the yearly manual control treatments have not eradicated the infestation and more intensive treatments may be required. The GNWT Environment and Natural Resources department does not currently have an invasiveness rating for scentless chamomile; however, in the Yukon Territory, Environment Yukon currently rates this species as highly invasive and may displace or replace native ecosystems (EY 2012). This species is a prolific seed producer and can easily propagate large numbers of plants which will out-compete the native vegetation species growing in the infestation area, thereby creating large, dense stands of scentless chamomile.

Following completion of monitoring tasks at the Wellsite Area, manual invasive plant control treatment was carried out. Treatment included hand pulling of all plants and storing them in a heavy duty garbage bag. The invasive plants were later disposed of at the Inuvik landfill facility; approximately half a garbage bag containing flower heads, stems and leaves was collected and disposed of.

Invasive plants were not observed at the Sump Area during the August 2016 site visit. In addition, conditions that may lead to invasive plant establishment such as outside sources of invasive plant seeds (i.e., infestations adjacent to the sump) were not present at the time of the site visit. Overall, the sump has a low risk of infestation.

5.5.4 Signs of Wildlife Use

Evidence of wildlife use of the sites were observed during the 2016 site visit, which included bird droppings on the wellhead, unidentified geese were observed flying over the Wellsite and Sump Areas, goose and ungulate droppings were observed in the Sump Area and an animal den was observed on the sump. The current level of wildlife use is not creating any visible impacts at the Wellsite or the Sump Areas.

6 CONCLUSIONS AND RECOMMENDATIONS

A summary of 2017 recommendations for the Site are provided in Table 6-1.

6.1 On-Site Materials

6.1.1 Wellsite Area

The wellhead, protective culvert and identification sign appeared in good conditions. No actions related to on-site materials are recommended in 2017.

6.1.2 Sump Area

Four thermistor cables and metal protective casings were present at the sump. The equipment was not recording data and is assumed to be unrepairable. KAVIK-STANTEC recommends that the data logger protective casings, steel post and segment of cables located within or above the active layer be removed from the site during the 2017 site visit. Minor to no ground disturbance will be generated while removing the equipment (i.e., some soil might be disturbed when pulling the metal posts from the ground.

6.2 Terrain Conditions

6.2.1 Wellsite Area

No issues related to permafrost degradation were identified within the Wellsite Area during the 2016 site visit.

Two shallow linear depressions assumed to correspond to the presence of ice-wedges were present within 20 m of the wellhead. The features were free of standing water and no signs of erosion, stress or subsidence were identified, KAVIK-STANTEC recommends that visual monitoring be conducted during the 2017 site visit(s) for potential signs of permafrost degradation within 50 m of the wellhead.

A retrogressive thaw slump covering an area of approximate 3.2 ha was located 300 m east from the wellhead. The eastern and western portions of the slump were active, however based on the observed 2016 conditions and on retrogression rates for such landslides (i.e., maximum 15m / year); the slump is not believed to pose a threat to the stability of the wellhead. KAVIK-STANTEC recommends that the retrogressive thaw slump be monitored for any signs of increase activity, especially the westernmost portion of the landslide. The position of the head wall should be delineated so that a retrogression rate can later be assessed.

6.2.2 Sump Area

No issues related to permafrost degradation or erosion was identified at the sump during the 2016 site visit and no control measures are required.

An increase of the active layer on, or immediately around the sump, could negatively impact its stability by allowing the material to thaw, therefore potentially leading to sump failure (i.e., thawing and collapsing of the sump cap and potential seepage of sump-impacted water).

KAVIK-STANTEC recommends continue monitoring of the ice-wedges located in contact with the perimeter of the sump (especially to ones to the north and south) for potential signs of instability and/or erosion.

6.3 Remediation

The soil and water results from the 2016 program were placed into KAVIK-STANTEC's remediation/reclamation treatments decision tree (Appendix H) and the results indicate that additional soil and water sampling is recommended in 2017.

Past EM surveys suggest that areas north and south of the sump have elevated EC that could be related to the migration of ion rich water. Soil and water samples should be collected in the areas of observed elevated conductivity at that time to characterize the soil and water and corroborate the findings of the EM survey.

To appropriately characterize the background conditions at the sump, further reference data are necessary. It is recommended that between eight to ten soil and water samples be collected from off-lease locations surrounding the sump. The EM survey should be completed in the area of each reference sample to allow for the correlation of data (analytical and survey results). The collected samples should be submitted for analysis of all PCOCs associated with the sites.

No further remediation action is recommended for the Wellsite and Sump Areas in 2017.

6.4 Reclamation

6.4.1 Wellsite Area

Based on KAVIK-STANTEC's remediation/reclamation treatments decision tree (Appendix H) no further reclamation treatments are recommended in 2017 for the Wellsite Area outside of the wellhead and the native grass seeded area directly south of the wellhead as these sections had good vegetation establishment, growth, and health to meet Land Use Permit N2003A0035 (INAC 2003a) requirements.

For the lightly vegetated area around the wellhead culvert, it is recommended to carry out vegetation monitoring in 2017 to determine if there is establishment of the grass seed that was applied in 2016 and increased growth and density of the currently established grasses. The findings of the monitoring will determine if additional treatments will be required.

6.4.2 Sump Area

Based on KAVIK-STANTEC's remediation/reclamation treatments decision tree (Appendix H) no further reclamation treatments are recommended in 2017 for the Sump Area because it had good vegetation establishment, growth, and health to meet Land Use Permit N2003A0035 (INAC 2003a) requirements.

Additional vegetation monitoring is recommended in 2017 for the impacted vegetation locations south of the Sump Area (refer to Appendix A, Figure A-4 for areas requiring additional monitoring) because they were not meeting Land Use Permit N2003A0035 (INAC 2003a) requirements. The V3-01 impacted vegetation location just meets vegetation cover requirements; however, the vegetation does appear to be changing in composition and plant health appeared to be stressed. The vegetation monitoring would be used to delineate the impacted vegetation locations and any other areas of impacted vegetation near the Sump Area, and track changes in vegetation species composition, cover, plant establishment and growth, and overall vegetation health. In addition, it is recommended to undertake vegetation monitoring in local off-site non-impacted reference sites and carry out a search and review of information or literature on historical drilling associated operations in the Sump Area. Findings of the monitoring would be used to determine the following:

- The extent of the area containing impacted vegetation and the distribution;
- Whether exceedances detected in soil and water samples are having an effect on vegetation establishment, growth, and health;
- Determine if vegetation species composition and cover in non-impacted off-lease reference sites are different than the vegetation in the impacted areas;
- If there were any historical localized spills of contaminants in the impacted areas that may be affecting vegetation growth and health and;
- If the plant species that are currently well established and healthy in these areas can be left on their own to naturally grow and develop a self-sustaining vegetation cover, or if vegetation maintenance treatments would be required in 2018.

6.4.3 Invasive Plants

Invasive plant monitoring and control is recommended for the Wellsite Area in 2017 so that invasive plants (scentless chamomile) do not become widespread in the native grass seeded area immediately south of the wellhead or become established in the adjacent undisturbed tundra area. For this species, manual control method of pulling plants, storing them in garbage bags and disposing off-site at the Inuvik landfill is recommended; the monitoring and control work could be carried out in the summer of 2017 prior to seed ripening when sump monitoring is conducted. In addition, it is recommended in 2017 to study potential alternative treatments, such as herbicide application or biocontrol (i.e., control of invasive plants using insects, parasites, and pathogens), that would provide more effective and longer term control and possible eradication of the scentless chamomile but not affect the well-established, healthy, and self-sustaining native grass cover currently present.

Table 6-1 2017 Recommendations – N-16 Wellsite Area and Sump Area

Parameter	Recommendations
Ground temperature monitoring	• Remove the remaining ground temperature equipment from the Sump Area.
Terrain and permafrost	• Monitor the ice-wedges present next to the Wellsite Area and the Sump Area. • Monitor the retrogressive thaw slump for signs of active activity; delineate the headwall so that a retrogression rate can later be assessed.
Soil and Water Sampling	• Complete reference sampling in the area surrounding the sump. • Collect additional soil samples in vicinity of the observed elevated conductivities to confirm the findings of the EM survey.
Wellsite Area Reclamation	• Conduct vegetation monitoring on the lightly vegetated area around the wellhead culvert to determine if there is establishment of the grass seed that was applied in 2016 and increased growth and density of the currently established grasses. • Findings of the monitoring will determine if additional treatments will be required.
Sump Area Reclamation	• Conduct vegetation monitoring of the V3-01 and V2-03 impacted vegetation areas south of the sump (Latitude: 69°23’18” N; Longitude: 134°03’45” W; Latitude: 69°23’18” N; Longitude: 134°03’49” W) to delineate current areas and locate additional areas of impacted vegetation. The monitoring should comprise vegetation species composition and cover, plant establishment and growth, overall vegetation health. Also conduct vegetation monitoring at equivalent non-impacted reference sites in surrounding areas for comparison of vegetation cover and species composition and conduct information/literature search of previous drilling operations for documentation of any spills. • Findings of the vegetation monitoring would be used to determine the extent of the area containing impacted vegetation and the distribution; determine if exceedances detected in soil and water samples are having an effect on vegetation establishment, growth, and health; and if the plant species that are currently well established and healthy in these areas can be left on their own to naturally grow and develop a self-sustaining vegetation cover, or if vegetation maintenance treatments would be required in 2018.
Invasive plants	• Monitor invasive plant infestation (scentless chamomile) in native grass seeded area immediately south of the wellhead (Latitude: 69°25’53.304” N; Longitude: 134°19’6.366” W.). • Carry out control treatments including pulling invasive plants, storing in garbage bags, and disposing offsite in the Inuvik landfill. Monitoring and control treatment should be carried out in the summer of 2017 prior to seed ripening. • Study potential alternative treatments, such as herbicide application or biocontrol (i.e., control of invasive plants using insects, parasites, and pathogens), that would provide more effective and longer term control.

7 LIMITATIONS AND CLOSURE

This report documents work that was performed in accordance with generally accepted professional standards at the time and location in which the services were provided. No other representations, warranties or guarantees are made concerning the accuracy or completeness of the data or conclusions contained within this report, including no assurance that this work has uncovered all potential liabilities associated with the identified property.

This report provides an evaluation of selected environmental conditions associated with the identified portion of the properties that were assessed at the time the review was conducted and is based on information obtained by and/or provided to KAVIK-STANTEC at that time. There are no assurances regarding the accuracy and completeness of this information. All information received from the client or third parties in the preparation of this report has been assumed by KAVIK-STANTEC to be correct. KAVIK-STANTEC assumes no responsibility for any deficiency or inaccuracy in information received from others.

Conclusions made within this report consist of KAVIK-STANTEC's professional opinion as of the time of the writing of this report, and are based solely on the scope of work described in the report, the limited data available and the results of the work. They are not a certification of the property's environmental condition. This report should not be construed as legal advice.

This report has been prepared for the exclusive use of the client identified herein and any use by any third party is prohibited. KAVIK-STANTEC assumes no responsibility for losses, damages, liabilities or claims, howsoever arising, from third party use of this report.

This report is limited by the following:

- Soil and surface water samples were collected by MGM. Furthermore, MGM made decisions on which samples and parameters to analyze.
- This report is limited by the information provided in the referenced historical reports and the conditions observed during the field program.

The locations of any utilities, structures, and property boundaries illustrated in or described within this report, if any, including surface or sub-surface structures are not guaranteed. Before starting work, the exact location of all such structures should be confirmed and KAVIK-STANTEC assumes no liability for damage to them.

The conclusions are based on factors such as areas of potential concern identified in previous studies, site conditions (e.g., utilities), site components, etc. Due to the nature of the investigation and the limited data available, KAVIK-STANTEC does not warrant against undiscovered environmental liabilities. As the purpose of this report is to identify site conditions which may pose an environmental risk; the identification of non-environmental risks to structures or people on the Site is beyond the scope of this assessment.

Should additional information become available which differs significantly from our understanding of conditions presented in this report, KAVIK-STANTEC specifically disclaims any responsibility to update the conclusions in this report.

8 QUALITY MANAGEMENT

This document titled MGM Energy – 2016 Environmental Site Monitoring Report Site: Umiak N-16 Wellsite and Sump was prepared by KAVIK-STANTEC Inc. for MGM Energy Corporation. The report herein has been prepared by Patricia Coyne, B.Sc., Olivier Piraux, M.Sc., Lionel Borges, B.Sc., and reviewed by Matthew Redmond, P.Eng. (BC), Natalie Tashe, P.Ag. (BC) and Richard Guthrie, P.Geo (NT).

Yours truly,

KAVIK-STANTEC INC.

Patricia Coyne, B.Sc.
Environmental Scientist

Olivier Piraux, M.Sc.
Terrain Scientist

Lionel Borges, B.Sc.
Senior Biologist / Reclamation Specialist

This report was reviewed by:

Richard Guthrie, P.Geo (BC, AB, NU and NT)
Signing for sections related to permafrost conditions, erosion and erosion control

Matthew Redmond, P.Eng (BC)
Signing for sections related to soil, surface water and remediation

Natalie Tashe, P.Ag. (BC and AB)
Signing for sections related to reclamation

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APPENDIX A Site Figures

Sources: Base Data - Natural Earth. Thematic Data - Kavik-Stantec Ltd, Government of Northwest Territories

Disclaimer: This map is for illustrative purposes to support this Kavik-Stantec project; questions can be directed to the issuing agency.

MGM Energy Wellsite, Sump, and Bollard Locations within the Inuvialuit Settlement Region

KAVIK-STANTEC

LOCATION OVERVIEW

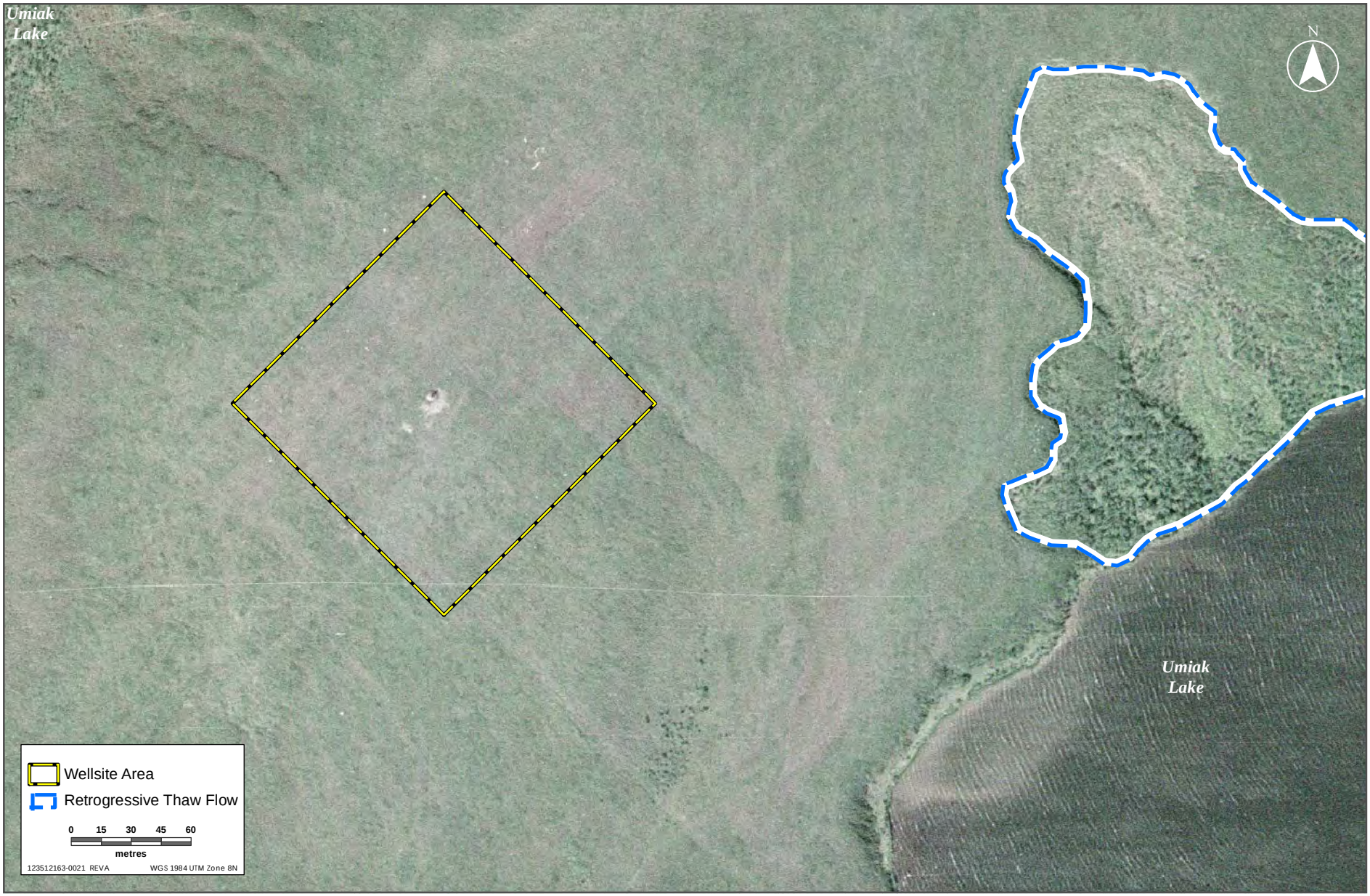
Figure A-1

Sources: Base Data - Natural Earth. Thematic Data - Kavik-Stantec Ltd

Imagery: Aerial photos taken August 2004.

Disclaimer: This map is for illustrative purposes to support this Kavik-Stantec project; questions can be directed to the issuing agency.

Umiak N-16 Wellsite
Site Figure

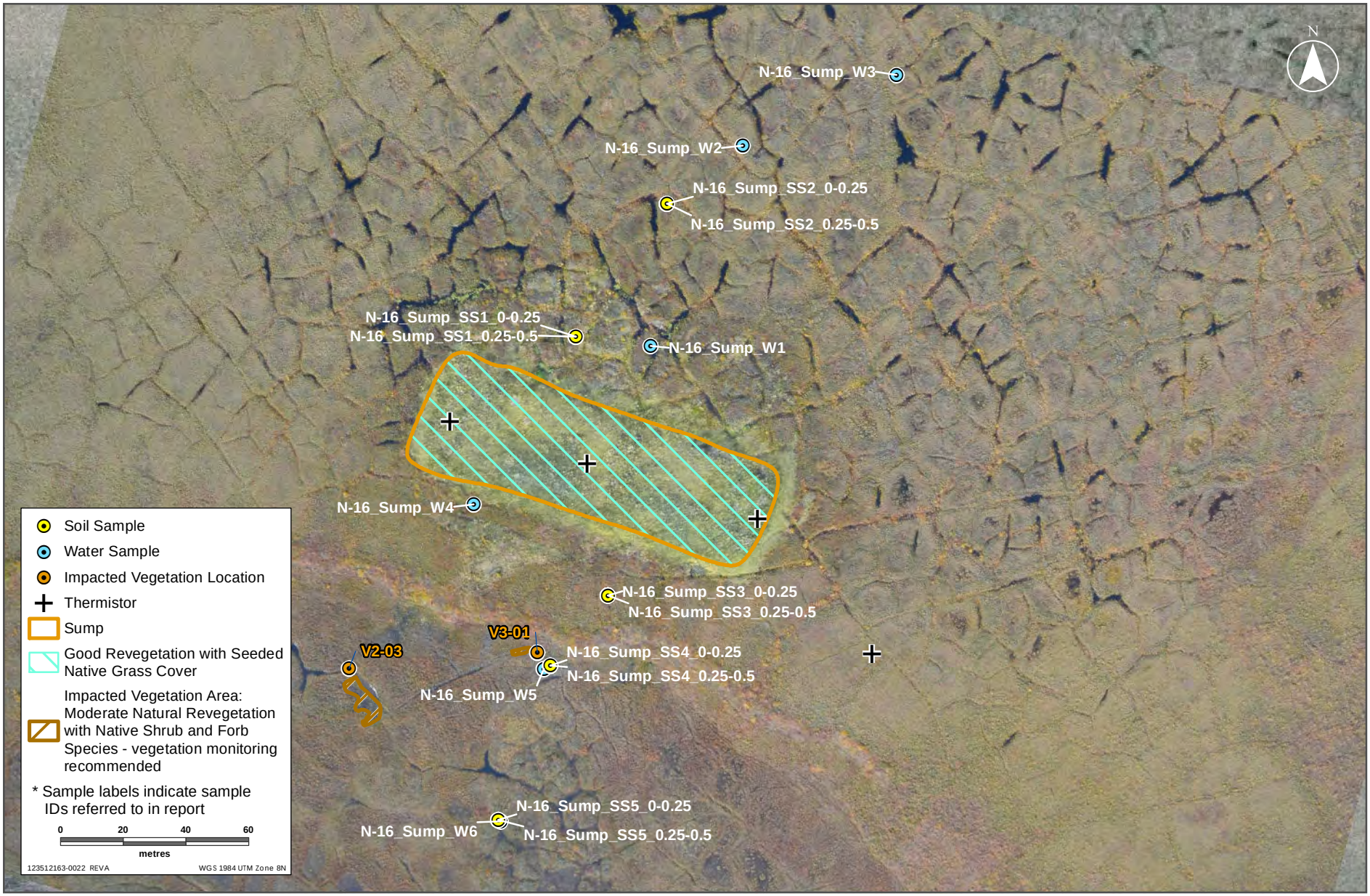


Sources: Base Data - Natural Earth. Thematic Data - Kavik-Stantec Ltd

Imagery: Aerial photos taken August 2004.

Disclaimer: This map is for illustrative purposes to support this Kavik-Stantec project; questions can be directed to the issuing agency.

Umiak N-16 Wellsite
Retrogressive Thaw Flow

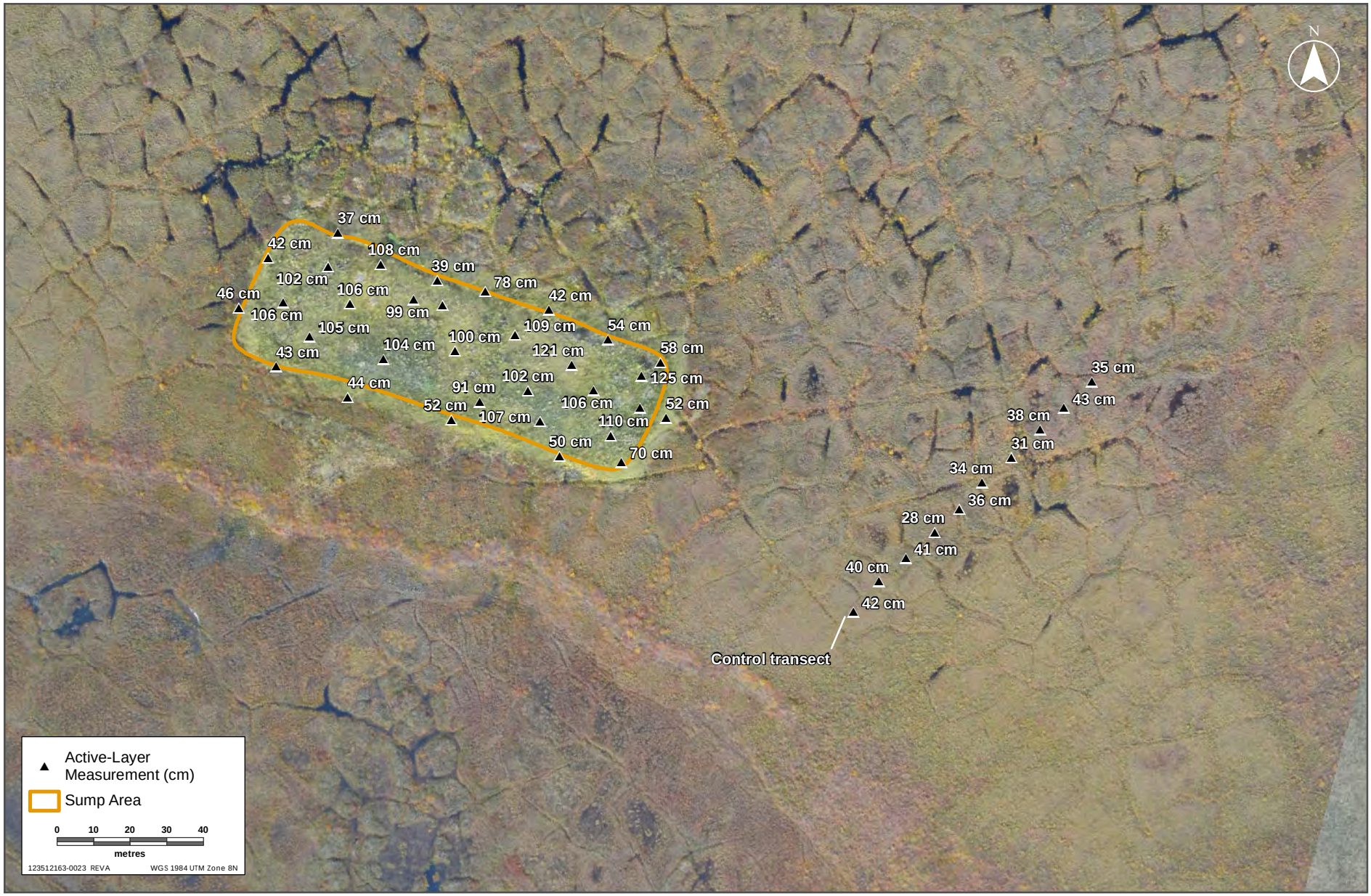


Sources: Base Data - Natural Earth. Thematic Data - Kavik-Stantec Ltd

Imagery: Aerial photos taken August 2004 and August 2012.

Disclaimer: This map is for illustrative purposes to support this Kavik-Stantec project; questions can be directed to the issuing agency.

Umiak N-16 Sump
Site Figure

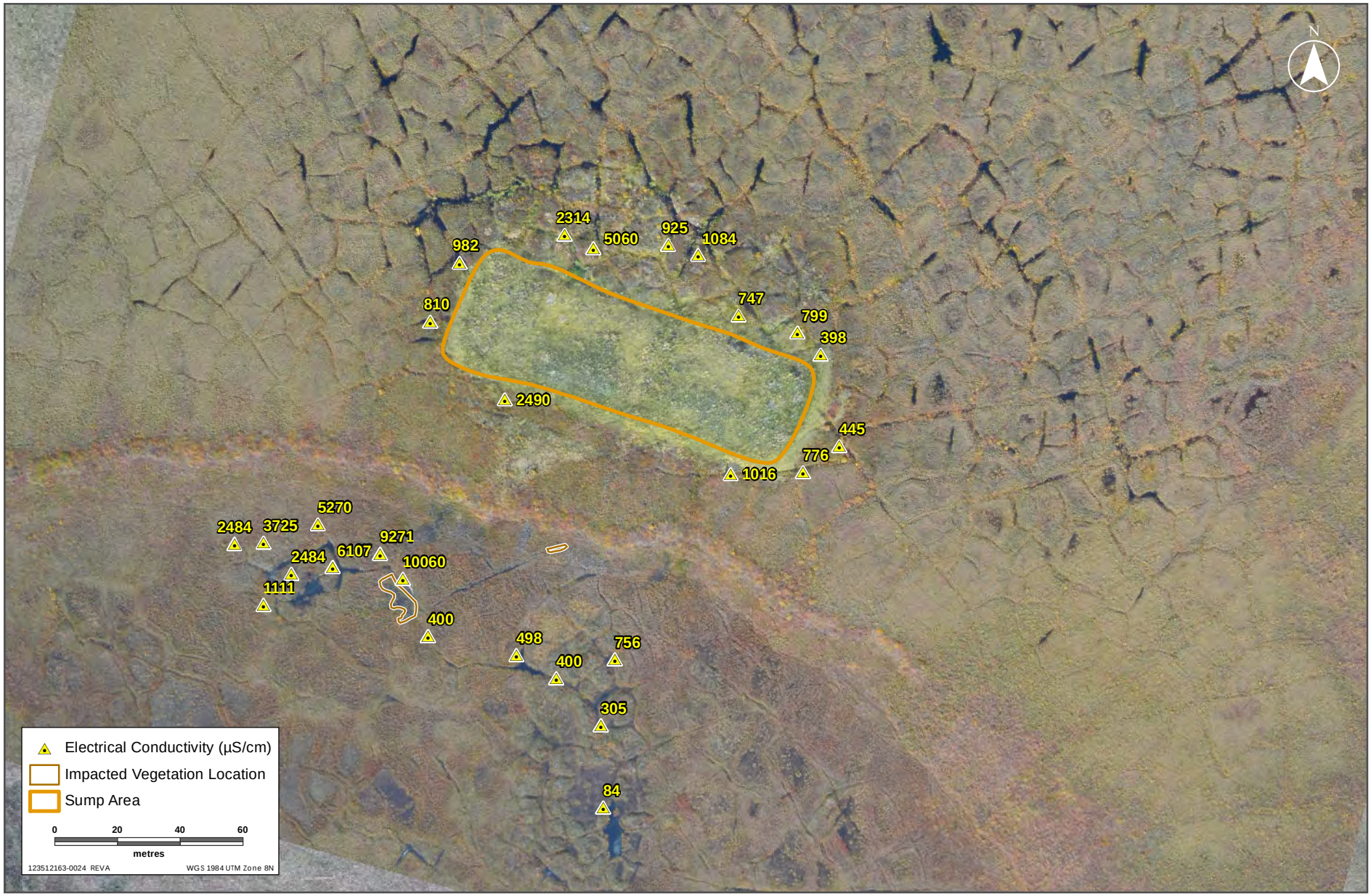


Sources: Base Data - Natural Earth. Thematic Data - Kavik-Stantec Ltd

Imagery: Aerial photos taken August 2004 and August 2012.

Disclaimer: This map is for illustrative purposes to support this Kavik-Stantec project; questions can be directed to the issuing agency.

Umiak N-16 Sump
Active Layer Measurements



Sources: Base Data - Natural Earth. Thematic Data - Kavik-Stantec Ltd

Imagery: Aerial photos taken August 2004 and August 2012.

Disclaimer: This map is for illustrative purposes to support this Kavik-Stantec project; questions can be directed to the issuing agency.

Umiak N-16 Sump
Electrical Conductivity Readings

APPENDIX B Site Photographs

Photo B-1 **N-16 Wellsite: Aerial overview of wellhead and surrounding Wellsite Area (looking east). August 22, 2016.**

Photo B-2 **N-16 Sump: Aerial overview of the sump (looking northeast). August 22, 2016**

Photo B-3 **N-16 Wellsite: View of shallow linear depression (trough) located above a suspected ice wedge near wellhead (looking east). August 22, 2016.**

Photo B-4 **N-16 Wellsite: Retrogressive thaw slump located approximately 300 m east of the wellhead. The landslide is composed of a larger suspended landslide (i.e., an inactive landslide that still has the potential to move, but currently stationary or without measurable displacement for over five years) and two active landslides (i.e., landslides that are currently moving) August 22, 2016.**

Photo B-5 **N-16 Wellsite: Approximately 8 m of massive-ice exposed along the headwall of the retrogressive thaw slump. August 22, 2016.**

Photo B-6 **N-16 Wellsite. Aerial overview of the Wellsite Area vegetation cover. Note dashed line delineates native grass seeded area south of wellhead containing invasive plants. Photo looking east. August 22, 2016.**

Photo B-7 **N-16 Wellsite. View of native grass seeded area south of wellhead containing invasive plants. Photo looking northeast. August 22, 2016.**

Photo B-8 **N-16 Wellsite. View of lightly vegetated area around wellhead culvert. Photo looking west. August 22, 2016.**

Photo B-9 **N-16 Sump. Aerial overview of the sump vegetation cover and surrounding area vegetation cover. Note impacted vegetation areas to the south of the sump, delineated with dashed lines. Photo looking northwest. August 22, 2016.**

Photo B-10 **N-16 Sump. Native grass growth on the sump top. Photo looking southeast. August 22, 2016.**

Photo B-11 **N-16 Sump. View of impacted vegetation area located approximately 50 m south of the sump (Impacted vegetation location: V3-01). Photo looking northeast. August 22, 2016.**

Photo B-12 **N-16 Sump. View of impacted vegetation area located approximately 50 m south of the sump (Impacted vegetation location: V3-01). Photo looking southwest. August 22, 2016.**

Photo B-13 **N-16 Sump. View of impacted vegetation area located approximately 70 m southwest of the sump (Impacted vegetation location: V2-03). Photo looking west. August 22, 2016.**

Photo B-14 **N-16 Sump. View of impacted vegetation area located approximately 70 m southwest of sump (Impacted vegetation location: V2-03). Photo looking east. August 22, 2016.**

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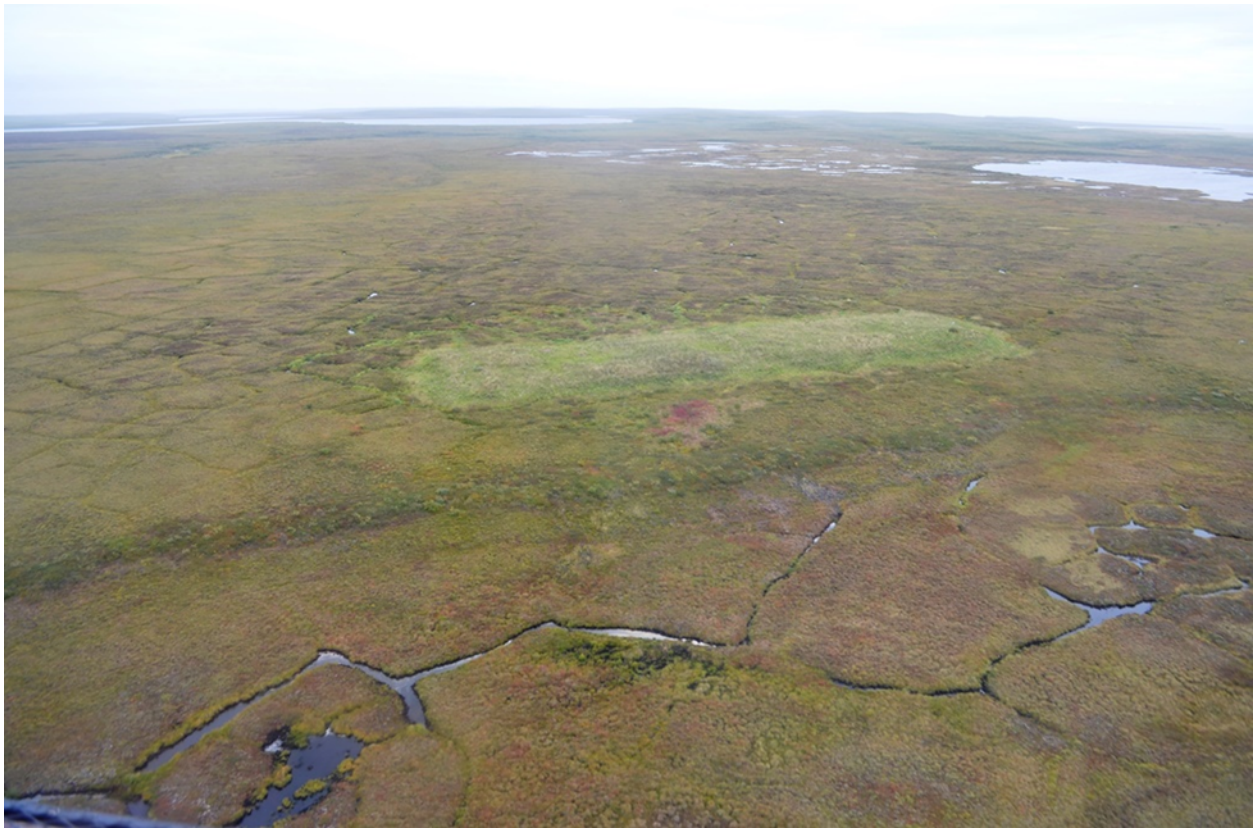

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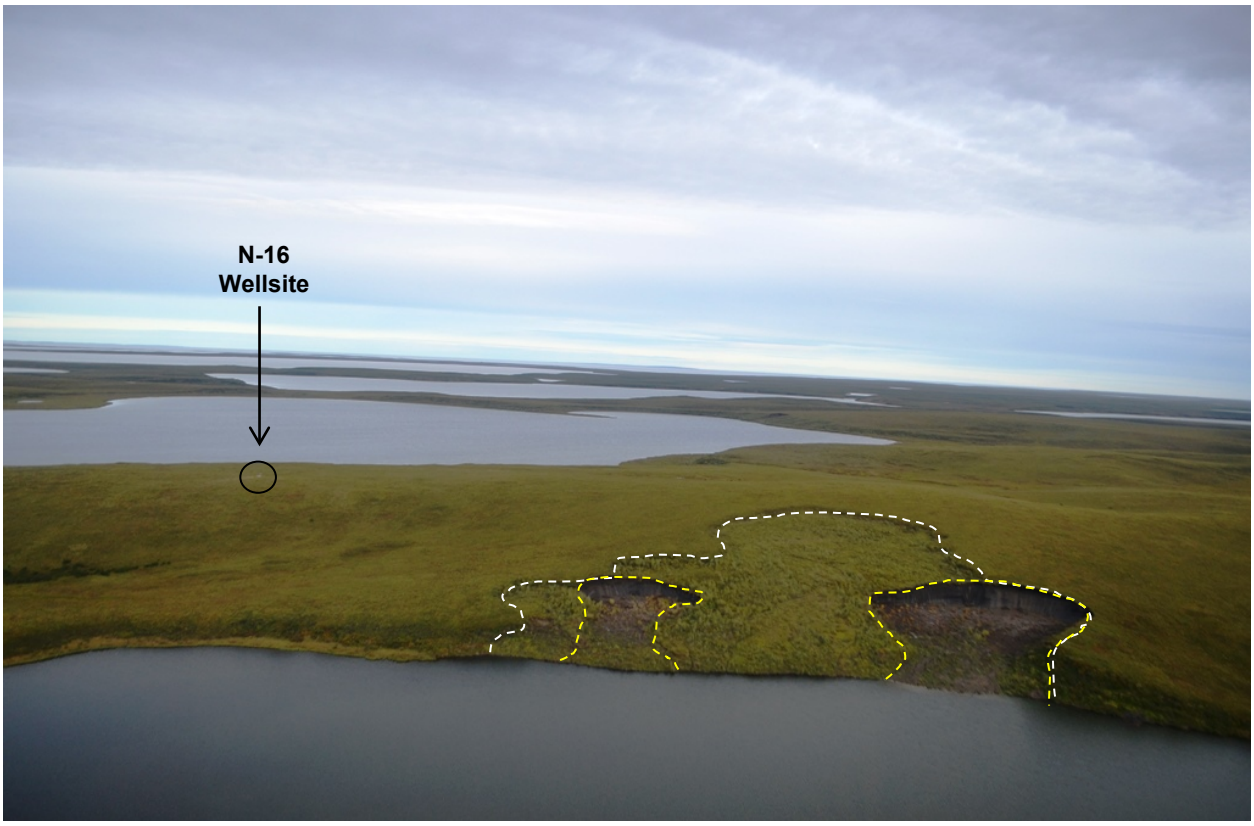


Photo B-4 **N-16 Wellsite: Retrogressive thaw slump located approximately 300 m east of the wellhead. The landslide is composed of a larger suspended landslide (i.e., an inactive landslide that still has the potential to move, but currently stationary or without measurable displacement for over five years) and two active landslides (i.e., landslides that are currently moving) August 22, 2016.**

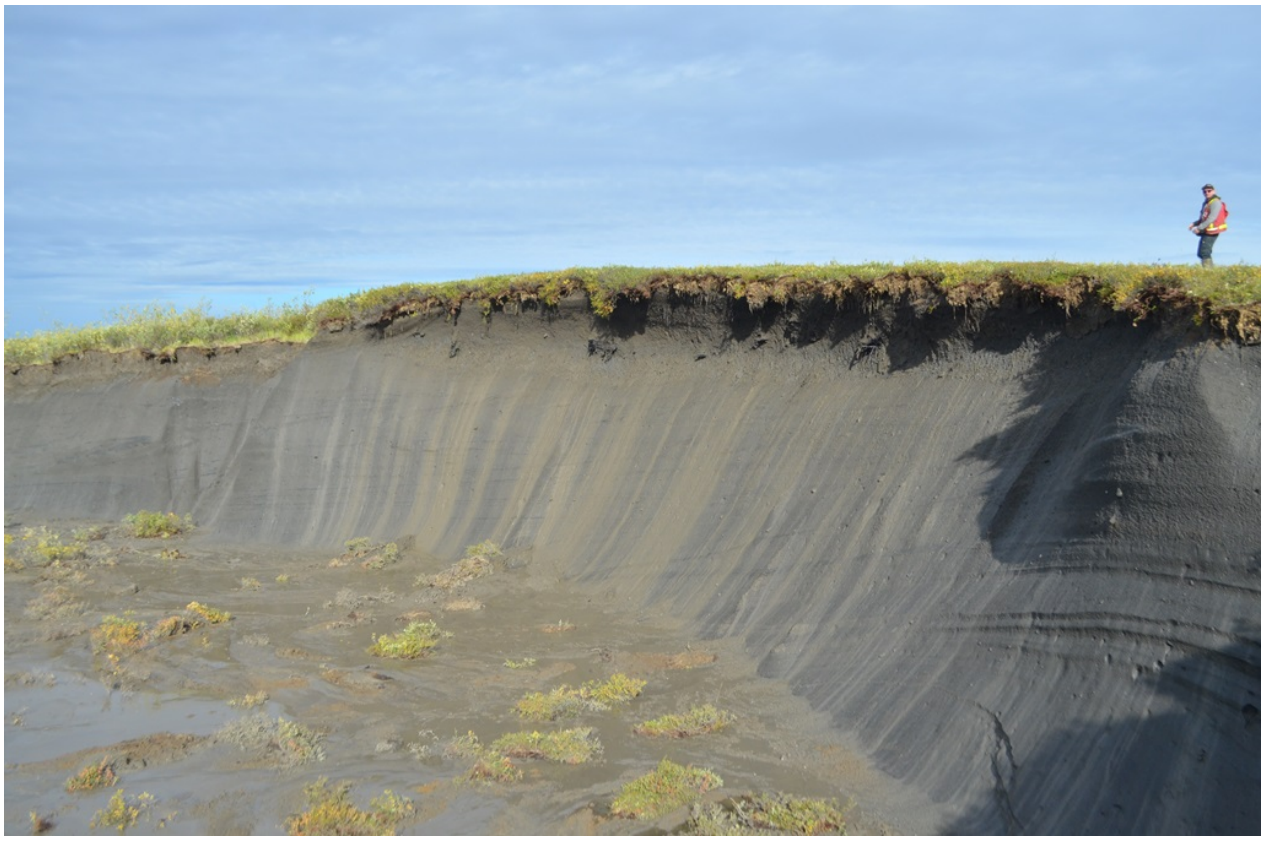
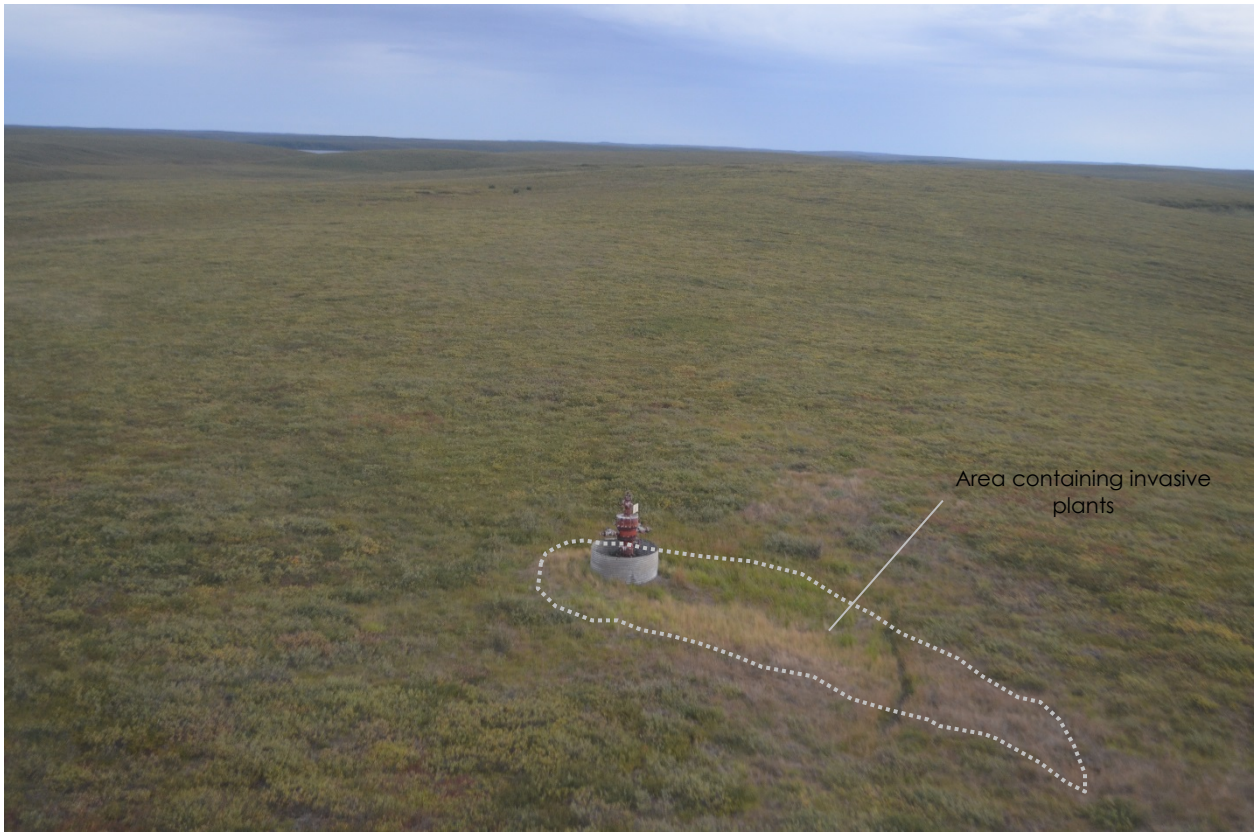


Photo B-5 **N-16 Wellsite: Approximately 8 m of massive-ice exposed along the headwall of the retrogressive thaw slump. August 22, 2016.**



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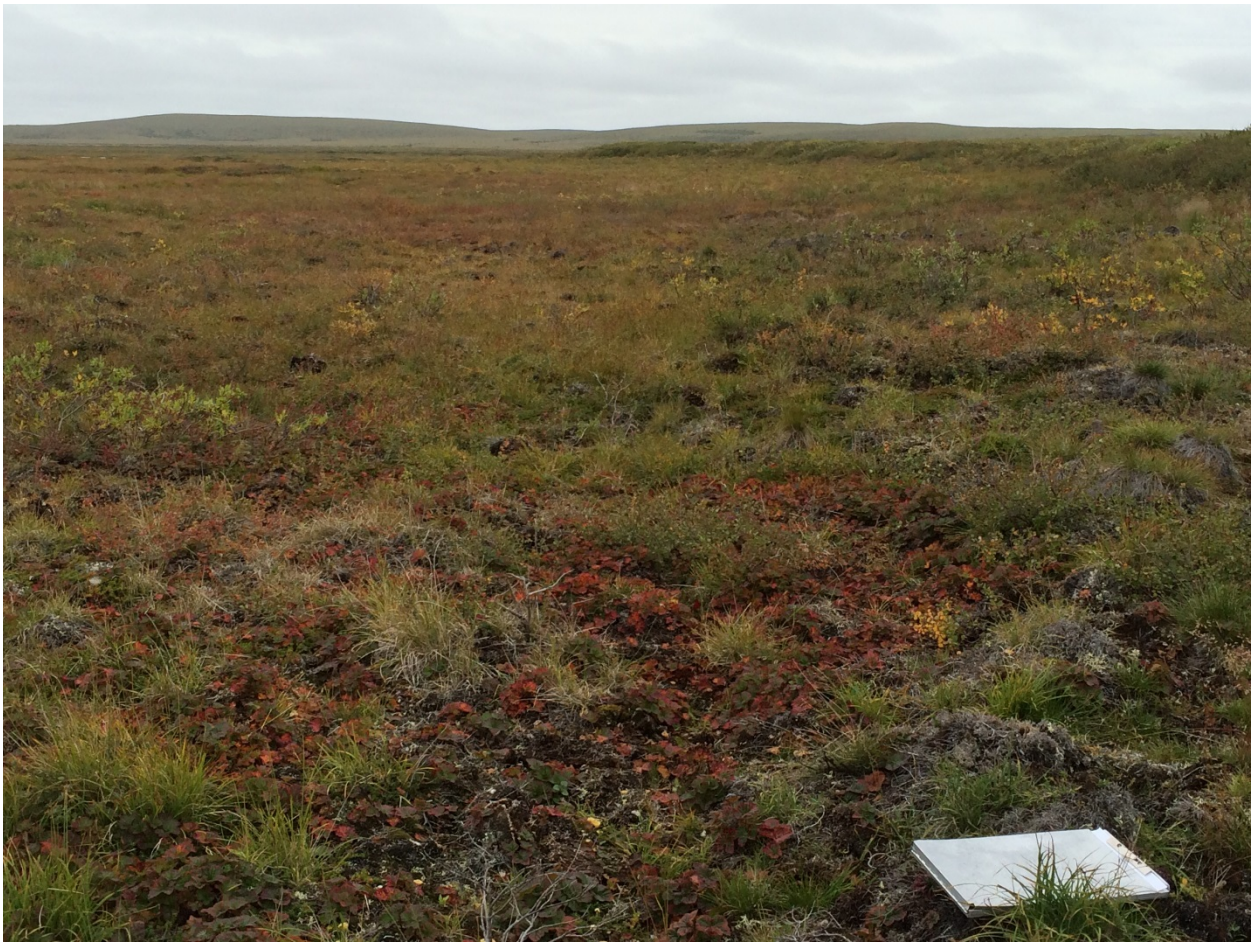

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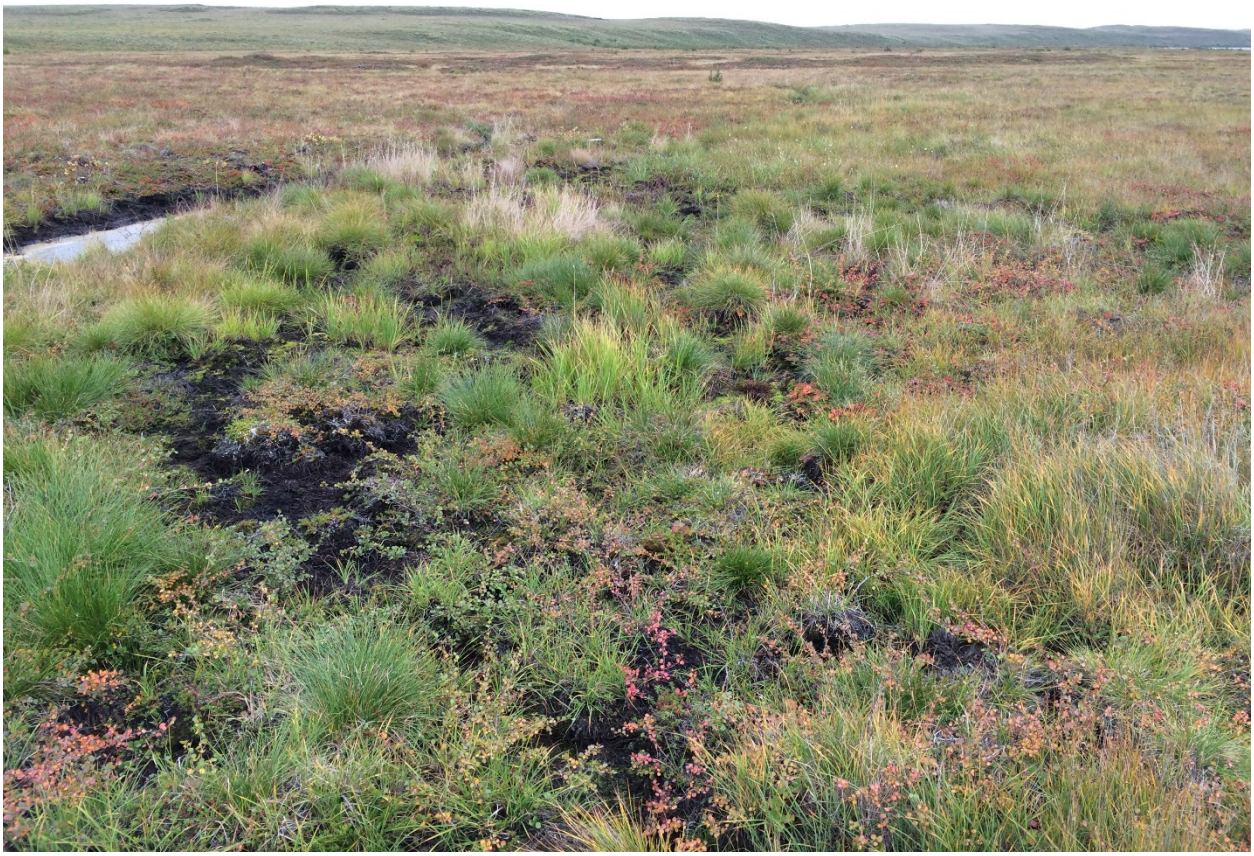

Photo B-14 **N-16 Sump. View of impacted vegetation area located approximately 70 m southwest of sump (Impacted vegetation location: V2-03). Photo looking east. August 22, 2016.**

APPENDIX C Sampling Methods

KAVIK-STANTEC followed standardized procedures for field activities to maintain consistency in data collection and reduce the potential for cross-contamination. The procedures were in general accordance with our Safe Work Practices and Standard Operating Procedures where applicable, and adopted based on generally accepted industry practices.

SOIL SAMPLING METHODS

Soil samples were collected from boreholes at varying depth intervals using a Dutch auger. At select depth intervals, soil samples were collected and placed into laboratory-supplied containers. Applicable sample collection information was documented on field forms. Sampling equipment was decontaminated with Alconox and distilled water after each sample collection.

SURFACE WATER SAMPLING METHODS

Surface water samples were collected using dedicated laboratory supplied bottles. The bottles were lowered horizontally into the water with the mouth of the bottle intercepting the surface of the water. If dissolved metals analysis was required, samples were filtered in the laboratory. For parameters requiring preservation, the laboratory supplied bottles come precharged with preservatives.

SAMPLE HANDLING AND ANALYSIS

Samples for laboratory analyzes were placed in coolers with ice and shipped to Maxxam in Edmonton, Alberta. A chain of custody form was completed and included with each sample shipment specifying identification and the analyzes required.

QUALITY ASSURANCE / QUALITY CONTROL PROGRAM

Efforts were made during sampling to reduce the potential for sample cross contamination. Accordingly, sampling was completed using a new pair of disposable nitrile gloves for each sample and dedicated sampling bottles were used to collect water samples.

Maxxam was used for the chemical analyzes (soil and standing water). The laboratory is accredited to the International Organization for Standardization (ISO) Standard 17025 through the Standards Council of Canada.

Maxxam has QA/QC protocols for instrument calibration, laboratory duplicates, matrix spikes, method blanks, process recovery and surrogate spikes. The laboratory follows Standard Operating Procedures, including holding time limitations, sample preparation and preservation, data production and reporting. The analytical methods used are outlined in the laboratory certificates of analysis provided in Appendix G.

APPENDIX D

Reclamation Assessment Methods

Table D-1 Reclamation Assessment Methods

Site Feature	Assessment Method
Presence of wastes	• Observe and document presence of waste material features (if applicable). • Confirm location and extent of wastes using GPS • Collect photos of waste materials on site (if applicable). • Collect soil and water samples for analyzes (if applicable).
Presence of spills	• Observe and document presence of spill features. • Confirm location and extent of spills (if present) using GPS • Collect photos of spill site(s) (if applicable). • Collect soil and water samples for analyzes (if applicable).
Site topography and surface expression	• Measure slope angle and aspect of site (in degrees). • Assess and document overall surface expression of site: inclined, fan, level, undulating, rolling, steep or terraced.
Permafrost conditions	• Observe and document presence of permafrost issues on site including evidence of: cryoturbation, polygon effect, slumping, subsidence, frost heaving. • Confirm location and extent of permafrost issues using GPS. • Collect photos of permafrost issues (if applicable).
Water presence	• Observe and document location and extent of standing water on-site using GPS (if applicable). • Collect photos of standing water on-site (if applicable).
Vegetation establishment and condition	• Observe and document the vegetation species, cover and health conditions present on the Site overall. • Sample and record vegetation cover and plant species composition using 100 m^2 circular plot(s) at select locations with typical (i.e., native undisturbed or naturally re-established) vegetation. • Measure and record vegetation cover and plant species composition using 100 m^2 circular plot(s) at select locations within previously-disturbed revegetated areas (e.g., within areas disturbed by drilling operations) • Plot locations were recorded with GPS and on field diagrams • Photos of plot locations and vegetation cover.
Invasive plant (weed) presence	• Observe and document the presence of weed species within the Site. • Record the location of weed infestation (if applicable) using a GPS. Note the species present, plant growth stage, percent cover and aerial extent. • Collect photos of the weed infestation (if applicable).
Wildlife use or presence	• Record the presence of wildlife observed during the Site visit.
Erosion or drainage issues	• Observe and document the presence of any erosion/drainage issues occurring within the Site • Record the location and extent of the erosion/drainage issues using a GPS (if applicable). • Collect photos of the erosion/drainage issues (if applicable).
Erosion control methods in place	• Observe and document the presence of any erosion control structures/materials installed on site. • Assess the current condition of structures and degree of effectiveness controlling erosion. • Record the location of the erosion control methods using a GPS. • Collect photos of structure(s) and location(s) (if applicable).

APPENDIX E

Site Monitoring Report Tables

Table E-1 Active layer measurements on August 22, 2016 at the N-16 Sump Area

	Umiak N-16		
	Sump Cap	**Sump Perimeter**	**Control Transect**
Measurements collected	17	15	10
Minimum thawing depth (cm)	91	37	28
Maximum thawing depth (cm)	125	108	43
August 22, 2016 average (cm)	106	54	37
August 18, 2015 average (cm)	103	58	38
2014 average	N.A.	N.A.	N.A.
2013 average	N.A.	N.A.	N.A.
Sept 6, 2012 average (cm)	114	55	42
August 23, 2011 average (cm)	114	51	36
August 24, 2010 average (cm)	108	48	31
August 17, 2009 average (cm)	82	36	25
August 18, 2008 average (cm)	110	34	33

Table E-2 Vegetation Monitoring N-16 Wellsite and Sump Areas: Percent Ground Coverage

	Total % Cover (Individual values cannot exceed 100%, sums cannot exceed 100%):						
Site	**Seeded Grass**	**Naturally Established Native Vegetation**	**Invasive Plants**	**Bare Ground**	**Wood Debris**	**Vegetation Litter**	**Totals**
N-16 Wellsite-lightly vegetated wellhead culvert area	52	5	2	30	1	10	100
N-16 Sump-impacted vegetation area: V3-01	0	70	0	5	<1	25	100
N-16 Sump-impacted vegetation area: V2-03	0	40	0	55	0	5	100

NOTE:
Percent cover estimates are visual estimates over large scale area, not from plots.

Table E-3 Vegetation Monitoring N-16 Wellsite and Sump Areas: Species Composition Percent Cover

Species	N-16 Wellsite- lightly vegetated wellhead culvert area	N-16 Sump- impacted vegetation area: V3-01	N-16 Sump- impacted vegetation area: V2-03
violet wheatgrass (*Agropyron violaceum/Elymus alaskanus*)	15	-	-
alpine bearberry (*Arctostaphylos alpina)*	-	1	-
dwarf birch (*Betula glandulosa*)	-	5	2
sedges *(Carex sp.)*	-	5	5
tufted hairgrass (*Deschampsia caespitosa*)	37	-	-
crowberry (*Empetrum nigrum*)	-	23	5
fireweed (*Epilobium angustifolium*)	5	-	-
cottongrass (*Eriophorum sp.*)	-	5	20
cloudberry (*Rubus chamaemorus*)	-	24	3
willows (*Salix sp.*)	-	1	-
bog cranberry (*Vaccinium vitis-idaea*)	-	1	-
mosses	-	-	5
lichens	-	5	
Invasive Plants (scentless chamomile- *Tripleurospermum inodorum*)	2	0	0
Bare Ground	30	5	55
Wood Debris	1	<1	0
Vegetation Litter	10	25	5
Totals:	**100**	**100**	**100**

Table E-4 N-16 Wellsite Area: Invasive Plant Species Information

Common name	Scientific name	Area (m^2)	Percent cover (%)	Location coordinates
scentless chamomile	*Tripleurospermum inodorum*	200 (Observed individual plants and small groups of plants within native grass seeded wellhead area)	10	Latitude: 69°25’53.304” N; Longitude: 134°19’6.366” W.

APPENDIX F

Analytical Tables

Table F-1 Soil Analytical Results
Umiak N-16 Sump, Inuvialuit Settlement Region, NT

Site		Criteria		N-16 Sump									
Location Description				**Salinity Impact Assessment - North of Sump**				**Salinity Impact Assessment - South of Sump**		**Impacted Vegetation Area**		**Salinity Assessment - South of Sump**	
Sample Date				8/22/2016	8/22/2016	8/22/2016	8/22/2016	8/22/2016	8/22/2016	8/22/2016	8/22/2016	8/22/2016	8/22/2016
Sample ID	**Units**			N-16_Sump_SS1_0-0.25	N-16_Sump_SS1_0.25-0.5	N-16_Sump_SS2_0-0.25	N-16_Sump_SS2_0.25-0.5	N-16_Sump_SS3_0-0.25	N-16_Sump_SS3_0.25-0.5	N-16_Sump_SS4_0-0.25	N-16_Sump_SS4_0.25-0.5	N-16_Sump_SS5_0-0.25	N-16_Sump_SS5_0.25-0.5
Laboratory				Maxxam	Maxxam	Maxxam	Maxxam	Maxxam	Maxxam	Maxxam	Maxxam	Maxxam	Maxxam
Laboratory Work Order		**CCME**	**AEP**	B673175	B673175	B673175	B673175	B673175	B673175	B673175	B673175	B673175	B673175
Laboratory Sample ID				PJ3268	PJ3269	PJ3270	PJ3271	PJ3272	PJ3273	PJ3274	PJ3275	PJ3276	PJ3277
Sample Type				Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Depth				0 - 0.25 m	0.25 - 0.5 m	0 - 0.25 m	0 - 0.25 m	0.25 - 0.5 m	0 - 0.25 m	0.25 - 0.5 m	0 - 0.25 m	0.25 - 0.5 m	0 - 0.25 m
Calculated Parameters													
Anion Sum	meq/L	n/v	n/v	4.3	4.0	2.8	0.61	3.3	5.1	5.7	6.2	0.50	1.2
Cation Sum	meq/L	n/v	n/v	5.2	4.8	3.6	0.92	3.5	5.0	6.7	6.6	0.88	1.6
Cation/EC Ratio	N/A	n/v	n/v	9.5	9.1	9.4	7.2	7.5	7.9	8.4	8.1	7.4	9.1
Ion Balance	N/A	n/v	n/v	1.2	1.2	1.3	1.5	1.1	0.98	1.2	1.1	1.7	1.4
Calculated Calcium (Ca)	mg/kg	n/v	n/v	120	130	57	9.5	12	22	190	170	18	53
Calculated Magnesium (Mg)	mg/kg	n/v	n/v	38	38	20	2.0	5.3	9.2	54	46	<6.4	25
Calculated Sodium (Na)	mg/kg	n/v	n/v	63	88	33	22	11	14	120	140	69	96
Calculated Potassium (K)	mg/kg	n/v	n/v	7.3	25	8.5	<2.3	2.8	1.7	480	530	35	25
Calculated Chloride (Cl)	mg/kg	n/v	n/v	280	360	120	18	30	54	440	640	71	200
Calculated Sulphate (SO4)	mg/kg	n/v	n/v	92	78	64	27	33	50	710	570	59	73
Soluble Parameters													
Soluble Chloride	mg/L	n/v	n/v	120	120	72	10	65	110	93	130	11	34
Soluble Conductivity	dS/m	2[AB]	[FG]	0.55	0.52	0.39	0.13	0.47	0.64	0.79	0.82	0.12	0.18
Soluble (CaCl2) pH	pH	6-8[AB]	6-8.5[CD]	**5.39[ABCD]**	**5.24[ABCD]**	**4.60[ABCD]**	**4.52[ABCD]**	**4.29[ABCD]**	**4.28[ABCD]**	**5.06[ABCD]**	**5.07[ABCD]**	**3.87[ABCD]**	**4.18[ABCD]**
Sodium Adsorption Ratio	N/A	5[AB]	[FG]	0.85	1.0	0.73	1.2	0.98	0.90	0.92	1.2	1.8	1.1
Soluble Calcium (Ca)	mg/L	n/v	n/v	51	44	34	5.3	27	43	40	35	2.8	8.6
Soluble Magnesium (Mg)	mg/L	n/v	n/v	17	13	12	1.1	11	18	11	9.5	<1.0	4.1
Soluble Sodium (Na)	mg/L	n/v	n/v	27	30	19	12	24	28	26	30	11	16
Soluble Potassium (K)	mg/L	n/v	n/v	3.2	8.7	5.0	<1.3	6.0	3.4	100	110	5.5	4.2
Saturation %	%	n/v	n/v	230	290	170	180	46	50	470	480	640	610
Soluble Sulphate (SO4)	mg/L	n/v	n/v	40	27	38	15	73	100	150	120	9.1	12
Theoretical Gypsum Requirement	tonnes/ha	n/v	n/v	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

Notes:

CCME	Canadian Environmental Quality Guidelines, Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, on-line summary table, for Residential/Parkland land use and fine grained soil
[A]	
[B]	Canadian Environmental Quality Guidelines, Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, on-line summary table, for Residential/Parkland land use and coarse grained soil
AEP	Alberta Environment and Parks, Alberta Tier 1 Soil and Groundwater Remediation Guidelines, 2016
[C]	Table 1 - Residential/Parkland - Fine
[D]	Table 1 - Residential/Parkland - Coarse
6.5[F]	Concentration exceeds the indicated standard.
15.2	Measured concentration was less than the applicable standard.
<0.50	Laboratory reporting limit was greater than the applicable standard.
<0.03	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.
meq/L	milliequvialent per litre
mg/L	milligrams per litre
mg/kg	milligrams per kilogram
dS/m	decisiemens per metre
tonnes/ha	tonnes per hectare
-	Parameter not analyzed / not available.
N/A	Not applicable
[F]	The AEP topsoil and subsoil guidelines are divided into four rating categories for Electrical Conductivity and Sodium Absorption Ratio.

AEP ratings for top soil (A horizon)

	SAR	EC
Good	<4	<2
Fair	4 to 8	2 to 4
Poor	8 to 12	4 to 8
Unsuitable	>12	>8

[G] AEP ratings for Subsoil (B and C horizons and the upper part of any parent material

	SAR	EC
Good	<4	<3
Fair	4 to 8	3 to 5
Poor	8 to 12	5 to 10
Unsuitable	>12	>10

Table F-2 Water Analytical Results
Umiak N-16 Wellsite, Inuvialuit Settlement Region, NT

Site			N-16 Sump					
Location Description	**Units**	**Criteria**	**North of Sump**	**South of Sump**	**Reference Samples**		**Impacted Vegetation Area**	**Reference Sample**
Sample Date			22/08/2016	22/08/2016	22/08/2016	22/08/2016	22/08/2016	22/08/2016
Sample ID			N-16_Sump_W1	N-16_Sump_W4	N-16_Sump_W2	N-16_Sump_W3	N-16_Sump_W5	N-16_Sump_W6
Laboratory		**CCME PAL**	Maxxam	Maxxam	Maxxam	Maxxam	Maxxam	Maxxam
Laboratory Work Order			B673175	B673175	B673175	B673175	B673175	B673175
Laboratory Sample ID			PJ3262	PJ3265	PJ3263	PJ3264	PJ3266	PJ3267
Sample Type			Water	Water	Water	Water	Water	Water
General Chemistry								
Anion Sum	meq/L	n/v	12	38	1.4	1.4	5.6	1.9
Cation Sum	meq/L	n/v	13	42	2.2	2.9	6.2	2.6
Hardness (CaCO3)	mg/L	n/v	530	1600	86	95	160	81
Ion Balance	none	n/v	1.1	1.1	1.6	2.0	1.1	1.3
Dissolved Nitrate (NO3)	mg/L	n/v	<0.044	<0.044	<0.044	0.082	<0.044	<0.044
Nitrate plus Nitrite (N)	mg/L	n/v	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Dissolved Nitrite (NO2)	mg/L	n/v	0.053	<0.033	<0.033	<0.033	<0.033	<0.033
Total Dissolved Solids	mg/L	n/v	660	2400	84	110	350	120
Misc. Inorganics								
Conductivity	µS/cm	n/v	1200	4100	150	180	700	250
pH	S.U.	6.5-9.0[A]	7.61	**5.93[AB]**	6.63	**5.55[AB]**	6.56	**5.42[AB]**
Anions								
Alkalinity (P as CaCO3)	mg/L	n/v	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Alkalinity (Total as CaCO3)	mg/L	n/v	200	15	39	23	21	4.8
Bicarbonate (HCO3)	mg/L	n/v	250	19	48	29	25	5.9
Carbonate (CO3)	mg/L	n/v	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Hydroxide (OH)	mg/L	n/v	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dissolved Sulphate (SO4)	mg/L	n/v	110	500 (1)	<0.50	<0.50	10	<0.50
Dissolved Chloride (Cl)	mg/L	640[A]/120[B]	**190[B]**	**970 (1)[AB]**	20	34	**180[B]**	65
Nutrients								
Dissolved Nitrite (N)	mg/L	0.06[B]	0.016	<0.010	<0.010	<0.010	<0.010	<0.010
Dissolved Nitrate (N)	mg/L	550[A]/13[B]	<0.010	<0.010	<0.010	0.018	<0.010	<0.010
Dissolved Metals								
Dissolved Calcium (Ca)	mg/L	n/v	130	430	19	22	41	16
Dissolved Iron (Fe)	mg/L	0.3[A]	**1.2[A]**	**2.4[A]**	**3.1[A]**	**12[A]**	**1.6[A]**	**1.9[A]**
Dissolved Magnesium (Mg)	mg/L	n/v	48	120	9.3	9.6	13	9.8
Dissolved Manganese (Mn)	mg/L	n/v	0.83	5.8	0.085	0.43	0.20	0.078
Dissolved Potassium (K)	mg/L	n/v	29	220	0.33	0.82	71	5.0
Dissolved Sodium (Na)	mg/L	n/v	31	91	8.2	12	27	18

Notes:

CCME PAL	Canadian Council of Ministers of the Environment, Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life (PAL)
A	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Short Term
B	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term
6.5	Concentration exceeds the CCME Guideline
15.2	Measured concentration was less than the applicable standard.
<0.50	Laboratory reporting limit was greater than the applicable standard.
<0.03	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.
mg/L	milligrams per litre
meq/L	milliequvialent per litre
µg/L	micrograms per litre
µS/cm	microsiemens per centimetre
(1)	Detection limits raised due to dilution to bring analyte within the calibrated range.

APPENDIX G

Laboratory Certificate of Analysis

Maxxam
A Bureau Veritas Group Company

Success Through Science®

Your Project #: 123512163

Attention:STEPHANINE LAPKA

STANTEC CONSULTING LTD
PO BOX 1777
2nd FLOOR 4910 53 STREET
Yellowknife, NT
CANADA X1A 2P4

Report Date: 2016/11/16
Report #: R2301583
Version: 10 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B673175
Received: 2016/08/25, 10:45

Sample Matrix: Soil
Samples Received: 10

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Cation/EC Ratio	10	N/A	2016/09/03	AB WI-00065	Auto Calc
Chloride (Soluble)	10	2016/09/02	2016/09/02	AB SOP-00033 / AB SOP-00020	SM 22 4500-Cl G m
Conductivity @25C (Soluble)	10	2016/09/02	2016/09/02	AB SOP-00033 / AB SOP-00004	SM 22 2510 B m
Ion Balance	10	N/A	2016/09/03	AB WI-00065	Auto Calc
Sum of Cations, Anions	10	N/A	2016/09/03	AB WI-00065	Auto Calc
pH @25C (1:2 Calcium Chloride Extract)	6	2016/09/01	2016/09/01	AB SOP-00033 / AB SOP-00006	SM 22 4500 H+B m
pH @25C (1:2 Calcium Chloride Extract)	4	2016/09/02	2016/09/02	AB SOP-00033 / AB SOP-00006	SM 22 4500 H+B m
Sodium Adsorption Ratio	10	N/A	2016/09/03	AB WI-00065	Auto Calc
Soluble Ions	1	2016/09/01	2016/09/02	AB SOP-00033 / AB SOP-00042	EPA 200.7 CFR 2012 m
Soluble Ions	9	2016/09/02	2016/09/02	AB SOP-00033 / AB SOP-00042	EPA 200.7 CFR 2012 m
Soluble Paste	1	2016/09/01	2016/09/02	AB SOP-00033	Carter 2nd ed 15.2m
Soluble Paste	9	2016/09/02	2016/09/02	AB SOP-00033	Carter 2nd ed 15.2m
Soluble Ions Calculation	6	N/A	2016/09/01	AB WI-00065	Auto Calc
Soluble Ions Calculation	4	N/A	2016/09/02	AB WI-00065	Auto Calc
Theoretical Gypsum Requirement (1)	10	N/A	2016/09/03	AB WI-00065	Auto Calc

Sample Matrix: Water
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity @25C (pp, total), CO3,HCO3,OH	6	N/A	2016/08/27	AB SOP-00005	SM 22 2320 B m
Chloride by Automated Colourimetry	6	N/A	2016/08/30	AB SOP-00020	SM 22 4500-Cl G m
Chloride (Cl) and Sulphate (SO4) by IC	3	2016/08/30	2016/08/30	AB SOP-00026	SM 22 4110 B m
Conductivity @25C	6	N/A	2016/08/27	AB SOP-00005	SM 22 2510 B m
Hardness	6	N/A	2016/09/01	AB WI-00065	Auto Calc

Your Project #: 123512163

Attention:STEPHANINE LAPKA

STANTEC CONSULTING LTD
PO BOX 1777
2nd FLOOR 4910 53 STREET
Yellowknife, NT
CANADA X1A 2P4

Report Date: 2016/11/16
Report #: R2301583
Version: 10 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B673175
Received: 2016/08/25, 10:45

Sample Matrix: Water
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Elements by ICP-Dissolved-Lab Filtered	6	N/A	2016/08/31	AB SOP-00042	EPA 200.7 CFR 2012 m
Ion Balance	6	N/A	2016/09/01	AB WI-00065	Auto Calc
Sum of cations, anions	6	N/A	2016/09/01	AB WI-00065	Auto Calc
Nitrate and Nitrite	6	N/A	2016/08/29	AB WI-00065	Auto Calc
Nitrate + Nitrite-N (calculated)	6	N/A	2016/08/29	AB WI-00065	Auto Calc
Nitrogen, (Nitrite, Nitrate) by IC	2	N/A	2016/08/28	AB SOP-00023	SM 22 4110 B m
Nitrogen, (Nitrite, Nitrate) by IC	4	N/A	2016/08/29	AB SOP-00023	SM 22 4110 B m
pH @25°C	6	N/A	2016/08/27	AB SOP-00005	SM 22 4500 H+ B m
Sulphate by Automated Colourimetry	3	N/A	2016/08/30	AB SOP-00018	SM 22 4500-SO4 E m
Total Dissolved Solids (Calculated)	6	N/A	2016/09/01	AB WI-00065	Auto Calc

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods. Results relate to samples tested.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) TGR calculation is based on a theoretical SAR of 4. Salt Contamination and Assessment and remediation guideline 2001 recommended SAR is ranging 4-8. TGR is reported in tonnes/ha.

Your Project #: 123512163

Attention:STEPHANINE LAPKA

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PO BOX 1777
2nd FLOOR 4910 53 STREET
Yellowknife, NT
CANADA X1A 2P4

Report Date: 2016/11/16
Report #: R2301583
Version: 10 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B673175
Received: 2016/08/25, 10:45

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Wendy Sears, Project manager
Email: WSears@maxxam.ca
Phone# (403)735-2277

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B673175
Report Date: 2016/11/16

STANTEC CONSULTING LTD
Client Project #: 123512163
Sampler Initials: N/A

ROUTINE WATER - FILTERED (WATER)

Maxxam ID		PJ3262	PJ3263	PJ3264		PJ3265		
Sampling Date		2016/08/22	2016/08/22	2016/08/22		2016/08/22		
	UNITS	N-16_SUMP_W1	N-16_SUMP_W2	N-16_SUMP_W3	RDL	N-16_SUMP_W4	RDL	QC Batch
Calculated Parameters								
Anion Sum	meq/L	12	1.4	1.4	N/A	38	N/A	8378848
Cation Sum	meq/L	13	2.2	2.9	N/A	42	N/A	8378848
Hardness (CaCO3)	mg/L	530	86	95	0.50	1600	0.50	8378844
Ion Balance	N/A	1.1	1.6	2.0	0.010	1.1	0.010	8378845
Dissolved Nitrate (NO3)	mg/L	<0.044	<0.044	0.082	0.044	<0.044	0.044	8378852
Nitrate plus Nitrite (N)	mg/L	<0.020	<0.020	<0.020	0.020	<0.020	0.020	8378853
Dissolved Nitrite (NO2)	mg/L	0.053	<0.033	<0.033	0.033	<0.033	0.033	8378852
Calculated Total Dissolved Solids	mg/L	660	84	110	10	2400	10	8378860
Misc. Inorganics								
Conductivity	uS/cm	1200	150	180	1.0	4100	1.0	8379041
pH	pH	7.61	6.63	5.55	N/A	5.93	N/A	8379019
Anions								
Alkalinity (PP as CaCO3)	mg/L	<0.50	<0.50	<0.50	0.50	<0.50	0.50	8379039
Alkalinity (Total as CaCO3)	mg/L	200	39	23	0.50	15	0.50	8379039
Bicarbonate (HCO3)	mg/L	250	48	29	0.50	19	0.50	8379039
Carbonate (CO3)	mg/L	<0.50	<0.50	<0.50	0.50	<0.50	0.50	8379039
Hydroxide (OH)	mg/L	<0.50	<0.50	<0.50	0.50	<0.50	0.50	8379039
Dissolved Sulphate (SO4)	mg/L	110	N/A	N/A	1.0	500 (1)	5.0	8379469
Dissolved Chloride (Cl)	mg/L	190	20	34	1.0	970 (1)	5.0	8379467
Nutrients								
Dissolved Nitrite (N)	mg/L	0.016	<0.010	<0.010	0.010	<0.010	0.010	8379755
Dissolved Nitrate (N)	mg/L	<0.010	<0.010	0.018	0.010	<0.010	0.010	8379755
Lab Filtered Elements								
Dissolved Calcium (Ca)	mg/L	130	19	22	0.30	430	0.30	8383275
Dissolved Iron (Fe)	mg/L	1.2	3.1	12	0.060	2.4	0.060	8383275
Dissolved Magnesium (Mg)	mg/L	48	9.3	9.6	0.20	120	0.20	8383275
Dissolved Manganese (Mn)	mg/L	0.83	0.085	0.43	0.0040	5.8	0.0040	8383275
Dissolved Potassium (K)	mg/L	29	0.33	0.82	0.30	220	0.30	8383275
Dissolved Sodium (Na)	mg/L	31	8.2	12	0.50	91	0.50	8383275

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

Maxxam Analytics International Corporation o/a Maxxam Analytics Edmonton: 9331 - 48th Street T6B 2R4 Telephone (780)577-7100 Fax (780)450-4187

Maxxam Job #: B673175
Report Date: 2016/11/16

STANTEC CONSULTING LTD
Client Project #: 123512163
Sampler Initials: N/A

ROUTINE WATER - FILTERED (WATER)

Maxxam ID		PJ3266		PJ3267		
Sampling Date		2016/08/22		2016/08/22		
	UNITS	N-16_SUMP_W5	QC Batch	N-16_SUMP_W6	RDL	QC Batch
Calculated Parameters						
Anion Sum	meq/L	5.6	8378848	1.9	N/A	8378848
Cation Sum	meq/L	6.2	8378848	2.6	N/A	8378848
Hardness (CaCO3)	mg/L	160	8378844	81	0.50	8378844
Ion Balance	N/A	1.1	8378845	1.3	0.010	8378845
Dissolved Nitrate (NO3)	mg/L	<0.044	8378852	<0.044	0.044	8378852
Nitrate plus Nitrite (N)	mg/L	<0.020	8378853	<0.020	0.020	8378853
Dissolved Nitrite (NO2)	mg/L	<0.033	8378852	<0.033	0.033	8378852
Calculated Total Dissolved Solids	mg/L	350	8378860	120	10	8378860
Misc. Inorganics						
Conductivity	uS/cm	700	8379041	250	1.0	8379386
pH	pH	6.56	8379019	5.42	N/A	8379383
Anions						
Alkalinity (PP as CaCO3)	mg/L	<0.50	8379039	<0.50	0.50	8379385
Alkalinity (Total as CaCO3)	mg/L	21	8379039	4.8	0.50	8379385
Bicarbonate (HCO3)	mg/L	25	8379039	5.9	0.50	8379385
Carbonate (CO3)	mg/L	<0.50	8379039	<0.50	0.50	8379385
Hydroxide (OH)	mg/L	<0.50	8379039	<0.50	0.50	8379385
Dissolved Sulphate (SO4)	mg/L	10	8379469	N/A	1.0	N/A
Dissolved Chloride (Cl)	mg/L	180	8379467	65	1.0	8379467
Nutrients						
Dissolved Nitrite (N)	mg/L	<0.010	8379755	<0.010	0.010	8379755
Dissolved Nitrate (N)	mg/L	<0.010	8379755	<0.010	0.010	8379755
Lab Filtered Elements						
Dissolved Calcium (Ca)	mg/L	41	8383275	16	0.30	8383275
Dissolved Iron (Fe)	mg/L	1.6	8383275	1.9	0.060	8383275
Dissolved Magnesium (Mg)	mg/L	13	8383275	9.8	0.20	8383275
Dissolved Manganese (Mn)	mg/L	0.20	8383275	0.078	0.0040	8383275
Dissolved Potassium (K)	mg/L	71	8383275	5.0	0.30	8383275
Dissolved Sodium (Na)	mg/L	27	8383275	18	0.50	8383275

RDL = Reportable Detection Limit
N/A = Not Applicable

Maxxam Analytics International Corporation o/a Maxxam Analytics Edmonton: 9331 - 48th Street T6B 2R4 Telephone (780)577-7100 Fax (780)450-4187

Maxxam Job #: B673175
Report Date: 2016/11/16

STANTEC CONSULTING LTD
Client Project #: 123512163
Sampler Initials: N/A

SOIL SALINITY 4 (SOIL)

Maxxam ID		PJ3268			PJ3269		
Sampling Date		2016/08/22			2016/08/22		
	UNITS	N-16_SUMP_SS1_0-0.25	RDL	QC Batch	N-16_SUMP_SS1_0.25-0.5	RDL	QC Batch
Calculated Parameters							
Anion Sum	meq/L	4.3	N/A	8378850	4.0	N/A	8378850
Cation Sum	meq/L	5.2	N/A	8378850	4.8	N/A	8378850
Cation/EC Ratio	N/A	9.5	0.10	8378835	9.1	0.10	8378835
Ion Balance	N/A	1.2	0.010	8378847	1.2	0.010	8378847
Calculated Calcium (Ca)	mg/kg	120	3.5	8378858	130	4.4	8378858
Calculated Magnesium (Mg)	mg/kg	38	2.3	8378858	38	2.9	8378858
Calculated Sodium (Na)	mg/kg	63	5.8	8378858	88	7.3	8378858
Calculated Potassium (K)	mg/kg	7.3	3.0	8378858	25	3.8	8378858
Calculated Chloride (Cl)	mg/kg	280	12	8378858	360	15	8378858
Calculated Sulphate (SO4)	mg/kg	92	12	8378858	78	15	8378858
Soluble Parameters							
Soluble Chloride (Cl)	mg/L	120	5.0	8386632	120	5.0	8386632
Soluble Conductivity	dS/m	0.55	0.020	8386271	0.52	0.020	8386271
Soluble (CaCl2) pH	pH	5.39	N/A	8384889	5.24	N/A	8385638
Sodium Adsorption Ratio	N/A	0.85	0.10	8378855	1.0	0.10	8378855
Soluble Calcium (Ca)	mg/L	51	1.5	8386603	44	1.5	8386603
Soluble Magnesium (Mg)	mg/L	17	1.0	8386603	13	1.0	8386603
Soluble Sodium (Na)	mg/L	27	2.5	8386603	30	2.5	8386603
Soluble Potassium (K)	mg/L	3.2	1.3	8386603	8.7	1.3	8386603
Saturation %	%	230	N/A	8385796	290	N/A	8385796
Soluble Sulphate (SO4)	mg/L	40	5.0	8386603	27	5.0	8386603
Theoretical Gypsum Requirement	tonnes/ha	<0.20	0.20	8378863	<0.20	0.20	8378863

RDL = Reportable Detection Limit
N/A = Not Applicable

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STANTEC CONSULTING LTD
Client Project #: 123512163
Sampler Initials: N/A

SOIL SALINITY 4 (SOIL)

Maxxam ID		PJ3270		PJ3271		
Sampling Date		2016/08/22		2016/08/22		
	UNITS	N-16_SUMP_SS2_0-0.25	RDL	N-16_SUMP_SS2_0.25-0.5	RDL	QC Batch
Calculated Parameters						
Anion Sum	meq/L	2.8	N/A	0.61	N/A	8378850
Cation Sum	meq/L	3.6	N/A	0.92	N/A	8378850
Cation/EC Ratio	N/A	9.4	0.10	7.2	0.10	8378835
Ion Balance	N/A	1.3	0.010	1.5	0.010	8378847
Calculated Calcium (Ca)	mg/kg	57	2.5	9.5	2.7	8378858
Calculated Magnesium (Mg)	mg/kg	20	1.7	2.0	1.8	8378858
Calculated Sodium (Na)	mg/kg	33	4.2	22	4.5	8378858
Calculated Potassium (K)	mg/kg	8.5	2.2	<2.3	2.3	8378858
Calculated Chloride (Cl)	mg/kg	120	8.5	18	8.9	8378858
Calculated Sulphate (SO4)	mg/kg	64	8.5	27	8.9	8378858
Soluble Parameters						
Soluble Chloride (Cl)	mg/L	72	5.0	10	5.0	8386632
Soluble Conductivity	dS/m	0.39	0.020	0.13	0.020	8386271
Soluble (CaCl2) pH	pH	4.60	N/A	4.52	N/A	8385638
Sodium Adsorption Ratio	N/A	0.73	0.10	1.2	0.10	8378855
Soluble Calcium (Ca)	mg/L	34	1.5	5.3	1.5	8386603
Soluble Magnesium (Mg)	mg/L	12	1.0	1.1	1.0	8386603
Soluble Sodium (Na)	mg/L	19	2.5	12	2.5	8386603
Soluble Potassium (K)	mg/L	5.0	1.3	<1.3	1.3	8386603
Saturation %	%	170	N/A	180	N/A	8385796
Soluble Sulphate (SO4)	mg/L	38	5.0	15	5.0	8386603
Theoretical Gypsum Requirement	tonnes/ha	<0.20	0.20	<0.20	0.20	8378863

RDL = Reportable Detection Limit
N/A = Not Applicable

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STANTEC CONSULTING LTD
Client Project #: 123512163
Sampler Initials: N/A

SOIL SALINITY 4 (SOIL)

Maxxam ID		PJ3272			PJ3273		
Sampling Date		2016/08/22			2016/08/22		
	UNITS	N-16_SUMP_SS3_0-0.25	RDL	QC Batch	N-16_SUMP_SS3_0.25-0.5	RDL	QC Batch
Calculated Parameters							
Anion Sum	meq/L	3.3	N/A	8378850	5.1	N/A	8378850
Cation Sum	meq/L	3.5	N/A	8378850	5.0	N/A	8378850
Cation/EC Ratio	N/A	7.5	0.10	8378835	7.9	0.10	8378835
Ion Balance	N/A	1.1	0.010	8378847	0.98	0.010	8378847
Calculated Calcium (Ca)	mg/kg	12	0.69	8378858	22	0.75	8378859
Calculated Magnesium (Mg)	mg/kg	5.3	0.46	8378858	9.2	0.50	8378859
Calculated Sodium (Na)	mg/kg	11	1.2	8378858	14	1.3	8378859
Calculated Potassium (K)	mg/kg	2.8	0.60	8378858	1.7	0.65	8378859
Calculated Chloride (Cl)	mg/kg	30	2.3	8378858	54	2.5	8378859
Calculated Sulphate (SO4)	mg/kg	33	2.3	8378858	50	2.5	8378859
Soluble Parameters							
Soluble Chloride (Cl)	mg/L	65	5.0	8386632	110	5.0	8386137
Soluble Conductivity	dS/m	0.47	0.020	8386271	0.64	0.020	8385241
Soluble (CaCl2) pH	pH	4.29	N/A	8385638	4.28	N/A	8384375
Sodium Adsorption Ratio	N/A	0.98	0.10	8378855	0.90	0.10	8378856
Soluble Calcium (Ca)	mg/L	27	1.5	8386603	43	1.5	8386066
Soluble Magnesium (Mg)	mg/L	11	1.0	8386603	18	1.0	8386066
Soluble Sodium (Na)	mg/L	24	2.5	8386603	28	2.5	8386066
Soluble Potassium (K)	mg/L	6.0	1.3	8386603	3.4	1.3	8386066
Saturation %	%	46	N/A	8385796	50	N/A	8384559
Soluble Sulphate (SO4)	mg/L	73	5.0	8386603	100	5.0	8386066
Theoretical Gypsum Requirement	tonnes/ha	<0.20	0.20	8378863	<0.20	0.20	8378863

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Sampler Initials: N/A

SOIL SALINITY 4 (SOIL)

Maxxam ID		PJ3274		PJ3275		
Sampling Date		2016/08/22		2016/08/22		
	UNITS	N-16_SUMP_SS4_0-0.25	RDL	N-16_SUMP_SS4_0.25-0.5	RDL	QC Batch
Calculated Parameters						
Anion Sum	meq/L	5.7	N/A	6.2	N/A	8378850
Cation Sum	meq/L	6.7	N/A	6.6	N/A	8378850
Cation/EC Ratio	N/A	8.4	0.10	8.1	0.10	8378835
Ion Balance	N/A	1.2	0.010	1.1	0.010	8378847
Calculated Calcium (Ca)	mg/kg	190	7.1	170	7.2	8378859
Calculated Magnesium (Mg)	mg/kg	54	4.7	46	4.8	8378859
Calculated Sodium (Na)	mg/kg	120	12	140	12	8378859
Calculated Potassium (K)	mg/kg	480	6.2	530	6.3	8378859
Calculated Chloride (Cl)	mg/kg	440	24	640	24	8378859
Calculated Sulphate (SO4)	mg/kg	710	24	570	24	8378859
Soluble Parameters						
Soluble Chloride (Cl)	mg/L	93	5.0	130	5.0	8386632
Soluble Conductivity	dS/m	0.79	0.020	0.82	0.020	8386271
Soluble (CaCl2) pH	pH	5.06	N/A	5.07	N/A	8384889
Sodium Adsorption Ratio	N/A	0.92	0.10	1.2	0.10	8378856
Soluble Calcium (Ca)	mg/L	40	1.5	35	1.5	8386603
Soluble Magnesium (Mg)	mg/L	11	1.0	9.5	1.0	8386603
Soluble Sodium (Na)	mg/L	26	2.5	30	2.5	8386603
Soluble Potassium (K)	mg/L	100	1.3	110	1.3	8386603
Saturation %	%	470	N/A	480	N/A	8385796
Soluble Sulphate (SO4)	mg/L	150	5.0	120	5.0	8386603
Theoretical Gypsum Requirement	tonnes/ha	<0.20	0.20	<0.20	0.20	8378863

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Sampler Initials: N/A

SOIL SALINITY 4 (SOIL)

Maxxam ID		PJ3276		PJ3277		
Sampling Date		2016/08/22		2016/08/22		
	UNITS	N-16_SUMP_SS5_0-0.25	RDL	N-16_SUMP_SS5_0.25-0.5	RDL	QC Batch
Calculated Parameters						
Anion Sum	meq/L	0.50	N/A	1.2	N/A	8378850
Cation Sum	meq/L	0.88	N/A	1.6	N/A	8378850
Cation/EC Ratio	N/A	7.4	0.10	9.1	0.10	8378835
Ion Balance	N/A	1.7	0.010	1.4	0.010	8378847
Calculated Calcium (Ca)	mg/kg	18	9.7	53	9.2	8378859
Calculated Magnesium (Mg)	mg/kg	<6.4	6.4	25	6.1	8378859
Calculated Sodium (Na)	mg/kg	69	16	96	15	8378859
Calculated Potassium (K)	mg/kg	35	8.4	25	7.9	8378859
Calculated Chloride (Cl)	mg/kg	71	32	200	31	8378859
Calculated Sulphate (SO4)	mg/kg	59	32	73	31	8378859
Soluble Parameters						
Soluble Chloride (Cl)	mg/L	11	5.0	34	5.0	8386632
Soluble Conductivity	dS/m	0.12	0.020	0.18	0.020	8386271
Soluble (CaCl2) pH	pH	3.87	N/A	4.18	N/A	8384889
Sodium Adsorption Ratio	N/A	1.8	0.10	1.1	0.10	8378856
Soluble Calcium (Ca)	mg/L	2.8	1.5	8.6	1.5	8386603
Soluble Magnesium (Mg)	mg/L	<1.0	1.0	4.1	1.0	8386603
Soluble Sodium (Na)	mg/L	11	2.5	16	2.5	8386603
Soluble Potassium (K)	mg/L	5.5	1.3	4.2	1.3	8386603
Saturation %	%	640	N/A	610	N/A	8385796
Soluble Sulphate (SO4)	mg/L	9.1	5.0	12	5.0	8386603
Theoretical Gypsum Requirement	tonnes/ha	<0.20	0.20	<0.20	0.20	8378863

RDL = Reportable Detection Limit
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RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		PJ3263	PJ3264	PJ3267		
Sampling Date		2016/08/22	2016/08/22	2016/08/22		
	UNITS	N-16_SUMP_W2	N-16_SUMP_W3	N-16_SUMP_W6	RDL	QC Batch
Anions						
Dissolved Sulphate (SO4)	mg/L	<0.50	<0.50	<0.50	0.50	8382164
RDL = Reportable Detection Limit						

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STANTEC CONSULTING LTD
Client Project #: 123512163
Sampler Initials: N/A

GENERAL COMMENTS

As per client request, this report contains data for site N16 only. The client request was received 2016/11/14.

Maxxam Analytics Disclaimer

HYDROCARBON RESEMBLANCE
The reported hydrocarbon resemblance was obtained by visual comparison of the sample chromatogram with a library of reference product chromatograms. Since variables such as the degree and type of weathering and the presence of non-petrogenic hydrocarbons cannot be duplicated in reference spectra, the resemblance information must be regarded as approximate and qualitative and as such, Maxxam can assume no liability for any conclusions drawn from these data.

CHROMATOGRAM PROVISION
The chromatograms are provided for information purposes only. Any conclusion drawn by the data user from these chromatograms is their sole responsibility. Maxxam can assume no liability for any such 3rd-party interpretations and is responsible only for the quality of the quantitative data provided.

Sample PJ3263 [N-16_SUMP_W2] : Cation anion balance exceeds normal acceptance limits, due to the low concentrations of ions being measured.

Sample PJ3264 [N-16_SUMP_W3] : Cation anion balance exceeds normal acceptance limits, due to the low concentrations of ions being measured.

Sample PJ3267 [N-16_SUMP_W6] : Cation anion balance exceeds normal acceptance limits, due to the low concentrations of ions being measured.

Results relate only to the items tested.

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Client Project #: 123512163
Sampler Initials: N/A

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8379019	CH7	Spiked Blank	pH	2016/08/27		100	%	97 - 103
8379019	CH7	RPD	pH	2016/08/27	0.74		%	N/A
8379039	CH7	Spiked Blank	Alkalinity (Total as CaCO3)	2016/08/27		99	%	80 - 120
8379039	CH7	Method Blank	Alkalinity (PP as CaCO3)	2016/08/27	<0.50		mg/L	
			Alkalinity (Total as CaCO3)	2016/08/27	<0.50		mg/L	
			Bicarbonate (HCO3)	2016/08/27	<0.50		mg/L	
			Carbonate (CO3)	2016/08/27	<0.50		mg/L	
			Hydroxide (OH)	2016/08/27	<0.50		mg/L	
8379039	CH7	RPD	Alkalinity (PP as CaCO3)	2016/08/27	NC		%	20
			Alkalinity (Total as CaCO3)	2016/08/27	NC		%	20
			Bicarbonate (HCO3)	2016/08/27	NC		%	20
			Carbonate (CO3)	2016/08/27	NC		%	20
			Hydroxide (OH)	2016/08/27	NC		%	20
8379041	CH7	Spiked Blank	Conductivity	2016/08/27		101	%	90 - 110
8379041	CH7	Method Blank	Conductivity	2016/08/27	1.3, RDL=1.0		uS/cm	
8379041	CH7	RPD	Conductivity	2016/08/27	NC		%	20
8379383	CH7	Spiked Blank	pH	2016/08/27		100	%	97 - 103
8379383	CH7	RPD [PJ3208-01]	pH	2016/08/27	0.53		%	N/A
8379385	CH7	Spiked Blank	Alkalinity (Total as CaCO3)	2016/08/27		99	%	80 - 120
8379385	CH7	Method Blank	Alkalinity (PP as CaCO3)	2016/08/27	<0.50		mg/L	
			Alkalinity (Total as CaCO3)	2016/08/27	<0.50		mg/L	
			Bicarbonate (HCO3)	2016/08/27	<0.50		mg/L	
			Carbonate (CO3)	2016/08/27	<0.50		mg/L	
			Hydroxide (OH)	2016/08/27	<0.50		mg/L	
8379385	CH7	RPD [PJ3208-01]	Alkalinity (PP as CaCO3)	2016/08/27	NC		%	20
			Alkalinity (Total as CaCO3)	2016/08/27	3.2		%	20
			Bicarbonate (HCO3)	2016/08/27	3.2		%	20
			Carbonate (CO3)	2016/08/27	NC		%	20
			Hydroxide (OH)	2016/08/27	NC		%	20
8379386	CH7	Spiked Blank	Conductivity	2016/08/27		99	%	90 - 110
8379386	CH7	Method Blank	Conductivity	2016/08/27	<1.0		uS/cm	
8379386	CH7	RPD [PJ3208-01]	Conductivity	2016/08/27	0.085		%	20
8379467	KD5	Matrix Spike [PJ3204-01]	Dissolved Chloride (Cl)	2016/08/30		NC	%	80 - 120
8379467	KD5	Spiked Blank	Dissolved Chloride (Cl)	2016/08/30		101	%	80 - 120
8379467	KD5	Method Blank	Dissolved Chloride (Cl)	2016/08/30	<1.0		mg/L	
8379467	KD5	RPD [PJ3204-01]	Dissolved Chloride (Cl)	2016/08/30	2.3		%	20
8379469	KD5	Matrix Spike [PJ3204-01]	Dissolved Sulphate (SO4)	2016/08/30		NC	%	80 - 120
8379469	KD5	Spiked Blank	Dissolved Sulphate (SO4)	2016/08/30		106	%	80 - 120
8379469	KD5	Method Blank	Dissolved Sulphate (SO4)	2016/08/30	<1.0		mg/L	
8379469	KD5	RPD [PJ3204-01]	Dissolved Sulphate (SO4)	2016/08/30	1.5		%	20
8379755	LMD	Matrix Spike [PJ3142-01]	Dissolved Nitrite (N)	2016/08/28		104	%	80 - 120
			Dissolved Nitrate (N)	2016/08/28		104	%	80 - 120
8379755	LMD	Spiked Blank	Dissolved Nitrite (N)	2016/08/28		101	%	80 - 120
			Dissolved Nitrate (N)	2016/08/28		101	%	80 - 120
8379755	LMD	Method Blank	Dissolved Nitrite (N)	2016/08/28	<0.010		mg/L	
			Dissolved Nitrate (N)	2016/08/28	<0.010		mg/L	
8379755	LMD	RPD [PJ3142-01]	Dissolved Nitrite (N)	2016/08/28	NC		%	20
			Dissolved Nitrate (N)	2016/08/28	NC		%	20
8382164	LMD	Matrix Spike	Dissolved Sulphate (SO4)	2016/08/30		100	%	80 - 120
8382164	LMD	Spiked Blank	Dissolved Sulphate (SO4)	2016/08/30		100	%	80 - 120
8382164	LMD	Method Blank	Dissolved Sulphate (SO4)	2016/08/30	<0.50		mg/L	
8382164	LMD	RPD	Dissolved Sulphate (SO4)	2016/08/30	NC		%	20

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Sampler Initials: N/A

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8383275	PM5	Matrix Spike	Dissolved Calcium (Ca)	2016/08/31		NC	%	80 - 120
			Dissolved Iron (Fe)	2016/08/31		106	%	80 - 120
			Dissolved Magnesium (Mg)	2016/08/31		101	%	80 - 120
			Dissolved Manganese (Mn)	2016/08/31		NC	%	80 - 120
			Dissolved Potassium (K)	2016/08/31		104	%	80 - 120
			Dissolved Sodium (Na)	2016/08/31		99	%	80 - 120
8383275	PM5	Spiked Blank	Dissolved Calcium (Ca)	2016/08/31		99	%	80 - 120
			Dissolved Iron (Fe)	2016/08/31		101	%	80 - 120
			Dissolved Magnesium (Mg)	2016/08/31		101	%	80 - 120
			Dissolved Manganese (Mn)	2016/08/31		99	%	80 - 120
			Dissolved Potassium (K)	2016/08/31		101	%	80 - 120
			Dissolved Sodium (Na)	2016/08/31		97	%	80 - 120
8383275	PM5	Method Blank	Dissolved Calcium (Ca)	2016/08/31	<0.30		mg/L	
			Dissolved Iron (Fe)	2016/08/31	<0.060		mg/L	
			Dissolved Magnesium (Mg)	2016/08/31	<0.20		mg/L	
			Dissolved Manganese (Mn)	2016/08/31	<0.0040		mg/L	
			Dissolved Potassium (K)	2016/08/31	<0.30		mg/L	
			Dissolved Sodium (Na)	2016/08/31	<0.50		mg/L	
8383275	PM5	RPD	Dissolved Calcium (Ca)	2016/08/31	0.30		%	20
			Dissolved Iron (Fe)	2016/08/31	NC		%	20
			Dissolved Magnesium (Mg)	2016/08/31	0.49		%	20
			Dissolved Manganese (Mn)	2016/08/31	0.0073		%	20
			Dissolved Potassium (K)	2016/08/31	0.26		%	20
			Dissolved Sodium (Na)	2016/08/31	0.91		%	20
8384375	VP7	QC Standard	Soluble (CaCl2) pH	2016/09/01		101	%	97 - 103
8384375	VP7	Spiked Blank	Soluble (CaCl2) pH	2016/09/01		100	%	97 - 103
8384375	VP7	RPD [PJ3135-01]	Soluble (CaCl2) pH	2016/09/01	2.6		%	N/A
8384559	LX	QC Standard	Saturation %	2016/09/02		102	%	89 - 111
8384559	LX	RPD [PJ3025-01]	Saturation %	2016/09/02	1.7		%	12
8384889	BJO	QC Standard	Soluble (CaCl2) pH	2016/09/01		100	%	97 - 103
8384889	BJO	Spiked Blank	Soluble (CaCl2) pH	2016/09/01		101	%	97 - 103
8384889	BJO	RPD [PJ3021-01]	Soluble (CaCl2) pH	2016/09/01	0.69		%	N/A
8385241	BJO	QC Standard	Soluble Conductivity	2016/09/02		103	%	84 - 116
8385241	BJO	Spiked Blank	Soluble Conductivity	2016/09/02		102	%	90 - 110
8385241	BJO	Method Blank	Soluble Conductivity	2016/09/02	<0.020		dS/m	
8385241	BJO	RPD [PJ3025-01]	Soluble Conductivity	2016/09/02	4.9		%	35
8385638	BJO	QC Standard	Soluble (CaCl2) pH	2016/09/02		100	%	97 - 103
8385638	BJO	Spiked Blank	Soluble (CaCl2) pH	2016/09/02		100	%	97 - 103
8385638	BJO	RPD	Soluble (CaCl2) pH	2016/09/02	0.13		%	N/A
8385796	LX	QC Standard	Saturation %	2016/09/02		100	%	89 - 111
8385796	LX	RPD [PJ3024-01]	Saturation %	2016/09/02	1.9		%	12
8386066	PM5	Matrix Spike [PJ3025-01]	Soluble Calcium (Ca)	2016/09/02		NC	%	75 - 125
			Soluble Magnesium (Mg)	2016/09/02		100	%	75 - 125
			Soluble Sodium (Na)	2016/09/02		97	%	75 - 125
			Soluble Potassium (K)	2016/09/02		100	%	75 - 125
8386066	PM5	QC Standard	Soluble Calcium (Ca)	2016/09/02		102	%	75 - 125
			Soluble Magnesium (Mg)	2016/09/02		104	%	75 - 125
			Soluble Sodium (Na)	2016/09/02		103	%	75 - 125
			Soluble Potassium (K)	2016/09/02		87	%	75 - 125
			Soluble Sulphate (SO4)	2016/09/02		108	%	75 - 125
8386066	PM5	Spiked Blank	Soluble Calcium (Ca)	2016/09/02		97	%	75 - 125
			Soluble Magnesium (Mg)	2016/09/02		104	%	75 - 125
			Soluble Sodium (Na)	2016/09/02		105	%	75 - 125

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Maxxam Job #: B673175
Report Date: 2016/11/16

STANTEC CONSULTING LTD
Client Project #: 123512163
Sampler Initials: N/A

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Soluble Potassium (K)	2016/09/02		103	%	75 - 125
8386066	PM5	Method Blank	Soluble Calcium (Ca)	2016/09/02	<1.5		mg/L	
			Soluble Magnesium (Mg)	2016/09/02	<1.0		mg/L	
			Soluble Sodium (Na)	2016/09/02	<2.5		mg/L	
			Soluble Potassium (K)	2016/09/02	<1.3		mg/L	
			Soluble Sulphate (SO4)	2016/09/02	<5.0		mg/L	
8386066	PM5	RPD [PJ3025-01]	Soluble Calcium (Ca)	2016/09/02	8.0		%	35
			Soluble Magnesium (Mg)	2016/09/02	7.7		%	35
			Soluble Sodium (Na)	2016/09/02	6.3		%	35
			Soluble Potassium (K)	2016/09/02	6.4		%	35
			Soluble Sulphate (SO4)	2016/09/02	6.9		%	35
8386137	KD5	Matrix Spike [PJ3025-01]	Soluble Chloride (Cl)	2016/09/02		NC	%	75 - 125
8386137	KD5	QC Standard	Soluble Chloride (Cl)	2016/09/02		102	%	75 - 125
8386137	KD5	Spiked Blank	Soluble Chloride (Cl)	2016/09/02		106	%	75 - 125
8386137	KD5	Method Blank	Soluble Chloride (Cl)	2016/09/02	<5.0		mg/L	
8386137	KD5	RPD [PJ3025-01]	Soluble Chloride (Cl)	2016/09/02	15		%	35
8386271	BJO	QC Standard	Soluble Conductivity	2016/09/02		89	%	84 - 116
8386271	BJO	Spiked Blank	Soluble Conductivity	2016/09/02		101	%	90 - 110
8386271	BJO	Method Blank	Soluble Conductivity	2016/09/02	<0.020		dS/m	
8386271	BJO	RPD [PJ3024-01]	Soluble Conductivity	2016/09/02	11		%	35
8386603	PM5	Matrix Spike [PJ3024-01]	Soluble Calcium (Ca)	2016/09/02		NC	%	75 - 125
			Soluble Magnesium (Mg)	2016/09/02		106	%	75 - 125
			Soluble Sodium (Na)	2016/09/02		103	%	75 - 125
			Soluble Potassium (K)	2016/09/02		105	%	75 - 125
8386603	PM5	QC Standard	Soluble Calcium (Ca)	2016/09/02		82	%	75 - 125
			Soluble Magnesium (Mg)	2016/09/02		88	%	75 - 125
			Soluble Sodium (Na)	2016/09/02		97	%	75 - 125
			Soluble Potassium (K)	2016/09/02		90	%	75 - 125
			Soluble Sulphate (SO4)	2016/09/02		89	%	75 - 125
8386603	PM5	Spiked Blank	Soluble Calcium (Ca)	2016/09/02		97	%	75 - 125
			Soluble Magnesium (Mg)	2016/09/02		106	%	75 - 125
			Soluble Sodium (Na)	2016/09/02		105	%	75 - 125
			Soluble Potassium (K)	2016/09/02		104	%	75 - 125
8386603	PM5	Method Blank	Soluble Calcium (Ca)	2016/09/02	<1.5		mg/L	
			Soluble Magnesium (Mg)	2016/09/02	<1.0		mg/L	
			Soluble Sodium (Na)	2016/09/02	<2.5		mg/L	
			Soluble Potassium (K)	2016/09/02	<1.3		mg/L	
			Soluble Sulphate (SO4)	2016/09/02	<5.0		mg/L	
8386603	PM5	RPD [PJ3024-01]	Soluble Calcium (Ca)	2016/09/02	13		%	35
			Soluble Magnesium (Mg)	2016/09/02	12		%	35
			Soluble Sodium (Na)	2016/09/02	11		%	35
			Soluble Potassium (K)	2016/09/02	4.1		%	35
			Soluble Sulphate (SO4)	2016/09/02	13		%	35
8386632	KD5	Matrix Spike [PJ3024-01]	Soluble Chloride (Cl)	2016/09/02		NC	%	75 - 125
8386632	KD5	QC Standard	Soluble Chloride (Cl)	2016/09/02		92	%	75 - 125
8386632	KD5	Spiked Blank	Soluble Chloride (Cl)	2016/09/02		98	%	75 - 125
8386632	KD5	Method Blank	Soluble Chloride (Cl)	2016/09/02	<5.0		mg/L	

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Maxxam Job #: B673175
Report Date: 2016/11/16

STANTEC CONSULTING LTD
Client Project #: 123512163
Sampler Initials: N/A

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8386632	KD5	RPD [PJ3024-01]	Soluble Chloride (Cl)	2016/09/02	9.4		%	35

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

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Maxxam Job #: B673175
Report Date: 2016/11/16

STANTEC CONSULTING LTD
Client Project #: 123512163
Sampler Initials: N/A

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Suwan Fock, B.Sc., QP, Inorganics Senior Analyst

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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ADDITIONAL COOLER TEMPERATURE RECORD

CHAIN-OF-CUSTODY RECORD

CHAIN OF CUSTODY #	
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COOLER OBSERVATIONS:

MAXXAM JOB#:

COOLER ID	CUSTODY SEAL PRESENT (YES / NO)	CUSTODY SEAL INTACT (YES / NO)	ICE PRESENT (YES / NO)	TEMP 1	TEMP 2	TEMP 3
W	✓ /	✓ /	✓ /	2	1	1
R	✓ /	✓ /	✓ /	1	2	0
5	✓ /	✓ /	✓ /	0	1	1
W	✓ /	✓ /	✓ /	1	1	0
R	✓ /	✓ /	✓ /	-1	-1	0

COOLER ID	CUSTODY SEAL PRESENT (YES / NO)	CUSTODY SEAL INTACT (YES / NO)	ICE PRESENT (YES / NO)	TEMP 1	TEMP 2	TEMP 3

RECEIVED BY (SIGN & PRINT)		DATE (YYYY/MM/DD)	TIME (HH:MM)
	Jenna Walter	20160826	1146

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CHAIN OF CUSTODY RECORD

1281(5)

Invoice Information		Report Information (if differs from invoice)		Project Information		Turnaround Time (TAT) Required	
Company :	Stantec	Company:		Quotation #:		[x] 5 - 7 Days Regular (Most analyses)	
Contact Name:	Stephanie Lapka	Contact Name:		P.O. #/ AFE#:		PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS	
Address:	HOLD FOR ANALYSIS INSTRUCTION	Address:		Project #:		Rush TAT (Surcharges will be applied)	
Phone:	403-750-2447	Phone:		Site Location:		[ ] Same Day [ ] 2 Days [ ] 1 Day [ ] 3-4 Days	
Email:	stephanie.lapka@stantec.com	Email:		Site #:		Date Required:	
Copies:		Copies:		Sampled By:		Rush Confirmation #:	

Laboratory Use Only

	YES	NO	Cooler ID	Temp
Seal Present				
Seal Intact				
Cooling Media				
	YES	NO	Cooler ID	Temp
Seal Present				
Seal Intact				
Cooling Media				
	YES	NO	Cooler ID	Temp
Seal Present				
Seal Intact				
Cooling Media				

See ACTR

Depot Reception: YELLOWKNIFE
By: Michelle Goyette 10:45
2016-08-25
9-8-8
8-7-8
7-7-8
Temp: 7 4 5

Analysis Requested

	Sample Identification	Depth (Unit)	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	# of containers	BTEX F1 [ ] VOC	BTEX F1-F2	BTEX F1-F4	Routine Water	Regulated Metals [ ] Tot [ ] Diss	Mercury [ ] Total [ ] Dissolved	Salinity 4	Sieve (75 micron)	Texture (% Sand, Silt, Clay)	Basic Class II Landfill	HOLD - DO NOT ANALYZE	Special Instructions
1	H01_Sump_W1_Aug2016	surface	8/19/2016	16:00	Water	1												Routine
2	H01_Sump_W2_Aug2016	surface	8/19/2016	17:00	Water													Routine
3	H01_Sump_W3_Aug2016	surface	8/19/2016	17:30	Water													Routine
4	Duplicate_H01_Sump_W3_Aug2016	surface	8/19/2016	17:30	Water													Routine
5	H01_Sump_W4_Aug2016	surface	8/19/2016	18:00	Water													Routine
6	H01_Sump_SS1_0-0.25	0-0.25m	8/19/2016		Soil-bag													
7	H01_Sump_SS1_0.25-0.5	0.25-0.5m	8/19/2016		Soil-bag													
8	H01_Sump_SS1_0.5-0.75	0.50-0.75	8/19/2016		Soil-bag													
9	H01_Sump_SS2_0-0.25	0-0.25m	8/19/2016		Soil-bag													
10	H01_Sump_SS2_0.25-0.5	0.25-0.5m	8/19/2016		Soil-bag													

Please indicate Filtered, Preserved or Both (F, P, F/P) →

Regulatory Criteria

- [ ] AT1/CCME
- [ ] Drinking Water
- [ ] Saskatchewan
- [ ] D50 (Drilling Waste)
- [ ] Other:

Relinquished by: (Signature/ Print)	DATE (YYYY/MM/DD)	Time (HH:MM)	Received by: (Signature/ Print)	DATE (YYYY/MM/DD)	Time (HH:MM)	Maxxam Job #
			Jenna Walter	20160826	1146	B673175

AB FCD-00331/6

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CHAIN OF CUSTODY RECORD

Report Information

Company: Stantec
Contact: Stephanie Lapka
Phone:
Email:
Sampled by:

Comments

hold for anyalysis instruction

Same as CoC

Project/LSD

Special Instructions

Analysis Requested

	Sample Identification	Depth (Unit)	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	# of containers	BTEX F1 ☐ VOC ☐	BTEX F1-F2	BTEX F1-F4	Routine Water	Regulated Metals ☐ Tot ☐ Diss	Mercury ☐ Total ☐ Dissolved	Salinity 4	Sieve (75 micron)	Texture (% Sand, Silt, Clay)	Basic Class II Landfill	HOLD - DO NOT ANALYZE
11	H01_Sump_SS2_0.5-0.75	0.5-0.75	8/19/2016		Soil-bag												
12	H01_Sump_Control1_0-0.25	0-0.25	8/19/2016		Soil-bag												
13	H01_Sump_Control1_0-0.5	0.25-0.5	8/19/2016		Soil-bag												
14	H01_Sump_Control2_0-0.25	0-0.25	8/19/2016		Soil-bag												
15	H01_Sump_Control2_0-0.5	0.25-0.5	8/19/2016		Soil-bag												
16	H01_Sump_Control3_0-0.25	0-0.25	8/19/2016		Soil-bag												
17	H01_Sump_Control3_0-0.5	0.25-0.5	8/19/2016		Soil-bag												
18	H01_Sump_Control4_0-0.25	0-0.25	8/19/2016		Soil-bag												
19	H01_Sump_Control4_0-0.5	0.25-0.5	8/19/2016		Soil-bag												
20	H01_Sump_Control5_0-0.25	0-0.25	8/19/2016		Soil-bag												
21	H01_Sump_Control5_0-0.5	0.25-0.5	8/19/2016		Soil-bag												
22	H01_Sump_Control6_0-0.25	0-0.25	8/19/2016		Soil-bag												
23	H01_Sump_Control6_0-0.5	0.25-0.5	8/19/2016		Soil-bag												
24	H01_Sump_Control7_0-0.25	0-0.25	8/19/2016		Soil-bag												
25	H01_Sump_Control7_0-0.5	0.25-0.5	8/19/2016		Soil-bag												
26	H01_Sump_Control8_0-0.25	0-0.25	8/19/2016		Soil-bag												
27	H01_Sump_Control8_0-0.5	0.25-0.5	8/19/2016		Soil-bag												
28	H01_Sump_Crust	0-0.15	8/19/2016		Soil-bag												
29	H01_Well_SS1_0-0.15	0-0.15	8/19/2016		Bag/Jar												
30	H01_Well_SS2_0-0.15	0-0.15	8/19/2016		Bag/Jar												

RECEIVED IN YELLOWKNIFE
By: Michelle Gaule 10:45
2016 -08- 25
9-8-8
8-7-8
7-7-6
Temp: 7 1 4 5

See ACTR

Please indicate Filtered, Preserved or Both (F, P, F/P) →

Relinquished by: (Signature/ Print)	DATE (YYYY/MM/DD)	Time (HH:MM)	Received by: (Signature/ Print)	DATE (YYYY/MM/DD)	Time (HH:MM)	Maxxam Job #
			Jenna Walter	20160826	1146	B673175

AB FCD-00331/6

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CHAIN OF CUSTODY RECORD

Report Information

Company:
Contact:
Phone:
Email:
Sampled by:

Comments

Same as CoC

Project/LSD

Special Instructions

	Sample Identification	Depth (Unit)	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	# of containers	BTEX F1 ☐ VOC ☐	BTEX F1-F2	BTEX F1-F4	Routine Water	Regulated Metals ☐ Tot ☐ Diss	Mercury ☐ Total ☐ Dissolved	Salinity 4	Sieve (75 micron)	Texture (% Sand, Silt, Clay)	Basic Class II Landfill	HOLD - DO NOT ANALYZE	Special Instructions
11	Duplicate_H01_Sump_Control1_0-0.25	0.5-0.75	8/19/2016		Soil-bag													
12	Duplicate_H01_Sump_Control4_0-0.25	0-0.25	8/19/2016		Soil-bag													
13	K30_Sump_W1_Aug2016		8/20/2016		Water													Routine
14	K30_Sump_W2_Aug2016		8/20/2016		Water													Routine
15	K30_Sump_W3_Aug2016		8/20/2016		Soil-bag													Routine
16	K30_Sump_SS1_0-0.25		8/20/2016		Soil-bag													
17	K30_Sump_SS1_0.25-0.5		8/20/2016		Soil-bag													
18	K30_Sump_SS1_0.5-0.75		8/20/2016		Soil-bag													
19	K30_Sump_SS2_0-0.25		8/20/2016		Soil-bag													
20	K30_Sump_SS2_0.25-0.5		8/20/2016		Soil-bag													
21	K30_Sump_SS2_0.5-0.75		8/20/2016		Soil-bag													
22	K30_Sump_SS3_0-0.25		8/20/2016		Soil-bag													
23	K30_Sump_SS3_0.25-0.5		8/20/2016		Soil-bag													
24	Duplicate K30_Sump_SS4_0-0.24		8/20/2016		Soil-bag													
25	K30_Sump_SS4_0-0.25		8/20/2016		Soil-bag													
26	K30_Sump_SS4_0.25-0.5		8/20/2016		Soil-bag													
27	K30_Sump_SS5_0-0.25		8/20/2016		Soil-bag													
28	K30_Sump_SS5_0.25-0.5		8/20/2016		Soil-bag													
29	H01_Seawater		8/20/2016		Soil-bag													Routine
30																		See AeTR

RECEIVED IN YELLOWKNIFE
By: Michelle Lueck 10:45
2016 -08- 25
Temp: 9-8-8 / 8-7-8 / 7-7-6 / 7 1 4 5

Please indicate Filtered, Preserved or Both (F, P, F/P) →

Relinquished by: (Signature/ Print)	DATE (YYYY/MM/DD)	Time (HH:MM)	Received by: (Signature/ Print)	DATE (YYYY/MM/DD)	Time (HH:MM)	Maxxam Job #
			Jenna Walter	20160826	1146	B673175

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CHAIN OF CUSTODY RECORD

Report Information

Company:
Contact:
Phone:
Email:
Sampled by:

Comments

Same as CoC

Project/LSD

Special Instructions

Analysis Requested

	Sample Identification	Depth (Unit)	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	# of containers	BTEX F1 ☐ VOC ☐	BTEX F1-F2	BTEX F1-F4	Routine Water	Regulated Metals ☐ Tot ☐ Diss	Mercury ☐ Total ☐ Dissolved	Salinity 4	Sieve (75 micron)	Texture (% Sand, Silt, Clay)	Basic Class II Landfill	HOLD - DO NOT ANALYZE	Special Instructions
11	I25_Sump_W1_Aug2016		8/21/2016		Water													Routine
12	I25_Sump_W2_Aug2016		8/21/2016		Water													Routine
13	I25_Sump_W3_Aug2016		8/21/2016		Water													Routine
14	I25_Sump_W4_Aug2016		8/21/2016		Water													Routine
15	I25_Sump_W5_Aug2016		8/21/2016		Water													Routine
16	I25_Sump_SS1_0-0.25		8/21/2016		Soil-bag													
17	I25_Sump_SS1_0.25-0.4		8/21/2016		Soil-bag													
18	I25_Well_W1		8/21/2016		Water													Routine, TSS, Metals, PHC's
19	I25_Well_W2		8/21/2016		Water													Routine, TSS, Metals, PHC's
20	I25_Well_W3		8/21/2016		Water													Routine, TSS, Metals, PHC's
21	I25_Well_W4		8/21/2016		Water													Routine, TSS, Metals, PHC's
22	I25_Well_W5		8/21/2016		Water													Routine, TSS, Metals, PHC's
23	I25_Well_W6		8/21/2016		Water													Routine, TSS, Metals, PHC's
24	I25_Well_W7		8/21/2016		Water													Routine, TSS, Metals, PHC's
25																		
26	I48_Sump _SS1_0-0.25		8/21/2016		Soil-bag													
27	I48_Sump _SS1_0.25-0.50		8/21/2016		Soil-bag													
28	I48_Sump _SS2_0-0.25		8/21/2016		Soil-bag													
29	I48_Sump _SS2_0.25-0.50		8/21/2016		Soil-bag													
30	I48_Sump _SS3_0-0.25		8/21/2016		Soil-bag													See AeTR

RECEIVED IN YELLOWKNIFE
By: Michelle Guik 10:45
2016-08-25
Temp: 7.1 7.6 7.4.5

Please indicate Filtered, Preserved or Both (F, P, F/P) →

Relinquished by: (Signature/ Print)	DATE (YYYY/MM/DD)	Time (HH:MM)	Received by: (Signature/ Print)	DATE (YYYY/MM/DD)	Time (HH:MM)	Maxxam Job #
			Jennah Ifer	20160826	1146	B673175

AB FCD-00331/6

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CHAIN OF CUSTODY RECORD

Report Information

Company:
Contact:
Phone:
Email:
Sampled by:

Comments

Same as CoC

Project/LSD

Special Instructions

	Sample Identification	Depth (Unit)	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	# of containers	BTEX F1 ☐ VOC	BTEX F1-F2	BTEX F1-F4	Routine Water	Regulated Metals ☐ Tot ☐ Diss	Mercury ☐ Total ☐ Dissolved	Salinity 4	Sieve (75 micron)	Texture (% Sand, Silt, Clay)	Basic Class II Landfill	HOLD - DO NOT ANALYZE	Special Instructions
11	I48_Sump _SS3_0.25-0.50		8/21/2016		Soil-bag													
12	I48_Sump _SS4_0-0.25		8/21/2016		Soil-bag													
13	I48_Sump _SS4_0.25-0.50		8/21/2016		Soil-bag													
14	I48_Sump _Control1_0-0.25		8/21/2016		Soil-bag													
15	I48_Sump _Control2_0-0.25		8/21/2016		Soil-bag													
16	I48_Sump_W1		8/21/2016		Water													Routine
17	I48_Sump_W2		8/21/2016		Water													Routine
18	I48_Sump_W3		8/21/2016		Water													Routine
19	I48_Sump_W4		8/21/2016		Water													Routine
20	I48_Sump_W5		8/21/2016		Water													Routine
21	I48_Well _SS1		8/21/2016		Soil-bag													
22	N-05_Sump_W1		8/22/2016		Water													Routine
23	N-05_Sump_W2		8/22/2016		Water													Routine
24	N-05_Sump_W3		8/22/2016		Water													Routine
25	N-05_Sump_W4		8/22/2016		Water													Routine
26	N-05_Sump_W5		8/22/2016		Water													Routine
27	N-05_Sump_W6		8/22/2016		Water													Routine
28	N-05_Sump_W7		8/22/2016		Water													PHC
29	N-05_Sump_SS1_0-0.25		8/22/2016		Soil-bag													
30	N-05_Sump_SS1_0.25-0.5		8/22/2016		Soil-bag													

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CHAIN OF CUSTODY RECORD

Report Information

Company:
Contact:
Phone:
Email:
Sampled by:

Comments

Analysis Requested

Same as CoC

Project/LSD

Special Instructions

	Sample Identification	Depth (Unit)	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	# of containers	BTEX F1 ☐ VOC ☐	BTEX F1-F2	BTEX F1-F4	Routine Water	Regulated Metals Tot ☐ Diss ☐	Mercury Total ☐ Dissolved ☐	Salinity 4	Sieve (75 micron)	Texture (% Sand, Silt, Clay)	Basic Class II Landfill	HOLD - DO NOT ANALYZE	Special Instructions
11	N-05_Sump_SS2_0-0.25		8/22/2016		Soil-bag													
12	N-05_Sump_SS3_0-0.25		8/22/2016		Soil-bag													
13	N-05_Sump_SS3_0.25-0.5		8/22/2016		Soil-bag													
14	N-05_Sump_SS4_0-0.25		8/22/2016		Soil-bag													
15	N-05_Sump_SS4_0.25-0.5		8/22/2016		Soil-bag													
16	N-05_Sump_SS5_0-0.25		8/22/2016		Soil-bag													
17	N-05_Sump_SS5_0.25-0.5		8/22/2016		Soil-bag													
18	N-05_Sump_SS6_0-0.25		8/22/2016		Soil-bag													
19	N-05_Sump_SS6_0.25-0.5		8/22/2016		Soil-bag													
20	N-05_Sump_SS7_0-0.25		8/22/2016		Soil-bag													
21	N-05_Sump_SS7_0.25-0.5		8/22/2016		Soil-bag													
22	N-05_Sump_SS8_0-0.25		8/22/2016		Soil-bag													
23	N-05_Sump_SS8_0.25-0.5		8/22/2016		Soil-bag													
24	N-05_Well_W1		8/22/2016		Water													Routine, TSS, Metals, PHC's
25	N-05_Well_W2		8/22/2016		Water													Routine, TSS, Metals, PHC's
26	N-05_Well_W3		8/22/2016		Water													Routine, TSS, Metals, PHC's
27	N-05_Well_W4		8/22/2016		Water													Routine, TSS, Metals, PHC's
28	N-05_Well_W5		8/22/2016		Water													Routine, TSS, Metals, PHC's
29	N-05_Well_W6		8/22/2016		Water													Routine, TSS, Metals, PHC's
30	N-05_Well_SS1_0-0.25		8/22/2016		Bag-Jar													Bag and Jar

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CHAIN OF CUSTODY RECORD

Report Information

Company:
Contact:
Phone:
Email:
Sampled by:

Comments

Analysis Requested

Same as CoC

Project/LSD

Special Instructions

	Sample Identification	Depth (Unit)	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	# of containers	BTEX F1 ☐ VOC ☐	BTEX F1-F2	BTEX F1-F4	Routine Water	Regulated Metals ☐ Tot ☐ Diss	Mercury ☐ Total ☐ Dissolved	Salinity 4	Sieve (75 micron)	Texture (% Sand, Silt, Clay)	Basic Class II Landfill	HOLD - DO NOT ANALYZE	Special Instructions
11	N-05_Well_SS1_0.25-0.5		8/22/2016		Bag-Jar													Bag and Jar
12	N-16_Sump_W1		8/22/2016		Water													Routine
13	N-16_Sump_W2		8/22/2016		Water													Routine
14	N-16_Sump_W3		8/22/2016		Water													Routine
15	N-16_Sump_W4		8/22/2016		Water													Routine
16	N-16_Sump_W5		8/22/2016		Water													Routine
17	N-16_Sump_W6		8/22/2016		Water													Routine
18	N-16_Sump_SS1_0-0.25		8/22/2016		Soil-bag													
19	N-16_Sump_SS1_0.25-0.5		8/22/2016		Soil-bag													
20	N-16_Sump_SS2_0-0.25		8/22/2016		Soil-bag													
21	N-16_Sump_SS2_0.25-0.5		8/22/2016		Soil-bag													
22	N-16_Sump_SS3_0-0.25		8/22/2016		Soil-bag													
23	N-16_Sump_SS3_0.25-0.5		8/22/2016		Soil-bag													
24	N-16_Sump_SS4_0-0.25		8/22/2016		Soil-bag													
25	N-16_Sump_SS4_0.25-0.5		8/22/2016		Soil-bag													
26	N-16_Sump_SS5_0-0.25		8/22/2016		Soil-bag													
27	N-16_Sump_SS5_0.25-0.5		8/22/2016		Soil-bag													
28	I48_Sump _SS4_0.5-0.75		8/21/2016		Soil-bag													
29	I48_Sump _SS4_0.75-1.0		8/21/2016		Soil-bag													
30																		

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By: Meguie Michelle Cruz 10:45
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Temp:
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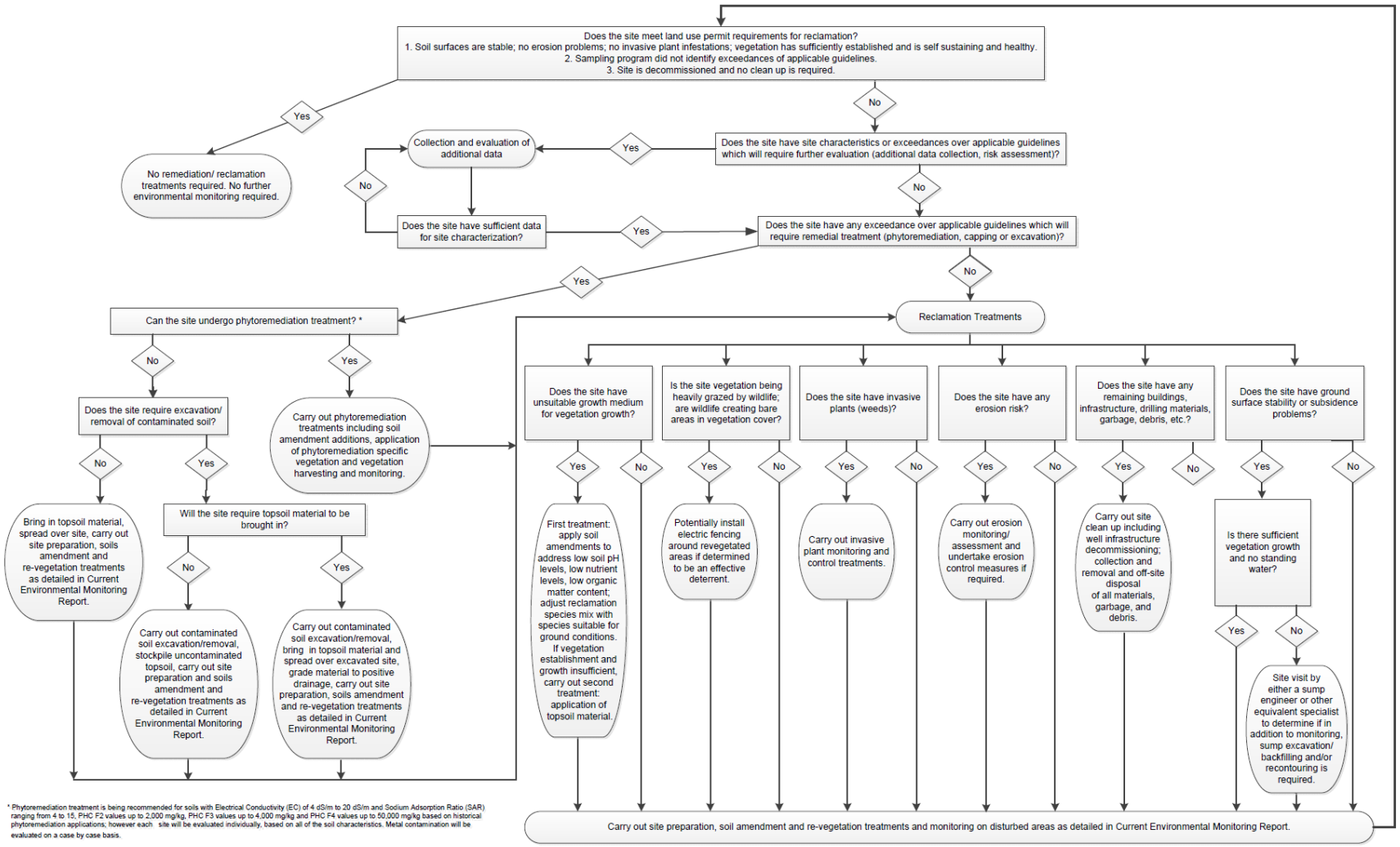
APPENDIX H

Remediation/Reclamation Decision Tree

(flow diagram for determination if environmental monitoring is no longer required or if additional sampling, remediation and reclamation treatments are required to meet land use permit guidelines)


Does the site meet land use permit requirements for reclamation?
1. Soil surfaces are stable; no erosion problems; no invasive plant infestations; vegetation has sufficiently established and is self sustaining and healthy.
2. Sampling program did not identify exceedances of applicable guidelines.
3. Site is decommissioned and no clean up is required.
Yes
No remediation/ reclamation treatments required. No further environmental monitoring required.
No
Does the site have site characteristics or exceedances over applicable guidelines which will require further evaluation (additional data collection, risk assessment)?
Yes
Collection and evaluation of additional data
No
Does the site have sufficient data for site characterization?
Yes
No
Does the site have any exceedance over applicable guidelines which will require remedial treatment (phytoremediation, capping or excavation)?
Yes
Can the site undergo phytoremediation treatment? *
No
Does the site require excavation/ removal of contaminated soil?
No
Bring in topsoil material, spread over site, carry out site preparation, soils amendment and re-vegetation treatments as detailed in Current Environmental Monitoring Report.
Yes
Will the site require topsoil material to be brought in?
No
Carry out contaminated soil excavation/removal, stockpile uncontaminated topsoil, carry out site preparation and soils amendment and re-vegetation treatments as detailed in Current Environmental Monitoring Report.
Yes
Carry out contaminated soil excavation/removal, bring in topsoil material and spread over excavated site, grade material to positive drainage, carry out site preparation, soils amendment and re-vegetation treatments as detailed in Current Environmental Monitoring Report.
Yes
Carry out phytoremediation treatments including soil amendment additions, application of phytoremediation specific vegetation and vegetation harvesting and monitoring.
* Phytoremediation treatment is being recommended for soils with Electrical Conductivity (EC) of 4 dS/m to 20 dS/m and Sodium Adsorption Ratio (SAR) ranging from 4 to 15, PHC F2 values up to 2,000 mg/kg, PHC F3 values up to 4,000 mg/kg and PHC F4 values up to 50,000 mg/kg based on historical phytoremediation applications; however each site will be evaluated individually, based on all of the soil characteristics. Metal contamination will be evaluated on a case by case basis.
No
Reclamation Treatments
Does the site have unsuitable growth medium for vegetation growth?
Yes
First treatment: apply soil amendments to address low soil pH levels, low nutrient levels, low organic matter content; adjust reclamation species mix with species suitable for ground conditions. If vegetation establishment and growth insufficient, carry out second treatment: application of topsoil material.
No
Is the site vegetation being heavily grazed by wildlife; are wildlife creating bare areas in vegetation cover?
Yes
Potentially install electric fencing around revegetated areas if determined to be an effective deterrent.
No
Does the site have invasive plants (weeds)?
Yes
Carry out invasive plant monitoring and control treatments.
No
Does the site have any erosion risk?
Yes
Carry out erosion monitoring/ assessment and undertake erosion control measures if required.
No
Does the site have any remaining buildings, infrastructure, drilling materials, garbage, debris, etc.?
Yes
Carry out site clean up including well infrastructure decommissioning; collection and removal and off-site disposal of all materials, garbage, and debris.
No
Does the site have ground surface stability or subsidence problems?
Yes
Is there sufficient vegetation growth and no standing water?
Yes
No
Site visit by either a sump engineer or other equivalent specialist to determine if in addition to monitoring, sump excavation/ backfilling and/or recontouring is required.
No
Carry out site preparation, soil amendment and re-vegetation treatments and monitoring on disturbed areas as detailed in Current Environmental Monitoring Report.