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Indigenous and Northern Affairs Canada – Nunavut Regional Office

LONG TERM MONITORING - 2016

CAM-D, Simpson Lake, Nunavut

February 3, 2017

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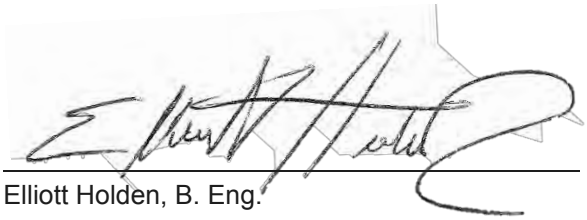

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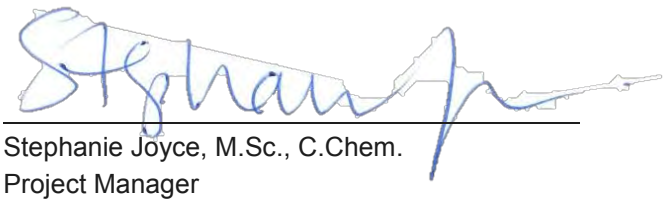

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100347-001

Date:

February 3, 2017

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ACRONYMS AND ABBREVIATIONS

AMSRP	Abandoned Military Site Remediation Protocol
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
CALA	Canadian Association for Laboratory Accreditation
CCME	Canadian Council of Ministers of the Environment
CEQG	Canadian Environmental Quality Guidelines
DEW	Distant Early Warning
EC	Environment Canada
FCSAP	Federal Contaminated Sites Action Plan
FIGQG	Federal Interim Groundwater Quality Guidelines
GIS	Geographic Information System
GPS	Global Positioning System
HASP	Health and Safety Plan
INAC	Indigenous and Northern Affairs Canada
LTM	Long Term Monitoring
M	Metres
NHWL	Non-Hazardous Waste Landfill
PCBs	Polychlorinated Biphenyls
PHCs	Petroleum Hydrocarbons
POL	Petroleum, Oil and Lubricants
QA/QC	Quality Assurance/Quality Control
RDL	Reportable Detection Limit
RPD	Relative Percent Difference

EXECUTIVE SUMMARY

Arcadis Canada Inc. (Arcadis) was retained by Indigenous and Northern Affairs Canada (INAC) – Nunavut Regional Office to conduct long term monitoring (LTM) activities in 2016 at the former Distant Early Warning Line site CAM-D. The site is within the Kitikmeot Region of Nunavut and is centrally located on the Boothia Peninsula.

The site was constructed in 1957 and abandoned in 1963. A full remediation project was conducted at the site between 2008 and 2011. All hazardous waste materials were shipped off site for disposal. All non-hazardous debris, demolition waste and impacted soils were placed in a non-hazardous waste landfill (NHWL) constructed on-site. In 2011, four groundwater monitoring wells were installed around the perimeter of the NHWL and the landfill was closed.

The 2016 site visit by Arcadis is the third monitoring event to take place since the completion of the remediation activities. Overall, physical observations suggest that the NHWL is in marginal condition. The NHWL is currently performing as designed to contain the enclosed waste, although considerable deterioration was noted since the previous monitoring event by Arcadis in 2014. In particular, horizontal cracks running along the northeast and northwest berms have developed, indicating that this corner of the NHWL may be unstable.

Minor areas of erosion were identified on all four berms of the NHWL. Ponded water was observed on the ground surface around the base of the landfill and two small potholes have developed on the outside of the NHWL. Some exposed debris was observed in the north corner and on top of the NHWL near the west corner. These features are considered to be of little consequence at the present time.

The road from the airstrip to the NHWL had evidence of erosion and one culvert under this road was deteriorating. On the airstrip, a small area of ponded water was observed at its northeast end. In general, the airstrip for the site is comprised of loosely compacted coarse sand and gravel. The wheels on the landing gear on the Dornier 228 used to reach the site in 2016 sank between 4 to 6 centimetres into the airstrip. The overall wet condition of the surrounding area also likely contributed to the soft conditions of the airstrip encountered in 2016.

In addition to physical observations, Arcadis collected groundwater samples to assess the performance of the NHWL. Concentrations of contaminants of concern in groundwater were compared to historical groundwater results from 2012 and 2014. The total chromium concentration in the groundwater sample collected from monitoring well MW04 and the total suspended solids concentrations in the groundwater

samples collected from monitoring wells MW03 and MW04 exceeded their respective calculated upper limit of acceptability.

A number of total and dissolved metals in all five groundwater samples collected reported concentrations above the Federal Interim Groundwater Quality Guidelines for protection of freshwater life. Given the site conditions and location of the NHWL in relation to annually upheld surface water bodies (none in the near vicinity), Arcadis believes that these concentrations are not of a concern at this time.

Based on the results of the 2016 site visit, Arcadis recommends continued monitoring at an increased frequency of the features identified, especially the northern corner of the NHWL where horizontal cracks have developed in the past couple of years. As 2016 represented Year 5 of the LTM, it is recommended that additional monitoring events take place in Year 7 (2018), Year 9 (2020) and Year 11 (2022).

This executive summary should be read in conjunction with the main report and is subject to the same limitations described in Section 10.

1 INTRODUCTION

Arcadis Canada Inc. (Arcadis) was retained by Indigenous and Northern Affairs Canada (INAC) – Nunavut Regional Office to conduct long term monitoring (LTM) activities at the former Distant Early Warning (DEW) Line site CAM-D. This project was completed under INAC Standing Offer Number 4600000861, Order Number 4500352890.

This report describes the monitoring activities completed for INAC at CAM-D and was prepared in accordance with the Arcadis proposal Number 566661-000, dated June 23, 2016. As 2016 represents the final year in Phase I of the LTM Plan, an assessment of the data collected to date is also included in this report.

Throughout this report the INAC DEW Line site CAM-D will be referred to as “the site”.

1.1 Project Objectives

The objective of the 2016 LTM program was to complete Year 5 monitoring activities as described in the *CAM-D (Simpson Lake) Long-Term Monitoring Plan* (INAC, 2010; referred to as the LTM Plan). The program included visual observations, chemical analyses (where useful and possible), and interviews with members of the nearby community knowledgeable about local activities at the site. The purpose of the program was to assess the condition of the natural environment and whether the site infrastructure is performing as designed.

1.2 Scope of Work

Consistent with previous monitoring activities at the site, the scope of work undertaken in 2016, as described in the 2010 LTM Plan, was as follows:

1. Visual monitoring of the general site conditions including borrow areas, excavation areas, regrades etc.;
2. Natural environmental monitoring as detailed in the Abandoned Military Site Remediation Protocol (AMSRP);
3. Visual monitoring of the non-hazardous waste landfill (NHWL) including:
    - Checking the physical integrity of the NHWL and observing any evidence of erosion, ponding, frost action, settlement and lateral movement, and completing a visual monitoring checklist;

- Taking photographs to document the condition of NHWL to substantiate the recorded observations;

4. Active layer water (groundwater) monitoring of the NHWL, including:
   - Collection of groundwater samples from the four monitoring wells installed around the NHWL;
   - Examination and analysis of the groundwater samples for colour, hardness, pH, conductivity, temperature, total and dissolved metals (Canadian Council of Ministers of the Environment (CCME) suite), polychlorinated biphenyls (PCBs), petroleum hydrocarbons (PHCs), major ions (fluoride, orthophosphate, dissolved sulphate, dissolved chloride, nitrite, nitrate), total dissolved solids (TDS), and total suspended solids (TSS);
   - Natural environment monitoring;
   - Documentation of observations of wildlife and evidence of wildlife present at the site;
   - Interview(s) with member(s) of the local Hunters and Trappers Organization in Cambridge Bay or other persons knowledgeable of the site; collection of anecdotal information relevant to the use of the site by humans;
5. Report preparation, documenting the 2016 monitoring program.

To fulfil the scope of work as described above, Arcadis along with INAC, devised a work plan that included the following tasks:

a) Preparation of a health and safety plan;

b) Preparation of a sampling plan for groundwater;

c) Collection of groundwater samples from wells for chemical analysis;

d) Interpretation of analytical data;

e) Visual inspection and photo documentation of the site;

f) Observations of land use and wildlife trends;

g) Interviews with local residents and officials to understand land use and wildlife trends; and

h) Preparation of a report.

2 BACKGROUND INFORMATION

2.1 Site Description

The CAM-D Simpson Lake site (the site) is within the Kitikmeot Region of Nunavut and is centrally located on the Boothia Peninsula. It is approximately 80 kilometres (km) west of Kugaaruk, 120 km southeast of Taloyoak, and 160 km east of Gjoa Haven, at the general latitude of 68°35'36" N and general longitude 91°58'52" W (See Figure 1).

CAM-D was an intermediate DEW Line site. The site was constructed in 1957 and abandoned in 1963. The custody of the site was assumed by INAC in 1965. Between 1992 and 1995 the Department of National Defence (DND) constructed an automated Short Range Radar (SRR) facility, part of the North Warning System, approximately one kilometre east of the former CAM-D DEW Line site. The SRR facility is currently operational and was not included as part of the CAM-D remediation program.

Historic site infrastructure consisted of a module train, warehouse, garage, Inuit house, petroleum, oil and lubricants (POL) tanks, Quonset huts, storage pads, a radar tower and a 750 metres (m) long airstrip. The main station buildings were located at Ross Hills at an elevation of 370 m above mean sea level (amsl). In 1985, INAC, DND and Environment Canada (EC) conducted a partial clean-up of the site; some hazardous materials were removed from the site and other potential environmental hazards were identified.

The Environmental Sciences Group of Royal Roads Military College conducted a scientific investigation of the CAM-D site in 1994 which included a soil sample collection program. Tier I and Tier II contaminated soils were identified, as defined by the AMSRP. The impacts were predominantly associated with the five dumps or debris areas identified at the site (Main Dump, POL Area Dump, Vehicle Dump, Large Barrel Dump and the Pallet Line Area). As has been the practice at similar DEW line facilities, a detailed site investigation was undertaken prior to the commencement of remediation activities. The CAM-D site remediation activities took place between 2008 and 2011 including the construction of a NHWL.

The NHWL was designed to contain non-hazardous materials only. The NHWL was constructed on native ground, with all organic matter removed, and consists of four perimeter berms constructed of granular material. The following material is contained within the NHWL at CAM-D:

- Tier I contaminated soil (Lead concentration between 200 and 500 ppm and PCB concentrations between 1 and 5 ppm);
- PHC F3 and F4 contaminated soil;

- Non-hazardous demolition debris, such as timbers, plywood, and sheet metal;
- Non-hazardous site debris, such as scrap metal and wood;
- Non-hazardous debris/soil excavated from landfills;
- Creosote timbers; and
- Double-bagged asbestos.

Groundwater at the site is not considered to be used for water supply purposes as the site is not inhabited, nor is the area reported to be used by hunters and fishermen with any frequency.

2.2 Previous Monitoring Programs

The post construction landfill monitoring frequency has followed the schedule recommended in the AMRSP to date (INAC, 2009). The three phases recommended by the protocol are:

- Phase I: Years 1, 3 and 5.
- Phase II (if required): Years 7, 10, 15 and 25
- Phase III (if required): beyond 25 years

Prior to the field program, Arcadis reviewed the following reports pertaining to the CAM-D DEW Line site, some of which include previous site investigations and remedial activities:

- Franz Environmental Inc., March 2015, Long-Term Monitoring, 2014, CAM-D, Simpson Lake, Nunavut;
- Franz Environmental Inc., November 2012, Long-Term Monitoring, 2012, CAM-D, Simpson Lake, Nunavut;
- CAM-D Simpson Lake Long-Term Monitoring Plan, February 22, 2010, INAC;
- CAM-D Long Term Monitoring NWB Water License 1BR-SIM1520, 2015, Nunavut Water Board; and
- Abandoned Military Site Remediation Protocol, March 2009, INAC, Contaminated Sites Program.

The 2016 monitoring program was the third of seven scheduled over a 25-year period for the site and the last monitoring event in Phase I. Information from previous investigations was incorporated into this year's sampling plan. An analysis of the Phase I data is also included in the report.

As part of the investigation, information regarding land use by both humans and wildlife was gathered through interviews with a member of the Ekaluktutiak Hunters and Trappers Organization.

3 REGULATORY REVIEW

3.1 Guideline Review

Arcadis reviewed the CAM-D LTM Plan and AMSRP for mention of specific guidelines to use for comparison purposes. Federal guidelines were used where site-specific criteria were absent and/or were less strict than federal standards.

3.2 Groundwater

3.2.1 Comparison to Background Concentrations

There are no groundwater guidelines provided in the CAM-D LTM Plan. In the absence of site-specific guidelines, the AMSRP guidance on post-construction monitoring indicates that “comparison to background and baseline values is recommended.”

Arcadis used historical data presented in previous reports to obtain means and standard deviations of analytical results from monitoring activities conducted in 2012 and 2014 to establish statistical upper limits of acceptability (ULA). These limits are calculated as mean plus three standard deviations, and are used for comparison with analytical results from the 2016 field program. This is a very limited data set and therefore standard deviations for some parameters are quite high; others are low due to little variation in the two years of groundwater analytical results. As more monitoring events are conducted, additional data will help to create more realistic limits. Maximum acceptable values from these ranges are presented in tables of groundwater analytical results, located at the end of this report.

For some parameters, specifically petroleum hydrocarbon compounds (PHCs), benzene, toluene, ethylbenzene and xylenes (BTEX) and polychlorinated biphenyls (PCBs), sufficient data to support calculations of mean and standard deviation were not available. This is primarily due to the high frequency of not detected (i.e. concentrations less than reportable detection limits) results for BTEX, PCBs and PHC compounds in collected samples.

The AMSRP provides the following table for the assessment of groundwater analytical data.

Table 3-1: Groundwater Assessment

Geochemical Assessment	Acceptable	Marginal	Significant	Unacceptable
Groundwater concentrations within average ± three standard deviations or within analytical variability	Performing as expected	-	-	-
Increasing trend in contaminant data over 2 or more successive monitoring events (variation in excess of average ± three standard deviations or analytical variability)	-	Low risk of failure	-	-
Groundwater concentrations in excess of three times average baseline concentrations in more than one monitoring event	-	-	Moderate risk of failure	-
Where applicable, surface water concentrations in excess of surface water quality guidelines for the protection of aquatic life	-	-	-	Failure
Required Actions	Monitor as per schedule	Increase monitoring frequency. Monitor surface water quality, if applicable, in downgradient water bodies within 300 m.	Assess causes of increasing contaminant concentrations. Evaluate whether remediation is required.	Assess cause of contaminant concentrations. Develop remedial plan. Implement remedial plan.

Note: This table is reproduced from AMSRP Chapter 11, Table 4.2

3.2.2 Federal Interim Groundwater Quality Guidelines

In May 2010, EC under the Federal Contaminated Sites Action Plan (FCSAP) released the *Federal Interim Groundwater Quality Guidelines* (FIGQG) for Federal Contaminated Sites. The guidelines were released based on the observed need for federal custodians and others to apply appropriate groundwater guidelines at federal sites. Previously, a mixture of provincial standards, federal surface water guidelines, and drinking water quality guidelines were applied to groundwater at federal sites. The FIGQGs remove the need for this patchwork of regulations, which were not consistently applied. The FIGQGs were updated in November 2015.

The FIGQGs were not developed with the scientific rigour associated with the Canadian Environmental Quality Guidelines (CEQGs). Instead, EC requested the development of guidelines based on a review and evaluation of existing approaches in other jurisdictions.

The FIGQGs follow a tiered framework, consistent with the Canadian Soil Quality Guidelines development through the CCME. The tiers are:

- Tier 1: direct application of the generic numerical guidelines; specifically, application of the lowest guideline for any pathway;
- Tier 2: allows for the development of site-specific remediation objectives through the consideration of site-specific conditions, by modifying (within limits) the numerical guidelines based on site-specific conditions and focusing on exposure pathways and receptors that are applicable to the site; and
- Tier 3: use of site-specific risk assessment to develop Site-Specific Remediation Objectives.

The FIGQGs are based on the consideration of a number of potential receptors and exposure pathways, including:

- Groundwater transport to surface water at least 10 m from the contamination and subsequent exposure of freshwater and marine life;
- Direct contact of soil organisms with contaminated groundwater;
- Use of groundwater for irrigation water;
- Use of groundwater for livestock watering;
- Groundwater transport to surface water at least 10 m from the contamination and subsequent ingestion by wildlife;
- Migration of contaminant vapours to indoor air and subsequent inhalation by humans; and
- Use of groundwater for human consumption (i.e., drinking water).

The generic guidelines are point estimates of a chemical concentration in groundwater associated with an approximate no- to low-effects level based on toxicological information about the chemical, along with a screening-level evaluation and environmental fate and transport and estimated intake rates, or exposure, by potential receptors.

As a result, the "Table 2 *Federal Interim Groundwater Quality Guidelines*, *Generic Guidelines for Residential/Parkland Land Uses"* Tier 1, Freshwater Life pathway for coarse-grained soil (FIGQG Table 2 Tier 1) were referenced for comparison purposes.

3.3 Soil

3.3.1 Comparison to Background Concentrations

No soil samples were collected in 2016. Soil samples have only been collected during the 2012 monitoring event, which can serve as background samples for future soil sampling, laboratory analysis and analytical data comparison (if needed). Soil guidelines used for comparison in previous monitoring programs included the following:

- AMSRP, Volume I – Main Report (INAC, 2009).
- *CSQGs for the Protection of Environmental and Human Health* (CCME, 1999, with updates) for residential/parkland use, including fact sheets for BTEX. Non-potable groundwater is stipulated and coarse-grain material is assumed based on a 2009 grain-size analysis, field observation (generally sandy material) as well as for conservative reasons – being that coarse-grain criteria are more stringent than those applied to fine grain.
- *Canada-Wide Standard (CWS) for Petroleum Hydrocarbons in Soil* (CCME, 2008a) - Tier 1 Residential/Parkland, coarse-grained soil, non-potable groundwater.

These can be referenced in future monitoring events, should soil samples be collected.

4 INVESTIGATIVE METHODOLOGY

The monitoring program was carried out at the site on August 20, 2016. During the field investigations, weather conditions were sunny with temperatures between 8 and 15˚C. The monitoring program included the following tasks:

- Completing a health and safety kick-off meeting;
- Visually observing and photographically documenting the physical integrity of the landfill and the reporting on the observable conditions over the rest of the site;
- Natural environment monitoring and gathering information from knowledgeable persons regarding local wildlife and human activity;
- Sampling of groundwater from monitoring wells at the site;
- Measuring various physical parameters in the water samples; and
- Submitting groundwater samples, including duplicates, for applicable laboratory analysis.

The field investigation procedures are described below.

4.1 Health and Safety Plan

Before commencing site activities, a site-specific health and safety plan (HASP) was developed. The HASP identified and provided mitigative actions for potential physical and chemical hazards associated with the monitoring work. The HASP also contained a listing of emergency contact numbers and provided protocols to follow in the event of an emergency. A copy of the HASP is located in Appendix E.

A copy of the HASP was presented to INAC for review and approval before site activities began. This plan was reviewed, discussed and signed off by all personnel involved in the investigative program prior to conducting any work on-site. A copy of the HASP has been retained on file at Arcadis and at the INAC Nunavut Regional Office.

4.2 Visual Inspection

The physical integrity of the NHWL and surrounding areas were assessed using systematic visual observations and empirical measurements to record evidence of erosion, ponding, frost action, settlement and lateral movement of the landfills. Definitions for completing the checklist are found in Table 4-1 (below). A visual monitoring checklist, presented in the CAM-D LTM Plan, was completed for the landfill and is found in Tables 5-1 and 5-2 in Section 5.3. A photographic record was completed to document the condition of the structures and substantiate the visual observations (Appendix A).

Table 4-1: Preliminary Visual Inspection Report NHWL - Definitions

Performance / Severity Rating	Description
Acceptable	Noted features are of little consequence. The landfill is performing as designed. Minor deviations in environmental or physical performance may be observed, such as isolated areas of erosion, settlement.
Marginal	Physical/environmental performance appears to be deteriorating with time. Observations may include an increase in size or number of features of note, such as differential settlement, erosion or cracking. No significant impact on landfill stability to date, but potential for failure is assessed as low or moderate.
Significant	Significant or potentially significant changes affecting landfill stability, such as significant changes in slope geometry, significant erosion or differential settlement; scarp development. The potential for failure is assessed as imminent.
Unacceptable	Stability of landfill is compromised to the extent that ability to contain waste materials is compromised. Examples may include: • Debris exposed in erosion channels or areas of differential settlement. • Liner exposed. • Slope failure.
Extent	**Description**
Isolated	Singular feature
Occasional	Features of note occurring at irregular intervals/locations
Numerous	Many features of note, impacted less than 50% of the surface area of the landfill
Extensive	Impacting greater than 50% of the surface area of the landfill

The 2016 visual inspection was conducted with the aid of a Trimble Pro XRT GPS unit (real-time accuracy of 1-2 m and corrected accuracy of 10-30 cm while connected to OmniSTAR). The Trimble Pro XRT GPS was preloaded with the 2014 logged GPS data file enabling Arcadis field personnel to accurately locate features of note. However, changes to features observed in 2016 and new photograph viewpoints could not be captured on the GPS unit due to operational difficulties. The 2014 SSF format file is still the most up-to-date version of the spatial data gathered at the site. Use of the Trimble Pro XRT GPS to facilitate observation and documentation of any changes to the condition of the NHWL in future site monitoring visits is still recommended.

4.3 Wildlife Survey

Arcadis recorded observations of the natural environment made during the site visit including direct sightings of wildlife, other evidence of wildlife (e.g., droppings, tracks, and feathers/fur), wildlife activities (migrating, nesting, etc.), numerical estimates of wildlife and vegetation.

As part of the investigation, information was gathered from the wildlife monitor, a member of the Ekaluktutiak Hunters and Trappers Organization. Land use by both humans and wildlife were discussed.

A discussion of the recorded observations and information obtained is presented in Section 6.0 of this report.

4.4 Groundwater Sample Collection

The ground water sampling methodology conformed to guidance provided in the following CCME documents:

- CCME EPC-NCS62E Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites - Volume I: Main Report, Dec 93 (CCME catalogue - http://www.ccme.ca/assets/pdf/pn_1101_e.pdf); and
- CCME EPC-NCS66E Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites - Volume II: Analytical Method Summaries, Dec 93 (CCME catalogue - http://www.ccme.ca/assets/pdf/pn_1103_e.pdf).

Groundwater was sampled at four predetermined locations (i.e., monitoring wells MW01 to MW04). All wells were observed to have a slow recharge; however, sufficient water was available for sample collection.

Bailers were used to purge the designated monitoring wells. Wells were purged of standing water and allowed to recharge prior to sampling. A peristaltic pump and low flow tubing were used during sample collection. A YSI 556 MPS water quality meter was calibrated and used to measure *in situ* field parameters including temperature, conductivity, dissolved oxygen, pH and oxidation-reduction potential (ORP). Water samples submitted for total metals analyses were preserved but not field-filtered. Water samples submitted for dissolved metals were field filtered and placed in laboratory supplied bottles pre-charged with preservative.

All samples were stored immediately in laboratory prepared sample jars for subsequent laboratory analysis. Water samples were stored in laboratory supplied coolers and were placed on ice for delivery to the laboratory.

4.5 Soil Sample Collection

Because there were no indications of seepage or staining as part of the visual inspection, no soil samples were collected during the 2016 monitoring activities, as per the 2010 LTM Plan for the site.

4.6 Quality Assurance/Quality Control

Field personnel employed Arcadis' Quality Assurance/Quality Control (QA/QC) protocols, including appropriate techniques for soil sampling, sample storage, shipping and handling, as well as collection of duplicates.

4.6.1 Field

Groundwater samples were collected from monitoring wells and placed in appropriately sized and prepared laboratory vessels. Sample numbers were clearly marked on the containers. The water bottles were filled to capacity with minimum headspace and stored in coolers with ice to moderate temperature fluctuations during transport to the laboratory.

As a quality control measure, one groundwater blind field duplicate sample was collected and analyzed for identical parameters (PHCs, BTEX, total and dissolved metals, PCBs, total dissolved solids (TDS), total suspended solids (TSS), major ions, hardness, pH and conductivity).

The samples, accompanied by a Chain of Custody form, were shipped via Canadian North to Maxxam Analytics (Maxxam) in Yellowknife. There, the samples were re-packaged and shipped by Maxxam to the appropriate analytical laboratory in either Edmonton or Calgary. Copies of the Chain of Custody forms are provided in Appendix B.

Analytical results from these samples were compared with the analytical results from previous annual monitoring events.

4.6.2 Laboratory

The selected laboratory, Maxxam, is certified by the Canadian Association for Laboratory Accreditation, Inc. (CALA) and has an internal QA/QC protocol. The internal QA/QC protocol includes the analysis of matrix spikes, spike blanks and method blanks. The laboratory QA/QC documentation is provided with the analytical report and was reviewed by Arcadis as part of the QA/QC protocol.

4.7 Analytical Program

A summary of the samples that were collected and submitted for laboratory analysis during the groundwater sampling activities is provided in Table 4-2 below. Groundwater sampling logs are included in Appendix C.

Table 4-2: Summary of Groundwater Sample Collection near the NHWL

Sample	Analytical Parameters
MW01 and DUP1	• PHC Fractions F1-F4 and BTEX • Total and dissolved metals • PCBs • Inorganic parameters (major ions, TDS, TSS, colour, pH, conductivity)
MW02	
MW03	
MW04	

5 NON-HAZARDOUS WASTE LANDFILL

5.1 Area Summary

The NHWL is located west of the airstrip, as shown in Figure 1. The monitoring of the NHWL landfill included visual observations to assess its physical integrity, including evidence for erosion, ponding, frost action, settlement and lateral movement. Groundwater samples were collected from the wells located on the northwest (MW03), southeast (MW01), northeast (MW02) and southwest (MW04) sides of the landfill.

A plan view of the NHWL indicating photographic viewpoints can be seen in Figure 2. The visual inspection report, including supporting photo references and drawings, is presented in the following sections, and in Table 5-1 and Table 5-2 below.

5.2 Photographic Record

The photographic record of the NHWL was completed as per the work plan. Prints of the photographs are provided in Appendix A, where photograph captions provide the landfill viewpoint number (as seen on Figure 2), where applicable. Full resolution digital copies of the photographs are provided on the accompanying DVD. Note that in this report, Photo numbers refer to the selected photos in Appendix A and Viewpoint numbers refer to the photos on the DVD.

5.3 Visual Inspection Report

The visual inspection of the NHWL and surrounding area was conducted on August 20, 2016. A plan view of the NHWL indicating photographic viewpoints, observations and locations of groundwater monitoring wells presented in Figure 2, located following Section 11. The visual monitoring checklist was completed using the format requested by INAC and is presented as Table 5-3 of this report. Field notes relating to the visual inspection are included in Appendix D. Table 5-1 and Table 5-2 present the preliminary visual inspection results for 2016 monitoring of the NHWL at CAM-D.

Table 5-1: Preliminary Visual Inspection Report NHWL

Feature	Presence (Y/N)	Severity Rating	Extent
Settlement	Y	Acceptable	Marginal
Erosion	Y	Acceptable	Occasional
Frost Action	N	Not Observed	None
Animal Borrows	N	Not Observed	None
Vegetation	Y	Acceptable	Isolated
Staining	N	Not Observed	None
Vegetation Stress	N	Not Observed	None
Seepage / Ponded Water	Y	Acceptable	Numerous
Debris Exposure	Y	Acceptable	Occasional
Monitoring Well Condition	Y	Good condition - Acceptable	
Overall Landfill Performance		**Marginal**	

Settlement

Several areas of settlement were observed. Horizontal cracks along the berms (Features G, K and L), noted along the northeast and northwest berms, were attributed to slumping of the surface materials. The horizontal cracks are considerably longer and more numerous than observed previously; however, these currently do not appear to have significant impact on landfill stability.

Three additional horizontal cracks were noted on the southwest berm (Features F and N) and the southeast berm (Feature J). Features F and J had been observed previously, and no significant change was noted in 2016. Feature N was noted in 2016.

One small pothole (approximately 1 m^2 and 0.15 m in depth) was observed along the base of the east corner of the NHWL (Feature I). This pothole was considered small in nature and does not impact the integrity of the landfill.

Erosion

Two minor erosion channels were observed on the southwest (Feature A) and northeast (Feature H) berms of the NHWL. No significant change was noted when compared to the 2014 photographs.

Significant solifluction was observed approximately 100 m north of the north corner of the NHWL (Feature E). Solifluction is the gradual downslope movement of sediment, related to the freeze-thaw activity of the ground. Although it is a substantial distance from the NHWL, it may be affecting the slumping observed in the north corner of the NHWL.

Frost Action

No evidence of heaving or cracking was observed on the top or sides of the NHWL.

Evidence of Burrowing Animals

Indications of the presence of burrowing animals were not observed.

Vegetation

One area of vegetation growth was observed along the western edge of the landfill. Vegetation appeared more abundant in 2016 when compared to 2014 photographs.

Staining

Indications of staining on or around the NHWL were not observed.

Seepage / Ponded Water

Significant ponding was observed around the NHWL. Evidence of staining or product seepage from the landfill were not observed. Conditions at the site were generally wet due to recent rainfall, and many areas of saturated soil were observed around the NHWL at the ground surface. No ponded water was observed on the landfill surface, and landfill stability did not appear to be affected.

Exposed Debris

Exposed debris was observed at two locations. A piece of metal was observed at the north corner of the NHWL (Feature O); a wire was sticking out of the surface of the landfill, near the west corner (Feature P).

Discussion

Based on this visual assessment, the landfill performance is rated as marginal (see Table 4-1). The settlement historically observed at the northern corner of the NHWL has developed considerably over the past two years. Horizontal cracks along the northeast and northwest berms have increased in length

since 2014. As well, a couple of lengthy cracks (e.g. 15 to 30 m) were observed in 2016 that had not previously been reported. This northern corner and adjacent berms should be given special attention in future monitoring programs, to determine if further deterioration is observed. A summary of the features with observations and photo references is presented in Table 5-2.

Table 5-2: Visual Monitoring Checklist – CAM-D

Checklist Item	Feature Letter	Relative Location	Length (m)	Width (m)	Depth (m)	Extent	Description (Change)	Additional Comments	Photo Reference
Erosion	A	Top of NHWL, 16 m northwest from the south top corner	0.5 m^2		0.1	<1%	Small erosion rill	No change since 2014	53
Vegetation	B	Bottom of NHWL, 20 m northeast of MW04	10 m^2		---	<1%	Grass vegetation	More abundant growth noted since 2014	54
Ponded Water	C	Numerous areas at base of NHWL	600 m^2		0.2	<1%	Slight low areas	Significantly more ponded water observed in 2016, ponds surround NHWL	3, 4, 9, 10, 14, 27, 28, 34B
Ponded Water	D	Included in above description	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Erosion	E	100 m northeast of north corner of NHWL	60 m (NW to SE)	1-2 m (top to toe of berm)	0.5-1 m (top to toe)	n/a	Area of preferential drainage coupled with fine grained silts, resulting in solifluction	Significant distance from NHWL but may be impacting slumping observed in north corner of the NHWL	13B through 13F

Checklist Item	Feature Letter	Relative Location	Length (m)	Width (m)	Depth (m)	Extent	Description (Change)	Additional Comments	Photo Reference
Settlement	F	Southwest berm of NHWL	15 m	0.2 m	0.2 m	<1%	Small horizontal crack, appears to be slump of surface fill material	Minor in nature	61
Settlement	G	Northwest berm of NHWL	50 m	0.3 to 0.6 m	0.2 m	<1%	Horizontal crack, appears to be slump of surface fill material	Increased in size (length, width, depth and number) since 2014	60, 65, 66
Erosion	H	Northeast berm of NHWL	8 m	0.2 m	0.1 m	<1%	Small erosion rill	No significant change since 2014, minor in nature	59
Settlement	I	East corner of NHWL	1.5 m	0.7 m	0.15 m	<1%	Small pothole	Minor in nature, adjacent to the NHWL	58
Settlement	J	Southeast berm of NHWL	25 m	0.2 m	0.15 m	<1%	Small horizontal crack, appears to be slump of surface fill material	Increased in length since 2014	57
Settlement	K	Northeast berm	30 m	0.05 to 0.15 m	0.05 to 0.12 m	<1%	Horizontal crack, appears to be slump of surface fill material	New feature in 2016	15, 17, 59, 62
Settlement	L	Northeast berm	15 m	0.05 to 0.15 m	0.05 to 0.12 m	<1%	Horizontal crack, appears to be slump of surface fill material	New feature in 2016	15, 17, 59, 63, 64

Checklist Item	Feature Letter	Relative Location	Length (m)	Width (m)	Depth (m)	Extent	Description (Change)	Additional Comments	Photo Reference
Settlement	M	5 m from north corner of NHWL	1 m^2		0.05 m	<1%	Small pothole located at top of erosion channel (Feature H)	New feature in 2016	15, 59
Settlement	N	Middle southwest berm, at toe (near Feature B)	8 m	0.5 m	0.2	<1%	Horizontal crack, at toe of berm	New feature in 2016	54
Debris	O	North corner of NHWL	0.15 m	0.01 m	N/A	<1%	Metal strapping exposed	New feature in 2016	67
Debris	P	Surface of NHWL, near west corner	0.12 m	0.01 m diameter	N/A		Plastic coated wire exposed	New feature in 2016	69

5.4 Groundwater Analytical Results

As described in Section 4.4, a total of five groundwater samples (four samples plus one blind duplicate) were submitted to Maxxam in Yellowknife, Northwest Territories and subsequently shipped to Calgary for analyses of PHCs, metals, PCBs and inorganic parameters. Analytical results are discussed below. The AMSRP Chapter 11 "Post-Construction Monitoring," suggests that analytical results be compared to the mean of previous data. The AMSRP indicates that where groundwater concentrations are within the range of the average ± three standard deviations, the landfill is performing acceptably.

Arcadis used historical data presented in previous reports to obtain means and standard deviations of analytical results from monitoring activities conducted in 2012 and 2014 to establish statistical ULAs. Calculations are shown in Tables 4 and 6, presented at the end of this report. The calculated ULA values are included in the groundwater analytical tables presented in Tables 1, 2, 3 and 5 (attached at the end of this report).

PHCs

Concentrations for all parameters were below laboratory reportable detection limits in 2016 (see Table 1). The range of the average ± three standard deviations could not be calculated as all parameters were below detection limits for both the 2012 and 2014 sampling rounds as well.

PCBs

The PCBs concentrations for all samples were below the detection limit in 2016 (see Table 2). The range of the average ± three standard deviations could not be calculated as all parameters were below the detection limit for both the 2012 and 2014 sampling rounds as well.

Metals

Results for both total and dissolved metal concentrations in collected groundwater samples are presented in Table 3. Historical results (and ULA calculation) are presented in Table 4. Groundwater samples collected from all four wells had low concentrations of several total and dissolved metals. The following exceedances of the FIGQGs were noted:

- Total aluminum concentrations exceeded the FIGQG concentration of 0.1 mg/L in the samples collected from monitoring wells MW03 and MW04. In addition, the dissolved aluminum concentration reported for the sample collected from monitoring well MW4 also exceeded the FIGQG;

- The sample collected from monitoring well MW01 and its duplicate reported total and dissolved cadmium concentrations greater than the FIGQG of 0.017 µg/L. The total cadmium concentration reported in monitoring well MW02 also exceeded the FIGQG. For the remaining analyses (dissolved cadmium concentrations reported in the sample collected from monitoring well MW02 and total and dissolved cadmium concentrations reported in the samples collected from monitoring wells MW03 and MW04), results less than the detection limit were reported; however, the detection limit (0.020 µg/L) is slightly higher than the FIGQG;
- All total and dissolved copper concentrations were reported to be greater than the FIGQG (the guideline was calculated for each sample individually, as it is dependent on water hardness), with the exception of dissolved copper concentrations reported in the sample collected from monitoring well MW03;
- Total iron concentrations reported in the samples collected from monitoring wells MW03 and MW04 exceeded the FIGQG of 0.3 mg/L;
- The total lead concentration reported for the sample collected from monitoring well MW03 exceeded the FIGQG. The guideline was calculated for each sample, as it is dependent on hardness.
- Total and dissolved molybdenum concentrations in the samples collected from monitoring well MW01 (sample plus its duplicate) were reported in excess of the FIGQG of 0.073 mg/L;
- Total and dissolved selenium concentrations in the samples collected from monitoring well MW01 (sample plus its duplicate) were reported in excess of the FIGQG of 0.001 mg/L;
- Total titanium concentrations reported in the samples collected from monitoring wells MW03 and MW04 exceeded the FIGQG of 0.1 mg/L;
- All samples collected from monitoring wells MW01, MW02 and MW03 reported total and dissolved uranium concentrations in excess of the FIGQG of 0.015 mg/L; and
- The sample collected from monitoring well MW04 reported total zinc concentrations slightly above the FIGQG of 0.01 mg/L.

When compared to the re-calculated ULA values (using data from 2012 and 2014), the following exceedances were noted:

- The total chromium concentration reported for the sample collected from monitoring well MW04 exceeded the calculated ULA of 0.0035 mg/L. The dissolved chromium concentration in this sample was reported as non-detect, so it is likely that the chromium is associated with sediment in the sample. The total chromium concentration did not exceed the FIGQG.

Total chromium concentrations exceeded the ULA in 2014 in only the duplicate sample (duplicate of sample MW01). The calculated RPD was considered unacceptable for the MW01 duplicate pair in 2014, perhaps indicating some inconsistency in sample collection and/or analysis. Although results are below the FIGQG, chromium concentrations have increased in three successive years. This indicates a potential concern, based on criteria in the AMRSP and is further evaluated in Section 8.0.

Inorganics

Results for general inorganic parameters are summarized in Table 5. Historical results (and ULA calculation) are presented in Table 6. The following exceedances of the FIGQG and/or ULA were reported:

- The samples collected from monitoring wells MW03 and MW04 reported dissolved nitrite concentrations greater than the FIGQG (0.06 mg/L);
- The samples collected from monitoring wells MW03 and MW04 reported TSS concentrations greater than the ULA (18 mg/L);
- All samples collected reported sulphate concentrations greater than the FIGQG of 100 mg/L;
- The samples collected from monitoring wells MW03 and MW04 reported dissolved chloride concentrations greater than the FIGQG of 120 mg/L; and
- All samples collected reported fluoride concentrations greater than the FIGQG of 0.12 mg/L.

These inorganic parameters can fluctuate considerably from year to year. Given that only two years of data have been used to calculate the means and standard deviations, it is not unexpected to report some exceedances. An exceedance of the ULA for two or more successive monitoring events corresponds to a low risk of failure of the NHWL (AMSRP, Volume II, Chapter 11, Table 4.2). TSS concentrations exceeded the ULA in 2016 but no previous exceedances have been reported.

Laboratory certificates of analyses for the 2016 groundwater samples are provided in Appendix B. Further analysis of the groundwater data, including trend analysis, is provided in Section 8.0.

5.5 QA/QC Discussion

In order to obtain the required minimum of 20% duplicate samples, as stipulated in CAM-D LTM plan, one duplicate groundwater sample was collected from monitoring well MW01 in 2016. Analytical results for submitted samples and their duplicate pairs were compared to provide an indication of the precision of both the field sampling and laboratory analysis methods.

As a quality control check, a Relative Percent Difference (RPD) was calculated when analytical results from both the sample and its duplicate were greater than five times the reportable detection limit (RDL). Results are presented along with analytical results in Tables 1, 2, 3 and 5. As per CCME Guidance (Guidance Manual for Environmental Site Characterization in Support of Human and Health Risk Assessment, Volume I Guidance Manual, CCME, 2016), the RPDs for parameters of duplicate groundwater samples should not exceed 40%.

The TSS analyses had an unacceptable RPD of 41%, slightly exceeding the acceptable value of 40%. High RPDs highlight the difficulty in obtaining true field duplicates. While every effort was made in the field to obtain good-quality duplicates, it is likely that differing amounts of suspended material entered each sample jar during sample collection. This could cause these minor differences in TSS concentrations between primary and duplicate samples.

The groundwater samples analyzed for the remaining metals and inorganics fell within limits of QA/QC acceptability. The internal laboratory quality control for analyses meets acceptability criteria; therefore, based on both laboratory and field QA/QC results, the data is reliable for its intended use. Laboratory QA/QC results are included in the laboratory certificates of analyses provided in Appendix B.

6 SURROUNDING AREAS

The area surrounding the NHWL at the site was also observed, including the air strip and road leading to the NHWL. The North Warning SRR Station was not approached during the site visit in 2016.

Arcadis field personnel observed that the first culvert in the road from the airstrip to the NHWL was deteriorating and there was evidence of erosion at multiple locations along the road.

Pooled water was observed on the airstrip approximately 230 m from its northeast end, refer to Photo 23 in Appendix A. Sufficient airstrip was present to safely land a Dornier 228 near the southwest end of the airstrip. However, the airstrip is comprised of loosely compacted coarse sand and gravel which may be problematic for the landing gear on heavier aircrafts. The wheels of the landing gear on the Dornier 228 sank between 4 to 6 cm into the airstrip, refer to Photo 24 in Appendix A.

An area of solifluction (Feature E) was observed approximately 100 m northeast of the NHWL; see Photos 1 and 12 in Appendix A. This area of erosion is sufficiently distant from the NHWL to be of no concern to the landfill integrity, however, the area should be monitored in subsequent site visits.

7 NATURAL ENVIRONMENT

Long-Term Monitoring plans for other, similarly managed INAC sites recommend monitoring the following parameters to better understand the presence and temporal changes to wildlife and the natural environment:

- Wildlife sightings
- Other evidence of recent presence of wildlife (e.g. droppings, tracks)
- Wildlife activity (e.g. nesting, migration)
- Qualitative assessment of relative numbers versus previous years
- Revegetation of disturbed areas versus previous years

Information regarding these parameters was either gathered directly, through personal observation while on site or indirectly, and through our wildlife monitor, a member of the Ekaluktutiak Hunters and Trappers Organization.

Wildlife and Human Activity

Information was gathered from the wildlife monitor, Mr. Jimmy Evalik, a member of the Ekaluktutiak Hunters and Trappers Organization in Cambridge Bay, Nunavut.

Previous wildlife monitors have indicated that the site is not frequently used by people for hunting or fishing. The site may be infrequently visited by muskox hunting parties from Kugaaruk, but not very often, and the site is rarely visited by residents of Gjoa Haven. Mr. Adam Ukuqtunnuak reported that wildlife known to be present in the area of the site included wolves, wolverine, caribou, grizzly bear, ground squirrel, rabbits and snow geese.

A soapstone quarry has been reported to be located approximately 30-50 km west northwest of the site, though it is unlikely that persons gathering soapstone would visit the site. The site may also be infrequently visited by individuals travelling between Kugaaruk and Gjoa Haven during the winter.

During the site visit, the following wildlife sightings and evidence of wildlife were observed between late morning and late afternoon of August 20, 2016:

- A flock of snow geese were observed approximately 10 km north of the site upon arrival;
- 4 caribou (3 female and 1 male) were observed approximately 100 m southwest of the airstrip upon arrival;

- Caribou tracks and scat on top of NHWL;
- Single, male caribou approximately 600 m south of NHWL was observed in the late afternoon.

Re-establishment of Vegetation

Major site remedial work, comprised of excavation and construction activities, was completed in the summer of 2011. Little evidence of revegetation was observed in August 2014; increased growth was observed in 2016. Given the regional setting and elevation of the CAM-D DEW Line site and re-growth observed at other, similar sites in the Nunavut region, it is reasonable to assume that it will take several years to decades for native vegetation to fully re-establish at the site.

A lone area of vegetation (sedge grass) was observed to be taking root at the southwest toe of the NHWL; it is identified as Feature B in Figure 2 (Photo 54).

8 PHASE I ASSESSMENT

LTM has been conducted at the CAM-D site in 2012, 2014 and 2016. This represents the end of Phase I, as outlined in the LTM Plan (INAC, 2010). An assessment of the data collected to date is included, to consider if monitoring should continue according to the LTM Plan, or if modifications are required.

8.1 Evaluation of CAM-D Data

8.1.1 Visual Monitoring Summary

The physical integrity of the NHWL and surrounding areas were assessed during each monitoring event using systematic visual observations and empirical measurements to record evidence of erosion, ponding, frost action, settlement and lateral movement of the landfills. A photographic record was completed to document the condition of the structures and substantiate the visual observations.

Features of note at the NHWL included horizontal cracking along the northwest and northeast berms, which has increased considerably since 2014. In addition, an area of solifluction was observed at this corner, approximately 100 m north of the NHWL, which could be contributing to the observed slumping. Other features include minor erosion channels, ponded water around the NHWL, two areas of exposed debris as well as increased vegetation in one location.

The increase in settlement observed at the northern corner of the NHWL (between northwest and northeast berms) has developed considerably over the past two years. Horizontal cracks along the northeast and northwest berms have increased in length since 2014. As well, a couple of lengthy cracks (e.g. 15 to 30 m) were observed in 2016 that had not previously been reported.

Table 5-2, in Section 5.3, summarizes the features observed during the visual inspections conducted in 2012, 2014 and 2016.

New features have been identified in each year of monitoring, with several significant changes observed in 2016. It does not appear that the NHWL has yet stabilized in the years since its construction. Based on evaluation criteria from the AMSRP Volume II: Technical Supporting Documentation (Chapter 11), the landfill performance is rated as marginal (see Table 4-1). No significant impact on NHWL stability has been observed to date, but the potential for failure is assessed as low or moderate.

8.1.2 Analytical Monitoring Summary

8.1.2.1 Summary of Samples Collected

The following table summarizes the samples collected during Years 1, 3 and 5 of the LTM activities.

Table 8-1: Summary of Samples Collected during LTM Events at CAM-D

Year	GW Samples	Soil Samples
2012	Groundwater samples were collected from monitoring wells MW01, MW03 and MW04, with a duplicate sample collected from MW04.	Four test pits were advanced, with 2 soil samples collected from each test pit at different depths.
2014	Groundwater samples were collected from all 4 monitoring wells, with a duplicate sample collected from monitoring well MW01.	None – no evidence of seepage or staining observed
2016	Groundwater samples were collected from all 4 monitoring wells, with a duplicate sample collected from monitoring well MW01.	None – no evidence of seepage or staining observed

8.1.2.2 Summary of Results for CAM-D

Groundwater

Over the three LTM events, a total of 11 groundwater samples have been collected and at least two groundwater samples have been collected from all wells. This represents a good data set for evaluation of the first phase of LTM. No background samples were collected during remedial activities, so results have been compared to previous LTM data, as it is reported and the FIGQGs. As the ULA is calculated based on previous data, this analysis will focus on comparison to the FIGQGs.

In 2012 and 2014, groundwater samples were only analysed for select metals (arsenic, cadmium, chromium, cobalt, copper, lead, nickel and zinc). In 2016, groundwater samples were analysed for a full metals suite (CCME metals). Analysis of the data reported for the select metals provides the best interpretation of trends observed over the years.

The FIGQGs apply to groundwater samples collected by standard methods, which refers to samples that have been field filtered and preserved accordingly. As per the Sampling Plan, groundwater samples analysed for total metals were not field filtered and samples analysed for dissolved metals were field

filtered. Both groundwater samples analysed for total and dissolved metals were collected in laboratory supplied bottles pre-charged with preservative. Because the analysis of unfiltered total metals includes the metal ions adsorbed to sediment particles captured in the groundwater sample, the total metal concentration measured in the groundwater sample maybe an over representation of the actual total metal concentration in the groundwater. Although the low flow sampling technique used in the field program limits the amount of sediment particles captured in the groundwater sample, some sediment might still be collected within the groundwater sample. As a result, the FIGQGs represent very conservative guidelines in this situation. The copper guideline is derived from the surface water guideline for the protection of freshwater aquatic life, assuming the groundwater well is less than 50 m from the surface water (the CAM-D NHWL is approximately 900 m from the nearest surface water body). The cadmium guideline is calculated based on water hardness and can be below laboratory detection limits (as is the case with the 2016 samples from MW03 and MW04). Given the conservative nature of these guidelines, the reported exceedances themselves are not a significant concern. If increasing trends were to be observed or metal concentrations remained high for several years, there may be cause for concern.

Cadmium and copper concentrations have always been greater than the FIGQG of 0.017 µg/L in all samples collected from all monitoring wells. Highest concentrations of each metal were observed in 2012 (monitoring wells MW03 and MW04) and 2014 (monitoring wells MW01 and MW02). Several zinc exceedances of the FIGQG have been reported over the years; most have been reported in samples collected from monitoring well MW01, although the samples collected from monitoring well MW03 in 2012 and monitoring well MW04 in 2016 also reported zinc in concentrations greater than the FIGQG. No increasing trend is observed.

Although consistently below the FIGQG, increasing trends of total arsenic (MW04), chromium (MW03 and MW04) and cobalt (MW03) concentrations have been reported. The reported 2016 concentrations are considerably higher than previous data; however, TSS concentrations were also higher in 2016. For example, total chromium concentrations in the sample collected from monitoring well MW04 were six times higher than the 2014 results, but dissolved chromium concentrations were below detection limits, which is similar to previous results. The chromium atoms are likely associated with the sediment in the sample (TSS concentrations were reported to be 61 mg/L in monitoring well MW04 in 2016, compared to previous non-detect concentrations). Based on the AMRSP Volume II: Technical Supporting Documentation (Chapter 11), increasing trends in data over two or more successive monitoring events signifies a “marginal” evaluation, with “low risk of failure”.

Exceedances of other metals were reported in 2016 (e.g. aluminium, iron, molybdenum, selenium, titanium and uranium); however, as this is the only year of data collected for these parameters, trends are not possible to determine.

Concentrations of sulphate, fluoride and, in several instances chloride, have been reported to be higher than the respective FIGQG in all samples collected since 2012. This indicates the groundwater is highly mineralized. High concentrations of nitrite and TSS were reported in samples collected from monitoring well MW03 and MW04 in 2016. Natural fluctuation of these inorganic parameters is to be expected.

Concentrations of PHCs and PCBs have always been below detection limits, in all samples collected from the monitoring wells at CAM-D since 2012.

Climate change is a reality in the arctic, and consequences are unknown. At this stage, it can be assumed that ground temperature thermal regimes have reached equilibrium within the CAM-D NHWL, based on statements in the AMSRP. Forthcoming climate change could influence ground temperatures and permafrost; future groundwater sample collection would monitor any changes.

Soil

Soil samples were only collected in 2012, so trend analysis is not possible. The soil samples were collected for the purposes of establishing baseline conditions (at Year 1). No concerns were noted at this time.

8.2 Recommendations

Based on systematic visual observations and measurements, photographic documentation and analytical results, the CAM-D NHWL is considered to be in marginal condition with a low risk of failure. Based on the AMRSP Volume II (Chapter 11, Tables 4.1 and 4.2), increasing the monitoring frequency is recommended. As 2016 represented Year 5 of the LTM, it is recommended that the Phase I LTM be extended and additional monitoring events take place in Year 7 (2018), Year 9 (2020) and Year 11 (2022).

Given the low solubility of PCBs in water, analyses of PCBs could be discontinued as they were not detected in the first five years of monitoring, as per the AMSRP (Volume II, Chapter 11). Arcadis also recommends that all metal parameters included in the full CCME metals suite continue to be analyzed in groundwater samples collected during future LTM events.

Arcadis recommends collecting soil samples only when seepage or staining has been identified as part of the visual inspection.

9 CONCLUSION

Overall, physical observations suggest that the NHWL is in marginal condition. It is currently performing as designed to contain the enclosed waste, although considerable deterioration was noted in the two years since the previous monitoring event. In particular, horizontal cracks running along the northeast and northwest berms have developed, indicating that this corner of the NHWL may be unstable.

Minor areas of erosion were identified on all four berms of the NHWL. Ponded water was observed on the ground surface around the base of the landfill. Two small potholes have developed on the outside of the NHWL. Some exposed debris was observed in the north corner and on top of the NHWL near the west corner. These features are considered to be of little consequence at the present time.

In addition to physical observations, Arcadis collected groundwater samples to assess the performance of the NHWL. Concentrations of contaminants of concern in groundwater were compared to historical groundwater results from 2012 and 2014. Total chromium concentrations in the sample collected from MW04 and TSS concentrations in the samples collected from monitoring well MW03 and MW04 exceeded their respective calculated ULA.

A number of total and dissolved metals in all five groundwater samples collected reported concentrations above the CCME FIGQGs pathway specific guidelines for protection of freshwater life. Given the site conditions and location of the NHWL in relation to surface water bodies (none in the near vicinity), Arcadis believes that these concentrations are not a concern at this time.

Based on the results of Year Five visit of long-term monitoring, Arcadis recommends continued monitoring at an increased frequency of the features identified, especially the northern corner of the NHWL where horizontal cracks have developed in the past couple of years (Figure 2). As 2016 represented Year 5 of the LTM, it is recommended that the Phase I LTM be extended and additional monitoring events take place in Year 7 (2018), Year 9 (2020) and Year 11 (2022).

10 LIMITATIONS

This report has been prepared exclusively for Indigenous and Northern Affairs Canada. Any other person or entity may not rely upon the report without the express written consent from Indigenous and Northern Affairs Canada.

Any use, which a third party makes of this report, or any reliance on decisions made based on it, is the responsibility of such third parties. Arcadis Canada Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Some of the information presented in this report was provided through existing documents and interviews. Although attempts were made, whenever possible, to obtain a minimum of two confirmatory sources of information, Arcadis Canada Inc., in certain instances, has been required to assume that the information provided is accurate.

The conclusions presented represent the best judgment of the assessors based on current environmental standards and on the site conditions observed on August 20, 2016. Due to the nature of the investigation and the limited data available, the assessors cannot warrant against undiscovered environmental liabilities.

Should additional information become available, Arcadis Canada Inc. requests that this information be brought to our attention so that we may re-assess the conclusions presented herein.

There is no warranty, expressed or implied that the work reported herein has uncovered all potential environmental liabilities, nor does the report preclude the possibility of contamination outside of the areas of investigation. The findings of this report were developed in a manner consistent with a level of care and skill normally exercised by members of the environmental science and engineering profession currently practicing under similar conditions in the area.

A potential remains for the presence of unknown, unidentified, or unforeseen surface and sub-surface contamination. Any evidence of such potential site contamination would require appropriate surface and sub-surface exploration and testing.

If new information is developed in future work (which may include excavations, borings, or other studies), Arcadis Canada Inc. should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

11 REFERENCES

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TABLES

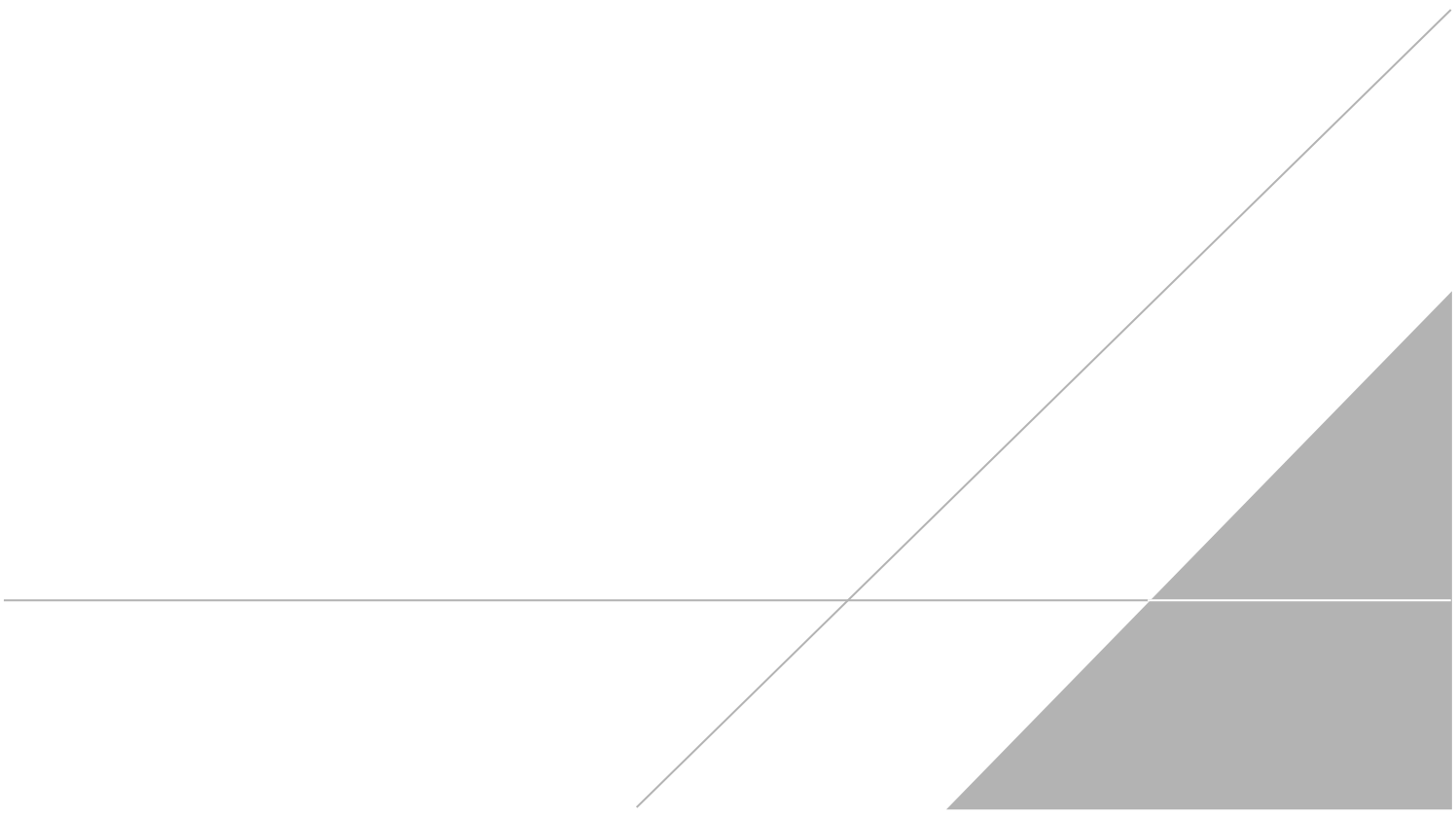


Table 1
PHC Analytical Results for Groundwater Samples
Indigenous and Northern Affairs Canada

ARCADIS Design & Consultancy for natural and built assets

PARAMETER	FIGQGs[1]	Upper Limit of Acceptability[2]	RDL	MW01			MW02	MW03	MW04
Sample ID									
Date				2016-08-20	2016-08-20	RPD	2016-08-20	2016-08-20	2016-08-20
BTEX & F1 Hydrocarbons (ug/L)					Duplicate				
Benzene	140	NC	0.40	<0.40	<0.40	NC	<0.40	<0.40	<0.40
Toluene	83	NC	0.40	<0.40	<0.40	NC	<0.40	<0.40	<0.40
Ethylbenzene	11000	NC	0.40	<0.40	<0.40	NC	<0.40	<0.40	<0.40
o-Xylene	NA	NC	0.80	<0.40	<0.40	NC	<0.40	<0.40	<0.40
p+m-Xylene	NA	NC	0.40	<0.80	<0.80	NC	<0.80	<0.80	<0.80
Total Xylenes	3900	NC	0.80	<0.80	<0.80	NC	<0.80	<0.80	<0.80
F1 (C6-C10)	810	NC	100	<100	<100	NC	<100	<100	<100
F1 (C6-C10) - BTEX	NA	NC	100	<100	<100	NC	<100	<100	<100
F2-F4 Hydrocarbons (mg/L)									
F2 (C10-C16 Hydrocarbons)	1300	NC	0.10	<0.10	<0.10	NC	<0.10	<0.10	<0.10
F3 (C16-C34 Hydrocarbons)	NA	NC	0.20	<0.20	<0.20	NC	<0.20	<0.20	<0.20
F4 (C34-C50 Hydrocarbons)	NA	NC	0.20	<0.20	<0.20	NC	<0.20	<0.20	<0.20
Reached Baseline at C50	NA	NC	N/A	Yes	Yes	NC	Yes	Yes	Yes

Notes:

1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (mg/L), Tier 1, Freshwater Life pathway for coarse grained soils.

2 = Upper Limit of Acceptability is determined as described in Report Section 3.2.1. Upper limits of acceptability are calculated using mean of baseline data +3 standard deviations.

N/A = Not Applicable

NC = Not calculated. Where there are no values other than "non-detect," no standard deviation is calculated. The acceptable range for these samples should be close to the detection limit.

RDL= Reportable Detection Limit

20 = Exceeds CCME guideline

21 = Exceeds Upper Limit of Acceptability

PARAMETER	CCME FIGQGs[1]	Upper Limit of Acceptability[2]	MW01			MW02	MW03	MW04
Sample ID								
Date			2016-08-20	2016-08-20	RPC	2016-08-20	2016-08-20	2016-08-20
PCBs (ug/L)				Duplicate				
Aroclor 1016	NG	NC	<0.05	<0.05	NC	<0.05	<0.05	<0.05
Aroclor 1221	NG	NC	<0.05	<0.05	NC	<0.05	<0.05	<0.05
Aroclor 1232	NG	NC	<0.05	<0.05	NC	<0.05	<0.05	<0.05
Aroclor 1242	NG	NC	<0.05	<0.05	NC	<0.05	<0.05	<0.05
Aroclor 1248	NG	NC	<0.05	<0.05	NC	<0.05	<0.05	<0.05
Aroclor 1254	NG	NC	<0.05	<0.05	NC	<0.05	<0.05	<0.05
Aroclor 1260	NG	NC	<0.05	<0.05	NC	<0.05	<0.05	<0.05
Aroclor 1262	NG	NC	<0.05	<0.05	NC	<0.05	<0.05	<0.05
Aroclor 1268	NG	NC	<0.05	<0.05	NC	<0.05	<0.05	<0.05
Total PCB	NG	NC	<0.05	<0.05	NC	<0.05	<0.05	<0.05

Notes:

1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (mg/L), Tier 1, Lowest Guideline for coarse grained soils.

2 = Upper Limit of Acceptability is determined as described in Report Section 3.2.1. Upper limits of acceptability are calculated using mean of baseline data +3 standard deviations.

NC = Not calculated. Where there are no values other than "non-detect," no standard deviation is calculated. The acceptable range for these samples should be close to the detection limit.

NG = No Guideline

Table 3
Metal Analytical Results for Groundwater Samples
Indigenous and Northern Affairs Canada

PARAMETER		Guidelines			Lowest RDL	MW01						MW02		MW03		MW04	
Sample ID		FIGQGs[1]	Upper Limit of Acceptability[2]														
Date						2016-08-20	2016-08-20	RPD	2016-08-20	2016-08-20	RPD	2016-08-19	2016-08-19	2016-08-19	2016-08-19	2016-08-19	2016-08-19
Metals	Units	Total	Total	Dissolved		Total	Duplicate		Dissolved	Duplicate		Total	Dissolved	Total	Dissolved	Total	Dissolved
Aluminum (Al)	mg/L	0.1	NC	NC	0.003	0.022	0.023	4%	0.0079	0.0071	NC	0.063	0.0061	1.2	0.023	5.9	0.83
Antimony (Sb)	mg/L	2.0	NC	NC	0.00060	0.0016	0.0016	NC	0.0014	0.0014	NC	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060
Arsenic (As)	mg/L	0.005	0.006	0.006	0.0002	0.0026	0.0027	4%	0.0026	0.0026	0%	0.00041	0.00029	0.0017	0.0013	0.0016	0.0013
Barium (Ba)	mg/L	0.5	NC	NC	0.01	0.011	0.011	NC	<0.010	<0.010	NC	0.011	<0.010	0.039	0.029	0.039	0.014
Beryllium (Be)	mg/L	0.0053	NC	NC	0.001	<0.0010	<0.0010	NC	<0.0010	<0.0010	NC	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Boron (B)	mg/L	5	NC	NC	0.02	0.073	0.072	NC	0.073	0.072	NC	0.049	0.047	0.067	0.063	0.063	0.058
Cadmium	ug/L	0.017	1.4	0.24	0.02	0.043	0.072	NC	0.051	0.063	NC	0.026	<0.020	<0.020	<0.020	<0.020	<0.020
Calcium (Ca)	mg/L	NG	NC	NC	0.3	67	67	0%	66	66	0%	96	93	60	55	26	24
Chromium (Cr)	mg/L	0.0089	0.0035	0.0018	0.0010	0.0011	0.0011	NC	<0.0010	<0.0010	NC	<0.0010	<0.0010	0.0029	<0.0010	0.0065	<0.0010
Chromium VI (6+)	mg/L	NG	NC	NC	0.0010	<0.0010	<0.0010	NC	NA	NA	NC	<0.0010	NA	<0.0010	NA	<0.0010	NA
Cobalt (Co)	mg/L	NG	0.0014	0.0010	0.0003	0.00063	0.00062	NC	0.00059	0.00059	NC	0.00089	0.00085	0.0010	0.00031	0.0015	<0.00030
Copper (Cu)	mg/L	0.002-0.004 [3]	0.065	0.055	0.0002	0.02	0.02	0%	0.012	0.012	0%	0.0080	0.0076	0.0071	0.0040	0.013	0.0029
Iron (Fe)	mg/L	0.3	NC	NC	0.060	<0.060	<0.060	NC	<0.060	<0.060	NC	0.10	<0.060	2.0	0.12	4.1	<0.060
Lead (Pb)	mg/L	0.001-0.007 [3]	0.0050	0.0042	0.0002	0.00076	0.00079	NC	0.00078	0.00074	NC	0.0027	<0.00020	0.00083	<0.00020	0.00092	<0.00020
Lithium (Li)	mg/L	NG	NC	NC	0.02	0.15	0.15	0%	0.14	0.15	7%	0.051	0.047	0.078	0.068	0.029	<0.020
Magnesium (Mg)	mg/L	NG	NC	NC	0.2	65	66	2%	64	64	0%	99	98	72	66	15	13
Manganese (Mn)	mg/L	NG	NC	NC	0.004	0.078	0.08	3%	0.072	0.074	3%	0.73	0.70	0.11	0.075	0.075	0.015
Mercury (Hg)	ug/L	0.026	NC	NC	0.002	0.0029	<0.0020	NC	<0.0020	<0.0020	NC	0.0028	<0.0020	0.0024	<0.0020	<0.0020	<0.0020
Molybdenum (Mo)	mg/L	0.073	NC	NC	0.0002	0.085	0.086	1%	0.083	0.084	1%	0.0093	0.0093	0.036	0.033	0.0082	0.0083
Nickel (Ni)	mg/L	0.025-0.15 [3]	0.059	0.043	0.0005	0.03	0.03	0%	0.026	0.027	4%	0.0031	0.0028	0.012	0.0088	0.0037	0.00055
Phosphorus (P)	mg/L	NG	NC	NC	0.1	<0.10	<0.10	NC	<0.10	<0.10	NC	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Potassium (K)	mg/L	NG	NC	NC	0.3	18	18	0%	18	18	0%	9.5	9.0	29	26	23	19
Selenium (Se)	mg/L	0.001	NC	NC	0.0002	0.0049	0.0049	0%	0.0060	0.0046	26%	<0.00020	0.00030	0.00039	0.00051	0.00036	0.00040
Silicon (Si)	mg/L	NG	NC	NC	0.1	4.9	4.9	0%	4.6	4.7	2%	2.8	2.6	4.5	2.4	7.6	0.83
Silver (Ag)	mg/L	0.0001	NC	NC	0.0001	<0.00010	<0.00010	NC	<0.00010	<0.00010	NC	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Sodium (Na)	mg/L	NG	NC	NC	0.50	910	910	0%	860	870	1%	51	48	230	210	140	130
Strontium (Sr)	mg/L	NG	NC	NC	0.020	0.71	0.72	1%	0.68	0.69	1%	0.41	0.39	0.41	0.37	0.18	0.16
Sulphur (S)	mg/L	NG	NC	NC	0.20	620	610	2%	590	600	2%	110	100	150	130	61	61
Thallium (Tl)	mg/L	0.0008	NC	NC	0.0002	<0.00020	<0.00020	NC	<0.00020	<0.00020	NC	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Tin (Sn)	mg/L	NG	NC	NC	0.0010	<0.0010	<0.0010	NC	<0.0010	<0.0010	NC	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)	mg/L	0.1	NC	NC	0.0010	0.0014	0.0012	NC	<0.0010	<0.0010	NC	0.0052	<0.0010	0.11	<0.0010	0.27	<0.0010
Uranium (U)	mg/L	0.015	NC	NC	0.0001	0.27	0.28	4%	0.27	0.27	0%	0.19	0.19	0.074	0.064	0.0048	0.0047
Vanadium (V)	mg/L	NG	NC	NC	0.0010	0.001	0.0011	NC	<0.0010	<0.0010	NC	<0.0010	<0.0010	0.0047	<0.0010	0.0089	<0.0010
Zinc (Zn)	mg/L	0.01	0.021	0.014	0.0030	0.0052	0.0051	NC	0.0034	<0.0030	NC	<0.0030	<0.0030	0.0069	0.0034	0.011	<0.0030

Notes:

1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (mg/L), Tier 1, Lowest Guideline for coarse grained soils

2 = Upper Limit of Acceptability is determined as described in Report Section 3.2.1. Upper limits of acceptability are calculated using mean of previous sampling rounds +3 standard deviations.

3 = Guideline depends on hardness, guideline calcuated for each sample and compared to result

NC: Not calculated

NG: No guideline

NA: Not Analyzed

RDL= Reportable Detection Limit

20 = Exceeds FIGQG guideline.

20 = Results exceeds ULA

Table 4
Calculation of ULAs for Metal Parameters
Indigenous and Northern Affairs Canada

Sample #	Date	Total Arsenic (As)	Dissolved Arsenic (As)	Total Cadmium (Cd)	Dissolved Cadmium (Cd)	Total Cobalt (Co)	Dissolved Cobalt (Co)	Total Chromium (Cr)	Dissolved Chromium (Cr)	Total Copper (Cu)	Dissolved Copper (Cu)	Total Nickel (Ni)	Dissolved Nickel (Ni)	Total Lead (Pb)	Dissolved Lead (Pb)	Total Zinc (Zn)	Dissolved Zinc (Zn)
Surface Water Samples																	
MW01	2012	3.7	3.9	0.18	0.130	0.44	0.42	1.8	1.6	12	11	1.0	9.4	3.1	2.9	12	9.7
MW03	2012	1.6	1.6	1.1	0.061	0.44	<0.3	<1.0	<1.0	46	41	3.6	3.1	1.0	0.55	11	8.0
MW04	2012	0.44	0.45	0.075	0.042	0.50	0.41	<1.0	<1.0	24	21	7.5	6.6	<0.2	<0.2	5.6	3.3
MW01	2014	4.2	3.1	0.23	0.17	1.2	0.80	2.9	<1.0	38	27	45	33	2.9	2.0	14	9.2
MW02	2014	0.52	0.35	0.030	0.026	0.44	0.31	1.1	<1.0	32	20	5.8	3.9	0.73	<0.20	4.3	6.5
MW03	2014	1.1	0.82	0.053	0.046	0.52	0.42	1.2	<1.0	17	10	18	14	0.40	<0.20	7.3	8.0
MW04	2014	0.72	0.55	0.024	0.023	<0.30	<0.30	1.1	<1.0	13	6.9	3.8	2.5	<0.20	<0.20	<3.0	4.6
MW01	2016	2.6000	2.7000	0.043	0.072	0.63	0.62	1.1000	1.1000	20.0	20.0	30.0	30.0	0.76	0.79	5.2	5.1
MW02	2016	0.41000	0.29000	0.026	<0.020	0.89	0.85	<1	<1	8.0	7.6	3.1	2.8	2.70	<0.20	<3	<3
MW03	2016	1.7000	1.3000	<0.020	<0.020	1.0	0.31	2.9000	<1	7.1	4.0	12.0	8.8	0.83	<0.20	6.9	3.4
MW04	2016	1.6000	1.3000	<0.020	<0.020	1.5	<0.30	6.5000	<1	13.0	2.9	3.7	0.55	0.92	<0.20	11	<3
Statistics																	
N Value		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
N Value [2012 & 2014 only]		7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Average		1.77	1.58	0.15	0.06	0.704167	0.48	1.9	1.05833333	20.2	15.3	13.3	11.8	1.2	0.7	7.225	5.6
Average [2012 & 2014 only]		1.75	1.54	0.24	0.07	0.55	0.42	1.44	1.09	26.0	19.6	12.1	10.4	1.22	0.89	8.17142857	7.04
Minimum		0.41	0.29	0.02	0.02	0.3	0.3	1	1	7.1	2.9	1	0.55	0.2	0.2	3	3
Maximum		4.2	3.9	1.1	0.17	1.5	0.85	6.5	1.6	46	41	45	33	3.1	2.9	14	9.7
Standard Deviation (s)* [2012 & 2014 only]		1.6	1.4	0.39	0.06	0.30	0.18	0.7	0.23	13	12	16	11	1.3	1.1	4.2	2.4
Acceptable Range (Average +/- 3s)		0 < 6.4	0 < 5.8	0 < 1.4	0 < 0.24	0 < 1.4	0 < 1	0 < 3.5	0 < 1.8	0 < 65	0 < 55	0 < 59	0 < 43	0 < 5	0 < 4.2	0 < 21	0 < 14

Detection limits are converted to results to calculate average and standard deviation
Zero is substituted for negative values where average minus 3s is less than zero
NC: Not calculated. Where there are no values other than "non-detect," no standard deviation is calculated. The acceptable range for these samples should be close to the detection limit.

PARAMETER		FIGQGs[1]	Upper Limit of Acceptability[2]	RDL	MW01		RPD	MW02	MW03	MW04
Sample ID										
Date					2016-08-20	2016-08-20		2016-08-20	2016-08-20	2016-08-20
Calculated Parameters						Duplicate				
Anion Sum	meq/L	NG	NC	N/A	53	50	6%	15	19	9.6
Cation Sum	meq/L	NG	NC	N/A	47	47	0%	15	18	8.6
Hardness ($CaCO_3$)	mg/L	NG	NC	0.50	430	430	0%	640	410	110
Ion Balance	N/A	NG	NC	0.010	0.88	0.93	6%	0.97	0.92	0.90
Dissolved Nitrate (NO_3)	mg/L NO_3	13	NC	0.044	5.8	5.8	0%	1.1	1.4	1.4
Nitrate plus Nitrite (N)	mg/L	NG	15	0.020	1.3	1.3	0%	0.24	0.36	0.40
Dissolved Nitrite (NO_2)	mg/L NO_2	0.06	NC	0.033	<0.033	<0.033	NC	<0.033	**0.18**	**0.25**
Misc. Inorganics										
Conductivity	uS/cm	NG	5863	1.0	4400	4400	0%	1400	1800	990
pH	pH	6.5-9.0	7 < 9	N/A	7.96	7.98	0%	7.60	7.86	8.47
Colour	PtCo units	NG	22	2	18	17	6%	7.1	9.1	5.1
Total Dissolved Solids	mg/L	NG	4406	10	3100	3100	0%	870	1200	590
Total Suspended Solids	mg/L	NG	18	1.0	8.0	5.3	**41%**	4.0	21	61
Anions										
Alkalinity (PP as $CaCO_3$)	mg/L	NG	NC	0.50	<0.50	<0.50	NC	<0.50	<0.50	1.6
Alkalinity (Total as $CaCO_3$)	mg/L	NG	NC	0.50	460	460	0%	350	260	99
Bicarbonate (HCO_3)	mg/L	NG	NC	0.50	560	560	0%	430	320	120
Carbonate (CO_3)	mg/L	NG	NC	0.50	<0.50	<0.50	NC	<0.50	<0.50	1.9
Hydroxide (OH)	mg/L	NG	NC	0.50	<0.50	<0.50	NC	<0.50	<0.50	<0.50
Dissolved Sulphate (SO_4)	mg/L	100	2279	1.0	**1900**	**1800**	5%	**310**	**420**	**190**
Dissolved Chloride (Cl)	mg/L	120	286	1.0	110	110	0%	65	**190**	**130**
Dissolved Fluoride (F)	mg/L	0.12	2	0.050	**0.64**	**0.67**	5%	**0.93**	**1.4**	**1.1**
Nutrients										
Dissolved Nitrite (N)	mg/L N	NG	0.13	0.010	<0.010	<0.010	NC	<0.010	0.054	0.077
Dissolved Nitrate (N)	mg/L N	NG	15	0.010	1.3	1.3	0%	0.24	0.31	0.33

Notes:

1 = Table 1: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (mg/L), Tier 1, Freshwater life pathway for coarse grained soils.

2 = Upper Limit of Acceptability is determined as described in Report Section 3.2.1. Upper limits of acceptability are calculated using mean of baseline data +3 standard deviations.

NG = No guideline
NC = Not calculated
RDL= Reportable Detection Limit
RPD = Relative Percent Difference
20 = Exceeds FIGQG guideline
20 = Results exceeds ULA

Table 6
Calculations of ULAs for PHCs and Inorganic Parameters
Indigenous and Northern Affairs Canada

Sample #	Location	Date	PCBs [ug/L]	PHC								Inorganic Parameters (mg/L)											
				Benzene [ug/L]	Toluene [ug/L]	Ethyl-benzene [ug/L]	Total Xylene [ug/L]	F1 [ug/L]	F2 [ug/L]	F3 [ug/L]	F4 [ug/L]	Colour	Conductivity	Total Dissolved Solids	Fluoride (F-)	Orthophosphate (P)	pH	Total Suspended Solids	Dissolved Sulphate (SO4)	Dissolved Chloride (Cl)	Nitrite (N)	Nitrate (N)	Nitrate + Nitrite
Surface Water Samples																							
MW01		2012	<0.05	<0.20	<0.20	<0.20	<0.40	<25	<100	<100	<100	16	3000	2210	1.07	<0.010	7.98	<10	1100	160	0.10	0.48	0.59
MW03		2012	<0.05	<0.20	<0.20	<0.20	<0.40	<25	<100	<100	<100	8	2100	1410	1.29	<0.010	7.85	15	550	170	0.054	0.57	0.63
MW04		2012	<0.3	<0.20	<0.20	<0.20	<0.40	<25	<100	<100	<100	5	1300	888	0.31	<0.010	7.43	<10	390	59	<0.010	0.44	0.44
MW01		2014	<0.05	<0.20	<0.20	<0.20	<0.40	<25	<100	<200	<200	14	4600	3420	0.7	<0.010	8.16	14	1700	140	0.02	0.31	0.33
MW02		2014	<0.05	<0.20	<0.20	<0.20	<0.40	<25	-	-	-	11	1200	802	0.41	<0.010	7.91	<10	190	44	<0.010	11.9	11.9
MW03		2014	<0.05	<0.20	<0.20	<0.20	<0.40	<25	<100	<200	<200	9	2000	1350	0.67	<0.010	7.93	<10	430	180	0.036	3.13	3.17
MW04		2014	<0.05	<0.20	<0.20	<0.20	<0.40	<25	<100	<200	<200	7	1500	956	0.34	<0.010	7.90	<10	380	120	0.014	2.51	2.53
MW01		2016	<0.05	<0.40	<0.40	<0.40	<0.80	<100	<100	<200	<200	18	4400	3100	0.64	-	7.96	8.0	1900	110	<0.010	1.3	1.3
MW02		2016	<0.05	<0.40	<0.40	<0.40	<0.80	<100	<100	<200	<200	7.1	1400	870	0.93	-	7.6	4	310	65	<0.010	0.24	0.24
MW03		2016	<0.05	<0.40	<0.40	<0.40	<0.80	<100	<100	<200	<200	9.1	1800	1200	1.4	-	7.86	21	420	190	0.054	0.31	0.36
MW04		2016	<0.05	<0.40	<0.40	<0.40	<0.80	<100	<100	<200	<200	5.1	990	590	1.1	-	8.47	61	190	130	0.077	0.33	0.4
Statistics																							
N Value			11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
N Value [2012 & 2014 only]			7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Average			<0.3	<0.4	<0.4	<0.4	<0.8	<100	<100	<200	<200	10	2208	1527	0.81	<0.01	7.9	15.7	687.27273	124	0.036	2.0	2.0
Average [2012 & 2014 only]			<0.3	<0.2	<0.2	<0.2	<0.4	<25	<100	<200	<200	10.0	2243	1577	0.68	<0.01	7.9	11.3	677.14286	125	0.035	2.8	2.8
Minimum			<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	5	990	590	0.31	<0.01	7.43	4	190	44	0.01	0.24	0.24
Maximum			<0.3	<0.4	<0.4	<0.4	<0.8	<100	<100	<200	<200	18	4600	3420	1.4	<0.01	8.47	61	1900	190	0.1	11.9	11.9
Standard Deviation (s)* [2012 & 2014 only]			NC	NC	NC	NC	NC	NC	NC	NC	NC	4	1207	943	0	NC	0	2	534	54	0	4	4
Acceptable Range (Average +/- 3s)			NC	NC	NC	NC	NC	NC	NC	NC	NC	0 < 22	0 < 5863	0 < 4406	0 < 2	NC	7 < 9	5 < 18	0 < 2279	0 < 286	0 < 0.134	0 < 15	0 < 15

Sample duplicates listed under primary sample.
Detection limits are converted to results to calculate average and standard deviation
Zero is substituted for negative values where average minus 3s is less than zero
NC: Not calculated. Where there are no values other than "non-detect," no standard deviation is calculated. The acceptable range for these samples should be close to the detection limit.

PARAMETER / Sample ID / Date	FIGQGs[1]	Upper Limit of Acceptability[2]	Lowest RDL	MW01						MW02		MW03				MW04			
				2012-08-07	2012-08-07	2014-08-23	2014-08-23	2016-08-20	2016-08-20	2014-08-23	2016-08-20	2012-08-07	2012-08-07	2014-08-23	2016-08-20	2012-08-07	2012-08-07	2014-08-23	2016-08-20
BTEX & F1 Hydrocarbons (ug/L)					Lab Dup.		Duplicate		Duplicate				Lab Dup.				Duplicate		
Benzene	140	NC	0.20	<0.20	<0.20	<0.20	<0.20	<0.40	<0.40	<0.20	<0.40	<0.20	-	<0.20	<0.40	<0.20	<0.20	<0.20	<0.40
Toluene	83	NC	0.20	<0.20	<0.20	<0.20	<0.20	<0.40	<0.40	<0.20	<0.40	<0.20	-	<0.20	<0.40	<0.20	<0.20	<0.20	<0.40
Ethylbenzene	11000	NC	0.20	<0.20	<0.20	<0.20	<0.20	<0.40	<0.40	<0.20	<0.40	<0.20	-	<0.20	<0.40	<0.20	<0.20	<0.20	<0.40
o-Xylene	NA	NC	0.20	<0.20	<0.20	<0.20	<0.20	<0.40	<0.40	<0.20	<0.40	<0.20	-	<0.20	<0.40	<0.20	<0.20	<0.20	<0.40
p+m-Xylene	NA	NC	0.40	<0.40	<0.40	<0.40	<0.40	<0.80	<0.80	<0.40	<0.80	<0.40	-	<0.40	<0.80	<0.40	<0.40	<0.40	<0.80
Total Xylenes	3900	NC	0.40	<0.40	<0.40	<0.40	<0.40	<0.80	<0.80	<0.40	<0.80	<0.40	-	<0.40	<0.80	<0.40	<0.40	<0.40	<0.80
F1 (C6-C10)	810	NC	25	<25	<25	<25	<25	<100	<100	<25	<100	<25	-	<25	<100	<25	<25	<25	<100
F1 (C6-C10) - BTEX	NA	NC	25	<25	<25	<25	<25	<100	<100	<25	<100	<25	-	<25	<100	<25	<25	<25	<100
F2-F4 Hydrocarbons (mg/L)																			
F2 (C10-C16 Hydrocarbons)	1300	NC	0.10	<100	-	<100	<100	<0.10	<0.10	-	<0.10	<100	<100	<100	<0.10	<100	<100	<100	<0.10
F3 (C16-C34 Hydrocarbons)	NA	NC	0.20	<100	-	<200	<200	<0.20	<0.20	-	<0.20	<100	<100	<200	<0.20	<100	<100	<200	<0.20
F4 (C34-C50 Hydrocarbons)	NA	NC	0.20	<100	-	<200	<200	<0.20	<0.20	-	<0.20	<100	<100	<200	<0.20	<100	<100	<200	<0.20
Reached Baseline at C50	NA	NC	N/A	Yes	-	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:

1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (mg/L), Tier 1, Freshwater Life pathway for coarse grained soils.

2 = Upper Limit of Acceptability is determined as described in Report Section 3.2.1. Upper limits of acceptability are calculated using mean of baseline data +3 standard deviations.

N/A = Not Applicable

NC = Not calculated. Where there are no values other than "non-detect," no standard deviation is calculated. The acceptable range for these samples should be close to the detection limit.

- = Not Analyzed

RDL= Reportable Detection Limit

20 = Exceeds CCME guideline

21 = Exceeds Upper Limit of Acceptability

PARAMETER / Sample ID / Date	CCME FIGQGs[1]	Upper Limit of Acceptability[2]	MW01					MW02		MW03				MW04			
			2012-08-07	2014-08-23	2014-08-23	2016-08-20	2016-08-20	2014-08-23	2016-08-20	2012-08-07	2012-08-07	2014-08-23	2016-08-20	2012-08-07	2012-08-07	2014-08-23	2016-08-20
PCBs (ug/L)					Duplicate		Duplicate				Lab Dup.				Duplicate		
Aroclor 1016	NG	NC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05
Aroclor 1221	NG	NC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05
Aroclor 1232	NG	NC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05
Aroclor 1242	NG	NC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05
Aroclor 1248	NG	NC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05
Aroclor 1254	NG	NC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05
Aroclor 1260	NG	NC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05
Aroclor 1262	NG	NC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05
Aroclor 1268	NG	NC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05
Total PCB	NG	NC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05

Notes:

1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (mg/L), Tier 1, Lowest Guideline for coarse grained soils.

2 = Upper Limit of Acceptability is determined as described in Report Section 3.2.1. Upper limits of acceptability are calculated using mean of baseline data +3 standard deviations.

* = See Quality Assurance and Quality Control section for scenario rationale.

NC = Not calculated. Where there are no values other than "non-detect," no standard deviation is calculated. The acceptable range for these samples should be close to the detection limit.

NG = No Guideline

Table 9
Historical Metal Concentrations in Groundwater Samples
Indigenous and Northern Affairs Canada

PARAMETER		Guidelines			Lowest RDL	MW01										MW02				MW		
Sample ID		FIGQGs[1]	Upper Limit of Acceptability[2]																			
Date						2012-08-07	2012-08-07	2014-08-23	2014-08-23	2014-08-23	2014-08-23	2016-08-20	2016-08-20	2016-08-20	2016-08-20	2014-08-23	2014-08-23	2016-08-19	**2016-08-19**	2012-08-07	2012-08-07	2014-08-23
Metals	**Units**	**Total**	**Total**	**Dissolved**		**Total**	**Dissolved**	**Total**	**Duplicate**	**Dissolved**	**Duplicate**	**Total**	**Duplicate**	**Dissolved**	**Duplicate**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum (Al)	mg/L	0.1	NC	NC	0.003	NA	NA	NA	NA	NA	NA	0.022	0.023	0.0079	0.0071	NA	NA	0.063	0.0061	NA	NA	NA
Antimony (Sb)	mg/L	2.0	NC	NC	0.00060	NA	NA	NA	NA	NA	NA	0.0016	0.0016	0.0014	0.0014	NA	NA	<0.00060	<0.00060	NA	NA	NA
Arsenic (As)	mg/L	0.005	0.006	0.006	0.0002	0.0037	0.0039	0.0042	0.0037	0.0031	0.0031	0.0026	0.0027	0.0026	0.0026	0.00052	0.00035	0.00041	0.00029	0.0016	0.0016	0.0011
Barium (Ba)	mg/L	0.5	NC	NC	0.01	NA	NA	NA	NA	NA	NA	0.011	0.011	<0.010	<0.010	NA	NA	0.011	<0.010	NA	NA	NA
Beryllium (Be)	mg/L	0.0053	NC	NC	0.001	NA	NA	NA	NA	NA	NA	<0.0010	<0.0010	<0.0010	<0.0010	NA	NA	<0.0010	<0.0010	NA	NA	NA
Boron (B)	mg/L	5	NC	NC	0.02	NA	NA	NA	NA	NA	NA	0.073	0.072	0.073	0.072	NA	NA	0.049	0.047	NA	NA	NA
Cadmium	**ug/L**	0.017	1.4	0.24	0.02	**0.18**	**0.130**	**0.23**	**0.20**	**0.17**	**0.18**	**0.043**	**0.072**	**0.051**	**0.063**	**0.030**	**0.026**	**0.026**	**<0.020**	**1.1**	**0.061**	**0.053**
Calcium (Ca)	mg/L	NG	NC	NC	0.3	NA	NA	NA	NA	NA	NA	67	67	66	66	NA	NA	96	93	NA	NA	NA
Chromium (Cr)	mg/L	0.0089	0.0035	0.0018	0.0010	0.0018	0.0016	0.0029	0.0036	<0.001	<0.001	0.0011	0.0011	<0.0010	<0.0010	0.0011	<0.0010	<0.0010	<0.0010	<0.001	<0.001	0.0012
Chromium VI (6+)	mg/L	NG	NC	NC	0.0010	NA	NA	NA	NA	NA	NA	<0.0010	<0.0010	NA	NA	NA	NA	<0.0010	NA	NA	NA	NA
Cobalt (Co)	mg/L	NG	0.0014	0.0010	0.0003	0.00044	0.00042	0.0012	0.001	0.0008	0.00082	0.00063	0.00062	0.00059	0.00059	0.00044	0.00031	0.00089	0.00085	0.00044	<0.0003	0.00052
Copper (Cu)	mg/L	0.002-0.004 [3]	0.065	0.055	0.0002	**0.012**	**0.011**	**0.038**	**0.032**	**0.027**	**0.027**	**0.02**	**0.02**	**0.012**	**0.012**	**0.032**	**0.020**	**0.0080**	**0.0076**	**0.046**	**0.041**	**0.017**
Iron (Fe)	mg/L	0.3	NC	NC	0.060	NA	NA	NA	NA	NA	NA	<0.060	<0.060	<0.060	<0.060	NA	NA	0.10	<0.060	NA	NA	NA
Lead (Pb)	mg/L	0.001-0.007 [3]	0.0050	0.0042	0.0002	0.0031	0.0029	0.0029	0.0025	0.002	0.0019	0.00076	0.00079	0.00078	0.00074	0.00073	<0.00020	**0.0027**	<0.00020	0.001	0.00055	0.0004
Lithium (Li)	mg/L	NG	NC	NC	0.02	NA	NA	NA	NA	NA	NA	0.15	0.15	0.14	0.15	NA	NA	0.051	0.047	NA	NA	NA
Magnesium (Mg)	mg/L	NG	NC	NC	0.2	NA	NA	NA	NA	NA	NA	65	66	64	64	NA	NA	99	98	NA	NA	NA
Manganese (Mn)	mg/L	NG	NC	NC	0.004	NA	NA	NA	NA	NA	NA	0.078	0.08	0.072	0.074	NA	NA	0.73	0.70	NA	NA	NA
Mercury (Hg)	**ug/L**	0.026	NC	NC	0.002	NA	NA	NA	NA	NA	NA	0.0029	<0.0020	<0.0020	<0.0020	NA	NA	0.0028	<0.0020	NA	NA	NA
Molybdenum (Mo)	mg/L	0.073	NC	NC	0.0002	NA	NA	NA	NA	NA	NA	**0.085**	**0.086**	**0.083**	**0.084**	NA	NA	0.0093	0.0093	NA	NA	NA
Nickel (Ni)	mg/L	0.025-0.15 [3]	0.059	0.043	0.0005	0.001	0.0094	0.045	0.040	0.033	0.032	0.03	0.03	0.026	0.027	0.0058	0.0039	0.0031	0.0028	0.0036	0.0031	0.018
Phosphorus (P)	mg/L	NG	NC	NC	0.1	NA	NA	NA	NA	NA	NA	<0.10	<0.10	<0.10	<0.10	NA	NA	<0.10	<0.10	NA	NA	NA
Potassium (K)	mg/L	NG	NC	NC	0.3	NA	NA	NA	NA	NA	NA	18	18	18	18	NA	NA	9.5	9.0	NA	NA	NA
Selenium (Se)	mg/L	0.001	NC	NC	0.0002	NA	NA	NA	NA	NA	NA	**0.0049**	**0.0049**	**0.0060**	**0.0046**	NA	NA	<0.00020	0.00030	NA	NA	NA
Silicon (Si)	mg/L	NG	NC	NC	0.1	NA	NA	NA	NA	NA	NA	4.9	4.9	4.6	4.7	NA	NA	2.8	2.6	NA	NA	NA
Silver (Ag)	mg/L	0.0001	NC	NC	0.0001	NA	NA	NA	NA	NA	NA	<0.00010	<0.00010	<0.00010	<0.00010	NA	NA	<0.00010	<0.00010	NA	NA	NA
Sodium (Na)	mg/L	NG	NC	NC	0.50	NA	NA	NA	NA	NA	NA	910	910	860	870	NA	NA	51	48	NA	NA	NA
Strontium (Sr)	mg/L	NG	NC	NC	0.020	NA	NA	NA	NA	NA	NA	0.71	0.72	0.68	0.69	NA	NA	0.41	0.39	NA	NA	NA
Sulphur (S)	mg/L	NG	NC	NC	0.20	NA	NA	NA	NA	NA	NA	620	610	590	600	NA	NA	110	100	NA	NA	NA
Thallium (Tl)	mg/L	0.0008	NC	NC	0.0002	NA	NA	NA	NA	NA	NA	<0.00020	<0.00020	<0.00020	<0.00020	NA	NA	<0.00020	<0.00020	NA	NA	NA
Tin (Sn)	mg/L	NG	NC	NC	0.0010	NA	NA	NA	NA	NA	NA	<0.0010	<0.0010	<0.0010	<0.0010	NA	NA	<0.0010	<0.0010	NA	NA	NA
Titanium (Ti)	mg/L	0.1	NC	NC	0.0010	NA	NA	NA	NA	NA	NA	0.0014	0.0012	<0.0010	<0.0010	NA	NA	0.0052	<0.0010	NA	NA	NA
Uranium (U)	mg/L	0.015	NC	NC	0.0001	NA	NA	NA	NA	NA	NA	**0.27**	**0.28**	**0.27**	**0.27**	NA	NA	**0.19**	**0.19**	NA	NA	NA
Vanadium (V)	mg/L	NG	NC	NC	0.0010	NA	NA	NA	NA	NA	NA	0.001	0.0011	<0.0010	<0.0010	NA	NA	<0.0010	<0.0010	NA	NA	NA
Zinc (Zn)	mg/L	0.01	0.021	0.014	0.0030	**0.012**	0.0097	**0.014**	**0.011**	0.0092	**0.011**	0.0052	0.0051	0.0034	<0.0030	0.0059	0.0065	<0.0030	<0.0030	**0.011**	0.008	0.007

Notes:
1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (mg/L), Tier 1, Lowest Guideline for coarse grained soils
2 = Upper Limit of Acceptability is determined as described in Report Section 3.2. Upper limits of acceptability are calculated using mean of 2012 and 2014 sampling rounds +3 standard deviations.
3 = Guideline depends on hardness, guideline calcuated for each sample and compared to result
NC = Not calculated
NG = No guideline
NA = Not Analyzed
RDL= Reportable Detection Limit
20 = Exceeds FIGQG guideline.
20 = Result exceeds ULA calculated in 2016

Table 9
Historical Metal Concentrations in Groundwater Samples
Indigenous and Northern Affairs Canada

PARAMETER		Guidelines			Lowest RDL	03			MW04							
Sample ID		FIGQGs[1]	Upper Limit of Acceptability[2]													
Date						2014-08-23	2016-08-19	2016-08-19	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2014-08-23	2014-08-23	2016-08-19	2016-08-19
Metals	Units	Total	Total	Dissolved		Dissolved	Total	Dissolved	Total	Duplicate	Dissolved	Duplicate	Total	Dissolved	Total	Dissolved
Aluminum (Al)	mg/L	0.1	NC	NC	0.003	NA	1.2	0.023	NA	NA	NA	NA	NA	NA	5.9	0.83
Antimony (Sb)	mg/L	2.0	NC	NC	0.00060	NA	<0.00060	<0.00060	NA	NA	NA	NA	NA	NA	<0.00060	<0.00060
Arsenic (As)	mg/L	0.005	0.006	0.006	0.0002	0.00082	0.0017	0.0013	0.00044	0.00042	0.00045	0.00036	0.00072	0.00055	0.0016	0.0013
Barium (Ba)	mg/L	0.5	NC	NC	0.01	NA	0.039	0.029	NA	NA	NA	NA	NA	NA	0.039	0.014
Beryllium (Be)	mg/L	0.0053	NC	NC	0.001	NA	<0.0010	<0.0010	NA	NA	NA	NA	NA	NA	<0.0010	<0.0010
Boron (B)	mg/L	5	NC	NC	0.02	NA	0.067	0.063	NA	NA	NA	NA	NA	NA	0.063	0.058
Cadmium	ug/L	0.017	1.4	0.24	0.02	0.046	<0.020	<0.020	0.075	0.064	0.042	0.039	0.024	0.023	<0.020	<0.020
Calcium (Ca)	mg/L	NG	NC	NC	0.3	NA	60	55	NA	NA	NA	NA	NA	NA	26	24
Chromium (Cr)	mg/L	0.0089	0.0035	0.0018	0.0010	<0.0010	0.0029	<0.0010	<0.001	<0.001	<0.001	<0.001	0.0011	<0.0010	0.0065	<0.0010
Chromium VI (6+)	mg/L	NG	NC	NC	0.0010	NA	<0.0010	NA	NA	NA	NA	NA	NA	NA	<0.0010	NA
Cobalt (Co)	mg/L	NG	0.0014	0.0010	0.0003	0.00042	0.0010	0.00031	0.0005	0.00049	0.00041	0.00042	<0.00030	<0.00030	0.0015	<0.00030
Copper (Cu)	mg/L	0.002-0.004 [3]	0.065	0.055	0.0002	0.010	0.0071	0.0040	0.024	0.025	0.021	0.02	0.013	0.0069	0.013	0.0029
Iron (Fe)	mg/L	0.3	NC	NC	0.060	NA	2.0	0.12	NA	NA	NA	NA	NA	NA	4.1	<0.060
Lead (Pb)	mg/L	0.001-0.007 [3]	0.0050	0.0042	0.0002	<0.00020	0.00083	<0.00020	<0.0002	<0.0002	<0.0002	<0.0002	<0.00020	<0.00020	0.00092	<0.00020
Lithium (Li)	mg/L	NG	NC	NC	0.02	NA	0.078	0.068	NA	NA	NA	NA	NA	NA	0.029	<0.020
Magnesium (Mg)	mg/L	NG	NC	NC	0.2	NA	72	66	NA	NA	NA	NA	NA	NA	15	13
Manganese (Mn)	mg/L	NG	NC	NC	0.004	NA	0.11	0.075	NA	NA	NA	NA	NA	NA	0.075	0.015
Mercury (Hg)	ug/L	0.026	NC	NC	0.002	NA	0.0024	<0.0020	NA	NA	NA	NA	NA	NA	<0.0020	<0.0020
Molybdenum (Mo)	mg/L	0.073	NC	NC	0.0002	NA	0.036	0.033	NA	NA	NA	NA	NA	NA	0.0082	0.0083
Nickel (Ni)	mg/L	0.025-0.15 [3]	0.059	0.043	0.0005	0.014	0.012	0.0088	0.0075	0.0076	0.0066	0.0063	0.0038	0.0025	0.0037	0.00055
Phosphorus (P)	mg/L	NG	NC	NC	0.1	NA	<0.10	<0.10	NA	NA	NA	NA	NA	NA	<0.10	<0.10
Potassium (K)	mg/L	NG	NC	NC	0.3	NA	29	26	NA	NA	NA	NA	NA	NA	23	19
Selenium (Se)	mg/L	0.001	NC	NC	0.0002	NA	0.00039	0.00051	NA	NA	NA	NA	NA	NA	0.00036	0.00040
Silicon (Si)	mg/L	NG	NC	NC	0.1	NA	4.5	2.4	NA	NA	NA	NA	NA	NA	7.6	0.83
Silver (Ag)	mg/L	0.0001	NC	NC	0.0001	NA	<0.00010	<0.00010	NA	NA	NA	NA	NA	NA	<0.00010	<0.00010
Sodium (Na)	mg/L	NG	NC	NC	0.50	NA	230	210	NA	NA	NA	NA	NA	NA	140	130
Strontium (Sr)	mg/L	NG	NC	NC	0.020	NA	0.41	0.37	NA	NA	NA	NA	NA	NA	0.18	0.16
Sulphur (S)	mg/L	NG	NC	NC	0.20	NA	150	130	NA	NA	NA	NA	NA	NA	61	61
Thallium (Tl)	mg/L	0.0008	NC	NC	0.0002	NA	<0.00020	<0.00020	NA	NA	NA	NA	NA	NA	<0.00020	<0.00020
Tin (Sn)	mg/L	NG	NC	NC	0.0010	NA	<0.0010	<0.0010	NA	NA	NA	NA	NA	NA	<0.0010	<0.0010
Titanium (Ti)	mg/L	0.1	NC	NC	0.0010	NA	0.11	<0.0010	NA	NA	NA	NA	NA	NA	0.27	<0.0010
Uranium (U)	mg/L	0.015	NC	NC	0.0001	NA	0.074	0.064	NA	NA	NA	NA	NA	NA	0.0048	0.0047
Vanadium (V)	mg/L	NG	NC	NC	0.0010	NA	0.0047	<0.0010	NA	NA	NA	NA	NA	NA	0.0089	<0.0010
Zinc (Zn)	mg/L	0.01	0.021	0.014	0.0030	0.0008	0.0069	0.0034	0.0056	0.0038	0.0033	<0.003	0.0039	0.0046	0.011	<0.0030

Notes:
1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Us
2 = Upper Limit of Acceptability is determined as described in Report Section 3.2. Upper limits of acceptability are
3 = Guideline depends on hardness, guideline calcuated for each sample and compared to result
NC = Not calculated
NG = No guideline
NA = Not Analyzed
RDL= Reportable Detection Limit
20 = Exceeds FIGQG guideline.
20 = Result exceeds ULA calculated in 2016

Table 10
Historical Inorganic Parameter Concentrations in Groundwater Samples
Indigenous and Northern Affairs Canada

PARAMETER		FIGQGs[1]	Upper Limit of Acceptability[2]	RDL	MW01					MW02		MW03			MW04			
Sample ID																		
Date					2012-08-07	2014-08-23	2014-08-23	2016-08-20	2016-08-20	2014-08-23	2016-08-20	2012-08-07	2014-08-23	2016-08-20	2012-08-07	2012-08-07	2014-08-23	2016-08-20
Calculated Parameters							Duplicate		Duplicate							Duplicate		
Anion Sum	meq/L	NG	NC	N/A				53	50		15			19				9.6
Cation Sum	meq/L	NG	NC	N/A				47	47		15			18				8.6
Hardness ($CaCO_3$)	mg/L	NG	NC	0.50	630			430	430		640	560		410	380	380		110
Ion Balance	N/A	NG	NC	0.010				0.88	0.93		0.97			0.92				0.90
Dissolved Nitrate (NO_3)	mg/L	13	NC	0.044				5.8	5.8		1.1			1.4				1.4
Nitrate plus Nitrite (N)	mg/L	NG	15	0.020	0.59	0.33	0.34	1.3	1.3	11.9	0.24	0.63	3.17	0.36	0.44	0.45	2.53	0.40
Dissolved Nitrite (NO_2)	mg/L	0.06	NC	0.033				<0.033	<0.033		<0.033			**0.18**				**0.25**
Misc. Inorganics																		
Conductivity	uS/cm	NG	5863	1.0	3000	4600	4700	4400	4400	1200	1400	2100	2000	1800	1300	1300	1500	990
pH	pH	6.5-9.0	7 < 9	N/A	7.98	8.16	8.22	7.96	7.98	7.91	7.60	7.85	7.93	7.86	7.43	7.50	7.90	8.47
Colour	PtCo units	NG	22	2	16	14	14	18	17	11	7.1	8	9	9.1	5	5	7	5.1
Total Dissolved Solids	mg/L	NG	4406	10	2210	3420	3410	3100	3100	802	870	1410	1350	1200	888	876	956	590
Total Suspended Solids	mg/L	NG	18	1.0	<10	14	15	8.0	5.3	<10	4.0	15	<10	21	<10	<10	<10	61
Anions																		
Alkalinity (PP as $CaCO_3$)	mg/L	NG	NC	0.50				<0.50	<0.50		<0.50			<0.50				1.6
Alkalinity (Total as $CaCO_3$)	mg/L	NG	NC	0.50				460	460		350			260				99
Bicarbonate (HCO_3)	mg/L	NG	NC	0.50				560	560		430			320				120
Carbonate (CO_3)	mg/L	NG	NC	0.50				<0.50	<0.50		<0.50			<0.50				1.9
Hydroxide (OH)	mg/L	NG	NC	0.50				<0.50	<0.50		<0.50			<0.50				<0.50
Dissolved Sulphate (SO_4)	mg/L	100	2279	1.0	**1100**	**1700**	**1800**	**1900**	**1800**	**190**	**310**	**550**	**430**	**420**	**390**	**390**	**380**	**190**
Dissolved Chloride (Cl)	mg/L	120	286	1.0	**160**	**140**	**140**	110	110	44	65	**170**	**180**	**190**	59	59	120	**130**
Dissolved Fluoride (F)	mg/L	0.12	2	0.050	**1.07**	**0.70**	**0.71**	**0.64**	**0.67**	**0.41**	**0.93**	**1.29**	**0.67**	**1.4**	**0.31**	**0.32**	**0.34**	**1.1**
Nutrients																		
Dissolved Nitrite (N)	mg/L	0.06	0.13	0.010	0.10	0.021	<0.010	<0.010	<0.010	<0.010	<0.010	0.054	0.036	0.054	<0.010	<0.010	0.014	**0.077**
Dissolved Nitrate (N)	mg/L	13	15	0.010	0.48	0.31	0.34	1.3	1.3	11.9	0.24	0.57	3.13	0.31	0.44	0.45	2.51	0.33

Notes:
1 = Table 1: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (mg/L), Tier 1, Freshwater life pathway for coarse grained soils.
2 = Upper Limit of Acceptability is determined as described in Report Section 3.2.1. Upper limits of acceptability are calculated using mean of baseline data +3 standard deviations.
NG = No guideline
NC = Not calculated
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
20 = Exceeds FIGQG guideline
20 = Result exceeds ULA calcuated in 2016

PARAMETER	Federal		RDL										
Sample ID	CCME [1] Residential/ Parkland	CWS for PHC in Soil (<1.5 m)[2]		CAM-D S1	CAM-D DUP1	CAM-D S1	CAM-D DUP1	CAM-D S2	CAM-D S2	CAM-D S3	CAM-D S3	CAM-D S4	CAM-D S4
Date				2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07
Depth (m)				0 - 0.15	0.-0.15	0.35-0.5	0.35-0.5	0-0.15	0.35-0.5	0-0.15	0.35-0.5	0-0.15	0.35-0.5
BTEX & F1 Hydrocarbons (ug/g)													
Benzene	0.03	NC	0.02	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Toluene	0.37	NC	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ethylbenzene	0.082	NC	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
o-Xylene	NC	NC	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
p+m-Xylene	NC	NC	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Total Xylenes	11	NC	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
F1 (C6-C10)	NC	NC	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
F1 (C6-C10) - BTEX	NC	30 (210)	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
F2-F4 Hydrocarbons (ug/g)													
F2 (C10-C16 Hydrocarbons)	NC	150 (150)	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
F3 (C16-C34 Hydrocarbons)	NC	300 (300)	10	54	61	<10	<10	64	18	100	14	43	20
F4 (C34-C50 Hydrocarbons)	NC	2800 (2800)	10	13	22	<10	<10	<10	<10	96	<10	<10	<10
Reached Baseline at C50	N/A	N/A	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:

1 = CCME Canadian Soil Quality Guidelines, Residential / Parkland Use, coarse-grained soils.

2 = CCME Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in coarse-grained surface soils. (Brackets) Protection of Eco Soil Contact from Table 1 - Technical Supplement.

NC = No Criteria

RDL = Reportable Detection Limit

PARAMETER	Federal	INAC DEW Line Cleanup Criteria, Tier II[2]	RDL										
Sample ID	CCME[1] Residential/ Parkland			CAM-D S1	CAM-D DUP1	CAM-D S1	CAM-D DUP1	CAM-D S2	CAM-D S2	CAM-D S3	CAM-D S3	CAM-D S4	CAM-D S4
Date				2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07
Depth (m)				0-0.15	0.-0.15	0.35-0.5	0.35-0.5	0-0.15	0.35-0.5	0-0.15	0.35-0.5	0-0.15	0.35-0.5
Polychlorinated Biphenyls (ug/g)													
Aroclor 1016	NC	NC	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Aroclor 1221	NC	NC	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Aroclor 1232	NC	NC	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Aroclor 1242	NC	NC	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Aroclor 1248	NC	NC	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Aroclor 1254	NC	NC	0.010	0.01	0.022	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Aroclor 1260	NC	NC	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Aroclor 1262	NC	NC	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Aroclor 1268	NC	NC	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total PCB	1.3	5	0.010	0.01	0.022	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

Notes:

1 = CCME (2007), Canadian Soil Quality Guidelines, Update 7.0, Table 1. Canadian Soil Quality Guidelines, Residential / Parkland Use, coarse-grained soils.

2 = Abandoned Military Site Remediation Protocol. Table 1. DEW Line Cleaup Criteria (DCC) for soil. DCC Tier II.

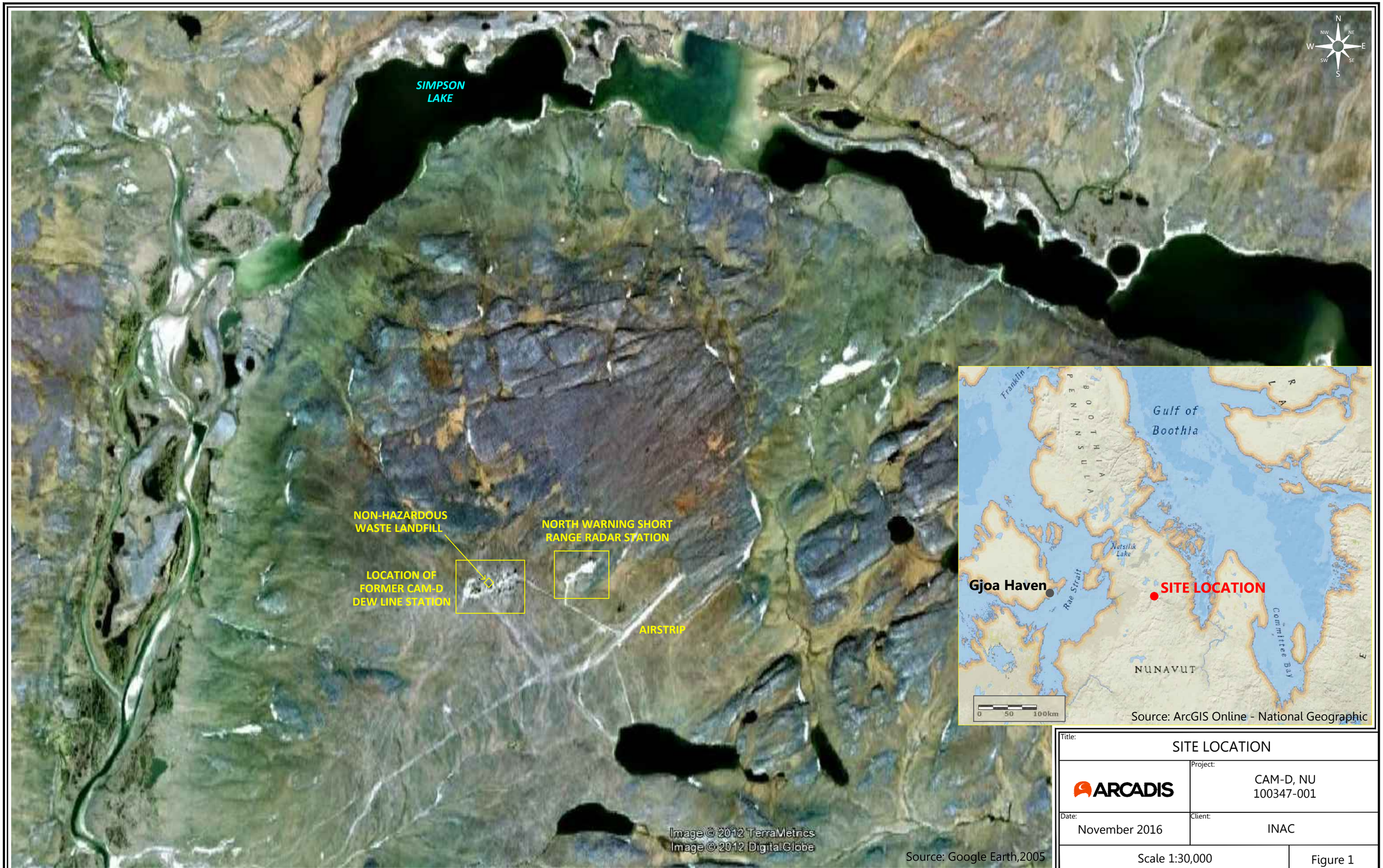
NC = No Criteria

RDL = Reportable Detection Limit

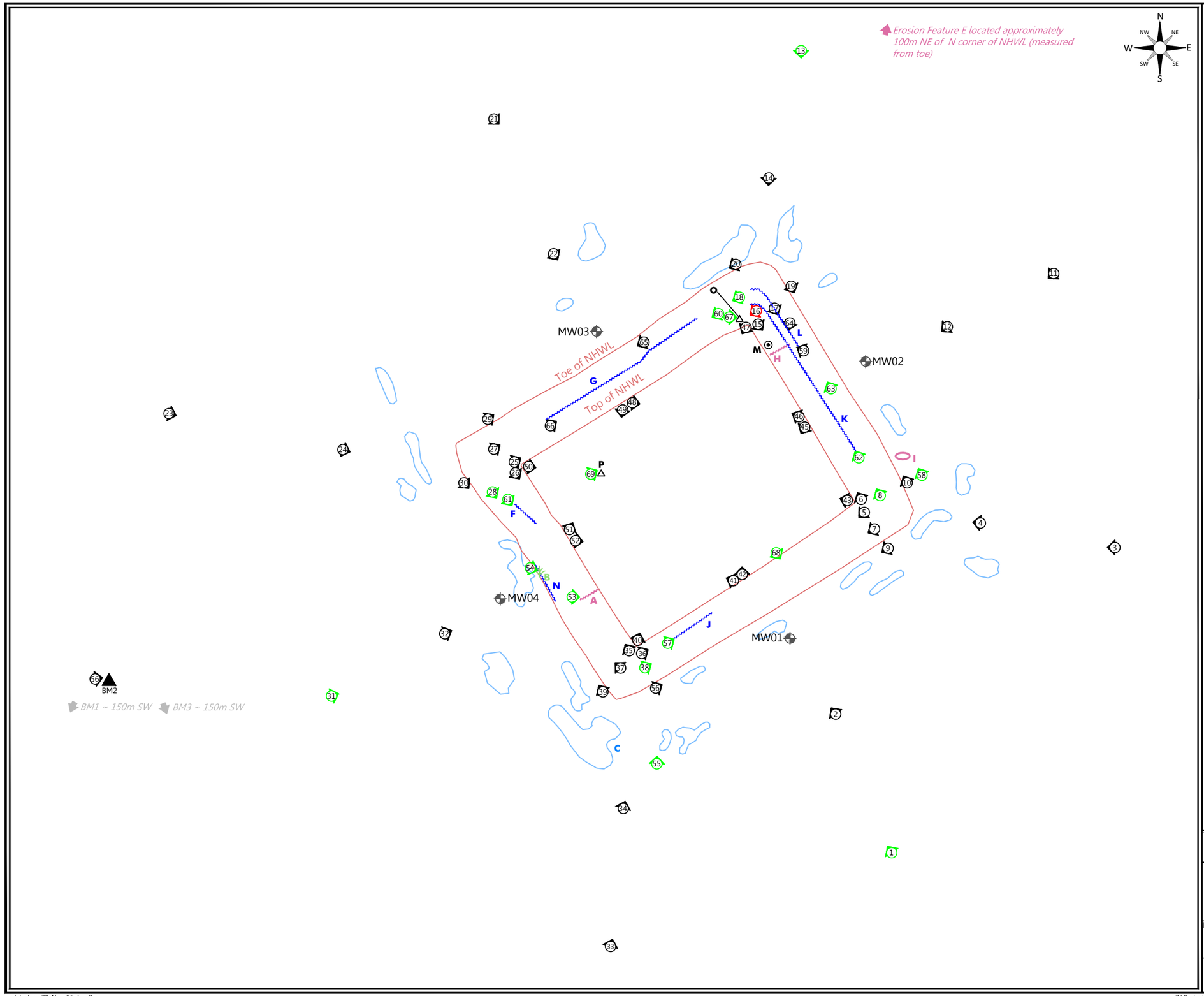
PARAMETER	Federal	INAC DEW Line Cleanup Criteria, Tier II[2]	RDL											
Sample ID	CCME[1] Residential/ Parkland			CAM-D S1	CAM-D DUP1	CAM-D S1	CAM-D DUP1	CAM-D S2	CAM-D S2	CAM-D S3	CAM-D S3	CAM-D S4	CAM-D S4	CAM-D S4 Lab-Dup
Date				2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07	2012-08-07
Depth (m)				0 - 0.15	0.-0.15	0.35-0.5	0.35-0.5	0-0.15	0.35-0.5	0-0.15	0.35-0.5	0-0.15	0.35-0.5	0.35-0.5
Metals (ug/g)														
Acid Extractable Arsenic (As)	12	30	1	1.4	1.3	1.4	1.9	1.3	1.1	<1.0	1.2	1.2	<1.0	1
Acid Extractable Cadmium (Cd)	10	5	0.1	0.14	0.17	<0.10	0.1	0.18	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Acid Extractable Chromium (Cr)	64	250	1	19	18	20	21.0	19.0	14.0	12.0	18.0	16	14	14
Acid Extractable Cobalt (Co)	50	50	0.1	6.4	6.2	6.9	7.4	6.6	5.1	4.5	6.1	5.8	5	4.5
Acid Extractable Copper (Cu)	63	100	0.5	11	11	11	12	13	8.3	5	8	8.1	7	6.7
Acid Extractable Lead (Pb)	140	500	1	8.2	8.5	8.5	7.5	7.9	5.8	4.9	5.7	6.5	5	5.2
Acid Extractable Nickel (Ni)	45	100	0.5	10	9.8	11	12	10	7.4	5.9	9.5	8.3	7	7.4
Acid Extractable Zinc (Zn)	200	500	5	42	42	39	42	41	27	21	35	38	28	29
Acid Extractable Mercury (Hg)	6.6	2	0.05	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Physical Properties														
Moisture (%)	NC	NC	1.0	7.1	7.7	7.1	1.0	12	10	10	9.6	7.9	10	8.5

Notes:
1 = CCME Canadian Soil Quality Guidelines, Residential / Parkland Use, coarse-grained soils.
2 = Abandoned Military Site Remediation Protocol. Table 1. DEW Line Cleaup Criteria (DCC) for soil. DCC Tier II.
N/A = Not applicable
NC = No Criteria
RDL = Reportable Detection Limit

FIGURES



Title: SITE LOCATION	
ARCADIS	Project: CAM-D, NU 100347-001
Date: November 2016	Client: INAC
Scale 1:30,000	Figure 1



Legend

- MW — Monitoring Well Locations
- 25 — Viewpoint Number
- 25 — Viewpoint Not Captured in 2016
- 25 — Photo included in Appendix of Report
- Ponded Water
- Erosion Features
- Surface Material Slump
- Vegetation
- Benchmark
- Pothole
- Metal Debris
- Depression

Title: SITE PLAN

ARCADIS

Project: CAM-D, NU 100347-001

Date: November 2016

Client: INAC

Metres: 10 0 10 20 — 1:850

Figure 2

updated on:28-Nov-16 by dlogan

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