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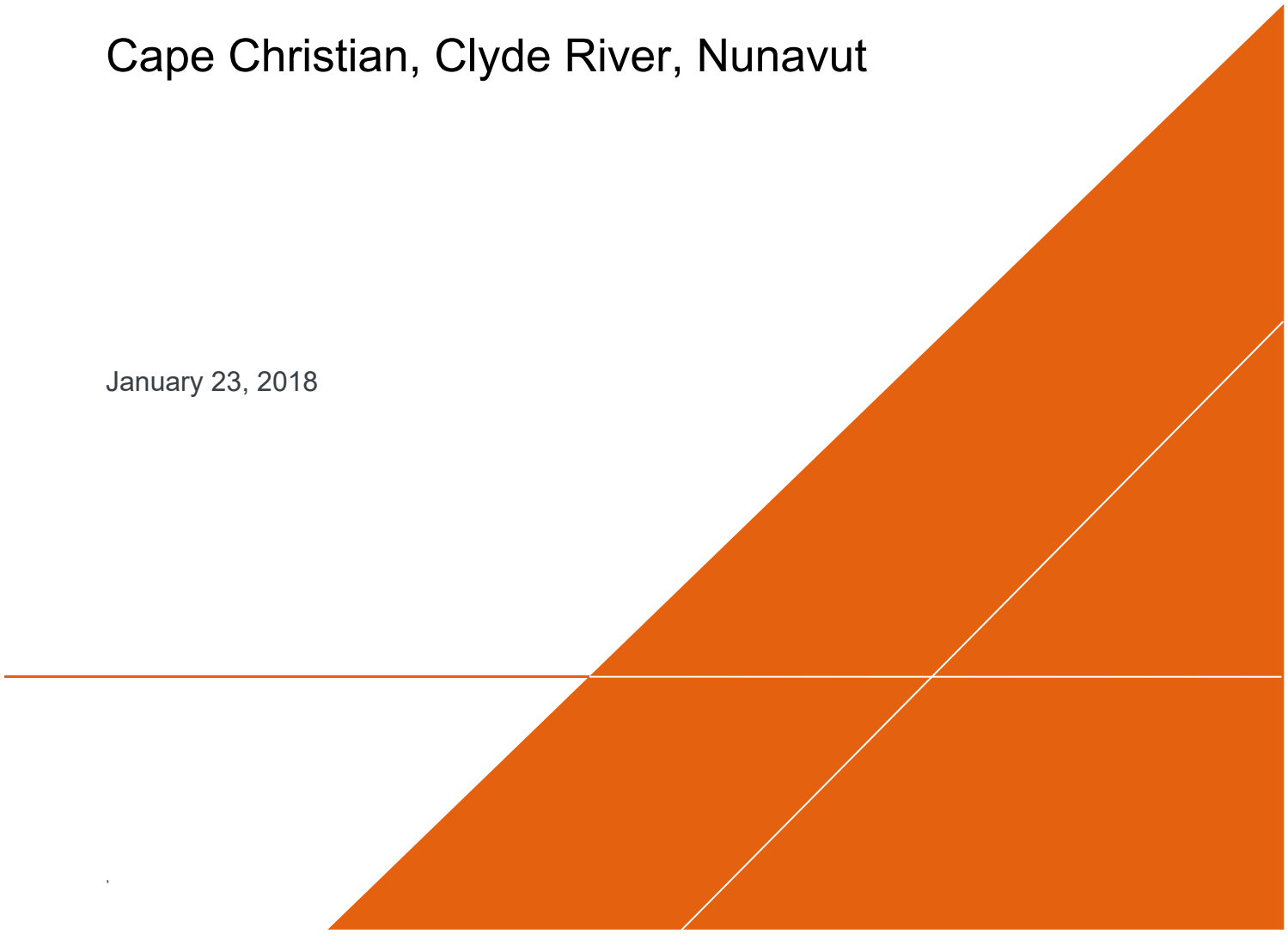
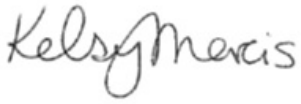
Indigenous and Northern Affairs Canada

LONG TERM MONITORING 2017

Cape Christian, Clyde River, Nunavut

January 23, 2018





Kelsy Marois, B.Eng., EIT

Field Assessor

Elliott Holden, B.Eng., EIT

Field Assessor

Stephanie Joyce, M.Sc., C.Chem.

Project Manager

Troy Austrins, P.Eng., PMP

Senior Reviewer

LONG TERM MONITORING 2017

Cape Christian, Clyde River, Nunavut

Prepared for:

Jean Allen

Contaminants Specialist

Indigenous and Northern Affairs Canada
Nunavut Regional Office

P.O. Box 2200,

Iqaluit, NU X0A 0H0

Prepared by:

Arcadis Canada Inc.

329 Churchill Avenue North

Suite 200

Ottawa

Ontario K1Z 5B8

Tel 613 721 0555

Fax 613 721 0029

Our Ref.:

100347-002

Date:

January 23, 2018

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DVD titled *Long Term Monitoring 2017. Cape Christian, Clyde River, Nunavut- ARCADIS*

ACRONYMS AND ABBREVIATIONS

INAC	Indigenous and Northern Affairs Canada (formerly AANDC)
AMSRP	Abandoned Military Site Remediation Protocol
AST	Aboveground storage tank
ATV	All-terrain vehicle
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
CSQG	Canadian Soil Quality Guidelines
CWS	Canada Wide Standard
EBA	EBA Engineering Consultants Ltd.
ECCC	Environment and Climate Change 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	Indian and Northern Affairs Canada
LORAN	Long Range Navigation
LTM	Long Term Monitoring
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
ULA	Upper Limit of Acceptability

EXECUTIVE SUMMARY

Arcadis Canada Inc. (Arcadis) was retained by Indigenous and Northern Affairs Canada (INAC) – Nunavut Regional Office to conduct Year 7 of the long-term monitoring (LTM) activities planned for the former Long-Range Navigation (LORAN) site Cape Christian. This was the fourth monitoring event to occur at Cape Christian. This project was completed under INAC Standing Offer Number 4600000861, Order number 4500365458.

The Cape Christian site is situated on a lowland coastal bluff located on the northeastern coast of Baffin Island about 16 km northeast of the Hamlet of Clyde River, Nunavut. The site was a former US Coast Guard LORAN communication station constructed and operated between 1954 and 1974 when it was abandoned. A remediation project led by INAC was conducted between 2008 and 2011. Hazardous wastes were removed from the site, buildings were demolished, and site debris was collected. All non-hazardous debris, demolition waste and contaminated soils were placed in a non-hazardous waste landfill (NHWL) constructed on-site.

The Year 7 monitoring efforts were conducted on August 17, 2017 while based out of Clyde River. The landfill monitoring program consisted of visual monitoring of the NHWL. In addition, the natural environment was observed; physical and anecdotal evidence and information suggest that wildlife and local hunters continue to use the site, primarily due to its proximity to Clyde River. The road leading to the Cape Christian LORAN site was in a good condition and the site was accessible by an all-terrain vehicle (ATV) during the site visit for the Year 7 monitoring activities.

Overall, physical observations suggest that the NHWL is in good condition and performing as designed to contain the enclosed waste. There was less standing water around the base of the landfill observed during the Year 7 LTM event in 2017, in comparison to observations made in the Year 1, Year 3 and Year 5 LTM events conducted in 2011, 2013 and, 2015 respectively. The two significant seepage faces, one along the north side of the landfill and the other located 14 m east of the southeast corner of the landfill, as well as the saturated soil along the perimeter of the north, west, and southwest corners of the landfill observed in the Year 1 monitoring event were observed to be significantly less during the Year 7 monitoring event.

Minor areas of soil staining were observed on both north and west sides of the NHWL. Grading was poor and uneven on the entire extent of the top of the landfill that would generate the potential for water infiltration. This should be monitored in future years. Only minor depressions were observed in the landfill area. No features indicating the deterioration of the performance of the landfill were identified during the Year 7 monitoring event and conditions remained stable when comparing results from the previous three monitoring events. Two new minor areas of settlement were noted along the east side of the NHWL, and an unrelated area of scattered waste was noted in the vicinity of the northeast corner of the landfill.

During remediation, four monitoring wells were installed at the site to allow for active layer water monitoring. During the 2017 monitoring program, Arcadis collected groundwater samples from the four

monitoring wells. However, due to an act of vandalism that took place overnight (August 17th, 2017) in Clyde River, no samples could be submitted for analysis.

This executive summary should be read in conjunction with the main report and is subject to the same limitations described in Section 8.0.

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 (Year 7, monitoring event 4) at the Long-Range Navigation (LORAN) communication station, Cape Christian located outside of Clyde River, Nunavut. Monitoring of the site is to be delivered in three phases over the next 25 years, as prescribed by INAC's Cape Christian LTM Plan. This project was completed under INAC Standing Offer Number 4600000861, Order number 4500365458.

This report describes the monitoring activities completed for INAC at Cape Christian and was prepared in accordance with the Arcadis proposal 510264-000 dated May 16, 2017.

Throughout this report, the LORAN site Cape Christian will be referred to as "the site".

1.1 Project Objectives

LTM of the Cape Christian site uses a three-phased approach, with evaluation of further monitoring requirements to be completed after the completion of each phase. Phase I was completed in 2015. The objective of the 2017 LTM was to complete Year 7, the first of four planned monitoring events in Phase II of the monitoring program for the Cape Christian site, as described in the Cape Christian LTM Plan (INAC, 2011). Phase II includes Year 7 through to Year 25. Monitoring included visual observations, chemical analyses (where warranted and/or possible) and interviews with members of the nearby community knowledgeable about local activities at the site to assess the condition of the natural environment and whether the site infrastructure is performing as designed.

1.2 Scope of Work

Consistent with the previous year's monitoring, the scope of work, as described in the Cape Christian LTM Plan was as follows:

1. Visual Monitoring of the Non-Hazardous Waste Landfill (NHWL), including
    - Visually checking the physical integrity of the NHWL and looking for evidence of settlement, erosion, lateral movement, frost action, animal burrows, vegetation, staining, vegetation stress, seepage points, exposed debris, and the condition of wells;
    - Taking photographs to document the condition of the NHWL and substantiate the recorded observations.
2. Active Layer Water Monitoring, including
    - Collecting groundwater samples from the 4 monitoring wells installed around the NHWL. These samples were to be analysed and the results compared to those from previous years and baseline samples, collected during site remediation activities.

3. Soil Monitoring (as required)
    - Soil sampling was to be limited to locations where seepage or staining was identified as part of the visual monitoring (if any).
4. Natural Environment Monitoring, including
    - Collection of direct and indirect evidence of wildlife presence and activity;
    - Observations of the revegetation of disturbed areas.
5. Preparation of a 2017 monitoring program report.

The following tasks were assessed as necessary to fulfill the scope:

a) Review of the Cape Christian LTM Plan, previous LTM reports for Cape Christian and the *Abandoned Military Site Remediation Protocol* (AMSRP, INAC, 2009);
b) Preparation of a health and safety plan;
c) Preparation of a sampling plan for soil and groundwater;
d) Collection of groundwater level data and observation of monitoring well condition at the site;
e) Collection of groundwater (if possible) and soil samples (if required);
f) Visual monitoring, measurement and photo documentation of the site;
g) Interviews with local residents and officials to understand land use and wildlife trends; and
h) Report preparation.

2 BACKGROUND INFORMATION

2.1 Site Description

According to INAC's Cape Christian LTM plan, from 1954 to 1974, the United States Coast Guard operated a LORAN communications station at the Cape Christian site. The station was comprised of five buildings: the main station, garage, hazmat building, terminal building and the survival hut. Six aboveground storage tanks (ASTs), each with a capacity of 102,600 L, and associated piping for fuel transfer and storage were also part of the station infrastructure. Barrels containing petroleum, oils, lubricants (POL), and other chemicals were supplied to the station during its years of operation, and used barrels were fully or partially buried at the site.

The site was abandoned in 1975 without decommissioning. After some initial efforts by others at cleaning up the site, INAC led the remediation of the site between 2008 and 2011. The remediation involved removal and off-site disposal of hazardous materials, demolition of buildings and structures, excavation of non-hazardous metals and petroleum hydrocarbon (PHC) - contaminated soils, and clean-up of other site debris. All the non-hazardous wastes were placed in a NHWL constructed on-site for that purpose.

Construction of the NHWL began in 2009 and was completed in 2010. The landfill is situated at approximately 25 m above sea level (asl). AMSRP (INAC, 2009) generic design plans for NHWLs describe construction on natural ground surface with the organic matter stripped, and consist of four perimeter berms constructed of granular material. In accordance with the AMSRP, the non-hazardous waste at Cape Christian was placed in the landfill in layers. The layers consist of 0.5 m lifts of waste covered by 0.15 m of granular fill, that the waste layers were compacted, and that a final cover consisting of a minimum of 1.0 m of granular fill was used to cap the landfill, as per the AMSRP (INAC, 2009). The cap of the NHWL at Cape Christian was armoured with large cobble and boulders to provide additional protection against weathering. The NHWL contains the following:

- Tier I contaminated soil (i.e., soil with lead content up to 500 parts per million (ppm) and polychlorinated-biphenyl (PCB) content up to 5 ppm);
- PHC fractions 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.

The lack of inhabitants at the site and the shallow permafrost make it extremely unlikely that groundwater would ever be used for drinking water in the area. The area is reported to be used by hunters and fishermen. Interviews with residents of the nearby Hamlet of Clyde River suggest that hunting is still popular in the area. Fishing and whaling in the area are considered good.

2.2 Baseline Soil and Groundwater Data

During site remediation (site clean-up) activities at Cape Christian, EBA Engineering Consultants (EBA) collected baseline soil and groundwater data to use for comparison during future monitoring events.

Groundwater monitoring wells were installed on each of the four sides of the NHWL for the purpose of collecting baseline background groundwater chemistry and in the long term to monitor upgradient and downgradient groundwater quality. Three monitoring wells, MW-1 (downgradient), MW-2 (downgradient), and MW-3 (upgradient), were installed in 2009. The final well, MW-4 (upgradient), was installed in 2010 after the final landfill footprint had been determined (EBA, 2011). All four wells were installed to an approximate depth of 3.3 m below ground surface. EBA conducted five rounds of baseline groundwater sampling (however one round was dry) between August 15, 2009 and September 12, 2010. Table 6, located at the end of this report, depicts the baseline groundwater analytical data for Cape Christian collected by EBA.

EBA also conducted baseline environmental soil sampling at the NHWL in order to gain an understanding of the background concentrations of organic and inorganic elements. In addition, EBA collected soils across the site to verify that the NHWL was not situated on a previously unknown historic spill, to confirm that borrow materials used in road-building and remedial activities were pristine, and to ensure that the contractor's activities did not adversely affect the environment at the end of remedial activities (EBA, 2011). Soils samples were analysed for PHC fractions F1 to F4, metals including arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, zinc and PCBs. Table 7, located at the end of this report, depicts the baseline soil analytical data for Cape Christian collected by EBA.

2.3 Previous Monitoring Programs

The 2017 monitoring program at Cape Christian was the fourth (Year 7) of a proposed eight that are scheduled over a 25-year period. It is the first LTM event in Phase II of the LTM Plan.

The post construction landfill monitoring frequency will follow the schedule recommended in the INAC AMSRP (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

To become familiar with the site, Arcadis reviewed the following reports pertaining to abandoned military sites:

- *Long Term Monitoring, 2015, Cape Christian, Nunavut*, Final Report, dated February 9, 2016 by Arcadis Canada Inc.;

- *Long Term Monitoring, 2013, Cape Christian, Nunavut*, Final Report, dated January 20, 2014 by Franz Environmental Inc.;
- *Long Term Monitoring, 2011, Cape Christian, Nunavut*, Final Report, dated January 17, 2012 by Franz Environmental Inc.;
- *Cape Christian Long-Term Monitoring Plan* dated February 10, 2009 by Indian and Northern Affairs Canada.
- *Abandoned Military Site Remediation Protocol* dated March 2009 by Indian and Northern Affairs Canada, Contaminated Sites Program.

3 REGULATORY AND OTHER GUIDELINES

3.1 Groundwater

3.1.1 Background and Baseline Samples

There were no groundwater guidelines provided in the Cape Christian LTM plan. In the absence of site-specific guidelines, the AMSRP (INAC, 2009) guidance on post-construction monitoring indicates that "comparison to background and baseline values is recommended." The AMSRP (INAC, 2009) provides the following table for the assessment of analytical data in groundwater.

Table 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 two 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.

This table is reproduced from AMSRP (INAC, 2009) Chapter 11, Table 4.2

Previously, Arcadis has used historical baseline data collected by EBA as discussed in Section 2.2, to obtain the mean and standard deviation of analytical results for comparison with results from the most recent field program. Arcadis derived acceptable values for groundwater results from these tables

(calculated as mean plus or minus three standard deviations). The 2011 and 2013 (no samples were collected in 2015) analytical results were compared to the upper limit of acceptability (ULA) equal to the average concentration ± 3 times of standard deviation of each analytical parameter.

For some parameters, specifically PHCs, benzene, toluene, ethylbenzene and xylenes (BTEX) and PCBs sufficient data to support calculations of mean and standard deviation were not available. This is primarily due to the high frequency of non-detected concentrations for BTEX, PCBs and PHC compounds in analysed samples.

3.1.2 Federal Interim Groundwater Quality Guidelines

In May 2010, Environment and Climate Change Canada (ECCC) under 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 at federal sites. The FIGQGs were updated most recently in June 2016.

The FIGQGs were not developed with the scientific rigour associated with the Canadian Environmental Quality Guidelines published by the Canadian Council of Ministers of the Environment (CCME). 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 (CSQGs) 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 many 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-effects 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, and with consideration to surrounding land use, Table 1 in the *FIGQGs*, *Generic Guidelines for Residential/Parkland Land Uses,* Tier 1 Lowest Guideline Values for coarse-grained soil (FIGQGs, Table 1, Tier 1) were referenced for comparison purposes.

3.2 Soil

Similar to groundwater, Arcadis previously used historical baseline soil analytical data collected by EBA and described in Section 2.2 to obtain the mean and standard deviation of analytical results for comparison with results from the most recent field program. Arcadis calculated the mean plus or minus three standard deviations to derive acceptable values for soil results. The 2011 and 2013 soil analytical results were compared to the ULA equal to the average concentration ± 3 times of standard deviation of each parameter. Sufficient data to support calculations of mean and standard deviation were not available for F1, BTEX and PCBs.

The soil standards or guidelines referenced in previous monitoring reports were inclusive of 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 the results of a 2009 grain-size analysis, field observation (generally sandy material) as well as for conservative reasons – being that criteria for coarse-grain over-burden 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.

As a preliminary and conservative determination of protection of human health and the environment at the site, Tier 1 levels of the CWS will apply to all analytical results where site specific values are not specified. The appropriate levels are presented with the laboratory analytical data in tables. The rationale for the selection of the appropriate criteria is discussed below.

BTEX Compounds

For the BTEX compounds specifically, the CSQGs were used to assess the appropriate pathway-specific guidelines. For benzene, for example, the 2004 update was used, with the following assumptions:

- Residential/Parkland land use
- Coarse-grained soils
- 10^{-5} acceptable incremental risk
- With applicable guidelines, the most conservative of:
    - Soil dermal contact guideline
    - Soil ingestion guideline
    - Eco soil contact

The groundwater check (drinking water) pathway was excluded, as groundwater in the area of Cape Christian is not used as a source of potable water. With its exclusion, the most conservative guideline for benzene applicable at the site is related to the protection of the pathway for the inhalation of indoor air (slab on grade), at 0.095 mg/kg; however, there are no buildings at the NHWL. The most conservative remaining guideline is therefore the ecological soil contact guideline, at 31 mg/kg. A similar process was used to assess the most conservative applicable guideline value for toluene, ethylbenzene and xylenes.

Petroleum Hydrocarbons

For petroleum hydrocarbons, the CWS for PHC in soil was used to assess the appropriate pathway-specific guidelines. Pathway-specific guidelines can be found in the CWS for PHC in Soil Technical Supplement (CCME, 2008c).

4 INVESTIGATIVE METHODOLOGY

The Year 7 monitoring event was carried out at the Cape Christian LORAN site on August 17th, 2017 by field assessors Kelsy Marois and Elliot Holden of Arcadis and Noah Shovinga of Nunatta Environmental, accompanied by INAC representative Jean Allen. Wildlife monitoring services were provided by Lymikee Palluq of Clyde River, NU. The site was accessed via an all-terrain vehicle (ATV). The road leading to Cape Christian from Clyde River was in good condition. During the field investigations, weather conditions were overcast, extremely windy and temperatures around 5 °C. The program consisted of the following:

- Completing a health and safety kick-off meeting;
- Visually observing and photographically documenting the physical integrity of the landfill;
- Inspecting groundwater monitoring wells and collecting groundwater samples; and
- Gathering information through first hand observation as well as through knowledgeable persons regarding local wildlife and human activity.

The field investigation procedures are described below. A copy of the field notes is available in Appendix A.

4.1 Health and Safety Plan

Before commencing with 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 was presented to INAC for approval before site activities began. The HASP was brought to the site by both Arcadis and INAC personnel. Prior to conducting any work on site, the plan was distributed and discussed with all personnel involved in the investigative program. A copy of the HASP has been retained on file at Arcadis and at the INAC Nunavut Regional Office.

4.2 Visual Monitoring

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. Definitions for completing the checklist are found in Table 2 (below). A visual monitoring checklist, presented in the Cape Christian LTM Plan, was completed for the landfill and is found in Table 3 and Table 4 in Section 5.3. A photographic record was completed to document the condition of the structures and substantiate the visual observations. A portion of this photographic record appears in Appendix B; and is presented in its entirety on the accompanying DVD, titled *Long Term Monitoring 2017; Cape Christian, Clyde River, Nunavut*.

Table 2: Preliminary Visual Monitoring 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

Similar to previous years, the 2017 visual monitoring was conducted with the aid of a Trimble Pro XRT global positioning system (GPS) unit to locate features of note and to collect geographical information system (GIS) information to be used in report preparation. A detailed data dictionary, which includes any historically collected data and GPS co-ordinates was downloaded for cross referencing during the site visit.

4.3 Wildlife Survey

Arcadis made observations of the natural environment at the time of the site visit and recorded the observations in field notes. Observations included direct sightings of wildlife (e.g. ravens, geese), other evidence of wildlife (e.g., droppings, tracks, feathers/fur), wildlife activities (e.g. migrating, nesting, etc.),

numerical estimates of wildlife, and vegetation observations. Where possible, observations by Arcadis have been compared to previously recorded observations.

As part of the investigation, Arcadis representatives interviewed people knowledgeable about surrounding areas. Land uses by humans and wildlife, as well as changes in use over previous years by each, were discussed and pertinent information is documented in this report.

4.4 Groundwater Sample Collection

No frost action was observed around or inside the casing of the wells at the time of the site visit. Groundwater levels at all the monitoring wells were measured upon arrival at the site. Thawed groundwater was present in all four monitoring wells at the time of the site visit and five groundwater samples were collected during the visit (four samples plus one duplicate sample). All groundwater was frozen during the 2015 site visit, indicating that 2017 was a warmer year in the area around the site.

A peristaltic pump was used to purge the monitoring wells prior to sample collection. Wells were purged of three well volumes except where poor recharge rates made it necessary to sample sooner. A YSI 556 water quality meter was calibrated and used to measure in situ field parameters including temperature, conductivity, dissolved oxygen, pH and oxidation-reduction potential. Water samples to be analyzed for dissolved metals analyses were field-filtered.

Approximately one well volume of water was purged from each monitoring well prior to sampling. Samples were to be submitted for analysis of various parameters: total and dissolved metals; PCBs; PHCs; benzene, toluene, ethylbenzene and total xylenes (BTEX); suspended and dissolved solids; major ions; hardness; pH and conductivity. A duplicate sample was collected from monitoring well MW-2. Each sample was collected in the appropriate sample containers supplied by the testing laboratory which were pre-charged with the appropriate chemical preservatives. Groundwater samples were placed in laboratory supplied coolers equipped with ice from the time of collection until delivery to the laboratory. Due to an act of vandalism in Clyde River overnight, the samples could not be delivered to the laboratory and analysis did not occur.

Data relative to groundwater depth was recorded in the field, and the wells were re-locked using keyed-alike padlocks following completion of the work.

4.5 Soil Sample Collection

Staining and seepage were observed in 2017 in the same locations as previously observed, but to a lesser extent than historically noted. As instructed by INAC prior to departing for the site visit, no soil samples were collected with regards to this previously identified staining. Based on the analytical results presented in the 2011 and 2013 monitoring reports (no soil samples were collected in 2015), historical soil sample analytical results showed concentrations of PHCs, metals, and PCBs either below the laboratory detection limits or below the applicable site criteria; therefore, INAC requested that no further soil sampling be conducted for these staining features in 2015 and onwards.

It should be noted that although staining is present in some areas surrounding the NHWL, similar staining is also present in areas surrounding the landfill and in un-disturbed areas in the general vicinity of Clyde River. This suggests that the observed staining may be a natural occurrence in this area.

5 NON-HAZARDOUS WASTE LANDFILL

5.1 Area Summary

The NHWL is located in the Lower Site Landfill Area (general coordinates 70º 31' 32.3'' N, 68º 18' 13.28'' W), between the Beach and Lake Areas of the Cape Christian LORAN site. Monitoring of the landfill included visual observations to assess its physical integrity including evidence of erosion, ponding, frost action, settlement and lateral movement. Groundwater at the NHWL was thawed during the 2017 monitoring round and five full sets of groundwater samples were collected (four samples plus one duplicate sample). Documentation resulting from the visual monitoring, including supporting photos and drawing, is presented in the following pages.

5.2 Photographic Record

The photographic record of the NHWL (and other areas of the site) has been completed as per the Terms of Reference (Viewpoints 1 to 85, attached DVD). Those portions of the record referenced in the body of this document are included in Appendix B. The complete photographic record, of full-resolution photographs, is provided in the attached DVD. Note that in this report, Viewpoint numbers refer to the photos on the DVD and Photo Reference numbers refer to photos in Appendix B.

5.3 Visual Monitoring Checklist

The physical integrity of the NHWL was assessed by collecting visual evidence of erosion, ponding, frost action, settlement and lateral movement. A plan view of the NHWL indicating photographic viewpoints, salient observations and locations of groundwater monitoring wells can be seen in Figure 2. The visual monitoring checklist provided in the Cape Christian LTM Plan has been completed and pertinent information is summarized in Table 3. Table 4 presents the visual monitoring results for the NHWL at Cape Christian.

Table 3: Cape Christian Preliminary Visual Monitoring Report

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

Settlement

There were six areas of minor settlement observed at the toe of the landfill in the initial 2011 monitoring event (see Features A, C, E, G, H, and K). Three of these areas (A, G, and K) also had orange staining. In 2011, wet conditions were encountered, and water was pooled in what appeared to be tracks left by the heavy equipment. Though these three features are not believed to be the result of settlement, they are noted for comparison to future observations. Much dryer site conditions were encountered during future monitoring events. Five of the features identified in 2011 that had ponded water were observed to be dry during the 2017 site visit (i.e., Features A, C, E, G, and H). Features J, K, L, M and N contained small volumes of pooled water at the time of the site visit. Features E, G and H were not observed in 2017. See Figure 2 for Viewpoint and feature locations.

Ponded water was observed in one area near the NHWL: Feature O, first identified in 2013 (Photo 17, Appendix B), is likely the result of the equipment used to construct the NHWL. These settlement and ponding areas do not appear to impact the structure of the landfill, or be a result of other impacts to the landfill structure. Due to road construction in the area and the creation of a new drainage channel along the new road, the staining and ponded water has migrated into Feature O. The new dimensions of Feature O observed in 2017 are approximately 27 m long by 2.7 m at its widest point.

Two sinkholes[1] were observed near the toe of the NHWL (see Features D and F, Figure 2 and Photos 6 and 9; Appendix B) during the Year 5 (2015) monitoring event. These were first observed in 2011. Feature D was not observed, and the size of Feature F appears to have decreased. Neither of the sinkholes contained water during the 2017 site visit.

There were no areas of settlement, areas of ponded water or saturated soils observed on top of the landfill cap or on the sides of the landfill during the site visit.

Erosion

Historical (2011 and 2013) evidence of minor erosion was reported on the north end of the NHWL (see Features N, M and J, Figure 2). However, these erosional features have decreased in size and extent since the previous site visits.

One feature indicated some evidence of minor erosion in 2015 (Feature A, Figure 2). This erosion was observed in 2017 but is still considered minimal (Photo 5, Appendix B).

Frost Action

No cracking was observed surrounding the landfill on the native soils This suggests that frost action in and outside of the landfill extents was not significant. No evidence of frost action on the landfill or the landfill berms was observed at the time of the site visit.

Evidence of Burrowing Animals

There was some evidence of burrowing animals observed in the area surrounding the NHWL. A small animal burrow was observed in the northeast area of the landfill, where scattered waste was observed and noted.

Re-establishment of Vegetation

Based on the regional setting of this landfill and the very coarse materials used to construct the landfill cap, re-establishment of vegetation is likely to take a significant amount of time. No vegetation growth was observed on the top or sides of the landfill at the time of the site visit.

[1] The term sinkhole has been used in historical reports and will be used in this report for consistency. The features described as sinkholes should be considered to be depressions.

Staining

Several areas of orange staining were observed surrounding the landfill. Soil was collected in 2011 and 2013 from three (3) locations around Features L, N, and A where the staining was observed; however, no additional soil sampling was conducted in 2015 or 2017 in the vicinity of these staining features. It was noted during the Year 7 monitoring event (2017) that staining in these areas appears to have decreased from previous observations.

The two areas of staining observed in 2011 on the west side of the landfill (Features P and Q, Photos 18 and 19, Appendix B) have lessened in severity and extent. These areas were dry, and no ponded water was observed at the time of the site visit. They are not considered to be seepage points, but simply low-lying areas where rain and moisture can collect.

Seepage Points

Three potential seepage points were observed during historical landfill monitoring events (2011 and 2013) at the southwest corner (Feature E) and northern side (Features M and L) of the NHWL. Features E and L were generally dry during the 2017 site visit (Photo 8, and 15; Appendix B) with some moist soil present, and ponding water accumulated in only Feature M (Photo 16, Appendix B).

Debris

Scattered waste debris was observed in an area to the northeast of the landfill. Upon inspection, it does not appear to be associated with the landfill. It appeared to be quite old and was at one point buried under a pile of large adjacent boulders. The scattered debris is likely from camping activities in the vicinity (see Photo 22, Appendix B).

Discussion

The features discussed above are currently considered to be of little consequence to the physical integrity of the NHWL. All physical observations indicate that the NHWL is performing as designed and is containing the enclosed waste.

Although the overall performance of the landfill is presently considered acceptable, as it was observed during the Year 1 monitoring event and again in Year 3, the grading of the landfill cap is poor, inconsistent, and does not appear to maintain a constant grade. It was also observed that the landfill cap consisted of many different particle sizes (i.e., small cobbles to fines). The inconsistent grading and particle size selection has led to many small undulations on the cap. A potential increase in water infiltration, over time, may cause excessive erosion, possible settlement issues, and potential seepage issues around the landfill perimeter in subsequent years. Special attention should be paid to the landfill cap in subsequent sampling years.

Table 4, on the next few pages, summarizes the results of the visual monitoring.

Table 4: Cape Christian - Visual Monitoring Checklist

Checklist Item	Feature Letter	Relative Location	Length (m)	Width (m)	Depth (m)	Extent	Description (Change)	Additional Comments	Viewpoint
Settlement	A	8 m south of the northwest corner of the NHWL	22.7	0.8	0.02	<1%	A possible seepage area with small drain connected. Staining at two locations. One of the locations had orange staining.	Soil sample CC-SS3 collected by the south end of the possible seepage area in 2011 and 2013. No further sampling conducted in 2015. Staining is minimal. No ponded water in 2017.	51, 52
Settlement	B	15 m south of the northwest corner of the NHWL	NA	NA	NA	NA	Minor settlement cracks.	Not observed in 2017.	52-53
Settlement	C	23 m south of the northwest corner of the NHWL		9 m^2		<1%	Dry and stains at toe of NHWL	No ponded water, no cracking observed during 2017.	54
Settlement	D	22 m south of the northwest corner of the NHWL		NA			Sinkhole	Sinkhole was not observed in 2015 or 2017.	55
Settlement	E	Southwest corner of the NHWL		NA			Dry, no staining	Feature was not observed in 2017.	56-58
Settlement	F	Southwest corner of the NHWL		0.1 m^3		<1%	Sinkhole	Size and extent of feature has decreased from previous observations.	59
Settlement	G	6 m east of the southwest corner of the NHWL			NA		Dry, no staining	Feature was not observed in 2015 or 2017.	3, 60-61
Settlement	H	Northeast corner of the NHWL			NA		Dry, no staining	Standing water in the area during the 2011 site visit, dry in 2013. Feature not observed in 2015 or 2017.	62, 63, 28
Settlement	I	11 m northeast of the northeast corner of the NHWL			NA		Saturated soils, no ponding and staining	Was identified as a drainage area with vegetation during the 2011 site visit, area is saturated but not ponded in 2013. No ponding or staining observed in 2015 or 2017.	64
Settlement	J	20 m west of the northeast corner of the NHWL		0.1 m^3		<1%	Ponded water with staining	Feature not observed in 2015. Minimal staining and small amount of ponded water in 2017.	65
Settlement	K	13 m west of the northeast corner of the NHWL	1	0.5	0.20	<1%	Ponded water with staining	Feature not observed in 2015. No staining, some ponded water in 2017.	66
Staining	L	22 m west of the northeast corner of the NHWL		18 m^2		<1%	Ponded water with staining may be due to equipment tracks	Soil sample CC-SS1 collected from this area in 2011/2013. No sampling conducted in 2015/2017. No significant change from previous observations.	68
Staining	M	32 m west of the northeast corner of the NHWL		38 m^2		<1%	Ponded water with staining may be due to equipment tracks	Ponded water and staining extents have decreased.	69-70
Staining	N	15 m east of the northwest corner of the NHWL		89 m^2		<1%	Ponded water with staining may be due to equipment tracks.	Soil sample CC-SS2 collected from this area in 2011/2013. No sampling conducted in 2015. Small amount of ponded water observed in 2017.	80, 72, 71, 31
Settlement	O	21 m east of the southeast corner of the NHWL		85 m^2		<1%	Minor pooling of water and minor staining in 2017.	Due to new road maintenance and a new drainage channel, the shape of Feature O has elongated in that direction. Area of feature remains similar.	73 to 75
Staining	P	10 m western of toe of NHWL		NA		NA	Soil staining, soils are dry, no ponding of water	Not observed in 2017.	77
Staining	Q	12 m western of toe of NHWL		NA		NA	Stained soils, dry, no ponding or seepage	Not observed in 2017.	76
Settlement	R	21 m east of the southeast corner of the NHWL		3 m^2		<1%	Saturated soils, no ponding or staining	New feature observed in 2017.	84
Settlement	S	2 m east of toe of NHWL		12 m^2		<1%	Saturated soils, no ponding or staining	New feature observed in 2017.	83

Checklist Item	Feature Letter	Relative Location	Length (m)	Width (m)	Depth (m)	Extent	Description (Change)	Additional Comments	Viewpoint
Debris	T	20 m northeast of the northeast corner of the NWHL		78.5 m^2		<1%	Area of scattered waste, likely from camping in the area.	New feature observed in 2017.	85

Notes: NA – Not Applicable

5.4 Analytical Results – Groundwater

As described in Section 4.4, the monitoring of the four groundwater wells and the collection of five groundwater samples (four samples plus one duplicate sample) was possible during the site visit. However, due to an act of vandalism occurring overnight (August 17th, 2017) in Clyde River, the samples could not be submitted for analysis (see accompanying photos on the attached DVD). Although no groundwater samples were submitted for analysis during the 2017 monitoring round, groundwater analytical tables showing the 2011 and 2013 analytical results are presented in the tables at the end of the report, as Tables 8 through 15, for ease of reference. Visual results of select average metal concentrations (total and dissolved) are presented in Appendix C. Note that when reported concentrations are below detection limits, one half of the detection limit was used for calculations and graphing purposes. Table 5, below, presents the groundwater monitoring results made during the 2017 monitoring event.

Table 5: Groundwater Monitoring Results

Well ID	Water Level (m btoc)	Depth to Bottom (m btoc)	Volume of Purge Water Removed	Groundwater Observations
MW-1	1.245	1.427	0.1 L	clear, colourless, no PHC odour, no sheen
MW-2	0.8731	1.402	0.3 L	clear, colourless, no PHC odour, no sheen
MW-3	1.597	1.618	0.01 L	clear, colourless, no PHC odour, no sheen
MW-4	1.305	1.505	0.1 L	clear, colourless, no PHC odour, no sheen

Note: m btoc - metres below top of well casing (i.e, top of well riser)

5.5 Analytical Results – Soil

Historically (i.e., in 2011 and 2013), a few soil samples were collected from the site and analysed for PHCs, Metals, and PCBs. The soil samples were collected to assess orange stains surrounding the NHWL, refer to Features A, L, N and O in Figure 2. Based on the results presented in the 2011 and 2013 monitoring reports, historical soil sample analytical results reported concentrations of PHCs, metals, and PCBs either below the laboratory detection limits or below the applicable site criteria. INAC requested that no further soil samples be collected for these staining features (i.e. Features A, L, N and O) in the future, unless changes in these staining features are observed.

No other areas of concern were identified in 2017; therefore, no soil sampling was conducted. The soil analytical results from 2011 and 2013 are presented as Tables 13 through 15 at the end of this report, for ease of reference.

6 SURROUNDING AREAS

As proposed, an inspection of outlying areas on site was completed during the Year 7 (2017) monitoring event.

The road from Clyde River to Cape Christian was in a good condition and the team arrived to the site via ATV. The community of Clyde River has begun a program to maintain the road out to the site area, such that access to the site via truck may be possible in the upcoming years.

Areas surrounding the landfill site were visually scarred from the remediation activities of previous years, road maintenance and activity in the area this past summer (i.e. as shown by fresh ATV tracks). The areas directly surrounding the landfill site were mostly void of vegetation due to the aforementioned remediation activities. A low-lying drainage area was present directly south of the landfill site and contained some ponding water, which eventually terminated at the ocean shoreline.

One building remained intact to the southeast of the landfill site. The building was left intact, at the request of the Hamlet of Clyde River, for the purpose of serving as a storm shelter for hunters and trappers frequenting the area. This building is now the responsibility of the Hamlet of Clyde River to maintain. Evidence of ATV traffic was observed in the form of tracks on the roadways and tundra on-site, as well as on surrounding lands.

7 NATURAL ENVIRONMENT

Information regarding the natural environment was gathered directly, through observation, and indirectly, through consultation with knowledgeable local persons in order to better understand the presence and temporal change of wildlife. The Cape Christian LTM Plan recommends monitoring the following parameters:

- 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; and
- Revegetation of disturbed areas versus previous years.

Wildlife and Human Activity

Arcadis interviewed Mr. John Barry in 2011, who has lived in Clyde River for his entire life. The following wildlife were reported to frequent the area on a regular basis:

- Ptarmigans;
- Foxes;
- Polar bears;
- Canada geese;
- Snow geese;
- Ringed seals;
- Arctic Char;
- Bowhead Whales;
- Small birds (i.e. bunting birds);
- Seagulls;
- Loons;
- Ravens; and
- Arctic hare.

Mr. Barry indicated that there are fewer animals than used to be in the area. The area is often used for hunting and fishing. However, more data are required to establish the long-term trend of animal activities at the site. In 2017, discussions with the local Hunters and Trappers Organization did not lead to further additions or omissions to the above outlined list.

Re-establishment of Vegetation

Based on the regional setting of this site and material used on the site, reestablishment of vegetation is likely to take a significant amount of time.

8 CONCLUSIONS AND RECOMMENDATIONS

Based on systematic visual observations and measurements, photographic documentation and analytical results, the PIN-D NHWL is considered to be in acceptable condition, is performing as designed, and is containing the enclosed waste. There was less standing water around the base of the landfill observed during the Year 7 LTM event in 2017, in comparison to previous LTM events. The two significant seepage faces, one along the north side of the landfill and the other located 14 m east of the southeast corner of the landfill, as well as the saturated soil along the perimeter of the north, west, and southwest corners of the landfill observed in the Year 1 monitoring event were observed to be significantly less during the Year 7 monitoring event.

Minor areas of soil staining were observed on both north and west sides of the NHWL. Grading was poor and uneven on the entire extent of the top of the landfill that would generate the potential for water infiltration. This should be monitored in future years. Only minor depressions were observed in the landfill area. No features indicating the deterioration of the performance of the landfill were identified during the Year 7 monitoring event and conditions remained stable when comparing results from the previous three monitoring events. Two new minor areas of settlement were noted along the east side of the NHWL, and an unrelated area of scattered waste was noted in the vicinity of the northeast corner of the landfill.

During remediation, four monitoring wells were installed at the site to allow for active layer water monitoring. During the 2017 monitoring program, Arcadis collected groundwater samples from the four monitoring wells. However, due to an act of vandalism that took place overnight in Clyde River, no groundwater samples could be submitted for analysis.

Based on the results of Year 7 LTM, the facility appears in acceptable condition. It is recommended that monitoring continue as per the schedule set out in the LTM Plan. The next monitoring event (Year 10) should be scheduled for 2020.

9 LIMITATIONS

This report has been prepared exclusively for Indigenous and Northern Affairs Canada (INAC). Any other person or entity may not rely upon the report without 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 17, 2017. 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.

10 REFERENCES

Arcadis Canada Inc., 2016. Long Term Monitoring, 2015, Cape Christian, Nunavut, Final Report, February 9, 2016.

Canadian Council of Ministers of the Environment. 2007. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health.

Canadian Council of Ministers of the Environment. 2008a. Canada-Wide Standards for Petroleum Hydrocarbons in Soil.

Canadian Council of Ministers of the Environment. 2008b. Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale Supporting Technical Document.

Canadian Council of Ministers of the Environment. 2008c. Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: User Guidance.

EBA Engineering Consultants, March 2011, Remediation Closure Report for Cape Christian Long-Range Navigation (LORAN) Station near Clyde River, Nunavut.

Federal Contaminated Sites Action Plan (FCSAP), May 2010. Guidance Document on Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites.

Franz Environmental Inc., 2012. Long Term Monitoring, 2011, Cape Christian, Nunavut.

Franz Environmental Inc., 2014. Long Term Monitoring, 2013, Cape Christian, Nunavut, Final Report, January 20, 2014.

Indian and Northern Affairs Canada, February 10, 2009. *Cape Christian Long-Term Monitoring Plan.*

Indian and Northern Affairs Canada. December 2009. *Abandoned Military Site Remediation Protocol*, Contaminated Sites Program.

TABLES

Tables 6 to 15

Table 6
Baseline Groundwater Analytical Data
INAC- Nunavut Regional Office
Cape Christian, Clyde River, Nunavut

ARCADIS Design & Consultancy for natural and built assets

Parameters (mg/L)	Units	MW-1 Aug-15-09	MW-1 Sept-18-09 Filtered	MW-1 Sept-18-09 Unfiltered	MW-1 Aug-21-10	MW-1 Sept-12-10	MW-2 Sept-18-09 Filtered	MW-2 Sept-18-09 Unfiltered	MW-2 Aug-21-10	MW-2 Sept-12-10	MW-3 Aug-15-09	MW-3 Sept-18-09 Filtered	MW-3 Sept-18-09 Unfiltered	MW-4 Aug-21-10	MW-4 Sept-12-10	Avg. Conc.	Std. Dev.
pH		9.4	10.9	10.8	8.16	8.21	7.4	7.3	0.77	7.96	9.6	8.2	8.1	7.89	7.58	8.6	1.2
Na	mg/L	464	813	782	436	210	156	159	123	108	75.2	78.9	77.6	19	25.7	252	267
K	mg/L	36.2	42.7	41.8	31.6	20.6	16	15	16.2	14.7	0.31	7.8	15.8	2.46	2.22	18.8	14
Mg	mg/L	6.6	0.6	2.5	40.9	40.8	45.5	45.5	62.3	69.6	3	4.9	6.4	4.5	5.26	24.2	25
Ca	mg/L	10.3	46.9	41.9	43.4	40.7	80	82.5	103	108	7	6.7	7.6	15.6	11.7	43.2	37
Hardness	mg/L	53	120	115	286	271	387	393	669	668	30	37	45.4	58	56	228	227
Fe	mg/L	<0.05	<0.05	<0.05	0.412	<0.3	5.9	10	31.8	35.3	4.2	0.27	4.7	<0.3	0.479	6.7	12
Mn	mg/L	<0.05	<0.05	<0.05	0.082	0.005	3.1	3.4	5.63	6.57	0.07	<0.05	0.07	0.012	0.055	1.4	2.3
Cl	mg/L	704	1070	1050	678	350	427	440	439	527	44.5	53.6	53.3	25	35	421	361
Nitrate	mg/L	0.26	<5	<5	<0.035	0.135	<1	<1	1380	0.603	0.38	0.28	<0.2	0.133	0.396	1.1	1.8
Nitrite	mg/L	<0.05	<5	<5	<0.02	<0.02	<1	<1	<0.02	<0.02	<0.05	<0.2	<0.2	<0.02	<0.02	-	-
Sulphate	mg/L	93.4	178	189	211	135	25.9	24.6	19	29	38.2	48.9	49.1	20	24	77.5	70
F1		<0.05	-	-	<0.1	<0.1	-	-	<0.1	<0.1	<0.05	-	-	<0.1	<0.1	-	-
F2		<0.5	-	-	-	<0.1	-	-	-	<0.1	<0.5	-	-	-	<0.1	-	-
PCBs		<0.003	-	-	<0.2	<0.1	-	-	<0.2	<0.1	<0.003	-	-	<0.2	<0.1	-	-
Total Cu	mg/L	0.055	-	0.0412	0.0201	0.0178	-	0.0185	0.0338	0.0125	0.046	-	0.111	0.016	0.0069	0.034	0.030
Total Ni	mg/L	0.482	-	0.291	0.197	0.122	-	0.226	0.106	0.459	0.146	-	0.898	0.222	0.0163	0.288	0.25
Total Co	mg/L	0.008	-	0.0042	<0.020	<0.020	-	0.0359	0.041	0.052	0.009	-	0.0222	<0.020	<0.020	0.023	0.015
Total Cd	mg/L	<0.001	-	<0.001	<0.0008	<0.0008	-	0.002	0.0038	<0.0008	<0.001	-	0.00121	<0.0008	<0.0008	0.001	0.00091
Total Pb	mg/L	<0.010	-	<0.010	0.0192	0.0447	-	<0.010	0.0109	0.262	<0.010	-	0.034	0.003	0.0011	0.038	0.076
Total Zn	mg/L	0.049	-	0.0128	0.0506	0.0298	-	1.74	0.855	0.395	0.069	-	0.375	0.0282	0.0225	0.330	0.54
Total Cr	mg/L	0.718	-	0.399	0.226	0.075	-	0.0442	0.071	0.013	0.187	-	0.938	0.071	<0.010	0.250	0.31
Total As	mg/L	<0.003	-	0.0032	0.0089	0.0039	-	<0.003	0.0102	0.005	0.005	-	0.0132	0.0014	<0.001	0.005	0.0039
Dissolved Cu	µg/L	0.009	0.0166	-	0.003	<0.003	0.0122	-	0.012	0.0034	0.013	0.00928	-	<0.003	<0.003	0.0080	0.0051
Dissolved Ni	µg/L	<0.005	<0.005	-	0.0038	0.0055	0.117	-	0.044	0.11	<0.005	0.00516	-	<0.002	0.002	0.0277	0.044
Dissolved Co	µg/L	<0.003	<0.003	-	<0.02	<0.02	0.0241	-	0.034	0.048	<0.003	<0.003	-	<0.020	<0.020	0.0180	0.015
Dissolved Cd	µg/L	<0.001	<0.001	-	<0.0008	<0.0008	0.001	-	<0.0008	<0.0008	<0.001	<0.001	-	<0.0008	<0.0008	-	-
Dissolved Pb	µg/L	<0.010	<0.01	-	<0.001	<0.001	<0.010	-	<0.001	<0.001	<0.01	<0.010	-	<0.001	<0.001	-	-
Dissolved Zn	µg/L	<0.010	<0.01	-	<0.003	0.0035	0.903	-	0.338	0.315	<0.010	<0.010	-	<0.003	0.0094	0.1468	0.28
Dissolved Cr	µg/L	<0.005	<0.005	-	<0.01	<0.01	<0.005	-	<0.01	<0.01	<0.005	<0.005	-	<0.010	<0.010	0.0077	0.0026
Dissolved As	µg/L	<0.003	<0.003	-	0.0056	0.0031	<0.003	-	0.0035	0.0046	0.003	0.004	-	<0.001	<0.001	0.0032	0.0014

Note: Detection limits were used for average calculations, when results were below detection limits

Result appears to be an outlier and is not included in average calculations.

Table 7
Baseline Soil Analytical Data
INAC- Nunavut Regional Office
Cape Christian, Clyde River, Nunavut

ARCADIS Design & Consultancy for natural and built assets

Location	Sample	F1 (ug/g)	F2 (ug/g)	F3 (ug/g)	F4 (ug/g)	As (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Co (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	Aroclor 1254	Aroclor 1260
NHWL	BTL-1	ND	ND	39	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	BTL-2	ND	ND	29	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	BTL-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	BTL-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	BTL-MW2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	16	ND	ND
		ND	ND	19	ND	ND	ND	34	5.2	5.9	ND	ND	8.4	22	ND	ND
	BTL-MW3	ND	ND	19	ND	ND	ND	ND	6.1	8.8	ND	ND	8.9	22	ND	ND
		ND	ND	10	ND	ND	ND	ND	7.3	13.1	ND	ND	9.1	28	ND	ND
BL-2 Landfarm	BL2-A	ND	ND	18.4	46.7	-	-	-	-	-	-	-	-	-	-	-
	BL2-B	ND	ND	11.4	35.5	-	-	-	-	-	-	-	-	-	-	-
	BL2-C	ND	ND	54.6	108	-	-	-	-	-	-	-	-	-	-	-
	BL2-D	ND	ND	118.9	60.2	-	-	-	-	-	-	-	-	-	-	-
	BL2-E	ND	ND	ND	31.6	-	-	-	-	-	-	-	-	-	-	-
	BL2-F	ND	ND	19.5	48.6	-	-	-	-	-	-	-	-	-	-	-
	BL2-G	ND	ND	ND	18.5	-	-	-	-	-	-	-	-	-	-	-
	BL2-H	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-
	BL2-I	ND	ND	ND	10.2	-	-	-	-	-	-	-	-	-	-	-
	BL2-J	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-
	BL2-K	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-
	BL2-L	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-
	BL2-M	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-
	BL2-N	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-
	BL2-O	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-
	BL2-P	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-
	DUP1	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-
	BL2-A_POST	-	ND	56	78	-	-	-	-	-	-	-	-	-	-	-
	BL2-C_POST	-	ND	46	32	-	-	-	-	-	-	-	-	-	-	-
	BL2-E_POST	-	700	277	53	-	-	-	-	-	-	-	-	-	-	-
	BL2-E_POST #2	-	20	23	15	-	-	-	-	-	-	-	-	-	-	-
	BL2-K_POST	-	198	42	11	-	-	-	-	-	-	-	-	-	-	-
	BL2-K_POST#2	-	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-
	BL2-L_POST	-	ND	65	38	-	-	-	-	-	-	-	-	-	-	-
	BL2-M_POST	-	39	1650	875	-	-	-	-	-	-	-	-	-	-	-
	BL2-M_POST#2	-	ND	17	ND	-	-	-	-	-	-	-	-	-	-	-
	BL2-N_POST	-	ND	33	42	-	-	-	-	-	-	-	-	-	-	-
	BL2-O_POST	-	ND	15	ND	-	-	-	-	-	-	-	-	-	-	-
	BL2-P_POST	-	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-

Table 7
Baseline Soil Analytical Data
INAC- Nunavut Regional Office
Cape Christian, Clyde River, Nunavut

ARCADIS Design & Consultancy for natural and built assets

Location	Sample	F1 (ug/g)	F2 (ug/g)	F3 (ug/g)	F4 (ug/g)	As (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Co (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	Aroclor 1254	Aroclor 1260
BL-3 Barrel Processing Area	BL3-A	ND	ND	ND	ND	ND	2.9	58	7.7	ND	ND	0.007	7.5	166	ND	ND
	BL3-4	-	26	51	23	-	-	-	-	-	-	-	-	-	-	-
	BL3-B	ND	ND	ND	ND	ND	ND	44	6	ND	ND	ND	5.8	252	ND	ND
	BL3-3	-	27	49	25	-	-	-	-	-	-	-	-	-	-	-
	BL3-C	ND	ND	ND	ND	ND	1.2	49	6.2	55	55	0.0321	9	249	ND	ND
	BL3-2	-	32	207	110	-	-	-	-	-	-	-	-	-	-	-
	BL3-D	ND	ND	ND	ND	ND	ND	80	8.7	11	11	0.019	8.3	143	ND	ND
	BL3-1	-	37	174	65	-	-	-	-	-	-	-	-	-	-	-
	BL3-E	ND	ND	ND	ND	ND	ND	72	8.2	ND	ND	0.0083	7.7	299	ND	ND
	BL3-5	-	26	51	25	-	-	-	-	-	-	-	-	-	-	-
	BL3-F	ND	ND	ND	ND	ND	ND	26	ND	ND	ND	ND	ND	ND	ND	ND
BL-5 Site Road	BL5-1	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	-	-
	BL5-2	ND	ND	231	95	ND	1.3	ND	ND	ND	ND	ND	ND	ND	-	-
	BL5-3	ND	ND	62	39	ND	2.2	ND	ND	ND	ND	ND	ND	130	-	-
	BL5-4	ND	15	59	16	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	BL5-5	ND	12	50	13	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	BL5-6	ND	13	22	11	ND	1.3	ND	ND	ND	ND	ND	ND	ND	-	-
	BL5-7	ND	ND	71	44	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	BL5-8	ND	10	28	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
BL-6 Temporary Waste Storage*	BL6-3	-	27	47	22	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	BL6-4	-	67	48	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	BL6-5	-	53	53	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	BL6-6	-	ND	51	32	-	-	-	-	-	-	-	-	-	-	-
	BL6-7	-	ND	30	18	-	-	-	-	-	-	-	-	-	-	-
	BL6-9	-	ND	34	20	-	-	-	-	-	-	-	-	-	-	-

Table 7
Baseline Soil Analytical Data
INAC- Nunavut Regional Office
Cape Christian, Clyde River, Nunavut

ARCADIS Design & Consultancy for natural and built assets

Location	Sample	F1 (ug/g)	F2 (ug/g)	F3 (ug/g)	F4 (ug/g)	As (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Co (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	Aroclor 1254	Aroclor 1260
BL-7 Camp Area	BL7-A	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	BL7-2		ND	ND	ND	ND	ND	ND	ND	ND	ND	0.2	ND	ND	-	-
	BL7-B	ND	ND	ND	ND	1.4	ND	ND	ND	ND	ND	ND	ND	16	-	-
	BL7-4		19	23	12	ND	ND	ND	ND	ND	ND	0.2	ND	ND	-	-
	BL7-C	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	BL7-1		ND	38	29	ND	ND	ND	ND	ND	ND	0.2	ND	ND	-	-
	BL7-D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.008	ND	ND	-	-
	BL7-5		ND	27	ND	ND	ND	ND	ND	ND	ND	0.2	ND	ND	-	-
	BL7-E	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	BL7-3		ND	ND	ND	ND	ND	ND	ND	ND	ND	0.2	ND	ND	-	-
	Garage 1	ND	ND	32	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	Garage 2	ND	ND	36	14	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	Garage 3	ND	ND	123	27	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	Garage 4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	Garage 5	ND	ND	159	26	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	Garage 6	ND	ND	72	15	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	FB1	ND	39	53	15	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	FB2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	FB3	ND	ND	25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	FB4	ND	ND	16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
BL-8 Borrow Sources	BL8-1	-	-	-	-	ND	ND	173	16.1	ND	ND	ND	15.6	21	-	-
	BL8-2	-	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	16	-	-
	BL8-3	-	-	-	-	ND	ND	197	18.7	ND	ND	ND	17.7	23	-	-
	BL8-4	-	-	-	-	ND	ND	41	ND	ND	ND	ND	5.1	ND	-	-
	BL8-5	-	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	BL8-7	-	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	BL8-8	-	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	DUP1	-	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-
	Avg. Conc.	-	75.6	91.5	56	1.4	1.8	77.4	9	18.8	33	0.107	9.4	100.2	-	-
	Stand. Dev.	-	161.5	234.5	135.3	-	0.7	59.3	4.6	20.4	31.1	0.1	3.8	104.8	-	-

Table 8
Groundwater Chemical Concentrations - PHCs
INAC Nunvaut Regional Office
Cape Christian, Nunavut

ARCADIS Design & Consultancy for natural and built assets

PARAMETER	CCME FIGQGs[1]	Upper Limit of Acceptability[2]	RDL	MW-1			MW-2		MW-3	MW-4	
				2011-08-24	2013-08-09	DUP 09/08/2013	2011-08-24	2013-08-09	2011-08-24	2011-08-24	2013-08-09
BTEX & F1 Hydrocarbons (ug/L)											
Benzene	140	NA	0.20	<0.2	<0.20	<0.20	<0.2	<0.20	<0.2	<0.2	<0.20
Toluene	83	NA	0.20	<0.2	0.26	0.27	<0.2	<0.20	<0.2	<0.2	<0.20
Ethylbenzene	1100	NA	0.20	<0.2	<0.20	<0.20	<0.2	<0.20	<0.2	<0.2	<0.20
o-Xylene	NC	NA	0.20	<0.2	<0.20	<0.20	<0.2	<0.20	<0.2	<0.2	<0.20
p+m-Xylene	NC	NA	0.40	<0.4	<0.40	<0.40	<0.4	<0.40	<0.4	<0.4	<0.40
Total Xylenes	3900	NA	0.40	<0.4	<0.40	<0.40	<0.4	<0.40	<0.4	<0.4	<0.40
F1 (C6-C10)	810	NA	25	<25	<25	<25	<25	<25	<25	<25	<25
F1 (C6-C10) - BTEX	NC	NA	25	<25	<25	<25	<25	<25	<25	<25	<25
F2-F4 Hydrocarbons (ug/L)											
F2 (C10-C16 Hydrocarbons)	1300	NA	100	<100	<100	<100	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	NC	NA	100	<100	<200	<200	<100	<200	<100	<100	<200
F4 (C34-C50 Hydrocarbons)	NC	NA	100	<100	<200	<200	<100	<200	<100	<100	<200
Reached Baseline at C50	NA	NA	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:
1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (µg/L), Tier 1, Lowest Guideline for coarse grained soils.
2 = Upper Limit of Acceptability, calculated using mean of baseline data +3 standard deviations.
NA = Not Applicable
NC = No Criteria

Table 9
Groundwater Chemical Concentrations - Total Metals
INAC Nunvaut Regional Office
Cape Christian, Nunavut

ARCADIS Design & Consultancy for natural and built assets

PARAMETER	CCME FIGQGs[1]	Upper Limit of Acceptability[2]	RDL	MW-1		MW-2		MW-3	MW-4	Average Concentration
				2011-08-24	2013-08-09	2011-08-24	2013-08-09	2011-08-24	2011-08-24	
Metals (µg/L)										
Total Aluminum (Al)	100	NA	3.0	---	1900	---	180	---	---	1040
Total Antimony (Sb)	2000	NA	0.60	---	<0.60	---	<0.60	---	---	<0.60
Total Arsenic (As)	5	17	0.20	1.0	1.8	2.0	0.91	<1.0	<1.0	1.3
Total Barium (Ba)	500	NA	10	---	13	---	45	---	---	29
Total Beryllium (Be)	5.3	NA	1.0	---	<1.0	---	<1.0	---	---	<1.0
Total Boron (B)	5000	NA	20	---	130	---	30	---	---	80
Total Cadmium (Cd)	0.017	4.0	0.005	<0.10	0.037	0.30	0.16	0.10	0.10	0.13
Total Calcium (Ca)	NC	NA	300	---	56000	---	110000	---	---	83000
Total Chromium (Cr)	8.9	1185	1.0	<5.0	36	<5.0	1.7	7.0	<5.0	10
Total Cobalt (Co)	NC	67	0.30	<0.50	0.74	**85**	31	3.4	<0.50	20
Total Copper (Cu)	2	123	0.20	1.0	11	11	8.4	14	3.0	8.1
Total Iron (Fe)	300	NA	60	---	840	---	29000	---	---	14920
Total Lead (Pb)	2	264	0.20	<0.50	38	1.5	0.40	3.5	<0.50	7.4
Total Lithium (Li)	NC	NA	20	---	<20	---	<20	---	---	<20
Total Magnesium (Mg)	NC	NA	200	---	53000	---	60000	---	---	56500
Total Manganese (Mn)	NC	NA	4.0	---	120	---	5900	---	---	3010
Total Molybdenum (Mo)	73	NA	0.20	---	9.5	---	2.1	---	---	5.8
Total Nickel (Ni)	83	1029	0.50	2.0	32	60	47	7.0	3.0	25
Total Phosphorus (P)	NC	NA	100	---	<100	---	<100	---	---	<100
Total Potassium (K)	NC	NA	300	---	15000	---	12000	---	---	13500
Total Selenium (Se)	1	NA	0.20	---	0.31	---	0.35	---	---	0.33
Total Silicon (Si)	NC	NA	100	---	4100	---	5600	---	---	4850
Total Silver (Ag)	0.1	NA	0.10	---	<0.10	---	<0.10	---	---	<0.10
Total Sodium (Na)	NC	NA	500	---	120000	---	90000	---	---	105000
Total Strontium (Sr)	NC	NA	20	---	330	---	540	---	---	435
Total Sulphur (S)	NC	NA	200	---	13000	---	12000	---	---	12500
Total Thallium (Tl)	0.8	NA	0.20	---	<0.20	---	<0.20	---	---	<0.20
Total Tin (Sn)	NC	NA	1.0	---	<1.0	---	<1.0	---	---	<1.0
Total Titanium (Ti)	100	NA	1.0	---	19	---	9.8	---	---	14
Total Uranium (U)	15	NA	0.10	---	5.4	---	0.39	---	---	2.9
Total Vanadium (V)	NC	NA	1.0	---	2.7	---	1.7	---	---	2.2
Total Zinc (Zn)	10	1937	3.0	<5.0	8.6	120	71	38	5.0	41

Notes:
1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (µg/L), Tier 1, Lowest Guideline for coarse grained soils.
2 = Upper Limit of Acceptability, calculated using mean of baseline data +3 standard deviations.
NA = Not Available
NC = No Criteria

RDL= Reportable Detection Limit

20 = Result exceeds FIGQGs.
67 = Result exceeds Upper Limit of Acceptability
Note that when results were less than the RDL, the RDL was used in average calculations.

Table 10
Groundwater Chemical Concentrations - Dissolved Metals
INAC Nunavut Regional Office
Cape Christian, Nunavut

ARCADIS Design & Consultancy for natural and built assets

PARAMETER	CCME FIGQGs[1]	Upper Limit of Acceptability[2]	RDL	MW-1		MW-2		MW-3	MW-4	Average Concentration
				2011-08-24	2013-08-09	2011-08-24	2013-08-09	2011-08-24	2011-08-24	
Metals (µg/L)										
Dissolved Aluminum (Al)	100	NA	3.0	---	28	---	32	---	---	30
Dissolved Antimony (Sb)	2000	NA	0.60	---	<0.60	---	<0.60	---	---	<0.60
Dissolved Arsenic (As)	5	7.3	0.20	1.0	1.4	1.0	0.72	<1.0	<1.0	1.0
Dissolved Barium (Ba)	500	NA	10	---	12	---	47	---	---	30
Dissolved Beryllium (Be)	5.3	NA	1.0	---	<1.0	---	<1.0	---	---	<1.0
Dissolved Boron (B)	5000	NA	20	---	95	---	<20	---	---	58
Dissolved Cadmium (Cd)	0.017	NA	0.005	<0.10	0.031	0.30	0.21	0.60	0.70	0.32
Dissolved Calcium (Ca)	NC	NA	300	---	54000	---	110000	---	---	82000
Dissolved Chromium (Cr)	8.9	16	1.0	<5.0	<1.0	<5.0	<1.0	<5.0	<5.0	<1.0
Dissolved Cobalt (Co)	NC	62	0.30	<0.50	<0.30	**72**	32	0.50	<0.50	18
Dissolved Copper (Cu)	2	23	0.20	1.0	1.3	5.0	6.1	4.0	2.0	3.2
Dissolved Iron (Fe)	300	NA	60	---	190	---	28000	---	---	14095
Dissolved Lead (Pb)	2	NA	0.20	<0.50	<0.20	<0.50	<0.20	<0.50	<0.50	<0.20
Dissolved Lithium (Li)	NC	NA	20	---	<20	---	<20	---	---	<20
Dissolved Magnesium (Mg)	NC	NA	200	---	53000	---	63000	---	---	58000
Dissolved Manganese (Mn)	NC	NA	4.0	---	81	---	6100	---	---	3090.5
Dissolved Molybdenum (Mo)	73	NA	0.20	---	8.7	---	2.0	---	---	5.4
Dissolved Nickel (Ni)	83	160	0.50	3.0	2.0	56	44	3.0	2.0	18
Dissolved Phosphorus (P)	NC	NA	100	---	<100	---	<100	---	---	<100
Dissolved Potassium (K)	NC	NA	300	---	15000	---	12000	---	---	13500
Dissolved Selenium (Se)	1	NA	0.20	---	0.31	---	0.33	---	---	0.32
Dissolved Silicon (Si)	NC	NA	100	---	3400	---	5700	---	---	4550
Dissolved Silver (Ag)	0.1	NA	0.10	---	<0.10	---	<0.10	---	---	<0.10
Dissolved Sodium (Na)	NC	NA	500	---	120000	---	94000	---	---	107000
Dissolved Strontium (Sr)	NC	NA	20	---	320	---	570	---	---	445
Dissolved Sulphur (S)	NC	NA	200	---	13000	---	12000	---	---	12500
Dissolved Thallium (Tl)	0.8	NA	0.20	---	<0.20	---	<0.20	---	---	<0.20
Dissolved Tin (Sn)	NC	NA	1.0	---	<1.0	---	<1.0	---	---	<1.0
Dissolved Titanium (Ti)	100	NA	1.0	---	<1.0	---	<1.0	---	---	<1.0
Dissolved Uranium (U)	15	NA	0.10	---	2.7	---	0.38	---	---	1.5
Dissolved Vanadium (V)	NC	NA	1.0	---	<1.0	---	<1.0	---	---	<1.0
Dissolved Zinc (Zn)	10	991	3.0	<5.0	<3.0	130	84	10	8.0	40

Notes:

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

2 = Upper Limit of Acceptability, calculated using mean of baseline data +3 standard deviations.

NA = Not Available

NC = No Criteria

RDL= Reportable Detection Limit

20 = Exceeds FIGQGs.

67 = Result exceeds Upper Limit of Acceptability

Note that when results were less than the RDL, the RDL was used in average calculations.

Table 11
Groundwater Chemical Concentrations - PCBs
INAC Nunvaut Regional Office
Cape Christian, Nunavut

ARCADIS Design & Consultancy for natural and built assets

PARAMETER	CCME FIGQGs[1]	Upper Limit of Acceptability[2]	RDL	MW-1		MW-2		MW-3	MW-4
				2011-08-24	2013-08-09	2011-08-24	2013-08-09	2011-08-24	2011-08-24
PCBs (ug/L)									
Aroclor 1016	NC	NA	0.010	<0.050	<0.010	<0.050	<0.010	<0.050	<0.050
Aroclor 1221	NC	NA	0.010	<0.050	<0.010	<0.050	<0.010	<0.050	<0.050
Aroclor 1232	NC	NA	0.010	<0.050	<0.010	<0.050	<0.010	<0.050	<0.050
Aroclor 1242	NC	NA	0.010	<0.050	<0.010	<0.050	<0.010	<0.050	<0.050
Aroclor 1248	NC	NA	0.010	<0.050	<0.010	<0.050	<0.010	<0.050	<0.050
Aroclor 1254	NC	NA	0.010	<0.050	<0.010	<0.050	<0.010	<0.050	<0.050
Aroclor 1260	NC	NA	0.010	<0.050	<0.010	<0.050	<0.010	<0.050	<0.050
Aroclor 1262	NC	NA	0.010	<0.050	<0.010	<0.050	<0.010	<0.050	<0.050
Aroclor 1268	NC	NA	0.010	<0.050	<0.010	<0.050	<0.010	<0.050	<0.050
Total PCB	NC	NA	0.010	<0.050	<0.010	<0.050	<0.010	<0.050	<0.050

Notes:

1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (µg/L), Tier 1, Lowest Guideline for coarse grained soils.
2 = Upper Limit of Acceptability, calculated using mean of baseline data +3 standard deviations.
NA = Not Available
NC = No Criteria
RDL= Reportable Detection Limit

Table 12
Groundwater Chemical Concentrations - Inorganics
INAC Nunvaut Regional Office
Cape Christian, Nunavut

ARCADIS Design & Consultancy for natural and built assets

PARAMETER	Units	CCME FIGQGs[1]	Upper Limit of Acceptability[2]	RDL	MW-1		MW-2		MW-3	MW-4	Average Concentration
					2011-08-24	2013-08-09	2011-08-24	2013-08-09	2011-08-24	2011-08-24	
Inorganics	**Units**										
Colour	TCU	NC	NA	20	6.0	5.0	350	610	7.0	6.0	164
Conductivity	umho/cm	NC	NA	1.0	1500	1300	1890	1600	179	703	1195
Total Dissolved Solids	mg/L	3000	NA	10	1070	780	1440	1520	128	802	957
Fluoride (F-)	mg/L	0.12	NA	0.10	0.30	0.34	<0.10	0.22	0.10	0.20	0.23
Orthophosphate (P)	mg/L	NC	NA	0.010	<0.010	<0.010	<0.010	<0.050	<0.010	<0.010	<0.010
pH	pH	6.5-9	NA	NC	7.82	8.08	6.50	5.26	7.30	7.54	7.08
Total Suspended Solids	mg/L	NC	NA	3.0	6.0	10	14	81	9.0	3.0	21
Dissolved Sulphate (SO_4)	mg/L	100	296	1.0	50	37	20	28	11	63	35
Dissolved Chloride (Cl)	mg/L	NC	1505	6.0	300	250	490	450	23	120	272
Nitrite (N)	mg/L	0.060	NA	0.010	<0.010	<0.010	0.010	0.035	<0.010	<0.010	0.014
Nitrate (N)	mg/L	13.0	1636	0.10	0.20	<0.10	<0.10	0.30	1.0	<0.10	0.30
Nitrate + Nitrite	mg/L	NC	NA	0.10	0.20	<0.10	<0.10	0.34	1.0	<0.10	0.31
Hardness ($CaCO_3$)	mg/L	NC	908	0.50	---	350	---	540	---	---	445

Notes:
1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use, Tier 1, Lowest Guideline for coarse grained soils.
2 = Upper Limit of Acceptability, calculated using mean of baseline data +3 standard
NA = Not Available
NC = No Criteria
RDL= Reportable Detection Limit
20 = Exceeds FIGQGs.
RPD = Relative Percent Difference

Table 13
Soil Chemical Concentrations - PHCs
INAC Nunavut Regional Office
Cape Christian, Nunavut

PARAMETER	Federal		Upper Limit of Acceptability[3]	RDL	CC1 2011-08-24	CC-SS1 2013-08-09	CC2 2011-08-24	CC-SS2 2013-08-09	CC-DUP1 2013-08-09	Duplicate Evaluation	CC3 2011-08-24	CC-SS3 2013-08-09
Depth (m)	CCME [1] Residential/ Parkland	CWS for PHC in Soil (<1.5m)[2]			0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	RPD (%)	0 - 0.15	0 - 0.15
BTEX & F1 Hydrocarbons (ug/g)												
Benzene	0.03	NC	NC	0.005	<0.02	<0.005	<0.02	<0.005	<0.005	N/A	<0.02	<0.005
Toluene	0.37	NC	NC	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A	<0.02	<0.02
Ethylbenzene	0.082	NC	NC	0.01	<0.02	<0.01	<0.02	<0.01	<0.01	N/A	<0.02	<0.01
o-Xylene	NC	NC	NC	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A	<0.02	<0.02
p+m-Xylene	NC	NC	NC	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	N/A	<0.04	<0.04
Total Xylenes	11	NC	NC	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	N/A	<0.04	<0.04
F1 (C6-C10)	NC	NC	NC	10	<10	<10	<10	<10	<10	N/A	<10	<10
F1 (C6-C10) - BTEX	NC	30	NC	10	<10	<10	<10	<10	<10	N/A	<10	<10
F2-F4 Hydrocarbons (ug/g)												
F2 (C10-C16 Hydrocarbons)	NC	150	560	10	30	<10	12	<10	<10	N/A	<10	86
F3 (C16-C34 Hydrocarbons)	NC	300	795	50	19	<50	21	<50	<50	N/A	21	68
F4 (C34-C50 Hydrocarbons)	NC	2800	461	50	<10	<50	<10	<50	<50	N/A	<10	<50
Reached Baseline at C50	N/A	N/A	N/A	N/A	Yes	Yes	Yes	Yes	Yes	N/A	Yes	Yes

Notes:
1 = CCME, Canadian Soil Quality Guidelines, Residential / Parkland Use, coarse-grained soils.
2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in coarse-grained surface soils. Protection of Eco Soil Contact
3 = Upper Limit of Acceptability, calculated using mean of baseline data +3 standard deviations.
N/A = Not applicable
NC = No Criteria
RDL= Reportable Detection Limit
20 = Exceeds selected guideline.

PARAMETER	Federal		Upper Limit of Acceptability[3]	RDL	CC4 2011-08-24	CC-BK 2013-08-09
Depth (m)	CCME [1] Residential/ Parkland	CWS for PHC in Soil (<1.5m)[2]			0 - 0.15	0 - 0.15
BTEX & F1 Hydrocarbons (ug/g)						
Benzene	0.03	NC	NC	0.005	<0.02	<0.005
Toluene	0.37	NC	NC	0.02	<0.02	<0.02
Ethylbenzene	0.082	NC	NC	0.01	<0.02	<0.01
o-Xylene	NC	NC	NC	0.02	<0.02	<0.02
p+m-Xylene	NC	NC	NC	0.04	<0.04	<0.04
Total Xylenes	11	NC	NC	0.04	<0.04	<0.04
F1 (C6-C10)	NC	NC	NC	10	<10	<10
F1 (C6-C10) - BTEX	NC	30	NC	10	<10	<10
F2-F4 Hydrocarbons (ug/g)						
F2 (C10-C16 Hydrocarbons)	NC	150	560	10	<10	<10
F3 (C16-C34 Hydrocarbons)	NC	300	795	50	<10	<50
F4 (C34-C50 Hydrocarbons)	NC	2800	461	50	<10	<50
Reached Baseline at C50	N/A	N/A	N/A	N/A	Yes	Yes

Notes:
1 = CCME, Canadian Soil Quality Guidelines, Residential / Parkland Use, coarse-grained soils.
2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for
3 = Upper Limit of Acceptability, calculated using mean of baseline data +3 standard deviations.
N/A = Not applicable
NC = No Criteria
RDL= Reportable Detection Limit
20 = Exceeds selected guideline.

Table 14
Soil Chemical Concentrations - Metals
INAC Nunvaut Regional Office
Cape Christian, Nunavut

ARCADIS Design & Consultancy for natural and built assets

PARAMETER	CCME[1] Residential/ Parkland	CCME[2] Human Health Ingestion (H) / Eco Soil Contact (E)	INAC DEW Line Cleanup Criteria, Tier II	Upper Limit of Acceptability[3]	RDL	CC1 2011-08-24 0 - 0.15	CC-SS1 2013-08-09 0 - 0.15	CC2 2011-08-24 0 - 0.15	CC-SS2 2013-08-09 0 - 0.15	CC-DUP1 2013-08-09 0 - 0.15	Duplicate Evaluation RPD (%)	CC3 2011-08-24 0 - 0.15	CC-SS3 2013-08-09 0 - 0.15
Metals (ug/g)													
Sulphur (S)	NC	NC	NC	NA	50	---	74	---	150	81	60	---	<50
Antimony (Sb)	20	NC	NC	NA	0.20	---	<0.20	---	<0.20	<0.20	N/A	---	<0.20
Arsenic (As)	12	12H 17E	30	1.4	1.0	<1.0	<1.0	<1.0	2.3	1.4	47	<1.0	<1.0
Barium (Ba)	500	6800H	NC	NA	0.50	---	9.5	---	44	29	40	---	6.2
Beryllium (Be)	4.0	NC	NC	NA	0.20	---	<0.20	---	0.21	<0.20	0.05	---	<0.20
Boron (B)	NC	NC	NC	NA	5.0	---	<5.0	---	<5.0	<5.0	N/A	---	<5.0
Cadmium (Cd)	10	14H 10 E	**5.0**	3.9	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	N/A	<0.10	<0.10
Chromium (Cr)	64	220H 64E	250	952	1.0	24	7.4	35	16	13	20	10	36
Cobalt (Co)	50	NC	**50**	23	0.10	3.1	1.4	4.1	5.6	3.9	33	1.8	3.3
Copper (Cu)	63	1100H 63E	100	80	0.50	3.8	2.0	4.3	11	6.7	48	3.2	1.5
Lead (Pb)	140	140H 300E	500	126	1.0	3.0	1.8	3.0	4.9	3.7	18.0	2.0	2.6
Molybdenum (Mo)	10	NC	NC	NA	0.50	---	<0.50	---	<0.50	<0.50	N/A	---	<0.50
Nickel (Ni)	45	200H 45E	100	21	0.50	4.2	2.4	5.2	9.0	6.2	36.0	2.5	4.7
Selenium (Se)	1.0	80H 1E	NC	NA	0.50	---	<0.50	---	<0.50	<0.50	N/A	---	<0.50
Silver (Ag)	20	NC	NC	NA	0.20	---	<0.20	---	<0.20	<0.20	N/A	---	<0.20
Thallium (Tl)	1.0	1.0H 1.4E	NC	NA	0.05	---	<0.050	---	0.26	0.16	43	---	<0.050
Tin (Sn)	50	NC	NC	NA	5.0	---	<5.0	---	<5.0	<5.0	N/A	---	<5.0
Uranium (U)	23	23H 500E	NC	NA	0.05	---	0.33	---	0.86	0.62	28	---	0.29
Vanadium (V)	130	130E	NC	NA	5.0	---	19	---	34	31	9	---	100
Zinc (Zn)	200	200E	500	415	5.0	15	7.7	17	34	26	26.0	9.0	11
Mercury (Hg)	6.6	6.6H 12E	**2.0**	0.4	0.05	<0.050	<0.050	<0.050	<0.050	<0.050	N/A	<0.050	<0.050
Physical Properties													
Moisture (%)	NC	NC	NC		1.0	17	16	15	12	10	N/A	17	13

Notes:
1 = CCME Canadian Soil Quality Guidelines, Residential / Parkland Use, coarse-grained soils.
2 = CCME (2007), Canadian Soil Quality Guidelines, Update 7.0, Table 2. Human health soil ingestion and Eco Soil Contact.
3 = Upper Limit of Acceptability is determined as described in Report Section 3.2. Upper limits of acceptability are
NA = Not applicable
NC = No Criteria

RPD= Relative Percent Difference

RDL= Reportable Detection Limit

20 = Exceeds selected guideline.

Table 14
Soil Chemical Concentrations - Metals
INAC Nunvaut Regional Office
Cape Christian, Nunavut

PARAMETER	CCME[1] Residential/ Parkland	CCME[2] Human Health Ingestion (H) / Eco Soil Contact (E)	INAC DEW Line Cleanup Criteria, Tier II	Upper Limit of Acceptability[3]	CC4 2011-08-24 0 - 0.15	CC-BK 2013-08-09 0 - 0.15
Metals (ug/g)						
Sulphur (S)	NC	NC	NC	NA	---	150
Antimony (Sb)	20	NC	NC	NA	---	<0.20
Arsenic (As)	12	12H 17E	30	1.4	<1.0	1.3
Barium (Ba)	500	6800H	NC	NA	---	29
Beryllium (Be)	4.0	NC	NC	NA	---	<0.20
Boron (B)	NC	NC	NC	NA	---	<5.0
Cadmium (Cd)	10	14H 10 E	**5.0**	3.9	<0.10	<0.10
Chromium (Cr)	64	220H 64E	250	952	38	11
Cobalt (Co)	50	NC	**50**	23	3.0	3.6
Copper (Cu)	63	1100H 63E	100	80	1.1	4.7
Lead (Pb)	140	140H 300E	500	126	2.0	3.2
Molybdenum (Mo)	10	NC	NC	NA	---	<0.50
Nickel (Ni)	45	200H 45E	100	21	4.0	5.6
Selenium (Se)	1.0	80H 1E	NC	NA	---	<0.50
Silver (Ag)	20	NC	NC	NA	---	<0.20
Thallium (Tl)	1.0	1.0H 1.4E	NC	NA	---	0.15
Tin (Sn)	50	NC	NC	NA	---	<5.0
Uranium (U)	23	23H 500E	NC	NA	---	0.53
Vanadium (V)	130	130E	NC	NA	---	24
Zinc (Zn)	200	200E	500	415	7.0	27
Mercury (Hg)	6.6	6.6H 12E	**2.0**	0.4	<0.050	<0.050
Physical Properties						
Moisture (%)	NC	NC	NC		17	14

Notes:
1 = CCME Canadian Soil Quality Guidelines, Residential / Parkland Use, coarse-grained soils.
2 = CCME (2007), Canadian Soil Quality Guidelines, Update 7.0, Table 2. Human health soil ingestion and E
3 = Upper Limit of Acceptability is determined as described in Report Section 3.2. Upper limits of acceptability
NA = Not applicable
NC = No Criteria

RPD= Relative Percent Difference

RDL= Reportable Detection Limit

20 = Exceeds selected guideline.

Table 15
Soil Chemical Concentrations - PCBs
INAC Nunvaut Regional Office
Cape Christian, Nunavut

PARAMETER	Federal CCME[1] Residential/ Parkland	INAC DEW Line Cleanup Criteria, Tier II	Upper Limit of Acceptability[2]	RDL	CC1 2011-08-24 0 - 0.15	CC-SS1 2013-08-09 0 - 0.15	CC2 2011-08-24 0 - 0.15	CC-SS2 2013-08-09 0 - 0.15	CC-DUP1 2013-08-09 0 - 0.15	Duplicate Evaluation RPD (%)	CC3 2011-08-24 0 - 0.15	CC-SS3 2013-08-09 0 - 0.15
Polychlorinated Biphenyls (ug/g)												
Aroclor 1262	NC	NC	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	N/A	<0.01	<0.01
Aroclor 1016	NC	NC	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	N/A	<0.01	<0.01
Aroclor 1221	NC	NC	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	N/A	<0.01	<0.01
Aroclor 1232	NC	NC	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	N/A	<0.01	<0.01
Aroclor 1242	NC	NC	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	N/A	<0.01	<0.01
Aroclor 1248	NC	NC	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	N/A	<0.01	<0.01
Aroclor 1254	NC	NC	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	N/A	<0.01	<0.01
Aroclor 1260	NC	NC	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	N/A	<0.01	<0.01
Aroclor 1268	NC	NC	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	N/A	<0.01	<0.01
Total PCB	1.3	50	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	N/A	<0.01	<0.01

Notes:

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

2 = Upper Limit of Acceptability, calculated using mean of baseline data +3 standard deviations.

NC = No Criteria

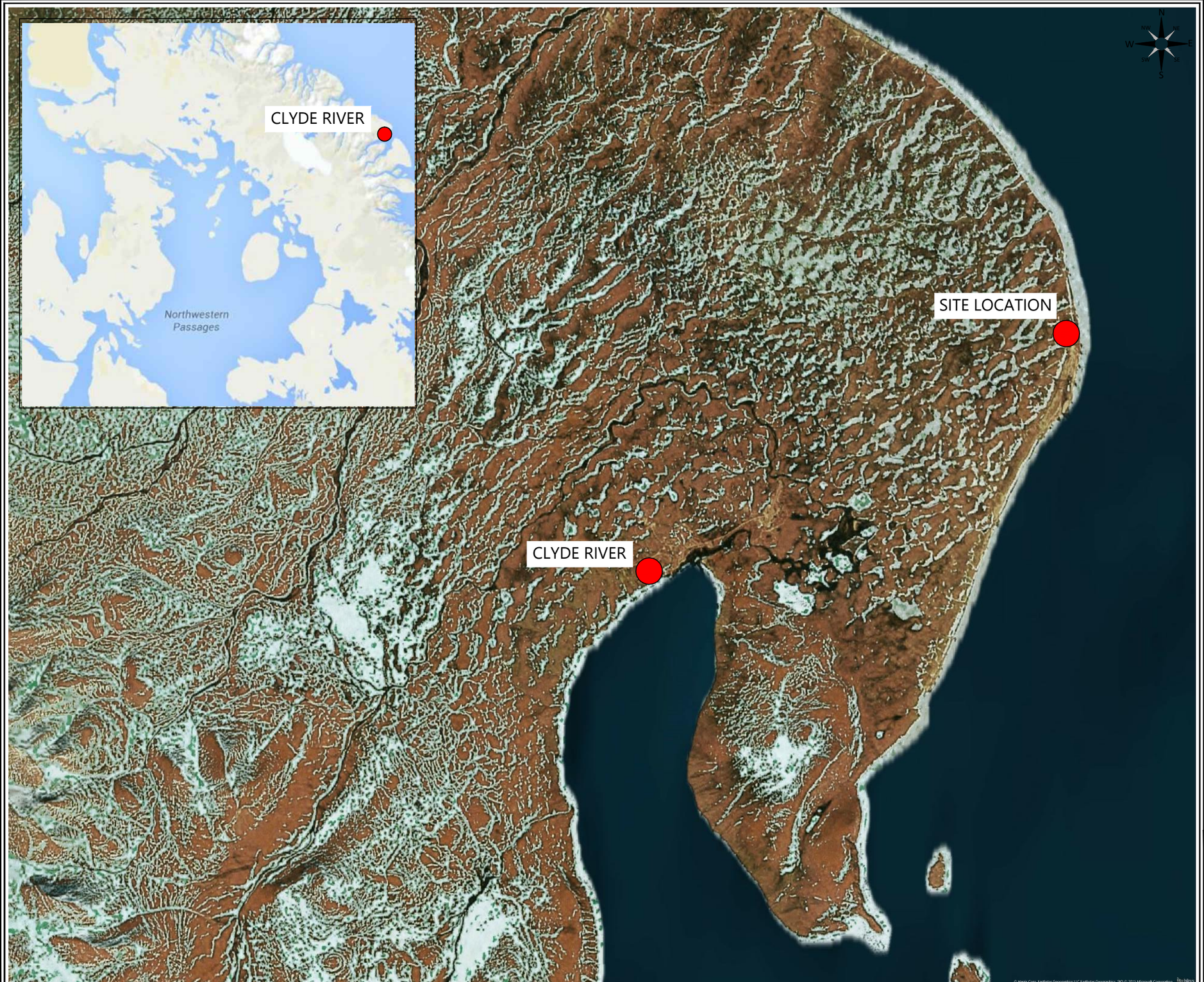
RPD= Relative Percent Difference

RDL= Reportable Detection Limit

20 = Exceeds selected guideline.

FIGURES

Figures 1 and 2



DRAFT

Note:
Image from Bing Maps, 2017. Inset image from Google Maps 2015

Title:
Cape Christian Site Location

ARCADIS

Project:
Cape Christian
100570-002

Date:
January 2018

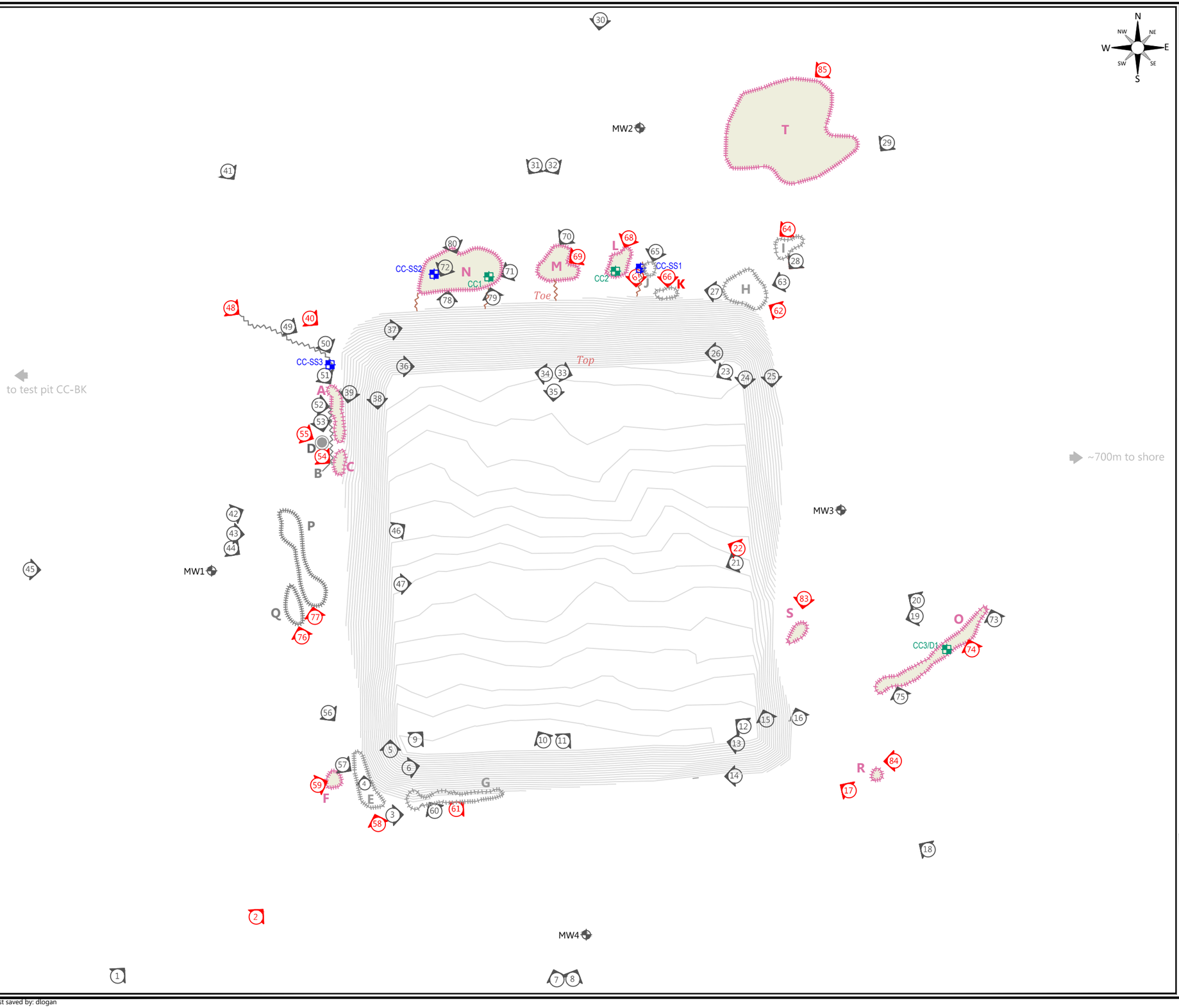
Client:
Indigenous and Northern Affairs Canada

0 2500 5000 1:100K
Meters

Figure 1

last saved by: dlogan

Z:\Projects\2017\100347-002 INAC LTM\Cape Christian\FIGURES\1-CAD\100347-002 Cape Christian.dwg(layout)



Legend

- MW — Monitoring Well Locations
- 2011 Soil Sample Locations
- 2013 Soil Sample Locations
- 25 — Picture Viewpoint Number
- 8 — Viewpoint Photograph Included in Appendices of Report
- A — Staining or Seepage
- Sinkhole
- Settlement
- A — Feature Reference Letter
- I — (Greyed Out) Feature is no Longer Present

DRAFT

Note:
Picture numbers refer to photograph names as they appear on the attached cd-rom.

Title: Non-Hazardous Waste Landfill

ARCADIS

Project: Cape Christian 1697-1501

Date: January 2018

Client: Indigenous and Northern Affairs Canada

Scale 1:750

20 15 10 5 0 20 metres

Figure 2

last saved by: dlogan

Z:\Projects\2017\100347-002 INAC LTM\Cape Christian\FIGURES\1-CAD\100347-002 Cape Christian.dwg(layout)

APPENDIX B

Site Photographs

Project Photographs

Long Term Monitoring, 2017
Cape Christian, Nunavut

Photo: 1

Date:
August 17, 2017

Description:
Landfill view from southwest approach.

Location:
Viewpoint 2 (Figure 2)

Direction Taken:
NE

Photo: 2

Date:
August 17, 2017

Description:
Landfill view from southeast approach.

Location:
Viewpoint 17 (Figure 2)

Direction Taken:
NW

Project Photographs

Long Term Monitoring, 2017
Cape Christian, Nunavut

Photo: 3

Date*:*
August 17, 2017

Description:
View of landfill cap from eastern edge.

Location:
Viewpoint 22 (Figure 2)

Direction Taken:
W

Photo: 4

Date:
August 17, 2017

Description:
Northwest toe of landfill.

Location:
Viewpoint 40 (Figure 2)

Direction Taken:
SE

Project Photographs

Long Term Monitoring, 2017
Cape Christian, Nunavut

Photo: 5

Date:
August 17, 2017

Description:
Former location of Feature A, drainage formation. Not observed in 2017

Location:
Viewpoint 48 (Figure 2)

Direction Taken:
SE

Photo: 6

Date:
August 17, 2017

Description:
Location of Feature C (settlement), not observed in 2017; western edge of landfill.

Location:
Viewpoint 54 (Figure 2)

Direction Taken:
E

Project Photographs

Long Term Monitoring, 2017
Cape Christian, Nunavut

Photo: 7

Date:
August 17, 2017

Description:
Location of Feature D (sinkhole), not observed in 2017; western edge of landfill.

Location:
Viewpoint 55 (Figure 2)

Direction Taken:
E

Photo: 8

Date:
August 17, 2017

Description:
Southwest corner of landfill and area where Feature E was observed in previous years.

Location:
Viewpoint 58 (Figure 2)

Direction Taken:
N

Project Photographs

Long Term Monitoring, 2017
Cape Christian, Nunavut

Photo: 9

Date:
August 17, 2017

Description:
Location of Feature F (sinkhole), size appears to have decreased in 2017 from previous years; southwestern toe of landfill.

Location:
Viewpoint 59 (Figure 2)

Direction Taken:
NE

Photo: 10

Date:
August 17, 2017

Description:
Location of Feature G (previously-documented depression), not observed in 2017.

Location:
Viewpoint 61 (Figure 2)

Direction Taken:
NE

Project Photographs

Long Term Monitoring, 2017
Cape Christian, Nunavut

Photo: 11

Date:
August 17, 2017

Description:
Location of Feature H (previously-documented depression), not observed in 2017.

Location:
Viewpoint 62 (Figure 2)

Direction Taken:
NW

Photo: 12

Date:
August 17, 2017

Description:
Feature I; no ponding or staining observed in 2017.

Location:
Viewpoint 64 (Figure 2)

Direction Taken:
SW

Project Photographs

Long Term Monitoring, 2017
Cape Christian, Nunavut

Photo: 13

Date:
August 17, 2017

Description:
Ponding in Feature K (settlement); no staining observed in 2017.

Location:
Viewpoint 66 (Figure 2)

Direction Taken:
S

Photo: 14

Date:
August 17, 2017

Description:
Location of previous area of settlement; not observed in 2017.

Location:
Viewpoint 67 (Figure 2)

Direction Taken:
S

Project Photographs

Long Term Monitoring, 2017
Cape Christian, Nunavut

Photo: 15

Date*:*
August 17, 2017

Description:
Location of Feature L, no significant change in the feature from previous observations; northern edge of the landfill

Location:
Viewpoint 68 (Figure 2)

Direction Taken:
S

Photo: 16

Date*:*
August 17, 2017

Description:
Location of previous area of settlement; extent of settlement and ponded water have decreased in 2017 from previous years

Location:
Viewpoint 69 (Figure 2)

Direction Taken:
SW

Project Photographs

Long Term Monitoring, 2017
Cape Christian, Nunavut

Photo: 17

Date:
August 17, 2017

Description:
Feature O. Area of settlement and staining appears to have migrated to the south toward the new drainage channel in 2017.

Location:
Viewpoint 74 (Figure 2)

Direction Taken:
N

Photo: 18

Date:
August 17, 2017

Description:
Former location of Feature Q; feature not observed in 2017; western edge of the landfill.

Location:
Viewpoint 76 (Figure 2)

Direction Taken:
N

Project Photographs

Long Term Monitoring, 2017
Cape Christian, Nunavut

Photo: 19

Date:
August 17, 2017

Description:
Former area of staining labelled as Feature P; no staining observed in 2017.

Location:
Viewpoint 77 (Figure 2)

Direction Taken:
N

Photo: 20

Date:
August 17, 2017

Description:
New Feature s; area of settlement observed in 2017.

Location:
Viewpoint 83 (Figure 2)

Direction Taken:
S

Project Photographs

Long Term Monitoring, 2017
Cape Christian, Nunavut

Photo: 21

Date:
August 17, 2017

Description:
New Feature R; area of settlement observed in 2017.

Location:
Viewpoint 84 (Figure 2)

Direction Taken:
W

Photo: 22

Date:
August 17, 2017

Description:
View of landfill (NE corner) from the location of waste disposal area observed in 2017, seen in foreground of photo.

Location:
Viewpoint 85 (Figure 2)

Direction Taken:
SW

Project Photographs

Long Term Monitoring, 2017
Cape Christian, Nunavut

Photo: 23

Date*:*
August 17, 2017

Description:
Debris examples observed in waste disposal area.

Location:
Feature T

Direction Taken:
N/A

Photo: 24

Date*:*
August 18, 2017

Description:
Vandalism of samples, discovered in the morning of August 18th, 2017 before leaving for flight to Iqaluit, NU.

Location:
Clyde River, NU

Direction Taken:
N/A

Arcadis Canada Inc.

329 Churchill Avenue North

Suite 200

Ottawa, Ontario K1Z 5B8

Tel 613 721 0555

Fax 613 721 0029

www.arcadis-canada.com