CONESTOGA-ROVERS & ASSOCIATES

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PRE EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN

IQALUIT INTERNATIONAL AIRPORT IMPROVEMENT PROJECT
IQALUIT, NUNAVUT

Prepared for: Arctic Infrastructure Partners & The Government of Nunavut

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Partners in Sustainability

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LIST OF ACRONYMS

µg/L	micrograms per litre
AIP	Arctic Infrastructure Partners
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CAEAL	Canadian Association of Environmental Analytical Laboratories
CCME	Canadian Council of Ministers of the Environment
COC	Contaminant of Concern
CMP	Pre-Existing Environmental Contamination Management Plan
CRA	Conestoga-Rovers & Associates
DSHMS	Designated Substance and Hazardous Material Survey
EDD	Electronic Data Delivery
EPD	Environment Protection Division (Government of Nunavut)
ESA	Environmental Site Assessment
FTA	Fire Training Area
GAC	Granular Activated Carbon
GN	Government of Nunavut
GNWT	Government of Northwest Territories
HASP	Health and Safety Plan
HDPE	High-density polyethylene
kg	kilogram
LNAPL	Light Non-Aqueous Phase Liquid
LTU	Land Treatment Unit
m	Metre
m^2	Square Metre
m^3	Cubic Metre
mAMSL	Metres Above Mean Sea Level
mbgs	Metres Below Ground Surface
MOE	Ministry of Environment (Ontario)
NAPL	Non-Aqueous Phase Liquid
NAP	National Airports Policy
O&G	Oil and Grease
O/W	Oil/Water Separator
ODS	Ozone-Depleting Substances
PAH	Polycyclic Aromatic Hydrocarbons

LIST OF ACRONYMS

PCB	Polychlorinated Biphenyl
PECAMP	Pre-Existing Environmental Contamination Assessment and Mitigation Plan
PHC	Petroleum Hydrocarbon
PPE	Personal Protective Equipment
PPM	Parts Per Million
PVC	Polyvinyl chloride
PID	Photoionization Detector
RBC	Risk-Based Concentration
RFP	Request for Proposal
QA/QC	Quality Assurance/Quality Control
QE	Qikiqtaaluk Environmental Inc.
SQG	Soil Quality Guideline
TC	Transport Canada
TDG	Transportation of Dangerous Goods
UFFI	Urea Formaldehyde Foam Insulation
VOC	Volatile Organic Compound
WHMIS	Workplace Hazardous Materials Information System

1.0 INTRODUCTION

Conestoga-Rovers & Associates (CRA) has prepared this Pre-Existing Environmental Contamination Management Plan (CMP) for Arctic Infrastructure Partners (AIP). The CMP has been prepared in accordance with the following documents:

- Environmental Assessment Agreement (EAA) for the Iqaluit International Airport Improvement Project, Government of Nunavut and Bouygues Building Canada Inc. and Sintra Inc., dated July 8, 2013
- Iqaluit International Airport Improvement Project, Schedule 8, Environmental Obligations, final version dated September 10, 2013 (Schedule 8)
- CRA's Proposal for Pre-Existing Environmental Contamination Management Plan, dated August 2013 (Proposal)

The scope of work for the CMP was developed and implemented to satisfy the requirements stipulated in the EAA and Schedule 8.

The CMP is based on the results of the Pre-Existing Environmental Contamination Assessment and Mitigation Plan (PECAMP), which was prepared for AIP and the Government of Nunavut (GN) in September 2013 (CRA, September 2013). The PECAMP identified areas of Pre-Existing Environmental Contamination that will be encountered during the Iqaluit International Airport Improvement Project (the Project). The Iqaluit International Airport is located at 1126 Mivvik Street, Iqaluit, Nunavut (Site). CRA understands that the airport improvement activities are scheduled to commence in 2014. CRA submitted a draft CMP to AIP and the GN on September 9, 2013. CRA has prepared this revised CMP to address comments received from AIP and the GN and to incorporate information provided to CRA regarding recent work completed at the Site by Transport Canada (TC).

The intent of the CMP is to provide AIP with the scope and methods to handle, manage, process, transport, dispose of or otherwise address the Pre-Existing Environmental Contamination identified in the PECAMP located within the areas of the Project. The CMP will provide the conceptual design for the selected remedial options to manage each area of Pre-Existing Environmental Contamination. Indicative cost estimates and schedule are also provided.

1.1 PROJECT BACKGROUND

CRA understands that AIP is a consortium comprised of the following entities: Bouygues Building Canada, InfraRed Capital Partners, Winnipeg Airports Authority and ColasCanada, through its subsidiary, Sintra Inc. (the Consortium). The Consortium retained CRA to prepare the PECAMP and the CMP for the Project.

The Project includes construction of a new Air Terminal Building, a new Combined Services Building and substantial improvements to the runways, taxiways and aprons (including construction of a new taxiway and expansion/alterations to all of the aprons) and construction of groundside infrastructure including access roads and parking lots, utilities, etc. The Project is scheduled to commence in 2014.

Based on the information provided in Schedule 8, Section 1.3(b) (1), (e), CRA developed the CMP in accordance with the following guidelines and objectives:

- The work and activities that are expected to be needed in order to manage Pre-Existing Environmental Contamination shall be planned and conducted in compliance with applicable Laws and the Project Agreement, in the most efficient manner, in terms of cost and time
- Materials and wastes will only be removed from the Site and disposed of off-Site where there is a lawful requirement to do so and where there is no other reasonable lawful option, such as on-site treatment, Temporary Storage and/or Disposal, or through the use of risk assessment
- Risk assessment will be used where feasible and reasonable
- If risk assessment is not available, on-site treatment, Temporary Storage and/or Disposal will be used where feasible, reasonable and in compliance with applicable Laws, in order to avoid the cost and delay associated with transporting and disposing of materials or wastes off site, which will only be done where there are no other lawful options available

Per Schedule 8 Environmental Obligations, Section 1.3(a) (1), (2), there are different areas of Pre-Existing Environmental Contamination that may be encountered during the Project and they are defined as follows:

1. Pre-Existing Environmental Contamination contained in buildings T-116, T-25 and T-120 as disclosed in the Designated Environmental Report, to the extent such Pre-Existing Environmental Contamination is not different than as disclosed in such report ("Disclosed Pre-Existing Environmental Contamination")

2. Pre-Existing Environmental Contamination disclosed in an Environmental Report, located in an Identified Contaminated Zone and disturbed by Project Co's[1] performance of the Construction or the Services ("Disturbed Pre-Existing Environmental Contamination")

3. To the extent that Project Co is required to handle, manage, store, transport or dispose of Pre-Existing Environmental Contamination pursuant to this Agreement, any Pre-Existing Environmental Contamination that is Released by Project Co or a Project Co Person where such Release was caused or permitted in non-compliance with Environmental Laws or this Agreement ("Mishandled Pre-Existing Environmental Contamination")

The CMP will focus on managing the environmental contamination located within the areas of the Project. CRA did not investigate areas outside of the scope of the Project, per AIP's direction.

CRA understands that the alignment of Taxiway G has been revised from the original alignment provided to CRA in April 2013. The scope of work included herein has been revised to include only the environmental contamination located within the revised limits of the Project.

1.2 REPORT ORGANIZATION

- Section 1.0 defines the purpose of the CMP and reviews the project organization
- Section 2.0 provides an overview of the Site history and setting and a review of the extent of historical contamination
- Section 3.0 discusses the remedial objectives and applicable guidelines
- Section 4.0 discusses the nature and extent of Pre-existing Environmental Contamination
- Section 5.0 introduces the conceptual remedial design
- Section 6.0 discusses the scope of work for the areas requiring environmental management
- Section 7.0 provides indicative project costs and schedule
- Section 8.0 provides the references used to prepare the CMP

[1] Project Co is defined as the Successful Proponent Team in the Environmental Assessment Agreement.

2.0 SITE BACKGROUND

2.1 SITE SETTING AND HISTORY

The Site is located at 1126 Mivvik Street in Iqaluit, Nunavut, and occupies approximately 538 hectares of land. A Site location map is presented on Figure 1.

The Site is located at the head of Frobisher Bay on southern Baffin Island between the Sylvia Grinnell River and Koojesse Inlet. The Site was developed by the United States in the 1940s to facilitate transportation from the United States to Europe by way of Canada, Greenland and Iceland. The Government of Canada purchased the airport's infrastructure in 1944, and retained ownership and operation of the Site. TC took over the Site operations in 1957.

TC issued the National Airports Policy (NAP) in 1994, and its major initiative was to transfer the regional/local airports to provincial and territorial governments. In July 1995, the ownership of the Site was transferred to the Government of Northwest Territories (GNWT) and was operated by the Arctic Airports Division of the Department of Transportation. The Site was then transferred to the GN in April 1999 and operated by the Nunavut Airports Division of the Nunavut Department of Community Government, Housing and Transportation. As a condition of the Arctic A Airport Transfer Agreement (July 1995), environmental contamination was to be remediated prior to the transfer of the Site to the GN. A series of Environmental Site Assessments (ESAs) were completed in the 1990s to investigate Site impacts. Environmental investigations and remedial activities were completed from the 1990s to present. The PECAMP provides a detailed summary of the Pre-Existing Environmental Contamination and remedial activities completed in the proposed Project areas at the Site.

Historical soil investigations indicate that the soil units underlying the Site are comprised of sand and gravel with some rocks above a continuous permafrost layer. Permafrost has been historically encountered from 0.8 to 2 metres below ground surface (mbgs). The permafrost layer acts as a confining layer to spring thawing conditions, and groundwater is encountered in isolated locations. Groundwater flow direction varies depending on surrounding topography, but generally flows to the south towards Frobisher Bay.

3.0 REMEDIAL OBJECTIVES/APPLICABLE GUIDELINES

The remedial objectives for the Project are as follows:

- To prevent exposure to impacted soil containing contaminants of concern (COCs) at concentrations greater than applicable CCME or Site specific risk-based concentrations (RBCs)
- To prevent exposure to groundwater on and off Site containing COCs at concentrations greater than applicable guidelines or Site specific RBCs
- Mitigate the potential for the volatilization of COCs in soil and groundwater to indoor air of future on-Site buildings

CRA used the following guidelines to assess soil and groundwater concentrations detected during the PECAMP field activities completed at the Site in July 2013.

Applicable Soil Standards for the Site:

1. Canadian Council of Ministers of the Environment (CCME) Tier 1 Industrial Guidelines: As presented in "*Canadian Environmental Quality Guidelines Summary Tables, Soil Quality Guidelines for the Protection of Environmental and Human Health, Industrial Land Use*", dated 1999, updated 2011 (CCME, 2011). CCME has recently updated their Soil Quality Guidelines (SQGs) for some polycyclic aromatic hydrocarbons (PAHs), as presented in "*Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health- Polycyclic Aromatic Hydrocarbons 2010*" (CCME, 2010). CCME Tier 1 Industrial Guidelines were used to determine if soil impacts are present at the Site.
2. Environment Protection Division (EPD) of the Department of Environment of the GN Tier 1 Criteria for PHC impacts in Surface Soil: As presented in the "*Environmental Guideline for Contaminated Site Remediation*", Department of Environment, Government of Nunavut, dated April 1999, updated January 2002 and March 2009. The EPD developed this guidance document with reference to the CCME document "*Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil*", dated 2001, updated in 2008. The PHC standards are consistent between the two guidance documents. The surface soil depth relates to any soil sample collected less than 1.5 mbgs. The GN Tier 1 Criteria were used to determine if soil impacts are present at the Site.

Based on CRA's field observations, the coarse-textured soil standards shall apply across the Site.

Groundwater standards used for comparison purposes:

1. CCME Water Quality Guidelines: As presented in "*Canadian Environmental Quality Guidelines Summary Tables, Water Quality Guidelines for the Protection of Aquatic Life, Freshwater*", dated 1999, updated 2012 (CCME, 2012). CCME does not have any guidelines for groundwater. CRA has used the short and long term guidelines for comparison purposes, and as an initial screening of the groundwater data. The CCME Water Quality Guidelines for the Protection of Aquatic Life were developed using freshwater toxicity data, which are conservative for a groundwater condition. The freshwater toxicity data do not take into account a dilution factor (i.e., groundwater entering into a freshwater body), and as such, CRA developed RBCs for the groundwater at the Site. The development of the RBCs is discussed further below.
2. Ontario's Ministry of Environment (MOE) Table 3 Standards: As presented in "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Ontario Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition", dated April 15, 2011, (MOE, 2011). MOE Table 3 Standards for industrial/commercial/community property use for coarse-textured soil were applied. In the absence of CCME Water Quality Guidelines for groundwater conditions, CRA used the MOE standards for comparison purposes.

The CCME Water Quality Guidelines were developed to be protective of ecological and human receptors for a fresh water environment, and are conservative when applied to a groundwater condition. CRA used the CCME guidelines as an initial and general screening of the groundwater data.

CRA used the MOE standards for full depth generic site condition standards in a non-potable groundwater condition for comparison purposes. The MOE standards are protective of ecological and human receptors and are applicable to sites in Ontario that are undergoing site remediation with an objective to achieve clean closure in accordance with the MOE generic standards.

CRA understands that the objective of the Project is to manage the Pre-Existing Environmental Contamination during the Project works and not to achieve Site clean-up. Based on this objective, CRA conducted a risk evaluation to determine if the soil and groundwater concentrations present pose an unacceptable risk to Site-specific receptors. CRA identified/calculated Site specific RBCs based on the following potential exposure pathways:

- Commercial worker direct contact (incidental ingestion and dermal contact) with soil
- Commercial worker inhalation of vapours (indoor air) from soil and groundwater
- Construction/utility worker direct contact (incidental ingestion, dermal contact, and ambient air inhalation) with soil and groundwater
- Trespasser direct contact (incidental ingestion, dermal contact, and ambient air inhalation) with soil
- Plants and soil organisms direct contact with soil and groundwater

The technical memoranda summarizing the development of the RBCs for soil and groundwater are provided in Appendix A and B, respectively.

Through the development of the RBCs for soil and groundwater, all potential exposure pathways were considered for human and ecological receptors. The above-noted exposure pathways were identified as the applicable exposure pathways for the Site based on Site conditions and land use (i.e., community).

For the development of the groundwater RBCs, a construction/utility worker, and plants and soil organisms were the only receptors identified that could come in direct contact with the impacted groundwater for the duration of the Project. Commercial workers and trespassers typically conduct activities at or near the surface and therefore direct contact with groundwater will not occur for these receptors. In addition, the groundwater to indoor air pathway was evaluated for a commercial worker under the assumption that a commercial building is present directly above the impacted groundwater.

For the development of the soil RBCs, a construction/utility worker, commercial worker, trespasser, and plants and soil organisms were identified as the receptors that could come in direct contact with the impacted soil. For the purpose of this evaluation, the trespasser was assumed to be a teenager trespassing on the Site for 2 hours/day, 2 days/week for 35 weeks/year. This was considered to be a conservative evaluation for persons that may be on the airport property that are not construction or commercial workers, including visitors to the airport. Based on the property use, a residential receptor was not identified as an applicable receptor to the Site. As noted above, the soil to indoor air pathway was evaluated for a commercial worker under the assumption that a commercial building is present directly above the impacted soil.

In accordance with the Department of Environment's Environmental Guideline document for Contaminated Site Remediation (Department of Environment 2009), a

property owner is required to notify the EPD upon discovery of soil or groundwater contamination.

As summarized in the Environmental Guideline, EPD has established a tiered approach for the development of site-specific remediation criteria and objectives. Tier 1 directly applies remediation criteria, as established by EPD and CCME. If the remediation of soil to Tier 1 criteria is not practical from a cost, logistical or technical perspective, then Tier 2 or Tier 3 site-specific remediation criteria can be used for site management. Tier 2 and Tier 3 approaches are modifications to the Tier 1 criteria based on site-specific receptors, site or contamination locations, and exposure pathways. Tier 2 is a modification to Tier 1 criteria within specified limits, whereas Tier 3 is a risk-based approach.

The AIP is required to consult EPD to obtain approval of the Tier 3 approach, which includes using the Site-specific RBCs for the Site. As discussed with the Director of the EPD, Mr. Robert Eno, the EPD relies on the expertise of the qualified professional to propose reasonable and practical approaches for the encountered contamination at each Site. EPD is generally agreeable to Tier 3 approaches as long as the proposed criteria are supported by fair assumptions and scientific rational. EPD strives to review and provide concurrence of site remedial objectives and criteria within a 2-week period in order to expedite remedial activities; however, EPD may use additional time and resources to review complex sites, if EPD deems it is warranted.

CRA recommends that AIP provide the soil and groundwater results collected in 2013 and the calculated RBCs for soil and groundwater prepared for the Site to EPD for review. Based on the low level and limited contamination encountered at the Site, CRA anticipates EPD's concurrence of the Site-specific RBCs (Tier 3 approach) would be obtained within a short time frame. If requested, CRA could facilitate this review process with the EPD.

4.0 NATURE AND EXTENT OF PRE-EXISTING ENVIRONMENTAL CONTAMINATION

During the PECAMP, CRA collected 36 soil samples and two grab groundwater samples for analyses of VOCs (including benzene, toluene, ethylbenzene and xylenes [BTEX]), PAHs, metals, PHC F1-F4, polychlorinated biphenyls (PCBs) and general chemistry parameters. The soil analytical data compared to the CCME Tier 1 Guidelines, the EPD Tier 1 Criteria for PHCs in surface soils, and the Site-specific RBCs are provided in Table 1. The groundwater analytical data compared to the CCME Water Quality Guidelines for the protection of freshwater aquatic life, the MOE Table 3 Standards, and the Site-specific RBCs are provided in Table 2.

The locations of the soil and groundwater exceedances identified throughout the PECAMP are provided on Figure 3.

Based on the findings of the PECAMP, CRA identified areas where environmental contamination will be encountered during the implementation of the proposed Project works. The extent of the contamination has not been fully delineated but is reasonably approximated herein based on the data available and CRA's inspection of the Site conditions during the PECAMP. Pre-construction verification and delineation sampling is recommended to be carried out (Section 5.2.1) to ensure delineation is achieved and the extent of the remedial work within the limits of the Project is verified prior to commencing the Project. The areas are described as follows:

- **Drum Cache 1** – Approximately 300, 205-litre drums and a 50,000 litre tank are currently staged in this area. Based on the historic reports reviewed and the condition of the drums, the drum cache has been located in this area since at least 1995. The drums contain varying quantities of a tar product (from residual to full). The tar product has leaked from some of the drums on to the surficial soil. The soil sample collected immediately underlying an area of tar product (TP32 - 0.15 mbgs) contains concentrations of ethylbenzene one order of magnitude greater than the CCME guideline. CRA anticipates that the ethylbenzene impacts do not extend beyond the sample depth into the soil, as the tar product is quite viscous. The drums, tank, tar product, and surficial soil located within this area must be managed prior to or during the Project works. A waste characterization sample was collected from the tar product. The analytical results are provided in Table 3.
- **LTUs and underlying soil** - Soil samples collected from LTU1, LTU2 and in the area surrounding the LTUs (test pit TP24) contain concentrations of PHC F2 and F3 greater than the EPD criteria. As summarized in the QE Phase II ESA, soil located in LTU1 and the western half of LTU2 contained concentrations of PHC F2 greater than

the applicable CCME guidelines. Based on the QE Report, soil located within the footprint of LTU3 does not contain concentrations of PHCs greater than the applicable CCME guidelines. As discussed above (Section 2.2), residual PHC F2 soil impacts may still be present in this area based on information provided in the Biogénie 2011 report; however, the exact location is unknown and CRA understands that the footprint of LTU3 where the exceedance was detected has since been covered with clean soil and landscaped. As discussed with Sintra in January 2014, CRA has removed management of potentially impacted soil from LTU3 from the scope of work for the CMP.

- **Buried asbestos waste** - CRA observed a sign located adjacent to the LTUs that demarcates the location of buried asbestos waste. CRA did not find any additional information in the historical reports on the type or volume of asbestos waste buried. The GN advised AIP and CRA that TC has anecdotal evidence that the buried asbestos waste was bagged and sealed prior to burial. Based on the revised alignment of Taxiway G, the buried asbestos waste has since been removed from the scope of work for the Project.
- **Arsenic-impacted soil adjacent to runway** - The soil sample collected from 0.8 mbgs at test pit TP15 located adjacent to the runway contained concentrations of arsenic greater than the CCME guideline. The arsenic-impacted soil located within this area must be managed prior to or during the Project works.
- **PAH-impacted groundwater** – The grab groundwater sample collected from test pit TP06 contained concentrations of PAH parameters greater than the MOE Table 3 Standards. Groundwater was encountered during the excavation of test pit TP06 at approximately 1.1 mbgs. The PAH-impacted groundwater encountered in this area must be managed during the Project works.
- **Hazardous or Designated Materials in Buildings: asbestos, lead, mercury, PCBs –** Two existing buildings (T-116 and T-120) will be demolished and one existing building (T-25) will be rehabilitated for an alternate use as part of the Project works. The designated substance and hazardous material survey (DSHMS) completed in 2013 identified the presence of asbestos, lead, mercury, and PCBs in buildings T-25, T-116, and T-120 (Genivar, 2013). These designated substances must be managed prior to or during the Project works.

As part of the PECAMP, CRA identified environmentally acceptable and practical remedial options for each of the above-noted areas requiring management. A description of the remedial options contemplated and recommendation of the preferred remedial option was provided in the PECAMP, and is summarized in the Remedial

Option Matrix included as Table 4 of this report. The following sections identify the selected remedial options and the conceptual design of the selected remedial option.

As requested by the GN, CRA has included the description of and indicative costs for an alternative remedial option for the management of the steel drums, steel tank, ethylbenzene-impacted soil (drum cache area) and for the PHC-impacted soil located in the former fire training area (FTA). The details for the alternative remedial options are provided in Section 6 and the indicative costs are provided in Table 6B.

5.0 CONCEPTUAL REMEDIAL DESIGN

5.1 EXPOSURE PATHWAYS

The current use and anticipated future use of the Site is commercial. As such, the receptors that may come in contact with the identified contamination on Site include:

- Commercial workers
- Construction workers
- Trespassers (include persons visiting the airport property)
- Potential aquatic and terrestrial wildlife

The exposure scenarios contemplated while developing the conceptual remedial design were:

Human receptors:

- Direct exposure to soil and groundwater (i.e., through dermal contact or incidental ingestion of contaminants)
- Inhalation of contaminants (soil and groundwater)

Ecological receptors:

- Bioaccumulation, bioconcentration, and direct toxicity to species as a result of soil and groundwater contamination on Site.

Prior to commencement of the remedial work, a worker health and safety plan will be required to be prepared for the Project.

2.2 EXTENT OF HISTORICAL CONTAMINATION

Various environmental investigation and remediation projects have been completed at the Site since the 1990s. The Consortium provided CRA with electronic copies of historical environmental documents (67 documents) that have been prepared for the Site, and are referenced in Appendix A of the PECAMP. CRA reviewed each of these documents to identify the location of areas of Pre-Existing Environmental Contamination and to determine if there were any areas of potential environmental

contamination not identified in the historic documents. As summarized in the PECAMP, CRA completed investigative activities to confirm the location and extent of Pre-Existing Environmental Contamination in the areas of the Project. Figure 2 provides a Site plan designating the areas of known or potential environmental contamination located within the Project area based on the document review.

A detailed summary of the historical documents reviewed by CRA is provided in the PECAMP.

In December 2013 Sintra (as provided by TC) provided CRA with the Qikiqtaaluk Environmental (QE) Phase II ESA Report on the Iqaluit Landfarm Maintenance (QE, 2013) activities completed in July to September 2013. As such, the details provided in the QE Phase II ESA were not included in the PECAMP (CRA, 2013) and the original version of the CMP (CRA, 2013), both of which were submitted to AIP and the GN in September 2013. The QE Phase II ESA summarizes the maintenance and confirmatory sampling conducted on land treatment unit No. 3 (LTU3) in July through September 2013. The noteworthy findings of this report are summarized below.

As previously noted in the PECAMP (CRA, 2013), Biogénie was retained by TC to decommission LTU3 in 2011. Analytical results from soil samples collected from the lower portion of soil in LTU3 identified concentrations of various parameters above applicable Canadian Council of Ministers of Environment (CCME) standards. As such, the top 0.4 m of soil in LTU3 was stockpiled for potential reuse as clean fill while the bottom portion of the soil in LTU3 was subsequently excavated and transported to the "active LTU"[2] for further treatment. Analytical results from the soil samples collected from beneath the geosynthetic liner within the footprint of LTU3 identified concentrations of petroleum hydrocarbon F2 fraction (PHC F2) and naphthalene above applicable standards. LTU3 was decommissioned but was not backfilled. The geosynthetic liner was reportedly disposed of at the City of Iqaluit Waste Management Facility/Landfill in Iqaluit, Nunavut (City landfill).

Subsequently in 2013, TC retained QE to complete additional soil sampling of the footprint of LTU3 and from the adjacent soil stockpiles (soil from LTU3 excavated by Biogénie in 2011). No parameters were detected at concentrations greater than the CCME guidelines in the soil samples collected from the footprint of LTU3 and from the stockpiled soil. QE reportedly used the stockpiled soil to backfill and re-landscape LTU3.

[2] As defined in the Land Treatment Unit Decommissioning Report (Biogénie, 2012). It is unclear to CRA if the active LTU is LTU1 or LTU2.

In 2013, QE also completed maintenance activities on LTU1 and LTU2, which included the application of nutrients and tilling of the soils. QE completed two rounds of tilling one month apart. QE collected soil samples from LUT1 and LTU2 following the second tilling to determine if further soil treatment was required. No parameters were detected at concentrations greater than the CCME guidelines in the soil samples collected from LTU1 and LTU2 with the exception of PHC F2. PHC F2 was detected at concentrations greater than the CCME guidelines in all soil samples (8) collected from LTU1 and half (4) of the soil samples collected from LTU2 (western portion of LTU2).

CRA has updated the CMP to include the information summarized in the QE Phase II ESA. It is important to note that CRA has updated the orientation and naming convention of the LTUs to be consistent with the information provided by TC and as requested by the GN. As such the naming convention used in the CMP differs from that used in the PECAMP.

5.2 DESCRIPTION OF THE SELECTED REMEDIAL OPTIONS

The PECAMP contemplated remedial options for each of the six areas of environmental contamination and identified the recommended remedial option for each area. This section provides the conceptual design for each selected remedial option.

The following remedial options were identified as the recommended alternative to manage the environmental contamination present within the identified areas:

- Pre-construction verification and delineation sampling within the limits of the Project works to confirm the extent of environmental contamination that will be encountered and require management during the Project works
- Construction of an on-Site waste containment cell to securely store drums, tanks, tar product, and impacted soil
- Excavation of impacted soils for placement in the on-Site waste containment cell or for use within secure areas of the Project works
- Development and application of RBCs to validate the acceptable use of arsenic and PHC-impacted soil within secure areas of the Project works
- Development and application of RBCs to validate the acceptability of ground discharge of treated PAH-impacted groundwater
- Abatement of designated substances from three on-Site buildings for off-Site disposal at licensed disposal facilities

The scope of work to be followed during the construction of the waste containment cell, excavation of impacted soil, use of impacted soil within the Project works, and the recommended pre-construction verification and delineation sampling is described below.

5.2.1 PRE-CONSTRUCTION VERIFICATION AND DELINEATION SAMPLING

It is recommended that pre-construction verification and delineation sampling be conducted prior to commencing the Project works to confirm the horizontal and vertical extent of environmental contamination requiring management within the limits of the Project works. Once AIP has demarcated the limits of the Project works (using stakes or other), test pits will be advanced between the limits of the environmental contamination encountered during the PECAMP and the limits of the Project works. Exact number of test pits will be determined based on observations made in the field and the limits

demarcated by AIP. The test pits will be advanced to the depths that the Project works will occur in that area.

Soil and groundwater (if encountered) samples will be collected from the test pits for chemical analysis of the COCs identified for that area during the PECAMP and in historical reports (i.e., soil samples collected from the former FTA will be analyzed for PHCs and PAHs).

The realignment of Taxiway G was approved by the GN in December 2013, and as such the PECAMP (completed in July 2013) did not include the collection of soil and groundwater samples within this area. Based on the historical documents reviewed by CRA during the PECAMP, this area is not designated as an area of known or potential environmental impact; however, CRA recommends that a test pit be advanced in this area during the pre-construction and verification sampling activities to confirm that environmental contamination will not be encountered during the construction of Taxiway G.

The observations made during the test pitting and sampling activities and the analytical results for the soil and groundwater samples collected during this exercise will be used to refine the volume of waste material that needs to be managed prior to or during the Project works. The soil and groundwater samples will be analyzed on an expedited basis in order to provide AIP with as much notice as possible of any potential changes to the waste volumes. CRA will advise AIP of any required changes to the remedial options discussed in this report based on changes in the waste volumes.

Implementing the pre-construction verification and delineation sampling program negates the need to collect confirmatory samples during the Project works as the extent of environmental contamination located within the limits of the Project works will be predetermined.

5.2.2 CONSTRUCTION OF ON-SITE WASTE CONTAINMENT CELL

The on-Site waste containment cell is to be constructed to contain various waste materials encountered during the Project works, which are anticipated to include:

- Steel drums, a steel tank, tar product, and ethylbenzene-impacted soil from the drum cache area
- PHC-impacted soil from the former FTA

- Arsenic-impacted soil from an area adjacent to the runway

The cell footprint is currently proposed to be approximately 900 m^2 and will have a waste disposal capacity of approximately 1,200 m^3. The current footprint of the cell is based on CRA's estimated volumes of waste material proposed to be placed within the cell, with approximately 50 percent contingency built in to the design. The estimated volumes and assumptions used to develop the waste volumes are included in Table 4 for each waste stream. If the pre-construction verification and delineation sampling program indicates a substantive change in the estimated volume of waste material to be placed in the cell, CRA will revise the cell dimensions accordingly. Plan and cross-sectional views are provided on Figure 4.

The base of the cell will be constructed at a depth of 1 mbgs with 1H:1V side slopes and a flat base. Sand and gravel perimeter berms are to be constructed at an approximate height of 0.5 m above existing ground surface around the perimeter of the cell to minimize surface water infiltration. The excavation will be completed to smooth even lines prior to construction of the cell liner system. Due to the anticipated coarse-grained nature of the underlying soil in the vicinity of the cell, the following liner system is proposed for the base of the cell to mitigate contaminant migration from the waste materials to the underlying soil (from bottom to top):

- 540 g/m^2 non-woven geotextile
- 1.5 mm high-density polyethylene (HDPE) geomembrane
- 540 g/m^2 non-woven geotextile
- 150 mm thick layer of on-Site sand and gravel

A schematic of the liner system is presented on Figure 5. The liner system will be installed along the entire base of the cell and extend up the 1:1 side slopes. The non-woven geotextiles and HDPE geomembrane components of the liner system will extend 1 m laterally into the perimeter granular berms and maintain a minimum of 0.3 m of cover, as shown on Figure 5.

Due to the variety of waste streams anticipated, CRA recommends that waste materials are placed in the following sequence (from bottom to top):

1. Minimum 0.3 m thick layer of impacted soil at the base of the cell to protect the underlying HDPE geomembrane (as noted in the liner system).

2. Drums and steel tank will be placed simultaneously with ethylbenzene impacted soil from the drum cache area to minimize void spaces between drums, ultimately minimizing settlement of the waste within the cell. The steel tank is to be crushed prior to disposal.
3. Other waste materials.
4. A 0.3 m thick layer of impacted soil shall be placed above waste materials, beneath the cover system, to protect the overlying HDPE geomembrane to be discussed below.

Following the disposal of all necessary waste materials, a cover system is to be constructed. The primary purpose of the cover system is to minimize the amount of leachate generated in the cell by minimizing the amount of water infiltration into the waste materials. The final cover system shall consist of the following components (top to bottom):

- 0.3 m thick layer of non-impacted on-Site sand and gravel
- 540 g/m^2 non-woven geotextile
- 1.5 mm HDPE geomembrane
- 0.3 m thick layer of impacted soil

A schematic of the cover system is presented on Figure 5. The non-woven geotextile and HDPE geomembrane within the cover system shall extend 1 m laterally into the perimeter berms and a minimum of 0.3 m of cover shall be maintained, as shown on Figure 5. The cover system shall be constructed such that a high centre point is to be maintained to achieve positive drainage off of the cell cover. The final slope of the cover will be determined in the field based on the quantity and placement of the wastes in the cell.

In order to monitor the level of leachate/water within the waste containment cell, three 100 mm (4 inch) diameter polyvinyl chloride (PVC) standpipes shall be installed. The locations of the standpipes are shown on Figure 4. The standpipes are to be installed as filling progresses and must consist of a slotted section at the base of the PVC standpipe to facilitate leachate/water collection. The slotted section can consist of a No. 10 slot well screen or it may be hand slotted and covered with a Geosock. Pressure fit caps or j-plugs are to be installed in the top of the standpipes. The standpipes will facilitate the removal of leachate from the cell in the future, if required.

A sign shall be erected adjacent to the containment cell indicating the presence of the cell and shall read as follows "Lined Solid Waste Containment Cell, Excavation in this Area Prohibited".

5.2.3 EXCAVATION OF IMPACTED SOILS

An estimated 4,950 cubic metres of impacted soil will be excavated prior to or during the Project works. The estimated quantity of impacted soil for each area is provided in Table 4.

The estimated quantities for the PHC-impacted soil, arsenic-impacted soil, and surficial soil located within the drum cache area are based on the analytical results collected from single test pits advanced in these areas and from single soil samples collected from the existing LTUs (LTU1 and LTU2). CRA has conservatively assumed that the top 0.15 m of soil located within the drum cache area (an area approximately 30 m by 30 m) and the top 0.15m of soil underlying the existing LTUs (LTU1 and LTU2) are impacted and must be excavated. . The volumes will be refined based on the results of the pre-construction verification and delineation sampling discussed in Section 5.2.1.

Based on the test pitting activities and analytical results obtained during the PECAMP, the maximum depth of excavation to remove impacted soils is anticipated to be 1 mbgs. The approximated limits of excavation for each area are shown on Figure 6. These areas are discussed in further detail in Section 6.0.

To the extent possible, impacted soil will be excavated and transported directly to either the waste containment cell or the designated location on Site where it will be used as common fill as part of the Project works. If soil stockpiling is required, impacted soil stockpiles will be placed on polyethylene sheeting underlain by non-woven geotextile and covered daily with polyethylene sheeting. A detail specifying secure stockpile construction is provided on Figure 5.

5.2.4 USE OF IMPACTED SOILS IN PROJECT WORKS

Arsenic and PHC-impacted soil are present within the areas of the Project works and must be managed prior to or during the subsurface activities proposed for these areas. CRA understands that a large volume of fill (approximately 10,000 cubic metres) is required in areas of the Project works that will either be covered with a minimum of 1.0 m of clean material (aggregate or soil) or with a paved asphalt surface. Based on

CRA's estimated soil volumes, there is approximately 100 cubic metres of arsenic-impacted soil located adjacent to the runway and approximately 4,950 cubic metres of PHC-impacted soil located within the former FTA (see Table 4).

CRA developed RBCs for arsenic and PHC concentrations in soil to validate the acceptable use of arsenic and PHC-impacted soil within secure areas of the Project works. A technical memorandum summarizing the development of the RBCs is provided in Appendix A. As noted in the technical memorandum, the arsenic and PHC-impacted soil can be used within secure areas of the Project works with application of the following risk management measures.

Stockpiling

If the impacted soils are excavated and temporarily stockpiled pending future re-use in the Project works, the impacted soils will need to be managed to prevent exposure. Excavated impacted soils will be placed in a designated area located away from publicly accessible areas, other than those impacted soils that will be stockpiled for a temporary time period (less than 48 hours). As discussed in Section 5.2.2, stockpiled impacted soils will be placed on polyethylene sheeting underlain by non-woven geotextile and covered daily with polyethylene sheeting to prevent impact to storm water runoff, prevent leaching of contaminants to the subsurface, and for dust control. The polyethylene sheeting must be weighted down at the edges and inspected regularly to confirm its integrity. It is also recommended that fencing be placed around the impacted soil stockpiles and signs put up to prevent direct contact to humans and wildlife.

Soil Cover

The concentrations of arsenic and PHCs detected in the soil samples collected from test pit TP15 and from the former FTA, respectively, exceeded the pathway specific RBCs for commercial workers and ecological receptors for direct contact with soil. As a result, soil excavated from these areas can be reused in the Project works as long as they are maintained under a clean cover. This clean cover must consist of a hard cap, such as asphalt or concrete (i.e., taxi pavement or runways) or a 1 m thick clean fill cap (soil or aggregate).

Based on discussions with AIP regarding the construction sequence of the Project works, CRA understands that there may be a period of time when the arsenic and PHC-impacted soil is placed as common fill without a clean cover (soil, aggregate, or asphalt). These areas must be managed in the interim to prevent direct contact to humans and wildlife and to prevent the generation of impacted surface water and leaching of the contaminants into the ground surface. Fencing, or some type of barrier system must be installed surrounding the perimeter of the uncovered impacted soil

areas, and the soil must be secured beneath polyethylene sheeting as an interim measure. The polyethylene sheeting must be weighted down at the edges and inspected regularly to confirm its integrity.

Inhalation of Vapours (Indoor Air)
The concentration of PHC F2 fraction detected in the soil sample collected from LTU1 exceeded the pathway specific RBC for the commercial worker inhalation of vapours via indoor air. As a result, soil excavated from LTU1 cannot be used as fill under a building or within 30 metres of any building.

5.3 LICENCES AND APPROVALS

Based on discussions with the EPD and the Nunavut Water Board, CRA understands that the following licences and approvals are required based on the proposed remedial activities.

Water Licence
In accordance with the Nunavut Water Board, a Water Licence is required for any use of water or the deposition of waste that may enter into a water body (inland and of any kind) in Nunavut. As defined by the Nunavut Water Board[1], inland waters are defined as waters in liquid or solid state (i.e., ice and permafrost), and waters on or below the surface of land (i.e. surface water and groundwater). There are two types of licences: Type A and Type B. Type A water licences are applicable to projects that have greater impacts anticipated to the environment. Type A water licences may require a public hearing. Type B water licences are applicable to projects that have less significant impacts to the environment, and no public hearing is required. Both Type A and B Water Licences require a 30 day public consultation period. Public comments will be reviewed by the Nunavut Water Board and may be incorporated into the terms and conditions of the Water Licence, if appropriate.

CRA anticipates that a Type B Water Licence will be required for the Project. The Nunavut Water Board typically issues a Type B Water Licence within a three month time frame. CRA understands that TC has a Water Licence for the remediation activities associated with the LTUs at the Site. Based on CRA's preliminary discussions with the Nunavut Water Board, CRA understands that it may be possible to complete the Project work under the current Water Licence for the Site. CRA will discuss this option further with the Nunavut Water Board and TC if approved by AIP and the GN.

[1] Activities that Require a Water Licence and Types of Water Licences, Nunavut Water Board, April 2010.

EPD Approval of a Work Plan for the Excavation and Management of Impacted Soil

As discussed with the Director of the EPD, Mr. Robert Eno, no permits or licences are required for the excavation and management of impacted soil; however, EPD requires that a work plan describing the excavation and management scope of work be provided to EPD for review and approval prior to the start of any excavation work. The work plan must describe the proposed excavation activities and provide the analytical data of the impacted soil to be excavated, and how the soil will be managed on Site. If the impacted soil is to be used as backfill on the Site, EPD requires that analytical data be provided of the area where the impacted soil will be placed or backfilled. EPD is generally agreeable to the use of impacted soil as backfill as long it does not have an adverse effect on the environment (i.e., not impacting clean soil).

EPD anticipates that a review of an excavation work plan can be completed within one month upon receipt of such work plan.

6.0 APPLICATION OF REMEDIAL OPTIONS TO AREAS REQUIRING MANAGEMENT

The PECAMP contemplated remedial options for each of the areas of environmental contamination and identified the recommended remedial option for each area (selected option). This section provides details on how the selected option will be implemented for each area. As requested by the GN, this section also provides a description of an alternative remedial option for the drum cache area and for the PHC-impacted soil located within the former FTA.

6.1 DRUM CACHE – SELECTED OPTION

There are three waste streams that need to be managed within this area: 300, 205-litre drums and a 50,000 litre tank containing varying amounts of tar product, tar product released to the ground surface, and surficial soil impacted with volatile organic compounds (ethylbenzene). The selected remedial option for all three waste streams includes construction of an on-Site waste containment cell, excavation of the waste streams from their current location in the drum cache, and placement in the waste containment cell. Construction of the waste containment cell and excavation of impacted soil is discussed in Section 5.

Based on the quantity of drums present and the size of the tank, they will require approximately 175 cubic metres of air space in the waste containment cell. The drums will be removed from their current location and placed as is in the waste containment cell. As some of the drums are punctured, care must be taken during the relocation of the drums from the drum cache into the waste containment cell to avoid the release of tar product. The drums must be placed directly into the waste containment cell on their side. If this is not possible and they will be staged temporarily before being placed in the waste containment cell, they must be staged on a non-woven geotextile overlain with polyethylene sheeting to prevent contaminating the surrounding surficial soils.

Based on the size of the tank it will need to be crushed prior to placement in the waste containment cell. The tar product will remain in the drums/tank during this process. The tar product present on the ground surface will be excavated and transported directly to the waste containment cell.

The top 0.15 m of soil within the drum cache area (an area approximately 30 m by 30 m) will be excavated and transported directly to the waste containment cell and co-disposed of with the drums and tank to fill the void spaces. The estimated limits of

the surficial excavation within the drum cache area are shown on Figure 6. The limits of excavation will be confirmed during the pre-construction verification and delineation sampling activities. Soil samples collected from this area during the pre-construction verification and delineation sampling must be analyzed for BTEX, PHCs, and PAHs.

Depending on the proposed grades within the drum cache area, AIP may choose to backfill this area with clean fill material.

As discussed above (Section 5.3), AIP must obtain a Water Licence and EPD approval of an excavation work plan prior to the excavation and management of impacted soil in the drum cache area.

6.1.1 ALTERNATIVE REMEDIAL OPTION FOR DRUM CACHE AREA

An alternative remedial option to manage the three waste streams from the drum cache area includes off-Site shipment and disposal of the waste streams at licensed disposal facilities. CRA understands that Nunavut does not maintain a licensed disposal facility for these waste streams and that out-of-territory disposal is required. CRA has identified approved disposal facilities in Ontario, New Brunswick and Quebec. Should GN select this alternative remedial option, the approved transportation and disposal facilities should be selected by a competitive bid process. It may be practical to coordinate the disposal of the drum cache area waste streams with the disposal of the building materials discussed in Section 6.5 for cost saving purposes. Disposal facilities may require additional analytical testing of the products in the drums and 50,000 L tank in order to further characterize the waste and to confirm transportation and disposal pricing. CRA is awaiting preliminary cost estimates for the transportation and disposal of the three waste streams from a disposal facility located in Quebec; however, this alternative will be significantly more expensive than placement of the waste in the waste containment cell on Site (as described in Section 6.1). CRA will forward the costs to AIP upon receipt for comparison purposes.

Prior to shipment of waste from the Site and out of the territory, the required permits must be obtained. The required permits will be determined pending the results of the competitive bid process (i.e. what province/territory the waste steams will be shipped to). Once the necessary permits are obtained, the drums, tank and ethylbenzene-impacted soil should be removed from their existing location and securely containerized. As noted above, as some of the drums are punctured, care must be taken during the relocation of the drums from the drum cache area to the transportation

equipment. The drums must be placed directly into the transportation equipment. If this is not possible and temporary staging is required, the drums must be staged on a non-woven geotextile overlain by polyethylene sheeting to prevent contaminating the surrounding surficial soils.

The top 0.15 m of soil within the drum cache area (an area approximately 30 m by 30 m) will be excavated and transported directly to the shipping container. The estimated limits of the surficial excavation within the drum cache area are shown on Figure 6. The limits of excavation will be confirmed during the pre-construction verification and delineation sampling activities. If the soil cannot be placed directly into the shipping containers and temporary staging is required, the drums must be staged on a non-woven geotextile overlain by polyethylene sheeting to prevent contaminating the surrounding surficial soils.

The shipping containers must be labeled in accordance with all permit requirements and the required shipping documents must be completed and accompany the shipping containers.

As discussed above (Section 5.3), AIP must obtain a Water Licence and EPD approval of an excavation work plan prior to the excavation and management of impacted soil in the drum cache area.

6.2 LTUs AND UNDERLYING SOIL

Two LTUs containing PHC-impacted soil (LTU1 and LTU2) are located within the former FTA. CRA has assumed that the surficial soil underlying LTU1 and LTU2 is impacted with PHCs. A soil sample collected from test pit TP24, located in close proximity to LTU1 and LTU2 contained PHC concentrations greater than the applicable standards. There is approximately 4,950 cubic metres of PHC-impacted soil located in this area that needs to be managed.

The selected remedial option for the PHC-impacted soil includes the development of RBCs for PHC concentrations in soil to validate the use of the PHC-impacted soil in secure areas of the Project works. Through the development of the RBCs, it was concluded that all PHC-impacted soil could be used as common fill in areas of the Project works where the soil will be covered with 1 m of clean cover (soil or aggregate), or an asphalt surface. Based on discussions with AIP, CRA understands that approximately 10,000 cubic metres of fill is required in the Project works so that all of the PHC-impacted soil can be used within the Project woks. The risk management

measures that must be adhered to when using the PHC-impacted soil throughout the Project works are discussed in Section 5.2.4.

Impacted soil must be excavated from LTU1 and LTU2 and transported directly to its designated location in the Project works. If impacted soil will be stockpiled temporarily, the protocol discussed in Section 5.2.4 must be adhered to. The geosynthetic liners currently in place at the base of LTU1 and LTU2 will be removed and placed directly into the waste containment cell.

The top 0.15 m of soil underlying LTU1 and LTU2 will be excavated and transported directly to the designated location in the Project works. The estimated limits of the surficial excavation within these areas are shown on Figure 5. Once the surficial soil is removed, confirmatory soil samples must be collected from a representative sampling grid to confirm that all impacted soil has been removed from this area (see Section 5.2.4). The confirmatory soil samples collected from this area must be analyzed for PHCs and PAHs.

Based on the depth of impact identified in test pit TP24, CRA has assumed that an excavation approximately 10 m by 10 m and 1 m deep will be required to remove the PHC-impacted soil from this area. The soil will be excavated and transported directly to the designated location in the Project works. The estimated excavation limits within this area are shown on Figure 6. The limits of excavation will be confirmed during the pre-construction verification and delineation sampling activities. Soil samples collected from this area during the pre-construction verification and delineation sampling activities must be analyzed for PHCs.

Depending on the proposed grades within the FTA, AIP may choose to backfill the excavation areas with clean fill material.

If the Project works change and there is a surplus of PHC-impacted soil that cannot be used as common fill, the surplus soil will be excavated and placed directly into the waste containment cell in accordance with the procedures discussed in Section 5.2.2.

Application of the RBCs in the Project works is pending receipt of EPD's concurrence on the development of the RBCs. Based on discussions with the EPD, CRA understands that this review process takes approximately one to two weeks to complete.

As discussed above (Section 5.3), AIP must obtain a Water Licence and EPD approval of an excavation work plan prior to the excavation and management of impacted soil in the LTUs and surrounding area.

6.2.1 ALTERNATIVE REMEDIAL OPTION FOR LTUS AND UNDERLYING SOIL

An alternative remedial option for the PHC-impacted soil includes placement of the soil in the on-Site waste containment cell. To accommodate the additional waste volume, the cell footprint will increase to 5,625 m^2 and the waste disposal capacity will increase to 7,700 m^3. The footprint of the cell is based on CRA's estimated volumes of waste material proposed to be placed within the cell under this alternative remedial option, with approximately 50 percent contingency built into the design. The construction procedures and sequences for construction of the waste containment cell will not differ from those presented in Section 5, aside from the size of the cell. If this remedial option is selected as the preferred option CRA will prepare plan and cross-sectional views of the new footprint of the waste containment cell.

Impacted soil must be excavated from LTU1 and LTU2 and transported directly to the waste containment cell. If impacted soil will be stockpiled temporarily, the protocol discussed in Section 5.2.4 must be adhered to. The geosynthetic liners currently in place at the base of LTU1 and LTU2 will be removed and placed directly into the waste containment cell.

The top 0.15 m of soil underlying LTU1 and LTU2 will be excavated and transported directly to the designated location in the Project works. The estimated limits of the surficial excavation within these areas are shown on Figure 5. Once the surficial soil is removed, confirmatory soil samples must be collected from a representative sampling grid to confirm that all impacted soil has been removed from this area (see Section 5.2.4). The confirmatory soil samples collected from this area must be analyzed for PHCs and PAHs.

Based on the depth of impact identified in test pit TP24, CRA has assumed that an excavation approximately 10 m by 10 m and 1 m deep will be required to remove the PHC-impacted soil from this area. The soil will be excavated and transported directly to the waste containment cell. The estimated excavation limits within this area are shown on Figure 6. The limits of excavation will be confirmed during the pre-construction verification and delineation sampling activities. Soil samples collected from this area during the pre-construction verification and delineation sampling activities must be analyzed for PHCs.

Depending on the proposed grades within the FTA, AIP may choose to backfill the excavation areas with clean fill material.

As discussed above (Section 5.3), AIP must obtain a Water Licence and EPD approval of an excavation work plan prior to the excavation and management of impacted soil in the LTUs and surrounding area.

6.3 ARSENIC-IMPACTED SOIL ADJACENT TO RUNWAY

The soil sample collected from 0.8 mbgs at test pit TP15 located adjacent to the runway contained concentrations of arsenic greater than the CCME guideline. CRA has assumed that an excavation approximately 10 m by 10 m and 1 mbgs would be required to remove the arsenic-impacted soil from this area. Under this assumption, there is approximately 100 cubic metres of arsenic-impacted soil located in this area that needs to be managed.

The selected remedial option for the arsenic-impacted soil includes the development of RBCs for arsenic concentrations in soil to validate the use of the arsenic-impacted soil in secure areas of the Project works. Through the development of the RBCs, it was concluded that all arsenic-impacted soil could be used as common fill in areas of the Project works where the soil will be covered with 1 m of clean cover (soil or aggregate), or an asphalt surface. Based on discussions with AIP, CRA understands that approximately 10,000 cubic metres of fill is needed in areas of the Project works that will be covered, and as such all of the arsenic-impacted soil can be used in the Project works. The risk management measures that must be adhered to when using the arsenic-impacted soil throughout the Project works are discussed in Section 5.2.4.

The arsenic-impacted soil will be excavated and transported directly to the designated location in the Project works. The estimated excavation limits within this area are shown on Figure 6. The limits of excavation will be confirmed during the pre-construction verification and delineation sampling activities. Soil samples collected from this area during the pre-construction verification and delineation sampling must be analyzed for arsenic.

Depending on the proposed grades within the FTA, AIP may choose to backfill the excavation areas with clean fill material.

If the design of the Project works is revised and there is a surplus of arsenic-impacted soil that cannot be used as common fill, the surplus soil will be excavated and placed

directly into the waste containment cell in accordance with the procedures discussed in Section 5.2.2.

Application of the RBCs in the Project works is pending receipt of EPD's concurrence on the development of the RBCs. Based on discussions with the EPD, CRA understands that this review process takes approximately one to two weeks to complete.

As discussed above (Section 5.3), AIP must obtain a Water Licence and EPD approval of an excavation work plan prior to the excavation and management of arsenic-impacted soil adjacent to the runway.

6.4 PAH-IMPACTED GROUNDWATER

The grab groundwater sample collected from test pit TP06 contained concentrations of PAH parameters greater than the MOE Table 3 groundwater standards. Groundwater was encountered during the excavation of test pit TP06 at approximately 1.1 mbgs. Based on information provided to CRA, excavations will be advanced to approximately 1.2 mbgs in this area during the Project works, as such, it is likely that PAH-impacted groundwater will be encountered and must be managed.

The selected remedial option was the development of RBCs for PAH concentrations in groundwater to validate the acceptability of the discharge of collected groundwater to the ground surface. A technical memorandum summarizing the development of groundwater RBCs is provided in Appendix B. A comparison of the RBCs to the PAH concentrations detected in the groundwater sample collected from test pit TP06 is provided in Table 2. As shown on Table 2, two PAH parameters (benzo(a)anthracene and indeno(1,2,3-cd)pyrene) were detected in the grab groundwater sample at concentrations greater than the respective RBCs, and as such the groundwater collected during the Project works in the vicinity of test TP06 must be containerized and treated prior to ground discharge.

A granular activated carbon (GAC) system will be employed as the primary groundwater treatment system for the PAH-impacted groundwater encountered during the Project works. GAC is a carbon filtration technology that is widely used for the removal of organic compounds (chlorinated solvents, PCBs, PAHs, etc.). Similar to most PAHs, benzo(a)anthracene and indendo(1,2,3-cd)pyrene have a high degree of absorbability by carbon. The GAC system has been designed to treat the impacted groundwater such that effluent concentrations of PAHs are below the RBCs.

Groundwater collected in the excavation will be pumped to a storage container pending treatment. Water from the storage container will be directed through the cartridge filters and carbon filters prior to direct ground discharge. Based on the lack of groundwater encountered across the Site during the test pitting activities, and the presence of permafrost consistently across the Site, CRA does not anticipate that a significant volume of groundwater will be encountered during excavation activities. As such, the proposed treatment system does not include an equalization tank. If a large volume of groundwater is encountered throughout the works, the addition of an equalization tank to attenuate peaks or surges to provide a fixed flow rate to the treatment system may be required.

Once the treatment system has been set-up on Site, it must be commissioned to ensure that the level of treatment is adequate. Effluent samples must be collected for PAH analyses to confirm that the concentrations of PAHs are less than the RBCs prior to ground discharge. Once the treatment has been proven adequate (through analysis of the effluent samples), the treated groundwater can be discharged to the ground surface in a designated area on Site. Effluent samples must be collected periodically throughout application of the treatment unit to confirm the adequacy of the level of treatment. The discharge area must be an area with vegetation to avoid soil erosion and away from public access areas.

A process flow diagram for the GAC system is shown on Figure 7 and consists of the following components:

Oil/Water Separator (Optional)

The oil/water separator (OWS) has been included as an optional item. Given that the samples were not analyzed for Oil and Grease (O&G), the presence of free oils in the groundwater is currently unknown; however, CRA did not observe the presence of a sheen on the groundwater and does not anticipate the presence of free oils in the groundwater. If future characterization of the influent groundwater identifies elevated levels of O&G, CRA recommends that an OWS be included in the treatment system for protection of the downstream carbon treatment units.

Influent groundwater will be conveyed from the storage container to the OWS for removal of free oils. Free oils will be collected and disposed of in the waste containment cell as necessary.

Cartridge Filtration

Cartridge filtration provides particulate removal prior to GAC filtration. The cartridge filters will be used to remove larger particles that might otherwise reduce the

effectiveness of the carbon filters. It is anticipated that two cartridge filters (25 micron and 5 micron) will be used in series to filter the groundwater. Pressure monitoring shall be undertaken at the cartridges to determine the necessity for cartridge replacement.

GAC system

A GAC system will be used to remove the PAHs that may be found at levels above their respective RBCs in the influent groundwater. The GAC system will include multiple carbon units, operated in series such that flow can be directed from one filter to another as the carbon is spent to ensure continuous operation and consistent effluent quality. It will be necessary to monitor the effluent from each carbon unit throughout the duration of the groundwater treatment activities to ensure that the system is successfully reducing PAH concentrations below respective RBCs.

As discussed in Section 6.2, application of the RBCs in the Project works is pending receipt of EPD's concurrence on the development of the RBCs. Based on discussions with the EPD, CRA understands that this review process takes approximately one to two weeks to complete.

As discussed above (Section 5.3), AIP must obtain a Water Licence and EPD approval prior to the discharge of the treated groundwater to the environment.

6.5 BUILDING MATERIALS – ASBESTOS, LEAD, MERCURY, PCBS

CRA understands that as part of the Project works, buildings T-116 and T-120 will be demolished, and building T-25 will be rehabilitated. A DSHMS was completed for the three buildings and identified asbestos in floor tiles and wall panels, lead in paint, mercury in fluorescent light bulbs, streetlight ballast and thermostats, and identified the potential for PCBs in fluorescent light ballasts (Biogénie, 2013). The DSHMS did not identify any other designated substances or hazardous materials in the buildings.

CRA has been advised by AIP that all designated substance and hazardous materials removed from the buildings are to be shipped off Site for disposal at licensed disposal facilities. Disposal facilities/waste brokers that are located in Quebec and licensed to manage/dispose of the designated substance and hazardous materials are provided in Table 6. Quebec disposal facilities are not permitted to accept waste generated outside of Province; however, they are permitted to accept designated substance and hazardous materials generated outside of Province. As such, the lead paint and asbestos must be separated from the demolition debris prior to being containerized and shipped to the

appropriate facility in Quebec for disposal. If this is not practical or feasible during abatement activities, the demolition debris containing the designated substances could be shipped to another province that will accept out-of-province generated waste.

The management of all designated substances and hazardous waste at the Site must follow the Environmental Guideline for the General Management of Hazardous Waste (Hazardous Waste Guideline) (Department of Environment, October 2010) and the Environmental Protection Act [Revised Statutes of the Northwest Territories (Nunavut) 1988, cE-7]. These documents provide a framework for managing designated and hazardous substances and specific requirements that must be followed during operation, handling, storage, and transportation and disposal activities. The Hazardous Waste Guideline is provided in Appendix C. The following provides the management plan for each designated substance or hazardous material that is anticipated to be encountered during the Project works at buildings T-25, T-116, and T-120.

In the DSHMS, Genivar evaluated each building for the presence of asbestos, lead, mercury, PCBs, ozone-depleting substances (ODS), urea formaldehyde foam insulation (UFFI), mould, silica, benzene, acrylonitirle, arsenic, coke oven emissions, ethylene oxide, isocyanates and vinyl chloride.

In the DSHMS, Genivar identified the following designated substances or hazardous materials to be present in each of the buildings:

Building T-25:

- Asbestos in 12 square metres (m^2) of floor tile and base for floor tile (mastic) in Section C
- Lead in green, white, brown, red, grey and orange paint
- Mercury in four florescent bulbs and a streetlight ballast

Building T-116:

- Lead in grey paint on the concrete floor
- Mercury in two florescent bulbs and one thermostat
- Ballasts in fluorescent lighting in Section A containing PCBs, and ballasts in Sections B and C may contain PCBs

Building T-120:

- Asbestos in 45 m^2 of floor tile in Section B
- Asbestos in 60 m^2 of wall/ceiling panels in the furnace room in Section D
- Lead in red, white, beige, grey and yellow paint
- Mercury in 12 florescent bulbs in Sections B and C and debris in Section B
- Ballasts in fluorescent lighting in Sections B and C may contain PCBs

UFFI, mould and ODS were not identified in any of the buildings.

Genivar did not make any mention in the observations and results section of the DSHMS of the presence or absence of other designated substances or hazardous materials (silica, benzene, acrylonitrile, arsenic, coke oven emissions, ethylene oxide, isocyanates and vinyl chloride).

Hazardous waste generators, carriers and receivers operating in Nunavut must be registered with the Nunavut Department of Environment. Each registrant is assigned a unique identifier which must be recorded on all waste manifests.

Genivar identified asbestos in floor tiles and wall panels, lead in paint, mercury in fluorescent light bulbs, streetlight ballast and thermostats, and identified that PCBs may be present in fluorescent light ballasts.

Asbestos

Non-friable asbestos was identified in Buildings T-25 and T-120. Asbestos must be removed in accordance with the Asbestos Safety Regulations (R-016-92) and the Environmental Guideline for Waste Asbestos (Department of Environment, January 2011) (Asbestos Guideline). This includes proper handling, storage, transportation and final disposal. The Asbestos Guideline is provided in Appendix D.

Removal of ACM must be conducted by qualified contractors in accordance with the Asbestos Safety Regulations and Asbestos Guideline. This includes wearing appropriate personal protective equipment (PPE) selected based on the abatement method, containing waste in sealed, airtight containers and affixing labels to the waste. Examples of acceptable containers are waste bins lined with 6 mil plastic with welded seams, double bagging in 6 mil plastic bags, or placing waste in 6 mil plastic bags followed by placement in metal drums.

In Nunavut, non-friable asbestos waste is not considered a hazardous waste and does not need to be manifested for transportation. Friable waste asbestos is classified as a Class 9 Miscellaneous Waste under the Transportation of Dangerous Goods (TDG) Act, and must be labeled and manifested appropriately. All properly containerized and labeled waste asbestos must be secured and transported either within an enclosed vehicle or secured with a tarpaulin or net if transported in a non-enclosed vehicle. Waste asbestos must be transported by a registered hazardous waste carrier to a registered waste receiver.

Waste asbestos may be disposed of at a permitted landfill, provided that the landfill has a method of tracking where the asbestos is buried to prevent future exposure, care is taken to ensure containment bags are not punctured during unloading and the waste asbestos is covered with at least 30 centimeters of soil or other cover to reduce the likelihood of further direct contact with people. Final cover of at least 60 centimeters of soil must be placed over the waste asbestos within 24 hours of disposal.

Lead

Lead paint is defined in the Environmental Guideline for Waste Lead and Lead Paint (Department of Environment, March 2011) (Lead Guideline) as "*a paint or other similar structural coating material containing 0.06% lead by weight (600 parts per million) or more*". Based on this definition, lead paint is present in the buildings at the Site. The Lead Guideline is provided in Appendix E.

If the lead paint is observed to be in good condition (not chipping or flaking), the lead paint can be left intact on the surfaces during demolition activities and disposed of with the demolition debris. If the lead paint is observed to be in good condition in Building T-25, no abatement activities are required. If the lead paint is observed to be in poor condition in the buildings to be demolished or rehabilitated, it must be removed prior to demolition activities (T-116 and T-120) or prior to reuse of the building (T-25).

Abrasive blasting paint removal techniques that are approved for use in Nunavut are presented in the Lead Guideline on Page 7. Other chemical means of removing paint are also available. PPE for workers is selected based on the removal and containment technique selected. In all cases, the removal is conducted by qualified contractors within containment to prevent paint debris from contaminating the environment. The paint debris must be containerized in sealable plastic or metal drums, closed tightly when not being loaded, and labeled in accordance with the Workplace Hazardous Materials Information System (WHMIS) and TDG.

Lead paint debris is classified as a Class 9 Miscellaneous Waste under TDG, and must be labeled and manifested appropriately. Lead paint debris must be transported by a registered hazardous waste carrier and be containerized and secured during transport to prevent releases to the environment.

Lead paint waste must not be disposed of in municipal landfills. Generally, lead paint waste is transported to a metal foundry, smelter or a registered disposal facility/recycler.

Mercury

Mercury is present in fluorescent light tubes in Buildings T-25, T-116, and T-120, a streetlight ballast in Building T-25, a thermostat in Building T-116 and fluorescent light debris in Building T-120. Mercury-containing devices, when removed from service, must be managed in accordance with the CCME Canada-Wide Standards for Mercury Containing Lamps, endorsed in 2001, and the Environmental Guideline for Mercury-Containing Products and Waste Mercury (Department of Environment, November 2010). The Mercury Guideline is provided in Appendix F.

When removed from service, mercury-containing devices must be packaged to prevent breakage and labeled in accordance with WHMIS and TDG. Waste mercury is classified as a Class 8 waste under TDG. Depending on the quantity of mercury, the waste may be classified as either hazardous or non-hazardous waste when being transported for recycling or disposal. A registered and qualified hazardous waste carrier must be used for transportation to the recycling or disposal facility.

PCBs

PCBs are present in some fluorescent light ballasts in Building T-116, and may be present in other fluorescent light ballasts in Buildings T-116 and T-120. As fluorescent light ballasts are removed from service, they must be inspected to determine if PCBs are present. Ballasts manufactured after 1980 generally do not contain PCBs and are marked "No PCBs". Ballasts without markings must be considered to contain PCBs and managed in accordance with the Canadian Environmental Protection Act, 1999 and the Canadian PCB Regulations (SOR/2008-273).

Ballasts which contain PCBs must be containerized in 16 gauge (or heavier) steel drums with a capacity of 205 litres or less with a closed-head double bung, which are painted or treated to prevent rusting. The container must be labeled in accordance with SOR/2008-273, which includes specific wording, colour and size of font for the label.

PCB waste, when the concentration of PCBs is greater than 50 parts per million (ppm), is classified as a Class 9 Miscellaneous Waste under TDG. PCB waste must be properly containerized and labeled prior to transport by a registered hazardous waste carrier to a registered receiver.

PCB waste must not be disposed of in a landfill, but must be sent to a registered facility for processing or destruction.

Other Hazardous Materials

Genivar did not identify any other designated substances or hazardous materials at the Site. Additional hazardous materials discovered during operation, construction, renovation or demolition must be assessed to determine proper handling, storage, transportation and disposal protocols.

7.0 INDICATIVE PROJECT COSTS AND SCHEDULE

CRA and AIP have developed indicative costs for each of the selected remedial options discussed in Section 6. The indicative costs for the selected remedial options are presented in Table 6A. As requested by the GN, indicative costs for the alternative remedial options discussed in Section 6 have been developed and are provided in Table 6B. These costs have been developed based on the current estimated waste quantities and are subject to change based on changes in the waste quantities encountered during the Project works. As noted in Section 6.1.1, CRA is currently awaiting preliminary costs from a disposal facility in Quebec for the transportation and disposal of the three waste streams associated with the drum cache area. The cost for this alternative remedial option will be significantly more expensive than the selected option of placing the wastes in an on-Site waste containment cell constructed on-Site. CRA will forward these costs to AIP upon receipt.

A schedule outlining the anticipated duration for each of the selected remedial options is provided in Table 7. It must be noted that these timelines are included in the CMP for the purpose of providing an indication of the duration of the remedial effort, and the sequencing is dependent on the construction schedule to be implemented by the AIP and the overall approval of the Project works.

8.0 REFERENCES

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All of Which is Respectfully Submitted,
CONESTOGA-ROVERS & ASSOCIATES

Lindsay Shepherd, P.Eng.

Gregory D. Ferraro, P.Eng.

Source: © 2013 - TerraServer®; Basemap: ESRI Basemap and data, accessed 2013; Coordinate System: NAD 1983 UTM Zone 19N

figure 1

SITE LOCATION MAP
PRE-EXISTING ENVIRONMENTAL
CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
Iqaluit, Nunavut

082415-00(004)GIS-OT001 August 30, 2013

0 80 160 240m

SCALE=1:8000

KEEWATIN AIR

NORTH COMMERCIAL ROAD

FEDERAL ROAD

APRON 1
ABANDONED HYDRANT
AND DISTRIBUTION
SYSTEM

NUNAVUT
ARCTIC COLLEGE

NUNAVUT
PUBLIC
WORKS

DND (T-325)

FORMER BRADLEY AIR SERVICES BUILDING
(T-326)

STORAGE SHED
(T-25)

APRON II

UQSUQ
(T-75)

FIRST AIR
CARGO HANGAR
(T-72)

FORMER ASPHALT PLANT AND DRUM CACHES

CANADIAN NORTH

LAND TREATMENT UNIT 2

FORMER LAND TREATMENT UNIT 3

APRON I

BURIED ASBESTOS WASTE
(ESTIMATED AREA)

TAXI-A

NEW TAXIWAY A ALIGNMENT

TAXIWAY G REALIGNMENT

TAXI-B

FORMER USAF
TANK FARM

APRON IIII

AIR TERMINAL
BUILDING

TAXI-C

TAXI-D

RUNWAY 18-36

LAND TREATMENT UNIT 1

FORMER FIRE TRAINING AREA (FTA)

AIRSIDE REFUELING AREA

TAXI-E

APRON IV

FIELD ELECTRICAL CENTRE
(T-116)

STORAGE FACILITY
(T-120)

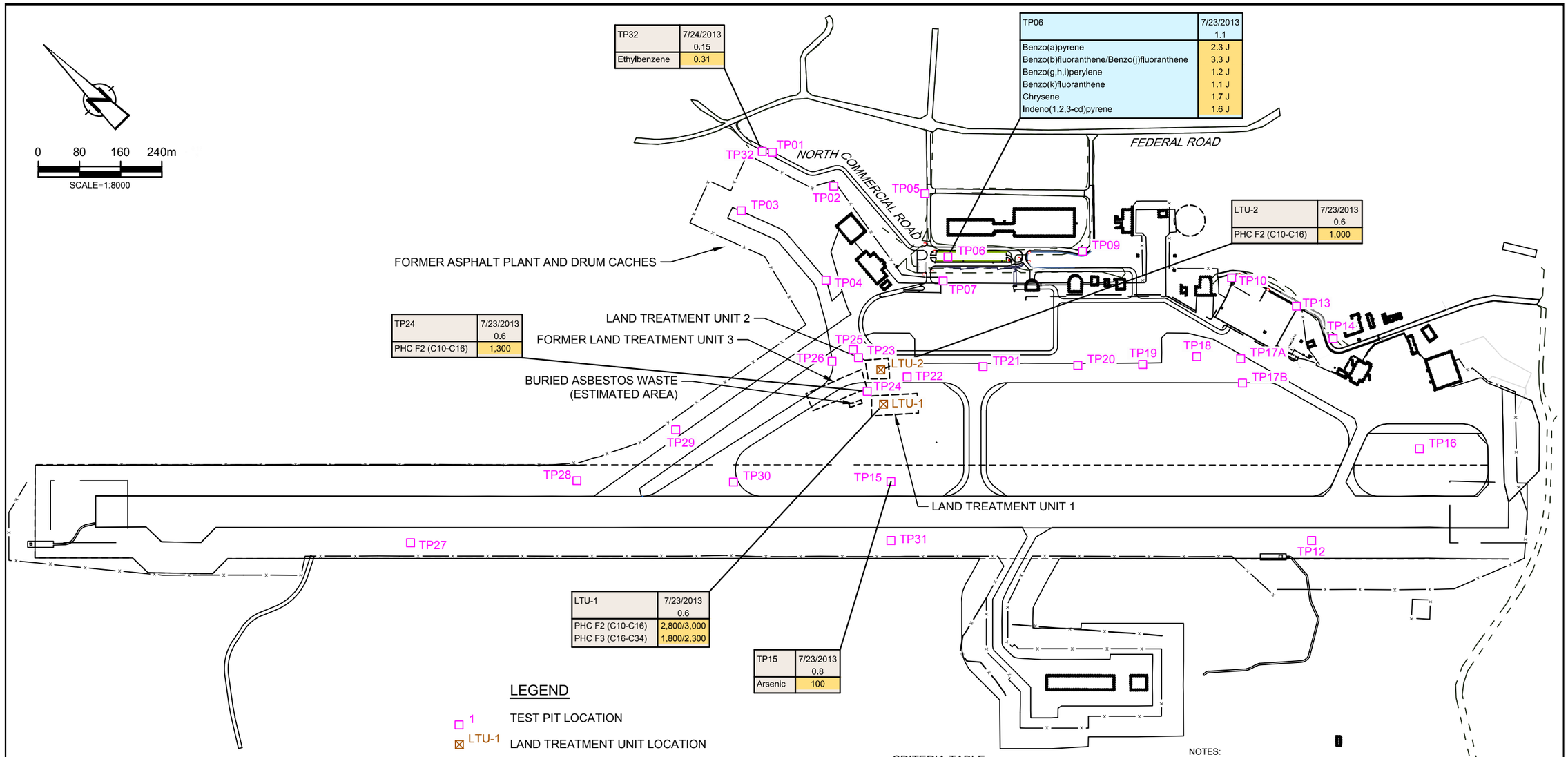
LEGEND

AREA OF KNOWN OR POTENTIAL ENVIRONMENTAL IMPACT WITHIN
AREA OF PROPOSED AIRPORT IMPROVEMENT CONSTRUCTION ACTIVITIES

NOTES: 1) THE LOCATIONS OF BUILDINGS T-25 AND T-120 ARE APPROXIMATE.
2) LOCATIONS OF LTU1, LTU2 AND LTU3 ARE APPROXIMATE AND ARE BASED ON THE PHASE II ESA REPORT FOR THE IQALUIT LANDFARM MAINTENANCE (QIKIQTAALUK ENVIRONMENTAL, 2013)

figure 2

SITE PLAN AND AREAS OF KNOWN OR POTENTIAL ENVIRONMENTAL IMPACT
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
Iqaluit, Nunavut



LEGEND

- TEST PIT LOCATION
- LAND TREATMENT UNIT LOCATION
- SAMPLE IDENTIFICATION
- SAMPLE DATE
- SAMPLE DEPTH (mBGS)
- CONCENTRATION
- PARAMETER
- EXCEEDANCE
- GROUNDWATER SAMPLE
- SOIL SAMPLE
- J — ANALYTE CONCENTRATION IS ESTIMATED

CRITERIA TABLE

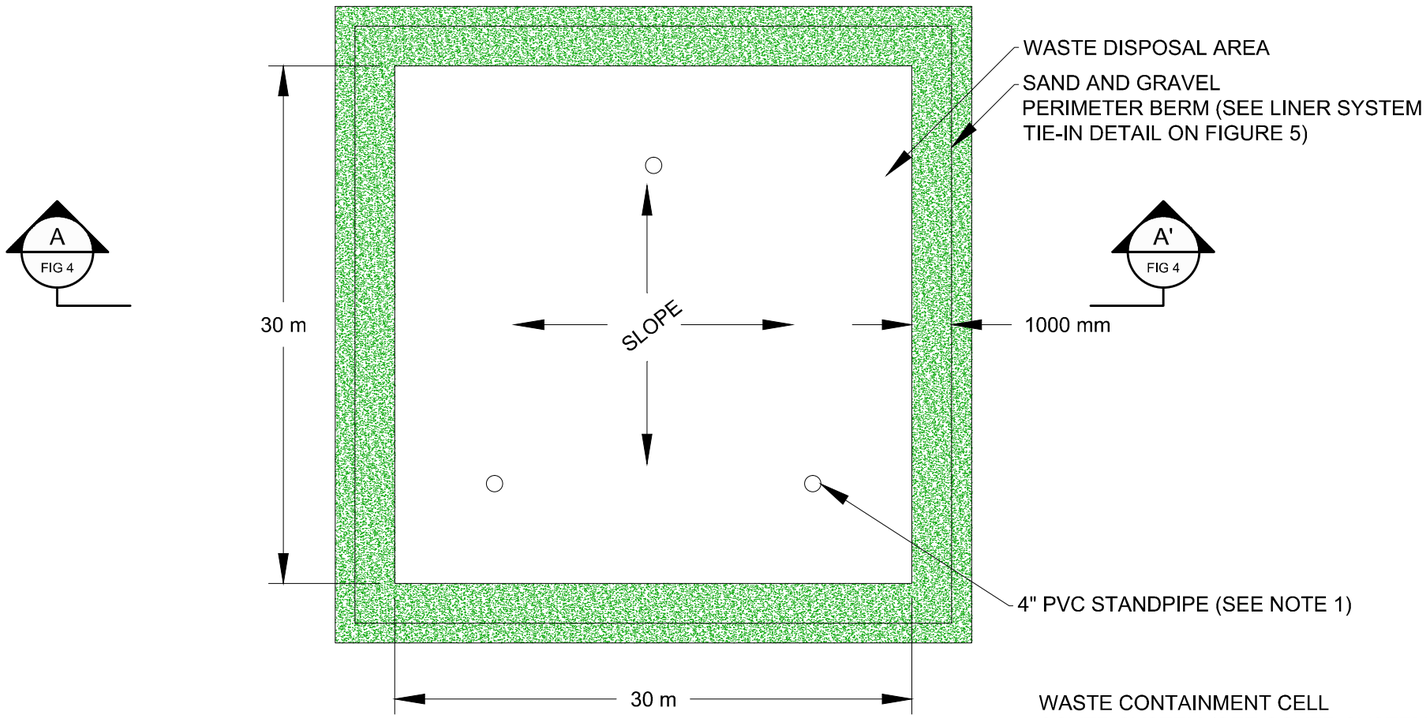
PARAMETER	UNITS	SOIL STANDARDS	GROUNDWATER STANDARDS
Arsenic (1)	µg/g	12	- -
Benzo(a)pyrene (3)	µg/L	- -	0.81
Benzo(b)fluoranthene/Benzo(j)fluoranthene (3)	µg/L	- -	0.75
Benzo(g,h,i)perylene (3)	µg/L	- -	0.2
Benzo(k)fluoranthene (3)	µg/L	- -	0.4
Chrysene (3)	µg/L	- -	1
Ethylbenzene (1)	µg/g	0.082	- -
Indeno(1,2,3-cd)pyrene (3)	µg/L	- -	0.2
PHC F2 (C10-C16) (2)	µg/g	260	- -
PHC F3 (C16-C34) (2)	µg/g	1,700	- -

NOTES:

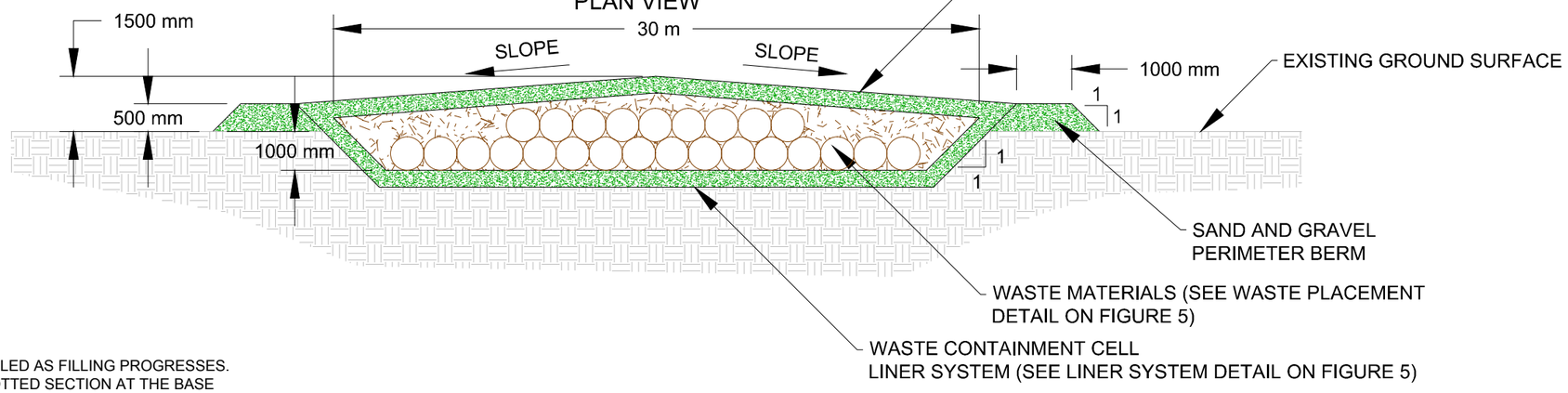
1. SOIL QUALITY GUIDELINES FOR THE PROTECTION OF ENVIRONMENT AND HUMAN HEALTH (TIER 1 INDUSTRIAL), CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (1997, UPDATED 2011).
2. ENVIRONMENTAL GUIDELINE FOR CONTAMINATED SITE REMEDIATION (TIER 1 INDUSTRIAL FOR COARSE-GRAINED SOIL), DEPARTMENT OF ENVIRONMENT, GOVERNMENT OF NUNAVUT (2009).
3. SOIL, GROUNDWATER AND SEDIMENT STANDARDS FOR USE UNDER PART XV.1 OF THE ENVIRONMENTAL PROTECTION ACT (ONTARIO MOE, 2011), TABLE 3: FULL DEPTH GENERIC SITE CONDITION STANDARDS IN A NON-POTABLE GROUNDWATER CONDITION.

figure 3

SOIL AND GROUNDWATER EXCEEDANCES
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
Iqaluit, Nunavut



WASTE CONTAINMENT CELL
PLAN VIEW



WASTE CONTAINMENT CELL
CROSS-SECTION A-A'

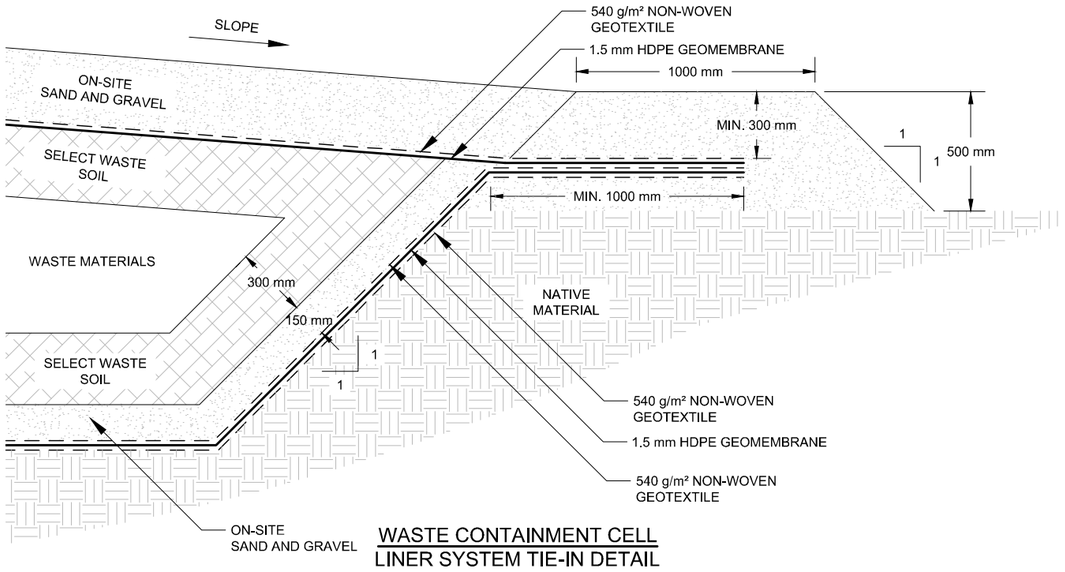
NOTES:

1. 4" PVC STANDPIPES SHALL BE INSTALLED AS FILLING PROGRESSES. STANDPIPES SHALL CONTAIN 1 m SLOTTED SECTION AT THE BASE OF INSTALLATION. SLOTTED SECTION SHALL CONSIST OF NO. 10 SLOT WELL SCREEN OR HAND SLOTTED AND COVERED IN GEOSOCK. STANDPIPES SHALL BE SEALED WITHIN COVER SYSTEM.

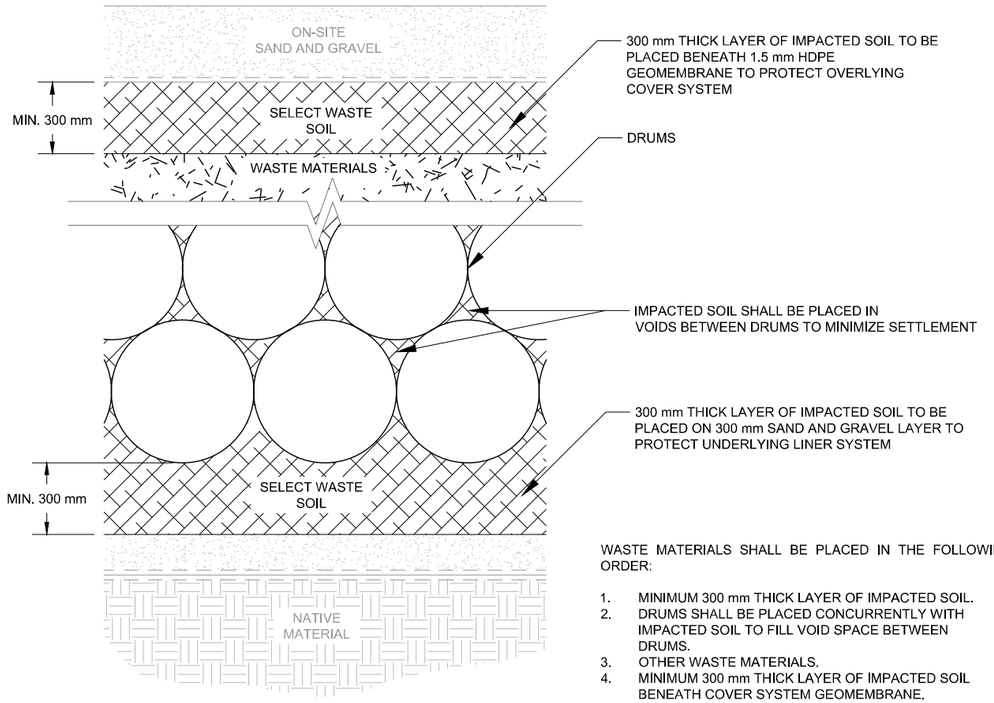
2. FINAL SLOPE TO BE DETERMINED IN THE FIELD BASED ON WASTE VOLUME PLACED IN CONTAINMENT CELL.

figure 4

WASTE CONTAINMENT CELL
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
Iqaluit, Nunavut



WASTE CONTAINMENT CELL
LINER SYSTEM TIE-IN DETAIL

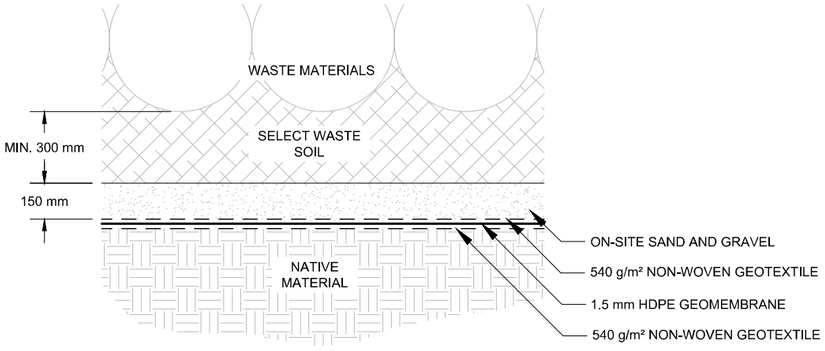


WASTE MATERIALS SHALL BE PLACED IN THE FOLLOWING ORDER:

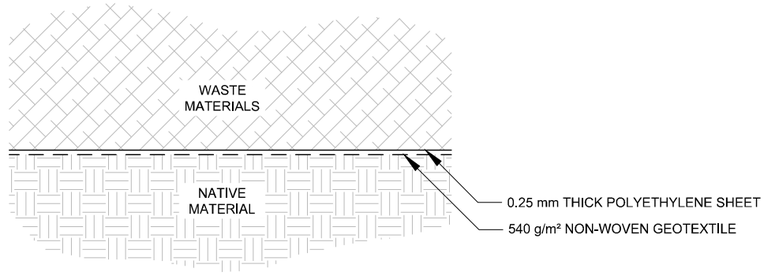
1. MINIMUM 300 mm THICK LAYER OF IMPACTED SOIL.
2. DRUMS SHALL BE PLACED CONCURRENTLY WITH IMPACTED SOIL TO FILL VOID SPACE BETWEEN DRUMS.
3. OTHER WASTE MATERIALS.
4. MINIMUM 300 mm THICK LAYER OF IMPACTED SOIL BENEATH COVER SYSTEM GEOMEMBRANE.

WASTE CONTAINMENT CELL
WASTE PLACEMENT DETAILS

WASTE CONTAINMENT CELL
COVER SYSTEM



WASTE CONTAINMENT CELL
LINER SYSTEM



TEMPORARY SECURE STOCKPILE
LINER SYSTEM

figure 5

WASTE CONTAINMENT CELL AND TEMPORARY SECURE STOCKPILE CONSTRUCTION DETAILS
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
Iqaluit, Nunavut

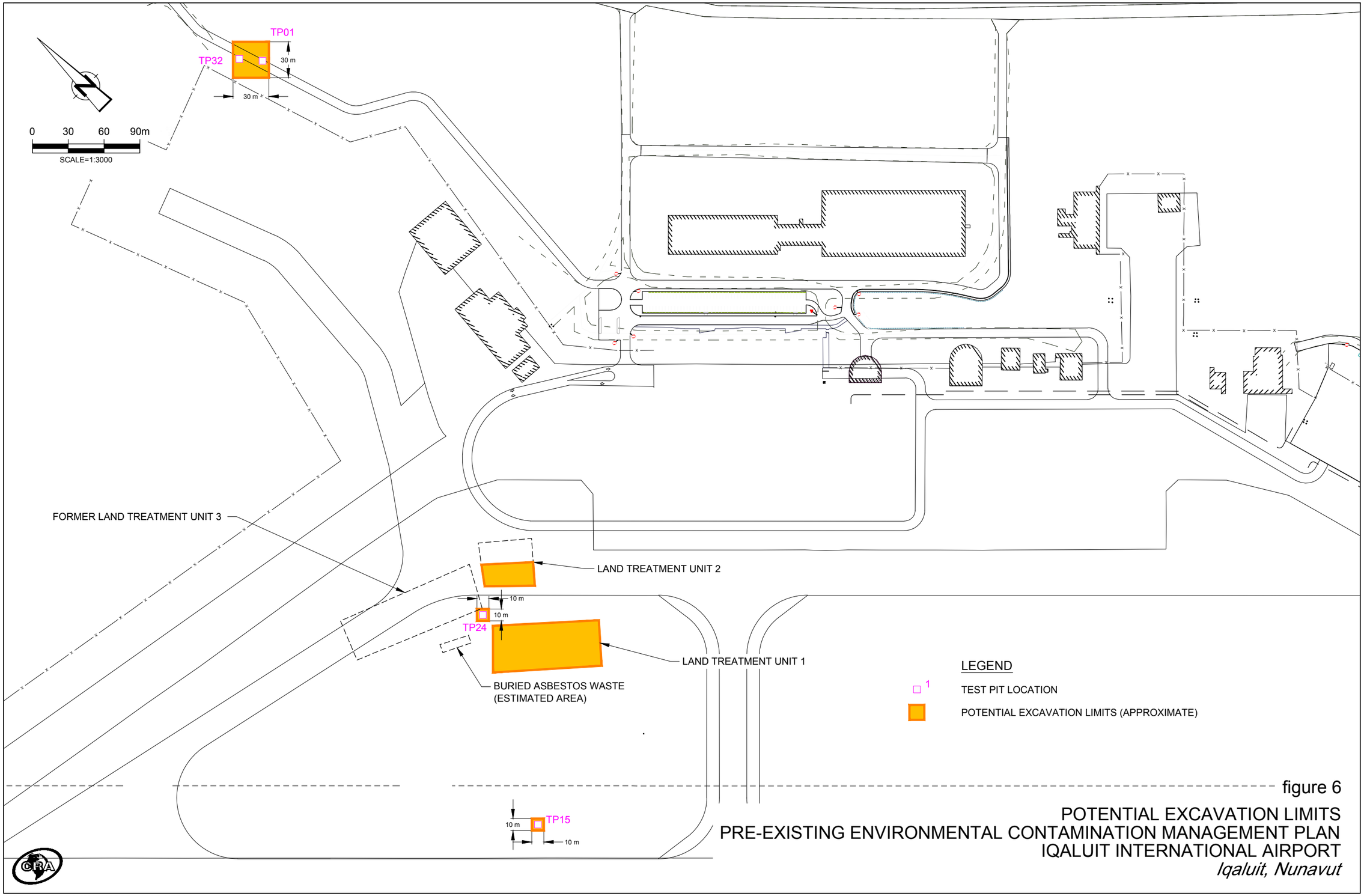


figure 6

POTENTIAL EXCAVATION LIMITS
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
Iqaluit, Nunavut

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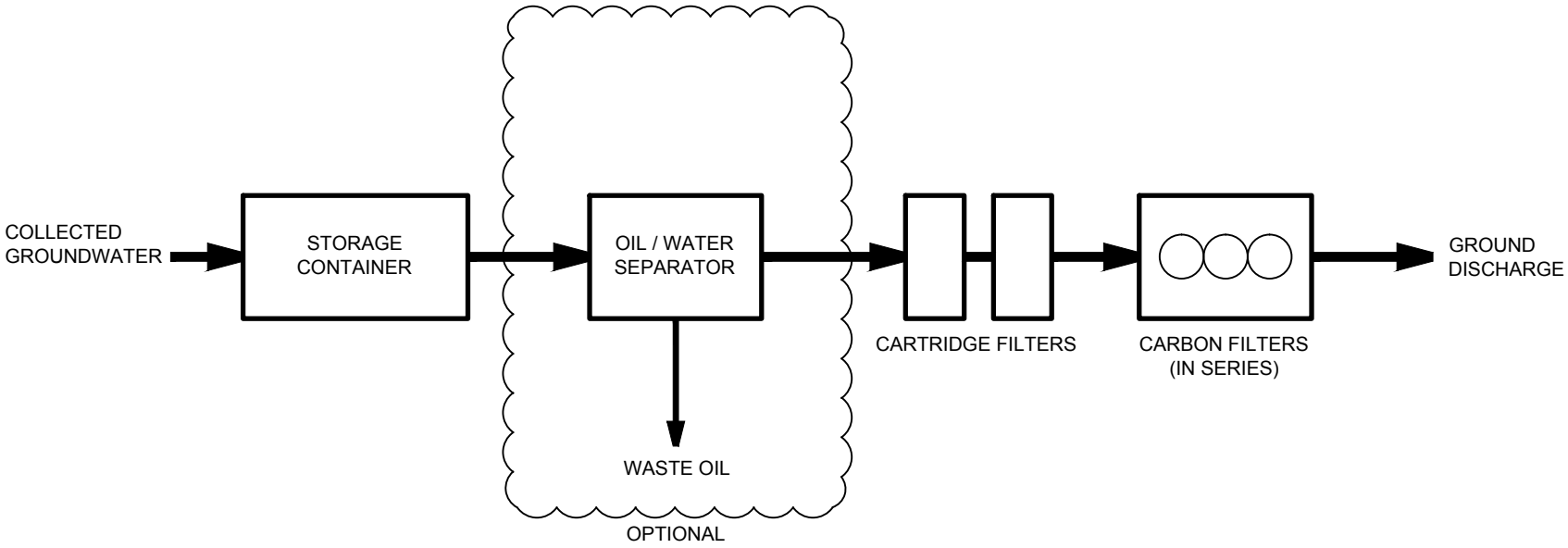

figure 7

CONCEPTUAL PROCESS FLOW DIAGRAM - GROUNDWATER TREATMENT SYSTEM
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
Iqaluit, Nunavut

TABLE 1

ANALYTICAL RESULTS - SOIL SAMPLES
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Sample Location:				*LTU-1*	*LTU-1*	*LTU-2*	*TP01*	*TP02*	*TP02*
Sample Date:				*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*
Sample Depth:				*0.6*	*0.6*	*0.6*	*0.9*	*1.5*	*1.5*
Parameters	*Units*	*CCME Industrial* [a]	*RBCs* [b]		*Duplicate*				*Duplicate*
Volatile Organic Compounds									
1,1,1,2-Tetrachloroethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,1-Trichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,2,2-Tetrachloroethane	µg/g	50	-	ND(0.35)	ND(0.23)	ND(0.060)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,2-Trichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1-Dichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1-Dichloroethene	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dibromoethane (Ethylene dibromide)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichloropropane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,3-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,4-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
2-Butanone (Methyl ethyl ketone) (MEK)	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
4-Methyl-2-pentanone (Methyl isobutyl ketone) (MIBK	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Acetone	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Benzene	µg/g	0.030	-	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)
Bromodichloromethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Bromoform	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Bromomethane (Methyl bromide)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Carbon tetrachloride	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Chlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Chloroform (Trichloromethane)	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
cis-1,2-Dichloroethene	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
cis-1,3-Dichloropropene	µg/g	-	-	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)
Dibromochloromethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Dichlorodifluoromethane (CFC-12)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Ethylbenzene	µg/g	0.082	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
Hexane	µg/g	6.5	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
m&p-Xylenes	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Methyl tert butyl ether (MTBE)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Methylene chloride	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
o-Xylene	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Styrene	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Tetrachloroethene	µg/g	0.6	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Toluene	µg/g	0.37	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
trans-1,2-Dichloroethene	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
trans-1,3-Dichloropropene	µg/g	-	-	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)
Trichloroethene	µg/g	0.01	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
Trichlorofluoromethane (CFC-11)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Vinyl chloride	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Xylenes (total)	µg/g	11	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Polycyclic Aromatic Hydrocarbons									
1-Methylnaphthalene	µg/g	-	-	ND(0.050)	0.36	ND(0.020)	ND(0.0050)	ND(0.0050)	ND(0.0050)
2-Methylnaphthalene	µg/g	-	-	0.028	ND(0.20)	ND(0.010)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Acenaphthene	µg/g	-	-	ND(0.040)	ND(0.10)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Acenaphthylene	µg/g	-	-	ND(0.050)	0.057	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Anthracene	µg/g	32	-	0.038	0.35	0.0054	ND(0.0050)	ND(0.0050)	ND(0.0050)
Benzo(a)anthracene	µg/g	-	-	0.28	1.4	0.011	ND(0.0050)	ND(0.0050)	ND(0.0050)
Benzo(a)pyrene	µg/g	72	-	0.31	1.6	0.018	ND(0.0050)	ND(0.0050)	ND(0.0050)
Benzo(b)fluoranthene/Benzo(j)fluoranthene	µg/g	10	-	0.21	0.80	0.031	ND(0.0050)	ND(0.0050)	ND(0.0050)
Benzo(g,h,i)perylene	µg/g	-	-	0.28	1.3	0.016	ND(0.0050)	ND(0.0050)	ND(0.0050)
Benzo(k)fluoranthene	µg/g	10	-	0.028	0.059	0.0089	ND(0.0050)	ND(0.0050)	ND(0.0050)
Chrysene	µg/g	-	-	0.39	2.0	0.011	ND(0.0050)	ND(0.0050)	ND(0.0050)
Dibenz(a,h)anthracene	µg/g	10	-	ND(0.025)	0.062	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Fluoranthene	µg/g	180	-	0.20	0.85	0.011	ND(0.0050)	ND(0.0050)	ND(0.0050)
Fluorene	µg/g	-	-	ND(0.040)	0.20	0.0082	ND(0.0050)	ND(0.0050)	ND(0.0050)
Indeno(1,2,3-cd)pyrene	µg/g	10	-	0.087	0.36	0.012	ND(0.0050)	ND(0.0050)	ND(0.0050)
Naphthalene	µg/g	22	22	ND(0.20)	0.16	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Phenanthrene	µg/g	50	-	0.14	3.2	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Pyrene	µg/g	100	-	1.3	5.9	0.059	ND(0.0050)	ND(0.0050)	ND(0.0050)
Metals									
Antimony	µg/g	40	-	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Arsenic	µg/g	12	26	1.8	1.9	2.7	3.5	1.5	1.5
Barium	µg/g	2000	-	21	24	29	52	13	11
Beryllium	µg/g	8	-	ND(0.20)	ND(0.20)	ND(0.20)	0.46	ND(0.20)	ND(0.20)
Boron (hot water soluble)	µg/g	-	-	0.15	0.12	0.089	0.21	ND(0.050)	ND(0.050)
Cadmium	µg/g	22	-	ND(0.10)	ND(0.10)	ND(0.10)	0.12	ND(0.10)	ND(0.10)
Chromium	µg/g	87	-	17	19	21	34	19	9.2
Chromium VI (hexavalent)	µg/g	1.4	-	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
Cobalt	µg/g	300	-	4.3	4.6	5.5	12	6.4	4.4
Copper	µg/g	91	-	9.1	9.7	70	24	9.7	9.0
Lead	µg/g	-	-	13	15	17	6.6	3.6	2.2
Mercury	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Molybdenum	µg/g	40	-	0.56	0.74	0.72	2.2	0.69	ND(0.50)
Nickel	µg/g	50	-	6.8	7.5	8.9	15	6.9	5.7
Selenium	µg/g	2.9	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Silver	µg/g	40	-	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Sulfur	µg/g	NV	-	110	130	160	870	ND(50)	ND(50)
Thallium	µg/g	1	-	ND(0.050)	ND(0.050)	ND(0.050)	0.076	ND(0.050)	ND(0.050)
Tin	µg/g	300	-	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
Uranium	µg/g	300	-	0.48	0.35	0.40	1.0	0.36	0.23
Vanadium	µg/g	130	-	39	39	44	67	46	19
Zinc	µg/g	360	-	35	36	39	110	30	29
PCBs									
Total PCBs	µg/g	33	-	0.046	0.044	ND(0.010)	ND(0.020)	ND(0.010)	ND(0.010)
Petroleum Hydrocarbons									
Petroleum hydrocarbons F1 (C6-C10)	µg/g	-	-	ND(50)	59	17	ND(10)	ND(10)	ND(10)
Petroleum hydrocarbons F1 (C6-C10) - less BTEX [2]	µg/g	320	-	ND(50)	59	17	ND(10)	ND(10)	ND(10)
Petroleum hydrocarbons F2 (C10-C16) [2]	µg/g	260	260	**2800**	**3000**	**1000**	ND(10)	ND(10)	ND(10)
Petroleum hydrocarbons F3 (C16-C34) [2]	µg/g	1700	1700	**1800**	**2300**	1500	ND(50)	ND(50)	ND(50)
Petroleum hydrocarbons F4 (C34-C50) [2]	µg/g	3300	-	740	1200	750	ND(50)	ND(50)	ND(50)
Gravimetric heavy hydrocarbons (F4G)	µg/g	-	-	-	-	-	-	-	-
General Chemistry									
Cyanide (free)	µg/g	-	-	0.03	0.02	0.02	0.04	ND(0.01)	ND(0.01)
pH, lab	s.u.	6-8	-	7.03	7.02	7.07	5.45	6.98	6.79
Moisture	%	-	-	8.0	7.9	8.0	33	3.5	3.3

TABLE 1

ANALYTICAL RESULTS - SOIL SAMPLES
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Sample Location:				*TP03*	*TP04*	*TP05*	*TP06*	*TP07*	*TP09*
Sample Date:				*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*
Sample Depth:				*1.3*	*2.1*	*1.45*	*1.1*	*1.25*	*3.5*
Parameters	*Units*	*CCME Industrial* [a]	*RBCs* [b]						
Volatile Organic Compounds									
1,1,1,2-Tetrachloroethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,1-Trichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,2,2-Tetrachloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,2-Trichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1-Dichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1-Dichloroethene	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dibromoethane (Ethylene dibromide)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichloropropane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,3-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,4-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
2-Butanone (Methyl ethyl ketone) (MEK)	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
4-Methyl-2-pentanone (Methyl isobutyl ketone) (MIBK	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Acetone	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Benzene	µg/g	0.030	-	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)
Bromodichloromethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Bromoform	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Bromomethane (Methyl bromide)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Carbon tetrachloride	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Chlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Chloroform (Trichloromethane)	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
cis-1,2-Dichloroethene	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
cis-1,3-Dichloropropene	µg/g	-	-	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)
Dibromochloromethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Dichlorodifluoromethane (CFC-12)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Ethylbenzene	µg/g	0.082	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
Hexane	µg/g	6.5	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
m&p-Xylenes	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Methyl tert butyl ether (MTBE)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Methylene chloride	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
o-Xylene	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Styrene	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Tetrachloroethene	µg/g	0.6	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Toluene	µg/g	0.37	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
trans-1,2-Dichloroethene	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
trans-1,3-Dichloropropene	µg/g	-	-	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)
Trichloroethene	µg/g	0.01	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
Trichlorofluoromethane (CFC-11)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Vinyl chloride	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Xylenes (total)	µg/g	11	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Polycyclic Aromatic Hydrocarbons									
1-Methylnaphthalene	µg/g	-	-	ND(0.010)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.050)	ND(0.0050)
2-Methylnaphthalene	µg/g	-	-	ND(0.010)	ND(0.0050)	ND(0.0050)	0.0057	ND(0.050)	ND(0.0050)
Acenaphthene	µg/g	-	-	ND(0.010)	ND(0.0050)	ND(0.0050)	0.011	ND(0.050)	ND(0.0050)
Acenaphthylene	µg/g	-	-	ND(0.010)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.050)	ND(0.0050)
Anthracene	µg/g	32	-	ND(0.010)	ND(0.0050)	ND(0.0050)	0.013	ND(0.050)	ND(0.0050)
Benzo(a)anthracene	µg/g	-	-	0.047	ND(0.0050)	ND(0.0050)	0.028	ND(0.050)	ND(0.0050)
Benzo(a)pyrene	µg/g	72	-	0.039	ND(0.0050)	ND(0.0050)	0.025	ND(0.050)	ND(0.0050)
Benzo(b)fluoranthene/Benzo(j)fluoranthene	µg/g	10	-	0.055	ND(0.0050)	ND(0.0050)	0.031	ND(0.050)	ND(0.0050)
Benzo(g,h,i)perylene	µg/g	-	-	0.027	ND(0.0050)	ND(0.0050)	0.015	ND(0.050)	ND(0.0050)
Benzo(k)fluoranthene	µg/g	10	-	0.020	ND(0.0050)	ND(0.0050)	0.012	ND(0.050)	ND(0.0050)
Chrysene	µg/g	-	-	0.034	ND(0.0050)	ND(0.0050)	0.023	ND(0.050)	ND(0.0050)
Dibenz(a,h)anthracene	µg/g	10	-	ND(0.010)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.050)	ND(0.0050)
Fluoranthene	µg/g	180	-	0.11	ND(0.0050)	ND(0.0050)	0.054	0.072	ND(0.0050)
Fluorene	µg/g	-	-	ND(0.010)	ND(0.0050)	ND(0.0050)	0.0095	ND(0.050)	ND(0.0050)
Indeno(1,2,3-cd)pyrene	µg/g	10	-	0.025	ND(0.0050)	ND(0.0050)	0.015	ND(0.050)	ND(0.0050)
Naphthalene	µg/g	22	22	0.013	ND(0.0050)	ND(0.0050)	0.017	0.075	ND(0.0050)
Phenanthrene	µg/g	50	-	0.032	ND(0.0050)	ND(0.0050)	0.044	0.25	ND(0.0050)
Pyrene	µg/g	100	-	0.088	ND(0.0050)	ND(0.0050)	0.039	0.053	ND(0.0050)
Metals									
Antimony	µg/g	40	-	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Arsenic	µg/g	12	26	1.6	4.4	1.1	2.2	2.0	2.4
Barium	µg/g	2000	-	28	31	8.0	47	30	16
Beryllium	µg/g	8	-	0.20	0.24	ND(0.20)	0.33	0.22	ND(0.20)
Boron (hot water soluble)	µg/g	-	-	0.094	ND(0.050)	ND(0.050)	0.055	0.18	0.11
Cadmium	µg/g	22	-	ND(0.10)	ND(0.10)	ND(0.10)	0.11	0.10	ND(0.10)
Chromium	µg/g	87	-	17	23	17	30	18	22
Chromium VI (hexavalent)	µg/g	1.4	-	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
Cobalt	µg/g	300	-	5.1	7.3	4.8	7.7	6.9	8.2
Copper	µg/g	91	-	12	17	8.0	16	16	15
Lead	µg/g	-	-	10	6.5	2.8	6.5	9.1	4.4
Mercury	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Molybdenum	µg/g	40	-	0.60	0.83	0.61	0.68	0.69	0.84
Nickel	µg/g	50	-	7.4	12	5.5	14	9.2	9.0
Selenium	µg/g	2.9	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Silver	µg/g	40	-	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Sulfur	µg/g	NV	-	100	150	82	130	190	86
Thallium	µg/g	1	-	ND(0.050)	ND(0.050)	ND(0.050)	0.099	ND(0.050)	ND(0.050)
Tin	µg/g	300	-	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
Uranium	µg/g	300	-	0.40	0.50	0.40	0.45	0.42	0.39
Vanadium	µg/g	130	-	35	50	38	52	38	49
Zinc	µg/g	360	-	52	53	26	95	56	34
PCBs									
Total PCBs	µg/g	33	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
Petroleum Hydrocarbons									
Petroleum hydrocarbons F1 (C6-C10)	µg/g	-	-	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
Petroleum hydrocarbons F1 (C6-C10) - less BTEX [2]	µg/g	320	-	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
Petroleum hydrocarbons F2 (C10-C16) [2]	µg/g	260	260	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
Petroleum hydrocarbons F3 (C16-C34) [2]	µg/g	1700	1700	110	ND(50)	ND(50)	ND(50)	190	ND(50)
Petroleum hydrocarbons F4 (C34-C50) [2]	µg/g	3300	-	82	ND(50)	ND(50)	ND(50)	170	ND(50)
Gravimetric heavy hydrocarbons (F4G)	µg/g	-	-	-	-	-	-	610	-
General Chemistry									
Cyanide (free)	µg/g	-	-	0.01	0.01	ND(0.01)	ND(0.01)	0.02	ND(0.01)
pH, lab	s.u.	6-8	-	7.54	7.54	7.96	7.39	7.34	7.99
Moisture	%	-	-	6.3	10	9.5	8.8	10	2.5

TABLE 1

ANALYTICAL RESULTS - SOIL SAMPLES
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Sample Location:				*TP10*	*TP12*	*TP13*	*TP14*	*TP15*	*TP16*
Sample Date:				*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*
Sample Depth:				*1.65*	*0.6*	*1.35*	*0.8*	*0.8*	*0.65*
Parameters	*Units*	*CCME Industrial* [a]	*RBCs* [b]						
Volatile Organic Compounds									
1,1,1,2-Tetrachloroethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,1-Trichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,2,2-Tetrachloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,2-Trichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1-Dichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1-Dichloroethene	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dibromoethane (Ethylene dibromide)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichloropropane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,3-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,4-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
2-Butanone (Methyl ethyl ketone) (MEK)	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
4-Methyl-2-pentanone (Methyl isobutyl ketone) (MIBK	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Acetone	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Benzene	µg/g	0.030	-	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)
Bromodichloromethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Bromoform	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Bromomethane (Methyl bromide)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Carbon tetrachloride	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Chlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Chloroform (Trichloromethane)	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
cis-1,2-Dichloroethene	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
cis-1,3-Dichloropropene	µg/g	-	-	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)
Dibromochloromethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Dichlorodifluoromethane (CFC-12)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Ethylbenzene	µg/g	0.082	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
Hexane	µg/g	6.5	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
m&p-Xylenes	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Methyl tert butyl ether (MTBE)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Methylene chloride	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
o-Xylene	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Styrene	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Tetrachloroethene	µg/g	0.6	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Toluene	µg/g	0.37	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
trans-1,2-Dichloroethene	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
trans-1,3-Dichloropropene	µg/g	-	-	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)
Trichloroethene	µg/g	0.01	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
Trichlorofluoromethane (CFC-11)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Vinyl chloride	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Xylenes (total)	µg/g	11	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Polycyclic Aromatic Hydrocarbons									
1-Methylnaphthalene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
2-Methylnaphthalene	µg/g	-	-	ND(0.0050)	ND(0.0050)	0.059	ND(0.0050)	ND(0.0050)	ND(0.0050)
Acenaphthene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Acenaphthylene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Anthracene	µg/g	32	-	ND(0.0050)	ND(0.0050)	ND(0.050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Benzo(a)anthracene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.050)	0.0076	ND(0.0050)	0.0064
Benzo(a)pyrene	µg/g	72	-	ND(0.0050)	ND(0.0050)	ND(0.050)	0.0089	ND(0.0050)	0.0073
Benzo(b)fluoranthene/Benzo(j)fluoranthene	µg/g	10	-	ND(0.0050)	ND(0.0050)	0.062	0.014	ND(0.0050)	0.010
Benzo(g,h,i)perylene	µg/g	-	-	ND(0.0050)	0.0062	ND(0.050)	0.0088	ND(0.0050)	0.0066
Benzo(k)fluoranthene	µg/g	10	-	ND(0.0050)	ND(0.0050)	ND(0.050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Chrysene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.050)	0.0077	ND(0.0050)	0.0063
Dibenz(a,h)anthracene	µg/g	10	-	ND(0.0050)	ND(0.0050)	ND(0.050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Fluoranthene	µg/g	180	-	ND(0.0050)	ND(0.0050)	0.059	0.016	ND(0.0050)	0.014
Fluorene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Indeno(1,2,3-cd)pyrene	µg/g	10	-	ND(0.0050)	ND(0.0050)	ND(0.050)	0.0085	ND(0.0050)	0.0055
Naphthalene	µg/g	22	22	ND(0.0050)	ND(0.0050)	0.094	ND(0.0050)	ND(0.0050)	ND(0.0050)
Phenanthrene	µg/g	50	-	ND(0.0050)	ND(0.0050)	0.077	0.0054	ND(0.0050)	0.0063
Pyrene	µg/g	100	-	ND(0.0050)	ND(0.0050)	0.081	0.012	ND(0.0050)	0.011
Metals									
Antimony	µg/g	40	-	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Arsenic	µg/g	12	26	1.2	2.2	1.5	1.6	**100**	1.7
Barium	µg/g	2000	-	14	16	21	15	24	20
Beryllium	µg/g	8	-	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Boron (hot water soluble)	µg/g	-	-	0.094	0.053	0.072	0.053	ND(0.050)	0.076
Cadmium	µg/g	22	-	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)
Chromium	µg/g	87	-	13	28	15	11	20	17
Chromium VI (hexavalent)	µg/g	1.4	-	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
Cobalt	µg/g	300	-	4.9	5.2	4.2	3.3	5.3	4.3
Copper	µg/g	91	-	8.0	7.1	9.6	6.2	6.0	8.2
Lead	µg/g	-	-	4.5	20	9.8	3.1	2.8	4.1
Mercury	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Molybdenum	µg/g	40	-	ND(0.50)	0.81	0.52	ND(0.50)	0.65	0.57
Nickel	µg/g	50	-	6.3	9.1	7.0	5.5	11	6.3
Selenium	µg/g	2.9	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Silver	µg/g	40	-	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Sulfur	µg/g	NV	-	53	100	83	63	120	140
Thallium	µg/g	1	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Tin	µg/g	300	-	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
Uranium	µg/g	300	-	0.25	0.42	0.31	0.31	0.33	0.31
Vanadium	µg/g	130	-	30	62	31	23	55	32
Zinc	µg/g	360	-	29	29	36	28	35	40
PCBs									
Total PCBs	µg/g	33	-	ND(0.010)	ND(0.010)	0.015	ND(0.010)	ND(0.010)	ND(0.010)
Petroleum Hydrocarbons									
Petroleum hydrocarbons F1 (C6-C10)	µg/g	-	-	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
Petroleum hydrocarbons F1 (C6-C10) - less BTEX [2]	µg/g	320	-	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
Petroleum hydrocarbons F2 (C10-C16) [2]	µg/g	260	260	ND(10)	ND(10)	110	ND(10)	ND(10)	ND(10)
Petroleum hydrocarbons F3 (C16-C34) [2]	µg/g	1700	1700	ND(50)	ND(50)	540	ND(50)	ND(50)	ND(50)
Petroleum hydrocarbons F4 (C34-C50) [2]	µg/g	3300	-	ND(50)	ND(50)	740	ND(50)	ND(50)	ND(50)
Gravimetric heavy hydrocarbons (F4G)	µg/g	-	-	-	-	2800	-	-	-
General Chemistry									
Cyanide (free)	µg/g	-	-	ND(0.01)	ND(0.01)	0.01	0.01	0.04	0.02
pH, lab	s.u.	6-8	-	7.69	7.81	7.57	7.24	5.90	7.44
Moisture	%	-	-	4.4	8.8	11	11	7.6	11

TABLE 1

ANALYTICAL RESULTS - SOIL SAMPLES
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Sample Location:				*TP17A*	*TP17B*	*TP18*	*TP19*	*TP20*	*TP21*
Sample Date:				*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*
Sample Depth:				*1.15*	*1.1*	*1.1*	*1.5*	*0.9*	*1.45*
Parameters	*Units*	*CCME Industrial* *a*	*RBCs* *b*						
Volatile Organic Compounds									
1,1,1,2-Tetrachloroethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,1-Trichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,2,2-Tetrachloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,2-Trichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1-Dichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1-Dichloroethene	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dibromoethane (Ethylene dibromide)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichloropropane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,3-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,4-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
2-Butanone (Methyl ethyl ketone) (MEK)	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
4-Methyl-2-pentanone (Methyl isobutyl ketone) (MIBK	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Acetone	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Benzene	µg/g	0.030	-	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)
Bromodichloromethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Bromoform	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Bromomethane (Methyl bromide)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Carbon tetrachloride	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Chlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Chloroform (Trichloromethane)	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
cis-1,2-Dichloroethene	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
cis-1,3-Dichloropropene	µg/g	-	-	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)
Dibromochloromethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Dichlorodifluoromethane (CFC-12)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Ethylbenzene	µg/g	0.082	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
Hexane	µg/g	6.5	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	0.060
m&p-Xylenes	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Methyl tert butyl ether (MTBE)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Methylene chloride	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
o-Xylene	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Styrene	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Tetrachloroethene	µg/g	0.6	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Toluene	µg/g	0.37	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
trans-1,2-Dichloroethene	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
trans-1,3-Dichloropropene	µg/g	-	-	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)
Trichloroethene	µg/g	0.01	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
Trichlorofluoromethane (CFC-11)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Vinyl chloride	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Xylenes (total)	µg/g	11	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Polycyclic Aromatic Hydrocarbons									
1-Methylnaphthalene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	0.079
2-Methylnaphthalene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	0.13
Acenaphthene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.010)
Acenaphthylene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.010)
Anthracene	µg/g	32	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	0.0086
Benzo(a)anthracene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	0.013
Benzo(a)pyrene	µg/g	72	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	0.033
Benzo(b)fluoranthene/Benzo(j)fluoranthene	µg/g	10	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	0.0086	0.021
Benzo(g,h,i)perylene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	0.0051	0.045
Benzo(k)fluoranthene	µg/g	10	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Chrysene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	0.016
Dibenz(a,h)anthracene	µg/g	10	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Fluoranthene	µg/g	180	-	0.0056	0.0059	ND(0.0050)	ND(0.0050)	0.0083	0.029
Fluorene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.050)
Indeno(1,2,3-cd)pyrene	µg/g	10	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	0.0052	0.014
Naphthalene	µg/g	22	22	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.010)	ND(0.10)
Phenanthrene	µg/g	50	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	0.0058	0.045
Pyrene	µg/g	100	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	0.0077	0.054
Metals									
Antimony	µg/g	40	-	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Arsenic	µg/g	12	26	2.0	1.0	ND(1.0)	ND(1.0)	1.0	5.2
Barium	µg/g	2000	-	20	11	9.6	12	12	25
Beryllium	µg/g	8	-	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Boron (hot water soluble)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	0.065	0.11	0.093
Cadmium	µg/g	22	-	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)
Chromium	µg/g	87	-	16	11	11	7.3	11	22
Chromium VI (hexavalent)	µg/g	1.4	-	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
Cobalt	µg/g	300	-	4.0	3.0	5.6	3.6	3.7	6.0
Copper	µg/g	91	-	6.6	6.8	8.4	7.2	7.2	15
Lead	µg/g	-	-	4.5	2.1	1.9	1.8	5.6	14
Mercury	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Molybdenum	µg/g	40	-	0.74	ND(0.50)	0.58	ND(0.50)	ND(0.50)	0.66
Nickel	µg/g	50	-	6.2	4.6	8.6	5.1	5.2	9.1
Selenium	µg/g	2.9	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Silver	µg/g	40	-	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Sulfur	µg/g	NV	-	96	ND(50)	67	64	91	190
Thallium	µg/g	1	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Tin	µg/g	300	-	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
Uranium	µg/g	300	-	0.32	0.23	0.18	0.29	0.22	0.42
Vanadium	µg/g	130	-	38	22	25	13	24	40
Zinc	µg/g	360	-	29	24	27	25	26	41
PCBs									
Total PCBs	µg/g	33	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	0.016
Petroleum Hydrocarbons									
Petroleum hydrocarbons F1 (C6-C10)	µg/g	-	-	ND(10)	ND(10)	ND(10)	ND(10)	10	ND(10)
Petroleum hydrocarbons F1 (C6-C10) - less BTEX [2]	µg/g	320	-	ND(10)	ND(10)	ND(10)	ND(10)	10	ND(10)
Petroleum hydrocarbons F2 (C10-C16) [2]	µg/g	260	260	ND(10)	ND(10)	ND(10)	ND(10)	64	130
Petroleum hydrocarbons F3 (C16-C34) [2]	µg/g	1700	1700	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	630
Petroleum hydrocarbons F4 (C34-C50) [2]	µg/g	3300	-	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	180
Gravimetric heavy hydrocarbons (F4G)	µg/g	-	-	-	-	-	-	-	-
General Chemistry									
Cyanide (free)	µg/g	-	-	0.02	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	0.01
pH, lab	s.u.	6-8	-	7.23	7.85	7.91	7.87	7.77	7.47
Moisture	%	-	-	6.9	9.4	3.7	4.8	4.9	12

TABLE 1

ANALYTICAL RESULTS - SOIL SAMPLES
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Sample Location:				*TP22*	*TP23*	*TP24*	*TP24*	*TP25*	*TP26*
Sample Date:				*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*
Sample Depth:				*1.6*	*1.5*	*0.6*	*1.6*	*1*	*0.95*
Parameters	*Units*	*CCME Industrial* *a*	*RBCs* *b*						
Volatile Organic Compounds									
1,1,1,2-Tetrachloroethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,1-Trichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,2,2-Tetrachloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.11)	ND(0.050)	ND(0.050)	ND(0.050)
1,1,2-Trichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1-Dichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,1-Dichloroethene	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dibromoethane (Ethylene dibromide)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,2-Dichloropropane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,3-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
1,4-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
2-Butanone (Methyl ethyl ketone) (MEK)	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
4-Methyl-2-pentanone (Methyl isobutyl ketone) (MIBK	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Acetone	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Benzene	µg/g	0.030	-	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)
Bromodichloromethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Bromoform	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Bromomethane (Methyl bromide)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Carbon tetrachloride	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Chlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Chloroform (Trichloromethane)	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
cis-1,2-Dichloroethene	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
cis-1,3-Dichloropropene	µg/g	-	-	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)
Dibromochloromethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Dichlorodifluoromethane (CFC-12)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Ethylbenzene	µg/g	0.082	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
Hexane	µg/g	6.5	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
m&p-Xylenes	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Methyl tert butyl ether (MTBE)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Methylene chloride	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
o-Xylene	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Styrene	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Tetrachloroethene	µg/g	0.6	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Toluene	µg/g	0.37	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
trans-1,2-Dichloroethene	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
trans-1,3-Dichloropropene	µg/g	-	-	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)
Trichloroethene	µg/g	0.01	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
Trichlorofluoromethane (CFC-11)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Vinyl chloride	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Xylenes (total)	µg/g	11	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)
Polycyclic Aromatic Hydrocarbons									
1-Methylnaphthalene	µg/g	-	-	ND(0.0050)	ND(0.0050)	0.025	ND(0.0050)	ND(0.0050)	ND(0.0050)
2-Methylnaphthalene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.025)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Acenaphthene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.025)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Acenaphthylene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.025)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Anthracene	µg/g	32	-	ND(0.0050)	ND(0.0050)	ND(0.025)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Benzo(a)anthracene	µg/g	-	-	ND(0.0050)	ND(0.0050)	0.031	ND(0.0050)	ND(0.0050)	ND(0.0050)
Benzo(a)pyrene	µg/g	72	-	ND(0.0050)	ND(0.0050)	0.063	0.0054	ND(0.0050)	ND(0.0050)
Benzo(b)fluoranthene/Benzo(j)fluoranthene	µg/g	10	-	ND(0.0050)	ND(0.0050)	0.10	0.0076	ND(0.0050)	ND(0.0050)
Benzo(g,h,i)perylene	µg/g	-	-	ND(0.0050)	ND(0.0050)	0.067	0.0056	ND(0.0050)	ND(0.0050)
Benzo(k)fluoranthene	µg/g	10	-	ND(0.0050)	ND(0.0050)	0.031	ND(0.0050)	ND(0.0050)	ND(0.0050)
Chrysene	µg/g	-	-	ND(0.0050)	ND(0.0050)	0.028	ND(0.0050)	ND(0.0050)	ND(0.0050)
Dibenz(a,h)anthracene	µg/g	10	-	ND(0.0050)	ND(0.0050)	ND(0.025)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Fluoranthene	µg/g	180	-	ND(0.0050)	ND(0.0050)	0.045	0.0068	ND(0.0050)	ND(0.0050)
Fluorene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.025)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Indeno(1,2,3-cd)pyrene	µg/g	10	-	ND(0.0050)	ND(0.0050)	0.052	ND(0.0050)	ND(0.0050)	ND(0.0050)
Naphthalene	µg/g	22	22	ND(0.0050)	ND(0.0050)	ND(0.10)	ND(0.0050)	ND(0.0050)	ND(0.0050)
Phenanthrene	µg/g	50	-	ND(0.0050)	ND(0.0050)	0.039	ND(0.0050)	ND(0.0050)	ND(0.0050)
Pyrene	µg/g	100	-	ND(0.0050)	ND(0.0050)	0.14	0.0098	ND(0.0050)	ND(0.0050)
Metals									
Antimony	µg/g	40	-	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Arsenic	µg/g	12	26	2.8	2.0	2.0	5.2	1.8	1.9
Barium	µg/g	2000	-	31	18	25	13	21	21
Beryllium	µg/g	8	-	0.24	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Boron (hot water soluble)	µg/g	-	-	0.069	ND(0.050)	0.25	0.064	0.091	0.057
Cadmium	µg/g	22	-	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)
Chromium	µg/g	87	-	22	15	19	27	16	16
Chromium VI (hexavalent)	µg/g	1.4	-	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
Cobalt	µg/g	300	-	6.6	4.0	4.6	5.1	4.1	5.7
Copper	µg/g	91	-	15	7.9	10	11	8.2	13
Lead	µg/g	-	-	9.3	2.1	23	3.7	2.4	3.0
Mercury	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Molybdenum	µg/g	40	-	0.66	0.76	0.60	0.73	0.62	0.57
Nickel	µg/g	50	-	9.9	5.8	7.3	7.1	6.4	7.1
Selenium	µg/g	2.9	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Silver	µg/g	40	-	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Sulfur	µg/g	NV	-	320	78	160	140	120	93
Thallium	µg/g	1	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Tin	µg/g	300	-	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
Uranium	µg/g	300	-	0.52	0.32	0.35	0.25	0.39	0.32
Vanadium	µg/g	130	-	49	30	36	63	30	35
Zinc	µg/g	360	-	42	23	40	28	26	28
PCBs									
Total PCBs	µg/g	33	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
Petroleum Hydrocarbons									
Petroleum hydrocarbons F1 (C6-C10)	µg/g	-	-	ND(10)	ND(10)	ND(50)	ND(10)	ND(10)	ND(10)
Petroleum hydrocarbons F1 (C6-C10) - less BTEX [2]	µg/g	320	-	ND(10)	ND(10)	ND(50)	ND(10)	ND(10)	ND(10)
Petroleum hydrocarbons F2 (C10-C16) [2]	µg/g	260	260	13	ND(10)	**1300**	ND(10)	ND(10)	ND(10)
Petroleum hydrocarbons F3 (C16-C34) [2]	µg/g	1700	1700	52	ND(50)	1300	ND(50)	ND(50)	ND(50)
Petroleum hydrocarbons F4 (C34-C50) [2]	µg/g	3300	-	ND(50)	ND(50)	730	ND(50)	ND(50)	ND(50)
Gravimetric heavy hydrocarbons (F4G)	µg/g	-	-	-	-	-	-	-	-
General Chemistry									
Cyanide (free)	µg/g	-	-	0.02	ND(0.01)	0.01	ND(0.01)	ND(0.01)	ND(0.01)
pH, lab	s.u.	6-8	-	7.27	7.68	7.25	7.80	7.64	7.87
Moisture	%	-	-	14	12	7.7	12	12	4.1

TABLE 1

ANALYTICAL RESULTS - SOIL SAMPLES
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Sample Location:				*TP27*	*TP28*	*TP29*	*TP30*	*TP31*	*TP32*
Sample Date:				*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*	*7/23/2013*
Sample Depth:				*0.6*	*1.2*	*1*	*0.6*	*1.2*	*0.15*
Parameters	*Units*	*CCME Industrial* *a*	*RBCs* *b*						
Volatile Organic Compounds									
1,1,1,2-Tetrachloroethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
1,1,1-Trichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
1,1,2,2-Tetrachloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
1,1,2-Trichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
1,1-Dichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
1,1-Dichloroethene	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
1,2-Dibromoethane (Ethylene dibromide)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
1,2-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
1,2-Dichloroethane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
1,2-Dichloropropane	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
1,3-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
1,4-Dichlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
2-Butanone (Methyl ethyl ketone) (MEK)	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(1.5)
4-Methyl-2-pentanone (Methyl isobutyl ketone) (MIBK	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(1.5)
Acetone	µg/g	-	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(1.5)
Benzene	µg/g	0.030	-	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.0060)	ND(0.018)
Bromodichloromethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
Bromoform	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
Bromomethane (Methyl bromide)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
Carbon tetrachloride	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
Chlorobenzene	µg/g	10	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
Chloroform (Trichloromethane)	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
cis-1,2-Dichloroethene	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
cis-1,3-Dichloropropene	µg/g	-	-	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.030)	ND(0.090)
Dibromochloromethane	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
Dichlorodifluoromethane (CFC-12)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
Ethylbenzene	µg/g	0.082	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	**0.31**
Hexane	µg/g	6.5	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
m&p-Xylenes	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	2.3
Methyl tert butyl ether (MTBE)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
Methylene chloride	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
o-Xylene	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	1.2
Styrene	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
Tetrachloroethene	µg/g	0.6	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
Toluene	µg/g	0.37	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	0.22
trans-1,2-Dichloroethene	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
trans-1,3-Dichloropropene	µg/g	-	-	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.12)
Trichloroethene	µg/g	0.01	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.030)
Trichlorofluoromethane (CFC-11)	µg/g	-	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.15)
Vinyl chloride	µg/g	-	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.060)
Xylenes (total)	µg/g	11	-	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	ND(0.020)	3.5
Polycyclic Aromatic Hydrocarbons									
1-Methylnaphthalene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	0.14
2-Methylnaphthalene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	0.22
Acenaphthene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.10)
Acenaphthylene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.10)
Anthracene	µg/g	32	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.10)
Benzo(a)anthracene	µg/g	-	-	ND(0.0050)	ND(0.0050)	0.015	ND(0.0050)	ND(0.0050)	ND(0.10)
Benzo(a)pyrene	µg/g	72	-	ND(0.0050)	ND(0.0050)	0.038	ND(0.0050)	ND(0.0050)	ND(0.10)
Benzo(b)fluoranthene/Benzo(j)fluoranthene	µg/g	10	-	ND(0.0050)	ND(0.0050)	0.015	ND(0.0050)	ND(0.0050)	ND(0.10)
Benzo(g,h,i)perylene	µg/g	-	-	ND(0.0050)	ND(0.0050)	0.071	ND(0.0050)	ND(0.0050)	ND(0.10)
Benzo(k)fluoranthene	µg/g	10	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.10)
Chrysene	µg/g	-	-	ND(0.0050)	ND(0.0050)	0.020	ND(0.0050)	ND(0.0050)	ND(0.10)
Dibenz(a,h)anthracene	µg/g	10	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.10)
Fluoranthene	µg/g	180	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.10)
Fluorene	µg/g	-	-	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.10)
Indeno(1,2,3-cd)pyrene	µg/g	10	-	ND(0.0050)	ND(0.0050)	0.018	ND(0.0050)	ND(0.0050)	ND(0.10)
Naphthalene	µg/g	22	22	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	0.19
Phenanthrene	µg/g	50	-	ND(0.0050)	ND(0.0050)	0.0061	ND(0.0050)	ND(0.0050)	ND(0.10)
Pyrene	µg/g	100	-	ND(0.0050)	ND(0.0050)	0.044	ND(0.0050)	ND(0.0050)	ND(0.10)
Metals									
Antimony	µg/g	40	-	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	0.23
Arsenic	µg/g	12	26	1.4	1.5	2.3	2.4	1.3	1.8
Barium	µg/g	2000	-	25	23	42	24	23	94
Beryllium	µg/g	8	-	ND(0.20)	0.25	0.26	0.28	ND(0.20)	0.23
Boron (hot water soluble)	µg/g	-	-	0.075	0.062	0.11	ND(0.050)	0.059	0.38
Cadmium	µg/g	22	-	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)	0.13
Chromium	µg/g	87	-	18	19	23	33	14	18
Chromium VI (hexavalent)	µg/g	1.4	-	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
Cobalt	µg/g	300	-	4.3	4.5	6.1	5.7	4.0	5.2
Copper	µg/g	91	-	7.6	9.4	14	6.7	8.0	22
Lead	µg/g	-	-	2.4	2.8	3.7	3.2	2.9	17
Mercury	µg/g	50	-	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
Molybdenum	µg/g	40	-	0.65	ND(0.50)	1.1	1.3	0.61	0.71
Nickel	µg/g	50	-	6.9	7.7	10	9.5	6.0	9.7
Selenium	µg/g	2.9	-	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
Silver	µg/g	40	-	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
Sulfur	µg/g	NV	-	58	88	230	220	75	1100
Thallium	µg/g	1	-	ND(0.050)	ND(0.050)	0.055	ND(0.050)	ND(0.050)	ND(0.050)
Tin	µg/g	300	-	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
Uranium	µg/g	300	-	0.33	0.32	0.54	0.39	0.41	1.3
Vanadium	µg/g	130	-	48	38	46	86	44	31
Zinc	µg/g	360	-	29	30	46	37	29	57
PCBs									
Total PCBs	µg/g	33	-	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.030)
Petroleum Hydrocarbons									
Petroleum hydrocarbons F1 (C6-C10)	µg/g	-	-	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(30)
Petroleum hydrocarbons F1 (C6-C10) - less BTEX [2]	µg/g	320	-	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(30)
Petroleum hydrocarbons F2 (C10-C16) [2]	µg/g	260	260	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	21
Petroleum hydrocarbons F3 (C16-C34) [2]	µg/g	1700	1700	ND(50)	ND(50)	150	ND(50)	ND(50)	1500
Petroleum hydrocarbons F4 (C34-C50) [2]	µg/g	3300	-	ND(50)	ND(50)	140	ND(50)	ND(50)	1300
Gravimetric heavy hydrocarbons (F4G)	µg/g	-	-	-	-	400	-	-	2700
General Chemistry									
Cyanide (free)	µg/g	-	-	0.02	0.03	0.02	0.02	0.01	0.07
pH, lab	s.u.	6-8	-	7.42	5.96	7.54	5.96	7.13	5.96
Moisture	%	-	-	6.0	10	12	12	5.6	61

TABLE 1

ANALYTICAL RESULTS - SOIL SAMPLES
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Sample Location:			
Sample Date:			
Sample Depth:			
Parameters	***Units***	***CCME Industrial a***	***RBCs b***
Volatile Organic Compounds			
1,1,1,2-Tetrachloroethane	µg/g	-	-
1,1,1-Trichloroethane	µg/g	50	-
1,1,2,2-Tetrachloroethane	µg/g	50	-
1,1,2-Trichloroethane	µg/g	50	-
1,1-Dichloroethane	µg/g	50	-
1,1-Dichloroethene	µg/g	50	-
1,2-Dibromoethane (Ethylene dibromide)	µg/g	-	-
1,2-Dichlorobenzene	µg/g	10	-
1,2-Dichloroethane	µg/g	50	-
1,2-Dichloropropane	µg/g	50	-
1,3-Dichlorobenzene	µg/g	10	-
1,4-Dichlorobenzene	µg/g	10	-
2-Butanone (Methyl ethyl ketone) (MEK)	µg/g	-	-
4-Methyl-2-pentanone (Methyl isobutyl ketone) (MIBK	µg/g	-	-
Acetone	µg/g	-	-
Benzene	µg/g	0.030	-
Bromodichloromethane	µg/g	-	-
Bromoform	µg/g	-	-
Bromomethane (Methyl bromide)	µg/g	-	-
Carbon tetrachloride	µg/g	50	-
Chlorobenzene	µg/g	10	-
Chloroform (Trichloromethane)	µg/g	50	-
cis-1,2-Dichloroethene	µg/g	-	-
cis-1,3-Dichloropropene	µg/g	-	-
Dibromochloromethane	µg/g	-	-
Dichlorodifluoromethane (CFC-12)	µg/g	-	-
Ethylbenzene	µg/g	0.082	-
Hexane	µg/g	6.5	-
m&p-Xylenes	µg/g	-	-
Methyl tert butyl ether (MTBE)	µg/g	-	-
Methylene chloride	µg/g	50	-
o-Xylene	µg/g	-	-
Styrene	µg/g	50	-
Tetrachloroethene	µg/g	0.6	-
Toluene	µg/g	0.37	-
trans-1,2-Dichloroethene	µg/g	-	-
trans-1,3-Dichloropropene	µg/g	-	-
Trichloroethene	µg/g	0.01	-
Trichlorofluoromethane (CFC-11)	µg/g	-	-
Vinyl chloride	µg/g	-	-
Xylenes (total)	µg/g	11	-
Polycyclic Aromatic Hydrocarbons			
1-Methylnaphthalene	µg/g	-	-
2-Methylnaphthalene	µg/g	-	-
Acenaphthene	µg/g	-	-
Acenaphthylene	µg/g	-	-
Anthracene	µg/g	32	-
Benzo(a)anthracene	µg/g	-	-
Benzo(a)pyrene	µg/g	72	-
Benzo(b)fluoranthene/Benzo(j)fluoranthene	µg/g	10	-
Benzo(g,h,i)perylene	µg/g	-	-
Benzo(k)fluoranthene	µg/g	10	-
Chrysene	µg/g	-	-
Dibenz(a,h)anthracene	µg/g	10	-
Fluoranthene	µg/g	180	-
Fluorene	µg/g	-	-
Indeno(1,2,3-cd)pyrene	µg/g	10	-
Naphthalene	µg/g	22	22
Phenanthrene	µg/g	50	-
Pyrene	µg/g	100	-
Metals			
Antimony	µg/g	40	-
Arsenic	µg/g	12	26
Barium	µg/g	2000	-
Beryllium	µg/g	8	-
Boron (hot water soluble)	µg/g	-	-
Cadmium	µg/g	22	-
Chromium	µg/g	87	-
Chromium VI (hexavalent)	µg/g	1.4	-
Cobalt	µg/g	300	-
Copper	µg/g	91	-
Lead	µg/g	-	-
Mercury	µg/g	50	-
Molybdenum	µg/g	40	-
Nickel	µg/g	50	-
Selenium	µg/g	2.9	-
Silver	µg/g	40	-
Sulfur	µg/g	NV	-
Thallium	µg/g	1	-
Tin	µg/g	300	-
Uranium	µg/g	300	-
Vanadium	µg/g	130	-
Zinc	µg/g	360	-
PCBs			
Total PCBs	µg/g	33	-
Petroleum Hydrocarbons			
Petroleum hydrocarbons F1 (C6-C10)	µg/g	-	-
Petroleum hydrocarbons F1 (C6-C10) - less BTEX [2]	µg/g	320	-
Petroleum hydrocarbons F2 (C10-C16) [2]	µg/g	260	260
Petroleum hydrocarbons F3 (C16-C34) [2]	µg/g	1700	1700
Petroleum hydrocarbons F4 (C34-C50) [2]	µg/g	3300	-
Gravimetric heavy hydrocarbons (F4G)	µg/g	-	-
General Chemistry			
Cyanide (free)	µg/g	-	-
pH, lab	s.u.	6-8	-
Moisture	%	-	-

Notes:

a Canadian Council of Ministers of the Environment (CCME) Tier 1 Industrial Guidelines: As presented in "Canadian Environmental Quality Guidelines Summary Tables, Soil Land Industrial Use", Quality Guidelines for the Protection of Environmental and Human Health, dated 1999, updated 2011 (CCME, 2011). CCME has recently updated their Soil Quality Guidelines (SQGs) for some polycyclic aromatic hydrocarbons (PAHs), as presented in Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health- Polycyclic Aromatic Hydrocarbons 2010 (CCME, 2010).

b Site-specific Risk-Based Concentrations (RBCs) were developed by CRA in 2013 (Reference Appendix A)

1 Environment Protection Department (EPD) of the Department of Environment of the GN Tier 1 Criteria for PHC impacts in Surface Soil: As presented in the "Environmental Guideline for Contaminated Site Remediation", Department of Environment, Government of Nunavut, dated April 1999, updated January 2002 and March 2009. The EPD developed this guidance document with reference to the CCME document "Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil", dated 2001, updated in 2008. The PHC standards are consistent between the two guidance documents. The surface soil depth relates to any soil sample collected less than 1.5 metres below ground surface (m BGS).

1.0 Exceeds RBC and requires risk management measures.

- No value

TABLE 2

ANALYTICAL RESULTS - GROUNDWATER SAMPLES
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Sample Location:						*TP06*	*TP12*
Sample Date:						*7/23/2013*	*7/23/2013*
Parameters	*Units*	*CCME [1] Short Term a*	*CCME [1] Long Term b*	*MOE Table 3 c*	*RBCs d*		
Volatiles							
1,1,1,2-Tetrachloroethane	µg/L	-	-	3.3	-	ND(0.50)	ND(0.50)
1,1,1-Trichloroethane	µg/L	-	-	640	-	ND(0.20)	ND(0.20)
1,1,2,2-Tetrachloroethane	µg/L	-	-	3.2	-	ND(0.50)	ND(0.50)
1,1,2-Trichloroethane	µg/L	-	-	4.7	-	ND(0.50)	ND(0.50)
1,1-Dichloroethane	µg/L	-	-	320	-	ND(0.20)	ND(0.20)
1,1-Dichloroethene	µg/L	-	-	1.6	-	ND(0.20)	ND(0.20)
1,2-Dibromoethane (Ethylene dibromide)	µg/L	-	-	0.25	-	ND(0.20)	ND(0.20)
1,2-Dichlorobenzene	µg/L	-	0.7	4600	-	ND(0.50)	ND(0.50)
1,2-Dichloroethane	µg/L	-	100	1.6	-	ND(0.50)	ND(0.50)
1,2-Dichloropropane	µg/L	-	-	16	-	ND(0.20)	ND(0.20)
1,3-Dichlorobenzene	µg/L	-	150	9600	-	ND(0.50)	ND(0.50)
1,4-Dichlorobenzene	µg/L	-	26	8	-	ND(0.50)	ND(0.50)
2-Butanone (Methyl ethyl ketone) (MEK)	µg/L	-	-	470000	-	ND(10)	ND(10)
4-Methyl-2-pentanone (Methyl isobutyl ketone) (MIBK)	µg/L	-	-	140000	-	ND(5.0)	ND(5.0)
Acetone	µg/L	-	-	130000	-	ND(10)	ND(10)
Benzene	µg/L	-	370	44	-	ND(0.20)	ND(0.20)
Bromodichloromethane	µg/L	-	-	85000	-	ND(0.50)	ND(0.50)
Bromoform	µg/L	-	-	380	-	ND(1.0)	ND(1.0)
Bromomethane (Methyl bromide)	µg/L	-	-	5.6	-	ND(0.50)	ND(0.50)
Carbon tetrachloride	µg/L	-	13.3	0.79	-	ND(0.20)	ND(0.20)
Chlorobenzene	µg/L	-	1.3	630	-	ND(0.20)	ND(0.20)
Chloroform (Trichloromethane)	µg/L	-	1.8	2.4	-	ND(0.20)	ND(0.20)
cis-1,2-Dichloroethene	µg/L	-	-	1.6	-	ND(0.50)	ND(0.50)
cis-1,3-Dichloropropene	µg/L	-	-	-	-	ND(0.30)	ND(0.30)
Dibromochloromethane	µg/L	-	-	82000	-	ND(0.50)	ND(0.50)
Dichlorodifluoromethane (CFC-12)	µg/L	-	-	4400	-	ND(1.0)	ND(1.0)
Ethylbenzene	µg/L	-	90	2300	-	ND(0.20)	ND(0.20)
Hexane	µg/L	-	-	51	-	ND(1.0)	ND(1.0)
m&p-Xylenes	µg/L	-	-	-	-	ND(0.20)	ND(0.20)
Methyl tert butyl ether (MTBE)	µg/L	-	10000	190	-	ND(0.50)	ND(0.50)
Methylene chloride	µg/L	-	98.1	610	-	ND(2.0)	ND(2.0)
o-Xylene	µg/L	-	-	-	-	ND(0.20)	ND(0.20)
Styrene	µg/L	-	72	1300	-	ND(0.50)	ND(0.50)
Tetrachloroethene	µg/L	-	110	1.6	396	0.58	ND(0.20)
Toluene	µg/L	-	2	18000	-	ND(0.20)	ND(0.20)
trans-1,2-Dichloroethene	µg/L	-	-	1.6	-	ND(0.50)	ND(0.50)
trans-1,3-Dichloropropene	µg/L	-	-	-	-	ND(0.40)	ND(0.40)
Trichloroethene	µg/L	-	21	1.6	-	ND(0.20)	ND(0.20)
Trichlorofluoromethane (CFC-11)	µg/L	-	-	2500	-	ND(0.50)	ND(0.50)
Vinyl chloride	µg/L	-	-	0.5	-	ND(0.20)	ND(0.20)
Xylenes (total)	µg/L	-	-	4200	-	ND(0.20)	ND(0.20)
Semi-volatiles							
2-Methylnaphthalene	µg/L	-	-	1800	164	0.066 J	0.12 J
Acenaphthene	µg/L	-	5.8	600	2048	0.31 J	ND(0.02) J
Acenaphthylene	µg/L	-	-	1.8	1029	0.032 J	ND(0.02) J
Acridine	µg/L	-	4.4	-	353	0.14 J	ND(0.02) J
Anthracene	µg/L	-	0.012	2.4	321	0.36 J	ND(0.02) J
Benzo(a)anthracene	µg/L	-	0.018	4.7	1.0	**2.1 J [d]**	0.03 J
Benzo(a)pyrene	µg/L	-	0.015	0.81	6.6	2.3 J	0.08 J
Benzo(b)fluoranthene/Benzo(j)fluoranthene	µg/L	-	-	0.75	39	3.3 J	0.12 J
Benzo(b)pyridine (Quinoline)	µg/L	-	3.4	-	-	ND(0.02) J	ND(0.05) J
Benzo(c)phenanthrene	µg/L	-	-	-	-	ND(0.3) J	ND(0.02) J
Benzo(e)pyrene	µg/L	-	-	-	6.6	2.0 J	0.30 J
Benzo(g,h,i)perylene	µg/L	-	-	0.2	6.4	1.2 J	0.17 J
Benzo(k)fluoranthene	µg/L	-	-	0.4	150	1.1 J	0.03 J
Chrysene	µg/L	-	-	1	22	1.7 J	0.07 J
Dibenz(a,h)anthracene	µg/L	-	-	0.52	2.6	0.37 J	ND(0.02) J
Fluoranthene	µg/L	-	0.04	130	501	3.3 J	0.09 J
Fluorene	µg/L	-	3	400	733	0.25 J	ND(0.02) J
Indeno(1,2,3-cd)pyrene	µg/L	-	-	0.2	0.096	**1.6 J [d]**	0.07 J
Naphthalene	µg/L	-	1.1	1400	43	0.11 J	0.08 J
Perylene	µg/L	-	-	-	257143	0.54 J	ND(0.02) J
Phenanthrene	µg/L	-	0.4	580	362	1.6 J	0.06 J
Pyrene	µg/L	-	0.025	68	52	2.8 J	0.15 J
Total benzo(a)pyrene equivalents	µg/L	-	-	-	3.9	3.6 J	0.12 J

TABLE 2

ANALYTICAL RESULTS - GROUNDWATER SAMPLES
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Sample Location:						*TP06*	*TP12*
Sample Date:						*7/23/2013*	*7/23/2013*
Parameters	*Units*	*CCME [1] Short Term*	*CCME [1] Long Term*	*MOE Table 3*	*RBCs*		
Metals							
Aluminum (dissolved)	µg/L	-	100	-	-	31 / ND(40)	61 / 270
Antimony (dissolved)	µg/L	-	-	20000	-	ND(0.6)	ND(0.6)
Arsenic (dissolved)	µg/L	-	5	1900	689	0.33	ND(0.2)
Barium (dissolved)	µg/L	-	-	29000	-	ND(10)	ND(10)
Beryllium (dissolved)	µg/L	-	-	67	-	ND(1)	ND(1)
Boron (dissolved)	µg/L	29000	1500	45000	7237	32	35
Cadmium (dissolved)	µg/L	-	-	2.7	-	ND(0.013) / ND(0.013)	ND(0.0058) / ND(0.0058)
Calcium (dissolved)	µg/L	-	-	-	-	65000	39000
Chromium (dissolved)	µg/L	-	-	810	-	ND(1) / ND(10)	ND(1) / ND(10)
Chromium VI (hexavalent) (dissolved)	µg/L	-	1	140	-	ND(1)	ND(1)
Cobalt (dissolved)	µg/L	-	-	66	430	0.36	ND(0.3)
Copper (dissolved)	µg/L	-	2	87	2595	2.5	3.2
Iron (dissolved)	µg/L	-	300	-	-	ND(60)	120
Lead (dissolved)	µg/L	-	1	25	434	0.24	ND(0.2)
Lithium (dissolved)	µg/L	-	-	-	-	ND(20)	ND(20)
Magnesium (dissolved)	µg/L	-	-	-	-	6400	5700
Manganese (dissolved)	µg/L	-	-	-	-	ND(4)	ND(4)
Mercury	µg/L	-	0.026	0.29	0.42	0.06	0.17
Molybdenum (dissolved)	µg/L	-	73	9200	1993	1	4.6
Nickel (dissolved)	µg/L	-	25	490	768	0.81	0.54
Phosphorus (dissolved)	µg/L	-	-	-	-	ND(100)	ND(100)
Potassium (dissolved)	µg/L	-	-	-	-	1500	4600
Selenium (dissolved)	µg/L	-	1	63	478	0.26	ND(0.2)
Silicon (dissolved)	µg/L	-	-	-	-	2700	3200
Silver (dissolved)	µg/L	-	0.1	1.5	-	ND(0.1)	ND(0.1)
Sodium (dissolved)	µg/L	-	-	2300000	-	7400	52000
Strontium (dissolved)	µg/L	-	-	-	-	120	98
Sulfur (dissolved)	µg/L	-	-	-	-	3100	1600
Thallium (dissolved)	µg/L	-	0.8	510	-	ND(0.2)	ND(0.2)
Tin (dissolved)	µg/L	-	-	-	-	ND(1)	ND(1)
Titanium (dissolved)	µg/L	-	-	-	-	ND(1)	1
Uranium (dissolved)	µg/L	33	15	420	248	0.53	1.1
Vanadium (dissolved)	µg/L	-	-	250	-	ND(1)	ND(1)
Zinc (dissolved)	µg/L	-	30	1100	-	ND(3)	ND(3)
PCBs							
Aroclor-1016 (PCB-1016)	µg/L	-	-	-	-	ND(0.01)	ND(0.01)
Aroclor-1221 (PCB-1221)	µg/L	-	-	-	-	ND(0.01)	ND(0.01)
Aroclor-1232 (PCB-1232)	µg/L	-	-	-	-	ND(0.01)	ND(0.01)
Aroclor-1242 (PCB-1242)	µg/L	-	-	-	-	ND(0.01)	ND(0.01)
Aroclor-1248 (PCB-1248)	µg/L	-	-	-	-	ND(0.01)	ND(0.01)
Aroclor-1254 (PCB-1254)	µg/L	-	-	-	-	ND(0.01)	ND(0.01)
Aroclor-1260 (PCB-1260)	µg/L	-	-	-	-	0.03	ND(0.01)
Aroclor-1262 (PCB-1262)	µg/L	-	-	-	-	ND(0.01)	ND(0.01)
Aroclor-1268 (PCB-1268)	µg/L	-	-	-	-	ND(0.01)	ND(0.01)
Total PCBs	µg/L	-	0.001	7.8	0.39	0.03	ND(0.01)
Petroleum Hydrocarbons							
Petroleum hydrocarbons F1 (C6-C10)	µg/L	-	-	750	-	ND(25)	ND(25)
Petroleum hydrocarbons F1 (C6-C10) - less BTEX	µg/L	-	-	750	-	ND(25)	ND(25)
Petroleum hydrocarbons F2 (C10-C16)	µg/L	-	-	150	-	ND(100)	ND(100)
Petroleum hydrocarbons F3 (C16-C34)	µg/L	-	-	500	-	ND(200)	ND(200)
Petroleum hydrocarbons F4 (C34-C50)	µg/L	-	-	500	-	ND(200)	ND(200)
General Chemistry							
Cyanide (total)	µg/L	-	5	66	-	ND(2)	ND(2)
pH, lab	s.u.	-	6.5-9	-	-	7.91	7.92

Notes:

1	Canadian Environmental Quality Guidelines Summary Tables, Water Quality Guidelines for the Protection of Aquatic, Freshwater, dated 1999, updated 2012.
a	Short Term Guidelines
b	Long Term Guidelines
c	Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition (coarse-textured soils), dated April 15, 2011
d	Site-specific Risk-Based Concentrations (RBCs) were developed by CRA in 2013 (Reference Appendix B)
1.0	Exceeds noted standard.
J	Value is estimated.
ND(0.01)	Value was not detected above the laboratory detection limit in brackets.

TABLE 3

ANALYTICAL RESULTS-WASTE CHARACTERIZATION OF DRUM CONTENTS
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Sample Location:				*Drum in Drum Cache 1*
Sample Date:				*7/23/2013*
Parameters	*Units*	*CCME Industrial* [1]	*TCLP O. Reg.* [2]	
VOCs				
1,1,1,2-Tetrachloroethane	µg/g	-	-	ND(0.75)
1,1,1-Trichloroethane	µg/g	50	-	ND(0.75)
1,1,2,2-Tetrachloroethane	µg/g	50	-	ND(0.75)
1,1,2-Trichloroethane	µg/g	50	-	ND(0.75)
1,1-Dichloroethane	µg/g	50	-	ND(0.75)
1,1-Dichloroethene	µg/g	50	-	ND(0.75)
1,2-Dibromoethane (Ethylene dibromide)	µg/g	-	-	ND(0.75)
1,2-Dichlorobenzene	µg/g	10	-	ND(0.75)
1,2-Dichloroethane	µg/g	50	-	ND(0.75)
1,2-Dichloropropane	µg/g	50	-	ND(0.75)
1,3-Dichlorobenzene	µg/g	10	-	ND(0.75)
1,4-Dichlorobenzene	µg/g	10	-	ND(0.75)
2-Butanone (Methyl ethyl ketone) (MEK)	µg/g	-	-	ND(7.5)
4-Methyl-2-pentanone (Methyl isobutyl ketone) (MIBK)	µg/g	-	-	ND(7.5)
Acetone	µg/g	-	-	ND(7.5)
Benzene	µg/g	0.030	-	**1.8**
Bromodichloromethane	µg/g	-	-	ND(0.75)
Bromoform	µg/g	-	-	ND(0.75)
Bromomethane (Methyl bromide)	µg/g	-	-	ND(0.75)
Carbon tetrachloride	µg/g	50	-	ND(0.75)
Chlorobenzene	µg/g	10	-	ND(0.75)
Chloroform (Trichloromethane)	µg/g	50	-	ND(0.75)
cis-1,2-Dichloroethene	µg/g	-	-	ND(0.75)
cis-1,3-Dichloropropene	µg/g	-	-	ND(0.45)
Dibromochloromethane	µg/g	-	-	ND(0.75)
Dichlorodifluoromethane (CFC-12)	µg/g	-	-	ND(0.75)
Ethylbenzene	µg/g	0.082	-	**69**
Hexane	µg/g	6.5	-	**19**
m&p-Xylenes	µg/g	-	-	380
Methyl tert butyl ether (MTBE)	µg/g	-	-	ND(0.75)
Methylene chloride	µg/g	50	-	ND(0.75)
o-Xylene	µg/g	-	-	130
Styrene	µg/g	50	-	ND(0.75)
Tetrachloroethene	µg/g	0.6	-	ND(0.75)
Toluene	µg/g	0.37	-	**25**
trans-1,2-Dichloroethene	µg/g	-	-	ND(0.75)
trans-1,3-Dichloropropene	µg/g	-	-	ND(0.60)
Trichloroethene	µg/g	0.01	-	ND(0.15)
Trichlorofluoromethane (CFC-11)	µg/g	-	-	ND(0.75)
Vinyl chloride	µg/g	-	-	ND(0.30)
Xylenes (total)	µg/g	11	-	**520**
VOCs - TCLP				
1,1-Dichloroethene	mg/L	-	1.4	ND(0.020)
1,2-Dichlorobenzene	mg/L	-	20	ND(0.050)
1,2-Dichloroethane	mg/L	-	0.5	ND(0.050)
1,4-Dichlorobenzene	mg/L	-	0.5	ND(0.050)
2-Butanone (Methyl ethyl ketone) (MEK)	mg/L	-	200	ND(1.0)
Benzene	mg/L	-	0.5	ND(0.020)
Carbon tetrachloride	mg/L	-	0.5	ND(0.020)
Chlorobenzene	mg/L	-	8	ND(0.020)
Chloroform (Trichloromethane)	mg/L	-	10	ND(0.020)
Methylene chloride	mg/L	-	5	ND(0.20)
Tetrachloroethene	mg/L	-	3	ND(0.020)
Trichloroethene	mg/L	-	5	ND(0.020)
Vinyl chloride	mg/L	-	0.2	ND(0.020)
Polycyclic Aromatic Hydrocarbons (PAHs)				
1-Methylnaphthalene	µg/g	-	-	390
2-Methylnaphthalene	µg/g	-	-	650
Acenaphthene	µg/g	-	-	33
Acenaphthylene	µg/g	-	-	ND(1)
Anthracene	µg/g	32	-	ND(1)
Benzo(a)anthracene	µg/g	-	-	ND(2)
Benzo(a)pyrene	µg/g	72	-	ND(1)
Benzo(b)fluoranthene/Benzo(j)fluoranthene	µg/g	-	-	ND(2)
Benzo(g,h,i)perylene	µg/g	-	-	ND(4)
Benzo(k)fluoranthene	µg/g	-	-	ND(2)
Chrysene	µg/g	-	-	ND(2)
Dibenz(a,h)anthracene	µg/g	-	-	ND(4)
Fluoranthene	µg/g	180	-	ND(1)
Fluorene	µg/g	-	-	22
Indeno(1,2,3-cd)pyrene	µg/g	-	-	ND(4)
Naphthalene	µg/g	-	-	240
Phenanthrene	µg/g	-	-	10
Pyrene	µg/g	-	-	ND(1)

TABLE 3

ANALYTICAL RESULTS-WASTE CHARACTERIZATION OF DRUM CONTENTS
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Sample Location:				*Drum in Drum Cache 1*
Sample Date:				*7/23/2013*
Parameters	*Units*	*CCME Industrial* [1]	*TCLP O. Reg.* [2]	
PAHs - TCLP				
2,3,4,6-Tetrachlorophenol	mg/L	-	10	ND(0.025)
2,4,5-Trichlorophenol	mg/L	-	400	ND(0.005)
2,4,6-Trichlorophenol	mg/L	-	0.5	ND(0.025)
2,4-Dichlorophenol	mg/L	-	90	ND(0.025)
2-Methylphenol	mg/L	-	200	0.029
3&4-Methylphenol	mg/L	-	-	0.098
Benzo(a)pyrene	mg/L	-	0.001	ND(0.001)
Hexachlorobenzene	mg/L	-	0.13	ND(0.1)
Hexachloroethane	mg/L	-	3	ND(0.1)
Nitrobenzene	mg/L	-	2	ND(0.1)
Pentachlorophenol	mg/L	-	6	ND(0.025)
Pyridine	mg/L	-	5	ND(0.1)
Total Cresol (reported not calculated)	mg/L	-	-	0.13
Metals - TCLP				
Arsenic	mg/L	-	2.5	ND(0.2)
Barium	mg/L	-	100	ND(0.2)
Boron	mg/L	-	500	ND(0.1)
Cadmium	mg/L	-	0.5	ND(0.05)
Chromium	mg/L	-	5	ND(0.1)
Lead	mg/L	-	5	ND(0.1)
Mercury	mg/L	-	0.1	ND(0.001)
Selenium	mg/L	-	1	ND(0.1)
Silver	mg/L	-	5	ND(0.01)
Uranium	mg/L	-	10	ND(0.01)
PCBs				
Aroclor-1016 (PCB-1016)	µg/g	-	-	ND(1)
Aroclor-1221 (PCB-1221)	µg/g	-	-	ND(1)
Aroclor-1232 (PCB-1232)	µg/g	-	-	ND(1)
Aroclor-1242 (PCB-1242)	µg/g	-	-	ND(1)
Aroclor-1248 (PCB-1248)	µg/g	-	-	ND(1)
Aroclor-1254 (PCB-1254)	µg/g	-	-	ND(1)
Aroclor-1260 (PCB-1260)	µg/g	-	-	ND(1)
Aroclor-1262 (PCB-1262)	µg/g	-	-	ND(1)
Aroclor-1268 (PCB-1268)	µg/g	-	-	ND(1)
Total PCBs	µg/g	33	-	ND(1)
Petroleum Hydrocarbons				
Petroleum hydrocarbons F1 (C6-C10)	µg/g	-	-	8200
Petroleum hydrocarbons F1 (C6-C10) - less BTEX	µg/g	-	-	7800
Petroleum hydrocarbons F2 (C10-C16)	µg/g	-	-	97000
Petroleum hydrocarbons F3 (C16-C34)	µg/g	-	-	90000
Petroleum hydrocarbons F4 (C34-C50)	µg/g	-	-	130000
Gravimetric heavy hydrocarbons (F4G)	µg/g	-	-	500000
General Chemistry				
Initial pH	s.u.			7.20
Final pH	s.u.			4.93
Ignitability	none			NI
Percent solids, vol.	%			100

Notes:

1 Canadian Council of Ministers of the Environment (CCME) Tier 1 Industrial Guidelines: As presented in "Canadian Environmental Quality Guidelines Summary Tables, Soil Land Industrial Use", Quality Guidelines for the Protection of Environmental and Human Health, dated 1999, updated 2011 (CCME, 2011). CCME has recently updated their Soil Quality Guidelines (SQGs) for some polycyclic aromatic hydrocarbons (PAHs), as presented in Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health- Polycyclic Aromatic Hydrocarbons 2010 (CCME, 2010).

2 Ontario Regulation 347- General Waste Management, Schedule 4, Leachate Quality Criteria

1.0 Exceeds CCME Tier 1 Standards.

- No value

TABLE 4

REMEDIAL OPTION MATRIX
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Item	*Waste Streams To Be Managed*	*Location*	*Remedial Options*	*Estimated Waste Volume (m^3)*	*Selected Option*	*Assumptions/Comments*
1	Drums containing tar product	Drum Cache - adjacent to Former Asphalt Plant	Place in On-Site Waste Containment Cell	175	Place in On-Site Waste Containment Cell	Assume 300-55 gallon steel drums. Drums will be placed in containment cell in as is condition and will not be crushed. Assume that the drums are 0.597 m in diameter and 0.876 m in height. For volume calculations, assume a rectangular prism using these two dimensions as length, width and height. Based on this, 1-55-gallon drum will make up 0.876x0.597x0.597 = 0.32 m^3. Therefore, 300-55-gallon drums will make up approximately 96 m^3. Plus, include 50,000 litre tank. From site photographs, and research of 50,000 L tank dimensions, assume tank is 3.2 m diameter x 7.32 m in length. Assume rectangular prism - 3.2x3.2x7.32 = 75 m^3
			Place in secure container for off-Site disposal			
2	Soil impacted with ethylbenzene	Drum Cache - adjacent to Former Asphalt Plant	Place in On-Site Waste Containment Cell	135	Place in On-Site Waste Containment Cell (Co-dispose with drums)	Assume 30 m x 30 m area of impacted soil in the vicinity of drums. Assume strip top 0.15 m of soil. Therefore total volume = 0.15x30x30 = 135 m^3 of soil to be co-disposed of with drums to fill void space.
			Place in secure container for off-Site disposal			
3	Tar product on ground surface	Drum Cache - adjacent to Former Asphalt Plant	Place in On-Site Waste Containment Cell	Included in Item 2 above.	Place in On-Site Waste Containment Cell	Excavation volume included in "soil impacted with ethylbenzene" area.
			Place in secure container for off-Site disposal			
4	PHC-impacted soil	TP24, LTU1, and LTU2 located within Former Fire Training Area	Place as fill under new asphalt areas	4,950	Place as fill in Project works	Assume 10m x 10m x1mbgs excavation = 100 m^3 in the vicinity of TP24. LTU1 = (1.5 m thick soil + 0.15mbgs) x 2,500 m2 area = 4,125 m^3. LTU2 = (1 m thick soil +0.15 mbgs) x 1,250 m^2 area (although only half area is impacted) = 7,19 m^3.
			Place in On-Site Waste Containment Cell			
5	Arsenic-impacted soil	Adjacent to runway	Place as fill under new asphalt areas	100	Place as fill in Project works	Assume 10 m x 10 m x 1 mbgs excavation = 100 m^3.
			Place in On-Site Waste Containment Cell			
6	PAH-impacted perched groundwater	TP6, south of Arctic College	Direct ground discharge	Waste volume not applicable to containment cell.	Treatment followed by ground discharge	Treatment via granular activated carbon.
			Treatment followed by ground discharge			
7	Building Materials - Asbestos, lead, mercury, PCBs (1)	T-25, T-116, T-120 (Buildings)	Place in secure container for off-Site disposal	Waste volume not applicable to containment cell.	Place in secure container for off-Site disposal	
			Total Waste Materials	5,360		

Notes:

PHC Petroleum Hydrocarbons
PAH Polycyclic Aromatic Hydrocarbons
PCBs Polychlorinated Biphenyls
(1) CRA has been advised by Arctic Infrastructure Partners that all designated substances removed from the buildings will be shipped off Site.

TABLE 5

DESIGNATED SUBSTANCE DISPOSAL FACILITY OPTIONS
PRE-EXISTING ENVIRONMENTAL CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

	Disposal Facility				
	Horizon Environmental Inc. [1]	*Stablex* [2]	*Newalta Corporation* [3]	*Veolia Environmental Services* [4]	*Sanexan Environmental Services* [5]
Waste Stream	***Landfill***	***Waste Treatment Station and Waste Broker***	***Waste Transfer and Treatment Station***	***Waste Transfer and Treatment Station***	***Waste Broker***
PCB light ballasts	Not Acceptable	Material can be managed and brokered to another facility	Acceptable	Acceptable	Acceptable
Mercury Fluorscent Lights	Not Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Lead paint in demolition debris	Acceptable; only if mixed in soil - soil must be greater than 50% of the mixture	Acceptable	Acceptable	Acceptable	Acceptable
Abestos in demolition debris	Acceptable; only if mixed in soil - soil must be greater than 50% of the mixture	Material can be managed and brokered to another facility	Acceptable	Acceptable	Acceptable

Notes:

1 Horizon Environmental Inc. is located at 120 Route 155, Grandes-Piles, Quebec, G0X 1H0

2 Stablex is located at 760 Industrial Boulevard, Blainville, Quebec, J7C 3V4

3 Newalta Corporation has various waste transfer and treatment stations located throughout Quebec.

4 Veolia Environmental Services treatment station is located at 787, boul de la Chaudière, Québec, G1X 4B8

5 Sanexan Environmental Services is a waste broker and does not own a disposal, treatment or transfer station

TABLE 6A

INDICATIVE CMP COSTS - SELECTED OPTIONS
PRE-EXISTING CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT, IQALUIT, NUNAVUT

AIP/GN Remediation Items	*Estimated Cost*
1) Pre-construction Verification and Delineation Sampling	$50,000.00
2) Project Health and Safety Program	$50,000.00
3) Remediation of Drum Cache Area	$65,000.00
4) Remediation of Fire Training Area (PHC-Impacted Soil)	$70,000.00
5) Remediation of Arsenic-Impacted Soil	$5,000.00
6) Treatment of PAH-impacted Groundwater	$40,000.00
7) Construction of On-Site Waste Containment Cell	$115,000.00
8) Temporary Stockpile Securement	$40,000.00
Subtotal	**$435,000.00**
Contractor Bonds & Insurance, Mobilization and Profit (20%)	$87,000.00
Engineering & Approvals (15%)	$65,250.00
Subtotal	**$587,250.00**
Project Contingency (25%)	$146,812.50
Total (excluding applicable taxes)	**$734,062.50**

TABLE 6B

INDICATIVE CMP COSTS - ALTERNATIVE REMEDIAL OPTIONS
PRE-EXISTING CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

AIP/GN Remediation Items	*Estimated Cost*	*Note*
1) Pre-construction Verification and Delineation Sampling	$50,000	
2) Project Health and Safety Program	$50,000	
3) Remediation of Drum Cache Area		(1)
4) Remediation of Fire Training Area (PHC-Impacted Soil)	$70,000	
5) Remediation of Arsenic-Impacted Soil	$5,000	
6) Treatment of PAH-impacted Groundwater	$40,000	
7) Construction of On-Site Waste Containment Cell	$570,000	
8) Temporary Stockpile Securement	$40,000	
Subtotal	**$825,000**	
Contractor Bonds & Insurance, Mobilization and Profit (20%)	$165,000	
Engineering & Approvals (15%)	$123,750	
Subtotal	**$1,113,750**	
Project Contingency (25%)	$278,438	
Total (excluding applicable taxes)	**$1,392,188**	

Notes:

(1) Costs for the remediation of the Drum Cache Area are based on transportation of waste streams from Iqaluit, Nunavu to licensed disposal facility located in Quebec. CRA is currently awaiting preliminary transportation and disposal pricing from a licensed facility. The cost for this alternative remedial option will be significantly higher than the cost included in Table 6A for the drum cache area. CRA will provide the costs to AIP upon receipt.

TABLE 7

INDICATIVE CMP SCHEDULE
PRE-EXISTING CONTAMINATION MANAGEMENT PLAN
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Task	*Duration* [1]	*Start Date*	*End Date*	*Constraints*
1) Obtain Environmental Protection Department's Concurrence on RBCs[2]	20 days	7-Feb-14	7-Mar-14	To commence upon receiving GN's approval of the CMP.
2) Pre-Construction Verification and Delineation Sampling, Including Sample Analysis[3]	15 days	2-Jun-14	21-Jun-14	
3) Construct On-Site Waste Containment Cell	7 days	23-Jun-14	1-Jul-14	Prior to starting remediation of Drum Cache.
4) Remediation of Drum Cache Area	11 days	1-Jun-15	16-Jun-15	Prior to construction of North Commercial Road.
5) Remediation of Fire Training Area (Land Treatment Units) and Arsenic-impacted Soil[4]	12 days	1-Jul-14	15-Jul-14	Prior to excavation of Apron I expansion, Taxiways A and G.
6) Treatment of PAH-impacted Groundwater[5]	10 days	15-Jul-14	30-Jul-14	Prior to construction of arch culvert under ATB parking lot.

Notes:

(1) Based on current estimated waste quantities

(2) To be commenced upon approval of CMP by GN

(3) To be commenced once AIP has demarcated the limits of the Project works. Assumes soil and groundwater samples will be analyzed on an expedited turn-around-time.

(4) Duration is for time required to excavate and stockpile and is not reflection of time to use material in Project works.

(5) Schedule is dependant on when AIP will be excavating within the vicinity of test pit TP06 and how long the excavation will remain open. 4 days allocated for commissioning, 6 days for operation and treatment.

APPENDIX A

DEVELOPMENT OF SOIL RISK-BASED CONCENTRATIONS

CONESTOGA-ROVERS & ASSOCIATES

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MEMORANDUM

TO:	Lindsay Shepherd	REF. NO.:	082415
	NK		
FROM:	Nicole Knezevich/Vincent Nero/ac/2	DATE:	August 29, 2013
RE:	**Development of Soil Risk-Based Concentrations Iqaluit International Airport Iqaluit, Nunavut**		

1.0 INTRODUCTION

Conestoga-Rovers & Associates (CRA) has prepared this memorandum to present the development of Risk-Based Concentrations (RBCs) for soil for the Iqaluit International Airport located in Iqaluit, Nunavut (Property or Site). These soil RBCs are considered to be protective of human and/or ecological receptors that may potentially be in contact with soil at the Site. Where soil concentrations are greater than the soil RBCs, the impacted soil could be remediated, or managed in such a way to prevent detrimental exposure from occurring.

2.0 DEVELOPMENT OF SOIL RBCs

This section presents the methodology for the development of soil RBCs that are protective of human and ecological receptors.

RBCs were identified/calculated for the parameters identified in Section 2.1, and for the following potential exposure pathways:

- Commercial worker direct contact (incidental ingestion and dermal contact) with soil– Section 2.2
- Commercial worker inhalation of vapours (indoor air)– Section 2.3
- Construction/utility worker direct contact (incidental ingestion, dermal contact, and ambient air inhalation) with soil – Section 2.4
- Trespasser direct contact (incidental ingestion, dermal contact, and ambient air inhalation) with soil – Section 2.4
- Plants and soil organisms direct contact with soil – Section 2.5

2.1 SOIL PARAMETERS

Soil samples collected from the Site during test pitting activities (July 2013) and during decommissioning of a land treatment unit (July 2011), identified the presence of petroleum hydrocarbons (PHCs), arsenic, and naphthalene at concentrations greater than the Canadian Council of Ministers of the Environment (CCME)

Tier 1 Industrial Guidelines (CCME, 2010; 2011). Soil RBCs have been identified/calculated for all parameters that exceeded the CCME Tier 1 Industrial Guidelines.
Soil RBCs were identified/calculated for the parameters summarized below:

- Arsenic
- Naphthalene
- PHC F2
- PHC F3

2.2 COMMERCIAL WORKER DIRECT CONTACT WITH SOIL

The RBCs for the commercial worker direct contact (incidental ingestion and dermal contact) with soil were obtained directly from CCME (1997; 2008; 2010). For arsenic, the soil quality guideline for human health for commercial land use (CCME, 1997), which is based on a soil ingestion guideline value, was applied after being adjusted to an incremental cancer risk of 1.0E-05 (Health Canada, 2012a). As CCME (2010) has not derived soil quality guidelines for human health for direct contact (ingestion, inhalation, and dermal exposure) for non-carcinogenic PAHs, no value was available for naphthalene. For PHC F2 and F3, the Direct Contact (ingestion and dermal contact) Tier 1 Levels for coarse-grained soil and commercial land use (CCME, 2008) were applied.

2.3 COMMERCIAL WORKER INHALATION OF VAPOURS (INDOOR AIR)

For PHC F2, the Vapour Inhalation (indoor) Tier 1 Level for coarse-grained soil and commercial land use was applied as the RBC for the commercial worker inhalation of vapours via indoor air. As CCME (2010) has not derived soil quality guidelines for human health for protection of indoor air quality for non-carcinogenic PAHs, no value was available for naphthalene. As arsenic and PHC F3 are not considered to be volatile this exposure pathway is not applicable. Therefore, no soil RBCs were applied for arsenic and PHC F3 for the inhalation of vapours via indoor air.

2.4 CONSTRUCTION/UTILITY WORKER AND TRESPASSER

As there are no CCME soil guidelines available for the construction/utility worker or trespasser, RBCs were developed for these receptors. The construction/utility worker is assumed to be an adult conducting ground intrusive activities (i.e., during maintenance of a subsurface utility) at the Site for 8 hours/day, 6 days/week for 13 weeks/year. The construction/utility worker could potentially be exposed to soil through incidental ingestions and dermal contact with exposed skin on the hands, arms, and legs. In addition, inhalation of volatile parameters in ambient air emitted from soil or parameters within windblown particulates could also occur during work completed in the immediate vicinity of the excavation.

The trespasser is assumed to be a teenager trespassing on the Site for 2 hours/day, 2 days/week for 35 weeks/year. The trespasser may be exposed to soil through incidental ingestion and dermal contact through exposed skin on the hands, arms, and legs. The trespasser may also be exposed to volatile compounds in the ambient air or parameters within windblown particles.

The RBCs developed for the construction/utility worker and trespasser incidental ingestion, dermal contact, and inhalation exposure to soil were derived based on the following equations. For each

parameter, two risk-based concentrations were initially developed if toxicity data was available: one protective of carcinogenic health impacts and a second protective of non-carcinogenic health impacts. The RBC for each particular exposure pathway was determined to be the lower value between carcinogenic and non-carcinogenic health impacts.

Carcinogenic Endpoint:

$$RBC_{soil} = \frac{TR \times ATc}{EF \times ED \times (((CSF \times IR \times CF \times RAFo)/BW) + (CSF \times SA \times AF \times CF \times RAFd)/BW) + (URF \times ET \times (VF \text{ or } PEF)))}$$

Non-Carcinogenic Endpoint:

$$RBC_{soil} = \frac{THQ \times ATnc}{EF \times ED \times ((((1/RfD) \times IR \times CF \times RAFo)/BW) + ((1/RfD) \times SA \times AF \times CF \times RAFd)/BW) + ((1/RfC) \times ET \times (VF \text{ or } PEF)))}$$

Where:

RBC_{soil} = Risk-Based Concentration in soil based on oral, dermal, and inhalation exposure (mg/kg)
TR = Target Cancer Risk
THQ = Target Hazard Quotient
BW = Body Weight (kg)
CF = Conversion factor (kg/mg)
CSF = Cancer Slope Factor - dermal - chemical-specific $(mg/kg/day)^{-1}$
URF = Inhalation Unit Risk Factor – chemical-specific $(mg/m^3)^{-1}$
RfD = Reference Dose Factor - dermal - chemical-specific (mg/kg/day)
RfC = Reference Concentration – inhalation – chemical-specific (mg/m^3)
IR = Ingestion rate (mg/day)
$RAFo$ = Relative Absorption Factor – Oral (% /100)
SA = Surface Area Exposed (cm^2)
AF = Adherence Factor (mg/cm^2)
$RAFd$ = Relative Absorption Factor – Dermal (% /100)
ET = Exposure Time – inhalation (hours/24 hours)
VF = Volatilization Factor – inhalation - chemical-specific (L/m^3)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
ATc = Averaging Time – carcinogen (days)
$ATnc$ = Averaging Time - non-carcinogen (days)
PEF = Particulate Emission Factor (kg/m^3)

The receptor-specific exposure assumptions for the construction/utility worker and trespasser applied in the derivation of the soil RBCs are summarized in the table below.

Parameter	*Receptor Characteristics*		*Reference*
	Construction/Utility Worker	*Trespasser*	
Ingestion Rate (IR)	100 mg/day	20 mg/day	Health Canada, 2012a
Relative Absorption Factor – Oral	Chemical-specific		Health Canada, 2010
Surface Area Exposed - adult	5,000 cm^2/day (1)	4,400 cm^2/day (2)	Health Canada, 2012a
Adherence Factor	0.1 mg/cm^2 (hands) 0.01 mg/cm^2 (rest of body)		Health Canada, 2012a
Relative Absorption Factor – Dermal	Chemical-specific		Health Canada, 2010
Exposure Frequency (EF)	78 days/year (3)	70 days/year (4)	Professional Judgment
Exposure Duration (ED)	1 year (5)	8 years	Professional Judgment; Health Canada, 2012a
Exposure Time (ET)– Inhalation	8 hours/24 hours	2 hours/24 hours (6)	Health Canada, 2012a; Professional Judgment
Body Weight (BW)	70.7 kg	59.7 kg	Health Canada, 2012a
Conversion Factor (CF)	1.0E-06 kg/mg		--
Averaging Time (cancer) (ATc)	21,900 days (7)	29,200 days (8)	Health Canada, 2012a
Averaging Time (non-cancer) (ATnc)	365 days	2,920 days	Health Canada, 2012a
Particulate Emission Factor (PEF)	2.50E-07 kg/m^3	7.60E-10 kg/m^3	Health Canada, 2012a
Volatilization Factor (VF)	Chemical-specific		Refer to Tables 2 and 4

Notes:

(1) Skin surface area includes hands (890 cm^2), lower arms (2500/2 cm^2), and lower legs (5720/2 cm^2).
(2) Skin surface area includes hands (800 cm^2), lower arms (2230/2 cm^2), and lower legs (4970/2 cm^2).
(3) Professional Judgment; 6 days per week for 13 weeks per year.
(4) Professional Judgment; 2 days per week for 35 weeks per year.
(5) Professional Judgment; assumes construction campaign to occur over a 1-year period.
(6) Professional Judgment; assumes that the trespasser would be at the Site 2 hours per day.
(7) Averaging time is for the duration of adulthood (60 years).
(8) Averaging time is the lifetime expectancy (80 years).

Table 1 presents the derivation of the pathway-specific RBCs for the construction/utility worker direct contact (incidental ingestion, dermal contact, and inhalation) exposure to soil, which have been summarized in Section 3.0. Table 3 presents the derivation of the pathway-specific RBCs for the trespasser direct contact (incidental ingestion, dermal contact, and inhalation) exposure to soil.

The inhalation of compounds within vapour originating from soil is modelled through the use of a VF to estimate ambient air concentrations based on the soil concentration. The VF is chemical-specific and was calculated using the approach presented by USEPA (2002). Chemical specific properties were obtained from CCME (2008; 2010), with MOE (2011) used as a secondary source. The VFs used in the calculation of inhalation exposure to soil in ambient air for the construction/utility worker and the trespasser are presented in Tables 2 and 4, respectively.

The toxicity values used in the calculation of the soil RBCs included cancer slope factors (CSFs) and unit risk factors (URFs) for carcinogenic effects, and chronic reference doses (RfDs) and reference concentrations (RfCs) for non-carcinogenic effects. All toxicity values were obtained from Health Canada (2010) and CCME (2008) for the PHCs. For naphthalene, a proposed residential indoor air quality guideline was applied as the RfC (Health Canada, 2012b). The human health RBCs are calculated using an acceptable cancer risk target level (10^{-5}, or one in a hundred thousand) and non-cancer hazard target level (0.2 or 0.5 for PHCs) (Health Canada, 2012a; CCME, 2008).

2.5 PLANTS AND SOIL ORGANISMS

The RBCs for the ecological receptors direct soil contact were obtained directly from CCME (1997; 2008; 2010). For arsenic, the soil quality guideline for environmental health for commercial land use (CCME, 1997) was applied. For PHC F2 and F3, Ecological Soil Contact Tier 1 Levels for coarse-grained surface soil from CCME (2008) were applied. For naphthalene, the provisional soil quality guideline for the protection of environmental health (CCME, 2010) was applied.

3.0 SUMMARY OF SOIL RBCs

The soil RBCs are presented in Table 5 and summarized in the table below. The final soil RBC represents the lower of the pathway-specific RBCs calculated for the human health receptors (commercial worker, construction worker, and trespasser) and the ecological receptors. The maximum soil concentration of each parameter was compared to the final RBC.

Parameter	*Human Health RBC (µg/g)*	*Ecological RBC (µg/g)*	*Final Soil RBC (1) (µg/g)*	*Maximum Soil Concentration (mg/kg)*	*Risk Management Measures Required*
Arsenic	**31**	**26**	**26**	**100**	**Yes**
Naphthalene	1,951	22	22	0.26	No
PHC F2	**1,700**	**260**	**260**	**3,000**	**Yes**
PHC F3	**23,000**	**1,700**	**1,700**	**2,300**	**Yes**

Notes:

Bold, Maximum soil concentration exceeds the final soil RBC

(1) Final RBC is the lowest of the human and ecological RBCs.

The maximum concentration of arsenic, PHC F2, and PHC F3 exceed the final soil RBCs, as a result, the impacted soil must be managed in such a way to prevent detrimental exposure from occurring through the following pathways:

- Commercial worker direct contact (incidental ingestion and dermal contact) with soil
- Commercial worker inhalation of vapours (indoor air)
- Plants and soil organisms direct contact with soil

4.0 RISK MANAGEMENT MEASURES

In 2011, a land treatment unit (LTU) was partially decommissioned at the Iqaluit Airport. PHC-impacted soil from the LTU was excavated and relocated into two adjacent LTUs, also containing PHC-impacted soil. Recent test pitting activities also identified the presence of arsenic-impacted soil adjacent to the airport runway. Proposed improvements to the airport include the construction of a taxiway through the area where the partially decommissioned and existing LTUs are located and installation of a utility corridor adjacent to the runway. As such, the LTUs must be decommissioned and the arsenic and PHC-impacted soil must be managed. It is proposed that the arsenic and PHC-impacted soil will be used as fill during the airport improvement activities. However, as several parameters exceed their respective final soil RBCs, the soils must be managed to prevent exposure from occurring.

Soil Management

If these impacted soils are excavated and temporarily stockpiled pending future re-use, these impacted soils will need to be managed to prevent exposure. In these instances, excavated impacted soils should be placed in a designated area. The stockpiles should be located away from publicly accessible areas, other than those of a very temporary nature (less than 48 hours). Stockpiled soils should be covered for dust control and to prevent impact to storm water runoff. Stockpiled soils should be placed on a liner, if practical, to prevent leaching to the subsurface. It is also recommended that fencing be placed around these stockpiled soils and signs put up to prevent unauthorized access.

Soil Cover

Arsenic, PHC F2, and PHC F3 exceeded the pathway specific RBCs for commercial workers and ecological receptors for direct contact with soil. As a result, soil excavated from the vicinity of TP15, LTU-1, LTU-2, TP24, LTU-BOTTOM 6, LUT-BOTTOM 8, LTU-WEST 1, and LTU-EAST 1 could be reused at the Site as long as they are maintained under a soil cover. This soil cover may consist of a hard cap, such as asphalt or concrete (i.e., taxi pavement or runways) or a clean fill cap.

Inhalation of Vapours (Indoor Air)

PHC F2 exceeded the pathway specific RBC for the commercial worker inhalation of vapours via indoor air. As a result, soil excavated from the vicinity of LTU-2 should not be used as fill under a building or within 30 metres of any building.

5.0 REFERENCES

CCME, 1997. Canadian soil quality guidelines for the protection of environmental and human health: Arsenic (inorganic). Updated In: 1999.

CCME, 2008. Canada-Wide Standards for Petroleum Hydrocarbons (PHCs) in Soil: Scientific Rationale. Supporting Technical Document. January 2008.

CCME, 2010. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health – Polycyclic Aromatic Hydrocarbons.

CCME, 2011. Canadian Environmental Quality Guidelines for the Protection of Environmental and Human Health, Summary Tables – Soil, Land Industrial Use.

Health Canada, 2010. Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0, September 2010.

Health Canada, 2012a. Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0, September 2012.

Health Canada, 2012b. Public Consultation on Proposed Residential Indoor Air Quality Guideline for Naphthalene. December 2012.

Biogenie, 2012. Land Treatment Unit Decommissioning, Iqaluit Airport.

MOE, 2011. Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario, April 15, 2011.

USEPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Office of Emergency and Remedial Response. OSWER 9355.4-24, December 2002.

TABLE 1

DERIVATION OF RISK-BASED CONCENTRATIONS IN SOIL - CONSTRUCTION/UTILITY WORKER ORAL, DERMAL, AND INHALATION EXPOSURE
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

	CSF		URF	RfD		RfC		Relative Absorption Factor			Construction/ Utility Worker RBCs			Risk-Based Concentrations
	oral	dermal	inhalation	oral	dermal	inhalation		Oral	Dermal	VF	Cancer	Non-Cancer		RBC_{soil} (1)
Parameters	*1/(mg/kg-d)*	*1/(mg/kg-d)*	*1/(mg/kg-d)*	*(mg/kg-d)*	*(mg/kg-d)*	*(mg/m^3)*		*(%/100)*	*(%/100)*	*(kg/m^3)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*
Metals														
Arsenic	1.80E+00	1.80E+00	6.40E+00	--	--	--		1	0.03	NA	8.83E+02	NV		883
PAHs														
Naphthalene	--	--	--	2.00E-02	2.00E-02	1.00E-02	(2)	1	0.148	1.51E-04	NV	6.28E+03		6,283
PHCs														
PHC F2												9.27E+04	(3)	92,670
Aliphatic (C10-C12)	--	--	--	1.00E-01	1.0E-01	1.00E+00		1	0.2	6.05E-04	NV	1.15E+05		
Aliphatic (C12-C16)	--	--	--	1.00E-01	1.0E-01	1.00E+00		1	0.2	2.84E-04	NV	1.23E+05		
Aromatic (C10-C12)	--	--	--	4.00E-02	4.0E-02	2.00E-01		1	0.2	2.07E-04	NV	4.78E+04		
Aromatic (C12-C16)	--	--	--	4.00E-02	4.0E-02	2.00E-01		1	0.2	9.05E-05	NV	5.03E+04		
PHC F3												1.86E+05	(3)	185,752
Aliphatic (C16-C21)	--	--	--	2.00E+00	2.00E+00	--		1	0.2	NA	NV	2.63E+06		
Aliphatic (C21-C34)	--	--	--	2.00E+00	2.00E+00	--		1	0.2	NA	NV	2.63E+06		
Aromatic (C16-C21)	--	--	--	3.00E-02	3.00E-02	--		1	0.2	NA	NV	3.94E+04		
Aromatic (C21-C34)	--	--	--	3.00E-02	3.00E-02	--		1	0.2	NA	NV	3.94E+04		

Notes:

-- = Not Available
NA = Not Applicable
NV = No Value
(1) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.
(2) Proposed residential indoor air quality guideline for naphthalene (Health Canada, 2012a).
(3) RBCs for PHC Fractions are determined from the relationship C_{soil} Fraction i = $1/\Sigma(MF_{subfractionj}/C_{gw\ subfractionj})$, where $MF_{subfractionj}$ is the mass fraction of each sub-fraction within Fraction i (CCME, 2008; Table B.4).

Construction/ Utility Worker Exposure Assumptions

Risk-Based Concentration in Soil (mg/kg)	RBC_{soil}	calculated	
Target Risk Level (unitless)	TR	1.0E-05	Health Canada, 2012b
Target Hazard Level (unitless)	THQ	0.2	Health Canada, 2012b
Target Hazard Level for PHCs (unitless)	THQ	0.5	CCME, 2008
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	Health Canada, 2010
Reference Dose Factor (mg/kg-day)	RfD	chemical-specific	Health Canada, 2010; CCME, 2008
Unit Risk Factor ($1/(mg/m^3)$)	URF	chemical-specific	Health Canada, 2010
Reference Concentration (mg/m^3)	RfC	chemical-specific	Health Canada, 2010; CCME, 2008
Ingestion Rate (mg/day)	IR	100	Health Canada, 2012b
Relative Absorption Factor - Oral (%/100)	RAFo	chemical-specific	Health Canada, 2010
Surface Area Exposed (cm^2/day)	SA	5,000	Health Canada, 2012b; Skin surface area includes hands (890 cm2), lower arms (2500/2 cm2), and lower legs (5720/2 cm2)

TABLE 1

DERIVATION OF RISK-BASED CONCENTRATIONS IN SOIL - CONSTRUCTION/UTILITY WORKER ORAL, DERMAL, AND INHALATION EXPOSURE
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Adherence Factor (mg/cm^2)	AF	0.1; 0.01	Health Canada, 2012b; Adherence factor for hands is 0.1 mg/cm2; adherence factor for rest of the body is 0.01 mg/cm2.
Relative Absorption Factor - Dermal (%/100)	RAFd	chemical-specific	Health Canada, 2010
Exposure Time (hrs/day)	ET	8/24	Health Canada, 2012b
Exposure Frequency (days/year)	EF	78	Professional Judgement; 6 days per week for 13 weeks per year
Exposure Duration (years)	ED	1	Professional Judgement; assumes construction campaign to occur over a 1-year period.
Body Weight (kg)	BW	70.7	Health Canada, 2012b
Conversion Factor (kg/mg)	CF	1.0E-06	
Averaging Time - carc. (days)	ATc	21,900	Health Canada, 2012b
Averaging Time - noncarc. (days)	ATnc	365	Health Canada, 2012b
Particulate Emission Factor (kg/m^3)	PEF	2.50E-07	Health Canada, 2012b
Volatilization Factor (kg/m^3)	VF	chemical-specific	Refer to Table 2

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{soil} = \frac{TR \times ATc}{EF \times ED \times [(CSF \times IR \times CF \times RAFo)/BW + (CSF \times SA \times AF \times CF \times RAFd)/BW + (URF \times ET \times (PEFor\ VF))]}$$

Non-Carcinogenic Endpoints:

$$RBC_{soil} = \frac{THQ \times ATnc}{EF \times ED \times [((1/RfD) \times IR \times CF \times RAFo)/BW + ((1/RfD) \times SA \times AF \times CF \times RAFd)/BW + ((1/RfC) \times ET \times (PEF\ or\ VF))]}$$

References:

CCME, 2008. Canada-Wide Standards for Petroleum Hydrocarbons (PHCs) in Soil: Scientific Rationale. Supporting Technical Document. January 2008.

Health Canada, 2010: Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0, September 2010.

Health Canada, 2012a. Public Consultation on Proposed Residential Indoor Air Quality Guideline for Naphthalene. December, 2012.

Health Canada, 2012b: Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0, September 2012.

TABLE 2

DERIVATION OF VOLATILIZATION FACTOR (VF) FOR SOIL - CONSTRUCTION/UTILITY WORKER INHALATION EXPOSURE
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

$$VF = (Q/C) \times 1/F_D \times ((3.14 \times D_a \times T)^{1/2}) \times 10^{-4} / (2 \times db \times D_a)$$

$$Da = ((Pa^{10/3} \times Di \times H + Pw^{10/3} \times Dw) / n^2)/(db \times Kd + Pw + Pa \times H)$$

$$Q/C_{sa} = A \times EXP [(\ln A_s - B)^2 / C]$$

$$F_D = 0.1852+(5.3537/t_c)+(-9.6318/t_c^2)$$

Input Parameters	*Reference*	*Parameters*				
		Naphthalene	F2 Aliphatic (C10-C12)	F2 Aliphatic (C12-C16)	F2 Aromatic (C10-C12)	F2 Aromatic (C12-C16)
VF/ volatilization factor (kg/m^3) =		**1.51E-04**	**6.05E-04**	**2.84E-04**	**2.07E-04**	**9.05E-05**
VF/ volatilization factor (m^3/kg) =	Equation 5-14, USEPA, 2002	**6.61E+03**	**1.65E+03**	**3.53E+03**	**4.82E+03**	**1.10E+04**
Da/ apparent diffusivity (cm^2/s) =	Equation 5-14, USEPA, 2002	1.16E-05	1.86E-04	4.09E-05	2.19E-05	4.17E-06
Q/C/ inverse of the mean conc. at center of square source (g/m^2-s per kg/m^3) =	Equation 5-15, USEPA, 2002	14.31	14.31	14.31	14.31	14.31
A/ constant (unitless) =	USEPA, 2002	2.4538	2.4538	2.4538	2.4538	2.4538
B/ constant (unitless) =	USEPA, 2002	17.566	17.566	17.566	17.566	17.566
C/ constant (unitless) =	USEPA, 2002	189.0426	189.0426	189.0426	189.0426	189.0426
A_s/ areal extent of site surface soil contamination (acres) =	USEPA, 2002	0.5	0.5	0.5	0.5	0.5
F_D/ dispersion correction factor (unitless) =	Equation E-16, USEPA, 2002	0.186	0.186	0.186	0.186	0.186
Pa/ air-filled soil porosity (L_{air}/L_{soil}) =	CCME, 2008; coarse-grained soil	0.241	0.241	0.241	0.241	0.241
Di/ diffusivity in air (cm^2/s) =	CCME, 2008; MOE, 2011	5.90E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02
H/ dimensionless Henry's law constant =	CCME, 2008; MOE, 2011	1.80E-02	1.20E+02	5.20E+02	1.40E-01	5.30E-02
Pw/ water-filled soil porosity (L_{water}/L_{soil}) =	CCME, 2008; coarse-grained soil	0.119	0.119	0.119	0.119	0.119
Dw/ diffusivity in water (cm^2/s) =	MOE, 2011	7.50E-06	6.00E-06	6.00E-06	6.00E-06	6.00E-06
n/ total soil porosity (L_{pore}/L_{soil}) =	CCME, 2008; coarse-grained soil	0.36	0.36	0.36	0.36	0.36
db/ dry soil bulk density (g/cm^3) =	CCME, 2008; coarse-grained soil	1.70	1.70	1.70	1.70	1.70
Kd/ soil-water partition coefficient (cm^3/g) =	USEPA, 2002 (Kd = Koc x foc)	3.54E+00	1.26E+03	2.51E+04	1.26E+01	2.51E+01
Koc/ soil organic carbon-water partition coefficient (cm^3/g) =	CCME, 2008; 2010	7.08E+02	2.51E+05	5.01E+06	2.51E+03	5.01E+03
foc/ organic carbon content of soil (g/g) =	CCME, 2008	0.005	0.005	0.005	0.005	0.005
t_c/ exposure interval (hrs) =	Site-Specific	8.76E+03	8.76E+03	8.76E+03	8.76E+03	8.76E+03
T/ exposure interval (s) =	Site-Specific	3.15E+07	3.15E+07	3.15E+07	3.15E+07	3.15E+07
Conversion Factor/ 10^{-4} (m^2/cm^2) =	USEPA, 2002	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04

References:

CCME, 2008. Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale, Supporting Technical Document. January 2008.

CCME, 2010. Canadian Soil Quality Guidelines - Carcinogenic and Other Polycyclic Aromatic Hydrocarbons (PAHs), Environmental and Human Health Effects, Scientific Criteria Document.

MOE, 2011: Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario, Appendix B, April 15, 2011.

USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.

TABLE 3

DERIVATION OF RISK-BASED CONCENTRATIONS IN SOIL - TRESPASSER ORAL, DERMAL, AND INHALATION EXPOSURE
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Chemicals of Potential Concern	*CSF*		*URF*	*RfD*		*RfC*		*Relative Absorption Factor*		*VF*	*Trespasser (Teen) RBC*			*Risk-Based Concentration*
	oral	*dermal*	*inhalation*	*oral*	*dermal*	*inhalation*		*Oral*	*Dermal*		*Cancer*	*Non-Cancer*		*RBC $_{soil}$ (1)*
	1/(mg/kg-d)	*1/(mg/kg-d)*	*1/(mg/kg-d)*	*(mg/kg-d)*	*(mg/kg-d)*	*(mg/m^3)*		*(%/100)*	*(%/100)*	*(kg/m^3)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*
Metals														
Arsenic	1.80E+00	1.80E+00	6.40E+00	--	--	--		1	0.03	NA	7.36E+02	NV		736
PAHs														
Naphthalene	--	--	--	2.00E-02	2.00E-02	1.00E-02	(2)	1	0.148	6.04E-05	NV	1.95E+03		1,951
PHCs														
PHC F2												1.10E+05	(2)	109,704
Aliphatic (C10-C12)	--	--	--	1.00E-01	1.0E-01	1.00E+00		1	0.2	2.42E-04	NV	9.52E+04		
Aliphatic (C12-C16)	--	--	--	1.00E-01	1.0E-01	1.00E+00		1	0.2	9.02E-05	NV	1.77E+05		
Aromatic (C10-C12)	--	--	--	4.00E-02	4.0E-02	2.00E-01		1	0.2	6.60E-05	NV	5.72E+04		
Aromatic (C12-C16)	--	--	--	4.00E-02	4.0E-02	2.00E-01		1	0.2	2.88E-05	NV	8.66E+04		
PHC F3												5.10E+05	(2)	509,848
Aliphatic (C16-C21)	--	--	--	2.00E+00	2.00E+00	--		1	0.2	NA	NV	7.21E+06		
Aliphatic (C21-C34)	--	--	--	2.00E+00	2.00E+00	--		1	0.2	NA	NV	7.21E+06		
Aromatic (C16-C21)	--	--	--	3.00E-02	3.00E-02	--		1	0.2	NA	NV	1.08E+05		
Aromatic (C21-C34)	--	--	--	3.00E-02	3.00E-02	--		1	0.2	NA	NV	1.08E+05		

Notes:

-- = Not Available

NA = Not Applicable

NV = No Value

(1) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.

(2) Proposed residential indoor air quality guideline for naphthalene (Health Canada, 2012a).

(3) RBCs for PHC Fractions are determined from the relationship C_{soil} Fraction i = $1/\Sigma(MF_{subfractionj}/C_{gw\ subfractionj})$, where $MF_{subfractionj}$ is the mass fraction of each sub-fraction within Fraction i (CCME, 2008; Table B.4).

Trespasser Exposure Assumptions

Risk-Based Concentration in Soil (mg/kg)	RBC_{soil}	calculated	
Target Risk Level (unitless)	TR	1.0E-05	Health Canada, 2012b
Target Hazard Level (unitless)	THQ	0.2	Health Canada, 2012b
Target Hazard Level for PHCs (unitless)	THQ	0.5	CCME, 2008
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	Health Canada, 2010
Reference Dose Factor (mg/kg-day)	RfD	chemical-specific	Health Canada, 2010; CCME, 2008
Unit Risk Factor (1/(mg/m^3))	URF	chemical-specific	Health Canada, 2010

TABLE 3

DERIVATION OF RISK-BASED CONCENTRATIONS IN SOIL - TRESPASSER ORAL, DERMAL, AND INHALATION EXPOSURE
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Reference Concentration (mg/m^3)	RfC	chemical-specific	Health Canada, 2010; CCME, 2008	
Ingestion Rate (mg/day) - Teen	IR	20	Health Canada, 2012b	
Relative Absorption Factor - Oral (%/100)	RAFo	chemical-specific	Health Canada, 2010b	
Surface Area Exposed (cm^2/day) - Teen	SA	4,400	Health Canada, 2012b	Skin surface area to include hands (800 cm^2), lower arms (2230/2 cm^2) and lower legs (4970/2 cm^2).
Adherence Factor (mg/cm^2)	AF	0.1; 0.01	Health Canada, 2012b	Adherence factor for hands is 0.1 mg/cm^2; adherence factor for rest of the body is 0.01 mg/cm^2.
Relative Absorption Factor - Dermal (%/100)	RAFd	chemical-specific	Health Canada, 2010	
Exposure Time (hrs/day)	ET	2/24	Professional Judgment; 2 hours per day	
Exposure Frequency (days/year)	EF	70	Professional Judgment; 2 days per week for 35 weeks per year	
Exposure Duration (years) - Teen	ED	8	Health Canada, 2012b	
Body Weight (kg) - Teen	BW	59.7	Health Canada, 2012b	
Conversion Factor (kg/mg)	CF	1.0E-06		
Averaging Time - carc. (days)	ATc	29,200	Health Canada, 2012b	
Averaging Time - noncarc. (days)	ATnc	2,920	Health Canada, 2012b	
Particulate Emission Factor (kg/m^3)	PEF	7.60E-10	Health Canada, 2012b	
Volatilization Factor (kg/m^3)	VF	chemical-specific	Refer to Table 4	

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{soil} = \frac{TR \times ATc}{EF \times ED \times [(CSF \times IR \times CF \times RAFo)/BW + (CSF \times SA \times AF \times CF \times RAFd)/BW + (URF \times ET \times (VF \text{ or } PEF))]}$$

Non-Carcinogenic Endpoints:

$$RBC_{soil} = \frac{THQ \times ATnc}{EF \times ED \times [((1/RfD) \times IR \times CF \times RAFo)/BW + ((1/RfD) \times SA \times AF \times CF \times RAFd)/BW + ((1/RfC) \times ET \times (VF \text{ or } PEF))]}$$

References:

Health Canada, 2010: Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0, September 2010.

Health Canada, 2012a. Public Consultation on Proposed Residential Indoor Air Quality Guideline for Naphthalene. December, 2012.

Health Canada, 2012: Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0, September 2012.

MOE, 2011: Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario, Table 2.23: Toxicological Reference Values (TRVs) for Derivation of Human Health Soil & Groundwater Standards, April 15, 2011.

TABLE 4

DERIVATION OF VOLATILIZATION FACTOR (VF) FOR SOIL - TRESPASSER INHALATION EXPOSURE
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

VF: Soil-to-Air Volatilization Factor

$$VF = Q/C \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4} (m^2/cm^2)$$

				Reference	*Units*	*Parameters*				
						Naphthalene	*F2 Aliphatic (C10 - C12)*	*F2 Aliphatic (C12 - C16)*	*F2 Aromatic (C10 - C12)*	*F2 Aromatic (C12 - C16)*
	VF		**soil-to-air volatilization factor**		kg/m³	**6.04E-05**	**2.42E-04**	**9.02E-05**	**6.60E-05**	**2.88E-05**
Where:	**VF**	**=**	**soil-to-air volatilization factor**	Equation 4-8, USEPA, 2002	m³/kg	**1.65E+04**	**4.13E+03**	**1.11E+04**	**1.52E+04**	**3.47E+04**
	Q/C_{vol}	=	inverse of mean conc - centre of square source	Equation D-3, USEPA, 2002	(g/m²-sec)/(kg/m³)	68.18	68.18	85.63	85.63	85.63
	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm²/s	1.16E-05	1.86E-04	4.09E-05	2.19E-05	4.17E-06
	T	=	exposure interval	Site Specific	s	2.52E+08	2.52E+08	2.52E+08	2.52E+08	2.52E+08
	r_b	=	soil dry bulk density	CCME, 2008; coarse-grained soil	g/cm³	1.70	1.70	1.70	1.70	1.70

Q/C_{vol}: Inverse of Mean Conc - Centre of Square Source

$$Q/C_{vol} = A \times \exp\frac{(\ln Area - B)^2}{C}$$

Where:	"A"	=	constant	USEPA, 2002		11.911	11.911	12.8612	12.8612	12.8612
	Area	=	areal extent of the site or contamination	USEPA, 2002	acres	0.5	0.5	0.5	0.5	0.5
	"B"	=	constant	USEPA, 2002		18.4385	18.4385	20.5164	20.5164	20.5164
	"C"	=	constant	USEPA, 2002		209.7845	209.7845	237.2798	237.2798	237.2798

D_A: Apparent Diffusivity

$$D_A = \frac{\left[\left(\Theta_a^{10/3} D_i H' + \Theta_w^{10/3} D_w\right) n^2\right]}{\rho_b K_d + \Theta_w + \Theta_a H'}$$

					Units					
Where:	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm²/s	1.16E-05	1.86E-04	4.09E-05	2.19E-05	4.17E-06
	Q_a	=	air-filled porosity	CCME, 2008; coarse-grained soil	unitless	0.241	0.241	0.241	0.241	0.241
	Q_w	=	water-filled porosity	CCME, 2008; coarse-grained soil	unitless	0.119	0.119	0.119	0.119	0.119
	n	=	total soil porosity	CCME, 2008; coarse-grained soil	unitless	0.36	0.36	0.36	0.36	0.36
	r_b	=	soil dry bulk density	CCME, 2008; coarse-grained soil	g/cm³	1.70	1.70	1.70	1.70	1.70
	H'	=	dimensionless Henry's Law Constant	CCME, 2008; MOE, 2011	unitless	1.80E-02	1.20E+02	5.20E+02	1.40E-01	5.30E-02
	D_i	=	diffusivity of chemical x in air	CCME, 2008; MOE, 2011	cm²/s	5.90E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02
	D_w	=	diffusivity of chemical x in water	MOE, 2011	cm²/s	7.50E-06	6.00E-06	6.00E-06	6.00E-06	6.00E-06
	K_d	=	soil-water partition coefficient	USEPA, 2002	cm³/g	3.54E+00	1.26E+03	2.51E+04	1.26E+01	2.51E+01

Kd: Soil-Water Partition Coefficient

$$K_d = K_{oc} \times f_{oc}$$

					Units					
Where:	K_d	=	soil-water partition coefficient	USEPA, 2002	cm³/g	3.54E+00	1.26E+03	2.51E+04	1.26E+01	2.51E+01
	K_{oc}	=	soil organic carbon-water partition coefficient	CCME, 2008	cm³/g	7.08E+02	2.51E+05	5.01E+06	2.51E+03	5.01E+03
	f_{oc}	=	organic content of soil	CCME, 2008	g/g	0.005	0.005	0.005	0.005	0.005

References:

CCME, 2008. Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale, Supporting Technical Document. January 2008.

MOE, 2011: Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario, Appendix B, April 15, 2011.

USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.

TABLE 5

SUMMARY OF SOIL RISK-BASED CONCENTRATIONS
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

	RBCs Per Exposure Pathway (Table Reference)								
	Human RBCs				*Ecological RBCs*				
Parameter	*Commerical Worker Direct Contact with Soil (Ingestion and Dermal) (1)*	*Construction Worker Direct Contact with Soil (Ingestion, Dermal, and Inhalation) (Table 1)*	*Trespasser Direct Contact with Soil (Ingestion, Dermal, and Inhalation) (Table 3)*	*Vapour Inhalation (Indoor Air) (1)*	*Ecological Soil Contact (1)*	*Final Soil RBC Value* (2)	*Maximum Soil Concentration (mg/kg)*	*Risk Management Measures Required*	*Proposed Risk Management Measure (3)*
Metals									
Arsenic	**31 (4)**	883	736	NA	**26**	26	100	Yes	A
PAHs									
Naphthalene	NV	6,283	1,951	NV	22 (5)	22	0.26	No	--
PHCs									
PHC F2	10,000	92,670	109,704	**1,700**	**260**	260	3,000	Yes	A, B
PHC F3	23,000	185,752	509,848	NA	**1,700**	1,700	2,300	Yes	A

Notes:
NV, no value
NA, not applicable as parameter is not considered to be volatile
Bold, the maximum soil concentration exceeds the pathway specific RBC
The maximum soil concentration exceeds the final soil RBC value.

(1) Direct contact with soil risk-based concentrations were obtained from CCME (1997) for arsenic, CCME (2010) for PAHs, and CCME (2008) for PHCs. For PHCs, coarse-grained soil Tier 1 Values were applied.

(2) The final RBC value is the lowest of the human and ecological RBC values.

(3) Risk Management Measure:
--: no risk management measure required
A: Soil Cover - to protect commerical workers and terrestrial ecological receptors (Locations of exceedance: TP15, LTU-1, LTU-2, TP24, LTU-BOTTOM 6, LTU-BOTTOM 8, LTU-WEST 1, LTU-EAST 1)
B: Vapour inhalation (indoor air) - impacted soils cannot be used as fill underneath or within 30 metres of any future building (Locations of exceedance: LTU-2)

(4) CCME soil ingestion guideline adjusted for an incremental lifetime cancer risk of 1.0E-05.

(5) Provisional soil quality guideline for the protection of environmental health (CCME, 2010).

Sources:

CCME, 1997. Canadian soil quality guidelines for the protection of environmental and human health: Arsenic (inorganic). Updated In: 1999.
CCME, 2008. Canada-Wide Standards for Petroleum Hydrocarbons (PHCs) in Soil: Scientific Rationale. Supporting Technical Document. January 2008.
CCME, 2010. Canadian Soil Quality Guidelines - Carcinogenic and Other Polycyclic Aromatic Hydrocarbons (PAHs), Environmental and Human Health Effects, Scientific Criteria Document.

APPENDIX B

DEVELOPMENT OF GROUNDWATER RISK-BASED CONCENTRATIONS

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MEMORANDUM

TO:	Heidi Steinberg	REF. NO.:	082415
FROM:	Tina LePage/Vincent Nero/Nicole Knezevich/jh/1	DATE:	September 9, 2013
RE:	**Development of Groundwater Risk-Based Concentrations Iqaluit International Airport Iqaluit, Nunavut**		

1.0 INTRODUCTION

Conestoga-Rovers & Associates (CRA) has prepared this memorandum to present the development of Risk-Based Concentrations (RBCs) for groundwater for the Iqaluit International Airport located in Iqaluit, Nunavut (Property or Site). These groundwater RBCs are considered to be protective of human and/or ecological receptors that may potentially be in contact with groundwater at the Site. Where groundwater concentrations are greater than the groundwater RBCs, the impacted groundwater could be remediated, or managed in such a way to prevent detrimental exposure from occurring.

2.0 DEVELOPMENT OF GROUNDWATER RBCs

This section presents the methodology for the development of groundwater RBCs that are protective of human and ecological receptors.

RBCs were calculated for the parameters identified in Section 2.1, and for the following potential exposure pathways:

- Construction/utility worker direct contact (incidental ingestion, dermal contact, and ambient air inhalation) with groundwater during subsurface activities that reach the water table – Section 2.2
- Commercial worker inhalation of vapours (indoor air) within a building that is above the groundwater impacts – Section 2.3
- Plants and soil organisms direct contact with groundwater from directly discharging impacted groundwater at the surface – Section 2.4

2.1 GROUNDWATER PARAMETERS

There were two grab groundwater samples collected at the Site. Current groundwater Standards do not address the construction/utility worker and plants to soil organism exposure pathways indicated above. Therefore, groundwater RBCs were calculated for all of the parameters that were detected in the groundwater samples. However, naturally occurring elements and nutrients (aluminum, calcium, iron, magnesium, potassium, silicon, sodium, strontium, sulfur, and titanium) were not considered in the

evaluation as they are naturally occurring elements and nutrients that typically have no available toxicity data.

Groundwater RBCs were calculated for the parameters summarized below:

- Tetrachloroethene
- 2-Methylnaphthalene
- Acenaphthene
- Acenaphthylene
- Acridine
- Anthracene
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(e)pyrene
- Benzo(g,h,i)perylene
- Benzo(k)fluoranthene
- Chrysene
- Dibenzo(a,h)anthracene
- Fluoranthene
- Fluorene
- Indeno(1,2,3-cd)pyrene
- Naphthalene
- Perylene
- Phenanthrene
- Pyrene
- Total PCBs
- Arsenic
- Boron
- Cobalt
- Copper
- Lead
- Mercury
- Molybdenum
- Nickel
- Selenium
- Uranium

Groundwater RBCs for the construction/utility worker were not derived for individual carcinogenic polycyclic aromatic hydrocarbons (PAHs). Human health effects from exposure to carcinogenic PAHs were addressed through the development of the groundwater RBC for Benzo(a)pyrene [B(a)P] total potency equivalents (TPE).

2.2 CONSTRUCTION/UTILITY WORKER

The RBCs developed for the construction/utility worker incidental ingestion, dermal contact, and inhalation exposure to groundwater were derived based on the following equations. For each parameter, two risk-based concentrations were initially developed if toxicity data was available: one protective of carcinogenic health impacts and a second protective of non-carcinogenic health impacts. The RBC for each particular exposure pathway was determined to be the lower value between carcinogenic and non-carcinogenic health impacts.

Carcinogenic Endpoint:

$$RBC_{gw} = \frac{TR \times ATc}{EFa \times EFb \times ED \times ((CSF \times IR/BW) + (CSF \times SA \times DAevent \times CF)/BW + (URF \times FT \times VF))}$$

Non-Carcinogenic Endpoint:

$$RBC_{gw} = \frac{THQ \times ATnc}{EFa \times EFb \times ED \times (((1/RfD) \times IR/BW) + ((1/RfD) \times SA \times DAevent \times CF)/BW) + ((1/RfC) \times FT \times VF)))}$$

Where:

RBC_{gw} = Risk-Based Concentration in groundwater based on oral, dermal, and inhalation exposure (mg/L)

TR = Target Cancer Risk
THQ = Target Hazard Quotient
BW = Body Weight (kg)
CSF = Cancer Slope Factor - dermal - chemical-specific $(mg/kg/day)^{-1}$
URF = Inhalation Unit Risk Factor – chemical-specific $(mg/m^3)^{-1}$
RfD = Reference Dose Factor - dermal - chemical-specific (mg/kg/day)
RfC = Reference Concentration – inhalation – chemical-specific (mg/m^3)
IR = Ingestion rate (L/day)
SA = Surface Area of skin exposed (cm^2)
DA_{event} = Dermal Absorbed per Event – chemical-specific $(mg/cm^2\text{-event})$
FT = Fraction of Time Exposed – inhalation (hours/24 hours) (accounts for the portion of the workday that a worker would be in the excavation and would inhale VOCs emitted from groundwater to ambient air at the base of the excavation)
CF = Conversion Factor $(1.0E\text{-}03\ L/cm^3)$
VF = Volatilization Factor – inhalation - chemical-specific (L/m^3)
EFa = Exposure Frequency (weeks/year)
EFb = Exposure Frequency (days/week)
ED = Exposure Duration (years)
ATc = Averaging Time – carcinogen (days)
ATnc = Averaging Time - non-carcinogen (days)

The dose absorbed per unit area per event (DA_{event}) equation for calculating dermal exposure to groundwater (USEPA, 2004) is:

For Organic Parameters:

$$\textbf{If } t_{event} \le t^*\textbf{, then } DA_{event} = 2 \times FA \times K_p \times \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}},$$

$$\textbf{If } t_{event} > t^*\textbf{, then } DA_{event} = FA \times K_p \times \left[\frac{t_{event}}{1+B} + 2 \times \tau_{event} \times \left(\frac{1 + 3 \times B + 3 \times B^2}{(1+B)^2} \right) \right]$$

For Inorganic Parameters:

$$DA_{event} = K_p \times C \times t_{event}$$

Where:

FA = Fraction absorbed water (dimensionless)
K_p = Dermal permeability coefficient of compound in water (cm/hr)
t_{event} = Event duration (hr/event)
τ_{event} = Lag time per event (hr/event)
t^* = Time to reach steady state (hr) = $2.4 \times \tau_{event}$
B = Dimensionless ratio of permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless)

The receptor-specific exposure assumptions for the construction/utility worker applied in the derivation of the groundwater RBCs are summarized in the table below.

Parameter	*Receptor Characteristics*	*Reference*
	Construction/Utility Worker	
Ingestion Rate (IR)	0.15 litres/day	Health Canada, 2012 (1)
Exposure Frequency (EFa)	13 weeks/year	Professional Judgment (2)
Exposure Frequency (EFb)	6 days/week	Professional Judgment (2)
Exposure Duration (ED)	1 years	Professional Judgment (3)
Fraction of Time Exposed (FT)– Inhalation	8 hours/24 hours	Professional Judgment (4)
Exposure Time	2 hours/day	Professional Judgment (5)
Event Frequency (EV)	1 event/day	USEPA, 2004
Body Weight (BW)	70.7 kg	Health Canada, 2012
Surface Area Exposed	5,000 cm^2	Health Canada, 2012 (6)
Conversion Factor	0.001 L/cm^3	--
Dermal Absorbed per Event	Chemical-specific	Refer to Table 2
Averaging Time (cancer) (ATc)	21,900 days	Health Canada, 2012 (7)
Averaging Time (non-cancer) (ATnc)	365 days	Health Canada, 2012
Volatilization Factor (VF) - groundwater	Chemical-specific	Refer to Table 3

Notes:

(1) The incidental ingestion rate of 0.15 L/day was derived from the MOE drinking water intake rate of 1.5 L/day for an adult resident. Because the workers are not using the groundwater as a drinking water source, but instead may have only occasional limited contact, a factor of 10 was applied to arrive at the reasonable incidental ingestion rate of 0.15 L/day.

(2) Professional Judgment; assumes the construction/utility worker would be in contact with groundwater during subsurface activities for a period of 6 days per week and 13 weeks per year.

(3) Assumes construction campaign to occur over a 1-year period.

(4) Professional Judgment; based on an 8-hour work day.

(5) Professional Judgment; it is assumed that the construction/utility worker would have direct dermal contact with groundwater for 2 hours/day.

(6) Skin surface area includes hands (890 cm^2), lower arms (2500/2 cm^2), and lower legs (5720/2 cm^2)

(7) Averaging time is for the duration of adulthood (60 years).

The inhalation of compounds within vapour originating from groundwater is modelled through the use of a VF to estimate ambient air concentrations based on the groundwater concentration. The VF is chemical-specific and was calculated using the approach presented by USEPA (1999).

Table 1 presents the derivation of the pathway-specific RBCs for the construction/utility worker direct contact (incidental ingestion, dermal contact, and inhalation) exposure to groundwater, which have been summarized in Section 3.0. Table 2 presents the calculation of the DAevent used in the calculation of dermal exposure to groundwater. Table 3 presents the calculation of the VF used in the calculation of

inhalation exposure to groundwater. The derivation of the groundwater RBC for lead is based on USEPA's Adult Lead Model and is presented in Table 4

The toxicity values used in the calculation of the groundwater RBCs included cancer slope factors (CSFs) and unit risk factors (URFs) for carcinogenic effects, and chronic reference doses (RfDs) and reference concentrations (RfCs) for non-carcinogenic effects. All toxicity values were obtained from Health Canada (2010), with MOE (2011) applied as a secondary source. The human health RBCs are calculated using the acceptable cancer risk target level (10^{-5}, or one in a hundred thousand) and non-cancer hazard target level (0.2) (Health Canada, 2012).

There are no available toxicity values for acridine, phenanthrene, and perylene and therefore, RBCs could not be developed for these parameters.

2.3 COMMERCIAL WORKER

The groundwater RBCs developed for the commercial worker inhalation of vapours (indoor air) were derived based on the following equation. Groundwater to indoor air RBCs were only developed for identified parameters considered volatile which included: tetrachloroethene, acenaphthene, acenaphthylene, 2-methylnaphthalene, naphthalene, and mercury. The remaining parameters are high molecular weight PAHs and metals that are not likely an issue for the vapour intrusion exposure pathway.

$$RBC_{gw} = [((RBC_{ia} / \alpha) \times T) \times H] / CF$$

Where:

- RBC_{gw} = Risk-Based Concentration in groundwater based on inhalation exposure (µg/L)
- RBC_{ia} = Risk-Based Concentration in indoor air based on inhalation exposure (µg/m^3)
- α = Default soil vapour attenuation factor
- T = Vadose zone temperature in Kelvin
- H = Compound-specific dimensionless Henry's Law constant equal to R/H_L, where H_L is the dimensioned Henry's Law constant (atmospheres cubic metres per mole [atm m^3/mol]) and R is the Universal Gas Law constant (8.206×10^{-3} atmospheres cubic metres per mole Kelvin [atm m^3/mol K]). The Henry's Law constants were adjusted to an average vadose zone temperature of 0°C based on professional judgment.
- CF = Units conversion factor of 1,000 L/m^3.

The indoor air RBCs (RBC_{ia}) used to derive the groundwater RBCs for the inhalation of vapours (indoor air) were calculated using the equations below.

For each parameter, two RBCs were initially developed if toxicity data was available: one protective of carcinogenic health impacts and a second protective of non-carcinogenic health impacts. The RBC for each particular exposure pathway was determined to be the lower value between carcinogenic and non-carcinogenic health impacts.

Carcinogenic Endpoint:

$$RBC_{ia} = \frac{TR \times ATc}{EFa \times EFb \times FT \times ED \times URF}$$

Non-Carcinogenic Endpoint:

$$RBC_{ia} = \frac{THQ \times ATnc}{EFa \times EFb \times ED \times (1/RfC)}$$

Where:

RBC_{ia} = Risk-Based Concentration in indoor air based on inhalation exposure ($\mu g/m^3$)
TR = Target Cancer Risk
THQ = Target Hazard Quotient
URF = Inhalation Unit Risk Factor – chemical-specific $(mg/m^3)^{-1}$
RfC = Reference Concentration – inhalation – chemical-specific (mg/m^3)
FT = Fraction of Time Exposed – inhalation (hours/24 hours)
EFa = Exposure Frequency (weeks/year)
EFb = Exposure Frequency (days/week)
ED = Exposure Duration (years)
ATc = Averaging Time – carcinogen (days)
$ATnc$ = Averaging Time – non-carcinogen (days)

The receptor-specific exposure assumptions for the commercial worker applied in the derivation of the groundwater RBCs protective of indoor air are summarized in the table below.

Parameter	*Receptor Characteristics*	*Reference*
	Commercial Worker	
Exposure Frequency (EFa)	52 weeks/year	Health Canada, 2012
Exposure Frequency (EFb)	5 days/week	Health Canada, 2012
Exposure Duration (ED)	35 years	Health Canada, 2012
Fraction of Time Exposed (FT)– Inhalation	8 hours/24 hours	Health Canada, 2012
Averaging Time (AT) – carcinogen	21,900 days	Health Canada, 2012
Averaging Time (AT) – non-carcinogen	12,775 days	Health Canada, 2012

Groundwater within the excavated test pits at the Site was encountered at depths less than 1 metre below ground surface. Given the shallow depth to groundwater, a default attenuation factor of 0.004 was applied, consistent with the default attenuation factor applied by MOE (2011) for industrial/commercial buildings.

The toxicity values used in the calculation of the groundwater RBCs included cancer slope factors (CSFs) and unit risk factors (URFs) for carcinogenic effects, and chronic reference doses (RfDs) and reference concentrations (RfCs) for non-carcinogenic effects. All toxicity values were obtained from Health Canada (2010), with MOE (2011) and USEPA Integrated Risk Information System (IRIS) database applied as secondary sources. The human health RBCs are calculated using the acceptable cancer risk target level (10^{-5}, or one in a hundred thousand) and non-cancer hazard target level (0.2) (Health Canada, 2012).

There are no available inhalation toxicity values for 2-methylnaphthalene, therefore, an RBC could not be developed for this parameter.

Table 5 presents the derivation of the groundwater RBCs for the commercial worker inhalation of vapours in indoor air (from groundwater), which have been summarized in Section 3.0. Table 6 presents the derivation of the indoor air RBCs that were used to derive the groundwater RBCs protective of the commercial worker inhalation of vapours (indoor air) from groundwater.

2.4 PLANTS AND SOIL ORGANISMS

The RBCs developed for plants and soil organisms direct contact exposure to groundwater were derived based on the following equation (FCSAP, 2012).

$$RBC_{gw} = SPV \times \frac{pb}{\theta w + (koc \times foc \times pb) + (H' \times \theta a)}$$

Where:

RBC_{gw} = Groundwater protection value (µg/L)
SPV = Soil protection value (mg/kg)
pb = Soil bulk density
θw = Soil moisture-filled porosity
koc = Organic carbon partitioning coefficient (L/kg)
foc = Fraction of organic carbon
H' = Dimensionless Henry's law constant
θa = Soil vapour-filled porosity

Soil protection values (SPV) obtained from CCME (2013), MOE (2011), and USEPA (2007) were used in the calculation of the groundwater RBCs. All soil properties were obtained from FCSAP (2012).

There are no available toxicity values for benzo(e)pyrene therefore, benzo(a)pyrene was applied as a surrogate.

Table 7 presents the derivation of the pathway-specific RBCs for plants and soil organisms direct contact exposure to groundwater, which have been summarized in Section 3.0.

3.0 SUMMARY OF GROUNDWATER RBCs

The groundwater RBCs are presented in Table 8 and summarized in the table below. The final groundwater RBC represents the lower of the pathway-specific RBCs calculated for the construction/utility worker, commercial worker, and plants/soil organisms. The maximum groundwater concentration of each parameter was compared to the pathway-specific and final groundwater RBCs.

Parameter	*Pathway-specific Groundwater RBC (µg/L)*			*Final Groundwater RBC (1) (µg/L)*	*Maximum Groundwater Concentration (µg/L)*
	Construction/Utility Worker (Direct Contact)	*Commercial Worker (Vapour Inhalation)*	*Plants and Soil Organisms (Direct Contact)*		
Tetrachloroethene	954	396	22,638	396	0.58
2-Methylnaphthalene	164	NV	1,939	164	0.12
Acenaphthene	2,435	29,799	2,048	2,048	0.31
Acenaphthylene	2,344	38,284	1,029	1,029	0.032
Acridine	NV	NA	353	353	0.14
Anthracene	6,832	NA	321	321	0.36
Benzo(a)anthracene	(2)	NA	**1.0**	**1.0**	**2.1**
Benzo(a)pyrene	(2)	NA	6.6	6.6	2.3
Benzo(b)fluoranthene	(2)	NA	39	39	3.3
Benzo(e)pyrene	(2)	NA	6.6	6.6	2.0
Benzo(g,h,i)perylene	(2)	NA	6.4	6.4	1.2
Benzo(k)fluoranthene	(2)	NA	150	150	1.1
Chrysene	(2)	NA	22	22	1.7
Dibenzo(a,h)anthracene	(2)	NA	2.6	2.6	0.37
Fluoranthene	501	NA	863	501	3.3
Fluorene	1,245	NA	733	733	0.25
Indeno(1,2,3-cd)pyrene	(2)	NA	**0.096**	**0.096**	**1.6**
Naphthalene	43	276	6,089	43	0.11
Perylene	NV	NA	257,143	257,143	0.54
Phenanthrene	NV	NA	362	362	1.6
Pyrene	423	NA	52	52	2.8
B(a)P TPE	3.9	NA	NA	3.9	3.6
Arsenic	689	NA	894	689	0.33
Boron	7,237	NA	NV	7,237	35
Cobalt	430	NA	6,656	430	0.36
Copper	37,633	NA	2,595	2,595	3.2
Lead	434	NA	667	434	0.24
Mercury	1.2	0.42	960	0.42	0.17
Molybdenum	9,511,643	NA	1,993	1,993	4.6
Nickel	4,788	NA	768	768	0.81
Selenium	2,274,523	NA	478	478	0.26
Uranium	248	NA	4,444	248	1.1
Total PCBs	0.39	NA	21	0.39	0.03

Notes:

Bold Maximum groundwater concentration exceeds the final RBC.

B(a)P TPE – benzo(a)pyrene total potency equivalents.

NA Not applicable.

NV No value.
(1) Final RBC is the lowest of the human and ecological RBCs.
(2) Human health effects from exposure to carcinogenic PAHs have been addressed through the development of the groundwater RBC for B(a)P TPE.

As indicated in the table above, the maximum groundwater concentrations of benzo(a)anthracene and indeno(1,2,3-cd)pyrene exceed their respective final groundwater RBCs. As a result, the impacted groundwater must be managed in such a way to prevent detrimental exposure from occurring through the following pathway:

- Plants and soil organisms direct contact with groundwater

Overland Discharge of Groundwater

Benzo(a)anthracene and indeno(1,2,3-cd)pyrene exceeded the pathway specific RBCs for plants and soil organisms direct contact with groundwater. Therefore, it is not recommended that impacted groundwater encountered during subsurface activities be discharged at the surface to protect any plants and soil organisms.

4.0 REFERENCES

Health Canada, 2010. Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0, September 2010.

Health Canada, 2012. Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0, September 2012.

FCSAP, 2012. Guidance Document on Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites, Federal Contaminated Sites Action Plant, November 2012.

MOE, 2011. Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario, April 15, 2011.

USEPA, 1999. Memorandum dated July 29, 1999 regarding the derivation of a volatilization factor to estimate upper bound exposure point concentration for workers in trenches flooded with ground water off-gassing volatile organic chemicals.

USEPA, 2004. USEPA Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, (Part E, Supplemental Guidance for Dermal Risk Assessment), Final, July.

USEPA, 2007. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs), Interim Final, OSWER Directive 9285.7-78. June.

TABLE 1

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR GROUNDWATER - CONSTRUCTION/UTILITY WORKER ORAL, DERMAL, AND INHALATION EXPOSURE
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

	Toxicity Values (1)						*Construction/ Utility Worker*		*Risk-Based Concentrations (2)*	
Parameter	*CSF oral/dermal 1/(mg/kg-d)*	*URF inhalation 1/(mg/m^3)*	*RfD oral/dermal (mg/kg-d)*	*RfC inhalation (mg/m^3)*	*DAevent (cm/event)*	*VF (L/m^3)*	*TR Adult (mg/L)*	*THQ Adult (mg/L)*	*RBC$_{gw}$ (mg/L)*	*(µg/L)*
VOCs										
Tetrachloroethene	2.10E-03	2.60E-04	1.40E-02	3.60E-01	1.2E-01	1.9E-01	7.22E+01	9.54E-01	9.54E-01	954
PAHs										
2-Methylnaphthalene	--	--	4.00E-03	--	2.9E-01	NA	NV	1.64E-01	1.64E-01	164
Acenaphthene	--	--	6.00E-02	--	3.0E-01	NA	NV	2.44E+00	2.44E+00	2,435
Acenaphthylene	--	--	6.00E-02	--	3.1E-01	NA	NV	2.34E+00	2.34E+00	2,344
Acridine	--	--	--	--	1.1E-01	NA	NV	NV	NV	NV
Anthracene	--	--	3.00E-01	--	5.5E-01	NA	NV	6.83E+00	6.83E+00	6,832
Fluoranthene	--	--	4.00E-02	--	1.0E+00	NA	NV	5.01E-01	5.01E-01	501
Fluorene	--	--	4.00E-02	--	4.0E-01	NA	NV	1.25E+00	1.25E+00	1,245
Naphthalene	--	--	2.00E-02	3.70E-03	1.4E-01	1.9E-01	NV	4.26E-02	4.26E-02	43
Perylene	--	--	--	--	5.3E+00	NA	NV	NV	NV	NV
Phenanthrene	--	--	--	--	5.6E-01	NA	NV	NV	NV	NV
Pyrene	--	--	3.00E-02	--	9.1E-01	NA	NV	4.23E-01	4.23E-01	423
B(a)P TPE	2.30E+00	3.10E-02	--	--	4.4E+00	NA	3.86E-03	NV	3.86E-03	3.9
Metals										
Arsenic	1.80E+00	2.70E+01	--	--	2.0E-03	NA	6.89E-01	NV	6.89E-01	689
Boron	--	--	1.75E-02	--	2.0E-03	NA	NV	7.24E+00	7.24E+00	7,237
Cobalt	--	--	1.00E-03	5.00E-04	8.0E-04	NA	NV	4.30E-01	4.30E-01	430
Copper	--	--	9.10E-02	--	2.0E-03	NA	NV	3.76E+01	3.76E+01	37,633
Lead	--	--	--	--	2.0E-04	NA	NV	NV	4.34E-01	434 (a)
Mercury	--	--	3.00E-04	9.00E-05	2.0E-03	1.7E-01	NV	1.20E-03	1.20E-03	1.2
Molybdenum	--	--	2.30E+01	1.20E-02	2.0E-03	NA	NV	9.51E+03	9.51E+03	9,511,643
Nickel	--	--	1.10E-02	1.80E-05	4.0E-04	NA	NV	4.79E+00	4.79E+00	4,788
Selenium	--	--	5.50E+00	--	2.0E-03	NA	NV	2.27E+03	2.27E+03	2,274,523
Uranium	--	--	6.00E-04	3.00E-04	2.0E-03	NA	NV	2.48E-01	2.48E-01	248
PCBs										
Total PCBs	--	--	1.30E-04	5.00E-04	4.3E+00	NA	NV	3.95E-04	3.95E-04	0.39

Notes :

-- Not Available
NA Not Applicable
NV No Value
B(a)P TPE = benzo(a)pyrene total potency equivalents

TABLE 1

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR GROUNDWATER - CONSTRUCTION/UTILITY WORKER ORAL, DERMAL, AND INHALATION EXPOSURE
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

(1) The toxicity values were obtained from Health Canada (2010). MOE (2011) was applied as a secondary source.

(2) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.
(a) Refer to Table 4

(3) The incidental ingestion rate of 0.15 L/day was derived from the MOE drinking water intake rate of 1.5 L/day for an adult resident. Because the workers are not using the groundwater as a drinking water source, but instead may have only occasional limited contact, a factor of 10 was applied to arrive at the reasonable incidental ingestion rate of 0.15 L/day.

(4) Professional Judgment; assumes the construction/utility worker would be in contact with groundwater during subsurface activities for a period of 6 days per week and 13 weeks per year.

(5) Assumes construction campaign to occur over a 1-year period.

(6) Professional Judgment; it is assumed that the construction/utility worker would have direct dermal contact with groundwater for 2 hours/day.

(7) Professional Judgment; based on an 8-hour work day.

(8) Skin surface area includes hands (890 cm^2), lower arms (2500/2 cm^2), and lower legs (5720/2 cm^2)

(9) Averaging time is for the duration of adulthood (60 years).

Construction/ Utility Worker Exposure Assumptions			
Risk-Based Concentration in Groundwater (mg/L)	RBC_{gw}	calculated	
Target Risk Level (unitless)	TR	1.0E-05	Health Canada, 2012
Target Hazard Level (unitless)	THQ	0.2	Health Canada, 2012
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	Health Canada, 2010; refer to Footnote (1)
Reference Dose Factor (mg/kg-day)	RfD	chemical-specific	Health Canada, 2010; refer to Footnote (1)
Unit Risk Factor (1/(mg/m^3))	URF	chemical-specific	Health Canada, 2010; refer to Footnote (1)
Reference Concentration (mg/m^3)	RfC	chemical-specific	Health Canada, 2010; refer to Footnote (1)
Ingestion Rate (L/day)	IR	0.15	Health Canada, 2012 (3)
Event Frequency (event/day)	EV	1	USEPA, 2004
Exposure Frequency (weeks/year)	EFa	13	Professional Judgement (4)
Exposure Frequency (days/week)	EFb	6	Professional Judgement (4)
Exposure Duration (years)	ED	1	Professional Judgement (5)
Exposure Time (hrs/day)	ET	2	Professional Judgement (6)
Fraction Time Exposed (unitless)	FT	8/24	Professional Judgement (7)
Body Weight (kg)	BW	70.7	Health Canada, 2012
Surface Area Exposed (cm^2)	SA	5,000	Health Canada, 2012 (8)
Conversion Factor (L/cm^3)	CF	0.001	
Dermal Absorbed per Event (cm/event)	DAevent	chemical-specific	Refer to Table 2
Averaging Time - carc. (days)	ATc	21,900	Health Canada, 2012 (9)
Averaging Time - noncarc. (days)	ATnc	365	Health Canada, 2012
Volatilization Factor (L/m^3)	VF	chemical-specific	Refer to Table 3

TABLE 1

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR GROUNDWATER - CONSTRUCTION/UTILITY WORKER ORAL, DERMAL, AND INHALATION EXPOSURE
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{gw} = \frac{TR \times ATc}{EFa \times EFb \times ED \times ((CSF \times IR)/BW + (CSF \times SA \times DAevent \times CF)/BW + (URF \times FT \times VF))}$$

Non-Carcinogenic Endpoints:

$$RBC_{gw} = \frac{THQ \times ATnc}{EFa \times EFb \times ED \times (((1/RfD) \times IR)/BW \times ((1/RfD) \times SA \times DAevent \times CF)/BW + ((1/RfC) \times FT \times VF))}$$

References:

Health Canada, 2012. Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0, September 2012.

Health Canada, 2010. Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0, September 2010.

MOE, 2011: Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario, April 15, 2011.

USEPA, 2004: Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005, July 2004.

TABLE 2

DERIVATION OF DAevent FOR GROUNDWATER - CONSTRUCTION/ UTILITY WORKER DERMAL EXPOSURE

IQALUIT INTERNATIONAL AIRPORT

IQALUIT, NUNAVUT

DAevent (cm/event) - Organics= ET <= t* =

$2 \times FA \times PC \times SQRT(6 \times \tau_{event} \times ET / PI)$

ET > t* =

$FA \times PC \times (ET/(1+B)+2 \times \tau_{event} \times ((1+3B+3B^2)/(1+B)^2)$

$t^* = 2.4 \times \tau_{event}$

DAevent (cm/event) - Inorganics= PC x ET

Parameter	*PC*	*Ref*	*FA*	*Ref*	*MW*	τ_{event}	D_{sc}	*b*	*c*	*t**	*ET (1)*	*B*	*DA event (2)*
	cm/hr		*unitless*		*g/mole*	*hr/event*	cm^2/hr	*unitless*	*unitless*	*hr*	*hr/event*	*dimensionless*	*cm/event*
VOCs													
Tetrachloroethene	3.30E-02	USEPA, 2004	1	USEPA, 2004	166	8.93E-01	1.86E-07	4.12E-01	4.50E-01	2.14E+00	2	1.64E-01	1.22E-01
PAHs													
2-Methylnaphthalene	9.10E-02	USEPA, 2004	1	USEPA, 2004	142	6.55E-01	2.54E-07	6.26E-01	6.52E-01	1.57E+00	2	4.17E-01	2.93E-01
Acenaphthene	8.41E-02	USEPA, 2004	1	USEPA, 2004	154	7.65E-01	2.18E-07	6.11E-01	6.39E-01	1.84E+00	2	4.01E-01	2.96E-01
Acenaphthylene	8.90E-02	USEPA, 2004	1	USEPA, 2004	152	7.45E-01	2.23E-07	6.31E-01	6.56E-01	1.79E+00	2	4.22E-01	3.09E-01
Acridine	2.80E-02	USEPA, 2004	1	USEPA, 2004	179	1.06E+00	1.58E-07	3.98E-01	4.35E-01	2.53E+00	2	1.44E-01	1.12E-01
Anthracene	1.38E-01	USEPA, 2004	1	USEPA, 2004	178	1.04E+00	1.60E-07	9.55E-01	9.04E-01	4.05E+00	2	7.09E-01	5.51E-01
Fluoranthene	2.20E-01	USEPA, 2004	1	USEPA, 2004	202.3	1.43E+00	1.17E-07	1.74E+00	1.35E+00	5.57E+00	2	1.20E+00	1.03E+00
Fluorene	1.07E-01	USEPA, 2004	1	USEPA, 2004	166	8.93E-01	1.86E-07	7.42E-01	7.48E-01	2.14E+00	2	5.30E-01	3.95E-01
Naphthalene	4.70E-02	USEPA, 2004	1	USEPA, 2004	128.2	5.48E-01	3.03E-07	4.43E-01	4.81E-01	1.32E+00	2	2.05E-01	1.40E-01
Perylene	8.20E-01	USEPA, 2004	1	USEPA, 2004	252	2.71E+00	6.15E-08	1.79E+01	5.06E+00	1.19E+01	2	5.01E+00	5.27E+00
Phenanthrene	1.40E-01	USEPA, 2004	1	USEPA, 2004	178	1.04E+00	1.60E-07	9.69E-01	9.13E-01	4.04E+00	2	7.20E-01	5.60E-01
Pyrene	1.95E-01	USEPA, 2004	1	USEPA, 2004	202	1.42E+00	1.17E-07	1.49E+00	1.23E+00	5.51E+00	2	1.06E+00	9.07E-01
B(a)P TPE	7.00E-01	USEPA, 2004	1	USEPA, 2004	250	2.64E+00	6.31E-08	1.33E+01	4.32E+00	1.15E+01	2	4.26E+00	4.44E+00
Metals													
Arsenic	1.00E-03	USEPA, 2004	--	--	--	--	--	--	--	--	2	--	2.00E-03
Boron	1.00E-03	USEPA, 2004	--	--	--	--	--	--	--	--	2	--	2.00E-03
Cobalt	4.00E-04	USEPA, 2004	--	--	--	--	--	--	--	--	2	--	8.00E-04
Copper	1.00E-03	USEPA, 2004	--	--	--	--	--	--	--	--	2	--	2.00E-03
Lead	1.00E-04	USEPA, 2004	--	--	--	--	--	--	--	--	2	--	2.00E-04
Mercury	1.00E-03	USEPA, 2004	--	--	--	--	--	--	--	--	2	--	2.00E-03

TABLE 2

DERIVATION OF DAevent FOR GROUNDWATER - CONSTRUCTION/ UTILITY WORKER DERMAL EXPOSURE

IQALUIT INTERNATIONAL AIRPORT

IQALUIT, NUNAVUT

DAevent (cm/event) - Organics= ET <= t* =

$2 \times FA \times PC \times SQRT(6 \times \tau_{event} \times ET / PI)$

ET > t* =

$FA \times PC \times (ET/(1+B)+2 \times \tau_{event} \times ((1+3B+3B^2)/(1+B)^2)$

$t^* = 2.4 \times \tau_{event}$

DAevent (cm/event) - Inorganics= PC x ET

Parameter	*PC*	*Ref*	*FA*	*Ref*	*MW*	τ_{event}	D_{sc}	*b*	*c*	*t**	*ET (1)*	*B*	*DA event (2)*
	cm/hr		*unitless*		*g/mole*	*hr/event*	cm^2/hr	*unitless*	*unitless*	*hr*	*hr/event*	*dimensionless*	*cm/event*
Metals (continued)													
Molybdenum	1.00E-03	USEPA, 2004	--	--	--	--	--	--	--	--	2	--	2.00E-03
Nickel	2.00E-04	USEPA, 2004	--	--	--	--	--	--	--	--	2	--	4.00E-04
Selenium	1.00E-03	USEPA, 2004	--	--	--	--	--	--	--	--	2	--	2.00E-03
Uranium	1.00E-03	USEPA, 2004	--	--	--	--	--	--	--	--	2	--	2.00E-03
PCBs													
Total PCBs	5.20E-01	USEPA, 2004	1	USEPA, 2004	292	4.53E+00	3.67E-08	8.94E+00	3.49E+00	1.94E+01	2	3.42E+00	4.33E+00

Notes:

(1) Professional Judgment; it is assumed that the construction/utility worker would have direct contact with groundwater for 2 hours/day out of an 8 hour work day.

(2) Calculated using equations presented above and in USEPA (2004).

References:

USEPA, 2004: RAGs Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

TABLE 3

DERIVATION OF VOLATILIZATION FACTOR (VF) FOR GROUNDWATER - CONSTRUCTION/ UTILITY WORKER INHALATION EXPOSURE
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Parameter	*Molecular Weight, MW_i (g/mol)*	*Henry's Law Constant, H_i (1) ($atm\text{-}m^3/mol$)*	*Liquid Phase Coefficient, k_{iL} (2) (cm/s)*	*Gas Phase Coefficient, k_{iG} (3) (cm/s)*	*Overall Mass Transfer Coefficient, Ki (4) (cm/s)*	*Volatilization Factor, VF (5) (L/m^3)*
VOCs						
Tetrachloroethene	1.66E+02	1.84E-02	8.49E-04	3.83E-01	8.47E-04	1.88E-01
PAHs						
Naphthalene	1.28E+02	4.99E-04	9.66E-04	4.17E-01	8.71E-04	1.93E-01
Metals						
Mercury	2.01E+02	1.15E-02	7.72E-04	3.59E-01	7.68E-04	1.71E-01

Temperature, T (K):	288.15
Ideal Gas Constant, R ($atm\text{-}m^3$/mole-K):	0.000082
Area of Trench, A (m^2):	10
Volume of Trench, V (m^3):	20
Depth of the trench, D, (m):	2
Width of the trench, W, (m):	1
Length of the trench, L, (m):	10
Wind speed 10 m above the water surface, u (m/s):	0.45
Air changes per hour, ACH (hr^{-1}):	162
Mixing factor (deviation from complete mixing in real conditions, k [unitless]):	0.5
Fraction of trench floor through which contaminant can enter, F (unitless):	1
Molecular weight of Oxygen, MW_{Oi} (g/mol)	16
liquid□phase mass transfer coefficient for oxygen at 25°C, k_L,O_2 (cm/s).	0.002
Conversion Factor, CF_1 (cm^2/m^2);	10000
Conversion Factor, CF_2 (L/cm^3);	0.001
Conversion Factor, CF_3 (sec/hr);	3600

Notes:

(1) Henry's Law constants were obtained from AENV (2010) and MOE (2011).

(2) Calculated using the following equation:

$$k_{iL} = \left(\frac{MW_{O_2}}{MW_i}\right)^{0.5}\left(\frac{T}{298}\right)(k_L, O_2)$$

(3) Calculated using the following equation:

$$k_{iG} = \left(\frac{MW_{H_2O}}{MW_i}\right)^{0.335}\left(\frac{T}{298}\right)^{1.005}(k_{iG}, H_2O)$$

(4) Calculated using the following equation:

$$\frac{1}{K_i} = \frac{1}{k_{iL}} + \frac{RT}{H_i k_{iG}}$$

(5) Calculated using the following equation:

$$VF_i = \frac{(K_i \times A \times F \times CF_1 \times CF_2 \times CF_3)}{(k \times ACH \times V)}$$

TABLE 4

RISK-BASED CONCENTRATION (RBC) FOR LEAD IN GROUNDWATER BASED ON THE ADULT LEAD MODEL

IQALUIT INTERNATIONAL AIRPORT

IQALUIT, NUNAVUT

Model Parameters	*Symbol*	*Units*	*Adult Worker*	*Ref*
Target Blood Lead (PbB) concentration in the fetus (95th percentile)	$PbB_{95fetal}$	µg/dL	5	(1)
Baseline blood lead value	$PbB_{adult,0}$	µg/dL	1	(2)
R (Mean ratio of fetal to maternal PbB)	$R_{fetal/maternal}$	unitless	0.9	(3)
Individual geometric standard deviation	GSD_i	unitless	1.8	(2)
Biokinetic slope factor	BKSF	µg/dL per µg/day	0.4	(3)
Water ingestion rate	IR_W	L/d	0.15	(4)
Exposure Frequency	EF	days/yr	78	(4)
Absolute absorption fraction of lead in water	AF_W	unitless	0.2	(3)
Averaging Time	AT	days/yr	365	(3)

Risk-Based Concentration (RBC) - Groundwater (µg/L) [5]	**4.34E+02**

Notes:

(1) MOE, 2007. Ontario Air Standards for Lead and Lead Compounds, Standards Development Branch, June 2007.

(2) USEPA, 2009. Transmittal of Update of the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameters, dated June 26, 2009

(3) USEPA, 2003. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. EPA-540-R-03-001. January 2003.

(4) Health Canada, 2012. The incidental ingestion rate of 0.15 L/day was derived from the Health Canada drinking water intake rate of 1.5 L/day for an adult resident. Because the workers are not using groundwater as a drinking water source, but instead may have only occasional limited contact, a factor of 10 was applied to arrive at the reasonable incidental ingestion rate of 0.15 L/day.
EF = Professional Judgment; it is assumed that the construction/utility worker would be in direct contact with groundwater for a period of 5 days per week and 13 weeks per year.

(5) The RBC was calculated using the following formula:

$$RBC = \frac{((PbB_{95fetal}/(GSD_i^{1.645} \times R_{fetal/maternal}) - PbB_{adult,0})) \times AT}{(BKSF \times IR \times AF \times EF)}$$

TABLE 5

CALCULATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR GROUNDWATER BASED ON PROTECTION OF INDOOR AIR QUALITY - COMMERCIAL WORKER
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

				Risk-Based Concentrations for Groundwater, RBC_{gw}		
	Chemical Properties (1)		*Default*	*Risk-Based Target Indoor*	*Soil Gas*	*Theoretical Groundwater*
	Henry's Law		*Soil Vapour*	*Air Concentration*	*Criteria*	*Concentration*
Contaminant of Concern	*Constant, H_L*		*Attenuation*	*RBC_{ia} (3)*	*C_{sg} (4)*	*C'_{gw} (5)*
(COC)	*(atm m³/mol)*		*Factor, α(2)*	*(µg/m³)*	*(µg/m³)*	*(µg/L)*
VOCs						
Tetrachloroethene	4.14E-03	(0° C)	4.00E-03	2.78E+02	6.94E+04	396
PAHs						
Acenaphthene	1.30E-05	(0° C)	4.00E-03	6.56E+01	1.64E+04	29,799
Acenaphthylene	1.01E-06	(0° C)	4.00E-03	6.56E+00	1.64E+03	38,284
2-Methylnaphthalene	4.14E-05	(0° C)	4.00E-03	NC	NC	NC
Naphthalene	6.68E-05	(0° C)	4.00E-03	3.12E+00	7.79E+02	276
Metals						
Mercury	1.07E-03	(0° C)	4.00E-03	7.58E-02	1.90E+01	0.42

Notes:

(1) Henry's Law constants were obtained from AENV (2010) and MOE (2011). The Henry's Law constants were corrected for an average vadose zone temperature of 0°C based on professional judgement.

(2) As depth to groundwater is less than one metre the soil vapour attenuation factor, α, was fixed at an empirically-derived value of 0.004 for a commercial/industrial setting (MOE, 2011)

(3) Refer to Table 6 for acceptable indoor air concentrations.

(4) The Site-specific soil vapour criteria beneath the existing Site building is calculated from $C_{sg}=RBC_{ia} / \alpha$.

(5) The theoretical groundwater concentration determined from the soil vapour concentration assuming equilibrium conditions and Henry's Law; C'gw=Csg*[(T*R)/HL/CF] where T is the vadose temperature in degrees Kelvin, the universal gas constant R is 8.206E-05 atm m^3/mol K, and CF is a conversion factor of 1,000 L/m3.

References:

AENV, 2010: Alberta Tier 1 Soil and Groundwater Remediation Guidelines, Government of Alberta, December 2010.

MOE, 2011: Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario, April 15, 2011.

TABLE 6

DERIVATION OF RISK-BASED CONCENTRATIONS FOR INDOOR AIR - COMMERCIAL WORKER INHALATION EXPOSURE
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

			Commercial Worker		*Indoor Air*	
			Carcinogen	*Non-Carcinogen*	*Risk-Based*	
	URF (1)	*RfC (1)*	*TR*	*THQ*	*Concentration*	
Contaminant of	*inhalation*	*inhalation*	*Adult*	*Adult*	*RBC $_{ia}$ (2)*	
Concern (COC)	*1/(mg/m^3)*	*(mg/m^3)*	*(mg/m^3)*	*(mg/m^3)*	*(mg/m^3)*	*(µg/m^3)*
VOCs						
Tetrachloroethene	2.60E-04	3.60E-01	2.78E-01	3.03E-01	2.78E-01	2.78E+02
PAHs						
Acenaphthene	1.10E-03	--	6.56E-02	NV	6.56E-02	6.56E+01
Acenaphthylene	1.10E-02	--	6.56E-03	NV	6.56E-03	6.56E+00
2-Methylnaphthalene	--	--	NV	NV	NC	NC
Naphthalene	--	3.70E-03	NV	3.12E-03	3.12E-03	3.12E+00
Metals						
Mercury	--	9.00E-05	NV	7.58E-05	7.58E-05	7.58E-02

Notes:

-- = Not Available
NV = No Value
NC = Not calculated
(1) The toxicity values were obtained from Health Canada (2010). MOE (2011) and the USEPA Integrated Risk Information System (IRIS) database were applied as a secondary source.
(2) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.

Commercial Worker Assumptions

Risk-Based Concentration in Indoor Air (mg/m^3)	RBC_{ia}	calculated	
Target Risk Level (unitless)	TR	1.0E-05	Health Canada, 2012
Target Hazard Level (unitless)	THQ	0.2	Health Canada, 2012
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	Health Canada, 2010; refer to Footnote (1)
Reference Concentration (mg/m^3)	RfC	chemical-specific	Health Canada, 2010; refer to Footnote (1)
Fraction Time Exposed (unitless)	FT	8/24	Health Canada, 2012
Exposure Frequency (weeks/year)	EFa	52	Health Canada, 2012
Exposure Frequency (days/week)	EFb	5	Health Canada, 2012
Exposure Duration (years)	ED	35	Health Canada, 2012
Averaging Time (days) - non-carcinogen	AT	12,775	Health Canada, 2012
Averaging Time (days) - carcinogen	AT	21,900	Health Canada, 2012

Exposure Equations

Carcinogenic Endpoints: $$RBC_{ia} = \frac{TR \times AT}{EFa \times EFb \times FT \times ED \times URF}$$

Non-Carcinogenic Endpoints: $$RBC_{ia} = \frac{THQ \times AT}{EFa \times EFb \times FT \times ED \times (1/RfC)}$$

References:

Health Canada, 2010. Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0, September 2010.

MOE, 2011: Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario, April 15, 2011.

TABLE 7

GROUNDWATER RISK-BASED CONCENTRATIONS FOR PROTECTION OF PLANTS AND SOIL ORGANISMS FROM DIRECT CONTACT
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Parameter	*Soil Protection Value Soil Direct Contact Plants and Soil Organisms (mg/kg) (1)*	*Source*	*Organic Carbon Partition Coefficient (L/kg) (2)*	*Dimensionless Henry's Law Constant (H') (2)*	*Groundwater Protection Value Groundwater Direct Contact Plants and Soil Organisms (3) (mg/L)*	*(µg/L)*
VOCs						
Tetrachloroethene	34	CCME, 2013	2.65E+02	7.54E-01	23	22,638
PAHs						
2-Methylnaphthalene	29	USEPA, 2007	2.98E+03	2.12E-02	1.9	1,939
Acenaphthene	29	USEPA, 2007	2.82E+03	6.56E-03	2	2,048
Acenaphthylene	29	USEPA, 2007	5.62E+03	4.78E-04	1	1,029
Acridine	29	USEPA, 2007	1.64E+04	1.62E-05	0.35	353
Anthracene	32	CCME, 2013	2.00E+04	1.50E-03	0.32	321
Benzo(a)anthracene	1	MOE, 2011	2.00E+05	1.42E-04	0.001	1
Benzo(a)pyrene	72	CCME, 2013	2.19E+06	4.78E-05	0.0066	6.6
Benzo(b)fluoranthene	18	USEPA, 2007	9.33E+04	4.68E-04	0.039	39
Benzo(e)pyrene	72	CCME, 2013	2.19E+06	4.78E-05	0.0066	6.6
Benzo(g,h,i)perylene	13	MOE, 2011	4.07E+05	5.97E-06	0.0064	6.4
Benzo(k)fluoranthene	15	MOE, 2011	2.00E+04	3.51E-05	0.15	150
Chrysene	14	MOE, 2011	1.26E+05	4.00E-03	0.022	22
Dibenzo(a,h)anthracene	18	USEPA, 2007	1.38E+06	6.22E-07	0.0026	2.6
Fluoranthene	180	CCME, 2013	4.17E+04	6.09E-04	0.86	863
Fluorene	18	USEPA, 2007	4.90E+03	3.37E-03	0.73	733
Indeno(1,2,3-cd)pyrene	0.76	MOE, 2011	1.58E+06	6.77E-05	0.000096	0.096
Naphthalene	22	MOE, 2011	7.08E+02	2.04E-02	6.1	6,089
Perylene	18	USEPA, 2007			257	257,143
Phenanthrene	12	MOE, 2011	6.61E+03	9.86E-04	0.36	362
Pyrene	18	USEPA, 2007	6.92E+04	4.66E-04	0.052	52
PCBs						
Total PCBs	33	CCME, 2013	3.09E+05	4.93E-03	0.021	21
Metals						
Arsenic	26	CCME, 2013	2.90E+01	NA	0.89	894
Boron	NV	--	3.00E+00	NA	NV	NV
Cobalt	300	CCME, 2013	4.50E+01	NA	6.7	6,656
Copper	91	CCME, 2013	3.50E+01	NA	2.6	2,595
Lead	600	CCME, 2013	9.00E+02	NA	0.67	667
Mercury	50	CCME, 2013	5.20E+01	NA	0.96	960
Molybdenum	40	CCME, 2013	2.00E+01	NA	2	1,993
Nickel	50	CCME, 2013	6.50E+01	NA	0.77	768
Selenium	2.9	CCME, 2013	6.00E+00	NA	0.48	478
Uranium	2,000	CCME, 2013	4.50E+02	NA	4.4	4,444

TABLE 7

GROUNDWATER RISK-BASED CONCENTRATIONS FOR PROTECTION OF PLANTS AND SOIL ORGANISMS FROM DIRECT CONTACT
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Notes:

(1) Soil protection values were obtained from CCME (2013), MOE (2011), and USEPA (2007).
(2) Organic partition coefficient and dimensionless Henry's Law Constant were obtained from AENV (2010) and MOE (2011).
(3) Groundwater protection values were calculated using the following equation (FCSAP, 2012):
Note: there are no Koc values for metals, and therefore the value presented is the soil to water partition coefficient (Kd).

$$RBC_{gw} = SPV \times \frac{\rho b}{\theta w + (koc \times foc \times pb) + (H' \times \theta a)}$$

Soil Bulk Density	ρb	1.7	FCSAP, 2012
Soil Total Porosity	θt	0.36	FCSAP, 2012
Soil Moisture-Filled Porosity	θw	0.119	FCSAP, 2012
Soil Vapour-Filled Porosity	θa	0.241	FCSAP, 2012
Fraction of Organic Carbon	foc	0.005	FCSAP, 2012

Note: metals are not volatile and therefore partitioning to air using Henry's Law Constant was not considered for these parameters

Sources:

AENV, 2010. Alberta Tier 1 Soil and Groundwater Remediation Guidelines, Alberta Environment, December 2010.
CCME, 2013. Canadian Environmental Quality Guidelines, Canadian Soil Quality Guidelines for the Protection of Human and Environmental Health, 1999, Accessed online, August 2013.
FCSAP, 2012. Guidance Document on Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites, Federal Contaminated Sites Action Plant, November 2012.
MOE, 2011. Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario, April 15, 2011.
USEPA, 2007. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs), Interim Final, OSWER Directive 9285.7-78. June.

TABLE 8

SUMMARY OF GROUNDWATER RISK-BASED CONCENTRATIONS
IQALUIT INTERNATIONAL AIRPORT
IQALUIT, NUNAVUT

Parameter	*Calculated RBCs Per Exposure Pathway (Table Reference)*			*Final RBC Value*	*Maximum Groundwater Concentration*
	Human RBCs		*Ecological RBCs*		
	Construction/Utility Worker	*Commercial Worker*	*Plants and Soil Organisms*	(1)	*(2)*
	(Table 1,4)	*(Table 5)*	*(Table 7)*		
VOCs					
Tetrachloroethene	954	396	22,638	396	0.58
PAHs					
2-Methylnaphthalene	164	NV	1,939	164	0.12
Acenaphthene	2,435	29,799	2,048	2,048	0.31
Acenaphthylene	2,344	38,284	1,029	1,029	0.032
Acridine	NV	NA	353	353	0.14
Anthracene	6,832	NA	321	321	0.36
Benzo(a)anthracene	(2)	NA	**1.0**	1.0	**2.1**
Benzo(a)pyrene	(2)	NA	6.6	6.6	2.3
Benzo(b)fluoranthene	(2)	NA	39	39	3.3
Benzo(e)pyrene	(2)	NA	6.6	6.6	2.0
Benzo(g,h,i)perylene	(2)	NA	6.4	6.4	1.2
Benzo(k)fluoranthene	(2)	NA	150	150	1.1
Chrysene	(2)	NA	22	22	1.7
Dibenzo(a,h)anthracene	(2)	NA	2.6	2.6	0.37
Fluoranthene	501	NA	863	501	3.3
Fluorene	1,245	NA	733	733	0.25
Indeno(1,2,3-cd)pyrene	(2)	NA	**0.096**	0.096	**1.6**
Naphthalene	43	276	6,089	43	0.11
Perylene	NV	NA	257,143	257,143	0.54
Phenanthrene	NV	NA	362	362	1.6
Pyrene	423	NA	52	52	2.8
B(a)P TPE	3.9	NA	NA	3.9	3.6
PCBs					
Total PCBs	0.39	NA	21	0.39	0.03
Metals					
Arsenic	689	NA	894	689	0.33
Boron	7,237	NA	NV	7,237	35
Cobalt	430	NA	6,656	430	0.36
Copper	37,633	NA	2,595	2,595	3.2
Lead	434	NA	667	434	0.24
Mercury	1.2	0.42	960	0.42	0.17
Molybdenum	9,511,643	NA	1,993	1,993	4.6
Nickel	4,788	NA	768	768	0.81
Selenium	2,274,523	NA	478	478	0.26
Uranium	248	NA	4,444	248	1.1

Notes:

NV No value
NA Not applicable
B(a)P TPE, benzo(a)pyrene total potency equivalents
Bold, The maximum groundwater concentration exceeds the pathway-specific RBC.
45 Maximum groundwater concentration exceeds the final RBC.
(1) The final RBC value is the lower of the human and ecological RBC value.
(2) Human health effects from exposure to carcinogenic PAHs have been addressed through the development of the groundwater RBC for B(a)P TPE.

APPENDIX C

ENVIRONMENTAL GUIDELINE FOR THE GENERAL MANAGEMENT OF HAZARDOUS WASTE (HAZARDOUS WASTE GUIDELINE)

Environmental Guideline for the

General Management of Hazardous Waste

Department of Environment
Government of Nunavut

GUIDELINE: GENERAL MANAGEMENT OF HAZARDOUS WASTE

Original: April 1999
Revised: January 2002
April 2010
October 2010

This Guideline has been prepared by the Department of Environment's Environmental Protection Division and approved by the Minister of Environment under the authority of Section 2.2 of the *Environmental Protection Act.*

This Guideline is not an official statement of the law and is provided for guidance only. Its intent is to increase the awareness and understanding of the risks and hazards associated with hazardous waste and to assist in its proper management. This Guideline does not replace the need for the owner or person in charge, management or control of a hazardous waste to comply with all applicable legislation and to consult with Nunavut's Department of Environment, other regulatory authorities and qualified persons with expertise in the management of hazardous waste.

Copies of this Guideline are available upon request from:

Department of Environment
Government of Nunavut
P.O. Box 1000, Station 1360, Iqaluit, NU, X0A 0H0
Electronic version of the Guideline is available at http://env.gov.nu.ca/programareas/environmentprotection

Cover Photos: E. Paquin

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Appendices

Introduction

'Waste' is a term used to describe materials that are no longer wanted or are unusable for their original intended purpose. Many different types of waste are generated each day in Nunavut by industry and small business, hospitals and health centers, schools and individuals during the normal course of carrying out daily activities. Some types of waste pose greater risks than others because of their chemical, physical and biological properties. These wastes are generally referred to as being a 'hazardous waste'. Examples of hazardous waste include discarded paint, used solvents, motor and lubricating oil, cleaning compounds, certain building construction and demolition waste and products with an expired shelf life. They will generally exhibit one or more of the following characteristics - ignitable (i.e. flammable), reactive, corrosive or toxic. Hazardous waste often requires that specific management measures be taken to ensure the health and safety of the environment, workers and the general public.

The purpose of the Environmental Guideline for the General Management of Hazardous Waste (the Guideline) is to ensure the safe, effective and efficient management of hazardous waste in Nunavut. It provides information to generators, carriers and receivers of hazardous waste on its hazards, how best to reduce or eliminate the effects it can have on the environment, worker and public safety and guidance on its storage, registration and transportation.

The *Environmental Protection Act* enables the Government of Nunavut to implement measures that preserve, protect and enhance the quality of the environment. Section 2.2 of the *Act* provides the Minister with authority to develop, coordinate, and administer the Guideline.

The Guideline is not an official statement of the law. For further information and guidance, the owner or person in charge, management or control of a hazardous waste is encouraged to review all applicable legislation and consult the Department of Environment, other regulatory agencies or qualified persons with expertise in hazardous waste management.

1.1 Definitions

Carrier	A person who accepts hazardous waste for transportation or transports hazardous waste, whether or not for hire or reward. A carrier is also referred to as a transporter of hazardous waste.
Commercial	Actions undertaken for hire or reward.
Commissioner's Land	Lands that have been transferred by Order-in-Council to the Government of Nunavut. This includes roadways and land subject to block land transfers. Most Commissioner's Land is located within municipalities.
Consignee	A person to whom hazardous waste is being or is intended to be transported. A consignee is also referred to as a receiver of hazardous waste.

Consignor	A person who has possession of hazardous waste immediately before it is transported. A consignor may also be a generator of hazardous waste.
Contaminant	Any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment, (a) endangers the health, safety or welfare of persons, (b) interferes or is likely to interfere with normal enjoyment of life or property, (c) endangers the health of animal life, or (d) causes or is likely to cause damage to plant life or to property.
Dangerous Good	Any product, substance or organism included by its nature or by the *Transportation of Dangerous Goods Regulations* in any of the classes listed in the Schedule provided in the *Transportation of Dangerous Goods Act* (Canada).
Empty Container	A container that previously held a hazardous waste and has been emptied to the greatest extent practical or triple rinsed with an appropriate cleaning agent. This does not include containers that previously contained mercury or Class 2.3, 5.1 or 6.1 materials.
Environment	Means the components of the Earth and includes (a) air, land and water, (b) all layers of the atmosphere, (c) all organic and inorganic matter and living organisms, and (d) the interacting natural systems that include components referred to in paragraphs (a) to (c) above.
Generator	The owner or person in charge, management or control of a hazardous waste at the time it is generated or a facility that generates a hazardous waste. A generator may also be a consignor of hazardous waste.
Hazardous Waste	A contaminant that is a dangerous good and is no longer wanted or is unusable for its original intended purpose and is intended for storage, recycling, treatment or disposal. A hazardous waste does not include a contaminant that is (a) household in origin; (b) exempted as a small quantity; (c) returned directly to a manufacturer or supplier of the product, substance or organism for reprocessing, repackaging or resale for any reason; (d) an empty container; or (e) intended for disposal in a landfill or a sewage treatment facility and meets the applicable standards set out in the Environmental Guideline for Industrial Waste Discharges.

Hazardous Waste Management Facility	A commercial facility used for the collection, storage, transfer, treatment, recycling or disposal of a hazardous waste. For clarity, a hazardous waste management facility does not include a municipal landfill or sewage lagoon.
Incompatible Hazardous Waste	A hazardous waste that, when in contact with another substance or hazardous waste under normal circumstances, reacts to produce heat, gas, fire, explosion or a corrosive or toxic substance.
Landfilling	The intentional depositing or placement of waste in or on land for the purposes of disposal.
Long-term Storage	The storage of hazardous waste for a period of 180 days or more.
Manifest	The manifest as set out in Schedule IX to the *Export and Import of Hazardous Waste and Hazardous Recyclables Regulations* under the *Canadian Environmental Protection Act* (Canada).
Minister	The Minister of Environment of the Government of Nunavut.
Qualified Person	A person who has an appropriate level of knowledge and experience in all relevant aspects of hazardous waste management.
Receiver	A person to whom hazardous waste is being or is intended to be transported. A receiver is also referred to as a consignee of hazardous waste.
Responsible Party	The owner or person in charge, management or control of the hazardous waste.
Small Quantity	Hazardous waste that is generated in an amount that is less than five kilograms per month if a solid or less than five litres per month if a liquid, and where the total quantity accumulated at any one time does not exceed five kilograms or five litres. This does not include hazardous waste that is mercury or Class 2.3, 5.1 or 6.1 materials. These wastes must be generated in an amount that is less than one kilogram per month if a solid or less than one litre per month if a liquid, and where the total quantity accumulated at any one time does not exceed one kilogram or one litre.
Transport Authority	The statute and regulations controlling the management of hazardous waste under that mode of transport. These include (a) Road and Rail - *Transportation of Dangerous Goods Act* (Canada) and *Regulations; Interprovincial Movement of Hazardous Waste Regulations* (CEPA) and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (CEPA). (b) Air – *International Air Transport Association (IATA) Dangerous Goods Regulations* and *International Civil Aviation Organization* (ICAO) *Technical Instructions;* and

(c) Marine – *International Maritime Dangerous Goods Code* (IMDG).

Transfer	The temporary storage of hazardous waste for a period of 179 days or less for the purpose of changing from one vehicle or means of transportation to another.
Transporter	A person who accepts hazardous waste for transportation or transports hazardous waste, whether or not for hire or reward. A transporter is also referred to as a carrier of hazardous waste.
Waste Audit	An inventory or study of the amount and type of waste that is produced at a location.

1.2 Roles and Responsibilities

1.2.1 Environmental Protection Division

The Environmental Protection Division of the Department of Environment is the key environmental agency responsible for ensuring the proper management of hazardous waste and other contaminants on Commissioner's Land. Authority is derived from the *Environmental Protection Act*, which prohibits the discharge of contaminants to the environment and enables the Minister to undertake actions to ensure appropriate management measures are in place. Although programs and services are applied primarily to activities taking place on Commissioner's and municipal lands and to Government of Nunavut undertakings, the *Environmental Protection Act* may be applied to the whole of the territory where other controlling legislation, standards and guidelines do not exist. A complete listing of relevant legislation and guidelines can be obtained by contacting the Department of Environment or by visiting the web site at http://env.gov.nu.ca/programareas/environmentprotection.

The Department of Environment will provide advice and guidance on the proper management of hazardous waste. However, it remains the responsibility of the owner or person in charge, management or control of the hazardous waste to ensure compliance with all applicable statutes, regulations, standards, guidelines and local by-laws.

1.2.2 Generators of Hazardous Waste

The generator is the owner or person in charge, management or control of the hazardous waste at the time it is produced or of the facility that produces the hazardous waste. The generator is responsible for any and all hazardous waste produced and must ensure the hazardous waste is properly and safely managed from the time it is generated to its final disposal. This is referred to as managing the waste from cradle-to-grave.

Contractors may manage hazardous waste on behalf of the generator. However, the generator remains responsible for determining whether the waste is hazardous and ensuring the method of management complies with all applicable statutes, regulations, standards, guidelines and local by-laws. If the contractor does not comply with the requirements of the *Environmental Protection Act* and is charged with a violation while managing the waste, the generator may also be held liable.

The basic responsibilities of a hazardous waste generator in Nunavut are:

- Registering with the Department of Environment as a generator of hazardous waste.
- Registering the facility with the Department of Environment as a hazardous waste management facility where the facility is used for commercial purposes and is intended for the storage of hazardous waste for a period of 180 days or more, where stored quantities exceed the criteria set out in Appendix 8 or where hazardous waste is recycled, treated or disposed of in quantities in any single month that exceed a 'small quantity'.
- Classifying and labeling hazardous waste in accordance with the Transport Authority.
- Managing the hazardous waste in accordance with the Guideline, *Environmental Protection Act, Fire Prevention Act*, *Safety Act, Public Health Act* and all other applicable statutes, regulations, standards, guidelines and local by-laws.
- Reusing, recycling, treating or disposing of the hazardous waste in a proper and safe manner.
- Where the hazardous waste is transported off-site, completing Part A of the waste manifest form and retaining a copy for two years, using a registered hazardous waste carrier to transport the waste and sending the waste to a registered receiver or hazardous waste management facility.
- Ensuring staff are trained and qualified to safely handle the hazardous waste.
- Filing a spill contingency plan with the Minister where stored quantities of hazardous waste exceed the criteria set out in Schedule A of the *Spill Contingency Planning and Reporting Regulations*.
- Reporting any spill immediately to the NWT/Nunavut Spill Report Line at (867) 920-8130.

Further information and application forms for registering as a generator or a hazardous waste management facility are available from the Department of Environment. Refer to sections 3.2.1 and 3.2.2 and Appendices 4 and 7 for further information.

1.2.3 Carriers of Hazardous Waste

Hazardous waste must be transported in accordance with the appropriate Transport Authority: Road and Rail - *Transportation of Dangerous Goods Act* (Canada) and *Regulations, Interprovincial Movement of Hazardous Waste Regulations* (CEPA) and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (CEPA)*;* Air – *International Air Transport Association (IATA) Dangerous Goods Regulations* and *International Civil Aviation Organization* (ICAO) *Technical Instructions;* and Marine – *International Maritime Dangerous Goods Code* (IMDG).

Carriers operating in Nunavut must be registered with the Department of Environment before transporting hazardous waste. Other basic responsibilities of hazardous waste carriers are:

- Placarding and labeling all transport vehicles and containers in accordance with the appropriate Transport Authority.
- Completing Part B of the waste manifest form and retaining a copy for two years.
- Accepting hazardous waste only from registered generators and safely transporting hazardous waste only to a registered receiver or hazardous waste management facility.
- Ensuring staff are trained and qualified to safely transport hazardous waste.
- Reporting any spill immediately to the NWT/Nunavut Spill Report Line at (867) 920-8130.

Further information and application forms for registering as a hazardous waste carrier are available from the Department of Environment. Refer to section 3.2.1 and Appendix 5 for further information.

1.2.4 Receivers of Hazardous Waste

Any person receiving or accepting hazardous waste in Nunavut for the purpose of storage, transfer, reuse, recycling, treatment or disposal must be registered with the Department of Environment as a hazardous waste receiver. The facility must also be registered as a hazardous waste management facility where it is used for commercial purposes and is used to store hazardous waste for a period of 180 days or more, store quantities that exceed the criteria set out in Appendix 8 or hazardous waste is recycled, treated or disposed of in quantities in any single month that exceed a 'small quantity'. Other basic responsibilities of hazardous waste receivers in Nunavut are:

- Handling and storing the hazardous waste in accordance with the Guideline, *Environmental Protection Act, Fire Prevention Act*, *Safety Act, Public Health Act* and all other applicable statutes, regulations, standards, guidelines and local by-laws.
- Reusing, recycling, treating or disposing of the hazardous waste in a proper and safe manner.
- Completing Part C of the waste manifest form and retaining a copy for two years.
- Accepting hazardous waste only from registered generators and carriers.
- Ensuring staff are trained and qualified to safely handle hazardous waste.
- Filing a spill contingency plan with the Minister where stored quantities of hazardous waste exceed the criteria set out in Schedule A of the *Spill Contingency Planning and Reporting Regulations*.
- Reporting any spill immediately to the NWT/Nunavut Spill Report Line at (867) 920-8130.

Further information and application forms for registering as a receiver or hazardous waste management facility are available from the Department of Environment. Refer to sections 3.2.1 and 3.2.2 and Appendices 6 and 7 for further information.

1.2.5 Other Regulatory Agencies

Other regulatory agencies may have to be consulted regarding the management of hazardous waste as there may be other environmental or public and worker health and safety issues to consider. Some of the other agencies include:

Department of Economic Development and Transportation

The Motor Vehicles Division is responsible for ensuring the safe transport of hazardous waste and other dangerous goods by road through administration of the *Transportation of Dangerous Goods Act*. The Department is also responsible under the *Motor Vehicles Act* for driver licensing and various other vehicle and load safety matters.

Workers' Safety and Compensation Commission

The Workers' Safety and Compensation Commission is responsible for promoting and regulating worker and workplace health and safety in Nunavut. The Commission derives its authority from the *Workers' Compensation Act* and *Safety Act* which require an employer to maintain a safe workplace and ensure the safety and well being of workers. The Workplace Hazardous Materials Information System, or WHMIS, requires information be provided to workers on the safe use of any hazardous material used in the workplace. All hazardous waste generators, carriers and receivers should consult the Prevention Services Division for further information and guidance.

Department of Community and Government Services

The Department of Community and Government Services is responsible under the *Commissioners' Lands Act* for the issuance of land leases, reserves, licenses and permits on Commissioner's Lands. The Department, in cooperation with communities, is also responsible for the planning and funding of municipal solid waste and sewage disposal facilities in most Nunavut communities. Emergency planning responsibilities under the *Emergency Measures Act* include developing territorial emergency response plans, coordinating emergency operations at the territorial and regional levels and supporting community emergency response operations.

The Office of the Fire Marshal is responsible for ensuring the safe storage, handling and use of flammable and combustible liquids and materials. The Office of the Fire Marshal derives its authority from the *Fire Prevention Act*, National Fire Code and National Building Code.

Department of Health and Social Services

Activities related to the generation, storage, transportation, treatment and disposal of hazardous waste may have an impact on public health. The Office of the Chief Medical Officer of Health and Regional Environmental Health Officers should be consulted regarding legislated requirements under the *Public Health Act.*

Environment Canada

Environment Canada is responsible under the *Canadian Environmental Protection Act* for ensuring the safe management of designated hazardous waste at federal facilities and on federal lands. The management, disposal and export of polychlorinated biphenyl (PCB) waste is controlled under the *PCB Regulations*, the *Federal Mobile PCB Treatment and Destruction Regulations* and the *PCB Waste Export Regulations*. The interprovincial and international transport of waste is controlled under the *Interprovincial Movement of Hazardous Waste Regulations* and the *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations*. Environment Canada is also responsible for administering the pollution prevention provisions of the federal *Fisheries Act*.

Indian and Northern Affairs Canada

Indian and Northern Affairs Canada is responsible under the *Territorial Lands Act* and *Nunavut Waters and Nunavut Surface Rights Tribunal Act* for the management of federal lands and waters in Nunavut, including the impact hazardous waste may have on the quality of these lands and waters.

Natural Resources Canada

The *Explosives Act* provides Natural Resources Canada with authority to manage explosives in Canada, including waste explosives. The Canadian Nuclear Safety Commission, which reports to Parliament through the Minister of Natural Resources, administers the safe handling and disposal of radioactive materials and licenses institutions and companies to possess and use radioactive materials under the *Nuclear Safety and Control Act* and *Nuclear Liability Act.*

Local Municipal Governments

The role of municipal governments is important in the proper local management of hazardous waste. Under the Nunavut Land Claim Agreement, municipalities are entitled to control their own municipal disposal sites. Hazardous waste may be deposited into municipal landfill sites and sewage treatment facilities only with the consent of the local government. Local environmental and safety standards are determined, in part, by how the property is designated under municipal government development plans (i.e. land use zoning). The local fire department may also be called upon if a fire or other public safety issue is identified.

Co-management Boards and Agencies

Co-management boards and agencies established under the Nunavut Land Claim Agreement have broad authority for land use planning, impact assessment and the administration of land and water. Activities involving hazardous waste may be controlled through the setting of terms and conditions in plans, licenses and permits issued by the Nunavut Water Board and other co-management boards and agencies.

Appendix 3 provides further assistance in determining the primary regulatory agency contact for managing hazardous waste in Nunavut.

Appendix 11 provides mailing addresses, phone and fax numbers for each of the regulatory agencies.

Management of Hazardous Waste

2.1 What is Hazardous Waste?

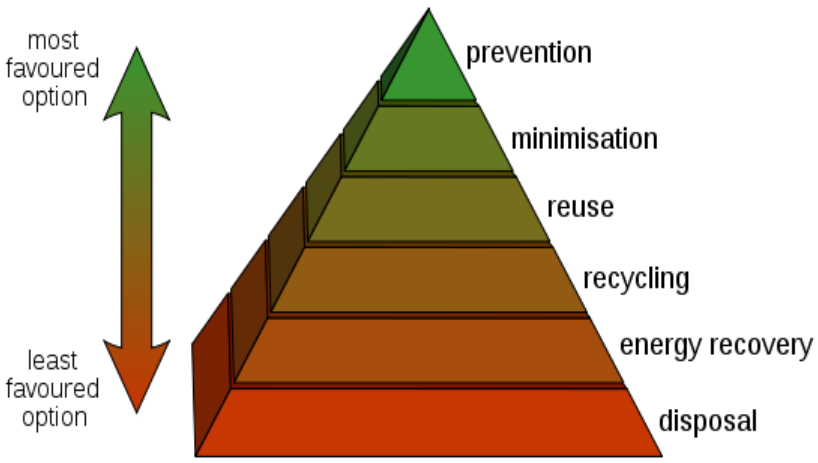
Hazardous waste is unwanted material or products that can cause illness or death to people, plants and animals. It may be a liquid, solid, sludge or gas and contain chemicals, heavy metals, radioactives, infectious organisms or other toxic substances. It may be a single product or a combination of many hazardous and non-hazardous materials (i.e. mixed waste). Its harmful effects may exist for a relatively short period of time (i.e. oil-based paint before hardening) or continue for hundreds of years. It can persist in soil, water and sediment (i.e. radioactive materials) or bioaccumulate in plants and animals (i.e. mercury, PCBs).

Hazardous waste is generated by everybody. Households commonly generate unwanted gasoline, brake and windshield wiper fluid, cleaning supplies, paints and paint thinners, lead acid batteries, used computer equipment and construction materials (i.e. asbestos), pesticides and others. Hospitals and nursing stations generate unwanted needles and waste human tissue, body fluids and biotic cultures. Business and industry generate many different types of hazardous waste including used motor and lubricating oil, cleaning solvent, drilling fluid and cuttings and mine tailings.

2.2 Waste Management

Proper waste management simply makes good sense. Minimizing or eliminating the generation of hazardous and other waste helps to reduce the hazards and costs associated with its handling, storage, transport, recycling, treatment and disposal. It also reduces the impacts waste could have on the environment, human and worker health and safety and reduces the global emission of greenhouse gases by minimizing the use of raw materials. Another term commonly used to describe activities that reduce the amount of material entering a waste stream or being released to the environment is ‘pollution prevention’.

Once a waste is created, the generator is responsible for its safe management from cradle-to-grave. Waste generators can prevent pollution and reduce costs by implementing various waste reduction, reuse and recycling programs through changes to operational procedures, maintenance practices and raw material use. Treating and disposing of waste either locally or outside of Nunavut should be considered only if reuse and recycling options are not available or practical.



2.2.1 Reduce and Minimize – the first option

Using raw materials efficiently and reducing the amount of waste generated is the first and most important step in effective waste management. Both environmentally and economically, consuming less is the most fundamental and effective step to reducing waste.

A waste audit should be undertaken to inventory and study the waste produced at a location or business. The audit should identify the type and amount of waste being generated, the costs of current management methods including handling, storage, treatment, transport and disposal, and examine opportunities and set targets for reducing or reusing waste. These opportunities include awareness and education, the substitution or reduction of purchased raw materials, production redesign, process changes and improved maintenance activities. Other opportunities include purchasing products that are durable or are manufactured from environmentally-friendly materials (i.e. biodegradable or post-consumer materials), avoiding products that are designed for single or short life usage and buying only the quantity that is needed. Effective communications is critical to the success of any waste reduction program.

2.2.2 Reuse and Recycle

Even with effective waste reduction measures in place there will be waste generated. Reusing the waste product for a different but related purpose (reuse) or producing a new product from the original material (recycle) is an effective way to reduce the volume of waste. The waste audit should identify whether opportunities are available for reusing or recycling waste within the generating facility. Alternatively, other local or distant users may be found to reuse or recycle the waste that would otherwise require treatment or disposal.

The Department of Environment encourages the reuse and recycling of hazardous and other waste in the following ways:

- Local reuse and recycle programs are available in various communities for some types of hazardous waste including used oil and waste fuel. Generators should contact the Department of Environment or local municipal government for the names of registered waste receivers or other opportunities to reuse or recycle wastes locally.
- Waste exchanges and associations offer opportunities for waste generators to transfer unwanted, overstocked, obsolete, damaged, contaminated and post-dated material to another person or company that can use it. In some cases, the receiving company will purchase the waste from the generator. Appendix 10 provides a listing of several waste exchanges and associations in Canada.

2.2.3 Treatment and Disposal in Nunavut

Treatment and disposal of a hazardous waste is the last step in effective waste management and should be undertaken only after all other practical reuse and recycle options have been examined.

Treatment covers a broad spectrum of activities. It includes any method, technique or process that will change the physical, chemical or biological character or composition of a hazardous waste so as to reduce its volume, neutralize or make the waste less hazardous and make it safer to transport or store

prior to its disposal. In some cases, more than one process may be required to treat the waste. Facilities in Nunavut at which hazardous waste is stored, treated, recycled or disposed of for commercial purposes must be registered as a hazardous waste management facility. The owner or operator of a facility should refer to section 3.2.2 and Appendix 7 for further information.

It is a contravention of the *Environmental Protection Act* for hazardous waste to be abandoned or disposed of on land or into water in Nunavut. Although a detailed discussion on specific hazardous waste disposal methods is beyond the scope of the Guideline, the following are general points for consideration:

- Hazardous waste must not be mixed or diluted with another substance, or divided into smaller quantities, simply to avoid meeting the definition of a hazardous waste.
- The generator is responsible for determining how hazardous waste can be safely disposed of and to comply with all applicable statutes, regulations, standards, guidelines and local by-laws. The Department of Environment will provide advice and guidance on the management of hazardous waste. Other sources of information and assistance include:
    - Manufacturer or distributor of the new product;
    - Manufacturer's Material Safety Data Sheets (MSDS); and
    - Waste exchanges and associations, other regulatory authorities, waste management consultants and other qualified persons with expertise in the management of hazardous waste.
- Hazardous waste that meets standards set out in the Environmental Guideline for Industrial Waste Discharges may be directed to municipal landfills and sewage treatment systems for disposal. The local municipal government must be consulted and consent to the use of their facility prior to the waste being disposed. Waste that does not meet the standards set out in the Environmental Guideline for Industrial Waste Discharges must be treated prior to disposal or transported to a facility that is registered to accept the waste.
- The open burning of hazardous waste is not an acceptable practice as toxic substances may be released into the atmosphere.
- Incompatible hazardous waste should not be mixed, combined or stored together in the same container as new hazards may be created. Combining or mixing one waste with another waste may also prevent its reuse or recycling and increase disposal costs.
- Containers that previously held a hazardous waste must be emptied to the greatest extent practical or triple rinsed with an appropriate cleaning agent prior to disposal. The rinsings must then also be managed according to their waste characteristics. Cleaned containers should be rendered unusable by puncturing or crushing prior to disposal to prevent their reuse. This is especially important for containers that could be reused for water or food storage.

The Department of Environment will consider alternate hazardous waste management and disposal measures that provide an equivalent level of environmental protection to those identified in this Guideline.

2.2.4 Treatment and Disposal Outside Nunavut

Hazardous waste can be sent to a receiver or hazardous waste management facility located outside of Nunavut only where the receiver or facility has been registered in the receiving province or territory to

accept that waste. The generator must comply with all applicable statutes, regulations, standards, guidelines and local by-laws of the receiving jurisdiction.

Within Canada, Environment Canada monitors and controls the interprovincial movement of hazardous waste under the *Interprovincial Movement of Hazardous Waste Regulations*. Waste manifests must accompany each shipment of waste in accordance with the Transport Authorities' requirements. Generators and carriers should refer to section 3.3 of the Guideline for additional information on transport and waste manifest requirements.

The international movement of hazardous waste is controlled under the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. Known simply as the Basel Convention, it is an international treaty to control and reduce the transfer of hazardous waste from developed to less developed countries. Environment Canada monitors and controls the international movement of hazardous waste under the *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations*.

A listing of Canadian waste management facilities may be obtained by contacting the waste exchanges and other organizations listed in Appendix 10.

General Requirements

Hazardous waste is classified using the system developed under the *Transportation of Dangerous Goods Act (Canada)*. Wastes are categorized into one of nine classes according to their chemical, physical or biological properties. Each waste, or group of similar wastes, is then identified using a specific 'UN' number assigned under the *Transportation of Dangerous Goods Regulations*. Refer to Appendix 2 for additional information on dangerous goods classifications.

3.1 Storage

Storage refers to containment of a hazardous waste for transport, or while awaiting treatment and disposal. Except under extraordinary circumstances (i.e. radioactive materials), storage should always be considered as a temporary measure and is not acceptable for the long-term management of hazardous waste.

Recognition of the incompatibility of different wastes during storage is important in order to avoid the possibility of violent, explosive reactions and toxic fumes. Various systems have been developed to ensure compatible storage including the 'Hazardous Waste Compatibility Chart' adopted by the United States' Environmental Protection Agency[1].

3.1.1 Containers

Hazardous waste storage containers are designed to hold, store and transport small quantities of waste. Many different types of containers are available (i.e. barrels, bottles, bags and boxes) and are made from a variety of materials (i.e. aluminum, plastic, steel, and stainless steel). Selecting the proper container requires an understanding of the properties of the waste to be stored. If transport is to be undertaken, the generator should consult the Transport Authority to confirm the container meets all legislated requirements.

The following are additional general points for consideration:

- Hazardous waste should be stored in their original containers where possible or in containers specially manufactured for the purpose of storing hazardous waste. The containers must be sound, sealable and not damaged or leaking.
- Containers should be clearly labeled to identify their contents according to requirements of the Workplace Hazardous Materials Information System (WHMIS) and the relevant Transport Authority, if transport is planned.
- Small quantities of compatible hazardous waste should be bulked into 16 gauge or equivalent metal or plastic 205 litre (45 gallon) drums for the purpose of secondary containment.
- Containers should be closed and sealed at all times, except while waste is being added or removed.

[1] EPA-600/2-80-076 April 1980. A Method for Determining the Compatibility of Chemical Mixtures.

3.1.2 Facilities

A hazardous waste storage facility is a specially designed building or area that helps to ensure the safe and secure storage of hazardous waste. Detailed storage facility building designs are beyond the scope of the Guideline. The Department of Environment or other qualified person should be consulted prior to designing and constructing a storage facility.

The following are general points to consider when establishing a storage facility:

- The facility should meet all local and territorial siting and construction requirements and be readily accessible for fire fighting and other emergency responses. The local Fire Chief should be advised of the storage facility and its contents for emergency planning and response purposes.
- The facility should be secure. Access should be limited where practical to employees who have been trained in safety and emergency procedures. These procedures should be documented and a copy made available to those employees who have access to the facility.
- Inspections of the facility and stored wastes should be performed and recorded at least once every week.
- Containers should be placed so that each can readily and easily be inspected for signs of leakage, corrosion or deterioration. Leaking, corroded or deteriorated containers should immediately be removed and their contents transferred to a sound container.
- Records should be maintained indicating the type and quantity of waste being stored along with the date, type and quantity of hazardous waste brought into or removed from the facility.
- Drainage into and from the storage facility site should be controlled to prevent spills or leaks from leaving the site and to prevent run-off from entering the site.
- All waste should be stored on a firm working surface that is impervious to leaks.
- Incompatible waste must be stored in a manner that contact in the event of a spill or accidental release is not possible.
- Emergency response plans should be developed in cooperation with local emergency response personnel and emergency response equipment should be locally available in the event of a spill, fire or other emergency situation.

Where the facility is used for commercial purposes and is used to store hazardous waste for periods of 180 days or more or the quantity of waste stored on-site exceeds the criteria set out in Appendix 8, the facility must be registered with the Department of Environment as a hazardous waste management facility.

3.2 Registration

3.2.1 Hazardous Waste Generators, Carriers and Receivers

Generators, carriers and receivers of hazardous waste must be registered before undertaking activities involving these wastes. Completion of the approved form and submission of accurate information enables the Department of Environment to quickly complete the registration process. Registration enables the government to track the generation, transport and disposal of hazardous waste in Nunavut. It also provides assurance that the company has the necessary emergency response and spill

contingency plans in place should an accident or other incident occur involving a hazardous waste. Upon registration, the applicant will be assigned a unique identification number. This number is required in order to complete the waste manifest form.

Appendices 4, 5 and 6 provide samples of registration forms required for generators, carriers and receivers to apply for registration in Nunavut. Original forms and users' guides are available from Nunavut's Department of Environment or by downloading through the department's web site. Incomplete applications will result in delays in completing the registration process.

Generators and receivers of hazardous waste located in Nunavut must be registered with the Department of Environment. Carriers may be registered either in Nunavut or in the province or territory in which the company is based.

3.2.2 Hazardous Waste Management Facilities

A hazardous waste management facility is a facility or specially-designated area that is used for the collection, storage, transfer, treatment, recycling or disposal of hazardous waste for commercial purposes. Where the facility is used solely for the collection, storage or transfer of hazardous waste, the facility must be registered where waste is stored for a period of 180 days or more or the quantities exceed those set out in Appendix 8 of the Guideline. Where the facility is to be used for the treatment, recycling or disposal of hazardous waste, the facility must be registered where the quantity treated, recycled or disposed of in any single month exceeds a 'small quantity'.

The collection, storage, transfer, treatment, recycling or disposal of hazardous waste on behalf of a third-party does not remove the obligation of the owner or operator of a hazardous waste management facility to register the facility.

Appendix 7 includes a sample of the registration form required for the owner or operator of a hazardous waste management facility to apply for registration of the facility. The owner or operator may obtain an original form and users' guide by contacting Nunavut's Department of Environment or by downloading through the department's web site. Incomplete applications will result in delays in completing the registration process.

Registration of a hazardous waste management facility does not remove the obligation to comply with all other applicable municipal, territorial and federal statutes, regulations, standards, guidelines and by-laws. Guidance on planning for and achieving territorial environmental requirements for new industrial projects may be found in the *Environmental Guideline for Industrial Projects on Commissioner's Lands.*

3.3 Transportation

Carriers must ensure hazardous waste is packaged, documented, labeled and placarded in compliance with the method of transport used - road, rail, air or marine. A completed waste manifest must accompany each shipment of hazardous waste. Completion of the manifest together with proper marking and placarding of containers and vehicles enables police, ambulance, fire and other first responders to react effectively and safely in the event of a spill or other accident involving hazardous waste while in transit.

The transport of hazardous waste by road in Canada is controlled under the territorial and federal *Transportation of Dangerous Goods Acts* and the federal *Interprovincial Movement of Hazardous Waste Regulations* and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations.* These Acts and Regulations require that personnel are trained, containers and transport vehicles are labeled and placarded and a completed waste manifest accompanies each shipment. The generator, carrier and receiver must each complete their portion of the manifest form and provide copies to the Department of Environment at various stages in the transport process. Refer to Appendix 9 for a copy of the manifest. Original manifest forms are available from Nunavut's Department of Environment and completion instructions are included on the reverse side of each manifest. Further assistance in completing a waste manifest may be obtained by referring to the *User's Guide for the Hazardous Waste Manifest* produced by Environment Canada or by contacting the Motor Vehicles Division of the Department of Economic Development and Transportation.

The International Air Transport Association (IATA) requires that all shipments of hazardous wastes tendered to air carriers be accompanied by the IATA Shipper's Declaration of Dangerous Goods. The consignor is responsible for completion of the form in accordance with IATA requirements and to ensure all packaging, placarding and labeling is consistent with the product being transported.

The International Marine Dangerous Goods Code requires use of the International Marine Organization's Multimodal Dangerous Goods Form when transporting dangerous goods or hazardous waste by ship or barge.

Further information on transporting hazardous waste by air or marine can be obtained by contacting Transport Canada. Information and instructions on manifesting, placarding and labeling hazardous waste commonly generated in Nunavut can be obtained by referring to waste-specific guidelines produced by the Department of Environment. A complete listing of guidelines is available at http://env.gov.nu.ca/programareas/environmentprotection.

Conclusion

This is a general introduction to the risks associated with hazardous waste and is intended to inform the reader about the proper handling, storage and transportation of hazardous waste in Nunavut. Detailed guidance on the management of specific waste types can be obtained by referring to other guidelines developed by the Department of Environment.

For additional information on the management of hazardous waste, or to obtain a complete listing of available guidelines, contact the Department of Environment at:

Environmental Protection Division
Department of Environment
Government of Nunavut
Inuksugait Plaza, Box 1000, Station 1360
Iqaluit, Nunavut, X0A 0H0

Phone: (867) 975-7729
Fax: (867) 975-7739
Email: EnvironmentalProtection@gov.nu.ca
Website: http://env.gov.nu.ca/programareas/environmentprotection

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APPENDICES

APPENDIX 1 - *ENVIRONMENTAL PROTECTION ACT*

The following are excerpts from the *Environmental Protection Act*

1. "Contaminant" means any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment,
   (a) endangers the health, safety or welfare of persons,
   (b) interferes or is likely to interfere with normal enjoyment of life or property,
   (c) endangers the health of animal life, or
   (d) causes or is likely to cause damage to plant life or to property;

   "Discharge" includes, but not so as to limit the meaning, any pumping, pouring, throwing, dumping, emitting, burning, spraying, spreading, leaking, spilling, or escaping;

   "Environment" means the components of the Earth and includes
   (a) air, land and water,
   (b) all layers of the atmosphere,
   (c) all organic and inorganic matter and living organisms, and
   (d) the interacting natural systems that include components referred to in paragraphs (a) to (c).

   "Inspector" means a person appointed under subsection 3(2) and includes the Chief Environmental Protection Officer.

2.2 The Minister may
   (a) establish, operate and maintain stations to monitor the quality of the environment in the Territories;
   (b) conduct research studies, conferences and training programs relating to contaminants and to the preservation, protection or enhancement of the environment;
   (c) develop, co-ordinate and administer policies, standards, guidelines and codes of practice relating to the preservation, protection or enhancement of the environment;
   (d) collect, publish and distribute information relating to contaminants and to the preservation, protection or enhancement of the environment:

3. (1) The Minister shall appoint a Chief Environmental Protection Officer who shall administer and enforce this Act and the regulations.

   (2) The Chief Environmental Protection Officer may appoint inspectors and shall specify in the appointment the powers that may be exercised and the duties that may be performed by the inspector under this Act and regulations.

5. (1) Subject to subsection (3), no person shall discharge or permit the discharge of a contaminant into the environment.

   (3) Subsection (1) does not apply where the person who discharged the contaminant or permitted the discharge of the contaminant establishes that
   (a) the discharge is authorized by this Act or the regulations or by an order issued under this Act or the regulations;
   (b) the contaminant has been used solely for domestic purposes and was discharged from within a dwelling house;
   (c) the contaminant was discharged from the exhaust system of a vehicle;
   (d) the discharge of the contaminant resulted from the burning of leaves, foliage, wood, crops or stubble for domestic or agricultural purposes;

(e) the discharge of the contaminant resulted from burning for land clearing or land grading;
(f) the discharge of the contaminant resulted from a fire set by a public official for habitat management of silviculture purposes;
(g) the contaminant was discharged for the purposes of combating a forest fire;
(h) the contaminant is a soil particle or grit discharged in the course of agriculture or horticulture; or
(i) the contaminant is a pesticide classified and labelled as "domestic" under the *Pest Control Products Regulations* (Canada).

(4) The exceptions set out in subsection (3) do not apply where a person discharges a contaminant that the inspector has reasonable grounds to believe is not usually associated with a discharge from the excepted activity.

5.1. Where a discharge of a contaminant into the environment in contravention of this Act or the regulations or the provisions of a permit or license issued under this Act or the regulations occurs or a reasonable likelihood of such a discharge exists, every person causing or contributing to the discharge or increasing the likelihood of such a discharge, and the owner or the person in charge, management or control of the contaminant before its discharge or likely discharge, shall immediately:
(a) subject to any regulations, report the discharge or likely discharge to the person or office designated by the regulations;
(b) take all reasonable measures consistent with public safety to stop the discharge, repair any damage caused by the discharge and prevent or eliminate any danger to life, health, property or the environment that results or may be reasonably expected to result from the discharge or likely discharge; and
(c) make a reasonable effort to notify every member of the public who may be adversely affected by the discharge or likely discharge.

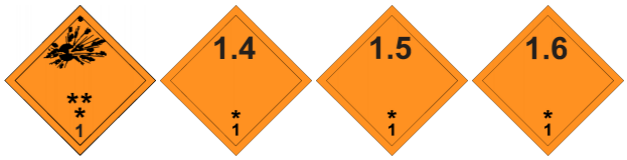
6. **(**1) Where an inspector believes on reasonable grounds that a discharge of a contaminant in contravention of this Act or the regulations or a provision of a permit or license issued under this Act or the regulations has occurred or is occurring, the inspector may issue an order requiring any person causing or contributing to the discharge or the owner or the person in charge, management or control of the contaminant to stop the discharge by the date named in the order.

7. (1) Notwithstanding section 6, where a person discharges or permits the discharge of a contaminant into the environment, an inspector may order that person to repair or remedy any injury or damage to the environment that results from the discharge.

(2) Where a person fails or neglects to repair or remedy any injury or damage to the environment in accordance with an order made under subsection (1) or where immediate remedial measures are required to protect the environment, the Chief Environmental Protection Officer may cause to be carried out the measures that he or she considers necessary to repair or remedy an injury or damage to the environment that results from any discharge.

APPENDIX 2 - DANGEROUS GOODS CLASSIFICATIONS

Class 1 – Explosives[1]



Class 2 – Compressed Gases
Division 2.1 – Flammable Gases
Division 2.2 – Non-flammable and Non-toxic Gases
Division 2.3 – Poison Gases

Class 3 - Flammable Liquids

Class 4 – Flammable Solids
Division 4.1 – Flammable Solids
Division 4.2 – Spontaneously Combustible
Division 4.3 – Water Reactive

Class 5 - Oxidizing Substances and Organic Peroxides
Division 5.1 – Oxidizing Substances
Division 5.2 – Organic Peroxides

Class 6 - Toxic and Infectious Substances
Division 6.1 – Toxic Substances
Division 6.2 – Infectious Substances

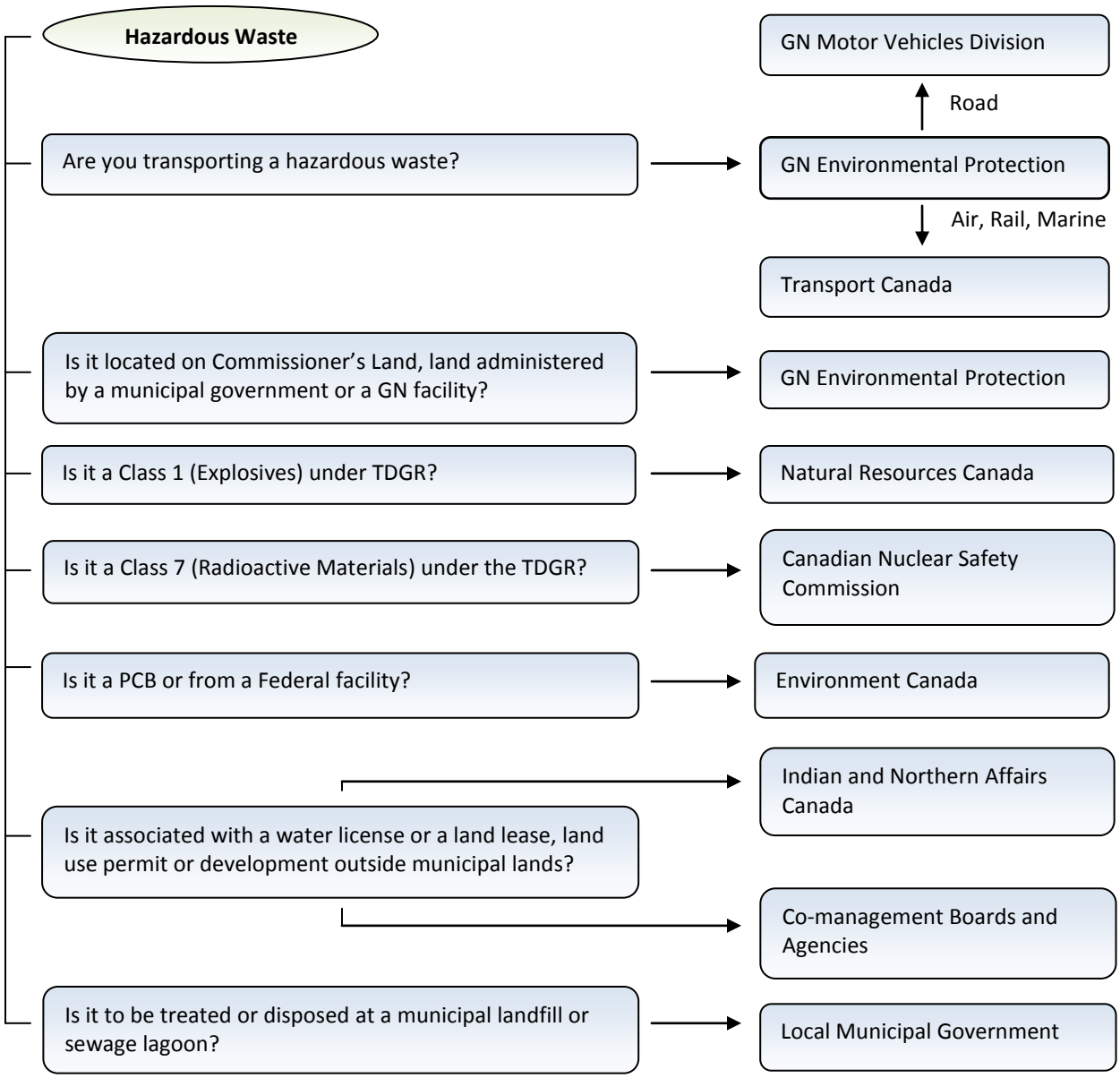
Class 7 - Radioactive Materials[2]

Class 8 - Corrosives

Class 9 - Miscellaneous

1. Class 1 substances (Explosives) are regulated by Natural Resources Canada under the *Explosives Act*.
2. Class 7 substances (Radioactive Materials) are regulated by the Canadian Nuclear Safety Commission under the *Nuclear Safety and Control Act* and *Nuclear Liability Act*.

APPENDIX 3 - DETERMINING REGULATORY AGENCY CONTACTS



APPENDIX 4 – REGISTRATION FORM – HAZARDOUS WASTE GENERATOR

A copy of the generator registration form and users' guide is available by contacting the Department of Environment or by downloading at http://env.gov.nu.ca/programareas/environmentprotection.

Instructions

1. The following information must be provided in order to register as a hazardous waste generator in Nunavut and to obtain a generator number. Incomplete applications will be returned to the applicant.
2. Completed registration forms are to be forwarded to the Manager of Pollution Control, Department of Environment, Government of Nunavut, Box 1000, Station 1360, Iqaluit, Nunavut, X0A 0H0. Electronic registration forms are preferred and may be forwarded to EnvironmentalProtection@gov.nu.ca.
3. Use additional pages to provide information as required.
4. Applicants should refer to the accompanying users' guide for further assistance on completing the generator registration form.

Section 1 - Identification

Generator (Legal Name) _____

Mailing Address _____ Postal Code _____

Principle Contact Person _____ Title _____

Phone _____ Email _____

Alternate Contact Person _____ Title _____

Phone _____ Email _____

Section 2 - Description of Waste Generated (provide a separate table if required)

Site Location(s) where Waste is Generated _____

Shipping Name (Description)	TDG Number	TDG Class	Quantity Generated each Month (L or Kg)	Frequency of Generation

Section 3 - Waste Management Information

General Type of Business _____

Source of Waste _____

Hazardous Waste Carrier(s) Used _____

Hazardous Waste Receiver(s) Used _____

Do you have an approved Emergency Response and Spill Contingency Plan? Yes ____ (attach copy) No _____

Section 4 - Certification

I certify that the information provided on this form is correct, accurate and complete.

Signature of Contact Person _____ Date (dd/mm/yy) _____

Print Name of Contact Person _____ Title _____

Phone _____ Email _____

For Department Use Only
Generator Number NUG# _____ Approved by _____ Date _____

APPENDIX 5 – REGISTRATION FORM – HAZARDOUS WASTE CARRIER

A copy of the carrier registration form and users' guide is available by contacting the Department of Environment or by downloading at http://env.gov.nu.ca/programareas/environmentprotection.

Instructions

1. The following information must be provided in order to register as a hazardous waste carrier in Nunavut and to obtain a carrier number. Incomplete applications will be returned to the applicant.
2. Completed registration forms are to be forwarded to the Manager of Pollution Control, Department of Environment, Government of Nunavut, Box 1000, Station 1360, Iqaluit, Nunavut, X0A 0H0. Electronic registration forms are preferred and may be forwarded to EnvironmentalProtection@gov.nu.ca.
3. Use additional pages to provide information as required.
4. Applicants should refer to the accompanying users' guide for further assistance on completing the carrier registration form.

Section 1 - Identification

Carrier (Legal Name) _____

Corporate Address _____

Site (Dispatch) Address _____

Principle Contact Person _____ Title _____

Phone _____ Email _____

Alternate Contact Person _____ Title _____

Phone _____ Email _____

Section 2 - Description of Waste Transported (provide a separate table if required)

Shipping Name (Description)	TDG Number	TDG Class	Quantity Transported each Month (L or Kg)	Frequency of Transport

Section 3 - Waste Management Information

Mode of Transport (check all that apply) Road _____ Rail _____ Marine _____ Air _____

Hazardous Waste Generator(s) Used _____

Hazardous Waste Receiver(s) Used _____

Do you have an approved Emergency Response and Spill Contingency Plan? Yes _____ (attach copy) No _____

Section 4 - Certification

I certify that the information provided on this form is correct, accurate and complete.

Signature of Contact Person _____ Date (dd/mm/yy) _____

Print Name of Contact Person _____ Title _____

Phone _____ Email _____

For Department Use Only
Carrier Number NUC# _____ Approved by _____ Date _____

APPENDIX 6 – REGISTRATION FORM – HAZARDOUS WASTE RECEIVER

A copy of the receiver registration form and users' guide is available by contacting the Department of Environment or by downloading at http://env.gov.nu.ca/programareas/environmentprotection.

Instructions

1. The following information must be provided in order to register as a hazardous waste receiver in Nunavut and to obtain a receiver number. Incomplete applications will be returned to the applicant.
2. A receiver who operates a commercial business for the purpose of collecting, storing, transferring, treating, recycling or disposing of hazardous waste may be required to register the facility as a hazardous waste management facility. Refer to section 3.2.2 of the *Environmental Guideline for the General Management of Hazardous Waste* for further information.
3. Completed registration forms are to be forwarded to the Manager of Pollution Control, Department of Environment, Government of Nunavut, Box 1000, Station 1360, Iqaluit, Nunavut, X0A 0H0. Electronic registration forms are preferred and may be forwarded to EnvironmentalProtection@gov.nu.ca.
4. Use additional pages to provide information as required.
5. Applicants should refer to the accompanying users' guide for further assistance on completing the receiver registration form.

Section 1 - Identification

Receiver (Legal Name) _____

Mailing Address _____ Postal Code _____

Principle Contact Person _____ Title _____

Phone _____ Email _____

Alternate Contact Person _____ Title _____

Phone _____ Email _____

Section 2 - Description of Waste Received (provide a separate table if required)

Site Location(s) where Waste is Received _____

Shipping Name (Description)	TDG Number	TDG Class	Quantity Received each Month (L or Kg)	Frequency of Acceptance

Attach a brief description of the proposed facility.

Section 3 - Waste Management Information

General Type of Business _____

General Type of Activity _____

Hazardous Waste Generator(s) Used _____

Hazardous Waste Carriers(s) Used _____

Hazardous Waste Management Facilities Used _____

Do you have an approved Emergency Response and Spill Contingency Plan? Yes _____ (attach copy) No _____

Section 4 - Certification

I certify that the information provided on this form is correct, accurate and complete.

Signature of Contact Person _____ Date (dd/mm/yy) _____

Print Name of Contact Person _____ Title _____

Phone _____ Email _____

For Department Use Only
Receiver Number NUR# _____ Approved by _____ Date _____

APPENDIX 7
REGISTRATION FORM – HAZARDOUS WASTE MANAGEMENT FACILITY

A copy of the management facility registration form and users' guide is available by contacting the Department of Environment or by downloading at http://env.gov.nu.ca/programareas/environmentprotection.

Instructions

1. The following information must be provided in order to register as a hazardous waste management facility in Nunavut and obtain a management facility number. Incomplete applications will be returned to the applicant.
2. Completed registration forms are to be forwarded to the Manager of Pollution Control, Department of Environment, Government of Nunavut, Box 1000, Station 1360, Iqaluit, Nunavut, X0A 0H0. Electronic registration forms are preferred and may be forwarded to EnvironmentalProtection@gov.nu.ca.
3. Use additional pages to provide information as required.
4. Applicants should refer to the accompanying users' guide for further assistance on completing the management facility registration form.

Section 1 - Identification

Applicant (Legal Name) _____

Corporate Address _____

Facility Address _____

Principle Contact Person _____ Title _____

Phone _____ Email _____

Alternate Contact Person _____ Title _____

Phone _____ Email _____

Section 2 - Description of Waste to be Managed (provide a separate table if required)

Site Location(s) where Waste is Managed _____

Shipping Name (Description)	TDG Number	TDG Class	Quantity Managed each Month (L or Kg)	Frequency of Acceptance

Attach a complete description of the proposed facility, safety measures, equipment and management processes to be used. Include engineered drawing where applicable.

Section 3 - Waste Management Information

General Type of Business (check all that apply) Receiver of Waste _____ Manage Self-generated Waste _____

Type of Activity (check all that apply) Collect and Store _____ Transfer _____

Treat _____ Recycle _____ Dispose _____

Hazardous Waste Generator(s) Used _____

Hazardous Waste Carriers(s) Used _____

Do you have an approved Emergency Response and Spill Contingency Plan? Yes _____ (attach copy) No _____

Section 4 - Certification

I certify that the information provided on this form is correct, accurate and complete.

Signature of Contact Person _____ Date (dd/mm/yy) _____

Print Name of Contact Person _____ Title _____

Phone _____ Email _____

For Department Use Only
Management Facility Number NUF# _____ Approved by _____ Date _____

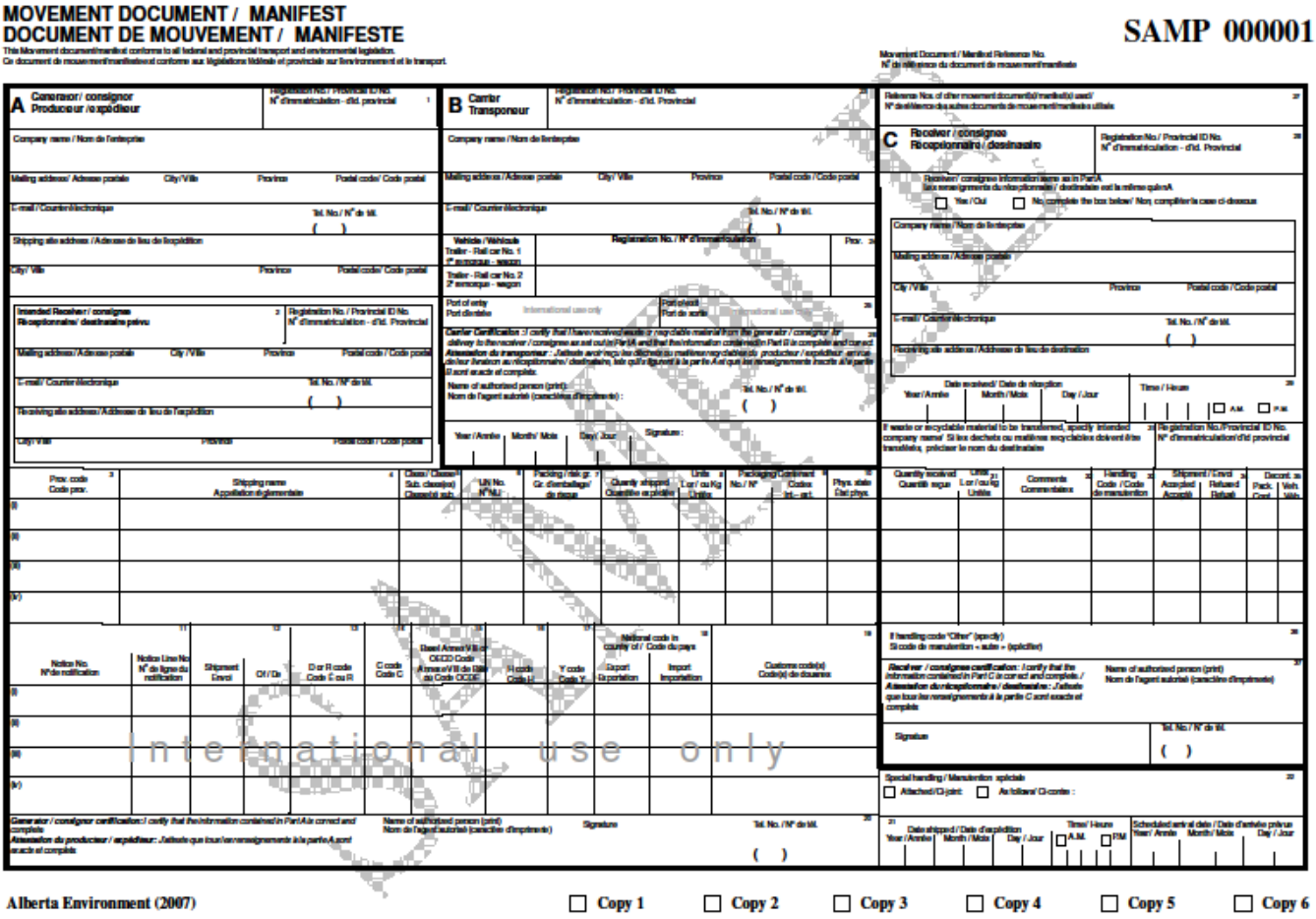
APPENDIX 8 - CRITERIA FOR REGISTERING A HAZARDOUS WASTE MANAGEMENT FACILITY

A facility must be registered with the Department of Environment as a hazardous waste management facility where it is used for commercial purposes to store hazardous waste for a period of 180 days or more or the quantity of hazardous waste[1] stored on-site at any one time exceeds the criteria established in the following table. Where the facility is to be used for the treatment, recycling or disposal of hazardous waste, the facility must be registered as a hazardous waste management facility where the quantity treated, recycled or disposed of each month exceeds a 'small quantity'[2].

	Description	**Quantity[3] (Kg or L)**
Class 1	Explosives	50
Class 2	Division 2.1 – Flammable Gases	500[4]
	Division 2.2 – Non-flammable and Non-toxic Gases	5000[4]
	Division 2.3 – Poison Gases	200[4]
Class 3	Flammable Liquids	4000
Class 4	Division 4.1 – Flammable Solids	5000
	Division 4.2 – Spontaneously Combustible	1000
	Division 4.3 – Water Reactive	500
Class 5	Division 5.1 – Oxidizing Substances	1000
	Division 5.2 – Organic Peroxides	50
Class 6	Division 6.1 – Toxic Substances	1000
	Division 6.2 – Infectious Substances	500[4]
Class 7	Radioactive Materials	Any amount
Class 8	Corrosives	1000
Class 9	Miscellaneous	1000
	PCB Materials	50
	Environmentally Hazardous Substance Solid – UN3077	5000
All Classes	Total Aggregate Quantity	5000

1. Applies to hazardous waste only and not to dangerous goods.
2. Small quantity means hazardous waste that is generated in an amount that is less than five kilograms per month if a solid or less than five litres per month if a liquid, and where the total quantity accumulated at any one time does not exceed five kilograms or five litres. This does not include hazardous waste that is mercury or Class 2.3, 5.1 or 6.1 materials. These wastes must be generated in an amount that is less than one kilogram per month if a solid or less than one litre per month if a liquid, and where the total quantity accumulated at any one time does not exceed one kilogram or one litre.
3. Quantity applies to solids when expressed in kilograms (kg) and liquids when expressed in litres (L).
4. Total liquid capacity of the container.

APPENDIX 9 – HAZARDOUS WASTE MANIFEST



MOVEMENT DOCUMENT / MANIFEST
DOCUMENT DE MOUVEMENT / MANIFESTE

SAMP 000001

This Movement document/manifest conforms to all federal and provincial transport and environmental legislation.
Ce document de mouvement/manifeste est conforme aux législations fédérale et provinciale sur l'environnement et le transport.

Movement Document / Manifest Reference No.
N° de référence du document de mouvement/manifeste

A Generator / consignor
Producteur / expéditeur

Registration No./ Provincial ID No.
N° d'immatriculation - d'id. provincial

Company name / Nom de l'entreprise

Mailing address/ Adresse postale | City/ Ville | Province | Postal code/ Code postal

E-mail / Courriel électronique | Tel. No. / N° de tél.

Shipping site address / Adresse de lieu de l'expédition

City/ Ville | Province | Postal code/ Code postal

Intended Receiver / consignee
Récipiendaire/ destinataire prévu

Registration No. / Provincial ID No.
N° d'immatriculation - d'id. Provincial

Mailing address/ Adresse postale | City/ Ville | Province | Postal code / Code postal

E-mail/ Courriel électronique | Tel. No. / N° de tél.

Receiving site address / Address de lieu de l'expédition

City/ Ville | Province | Postal code / Code postal

B Carrier
Transporteur

Registration No./ Provincial ID No.
N° d'immatriculation - d'id. Provincial

Company name / Nom de l'entreprise

Mailing address / Adresse postale | City/ Ville | Province | Postal code / Code postal

E-mail/ Courriel électronique | Tel. No. / N° de tél.

Vehicle / Véhicule
Trailer - Rail car No. 1
1er remorque - wagon
Trailer - Rail car No. 2
2e remorque - wagon

Registration No. / N° d'immatriculation | Prov.

Port of entry
Port d'entrée
International use only

Port of exit
Port de sortie
International use only

Carrier Certification: I certify that I have received waste or recyclable material from the generator / consignor for delivery to the receiver / consignee as set out in Part A and that the information contained in Part B is complete and correct.
Attestation du transporteur : J'atteste avoir reçu les déchets ou matières recyclables du producteur / expéditeur en vue de leur livraison au récipiendaire / destinataire, tels qu'ils figurent à la partie A et que les renseignements inscrits à la partie B sont exacts et complets.

Name of authorized person (print)
Nom de l'agent autorisé (caractères d'imprimerie) :

Tel. No. / N° de tél.
( )

Year / Année | Month / Mois | Day / Jour | Signature :

C Receiver / consignee
Récipiendaire / destinataire

Registration No. / Provincial ID No.
N° d'immatriculation - d'id. Provincial

Receiver / consignee information same as in Part A
Les renseignements du récipiendaire / destinataire sont la même que ceux de la partie A
☐ Yes / Oui ☐ No, complete the box below / Non, compléter la case ci-dessous

Company name / Nom de l'entreprise

Mailing address / Adresse postale

City / Ville | Province | Postal code / Code postal

E-mail / Courriel électronique | Tel. No. / N° de tél.
( )

Receiving site address / Address de lieu de destination

Date received / Date de réception
Year / Année | Month / Mois | Day / Jour

Time / Heure
☐ A.M. ☐ P.M.

If waste or recyclable material to be transferred, specify intended company name/ Si les déchets ou matières recyclables doivent être transférés, préciser le nom du destinataire

Registration No./Provincial ID No.
N° d'immatriculation/d'id provincial

Prov. code Code prov.	Shipping name Appellation réglementaire	Class/ Classe Sub. class(es) Classe(s) sub.	UN No. N° NU	Packing / Risk gr. Gr. d'emballage/ de risque	Quantity shipped Quantité expédiée	Units L or / ou Kg Unités	Packaging/ Contained No. / N°	Packaging/ Contained Codes Int. – ext.	Phys. state Etat phys.
(i)									
(ii)									
(iii)									
(iv)									

Quantity received Quantité reçue	Units L or / ou Kg Unités	Comments Commentaires	Handling Code / Code de manutention	Shipment / Load Accepted Accepté	Shipment / Load Refused Refusé	Decont. as Pack. Cont.	Decont. as Veh. Véh.

Notice No. N° de notification	Notice Line No. N° de ligne de notification	Shipment Load	Ot / De	D or R code Code D ou R	C code Code C	Basel Annex VIII or OECD Code Annexe VIII de Bâle ou Code OCDE	H code Code H	Y code Code Y	National code in country of / Code du pays Export Exportation	National code in country of / Code du pays Import Importation	Customs code(s) Code(s) de douane
(i)											
(ii)											
(iii)											
(iv)											

If handling code "Other" (specify)
Si code de manutention « autre » (spécifier)

Receiver / consignee certification: I certify that the information contained in Part C is correct and complete. / Attestation du récipiendaire / destinataire : J'atteste que tous les renseignements à la partie C sont exacts et complets

Name of authorized person (print)
Nom de l'agent autorisé (caractères d'imprimerie)

Signature | Tel. No. / N° de tél. ( )

Special handling / Manutention spéciale
☐ Attached / Ci-joint ☐ As follows / Ci-contre :

Generator / consignor certification: I certify that the information contained in Part A is correct and complete.
Attestation du producteur / expéditeur : J'atteste que tous les renseignements à la partie A sont exacts et complets

Name of authorized person (print)
Nom de l'agent autorisé (caractères d'imprimerie)

Signature | Tel. No. / N° de tél. ( )

Date shipped / Date d'expédition
Year / Année | Month / Mois | Day / Jour

Time / Heure
☐ A.M. ☐ P.M.

Scheduled arrival date / Date d'arrivée prévue
Year / Année | Month / Mois | Day / Jour

International use only

Alberta Environment (2007)

☐ Copy 1 ☐ Copy 2 ☐ Copy 3 ☐ Copy 4 ☐ Copy 5 ☐ Copy 6

APPENDIX 10 - WASTE EXCHANGES AND ASSOCIATIONS

The concept of exchanging waste began in Canada in the 1980s. It involves the transfer of unwanted, overstocked, obsolete, damaged, contaminated or post-dated material and waste to another company or person who would reuse it. Various waste exchanges and associations have been established in Canada to facilitate these transfers. Several, but not all, waste exchanges and associations are listed below.

Northern Territories Water and Waste Association
201, 4817- 49 Street
Yellowknife, Northwest Territories X1A 3S7
(867) 873-4325
http://www.ntwwa.com

Recycling Council of British Columbia
Unit #10, 119 West Pender Street
Vancouver, British Columbia V6B 1S5
(604) 683-6009
http://www.rcbc.bc.ca

Alberta Waste Materials Exchange
Building #350, 6815 Eighth Street NE
Calgary, Alberta T2E 7H7
(403) 297-7505

Calgary Materials Exchange
809 Fourth Avenue NE
Calgary, Alberta T2P 0K5
(403) 230-1443
http://www.cmex.ca

Saskatchewan Waste Materials Exchange
515 Henderson Drive.
Regina, Saskatchewan S4N 5X1
(306) 787-9800

Manitoba Waste Exchange
1329 Niakwa Road
Winnipeg, Manitoba R2J 3T4
(204) 257-3891

Ontario Waste Exchange
OCETA 63 Polson Street, 2nd floor
Toronto, Ontario M5A 1A4
(416) 778-4199
http://www.owe.org

Canadian Waste Materials Exchange
2395 Spearman Drive
Mississauga, Ontario L5K 1B3
(416) 822-4111

Canadian Chemical Exchange
900 Blondin
Ste-Adele, Quebec J0R 1L0
(450) 229-6511
http://www.stobec.com

Quebec Waste Materials Exchange
14 Place du Commerce, Bureau 350
Le-des-Squeurs, Quebec H3E 1T5
(514) 762-9012

APPENDIX 11 – GOVERNMENT CONTACTS

Government of Nunavut

Environmental Protection Division
Department of Environment
Inuksugait Plaza
P.O. Box 1000, Station 1360
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-7729 Fax: (867) 975-7739

Workers' Safety and Compensation Commission
P.O. Box 669
Baron Building/1091
Iqaluit, Nunavut X0A 0H0
Telephone: 1-877-404-4407 (toll free) Fax: 1-866-979-8501

Office of Chief Medical Health Officer of Health
Department of Health and Social Services
P.O. Box 1000, Station 1000
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-5774 Fax: (867) 975-5755

Motor Vehicles Division
Department of Economic Development and Transportation
P.O. Box 10
Gjoa Haven, Nunavut X0B 1J0
Telephone: (867) 360-4615 Fax: (867) 360-4619

Department of Community and Government Services (all Divisions)
P.O. Box 1000, Station 700
4th Floor, W.G. Brown Building
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-5400 Fax: (867) 975-5305

Government of Canada

Indian and Northern Affairs – Nunavut Region
P.O. Box 2200
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-4500 Fax: (867) 975-4560

Department of Transport – Road, Rail, Marine, Air
P.O. Box 8550
344 Edmonton Street
Winnipeg, Manitoba R3C 1P6
Telephone: 1-888-463-0521 (toll free)
Fax: (204) 983-8992 Road, Rail and Marine only
Fax: (204) 983-1734 Air only

Environment Canada (NWT and Nunavut)
5019 52nd Street
Yellowknife, Northwest Territories X1A 1T5
Telephone: (867) 669-4730 Fax: (867) 873-8185

APPENDIX D

ENVIRONMENTAL GUIDELINE FOR WASTE ASBESTOS

Environmental Guideline for

Waste Asbestos

Department of Environment
Government of Nunavut

GUIDELINE: WASTE ASBESTOS

Original: January 2002
Revised: January 2011

This Guideline has been prepared by the Department of Environment's Environmental Protection Division and approved by the Minister of Environment under the authority of Section 2.2 of the *Environmental Protection Act.*

This Guideline is not an official statement of the law and is provided for guidance only. Its intent is to increase the awareness and understanding of the risks, hazards and best management practices associated with waste asbestos. This Guideline does not replace the need for the owner or person in charge, management or control of the waste to comply with all applicable legislation and to consult with Nunavut's Department of Environment, other regulatory authorities and qualified persons with expertise in the management of waste asbestos.

Copies of this Guideline are available upon request from:

Department of Environment
Government of Nunavut
P.O. Box 1000, Station 1360, Iqaluit, NU, X0A 0H0
Electronic version of the Guideline is available at http://env.gov.nu.ca/programareas/environmentprotection

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Centre – Public Domain
Right – Arun District Council, United Kingdom

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Appendices

Introduction

Asbestos is the commercial term given to a group of silicate minerals that occur naturally in the environment. These minerals have separable long fibers that are heat resistant, strong and flexible enough to be woven or spun. Because of these characteristics, asbestos has been used in a wide range of manufactured products, mostly in building materials (i.e. roofing shingles, ceiling and floor tiles, wallboard, clapboard and asbestos cement products), friction products (i.e. automobile clutch, brake and transmission parts) and heat resistant insulation, fabrics, packaging, gaskets and coatings. Loose-fill vermiculite insulation may also contain small amounts of asbestos.

During the 1980s the health and safety risks associated with asbestos started to become known. As a result, the use of asbestos was banned or phased out throughout North America. Asbestos products may still be found when buildings are being renovated or demolished, or when carrying out repairs on older vehicles and electrical appliances.

Although asbestos is typically considered to be a human health hazard, the route of exposure is through breathing air and drinking water that contain the very small asbestos fibres. The *Environmental Guideline for Waste Asbestos* (the Guideline) provides information on the characteristics and potential environmental and human health effects of waste asbestos and guidance on its proper storage, handling and removal, transportation and disposal. It is not an official statement of the law. For further information and guidance, the owner or person in charge, management or control of waste asbestos is encouraged to review all applicable legislation and consult the Department of Environment, other regulatory agencies or qualified persons with expertise in the management of waste asbestos.

The *Environmental Protection Act* enables the Government of Nunavut to implement measures to preserve, protect and enhance the quality of the natural environment. Section 2.2 of the *Act* provides the Minister with authority to develop, coordinate, and administer the Guideline.

1.1 Definitions

Asbestos	A commercial term given to naturally occurring fibrous silicate minerals including crocidolite, amosite, chrysotile, fibrous anthophyllite, tremolite, actinolite and mysorite.
Commissioner's Land	Lands that have been transferred by Order-in-Council to the Government of Nunavut. This includes roadways and land subject to block land transfers. Most Commissioner's Land is located within municipalities.
Contaminant	Any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment, (a) endangers the health, safety or welfare of persons, (b) interferes or is likely to interfere with normal enjoyment of life or property, (c) endangers the health of animal life, or (d) causes or is likely to cause damage to plant life or to property.

Dangerous Good	Any product, substance or organism included by its nature or by the *Transportation of Dangerous Goods Regulations* in any of the classes listed in the schedule provided in the *Transportation of Dangerous Goods Act*.
Environment	The components of the Earth and includes (a) air, land and water, (b) all layers of the atmosphere, (c) all organic and inorganic matter and living organisms, and (d) the interacting natural systems that include components referred to in paragraphs (a) to (c) above.
Friable Waste Asbestos	Waste asbestos which can be crumbled by hand pressure when it is dry.
Minister	The Minister of Environment of the Government of Nunavut.
Qualified Person	A person who has an appropriate level of knowledge and experience in all relevant aspects of waste management.
Responsible Party	The owner or person in charge, management or control of the waste.
Transport Authority	The statute and regulations controlling the management of hazardous waste under that mode of transport. These include (a) Road and Rail - *Transportation of Dangerous Goods Act* (Canada) and *Regulations; Interprovincial Movement of Hazardous Waste Regulations and Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations*. (b) Air – *International Air Transport Association (IATA) Dangerous Goods Regulations* and *International Civil Aviation Organization* (ICAO) *Technical Instructions;* and (c) Marine – *International Maritime Dangerous Goods Code* (IMDG).
Waste Asbestos	A substance containing asbestos in a concentration greater than 1% by weight that is no longer wanted or is unusable for its intended purpose and is intended for storage or disposal. Waste asbestos does not include asbestos that is immersed or fixed in a natural or artificial binder.

1.2 Roles and Responsibilities

1.2.1 Department of Environment

The Environmental Protection Division is the key environmental agency responsible for ensuring parties properly manage waste asbestos and will provide advice and guidance on its management. Authority is derived from the *Environmental Protection Act*, which prohibits the discharge of contaminants to the environment and enables the Minister to undertake actions to ensure appropriate management measures are in place. Although programs and services are applied primarily to activities taking place on Commissioner's and municipal lands and to Government of Nunavut undertakings, the *Environmental Protection Act* may be applied to the whole of the territory where other controlling legislation, standards and guidelines do not exist. A complete listing of relevant legislation and guidelines can be

obtained by contacting the Department of Environment or by visiting the web site at http://env.gov.nu.ca/programareas/environmentprotection.

1.2.2 Generators of Waste Asbestos

The owner or person in charge, management or control of waste asbestos is known as the responsible party. In general, the responsible party must ensure asbestos is properly and safely managed from the time it is produced to its final disposal. This is referred to as managing the waste from cradle-to-grave. Information on the general management of hazardous waste in Nunavut, including generator, carrier and receiver responsibilities, can be obtained by referring to the *Environmental Guideline for the General Management of Hazardous Waste*.

Contractors may manage unwanted or waste asbestos on behalf of the responsible party. However, the responsible party remains liable for ensuring the method of management complies with all applicable statutes, regulations, standards, guidelines and local by-laws. If the contractor does not comply with the requirements of the *Environmental Protection Act* and is charged with a violation while managing the waste, the responsible party may also be charged.

1.2.3 Other Regulatory Agencies

Other regulatory agencies may have to be consulted regarding the management of waste asbestos as there may be other environmental or public and worker health and safety issues to consider.

Workers' Safety and Compensation Commission

The Workers' Safety and Compensation Commission is responsible for promoting and regulating worker and workplace health and safety in Nunavut. The Commission derives its authority from the *Workers' Compensation Act* and *Safety Act* which require an employer to maintain a safe workplace and ensure the safety and well being of workers. The *Asbestos Safety Regulations* provide specific requirements for the safe handling of asbestos in the workplace and for medical surveillance of workers.

Department of Community and Government Services

The Department of Community and Government Services is responsible under the *Commissioners' Lands Act* for the issuance of land leases, reserves, licenses and permits on Commissioner's Lands. The Department, in cooperation with communities, is also responsible for the planning and funding of municipal solid waste and sewage disposal facilities in most Nunavut communities.

Department of Health and Social Services

Activities related to the handling and management of waste asbestos may have an impact on public health. The Office of the Chief Medical Officer of Health and Regional Environmental Health Officers should be consulted regarding legislated requirements under the *Public Health Act.*

Department of Economic Development and Transportation

The Motor Vehicles Division of the Department of Economic Development and Transportation is responsible for the safe transport of hazardous waste and other dangerous goods by road through administration of the *Transportation of Dangerous Goods Act*. The Department is also responsible under the *Motor Vehicles Act* for driver licensing and various other vehicle and road safety matters.

Environment Canada

Environment Canada is responsible for administering the *Canadian Environmental Protection Act* (CEPA)[1] and for regulating the interprovincial and international movement of hazardous waste, including waste asbestos, under the *Interprovincial Movement of Hazardous Waste Regulations* and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations*. Environment Canada is also responsible for administering the pollution prevention provisions of the federal *Fisheries Act*.

Indian and Northern Affairs Canada

Indian and Northern Affairs Canada is responsible under the *Territorial Lands Act* and *Nunavut Waters and Nunavut Surface Rights Tribunal Act* for the management of federal lands and waters, including the impact waste asbestos may have on the quality of these lands and waters.

Local Municipal Governments

The role of municipal governments is important in the proper local management of waste asbestos. Under the Nunavut Land Claims Agreement, municipalities are entitled to control their own municipal disposal sites. Unwanted waste may be deposited into municipal landfill sites and sewage lagoons only with the consent of the local government. The local fire department may also be called upon if a fire or other public safety issue involving asbestos is identified.

Co-management Boards and Agencies

Co-management boards and agencies established under the Nunavut Land Claims Agreement have broad authority for land use planning, impact assessment and the administration of land and water. Activities involving the management and disposal of waste asbestos may be controlled through the setting of terms and conditions in plans, permits and licenses issued by the Nunavut Water Board and other co-management boards and agencies.

[1] Asbestos is listed in Schedule 1 of the *Canadian Environmental Protection Act* as being a 'Toxic Substance"

Characteristics and Potential Effects of Asbestos

2.1 Characteristics

Asbestos is a naturally occurring silicate mineral with several unusual properties. Its long flexible silky fibres are strong enough to be spun or woven into a variety of blanket-like products. It is resistant to high temperatures, chemical corrosion and wear. A poor conductor of electricity, asbestos also insulates well against heat and electricity. This combination of properties gives asbestos performance characteristics that are difficult to match and, as a result, it has been used in a wide range of manufactured products over the years including building materials (i.e. roofing shingles, ceiling and floor tiles, wallboard, clapboard and asbestos cement products), various automotive friction products (i.e. clutch, brake and transmission parts) as well as heat resistant insulation, fabrics, packaging, gaskets and coatings. Although asbestos use was either banned or largely phased out in North America starting in the mid 1980s, it can still be found in many older buildings, vehicles and appliances. Appendix 3 provides a listing of products that have been manufactured in the past using asbestos.

Figure 1 - Anthophyllite Asbestos Fibres
Source: Public Domain

2.2 Potential Effects on Environment and Human Health

Asbestos fibres are stable and do not break down into other compounds in soil, evaporate into air or dissolve in water. In other words, the basic silicate structure of the flbre remains largely intact in the environment. Small diameter fibres may remain suspended in air and water and be carried long distances while larger fibres tend to be deposited more quickly. Asbestos fibres are not able to move through soil.

Human exposure to asbestos occurs when the asbestos-containing material is disturbed in some way so as to release fibres into the air and water. Small amounts can also be released to the environment through the breakdown of natural deposits. Health risks occur when fibres are present in drinking water and in the air that people breathe. When inhaled, asbestos fibres can cause asbestosis (a scarring of the lungs which makes breathing difficult), lung cancer and mesothelioma (a rare cancer of the lining of the chest or abdominal cavity). The risk of contracting an asbestos related disease is greatest when fibre concentrations in the air are high and the exposure period is long, such as in the workplace. Smoking combined with asbestos inhalation also greatly increases the risk of lung cancer.

Waste Management

Minimizing or avoiding the creation of pollutants and wastes can be more effective in protecting the environment than treating or cleaning them up after they have been created.[2]

3.1 Pollution Prevention

Pollution prevention is a term used to describe methods and practices that minimize or eliminate the generation of waste. If asbestos is known to be present, removal of the asbestos material should only be undertaken by a qualified person and only when the material is beyond repair or, if it is in a building, when the building is undergoing renovation or demolition. Asbestos that is not disturbed or deteriorated does not, in general, pose a risk to human health and can be left alone.

Other pollution prevention opportunities for waste asbestos include:

Reduce

- Replace asbestos-containing materials with less hazardous materials. A number of materials have been developed as replacements for asbestos in manufactured products including fiberglass, carbon and graphite fibres and PTFE (polytetra fluroethylene).

Reuse

- Encapsulate existing asbestos material by sealing with paint or an epoxy product or cover the material with paneling or other non-asbestos product. The Workers' Safety and Compensation Commission, Chief Medical Officer of Health and your Regional Environmental Health Officer must be consulted prior to encapsulating or sealing existing asbestos material.
- Friable asbestos materials should never be reused for any purpose once it has been removed. Non-friable asbestos materials (i.e. asbestos cementous board) can only be re-used if it remains intact and unbroken. This will extend the life of the product and reduce replacement costs.

Public and commercial building and home owners should keep an inventory of asbestos material so as to inform users, contractors and regulatory and municipal authorities in the event of renovation or demolition activities or an emergency (i.e. fire).

3.2 Handling and Removal

The safe handling and removal of asbestos requires a thorough understanding of the potential risks and knowledge of abatement measures. As long as the asbestos fibres remain enclosed or tightly bound in the material, the fibres will not be released to the air and there is no significant health risk. However, asbestos materials that are disturbed, broken or removed can result in the release of fibres if adequate safety measures are not in place. Unfortunately, simply looking at the material may not confirm whether asbestos is present. If in doubt, have the material analyzed by a qualified person.

Homeowners should contact the Chief Medical Health Officer or Regional Environmental Health Officer before handling material that contains asbestos. Check the material regularly for any sign of damage or wear and have renovations or asbestos removal carried out by a trained and qualified person.

[2] Source – Canadian Council of Ministers of the Environment.

The *Asbestos Safety Regulations* provide employers with specific requirements for the safe handling of asbestos in the workplace. The *Regulations* require that employers:

- Provide workers with protective respiratory equipment, clothing and eye protection.
- Enclose the work area and ventilate the air using filtering equipment.
- Post warning signs and notices.
- Soak the asbestos material through its entire thickness with water during its removal to minimize release of asbestos fibres.
- Thoroughly clean the work area each day.
- Place all asbestos material and debris in clearly labeled, sealed and airtight containers.
- Provide training to workers in the use of protective equipment, the safe handling and disposal of asbestos waste and health information on the potential effects of asbestos exposure.
- Pay and arrange for a medical examination upon the written request of a worker involved in handling and disposing of asbestos materials and waste.

Employers should consult the *Asbestos Safety Regulations* in order to obtain a complete description of the regulatory requirements. A consolidated copy of the current *Regulations* is provided in Appendix 2. The authoritative text can be obtained by contacting the Workers' Safety and Compensation Commission or by downloading a copy from the Department of Justice web site at http://www.justice.gov.nu.ca/apps/search/docSearch.aspx.

The handling and removal of asbestos should only be undertaken by trained and qualified persons. The names of qualified asbestos abatement companies can be obtained by contacting the Workers' Safety and Compensation Commission or the waste management exchanges and associations listed in Appendix 10 of the *Environmental Guideline for the General Management of Hazardous Waste.*

3.3 Storage

Storage refers to the maintenance of waste asbestos while awaiting its transport and disposal. Storage is not acceptable for the long-term management of waste asbestos except under extraordinary circumstances and should be considered as a temporary measure only.

Waste asbestos should be stored in the following manner:

- Store wet waste asbestos in airtight, non-leaking plastic or 16 gauge steel drums. Dry asbestos can be stored in 6 mil plastic bags sealed within non-reusable drums or a second 6 mil plastic bag. Containers should be tightly sealed when not in use to prevent release of asbestos fibres.
- Each container must be clearly labeled "ASBESTOS" in accordance with the *Asbestos Safety Regulations.* If waste asbestos is being stored in an institutional, commercial or industrial location or if the asbestos is being stored for transport, the containers must also be labeled in accordance with the *Workplace Hazardous Materials Information System* (WHMIS) and relevant Transport Authority.
- Place all labeled containers in a secure and clearly marked area.
- Containers should be located so as to be protected from the sun, weather and physical damage.
- Workers must be trained in the safe handling and shipping for waste asbestos, have access to material safety data sheets and be provided with personal protective equipment. Only trained personnel should have access to the designated storage area.

If a commercial facility is used to store hazardous waste for periods of 180 days or more or the quantity of asbestos and other waste on-site at any one time exceeds the criteria set out in the *Environmental Guideline for the General Management of Hazardous Waste*[3], the facility must be registered with the Department of Environment as a hazardous waste management facility. Copies of registration forms are available at http://env.gov.nu.ca/programareas/environmentprotection/forms-applications or by contacting Nunavut's Department of Environment. Refer to the *Environmental Guideline for the General Management of Hazardous Waste* for additional information on the registration process.

3.4 Transportation

Friable waste asbestos should never be transported in bulk, but in storage containers as described in section 3.3 of the Guideline. The waste should be properly secured and transported within an enclosed vehicle or covered with a tarpaulin or net if transported in a vehicle that is not enclosed. A compaction type waste haulage vehicle must never be used to transport friable asbestos waste. Asbestos waste that is non-friable (i.e. asbestos that is immersed or fixed in a natural or artificial binder) does not need to be specially packaged for transport and disposal.

Under the federal *Interprovincial Movement of Hazardous Waste Regulations* and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations,* no person may transport hazardous waste in Canada for the purpose of disposal or recycling in a quantity greater than five litres or five kilograms unless it is accompanied by a completed manifest. Manifest forms are available from Nunavut's Department of Environment and completion instructions are included on the reverse side of each manifest. Further information on manifesting can be obtained by referring to the *Environmental Guideline for the General Management of Hazardous Waste* or Environment Canada's *User's Guide for the Hazardous Waste Manifest*.

Friable waste asbestos is classified as a Class 9 Miscellaneous Waste by the *Transportation of Dangerous Goods Act*. The classification, packaging, labeling and placarding of this waste must conform to the federal and territorial *Transportation of Dangerous Goods Act* and *Regulations*. Schedule I of the *Regulations* classifies waste asbestos as follows:

Shipping Name:	WASTE Asbestos Blue (crocidolite) Classification: 9 Product Identification Number: UN2212 Packing Group: II
Shipping Name:	WASTE Asbestos Brown (amosite, mysorite) Classification: 9 Product Identification Number: UN2212 Packing Group: II
Shipping Name:	WASTE Asbestos White (chrysotile, actinolite, anthophyllite, tremolite) Classification: 9 Product Identification Number: UN2590 Packing Group: III

[3] The criterion for Class 9 Miscellaneous Waste is 1000 kilograms or litres and the total aggregate quantity is 5000 kilograms or litres.

Non-friable asbestos is not a hazardous waste and does not need to be accompanied by a manifest.

The transport of waste asbestos by air must conform to the *International Air Transport Association* (IATA) *Dangerous Goods Regulations* and *International Civil Aviation Organization* (ICAO) *Technical Instructions,* while transport by marine must conform to the *International Marine Dangerous Goods Code*. Further information on transporting these materials can be obtained by contacting Transport Canada or by referring to the appropriate Transport Authority.

Hazardous waste generators, carriers and receivers operating in Nunavut must be registered with the Nunavut Department of Environment. A unique registration number is assigned to each registrant through the registration process, which enables completion of the manifest document. Copies of registration forms are available at http://env.gov.nu.ca/programareas/environmentprotection/forms-applications or by contacting Nunavut's Department of Environment. Refer to the *Environmental Guideline for the General Management of Hazardous Waste* for additional information on the registration process.

A listing of hazardous waste carriers, receivers and management facilities registered to operate in Nunavut is available by contacting Nunavut's Department of Environment.

3.5 Disposal

Friable waste asbestos may be disposed of at a municipal landfill site in Nunavut provided that authorization and approval has first been obtained from the local municipal government. The local municipal government must be registered with Nunavut's Department of Environment as a hazardous waste receiver before accepting the waste.

Upon arrival at the landfill site, the waste asbestos should immediately be buried and covered with at least 30 centimetres (one foot) of soil to ensure further direct contact with people and heavy equipment is avoided. Care should be taken to ensure the asbestos containment (i.e. plastics bags) is not broken or ruptured while being covered. A final cover of at least 60 centimetres (two feet) of soil should be placed over the waste asbestos within 24 hours. The excavation site should be separate from other disposal or burning activities and a sign erected so the asbestos is never disturbed. A detailed map or drawing of the excavation site location should also be maintained by the local municipal government for future reference.

Where friable asbestos is being unloaded for the purpose of disposal, the unloading must be carried out so that no loose asbestos waste or punctured, broken or leaking containers are landfilled. Any friable asbestos that is in a punctured, broken or leaking container must be repackaged in drums or two 6 mil plastic bags prior to its disposal.

Where local disposal of friable waste asbestos is not available, the asbestos should be transported for disposal by a registered hazardous waste carrier to a receiver or management facility that is registered to operate in Nunavut. A listing of hazardous waste carriers, receivers and management facilities is available by contacting Nunavut's Department of Environment. A listing of receivers and management facilities authorized to accept waste asbestos in other territories and provinces can be obtained by contacting the environment department in that jurisdiction or the Canadian waste exchanges and associations found in Schedule 10 of the *Environmental Guideline for the General Management of Hazardous Waste.*

Conclusion

Asbestos is a commercial term given to a group of fibrous silicate minerals that occur naturally in the environment. Because of its unique and unusual properties, asbestos has been used over the years in the manufacture of a wide range of products. These products include building materials, friction products, heat resistant insulation, fabrics, packaging, gaskets and various coatings. During the 1980s the human health and safety risks associated with asbestos started to become known. As a result, the use of asbestos was banned or phased out throughout North America. However, a variety of asbestos products may still be found when older buildings are being renovated or demolished, or when repairs are being carried out on older vehicles and electrical appliances. The *Environmental Guideline for Waste Asbestos* is an introduction to the management of asbestos. It provides information on the characteristics of asbestos, its possible effects on the environment and human health and guidance on its proper storage, handling and removal, transportation and disposal.

Familiarity with the Guideline does not replace the need for the owner or person in charge, management or control of waste asbestos to comply with all applicable federal and territorial legislation and municipal by-laws. The management of waste asbestos may also be controlled through permits and licenses issued by Nunavut's co-management boards, Indian and Northern Affairs Canada and other regulatory agencies. These permits and licenses must be complied with at all times.

For additional information on the management of waste asbestos, or to obtain a listing of available guidelines, go to the Department of Environment web site or contact the Department at:

Environmental Protection Division
Department of Environment
Government of Nunavut
Inuksugait Plaza, P.O. Box 1000, Station 1360
Iqaluit, Nunavut X0A 0H0

Telephone: (867) 975-7729
Fax: (867) 975-7739
Email: EnvironmentalProtection@gov.nu.ca
Website: http://env.gov.nu.ca/programareas/environmentprotection

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Health Canada. Health Risks of Asbestos Webpage. http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/environ/asbestos-amiante-eng.php

Krytiuk Specialty Contracting Inc. What is Asbestos Webpage. http://ksccanada.com/21.html

APPENDICES

APPENDIX 1 - *ENVIRONMENTAL PROTECTION ACT*

The following are excerpts from the *Environmental Protection Act*

1. "Contaminant" means any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment,
   (a) endangers the health, safety or welfare of persons,
   (b) interferes or is likely to interfere with normal enjoyment of life or property,
   (c) endangers the health of animal life, or
   (d) causes or is likely to cause damage to plant life or to property;

   "Discharge" includes, but not so as to limit the meaning, any pumping, pouring, throwing, dumping, emitting, burning, spraying, spreading, leaking, spilling, or escaping;

   "Environment" means the components of the Earth and includes
   (a) air, land and water,
   (b) all layers of the atmosphere,
   (c) all organic and inorganic matter and living organisms, and
   (d) the interacting natural systems that include components referred to in paragraphs (a) to (c).

   "Inspector" means a person appointed under subsection 3(2) and includes the Chief Environmental Protection Officer.

2.2 The Minister may
   (a) establish, operate and maintain stations to monitor the quality of the environment in the Territories;
   (b) conduct research studies, conferences and training programs relating to contaminants and to the preservation, protection or enhancement of the environment;
   (c) develop, co-ordinate and administer policies, standards, guidelines and codes of practice relating to the preservation, protection or enhancement of the environment;
   (d) collect, publish and distribute information relating to contaminants and to the preservation, protection or enhancement of the environment:

3. (1) The Minister shall appoint a Chief Environmental Protection Officer who shall administer and enforce this Act and the regulations.

   (2) The Chief Environmental Protection Officer may appoint inspectors and shall specify in the appointment the powers that may be exercised and the duties that may be performed by the inspector under this Act and regulations.

5. (1) Subject to subsection (3), no person shall discharge or permit the discharge of a contaminant into the environment.

   (3) Subsection (1) does not apply where the person who discharged the contaminant or permitted the discharge of the contaminant establishes that
   (a) the discharge is authorized by this Act or the regulations or by an order issued under this Act or the regulations;
   (b) the contaminant has been used solely for domestic purposes and was discharged from within a dwelling house;
   (c) the contaminant was discharged from the exhaust system of a vehicle;

(d) the discharge of the contaminant resulted from the burning of leaves, foliage, wood, crops or stubble for domestic or agricultural purposes;
(e) the discharge of the contaminant resulted from burning for land clearing or land grading;
(f) the discharge of the contaminant resulted from a fire set by a public official for habitat management of silviculture purposes;
(g) the contaminant was discharged for the purposes of combating a forest fire;
(h) the contaminant is a soil particle or grit discharged in the course of agriculture or horticulture; or
(i) the contaminant is a pesticide classified and labelled as "domestic" under the *Pest Control Products Regulations* (Canada).

(4) The exceptions set out in subsection (3) do not apply where a person discharges a contaminant that the inspector has reasonable grounds to believe is not usually associated with a discharge from the excepted activity.

5.1. Where a discharge of a contaminant into the environment in contravention of this Act or the regulations or the provisions of a permit or license issued under this Act or the regulations occurs or a reasonable likelihood of such a discharge exists, every person causing or contributing to the discharge or increasing the likelihood of such a discharge, and the owner or the person in charge, management or control of the contaminant before its discharge or likely discharge, shall immediately:
(a) subject to any regulations, report the discharge or likely discharge to the person or office designated by the regulations;
(b) take all reasonable measures consistent with public safety to stop the discharge, repair any damage caused by the discharge and prevent or eliminate any danger to life, health, property or the environment that results or may be reasonably expected to result from the discharge or likely discharge; and
(c) make a reasonable effort to notify every member of the public who may be adversely affected by the discharge or likely discharge.

6. **(**1) Where an inspector believes on reasonable grounds that a discharge of a contaminant in contravention of this Act or the regulations or a provision of a permit or license issued under this Act or the regulations has occurred or is occurring, the inspector may issue an order requiring any person causing or contributing to the discharge or the owner or the person in charge, management or control of the contaminant to stop the discharge by the date named in the order.

7. (1) Notwithstanding section 6, where a person discharges or permits the discharge of a contaminant into the environment, an inspector may order that person to repair or remedy any injury or damage to the environment that results from the discharge.

(2) Where a person fails or neglects to repair or remedy any injury or damage to the environment in accordance with an order made under subsection (1) or where immediate remedial measures are required to protect the environment, the Chief Environmental Protection Officer may cause to be carried out the measures that he or she considers necessary to repair or remedy an injury or damage to the environment that results from any discharge.

APPENDIX 2 – *SAFETY ACT: ASBESTOS SAFETY REGULATIONS*

This consolidation is not an official statement of the *Asbestos Safety Regulations*. It is a current consolidation prepared for convenience of reference only. The authoritative text of the *Regulations* should be obtained from the Northwest Territories and Nunavut Workers' Safety and Compensation Commission.

1. In these regulations,

"Asbestos" means crocidolite, amosite, chrysotile, fibrous anthophyllite, tremolite, actinolite or any mixture containing any of these minerals;
"Asbestos dust" means dust consisting of or containing asbestos fibres;
"Asbestos process" means the handling of materials containing asbestos and includes:
(a) sawing, cutting, sanding or spraying materials,
(b) repair or maintenance of materials,
(c) cleaning or disposal of materials,
(d) mixing or applying asbestos shorts, cements, grouts, putties or similar compounds,
(e) storage or conveyance of materials.

2. These regulations apply to every establishment.

3. No person shall use crocidolite in any asbestos process.

4. No person shall apply, by spraying, insulation materials containing asbestos.

5. (1) An employer conducting an asbestos process shall:
(a) provide each worker who may be exposed to asbestos with respiratory equipment designed for use in asbestos processes and that has been approved by the Canadian Standards Association;
(b) provide each worker who may be exposed to asbestos with dustproof coveralls, gauntlets, eye protection and headgear;
(c) ensure that, at all times during the asbestos process, ventilation and air filtering equipment is in operation and removing asbestos dust from the air;
(d) enclose the work area to prevent the escape of asbestos dust;
(e) post warning notices in prominent places indicating that an asbestos process is in progress;
(f) ensure that, prior to disturbing any asbestos surface, the asbestos is soaked with water through its entire thickness;
(g) where a safety officer is of the opinion that it is not practicable to comply with the requirements in paragraph (d), ensure that any asbestos surface is kept wet as it is being disturbed;
(h) clean the work area surrounding an asbestos process thoroughly each day by vacuum equipment or a wet cleaning method approved by a safety officer; and
(i) ensure that all asbestos materials, debris and dust are placed in sealed, airtight containers and clearly labeled "ASBESTOS".

(2) A safety officer may, in writing, exempt an employer from the requirements of paragraph 1(a) where the safety officer is of the opinion that the nature of the asbestos process is such that the employer cannot, practically, comply with the requirements.

(3) An employer providing equipment under subsection (1) shall dispose of the equipment after use or shall remove all traces of asbestos dust and shall store the equipment in an airtight container.

6. An employer conducting an asbestos process shall provide the following training to any worker who is likely to come in contact with asbestos:
   (a) demonstration and instruction in the use of all protective equipment;
   (b) the safe handling and proper disposal of waste asbestos;
   (c) health education including information relating to pneumoconiosis, lung cancer, mesothelioma and the effects of smoking; and
   (d) any other information a safety officer considers necessary.

7. (1) Where an employer uses ventilation and air filtering equipment, the employer shall inspect and clean the equipment weekly.

   (2) A safety officer may designate a person in the workplace to inspect any ventilation and air filtering equipment yearly to report to the employer on the condition of the equipment and the need for repair.

   (3) An employer receiving a report recommending repair under subsection (2) shall complete the recommended repairs within 30 days of receipt of the report.

8. No person shall employ a minor where an asbestos process is being conducted unless
   (a) the process is conducted under constant supervision; and
   (b) the process has been inspected and approved by a safety officer.

9. (1) Within 30 days of receipt of a written request for a medical examination by a worker involved in an asbestos process, an employer shall arrange and pay the full cost of an examination by a physician.

   (2) The employer shall make arrangements for a medical examination that includes:
   (a) a complete physical examination with special attention to the respiratory system;
   (b) lung function tests including forced vital capacity and forced expiratory volume at one second; and
   (c) any medical procedures considered necessary by the examining physician for the diagnosis of asbestos related illness.

   (3) Upon written request by the Minister, a physician who has conducted an examination under subsection (2) shall provide the Minister with a report containing all information resulting from the examination.

   (4) Every report provided under subsection (3) is a privileged communication of the person making it.

APPENDIX 3 – ASBESTOS CONTAINING MATERIALS

The following products have in the past been manufactured using asbestos. If in doubt, confirm with the product's manufacturer as to whether it is asbestos-free.

- Acoustical Plaster
- Base Flashing
- Breaching Insulation
- Cement Pipes
- Chalkboards
- Ductwork
- Electrical Panel Partitions
- Fire Blankets
- Fireproofing Materials
- Heating and Electrical Ducts
- Joint Compounds
- Packing Materials
- Roofing Shingles
- Taping Compounds (thermal)
- Wallboard
- Vinyl Floor Tile
- Adhesives
- Blown-in Insulation
- Caulking and Putties
- Cement Siding
- Construction Mastics and Adhesives
- Electrical Wiring Insulation
- Elevator Brake Shoes
- Fire Curtains
- Flexible Fabric Connections
- High Temperature Gaskets
- Laboratory Gloves
- Pipe Insulation
- Spackling Compounds
- Textured Paints and Coatings
- Vinyl Sheet Flooring
- Cooling Towers
- Asphalt Floor Tile
- Boiler Insulation
- Ceiling Tiles
- Cement Wallboard
- Decorative Plaster
- Electrical Cloth
- Elevator Equipment Panels
- Fire Doors
- Flooring Backing
- HVAC Duct Insulation
- Laboratory Hoods and Table Tops
- Roofing Felt
- Spray-Applied Insulation
- Thermal Paper Products
- Vinyl Wall Coverings

Source - Krytiuk Specialty Contracting Inc.

APPENDIX 4 – GOVERNMENT AND INDUSTRY CONTACTS

Government of Nunavut

Environmental Protection Division
Department of Environment
Inuksugait Plaza
P.O. Box 1000, Station 1360
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-7729 Fax: (867) 975-7739

Workers' Safety and Compensation Commission
P.O. Box 669
Baron Building/1091
Iqaluit, Nunavut X0A 0H0
Telephone: 1-877-404-4407 (toll free)
Fax: 1-866-979-8501

Office of Chief Medical Health Officer of Health
Department of Health and Social Services
P.O. Box 1000, Station 1000
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-5774 Fax: (867) 975-5755

Motor Vehicles Division
Department of Economic Development and Transportation
P.O. Box 10
Gjoa Haven, Nunavut X0B 1J0
Telephone: (867) 360-4615 Fax: (867) 360-4619

Department of Community and Government Services (all Divisions)
P.O. Box 1000, Station 700
4th Floor, W.G. Brown Building
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-5400 Fax: (867) 975-5305

Government of Canada

Indian and Northern Affairs – Nunavut Region
P.O. Box 2200
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-4500 Fax: (867) 975-4560

Department of Transport – Road, Rail, Marine, Air
P.O. Box 8550
344 Edmonton Street
Winnipeg, Manitoba R3C 1P6
Telephone: 1-888-463-0521 (toll free)
Fax: (204) 983-8992 Road, Rail and Marine
Fax: (204) 983-1734 Air

Environment Canada (NWT and Nunavut)
5019 52nd Street
Yellowknife, Northwest Territories X1A 1T5
Telephone: (867) 669-4730 Fax: (867) 873-8185

Industry

National Demolition Association
16 N. Franklin Street, Suite 203
Doylestown, Pennsylvania USA 18901-3536
Telephone: (215) 348-4949 Fax (215) 348-8422
Website: http://www.demolitionassociation.com

APPENDIX E

ENVIRONMENTAL GUIDELINE FOR WASTE LEAD AND LEAD PAINT

Environmental Guideline for

Waste Lead and Lead Paint

Department of Environment
Government of Nunavut

GUIDELINE: WASTE LEAD AND LEAD PAINT

Original: November 2001
Revised: March 2011

This Guideline has been prepared by the Department of Environment's Environmental Protection Division and approved by the Minister of Environment under the authority of Section 2.2 of the *Environmental Protection Act.*

This Guideline is not an official statement of the law and is provided for guidance only. Its intent is to increase the awareness and understanding of the risks, hazards and best management practices associated with waste lead and lead paint. This Guideline does not replace the need for the owner or person in charge, management or control of waste lead and lead paint to comply with all applicable legislation and to consult with Nunavut's Department of Environment, other regulatory authorities and qualified persons with expertise in the management of these wastes.

Copies of this Guideline are available upon request from:

Department of Environment
Government of Nunavut
P.O. Box 1000, Station 1360, Iqaluit, NU, X0A 0H0
Electronic version of the Guideline is available at http://env.gov.nu.ca/programareas/environmentprotection

Cover Photos: Government of Nunavut Department of Environment

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Introduction

Lead is a heavy, soft bluish-grey metal that occurs naturally in the earth's crust. Lead can be found everywhere in the environment, not only because it occurs naturally, but because it has been widely used in the manufacture of many different consumer products. Although regulatory and non-regulatory initiatives were introduced in Canada starting in the 1970s to reduce Canadians' exposure to lead, it can still be found in many older products such as pipes, sheeting, body filler used in the automotive repair industry, solder, ammunition, fishing weights and in cathode-ray tube television and computer screens. Today, lead-acid batteries account for the most significant proportion of global lead consumption.

In the past lead pigment was also added to paint to speed drying, increase durability and resist moisture that causes corrosion. Although modern regulations prohibit the manufacture and use of lead paint in Canada, it can still be found on structures painted prior to the introduction of these controls. These structures commonly include metal bridges, water tanks and oil storage tanks. The likelihood of houses and other buildings containing lead paint depends on when they were built and painted. There is a high likelihood that buildings constructed before 1960 contain lead paint. If the building was constructed after 1980 it is unlikely that lead paint was used on interior walls, but there may be lead in paint used on the outside. Buildings constructed after 1992 likely do not contain lead paint because all consumer paints produced in Canada by that time were lead-free. Paint with significant lead content is still used by some companies for painting roadways, parking lot lines and traffic signs and by the military.

It has been known for a long time that exposure to lead is dangerous. The *Environmental Guideline for Waste Lead and Lead Paint* (the Guideline) provides information on the characteristics and possible effects of waste lead and lead paint and guidance on its proper containment and removal, storage, transportation and disposal. It is not an official statement of the law. For further information and guidance, the owner or person in charge, management or control of waste lead and lead paint is encouraged to review all applicable legislation and consult the Department of Environment, other regulatory agencies or qualified persons with expertise in the management of waste paint.

The *Environmental Protection Act* enables the Government of Nunavut to implement measures to preserve, protect and enhance the quality of the natural environment. Section 2.2 of the *Act* provides the Minister with authority to develop, coordinate, and administer the Guideline.

1.1 Definitions

Commissioner's Land — Lands that have been transferred by Order-in-Council to the Government of Nunavut. This includes roadways and land subject to block land transfers. Most Commissioner's Land is located within municipalities.

Contaminant — Any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment,

(a) endangers the health, safety or welfare of persons,
(b) interferes or is likely to interfere with normal enjoyment of life or property,
(c) endangers the health of animal life, or
(d) causes or is likely to cause damage to plant life or to property.

Dangerous Good	Any product, substance or organism included by its nature or by the *Transportation of Dangerous Goods Regulations* in any of the classes listed in the schedule provided in the *Transportation of Dangerous Goods Act*.
Environment	The components of the Earth and includes (a) air, land and water, (b) all layers of the atmosphere, (c) all organic and inorganic matter and living organisms, and (d) the interacting natural systems that include components referred to in paragraphs (a) to (c) above.
Lead Paint	A paint or other similar structural coating material containing 0.06% lead by weight (600 parts per million) or more that is used as an anti-corrosive or anti-weathering coating on the interior or exterior surfaces of any building; as an anti-corrosive or anti-weathering coating on equipment used for commercial, industrial, institutional or public purposes; as touch-up paint for metal surfaces or on traffic signs.
Overcoating	Removing loose paint and spot cleaning degraded painted surfaces, priming cleaned areas and applying a new coating over the primed surface.
Minister	The Minister of Environment of the Government of Nunavut.
Qualified Person	A person who has an appropriate level of knowledge and experience in all relevant aspects of waste management.
Responsible Party	The owner or person in charge, management or control of the waste.
Transport Authority	The statute and regulations controlling the management of hazardous waste under that mode of transport. These include (a) Road and Rail - *Transportation of Dangerous Goods Act* (Canada) and *Regulations; Interprovincial Movement of Hazardous Waste Regulations* and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations*. (b) Air – *International Air Transport Association (IATA) Dangerous Goods Regulations* and *International Civil Aviation Organization* (ICAO) *Technical Instructions;* and (c) Marine – *International Maritime Dangerous Goods Code* (IMDG).
Waste Lead	Metallic lead, or a material comprised primarily of metallic lead, that is no longer wanted or is unusable for its intended purpose and is intended for storage, recycling, treatment or disposal. Examples include ammunition, lead-acid electrical storage batteries, lead solder, pipes, radiation shields and sheaths for electrical cable.

1.2 Roles and Responsibilities

1.2.1 Department of Environment

The Environmental Protection Division is the key environmental agency responsible for ensuring parties properly manage waste lead and lead paint and will provide advice and guidance on its management, including disposal. Authority is derived from the *Environmental Protection Act*, which prohibits the discharge of contaminants to the environment and enables the Minister to undertake actions to ensure appropriate management measures are in place. Although programs and services are applied primarily to activities taking place on Commissioner's and municipal lands and to Government of Nunavut undertakings, the *Environmental Protection Act* may be applied to the whole of the territory where other controlling legislation, standards and guidelines do not exist. A complete listing of relevant legislation and guidelines can be obtained by contacting the Department of Environment or by visiting the web site at http://env.gov.nu.ca/programareas/environmentprotection.

1.2.2 Generators of Waste Lead and Lead Paint

The owner or person in charge, management or control of waste lead and lead paint is known as the responsible party. In general, the responsible party must ensure the unwanted waste is properly and safely managed from the time it is produced to its final disposal. This is referred to as managing the waste from cradle-to-grave. Information on the general management of hazardous waste in Nunavut, including generator, carrier and receiver responsibilities, can be obtained by referring to the *Environmental Guideline for the General Management of Hazardous Waste*.

Contractors may manage waste lead and lead paint on behalf of the responsible party. However, the responsible party remains liable for ensuring the method of management complies with all applicable statutes, regulations, standards, guidelines and local by-laws. If the contractor does not comply with the requirements of the *Environmental Protection Act* and is charged with a violation while managing the waste, the responsible party may also be charged.

1.2.3 Other Regulatory Agencies

Other regulatory agencies may have to be consulted regarding the management of waste lead and lead paint as there may be other environmental or public and worker health and safety issues to consider.

Workers' Safety and Compensation Commission

The Workers' Safety and Compensation Commission is responsible for promoting and regulating worker and workplace health and safety in Nunavut. The Commission derives its authority from the *Workers' Compensation Act* and *Safety Act* which require an employer to maintain a safe workplace and ensure the safety and well being of workers.

Department of Community and Government Services

The Department of Community and Government Services is responsible under the *Commissioners' Lands Act* for the issuance of land leases, reserves, licenses and permits on Commissioner's Lands. The Department, in cooperation with communities, is also responsible for the planning and funding of municipal solid waste and sewage disposal facilities in most Nunavut communities.

Department of Health and Social Services

Activities related to the management of waste lead and lead paint may have an impact on public health. The Office of the Chief Medical Officer of Health and Regional Environmental Health Officers should be consulted regarding legislated requirements under the *Public Health Act.*

Department of Economic Development and Transportation

The Motor Vehicles Division is responsible for ensuring the safe transport of hazardous waste and other dangerous goods by road through administration of the *Transportation of Dangerous Goods Act*. The Department is also responsible under the *Motor Vehicles Act* for driver licensing and various other vehicle and road safety matters.

Environment Canada

Environment Canada and Health Canada are responsible for administering the *Canadian Environmental Protection Act*. Lead was one of the first chemicals to be added to the List of Toxic Substances in Schedule I of the *Act* and since then many regulations, codes of practice and guidelines have been adopted[1]. Environment Canada is also responsible for regulating international and interprovincial movement of hazardous waste, including waste lead and lead paint, under the *Interprovincial Movement of Hazardous Waste Regulations* and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations*. Environment Canada is also responsible for administering the pollution prevention provisions of the federal *Fisheries Act*.

Indian and Northern Affairs Canada

Indian and Northern Affairs Canada is responsible under the *Territorial Lands Act* and *Nunavut Waters and Nunavut Surface Rights Tribunal Act* for the management of federal lands and waters in Nunavut, including the impact waste lead and lead paint may have on the quality of these lands and waters.

Local Municipal Governments

The role of municipal governments is important in the proper local management of waste lead and lead paint. Under the Nunavut Land Claims Agreement, municipalities are entitled to control their own municipal disposal sites. Unwanted waste may be deposited into municipal landfill sites and sewage lagoons only with the consent of the local government. The local fire department may also be called upon if a fire or other public safety issue is identified.

Co-management Boards and Agencies

Co-management boards and agencies established under the Nunavut Land Claims Agreement have broad authority for land use planning, impact assessment and the administration of land and water. Activities involving the management and disposal of waste lead and lead paint may be controlled through the setting of terms and conditions in plans, permits and licenses issued by the Nunavut Water Board and other co-management boards and agencies.

[1] In Canada, the concentration of lead present in paint applied to common consumer products is controlled by Health Canada through the *Surface Coating Materials Regulations* that have been adopted under the *Hazardous Products Act.*

Characteristics and Potential Effects of Lead and Lead Paint

2.1 Characteristics

Lead occurs naturally in the earth's crust. Although it is normally present only in trace amounts, significant concentrations have been found in the air, soil and water adjacent to lead mines, smelters, facilities that use lead in the manufacture of products and along highways.

Metallic lead is bright and silvery when freshly cut but the surface rapidly tarnishes in air to produce the commonly observed dull luster normally associated with lead. It is a dense, very soft and highly malleable bluish-grey metal that has poor electrical conductivity when compared to most other metals. Lead is resistant to corrosion, although it will slowly dissolve in water and other solutions if exposed for long periods of time. Because of these properties, lead was widely used in the manufacture of many consumer products such as pipes, sheeting, automobile parts, electronic equipment and pigments until regulatory controls designed to reduce Canadians' exposure to the metal were introduced starting in the 1970s. Lead is still used today in some products including lead-acid batteries and radiation shielding.

2.2 Potential Effects on Environment and Human Health

Lead is a particularly dangerous and toxic metal. It can enter water through runoff of lead-contaminated soils and from sewage and industrial waste streams. In the past, significant amounts of lead entered the environment through the use of leaded gasoline. Elevated levels of lead in water can damage the reproductive systems of aquatic organisms and cause blood and neurological changes in fish. Wildlife can ingest lead while grazing on plants or by consuming other animals that have been exposed to lead. Wildlife that has been exposed to lead can experience the same kinds of effects as humans. Low concentrations of lead in the soil can also slow down plant growth.

Short-term exposure to high concentrations of lead by humans can cause vomiting, diarrhea, convulsions, coma and even death. Although severe cases of lead poisoning are rare in Canada, ongoing exposure to small amounts of lead has been documented. This long-term exposure can result in anaemia and damage to the brain and nervous system. Other symptoms of lead exposure include loss of appetite, abdominal pain, constipation, fatigue, sleeplessness, irritability and headaches. Kidney function can be affected through continual exposure to high levels of lead, such as in an industrial setting. Unborn fetuses, infants and young children are especially sensitive to even low levels of lead and exposure can result in learning disabilities and lowered intelligence.

Waste Management

> *Minimizing or avoiding the creation of pollutants and wastes can be more effective in protecting the environment than treating or cleaning them up after they have been created.*[2]

Refer to the *Environmental Guideline for Waste Batteries* for guidance on the storage, transportation and disposal of unwanted lead-acid batteries.

3.1 Pollution Prevention

Pollution prevention is a term used to describe methods and practices that focus on minimizing or eliminating the generation of waste. Pollution prevention opportunities for waste lead and lead paint include:

Reduce

- Replace lead-containing products with less hazardous products by choosing lead-free or EcoLogo certified products whenever possible. A complete listing of environmentally-preferable EcoLogo certified products is available for downloading at http://www.ecologo.org/en/index.asp.
- Check the label to confirm old, stockpiled paint does not contain lead.
- Where surfaces previously covered with lead paint are flaking or peeling, they must be repaired to prevent further deterioration of the paint and release of paint chips. Encapsulate the existing paint by overcoating with non-lead paint or by covering the surface with vinyl wallpaper, wallboard or paneling. Do not delay encapsulating or removing the lead-based paint if the paint is flaking or chipping. The Workers' Safety and Compensation Commission, Chief Medical Officer of Health and your Regional Environmental Health Officer must be consulted prior to encapsulating or removing lead paint.

Lead paint is no longer available for purchase in Canada as governments have regulated its sale and industry advances have resulted in the development of paints and coatings that provide superior drying, durability and corrosion resistance. Before painting, always prepare the surface to be painted in accordance with manufacturers' instructions. This will extend the life of the new product and reduce replacement costs.

The Steel Structures Painting Council has developed a series of guidance documents on surface preparation, coating application and other materials, technologies, and practices. A complete listing of these documents can be obtained through the Council's web site at http://www.sspc.org/standards.

3.2 Removal and Containment of Lead Paint Debris

Proper surface preparation, including the removal of old peeling paint, will help to ensure good coating adherence and long service life. In some cases, the removal of paint from the entire surface may be more beneficial over the long term than spot cleaning or overcoating. The owner of the facility should consider all relevant factors including condition of the existing paint, operational life of the facility and cost when deciding whether, and how, to repaint a major structure.

[2] Source – Canadian Council of Ministers of the Environment.

If lead paint is suspected of being present, laboratory testing must be undertaken prior to the commencement of work. A one square inch sample should be collected from tightly adhered paint by scraping down to the metal surface. The sample should include all layers of the paint while being careful not to include any metal. Analysis must be conducted by a laboratory that has been formally recognized by the Canadian Association of Environmental Analytical Laboratories (CAEAL) as being competent to perform the specified tests. Paint that contains 0.06% lead by weight (600 parts per million) or more is considered to be a hazardous waste[3] and must be removed, contained, stored, transported and disposed of in accordance with this Guideline and the *Environmental Guideline for the General Management of Hazardous Waste.*

A number of lead paint removal and containment techniques are acceptable for use in Nunavut. Each method ensures abrasives and paint debris are not released to the environment. The following table describes some of these techniques.

Removal and Containment Technique	Description
Dry Adhesive Blast Cleaning, within Full Containment with Negative Pressure	Sand (silica) or recyclable metallic abrasives remove the existing paint while a sealed enclosure prevents abrasives and paint debris from escaping. An airlock or resealable entrance enables workers to enter and exit the enclosure without the escape of blasting residue. Filtration equipment is used to ensure exhaust air is free of dust and other airborne residue.
Vacuum Blast Cleaning, within Containment	A vacuum is attached to the abrasive blasting equipment to provide a closed-loop containment system during paint removal. The system is capable of separating the removed coating and returning clean abrasive to the working surface. Additional containment sheets are attached around and under the work area to contain abrasives and paint debris in the event of an accidental release from the vacuum shroud.
Vacuum-shrouded Power Tool Cleaning, within Containment	Power tools equipped with vacuums and High Efficiency Particulate Air (HEPA) filters are used to remove the existing paint. Similar to 'Vacuum Blast Cleaning within Containment', a secondary containment structure is placed under and around the work area to contain any residue materials that may not be captured by the vacuum shroud.
Power Tool Cleaning without Vacuum, within Containment	Power tools are used to remove the existing paint, but unlike "Vacuum-shrouded Power Tool Cleaning', a completely sealed enclosure similar to 'Dry Adhesive Blast Cleaning within Full Containment with Negative Pressure' prevents the escape of residue materials.
Water Jetting or Wet Abrasives Blast Cleaning, within Containment	Water jetting, or wet adhesive blasting, removes the existing paint while an impermeable containment system captures all water wastes. The collected water is filtered to ensure lead concentrations do not exceed 5 milligrams per litre (5 parts per million), or as specified in the applicable permit or license. Laboratory analysis results must be submitted to Nunavut's Department of Environment prior to the water being discharged to a sewage lagoon or the environment. Recycling the filtered water reduces the volume of waste generated.

[3] Due to the complex chemical relationship between lead and iron, the Toxic Characteristic Leaching Procedure (TCLP) is not acceptable for lead paint analysis. Analysis for 'Total Lead' is only the only acceptable method of analysis because iron masks TCLP detection of lead.

The containment system must comply with the *Steel Structures Painting Council Guide 6(95): Guide for Containing Debris Generated during Paint Removal Operations*. A copy of the Guide can be obtained through the Council's web site at http://www.sspc.org/standards.

The removal and containment of lead paint and lead paint debris should only be undertaken by trained and qualified persons. The names of qualified lead paint removal companies can be obtained by contacting the Workers' Safety and Compensation Commission or the waste management exchanges and associations listed in Appendix 10 of the *Environmental Guideline for the General Management of Hazardous Waste.* The Workers' Safety and Compensation Commission, Chief Medical Officer of Health and your Regional Environmental Health Officer must also be consulted during the planning phase to ensure all necessary worker and public health and safety measures are in place.

3.3 Storage

Storage refers to keeping waste lead and lead paint debris while awaiting its transport and disposal. Except under extraordinary circumstances, storage is not acceptable for the long-term management of waste and should be considered as a temporary measure only.

Waste lead and lead paint debris should be stored in the following manner:

- Store in plastic drums, 16 gauge or heavier steel drums or containers manufactured for this purpose. The containers should be sound, sealable, not damaged or leaking and placed on strong wooden pallets to make relocation with a forklift easier.
- Containers should be tightly sealed when not in use to avoid spills.
- Clearly label each container to identify its contents. If waste lead or lead paint debris is being stored in an institutional, commercial or industrial location or if the waste is being stored for transport, the containers must be labeled in accordance with the *Workplace Hazardous Materials Information System* and relevant Transport Authority.
- Place all labeled containers in a clearly marked and designated area located so as to be protected from the weather and any physical damage.
- Train workers in the safe storage and shipping procedures for waste lead and lead paint. Only trained personnel should have access to the storage area.

If the facility is used for commercial purposes to store hazardous waste for periods of 180 days or more or the quantity of waste lead or lead paint debris stored on-site exceeds the criteria set out in the *Environmental Guideline for the General Management of Hazardous Waste*[4], the facility must be registered with the Department of Environment as a hazardous waste management facility. Copies of registration forms are available at http://env.gov.nu.ca/programareas/environmentprotection/forms-applications or by contacting Nunavut's Department of Environment. Refer to the *Environmental Guideline for the General Management of Hazardous Waste* for additional information on the registration process.

3.4 Transportation

Lead paint debris is classified as a Class 9 Miscellaneous Waste under the *Transportation of Dangerous Goods Act* and must be transported in accordance to this Section. While metallic lead is not classified as

[4] The criterion for UN3077 wastes, or for the aggregate quantity of all hazardous waste, is 5000 kilograms or litres.

a dangerous good and is exempt from these requirements, it must still be transported in a safe and secure manner (i.e. in sealable metal or plastic drums, securely tied to the bed of the truck or trailer) to prevent its release into the environment.

Under the federal *Interprovincial Movement of Hazardous Waste Regulations* and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations,* no person may transport hazardous waste in Canada for the purpose of disposal or recycling in a quantity greater than five kilograms or five litres unless it is accompanied by a completed manifest. Manifest forms are available from Nunavut's Department of Environment and completion instructions are included on the reverse side of each manifest. Further information on manifesting can be obtained by referring to the *Environmental Guideline for the General Management of Hazardous Waste* or Environment Canada's *User's Guide for the Hazardous Waste Manifest*.

The classification, packaging, labeling and placarding of lead paint debris while being transported must conform to the federal and territorial *Transportation of Dangerous Goods Act* and *Regulations*. Schedule I of the *Regulations* classify lead paint debris as follows:

Shipping Name:	WASTE Environmentally Hazardous Substance, Solid, N.O.S. Classification: 9 Product Identification Number: UN3077 Packing Group: III Special Provision: 16

The transport of lead paint debris by air must conform to the *International Air Transport Association* (IATA) *Dangerous Goods Regulations* and *International Civil Aviation Organization* (ICAO) *Technical Instructions,* while transport by marine must conform to the *International Marine Dangerous Goods Code*. Further information on transporting this waste can be obtained by contacting Transport Canada or referring to the appropriate Transport Authority.

Chemical stripping of lead paint produces both a lead leachable waste and a corrosive waste. While the disposal options are the same as for dry lead paint debris, the classification, packaging, labeling and placarding for transport must also reflect the corrosive nature of the waste. Consultation with Transport Canada or referral to the appropriate Transport Authority is encouraged.

Hazardous waste generators, carriers and receivers operating in Nunavut must be registered with the Nunavut Department of Environment. A unique registration number is assigned to each registrant through the registration process, which enables completion of the manifest document. Copies of registration forms are available at http://env.gov.nu.ca/programareas/environmentprotection/forms-applications or by contacting Nunavut's Department of Environment. Refer to the *Environmental Guideline for the General Management of Hazardous Waste* for additional information on the registration process.

A listing of hazardous waste carriers, receivers and management facilities registered to operate in Nunavut is available by contacting Nunavut's Department of Environment.

3.5 Disposal

Lead is a particularly dangerous and toxic metal. Waste lead and lead paint debris must never be thrown in the garbage or disposed of in a community landfill.

Disposal options for waste lead and lead paint in Nunavut are limited. The majority of these materials are used in government, commercial, industrial and institutional facilities and any unwanted or end-of-life products should be safely stored until they can be transported to a metals foundry, smelter or registered hazardous waste receiver that is licensed to accept waste lead and lead paint. Names of Canadian metal foundries, smelters and disposal companies are available by contacting the waste management exchanges and associations listed in Appendix 10 of the *Environmental Guideline for the General Management of Hazardous Waste.*

Advances in the stabilization and solidification of leachable lead waste are currently being made by industry. These chemical processes convert leachable lead waste (i.e. lead paint debris, soil contaminated with lead) to a non-leachable form by converting or binding the lead into a stable form. Proposals that can demonstrate the stabilization of leachable lead waste into a form that reduces Toxicity Characteristic Leaching Procedure (TCLP) lead levels to below the 5 milligrams per litre (5 parts per million) would be considered by the Department of Environment.

Conclusion

Lead is a particularly dangerous and toxic metal. While its low cost, malleability and poor electrical conductivity resulted in its use in a wide range of consumer and industrial products, regulatory and non-regulatory initiatives began to be introduced in Canada in the 1970s that were intended to reduce Canadians exposure to the metal. Today, lead can still be found in many older products as well as lead-acid batteries and x-ray shielding equipment. Lead can also be found in older paints used to protect large steel structures from corrosion such as bridges, water tanks and oil storage tanks. The *Environmental Guideline for Waste Lead and Lead Paint* is an introduction to the management of waste lead and lead paint. It provides information on the characteristics of lead and lead paint, its possible effects on the environment and guidance on its proper containment and removal, storage, transportation and disposal.

Familiarity with the Guideline does not replace the need for the owner or person in charge, management or control of waste lead and lead paint to comply with all applicable federal and territorial legislation and municipal by-laws. The management of these materials may also be controlled through permits and licenses issued by Nunavut's co-management boards, Indian and Northern Affairs Canada and other regulatory agencies. These permits and licenses must be complied with at all times.

For additional information on the management of waste lead and lead paint, or to obtain a complete listing of guidelines, go to the Department of Environment web site or contact the Department at:

Environmental Protection Division
Department of Environment
Government of Nunavut
Inuksugait Plaza, P.O. Box 1000, Station 1360
Iqaluit, Nunavut X0A 0H0

Telephone: (867) 975-7729
Fax: (867) 975-7739
Email: EnvironmentalProtection@gov.nu.ca
Website: http://env.gov.nu.ca/programareas/environmentprotection

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Government of Canada, Department of Justice. *Consolidation of the Surface Coating Materials Regulations.*
http://laws.justice.gc.ca/en/H-3/SOR-2005-109/index.html

Government of Nunavut, Department of Environment. Environmental Guideline for the General Management of Hazardous Waste, (2010).
http://env.gov.nu.ca/node/82#Guideline Documents

Government of Nunavut, Department of Environment. Environmental Guideline for the Management of Waste Lead and Lead Paint, (2001).

Health Canada. Environmental and Workplace Health: Lead Website
http://www.hc-sc.gc.ca/ewh-semt/contaminants/lead-plomb/index-eng.php

State of Illinois. Containment and Disposal of Lead Paint Cleaning Residues, (2010)
http://www.dot.state.il.us/bridges/gbsp26.pdf

Steel Structures Painting Council Website.
http://www.sspc.org

APPENDICES

APPENDIX 1 - *ENVIRONMENTAL PROTECTION ACT*

The following are excerpts from the *Environmental Protection Act*

1. "Contaminant" means any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment,
   (a) endangers the health, safety or welfare of persons,
   (b) interferes or is likely to interfere with normal enjoyment of life or property,
   (c) endangers the health of animal life, or
   (d) causes or is likely to cause damage to plant life or to property;

   "Discharge" includes, but not so as to limit the meaning, any pumping, pouring, throwing, dumping, emitting, burning, spraying, spreading, leaking, spilling, or escaping;

   "Environment" means the components of the Earth and includes
   (a) air, land and water,
   (b) all layers of the atmosphere,
   (c) all organic and inorganic matter and living organisms, and
   (d) the interacting natural systems that include components referred to in paragraphs (a) to (c).

   "Inspector" means a person appointed under subsection 3(2) and includes the Chief Environmental Protection Officer.

2.2 The Minister may
   (a) establish, operate and maintain stations to monitor the quality of the environment in the Territories;
   (b) conduct research studies, conferences and training programs relating to contaminants and to the preservation, protection or enhancement of the environment;
   (c) develop, co-ordinate and administer policies, standards, guidelines and codes of practice relating to the preservation, protection or enhancement of the environment;
   (d) collect, publish and distribute information relating to contaminants and to the preservation, protection or enhancement of the environment:

3. (1) The Minister shall appoint a Chief Environmental Protection Officer who shall administer and enforce this Act and the regulations.

   (2) The Chief Environmental Protection Officer may appoint inspectors and shall specify in the appointment the powers that may be exercised and the duties that may be performed by the inspector under this Act and regulations.

5. (1) Subject to subsection (3), no person shall discharge or permit the discharge of a contaminant into the environment.

   (3) Subsection (1) does not apply where the person who discharged the contaminant or permitted the discharge of the contaminant establishes that
   (a) the discharge is authorized by this Act or the regulations or by an order issued under this Act or the regulations;
   (b) the contaminant has been used solely for domestic purposes and was discharged from within a dwelling house;
   (c) the contaminant was discharged from the exhaust system of a vehicle;

(d) the discharge of the contaminant resulted from the burning of leaves, foliage, wood, crops or stubble for domestic or agricultural purposes;
(e) the discharge of the contaminant resulted from burning for land clearing or land grading;
(f) the discharge of the contaminant resulted from a fire set by a public official for habitat management of silviculture purposes;
(g) the contaminant was discharged for the purposes of combating a forest fire;
(h) the contaminant is a soil particle or grit discharged in the course of agriculture or horticulture; or
(i) the contaminant is a pesticide classified and labelled as "domestic" under the *Pest Control Products Regulations* (Canada).

(4) The exceptions set out in subsection (3) do not apply where a person discharges a contaminant that the inspector has reasonable grounds to believe is not usually associated with a discharge from the excepted activity.

5.1. Where a discharge of a contaminant into the environment in contravention of this Act or the regulations or the provisions of a permit or license issued under this Act or the regulations occurs or a reasonable likelihood of such a discharge exists, every person causing or contributing to the discharge or increasing the likelihood of such a discharge, and the owner or the person in charge, management or control of the contaminant before its discharge or likely discharge, shall immediately:
(a) subject to any regulations, report the discharge or likely discharge to the person or office designated by the regulations;
(b) take all reasonable measures consistent with public safety to stop the discharge, repair any damage caused by the discharge and prevent or eliminate any danger to life, health, property or the environment that results or may be reasonably expected to result from the discharge or likely discharge; and
(c) make a reasonable effort to notify every member of the public who may be adversely affected by the discharge or likely discharge.

6. **(**1) Where an inspector believes on reasonable grounds that a discharge of a contaminant in contravention of this Act or the regulations or a provision of a permit or license issued under this Act or the regulations has occurred or is occurring, the inspector may issue an order requiring any person causing or contributing to the discharge or the owner or the person in charge, management or control of the contaminant to stop the discharge by the date named in the order.

7. (1) Notwithstanding section 6, where a person discharges or permits the discharge of a contaminant into the environment, an inspector may order that person to repair or remedy any injury or damage to the environment that results from the discharge.

(2) Where a person fails or neglects to repair or remedy any injury or damage to the environment in accordance with an order made under subsection (1) or where immediate remedial measures are required to protect the environment, the Chief Environmental Protection Officer may cause to be carried out the measures that he or she considers necessary to repair or remedy an injury or damage to the environment that results from any discharge.

APPENDIX 2 – GOVERNMENT AND INDUSTRY CONTACTS

Government of Nunavut

Environmental Protection Division
Department of Environment
Inuksugait Plaza
P.O. Box 1000, Station 1360
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-7729 Fax: (867) 975-7739

Workers' Safety and Compensation Commission
P.O. Box 669
Baron Building/1091
Iqaluit, Nunavut X0A 0H0
Telephone: 1-877-404-4407 (toll free)
Fax: 1-866-979-8501

Office of Chief Medical Health Officer of Health
Department of Health and Social Services
P.O. Box 1000, Station 1000
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-5774 Fax: (867) 975-5755

Motor Vehicles Division
Department of Economic Development and Transportation
P.O. Box 10
Gjoa Haven, Nunavut X0B 1J0
Telephone: (867) 360-4615 Fax: (867) 360-4619

Department of Community and Government Services (all Divisions)
P.O. Box 1000, Station 700
4th Floor, W.G. Brown Building
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-5400 Fax: (867) 975-5305

Government of Canada

Indian and Northern Affairs – Nunavut Region
P.O. Box 2200
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-4500 Fax: (867) 975-4560

Department of Transport – Road, Rail, Marine, Air
P.O. Box 8550
344 Edmonton Street
Winnipeg, Manitoba R3C 1P6
Telephone: 1-888-463-0521 (toll free)
Fax: (204) 983-8992 Road, Rail and Marine
Fax: (204) 983-1734 Air

Environment Canada (NWT and Nunavut)
5019 52nd Street
Yellowknife, Northwest Territories X1A 1T5
Telephone: (867) 669-4730 Fax: (867) 873-8185

Health Canada
Regional Product Safety Office
2301 Midland Avenue
Toronto, Ontario M1P 4R7
Telephone: 1-866-662-0666 (toll free)

Industry

Canadian Association for Environmental Analytical Laboratories
300-265 Carling Avenue
Ottawa, Ontario K1S 2E1
Telephone: (613) 233-5300 Fax: (613) 233-5500

Steel Structures Painting Council
40 24th Street, 6th Floor · Pittsburgh PA 15222-4656 USA
Telephone: 1-877-281-7772 (toll free)
Fax: (412) 281-9992

APPENDIX F

ENVIRONMENTAL GUIDELINE FOR MERCURY-CONTAINING PRODUCTS AND WASTE MERCURY

Environmental Guideline for

Mercury-Containing Products and Waste Mercury

Department of Environment
Government of Nunavut

GUIDELINE: MERCURY-CONTAINING PRODUCTS AND WASTE MERCURY

Original: November 2010

This Guideline has been prepared by the Department of Environment's Environmental Protection Division and approved by the Minister of Environment under the authority of Section 2.2 of the *Environmental Protection Act.*

This Guideline is not an official statement of the law and is provided for guidance only. Its intent is to increase the awareness and understanding of the risks, hazards and best management practices associated with common mercury-containing products and waste mercury. This Guideline does not replace the need for the owner or person in charge, management or control of the product or waste to comply with all applicable legislation and to consult with Nunavut's Department of Environment, other regulatory authorities and qualified persons with expertise in the management of mercury.

Copies of this Guideline are available upon request from:

Department of Environment
Government of Nunavut
P.O. Box 1000, Station 1360, Iqaluit, NU, X0A 0H0
Electronic version of the Guideline is available at http://env.gov.nu.ca/programareas/environmentprotection

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Bottom Left - E. Paquin

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Introduction

Mercury is a naturally-occurring element that is found in soil, air and water around the world. It is constantly being released from natural sources such as volcanic eruptions and the weathering of soil and rock. It can exist as a gas or in a range of organic and inorganic forms that vary in toxicity and can cycle between the earth's land, water and air. Mercury is a persistent substance. If released into the atmosphere, it can remain airborne for long periods of time and be deposited in soil and water in the Canadian Arctic, an area with no significant local industrial sources of mercury. Almost all forms of mercury are toxic to some degree or can be converted through biological activity into the highly toxic organic form called methylmercury. Mercury may also build up, or bioaccumulate[1] and biomagnify[2], in living organisms. This results in animals such as predatory fish, fish-eating birds and mammals being at a higher risk of harm from mercury than those species which do not prey upon other organisms.

Mercury has been used for many years in a variety of consumer and industrial products because it is an excellent conductor of electricity and reacts predictably to changes in temperature and pressure. Common consumer and industrial products that can contain mercury include fluorescent lamps, thermometers and thermostats, batteries, dental amalgam, medical and other measuring devices, and electrical switches and relays. Although the use of mercury in these products has declined significantly over the past several decades, stockpiles of older mercury-containing products and the current technical requirements of products such as fluorescent lamps and specialized batteries suggests that the elimination of mercury use is not expected soon. For this reason, mercury-containing products must continue to be actively managed.

The Guideline for Mercury-Containing Products and Waste Mercury (the Guideline) provides information on the risks, hazards and best management practices associated with various mercury-containing products commonly used in Nunavut. It examines the characteristics and effects of mercury on the environment and human health, identifies non-mercury alternatives for common products and provides guidance on the proper cleanup, storage, transportation and disposal of unwanted mercury.

The *Environmental Protection Act* enables the Government of Nunavut to implement measures to preserve, protect and enhance the quality of the natural environment. Section 2.2 of the *Act* provides the Minister with authority to develop, coordinate, and administer the Guideline.

The Guideline is not an official statement of the law. For further information and guidance, the owner or person in charge, management or control of a mercury-containing product or waste mercury is encouraged to review all applicable legislation and consult the Department of Environment, other regulatory agencies or qualified persons with expertise in the management of mercury.

1.1 Definitions

Commissioner's Land — Lands that have been transferred by Order-in-Council to the Government of Nunavut. This includes roadways and land subject to block land transfers. Most Commissioner's Land is located within municipalities.

[1] The accumulation over time of metals and other persistent substances within an organism from both biotic (i.e. other organisms) or abiotic (i.e. land, air and water) sources.

[2] The progressive buildup of metals or other persistent substances through successive trophic levels – meaning that it relates to the concentration ratio in the tissue of a predator as compared to that in its prey.

Contaminant	Any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment, (a) endangers the health, safety or welfare of persons, (b) interferes or is likely to interfere with normal enjoyment of life or property, (c) endangers the health of animal life, or (d) causes or is likely to cause damage to plant life or to property.
Dangerous Good	Any product, substance or organism included by its nature or by the Transportation of Dangerous Goods Regulations in any of the classes listed in the schedule provided in the *Transportation of Dangerous Goods Act*.
Environment	The components of the Earth and includes (a) air, land and water, (b) all layers of the atmosphere, (c) all organic and inorganic matter and living organisms, and (d) the interacting natural systems that include components referred to in paragraphs (a) to (c) above.
Hazardous Waste	A contaminant that is a dangerous good and is no longer wanted or is unusable for its original intended purpose and is intended for storage, recycling, treatment or disposal.
Mercury-Containing Product	A manufactured device or part of a device that contains elemental mercury which is integral to its function.
Minister	The Minister of Environment of the Government of Nunavut.
Qualified Person	A person who has an appropriate level of knowledge and experience in all relevant aspects of waste management.
Responsible Party	The owner or person in charge, management or control of the waste.
Transport Authority	The statute and regulations controlling the management of hazardous waste under that mode of transport. These include (a) Road and Rail - *Transportation of Dangerous Goods Act* (Canada) and *Regulations; Interprovincial Movement of Hazardous Waste Regulations* (CEPA) and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (CEPA). (b) Air – *International Air Transport Association (IATA) Dangerous Goods Regulations* and *International Civil Aviation Organization* (ICAO) *Technical Instructions;* and (c) Marine – *International Maritime Dangerous Goods Code* (IMDG).
Waste Mercury	Mercury that is no longer wanted or is unusable for its intended purpose and is intended for storage, recycling, treatment or disposal.

1.2 Roles and Responsibilities

1.2.1 Department of Environment

The Department of Environment is the key environmental agency responsible for ensuring responsible parties properly manage unwanted mercury-containing products and waste mercury and will provide advice and guidance on its management, including proper disposal. Authority is derived from the *Environmental Protection Act*, which prohibits the discharge of contaminants to the environment and enables the Minister to undertake actions to ensure appropriate management measures are in place. Although programs and services are applied primarily to activities taking place on Commissioner's and municipal lands and to Government of Nunavut undertakings, the *Environmental Protection Act* may be applied to the whole of the territory where other controlling legislation, standards and guidelines do not exist. A complete listing of relevant legislation and guidelines can be obtained by contacting the Department of Environment or by visiting the web site at http://env.gov.nu.ca/programareas/environmentprotection.

1.2.2 Generators of Unwanted Mercury-Containing Products and Waste Mercury

The owner or person in charge, management or control of the unwanted mercury-containing product or waste mercury is known as the responsible party. In general, the responsible party must ensure the unwanted product and waste mercury is properly and safely managed from the time it is produced to its final disposal. This is referred to as managing the product and waste from cradle-to-grave. Information on the general management of hazardous waste in Nunavut, including generators, carriers and receivers, can be obtained by referring to the *Environmental Guideline for the General Management of Hazardous Waste*.

Contractors may manage unwanted mercury-containing products and waste mercury on behalf of the responsible party. However, the responsible party remains liable for ensuring the method of management complies with all applicable statutes, regulations, standards, guidelines and local by-laws. If the contractor does not comply with the requirements of the *Environmental Protection Act* and is charged with a violation while managing the waste, the responsible party may also be charged.

1.2.3 Other Regulatory Agencies

Other regulatory agencies may have to be consulted regarding the management of unwanted mercury-containing products and waste mercury as there may be other environmental or public and worker health and safety issues to consider.

Workers' Safety and Compensation Commission

The Workers' Safety and Compensation Commission is responsible for promoting and regulating worker and workplace health and safety in Nunavut. The Commission derives its authority from the *Workers' Compensation Act* and the *Safety Act,* both of which require an employer to maintain a safe workplace and ensure the safety and well being of workers.

Department of Community and Government Services

The Department of Community and Government Services is responsible under the *Commissioners' Lands Act* for the issuance of land leases, reserves, licenses and permits on Commissioner's Lands. The Department, in cooperation with communities, is also responsible for the planning and funding of municipal solid waste and sewage disposal facilities in most Nunavut communities.

Department of Health and Social Services

Activities related to the management of unwanted mercury-containing products and waste mercury may have an impact on public health. The Office of the Chief Medical Officer of Health and Regional Environmental Health Officers should be consulted regarding legislated requirements under the *Public Health Act.*

Department of Economic Development and Transportation

The Motor Vehicles Division is responsible for ensuring the safe transport of hazardous waste and other dangerous goods by road through administration of the *Transportation of Dangerous Goods Act*. The Department is also responsible under the *Motor Vehicles Act* for driver licensing and various other vehicle and road safety matters.

Environment Canada

Environment Canada is responsible for administering the *Canadian Environmental Protection Act* (CEPA). Mercury is listed as a Toxic Substance in Schedule I of CEPA and notices have been published in the Canada Gazette requiring the preparation and implementation of pollution prevention plans in regard to mercury releases from switches in end-of-life vehicles and dental amalgam waste. Environment Canada is also responsible for regulating international and interprovincial movement of hazardous waste, including unwanted mercury-containing products and waste mercury, under the *Interprovincial Movement of Hazardous Waste Regulations* and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations*. Environment Canada is also responsible for administering the pollution prevention provisions of the federal *Fisheries Act*.

Indian and Northern Affairs Canada

Indian and Northern Affairs Canada is responsible under the *Territorial Lands Act* and *Nunavut Waters and Nunavut Surface Rights Tribunal Act* for the management of federal lands and waters in Nunavut, including the impact waste mercury may have on the quality of these lands and waters.

Local Municipal Governments

The role of municipal governments is important in the proper local management of unwanted mercury-containing products and waste mercury. Under the Nunavut Land Claims Agreement, municipalities are entitled to control their own municipal disposal sites. Unwanted waste may be deposited into municipal landfill sites and sewage lagoons only with the consent of the local government. The local fire department may also be called upon if a fire or other public safety issue is identified.

Co-management Boards and Agencies

Co-management boards and agencies established under the Nunavut Land Claims Agreement have broad authority for land use planning, impact assessment and the administration of land and water. Activities involving the management and disposal of unwanted mercury-containing products and waste mercury may be controlled through the setting of terms and conditions in plans, permits and licenses issued by the Nunavut Water Board and other co-management boards and agencies.

Characteristics and Effects of Mercury

Mercury is a naturally occurring element that can be released to the environment from natural sources or through human activities. Natural sources include the release of mercury from the Earth's crust through volcanic activity and the weathering of soil and rock. Human activities contribute to mercury levels in the environment primarily through the burning of coal and the burning and landfilling of products or waste that contain mercury.

Elemental mercury is a shiny, silver-white metal that is liquid at room temperature. It is a persistent element that can cycle between the earth's land, water and air for long periods of time. Through a process known as 'atmospheric mercury depletion events'[3] relatively high concentrations of mercury are now being found in the Canadian Arctic, a region with no significant industrial sources of the metal.

Several forms of mercury occur naturally in the environment with microorganisms and natural processes being able to change the mercury from one form to another. The most common natural forms of mercury found in the environment are metallic mercury, mercuric sulphide, mercuric chloride, and the organic form methylmercury. Being an element, mercury cannot be broken down or degraded further into harmless substances.

2.1 Effects on the Environment

All forms of mercury can accumulate in organisms to some degree. Of most importance is methylmercury, which is a fat soluble compound that readily bioaccumulates in living organisms and biomagnifies up the food chain. This can result in methylmercury levels in edible freshwater and saltwater fish, aquatic mammals and predatory birds that are thousands of times greater than levels in the surrounding water. Wildlife exposed to these high levels of methylmercury is at risk of harm. Depending upon the species and level of exposure, harmful effects can include slower growth, reproductive failure, death and the development of abnormal behaviors that can affect survival rates.

As little as 25 milligrams (or 25 thousandths of a gram) of mercury, the amount contained in many common consumer products, can contaminate as much as one hundred thousand litres of water beyond the safe limits for the protection of aquatic life[4].

2.2 Effects on Human Health

Mercury is a neurotoxin that can cause damage to the brain, central nervous system, kidney and lungs in humans. The severity of the toxic effect depends on the form and concentration of mercury and its route of exposure. Methylmercury readily enters the brain and can lead to health effects including personality changes, tremors, changes in vision, deafness, loss of muscle coordination and sensation, memory loss, intellectual impairment, and in extreme cases, death. Mercury can also cross the placental barrier of pregnant mothers affecting the fetus while in the womb. Affected children may exhibit reduced coordination and growth, lower intelligence and seizures.

[3] 'Atmospheric mercury depletion events' occur when a series of photochemical reactions involving halogens convert gaseous elemental mercury to a more reactive form. This new form of mercury then adheres to dust and other particles in the atmosphere and is deposited in the Arctic, sub-Arctic and Antarctic regions.

[4] The Canadian Council of Ministers of the Environment (CCME) has established 0.026 micrograms of inorganic mercury per litre of water as the water quality guideline for the protection of aquatic life.

Waste Management

> *Minimizing or avoiding the creation of pollutants and wastes can be more effective in protecting the environment than treating or cleaning them up after they have been created.*[5]

Responsible waste management involves adopting methods and techniques that have been shown to prevent or reduce pollution. These policies, prohibitions of practices, maintenance and monitoring procedures can include reducing the amount of waste generated, reusing the waste for a different purpose or recycling the waste to produce a new product. Implementing these management practices is an effective way of reducing a person's costs, reducing pollution and reducing legal liabilities.

3.1 Pollution Prevention - Mercury-Containing Products and Non-Mercury Alternatives

Pollution prevention methods reduce or eliminate the creation of waste mercury. Scientific and technical advances in product manufacture and design have enabled the amount of mercury in many consumer, institutional, commercial and industrial products to be reduced or eliminated. In many cases, these non-mercury or low-mercury alternatives have the same performance characteristics and cost less to operate than the original mercury-containing product. The following sections introduce the common mercury-containing products used in Canada and their non-mercury alternatives.

Figure 1 - Compact Fluorescent Lamp Tube
Source – E. Paquin

3.1.1 Fluorescent and Other Lamps

Mercury is an essential element needed for the operation of most fluorescent, high intensity discharge and neon lamps. Light is produced when electricity passes through the lamp and excites the contained mercury vapour. The quantity of mercury in these lamps varies according to the type and size of the lamp. Table 1 describes the common types of mercury-containing lamps and their mercury content.

In recent years, industry has been able to reduce the amount of mercury in these lamps but, because it remains an essential element for the lamp's operation, small amounts of mercury continue to be used in their manufacture.

Figure 2 - Linear Fluorescent Lamp Tube

When fluorescent and other mercury-containing lamps burn out, much of the mercury tends to be absorbed by other lamp materials such as phosphorous and glass. However, a small amount of mercury still remains in vapour form, which can result in an inhalation hazard if the lamp is broken or crushed. Over 75% of the mercury used in lamps in Canada currently ends up in landfill sites.

[5] Source – Canadian Council of Ministers of the Environment.

Table 1. Mercury-Containing Lamps

Lamp Type	Description and Use	Mercury Content[6]
Linear Fluorescent	Linear fluorescent lamps are sealed glass tubes that are between 2 and 8 feet in length and contain small amounts of mercury, an inert gas and phosphor powder coating the inside of the tube. The lamps are commonly used in offices, stores, warehouses and homes.	3 to 50 milligrams
Compact Fluorescent	Compact fluorescent lamps (CFL's) have the same characteristics as linear fluorescent lamps except the glass tube has been replaced with a compact coil. CFL's are designed to replace the traditional incandescent lamp and are becoming increasingly common in homes and offices.	1 to 25 milligrams
Mercury Vapour Discharge	Mercury vapour lamps consist of a glass envelope with a pinched quartz glass tube and several electrodes within. Mercury vapour is contained within the glass tube. The lamps are used for street and floodlighting applications. The emitted light has a bluish glow.	25 to 225 milligrams
High Pressure Sodium Vapour Discharge	High pressure sodium vapour lamps (70 to 1000 watts) have the same physical characteristics as mercury vapour discharge lamps except they contain solid sodium, mercury and a small amount of neon and argon gas. Low pressure sodium vapour lamps (35 to 180 watts) do not contain mercury. Both are high intensity discharge lamps used for street and floodlighting applications. The emitted light has a yellowish glow.	20 to 145 milligrams
Metal Halide	Metal halide lamps have the same physical characteristics as mercury and sodium vapour discharge lamps except they contain metal halides, mercury and argon gas. Sodium iodide and scandium iodide are commonly used as the metal halide. These lamps are used to light sporting facilities where a very bright light is required.	25 to 225 milligrams
Neon	Neon lamps are similar to florescent lamps except that the colour emitted depends on the mixture of gases and the colour of the glass. Although the term refers to all gas discharge bulbs using noble gases, only the red lamps use neon. Red neon lamps do not contain mercury. Other neon lamps use argon, mercury and phosphor to produce additional colours.	Varies by colour and size

Non-Mercury Alternatives

Fluorescent and high intensity discharge lamps are currently the most energy-efficient lamps available for their specific applications and similar energy-efficient alternatives are currently not commonly available. Using these lamps in place of incandescent bulbs reduces the overall amount of greenhouse gases and other contaminants emitted from electrical generating stations powered by fossil fuels because of the lamp's energy efficiency. High-efficiency, low-mercury content lamps should be

[6] To assist in putting mercury content into the proper context, one Canadian penny weighs approximately 2300 milligrams.

purchased whenever possible. In some cases, light emitting diode (LED) lamps can be used to replace neon and other mercury-containing lamps, although LED lamps can be more costly and cannot be used in all applications.

Figure 3 – High Pressure Sodium Discharge Lamp

Figure 4 – Metal Halide Lamp

Figure 5 – Mercury Vapour Lamp

3.1.2 Thermometers and Other Measuring Devices

Mercury has been used in a variety of measuring devices because the liquid reacts predictably to changes in temperature and pressure. Table 2 describes various mercury-containing measuring devices that can be found in Nunavut. These devices can be found in homes, schools, laboratories, hospitals, nursing stations, as well as commercial and industrial facilities.

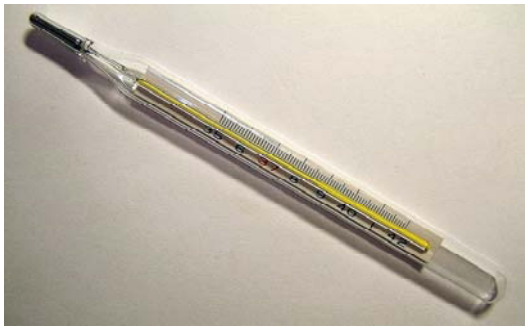

Figure 6 – Clinical Mercury Thermometer

Non-Mercury Alternatives

Various digital, mechanical and non-mercury liquid alternatives have been developed. Table 2 provides a list of several non-mercury alternatives for thermometers and other measuring devices. Availability, product effectiveness and relative cost should be considered when switching to a non-mercury alternative.

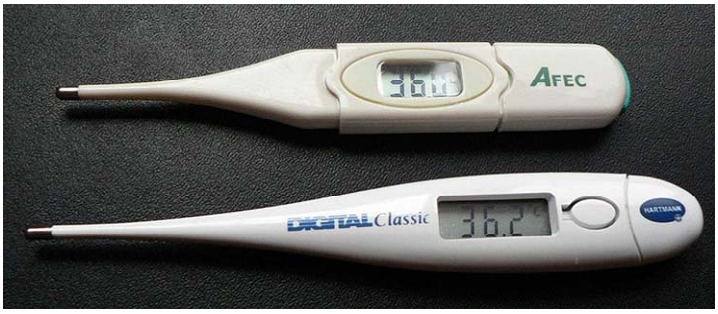

Figure 7 - Electronic Clinical Thermometers

Table 2. Mercury-Containing Measuring Devices

Device Type	Description and Use	Alternatives
Thermometer	Thermometers measure temperature. Held within a bulb at the base of the instrument, heat and cold causes the mercury to move up and down a thin tube where its position indicates the temperature. Various types of thermometers exist and can be found in homes, laboratories, schools and industries.	Digital, alcohol or spirit-filled thermometer
Barometer and Manometer	Barometers measure air pressure while manometers measure pressure differences. They consist of long tubes filled with mercury where air pressure causes the mercury to move up or down the tube. These devices are commonly used at airports and other weather stations.	Digital or aneroid barometer, digital manometer or needle bourdon gauge
Flowmeter	Flowmeters measure the rate of flow of gas, water and air streams. Although no longer manufactured, mercury-containing flowmeters are still used in water and sewage treatment plants, power stations and other industrial applications.	Digital or ball-actuated flowmeter
Hydrometer	Hydrometers measure the specific gravity and density of a liquid. They look similar to a thermometer except the bulb at the bottom is wider and weighted to keep the hydrometer upright when placed in a liquid. Hydrometers are commonly used in laboratories and in the production of alcohol.	Spirit filled hydrometer
Hygrometer	Hygrometers measure the moisture content of air. The most common type, the psychrometer, looks like a dual thermometer, one with a wet base and the other with a dry base. Hygrometers are used for weather forecasting.	Digital or spirit-filled psychometer
Medical Devices	Examples of medical devices that contain mercury include: sphygmomanometers (measure blood pressure), esophageal dilators (open the patient's throat during surgery), and gastrointestinal tubes (removal of intestinal obstructions).	Aneroid or digital sphygmomanometer

3.1.3 Thermostats

Mercury-containing thermostats are used to control residential, commercial and institutional heating and cooling systems. These thermostats contain small glass containers, or ampoules, of mercury which act as temperature-sensitive tilt switches to automatically control the furnace or other device. Each ampoule generally contains three grams of mercury, with each thermostat having up to six ampoules depending upon its application.

Figure 8 - Home Thermostat

Thermostats that contain mercury can be identified by removing the front cover of the device and visually inspecting its contents. If there are glass ampoules inside that contain a shiny silver-white liquid, it is most likely mercury.

Figure 9 - Touch Screen Digital Thermostat

Non-Mercury Alternatives

Mercury-containing thermostats can be replaced using relatively inexpensive digital thermostats. Most modern digital thermostats are programmable, which enables temperature in a building to be automatically adjusted according to a predetermined schedule. This results in energy and cost savings.

3.1.4 Batteries

Since the late 1990's North American battery manufacturers have eliminated or significantly reduced the mercury found in batteries. The use of mercury in the common alkaline battery has been eliminated while small amounts of mercury – anywhere from 5 to 25 milligrams - continue to be used in the manufacture of several types of button-cell batteries[7]. Button-cell batteries are small, thin energy cells that are not rechargeable. They continue to be used in a wide variety of electronic advices because of their small size and steady voltage output. Table 3 describes the common button-cell batteries in use today.

Examples of various sized button cell batteries.

Figure 10
Source – Vermont Department of Environmental Conservation

Table 3. Mercury-Containing Button-Cell Batteries

Battery Type	Common Uses
Zinc Air Miniature Batteries	Mostly used in hearing aids because of their high energy concentration and ability to continuously discharge energy. May also be used in small devices such as wristwatch pagers and ear speech processors.
Silver Oxide Button-Cell Batteries	Used in various devices such as hearing aids, watches, cameras and clocks. Silver oxide batteries may come in a large size as well as button-cell however, their manufacture is limited due to the price of silver.
Alkaline Manganese Oxide Button-Cell Batteries	Used in toys, calculators, remote control devices and cameras.

[7] Gas can form in button-cell batteries because of the corrosion of zinc causing the battery to leak. Mercury suppresses this corrosion. Button-cell batteries can contain up to 0.005 grams of mercury in the insulating paper surrounding the battery, or mercury can be mixed in the battery anode itself.

Mercuric oxide batteries contain mercury as the electrode and are useful in applications that require a high energy density and steady voltage output. Although North American battery manufacturers discontinued production of these batteries in 1996, larger mercuric oxide batteries may still be used in applications such as military, medical and industrial equipment.

Non-Mercury Alternatives

Few mercury-free alternatives currently exist for button-cell batteries and those that do exist are generally considered to have reduced performance and a higher cost. Observing battery packaging and labeling is the best method for identifying mercury-free or mercury-reduced button-cell batteries. Electrical devices that can operate on standard 110 volt power supplies (i.e. smoke and carbon dioxide detectors) should be purchased where practical rather than battery-powered devices. The use of rechargeable batteries is also a good alternative to non-rechargeable batteries where the replacements are compatible with the device.

3.1.5 Switches and Relays

Figure 11 - Mercury-Containing Switches
Source – California Department of Toxic Substances Control

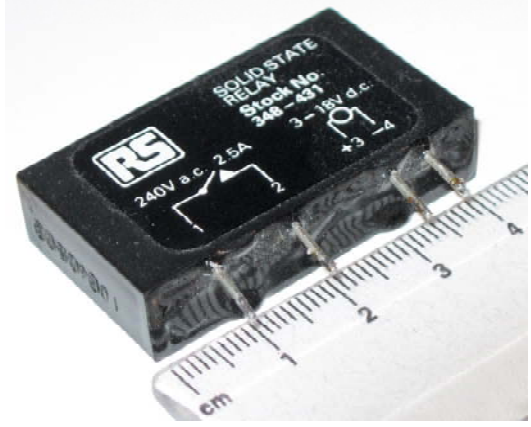

Figure 12 – Solid State Relay Switch

Switches are products that open or close an electrical circuit. When open, switches allow the electrical current to flow and when closed the circuit is broken and flow of current is stopped. Many older switches contain mercury because of the metallic liquid's excellent ability to conduct electricity. The most common consumer applications have been in tilt switches (i.e. older-model thermostats, hood and trunk lights on older-model vehicles) and float switches (i.e. boat bilge pumps).

Relays are products that open or close electrical contacts to control the operation of other electrical devices. They enable large electrical loads to be turned on or off by supplying relatively small currents to a control circuit.

Table 4 describes various mercury-containing switches and relays used in Canada and their available non-mercury alternatives.

Non-Mercury Alternatives

Mechanical and digital switches are widely available to replace mercury switches for all common applications. These vary in price depending on use and design. Not all non-mercury alternatives may be suitable for any one application without retrofit as electrical requirements must be strictly adhered to. If in doubt, the manufacturers or distributors of the specific equipment should be consulted.

Displacement and contactor relays are very specific for

their applications and non-mercury alternatives have generally not provided equal performance and reliability. Mercury wetted relays can be replaced by dry magnetic reed relays for most applications.

Table 4. Mercury-Containing Switches and Relays

Device Type	Description and Use	Alternatives
Float Switch	Float switches monitor liquid levels and are most commonly used in sump pumps. They are also used in boat bilge pumps, boilers, sewage treatment plants and pumping stations. The mercury is normally contained inside a sealed ampoule within a cylindrical outer casing.	Mechanical, optical, metallic ball, sonic or ultrasonic, pressure transmitter, alloy, thermal or capacitance float switches
Tilt Switch	Tilt switches are activated by a change in the switch position. They have been commonly used in older-model thermostats as well as applications that activate upon opening such as hood and trunk lights in older-model vehicles and chest freezers. Mercury tilt switches are typically small glass tubes with two electrical contacts at one end.	Metallic ball, electrolytic, mechanical, digital or capacitance tilt switches
Pressure Switch	Pressure switches are activated by a change in pressure. These switches have been used in HVAC systems, medical devices, automobiles (ABS brakes), appliances and other applications. Pressure switches are comprised of a diaphragm, piston or other pressure-response device coupled with a mercury ampoule.	Mechanical or digital switches
Temperature Switch	Temperature switches are activated by a change in temperature. These switches are used in a wide variety of applications including food warming trays, hot water boilers, ovens, sterilizers and heat exchangers. The switch is similar to a tilt switch and is usually attached to a temperature sensing device such as a bi-metallic strip.	Mechanical or digital switches
Relays	Relays are devices that open or close electrical control circuits to operate other devices in the same or different electrical circuit. They include displacement, contactor and wetted reed relays. Relays are commonly used in electronic circuit boards, commercial and industrial electric ranges and other cooking equipment.	Dry magnetic reed relays

3.1.6 Dental Amalgam

Dental amalgam is a mixture of metals that has been used for over 150 years to restore teeth. The metal mixture, commonly referred to as ‘silver fillings’, can consist of up to 50% mercury. Despite its use for many years, there is currently no evidence to suggest that mercury in dental amalgam is a risk to human health in the general population.

Mercury amalgam continues to be used for tooth restorations because of its durability, ease of use and low cost[8]. In the past, dentists mixed the amalgam on site using bulk mercury and metal powders. This practice resulted in a health risk to workers through physical contact with the elemental mercury and to the environment through spillage. Today, dental amalgam is purchased in pre-dosed amalgam capsules that come in different sizes.

In 2001, federal, provincial and territorial governments endorsed the *Canada-Wide Standard on Mercury for Dental Amalgam Waste* through the Canadian Council of Ministers of the Environment (CCME). The Standard called for dentists to apply 'best management practices' to achieve a 95% national reduction in mercury releases from dental amalgam by 2005. These practices include the installation, use and maintenance of International Organization for Standardization (ISO) certified amalgam separators, traps and filters to remove waste mercury from dental office wastewater. A report released in 2007 indicates that 70% of dentists operating in Canada were employing ISO certified amalgam separators (Environment Canada, 2007).

Non-Mercury Alternatives

There are several resin and composite materials that are substitutes for mercury amalgam. These include cast gold, bonded amalgam and dental ceramics. These alternatives are usually more costly than mercury amalgam fillings and may not be suitable for all procedures. Composite resins are tooth-coloured plastic materials often used to restore front teeth where a natural appearance is important. These resins can also be used as fillings on back teeth depending on the location and extent of tooth decay.

3.2 What to do if a Spill of Mercury Occurs

Cleanup actions must be started as soon as possible following a spill of mercury so workers and family members are not exposed to its hazards. When a thermometer or other liquid mercury-containing product is broken, the mercury will quickly form beads that accumulate in small pools and in the tiniest of spaces, making cleanup difficult. When a fluorescent or other mercury-containing lamp is broken or if mercury remains trapped (i.e. in tiny spaces, drains or soft surfaces such as carpet and furniture), mercury vapour is released directly to the air. Although mercury evaporates slowly at normal room temperature, dangerous levels of mercury vapour can build up in indoor air.

The following should be considered when cleaning up a spill of mercury:

- It can be very dangerous to touch liquid mercury directly or breathe mercury vapour. Immediately isolate the spill area by keeping people and pets away, closing all interior doors that lead to other rooms in the building and turning off heaters. Ventilate the area by turning on fans that vent directly to the outdoors and opening windows and exterior doors.
- Protect yourself by changing into old clothing and shoes that can be thrown away after clean up has been completed, removing all jewelry as mercury can adhere to metal and putting on gloves, preferably made of rubber, nitrile or latex.
- On a hard surface (i.e. linoleum, tile or concrete), push the mercury beads together using razor blades, stiff paper or cardboard, pick up the beads using a dustpan or stiff paper and carefully transfer the mercury into a wide-mouth container or plastic bag. Any remaining beads of

[8] Approximately 1.3 tonnes of mercury in new filling material is placed each year in the mouths of Canadians (CCME, 2001).

mercury can be picked up using tape, cotton balls or a moist paper towel. All debris should be placed inside the container or bag and the lid sealed tightly with tape.

- On a soft surface (i.e. carpet, couch or clothing), it is best to cut out the contaminated materials and place them into a sealable container or plastic bag. If you're not willing to cut out the materials, use cotton balls, moist paper towel or an eye dropper to pick up the spilled mercury and place it, along with any debris, into the container or bag.
- When a fluorescent or other mercury-containing lamp is broken, quickly ventilate the area by turning on fans that vent to the outdoors and opening all windows and exterior doors. Leave the area for at least 30 minutes and then follow the instructions for the type of surface to be cleaned.
- In every case, place the sealed container or plastic bag containing the mercury and debris into another container or bag for additional protection against breakage and leakage.
- Wash your hands thoroughly and take a shower immediately after the cleanup.

Never allow people who are wearing clothing or shoes contaminated with mercury to walk around the building, never use a broom or ordinary vacuum cleaner to clean up mercury, never pour mercury down a drain and never launder mercury-contaminated clothing in a washing machine.

Mercury spill kits are commercially available from safety supply companies to assist in the cleanup of spilled mercury. Although convenient, these kits may be expensive and are not absolutely necessary to clean up a small contained spill of mercury, such as from a mercury switch or thermometer. The following are some commonly available items that can be used to construct a mercury spill kit: rubber gloves, goggles or other eye protection, flashlight, sponge or cotton balls, wide duct or masking tape, eye dropper or syringe without needle, stiff index cards, plastic containers with tight-fitting lids and plastic bags with zipper seals.

All spills of mercury must immediately be reported to the NWT/Nunavut 24-Hour Spill Report Line at (867) 920-8130 (toll free) or e-mailed to: spills@gov.nt.ca . Spill reporting forms are available on the Department of Environment's website: http://env.gov.nu.ca/programareas/environmentprotection

The local nursing station or health authority should also immediately be notified.

3.3 Storage

Storage refers to keeping unwanted material while awaiting its transport, recycling or disposal. Except under extraordinary circumstances, storage is not acceptable for the long-term management of unwanted mercury-containing products and waste mercury and should be considered as a temporary measure only.

Unwanted mercury-containing products and waste mercury should be stored in the following manner:

- If the packaging that was used to originally ship the product is available and the product is unbroken, place it in the packaging and seal the package securely with tape.
- If the original packaging is not available or if the mercury is from a spill, place the product or container containing the mercury and any cleanup materials and debris inside a larger metal or plastic container. Place kitty litter or other oil absorbent packing material around the product or

small container to protect it from breaking or sudden shock. Secure the larger container with a tight fitting lid or tape.

- Clearly label all storage containers as containing mercury according to the requirements of the *Workplace Hazardous Materials Information System* (WHMIS) and relevant Transport Authority.
- Place all labeled storage containers in a clearly marked designated area which is separate from other waste to prevent its disposal with normal garbage.
- If mercury-containing lamps are being stored, do not crush the lamps as crushing will release vapours that may pose health and environmental hazards. Broken lamps are a hazardous waste.

If the storage facility is used for commercial purposes to store hazardous waste for periods of 180 days or more or the quantity of waste stored on-site exceeds the criteria set out in the *Environmental Guideline for the General Management of Hazardous Waste*, the facility must be registered with the Department of Environment as a hazardous waste management facility[9]. Copies of registration forms are available at http://env.gov.nu.ca/programareas/environmentprotection/forms-applications or by contacting Nunavut's Department of Environment. Refer to the GN *Environmental Guideline for the General Management of Hazardous Waste* for additional information on the registration process.

3.4 Transportation

Unwanted mercury-containing products and waste mercury may be classified as a hazardous waste for the purposes of transportation depending upon the quantity of waste being transported for recycling or disposal. Under the federal *Interprovincial Movement of Hazardous Waste Regulations*, no person may transport waste mercury in Canada in a quantity greater than five kilograms or five litres unless it is accompanied by a completed manifest[10]. Manifesting requirements for the international transport of waste are controlled under the federal *Export and Import of Hazardous Waste and Recyclable Material Regulations*. Manifest forms are available from Nunavut's Department of Environment and completion instructions are included on the reverse side of each manifest. Further information on manifesting can be obtained by referring to Environment Canada's *User's Guide for the Hazardous Waste Manifest* or the *Environmental Guideline for the General Management of Hazardous Waste*.

The classification, packaging, labeling and placarding of mercury-containing products and waste mercury while being transported must conform to the federal and territorial *Transportation of Dangerous Goods Act* and *Regulations*. Schedule I of the *Regulations* classify waste mercury as follows[11]:

Shipping Name: WASTE Mercury
Classification: 8
Product Identification Number: UN2809
Packing Group: III

[9] The criterion for Class 8 Corrosives is 1000 kilograms and the criterion for the aggregate quantity of hazardous waste is 5000 kilograms.
[10] In response to the 2007 federal government direction on streamlining regulation in Canada, the alignment of definitions in the *Interprovincial Movement of Hazardous Waste Regulations* (IMHWR) and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (EIHWHRMR) is being undertaken by Environment Canada. Under the current proposal, the quantity of waste mercury requiring a manifest while being transported in Canada would be revised to less than 50 milliliters (ml) per shipment, which is the same as is currently required for international transport under the EIHWRHMR (Environment Canada, 2010).
[11] A wide variety of mercury-containing chemicals and compounds in addition to elemental mercury are available for use in Canada. Refer to Schedule I of the *Transportation of Dangerous Goods Regulations* for the specific classification, product identification number and packing group of these chemicals and compounds.

The transport of mercury-containing products and waste mercury by air must conform to the *International Air Transport Association* (IATA) *Dangerous Goods Regulations* and *International Civil Aviation Organization* (ICAO) *Technical Instructions,* while transport by marine must conform to the *International Marine Dangerous Goods Code*. Further information on transporting these materials can be obtained by contacting Transport Canada or the appropriate Transport Authority.

Hazardous waste generators, carriers and receivers operating in Nunavut must be registered with the Nunavut Department of Environment. A unique registration number is assigned to each registrant through the registration process, which enables completion of the manifest document. Copies of registration forms are available at http://env.gov.nu.ca/programareas/environmentprotection/forms-applications or by contacting Nunavut's Department of Environment. Refer to the *Environmental Guideline for the General Management of Hazardous Waste* for additional information on the registration process.

A listing of hazardous waste carriers, receivers and hazardous waste management facilities registered to operate in Nunavut is available by contacting Nunavut's Department of Environment.

3.5 Disposal

Municipal landfill sites and sewage lagoons in Canada have over the years become a major source of mercury to the environment. Unwanted mercury-containing products and waste mercury must never be thrown in the garbage and liquid mercury must never be poured down the drain[12].

Recycling and disposal options for unwanted mercury-containing products and waste mercury in Nunavut are limited. The majority of these materials are used in government, commercial, industrial and institutional facilities and any unwanted or end-of-life products should be safely stored until they can be transported to a registered hazardous waste receiver that is licensed to recycle or dispose of mercury. Names of Canadian recyclers and disposal companies are available by contacting the waste management exchanges and associations listed in Appendix 10 of the *Environmental Guideline for the General Management of Hazardous Waste.* Additional information on commercial processors of mercury-containing waste can be obtained through the following web site links:

- lamprecycle.org/ - The lamprecycle.org web site is an American resource of information on mercury-containing lamp recycling and lists several lamp recycling companies in Canada.
- www.almr.org/ - The Association of Lighting and Mercury Recyclers represents the majority of commercial processors of mercury-containing waste in the United States, some of which also operate in Canada.

Some Municipalities in Nunavut are starting to implementing programs aimed at collecting and safely storing unwanted or end-of-life fluorescent lamps and other mercury-containing products as part of their household garbage collection programs. Homeowners wishing to dispose of these wastes should contact their municipality for local disposal information.

[12] The *Guideline for Industrial Waste Discharges* prohibits the disposal of mercury in sewage lagoons and landfills if mercury is present in excess of 0.1 milligrams per litre (parts per million) based on leachate quality test results.

Conclusion

Mercury is a naturally occurring element that is found in soil, air and water around the world and which can take many different forms, some of which are harmful to humans and wildlife. Mercury has also been used for many years in a variety of consumer and industrial products because of its ability to conduct electricity and react predictably to changes in temperature and pressure. The Guideline is an introduction to the risks, hazards and best management practices associated with various mercury-containing products and waste mercury. It examines the characteristics and effects of mercury on the environment and human health, identifies non-mercury alternatives for common products and provides guidance on the proper cleanup of spilled mercury and the storage, transportation and disposal of unwanted products.

Familiarity with the Guideline does not replace the need for the owner or person in charge, management or control of mercury-containing products and waste mercury to comply with all applicable federal and territorial legislation and municipal by-laws. The management of these materials may also be controlled through permits and licenses issued by Nunavut's co-management boards, Indian and Northern Affairs Canada and other regulatory agencies. These permits and licenses must be complied with at all times.

For additional information on the management of mercury-containing products and waste mercury, or to obtain a complete listing of available guidelines, go to the Department of Environment web site or contact the Department at:

Environmental Protection Division
Department of Environment
Government of Nunavut
Inuksugait Plaza, P.O. Box 1000, Station 1360
Iqaluit, Nunavut X0A 0H0

Telephone: (867) 975-7729
Fax: (867) 975-7739
Email: EnvironmentalProtection@gov.nu.ca
Website: http://env.gov.nu.ca/programareas/environmentprotection

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Canadian Council of Ministers of the Environment (CCME). Canada-Wide Standards for Mercury-Containing Lamps, (2001).

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Northeast Waste Management Officials Association (NEWMOA). Mercury-Added Products Fact Sheets Website - http://www.newmoa.org/prevention/mercury/imerc/factsheets.

United Nations Environment Programme (UNEP). Global Mercury Assessment, (2002).

United States Environmental Protection Agency (USEPA). Mercury Releases and Spills Website – http://www.epa.gov/mercury/spills.

APPENDICES

APPENDIX 1 - *ENVIRONMENTAL PROTECTION ACT*

The following are excerpts from the *Environmental Protection Act*

1. "Contaminant" means any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment,
   (a) endangers the health, safety or welfare of persons,
   (b) interferes or is likely to interfere with normal enjoyment of life or property,
   (c) endangers the health of animal life, or
   (d) causes or is likely to cause damage to plant life or to property;

   "Discharge" includes, but not so as to limit the meaning, any pumping, pouring, throwing, dumping, emitting, burning, spraying, spreading, leaking, spilling, or escaping;

   "Environment" means the components of the Earth and includes
   (a) air, land and water,
   (b) all layers of the atmosphere,
   (c) all organic and inorganic matter and living organisms, and
   (d) the interacting natural systems that include components referred to in paragraphs (a) to (c).

   "Inspector" means a person appointed under subsection 3(2) and includes the Chief Environmental Protection Officer.

2.2 The Minister may
   (a) establish, operate and maintain stations to monitor the quality of the environment in the Territories;
   (b) conduct research studies, conferences and training programs relating to contaminants and to the preservation, protection or enhancement of the environment;
   (c) develop, co-ordinate and administer policies, standards, guidelines and codes of practice relating to the preservation, protection or enhancement of the environment;
   (d) collect, publish and distribute information relating to contaminants and to the preservation, protection or enhancement of the environment:

3. (1) The Minister shall appoint a Chief Environmental Protection Officer who shall administer and enforce this Act and the regulations.

   (2) The Chief Environmental Protection Officer may appoint inspectors and shall specify in the appointment the powers that may be exercised and the duties that may be performed by the inspector under this Act and regulations.

5. (1) Subject to subsection (3), no person shall discharge or permit the discharge of a contaminant into the environment.

   (3) Subsection (1) does not apply where the person who discharged the contaminant or permitted the discharge of the contaminant establishes that
   (a) the discharge is authorized by this Act or the regulations or by an order issued under this Act or the regulations;
   (b) the contaminant has been used solely for domestic purposes and was discharged from within a dwelling house;
   (c) the contaminant was discharged from the exhaust system of a vehicle;

(d) the discharge of the contaminant resulted from the burning of leaves, foliage, wood, crops or stubble for domestic or agricultural purposes;
(e) the discharge of the contaminant resulted from burning for land clearing or land grading;
(f) the discharge of the contaminant resulted from a fire set by a public official for habitat management of silviculture purposes;
(g) the contaminant was discharged for the purposes of combating a forest fire;
(h) the contaminant is a soil particle or grit discharged in the course of agriculture or horticulture; or
(i) the contaminant is a pesticide classified and labelled as "domestic" under the *Pest Control Products Regulations* (Canada).

(4) The exceptions set out in subsection (3) do not apply where a person discharges a contaminant that the inspector has reasonable grounds to believe is not usually associated with a discharge from the excepted activity.

5.1. Where a discharge of a contaminant into the environment in contravention of this Act or the regulations or the provisions of a permit or license issued under this Act or the regulations occurs or a reasonable likelihood of such a discharge exists, every person causing or contributing to the discharge or increasing the likelihood of such a discharge, and the owner or the person in charge, management or control of the contaminant before its discharge or likely discharge, shall immediately:
(a) subject to any regulations, report the discharge or likely discharge to the person or office designated by the regulations;
(b) take all reasonable measures consistent with public safety to stop the discharge, repair any damage caused by the discharge and prevent or eliminate any danger to life, health, property or the environment that results or may be reasonably expected to result from the discharge or likely discharge; and
(c) make a reasonable effort to notify every member of the public who may be adversely affected by the discharge or likely discharge.

6. **(**1) Where an inspector believes on reasonable grounds that a discharge of a contaminant in contravention of this Act or the regulations or a provision of a permit or license issued under this Act or the regulations has occurred or is occurring, the inspector may issue an order requiring any person causing or contributing to the discharge or the owner or the person in charge, management or control of the contaminant to stop the discharge by the date named in the order.

7. (1) Notwithstanding section 6, where a person discharges or permits the discharge of a contaminant into the environment, an inspector may order that person to repair or remedy any injury or damage to the environment that results from the discharge.

(2) Where a person fails or neglects to repair or remedy any injury or damage to the environment in accordance with an order made under subsection (1) or where immediate remedial measures are required to protect the environment, the Chief Environmental Protection Officer may cause to be carried out the measures that he or she considers necessary to repair or remedy an injury or damage to the environment that results from any discharge.

APPENDIX 2 – GOVERNMENT CONTACTS

Government of Nunavut

Environmental Protection Division
Department of Environment
Inuksugait Plaza
P.O. Box 1000, Station 1360
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-7729 Fax: (867) 975-7739

Workers' Safety and Compensation Commission
P.O. Box 669
Baron Building/1091
Iqaluit, Nunavut X0A 0H0
Telephone: 1-877-404-4407 (toll free) Fax: 1-866-979-8501

Office of Chief Medical Health Officer of Health
Department of Health and Social Services
P.O. Box 1000, Station 1000
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-5774 Fax: (867) 975-5755

Motor Vehicles Division
Department of Economic Development and Transportation
P.O. Box 10
Gjoa Haven, Nunavut X0B 1J0
Telephone: (867) 360-4615 Fax: (867) 360-4619

Department of Community and Government Services (all Divisions)
P.O. Box 1000, Station 700
4th Floor, W.G. Brown Building
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-5400 Fax: (867) 975-5305

Government of Canada

Indian and Northern Affairs – Nunavut Region
P.O. Box 2200
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-4500 Fax: (867) 975-4560

Department of Transport – Road, Rail, Marine, Air
P.O. Box 8550
344 Edmonton Street
Winnipeg, Manitoba R3C 1P6
Telephone: 1-888-463-0521 (toll free)
Fax: (204) 983-8992 Road, Rail and Marine only
Fax: (204) 983-1734 Air only

Environment Canada (NWT and Nunavut)
5019 52nd Street
Yellowknife, Northwest Territories X1A 1T5
Telephone: (867) 669-4730 Fax: (867) 873-8185