AGNICO EAGLE

Meliadine Advanced Exploration Project
Water Licence 2BB-MEL0914

Landfarm Management Plan

January 2014

EXECUTIVE SUMMARY

The Landfarm Management Plan (LMP) describes the design features and operational procedures for a landfarm for the storage and treatment of petroleum hydrocarbon contaminated soil. It is proposed to be located within the old fuel bladder containment area at Agnico Eagle Mines Limited (AEM) Advanced Exploration Project site.

The old fuel bladder containment area, which used to hold bladders filled with diesel fuel, has berms on all sides and an impervious liner. The containment area measures 26 by 62 metres and has a volume of approximately 1,800 cubic metres.

DOCUMENT CONTROL

Version	Date	Section	Page	Revision
1	January 2014			First draft of the Meliadine Landfarm Management Plan

Plan prepared by:

John Witteman
Environmental Consultant to Agnico Eagle Mines Limited

Approved by:

Stéphane Robert
Manager, Regulatory Affairs Nunavut

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1. INTRODUCTION

1.1 Project History

Agnico Eagle Mines Limited (AEM) Meliadine Advanced Exploration Project (Project) currently operates advanced exploration project located on Inuit-owned land in the Kivalliq Region of Nunavut, approximately 25 kilometres north of the hamlet of Rankin Inlet. This Landfarm Management Plan is adapted from the Meadowbank Design and Management Plan (AEM 2013), which was developed by AEM in accordance with Water License 2AM-MEA0815 to describe the handling and remediation of petroleum hydrocarbon (PHC) contaminated soil at the Meadowbank site.

Advanced exploration has been active at the Meliadine Project since 2007 when the owner at the time opted to collect a bulk sample of the gold ore at depth using a decline. The decline was constructed in 2007 – 2008 to a depth of approximately 120 metres below surface. Since purchasing the Project in July 2010, AEM has continued the advanced exploration program through extensive drilling and further bulk sampling using the underground decline.

1.2 Objectives

Onsite storage and remediation has been established as the preferred method for treatment of petroleum hydrocarbon (PHC) contaminated soil that resulted from inadvertent spills at the Meliadine Project. Specifically, remediation through landfarming has been identified as the primary treatment option and, as such, is the focus of this management plan. Alternate contingency options in the event that landfarming is not successful or as efficient as planned are also discussed.

This plan is a component of the Meliadine Environmental Management System and has the following objectives:

1. To provide an overview of contaminated soil management at the Meliadine Advanced Exploration Project;
2. To describe the physical setting, location and design of the landfarm;
3. To define acceptable types of contaminated soils to be placed in the landfarm and conditions for removal of treated soil;
4. To define operating procedures and monitoring requirements for the landfarm; and
5. To describe contingency options for alternate treatment/storage of PHC contaminated soil.

2. SPILL PREVENTION

2.1 Spill Management Documentation

Spill prevention is the first stage in contaminated soil management at the Meliadine site. Methods employed include:

- Bi-weekly inspections of fuel/chemical storage areas for leaks;
- Training in safe handling procedures;
- Keep containers sealed;
- Use methods of secondary containment;
- Keep overpack drums nearby to contain leaking drums;
- Keep storage area secure from unauthorized access, and protected from weather and damage;
- Segregate incompatible materials; and
- Have regular meetings with site staff emphasizing spill prevention.

3. LANDFARM DESIGN

3.1 Background

When spills do occur, onsite storage and remediation is the most practical and efficient method of handling contaminated soil, particularly in an isolated location like the Meliadine Project. For PHC contamination, bioremediation through landfarming has been identified as a viable remedial technique. This method involves spreading, mechanical mixing, and placing the contaminated soil in windrows within a containment area and promoting conditions favourable for the volatilization and aerobic microbial degradation of hydrocarbons. A number of environmental factors and physical properties of the soil affect microbial growth and rates of biodegradation, including temperature, soil moisture, nutrient content, salinity and soil particle size.

Previously, a landfarm options analysis prepared for AEM by Golder (2007a) identified some of these factors, and presented the following information from the literature on landfarming in the north:

> *"Although rates of biodegradation decline with temperature, landfarming is still a feasible technique in arctic climates (Reimer et al. 2005). Microbial activity stops between 0 to -5°C (although volatilization continues at this temperature), so degradation in the north is typically restricted to the months of June – September. Nevertheless, degradation was reported at 70% after one year in a study in Alert, NU (Greer et al. 2007), and 90% over two summers on Resolution Island (Paudyn et al. 2005)."*

3.2 Location

The location of the landfarm facility is immediately adjacent to the tank farm located off the road between the underground exploration area and the camp site as shown in figure 3-1. It is to be located within the old fuel bladder containment area, which used to hold ten bladders each holding 113,000 litres of diesel fuel. It is has an impervious liner and berms on all sides. The containment area measures 26 by 62 metres and has a volume of approximately 1,800 cubic metres. Figure 3-2 depicts the old fuel bladder containment area.

The use of an existing facility for a landfarm does not lead to an increase in the footprint of the Project and reuses a facility that is presently sitting empty awaiting reclamation.

3.2.1 Proximity of Surface Water

Drainage from the facility is to Meliadine Lake, located approximately 500 metres to the northeast.

Figure 3-1 Location of the Landfarm

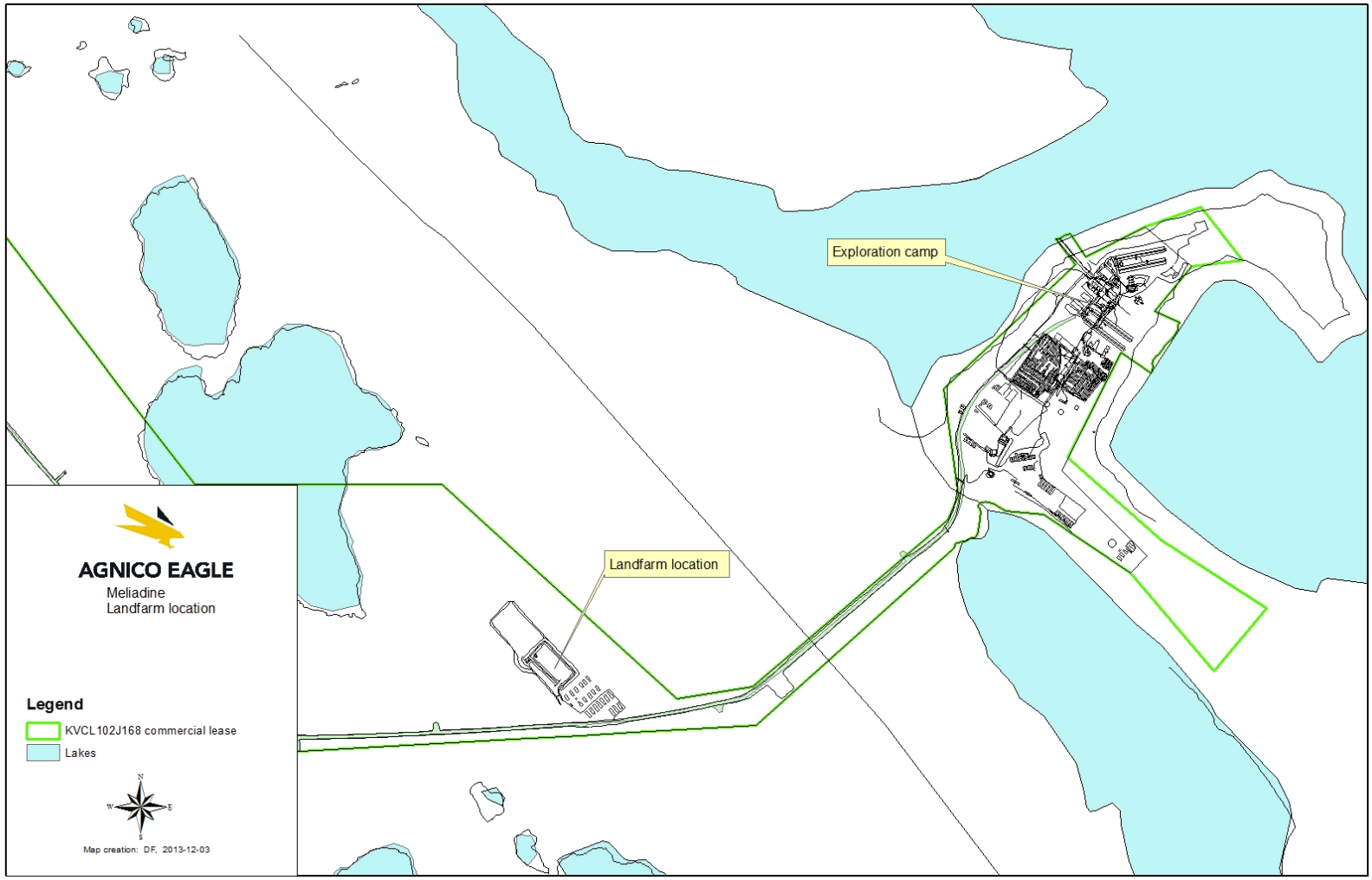
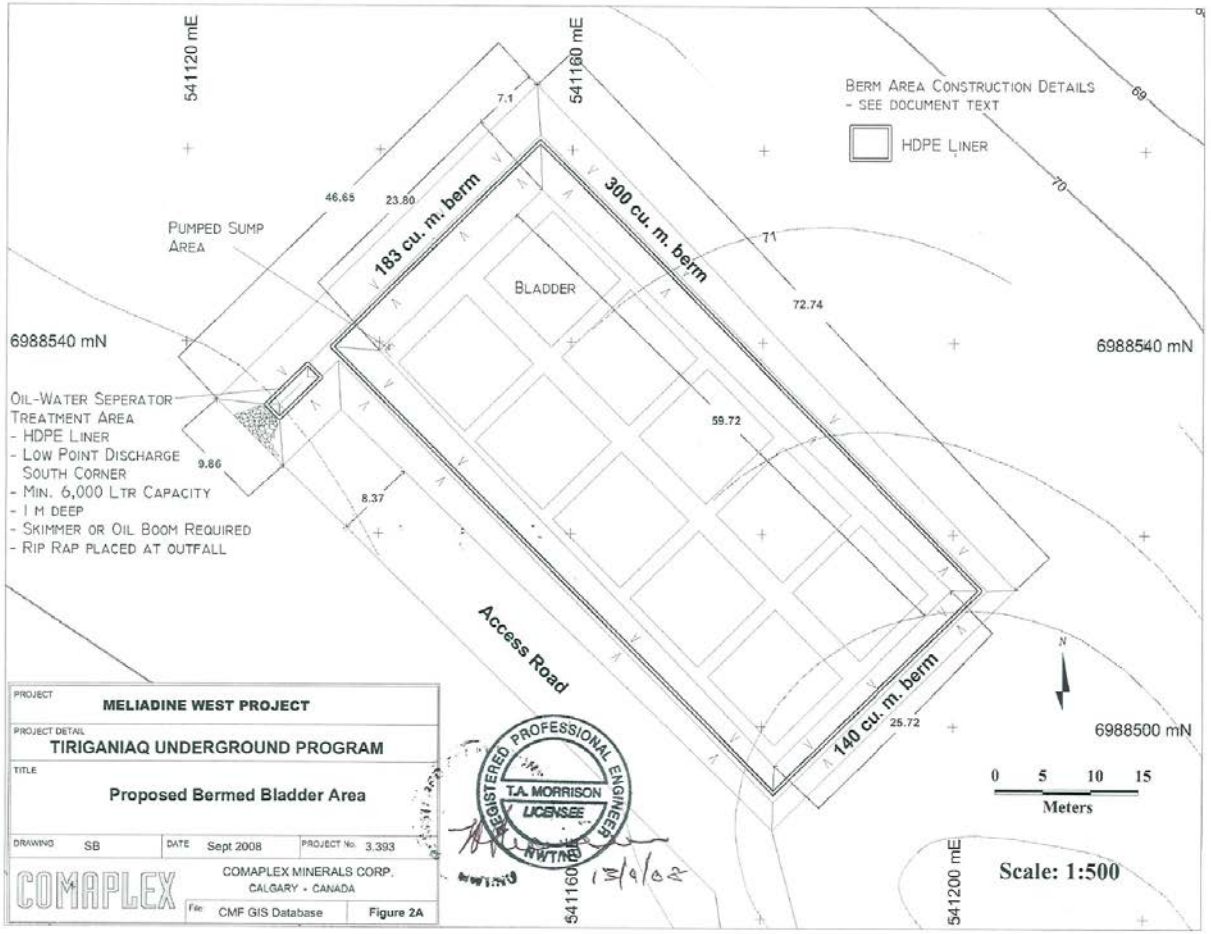


Figure 3-2 Design of the bermed bladder area to be used as a landfarm



3.2.2 Proximity of Groundwater

In the Meliadine area, shallow groundwater is estimated to be 1.5 m below surface, this being the average depth of thaw during July to October. In order to prevent movement of contaminants from the landfarm facility into groundwater and the surrounding environment, Environment Canada (SAIC, 2006) recommends placement of a barrier with 10^{-7} cm/s hydraulic conductivity at a thickness of 0.6 m. The Meliadine old fuel bladder containment area has an impermeable liner under an area capable of holding 1800 m^3 of material. As a result, no impacts on groundwater are anticipated.

3.3 Design

The landfarm facility is designed with one soil remediation/storage cell. The design volume of the cell is 1800 m^3 based on the available volume of the old fuel bladder containment area. This volume is believed sufficient for the quantity of contaminated soil expected at the Meliadine site.

4. LANDFARM OPERATION AND MANAGEMENT

The following presents the operational procedures for the landfarm facility.

4.1 Management Responsibility

AEM will be responsible for managing and implementing the landfarm management plan. Operation and monitoring of the facility will come under the responsibility of the Environment Coordinator. Designation of training requirements is the responsibility of Meliadine Environment Department.

4.2 Acceptable Material

4.2.1 Contaminants

The landfarm facility will only treat and/or store petroleum hydrocarbon contaminated soils that have been generated through exploration related activities at the Meliadine advanced exploration site. Material from other sites will not be accepted without approval from the Nunavut Water Board, Aboriginal Affairs and Northern Development Inspectors, and the Kivalliq Inuit Association.

If used onsite and spilled on soil, the following products may be treated in the landfarm:

- Diesel fuel;
- Gasoline;
- Aviation fuel (Jet A and Jet B);
- Hydraulic oil; and
- Other light oil e.g. engine oil, lubricating oil.

In the event that the contaminant source is unknown, soil samples will be analyzed for petroleum hydrocarbons and possibly additional contaminants prior to placement in the landfarm. These additional parameters could include total metals, oil and grease, and volatile organic compounds. Analysis for additional compounds will be determined by the Meliadine Environment Department on a case-by-case basis. Concentrations of contaminants will be compared to the site background values (for metals) and/or criteria in the Government of Nunavut (GN) Guidelines for Contaminated Site Remediation (March, 2009). If this analysis indicates soil contamination above background or GN guidelines with any substances not described in this section (i.e. non-PHC contaminants), it will not be placed in the landfarm facility. This is to ensure PHC contaminated soil is not contaminated with other products.

Spills of non-PHC material (e.g. solvents, glycol) will be placed in drums and stored in the site Hazmat area for shipment south to approved facilities during barge season.

4.2.2 Grain Size

While bioremediation will be inhibited with very coarse-grained larger soil material due to the inability to retain moisture and nutrients, volatilization will occur more rapidly (SAIC, 2006). It has been noted that this material likely contains lower concentrations of contaminants due to a lower volume:surface area ratio, and can typically be screened out prior to landfarming (SAIC, 2006). If possible, materials with grain size over 6" will be removed. This will occur at the spill location or in the landfarm. The two soil fractions will be treated separately in the landfarm (see Section 4.3.2).

4.3 Contaminated Soil Additions

4.3.1 Spill Excavation

Soil contaminated with the above-described petroleum hydrocarbon materials will be excavated from the source and transported to the landfarm facility in dump trucks or roll-off containers. Care will be exercised to ensure that the entire spill is excavated (verified by olfactory and visual assessment or sampling, if necessary) and that none of the contaminated material is lost during transport.

4.3.2 Placement in the Landfarm

As indicated above, larger coarse material (greater than 6") will be separated from the finer material in the landfarm and assessed visually for PHC staining and product. If the material is saturated, it will be spread out for volatilization or wash in the designated area of the landfarm.

Fine-grained materials identified as acceptable in the landfarm should be placed in windrows with dimensions about 6 m wide at base x 1.5 m high x 60 m long. Windrows may be piled higher as space permits. The on-site Environmental Coordinator will keep a record of the volume of contaminated soil placed in the landfarm and the location of each load within the facility.

4.4 Contaminated Snow

PHC contaminated snow will be placed in a designated area of the landfarm and treated as contact water after snow melt. After snow melt, the contaminated water will be pumped through the site's oil-water separator (carbon filter) to remove PHC residue. The treated water will be analysed and if it meets criteria (Clause D-17 in the water licence), will be release in the environment.

4.5 Remediation

Remediation of fine-grained PHC-contaminated soil in landfarms occurs naturally through volatilization and aerobic microbial degradation. Soil aeration and nutrient amendment are recognized as methods of

improving rates of remediation. To this end, remedial operations at the Meliadine site include soil mixing (aeration) and utilizing onsite nutrient additions, if applicable[1]. While it is recognized that pH, temperature, salinity, moisture content and microbial population density also contribute to rates of degradation, these factors will not be explicitly investigated or managed unless remediation rates are too slow to meet the site closure time period (see Section 5.2).

4.5.1 Absorbent Materials

Coarse-grained soils are not readily bio-remediated, but concentrations of PHC contaminants may still be reduced through volatilization. Oil absorbent pads will be used to help remove visible product from coarse-grained material. Used absorbent materials will be safely packaged and shipped to a southern facility for treatment, recycling and/or disposal.

4.5.2 Aeration

In order to promote aerobic conditions throughout the windrows, soil could be mixed mechanically with loader or by hand if the volume is small enough. This turnover of soil piles could occurred up to two to four times per year during the summer months.

4.5.3 Soil Moisture

Prior to turning, site personnel will ensure that soil is not so dry as to generate significant dust, nor overly saturated. If soil is dry, water from within the landfarm containment area will be used as a moisture source and sprayed on the piles. If no accumulated water is available, a freshwater supply will be used. If the windrows are saturated with water, aeration will be conducted later.

4.6 Removal of Soil from the Landfarm

Prior to the removal of the finer grained soil from the landfarm, soil samples will be analyzed to ensure they meet Government of Nunavut guidelines, as described below.

4.6.1 Remediation Guidelines

In assessing the remediation success of PHC contaminated soils being treated in the landfarm facility, AEM will use the Government of Nunavut (GN), Department of Environment, Environmental Guidelines for Site Remediation (March, 2009) to determine if the soil has been suitably treated. A copy of the guideline document has been included as Appendix A.

[1] Meadowbank is carrying out a pilot program on nutrient additions to contaminated soil. If successful, Meliadine will follow Meadowbank's example and add nutrients to contaminated soil.

The following parameters will be measured and compared with the GN industrial remediation criteria in order to determine whether PHC contaminated soil has been adequately remediated:

- Benzene, toluene, ethylbenzene and xylene (BTEX); and
- Petroleum hydrocarbon fractions 1 to 4.

GN remediation criteria are characterized for agricultural/wildland, residential/parkland, commercial and industrial land uses. At the Meliadine site, remediation to agricultural/wildland criteria is targeted. However, if these criteria cannot be efficiently met, industrial criteria will be followed and soil disposed of accordingly (see Section 4.6.3). Remediation criteria for coarse-grained (greater than 75 µm) soils will be applied. Table 1 presents the applicable Tier 1 criteria for coarse-grained soil, assuming agricultural/wildland or industrial land uses. For contaminated sites, a Tier 1 analysis involves the most conservative criteria, and may be applied when the proponent does not wish to establish site-specific criteria.

Table 1. Summary of Relevant GN Tier 1 Soil Remediation Criteria for Soil for Industrial Land Uses

	Criteria (mg/kg)	
Parameter	*Agricultural/Wildland*	*Industrial*
Benzene	0.03	0.03
Toluene	0.37	0.37
Ethylbenzene	0.082	0.082
Xylene	11	11
PHC Fraction 1	30	320
PHC Fraction 2	150	260
PHC Fraction 3	300	1700
PHC Fraction 4	2800	3300

4.6.2 Sampling and Analysis

Landfarm windrows will be sampled annually at the end of the summer season to determine if remediation objectives have been met. Representative composite samples will be taken of each windrow to estimate remaining PHC concentrations. For each 10 m of windrow length, one composite sample will be collected, each consisting of three surface sub-samples and three sub-samples at 0.5 m depth. Sub-samples will be taken approximately 3.3 m apart, and will be taken from both sides of the windrow.

After two seasons of treatment in the landfarm, degradation rates will be assessed to estimate the total remediation time required for PHC-contaminated soil under these conditions. If remediation to GN guidelines is feasible within three to four years, landfarm operations will continue, with aeration and possible nutrient amendments. If rates of TPH degradation are not sufficient through this method, alternate options will be further investigated (see Section 5).

4.6.3 Soil Removal

When sample analysis of fine-grained material at the end of a season indicates that concentrations of contaminants are below Government of Nunavut guidelines, the entire soil pile or the appropriate section of a pile will be deemed acceptable for removal from the facility.

Soil remediated to agricultural/wildland criteria will be appropriately delineated by Environment Department staff, and stockpiled at the operations pad for site works or reclamation activities.

Soil remediated to industrial-use criteria will be removed from the landfarm and placed on the operations pad. This material will continue to be monitored while it is stockpiled and possibly used on the pad or in the decline.

4.7 Water Management

Since the landfarm facility is uncovered to facilitate natural weathering, water accumulating inside the bermed area may come into contact with contaminated material. The handling of this potentially contaminated water is described below.

4.7.1 Snow Management

If possible, snow will be removed during winter to minimize the quantity of spring melt water inside the berm. Care will be taken to ensure contaminated snow/soil is not disturbed by leaving a base layer of snow (no less than 10 cm) in place. After snowmelt any contaminated water left from winter spill clean-up operations will be used in the landfarm, or treated and discharged to the receiving environment.

4.7.2 Water Management

Monitoring will be conducted for seepage of contact water through the berm, or accumulation of water within the containment berm through visual inspection by the Environment Department. In the event of water accumulation or seepage, the ponded water and seepage will be analyzed for BTEX, lead, oil and grease, phenols, as described in Part D, clause 17 of the Water Licence. If the water meets the limits set out in the Licence, the water will be discharged to the receiving environment. Alternatively, ponded water will be sprayed on the windrows to increase moisture content, as required.

Water accumulating in the landfarm and not meeting Water Licence limits will be treated before being discharged to the receiving environment.

4.8 Landfarm Reclamation

After removal of all remediated soil and prior to abandonment/closure of the landfarm, the berm and base will be sampled on a 10 m grid in representative locations to the depth of the impermeable liner to determine if these soils are free from PHC contamination. Results of this analysis will be compared to GN criteria. Should the berms and base of the landfarm meet the GN criteria, the landfarm will be covered with clean waste rock to a depth of 1 metre.

4.9 Summary of Activities

A summary of landfarm activities including monitoring of the physical condition and potential environmental impacts of the landfarm facility is provided in Table 2. A report will be prepared annually, indicating the volume of contaminated soil added to the facility; amount of remediated soil removed and disposal/reuse location; all analytical results; if applicable, the volume and type of nutrient addition; visual inspection results; and volume of contact water removed annually from the landfarm. This information will be appended to AEM's NWB Annual Report.

Table 2 Summary of landfarm activities, analyses and records to be kept

Activity	Analysis	Frequency of Analysis	Record
Excavation of spill and transport of contaminated material	If unsure of full excavation – F 1 to 4, BTEX	As needed	Date and time of excavation; estimated quantity of excavated soil; storage/disposal location of excavated soil, if applicable; any evidence of remaining product
Contaminated soil additions to the landfarm	If contaminant source unknown, F1-F4, BTEX, metals, oil and grease, VOCs (at discretion of Envir. Dept)	Prior to soil addition to landfarm	Date and time; quantity of soil; original location; landfarm location; spill/excavation record # or storage container label
Soil Aeration	N/A	Two to four times per summer	Date and time; location; soil condition (moisture content, odour, etc.)
Soil treatment with nutrients	Visual inspection to ensure proper incorporation	At least once during the summer on selected windrows	Date and time; type of treatment (aeration and/or nutrient amendment); location in landfarm; any odour noticed during aeration
Sampling for progress of remediation	Hydrocarbon vapour in headspace (by PID); F1-F4, BTEX (laboratory)	Vapour as needed; Laboratory annually	Date and time; location; odour, laboratory report
Soil removal from landfarm	Removal subject to meeting GN criteria	N/A	Date and time; location; quantity of soil removed; final location
Ponded contact water	BTEX, oil and grease, lead, phenols – as per Part D, Clause 17 of Water License	Prior to any dewatering; if re-used in landfarm, no sampling necessary	Date and time; location; laboratory report; Annual Report
Seepage	Visual inspection; BTEX, oil and grease, lead, phenols – as per Part D, Clause 17 of Water License	Weekly during summer	Location; extent; approximate depth; evidence of sheen; laboratory report
Identification of maintenance requirements	Visual inspection of facility	Twice annually during summer	Inspected areas; condition of berms and base; previously unidentified safety concerns

5. CONTINGENCY OPTIONS

The following sections describe the contaminated soil management plan, should a large spill event occur, and if landfarm treatment is not successful.

5.1 Large Spill Event

Considering that the landfarm is built to hold nearly three times as much contaminated soil as is expected to be produced, a large spill event producing a quantity of soil that cannot be contained in the landfarm is unlikely. Nevertheless, in such an event, soils will be placed in a temporary storage area. A temporary stockpile area would be set up on a location approved by the NWB, AANDC and Kivalliq Inuit Association (KIA). As space allows, the soil would then be placed in the landfarm as soon as practical. Through extensive spill prevention measures discussed earlier in this Plan, AEM is minimizing the probability of this scenario occurring.

5.2 Alternate Treatment Options

Should landfarm treatment not perform as anticipated and it is evident that rates of degradation are not sufficient to meet GN Tier 1 criteria within 3 to 4 years, the following alternative treatment options will be considered. Implementation will be after development of a more detailed protocol and approval of a revised plan by the NWB.

5.2.1 Soil Amendment

Since pH, salinity, moisture content, temperature and microbial population density all affect rates of biodegradation by microbes, these factors may be monitored and adjusted through soil amendments if they are not found to be optimal (see SAIC, 2006). In addition, the height of soil windrows could be reduced to maximize air exposure if space in the facility allows.

5.2.2 Tier 2 – Modified-Criteria Approach

According to the Government of Nunavut Environmental Guideline for Contaminated Site Remediation (Appendix A), in cases where site conditions, land uses, receptors or exposure pathways are different from those assumed in the development of the Tier 1 criteria, modified criteria may be permitted. This process requires the collection of site-specific information on exposure and risk estimates, and is subject to GN approval. In the case of the Meliadine site, landfarmed soils, after successful treatment, are to be placed on the operations pad and ultimately used in industrial surface applications as assumed in Tier 1. As the soils will meet GN criteria, minimal effects are expected from the exposure to any residual contamination. Therefore, the Tier 2 approach could be warranted if Tier 1 criteria cannot be met. Any consideration for this approach would be based on soil sampling results and science based information.

5.2.3 Thermal Desorption

In the thermal desorption process, excavated soils are heated in a chamber to rapidly volatilize PHCs. Gases produced are consumed in an oxidation unit, and particulate matter removed (baghouse). Soil, free of any contamination, can then be replaced, or used in site reclamation or construction processes. The other advantage of this approach is that this equipment is mobile and could be brought to any spill site for remediation activities (e.g. spills along the Phase 1 All Weather Access Road). This method is described by Environment Canada (2002). The purchase or rental of a portable thermal desorber unit is can be a contingency option.

6. PLAN REVIEW AND CONTINUAL IMPROVEMENT

The Landfarm Management Plan will be reviewed annually by the Meliadine Environmental Coordinator, in consultation with the Manager, Regulatory Affairs Nunavut and onsite managers. It will be updated, if necessary, at least every two years of operation.

The landfarm will be reclaimed following the construction of the mine.

7. REFERENCES

AEM 2013. Meadowbank Design and Management Plan, Water Licence 2AM-MEA0815

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Appendix A Environmental Guideline for Contaminated Site Remediation, GN March, 2009

Environmental Guideline for

Contaminated Site Remediation

Department of Environment
Government of Nunavut

GUIDELINE: CONTAMINATED SITE REMEDIATION

Originally Approved on April 1999
Revised January 2002
March 2009

This Guideline has been prepared by the Department of Environment's Environmental Protection Division and approved by the Minister of Environment under 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 contaminated sites and to assist in the management and remediation of these sites. This Guideline does not replace the need for the owner or person in charge, management or control of the contaminated site 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 contaminated sites.

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 this Guideline is available at http://www.gov.nu.ca/env/environment

Cover Photos: GNU Department of Environment

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Appendices

Introduction

In Nunavut and across Canada, contaminated sites can pose a threat to human health, safety and the environment. Petroleum hydrocarbon contamination in soil is a concern for several reasons. To differing degrees, petroleum hydrocarbons are toxic to plants and animals, and are mobile and persistent in the environment. Petroleum hydrocarbons can also pose a fire or explosion hazard and can create aesthetic problems such as offensive odours and tastes. In some cases the concern may also be financial, because of the loss of property value and the cost of remediating the property.

The intent of this Guideline is to help effectively manage contaminated sites. It helps to provide a consistent approach by describing the process used to manage (e.g. identify, assess, plan and remediate) contaminated or potentially contaminated sites on Commissioner's Land, including private land within municipalities, and by providing soil remediation criteria for petroleum hydrocarbons and other contaminants.

The *Environmental Protection Act (EPA)* gives the Government of Nunavut authority to take measures to ensure the preservation, protection and enhancement of the environment, with the goal of long-term sustainability and stewardship. Section 2.2 of the *EPA* provides the Minister of Environment with authority to develop, coordinate, and administer this Guideline (see Appendix 1).

The Department of Environment is the key territorial agency concerning the management of contaminated sites on Commissioner's Land. In Nunavut however, Indian and Northern Affairs Canada (INAC) retains responsibility for the management of inland waters, including surface water and groundwater. If contaminated water is encountered, INAC should immediately be consulted.

1.1 Definitions

CCME	The Canadian Council of Ministers of the Environment (CCME) is the major intergovernmental forum in Canada for discussion and joint action on environmental issues of national, international and global concern. The 14 member governments work as partners in developing nationally consistent environmental standards and practices (see Appendix 8).
Closure Report	The final report prepared by a qualified person and provided to the Environment Department following successful implementation of the Remedial Action Plan. The report generally includes a description of all site activities conducted, quantity of contaminated material treated or removed, treatment and disposal methods used, and analytical data generated.
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.
Contaminated Site	Areas of land, surface water, groundwater, or sediments that have levels of contaminants exceeding the remediation criteria. Contaminant sources can include on-site burial of wastes, small or frequent drips and spills, stockpiling and storage of materials, major spills, and releases during fires. Contamination may also be caused by illegal dumping of contaminated soil. Contaminated sites may have short or long term consequences to the health and safety of people and the quality of the environment.
Discharge	Includes 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) above.
Inspector	Means a person appointed under subsection 3(2) of the *EPA* and includes the Chief Environmental Protection Officer.
Phase I Environmental Site Assessment	The process, as outlined in the Canadian Standards Association's (CSA) Standard Z768, by which a qualified person determines whether a property is, or may be, contaminated.
Phase II Environmental Site Assessment	The process, as outlined in the CSA Standard Z769, by which a qualified person characterizes and delineates concentrations and quantities of contaminants on a site and compares those levels to acceptable remediation criteria.
Qualified Person	A person who has an appropriate level of knowledge and experience in all aspects of contaminated site investigation, remediation and management.
Remedial Action Plan	A plan that identifies Site-Specific Remedial Objectives for a site, identifies remedial options and outlines their feasibility, and describes a preferred conceptual remediation plan, a performance monitoring plan, and, if appropriate, requirements for ongoing site management.

Remediation	The process to restore a site's environmental condition and reduce any existing hazards to human health and safety to an acceptable level. Remediation involves the development and application of a planned approach that removes, destroys, contains or otherwise reduces the availability of contaminants to people and the environment.
Remediation Criteria	The numerical limits or narrative statements pertaining to individual substances or chemicals in soil, water or sediment which are recommended to protect and maintain the specified uses of the site. When measurements taken at a contaminated site indicate that the remediation criteria are being exceeded, the need for management and remediation is indicated.
Responsible Party	The owner or person in charge, management or control of the contaminant before it is discharged or owner of the contaminated site.

Additional definitions can be found in Appendix 2.

1.2 Roles and Responsibilities

1.2.1 Environment Protection Division, Department of Environment

The Environmental Protection Division of the Department of Environment is the key environmental agency responsible for ensuring the proper management of contaminated sites on Commissioner's Land. Responsibilities include confirming the required level of remediation using the remediation criteria cited in this document, reviewing the submitted Remedial Action Plan, monitoring the progress of the project and issuing a letter of confirmation when no further remedial action is required.

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 Environmental Protection Division or visit the web site at http://www.gov.nu.ca/env/environment.

The Environmental Protection Division will provide advice and guidance on remediation measures. However, it remains the sole responsibility of the polluter, facility operator and landowner to provide adequate site management and remediation and to ensure all applicable statutes, regulations, standards and guidelines are fully complied with.

1.2.2 Responsible Party

If the polluter, facility operator or landowner is notified or otherwise has reason to believe that a site is contaminated, or is potentially contaminated, that person must immediately report the incident and ensure an appropriate evaluation of the potential environmental effects and risks is completed to

determine what action, if any, is required under the *EPA* and this Guideline. Exercising timeliness in all matters related to the contaminated site is critical.

The responsibilities of a Responsible Party include the following:

- Reporting the incident to the NWT/Nunavut 24-Hour Spill Report Line (867-920-8130);
- Contacting EPD and other relevant regulatory agencies including the Regional Environmental Health Officer, Office of the Fire Marshal, local fire department, local government, landowner, affected adjacent landowners, 'Designated Inuit Organization', or other parties regarding health and safety concerns;
- Notifying members of the public who may be adversely affected by the contamination;
- Retaining a qualified person (see Section 1.1) to assess the site to determine the presence and extent of contamination; and
- Developing and implementing a Remedial Action Plan.

1.2.3 Other Regulatory Agencies

As there may be other environmental or public and worker health and safety issues to consider, other regulatory agencies may have to be contacted regarding the management of a contaminated site. Some of the other agencies include:

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 is also responsible for, in cooperation with communities, the planning, funding, operation and maintenance 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 the withdrawal of fuel storage tanks from service. 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

Contaminated sites may impact adjacent properties, residences or other buildings thereby potentially affecting the health and safety of the public. 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 contaminated soil and other hazardous waste 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 work place 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 work place and ensure the safety and well being of workers. The Work Site Hazardous Materials Information System, or WHMIS, requires information be provided to workers on the safe use of any hazardous materials used in the work place. All responsible parties should consult the Prevention Services Division for further information and guidance.

Local Municipal Governments

The role of local municipal governments is important in the management and safety of contaminated sites. Remediation standards are determined, in part, by how the property is used and how the property may be designated under local government development plans (e.g. land use zoning). Contaminated soil may be deposited for treatment and disposal at municipal landfill sites 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.

Indian and Northern Affairs Canada

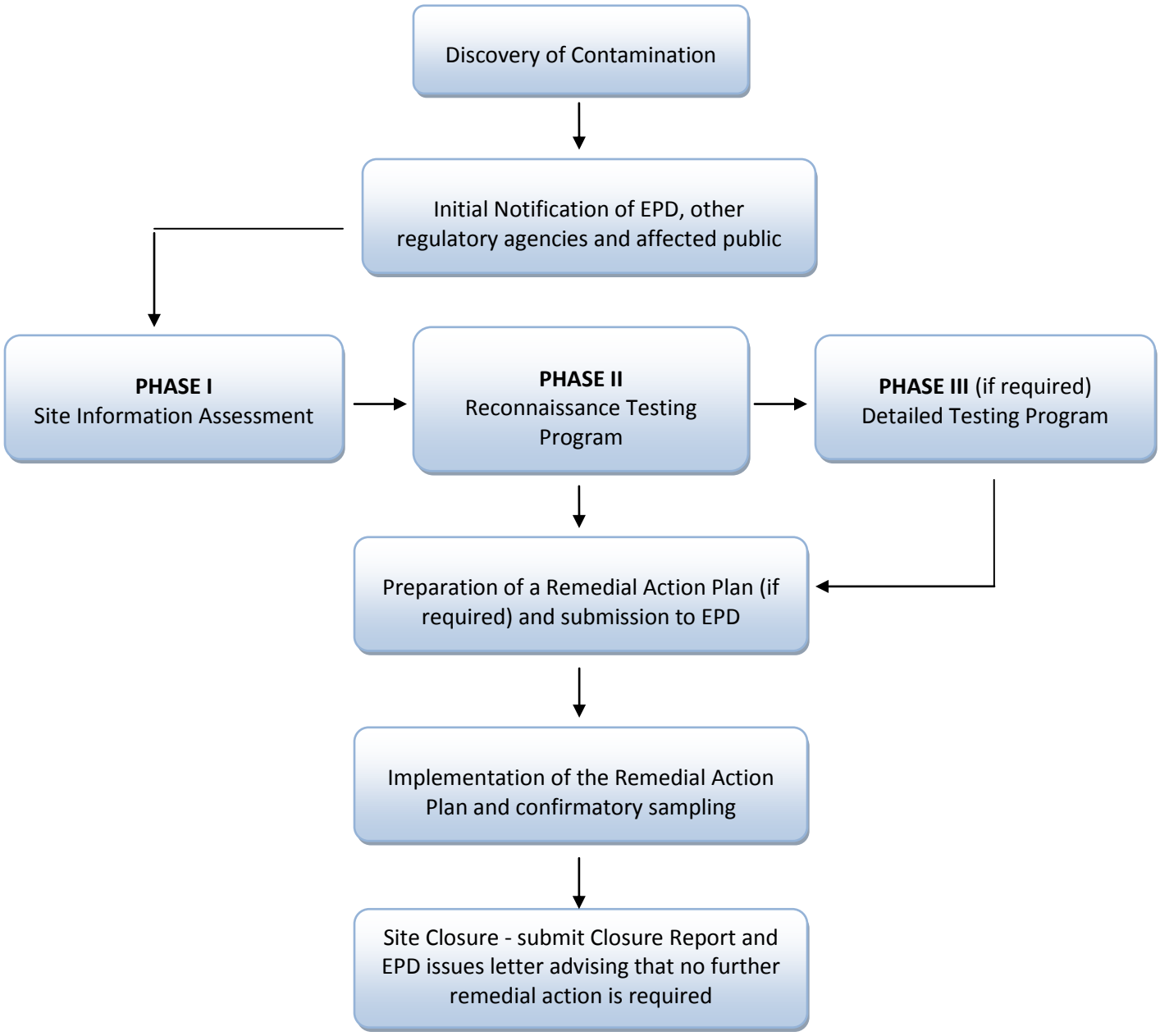
Indian and Northern Affairs Canada is responsible under the *Territorial Lands Act* and *Nunavut Waters and Nunavut Surface Rights Tribunal Act* for the management of federal lands and inland waters. Indian and Northern Affairs should be consulted if contaminated surface water or groundwater is encountered.

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 in settlement areas located outside of municipalities. The remediation of contaminated sites may be controlled through the setting of terms and conditions in plans, licenses and permits issued by these boards and agencies.

Contaminated Site Management Process

The management and remediation of a contaminated site consists of a phased approach starting with discovery of the contamination. A well-considered and comprehensive work plan will enable the Responsible Party to make informed decisions, which will result in the safe, effective and cost-efficient remediation of the site. The following flow chart describes the general steps in the overall management process.



2.1 Initial Notification

When a person discovers the presence of contamination, or has reason of believe a site is contaminated, they should immediately notify the Department of Environment and the owner of the facility or property. This discovery may occur as a result of a spill or other accident, an investigation completed for the sale or refinancing of a property, or other actions that identify contamination impacts to the environment.

Section 5.1 of the *EPA* states that where a discharge of a contaminant occurs, or is likely to occur, the owner or person in charge, management or control of the contaminant must immediately:

- report the discharge to the NWT/Nunavut 24-Hour Spill Report Line at (867) 920-8130;
- take all reasonable measures to safely stop the discharge and repair damages; and
- make reasonable efforts to notify any affected public.

Once this notification has occurred, EPD will assess the significance of the reported contamination by having an Inspector conduct a site visit or by reviewing other relevant information (e.g. site assessment report). If it is determined that contamination is present, or may be in the future, and that it poses a risk to human health, safety or the environment, the responsible party must undertake actions to repair the damages in a timely manner. These actions may include identifying the nature and extent of contamination, preparing a Remedial Action Plan and implementing the plan.

If it is determined that the problem cannot be resolved with limited remedial action, the responsible party may be instructed to obtain the services of a qualified person (e.g. environmental engineer or consultant). Obtaining the services of a qualified person is mandatory if there is evidence of groundwater contamination, if explosive vapours are present, or if a neighbouring property is affected. In all cases, the responsible party or its representative must consult the appropriate regulatory agencies (see section 1.2) and notify any affected members of the public. EPD may require the responsible party to provide proof of such consultation and notification.

Issues not related to public health, safety or the environment that arise between the responsible party and affected parties are civil matters, which are to be settled by the parties outside of this management process.

2.2 Site Assessment

Assessing, or characterizing, a contaminated site is a critical phase in the site management process. A well-planned and comprehensive assessment will enable the responsible party to make informed decisions about potential remediation actions.

There are normally up to three phases to an Environmental Site Assessment (ESA). These phases depend on the size and complexity of the contaminated site, and range from the general to the specific. While there are advantages with a phased approach, there may also be economies realized by combining information gathering and testing into a single investigation, particularly at remote locations where mobilization costs are significant.

2.2.1 Phase I: Site Information Assessment

The overall objective of the Phase I ESA is to identify whether actual or potential contamination exists at a site. At a minimum, the Phase I ESA must meet or exceed the Canadian Standards Association (CSA) Standard Z768-01, *Phase I Environmental Site Assessment*.

All available and relevant current and historical information pertaining to the site should be assembled when completing a Phase I ESA. This information will be used to estimate the likelihood, types and locations of contamination that may be present and help to develop a field-testing program, should one be required. Reports and information prepared for legal, transactional or environmental reasons (e.g. spill reporting, ESAs if already conducted) should be reviewed. Phase I ESAs do not involve the carrying out of a sampling plan.

The review frequently includes three broad aspects:

Facility Characteristics - A current and historical description of the site and its facilities is developed, particularly as it relates to the areas of concern (e.g. contaminant sources and potential discharge points). Reviewing facility records and discussions with past and present employees should also be used to gather relevant information. Additional information can be obtained by reviewing above and below ground structures (using blueprints, if available) as possible sources of contamination, as well as considering prior site and surrounding land uses.

Phase 1 - The initial actions undertaken to determine whether a property is, or is not, contaminated. A Phase I site information assessment involves reviewing all available reports, studies and other relevant documents on a site, but does not involve sampling, analysis and measurement of soil and water.

Phase II - Builds upon results of the Phase 1 assessment by sampling soil and water, and sometimes air, on a site to characterize and delineate the concentration of contaminants, and compare those levels to approved remediation criteria. A Remedial Action Plan may be developed following the Phase II reconnaissance testing program if all necessary information about the site has been obtained.

Phase III - The most detailed level of assessment that is intended to address any outstanding issues and information gaps following a Phase II assessment.

Contaminant Characteristics - Hydrocarbons, chemicals and other contaminants that may be stored at the site are identified. Their quantities and concentrations are estimated by visual inspections, reviewing documentation and interviewing past and present employees.

Physical Site Characteristics - The geology, hydrology and hydrogeology of the site and surrounding area are examined using available data. The objective is to develop a comprehensive understanding of local site characteristics and a current and historical description of the area.

Other sources of information can include aerial photographs, geology and groundwater reports; topographical, geological and other maps; the Government of the Northwest Territories' Hazardous Materials Spill Database (this database includes spills that have occurred in Nunavut) and previous site assessment reports.

The review should include a visual inspection of the site and discussions with local residents who may have knowledge of the site and its history. The site inspection will identify signs of contaminant discharge (e.g. leaks and drips, discoloured soil or discoloured building foundation walls), vegetation stress and examine local sensitive habitats (e.g. beaches, ponds, streams) for the presence of hydrocarbons. The proximity of the site to surrounding buildings, surface water bodies and sensitive habitats (e.g. wetlands) should also be identified.

2.2.2 Phase II: Reconnaissance Testing Program

The overall objective of the Phase II ESA is to confirm the presence and characterize the contaminants of concern at the site. At a minimum, the Phase II ESA must meet or exceed the CSA Standard Z769-00, *Phase II Environmental Site Assessment*.

Characterization of the contamination and site conditions require the carrying out of a sampling plan. The plan usually involves one or more field screening methods to identify suitable locations for more intrusive sampling and analysis. Overall, the sampling plan should enable the qualified person to confirm the presence of any contamination, provide an understanding of the nature of the contamination (e.g. location, quantity and direction of movement) and provide an understanding of the relevant site conditions (e.g. soil type, groundwater flow, exposure pathways). This information is necessary in order to develop a Remedial Action Plan or to identify the need for a more specific Phase III assessment, including human health and ecological risk assessments. It may also enable the qualified person to determine that no further action is required.

The Phase II testing program should include the adoption of recognized sampling procedures, quality assurance/quality control procedures and laboratory analytical protocols (see Appendices 5 and 6).

Environmental quality remediation criteria will need to be selected in consultation with EPD during the Phase II ESA. The data collected during the testing program will be compared to the applicable criteria to determine if, and where, exceedances exist on the property. See the CCME *Guidance Document on the Management of Contaminated Sites in Canada, April 1997* for further information.

2.2.3 Phase III: Detailed Testing Program

The results of the Phase II ESA will determine whether a Phase III ESA is required. If sufficient data has been obtained at Phase II to characterize the site and any potential risk to human health, safety and the environment, then the process may move directly to developing a Remedial Action Plan (if it is required).

Alternatively, a detailed Phase III ESA may be necessary if Phase II testing indicates that significant and wide-spread contamination exists. A Phase III ESA will address outstanding issues and information gaps with a view to obtaining enough information to enable development of a Remedial Action Plan. Specifically, the Phase III ESA will:

- target and delineate the boundaries of identified contamination;
- define site conditions and possible contaminant pathways in greater detail, particularly with respect to possible risk assessment;

- provide contaminant and other information necessary to finalize environmental quality remediation criteria or risk assessment; and
- provide all other information that is required in order to develop a Remedial Action Plan and enable contract specifications and tender documents to be prepared.

The Phase III detailed testing program will focus on areas identified in the Phase II program and involves a similar systematic process of sampling, analysis and evaluation. However, a greater number of samples are usually collected and a smaller suite of chemical substances may be analyzed as the program converges on the outstanding environmental issues. Field screening techniques are not usually employed in this testing.

Once the environmental condition of the site has been thoroughly assessed, the qualified person will be able to develop a site-specific Remedial Action Plan.

2.3 Land Use

Remediation criteria (see section 2.4) are presented in the context of four types of land use: agricultural/wildland, residential/parkland, commercial and industrial. The criteria are considered generally protective of human and environmental health for the 'normal' activities associated with each land use. It is important to note that it is the *current and intended future* land use that governs the decision on the level of remediation to be performed at a site. Identifying the appropriate land use will help to assess the extent of human and ecological exposure to contaminants in the soil, and is essential for preparing a Remedial Action Plan. The type of land use found adjacent to the contaminated site may also affect the remediation criteria to be achieved.

Agricultural/Wildland	Land on which the primary activity is related to the productive capability of the land. This includes lands that provides habitat for transitory wildlife and birds as well as greenhouses.
Residential/Parkland	Land on which dwelling, on a permanent, temporary or seasonal basis, is the primary activity. Institutions (e.g. hospitals, schools, daycares) and playgrounds are included under this land use. This land use also includes activity that is recreational in nature and that requires the natural or human designed capability of the land to sustain that activity. Residential/Parkland lands are normally readily accessible to the public.
Commercial	Land on which the primary activity is the commercial buying, selling, or trading of goods or services. Members of the public, including children, normally have free access to these lands.
Industrial	Land on which the primary activity is the production, manufacture, construction or storage of goods. Public access is restricted and children are not permitted continuous access or occupancy.

2.4 Application of Remediation Criteria at Contaminated Sites

There are three basic approaches that may be utilized for the development of site-specific remediation criteria and objectives:

Tier 1 Direct adoption of remediation criteria (Criteria-Based Approach).

Tier 2 Adoption of remediation criteria with modifications based on site-specific information (Modified-Criteria Approach).

Tier 3 Use of site-specific risk assessment (Risk-Based Approach).

The criteria-based approach (Tier 1) is designed to require fewer resources while providing a scientifically defensible basis for protection that is sufficiently flexible to account for certain site-specific factors. In most cases this approach provides an effective alternative to the modified-criteria (Tier 2) or detailed risk-based (Tier 3) approaches. The Tier 2 and Tier 3 approaches can be more complex and costly, and are utilized when the criteria-based approach is not suitable for a site (e.g. large, complex or remote industrial sites).

Regardless of the approach that is ultimately chosen, the level of human health, safety and environmental protection provided by each approach does not change, only the manner in which the level of protection is achieved.

The responsible party should consult with EPD before deciding which approach to take.

Tier 1 - Criteria-Based Approach

Under this approach, the remediation criteria selected for a site are adopted as the remediation objectives. In most cases this approach would involve either the reduction of petroleum hydrocarbon (PHC) concentrations in soil to achieve Tier 1 criteria or the removal and replacement of soil containing PHC concentrations in excess of the criteria. Factors that may bear weight on the decision of whether or not to directly adopt Tier 1 criteria include cost, time, simplicity and other practical and technical considerations (e.g. cost of obtaining additional data to support Tier 2 or Tier 3 approaches, risks associated with residual contamination, cost and commitment to long-term management and monitoring).

The Tier 1 criteria-based approach is applicable only where site conditions, receptors, and exposure pathways are similar with those assumed in the development of the criteria.

A summary of Tier 1 remediation criteria (mg/kg) for PHC in 'surface' soil is provided in Table 1.

Tier 1 criteria may also be used for the remediation of 'subsoil' even though PHC contaminated subsoil usually has a lower level of risk associated with direct human contact, vapour inhalation and ecological soil contact. The responsible party should balance the benefits associated with using Tier 1 criteria for the remediation of subsoil with the additional commitments associated with undertaking a Tier 2 modified-criteria approach. EPD must be consulted in all cases where PHC concentrations in 'subsoil' exceed Tier 1 criteria.

Table 1.

Land Use	Soil Texture	Fraction 1 (C6-C10)	Fraction 2 (>C10-C16)	Fraction 3 (>C16-C34)	Fraction 4 (>C34)
Agricultural/Wildland	Fine-grained soil	210 (170[a])	150	1300	5600
	Course-grained soil	30[b]	150	300	2800
Residential/Parkland	Fine-grained soil	210 (170[a])	150	1300	5600
	Course-grained soil	30[b]	150	300	2800
Commercial	Fine-grained soil	320 (170[a])	260 (230[a])	2500	6600
	Course-grained soil	320 (240[a])	260	1700	3300
Industrial	Fine-grained soil	320 (170[a])	260 (230[a])	2500	6600
	Course-grained soil	320 (240[a])	260	1700	3300

a = Where applicable, for protection against contaminated groundwater discharge to an adjacent surface water body or for protection of potable groundwater.
b = Assumes contamination near residence.

Additional Tier 1 criteria for PHC in soils can be found in Appendix 3. Remediation criteria for other contaminants in soil (e.g. BTEX, metals, PAHs) can be found in Appendix 4.

If the remediation of soil to Tier 1 criteria for the associated land use is not practical from a cost, logistical or technological perspective, then the responsible party will have to move to Tier 2 or Tier 3 site management.

Tier 2 - Modified-Criteria Approach

In certain circumstances, remediation criteria may be modified, within specified limits, and adopted for use as the site-specific remediation criteria when site conditions exist that modify human and ecological exposure to PHC contamination relative to the generic conditions used to derive Tier 1 criteria. In general, this modified-criteria approach is utilized in situations where site conditions, land use, receptors or exposure pathways differ only slightly from those assumed in the development of Tier 1 criteria. However, as pointed out above, the decision to undertake Tier 2 adjustments implies a commitment to increase the accuracy of information on site-specific factors, including exposure and risk estimates.

The acceptability of a Tier 2 approach for evaluation of site-specific impacts is subject to review by EPD. If the impacts also extend off-site, then the responsible party must seek the acceptance of other affected parties before proceeding with a Tier 2 approach.

Specific guidance on situations where modifications are allowed to the Tier 1 criteria, as well as details concerning implementation of the modified-criteria approach are provided in the *Canada-Wide Standard for Petroleum Hydrocarbons in Soil User Guide (CCME 2008).*

Tier 3 - Risk-Based Approach

In certain circumstances, neither the criteria-based or modified-criteria approach may be suitable for a site because pathways of exposure, target chemicals, receptors or other site characteristics differ significantly from those used to develop these more generic approaches. If this is the case, risk assessment procedures may be required to develop site-specific remediation objectives that correspond to an acceptable level of risk to human or ecological receptors. The Tier 3 approach involves completion of a site-specific risk assessment and development of a risk management plan, including long-term monitoring.

A contaminated site is a candidate for the risk-based approach when there are:

- significant ecological concerns (e.g. critical or sensitive habitats for wildlife; rare, threatened or endangered species; parkland or ecological reserves; special hunting or trapping resources);
- unacceptable data gaps (e.g. exposure conditions are particularly unpredictable or uncertain; lack of information about receptors; high degree of uncertainty about hazard levels); or
- special site characteristics (e.g. site is large or remote; the contamination is complex; estimated cost of remediation is prohibitive; site conditions, receptors and/or exposure pathways differ significantly from those assumed in the derivation of Tier 1 and Tier 2 criteria).

Further guidance on human health and ecological risk assessment is beyond the scope of this document. If the reader wishes to proceed with a risk-based approach to site remediation, they are encouraged to contact EPD and professionals competent in the field of human health and ecological risk assessment.

2.5 Preparation of a Remedial Action Plan

At this point the responsible party will review the results of the site assessment and determine whether to remediate the site to the generic Tier 1 criteria or develop site-specific remediation criteria using either a modified-criteria or risk-based approach. The selection should take into consideration factors such as effectiveness in achieving the remediation goals, practicality, safety and cost.

Once remediation criteria have been determined, the responsible party must prepare a Remedial Action Plan for the site which reflects the preferred remediation method. Where practical, the plan should favour permanent remediation solutions, and not solutions that require long-term management and monitoring. The Remedial Action Plan should:

- include names and contact information of all key personnel, consultants and contractors;
- summarize all data collected on contaminants identified during the site investigation(s);
- identify contaminants of concern and the media (e.g. soil, water) affected;
- identify the remediation criteria and the method(s) by which they have been derived;
- identify, quantify and characterize the materials to be treated, removed and disposed;
- summarize remedial options evaluated and the method used to select the preferred remedial strategy;
- describe the selected remediation method and its technical feasibility;
- detail an implementation plan, including a schedule for implementing the plan;

- discuss control measures to minimize fugitive air emissions, surface water control, and worker health and safety;
- identify the fate of any residual contaminants that may remain on-site following remediation; and
- identify remedial verification and long-term monitoring plans (if required).

The Remedial Action Plan should be submitted to EPD, and other regulatory agencies as appropriate, for review prior to the plan being implemented in order to confirm all regulatory requirements are being met.

2.6 Implementation of a Remedial Action Plan

Once all necessary approvals have been obtained, the responsible party shall implement the Remedial Action Plan in a timely manner and submit monitoring reports to EPD on the pre-determined schedule. The responsible party must advise EPD if any activities deviate from the approved Remedial Action Plan. In these cases, EPD will assess the significance of any deviations and advise accordingly.

The completion of remediation activities should be validated by comparing the results of confirmatory samples to the selected remediation criteria. Where the remediation criteria fail to be achieved, the responsible party would be required to re-evaluate the Plan and implement alternative remediation activities.

2.7 Site Closure

When the responsible party and is satisfied that all the requirements of the Remedial Action Plan have been met, a closure report should be prepared and forwarded to EPD. The closure report includes a description of all site activities conducted and remediation methods used, the quantity of contaminated material treated or disposed, and all analytical data generated.

Provided the remediated site complies with all appropriate criteria, management to Tier 1 or Tier 2 would normally enable unrestricted future use of the land within the particular land use designation. This is referred to as ‘unconditional closure’. Where a Tier 3 risk-based approach is used, land use controls and restrictions and long-term monitoring would likely be required to ensure human health, safety and environmental risks do not increase. This is referred to as ‘conditional closure’.

In the case of unconditional closure, EPD will conclude the management process upon receipt and acceptance of the closure report by issuing a letter advising the responsible party that no further remedial action is required. In the case of conditional closure, the letter would state that the management process remains on-going and confirm what land-use controls and restrictions and long-term monitoring is required.

Conclusion

This is a brief introduction to the contaminated site remediation process and is intended to inform the reader about the basic issues involved in contaminated site management. Once a contaminated site has been discovered or verified, the Environmental Protection Division of the Department of Environment must be contacted before proceeding though the contaminated site management process.

Environment Protection Division
Department of Environment
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://www.gov.nu.ca/env/environment

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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 - GLOSSARY

Accreditation	Formal recognition of the competence of an environmental analytical laboratory to carry out specified tests. Formal recognition is based on an evaluation of laboratory capability and performance. Site inspections are utilized in the evaluation of capability.
Adverse Effect	An undesirable or harmful effect to an organism, indicated by some result such as mortality, altered food consumption, altered body and organ weights, altered enzyme concentrations or visible pathological changes.
Assess or Assessment	Investigations, monitoring, testing and other information-gathering activities to identify: (1) the existence, source, nature and extent of contamination resulting from a release into the environment of a hazardous material or chemical substance; and (2) the extent of danger to the public health, safety, welfare, and the environment. The term also includes studies, services, and investigations to plan, manage, decommission and clean up a contaminated site.
Background	An area not influenced by contaminants released from the site.
Background Samples	Matrices minus the analytes of interest that are carried through all steps of the analytical procedure. They are used to provide a reference for determining whether environmental test sample results are significantly higher than "unpolluted" samples, which contain "zero", low, or acceptable levels of the analytes of interest. All matrices, sample containers, reagents, glassware, preparations, and instrumental analyses are included in the analysis of background samples.
Blank	The measured value obtained when a specified component of a sample is not present.
Borehole	A hole drilled into the earth, and into which casing or screen can be installed to construct a well.
Chemical	Any element, compound, formulation or mixture of a substance that might enter the environment through spillage, application or discharge. Examples of chemicals are insecticides, herbicides, fungicides, and agents for treating oil spills.
Clean up	The removal of a chemical substance or hazardous material from the environment to prevent, minimize or mitigate damage to public health, safety or welfare, or the environment that may result from the presence of the chemical substance or hazardous material. The clean up is carried out to attain specified remediation criteria.

Concentration	The amount of chemical or substance in a given environmental medium. Concentration is typically expressed as milligrams per litre (mg/L) in water, milligrams per kilogram (mg/kg) in soil and food and micrograms per cubic metre (µg/m^3) in air. Concentrations may also be expressed as parts per million (ppm) or parts per billion (ppb). 1 mg/litre = 1 ppm or 1000 ppb 1 mg/kg = 1 ppm or 1000 ppb
Criteria	Numerical standards that are established for concentrations of chemical parameters in various media to determine the acceptability of a site for a specific land use.
Detection Limit	The smallest concentration of a substance that can be reported as present with a specified degree of precision and accuracy by a specific analytical method.
Environmental Analytical Laboratory	A laboratory engaged in the physical, chemical or biological measurements of either the receiving environment or discharges to the receiving environment.
Ground Penetrating Radar	A geophysical method in which bursts of electromagnetic energy are transmitted downward from the land surface, to be reflected and refracted by velocity contrasts within the subsurface.
Groundwater	All subsurface water that occurs beneath the water table in rocks and geologic formations that are fully saturated.
Guidelines	Statements outlining a method, procedure, process or numerical value which, while not mandatory, should be followed unless there is a good reason not to do so, and includes the numerical limits or narrative statements that are recommended to protect and maintain the specified uses of water, sediment, soil or air. Guidelines also assist in clarifying the intent of the *Environmental Protection Act* and regulations.
Hazardous Material	Material that, because of its quality, concentration, chemical composition or corrosive, flammable, reactive, toxic, infectious or radioactive characteristics, constitutes a present or potential threat to human health and safety or the environment, when improperly stored, treated, transported, disposed of, used or otherwise managed.
Headspace	The empty volume in a container between the cap and the solid or liquid level of the sample.
Migration	The movement of chemicals, bacteria and gases in flowing water or vapour in the subsurface.

Monitoring	The routine (e.g. daily, weekly, monthly, quarterly) checking of quality or collection and reporting of information.
Monitoring Well	A well that is used to extract groundwater for physical, chemical or biological testing, or to measure water levels.
Objective	A numerical limit or narrative statement that has been established to protect and maintain a specified use of water, sediment or soil at a particular site by taking into account site-specific conditions. Objectives may be adopted directly from generic criteria or formulated to account for site-specific conditions.
Quality Assurance/Quality Control (QA/QC)	Those procedures and controls designed to monitor the conduct of a study in order to ensure the quality of the data and the integrity of the study.
Receptor	A person or organism subjected to chemical exposure. An ecosystem component that is, or may be, adversely affected by a pollutant or other stress emanating from a contaminated site. Receptors may include biological or abiotic (e.g. air or water quality) components.
Risk	Risk is a measure of both the severity of effects arising from exposure to a substance and the probability of its occurrence.
Risk Assessment	Procedure designed to determine the qualitative aspects of hazard identification and usually a quantitative determination of the level of risk based on deterministic or probabilistic techniques.
Screening	Rapid analysis to determine if further action (e.g. detailed analysis or clean up) is warranted.
Site-Specific Remedial Objectives	The objectives established for a specific site to be met by implementation of a Remedial Action Plan and, if appropriate, ongoing site management.
Subsoil	Soil which is 1.5 metres (approximately 5 feet) or deeper from the surface.
Surface Soil	Soil which is less than 1.5 metres (approximately 5 feet) from the surface.
Surface Water	Natural water bodies, such as rivers, streams, brooks and lakes, as well as artificial water courses, such as irrigation, industrial and navigational canals.
Test Pit	A shallow pit made to characterize the subsurface.

APPENDIX 3 - REMEDIATION CRITERIA FOR PETROLEUM HYDROCARBONS

The term 'Petroleum Hydrocarbons' (PHC) describes a mixture of organic compounds found in and derived from oil, bitumen and coal. Petroleum products typically contain thousands of compounds in varying proportions, composed predominantly of carbon and hydrogen, with minor amounts of nitrogen, sulphur and oxygen. The properties of PHC contamination in soils varies with the soil type, petroleum source and composition, degree of processing (crude, blended or refined) and the extent of weathering caused by exposure to the environment. Such factors complicate the assessment of the human health, safety and environmental risks associated with PHC contamination. This complicated assessment of risk makes it necessary to evaluate PHC as four fractions: F1, F2, F3, and F4. This differs from the previous guideline (2002) where PHC contamination in soil was assessed using one parameter - Total Petroleum Hydrocarbons.

PHCs are subdivided according to specified ranges of equivalent carbon number (ECN). Each fraction is, in turn, made of subfractions. These subfractions are described according to their relevant physical and chemical properties and toxicological characteristics. These divisions between the fractions have been established in consideration of analytical factors, physical and chemical properties, the expected relevance to biological response in soils and the ability to utilize the definitions and associated properties.

Fraction 1 (F1) The range of ECN from C6 to C10. It includes gasoline and represents the volatile fraction of most hydrocarbon mixtures. The F1 fraction consists of aromatic subfractions in the range C8 to C10, as well as aliphatic subfractions in the ranges of C6 to C8 and >C8 to C10. The fraction is generally considered to be high in mobility, volatility and solubility

Fraction 2 (F2) The range of ECN from >C10 to C16. It includes kerosene, jet fuel and light fuel oils (No. 2 fuel oil, Arctic diesel) and represents the semi-volatile fraction of petroleum hydrocarbons. The F2 fraction is comprised of aromatics and aliphatic subfractions in the ranges >C10 to C12 and >C12 to C16.

Fraction 3 (F3) The range of ECN from >C16 to C34 and includes medium fuel oils (No. 4 fuel oil, Bunker B), heavy fuels oils (Bunker C) and lubricating and motor oils. It is comprised of both aromatics and aliphatics in the ranges >C16 to C21 and >C21 to C34.

Fraction 4 (F4) The range of ECN from >C34 to C50+. PHC within this range often make up a significant proportion of crude oils. The fraction is generally considered to be of low mobility, volatility and solubility.

Some specific aromatic compounds found within the F1 fraction are managed separately from PHC. Benzene ("B") has been excluded because of its carcinogenic properties while toluene, ethylbenzene and xylene ("TEX") have been excluded because of the relatively long history of managing these compounds. Collectively these compounds are referred to as "BTEX".

Tier 1 and Tier 2 remediation criteria are prescribed for coarse-grained and fine-grained soils. As a result, sufficient textural information needs to be obtained through environmental site assessments to permit classification of the soils as either coarse or fine. These classifications are defined as follows:

Fine-grained soil — Soil having a medium grain size of <75 µm as defined by the American Society for Testing and Materials, and includes silts and clays.

Course-grained soil — Soil having a median grain size of >75 µm as defined by the American Society for Testing and Materials, and includes sands and gravels.

Tier 1 remediation criteria for PHC in soils are presented in Tables A3-1, A3-2 and A3-3. Remediation criteria for BTEX are identified separately in Appendix 4.

Table A3-1
Summary of Tier 1 Criteria (mg/kg) for PHC for Surface Soil.*

Land Use	Soil Texture	Fraction 1 (C6-C10)	Fraction 2 (>C10-C16)	Fraction 3 (>C16-C34)	Fraction 4 (>C34)
Agricultural/Wildland	Fine-grained soil	210 (170[a])	150	1300	5600
	Course-grained soil	30[b]	150	300	2800
Residential/Parkland	Fine-grained soil	210 (170[a])	150	1300	5600
	Course-grained soil	30[b]	150	300	2800
Commercial	Fine-grained soil	320 (170[a])	260 (230[a])	2500	6600
	Course-grained soil	320 (240[a])	260	1700	3300
Industrial	Fine-grained soil	320 (170[a])	260 (230[a])	2500	6600
	Course-grained soil	320 (240[a])	260	1700	3300

* EPD must be consulted if PHC concentrations in 'subsoil' exceed these criteria.
a = Where applicable, for protection against contaminated groundwater discharge to an adjacent surface water body or for protection of potable groundwater.
b = Assumes contamination near residence.

Table A3-2. Pathway-Specific Tier 1 Levels (mg/kg) for PHC for Fine-Grained Surface Soils.

Land Use	Exposure Pathways*	F1 (C6-C10)	F2 (>C10-C16)	F3 (>C16-C34)	F4 (>C34)
Agricultural/ Wildland	Direct Contact (Ingestion + Dermal Contact)	12 000	6800	15 000	21 000
	Vapour Inhalation (indoor, basement)	710	3600	NA	NA
	Vapour Inhalation (indoor, slab-on-grade)	610	3100	NA	NA
	Protection of Potable GW	170	230	NA	NA
	Protection of GW for Aquatic Life[a]	RES	RES	NA	NA
	Protection of GW for Livestock Watering	4200	10 000	NA	NA
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	210	150	1300	5600
	Eco Soil Ingestion	NC	NC	NC	NC
	Produce, Meat and Milk Ingestion	NC	NC	NC	NC
	Management Limit[b]	800	1000	3500	10 000
Residential/ Parkland	Direct Contact (Ingestion + Dermal Contact)	12 000	6 800	15 000	21 000
	Vapour Inhalation (indoor, basement)	710	3600	NA	NA
	Vapour Inhalation (indoor, slab-on-grade)	610	3100	NA	NA
	Protection of Potable GW	170	230	NA	NA
	Protection of GW for Aquatic Life[a]	RES	RES	NA	NA
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	210	150	1300	5600
	Produce Ingestion	NC	NC	NC	NC
	Management Limit[b]	800	1000	3500	10 000
Commercial	Direct Contact (Ingestion + Dermal Contact)	19 000	10 000	23 000	RES
	Vapour Inhalation (indoor)	4600	23 000	NA	NA
	Protection of Potable GW	170	230	NA	NA
	Protection of GW for Aquatic Life[a]	RES	RES	NA	NA
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	320	260	2500	6600
	Offsite Migration	NA	NA	19 000	RES
	Management Limit[b]	800	1000	5000	10 000
Industrial	Direct Contact (Ingestion + Dermal Contact)	RES	RES	RES	RES
	Vapour Inhalation (indoor)	4600	23 000	NA	NA
	Protection of Potable GW	170	230	NA	NA
	Protection of GW for Aquatic Life[a]	RES	RES	NA	NA
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	320	260	2500	6600
	Offsite Migration	NA	NA	19 000	RES
	Management Limit[b]	800	1000	5000	10 000

NA = Not applicable. Calculated value exceeds 1,000,000 mg/kg or pathway excluded.
RES = Residual PHC formation. Calculated value exceeds 30,000 mg/kg and solubility limit for PHC fraction.
NC = Not calculated. Insufficient data to allow derivation.
a = Assumes surface water body at 10 metres from site.
b = Includes additional considerations such as free phase formation, explosive hazards, and buried infrastructure effects.

Table A3-3. Pathway-Specific Tier 1 Levels (mg/kg) for PHC for Course-Grained Surface Soils.

Land Use	Exposure Pathways*	F1 (C6-C10)	F2 (>C10-C16)	F3 (>C16-C34)	F4 (>C34)
Agricultural/ Wildland	Direct Contact (Ingestion + Dermal Contact)	12 000	6800	15 000	21 000
	Vapour Inhalation (indoor, basement)	40	190	NA	NA
	Vapour Inhalation (indoor, slab-on-grade)	30	150	NA	NA
	Protection of Potable GW	240	320	NA	NA
	Protection of GW for Aquatic Life[a]	970	380	NA	NA
	Protection of GW for Livestock Watering	5300	14 000	NA	NA
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	210	150	300	2800
	Eco Soil Ingestion	NC	NC	NC	NC
	Produce, Meat and Milk Ingestion	NC	NC	NC	NC
	Management Limit[b]	700	1000	2500	10 000
Residential/ Parkland	Direct Contact (Ingestion + Dermal Contact)	12 000	6800	15 000	21 000
	Vapour Inhalation (indoor, basement)	40	190	NA	NA
	Vapour Inhalation (indoor, slab-on-grade)	30	150	NA	NA
	Protection of Potable GW	240	320	NA	NA
	Protection of GW for Aquatic Life[a]	970	380	NA	NA
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	210	150	300	2800
	Produce Ingestion	NC	NC	NC	NC
	Management Limit[b]	700	1000	2500	10 000
Commercial	Direct Contact (Ingestion + Dermal Contact)	19 000	10 000	23 000	RES
	Vapour Inhalation (indoor)	320	1700	NA	NA
	Protection of Potable GW	240	320	NA	NA
	Protection of GW for Aquatic Life[a]	970	380	NC	NC
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	230	260	1700	3300
	Offsite Migration	NA	NA	4300	RES
	Management Limit[b]	700	1000	3500	10 000
Industrial	Direct Contact (Ingestion + Dermal Contact)	RES	RES	RES	RES
	Vapour Inhalation (indoor)	320	1700	NA	NA
	Protection of Potable GW	240	320	NA	NA
	Protection of GW for Aquatic Life[a]	970	380	NC	NC
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	320	260	1700	3300
	Offsite Migration	NA	NA	4300	RES
	Management Limit[b]	700	1000	3500	10 000

NA = Not applicable. Calculated value exceeds 1,000,000 mg/kg or pathway excluded.
RES = Residual PHC formation. Calculated value exceeds 30,000 mg/kg and solubility limit for PHC fraction.
NC = Not calculated. Insufficient data to allow derivation.
a = Assumes surface water body at 10 metres from site.
b = Includes additional considerations such as free phase formation, explosive hazards, and buried infrastructure effects.

APPENDIX 4 – REMEDIATION CRITERIA FOR OTHER CONTAMINANTS

Table A4-1. Canadian Soil Quality Guidelines (mg/kg soil).

Substance[y]	Land Use and Soil Texture							
	Agricultural/ Wildland[*]		Residential/ Parkland[*]		Commercial[*]		Industrial[*]	
	Course	Fine	Course	Fine	Course	Fine	Course	Fine
Arsenic (inorganic)	12[b]		12[b]		12[b]		12[b]	
Barium	750[c]		500[c]		2000[c]		2000[c]	
Benzene								
Surface[w]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]
Subsoil[w]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]
Surface[x]	0.0095[t,u]	0.0068[t,u]	0.0095[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]
Subsoil[x]	0.011[t,u]	0.0068[t,u]	0.011[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]
Benzo(a)pyrene	0.1[e]		0.7[f]		0.7[f]		0.7[f]	
Cadmium	1.4[b]		10[g]		22[b]		22[b]	
Chromium								
Total chromium	64[b]		64[b]		87[b]		87[b]	
Hexavalent chromium (IV)	0.4[h]		0.4[h]		1.4[h]		1.4[h]	
Copper	63[b]		63[b]		91[b]		91[b]	
Cyanide (free)	0.9[b]		0.9[b]		8.0[b]		8.0[b]	
DDT (total)	0.7[i]		0.7[i]		12[i,j]		12[i,j]	
Diisopropanolamine (DIPA)[z]	180[b]		180[b]		180[b]		180[b]	
Ethylbenzene								
Surface	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]
Subsoil	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]
Ethylene glycol	960[k]		960[k]		960[k]		960[k]	
Lead	70[b]		140[b]		260[b]		600[b]	
Mercury (inorganic)	6.6[b]		6.6[b]		24[b]		50[b]	
Naphthalene	0.1[d]		0.6[h]		22[h]		22[h]	
Nickel	50[l]		50[l]		50[l]		50[l]	
Nonylphenol (and its ethyloxylates)	5.7[p]		5.7[p]		14[p]		14[p]	
Pentachlorophenol	7.6[b]		7.6[b]		7.6[b]		7.6[b]	
Phenol	3.8[b]		3.8[b]		3.8[b]		3.8[b]	
Polychlorinated biphenyls (PCB)	0.5[m]		1.3[l]		33[j,l]		33[j,l]	
Polychlorinated di-benzo-p-dioxins/dibenzofurans (PCDD/Fs)	4 ng TEQ/kg[q]		4 ng TEQ/kg[q]		4 ng TEQ/kg[r]		4 ng TEQ/kg[s]	
Propylene glycol	Insuff Info[v]		Insuff Info[v]		Insuff Info[v]		Insuff Info[v]	
Selenium	1[b]		1[b]		2.9[b]		2.9[b]	
Sulfolane[z]	0.8[b]		1[b]		1[b]		1[b]	
Tetrachloroethylene	0.1[e]		0.2[f]		0.5[f]		0.6[f]	
Thallium	1[n]		1[o]		1[o]		1[o]	
Toluene								
Surface	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]
Subsoil	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]
Trichloroethylene	0.01[b,u]		0.01[b,u]		0.01[b,u]		0.01[b,u]	
Uranium[z]	23[t]		23[t]		33[t]		300[t]	
Vanadium	130[l]		130[l]		130[i]		130[i]	
Xylenes								
Surface	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]
Subsoil	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]
Zinc	200[l]		200[l]		360[l]		360[l]	

Notes (Table 4A-1):

Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health are published in "Canadian Environmental Quality Guidelines (CCME, 1999, updated 2007).

SQG_E = Soil Quality Guideline for Environmental Health
SQG_{HH} = Soil Quality Guideline for Human Health

* For guidelines derived prior to 2004, differentiation between soil texture (coarse/fine) is not applicable.

[a] Guidelines released in 1997 were originally published in a working document entitled "Recommended Canadian Soil Quality Guidelines" (CCME 1997) and have been revised, edited and reprinted here. Guidelines revised/released in 1999 are published here for the first time.
[b] Data are sufficient and adequate to calculate an SQG_{HH} and an SQG_E. Therefore the soil quality guideline is the lower of the two and represents a fully integrated *de novo* guideline for this land use, derived in accordance with the soil protocol (CCME 1996; 2006).
[c] Data are insufficient/inadequate to calculate an SQG_{HH}, a provisional SQG_{HH}, an SQG_E or a provisional SQG_E. Therefore, the interim soil quality criterion (CCME 1991) is retained as the soil quality guideline for this land use.
[d] Data are sufficient and adequate to calculate only a provisional SQG_E. It is greater than the corresponding interim soil quality criterion (CCME 1991). Therefore, in consideration of receptors and/or pathways not examined, the interim soil quality criterion is retained as the soil quality guideline for this land use.
[e] Data are sufficient and adequate to calculate an SQG_{HH} and a provisional SQG_E. Both are greater than the corresponding interim soil quality criterion (CCME 1991). Therefore, in consideration of receptors and/or pathways not examined, the interim soil quality criterion is retained as the soil quality guideline for this land use.
[f] Data are sufficient and adequate to calculate an SQG_{HH} and a provisional SQG_E. Both are less than the corresponding interim soil quality criterion (CCME 1991). Therefore, the interim soil quality guideline supersedes the soil quality criterion for this land use.
[g] The soil-plant-human pathway was not considered in the guideline derivation. If produce gardens are present or planned, a site-specific objective must be derived to take into account the bioaccumulation potential (e.g. adopt the agricultural/wildland guideline as objective). The off-site migration check should be recalculated accordingly.
[h] Data are sufficient and adequate to calculate only a provisional SQG_E, which is less than the existing interim soil quality criterion (CCME 1991). Therefore, the provisional soil quality guideline supersedes the interim soil quality criterion for this land use.
[i] Data are sufficient and adequate to calculate only an SQG_E. An interim soil quality criterion (CCME 1991) was not established for this land use therefore, the SQG_E becomes the soil quality guideline.
[j] In site-specific situations where the size and/or the location of commercial and industrial land uses may impact primary, secondary or tertiary consumers, the soil and food ingestion guideline is recommended as the SQG_E.
[k] Data are sufficient and adequate to calculate only a provisional SQG_E.
[l] Data are sufficient and adequate to calculate only an SQG_E, which is less than the interim soil quality criterion (CCME 1991) for this land use. Therefore the SQG_E becomes the soil quality guideline for this land use.
[m] Data are sufficient and adequate to calculate only an SQG_E, which is greater than the interim soil quality criterion (CCME 1991) for this land use. Therefore the interim soil quality criterion (CCME 1991) is retained as the soil quality guideline for this land use.
[n] Data are sufficient and adequate to calculate a provisional SQG_{HH} and an SQG_E. The provisional SQG_{HH} is equal to the SQG_E and to the existing interim soil quality criterion (CCME 1991) and thus becomes the soil quality guideline for this land use.
[o] Data are sufficient and adequate to calculate a provisional SQG_{HH} and an SQG_E. The provisional SQG_{HH} is less than SQG_E and thus becomes the soil quality guideline for this land use.
[p] Data are sufficient and adequate to calculate only an SQG_E. An interim soil quality criterion (CCME 1991) was not established for these substances therefore, the SQG_E becomes the soil quality guideline.
[q] Data are sufficient and adequate to calculate only a provisional SQG_{HH} which is less than the existing interim soil quality criterion (CCME 1991). Thus the provisional SQG_{HH} becomes the soil quality guideline for this land use.
[r] Data are sufficient and adequate to calculate only a provisional SQG_{HH}. An interim soil quality criterion (CCME 1991) was not established for this land use therefore, the provisional SQG_{HH} becomes the soil quality guideline.
[s] Data are sufficient and adequate to calculate only an SQG_{HH}. An interim soil quality criterion (CCME 1991) was not established for this land use therefore, the SQG_{HH} becomes the soil quality guideline.
[t] Data are sufficient and adequate to calculate an SQG_{HH} and an SQG_E. Therefore the soil quality guideline is the lower of the two and represents a fully integrated *de* novo guideline for this land use.
[u] This guideline may be less than the common limit of detection.
[v] Data are sufficient and adequate to calculate only a provisional SQG_{FWAL} (Soil Quality Guideline for Freshwater Aquatic Life). This value is 6,210 mg/kg.
[w] 10^{-5} incremental risk.
[x] 10^{-6} incremental risk.
[y] Unless otherwise indicated supporting documents are available from the National Guidelines and Standards Office, Environment Canada.
[z] Supporting documents are available from the Canadian Council of Ministers of the Environment.

Table A4-2. Interim Remediation Criteria (mg/kg soil).

These interim remediation criteria should only be used when soil quality guidelines have not yet been developed for a given contaminant (see table A4-1).

Substance	Land Use and Soil Texture			
	Agricultural/ Wildland	Residential/ Parkland	Commercial	Industrial
General Parameters				
Conductivity [dS/m]	2	2	4	4
pH	6 to 8	6 to 8	6 to 8	6 to 8
Sodium adsorption ratio	5	5	12	12
Inorganic Parameters				
Antimony	20	20	40	40
Beryllium	4	4	8	8
Boron (hot water soluble)	2	-	-	-
Cobalt	40	50	300	300
Fluoride (total)	200	400	2000	2000
Molybdenum	5	10	40	40
Silver	20	20	40	40
Sulphur (elemental)	500	-	-	-
Tin	5	50	300	300
Monocyclic Aromatic Hydrocarbons				
Chlorobenzene	0.1	1	10	10
l,2-Dichlorobenzene	0.1	1	10	10
l,3-Dichlorobenzene	0.1	1	10	10
l,4-Dichlorobenzene	0.1	1	10	10
Styrene	0.1	5	50	50
Phenolic Compounds				
Chlorophenols[a] (each)	0.05	0.5	5	5
Nonchlorinated[b] (each)	0.1	1	10	10
Polycyclic Aromatic Hydrocarbons (PAHs)				
Benzo(*a*)anthracene	0.1	1	10	10
Benzo(*b*)fluoranthene	0.1	1	10	10
Benzo(*k*)fluoranthene	0.1	1	10	10
Dibenz(*a,h*)anthracene	0.1	1	10	10
Indeno(l,2,3-c,d)pyrene	0.1	1	10	10
Phenanthrene	0.1	5	50	50
Pyrene	0.1	10	100	100
Chlorinated Hydrocarbons				
Chlorinated aliphatics[c] (each)	0.1	5	50	50
Chlorobenzenes[d] (each)	0.05	2	10	10
Hexachlorobenzene	0.05	2	10	10
Hexachlorocyclohexane (Lindane)	0.01	-	-	-
Miscellaneous Organic Parameters				
Nonchlorinated aliphatics (each)	0.3	-	-	-
Phthalic acid esters (each)	30	-	-	-
Quinoline	0.1	-	-	-
Thiophene	0.1	-	-	-

Notes (Table 4A-2):

All values are in mg/kg soil unless otherwise indicated.

Interim remediation criteria were published in 1991 in "Interim Canadian Environmental Quality Criteria for Contaminated Sites (CCME, 1991).

These interim remediation criteria are considered generally protective of human and environmental health and were based on experience and professional judgement.

These interim criteria (CCME, 1991) should only be used when soil quality guidelines based on the CCME soil protocol (CCME, 1996; 2006) have not yet been developed for a given chemical. Also, because the interim remediation criteria were not developed using the soil protocol and its integral checks, they cannot be modified through the site specific remediation objective procedure.

a = Chlorophenols include
- Chlorophenol isomers (ortho, meta, para)
- Dichlorophenols (2,6- 2,5- 2,4- 3,5- 2,3- 3,4-)
- Trichlorophenols (2,4,6- 2,3,6- 2,4,5- 2,3,4- 3,4,5-)
- Tetrachlorophenols (2,3,5,6- 2,3,4,5- 2,3,4,6-)

b = Nonchlorinated phenolic compounds include
- 2,4-dimethylphenol
- 2,4-dinitrophenol
- 2-methyl 4,6-dinitrophenol
- Nitrophenol (2-,4-)
- Phenol
- Cresol

c = Aliphatic chlorinated hydrocarbons include
- Chloroform
- Dichloroethane (1,1- 1,2-), Dichloroethene (1,1- 1,2-)
- Dichloromethane
- 1,2-dichloropropane, 1,2-dichloropropene (cis and trans)
- 1,1,2,2-tetrachloroethane, tetrachloroethene
- Carbon tetrachloride
- Trichloroethane (1,1,1- 1,1,2-), trichloroethene

d = Chlorobenzenes include
- All trichlorobenzene isomers
- All tetrachlorobenzene isomers
- Pentachlorobenzene

APPENDIX 5 – FIELD SCREENING AND INTRUSIVE SAMPLING

Field screening and sampling methods are to be consistent with current professional standards. Because soils on any given site can be variable and complex (e.g. type of soil, grain size, depth of permafrost), all reasonable efforts must be made to ensure samples provide a true 'representation' of the site. Efforts should also be made to minimize the spread of contamination from one location to another as a result of activities during site assessment and cleanup.

Field screening methods help to identify suitable locations for more intrusive sampling and analysis. Screening with portable instruments is acceptable if the instruments are capable of calibrating measurements to relative or absolute levels of contamination, if the screening is verifiable in regard to procedures and results and finally, if results of such techniques can be correlated to *Canadian Association for Environmental Analytical Laboratories (CAEAL*) accredited laboratory results.

On sites where it cannot be determined through historical records that previous tanks and lines have been removed, an appropriate survey (e.g. ground penetrating radar) should be carried out before drilling, to determine whether tanks and lines are present.

Sample locations should provide an adequately detailed description of the nature and extent of contamination in three dimensions and provide information on potential subsurface contaminant migration pathways. The following are considered minimum requirements:

- Soil - 3-5 boreholes or test pits for each potential source area, except very small sites where a minimum of 1 borehole or test pit is sufficient. Potential source areas include storage tanks and barrels, lines, pump islands, loading areas, previous underground installations and areas of discoloured or stained soil. At a typical community POL facility with 1 tank nest, 1 set of lines, 1 pump island, and 1 waste oil tank, this would equate to 4 source test locations.
- Groundwater - Sufficient test locations to determine the direction of groundwater flow on-site should be selected (minimum of 3 groundwater monitoring wells or piezometers, including at least 1 multilevel installation to assess vertical gradients). Shallow wells are to be screened across the water table to intercept floating product.
- All soil test holes should extend to the bottom of the contaminated soil zone or to an impermeable layer (e.g. bedrock), whichever is shallower.
- All test holes and wells should be monitored for the presence of free product.
- At least 1 'control' site should be established to determine accurate background concentrations of the suspected contaminant.

Each sample location should be marked or documented so it can be found again, if needed.

APPENDIX 6 – SAMPLE ANALYSIS

Soil samples may be screened in the field for vapours, staining or odour in order to reduce the number of samples to be analyzed by the laboratory. All field observations must be included in reports.

Chemical analyses are to be conducted on at least 2 soil samples per test hole location - one surface <1.5 m depth, one subsurface >1.5 m depth. Chemical analyses are to be conducted on at least one groundwater sample from each well sampled.

Chemical analyses for petroleum hydrocarbon impacted sites are to include PHC and BTEX (benzene, toluene, ethylbenzene, xylene)[1]. Analysis for additional site-specific parameters may be required, depending on past or present land use (e.g. PAHs, lead, PCBs).

Grain size analyses are to be conducted on at least 1 sample per hydrogeologic unit if soil grain size criteria are to be applied.

Quality Assurance/Quality Control (QA/QC) – For small batches of soil samples (less than 10 samples), at least one blind duplicate should be analyzed per batch of samples. For larger batches of soil samples (greater than 10 samples), 10% duplicates should be analyzed. For groundwater samples, a blind duplicate and field blank sample should be collected and analyzed with each batch of samples tested. The QA/QC results should be presented and interpreted in the closure report.

All sampling, sample handling and chemical analysis must be consistent with accepted practices. In particular, samples for volatile organics must be collected such that there is a minimum headspace in soil samples and no headspace in water samples. Samples should be kept cool, but not frozen, until they are delivered to the laboratory. Sample handling procedures should be verified with the receiving laboratory and chemical analysis should be consistent with the PHC Canada-Wide Standard reference method. See *Guidance Manual on Sampling, Analysis and Data Management for Contaminated Sites, Volume 1: Main Report (*CCME, 1993), and *Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil – Tier 1 Method (CCME, 2001)*.

Accredited Laboratory

Laboratory analysis of contaminated soil, water and other materials must be conducted by laboratories that have been formally recognized as competent to perform specified tests by the Canadian Association for Environmental Analytical Laboratories (CAEAL*)*. CAEAL is a non-profit organization dedicated to raising the level of competency, consistency, capability, and communication within environmental testing laboratories in Canada. Their member laboratories voluntarily participate in rigorous programs of proficiency testing and accreditation, demonstrating their commitment to generate high quality and consistent data (see Appendix 8).

[1] Soils with high natural organic carbon (such as peats) may give a "false positive" result when analyzed. If this is suspected, it may be beneficial to collect additional background soil samples for organic carbon analysis.

APPENDIX 7 - TRANSPORTATION OF CONTAMINATED SOIL

Contaminated soil must be transported in accordance with requirements of the appropriate transport authority. The road transportation of contaminated soil is administered by the Nunavut Department of Economic Development and Transportation under the territorial *Transportation of Dangerous Goods Act* and Regulations (TDGR). The transportation of contaminated soil by air and marine mode is administered by Transport Canada under the federal *Transportation of Dangerous Goods Act* and *International Maritime Dangerous Goods Code,* respectively.

The TDGR require that a waste manifest form accompany shipments of contaminated oil and other hazardous waste. The completed manifest form provides:

- Detailed information on the types and amounts of hazardous waste shipped;
- A record of the parties involved in the shipment;
- Information on the storage, treatment or disposal of the waste; and
- Confirmation that the waste reached the final destination.

No chemical test of the hydrocarbon is required as “petroleum distillate” is a specified dangerous good in List II, Schedule II of TDGR. The word “waste” must precede the shipping name.

Manifest requirements:

	Shipping name:	WASTE SOLIDS CONTAINING FLAMMABLE LIQUID, n.o.s.*, (gasoline or diesel, as appropriate)
	Classification:	4.1
	UN number:	UN3175
	Packing group:	II
or	Shipping name:	WASTE ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, n.o.s.*, (gasoline or diesel, as appropriate)
	Classification:	9
	UN number:	UN3077
	Packing group:	III

Further assistance in completing a waste manifest can 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. Further information on hazardous waste management in Nunavut can be obtained by referring to the *Environmental Guideline for the General Management of Hazardous Waste (January 2002)* produced by the Department of Environment.

APPENDIX 8 - ADDITIONAL CONTACTS

Canadian Council of Ministers of the Environment (CCME)
CCME works to promote effective intergovernmental cooperation and coordinated approaches to interjurisdictional issues such as air pollution and toxic chemicals. Under the auspices of CCME, the federal, provincial and territorial ministers of environment collectively establish nationally consistent environmental standards, strategies and objectives so as to achieve a high level of environmental quality across the country. Comprehensive literature and technical documentation is available from:

Canadian Council of Ministers of the Environment
123 Main Street, Suite 360
Winnipeg, Manitoba R3C 1A3
Phone: (204) 948-2090; Fax: (204) 948-2125
Website: http://www.ccme.ca
E-mail: info@ccme.ca

Canadian Association for Environmental Analytical Laboratories (CAEAL)
CAEAL is a not-for-profit organization formed in 1989 dedicated to raising the level of competency, consistency, capability, and communication within environmental testing laboratories in Canada. Membership in CAEAL is open to individuals, institutions, user groups, consultants, industrial organizations, regulatory agencies, materials and laboratory equipment suppliers, and others interested in the work being carried out in environmental analytical laboratories. More information on CAEAL may be obtained from:

Canadian Association for Environmental Analytical Laboratories
300-265 Carling Avenue
Ottawa, Ontario K1S 2E1
Phone: (613) 233-5300; Fax: (613) 233-5501
Website: http://www.caeal.ca/

Canadian Standards Association (CSA)
CSA is a not-for-profit membership-based association serving business, industry, government and consumers in Canada and the global marketplace. As an organization, CSA works to develop standards that address a wide variety of needs, such as enhancing public health and safety, occupational health and safety, and the environment. More information on CSA may be obtained from:

Canadian Standards Association
5060 Spectrum Way
Mississauga, Ontario L4W 5N6
Phone: (416) 747-4000; Fax (416) 747-2473
Website: http://www.csa.ca