Remediation Planning and Remedial Action Plan – Feasibility Study

Eureka High Arctic Weather Station

FY12/13

FINAL REPORT

FCSI 2747 – Eureka High Arctic Weather Station

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EXECUTIVE SUMMARY

SENES Consultants Ltd. (SENES), in association with Franz Environmental Inc. (FRANZ), was retained by Public Works and Government Services Canada (PWGSC) on behalf of Environment Canada (EC) to prepare a remedial options feasibility study, in support of the Remedial Action Plan (RAP), at the Eureka High Arctic Weather Station (HAWS).

Objective

The objective of this report is to outline the feasibility of the remedial options for managing environmental impacts at the Eureka HAWS and to evaluate each option based on practicality, safety, cost, and site-specific logistics; and to identify the preferred and secondary remedial options. To complete the work, an update to the 2010 detailed quantitative risk assessment (DQRA) to include the data collected during the 2012 supplemental investigation and a geotechnical analysis of the stability of the slope west of the Powerhouse was required.

Work Completed in 2012

A supplemental investigation was completed in August 2012 to address the data gaps identified in the 2010 detailed quantitative risk assessment (DQRA). A background soil, sediment, and surface water sampling program was completed to confirm or refute that the elevated concentrations of metals at the site were attributable to natural, background conditions. Additional soil and sediment samples were collected in the area around the Powerhouse and Delta to delineate impacts. Indoor air and sub-slab vapour samples were collected to address the potentially unacceptable risk to operation and maintenance workers due to vapour intrusion into maintenance buildings. Geotechnical samples were collected to assess the stability of the slope west of the Powerhouse. Results of the supplemental investigation are provided under separate cover.

Results – Update to DQRA

Using rigorous statistical analysis, analytical results from background soil, surface water, and sediment samples were used to establish the highest concentration of metals that can be expected to result from natural sources (“background threshold levels”) through rigorous statistical analysis. The background threshold levels were compared to the concentration of metals found on site. The maximum concentrations from the indoor air and vapour sampling were input into the human health risk assessment model. Based on the results, the vapour inhalation pathway was eliminated as a source of potential unacceptable risk from petroleum hydrocarbons (PHC) F1 and F2. There are no potentially unacceptable risks to human health based on the identified contaminants of concern (COCs) on site.

Based on the updated risk assessment modelling, for soil there is still a potentially unacceptable risk from PHC F2 to terrestrial plants and invertebrates. In sediment, a potentially unacceptable

risk from PHC F1 and F2, xylenes, and 1-methylnaphthalene to benthic invertebrates and macrophytes remained. There is no potentially unacceptable risk to terrestrial birds and mammals as all the risk quotients were below risk threshold levels. The original DQRA identified a potentially unacceptable risk to terrestrial mammals and birds due to aluminum; however, all aluminum concentrations on site were below the established background threshold level. The aluminum concentrations that posed a potential unacceptable risk are naturally occurring and are not caused by site activities.

The site-specific target levels (SSTLs) were updated based on the data from the 2012 supplemental investigation. Based on the new SSTLs, volume estimates of impacted soil and sediment were calculated. The new expected volume of PHC F2 impacted soil (i.e., with concentrations above the SSTLs) at the Eureka HAWS is 13,200 m^3 and the volume of PHC F1 and F2, xylenes, and 1-methylnaphthalene impacted sediment is 2,400 m^3.

Results – Slope Stability Analysis

A slope stability assessment was conducted on the area between the Powerhouse and the Drainage Pond based on the select geotechnical sample analysis submitted as part of the 2012 supplemental investigation and review of site topography. The results of the slope stability analysis indicate that excavation at the top and bottom of the slope would be of high risk as there is a critical piece of infrastructure at the top, the fuel pipe line, and excavation at the toe of the slope would require an engineered shoring system that would cause limitation on where excavations could occur. Maintaining the necessary sidewalls for entry into an excavation would be difficult due to the presence of the Powerhouse and New Garage and fuel pipe line at the top and the steep slope, wet conditions, Drainage Pond, Drinking Water Reservoir walls and road at the bottom.

Results – Remedial Options Analysis

SENES/FRANZ evaluated multiple risk management options for the Eureka HAWS. These options included a site-wide remedial action plan for managing PHC impacted soils and sediment. SENES/FRANZ identified and tabulated reasonable remedial options available, and assessed and scored them with respect to applicability, limitations, time, and (order of magnitude) costs. Other criteria included the potential remedial options were evaluated based on the removal of hazards, long term effectiveness and overall protection of human health and the environment. The outcome of this remedial options evaluation process is a tabulated matrix evaluation assessing and scoring each of the remedial options identified.

Based on the evaluation and scoring of the remedial options analysis (ROA), and the SSTLs, the preferred remedial option for soil and sediment is risk management via long-term monitoring (LTM). The stability of the slope presents a high risk if excavation were to occur at the bottom or top of the slope. In addition, a critical piece of infrastructure, the fuel pipe line is at the top of the slope, and there would be a risk to the integrity of this pipeline

SENES/FRANZ recommends preparing and implementing a LTM plan which would clearly define the monitoring schedule, the comparison criteria, and the potential termination and action required criteria. The LTM program will be designed to assess whether there are any unacceptable changes in concentrations of COCs at the site that would change the risk assessment assumptions. This should also include monitoring the contributions of the seasonal active layer melt water to the seeps (if observed during monitoring round). If the long term monitoring indicates that either risk management measures are not meeting the risk management objectives or that the changing conditions (e.g., melting permafrost from climate change, new construction) are changing risk assumptions and the conceptual site model, the risk assessment and risk management plan will need to be reviewed and revised appropriately.

No secondary remedial option was identified as site conditions, such as the position of critical infrastructure, health and safety risk of the slope stability, and sensitive environment prevented the other remedial options from being applicable to the entire site. Capping was the remedial option that scored second highest; however, it would only be able to be applied in select locations.

If the proposed capital projects, including relocating the drinking water reservoir or removal of the buildings in the delta area, were to take place, an update to the remedial options is recommended.

This executive summary should be read in conjunction with the main report and is subject to the same limitations described in Section 7.0.

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1.0 INTRODUCTION

SENES Consultants Ltd. (SENES), in association with Franz Environmental Inc. (FRANZ) was retained by Public Works and Government Services Canada (PWGSC) on behalf of Environment Canada (EC) to prepare a remedial options feasibility study, in support of the Remedial Action Plan (RAP), at the Eureka High Arctic Weather Station (HAWS).

This project was completed under PWGSC Northern Supply Arrangement Agreement Number EW699-100053/002/NCS, Call-up number EW699-123266/001/NCS, and Amendment # 1 and # 2. This report describes the remedial options feasibility study completed for the Eureka HAWS and was prepared in accordance with the *Terms of Reference Remedial Planning and Remedial Action Plan Eureka High Arctic Weather Station FY11/12 and 12/13* dated March 2012, and the SENES/FRANZ work plan dated June 14, 2012.

The project has been conducted in four stages, the first of which included a supplemental investigation at the Eureka HAWS. The results of the supplemental investigation were reported separately.

The second stage, and the subject of this report, includes an assessment of the feasibility of different remedial options in support of the development of a Remedial Action Plan. The feasibility study incorporated considerations such as practicality, safety, cost, and site-specific logistics for each of the different options for the remediation at Eureka HAWS.

The third stage consists of the development of a substantive cost estimate, work breakdown structure, and Gantt chart for the preferred remedial strategy chosen by PWGSC and EC. The cost estimate will include all assumptions made, items of work, quantities, unit prices, complete list of all exclusions and reasoning for the exclusions.

The final stage is the preparation of the Remedial Action Plan based on the remediation strategy chosen by EC.

1.1 Study Area

Eureka High Arctic Weather Station (HAWS) is located on the north side of Slidre Fiord, at the northwestern tip of Fosheim Peninsula, Ellesmere Island, Nunavut (see Figure 1; Appendix A). The Eureka HAWS coordinates are 79°59'41"N and 85°48'48"W (according to a sign located at the corner of the living quarters). The site is accessed primarily by air, with an all-season airstrip located about 1.5 km northeast of the main operations facility and living quarters. Eureka HAWS is situated on a hillside sloping down from the airstrip, levelling out where most facilities are located, before sloping into the ocean. Down the slope south of the Eureka HAWS Main Complex is a flat section of land known as the Delta area. This area is used as an access point for the delivery of supplies via sea-lift by the Canadian Coast Guard ice breaker. The Fiord is covered with ice for most of the year, i.e., from September through June.

1.2 Project Objectives

The objective of this report is to outline the feasibility of the different remedial options for the Eureka HAWS and evaluate each option based on practicality, safety, cost, and site-specific logistics and to identify the preferred and secondary remedial options. The report will be used by PWGSC and EC to make a final decision on the remedial strategy.

1.3 Scope of Work

The scope of work consisted of the following tasks:

- Identification of potential remedial options including innovative/green technologies;
- Evaluation of each remedial option;
- Identification of preferred and secondary remedial options; and
- Preparation of the Feasibility Study report.

Once PWGSC and EC have identified the final, preferred remedial option, SENES/FRANZ will complete the following tasks:

- Prepare a substantive cost estimate for the preferred remedial option;
- Develop a work breakdown structure and Gantt chart; and
- Develop the Remedial Action Plan.

2.0 PREVIOUS STUDIES

2.1 2008/2009 Studies

In the summers of 2008 and 2009, FRANZ was retained by Public PWGSC on behalf of EC to complete a Phase III Environmental Site Assessment (ESA) at the Eureka High HAWS. This work resulted in the following reports, which were reviewed in preparing this work plan.

- *Phase III Environmental Site Assessment Eureka High Arctic Weather Station Nunavut Canada Final Report,* Franz Environmental Inc., March 2009. Prepared for Public Works Government Services Canada on behalf of Environment Canada (2008 Phase III ESA); and

- *Phase III Environmental Site Assessment Eureka High Arctic Weather Station Nunavut Canada Final Report,* Columbia Environmental Consulting Ltd. & Franz Environmental Inc., January 2010. Prepared for Public Works Government Services Canada on behalf of Environment Canada (2009 Phase III ESA).

The conclusions of these investigations indicated that some site-specific risk assessment activities were required at five Areas of Environmental Concern (AECs); see Figure 2, Appendix A:

- AEC B-2: In-situ Landfarm
- AEC B-3: Suspected Landfill
- AEC D: Powerhouse
- AEC E: Hydrogen Building
- AEC H: Old Maintenance Garage

Soil impact has also been delineated at depth from northwest of the tank farm at AEC B-1, between AEC B-2 and AEC B-3; therefore, this area was also considered for the risk assessment.

The 2008 Phase III ESA findings for the above five AECs and associated contaminants of concern (COCs) are summarized in Table 2-1 below (note that AEC B-3 and AEC H were not investigated until the 2009 study).

Table 2-1: Summary of 2008 Phase III ESA Findings

APEC/APEC	Field Observations/Evaluation	Summary of Results	Recommendation
APEC B-2: In-situ landfarm FCSI# 00002446	• Previous investigations have been completed at this APEC. Total petroleum hydrocarbons (TPH) concentrations were above the applicable guidelines • Since TPH is not a regulated parameter, re-sampling of the area was required • Field observations of petroleum hydrocarbon contamination were observed within and surrounding the in-situ landfarm	22 soil samples and 1 sediment sample had exceedences of benzene, toluene, ethylbenzene and total xylenes (BTEX), petroleum hydrocarbons (PHCs) and/or polycyclic aromatic hydrocarbons (PAHs). The total volume of PHC impacted soil was approximately 8,600 m^3.	• It does not appear that the PHC impacted soils are being remediated to any significant degree. • The remedial options for this AEC should be re-evaluated to develop a more effective approach. • Statistically based sampling should be implemented to identify trends (decreasing concentrations vs. no significant changes) • PQRA recommended
APEC D-1: Powerhouse located at main Camp FCSI# 07573001	• No previous investigations have been completed for this area • Field observations of contamination were observed downgradient of area • Appears that pure product is located in the sediment immediately downgradient of the Powerhouse, but surface water does not have sheen until sediment was disturbed • Collected surface soil samples from under building. The soil exhibited concentrations of petroleum hydrocarbons above the applicable guidelines under entire building	11 soil and 5 sediment samples had exceedences of arsenic. 2 soil and 2 sediment samples had anomalous exceedences of zinc, which are being re-evaluated. 3 soil samples had exceedences of selenium. 16 soil and 5 sediment samples had exceedences of BTEX, PHCs and/or PAHs. The total inferred volume of PHC impacted soil was approximately 3,200 m^3.	• This site is considered a high priority. • The elevated concentrations of petroleum hydrocarbons indicate free product in the soil and sediment. • PAH exceedences in a sediment sample downgradient of the drainage pond indicate that the contamination maybe migrating downgradient to the south towards Slidre Fiord. • Further sampling may be required downstream of the drainage pond in order to determine the extent of migration. • A remedial action plan should be developed to address the contaminated soil. • PQRA recommended

APEC/APEC	Field Observations/Evaluation	Summary of Results	Recommendation
APEC E-1: Hydrogen Building FCSI# 00002447	- No subsurface investigations have been completed at this APEC - No visual contamination was observed	2 samples had exceedences of arsenic. 4 samples had exceedences of BTEX and/or PHCs. The total inferred volume of PHC impacted soil was approximately 220 m^3.	- Further testing was required to determine the extent of hydrocarbon impacted soils and identify the source.

The 2009 Phase III ESA findings for the above five AECs were summarized in Table 2-2 as follows.

Table 2-2: Summary of APEC/AECs, COCs, and Recommendations

APEC/ AEC	Observations/ Evaluation	Summary of Results	Recommendation
AEC B-3: Suspected Landfill	This area contained imported fill (from elsewhere on the site). There are two small impacted areas north (identified in 2008) and northwest of the tank farm (identified in 2009), each containing a small amount of debris.	Using both 2008 and 2009 data, the COCs in soil were BTEX, and PHC F1- F3. Impacted areas were located around the small debris areas and immediately downgradient and along the drainage path towards the south. The total volume of PHC impacted soil was approximately 1,200 m^3.	It was recommended that a preliminary quantitative risk assessment (PQRA) be completed to confirm whether action is required. If the PQRA recommends active remediation, debris from the small waste caches north and northwest of the tank farm should be excavated and transported to the landfill, with the PHC impacted soil deposited in the *in situ* landfarm.
AEC D: Powerhouse	A site visit of the powerhouse indicated that overall, the powerhouse is well maintained and no on-going sources of contamination were identified. During the 2009 investigation, an active layer melt water seep was identified downgradient of	The 2009 results suggest that the source contamination in soil, sediment, and surface water is likely originating from the reported spill which occurred at a former day tank immediately to the north of the powerhouse (in the location of the current garage which is attached to the powerhouse) in 1996/97. The COCs in soil were BTEX,	It was recommended that a preliminary quantitative risk assessment (PQRA) be completed to confirm whether action is required. A risk management plan will likely be required to address the impacted soils, sediment, and surface water, and should include a strategy to protect the

APEC/ AEC	Observations/ Evaluation	Summary of Results	Recommendation
	the powerhouse. The water had a strong sheen, and the surface drainage path extended towards the fjord. Additional soil, sediment, and surface sampling from downstream of the drainage pond were necessary to determine the extent of contaminant migration.	PHC F1 to F4, naphthalene, 1-methyl naphthalene, 2-methyl naphthalene, phenanthrene, arsenic, selenium and zinc. The high concentrations of petroleum hydrocarbons indicated PHC liquid free product in the soil and sediment. The elevated PAHs in the sediment south of the road and downgradient of the drainage pond indicated that contamination may be present to the south. No PHCs were detected in surface water sampled from the drinking water pond. Lead was slightly elevated when compared to CCME fresh water aquatic life but below drinking water guidelines. The concentrations were consistent with background samples collected upstream of the Eureka station. Results from the source water assessment indicate that the proximity of the drinking water reservoir to the powerhouse and *in situ* land farm, as well as the fact that the reservoir is cross- or down-gradient from the impacted areas, may cause potential risk to drinking water quality. The total volume of PHC impacted soil was approximately 1,200 m^3.	drinking water reservoir.

APEC/ AEC	**Observations/ Evaluation**	**Summary of Results**	**Recommendation**
AEC E: Hydrogen Building	No visual indication of contamination was observed in the 2008 or 2009 investigations.	Soil sampled downgradient of the hydrogen building in 2008 exhibited concentrations of benzene, toluene, ethylbenzene and arsenic above the applicable guidelines; however none of the samples collected in 2009 exceeded the guidelines for PHCs. Arsenic was elevated in samples collected in 2009, but this was assumed to be representative of general background conditions. pH exceeded apparent background value at two locations (i.e., pH >9) The total volume of PHC impacted soil was approximately 50 m^3.	Delineation was complete. It was recommended that a preliminary quantitative risk assessment (PQRA) be completed to confirm that no further action is required.
AEC H: Old Maintenance Garage	The petroleum hydrocarbon impacts to soil are likely due to years of fuel handling and equipment operations around the old garage.	The COCs in soil were benzene, ethylbenzene and PHC F2. Some impacts at the garage may be attributed to impacts at the powerhouse immediately to the west. The total volume of PHC impacted soil was approximately 1,100 m^3.	Delineation is complete. It was recommended that no further sampling is required. It was recommended that a preliminary quantitative risk assessment (PQRA) be completed to confirm that no further action is required. If the structure is to be demolished, the impacted soil should be excavated and placed in the *in situ* landfarm. If the building will not be demolished, based on the proximity to the powerhouse, it could be included in the risk management plan developed for AEC D.

2.2 2010 Monitoring Report

1. The August, 2010 field investigation included eight test pit excavations, six hand auger holes for soil sampling, eight surface water samples and eight sediment samples. The COCs investigated were PHC as measured by PHC fraction F1 to F4, BTEX, PAHs, and total metals.
2. 2010 monitoring findings for **AEC D – Powerhouse**
   - As identified in previous studies, the results suggest that the source of hydrocarbon contamination in soil, sediment, and surface water likely originated from the historic and recent Powerhouse operations.
   - The COCs in soil were toluene, ethylbenzene, xylenes, F1, F2, 2-methyl naphthalene, and arsenic. Soil conditions and impact extents in AEC D (Powerhouse) were well characterized.
   - All surface water samples collected in 2010 from the drainage channel leading from the drainage pond were below detection limits or guidelines for all PHC and PAH parameters. Total metals in surface water were generally elevated above background; however, the concentrations can be attributed to hard water. Aluminum and iron were above the CCME Canadian Water Quality Guideline for the Protection of Freshwater Aquatic Life. Overall, the data from the last three years suggest that the surface water quality along the drainage path to the discharge point into the fiord is not impacted.
   - Although arsenic was elevated in sediment collected along the drainage pond area, this was consistent with background for this site. The most heavily impacted sediment was located immediately downgradient of the Powerhouse where PHC product was observed.
   - During the 2009 and 2010 site visits a groundwater seep with hydrocarbon sheen was observed south of the Powerhouse in the road leading towards the sealift area and the fiord. Several metals were detected above apparent background concentrations with aluminum and phosphorous above the Canadian Water Quality Guideline for the Protection of Freshwater Aquatic Life. Of greater significance are the elevated benzene, toluene, ethylbenzene, F1, F2, 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene concentrations above Canadian Water Quality Guideline for the Protection of Freshwater Aquatic Life. guidelines in this seep water. It is not clear if the elevated PHCs in water from the seep are related to contamination from the upgradient Powerhouse since it could also be from an accumulation of impacted groundwater from the entire complex.
   - No PHCs were detected in surface water sampled from the drinking water reservoir in 2010. Lead was slightly elevated in 2009 when compared to CCME fresh water aquatic life but below drinking water guidelines. The metals concentrations in the reservoir water samples were consistent with background samples collected upstream of the

Eureka station. In 2010, aluminum and phosphorous were above CCME fresh water aquatic life but also below drinking water guidelines.

- Observations from 2010 (i.e. product in sediment) are consistent with previous years.

3. 2010 monitoring findings for **AEC H – Old Maintenance Garage**
   - The petroleum hydrocarbon impacts to soil are likely due to years of fuel handling, equipment maintenance, and equipment operations around the old garage.
   - It is likely that there is contamination throughout the delta, with the impacted soils immediately down slope of the garage directly related to the maintenance of equipment around the garage. Since, the delta was not in the scope of this investigation, the identified impacted soil further downgradient of the Old Garage was included with the Old Garage impacted soils.
4. Sediment toxicity testing within the drainage pond and downstream thereof indicated that toxicity to benthic invertebrates in the vicinity of D1-SD10-1, collected within the visually observable impacted section of the drainage pond, was highly probable, although there was obvious capacity of some invertebrates to withstand the chemical impact of petroleum hydrocarbons. The sample collected in the drainage channel downgradient of the pond (where PHC F1 and F2 were not detectable) did not exhibit any impacts to sediment.

2.3 2010 Detailed Quantitative Risk Assessment Results

The objectives of the DQRA were to identify contaminants of concern (COCs) in media at the site and to identify whether any unacceptable risks to human health or ecological receptors were present.

All areas of environmental concern (AECs) were evaluated in a single DQRA, rather than evaluating each AEC separately, as the same types of receptors (e.g., adult HAWS workers and visitors, and ecological receptors) are present throughout the site.

The Site-Specific Human Health Risk Assessment indicated that there were potentially unacceptable risks to the operation and maintenance worker from PHCs fractions F1 and F2 in soil. This potentially unacceptable risk was attributable primarily to exposure to contaminated site soil via the inhalation of contaminant vapours emanating from subsurface soils at operation and maintenance buildings such as the Powerhouse/water storage and New Garage, the Old Garage, the Red Quonset north of the new garage, and down slope in the vicinity of Building # 17 (Plumbing Shack), the Former Bunk House, and the Old Transient Barracks. Hazard quotients for office site workers from all threshold and non-threshold contaminants indicated acceptable risk levels.

The Site-Specific Ecological Risk Assessment results indicate that:

- For soils, PHC F1 and F2, aluminum, boron, and chromium exceeded risk targets for terrestrial plants and invertebrates, while aluminum exceeded risk targets for mammals and birds.
- For sediment, PHC F1 and F2, xylenes, and 1-methylnaphthalene (all associated with diesel fuel or furnace oil), along with aluminum, boron, and iron exceeded risk targets for benthic invertebrates and macrophytes.
- For surface water, PHC F1 and F2, as well as a number of metals exceeded risk targets, but only in samples collected from an active layer water seep downgradient of the Powerhouse – these are not considered representative of surface water conditions at the site.
- All metals in soil, sediment and surface water were considered likely reflective of local background conditions, as metal "impacts" were widespread, but no anthropogenic sources were apparent. This was deemed to required confirmation through rigorous statistical analysis and possibly a comprehensive background sampling program.

Site-specific target levels (indicated in bold underline below) were developed for the parameters exceeding target levels. The SSTLs are summarized in Table 2-3.

Table 2-3: Summary of SSTLs in Soil and Sediment

Chemical Name	Hazard Quotient (HQ) Humans	Risk quotient (RQ) – Plants & Invertebrates (Soil) or benthic community (Sediment)	SSTL human health (mg/kg)	SSTL ecological health (mg/kg)
SOIL				
PHC F1	1.63 (target = 0.5)	0.1 (target = 1.0)	**<u>170</u>**	3700 (max. observed)
PHC F2	0.69 (target of 0.5)	1.8 (target = 1.0)	1794	**<u>1374</u>**
SEDIMENTS				
Xylenes	n/a	3.62 (target = 1.0)	n/a	**<u>1.46</u>**
1-methylnaphthalene	n/a	1.36 (target = 1.0)	n/a	**<u>3.6</u>**
PHC F1	n/a	28.7 (target = 1.0)	n/a	**<u>10</u>**
PHC F2	n/a	3,076 (target = 1.0)	n/a	**<u>12</u>**

Based on the SSTLs for soil and sediment, Table 2-4 presents a summary of estimated volumes of soil impacted by PHCs F1-F2. An additional expected area of 2400 m^2 and volume of 480 m^3 of sediment within the drainage pond was expected to be above the SSTLs for one or more of toluene, PHC F1 and F2 and 1-methylnaphthalene.

Table 2-4: Expected Volumes of Soils above SSTLs

Contaminant of Concern	AEC	Average Impacted Depth Interval (m)	Max. Depth of Impacts (m)	Expected Area of Contamination (m^2)	Expected Volume (m^3)	Maximum Expected Volume (m^3)
PHCs F1-F2	AEC B-2-1	0-1.0	1.4	5,700	5,700	8,000
	AEC D-1	0-0.7	1.2	1,800	1,300	2,200
	AEC H-1	0-1.0	1.3	300	300	400
	AEC H-2	0-0.2	0.5	1,200	250	600
			Total	**9,000**	**7,600**	**11,200**

The revised NCSCS scoring for areas of concern (AECs) are summarized in Table 2-5.

Table 2-5: Summary of NCSCS Scores

AEC	FCSI #	Previous NCSCS Score	Updated NCSCS Score
AEC B-2: In-situ Landfarm	00002446	79.0; Class 1 – High Priority for Action	71.3; Class 1
AEC B-3: Suspected Landfill	00002448	64.9; Class 2 - Medium Priority for Action	56.1; Class 2
AEC D: Powerhouse	07573001	83.7; Class 1	78.4; Class 1
AEC E: Hydrogen Building	00002447	60.2; Class 2	55.4; Class 2
AEC H: Old Maintenance Garage	07573002	59.4; Class 2	61.0; Class 2

2.4 Summary of 2012 Supplemental Investigation Activities

2.4.1 Objectives

The objectives of the 2012 supplemental investigation were to:

- Complete a data gap analysis;
- Prepare a sampling plan to address the identified data gaps;
- Conduct a site investigation at the areas identified in the data gap analysis; and
- Prepare a supplemental investigation report.

2.4.2 Scope

The scope of work of this study included the following activities:

1. Review previous studies;
2. Preparation of a data gap analysis report;

3. Preparation of a sampling plan to cover the gaps identified;
4. Implement a field investigation and sampling program consisting of the following tasks:
    a. Preparation of a health and safety plan;
    b. Identification of underground utilities;
    c. Excavation of test pits and hand augering holes;
    d. Collection of soil, sediment, and surface water samples for chemical analysis; and
    e. Collection of indoor air and sub-slab vapour samples.
5. Interpretation of analytical data; and
6. Reporting.

2.4.3 Findings

2.4.3.1 Data Gap Analysis

Background sampling

The 2010 SENES/FRANZ DQRA report indicated that elevated concentrations of metals in soil, sediment and surface water were likely reflective of naturally-existing conditions, as metals exceedances above guidelines were widespread and, in many cases, in areas where no anthropogenic sources were apparent. In order to add further support to this conclusion, it was recommended that the 2012 field program included a comprehensive sampling program for metals in soil, sediment, and surface water.

AEC D

The impacts in the areas around Building #17 (Plumbing Shack) in AEC D and the delta were not fully delineated in the previous field programs. A sampling program at AEC D and the delta to delineate the extent of the impacts was recommended.

Indoor Air Sampling

One of the sources of risk to the theoretical ‘operations and maintenance worker’ identified in the DQRA was the vapour inhalation pathway. Volatile contaminants in soil and water can migrate to indoor air, creating increased risks to receptors; however, the models used in risk assessment are conservative, and do not consider many factors that have an impact on vapour intrusion into site buildings. Northern construction techniques and weather conditions add to the uncertainty. A sampling plan to better quantify the potential risk to on-site operation and maintenance workers through the indoor air inhalation pathway was recommended.

Former Fuel Storage Area (FFSA), west of Station Creek

A former fuel storage area, west of Station Creek, was identified as an area with hydrocarbon impacts in the 2006 Jacques Whitford Ltd. (JW) *HHERA for the Eureka HAWS: Final Report.* The 2006 JW HHERA recommended that Environment Canada should consider removing the impacted soil from this area to prevent the potential migration of the petroleum impacts into the marine environment. If soil from the FFSA is to be included in the remedial action plan, additional samples from this area would ideally be collected to confirm the PHC concentrations observed by JW in 2006; however it was deemed not absolutely necessary as it is unlikely PHC concentrations have changed significantly since 2006 and the impacts were reasonably well delineated. The data from the 2006 JW investigation should be adequate to include the FFSA impacted soils into a RAP, should EC decide to do so later.

AEC A

AEC A, which consists of nine separate sub-areas, was last assessed in the summer of 2008. The results of the assessment were part of the 2008 Phase III ESA report. Three areas within AEC A: AEC-A7 *Ex Situ* Biotreatment Cell, AEC-A8 Contaminated Soil Area, and AEC-A9 Former First Air Lease Area contained soil exhibiting concentrations of PHC parameters above the guidelines. The 2008 data, as well as data from previous studies, should be adequate to include AECs A7, A8 and A9 in the RAP. As for the potential presence of metals in soil in other areas it is not expected that these concentrations have changed since 2008, as metals do not degrade to any significant degree. The 2008 data for metals in soil should be considered to be still valid.

Vertical Delineation of Sediment Impacts

Sediment impacts in the drainage pond from near the road and down slope of the AEC B-2 and AEC D were identified in the previous investigations. The sediment samples were surficial samples and the depth of the PHC impacts is not known. Multi-depth sediment sampling was recommended.

Sampling for Borrow Source Assessment

As part of the RAP, a borrow source may be required to replace the excavated contaminated material or for land treatment facility (LTF) construction, if that is part of the final RAP. Identification of potential borrow source areas was recommended.

Sampling for Slope Stability Evaluation

PHC impacts west of the powerhouse in AEC D are along the top edge of the slope leading towards the drainage pond, and at the base of the slope. As excavating the accessible impacted soil is part of the remedial strategy, the stability of the slope and foundation construction of the powerhouse and adjoining building will be required to determine soil excavation methodologies for the RAP. Collection of soil samples for select geotechnical analysis in the area of the slope was recommended.

2.4.3.2 Supplemental Investigation

The field investigation included 26 test pit excavations, 13 hand auger holes for soil sampling, nine surface water samples and 12 sediment samples. The field program was completed from August 12 to August 20, 2012. The COCs were PHC fraction F1 to F4, BTEX, PAHs, and total metals. The results of the supplemental field investigations are discussed below.

<u>Background</u>

Analytical results of soil background samples indicate that concentrations of metals were below EQGs, with two exceptions: arsenic concentrations were found above environmental quality guideline (EQG) in two samples. Both samples were collected north of Eureka HAWS around the Station Creek area. This indicates that is some variability in the concentration of arsenic in the background soil, including natural levels above EQG.

Background surface water samples collected from Blacktop Creek exhibited concentrations of aluminum, cadmium, copper, lead, iron, manganese, and zinc above the EQGs in all five samples collected. Nickel was above the EQG in four of the five samples, and arsenic in one of the five samples. From Station Creek, all four samples exhibited aluminum, selenium, and iron above EQGs and one sample had cadmium and zinc above the guidelines.

All nine background sediment samples collected (five from Blacktop Creek and four from Station Creek) had arsenic concentrations above the EQG. One sample collected from Blacktop Creek contained copper above the guideline.

<u>Powerhouse and Delta</u>

The results of the soil samples collected west of the Powerhouse, at the top and bottom of the slope to the drainage pond, indicate that toluene, ethylbenzene, PHC F1 to F3, 2-methyl naphthalene, naphthalene, and phenanthrene are contaminants of concern with concentrations above the EQGs. Arsenic was also above the guideline in the metals sample collected at the bottom of the slope. While there are no guidelines for PHC in sediment, the sediment samples collected down slope of the Powerhouse had concentrations that were above the background concentrations assessed in 2009 for BTEX and PHC F1 to F3.

Southeast of the Powerhouse, in the direction of Building # 17 (Plumbing Shack) and the Former Bunkhouse, arsenic, BTEX and PHC F1 to F3, 2-methyl naphthalene, naphthalene, and phenanthrene were above soil guidelines. Where soil samples were collected from multiple depths, the concentrations of the contaminants were above guidelines at both depths in this area. Two samples collected in between the Powerhouse and Building # 17 (Plumbing Shack), near the fuel pipeline, had BTEX and PHC concentrations below the EQGs, indicating horizontal delineation along the west side of the impacted area near Building # 17 (Plumbing Shack).

Test pits excavated to the southeast of Building # 17 (Plumbing Shack) and the Former Bunkhouse did contain concentrations of benzene, ethylbenzene, PHC F1 to F3, 2-methyl naphthalene, naphthalene, and phenanthrene above EQGs. Additional sampling within the delta area south of AEC D had concentrations above EQGs for benzene, ethylbenzene, PHC F1 and F2, 2-methyl naphthalene, naphthalene, and phenanthrene. The test pits in this area were stopped due to water infiltration. Test pits south and southwest of Building # 17 (Plumbing Shack) and into the delta area indicated BTEX and PHC concentrations below EQGs; however, there was arsenic and naphthalene reported above the guidelines.

Two soil samples were collected south of the drinking water reservoir and west of the drainage pond. BTEX and PHC concentrations were reported below EQGs; however, there were concentrations of arsenic, naphthalene, and phenanthrene above the guidelines.

Eight 24-hour air samples, including one duplicate sample, were collected from inside the operation and maintenance buildings at the Eureka HAWS. Five locations had concentrations of PHC F2 above the conservative reference thresholds: the Old Garage, Building #17 (Plumbing Shack), the Former Bunkhouse, the New Garage, and the Powerhouse. Some of these locations also exhibited benzene and xylenes above the reference thresholds. Of these, only Building #17 (Plumbing Shack) and the New Garage exhibited concentrations more than 2x the reference thresholds. Building #17 (Plumbing Shack) is primarily a storage building, and was observed to be occupied with tires and miscellaneous plumbing parts. The New Garage has a slab on grade concrete floor with a thermosyphon system within the slab; as a result, SENES/FRANZ was not able to install a sub-slab vapour probe. Vehicle maintenance occurs in the New Garage. During sampling in summer 2012, SENES/FRANZ noted several containers of chemicals (coolant, antifreeze, motor oil, varsol, hydraulic oil) that would likely interfere with the sample. Two other samples, one 24-hour and one 20-minute, were collected from the crawlspace beneath the Powerhouse. Both exhibited concentrations of PHCs/BTEX below applicable reference thresholds strongly suggesting the indoor PHC concentrations are from stored products and maintenance activities. The results of the sub-slab vapour sampling from the Old Garage exhibited concentrations of PHC F1 and F2 above reference thresholds.

Station Creek

Two of the four soil samples collected west of Station Creek had naphthalene and phenanthrene above EQGs. The concentrations were similar to those in the delta area where no PHC impacts were reported.

The EQGs for the ecological effects of PAHs were selected using the protection of freshwater aquatic life pathway, which tends to be lower than other pathways including human health and environmental protection. Based on the proximity of the sampling locations to surface water, either the drainage pond or the fjord, the protection of freshwater aquatic life pathway cannot be discounted at the site, and as a result, SENES/FRANZ has considered it as a conservative approach.

Nevertheless, given that a complete pathway for the transport of PAHs to surface water via groundwater is not anticipated at the site given the presence of permafrost and a brief period where active layer water may be present, SENES/FRANZ does not expect these relatively low exceedences to pose a threat to adjacent freshwater. No further action is recommended in this respect.

Borrow Source Assessment

Two samples were collected to identify a suitable borrow source if the RAP indicated that the removal of impacted material is a viable remedial plan. The 2011 WorleyParsons geotechnical report identified several potential borrow source areas; however, based on a conversation with the Eureka HAWS Station Manager, a new, superior borrow source was identified near Upper Paradise. The sample collected from this area did not have any concentrations above the EQGs. The second borrow source sample collected from the Blacktop Creek area did have arsenic above the EQG. All other parameters were below the guidelines.

2.5 Slope Stability Analysis

A geotechnical review of the stability of the slope west of the Powerhouse was conducted to determine what remedial options would be feasible within that area (see Figure 11; Appendix A for a cross-section of the slope). For the purposes of this assessment, it was assumed that all excavation works for the remediation program will be undertaken during the summer when there is 24 hour sunlight and above zero temperatures are normal. The protection of the permafrost is critical to the stability of the structures located adjacent to the excavation where the melting of the permafrost surface will occur quickly as the overlying soils are removed during the remediation program. The protection of the permafrost will become the primary concern for any excavation work that comes within 5 m of the Powerhouse or New Garage structure. Several factors influence the remedial options and what mitigation measures can be used to maintain the stability of the slope. They include:

- The foundations of the New Garage and Powerhouse were constructed separately at different times and will act independently to each other.
- The New Garage foundation has a refrigerant system designed to maintain the integrity of the permafrost. If the excavation were to approach the side of the cooling system and left exposed for a length of time, melting and saturation of the soil beneath the New Garage could be an issue. If enough melting and saturation occurred, this could cause the New Garage to sheer from the Powerhouse and tip. Additionally, any variation to the soil beneath the New Garage due to exposed permafrost and melt could change the geotechnical conditions.

- There is a critical piece of equipment, the fuel pipe line, at the top of the slope.
- Prior to slope failure, certain materials provide warning in the form of slumping that the slope is about to fail. The material that comprises the slope is not a type of soil material that will provide warning of failure through slumping, it will just collapse: that presents a health and safety risk.
- The material at the bottom of the slope is in a wet environment and the exact location of the permafrost active layer is not known.

Based on the type of soil material that comprises the slope, it is not anticipated that PHC impacts will influence slope stability.

The overburden soils at this part of the site have a natural angle of repose of 3 horizontal (H) to 1 vertical (V); therefore, the sidewall of any excavation should be cut to a minimum slope of 3H:1V prior to any staff accessing the excavation base. The distance from the Powerhouse/New Garage to the fuel line ranges from 5.7 m to 6 m. If the excavation were to extend more than 1.0 m below grade the remediation work would undermine the building or fuel line.

If soil was excavated between the "Drainage Pond" and the bottom of the slope, the slope cut would have to extend as much as 15 to 18 m back from the base of the excavation if the excavation extends 1 m bgs. As with the contaminated soils excavation, this could result in some undermining of the Powerhouse and New Garage structure and the fuel line.

The PHC impacted sediment within the Drainage Pond will be saturated and, as such, the removal of this material will require flatter slopes to ensure a stable side slope (assuming that the water in the pond is removed prior to remediation). From a geotechnical perspective, the removal of the sediment along the toe of the overburden embankment is a primary concern. The removal of the sediment at the toe of the embankment will require that the adjacent embankment be set back a minimum of 3 m from its present toe, which would extend into the side of the existing slope, to reduce the risk of a global rotational failure of the overburden embankment.

A complex engineering shoring system could be used, but there would still be practical limitation on the amounts of soil and sediment that could be excavated. Armour stones could be used to buttress the toe of the excavation. The blocks will have to be placed as it is excavated to maintain the stability of the slope; however, there will be difficulty maintaining a slope any greater than 3H:1V. The saturated nature of the material adjacent to the Drainage Pond will make manoeuvring of the heavy equipment difficult and the natural angle of the slope leaves limited manoeuvring area. During the excavation, the road leading from Eureka HAWS may be required to be shut down as the stability of the road may be at risk due to the excavation.

3.0 UPDATE OF REMEDIAL TARGETS

Based on the results 2012 supplemental investigation report, the contaminant pathways, receptors, and site-specific target levels (SSTLs) that were established in the 2010 DQRA Report were revised. The results of the 2012 supplemental investigation that were input into the DQRA model were:

1. Soil surrounding the Powerhouse was determined to be coarse-grained based on the results of the sieve and geotechnical analysis. The soil texture in the original DQRA was assumed to be fine-grained based on the data collected in previous investigations.
2. The results of the indoor air and sub-slab vapour sample were included in the DQRA modelling. The maximum concentration of indoor air was input into the model as part of the operations and maintenance vapour inhalation pathway.
3. Soil, surface water, and sediment metals concentrations from the background sampling program were used to establish background threshold levels.

3.1 Background Levels

The results on the background soil, sediment, and surface water samples were used to establish background levels. The analytical results for each parameter were input into the United States Environmental Protection Agency's (US EPA) statistical software for environmental applications (ProUCL Version 4.1). The 95% Upper Prediction Limit (95% UPL) was calculated to establish the background threshold level (BTL) for metals in soil, sediment, and surface water. The 95% UPL indicates with 95% confidence that future values will be below the concentration provided in Table 3-1. A normal distribution was assumed unless otherwise indicated.

Table 3-1: Summary of the Background Threshold Levels

Parameter	Soil (mg/kg)	Sediment (mg/kg)	Surface Water (mg/L)
Aluminum (Al)	16208	13322	4.544(1)
Antimony (Sb)	<1.0	0.707(1,2)	<0.0060
Arsenic (As)	14.69	24.92(3)	0.0122(3)
Barium (Ba)	106.6(3)	66.32	0.0628
Beryllium (Be)	10.919(2)	1.204	<0.0010
Bismuth (Bi)	<1.0	<1.0	---
Boron (B)	20.72	20.67(1)	0.0635
Cadmium (Cd)	<1.0	0.255(1,2)	0.000152(2)
Calcium (Ca)	14753(1)	10997	219.3(1)
Chromium (Cr)	25.04	27.12	0.0072(1, 2)
Cobalt (Co)	17.59(1)	14.73(1)	0.0172(1,2)
Copper (Cu)	28.21	40.85	0.021(1)

Parameter	Soil (mg/kg)	Sediment (mg/kg)	Surface Water (mg/L)
Iron (Fe)	67130$^{(3)}$	34487	32.15$^{(3)}$
Lead (Pb)	13.66	17.28	0.00795$^{(2)}$
Lithium (Li)	---	---	0.0128$^{(2)}$
Magnesium (Mg)	9704$^{(1)}$	5643	102.2$^{(1)}$
Manganese (Mn)	897.7$^{(3)}$	344.1	0.497$^{(1)}$
Mercury (Hg)	0.0588$^{(1,2)}$	0.129$^{(2)}$	---
Molybdenum (Mo)	1.496$^{(2)}$	3.58$^{(3)}$	0.000891$^{(2)}$
Nickel (Ni)	28.67	36.53	0.0389$^{(1)}$
Phosphorus (P)	1422$^{(3)}$	651.4	0.462$^{(2)}$
Potassium (K)	4551$^{(3)}$	2122	6.265$^{(1)}$
Selenium (Se)	0.803$^{(2)}$	1.031$^{(2)}$	0.00286$^{(1)}$
Silicon (Si)	---	---	8.057$^{(3)}$
Silver (Ag)	<1.0	<1.0	<0.00010
Sodium (Na)	8059$^{(3)}$	293.9$^{(2)}$	191.7$^{(1)}$
Strontium (Sr)	81.38	88.69	1$^{(1)}$
Sulphur (S)	---	---	302.6$^{(1,2)}$
Titanium (Ti)	---	---	0.0765
Thallium (Tl)	<1	<1	<0.00020
Tin (Sn)	<5	<1	<0.0010
Uranium (U)	<2	1.162$^{(1,2)}$	0.00154
Vanadium (V)	77.69$^{(3)}$	84.26$^{(3)}$	0.0209$^{(2)}$
Zinc (Zn)	71.19	75.89	5.891$^{(3)}$

Notes: 1: No discernable distribution (5% significance level) – normal distribution assumed
2: Not enough non-detect data points, reduced reliability
3: Lognormal distribution

3.2 Human Health

One of the sources of risk identified in the 2010 DQRA was to the theoretical ‘operations and maintenance worker’ through the vapour inhalation pathway. Volatile contaminants in soil and water can migrate to indoor air, creating increased risks to receptors; however, the models used in risk assessment are conservative, and do not consider many factors that have an impact on vapour intrusion into site buildings. The COCs for the operation and maintenance workers were PHC F1 and F2. By including the maximum concentrations of the 2012 indoor air vapour results into the model, the hazard quotients for humans for PHC F1 and F2 were below the target threshold of 0.5, indicating there is no potentially unacceptable risk.

PHC F1 and F2 were the only COCs identified in the human health risk assessment (HHRA) prior to the introduction of the indoor air results. The 2012 maximum concentrations of PHC fraction F1 and F2 in indoor air of 1.678 and 1.09 mg/m^3, were used to update the Health

Canada PQRA model. The calculated risks were 7.80E-2, and 3.24E-01 for adults from exposure to PHC fractions F1 and F2, respectively. These values are below the Health Canada target risk of 0.5, therefore, no potentially unacceptable risk was estimated for adults from exposure to PHC fractions F1 or F2 (see Figure 3; Appendix A). The results of the updated DQRA for human health are included in Appendix D.

3.3 Ecological Risk

Table 3-2 provides a summary of the ecological receptors and the COCs in the different medium identified in the 2010 DQRA.

Table 3-2: Summary of Contaminants Exceeding Ecological Target Risk or Hazard Quotients, 2010 DQRA

Parameter	Medium	Soil		Sediment	Surface Water
	Receptor	Terrestrial Plants & Invertebrates	Mammals and Birds	Benthic Invertebrates & Macrophytes	Fish, algae & invertebrates
PHCs	F1			x	
	F2	x		x	
BTEX	Xylenes			x	
PAHs	1-methylnaphthalene			x	
Metals	Aluminum	x	x	x	x
	Barium			x	
	Boron	x			
	Chromium	x			x
	Copper				x
	Iron			x	x
	Lead				x
	Lithium				x
	Nickel				x
	Vanadium				X
	Zinc				x

The 2009, 2010 and 2012 analytical results of the background soil, sediment, and surface water sampling were compared against the thresholds used in the DQRA model to confirm or refute that the concentration of metals on site reflect background conditions.

3.3.1 Soil

In the DQRA, the hazard quotient for the lemming for aluminum was above the threshold, which indicates a potential risk primarily influenced by soil ingestion. No EQG has been established for aluminum. The BTL level for aluminum was established at 16,208 mg/kg, which was exceeded in the single sample collected at the Upper Paradise potential borrow source. All other concentrations of aluminum were below the BTL; therefore, the concentrations of aluminum on site are considered to be indicative of background concentrations. The potentially unacceptable risk from aluminum for the lemming is not caused by anthroprogenic sources; therefore, no SSTL was be developed. It should be noted that aluminum was analyzed only in 2010 and 2012 in the areas of AEC D (Powerhouse), delta area, west of Station Creek, and the two potential borrow sources.

Boron was also identified as above the potential risk threshold. No EQG has been established for boron. The BTL was established at 20.72 mg/kg. Two locations, both within the delta area, contained boron concentrations above the BTL; however, no anthropogenic source of boron was identified at the site. It is not anticipated that boron will have a population level effect on the ecological receptors at the site.

Chromium was also identified above the potential risk threshold; however, none of the soil samples collected at the site contained concentrations above the EQG. The BTL was established at 25.04 mg/kg, below the EQG of 64 mg/kg. Areas with chromium above the BTL include:

- AEC A-1 to 3: Landfills;
- APEC A-4 and 5: Asbestos and Ash Landfills;
- APEC A-6: Barrel Crushing Area;
- AEC A-9: Former First Air Lease;
- APEC A-10: Battery Dump;
- AEC D: Powerhouse (one duplicate sample); and
- Delta area.

Since all the concentrations are below the EQGs, SENES/FRANZ does not consider chromium as a COC.

Three additional metals (arsenic, copper, and selenium) were qualitatively screened out of the ecological risk assessment based on MOE threshold values. Due to the switch from fine-grained soil to coarse-grained soil, the threshold values for these three metals were reviewed. The arsenic threshold value for plants decreased from 25 mg/kg to 20 mg/kg while the other two remained the same; therefore, remain qualitatively screened out. Areas with arsenic above the BTL include:

- AEC B-1: Fuel Tank Farm;
- AEC D-1: Powerhouse;
- Delta area,
- APEC E-1: Hydrogen Shed; and
- the Blacktop Creek borrow source area.

There are three locations, one in AEC D, one in the delta, and one at APEC E-1 with arsenic concentrations above the threshold value of 20 mg/kg. Based on the sporadic nature of the elevated arsenic concentrations at the site, SENES/FRANZ does not consider that arsenic will have a population effect on the ecological receptors at the site.

3.3.2 Surface Water

Surface water has been collected from a variety of locations at the Eureka HAWS including the drinking water reservoir, the drainage pond, and a permafrost melt water seep on the road leading towards the sealift area. Based on the 2012 comments from the Health Canada expert support team, the permafrost melt water is considered groundwater not surface water. Since the seep water represents only a small area and is limited to the warmer months, SENES/FRANZ does not consider ecological exposure to the groundwater pathway to be active.

The metals that were identified in the 2010 DQRA as above the risk quotient thresholds in surface water included aluminum, barium, chromium, cobalt, copper, iron, lead, lithium, nickel, vanadium, and zinc. PHC F1 and F2 also had risk quotients above the thresholds. PHC were not detected in surface water.

Of the metals identified above the risk quotient, barium, chromium, and lithium contained concentrations above the BTL; however, the concentrations of barium and chromium were below the EQGs. Both metals were above the BTL in the sample collected in the ponded water at AEC A-7: *Ex situ* Biotreatment cell and are not representative of site surface water conditions.

Lithium does not have an EQG. The concentration of lithium in the samples collected in the drainage pond and at the ponded water at AEC A-7: *Ex situ* Biotreatment cell contained concentrations above the BTL of 0.0128 mg/L; however, based on the number of non-detects there is reduced reliability with this estimate. While no anthropogenic source of lithium has been identified at the site, all samples collected within the drainage pound contained concentrations above the BTL; therefore, the SSTL for the site is set at the BTL of 0.0128 mg/L.

3.3.3 Sediment

The metals identified with risk quotients above threshold levels in sediment were aluminum, barium, and iron. Total xylenes, 1-methylnaphthalene, and PHC F1 and F2 also had risk quotients above thresholds.

All three metals (aluminum, barium, and iron) had site concentrations below the established BTL; therefore, these metals were excluded as the concentrations are attributed to background concentrations. Three additional metals (sodium, manganese, and zinc) contained concentrations above the BTL. Sodium and manganese do not have EQGs. Two sediment samples contained zinc above the BTL and EQG. Manganese and zinc were retained during the quantitative risk assessment, and site concentrations did not exceed the risk thresholds. Sodium was qualitatively excluded as it is believed to be attributed to the precipitation of salts.

3.4 Site-Specific Target Levels

The assessment endpoint chosen for the ecological risk assessment was a sustainable level of ecological health. As such, hazard quotients values above threshold indicate that adverse effects to individual receptors are possible, but not necessarily probable, and it does not necessarily indicate that adverse effects to receptors will translate into risk at the population level.

The soil related pathways for terrestrial mammals and birds do not add up to any potentially unacceptable risk (see Figure 4; Appendix A). While there is potentially unacceptable risk to terrestrial plants and invertebrates from the PHC F2 concentration is soil, several factors must be considered in the remedial options analysis. The area with PHC F2 impacts is already a disturbed area with fill material and given the total area, the chances of population level effects on the soil invertebrates and plants is very low. PHC F2 does not bioaccumulate and the concentrations are expected to decrease through natural attenuation over time. Additionally, more damage to the receptors could be caused during remediation given the intrusive nature of soil removal.

Based on the results from the 2012 Supplemental Investigation, the site-specific target levels (SSTLs) were updated for the site. The updated SSTLs are provided in Table 3-3. The SSTLs were used to estimate the area and volume of impacted soil and sediment for the conceptual model (Section 4.0).

Table 3-3: Summary of SSTLs in Soil, Surface Water, and Sediment

Chemical Name	SSTL
SOIL	
PHC F2	1374 mg/kg
SURFACE WATER	
Lithium	0.0128 mg/L
SEDIMENT	
Xylenes	1.46 mg/kg
1-methylnaphthalene	3.6 mg/kg
PHC F1	10 mg/kg
PHC F2	12 mg/kg

3.5 Applicability of SSTLs to AEC A

The original DQRA was for the main area of the Eureka HAWS and did not include the area around the landing strip. SENES/FRANZ believes the original DQRA is applicable to AEC A because:

- It is fine-grained soil;
- It is within the same geographic area; and
- Similar risk assumptions, pathways and receptors exist.

To confirm applicability of the DQRA, a review of the analytical data was required to compare the maximum concentration at the main station versus at AEC A. The majority of the compounds at AEC A were lower than at the main station and are therefore, considered to be adequately covered by the risk assessment. Additional assessment was required for the compounds found to be higher at AEC A, and is discussed below.

One sample in AEC 9 collected in a heavily stained soil area had nickel above guidelines. Threshold values for nickel were established as follows:

- Plants – 30 mg/kg (Efroymson *et al.,* 1997a);
- Earthworms – 200 mg/kg (Efroymson *et al.,* 1997b);
- Soil microbes – 90 mg/kg (Efroymson *et al.,* 1997b);
- Birds – 774 mg/kg (Sample *et al.,* 1996); and
- Mammals – 500 mg/kg (Sample *et al.,* 1996).

The maximum concentration of nickel was 65 mg/kg and was localized to a heavily stained area without plant growth, which is not indicative of typical site conditions; therefore, the soil microbe benchmark was chosen. Nickel was quantitatively screened out.

The maximum concentration of toluene and total xylenes in soil in AEC was above the maximum concentration at the main section of the Eureka HAWS. The maximum concentrations of toluene and total xylenes were from the same sample where the maximum nickel concentration was located (i.e., the heavily stained area in AEC A-9). Toluene was originally qualitatively screened out of the DQRA as the maximum concentration on site was below the CCME guidelines for both human and ecological health. The maximum toluene concentration in AEC A of 230 mg/kg is below the threshold of 2,700 mg/kg for human health; therefore, toluene remains qualitatively screened out. Total xylenes was original screened out of the human health risk assessment as the maximum concentration was below the CCME human health guideline of 320 mg/kg for the inhalation of indoor air; however, based on field observations the three buildings in the area are in disrepair and not used. The most applicable pathway for human health would be soil ingestion guideline at 150,000 mg/kg. The maximum observed concentration is 530 mg/kg; therefore, total xylenes are qualitatively screen out for human health.

For the ecological risk assessment, toluene was originally qualitatively screened out as the maximum concentration was below the CCME guideline for environmental health. Total xylenes were retained in the ecological risk assessment as the maximum concentration was above the CCME guideline for environmental health. New 95% Upper Confidence Limits of the Mean (UCLM) for toluene and total xylenes for the site were calculated using ProULC Version 4.1 to include the data from AEC A. The toxicity reference value (TRV) reported in Table 7-32 (Risk Quotients for Terrestrial Plants and Invertebrates) for total xylenes was 95 mg/kg and the new 95% UCLM was 16 mg/kg; therefore, there is no potentially unacceptable risk. Since toluene was screened out in the original risk assessment, a TRV was not included in Table 7-32; therefore, a TRV of 260 mg/kg was established (Sample *et al.,* 1996). The 95% UCLM for toluene was calculated to be 83.mg/kg indicating no potentially unacceptable risk.

Based on the review of the data used in the original DQRA, the SSTLs calculated are applicable to AEC A.

4.0 CONCEPTUAL SITE MODEL

4.1 Background Study Area Ownership and Occupiers

The Eureka HAWS occupies a Federal Department of Aboriginal Affairs and Northern Development Canada's land reserve, #1021 with an original area 2.23 ha (PWGSC, 2007). The permit was initially established in 1955 and was expanded to its current size of approximately 4,744 ha in 1972. Station Creek forms most of the western boundary and extends to the water line at the present beach loading location. The reserve extends northeast to encompass an airstrip several kilometres north. The facility is owned and operated by Environment Canada (EC), and the Meteorological Services of Canada (MSC) and has been in operation since April 7th, 1947. The facility consists of one runway, the experimental Arctic Stratospheric Observatory (ASTRO) laboratory, the main compound, and a Department of National Defence (DND) summer camp. It is SENES/FRANZ's understanding that with the exception of the DND Warehouse, located north of the living quarters and Fort Eureka, all buildings are owned and operated by Environment Canada. The DND Warehouse and Fort Eureka are owned and operated by DND. A 20 km road to the north connects the area with an experimental facility, the former ASTRO Lab, now known as the PEARL Facility (Polar Environment Atmospheric Research Laboratory). The area on the western side of Station Creek is not a part of the EC lease.

4.1.1 Existing Buildings and Infrastructure

There are presently fifteen primary buildings and other facilities at the Eureka HAWS. Buildings and infrastructure include:

- main complex and warehouse;
- former main complex;
- new garage;
- powerhouse and water storage;
- hydrogen shed;
- DND warehouse;
- old transient barracks;
- Building #17 (Plumbing Shack) (storage) with former water tanks;
- former bunkhouse;
- carpentry shop;
- greenhouse;
- storage shed;
- original Quonset /storage shed;
- sea canisters;
- red Quonset;

- the active landfill and a closed landfill;
- two contaminated soil treatment facilities;
- roads;
- water reservoir;
- sewage lagoon; and
- tank farm and fuel pipeline.

DND and First Air Services also have facilities south of the airstrip.

The new operation facility and living quarters was constructed by PWGSC and Ledcor Industries, and was first occupied in 2005. It is an 18,000 sq. ft., two-storey modified pre-engineered building, built on wood pile foundations into the permafrost and has an exterior envelope of a pre-finished Aluma Shield insulated panel system. The building consists of a main floor containing a cafeteria, laundry room, recreational amenities and all weather station offices. The second floor contains the living quarters for Eureka staff and visitors. This is the building where people, eat, sleep and work. There are no basements or crawl spaces.

The original powerhouse is currently in use to supply heat and electricity to the compound. A heat exchange and recovery system provides heat throughout the station. An equipment maintenance warehouse is attached to the north of the powerhouse and the water storage area is to the south. The water storage area has four water tanks that provide water to Eureka HAWS.

The Eureka HAWS is fuelled by a tank farm constructed in 1992 immediately north of the main facilities. The capacity of the storage system is approximately 1.31 million L. Three fuel bladders are in service, each with a 90,000 L capacity. The current tank farm replaced a 14 tank in-line system segregated into two farms, one farm located north of the current tank farm comprising 8 tanks and one farm located south of the current tank farm comprising 6 tanks. The original tank farm was located immediately northwest of the main facilities. The three fuel bladders were also in service at the time of the original tank farm.

Historically, fuel was stored by the Geological Survey of Canada at the west end of Station Creek and west of the main operation facilities. This facility is no longer in service and the fuel system has been removed. Remnants left at the study area include sections of the berm used for secondary containment. Barrels of product used to support both the Environment Canada and DND facilities and operations are stored immediately east of the main operation facilities.

4.1.2 Site Area History

Eureka HAWS was the first “Joint Arctic Weather Station” and was established on April 7, 1947 by the Department of Transport, Air Services Division, and Meteorological Branch (eventually to become the Meteorological Service of Canada) in a joint project with the United States Weather

Bureau (JW, 2005). The Eureka area is a prime location for the facility due to its central location on Ellesmere Island, the smooth ice of the Slidre Fiord, the protection by the surrounding hills from the north westerly winds, and the close proximity to two fresh water creeks. A six man joint Canadian/American staff erected Jamesway huts as temporary buildings to house themselves and their equipment, while starting and maintaining a program of weather observations. A landing airstrip was constructed in July, 1947 in the event of a medical emergency and to provide an alternative in case the ice would not freeze smoothly in the Fiord every year.

By the end of 1947, construction of permanent buildings was completed. Additional buildings were added in subsequent years to provide more space and additional facilities. An annual sea lift continues to provide the station with the majority of bulk goods and supplies. In 1970, the US withdrew their support for the station leaving the program in the hands of the Canadian Government, at which time the station was re-named the Eureka High Arctic Weather Station. The current tank farm, located immediately north of the main facilities was constructed in 1992. A facility complex was constructed by PWGSC and Ledcor Industries over a three-year period and was first occupied in 2005. Environment Canada weather observations and other scientific research continues today.

4.1.3 Current and Adjacent Land Use

Presently, Eureka HAWS is used for government sponsored scientific research, including research by Environment Canada atmospheric scientists. The world class ozone research facility, PEARL, operated by Environment Canada, became fully operational in 1993. PEARL plays an important role in the global monitoring and understanding of stratospheric ozone. The PEARL facility is located 14 km West of Eureka at 600 m elevation. It is also a centre for international research scientists from around the world conducting studies on ozone depletion, UV radiation, stratospheric aerosols, and trace gases associated with ozone depletion. The other major scientific initiative at Eureka HAWS is the NRCan Polar Continental Shelf Project (PCSP), a project dedicated to providing graduate students the opportunity to research the Arctic. In addition, the Canadian Military operates out of barracks located by the airstrip, known as Fort Eureka.

Eureka's proximity to Axel Heiberg Island and Ellesmere National Park Reserve make it a base point for many scientific and tourist expeditions. Eureka is also used for many expeditions to the North Pole as it is the farthest north permanent civilian site. Supply planes for the expeditions must refuel at Eureka.

4.1.4 Climate Conditions

The climate around Eureka is dry and cold and influenced by hemispherical air circulation patterns. The area around Eureka is classified as a desert and most of the precipitation is in the form of snow. Snow generally covers the ground for ten months a year, between September and June. The mean annual precipitation ranges from 50-150 mm. The mean temperature ranges from -30.5°C in the winter to 0.5°C in the summer. The highest temperatures occur in the months of July and August, and the lowest temperatures occur in the months of December and January.

Summers at Eureka are characterized by 24 hours of daylight, from mid-April through mid-August, while 24 hour darkness lasts from mid-October to mid-February. The Arctic receives its energy from solar radiation during the daylight months. Due to the high latitude, the sun does not rise very high. The sun's rays are dispersed, reducing the intensity of energy that reaches the surface. In winter, the land loses energy. As a result, the atmosphere is heated very little in the summer and is significantly cooled in the winter.

4.1.5 Natural Environment – Overview

4.1.5.1 Sensitive Habitat

A search for sensitive habitat, which includes the network of protected areas administered by Environment Canada, was conducted. The network, which includes Migratory Bird Sanctuaries (MBSs), National Wildlife Areas (NWAs), and Marine Wildlife Areas (MWAs), represents diverse habitats of national and international significance protected under federal legislation. Territorial websites were also reviewed for information regarding critical wildlife habitat. SENES/FRANZ reviewed the Government of Nunavut and the Environment Canada website and did not identify any protected or sensitive areas within 100 km of the Eureka HAWS.

4.1.5.2 Species at Risk

The federal *Species at Risk Act* (*SARA*, 2003) provides for the legal protection of wildlife species and the conservation of their biological diversity. Within *SARA*, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was established as an independent body of experts responsible for identifying and assessing wildlife species considered to be at risk. Once identified by COSEWIC, these results are considered for legal protection and recovery under SARA. The SARA Public Registry (http://www.sararegistry.gc.ca/sar/index/default_e.cfm) includes a listing of all species at risk, including the provinces they are known to inhabit, and their status under SARA and/or COSEWIC. In order to identify any species at risk that could potentially inhabit or use the Eureka HAWS site and/or surrounding environs, the SARA Public Registry was consulted. The range filter for Nunavut was used, and habitat/range maps for each species at risk listed for Nunavut were consulted to determine whether the species could be present at Eureka HAWS. Those species that could be present are listed in Table 4-1 below.

Table 4-1: Species at Risk

Common Name	**Latin Name**	**COSEWIC Status**	**SARA Status**
Ivory Gull	*Pagophila eburnean*	Endangered	Endangered

Common Name	**Latin Name**	**COSEWIC Status**	**SARA Status**
Peary Caribou (High Arctic population)	*Rangifer tarandus pearyi*	Endangered	Endangered
Polar Bear	*Ursus maritimus*	Special Concern	No status
Red Knot – rufa subspecies	*Calidris canutus rufa*	Endangered	No status
Red Knot - islandica species	*Calidris canutus islandica*	Special Concern	No status
Wolverine (Western population)	*Gulo gulo*	Special Concern	No status

4.1.5.3 Vegetation

Sparse tundra vegetation including moss, low-lying herbs, and shrubs are forced to adapt to the harsh environment of the Eureka Hills Ecoregion. Representative plant species found in the Ecoregion include Dryas species, daisies, dandelion, purple saxifrage, mountain avens, locoweed, arctic willow, kobresia, sedge, and arctic poppy (PWGSC, 2007). The plants remain close to the ground and have a shallow root system due to the permafrost. The stems are fuzzy to insulate them against the cold. Since permafrost restricts drainage, the ground becomes water logged and marshes develop. Arctic cotton which is typically found in these very wet settings was observed between the water reservoir and the powerhouse.

4.1.5.4 Wildlife

A variety of wildlife species are found in the Eureka Hills Ecoregion. Larger representatives include musk ox, arctic wolf, caribou, polar bear, and seal. Smaller members of the wildlife population include arctic hare, weasels, and lemmings (PWGSC, 2007). Bird species sighted in the Eureka area include yeagers, arctic terns, snow buntings, gulls, ptarmigan, snowy owls, ruddy turnstones, snow geese, ducks, brandts, hawks and ravens.

SENES/FRANZ confirmed the presence of musk ox, arctic hare, and a small arctic tern colony that breeds on the Station Creek delta beach area directly west of the station. A pack of arctic wolves were also confirmed in the area, near the landfill and near Station Creek.

4.2 Area near Airstrip (AEC A)

4.2.1 Summary of Current Land Use

APEC A-1 to A-3: Landfills

APEC A-1/2/3 landfills are located southeast of the end of the airstrip as shown in Figure 2; Appendix A. The landfills were grouped together as it was difficult to distinguish between landfill A-1 (east landfill), landfill A-2 (active landfill east of the airstrip) and landfill A-3 (existing landfill south of the airstrip at the east end) in the field. There are gullies that run through the landfill and may experience surface water flows during spring snowmelt. The gullies amalgamate just south of the landfill and eventually drain into the Slidre Fiord which is approximately 1.4 km away.

Large debris was observed in the landfill including boxes, insulation, large pieces of plastic piping, empty fuel barrels, and small metal debris such as food cans. Some of the waste debris appeared to be new. The maintenance staff indicated that soil is brought to the site to cap the debris when there is available time. Based on 2012 field observations, the landfill is currently in use.

Native soil at the testing locations is composed of silty clay. Permafrost was observed at 0.6 m below ground surface (bgs) to 1.2 m bgs.

APEC A-4 and A-5: Ash and Asbestos Landfills

The ash and asbestos landfill is located south of the airstrip just west of APECs A-1/2/3 (see Figure 2; Appendix A). A road leads from the airstrip to the ash and asbestos landfill. The landfills are capped, making it difficult to distinguish the two landfills from each other. Metal food cans were observed on the southwest corner of the capped area in 2008. SENES/FRANZ believes that these cans are old as there is no evidence of recent dumping.

Native soil in the area was observed to be composed of silty clay. Permafrost was found at 0.56 m bgs to 1.15 m bgs.

APEC A-6: Barrel Crushing Area and Barrel Landfills

The Barrel Crushing Area and Barrel Landfills are located south of the central portion of the airstrip (see Figure 2 and 5; Appendix A). The site is used to burn, crush, and bury empty fuel barrels. The area is fairly flat, but gradually slopes towards the south.

The barrels are primarily aviation fuel drums, generated by DND, the PCSP, Bradley Air and Kenn Borek Air. The east side of the site features the barrel crusher, two incineration reservoirs (cut-open day tanks in which any excess fuel is burned), and a fuel delivery system comprised of a trough and piping between the crusher and the reservoirs.

Native soil was observed to be composed of silty clay, while permafrost was found at 0.8 mbgs to 1.2 mbgs. APEC A-6 was extremely saturated with water during the 2008 investigation.

AEC A-7: *Ex situ* biotreatment cell

The *ex situ* biotreatment cell was constructed in 1999. It is located south of the airstrip, adjacent to the barrel crushing area, and just east of the DND facilities (see Figure 2 and 5; Appendix A). The cell is approximately 50 m by 20 m and clay from the site was reportedly used to construct the berm along the biotreatment cell. Approximately 350 m^3 of petroleum hydrocarbon contaminated soil from the main complex area was transferred to the cell. An area of ponded water south of the biotreatment cell was observed in 2008.

Native soil was observed to be silty clay. Permafrost was observed at 0.6 m bgs to 1.3 m bgs.

AEC A-8: Contaminated Soil Area

Approximately 140 m^3 of contaminated soil is contained in a liner located approximately 5 m north of the barrel crushing area. The contaminated soil and liner is believed to be owned and managed by the Department of National Defence (DND) and will not be included in the Remedial Action Plan.

AEC A-9: Former First Air Lease

Three small dilapidated wooden buildings are located immediately west of the *ex situ* biotreatment cell (see Figure 2 and 6; Appendix A). Based on 2008 observations, the buildings contain miscellaneous furniture and garbage. An old truck is located along the east wall of the most eastern building. Two aboveground storage tanks were observed, one located along the north wall of the central building, and the second located along the west wall of the most western building. Ground stains were observed on either side of the most eastern building in 2008. A piping hole in the east wall of the eastern building suggests that a tank was once attached to the building.

Native soil was observed to be silty clay, while permafrost was found at 0.6 m bgs to 1.2 m bgs.

APEC A-10: Battery Dump

The Battery Dump is located 2.2 km north of Slidre Fiord, north of the eastern end of the airstrip (see Figure 2; Appendix A). The dump covers an area of approximately 4,300 m^2. The batteries used for the High Arctic Data Communications System relay towers are reportedly changed annually and disposed of in the dump. Additional used batteries from vehicles and other equipment are also disposed of in the battery dump. During the 2008 investigation, the battery dump was found to be completely capped and backfilled, and there is no visible evidence of current use.

Native soil was observed to be of silty clay, while permafrost was found at 0.15 m bgs to 0.85 m bgs.

4.2.2 Proposed Future Land Use – AEC A

Based on the 2011 WorleyParsons geotechnical report, a barrel storage area is proposed north of the airstrip at the west end. During the 2012 field program, the Eureka Station Manager suggested that if additional land treatment facilities were to be constructed, the low-permeability of the soil near the airstrip would be an ideal location.

Based on information provided to SENES/FRANZ, no additional land use changes are planned for the areas in AEC A.

4.2.3 Contaminants of Concern

Based on the calculated SSTL, PHC F2 is the contaminant of concern in AEC A. The sample collected in the ponded water in AEC A-7 exhibited elevated metals.

4.2.4 Extent of Impacts

Based on the SSTLs, AEC A-7 has a PHC F2 impacted area of 100 m^2 with an average depth of 0.35 m for a total volume of 350 m^2. AEC A-9 has PHC F2 impacts in the range of 85 m^2 to 235 m^2 as the extent of the impacts are not fully delineated (see Figure 6; Appendix A). For the volume estimate, the worse case scenario is used; therefore, with an area of 235 m^2 and an average depth of 0.8 m^2, the total volume is 188 m^3.

4.3 Fuel Tank Farm at the Main Camp (AEC B-1)

4.3.1 Summary of Current Land Use

Constructed in 1992, the tank farm is located approximately 30 m northwest of the living quarters. The tank farm consists of a bermed area containing one single/vertical walled 770,000 L diesel fuel tank and nine single/vertical walled 60,000 L diesel fuel tanks. Once a year, an ice-breaker brings fuel to Eureka. The ice-beaker anchors off-shore while a floating hose is connected from the vessel to the land based pipe which runs from the shore to the tank farm. Approximately 450,000 L to 600,000 L of diesel is transferred into the large 770,000 L tank. The fuel is then transferred to the smaller tanks in the tank farm. Fuel from the smaller tanks is transferred to the day tanks in the generator building and throughout the site. Due to the remoteness of the site, there is always storage of two years worth of fuel in case the ice breaker is not able to reach the site. A small single walled 9,000 L gasoline tank is located on a gravel pad southeast of the tank farm: there is no secondary containment. There are limited numbers of vehicles on site that require gasoline.

Visual observations of the pipeline did not identify any evidence of leaks.

Underground utility power lines are located adjacent to and outside of the berm. The lines are believed to power the lights surrounding the tank farm.

Native soil was observed to be silty sand, while permafrost was found at 0.8 mbgs to1.2 mbgs.

4.3.2 Proposed Future Land Use

Based on the 2011 WorleyParsons geotechnical report, a new drinking water reservoir is being proposed for the Eureka HAWS. Five options were proposed, and one of the options places the new reservoir southeast of AEC B-1.

SENES/FRANZ is not aware of any additional changes to the land use changes in AEC B-1.

4.3.3 Contaminants of Concern

Based on the results of the SSTLs for soil, there are no parameters in soil above the SSTLs.

4.3.4 Extent of Impacts

Based on the SSTLs there are no impacts in AEC B-1 (see Figure 7; Appendix A).

4.4 *In situ* Landfarm (AEC B-2)

4.4.1 Summary of Current Land Use

The site of the old tank farm has become an *in situ* landfarm for treating contaminated soil. AEC B-2 is located at the northwest corner of the main complex site, and is due west of the current fuel tank farm (see Figure 2; Appendix A). The *in situ* landfarm is approximately 60 m in length x 15 m width, with an area of 900 m^2. The area to the north currently houses the CANDAC facility, which is a research station. Due east is a road and the main living complex. A quonset, maintenance garage and powerhouse are located due south of the *in situ* landfarm. The area to the west slopes steeply down to a drainage pond. The drinking water reservoir is approximately 20 m downgradient from the *in situ* landfarm.

Two major spill events are reported to have occurred on the old tank farm site. Approximately 40,000 L of diesel was spilled in 1973/74; and between 37,000 L to 40,000 L of diesel was spilled in 1990. It is likely that additional smaller spills occurred on site but were not reported, particularly during the early years of operation.

In 2000, an *in situ* remediation plan was developed by EBA Engineering Consultants Ltd. (EBA, 2000; Appendix A). The *in situ* remediation plan included tilling of the impacted soil and the addition of nutrients twice a summer for two years. The tilling area for the *in situ* remediation included the area north of the New Garage to the northern edge of the old tank farm. The east boundary was the road and west was 5 m from the edge of the slope. Due to risk of compacting the soil in the landfarm, only limiting testpitting has occurred. It is possible that a source of contamination is sitting as a sink on the permafrost in this area.

Native soil was observed to be composed of fine silty sand. Permafrost was found at approximately 0.5 m below natural surface grade, and approximately 1.8 m below fill.

4.4.2 Proposed Future Land Use

Based on the 2011 WorleyParsons geotechnical report, a new drinking water reservoir is being proposed for the Eureka HAWS. Five options were proposed, and one of the options places the new reservoir in AEC B-2.

SENES/FRANZ is not aware of any additional changes to the land use changes in AEC B-2.

4.4.3 Contaminants of Concern

Based on the calculated SSTLs, PHC F2 is the contaminant of concern in AEC B-2 (see Figure 8; Appendix A).

4.4.4 Extent of Impacts

Based on the SSTLs, there are is a PHC F2 impacted area of 3,830m^2. With an average depth of 1.2 m^2 the estimate volume of PHC F2 impacted material in AEC B-2 is 4,600 m^3.

4.5 Landfill North of Tank Farm (AEC B-3)

4.5.1 Summary of Current Land Use

In the 2008 investigation FRANZ identified a suspected landfill immediately north of the fuel tank farm (see Figure 2; Appendix A). Waste debris including ladders, wood, cans and small drums were discovered in excavations north of the tank farm. The suspected north boundary of the landfill was the old equipment drag line, the east and west boundary were the road, and the south boundary, the tank farm berm. Samples were collected during the 2009 field program. Based on field observations made at that time, the landfill is no longer being used.

4.5.2 Proposed Future Land Use

Based on the 2011 WorleyParsons geotechnical report, a new drinking water reservoir is being proposed for the Eureka HAWS. Five options were proposed, and one of the options places the new reservoir in AEC B-3.

SENES/FRANZ is not aware of any additional changes to the land use changes in AEC B-3.

4.5.3 Contaminants of Concern

Based on the results of the SSTLs for soil, there are no parameters in soil above the SSTLs.

4.5.4 Extent of Impacts

Based on the SSTLs there are no impacts in AEC B-3 (see Figure 7; Appendix A).

4.6 Powerhouse (AEC D)

4.6.1 Summary of Current Land Use

The Powerhouse is located southwest of the Main Station (see Figure 2; Appendix A). The Powerhouse shares walls with the New Garage to the north and the Water Tank Storage to the south. The Powerhouse is situated on the top of an embankment, up-gradient of the drinking water reservoir and the building is bounded to the south by the road crossing Station Creek.

Surface soil staining and a strong hydrocarbon odour were present along the western side of the building, where an old exterior day tank was located. A plastic drum with the top cut off collected dripping oil from an open valve on the external and west wall of the powerhouse was observed during the 2008 site visit. At the southwest corner of the building are electrical transformer boxes. Along the west side, approximately 6 m from the building exterior wall, is the fuel pipe line laid out on barrels.

In 1999, approximately 350 m^2 of soil was excavated in the vicinity of the Powerhouse, in the footprint of the proposed area for the new garage. The soil was placed in the clay lined cell near the airstrip. Soil was excavated to permafrost and the permafrost was left exposed to allow melting. The final depth of the excavation was approximately 1 m below ground surface. Clay plug walls were placed along the north and east walls of the excavation to minimize contaminant migration.

In 2012, soil was observed to be composed of coarse-grained sand with loam and clay. Previous field investigations identified the soil as being fine-grained. The majority of the samples that exhibited fine-grained soil were collected from the bottom of the slope near the drainage pond. Based on field observations, many of the fine-grained material from the slope had been washed down the slope leaving only coarse-grained material on the slope and depositing the fine-grained material at the bottom. The deposit of fine-grained material at the bottom of the slope, where the samples were collected, could potentially over-represent the amount of fine-grained material. The majority of the samples collected at the top of the slope and from the delta area were coarse-grained soil and representative of soil conditions at the site.

Despite the high density of testpitting in the area, no source or free product area has been located in AEC D. No samples have been collected beneath the Powerhouse building; therefore, it is possible that the source of contamination is sitting as a sink on the permafrost under the buildings.

Permafrost was found at 0.40 m bgs to 1.8 m bgs.

4.6.2 Proposed Future Land Use

SENES/FRANZ is not aware of any additional changes to the land use changes in AEC D with respect to the Powerhouse, Water Tanks, or New Garage. The water reservoir west of AEC D may be modified or moved to a new location. Additionally, old maintenance buildings to the east and south of the AEC D, in the area of the delta may be demolished.

4.6.3 Contaminants of Concern

There is soil, surface water and sediment in AEC D. Based on the SSTLs the following are the contaminants of concern in AEC D:

- Soil: PHC F2
- Sediment: total xylenes, 1-methylnaphthalene, PHC F1 and F2.
- Surface water: lithium

4.6.4 Extent of Impacts

There are three areas of PHC F2 impacts associated with AEC D as presented in Figure 8, Appendix A. Based on the proximity to AEC H and the Delta and the extent of the PHC impacted soil, the following areas also included soil from AEC H and the Delta:

- 190 m^2, at the bottom of the slope, west of the Powerhouse with an average depth of 0.9 m;
- 760 m^2, at the top of the slope and underneath the Powerhouse with an average depth of 1.3 m; and
- 5800 m^2, east of the Powerhouse towards AEC H – Old Garage and southeast in the Delta area with an average depth of 1.3 m.

The estimate volume of PHC F2 impacted soil is 8,750 m^3.

The area of sediment impacts is 1030 m^2 with an assumed depth of 1.0 m, the total volume of impacted sediment is 1030 m^3 (see Figure 9; Appendix A).

Lithium was above the SSTL in the samples collected from the drainage pond and stream leading from the drainage pond to the fjord. The maximum background concentration was 0.02 mg/L and the maximum concentration in the drainage pond was 0.038 mg/L. As no source for lithium was identified at the Eureka HAWS, the elevated lithium concentration is most likely due to the stagnant nature of the drainage pond.

4.7 Hydrogen Building (AEC E)

4.7.1 Summary of Current Land Use

As described in the PWGSC Phase I ESA, the hydrogen building is a 6.0 m by 9.0 m metal frame structure and consists of two main rooms: the generating room with the hydrogen generator tank and electrolyser, and the balloon release room with increased ceiling clearance and overhead door.

The building is located east of the living quarters and 10 m north of the sewage lagoon and Slidre Fjord. The building is located on top of the hill that slopes down towards the fjord.

Soil was observed to be composed of silty sand, while permafrost was found at 1.0 m bgs to 1.4 m bgs.

4.7.2 Proposed Future Land Use

SENES/FRANZ is not aware of any additional changes to the land use changes in AEC E. Based on the 2011 WorleyParsons geotechnical report, modification to the sewage lagoon are planned.

4.7.3 Contaminants of Concern

Based on the results of the SSTLs for soil, there are no parameters in soil above the SSTLs.

4.7.4 Extent of Impacts

Based on the SSTLs there are no impacts in AEC E (see Figure 10; Appendix A).

4.8 Old Maintenance Garage (AEC H)

4.8.1 Summary of Current Use

The old maintenance garage is approximately 35 m south of the main building, east of the powerhouse. East of the garage is the old main living quarters building and to the south is a slope leading towards the sealift area. The old maintenance garage is a 22 m by 14 m metal frame structure with a slab on grade concrete foundation. There are two large bay doors, one at the north end and the second at the south end of the building. Soil was observed to be composed of silty sand, while permafrost was found at 1.1 m bgs to 1.5 m bgs.

4.8.2 Proposed Future Land Use

A pre-demolition survey was conducted in the Old Maintenance Garage during summer 2012 by a different consultant indicating that the building may be slated for demolition.

4.8.3 Contaminants of Concern

The contaminant of concern, based on the SSTLs for soil is PHC F2.

4.8.4 Extent of Impacts

Based on the proximity of AEC H with AEC D, the area of soil impact is discussed with AEC D (see Figure 8; Appendix A).

4.9 Delta Area

4.9.1 Summary of Current and Proposed Future Land Use

The Delta area is south of AEC D and AEC H (see Figure 2; Appendix A). To the north are the old maintenance and operations buildings, including Building #17 (Plumbing Shack), the old Transient Barracks, Former Bunk House, Carpentry and Plumbing Shop, Greenhouse, Storage shed, Original Quonset Hut, and Sea Canisters. To the east and south is the fjord. The fuel pipe line run north south along the west portion of the Delta and further west is the stream from the drainage pond to the fjord.

4.9.2 Proposed Future Land Use

A pre-demolition inspection completed on the old maintenance buildings including the Former Main Complex, Transient Barracks, Building #17 (Plumbing Shack), and Bunkhouse during summer 2012 by another consultant.

4.9.3 Contaminants of Concern

The contaminants of concern associated with soil in the Delta area is PHC F2 based on the SSTLs. There are two isolated areas where boron is above the background concentration, as a SSTL for boron was not developed. No potential source of boron has been identified and the adjacent sampling locations did not have concentrations above the guideline; therefore, it is not anticipated that the isolated boron impacts will have an impact on the population of ecological receptors.

4.9.4 Extent of Impacts

Based on the proximity to AEC D, the area of impact in the Delta is an extension of that from AEC D and included in the volume calculation for AEC D (see Figure 8; Appendix A).

4.10 PEARL Facility

4.10.1 Summary of Current Land Use

The PEARL facility is located on the north side Slidre Fjord on Ellesmere Island, Nunavut, approximately 14 km northwest of the Eureka HAWS (see Figure 1; Appendix A). The PEARL facility, which included two single-story buildings, was the subject of a Phase I and Limited Phase II ESA by SENES/FRANZ where the site visit occurred in conjunction with the supplemental investigation.

The PEARL facility was constructed in 1992 by the Meteorological Service of Canada (MSC), then the Atmospheric Environmental Service (AES), for the study of the stratospheric ozone. The site was used as a centre for international research with scientists from around the world conducting studies on ozone depletion, UV radiation, stratospheric aerosols, and trace gases associated with ozone depletion. The observatory includes four large laboratories and a roof-top observing platform for instrumentation.

The site is developed with two single-storey buildings, the research facility and a safe hut. An observatory platform is located on the rooftop of the research facility which can be accessed by the stairway on the east exterior elevation. Based on interviews with individuals familiar with the site most of the equipment at PEARL is now automated and there is no longer a scientist on site daily.

4.10.2 Proposed Future Land Use

SENES/FRANZ is not aware of any additional changes to the land use changes in the PEARL facility.

4.10.3 Contaminants of Concern

Based on the results of the Phase I and Limited Phase II ESA, PHCs were not considered a COC. Two metals, copper and vanadium, were above the CCME guidelines in all samples collected at PEARL. When compared to the background sampling results from the Eureka HAWS, the concentrations at PEARL are above the background levels. Based on the field observation during the background sampling program the soil material is variable across the areas around Eureka HAWS. The soil material encountered at PEARL was a fine dark organic layer, a soil type that was not encountered at Eureka HAWS or during the background sampling, indicating that it might be a type of fill or the soil type at the higher elevation at PEARL is different than the lower elevations. Based on the site features and function, SENES/FRANZ does not consider the two metals will have a population impact on the ecological receptors at the site.

4.10.4 Extent of Impacts

Based on the results of the Phase I and Limited Phase II ESA an extent of the copper and vanadium impacts cannot be calculated; however, SENES/FRANZ does not consider the two metals will have a population impact on the ecological receptors at the site.

4.11 Volumes of Impacted Material

Based on the information from each AEC, SENES/FRANZ prepared a summary of the estimated volumes of impacted soil from PHC F2, which is provided in Table 4-2. The estimates of the impacted areas are based on the new SSTLs calculated in Section 3.2.

Table 4-2: Estimated Volume of Impacted Soil

COC	AEC	Area (m^2)	Depth (m)	Total Volume (m^3)
PHC F2	AEC A-7	1000	0.35	350
	AEC A-9	240	0.8	190
	AEC B-2	470	1.2	3,830
	AEC D, H, and Delta	190	0.9	170
		760	1.3	980
		5800	1.3	7,600
			TOTAL	**13,200**

A summary of the estimated volumes of impacted sediment, west of the Powerhouse is provided in Table 4-3.

Table 4-3: Estimated Volume of Impacted Sediment

COC	AEC	Area (m^2)	Depth (m)	Total Volume (m^3)
PHC F1 & F2, Xylenes, and 1-methylnaphthalene	AEC B-2 and D	2,400	1.0	2,400
			TOTAL	**2,400**

5.0 REMEDIAL OPTION ANALYSIS (ROA)

5.1 Overview of Remedial Options Analysis

The purpose of the supplemental investigation was to identify and fill the data gaps through a field investigation at the Eureka HAWS and to assess and recommend remedial options. Remedial objectives were defined in the DQRA as site-specific target levels (SSTLs) and were updated based on the results from the 2012 supplemental investigation. The SSTLs are protective of human health and ecological receptors at the site and are used as the basis for the analysis of the remedial and risk management options provided here.

The site was considered to be a single unit for the purposes of the DQRA; i.e., each area of environmental concern (AEC) was not evaluated separately. The remedial options analysis (ROA) provided here takes a similar approach: options are identified for the site as a whole, separated by media.

5.1.1 ROA Objectives

The objectives of the ROA were to:

1. Provide a conceptual evaluation of remedial options for the impacted soils, surface water, and sediments with the goal of reducing risks to human and ecological receptors by reducing contamination volumes or concentrations, and/or ultimately eliminating pathways;
2. Complete risk-benefit, cost and feasibility analyses of each potential remedial option;
3. Consider the applicability of each remedial option for long-term (25 year) performance in a northern Canadian environment; and
4. Recommend the best remedial option, providing justification for the selected option.

5.1.2 Scope of Work

The scope of work for the ROA consisted of the following activities:

1. *Remedial Options Evaluation:* SENES/FRANZ evaluated multiple risk management options for the Eureka HAWS. These options included a site-wide remedial action plan for managing PHC impacted soils and sediment. SENES/FRANZ identified and tabulated reasonable remedial options available, and assessed and scored them with respect to applicability, limitations, time, and (order of magnitude) costs. Other criteria included: the potential remedial options were evaluated based on the removal of hazards, long term effectiveness and overall protection of human health and the environment. The outcome of this remedial options evaluation process is a tabulated matrix evaluation assessing and coring each of the remedial options identified.

2. *Identification of a Preferred and Secondary Remedial Option:* Based on this matrix analysis, a preferred and secondary remedial option were selected and included for discussion and decision by EC.

5.2 ROA Methodology

The key to a successful remediation/risk management program is developing measurable objectives and planning the approach on a site-specific basis. Remedial action goals are critically important as they provide metrics to measure the long-term success of proposed actions.

After identification of remedial action goals, potential remedial options were identified for the site for all impacted media, with particular interest in those technologies with a proven or strong potential to be applicable in an arctic climate.

In order to select the preferred and secondary remedial option, SENES/FRANZ selected the following criteria to evaluate the remedial/risk management options.

- Effectiveness in meeting the selected remediation and/or risk management standards;
- Applicability to site conditions and ease of implementation;
- Complexity;
- Risk to human health and the environment (of the technology itself and potential risk reduction in the environment);
- Time frame to implement and complete; and
- Comparative cost.

In addition to the above criteria, the potential remedial options were evaluated based on the removal of hazards, long term effectiveness and overall protection of human health and the environment. The ideal option would also result in the least disturbance to the site.

Tables C-1 and C-2 (Appendix C) present the remedial options analysis for soil and sediment respectively.

SENES/FRANZ has made every effort to ensure the most accurate assessment of the remedial options with respect to the criteria outlined above.

5.3 Remediation and Risk Management Options

This discussion on remedial and risk management options is based on SENES/FRANZ's experience with similar contaminants and site conditions, on the United States Environmental Protection Agency's *Federal Remediation Technologies Roundtable* documentation[1] and the

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[1] http://www.frtr.gov/publib.htm

Queens-Royal Military College of Canada, *Geo-engineering Centre* documentation[2]. SENES/FRANZ reviewed many of the potential remedial and risk management strategies for the site, but considered in detail only those that are realistic and proven options, given the site conditions. Some innovative technologies, such as phytoremediation, are not practical given the remote, arctic nature of the site.

SENES/FRANZ anticipates that the final remedy for the site will consist of a combination of soil, active layer water and sediment remediation and/or risk management approaches. The synergies this will provide will reduce or eliminate the need to address one or more media (e.g., effective soil cleanup could eliminate the need to remediate or contain active layer water). As this is a preliminary identification of potential remedial options, all remedial technologies were evaluated as stand-alone solutions for the media they address. A detailed remedial action plan with indicative costing should be prepared based on these conceptual options, and take into account the opportunities for combining various technologies and achieving economies of scale. The remedial option screening matrices are presented in Appendix C.

5.3.1 Soil

For all *ex situ* options involving excavation and disposal, evaluations are based on disposing of soils near the station, for example, in a newly constructed biotreatment cell. Recent studies on *ex situ* options in cold environments have demonstrated success in reducing PHC concentration through bioremediation and volatilization with enhanced landfarming techniques such as the addition of nutrients (fertilizers) and aeration through rototilling.

Previous studies on the *in situ* land farm soils indicate that while concentrations of petroleum hydrocarbons may have decreased, they have not done so to any significant extent and may have reached an asymptote in terms of further degradation. This is not surprising given the nature of the contamination (i.e., diesel range organics, as measured by the PHC F2 fraction, which are less amenable to land farming compared to gasoline range organics, typically indicated by elevated PHC F1 concentrations) and the extremely cold temperatures for most of the year, which tend to inhibit or altogether stop any biodegradation processes. Given the remoteness of the site and lack of other feasible options landfarming may still be the best approach, provided contaminated soils are relocated away from areas where they might present a potentially significant risk.

An alternative is to ship impacted soil south via scheduled sea lifts; however, the costs for this option are expected to be prohibitively expensive.

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[2] http://www.geoeng.ca/index.htm

Based on the results of the supplemental investigations and update to the SSTLs, there was one COC above the SSTLs, PHC F2 and one COC above background levels, boron. The SSTLs for soil are for the protection of ecological heath as the potential unacceptable risk to human health was from the vapour inhalation pathway of the operation and maintenance worker for PHC F1 and F2. The SSTLs for human health were updated based on the indoor air results and resulted in no potential adverse risk. The ecological receptors with a potential for adverse risk are the plants and soil invertebrates. No potential adverse risk was identified in birds or mammals from any of the soil pathways. The goal of the ecological risk assessment was a sustainable level of ecological health. Based on the fact that the soil impacts are already in a disturbed area with fill, and the relative size of the impacted area, it does not indicate that adverse effects to receptors will translate into risk at the population level. The intrusive nature of many of the soil remediation technique would cause harm to the soil invertebrates and plants already in the impacted areas.

Any option involving excavation at the top and bottom of the slope will have to take slope stability into consideration. Complicating the issue is the piece of critical equipment, the fuel pipeline at the top of the slope. If excavation were to occur at the top of the slope, an underpinning program may be required to protect the integrity of the building foundations. The excavations could not be exposed for a long period of time, as it would cause damage to the permafrost and potentially the foundations of the adjacent buildings. Excavating at the toe of the slope will require an engineered shoring system, which will have to be shipped from the south and will limit where the excavation can occur. Development of plans to address the stability of the slope would have to be developed based on the chosen remedial option. Installing the shoring would increase the heavy equipment requirements.

The remedial option screening matrices for soil are presented in Table C-1, Appendix C.

5.3.1.1 Capping in Place

It is possible to place a cap on top of impacted soil at the site, which would remove pathways to plant receptors and soil invertebrates. Much of the surface area of the Eureka HAWS is already covered with packed fill. This option could be considered in combination with a strategy of removing the most heavily-impacted soils to an on site treatment facility and/or controlling migration of contaminants via active layer water with a sub-surface barrier. The more contaminated soil would be placed in the lined area and covered with geotextile, which would subsequently be covered by either borrow source material or imported sand and gravel. Capping will be a challenge at the top and bottom of slope to the west of the Powerhouse and may result in slope stability concerns by changing the angle of repose.

According to site personnel, there are several potential borrow sources near the station but not necessarily included in the area of Environment Canada's reserve; therefore, land use permits would likely be required. One proposed area, the west quarry, is approximately 3 km away from the station and is not within Environment Canada's land lease. The soil in the west quarry consists of fine white sand and coarse 5 to 12 cm gravel containing fossilized shells. This deposit is used mostly as filler, since using it on the roads causes too much damage to site equipment and vehicles.

The second potential borrow source quarry is approximately 2 km to the east of the runway at Blacktop Creek and is within Environment Canada's land lease. This material is a mix of 2.5 to 7.5 cm gravel, sand and clay. This material is currently used for roads and to cap off the landfill site. The station has also used it on the runway; however, after the material dries up, the sand and clay reportedly blow away in the wind leaving the larger rocks exposed. The analytical results indicate that arsenic in soil in this borrow source was above the EQG and established background level.

The third potential borrow source is in Upper Paradise, approximately 10 km west of the station. The Upper Paradise borrow source was recently identified to the Eureka Station Manager; however, SENES/FRANZ has not been provided with a geotechnical report or other information on conditions in the area. SENES/FRANZ collected a sample from Upper Paradise and submitted it for a select geotechnical analysis, PHC, PAH, and metals analysis. The material is coarse-grained sandy loam with 77% sand, 11% silt, and 12% clay. All chemical parameters results were below the EQGs; however, certain metals without guidelines (aluminum, calcium, magnesium, and phosphorous) were above the established background threshold level. Based on conversations with the Eureka Station Manager, the material at Upper Paradise is ideal for the use on the runway and roads, as it will not dry up and break down like the Blacktop Creek material. The Upper Paradise borrow source area is outside the Environment Canada's land lease.

Capping in place is a well understood remedial option and it is not a new or innovative technology. The capping material would ideally be sourced from nearby areas, which would limit potential impacts due to transportation. The impacts to the soil would remain in place and the capping would limit the degradation of contaminants. Heavy equipment would have to be shipped to the site. Capping would also cover any existing vegetation; therefore, it is not a very green or sustainable technology.

Advantage: The active pathways to ecological plant receptors are eliminated by capping the soil on the site. The costs would be lower than most other options. Costs for disposal and transportation of contaminated soil are eliminated and capping is usually a very quick process. The *in situ* landfarm within AEC B-2 is already functioning as a soil treatment area and the volume of impacted material within the landfarm was not included in the area and volume estimates of the impacted material.

Disadvantage: This option may be perceived as a strategy of avoidance and because contamination remains in place, this option is less desirable from ecological perspective. To provide an adequate cap to address ecological risk to plants and invertebrates, 0.2 metres of “clean” fill would have to be placed over the impacted soils, raising the general grade of the impacted area. While this might be viable in certain areas, raising the grade of the site in the areas where there are buildings already at or near grade (i.e., the building on the Delta) or slab on grade (i.e., Old Maintenance Garage) would present a logistical problem. If the old maintenance and operations buildings were to be demolished, capping may become a more realistic option.

West of the Powerhouse is the slope leading down towards the drainage pond. Impacted areas have been identified at the top and bottom of the slope. Based on observations during the 2012 supplemental investigations, erosion along the slope has occurred. Many of the fine materials from the top of the slope have washed to the bottom. If capping of the impacted material at the top and bottom of the slope were to occur, the long-term stability of the slope would be a potential issue.

Also west of the Powerhouse is the fuel pipe line from the sealift area to the tank farm and from the tank farm to the Powerhouse. The fuel line currently sits on top of vertical barrels, less than one metre above grade. If clean fill would be required over the impacted material, adjustment of the barrels could be required in certain areas. The Powerhouse provides all the necessary power to the Main Complex. As a result, any adjustment to the fuel supply line may not be technically feasible, based on the length of time that power would be out at the station.

The addition of capping material will also have an impact on the permafrost. The additional material will increase the separation between the ambient air and the active layer. For every additional centimetre of material added, the number of degree days required to melt the permafrost will increase. Eventually, the depth of the active layer will migrate upwards as there is not enough energy reaching the current depth. Since the foundations of some of the buildings rely on the permafrost for structural support, if capping were to occur, an analysis of its potential effect on the foundations could be required.

Based on site-specific constraints, capping of selective areas may be the only feasible option. Capping will not decrease long term liability as capped PHC contaminants are unlikely to be degraded. Additionally, this option would require a long-term monitoring program to ensure the condition of the cap has not been compromised by site operations and spring melt. The addition of the long-term monitoring program and the maintenance required for upkeep would add to the cost.

5.3.1.2 *In situ* Treatment (chemical oxidation)

In situ chemical oxidation would involve the mixing of a strong oxidant (e.g., sodium persulphate, hydrogen peroxide, etc.) into the subsurface strata via injection points. Injection points (permanent or temporary) would be designed to deliver the oxidant solution in contact with zones of impacted soils.

Ideally, *in situ* chemical oxidation is conducted on saturated soils, similar to those at the bottom of the slope. Shallow wells would be required in that area. In the unsaturated zone, the chemical oxidant could be applied in conjunction with soil tilling; however, this is not ideal as tilling the entire depth of the impacted zone is not possible.

Bench-scale testing is recommended to determine the effectiveness of oxidation technologies for site remediation at this location. A minimum, both modified Fenton’s reagent (catalyzed hydrogen peroxide) and persulfate (caustic catalyzed) should be tested to assess which might be most effective.

Chemical oxidation is a well understood remedial option and is not considered an innovative technology. The introduction of chemicals into the environment, specifically a sensitive, northern environment, is not considered a green technology.

<u>Advantage</u>: Soil contamination is permanently removed via chemical destruction. Theoretically, the site would be free of contamination and petroleum hydrocarbon impacts. This option provides a permanent solution, but due to the site characteristics there is a moderate possibility that impacts could remain on site. There would be moderate time frame involved to implement and the option would have limited long term monitoring requirements and associated operational costs. No imported soils would be required.

<u>Disadvantage</u>: This method is highly dependent on the contact of oxidant and the impacts; there is no guarantee that it will remediate all media at all locations across the site. Additional soil sampling will be required to monitor the success of the method and the program may need to be altered part way through. Numerous permanent or temporary injection points will be required, increasing initial capital costs. Temporary injection points allow for flexibility in the location where the oxidant is injected, allowing for a more targeted approach; however, the installation and decommissioning of the injection points each treatment round would be very expensive. Permanent injection points would require additional maintenance and could be limited by the arctic climate.

The chemical oxidant is a dangerous good, as defined by Transport Canada, and would require special handling. The costs to treat all impacted materials at once may be cost prohibitive. *In situ* chemical oxidation will require that chemical be introduced into a sensitive environment, which carries a risk, both ecologically and from a human health and safety perspective. As *in* *situ* chemical oxidation is a chemical reaction, depending on the oxidant, heat potentially could be a by-product. In a situation where permafrost provides structural support for buildings, the generation of heat in the sub-surface would not be wise.

The cost of installing the injection wells would be costly and maintaining the injections would have a high operations and maintenance cost. The use of chemical oxidant would be restricted to saturated soils. Certain oxidation chemicals are known to cause corrosion issues in buried utilities or structures and have been known to cause explosions if not used correctly. Vapour intrusion of the oxidation chemical though foundations can also present a health and safety risk. In addition, the large volume of soils exceeding SSTLs which would require treatment would make this option technically impractical. Monitoring of the results would add to the cost of this option.

5.3.1.3 *Ex situ* Treatment (Enhanced Landfarming)

Landfarming involves excavation and placement of contaminated soils on liners (or other materials) to control leaching (where necessary) and then periodically turning over or tilling the soils for aeration and to obtain optimal moisture content. Microbes in the soil break down contaminants to non-toxic end products. Amendments such as nutrients (nitrogen, phosphorous) can be added to encourage microbial processes. During landfarming, PHCs may be lost through bioremediation and volatilization.

A land treatment facility (LTF) could be constructed at the e*x-situ* Biotreatment Cell (AEC A-7), located approximately 1 km away from the main station. The LTF should be sized to accommodate soils exceeding SSTLs and constructed with appropriate surface water collection area and polyethylene liner. Soil would be excavated from the impacted area, transported to the landfarm, and reused on site once analytical results indicated that the soil was below generic land use guidelines. Soil conditions are often controlled to optimize the rate of contaminant degradation. Conditions normally controlled include:

- Moisture content (usually by irrigation or spraying);
- Aeration (by tilling the soil with a predetermined frequency, the soil is mixed and aerated);
- pH (low pH materials buffered to near neutral pH by adding crushed limestone or agricultural lime); and
- Other amendments (e.g., soil bulking agents, nutrients, etc.).

Several previous treatability studies were conducted to evaluate design parameters such as biodegradability of contaminants and appropriate oxygen and nutrient loading rates (Sanscartier *et al.* 2009; Paudyn *et al.,* 2008; Whyte *et al.,* 2001). Runoff collection facilities would need to be constructed and monitored. Land treatment sites must be managed properly to prevent both on-site and off-site problems with ground water, surface water, air, or food chain contamination.

Adequate monitoring and environmental safeguards would be required. Dust control is an important consideration, especially during tilling and other material handling operations. Approval for the construction of a land treatment facility must be obtained from the Nunavut Impact Review Board. Approval can take from several weeks to a year depending on the complexity of the proposal.

A bioremediation study at Eureka, lead by NRC (2000 to 2005), which included fertilizer amendment and tilling, suggested that the bioremediation potential of the soils in the low ambient summer temperatures (~5°C for the short Arctic summer ~4-6 weeks) was considerable. The numbers of cold-adapted viable bacteria were consistent over the years in the active layer and there was a noticeable increase in the permafrost zone suggesting adequately deep (to bottom) active layer development in the spring. Since these microorganisms are largely aerobic, water saturated soil from high melting periods would have led to anaerobic conditions, reducing the aerobic population sizes in the active layer and their biodegradation activity. As the soil drained and returned to normal levels of water saturation, the population levels of bacteria increased. Overall, the results indicated that indigenous microorganisms were actively degrading the aromatic fraction of the hydrocarbons, as represented by naphthalene. The total petroleum hydrocarbons (TPH) data showed that there was a significant degradation from both the active and permafrost zones over the treatment period, demonstrating that the fertilizer addition and tilling treatment increased the rate of hydrocarbon degradation.

Sanscartier *et al.*, (2009) conducted a field experiment at Quttinirpaaq National Park, Ellesmere Island, NU of soils primarily contaminated with weathered medium to high molecular-weight PHCs. One of the field conditions was the use of passive warming in a greenhouse. The findings were that while the greenhouse produced higher soil temperatures and extended the treatments season, there was no enhanced contamination removal. The hypothesis was the precipitation and wind play an important role in low-maintenance landfarming. The conclusion of the field experiment indicated that a combination of biostimulation through the addition of fertilizer and surfactant in an uncovered plot was the most effective.

Paudyn *et al.*, (2008) conducted landfarming experiments on diesel-contaminated soil on Resolution Island, NU. The results indicate that for the first two years a combination of fertilization and aeration through rototilling every four days had the highest reduction in PHC concentrations. By the third year, there was no significant difference in the fertilized soil versus the aerated only soil. Overall, the results indicate that bioremediation is viable but aerations can also achieve significant reductions in PHC concentrations.

Ex-situ landfarming is not a new technology. Landfarming uses existing microbes within the soil to treat the PHC impacts, which is considered a green technology. As the soil is not being transferred off-site, there is a reduction in the potential for impacts due to transportation and fuel consumption. Landfarms do require the addition of nutrients and tilling, which would required heavy equipment and consumption of fuel.

Advantage: *Ex situ* landfarming is commonly used in the arctic and, under typical circumstances in more southern climes, is considered to have above average effectiveness for PAHs and PHCs relative to other effective technologies, and has been proven successful in treating higher-carbon number PHCs (e.g. F2 fraction) that cannot be easily volatilized. It is also an effective technique for the removal of high molecular weight residuals. As a rule of thumb, the higher the molecular weight of a substance (and for PAHs, the greater the number of aromatic rings), the slower the degradation rate.

Costs would be below average relative to other effective technologies and cost-effective for PHCs. The soils would not have to be transported off Ellesmere Island, and there is already a suitable location for a landfarm (e.g., AEC A-7 with expansion). Eventually, landfarming could transform the contaminated soil into cover that could be used elsewhere on site, removing the logistical challenges of soil transport over long distances. Landfarming may not reduce contaminant concentrations to generic guidelines or SSTLs but it could result in soils suitable for utility purposes (i.e., landfill capping material). Excavation with enhanced landfarming could be applicable in some of the areas on the site were slope stability is not an issue.

Disadvantage: Landfarms may not reduce contaminant concentrations to generic guidelines or SSTLs. Landfarming is a long-term technology that requires large amounts of space and periodic re-handling of soil being remediated. It can often require years in northern, arctic environments to treat the soil to the target levels, particularly in the north as treatment time generally increases as the average temperature decreases. The length of time required before the contaminants would degrade to the point where they could be reused is difficult to predict. Bioremediation would not occur over the long winter months. Qualitatively, soils that are greater than 10 times the SSTLs most likely would not degrade to the point where re-use is possible. Most realistically, it is soils that are less than 2 times the SSTL that may degrade to the point where re-use is possible.

Heavy equipment is required for the construction and maintenance of a landfarm. While there is heavy equipment already at Eureka; it may not be available for use as it is required for maintenance of the Station and during the preparation for the sealift. Heavy equipment with operators may have to be brought in via barge, which would increase the cost.

The higher the PHC or PAH molecular weight, the slower the biological processes will proceed. The disposal of soil would also require special land and water permitting. Excavation of contaminated soils may be limited by slope stability around buildings, fuel pipeline, minor utilities, and access issues. In addition, with the limited season, excavating soil may be viewed as low priority as compared to other station operations and maintenance activities. Mid-August is when the sealift arrives with the supplies and the year's supply of fuel. Based on the results of the slope stability analysis, there are substantial risks to excavating at the top and bottom of the slope, as the stability of the slope, foundations of the buildings, and fuel line could be compromised.

5.3.1.4 *Ex situ* Treatment (Biopiles)

Biopile treatment is a full-scale technology in which excavated soils are mixed with soil amendments and placed on a treatment area (generally above grade) that includes leachate collection systems and some form of aeration. It is used to reduce concentrations of petroleum constituents in excavated soils through enhanced biodegradation. Moisture, heat, nutrients, oxygen, and pH can be controlled to enhance biodegradation. The contaminant degradation process is similar to landfarming. The construction of a biopile will require approval from the Nunavut Impact Review Board. Approval can take from several weeks to a year depending on the complexity of the proposal.

The treatment area is generally covered or contained with an impermeable liner to minimize the risk of contaminants leaching into uncontaminated soil. The drainage itself may be treated in a bioreactor before recycling. Vendors have developed proprietary nutrient and additive formulations and methods for incorporating the formulation into the soil to stimulate biodegradation. The formulations are usually modified for site-specific conditions. As with landfarming, biopiles used in cold climates would not remain operational throughout the winter as they would freeze solid.

Soil piles and cells commonly have an air distribution system buried within the contaminated soil to pass air through the soil either by vacuum or by positive pressure. Soil piles may be covered with an impermeable membrane to control runoff, evaporation, and volatilization and to promote solar heating. Nutrient and additive formulations are usually modified for site-specific conditions. If there are volatile contaminants in the soil that will volatilize into the air stream, the air leaving the soil may be treated to remove or destroy the contaminants before they are discharged to the atmosphere.

Ex situ biopiles are a well understood remedial option and are not considered innovative. While biopiles use existing microbes in the soil, the requirement for heavy equipment, leachate production and treatment, and air emissions reduce the "green technology" value of the option.

<u>Advantage</u>: *Ex situ* biopiles offer above average effectiveness for treatment of PHCs and average effectiveness for PAHs. According to the research by the Queens-RMC research group and the US EPA, bioremediation including biopiles is a cost-effective clean-up approach for PHC-contaminated soil in Polar Regions (Aislabie *et al*., 2006). Biopiles are relatively simple and require few personnel for operation and maintenance. It constitutes a short-term to medium-term technology for PHC remediation as operation and maintenance of biopiles may

last a few weeks to several months to several years, especially if heavier-end PHCs are involved. Treatment times can be expected to increase with the molecular weight of PAHs, although there are few PAH issues at Eureka. In addition, biopiles have below average costs relative to other effective technologies and are considered cost-effective for PHCs. Like landfarming, biopiles could eventually transform the contaminated soil into cover.

Disadvantage: Although biopiles are generally above-average in reducing PHC concentrations, they may not be capable of reducing concentrations to generic guidelines or SSTLs. Approvals are typically required for biopile technologies. The disposal of soil would also require special land and water permitting. There would be upfront costs to bring the material to the site for construction of the biopile. A bioreactor for the leachate would be required and the equipment would have to be brought in via barge. Similarly to the *ex situ* landfarm, excavation in some areas is limited by slope stability around buildings, fuel pipe line, and access issues. With the limited season excavating soil may be viewed as low priority as compared to other station operations and maintenance activities. Alternatively, additional equipment would have to be barged in to the site, increasing the cost substantially.

5.3.1.5 Risk Management through Long-term Monitoring (LTM)

Monitoring and evaluation strategies are designed to ensure that risks to human health and the environment associated with the presence of impacted media at a site are below the established acceptable levels or are following a decreasing trend. Natural processes, including the biological, chemical and physical degradation of contaminants in the subsurface are likely to be occurring at the site. A long-term monitoring (LTM) program would confirm that such processes are active. Such a program is particularly attractive for a remote site like the Eureka HAWS, where remedial methods involving excavation are very expensive and potentially damaging to structures.

A typical monitoring plan would involve implementing a 10 (or more) year monitoring and evaluation program with additional trend-monitoring sample locations. The soil concentrations in these trend-monitoring locations would be compared to those in the historical record to evaluate changes in concentrations. While there is no potentially unacceptable risk due to vapour intrusion from impacted soil, the indoor air results indicated that there were concentrations of BTEX and PHCs above applicable guidelines in the operations and maintenance buildings. An indoor air monitoring program would be included to the LTM program to confirm that there remains no potentially unacceptable risk due to vapour intrusion.

A LTM program is a well understood process and will not remove the contaminants from the soil; therefore, is not considered a green technology. The LTM program will not require the use of heavy equipment, reducing the required fuel consumption.

Advantage: LTM is a cost-effective risk management approach compared to other technologies. The costs associated with sampling and laboratory analysis over 25 years of monitoring would be spread out over the duration of the program, and would be limited to project management, labour and analytical testing. Site disturbance will be low, as there would be minimal need for excavation and use of heavy equipment. The updated DQRA with the vapour results indicated that there was no potential unacceptable risk to human health due to the impacted soil. The SSTLs for the site are for the ecological receptors of terrestrial plants and soil invertebrates. The other remedial options for soil include excavation or covering the existing grade with a cap. Both options would cause harm to the terrestrial plant and any invertebrates already existing in the soil. There was no potential unacceptable risk to terrestrial birds or mammals based on the ecological risk assessment; therefore, LTM would allow the existing plant and invertebrate populations to survive as is.

Disadvantage: Since the contaminants would remain on-site and will remain above SSTLs for an extended length of time, suggesting potential unacceptable risks remain, there may be low acceptability from stakeholders. Long-term monitoring typically accompanies implementation of risk mitigation measure such as capping, cut off walls or administrative controls. LTM by itself does not mitigate risk; it only demonstrates risk levels are either changing or staying constant. There would also be potential for future risk to the environment to develop if the environmental conditions change accordingly in the long-term, or if regulations and standards change.

5.3.2 Sediment Remedial Options

5.3.2.1 Special Considerations

The remedial option screening matrices for sediment are presented in Table C-2, Appendix C. A description of potential applicable technologies is provided below. The stability of the slope west of the Powerhouse will influence the applicability of the remedial option. If excavation of the sediments were to occur, an engineered shoring system would be required to maintain the stability of the slope. The design and the logistics of shipping the shoring system would increase the cost of excavation substantially. The placement of the shoring system may have practical limitation on how much can be excavated and the room available to manoeuvre equipment. The road south of the drainage pond is raised and the stability may be compromised during the excavation; therefore, the road may have to be closed during the program and reinstated at the end. The road is a critical link to operations areas such as the borrow source used for the preparation of the sea lift area and access to the PEARL facility, as such, closing the road for any length of time may not be an option. The potential borrow source for the remediation activities, is also west of the road. The preparation of the design to reinstate the roadway would also increase the cost.

5.3.2.2 Excavation with off-site Disposal

This remedial strategy involves excavation of contaminated sediment followed by transportation of the soil to an on- or off-site facility for treatment and/or disposal. This option could involve a focused excavation of the “worst case” area, which consists of almost pure product in sediments within the Drainage Pond, immediately downgradient of the Powerhouse. Once the contaminated sediment is excavated from this area, it would likely be classified as hazardous waste and would either be shipped as such down south, or disposed of *ex situ* (but on site) with appropriate permitting and treatment. This option could be combined with long-term monitoring.

Special provisions for removing impacted sediments from the drainage bed would be required, such as water management (e.g., diversion), sediment stabilization, and permitting for work near, or in, water. This is important in particular where aquatic life such as benthos might be affected by sediment removal. Typically, the consistency and moisture content of sediments make them difficult to handle and treat. Sediments may have to be dried or a bulking agent may have to be added before they can be disposed of as solid waste.

Excavation is not a new or innovative technology. The removal of the sediments off-site would require the use of heavy equipment and a barge with high fuel costs. Barging the sediment off site would increase the risk of cross contamination during shipping. If the soil was to remain on site, an appropriate treatment facility would be required. This would also require fuel and heavy equipment, as a results, excavation is not a green option.

<u>Advantage</u>: Sediment excavation in AEC D with off-site disposal offers above-average effectiveness for PHCs, PAHs and metals relative to other effective technologies. This option represents the fastest and most comprehensive way of removing contaminated sediment. The contaminated sediment would be taken away from the Drainage Pond area and treated or properly contained on site. As such, this option would be highly desirable to facility personnel considering the proximity of contaminated sediments to the drinking water reservoir and drainage channel to Slidre Fjord, serving to decrease pathways to ecological receptors. Excavation and off-site disposal (or on-site treatment and/or containment) is a relatively simple process, with proven procedures. Sediment excavation offers faster-than-average clean-up times relative to other effective technologies.

The results of the updated ecological risk assessment indicate that PHC F1 and F2, total xylenes and 1-methylnaphthalene pose a potential unacceptable risk to benthic invertebrates and macrophytes. While excavating and disposing of the sediment will cause damage to the invertebrates and macrophytes in that area of sediment, based on field observations and analytical results the sediment in that area is highly impacted. Currently, there is a layer of fines over the impacted sediment but any disturbance exposes the impacted sediment and causes a sheen on the surface water. Excavating and removing the heavily impacted material removes the potential for PHCs impacts to the surface water.

Disadvantage: Similar to soils, some sort of treatment and/or disposal area will have to be developed or modified to accommodate the sediments, due to the remoteness of Eureka resulting in an increase in costs. Special provisions for removing impacted sediments from the drainage pond in AEC D would be required, including permitting for work near, or in, water. This will need to be explored further as there is the potential for impact to aquatic life during sediment removal. Typically, the consistency and moisture content of sediments make them difficult to handle and treat. Sediments may have to be dried or a bulking agent may have to be added before they can be disposed of or treated on site as “solid waste”, unless permitting allows for site-specific alternatives. Since sediments have high moisture content, they are also difficult to treat by thermal methods. After considering the disposal options and cost, this approach may be the highest-cost option for most contaminants.

Additionally, the proximity of the Drainage Pond to the slope creates access and slope stability issues for excavation. An engineering shoring system would be required to be placed 3 m from the current toe of the slope to attempt to maintain the stability of the slope. The cost of getting the shoring system to Eureka would be costly based on the weight of the type of equipment required (i.e., armour stones). The road across the stream may have to be closed off as it is also raised in elevation compared to the Drainage Pond and the stability may be compromised during the excavation.

The length of time required before the contaminants would degrade to the point where the sediment could be reused is difficult to predict. Bioremediation would not occur over the long winter months. Qualitatively, sediment that are greater than 10 times the SSTLs most likely would not degrade to the point where re-use is possible. Most realistically, it is sediment that are less than 2 times the SSTL may degrade where re-use is possible.

5.3.2.3 Excavation via Hydrovac with off-site Disposal

Similar to the option above, excavation via hydrovac would remove the impacted sediment from the drainage pond. The excavated material would be placed through a batch plant were the solids and liquids would be separated. The water would be passed through an oil water separator where it could be either be put back into the Drainage Pond or kept in a water storage tank until testing could confirm the level of impacts. The solid material would either be shipped south, or disposed of *ex situ* (but on site) with appropriate permitting and treatment. This option could be combined with long-term monitoring.

Special provisions for removing impacted sediments from the drainage bed would be required, such as water management (e.g., diversion), sediment stabilization, and permitting for work near, or in, water.

The use of hydrovac equipment is not a new or innovative technology. The equipment would have to be barged to the site, increasing the consumption of fuel. If the solid material was removed off site it would have to be barged, increasing the risk of cross contamination during shipping. This would also require significant amounts of fuel. If the solid material was to remain on site, a proper disposal area would need to be constructed, which requires heavy equipment and fuel. As a result, this is not a green option.

Advantage: Sediment excavation in AEC D with off-site disposal offers above-average effectiveness for PHCs, PAHs and metals relative to other effective technologies. The hydrovac would minimize the amount of disturbance to the surrounding areas; however, there is still the issue with stability at the toe of the slope. If material removed by the hydrovac was done in small sections and immediately replaced with clean fill material, this would decrease the slope stability issues.

Disadvantage: The disadvantages to this option are similar to those listed above for cost, permitting, impacts to aquatic life, and handling of the material. Additionally, the cost of getting the hydrovac to Eureka, the accessibility concerns with the slope, road, and Drinking Water Reservoir, and the cost of shoring equipment would make this option very expensive compared to the benefits it would bring.

5.3.2.4 Capping in Place

For this option, the impacted sediments are covered with a capping layer, such as a geotextile (erosional control) with local materials or bentonite sheeting, which seals off the sediments creating a barrier between the sediments and the water column. SENES/FRANZ anticipates that for the drainage pond in AEC D, 0.2 metres of pit run gravel to prevent impacts from migrating out of sediment will be adequate. This capping would prevent contact between the contamination and biological receptors, including humans, and will reduce the possibility of contaminated sediments being carried downstream by any moving water in the drainage area. This option could involve a focused excavation of the “worst case” area, which consists of almost pure product in sediments within the Drainage Pond, immediately west and downgradient of the Powerhouse. Similar special provisions outlined in Section 5.3.2.2 for removing impacted sediments from the drainage bed would be required if excavation is undertaken. Spring melt in the high arctic can be quite a violent event with strong erosion. Although the cap would be designed to withstand the freeze-thaw cycles of the high arctic, there could be a risk in decrease of stability.

Geotechnical site characterization (pre and post capping installations) could be required in order to ensure that the cap effectively isolates the contaminated sediments from the water column. Long-term monitoring would be required, as the possibility exists for contaminant migration beneath the cap and eventual release of contaminants from sediments bordering the capped area.

Capping in place has existed for quite some time; therefore, it is not a new or innovative technology. The capping material would ideally be from sources from nearby areas, which would limit potential impacts due to transportation. The impacts to the sediment would remain in place and the capping would limit the degradation of contaminants and capping would also cover any existing aquatic vegetation; therefore, this is not a very green or sustainable technology.

<u>Advantage:</u> A cap over impacted sediments would protect fish and wildlife from the consumption of impacted sediments and aquatic plants. New sedimentary layers would eventually be deposited over the cap, but this could take many years if the deposition rate is slow, as is characteristic of many northern lakes. Equipment and materials are likely available at the site, as is material for capping.

<u>Disadvantage:</u> Installation of the cap would likely require extensive work by a team of workers with heavy equipment. There would be accessibility issues with getting the heavy equipment near the Drainage Pond with the slope, elevated road, and Drinking Water Reservoir. Natural habitat would be lost for fish and wildlife, and littoral zone vegetation and benthic organisms in the contaminated sediments will be destroyed. In the event that sources of hydrocarbon contamination remain, this option might not be effective in the long term as hydrocarbons could discharge past the cap impacting deep sediments. Capping the sediment contamination would inhibit natural attenuation, as the cap would prevent diffusion of oxygen from the water column to the sediments, thereby inhibiting biodegradation of organic contaminants by aerobic bacteria. Capping will not decrease long term liability as natural attenuation will be untenable under these conditions. Additionally, there is a risk of erosion of the cap due to violent spring melting. If materials for capping are required to be imported, the price could increase drastically. This option also requires a long-term monitoring component which would increase the cost.

5.3.2.5 Risk Management through Long-term Monitoring and Evaluation

Monitoring and evaluation strategies are designed to ensure that risks to human health and the environment associated with the presence of impacted media at a site are below the established acceptable levels or are following a decreasing trend. Natural processes, including the biological, chemical and physical degradation of contaminants in the subsurface are likely to be occurring at the site. A long-term monitoring (LTM) program would confirm that such processes are active. Such a program is particularly attractive for a remote site like the Eureka HAWS, where remedial methods involving excavation are very expensive and potentially damaging to structures.

A typical monitoring plan would involve implementing a 10 (or more) year monitoring and evaluation program with additional trend-monitoring sample locations. The sediment concentrations in these trend-monitoring locations would be compared to those in the historical record to evaluate changes in concentrations.

A LTM program is a well understood process and will not remove the contaminants from the soil; therefore, it is not considered a green technology. The LTM program will not require the use of heavy equipment, reducing the required fuel consumption.

Advantage: LTM is a cost-effective risk management approach compared to other technologies. The costs associated with sampling and laboratory analysis over 25 years of monitoring would be spread out over the duration of the program, and would be limited to project management, labour and analytical testing. Site disturbance will be low, as there is no need for heavy equipment during the sediment sampling. The updated DQRA indicates that there is no risk to human health due to sediment impacts. The SSTLs for the site are for the ecological receptors of benthic invertebrates and macrophytes. The other remedial options for sediment include excavation or covering with a cap. Both options would cause harm to the existing benthic invertebrates and macrophytes in the sediment. There was no potentially unacceptable risk to terrestrial birds or mammals based on the ecological risk assessment; therefore, LTM would allow the existing invertebrate and macrophytes populations to survive as is.

Disadvantage: Since the contaminants would remain on-site and will remain above SSTLs for an extended length of time, suggesting potential unacceptable risks remain, there may be low acceptability from stakeholders. Long-term monitoring typically accompanies implementation of risk mitigation measure such as capping, cut off walls or administrative controls. LTM by itself does not mitigate risk; it only demonstrates risk levels are either changing or staying constant. There would also be potential for future risk to the environment to develop if the environmental conditions change accordingly in the long-term, or if regulations and standards change.

5.3.3 Permafrost Active Layer Water – Site Wide

SENES/FRANZ considers that the remedial and risk management options discussed for soil and sediment will also address permafrost active layer water; however, if long-term monitoring is chosen as the preferred remedial option the following options may be applied for additional monitoring or treatment of active layer impacts.

5.3.3.1 Diversion and Passive Treatment

Based on the previous site investigations, there are two areas of the site where active layer water is presenting. One is in the drainage pond to the west of the Powerhouse and the second is a seep in the road south of the Powerhouse. A barrier or diversion system, such as a French drain, could be installed to prevent the flow of the active layer from reaching the aquatic environment.

Due to the slope stability issues surrounding the Powerhouse, it is technically difficult to excavate in that area to install a barrier or diversion system. A second option would be to continue allowing the active layer to seep into the drainage pond, which already acts as a catch basin. At the south end of the drainage pond is a culvert, which allows the drainage pond access to the fjord. To prevent the potential for contaminants flowing from the drainage pond to the fjord, passive treatment material, such as activated carbon or sorbent material could be placed either inside or in front of the culvert, removing the impacts in the surface water. To address the active layer seep on the road, a French drain system could be installed south of the Powerhouse and Old Garage between the buildings and the east-west road. A trench would be excavated to permafrost and a geotextile liner would be placed on the bottom and down-gradient wall of the trench. The trench would contain perforated drainage pipe and be backfilled with gravel. The trench would be sloped so the active layer water is directed into the drainage pond. To prevent failure of the drainage system in the spring, heat trace cables could be placed inside the trench to encourage melting inside the drainage trench. An engineered design of the passive filtration and the drainage trench would be required to ensure that the flow of the drainage pond and the integrity of the permafrost and building foundation are not compromised. Alternatively, the trench could be filled with a mitigative material, such as peat, which would reduce the concentration of contaminants prior to discharge into the drainage pond. The trench could be designed as an underflow system with gravel material below the active layer with peat over top. With this outlet controlled design, water would have to flow over the peat prior to discharge, and the gravel acting as a catch during periods with higher than average flow.

Advantage: The drainage system would manage the spread of the impact via the active layer. Using the drainage basin as a catch basin would eliminate the need to construct a water treatment system. The addition of peat in the trench could help reduce the concentration of impacts prior to discharge into the drainage pond.

Disadvantage: The installation of a passive system in or in front of the culvert may restrict the flow of the water. During spring melt, the reduced flow through the culvert could potentially cause the roadway to act as a dam. The water level in the drainage pond could rise and cause damage to the wall of the drinking water reservoir or to the slope west of the Powerhouse. The use of heat trace cables inside the drainage trench would melt the surrounding permafrost, which could compromise the structural integrity of the foundations of the nearby buildings. The engineered design of the filtration system and trench would increase the cost of this option. The trench would also be excavated across a roadway, which requires permafrost for structural support. While there is an alternate route, restricting access to the roadway during the installation of the trench maybe required. This could potentially conflict with site operations. Peat can reduce the permeability of the trench, and if the trench is not designed for proper capacity, overflow could occur.

5.3.3.2 Installation of Thermistors and Monitoring Wells

A second option for the active layer is to monitor the permafrost and movement of the active layer during the warm months. PHC F2 represents diesel range organics which have moderate mobility compared to other groundwater contaminants. It is SENES/FRANZ's experience that dissolved diesel range organics in groundwater do not migrate very far from the source area due to their moderate mobility and the fact that dissolved petroleum hydrocarbons in groundwater also tend to biodegrade over time. Installation of thermistors will monitor the temperature change within the ground surface and would determine the depth to permafrost and depth of the active layer. By installing monitoring wells in conjunction with the thermistors, the chemistry of the active layer and the extent of the plume can be monitored to confirm or refute the spread of the impacts. Changes in ambient temperature will influence the depth of the permafrost melt and active layer from year to year and the thermistors will be able to provide data as to how the permafrost behaves and if sinks are being created by the permafrost. Using stainless steel casings for the wells and thermistors is recommended.

Advantage: The monitoring of the thermistors and monitoring wells could be completed as part of the other program activities. Currently, migration of the contaminant plume via the active layer has not been confirmed or adequately described. Collection of active layer samples would determine the concentration of contaminants and if enough sample locations were installed, information on the potential spread of the contaminants across the site. Currently, information regarding impacts to the active layer is based on the seep location and analytical results from the drainage pond. The depth to permafrost varies across the site and the themistor data will provide information on thaw and freeze back cycles.

Disadvantage: Equipment and materials would have to be mobilized to the site, which would increase the cost. Previous wells have been installed on site via drivepoint with limited success. Installation could be completed using a back-hoe, but ideally, a track-mounted geoprobe would be used to install the wells and thermistors. In the area at the bottom of the slope, a pionjar would be required as it is difficult to access the area with heavy equipment. Based on previous experience with wells in arctic environment, wells closer to large bodies of water tend to have good flow. Further distances from these large water bodies often result in frozen wells or limited quantities of water. A geotechnical review of the proposed well and thermistor locations would be required if the proposed locations are close to buildings as not ensure the foundations are not compromised.

5.4 Greening Remedial Technologies

One of the remedial option selection criteria is the inclusion of green technologies. While many of the remedial technologies proposed are not by themselves considered a green technology, the US EPA has quick reference fact sheets for greener cleanups (US EPA, 2013). The core elements of a green remediation include:

- Reducing the total energy use and increasing renewable energy use;
- Reducing air pollutants and greenhouse gas emissions;
- Reducing water use and negative impacts on water resources;
- Improving materials management and water reduction efforts; and

- Enhancing land management and ecosystem protection.

Given the remote nature of the site, some of the proposed methods for greening a remediation are not applicable, such as the use of rail transport to reduce fuel consumption; however, there are still best management practices that can be incorporated during the remedial activities.

While heavy equipment is currently on site, it may not be available for use during the remediation. Remediation equipment would then have to be barged to the site. Depending on the remediation schedule, equipment may be included on the annual sealift already scheduled to go to Eureka. Selection of the appropriately sized equipment with newer, efficient engines would reduce fuel consumption. Other methods to reduce fuel consumption include:

- Avoiding engine idle or use machines with automatic idle shutdown;
- Using auxiliary power to heat the cab of the machine when unengaged; and
- Performing routine maintenance on the equipment to maintain peak fuel efficiency.

Reducing air emissions is the second core element of greener remediation. A reduction in air emissions can be achieved by securing and covering material in open trucks, limiting vehicles speeds as not to kick-up dust, and using equipment with low-maintenance multistage filters for cleaner engine exhaust. Using cleaner fuels or biofuels is also an option for reducing air emissions; however, it might not be feasible to transport and store a separate type of fuel at Eureka.

Green remediation also considers the reduction of fresh water use, reuse of uncontaminated water, minimizing potential for waterborne contamination, and minimising the introduction of toxic processing materials. Methods that can be used at Eureka to minimize impact to water include:

- Covering contaminated soil piles with biodegradable traps instead of spraying with water to prevent air-borne soils from blowing into water ways;
- Use of a closed loop grey water washing station of the heavy equipment to avoid tracking impacted material across the site;
- Using phosphate-free decontamination detergents;
- Use of geotextile bags for excavated sediment; and
- Use of geotextile barriers, such as silt fences, to prevent soil run-off into water ways and during sediment excavation.

Green purchasing, which considers product life cycles, should be considered when buying material for the remediation. Options include using bio-based or recyclable containers instead of petroleum based, non-toxic chemical alternatives, reusable packaging. Personnel protective equipment (PPE), such as gloves, tyvek suits, ear plugs, is one of the largest consumable product group used on a remediation site. Planning the project to reduce the frequency of switches from handling of impacted material to non-impacted material could reduce the PPE requirements. Using earmuff style protection would reduce the need to disposable ear plugs.

The final core element of a greener remediation is reducing the impacts to land and ecosystems. Conducting a detailed inventory, either through photographs or video, of the ecological species, land contours, and drainage patters before digging is recommended. The baseline inventory will allow for better restoration to original conditions once the remediation is complete. Other best management practices for reducing impacts to land and ecosystems include:

- Establishment of well designed traffic patterns to reduce impacts to surrounding ecosystems;
- Construction of earth dikes or swales to prevent upgradient surface flow into excavated areas; and
- Geotextile placement to avoid run-off.

5.5 Preferred Remedial Option

Treating PHC contamination (this includes PHCs F1 and F2, xylenes and 1-methylnaphthalene) in cold remote regions is difficult due to the short summers, suboptimal environmental conditions, and remoteness (Aislabie *et al.,* 2006).

Based on the evaluation and scoring of the ROA, and the SSTLs, the preferred remedial option for soil and sediment is long-term monitoring (LTM). The stability of the slope adjacent to the Powerhouse presents a high risk if excavation were to occur at the bottom or top of the slope. In addition, a critical piece of infrastructure, the fuel pipe line is at the top of the slope.

The results of the updated risk assessment with the inclusion of the indoor air and vapour data, and the background soil, sediment, and surface water data indicate that there is no potentially unacceptable risk to human health by the COCs identified on site. Potentially unacceptable risk was previously identified to the terrestrial plants and invertebrates, and benthic invertebrates and macrophytes. These receptors would be damaged by intrusive remedial activities, such as excavation. LTM would allow the existing plant and invertebrate populations to survive as is. There was no potentially unacceptable risk to terrestrial birds or mammals based on the ecological risk assessment.

SENES/FRANZ recommends preparing and implementing a LTM plan which would clearly define the monitoring schedule, the comparison criteria, and the potential termination and action required criteria.

The LTM program will be designed to assess whether there are any there any unacceptable changes in concentrations of COCs at the site in soil, sediment, surface water, and indoor air and will include contingency planning in this event. An evaluation of the moving average chemical concentrations will assist in understanding potential attenuation or migration vs. containment of contaminants. This should also include monitoring the contributions of the seasonal active layer melt water to the seeps (if observed during monitoring round).

Finally, it is recommended that the station update their standard operating procedures to include “Best Practices” for petroleum hydrocarbons storage and handling, and other waste management. Some strategies include the use of tidy tanks when fuelling and proper maintenance of heavy equipment (oil leaks).

If the long term monitoring indicates that risk management measures are not meeting the risk management objectives or that the changing conditions (e.g., melting permafrost from climate change, new construction) are changing risk assumptions and the conceptual site model, the risk assessment and risk management plan will need to be reviewed and revised appropriately.

5.6 Secondary Remedial Option

Based on the evaluation and scoring of the ROA, and the site specific conditions an all inclusive secondary remedial option was not identified. While capping scored the second highest, capping could not be effectively executed across the entire site. Positioning of critical infrastructure prevents the addition of the 0.2 m of material on the existing grade in some locations; therefore, only selective capping could occur. Excavation of impacted material would be restricted to areas away from buildings that rest on permafrost for structural support. Excavation of the slope west of the Powerhouse presents a large health and safety risk based on slope stability and would limit the possible excavation of soil and sediment. Excavation of impacted soil beneath the Powerhouse building would not be possible, leaving a potential source for the further spread of impacts. Relocating the critical infrastructure for capping or excavation (Powerhouse and fuel pipe line) was not considered to be feasible based on logistics and cost. The introduction of chemicals for *in situ* oxidation is not recommended as the site is a sensitive environment and currently there is no means of controlling the migration of the oxidant.

The potentially unacceptable risk at the site is to soil invertebrates and plants and benthic invertebrates and macrophytes. All the remaining remedial strategies, excavation, capping, and *in situ* chemical oxidation would harm and or kill the existing plants, invertebrates and macrophytes located in the impacted areas.

If the proposed capital projects, including relocating the drinking water reservoir or removal of the buildings in the delta area, were to take place, an update to the remedial options is recommended.

6.0 CONCLUSIONS

1. SENES Consultants Ltd. (SENES), in association with Franz Environmental Inc. (FRANZ), was retained by Public Works and Government Services Canada (PWGSC) on behalf of Environment Canada (EC) to prepare a remedial options feasibility study, in support of the Remedial Action Plan (RAP), at the Eureka High Arctic Weather Station (HAWS).

2. The project has been conducted in four stages:
   a. The first stage consisted of a supplemental investigation at the Eureka HAWS. The results of the supplemental investigation were reported separately.
   b. The second stage, and the subject of this report, includes the feasibility of different remedial options in support of the development of a Remedial Action Plan (RAP). The feasibility study incorporated considerations such as practicality, safety, cost, and site-specific logistics for each of the different options for the remediation at Eureka HAWS.
   c. The third stage consists of the development of a substantial cost estimate, work breakdown structure, and Gantt chart for the preferred remedial strategy chosen by PWGSC and EC. The cost estimate will include all assumptions made, items of work, quantities, unit prices, complete list of all exclusions and reasoning for the exclusions.
   d. The final stage is the preparation of the Remedial Action Plan based on the remediation strategy chosen by EC.

3. The scope of work consisted of the following tasks:
   - Identification of potential remedial options including innovative/green technologies;
   - Evaluation of each remedial option;
   - Identification of preferred and secondary remedial options; and
   - Preparation of the Feasibility Study report.

4. Once PWGSC and EC have identified the final, preferred remedial option, SENES/FRANZ will complete the following tasks:
   - Prepare a substantive cost estimate for the preferred remedial option; and
   - Develop a work breakdown structure and Gantt chart.
   - Develop the Remedial Action Plan.

5. The results of the risk assessment conducted in 2010 was updated in the feasibility study to include the results of the indoor air and vapour sampling, and the soil, sediment, and surface water background sampling program conducted as part of the 2012 supplemental investigation. The results of the background sampling program were used to establish background threshold levels for metals based on rigorous statistical analysis.

6. For human health, based on the 2012 indoor air and vapour results, the vapour inhalation pathway was eliminated as a source of potential unacceptable risk from petroleum

hydrocarbons (PHC) F1 and F2; therefore, there are no potentially unacceptable risks to human health based on the identified contaminants of concern (COCs) on site.

7. The original DQRA identified a potentially unacceptable risk to terrestrial mammals and birds due to aluminum; however, all aluminum concentrations on site were below the established background threshold level. The aluminum concentrations that posed a potential unacceptable risk are naturally occurring and not caused by site activities.
8. Based on the updated risk assessment modelling, for soil there is still a potentially unacceptable risk from PHC F2 to terrestrial plants and invertebrates. In sediment, there is a potentially unacceptable risk from PHC F1 and F2, xylenes, and 1-methylnaphthalene to benthic invertebrates and macrophytes. There is no potentially unacceptable risk to terrestrial birds and mammals as all the risk quotients were below risk threshold levels.
9. The site-specific target levels (SSTLs) were updated based on the data from the 2012 supplemental investigation. The new SSTLs are summarized in Table 6-1.

Table 6-1: Summary of SSTLs in Soil and Sediment

Chemical Name	SSTL
SOIL	
PHC F2	1374 mg/kg
SURFACE WATER	
Lithium	0.0128 mg/L
SEDIMENT	
Xylenes	1.46 mg/kg
1-methylnaphthalene	3.6 mg/kg
PHC F1	10 mg/kg
PHC F2	12 mg/kg

10. Based on the new SSTLs, volume estimates of impacted soil and sediment were calculated and summarized in Table 6-2 and Table 6-3.

Table 6-2: Estimated Volume of Impacted Soil

COC	AEC	Area (m^2)	Depth (m)	Total Volume (m^3)
PHC F1	AEC A-7	1000	0.35	350
	AEC A-9	240	0.8	190
	AEC B-2	470	1.2	3,830
	AEC D, H, and Delta	190	0.9	170
		760	1.3	980
		5800	1.3	7,600
			TOTAL	**13,200**

Table 6-3: Estimated Volume of Impacted Sediment

COC	AEC	Area (m^2)	Depth (m)	Total Volume (m^3)
PHC F1 & F2, Xylenes, and 1-methylnaphthalene	AEC B-2 and D	2,400	1.0	2,400
	TOTAL			**2,400**

11. A slope stability assessment was conducted based on the selected geotechnical sample analysis submitted as part of the 2012 supplemental investigation and a review of site topography. The results of the slope stability analysis indicate that excavation at the top and bottom of the slope would be of high risk as there is a critical piece of infrastructure at the top, the fuel pipe line, and excavation at the toe of the slope would require an engineered shoring system that would cause limitation on where excavations could occur.

12. SENES/FRANZ evaluated multiple risk management options for the Eureka HAWS. These options included a site-wide remedial action plan for managing PHC impacted soils and sediment. SENES/FRANZ identified and tabulated reasonable remedial options available, and assessed and scored them with respect to applicability, limitations, time, and (order of magnitude) costs. Other criteria included: the removal of hazards, long term effectiveness and overall protection of human health and the environment. The outcome of this remedial options evaluation process is a tabulated matrix evaluation assessing and coring each of the remedial options identified.

    a. The preferred remedial option for soil and sediment is risk management via long-term monitoring (LTM). The stability of the slope presents a high risk if excavation were to occur at the bottom or top of the slope. In addition, a critical piece of infrastructure, the fuel pipe line is at the top of the slope and there would be risk to the integrity of this pipeline. The risks to safety and infrastructure outweigh the potential benefit of clean-up. If the long term monitoring indicates that either risk management measures are not meeting the risk management objectives or that the changing conditions (e.g., melting permafrost from climate change, new construction) are changing risk assumptions and the conceptual site model, the risk assessment and risk management plan will need to be reviewed and revised appropriately.

    b. The secondary remedial was not identified as site conditions, such as the position of critical infrastructure, health and safety risk of the slope stability, and sensitive environment, prevented the other remedial options from being applicable to the entire site. Capping was the remedial option that scored second highest; however, it would only be able to be applied in select locations.

13. If the proposed capital projects, including relocating the drinking water reservoir or removal of the buildings in the delta area, were to take place, an update to the remedial options is recommended.

7.0 LIMITATIONS

This report has been prepared exclusively for Public Works and Government Services Canada and Environment Canada. The report may not be relied upon by any other person or entity without the express written consent of SENES Consultants Ltd. and Franz Environmental Inc.

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

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

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

Should additional information become available, SENES Consultants Ltd. and Franz Environmental Inc. requests that this information be brought to our attention so that we may re-assess the conclusions presented herein.

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

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

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

8.0 CLOSURE

We trust that this information is satisfactory for your present requirements. Should you have any questions or require additional information, please do not hesitate to contact the undersigned.

Yours truly,

SENES Consultants Ltd. / Franz Environmental Inc.

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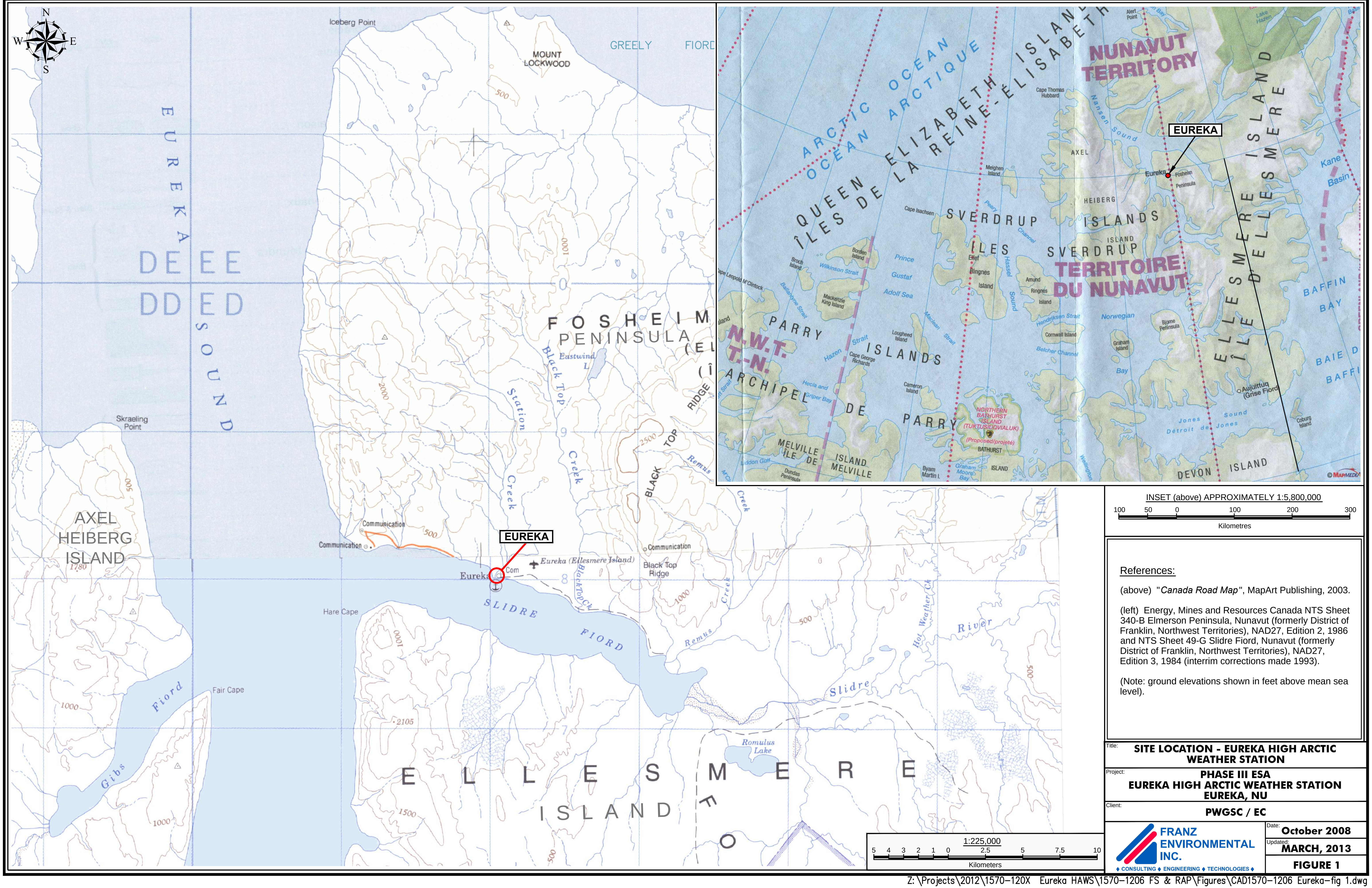
APPENDIX A

Figures



INSET (above) APPROXIMATELY 1:5,800,000

100 50 0 100 200 300

Kilometres

1:225,000

5 4 3 2 1 0 2.5 5 7.5 10

Kilometers

References:

(above) "*Canada Road Map*", MapArt Publishing, 2003.

(left) Energy, Mines and Resources Canada NTS Sheet 340-B Elmerson Peninsula, Nunavut (formerly District of Franklin, Northwest Territories), NAD27, Edition 2, 1986 and NTS Sheet 49-G Slidre Fiord, Nunavut (formerly District of Franklin, Northwest Territories), NAD27, Edition 3, 1984 (interrim corrections made 1993).

(Note: ground elevations shown in feet above mean sea level).

Title: **SITE LOCATION - EUREKA HIGH ARCTIC WEATHER STATION**

Project: **PHASE III ESA**
EUREKA HIGH ARCTIC WEATHER STATION
EUREKA, NU

Client: **PWGSC / EC**

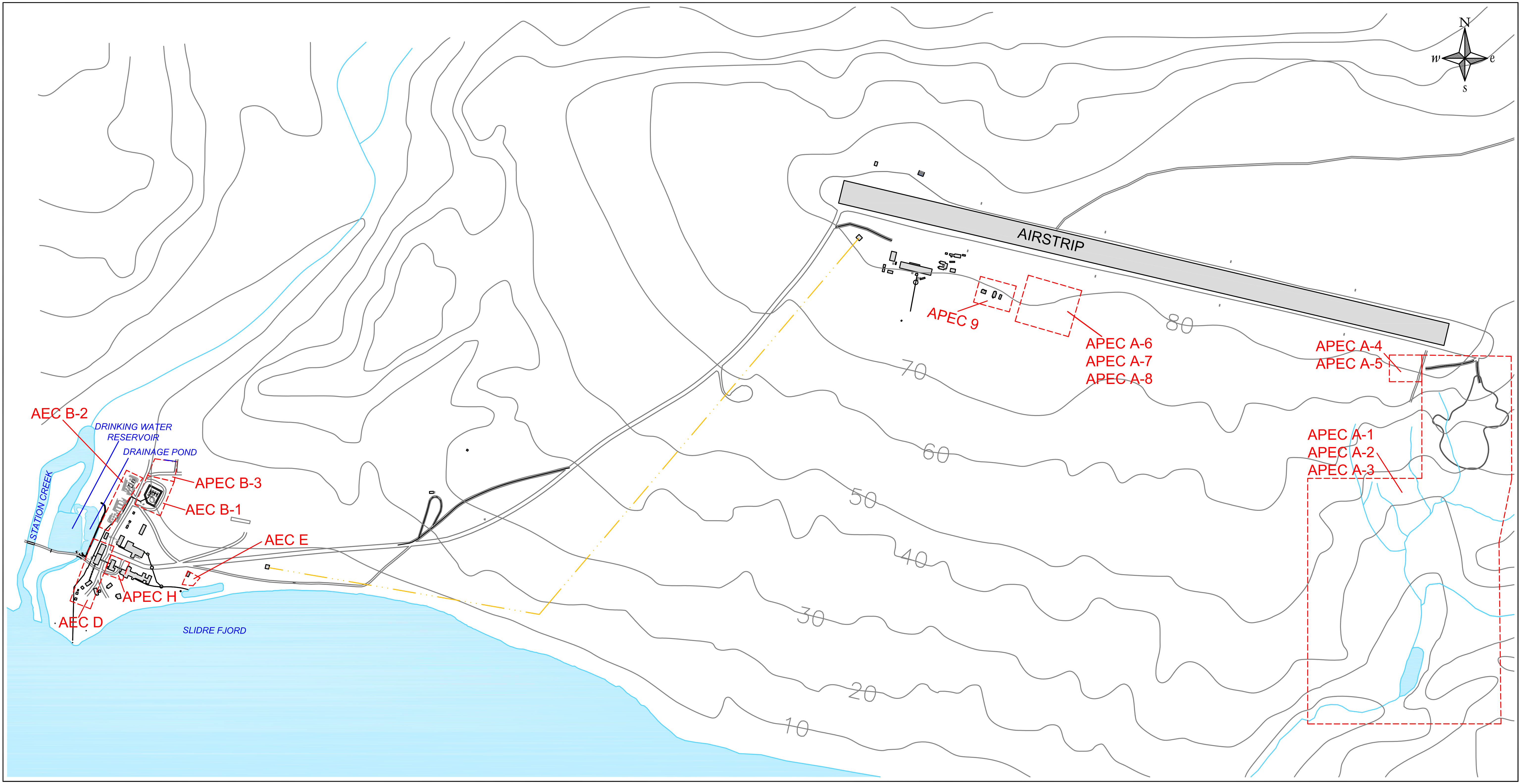
FRANZ ENVIRONMENTAL INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

Date: **October 2008**

Updated: **MARCH, 2013**

FIGURE 1

Z: \Projects\2012\1570-120X Eureka HAWS\1570-1206 FS & RAP\Figures\CAD1570-1206 Eureka-fig 1.dwg



LEGEND

------ AREA OF POTENTIAL ENVIRONMENTAL CONCERN /
AREA OF ENVIRONMENTAL CONCERN

Title:
SITE PLAN WITH APEC/AECs

FRANZ ENVIRONMENTAL INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

Project:
FEASIBILITY STUDY
EUREKA HIGH ARCTIC
WEATHER STATION
EUREKA, NU

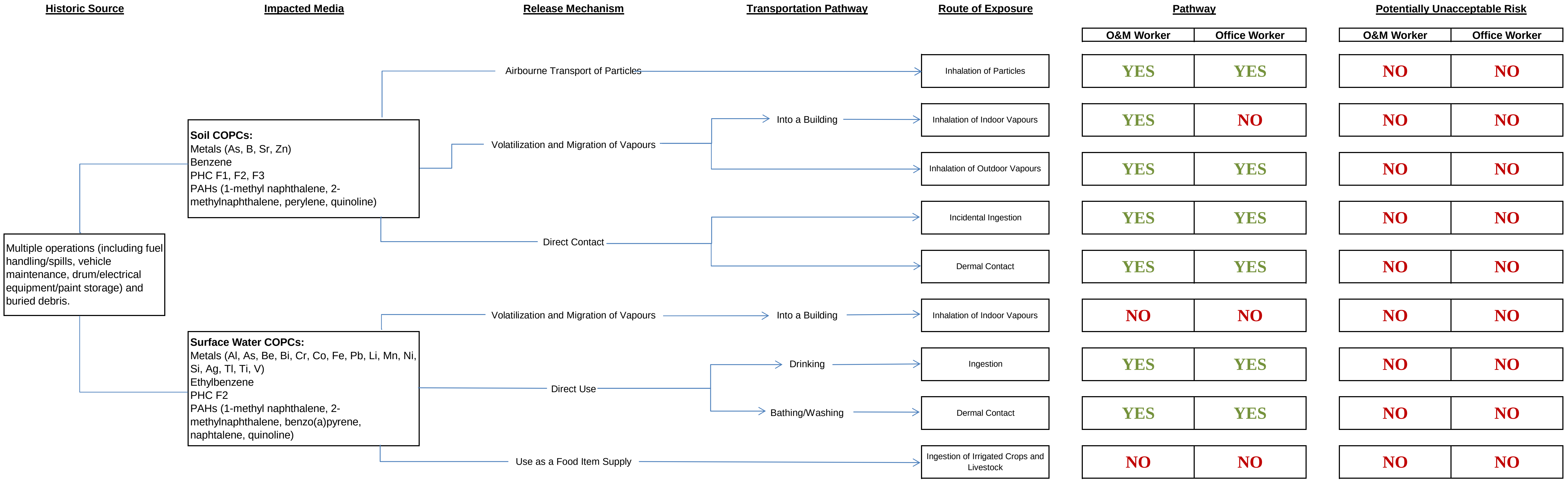
Date:
MARCH 2013

Client:
PWGSC/EC

SCALE 1:10,000
250 200 150 100 50 0 metres 250 500

FIGURE 2

Z:\Projects\2012\1570-120X Eureka HAWS\1570-1206 FS & RAP\Figures\CAD\1570-1206 - EUREKA-FEASIBILITY STUDY - FIGURE 2_7_5_6_10.dwg(layout)



Historic Source	Impacted Media	Release Mechanism	Transportation Pathway	Route of Exposure	Pathway: O&M Worker	Pathway: Office Worker	Potentially Unacceptable Risk: O&M Worker	Potentially Unacceptable Risk: Office Worker
Multiple operations (including fuel handling/spills, vehicle maintenance, drum/electrical equipment/paint storage) and buried debris.	**Soil COPCs:** Metals (As, B, Sr, Zn) Benzene PHC F1, F2, F3 PAHs (1-methyl naphthalene, 2-methylnaphthalene, perylene, quinoline)	Airbourne Transport of Particles		Inhalation of Particles	YES	YES	NO	NO
		Volatilization and Migration of Vapours	Into a Building	Inhalation of Indoor Vapours	YES	NO	NO	NO
				Inhalation of Outdoor Vapours	YES	YES	NO	NO
		Direct Contact		Incidental Ingestion	YES	YES	NO	NO
				Dermal Contact	YES	YES	NO	NO
	Surface Water COPCs: Metals (Al, As, Be, Bi, Cr, Co, Fe, Pb, Li, Mn, Ni, Si, Ag, Tl, Ti, V) Ethylbenzene PHC F2 PAHs (1-methyl naphthalene, 2-methylnaphthalene, benzo(a)pyrene, naphtalene, quinoline)	Volatilization and Migration of Vapours	Into a Building	Inhalation of Indoor Vapours	NO	NO	NO	NO
		Direct Use	Drinking	Ingestion	YES	YES	NO	NO
			Bathing/Washing	Dermal Contact	YES	YES	NO	NO
		Use as a Food Item Supply		Ingestion of Irrigated Crops and Livestock	NO	NO	NO	NO

LEGEND

YES	Complete (Operable) Pathway or Potential Unacceptable Risk
NO	Incomplete (Non-operable) Pathway or No Potentially Unacceptable Risk

Title:
HUMAN HEALTH CONCEPTUAL SITE MODEL

FRANZ ENVIRONMENTAL INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

Project:
FEASIBILITY STUDY
EUREKA HIGH ARCTIC
WEATHER STATION
EUREKA, NU

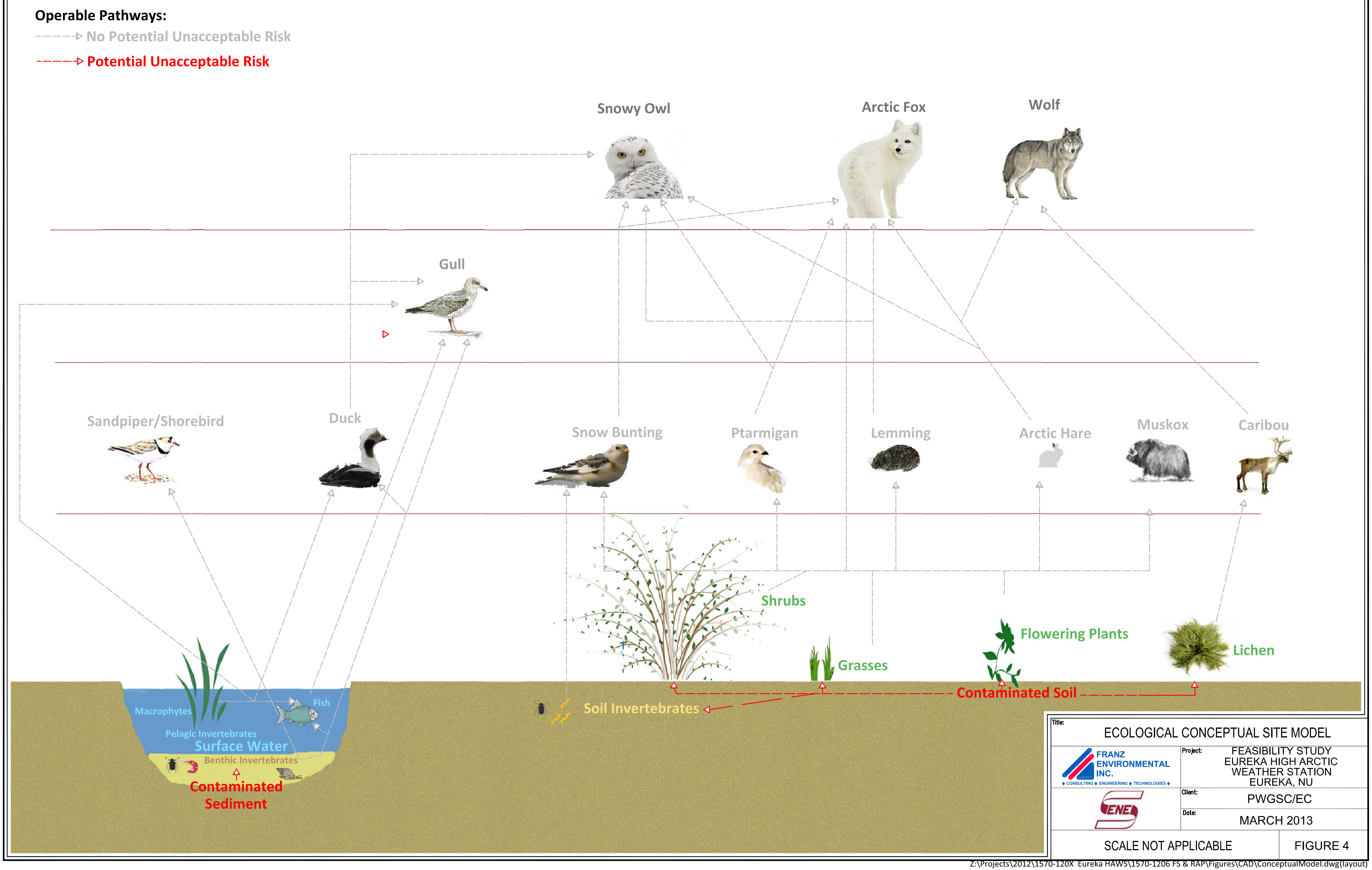
ENE

Client: PWGSC/EC

Date: MARCH 2013

SCALE NOT APPLICABLE

FIGURE 3



Title:
ECOLOGICAL CONCEPTUAL SITE MODEL

FRANZ ENVIRONMENTAL INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

ENE

Project:
FEASIBILITY STUDY
EUREKA HIGH ARCTIC
WEATHER STATION
EUREKA, NU

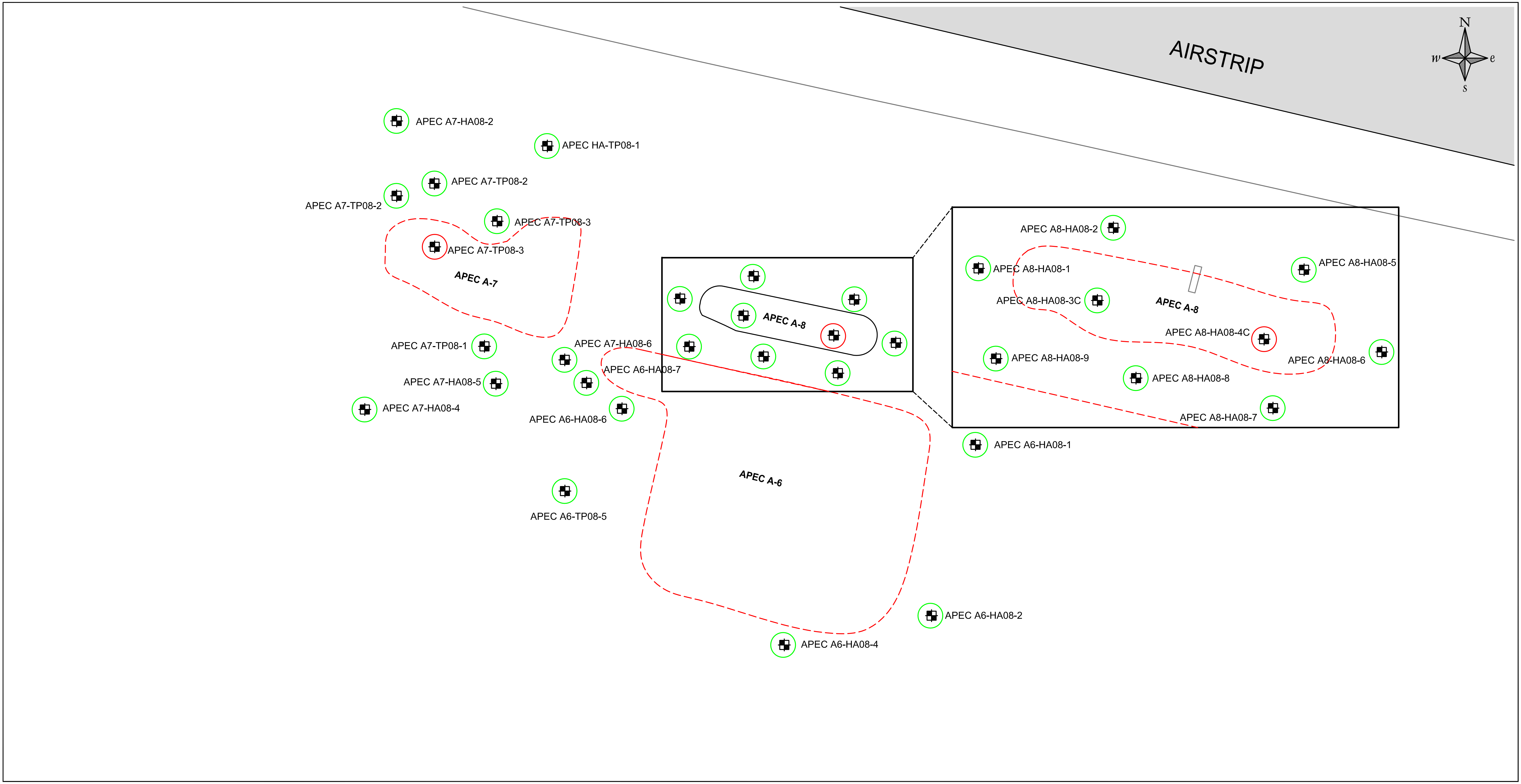
Client:
PWGSC/EC

Date:
MARCH 2013

SCALE NOT APPLICABLE

FIGURE 4

Z:\Projects\2012\1570-120X Eureka HAWS\1570-1206 FS & RAP\Figures\CAD\ConceptualModel.dwg(layout)



LEGEND

- - - AREA OF ENVIRONMENTAL CONCERN

○ SAMPLE LOCATION NOT EXCEEDING SSTL

○ SAMPLE LOCATION EXCEEDING SSTL

PARAMETER	SSTL mg/kg
F2	1374

Title:
LOCATIONS ABOVE SSTL AEC A-6 TO A-8

FRANZ
ENVIRONMENTAL
INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

Project:
FEASIBILITY STUDY
EUREKA HIGH ARCTIC
WEATHER STATION
EUREKA, NU

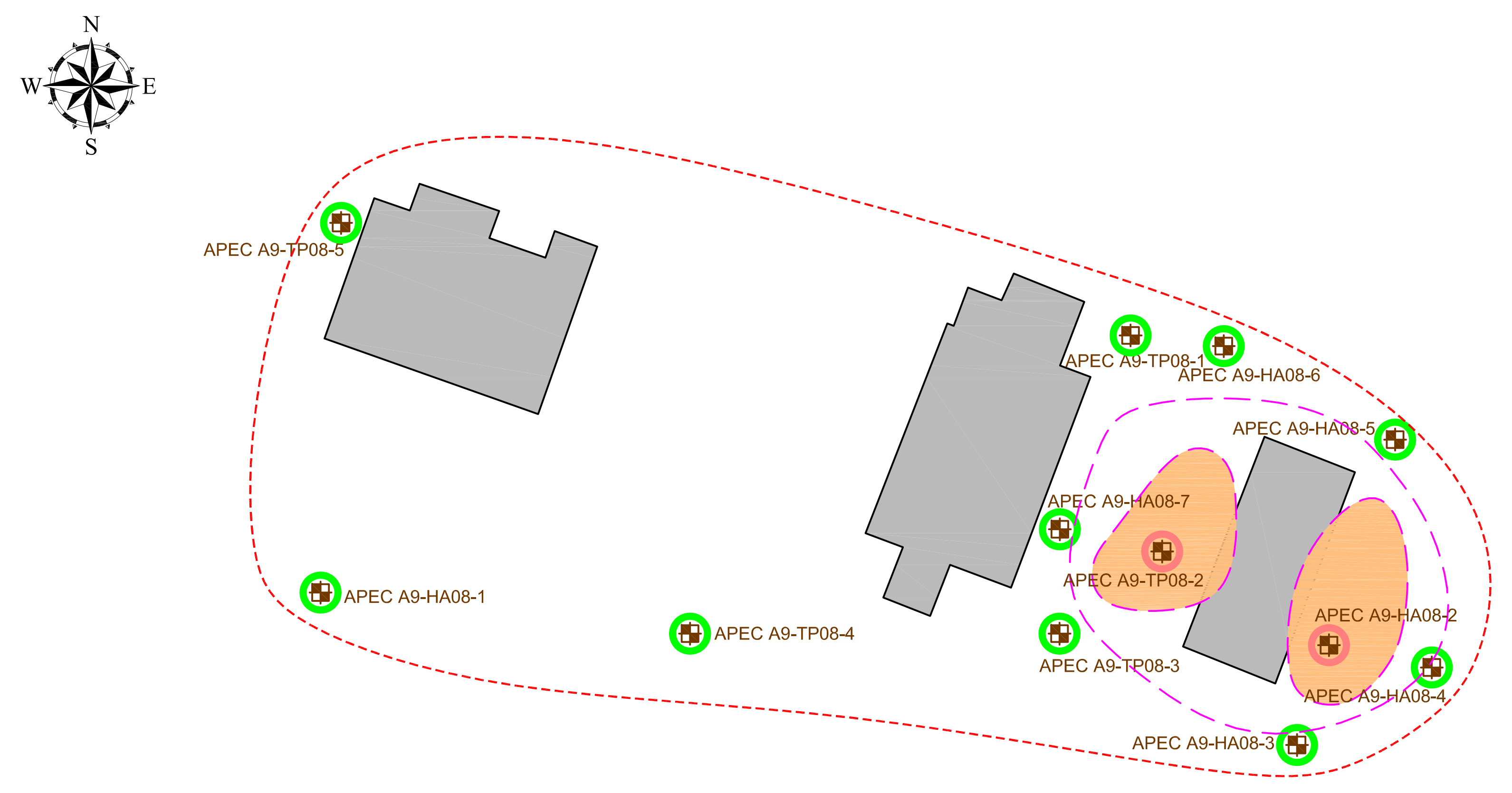
Date:
MARCH 2013

Client:
PWGSC/EC

Scale 1:600
20 16 12 8 4 0 10
metres

FIGURE 5

Z:\Projects\2012\1570-120X Eureka HAWS\1570-1206 FS & RAP\Figures\CAD\1570-1206 - EUREKA-FEASIBILITY STUDY - FIGURE 2_7_5_6_10.dwg (layout)



Legend

- Test Pit/Soil Sampling Location (FRANZ, 2008)

Inferred Extent of Contamination (FRANZ 2008)

Maximum Extent of Contamination (FRANZ 2012)

🟩 - Concentrations of analyzed parameters in sample are less than SSTL

🟥 - Concentrations of one or more analyzed parameter in sample are greater than SSTL

PARAMETER	SSTL mg/kg
F2	1374

Title:
LOCATIONS ABOVE SSTL
AEC A-9

FRANZ
ENVIRONMENTAL
INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

Project:
FEASIBILITY STUDY
EUREKA HIGH ARCTIC
WEATHER STATION
EUREKA, NU

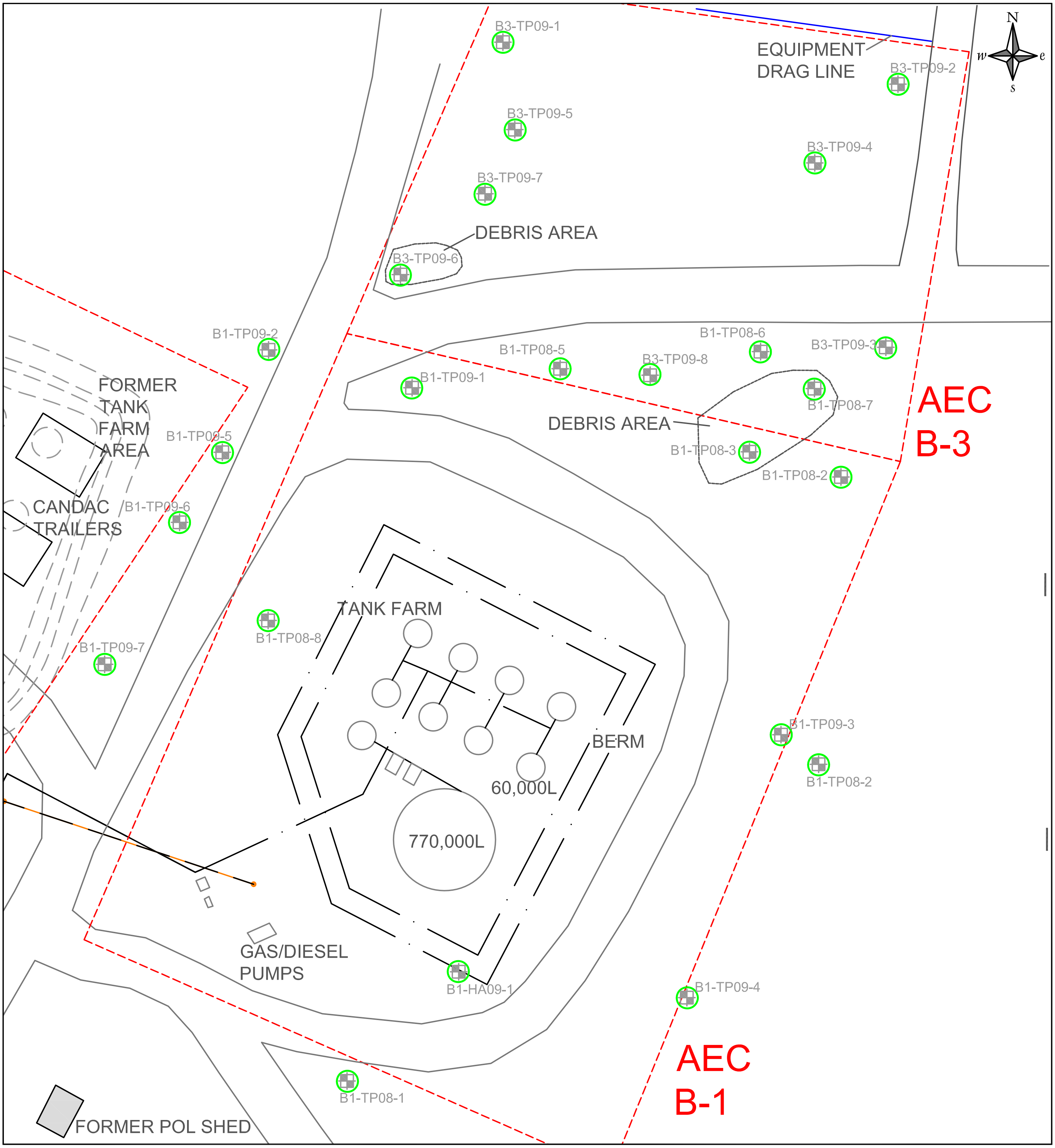
Date:
MARCH 2013

Client:
PWGSC/EC

1:350
5 0 5 10
Metres

FIGURE 6

Z:\Projects\2012\1570-120X Eureka HAWS\1570-1206 FS & RAP\Figures\CAD\1570-1206 - EUREKA-FEASIBILITY STUDY - FIGURE 2_7_5_6_10.dwg (layout)



LEGEND

🟢 SAMPLE LOCATION NOT EXCEEDING SSTL
🔴 SAMPLE LOCATION EXCEEDING SSTL
------ AREA OF ENVIRONMENTAL CONCERN

PARAMETER	SSTL mg/kg
F2	1374

Title:
LOCATIONS ABOVE SSTLs
AEC B-1 AND AEC B-3

FRANZ
ENVIRONMENTAL
INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

Project:
FEASIBILITY STUDY
EUREKA HIGH ARCTIC
WEATHER STATION
EUREKA, NU

Date:
MARCH 2013

Client:
PWGSC/EC

SCALE 1:500
10 5 0 10 20 30
metres

FIGURE 7

Z:\Projects\2012\1570-120X Eureka HAWS\1570-1206 FS & RAP\Figures\CAD\1570-1206 - EUREKA-FEASIBILITY STUDY - FIGURE 2_7_5_6_10.dwg (layout)

L e g e n d

- ▭ Building
- Pipeline
- Hydro Overhead
- Water Line
- Road
- Sewer
- ▭ Tank
- □ Powerbox
- ⬚ Area of Environmental Concern(AEC)
- ▨ Soil Sampling Location
- ▭ Land Farm
- ○ Sample Location Exceeding SSTL
- ○ Sample Location Not Exceeding SSTL
- ▨ Estimated Area of PHCF2 Impacts in Soil

Parameter	SSTL(mg/kg)
F2	1374

AEC B-2: In-Situ Landfarm (former Tank Farm)
AEC D-1: Powerhouse and Down Gradient
AEC H-1: Old Maintenance Garage
AEC H-2: Down Gradient Old Maintenance Garage

Title:
Locations Above SSTLs in Soil AECB-2, AECD and Delta

FRANZ ENVIRONMENTAL INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

Project:
FEASIBILITY STUDY
EUREKA HIGH ARCTIC WEATHER STATION
EUREKA, NU

Client:
PWGSC/EC

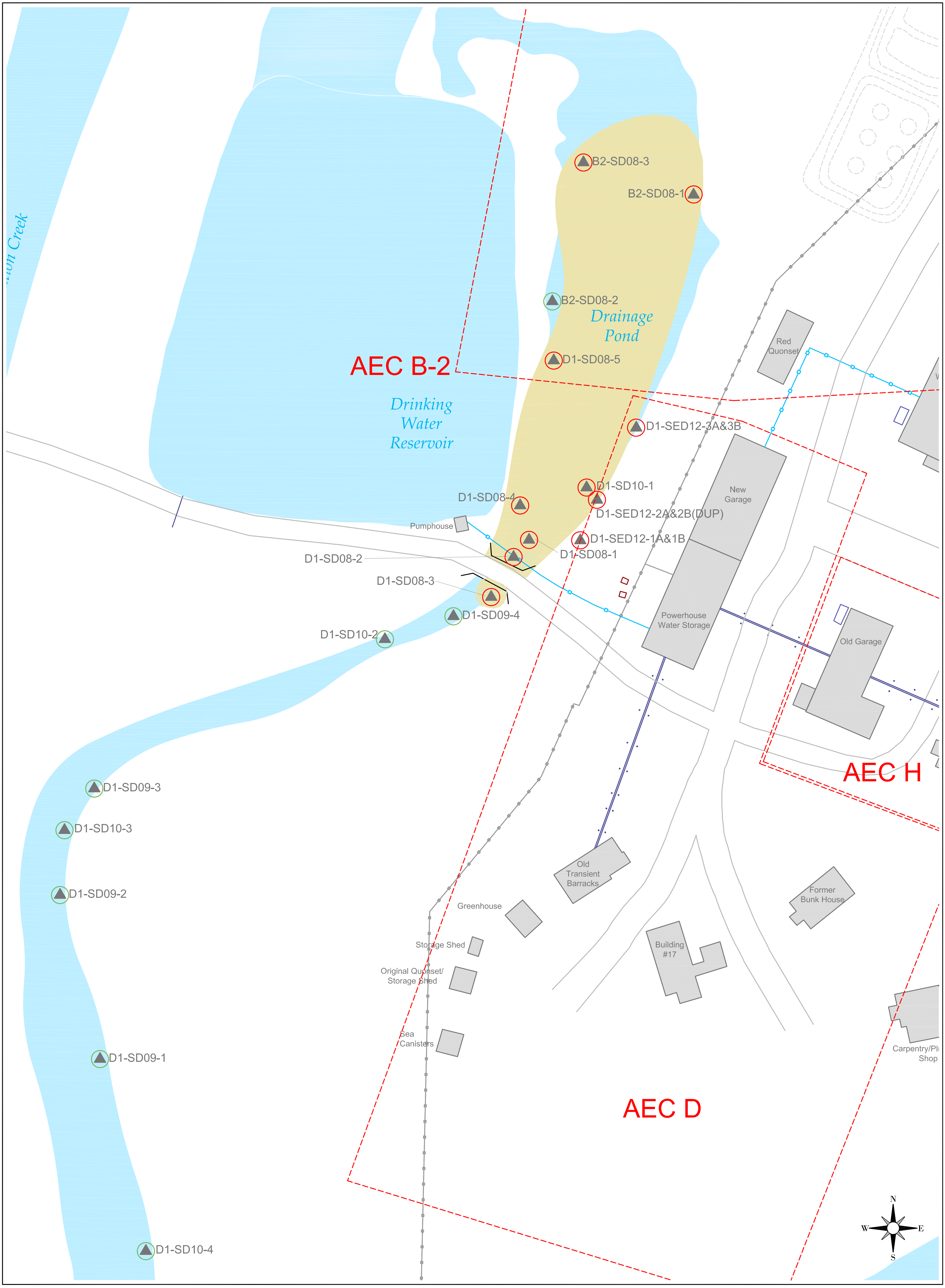
Date:
MARCH 2013

SCALE 1:1000
25 20 15 10 5 0 25 50
metres

FIGURE 8

updated on 27-Feb-13 by rfletcher

Z:\Projects\2012\1570-120X Eureka HAWS\1570-1206 FS & RAP\Figures\CAD\1570-1206 - EUREKA-FEASABILITY STUDY - FIGURE 3 AND 8_recover.dwg (layout)



L e g e n d

- ▭ Building
- Pipeline
- Hydro Overhead
- Water Line
- Road
- Sewer
- ▭ Tank
- ☐ Powerbox
- Area of Environmental Concern(AEC)
- ▲ Sediment Sampling Location Exceeding SSTLs *Parameters with concentrations exceeding SSTLs*
- ▲ Sediment Sampling Location Not Exceeding SSTLs
- Estimated Area of Contaminants Exceeding SSTLs

PARAMETER	SSTL mg/kg
Xylene	1.46
1-methylnaphthalene	3.6
F1	10
F2	12

Title: LOCATIONS ABOVE SSTLs FOR SEDIMENT AECB-2 AND AECD

FRANZ ENVIRONMENTAL INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

Project: FEASIBILITY STUDY
EUREKA HIGH ARCTIC
WEATHER STATION
EUREKA, NU

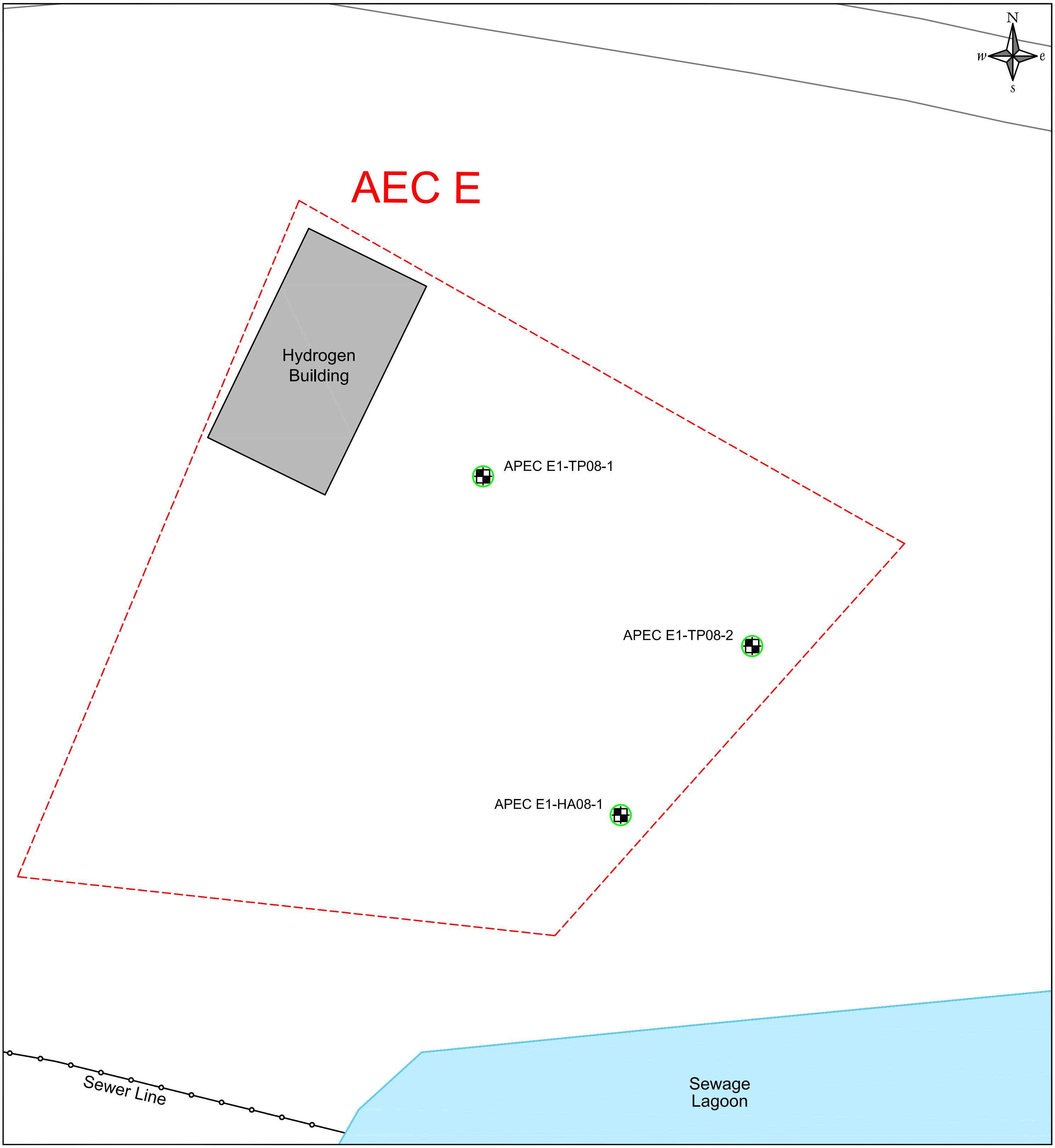
Client: PWGSC/EC

Date: MARCH 2013

SCALE 1:700
0 10 20 30 metres

FIGURE 9

Z:\Projects\2012\1570-120X Eureka HAWS\1570-1206 FS & RAP\Figures\CAD\1570-1206 - EUREKA-FEASABILITY STUDY - FIGURE 9.dwg (layout)



LEGEND

- 🔴 SAMPLE LOCATION EXCEEDING SSTL
- 🟢 SAMPLE LOCATION NOT EXCEEDING SSTL
- ------ AREA OF ENVIRONMENTAL CONCERN
- •—• SEWAGE LINE

PARAMETER	SSTL mg/kg
F2	1374

Title: LOCATIONS ABOVE SSTL
AEC E

FRANZ ENVIRONMENTAL INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

Project: FEASIBILITY STUDY
EUREKA HIGH ARCTIC
WEATHER STATION
EUREKA, NU

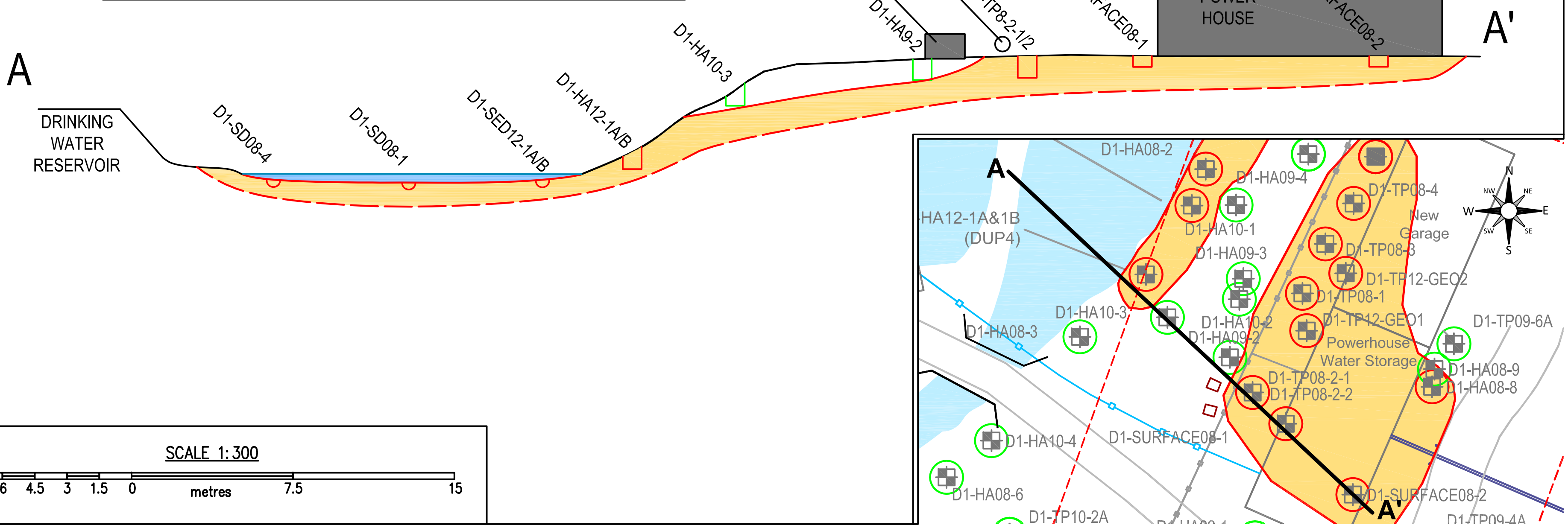
Date: MARCH 2013

Client: PWGSC/EC

SCALE 1:250
5 4 3 2 1 0 2.5 metres 5 7.5 10

FIGURE 10

Z:\Projects\2012\1570-120X Eureka HAWS\1570-1206 FS & RAP\Figures\CAD\1570-1206 - EUREKA-FEASIBILITY STUDY - FIGURE 2_7_5_6_10.dwg (layout)



SCALE 1: 300

7.5 6 4.5 3 1.5 0 metres 7.5 15

Legend

- ▇ Building/Structure
- ⬚ Area of Environmental Concern(AEC)
- ⊞ Soil Sampling Location
- 🟦 Water
- ▫—▫ Pipeline
- — Road
- ○ Sample Location Not Exceeding SSTL
- ☐ Test Pit Soil Sample Location Not Exceeding SSTL
- ☐ Test Pit Soil Sample Location Exceeding SSTL
- ◡ Sediment Sample Location Exceeding SSTL
- ○ Sample Location Exceeding SSTL
- 🟧 Estimated Area of PHC Impacts in Soil
- A——A' Cross Section Location

Title:
CROSS SECTION OF SLOPE - WEST OF POWERHOUSE

FRANZ ENVIRONMENTAL INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

Project:
FEASIBILITY STUDY
EUREKA HIGH ARCTIC
WEATHER STATION
EUREKA, NU

Date:
MARCH 2013

Client:
PWGSC/EC

INSET SCALE 1:750
20 15 10 5 0 20
metres

FIGURE 11

updated on:21-Mar-13 by rfletcher

Z:\Projects\2012\1570-120X Eureka HAWS\1570-1206 FS & RAP\Figures\CAD\1570-1206_ROA_Cross Section.dwg (layout)

APPENDIX B

Tables

Table B-1:
Soil Chemical Concentrations - Background Metals

PARAMETER	**Soil Criteria**	**RDL**	**BACKGROUND 2008**				**BACKGROUND 2010**	**BACKGROUND 2012**										**Background Average**
Sample Number	**Federal**		**BG08-1**	**BG08-2**	**BG08-3**	**BG08-4**	**BK-HA10-1**	**BG-HA12-1**	**BG-HA12-2**	**BG-HA12-DUP 1 Duplicate of BG-HA12-2**	**BG-HA12-3**	**BG-HA12-4**	**BG-HA12-5**	**BG-HA12-6**	**BG-HA12-7**	**BG-HA12-8**	**BG-HA12-9**	
Sample Date	**CCME 2007 [1] Residential/ Parkland**		**22/08/2008**	**22/08/2008**	**22/08/2008**	**22/08/2008**	**17/08/2010**	**18/08/2012**	**18/08/2012**	**18/08/2012**	**18/08/2012**	**18/08/2012**	**29/08/2012**	**29/08/2012**	**29/08/2012**	**29/08/2012**	**29/08/2012**	
Sample Depth (m)			0.3	0.4	0.3	0.4	0.1	0.1 - 0.2	0.1 - 0.2	0.1 - 0.2	0.1 - 0.2	0.1 - 0.2	0.1 - 0.2	0.1 - 0.2	0.1 - 0.2	0.1 - 0.2	0.1 - 0.2	
Total Metals (mg/kg)																		
Aluminum (Al)	---	10	---	---	---	---	1700	6200	10000	8700	18000	9100	6300	8400	6500	4400	4500	7618
Antimony (Sb)	20	1.0	<0.2	<0.2	<0.2	<0.2	<0.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic (As)	12	1.0	9.7	8.2	7.4	6.1	3	7.3	9.1	9.0	2.5	7.5	17	9.7	13	7.7	6.8	8.3
Barium (Ba)	500	10	64	55	78	30	20	39	58	53	130	48	31	44	31	24	26	49
Beryllium (Be)	4	0.40	<1	<1	<1	<1	0.2	0.64	0.94	0.86	<0.40	0.73	0.53	0.45	0.48	<0.40	<0.40	0.74
Bismuth (Bi)	---	1.0	---	---	---	---	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Boron (B)	---	2.0	---	---	---	---	9	22	15	14	2.2	9.5	6.9	12	5.1	6.9	12	10
Cadmium (Cd)	10	0.10	<0.5	<0.5	<0.5	<0.5	<0.1	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	0.21
Calcium (Ca)	---	50	---	---	---	---	6000	4900	4500	4000	20000	3200	2600	4100	3600	2000	3000	5264
Chromium (Cr)	64	1.0	20.4	21.6	23.1	10	5	13	20	18	4.4	18	15	15	12	9.1	9.1	14.2
Cobalt (Co)	50	1.0	7	8	10	6	4.8	6.8	9.5	8.9	25	8.2	10	4.7	10	6.0	5.5	8.7
Copper (Cu)	63	5.0	16	18	19	9	5.7	19	21	20	17	20	28	23	23	20	14	18
Iron (Fe)	---	10	---	---	---	---	8700	20000	26000	24000	49000	22000	47000	23000	51000	19000	16000	29700
Lead (Pb)	140	1.0	11	10	11	6	5	8.9	12	11	2.1	8.9	11	9.3	9.3	6.5	5.9	8.5
Magnesium (Mg)	---	20	---	---	---	---	1600	3300	3800	3400	13000	2900	3100	3000	3200	2500	1800	3782
Manganese (Mn)	---	10	---	---	---	---	80	190	230	210	460	210	640	90	670	290	230	300
Mercury (Hg)	6.6	0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.064	0.073	<0.050	<0.050	0.052
Molybdenum (Mo)	10	0.40	<1	<1	<1	<1	<0.5	0.78	0.96	0.92	<0.40	0.73	1.6	0.93	1.6	0.53	0.54	0.94
Nickel (Ni)	50	1.0	16	19	20	11	9.4	16	23	22	13	19	29	15	26	24	15	18
Phosphorus (P)	---	20	---	---	---	---	190	370	530	460	2000	360	550	330	710	320	320	558
Potassium (K)	---	25	---	---	---	---	330	1400	1700	1500	4400	1500	790	2300	640	690	940	1472
Selenium (Se)	1	0.50	0.7	0.6	0.5	0.2	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	0.51	0.82	0.51	<0.50	<0.50	0.523
Silver (Ag)	20	1.0	<1	<1	<1	<1	<0.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium (Na)	---	50	---	---	---	---	370	4900	1100	920	4100	1100	57	630	130	430	790	1321
Strontium (Sr)	---	10	---	---	---	---	24	50	74	68	64	47	19	41	20	15	23	40
Tin (Sn)	50	0.30	<5	<5	<5	<5	<5	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<5
Thallium (Tl)	1	1.0	<1	<1	<1	<1	<0.05	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Uranium (U)	23	1.0	<2	<2	<2	<2	0.41	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<2
Vanadium (V)	130	1.0	28	33	38	21	13	26	36	33	110	35	49	18	47	21	20	35
Zinc (Zn)	200	10	50	60	70	30	24	44	60	57	32	50	59	48	52	36	38	47

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland

RDL= Reportable Detection Limit
20 = Denotes concentration above guidelines

Table B-2: Soil Chemical Concentrations
- Metals

PARAMETER	Soil Criteria		RDL	APEC A: Landfill 2009								APEC A: Landfill 2009							
Sample Number	**Federal**	**Established Background Level**		**LANDFILL -HA08-1**	**LANDFILL -HA08-2**	**LANDFILL -HA08-3**	**LANDFILL -HA08-4**	**LANDFILL -HA08-5**	**DUP1 (LANDFILL HA08-5)**	**LANDFILL -HA08-6**	**LANDFILL -HA08-7**	**A-HA09-1**	**A-HA09-2**	**A-HA09-3**	**A-HA09-DUP1**	**A-HA09-4**	**A-HA09-5**	**A-HA09-6**	**A-HA09-7**
Sample Date	**CCME 2007 [1] Residential/ Parkland**	**2009- 2012**		**16/08/2008**	**16/08/2008**	**16/08/2008**	**16/08/2008**	**16/08/2008**	**16/08/2008**	**16/08/2008**	**16/08/2008**	08/11/2009	08/11/2009	08/11/2009	08/11/2009	08/11/2009	08/11/2009	08/11/2009	08/11/2009
Sample Depth (m)				0.9	1	1.1	1.15	1	1	0.6	1.1	0.7	0.6	0.7	0.7	0.5	0.6	0.6	0.5
Total Metals (mg/kg)																			
Aluminum (Al)	**---**	**16208**	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Antimony (Sb)	**20**	<1.0	1.0	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.23	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic (As)	12	**14.69**	1.0	7.4	7.6	7.4	7.7	7.9	7.9	7.9	7.6	7.17	6.29	3.3	6.4	6.48	3.78	3.66	5.25
Barium (Ba)	**500**	106.6	10	90	96	73	57	98	100	94	53	90	40.8	16.7	38.7	27.5	22.9	24.9	27.1
Beryllium (Be)	4	**10.919**	0.40	1	1	<1	<1	1	1	1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bismuth (Bi)	---	<1.0	1.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Boron (B)	---	20.72	2.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Cadmium (Cd)	**10**	<1.0	0.10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Calcium (Ca)	---	14753	50	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chromium (Cr)	**64**	25.04	1.0	25.8	27	21.2	16.9	26.2	27.5	27	16.9	26.1	15.7	5.82	15.3	15.1	7.18	7.13	8.62
Cobalt (Co)	**50**	17.59	1.0	13	13	11	9	14	14	13	8	10.6	5.9	3.4	4.6	5.3	4.6	4.4	5.1
Copper (Cu)	**63**	28.21	5.0	26	25	20	17	26	26	25	14	19.7	10.8	6.1	10.7	8.1	6.5	6.6	6.6
Iron (Fe)	---	67130	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Lead (Pb)	**140**	13.66	1.0	14	14	12	10	15	15	15	10	19.6	8.4	<5.0	11.4	6.6	5.4	5.8	5.2
Magnesium (Mg)	---	9704	20	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Manganese (Mn)	---	897.7	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mercury (Hg)	**6.6**	0.0588	0.050	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.050	<0.050	<0.050	0.052	<0.050	<0.050	<0.050	<0.050
Molybdenum (Mo)	**10**	1.496	0.40	<1	<1	<1	<1	<1	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Nickel (Ni)	**50**	28.67	1.0	27	26	22	19	28	28	26	17	25	14.8	6.8	11.2	16.7	8.4	8.3	10
Phosphorus (P)	---	1422	20	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Potassium (K)	---	3603	25	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Selenium (Se)	**1**	0.803	0.50	0.7	0.6	0.5	0.5	0.8	0.8	0.7	0.5	0.25	<0.20	<0.20	0.41	0.22	<0.20	<0.20	<0.20
Silver (Ag)	**20**	<1.0	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium (Na)	---	8059	50	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Strontium (Sr)	---	81.38	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Thallium (Tl)	**1**	<1	0.30	<1	<1	<1	<1	<1	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tin (Sn)	**50**	<5	1.0	<5	<5	<5	<5	<5	<5	<5	<5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Uranium (U)	**23**	<2	1.0	<2	<2	<2	<2	<2	<2	<2	<2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Vanadium (V)	**130**	77.69	1.0	43	45	37	31	42	45	45	27	35.7	21.3	13.6	25.2	20	16	15.6	22
Zinc (Zn)	**200**	71.19	10	80	80	70	60	90	90	90	50	66	39	29	33	41	30	33	32

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland

--- = Not analyzed or no criterion/guideline established.

RDL= Reportable Detection Limit
20 = Denoted the guideline/threshold
20 = Denotes parameter above guideline/threshold

Table B-2: Soil Chemical Concentrations
- Metals

PARAMETER	**Soil Criteria**		**RDL**	**AEC A: Landfill 2009**				**APEC A-4 & A-5: ASBESTOS & ASH LANDFILL 2008**					**APEC A-6: BARREL CRUSHING AREA AND BAREL LANDFILLS 2008**							
Sample Number	**Federal**	**Established Background Level**		**A-HA09-8**	**A-HA09-9**	**A-HA09-10**	**A-HA09-11**	**LANDFILL AA-TP08-2**	**LANDFILL AA-TP08-3**	**LANDFILL AA-TP08-4**	**LANDFILL AA-HA08-1**	**LANDFILL AA-HA08-2**	**APEC A6-HA08-1**	**APEC A6-HA08-2**	**APEC A6-HA08-3**	**APEC A6-HA08-4**	**APEC A6-HA08-5**	**DUP 4 (APEC A6-HA08-5)**	**APEC A6-HA08-6**	**APEC A6-HA08-7**
Sample Date	**CCME 2007 [1] Residential/ Parkland**	**2009- 2012**		08/11/2009	08/11/2009	08/11/2009	08/11/2009	**17/08/2008**	**17/08/2008**	**17/08/2008**	**17/08/2008**	**17/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**
Sample Depth (m)				0.5	0.7	0.75	0.85	0.56	1.15	0.82	0.68	0.7	0.9	1.2	0.8	1	0.8	0.8	1	1
Total Metals (mg/kg)																				
Aluminum (Al)	**---**	**16208**	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Antimony (Sb)	**20**	<1.0	1.0	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic (As)	12	**14.69**	1.0	4.36	4.96	5.84	6.23	7.8	9.3	8.6	8.7	9.6	8.1	7	8	7.4	6.9	7.5	7.9	8.5
Barium (Ba)	**500**	106.6	10	34.7	37.2	44.9	110	76	85	104	85	64	53	46	60	53	53	56	72	89
Beryllium (Be)	4	**10.919**	0.40	<1.0	<1.0	<1.0	<1.0	<1	1	1	1	<1	<1	<1	<1	<1	<1	<1	1	1
Bismuth (Bi)	---	<1.0	1.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Boron (B)	---	20.72	2.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Cadmium (Cd)	**10**	<1.0	0.10	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Calcium (Ca)	---	14753	50	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chromium (Cr)	**64**	25.04	1.0	9.5	18.9	18.1	20.7	23.6	24.3	29.5	23.8	21.6	19.7	15.4	23	20.3	17.2	20.1	24.7	29.1
Cobalt (Co)	**50**	17.59	1.0	5.5	6.2	7.4	5.4	11	13	14	13	10	9	7	10	10	8	9	11	13
Copper (Cu)	**63**	28.21	5.0	9.1	9.7	13.1	8.5	21	25	27	24	19	16	14	19	17	15	17	20	26
Iron (Fe)	---	67130	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Lead (Pb)	**140**	13.66	1.0	6.3	6.9	8.6	7.3	12	14	15	14	12	11	9	12	11	10	11	12	14
Magnesium (Mg)	---	9704	20	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Manganese (Mn)	---	897.7	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mercury (Hg)	**6.6**	0.0588	0.050	<0.050	<0.050	<0.050	<0.050	<0.05	0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum (Mo)	**10**	1.496	0.40	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel (Ni)	**50**	28.67	1.0	11	17.2	17.2	16.2	23	28	31	28	19	17	15	19	19	17	19	22	27
Phosphorus (P)	---	1422	20	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Potassium (K)	---	3603	25	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Selenium (Se)	**1**	0.803	0.50	<0.20	0.26	0.33	<0.20	0.5	0.8	0.8	0.7	0.6	0.5	0.4	0.5	0.6	0.5	0.7	1	0.6
Silver (Ag)	**20**	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium (Na)	---	8059	50	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Strontium (Sr)	---	81.38	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Thallium (Tl)	**1**	<1	0.30	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Tin (Sn)	**50**	<5	1.0	<5.0	<5.0	<5.0	<5.0	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Uranium (U)	**23**	<2	1.0	<2.0	<2.0	<2.0	<2.0	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Vanadium (V)	**130**	77.69	1.0	19.7	21.4	27	19.9	43	39	46	41	39	39	28	40	35	30	35	40	48
Zinc (Zn)	**200**	71.19	10	33	35	46	32	70	80	90	80	60	50	50	70	60	50	60	70	80

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland

--- = Not analyzed or no criterion/guideline established.

RDL= Reportable Detection Limit
20 = Denoted the guideline/threshold
20 = Denotes parameter above guideline/threshold

Table B-2: Soil Chemical Concentrations
- Metals

PARAMETER	Soil Criteria		RDL	AEC A-9: FORMER FIRST AIR LEASE 2008					AEC A-9: FORMER FIRST AIR LEASE 2008							APEC A-10: BATTERY DUMP 2008			
Sample Number	**Federal**	**Established Background Level**		**APEC A9-TP08-1**	**APEC A9-TP08-2**	**APEC A9-TP08-3**	**APEC A9-TP08-4**	**APEC A9-TP08-5**	**APEC A9-HA08-1**	**APEC A9-HA08-2**	**APEC A9-HA08-3**	**APEC A9-HA08-4**	**APEC A9-HA08-5**	**APEC A9-HA08-6**	**APEC A9-HA08-7**	**BATTERY DUMP-HA08-1**	**BATTERY DUMP-HA08-2**	**BATTERY DUMP-HA08-3**	**BATTERY DUMP-HA08-4**
Sample Date	**CCME 2007 [1] Residential/ Parkland**	**2009- 2012**		**17/08/2008**	**17/08/2008**	**17/08/2008**	**17/08/2008**	**17/08/2008**	**17/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**16/08/2008**	**16/08/2008**	**16/08/2008**	**16/08/2008**
Sample Depth (m)				0.9	0.6	0.8	1	0.7	1	1.2	1.1	0.8	0.6	0.6	0.7	0.6	0.75	0.15	0.85
Total Metals (mg/kg)																			
Aluminum (Al)	**---**	**16208**	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Antimony (Sb)	**20**	<1.0	1.0	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic (As)	12	**14.69**	1.0	10.6	11.3	9.1	9.7	8.8	8.7	8.1	8.7	7.3	8.2	8.6	7.6	10	8.1	7.3	7.7
Barium (Ba)	**500**	106.6	10	65	74	95	103	92	106	92	92	100	84	94	66	96	103	114	116
Beryllium (Be)	4	**10.919**	0.40	<1	<1	1	1	1	1	1	1	1	<1	1	<1	1	1	1	1
Bismuth (Bi)	---	<1.0	1.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Boron (B)	---	20.72	2.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Cadmium (Cd)	**10**	<1.0	0.10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Calcium (Ca)	---	14753	50	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chromium (Cr)	**64**	25.04	1.0	17.6	18.3	24	29.7	30	30.1	29.1	28.7	30.4	26.9	31.3	17	27	32.3	30.8	32.5
Cobalt (Co)	**50**	17.59	1.0	13	20	13	14	13	15	12	13	12	12	14	10	14	14	15	15
Copper (Cu)	**63**	28.21	5.0	27	28	26	30	25	29	23	24	24	22	27	21	27	28	29	30
Iron (Fe)	---	67130	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Lead (Pb)	**140**	13.66	1.0	12	15	15	17	15	22	14	14	13	15	15	14	15	16	16	16
Magnesium (Mg)	---	9704	20	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Manganese (Mn)	---	897.7	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mercury (Hg)	**6.6**	0.0588	0.050	0.05	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	0.06	<0.05
Molybdenum (Mo)	**10**	1.496	0.40	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel (Ni)	**50**	28.67	1.0	50	65	27	31	28	31	25	25	25	24	28	27	27	29	29	30
Phosphorus (P)	---	1422	20	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Potassium (K)	---	3603	25	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Selenium (Se)	**1**	0.803	0.50	1	1	0.8	0.9	0.7	0.8	0.5	0.6	1	0.5	0.5	0.8	0.7	0.7	0.8	0.8
Silver (Ag)	**20**	<1.0	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium (Na)	---	8059	50	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Strontium (Sr)	---	81.38	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Thallium (Tl)	**1**	<1	0.30	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Tin (Sn)	**50**	<5	1.0	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Uranium (U)	**23**	<2	1.0	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Vanadium (V)	**130**	77.69	1.0	26	26	41	48	51	47	50	49	48	46	54	28	44	52	50	53
Zinc (Zn)	**200**	71.19	10	50	60	80	100	80	90	80	80	80	70	90	60	90	90	100	100

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland

--- = Not analyzed or no criterion/guideline established.

RDL= Reportable Detection Limit
20 = Denoted the guideline/threshold
20 = Denotes parameter above guideline/threshold

Table B-2: Soil Chemical Concentrations
- Metals

PARAMETER	**Soil Criteria**		**RDL**	**APEC B-1: FUEL TANK FARM LOCATED AT THE MAIN CAMP 2008**				**APEC B-3: Suspected Landfill 2009**									
Sample Number	**Federal**	**Established Background Level**		**APEC B1-TP08-6**	**APEC B1-TP08-7**	**B1-TP09-1A**	**B1-TP09-1B**	**B3-TP09-1A**	**B3-TP09-1B**	**B3-TP09-2A**	**B3-TP09-2B**	**B3-TP09-3A**	**B3-TP09-3B**	**B3-TP09-4A**	**B3-TP09-4B**	**B3-TP09-5A**	**B3-TP09-5B**
Sample Date	**CCME 2007 [1] Residential/ Parkland**	**2009- 2012**		**20/08/2008**	**20/08/2008**	14/8/2009	14/8/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009
Sample Depth (m)				1	1	1	1.2	0.5	0.9	0.5	1.4	1	1.2	0.5	0.9	0.5	1.4
Total Metals (mg/kg)																	
Aluminum (Al)	**---**	**16208**	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Antimony (Sb)	**20**	<1.0	1.0	<0.2	0.2	0.34	1.15	0.37	0.28	0.28	0.27	<0.20	<0.20	0.29	0.33	<0.20	<0.20
Arsenic (As)	12	**14.69**	1.0	7.2	15.8	13.3	17	15	12.6	11.5	12	8.04	7.99	12.1	10.1	7.76	8.61
Barium (Ba)	**500**	106.6	10	44	75	26	31.7	46.2	26.8	40	44.1	35.9	34.5	18.6	46.7	27.6	34.9
Beryllium (Be)	4	**10.919**	0.40	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bismuth (Bi)	---	<1.0	1.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Boron (B)	---	20.72	2.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Cadmium (Cd)	**10**	<1.0	0.10	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Calcium (Ca)	---	14753	50	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chromium (Cr)	**64**	25.04	1.0	15.4	21	12.4	13.3	23.1	18.1	36.4	33.5	22.1	18.3	11	21.2	13	15.4
Cobalt (Co)	**50**	17.59	1.0	8	10	11.3	13	14.2	10.2	10.2	10.6	7.2	6.6	8.3	8.3	5.6	6.8
Copper (Cu)	**63**	28.21	5.0	14	54	19.9	21.4	27.2	17	18	19.1	12.4	11.7	16.3	15.9	10.3	12.7
Iron (Fe)	---	67130	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Lead (Pb)	**140**	13.66	1.0	14	109	10.4	67.4	11	8.8	9.2	13	9.1	8.7	7.8	11.9	7.5	9
Magnesium (Mg)	---	9704	20	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Manganese (Mn)	---	897.7	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mercury (Hg)	**6.6**	0.0588	0.050	<0.05	0.06	0.069	0.079	0.074	0.052	0.067	0.052	<0.050	0.079	0.084	0.057	<0.050	<0.050
Molybdenum (Mo)	**10**	1.496	0.40	<1	2	1.5	1.8	2.1	1.5	2.9	1.9	2	1.1	1.8	1.3	<1.0	1
Nickel (Ni)	**50**	28.67	1.0	19	22	25.9	28	33.7	25.8	34.3	31.9	20.8	18	19.3	22	14.1	17.9
Phosphorus (P)	---	1422	20	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Potassium (K)	---	3603	25	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Selenium (Se)	**1**	0.803	0.50	0.8	0.8	0.55	0.61	0.55	0.43	0.52	0.41	0.29	0.24	0.34	0.49	<0.20	0.27
Silver (Ag)	**20**	<1.0	1.0	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium (Na)	---	8059	50	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Strontium (Sr)	---	81.38	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Thallium (Tl)	**1**	<1	0.30	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tin (Sn)	**50**	<5	1.0	<5	<5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Uranium (U)	**23**	<2	1.0	<2	<2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Vanadium (V)	**130**	77.69	1.0	27	45	40.2	39.6	52.1	36.7	44.9	35.4	22.7	22.3	38.1	27.5	20.4	21.6
Zinc (Zn)	**200**	71.19	10	70	150	55	66	81	51	53	94	43	43	48	52	37	54

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland

--- = Not analyzed or no criterion/guideline established.

RDL= Reportable Detection Limit
20 = Denoted the guideline/threshold
20 = Denotes parameter above guideline/threshold

Table B-2: Soil Chemical Concentrations
- Metals

PARAMETER	**Soil Criteria**		**RDL**	**APEC B-3**						**APEC D-1: POWERHOUSE LOCATED AT THE MAIN CAMP**						
Sample Number	**Federal**	**Established Background Level**		**B3-TP09-6A**	**B3-TP09-6B**	**B3-TP09-7A**	**B3-TP09-7B**	**B3-TP09-8A**	**B3-TP09-8B**	**APEC D1-TP08-1**	**APEC D1-TP08-2-1**	**APEC D1-TP08-2-2**	**DUP6 (APEC D1-TP08-2-2)**	**APEC D1-TP08-3**	**APEC D1-TP08-4**	**APEC D1-TP08-5**
Sample Date	**CCME 2007 [1] Residential/ Parkland**	**2009- 2012**		08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**
Sample Depth (m)				1	1.2	1	1.2	0.3	1.3	0.65	1	1	1	1	1.1	1.2
Total Metals (mg/kg)																
Aluminum (Al)	**---**	**16208**	10	---	---	---	---	---	---	---	---	---	---	---	---	---
Antimony (Sb)	**20**	<1.0	1.0	0.61	0.55	0.28	0.37	0.22	0.24	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic (As)	12	**14.69**	1.0	12.5	15.6	14.7	15.8	9.01	9.52	16.6	5.6	13	11.8	13.9	8.2	18.9
Barium (Ba)	**500**	106.6	10	33.7	38.2	28.2	41.6	20.6	18.7	41	101	28	53	38	40	40
Beryllium (Be)	4	**10.919**	0.40	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	<1	<1	<1
Bismuth (Bi)	---	<1.0	1.0	---	---	---	---	---	---	---	---	---	---	---	---	---
Boron (B)	---	20.72	2.0	---	---	---	---	---	---	---	---	---	---	---	---	---
Cadmium (Cd)	**10**	<1.0	0.10	<0.50	0.94	<0.50	<0.50	<0.50	<0.50	<0.5	0.8	<0.5	<0.5	<0.5	<0.5	<0.5
Calcium (Ca)	---	14753	50	---	---	---	---	---	---	---	---	---	---	---	---	---
Chromium (Cr)	**64**	25.04	1.0	18.2	16.5	11.7	12	7.62	8.75	13.8	31.1	8.3	9.6	11.3	9.5	11.8
Cobalt (Co)	**50**	17.59	1.0	13.9	10.7	8.4	10.2	5.1	6.5	12	4	8	8	10	7	12
Copper (Cu)	**63**	28.21	5.0	22.2	22	16.5	18.4	9.2	9.8	30	55	12	14	22	14	22
Iron (Fe)	---	67130	10	---	---	---	---	---	---	---	---	---	---	---	---	---
Lead (Pb)	**140**	13.66	1.0	13.9	17.8	9	10.3	5.4	6.1	12	29	8	8	11	9	11
Magnesium (Mg)	---	9704	20	---	---	---	---	---	---	---	---	---	---	---	---	---
Manganese (Mn)	---	897.7	10	---	---	---	---	---	---	---	---	---	---	---	---	---
Mercury (Hg)	**6.6**	0.0588	0.050	0.366	0.208	0.075	0.095	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum (Mo)	**10**	1.496	0.40	1.8	1.7	1.9	1.7	<1.0	1.2	2	1	<1	<1	1	<1	2
Nickel (Ni)	**50**	28.67	1.0	33.6	27.5	20.4	25.4	10.8	13	27	17	18	17	22	16	28
Phosphorus (P)	---	1422	20	---	---	---	---	---	---	---	---	---	---	---	---	---
Potassium (K)	---	3603	25	---	---	---	---	---	---	---	---	---	---	---	---	---
Selenium (Se)	**1**	0.803	0.50	0.43	0.42	0.38	0.42	<0.20	0.21	1	0.3	0.4	0.8	0.6	0.4	0.8
Silver (Ag)	**20**	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	<1	<1	<1
Sodium (Na)	---	8059	50	---	---	---	---	---	---	---	---	---	---	---	---	---
Strontium (Sr)	---	81.38	10	---	---	---	---	---	---	---	---	---	---	---	---	---
Thallium (Tl)	**1**	<1	0.30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1	<1	<1	<1
Tin (Sn)	**50**	<5	1.0	5.4	<5.0	<5.0	<5.0	<5.0	<5.0	<5	<5	<5	<5	<5	<5	<5
Uranium (U)	**23**	<2	1.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2	<2	<2	<2	<2	<2
Vanadium (V)	**130**	77.69	1.0	42	39.7	33.2	37.9	22.9	25.3	42	16	19	21	33	26	37
Zinc (Zn)	**200**	71.19	10	85	66	46	59	35	38	60	1570	40	40	50	40	80

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland

--- = Not analyzed or no criterion/guideline established.

RDL= Reportable Detection Limit
20 = Denoted the guideline/threshold
▨ 20 = Denotes parameter above guideline/threshold

Table B-2: Soil Chemical Concentrations
- Metals

PARAMETER	Soil Criteria		RDL	AEC D-1: POWERHOUSE LOCATED AT THE MAIN CAMP 2008											
Sample Number	**Federal**	**Established Background Level**		**APEC D1-TP08-6**	**APEC D1-HA08-1**	**APEC D1-HA08-2**	**APEC D1-HA08-3**	**APEC D1-HA08-4**	**APEC D1-HA08-5**	**APEC D1-HA08-7**	**APEC D1-HA08-8**	**DUP 10 (APEC D1-HA08-8)**	**APEC D1-HA08-9**	**APEC D1-SURFACE 08-1**	**APEC D1-SURFACE 08-2**
Sample Date	**CCME 2007 [1] Residential/ Parkland**	**2009- 2012**		**19/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**22/08/2008**	**21/08/2008**	**21/08/2008**
Sample Depth (m)				0.7	0.4	0.6	0.6	0.35	0.4	1.8	0.85	0.85	0.6	surface	surface
Total Metals (mg/kg)															
Aluminum (Al)	**---**	**16208**	10	---	---	---	---	---	---	---	---	---	---	---	---
Antimony (Sb)	**20**	<1.0	1.0	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic (As)	12	**14.69**	1.0	12.6	12	13.7	14.5	22.3	10.9	9.7	14.8	15	10.9	9.8	11.3
Barium (Ba)	**500**	106.6	10	30	53	42	47	37	21	39	40	37	65	42	38
Beryllium (Be)	4	**10.919**	0.40	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bismuth (Bi)	---	<1.0	1.0	---	---	---	---	---	---	---	---	---	---	---	---
Boron (B)	---	20.72	2.0	---	---	---	---	---	---	---	---	---	---	---	---
Cadmium (Cd)	**10**	<1.0	0.10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Calcium (Ca)	---	14753	50	---	---	---	---	---	---	---	---	---	---	---	---
Chromium (Cr)	**64**	25.04	1.0	8.5	16.3	14.1	15.3	11	9.5	16.4	12.7	12.4	19.2	15.2	13.7
Cobalt (Co)	**50**	17.59	1.0	8	10	10	10	11	10	8	10	10	9	7	11
Copper (Cu)	**63**	28.21	5.0	10	16	22	21	28	21	15	26	23	16	26	37
Iron (Fe)	---	67130	10	---	---	---	---	---	---	---	---	---	---	---	---
Lead (Pb)	**140**	13.66	1.0	8	13	11	11	13	8	10	21	26	12	64	10
Magnesium (Mg)	---	9704	20	---	---	---	---	---	---	---	---	---	---	---	---
Manganese (Mn)	---	897.7	10	---	---	---	---	---	---	---	---	---	---	---	---
Mercury (Hg)	**6.6**	0.0588	0.050	<0.05	0.07	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum (Mo)	**10**	1.496	0.40	<1	<1	1	1	3	<1	<1	1	2	<1	3	1
Nickel (Ni)	**50**	28.67	1.0	17	22	23	25	28	23	19	21	21	20	17	21
Phosphorus (P)	---	1422	20	---	---	---	---	---	---	---	---	---	---	---	---
Potassium (K)	---	3603	25	---	---	---	---	---	---	---	---	---	---	---	---
Selenium (Se)	**1**	0.803	0.50	0.3	0.6	0.7	0.7	1.1	0.6	0.5	0.6	0.6	1	0.4	0.6
Silver (Ag)	**20**	<1.0	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium (Na)	---	8059	50	---	---	---	---	---	---	---	---	---	---	---	---
Strontium (Sr)	---	81.38	10	---	---	---	---	---	---	---	---	---	---	---	---
Thallium (Tl)	**1**	<1	0.30	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Tin (Sn)	**50**	<5	1.0	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Uranium (U)	**23**	<2	1.0	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Vanadium (V)	**130**	77.69	1.0	19	29	32	33	41	27	27	38	32	30	26	45
Zinc (Zn)	**200**	71.19	10	40	60	60	70	70	90	50	60	50	70	700	140

Notes:

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20 = Denotes parameter above guideline/threshold

Table B-2: Soil Chemical Concentrations
- Metals

PARAMETER	**Soil Criteria**		**RDL**	**AEC D: Powerhouse 2009**															
Sample Number	**Federal**	**Established Background Level**		**D1-TP09-1A**	**D1-TP09-1B**	**D1-TP09-2A**	**D1-TP09-2B**	**D1-TP09-3A**	**D1-TP09-3B**	**D1-TP09-4A**	**D1-TP09-4B**	**D1-TP09-5A**	**D1-TP09-5B**	**D1-TP09-6A**	**D1-TP09-DUP1A**	**D1-TP09-6B**	**D1-TP09-DUP1B**	**D1-HA09-1**	**D1-HA09-2**
Sample Date	**CCME 2007 [1] Residential/ Parkland**	**2009- 2012**		13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009
Sample Depth (m)				0.5	1	1.75	1.8	0.5	1.3	1	1.2	1	1.1	1	1	1.8	1.8	0.8	0.5
Total Metals (mg/kg)																			
Aluminum (Al)	**---**	**16208**	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Antimony (Sb)	**20**	<1.0	1.0	<0.20	0.2	0.47	0.28	0.35	0.31	0.34	0.26	0.5	0.29	0.43	0.38	0.38	0.36	0.22	0.28
Arsenic (As)	12	**14.69**	1.0	13.7	9.21	16.6	13.3	11.6	12.3	10.7	11.8	10.1	13.9	10.1	14.4	17.3	14.7	10.7	12.4
Barium (Ba)	**500**	106.6	10	32.2	29.7	16.8	16.3	37.6	39.7	49.6	33.6	43.5	37	38.4	38.1	42	45.4	35.5	37.1
Beryllium (Be)	4	**10.919**	0.40	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bismuth (Bi)	---	<1.0	1.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Boron (B)	---	20.72	2.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Cadmium (Cd)	**10**	<1.0	0.10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Calcium (Ca)	---	14753	50	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chromium (Cr)	**64**	25.04	1.0	8.19	10.4	8.62	7.44	14	15.7	16.9	12.2	13.5	11.7	11.4	12.9	17	14.7	13.3	13.8
Cobalt (Co)	**50**	17.59	1.0	6.9	7.2	7.1	6.9	9.4	10.1	9.2	8.1	8.1	9.5	6.4	8.5	10.5	10.7	8.5	9.8
Copper (Cu)	**63**	28.21	5.0	12.7	12.9	28.7	14	24.6	23.7	27.4	19	24.7	15.5	17.9	22.3	27.5	29	15.6	21.8
Iron (Fe)	---	67130	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Lead (Pb)	**140**	13.66	1.0	6.1	7.9	10.7	35.8	12.8	16	27.6	10.6	10.7	9	12.9	11.9	25.5	13.5	10.8	10.9
Magnesium (Mg)	---	9704	20	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Manganese (Mn)	---	897.7	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mercury (Hg)	**6.6**	0.0588	0.050	0.062	<0.050	0.054	0.052	0.066	0.068	0.061	0.056	<0.050	0.059	0.053	0.078	0.088	0.072	<0.050	0.087
Molybdenum (Mo)	**10**	1.496	0.40	1.5	<1.0	2.2	1.9	1.3	1.5	1.4	1.4	1.2	1.2	1.4	3.2	1.9	1.9	1.2	1.5
Nickel (Ni)	**50**	28.67	1.0	16.6	16.7	14.9	14.4	22	22.8	20.6	18.7	19.7	21.2	15.5	19.8	23.5	25.4	19.7	22.5
Phosphorus (P)	---	1422	20	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Potassium (K)	---	3603	25	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Selenium (Se)	**1**	0.803	0.50	0.86	0.41	0.45	0.36	0.52	0.52	0.51	0.42	0.47	0.39	0.43	0.61	0.6	0.63	0.5	0.54
Silver (Ag)	**20**	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium (Na)	---	8059	50	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Strontium (Sr)	---	81.38	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Thallium (Tl)	**1**	<1	0.30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tin (Sn)	**50**	<5	1.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Uranium (U)	**23**	<2	1.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Vanadium (V)	**130**	77.69	1.0	25.7	21.9	32.3	28	42	44.1	34.8	34.4	36.7	32.1	30.2	37	49.6	50	26.4	38
Zinc (Zn)	**200**	71.19	10	34	39	38	33	52	70	76	54	43	45	42	46	54	53	53	53

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland

--- = Not analyzed or no criterion/guideline established.

RDL= Reportable Detection Limit
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▨ 20 = Denotes parameter above guideline/threshold

Table B-2: Soil Chemical Concentrations
- Metals

PARAMETER	Soil Criteria		RDL	AEC D: Powerhouse 2009										AEC D: Powerhouse 2010				
Sample Number	**Federal**	**Established Background Level**		**D1-HA09-3**	**D1-HA09-4**	**D1-HA09-5**	**D1-HA09-6**	**D1-HA09-7**	**D1-HA09-8**	**D1-HA09-9**	**D1-HA09-10**	**D1-HA09-11**	**D1-HA09-12**	**D1-HA10-1**	**D1-HA10-2**	**D1-HA10-DUP1**	**D1-HA10-3**	**D1-HA10-4**
Sample Date	**CCME 2007 [1] Residential/ Parkland**	**2009- 2012**		13/8/2009	13/8/2009	13/8/2009	13/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010
Sample Depth (m)				0.5	0.7	0.3	0.2	0.1	0.1	0.15	0.1	0.1	0.1	0.1	0.15	0.15	0.1	0.05
Total Metals (mg/kg)																		
Aluminum (Al)	**---**	**16208**	10	---	---	---	---	---	---	---	---	---	---	3000	4800	4500	4600	3100
Antimony (Sb)	**20**	<1.0	1.0	<0.20	0.28	<0.20	0.27	<0.20	0.4	0.32	0.26	0.29	0.34	0.2	<0.2	0.2	<0.2	<0.2
Arsenic (As)	12	**14.69**	1.0	4.13	17.7	6.18	8.65	5.57	12	14.2	6.58	10.5	13.8	13	11	10	10	8
Barium (Ba)	**500**	106.6	10	33.6	30.8	24.4	36.8	39.9	40.9	33.7	27.3	35.7	44.2	24	47	43	41	31
Beryllium (Be)	4	**10.919**	0.40	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.3	0.5	0.4	0.4	0.3
Bismuth (Bi)	---	<1.0	1.0	---	---	---	---	---	---	---	---	---	---	<1	<1	<1	<1	<1
Boron (B)	---	20.72	2.0	---	---	---	---	---	---	---	---	---	---	<5	11	10	7	8
Cadmium (Cd)	**10**	<1.0	0.10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium (Ca)	---	14753	50	---	---	---	---	---	---	---	---	---	---	1800	3000	3600	4600	12000
Chromium (Cr)	**64**	25.04	1.0	6.18	12.7	8.2	13.3	7.18	13.8	13.8	8.46	12.7	15.4	12	12	12	12	8
Cobalt (Co)	**50**	17.59	1.0	3.9	9.9	6	6.8	3	10.1	10.4	5.9	7.7	9.8	7.8	8.2	8.1	7.2	6.7
Copper (Cu)	**63**	28.21	5.0	7.2	24.9	10.3	16.4	7.1	20.6	19.3	10.8	17.2	26.3	17	21	20	18	13
Iron (Fe)	---	67130	10	---	---	---	---	---	---	---	---	---	---	30000	26000	28000	25000	26000
Lead (Pb)	**140**	13.66	1.0	<5.0	10.5	6.4	11.9	<5.0	15.3	10.4	6.8	11.4	17.1	9	11	10	10	7
Magnesium (Mg)	---	9704	20	---	---	---	---	---	---	---	---	---	---	1800	3000	3000	3800	5900
Manganese (Mn)	---	897.7	10	---	---	---	---	---	---	---	---	---	---	360	260	340	270	280
Mercury (Hg)	**6.6**	0.0588	0.050	<0.050	0.123	<0.050	<0.050	<0.050	0.056	0.08	<0.050	0.054	0.076	0.09	<0.05	<0.05	<0.05	<0.05
Molybdenum (Mo)	**10**	1.496	0.40	<1.0	2.4	<1.0	1.4	1.6	1.6	1.9	<1.0	1.3	1.6	1.1	0.9	0.9	0.9	1.0
Nickel (Ni)	**50**	28.67	1.0	12.1	24.4	13.2	17.2	9.9	23	23.8	13.2	17.5	23	18	23	23	21	16
Phosphorus (P)	---	1422	20	---	---	---	---	---	---	---	---	---	---	300	400	430	390	360
Potassium (K)	---	3603	25	---	---	---	---	---	---	---	---	---	---	460	950	840	930	530
Selenium (Se)	**1**	0.803	0.50	0.3	0.75	0.25	0.28	<0.20	0.5	0.63	0.29	0.48	0.58	<0.5	<0.5	<0.5	<0.5	<0.5
Silver (Ag)	**20**	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.2	<0.2	<0.2	<0.2	<0.2
Sodium (Na)	---	8059	50	---	---	---	---	---	---	---	---	---	---	170	170	160	140	350
Strontium (Sr)	---	81.38	10	---	---	---	---	---	---	---	---	---	---	15	48	46	32	25
Thallium (Tl)	**1**	<1	0.30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.14	0.08	0.10	0.10	0.06
Tin (Sn)	**50**	<5	1.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5	<5	<5	<5	<5
Uranium (U)	**23**	<2	1.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0.40	0.76	0.61	0.59	0.50
Vanadium (V)	**130**	77.69	1.0	12.2	38.1	28	29	12.7	39	34.5	21.5	32.5	39	45	29	35	30	27
Zinc (Zn)	**200**	71.19	10	55	51	39	71	20	62	56	36	46	57	50	58	54	67	39

Notes:

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Table B-2: Soil Chemical Concentrations
- Metals

PARAMETER	**Soil Criteria**		**RDL**	**AEC D: Powerhouse 2010**												
Sample Number	**Federal**	**Established Background Level**		**D1-HA10-5**	**D1-TP10-1**	**D1-TP10-DUP2**	**D1-TP10-2A**	**D1-TP10-2B**	**D1-TP10-3**	**D1-TP10-4**	**D1-TP10-5**	**D1-TP10-6**	**D1-TP10-7A**	**D1-TP10-7B**	**D1-TP10-8A**	**D1-TP10-8B**
Sample Date	**CCME 2007 [1] Residential/ Parkland**	**2009- 2012**		17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010
Sample Depth (m)				0.05	0.1	0.1	0.05	0.9	0.1	0.1	0.05	0.1	0.05	0.5	0.1	1.1
Total Metals (mg/kg)																
Aluminum (Al)	**---**	**16208**	10	4500	3600	3500	3200	4800	4100	3500	4300	5400	4100	4100	2600	4000
Antimony (Sb)	**20**	<1.0	1.0	<0.2	0.2	0.2	<0.2	<0.2	<0.2	<0.2	0.2	1.2	0.3	<0.2	<0.2	<0.2
Arsenic (As)	12	**14.69**	1.0	11	16	16	6	8	8	7	9	14	16	8	12	8
Barium (Ba)	**500**	106.6	10	43	31	32	26	29	27	30	31	45	25	33	22	34
Beryllium (Be)	4	**10.919**	0.40	0.5	0.4	0.3	0.3	0.5	0.5	0.4	0.3	0.4	0.4	0.4	0.2	0.4
Bismuth (Bi)	---	<1.0	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Boron (B)	---	20.72	2.0	7	7	6	10	15	7	7	9	11	8	14	9	18
Cadmium (Cd)	**10**	<1.0	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1
Calcium (Ca)	---	14753	50	2600	2100	1800	2500	2100	2000	1500	2700	2300	4500	1600	1100	2000
Chromium (Cr)	**64**	25.04	1.0	11	14	12	8	12	11	9	10	13	16	10	8	10
Cobalt (Co)	**50**	17.59	1.0	8.3	9.9	8.3	6.1	8.1	7.6	6.4	8.5	9.4	11	7.0	5.8	6.0
Copper (Cu)	**63**	28.21	5.0	18	21	19	11	16	14	13	15	95	24	14	12	12
Iron (Fe)	---	67130	10	27000	40000	35000	15000	22000	21000	17000	22000	34000	41000	17000	20000	16000
Lead (Pb)	**140**	13.66	1.0	11	11	10	8	11	11	8	13	45	11	10	8	10
Magnesium (Mg)	---	9704	20	2700	1900	1700	2400	2900	2100	1500	2300	2300	2900	2300	1500	2500
Manganese (Mn)	---	897.7	10	230	450	350	160	340	210	350	400	370	430	200	150	110
Mercury (Hg)	**6.6**	0.0588	0.050	0.07	0.11	0.12	<0.05	<0.05	<0.05	<0.05	0.05	0.08	0.10	0.06	0.07	<0.05
Molybdenum (Mo)	**10**	1.496	0.40	0.8	1.3	1.3	0.7	0.7	1.0	0.6	1.2	1.6	1.4	0.8	1.0	1.0
Nickel (Ni)	**50**	28.67	1.0	21	22	19	14	20	18	15	19	26	25	16	12	14
Phosphorus (P)	---	1422	20	390	400	420	300	380	350	290	370	430	550	320	260	360
Potassium (K)	---	3603	25	870	640	570	770	1000	670	730	970	970	700	1000	570	1200
Selenium (Se)	**1**	0.803	0.50	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silver (Ag)	**20**	<1.0	1.0	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sodium (Na)	---	8059	50	700	330	300	1100	2400	200	170	<100	430	340	1200	790	2500
Strontium (Sr)	---	81.38	10	29	17	19	22	28	17	18	22	26	22	27	18	32
Thallium (Tl)	**1**	<1	0.30	0.09	0.09	0.09	<0.05	0.06	0.06	0.06	0.07	0.08	0.13	0.08	<0.05	0.07
Tin (Sn)	**50**	<5	1.0	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Uranium (U)	**23**	<2	1.0	0.61	0.49	0.41	0.50	0.61	0.58	0.45	0.70	0.62	0.61	0.67	0.48	0.70
Vanadium (V)	**130**	77.69	1.0	29	57	55	18	22	25	23	24	45	48	20	28	21
Zinc (Zn)	**200**	71.19	10	53	57	53	37	48	45	43	51	77	62	44	38	44

Notes:

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RDL=	Reportable Detection Limit
20 =	Denoted the guideline/threshold
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Table B-2: Soil Chemical Concentrations
- Metals

PARAMETER	**Soil Criteria**		**RDL**	**AEC D: Powerhouse 2012**													**Delta 2012**			
Sample Number	**Federal**	**Established Background Level**		**D1-TP12-1A**	**D1-TP12-1B**	**D1-TP12-4A**	**D1-TP12-4B**	**DUP-1 (Duplicated of D1-TP12-4B)**	**D1-TP12-6**	**DUP-2 (Duplicated of D1-TP12-6)**	**D1-TP12-8A**	**D1-TP12-8B**	**D1-TP12-9A**	**D1-TP12-9B**	**D1-HA12-1B**	**DUP-4 (Duplicated of D1-HA12-1B)**	**Delta-TP12-1A**	**Delta-TP12-1B**	**Delta-TP12-3A**	**Delta-TP12-3B**
Sample Date	**CCME 2007 [1] Residential/ Parkland**	**2009- 2012**		13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012			14/08/2012	14/08/2012	14/08/2012	14/08/2012
Sample Depth (m)				0.2 - 0.5	0.7 - 1.7	0.3 - 0.8	0.8 - 1.3	0.8 - 1.3	0.1 - 0.8	0.1 - 0.8	0.4 - 0.8	0.8 - 1.2	0.1 - 0.5	0.5 -1.1	0.7 - 0.9	0.7 - 0.9	0.1 - 1.0	1.0 - 1.5	0.1 - 0.5	0.5 - 1.0
Total Metals (mg/kg)																				
Aluminum (Al)	**---**	**16208**	10	5600	6700	3300	5900	6100	5500	6100	3800	2900	2900	4900	8500	9000	5400	8600	3800	5800
Antimony (Sb)	**20**	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic (As)	12	**14.69**	1.0	13	12	2.6	11	11	12	11	15	11	13	11	13	13	14	10	11	10
Barium (Ba)	**500**	106.6	10	39	40	27	27	31	26	26	24	16	21	28	34	41	20	45	15	40
Beryllium (Be)	4	**10.919**	0.40	0.42	0.48	<0.40	0.44	0.44	<0.40	0.42	<0.40	<0.40	<0.40	0.46	0.61	0.72	0.52	0.65	<0.40	0.45
Bismuth (Bi)	---	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Boron (B)	---	20.72	2.0	8.5	10	3.1	9.2	10	8.4	7.8	6.4	5.9	2.8	9.6	14	16	8.8	27	8.0	17
Cadmium (Cd)	**10**	<1.0	0.10	0.12	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.20	0.39	<0.10	0.10	<0.10	<0.10	<0.10	<0.10
Calcium (Ca)	---	14753	50	5800	4900	12000	2900	2500	1800	2000	1700	1500	1400	4200	7400	7100	2300	1900	1900	2900
Chromium (Cr)	**64**	25.04	1.0	12	16	4.2	13	13	19	35	8.1	6.0	6.0	20	16	18	10	19	7.9	21
Cobalt (Co)	**50**	17.59	1.0	9.0	9.5	2.5	7.7	7.2	7.8	8.3	8.0	5.5	6.1	7.4	9.6	9.3	11	8.6	6.3	8.3
Copper (Cu)	**63**	28.21	5.0	26	30	15	14	14	16	15	19	13	26	27	28	39	19	17	19	14
Iron (Fe)	---	67130	10	40000	43000	13000	26000	24000	27000	29000	31000	24000	28000	29000	35000	40000	38000	25000	27000	28000
Lead (Pb)	**140**	13.66	1.0	13	11	2.8	8.2	8.4	9.8	8.4	9.9	6.1	15	15	11	11	8.2	12	10	9.3
Magnesium (Mg)	---	9704	20	3600	3400	9800	2800	2500	2000	2200	1400	1300	1200	2100	5000	5300	2100	3500	1900	3000
Manganese (Mn)	---	897.7	10	440	420	95	270	250	320	300	310	200	330	320	330	370	340	230	250	360
Mercury (Hg)	**6.6**	0.0588	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Molybdenum (Mo)	**10**	1.496	0.40	1.8	1.2	<0.40	0.99	1.0	1.4	1.5	1.4	1.5	1.5	1.7	1.3	1.2	1.4	1.0	1.1	0.97
Nickel (Ni)	**50**	28.67	1.0	21	22	6.6	20	20	22	31	18	12	18	23	29	29	24	22	16	25
Phosphorus (P)	---	1422	20	450	560	200	340	340	380	400	410	280	310	420	430	540	490	470	340	570
Potassium (K)	---	3603	25	890	980	340	1000	1100	1000	970	570	410	300	780	1500	1800	780	2000	500	1200
Selenium (Se)	**1**	0.803	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.52	0.73	0.63	0.58	<0.50	<0.50	<0.50	<0.50
Silver (Ag)	**20**	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium (Na)	---	8059	50	200	230	120	240	210	280	380	88	310	<50	150	65	100	260	2500	1000	2500
Strontium (Sr)	---	81.38	10	25	27	35	21	23	21	20	16	15	10	27	45	53	19	44	17	38
Thallium (Tl)	**1**	<1	0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Tin (Sn)	**50**	<5	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Uranium (U)	**23**	<2	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vanadium (V)	**130**	77.69	1.0	41	46	9.3	25	24	33	32	27	25	28	31	34	35	32	30	25	24
Zinc (Zn)	**200**	71.19	10	52	53	19	40	40	44	48	41	30	65	83	62	67	53	54	34	42

Notes:

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RDL= Reportable Detection Limit
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20 = Denotes parameter above guideline/threshold

Table B-2: Soil Chemical Concentrations
- Metals

PARAMETER	**Soil Criteria**		**RDL**	**Delta 2012**				**Station Creek 2012**		**APEC E-1: HYDROGEN BUILDING**			**APEC E 2009**						
Sample Number	**Federal**	**Established Background Level**		**Delta-TP12-4**	**Delta-TP12-6**	**Delta-TP12-8A**	**Delta-TP12-8B**	**SC-TP12-1**	**SC-TP12-3**	**APEC E1-TP08-1**	**APEC E1-TP08-2**	**APEC E1-HA08-1**	**E-HA09-1A**	**E-HA09-1B**	**E-HA09-2A**	**E-HA09-2B**	**E-HA09-3A**	**E-HA09-3B**	**E-HA09-4A**
Sample Date	**CCME 2007 [1] Residential/ Parkland**	**2009- 2012**		14/08/2012	14/08/2012	14/08/2012	14/08/2012			**20/08/2008**	**20/08/2008**	**20/08/2008**	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009
Sample Depth (m)				0.5 - 1.5	0.1 - 0.6	0.1 - 0.8	0. 8 - 1.0	0.5 - 1.0	0.5 - 1.0	1.4	1	0.5	0.3	1.2	0.3	0.9	0.3	0.5	0.3
Total Metals (mg/kg)																			
Aluminum (Al)	**---**	**16208**	10	5700	4300	6000	9000	5200	9100	---	---	---	---	---	---	---	---	---	---
Antimony (Sb)	**20**	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.2	<0.2	<0.2	0.23	0.24	0.56	0.56	0.53	0.4	0.35
Arsenic (As)	12	**14.69**	1.0	9.9	10	21	14	9.6	10	16.5	13.1	10.5	7.05	7.91	10.2	12.1	13.8	18.7	13.6
Barium (Ba)	**500**	106.6	10	31	24	35	54	25	38	39	58	48	35.3	45.3	68.8	49.3	34.2	33.8	38.3
Beryllium (Be)	4	**10.919**	0.40	0.49	<0.40	0.46	0.61	0.43	0.70	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bismuth (Bi)	---	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	---	---	---	---	---	---	---	---	---	---
Boron (B)	---	20.72	2.0	24	14	6.5	15	15	18	---	---	---	---	---	---	---	---	---	---
Cadmium (Cd)	**10**	<1.0	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.5	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Calcium (Ca)	---	14753	50	2300	2600	4600	2300	2500	3100	---	---	---	---	---	---	---	---	---	---
Chromium (Cr)	**64**	25.04	1.0	13	11	30	21	11	17	14.4	23.1	15.9	9.7	24.1	17.2	19	14.3	18.3	13.7
Cobalt (Co)	**50**	17.59	1.0	6.7	6.3	11	8.9	7.7	9.3	12	10	8	5.3	7.5	9.5	10.4	8.9	10.1	8.3
Copper (Cu)	**63**	28.21	5.0	13	10	31	18	38	34	25	20	16	11.9	13.1	19.6	20.8	18	22	18.6
Iron (Fe)	---	67130	10	21000	22000	51000	31000	21000	29000	---	---	---	---	---	---	---	---	---	---
Lead (Pb)	**140**	13.66	1.0	9.3	6.4	11	14	7.9	11	10	15	11	10	10.9	15.7	18.1	11	10.2	10.5
Magnesium (Mg)	---	9704	20	3100	2300	3000	2900	2600	4500	---	---	---	---	---	---	---	---	---	---
Manganese (Mn)	---	897.7	10	160	210	550	230	280	280	---	---	---	---	---	---	---	---	---	---
Mercury (Hg)	**6.6**	0.0588	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.050	<0.050	0.055	<0.050	0.072	0.061	<0.050
Molybdenum (Mo)	**10**	1.496	0.40	1.3	1.2	2.4	1.0	0.97	0.91	2	<1	1	<1.0	1.3	1.3	1.5	1.6	1.7	1.1
Nickel (Ni)	**50**	28.67	1.0	17	16	35	23	19	25	28	23	18	12	21.2	22.2	24	19.8	23.5	19.1
Phosphorus (P)	---	1422	20	350	350	750	500	360	460	---	---	---	---	---	---	---	---	---	---
Potassium (K)	---	3603	25	1400	810	860	2000	1100	1800	---	---	---	---	---	---	---	---	---	---
Selenium (Se)	**1**	0.803	0.50	<0.50	<0.50	0.67	0.53	<0.50	<0.50	0.7	0.6	0.7	0.36	0.4	0.55	0.53	0.55	0.52	0.46
Silver (Ag)	**20**	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium (Na)	---	8059	50	3700	1500	340	800	980	4400	---	---	---	---	---	---	---	---	---	---
Strontium (Sr)	---	81.38	10	30	21	27	57	25	34	---	---	---	---	---	---	---	---	---	---
Thallium (Tl)	**1**	<1	0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tin (Sn)	**50**	<5	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5	<5	<5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Uranium (U)	**23**	<2	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<2	<2	<2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Vanadium (V)	**130**	77.69	1.0	24	23	53	32	25	29	43	35	25	23.8	23	30.8	31.8	39.1	47.1	32.6
Zinc (Zn)	**200**	71.19	10	46	35	54	61	46	54	70	70	50	35	50	67	66	49	53	53

Notes:

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--- = Not analyzed or no criterion/guideline established.

RDL= Reportable Detection Limit
20 = Denoted the guideline/threshold
20 = Denotes parameter above guideline/threshold

Table B-2: Soil Chemical Concentrations
- Metals

PARAMETER	**Soil Criteria**		**RDL**	**APEC E 2009**							**APEC H**									**Borrow Source**	
Sample Number	**Federal**	**Established Background Level**		**E-HA09-4B**	**E-HA09-5A**	**E-HA09-5B**	**E-HA09-6A**	**E-HA09-6B**	**E-HA09-7A**	**E-HA09-7B**	**H-TP09-1A**	**H-TP09-1B**	**H-TP09-2A**	**H-TP09-2B**	**H-TP09-3A**	**H-TP09-3B**	**H-HA09-1**	**H-HA09-2**	**H-HA09-3**	**Borrow-1**	**Borrow-2**
Sample Date	**CCME 2007 [1] Residential/ Parkland**	**2009- 2012**		08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009		
Sample Depth (m)				0.9	0.3	1	0.3	0.9	0.3	0.5	1	1.1	1.4	2	1.3	1.5	0.2	0.3	0.2	0.1 - 0.2	0.1 - 0.2
Total Metals (mg/kg)																					
Aluminum (Al)	**---**	**16208**	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	25000	3800
Antimony (Sb)	**20**	<1.0	1.0	0.3	0.47	0.33	0.33	0.34	0.44	0.37	0.31	0.26	0.34	0.32	0.23	0.27	0.31	<0.20	0.47	<1.0	<1.0
Arsenic (As)	12	**14.69**	1.0	13.5	15.5	13.3	15.6	16.6	21.3	14.7	15.3	13.3	13.4	15.1	10.7	10.7	13.4	4.18	15.5	4.9	16
Barium (Ba)	**500**	106.6	10	46	47.2	35.3	38.5	37.6	37.3	35.5	37.1	42.6	38.7	39.9	38.1	30	35.1	28.7	38	120	19
Beryllium (Be)	4	**10.919**	0.40	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.53	0.42
Bismuth (Bi)	---	<1.0	1.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<1.0	<1.0
Boron (B)	---	20.72	2.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5.2	3.7
Cadmium (Cd)	**10**	<1.0	0.10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.10	<0.10
Calcium (Ca)	---	14753	50	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	15000	2300
Chromium (Cr)	**64**	25.04	1.0	14.2	15.4	15.2	14.8	15.6	16.1	15.4	12.5	16.4	13.7	13.5	14.9	12	11.9	5.95	16.5	11	8.0
Cobalt (Co)	**50**	17.59	1.0	7.7	11.2	9.5	9.2	9.9	10.6	11.3	10.5	9.9	10.6	9.9	8.5	8.8	8	3.1	9.6	25	8.3
Copper (Cu)	**63**	28.21	5.0	17.9	22	20.7	19	19.8	22.8	23	21.8	29.1	25.4	22.8	24.2	22.3	19.9	8.1	29.2	22	13
Iron (Fe)	---	67130	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	51000	36000
Lead (Pb)	**140**	13.66	1.0	10.5	10	9.9	9.6	10.7	11.8	10.3	9.8	12	11.9	10.7	14.4	10.5	13.5	<5.0	56.1	4.9	6.6
Magnesium (Mg)	---	9704	20	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	12000	1800
Manganese (Mn)	---	897.7	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	480	430
Mercury (Hg)	**6.6**	0.0588	0.050	<0.050	0.082	0.063	0.059	0.078	0.084	0.097	0.107	0.067	0.082	0.08	<0.050	0.053	0.063	<0.050	0.065	<0.050	<0.050
Molybdenum (Mo)	**10**	1.496	0.40	1.7	1.9	1.6	1.4	1.9	1.8	2.3	1.5	1.6	1.7	1.5	1.2	1.2	1.7	<1.0	1.8	0.66	0.83
Nickel (Ni)	**50**	28.67	1.0	18.4	24.8	21.9	20.6	23.1	25	26.7	25.5	23.8	25.7	23.8	20.2	19.1	21	8.3	21.8	26	19
Phosphorus (P)	---	1422	20	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1500	690
Potassium (K)	---	3603	25	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3400	390
Selenium (Se)	**1**	0.803	0.50	0.56	0.59	0.5	0.51	0.52	0.49	0.6	0.76	0.59	0.67	0.58	0.48	0.42	0.5	0.25	0.5	<0.50	<0.50
Silver (Ag)	**20**	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium (Na)	---	8059	50	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5100	270
Strontium (Sr)	---	81.38	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	76	17
Thallium (Tl)	**1**	<1	0.30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.30	<0.30
Tin (Sn)	**50**	<5	1.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<1.0	<1.0
Uranium (U)	**23**	<2	1.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<1.0	<1.0
Vanadium (V)	**130**	77.69	1.0	25.7	47.9	54.3	49.1	44.1	46.7	44.1	35.1	39.3	46.2	42.6	31.9	33.5	31	13.1	40.5	140	34
Zinc (Zn)	**200**	71.19	10	51	65	55	51	51	61	59	50	59	52	53	50	42	51	36	58	52	43

Notes:

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20 = Denotes parameter above guideline/threshold

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria			Risk Assessment	RDL	APEC A-1-2-3: LANDFILL 2008							APEC A-4 & A-5: ASBESTOS & ASH LANDFILL 2008					
Sample Number	Federal		Provincial			LANDFILL -HA08-2	LANDFILL -HA08-3	LANDFILL -HA08-4	LANDFILL -HA08-5	DUP1 (LANDFILL -HA08-5)	LANDFILL -HA08-6	LANDFILL -HA08-7	LANDFILL AA-TP08-1	LANDFILL AA-TP08-2	LANDFILL AA-TP08-3	LANDFILL AA-TP08-4	LANDFILL AA-HA08-1	LANDFILL AA-HA08-2
Sampling Date	Env. Health (non carcinogenic effects)	Human health (carcinogenic effects)	MOE Table 2^3 Residential / Parkland	SSTL		16/08/2008	16/08/2008	16/08/2008	16/08/2008	16/08/2008	16/08/2008	16/08/2008	17/08/2008	17/08/2008	17/08/2008	17/08/2008	17/08/2008	17/08/2008
Sampling Depth (m)						1	1.1	1.15	1	1	0.6	1.1	0.56	0.56	1.15	0.82	0.68	0.7
BTEX Parameters (mg/kg)																		
Benzene	0.03	NC	NA	---	0.005	---	---	---	---	---	---	---	---	---	---	---	---	---
Toluene	0.37	NC	NA	---	0.01	---	---	---	---	---	---	---	---	---	---	---	---	---
Ethylbenzene	0.082	NC	NA	---	0.01	---	---	---	---	---	---	---	---	---	---	---	---	---
Xylenes	11	NC	NA	---	0.02	---	---	---	---	---	---	---	---	---	---	---	---	---
Petroleum Hydrocarbons (mg/kg)																		
F1(C6-C10) - BTEX	NC	30	NC	---	12	---	---	---	---	---	---	---	---	---	---	---	---	---
F2 (C10-C16)	NC	150	NC	1374	10	<5	<5	<5	<5	<5	<5	<5	---	---	---	---	---	---
F3 (C16-C34)	NC	300	NC	---	10	91	99	140	89	82	66	54	---	---	---	---	---	---
F4 (C34-C50)	NC	2800	NC	---	10	36	36	67	32	49	30	31	---	---	---	---	---	---
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	YES	YES	NO	YES	YES	YES	YES	---	---	---	---	---	---
% Moisture	NC	NC	NC	---	0.1	24	25	26	23	33	33	33	20	19	22	27	20	19
Polycyclic Aromatics (mg/kg)																		
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	---	---	---	---	---	---	---	---	---	---	---	---
Acridine	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02	<0.01	<0.01
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.04	0.04	0.01	<0.01
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02	<0.01	<0.01
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluorene	15.4	---	62	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01
2-Methyl Naphthalene	---	---	0.99	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02	<0.01	<0.01
Naphthalene	0.013	---	0.6	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	0.046	---	6.2	---	0.0050	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	0.05	0.02	0.01
Perylene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.07	0.07	0.02	<0.01
Quinoline	---	---	---	---	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
1-Methyl Naphthalene	---	---	1.2	---	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.01	0.02	<0.01

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria			Risk Assessment	RDL	APEC A-6: BARREL CRUSHING AREA AND BAREL LANDFILLS 2008								APEC A-7: EX-SITU BIOTREATMENT CELL								
Sample Number	**Federal**		**Provincial**			**APEC A6-HA08-1**	**APEC A6-HA08-2**	**APEC A6-HA08-3**	**APEC A6-HA08-4**	**APEC A6-HA08-5**	**DUP 4 (APEC A6-HA08-5)**	**APEC A6-HA08-6**	**APEC A6-HA08-7**	**APEC A7-TP08-1**	**APEC A7-TP08-2**	**DUP 2 (APEC A7-TP08-2)**	**APEC A7-TP08-3**	**APEC A7-TP08-4**	**APEC A7-HA08-1**	**APEC A7-HA08-2**	**APEC A7-HA08-3**	**DUP 3 (APEC A7-HA08-3)**
Sampling Date						**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**17/08/2008**	**17/08/2008**	**17/08/2008**	**17/08/2008**	**17/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**
Sampling Depth (m)	**Env. Health (non-carcinogenic effects)**	**Human health (carcinogenic effects)**	**MOE Table 2^3 Residential / Parkland**	**SSTL**		0.9	1.2	0.8	1	0.8	0.8	1	1	1	1	1	1.3	1.2	0.65	0.55	0.6	0.6
BTEX Parameters (mg/kg)																						
Benzene	0.03	NC	NA	---	0.005	---	---	---	---	---	---	---	---	<0.005	<0.005	0.008	<0.005	0.013	<0.005	<0.005	<0.005	<0.005
Toluene	0.37	NC	NA	---	0.01	---	---	---	---	---	---	---	---	0.019	<0.01	0.02	0.04	0.04	<0.01	<0.01	<0.01	<0.01
Ethylbenzene	0.082	NC	NA	---	0.01	---	---	---	---	---	---	---	---	<0.01	<0.01	<0.01	0.11	0.03	<0.01	<0.01	<0.01	<0.01
Xylenes	11	NC	NA	---	0.02	---	---	---	---	---	---	---	---	0.043	<0.02	0.03	0.92	0.26	<0.02	<0.02	<0.02	<0.02
Petroleum Hydrocarbons (mg/kg)																						
F1(C6-C10) - BTEX	NC	30	NC	---	12	---	---	---	---	---	---	---	---	<5	<5	63	88	150	<5	<5	<5	<5
F2 (C10-C16)	NC	150	NC	1374	10	<5	<5	<5	<5	<5	<5	<5	<5	440	14	870	2300	1200	<5	<5	<5	<5
F3 (C16-C34)	NC	300	NC	---	10	30	50	77	69	110	68	69	89	220	62	140	180	230	44	42	28	36
F4 (C34-C50)	NC	2800	NC	---	10	7	23	60	65	51	26	55	15	10	10	10	<5	<5	40	29	21	37
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	YES	YES	NO	NO	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
% Moisture	NC	NC	NC	---	0.1	21	16	20	15	15	15	16	21	15	22	18	15	11	21	19	20	19
Polycyclic Aromatics (mg/kg)																						
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acridine	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	---	---	---	---
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.01	0.01	0.02	<0.01	0.02	0.02	0.01	<0.01	<0.01	---	---	---	---	---	---	---	---
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	---	---	---	---
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	---	---	---	---
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	---	---	---	---
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluorene	15.4	---	62	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	---	---	---	---
2-Methyl Naphthalene	---	---	0.99	---	0.0050	<0.01	<0.01	0.02	0.02	0.01	<0.01	<0.01	<0.01	0.1	---	---	---	---	---	---	---	---
Naphthalene	0.013	---	0.6	---	0.0050	<0.01	<0.01	<0.01	15	<0.01	<0.01	<0.01	<0.01	0.05	---	---	---	---	---	---	---	---
Phenanthrene	0.046	---	6.2	---	0.0050	<0.01	0.02	0.02	<0.01	0.01	0.01	0.01	<0.01	0.03	---	---	---	---	---	---	---	---
Perylene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	<0.01	0.01	0.03	0.01	0.01	0.02	0.01	<0.01	0.04	---	---	---	---	---	---	---	---
Quinoline	---	---	---	---	0.010	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	---	---	---	---
1-Methyl Naphthalene	---	---	1.2	---	0.01	<0.01	<0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	0.07	---	---	---	---	---	---	---	---

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria			Risk Assessment	RDL	APEC A-7: EX-SITU BIOTREATMENT CELL 2008			APEC A-8: CONTAMINATED SOIL AREA ADJACENT TO BARREL CRUSHING AREA (DND) 2008								
Sample Number	**Federal**		**Provincial**			**APEC A7-HA08-4**	**APEC A7-HA08-5**	**APEC A7-HA08-6**	**APEC A8-HA08-1**	**APEC A8-HA08-2**	**APEC A8-HA08-3C**	**APEC A8-HA08-4C**	**APEC A8-HA08-5**	**APEC A8-HA08-6**	**APEC A8-HA08-7**	**APEC A8-HA08-8**	**APEC A8-HA08-9**
Sampling Date	**Env. Health (non carcinogenic effects)**	**Human health (carcinogenic effects)**	**MOE Table 2^3 Residential / Parkland**	**SSTL**		**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**
Sampling Depth (m)						0.57	0.6	0.6	0.6	0.5	composite	composite	1	1	1	0.6	1.1
BTEX Parameters (mg/kg)																	
Benzene	0.03	NC	NA	---	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.011	<0.005	<0.005	<0.005	<0.005	<0.005
Toluene	0.37	NC	NA	---	0.01	<0.01	<0.01	<0.01	0.05	<0.01	0.01	0.08	<0.01	<0.01	<0.01	<0.01	<0.01
Ethylbenzene	0.082	NC	NA	---	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
Xylenes	11	NC	NA	---	0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	0.12	<0.02	<0.02	<0.02	<0.02	<0.02
Petroleum Hydrocarbons (mg/kg)																	
F1(C6-C10) - BTEX	NC	30	NC	---	12	<5	<5	<5	<5	<5	<5	25	<5	<5	<5	<5	<5
F2 (C10-C16)	NC	150	NC	1374	10	<5	<5	<5	<5	<5	88	3300	<5	<5	<5	<5	<5
F3 (C16-C34)	NC	300	NC	---	10	100	75	140	150	25	70	280	18	33	52	42	69
F4 (C34-C50)	NC	2800	NC	---	10	73	51	23	120	29	32	6	11	21	25	26	20
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	NO	NO	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES
% Moisture	NC	NC	NC	---	0.1	22	18	18	21	14	13	13	16	19	16	14	23
Polycyclic Aromatics (mg/kg)																	
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	---	---	---	---	---	---	---	---	---	---	---
Acridine	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	0.01	---	0.01	---	---	---	<0.01	---	---	<0.01	<0.01	---
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	0.02	---	0.02	---	---	---	<0.01	---	---	<0.01	0.01	---
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.01	---	<0.01	---	---	---	<0.01	---	---	<0.01	<0.01	---
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	0.01	---	0.01	---	---	---	<0.01	---	---	<0.01	<0.01	---
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	<0.01	---	<0.01	---	---	---	<0.01	---	---	<0.01	<0.01	---
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---
Fluorene	15.4	---	62	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	<0.01	---	<0.01	---	---	---	<0.01	---	---	<0.01	<0.01	---
2-Methyl Naphthalene	---	---	0.99	---	0.0050	0.01	---	0.02	---	---	---	<0.01	---	---	0.01	<0.01	---
Naphthalene	0.013	---	0.6	---	0.0050	<0.01	---	0.01	---	---	---	<0.01	---	---	<0.01	<0.01	---
Phenanthrene	0.046	---	6.2	---	0.0050	0.02	---	0.03	---	---	---	0.02	---	---	0.02	0.01	---
Perylene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	0.04	---	0.04	---	---	---	0.02	---	---	0.02	<0.01	---
Quinoline	---	---	---	---	0.010	<0.01	---	<0.01	---	---	---	<0.01	---	---	<0.01	<0.01	---
1-Methyl Naphthalene	---	---	1.2	---	0.01	0.01	---	0.02	---	---	---	<0.01	---	---	0.02	<0.01	---

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria			Risk Assessment	RDL	2008APEC A-9: FORMER FIRST AIR LEASE												APEC B-1: FUEL TANK FARM LOCATED AT THE MAIN CAMP 2008				
Sample Number	Federal		Provincial			APEC A9-TP08-1	APEC A9-TP08-2	APEC A9-TP08-3	APEC A9-TP08-4	APEC A9-TP08-5	APEC A9-HA08-1	APEC A9-HA08-2	APEC A9-HA08-3	APEC A9-HA08-4	APEC A9-HA08-5	APEC A9-HA08-6	APEC A9-HA08-7	APEC B1-TP08-1	APEC B1-TP08-2	DUP8 (APEC B1-TP08-2)	APEC B1-TP08-3	APEC B1-TP08-4
Sampling Date	Env. Health (non-carcinogenic effects)	Human health (carcinogenic effects)	MOE Table 2^3 Residential / Parkland	SSTL		17/08/2008	17/08/2008	17/08/2008	17/08/2008	17/08/2008	17/08/2008	18/08/2008	18/08/2008	18/08/2008	18/08/2008	18/08/2008	18/08/2008	20/08/2008	20/08/2008	20/08/2008	20/08/2008	20/08/2008
Sampling Depth (m)						0.9	0.6	0.8	1	0.7	0.4	1.2	1.1	0.8	0.6	0.6	0.7	1.2	0.8	0.8	1	1
BTEX Parameters (mg/kg)																						
Benzene	0.03	NC	NA	---	0.005	---	14	0.01	0.012	<0.005	---	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.017	<0.005	<0.005	<0.005
Toluene	0.37	NC	NA	---	0.01	---	230	0.04	0.05	<0.01	---	0.2	0.02	<0.01	<0.01	0.02	<0.01	<0.01	0.02	<0.01	1.6	<0.01
Ethylbenzene	0.082	NC	NA	---	0.01	---	63	<0.01	<0.01	<0.01	---	0.08	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	6.9	<0.01
Xylenes	11	NC	NA	---	0.02	---	530	0.09	0.03	<0.02	---	3.6	0.05	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	77	<0.02
Petroleum Hydrocarbons (mg/kg)																						
F1(C6-C10) - BTEX	NC	30	NC	---	12	---	4300	<5	<5	25	---	600	<5	<5	<5	<5	<5	<5	<5	<5	1800	<5
F2 (C10-C16)	NC	150	NC	1374	10	<5	6800	27	<5	110	<5	3900	65	9	16	75	7	<5	<5	<5	18	<5
F3 (C16-C34)	NC	300	NC	---	10	180	190	100	110	71	67	250	210	46	200	75	190	<5	20	33	16	<5
F4 (C34-C50)	NC	2800	NC	---	10	130	<5	33	46	28	30	32	59	38	59	30	110	<5	<5	19	7	<5
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	NO	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES	YES
% Moisture	NC	NC	NC	---	0.1	24	25	25	26	21	26	21	20	19	18	18	23	8.5	19	21	17	12
Polycyclic Aromatics (mg/kg)																						
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acridine	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	0.01	0.02	0.01	0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	---	---	---	---	---
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	0.03	0.04	0.03	0.02	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	---	---	---	---	---
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	---
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	0.02	0.02	0.02	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	---	---	---	---	---
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	---
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluorene	15.4	---	62	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	---
2-Methyl Naphthalene	---	---	0.99	---	0.0050	0.03	43	0.04	0.02	<0.01	0.02	<0.01	0.02	<0.01	0.02	0.04	0.02	---	---	---	---	---
Naphthalene	0.013	---	0.6	---	0.0050	0.01	23	0.01	0.01	<0.01	<0.01	0.02	0.01	<0.01	<0.01	0.02	<0.01	---	---	---	---	---
Phenanthrene	0.046	---	6.2	---	0.0050	0.04	0.22	0.02	0.03	<0.01	0.05	<0.01	<0.01	<0.01	0.01	0.02	0.03	---	---	---	---	---
Perylene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	0.06	0.12	0.05	0.03	<0.01	0.06	0.01	<0.01	<0.01	<0.01	<0.01	0.04	---	---	---	---	---
Quinoline	---	---	---	---	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	---
1-Methyl Naphthalene	---	---	1.2	---	0.01	0.02	33	0.02	0.01	<0.01	0.02	0.03	0.02	<0.01	0.01	0.02	0.02	---	---	---	---	---

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	**Soil Criteria**			**Risk Assessment**	**RDL**	**APEC B-1: Tank Farm 2008**												**APEC B-1: Tank Farm 2009**			
Sample Number	**Federal**		**Provincial**			**APEC B1-TP08-5**	**APEC B1-TP08-6**	**APEC B1-TP08-7**	**APEC B1-TP08-8**	**B1-TP09-1A**	**B1-TP09-1B**	**B1-TP09-2A**	**B1-TP09-2B**	**B1-TP09-3A**	**B1-TP09-DUP1A**	**B1-TP09-3B**	**B1-TP09-DUP1B**	**B1-TP09-4A**	**B1-TP09-4B**	**B1-TP09-5A**	**B1-TP09-5B**
Sampling Date						**20/08/2008**	**20/08/2008**	**20/08/2008**	**20/08/2008**	14/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009
Sampling Depth (m)	**Env. Health (non-carcinogenic effects)**	**Human health (carcinogenic effects)**	**MOE Table 2^{3} Residential / Parkland**	**SSTL**		0.85	1	1	0.8	1	1.2	1	1.2	0.2	1.2	0.2	1.2	1	1.4	0.8	1
BTEX Parameters (mg/kg)																					
Benzene	0.03	NC	NA	---	0.005	<0.005	<0.005	2.5	0.008	<0.0050	<0.0050	<0.0050	0.108	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.767
Toluene	0.37	NC	NA	---	0.01	0.08	<0.01	10	0.02	<0.050	<0.050	<0.050	0.494	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Ethylbenzene	0.082	NC	NA	---	0.01	<0.01	<0.01	9.6	0.01	<0.015	<0.015	<0.015	0.029	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	0.267
Xylenes	11	NC	NA	---	0.02	19	<0.02	36	0.04	<0.10	<0.10	<0.10	1.45	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	2.49
Petroleum Hydrocarbons (mg/kg)																					
F1(C6-C10) - BTEX	NC	30	NC	---	12	390	<5	840	5	<10	<10	<10	19	<10	<10	<10	<10	<10	<10	<10	<10
F2 (C10-C16)	NC	150	NC	1374	10	660	<5	92	<5	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
F3 (C16-C34)	NC	300	NC	---	10	32	73	22	14	312	91	<20	31	35	25	23	<20	<20	<20	<20	30
F4 (C34-C50)	NC	2800	NC	---	10	<5	40	<5	16	125	42	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	YES	YES	YES	YES	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
% Moisture	NC	NC	NC	---	0.1	14	17	17	8.2	12	5.07	11	12.9	11.2	12	12.6	12.3	10.5	9.68	9.57	18.1
Polycyclic Aromatics (mg/kg)																					
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acridine	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluorene	15.4	---	62	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2-Methyl Naphthalene	---	---	0.99	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Naphthalene	0.013	---	0.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Phenanthrene	0.046	---	6.2	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Perylene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Quinoline	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1-Methyl Naphthalene	---	---	1.2	---	0.01	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	**Soil Criteria**			**Risk Assessment**	**RDL**	**APEC B-1: Tank Farm 2008**						**AEC B-2: IN-SITU LANDFARM 2008**									
Sample Number	**Federal**		**Provincial**			**B1-TP09-6A**	**B1-TP09-6B**	**B1-TP09-7A**	**B1-TP09-7B**	**B1-HA09-1A**	**B1-HA09-1B**	**APEC B2-TP08-1**	**APEC B2-TP08-2**	**APEC B2-TP08-3**	**APEC B2-TP08-4**	**APEC B2-TP08-5**	**APEC B2-DUP5 (APEC B2-TP08-5)**	**APEC B2-TP08-6**	**APEC B2-TP08-7**	**APEC B2-TP08-8**	**APEC B2 TP08-9**
Sampling Date						14/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**22/08/2008**
Sampling Depth (m)	**Env. Health (non carcinogenic effects)**	**Human health (carcinogenic effects)**	**MOE Table 2^3 Residential / Parkland**	**SSTL**		0.6	1.4	0.5	1	0.1	0.3	1.4	1.2	1.25	1.3	1.25	1.25	1.3	1	1	0.9
BTEX Parameters (mg/kg)																					
Benzene	0.03	NC	NA	---	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.005	0.076	0.046	<0.005	0.39	0.019	<0.005	0.029	<0.005	<0.005
Toluene	0.37	NC	NA	---	0.01	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.44	4	0.13	0.29	3	0.47	<0.01	1	0.05	0.01
Ethylbenzene	0.082	NC	NA	---	0.01	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	0.29	0.57	<0.01	0.52	1.6	0.28	<0.01	0.59	0.03	<0.01
Xylenes	11	NC	NA	---	0.02	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	25	26	0.58	23	16	8.4	<0.02	13	0.4	0.18
Petroleum Hydrocarbons (mg/kg)																					
F1(C6-C10) - BTEX	NC	30	NC	---	12	<10	<10	<10	<10	<10	<10	760	1200	19	1300	570	610	<5	810	190	28
F2 (C10-C16)	NC	150	NC	1374	10	<20	<20	<20	<20	<20	<20	11000	4400	340	11000	9400	5700	120	4200	3700	680
F3 (C16-C34)	NC	300	NC	---	10	<20	48	<20	<20	<20	<20	210	490	27	360	660	<5	27	99	76	70
F4 (C34-C50)	NC	2800	NC	---	10	<20	20	<20	<20	<20	<20	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	Yes	Yes	Yes	Yes	Yes	Yes	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
% Moisture	NC	NC	NC	---	0.1	9.34	16.5	6.91	7.67	3.21	2.85	13	13	9.2	11	16	12	11	11	13	8.9
Polycyclic Aromatics (mg/kg)																					
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acridine	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	---	---	---	---	---	---	0.02	<0.01	<0.01	---	---	<0.01	---	<0.01	---	---
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	---	---	---	---	---	---	0.01	<0.01	<0.01	---	---	<0.01	---	0.01	---	---
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	---	---	---	---	---	---	<0.01	<0.01	<0.01	---	---	<0.01	---	<0.01	---	---
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	---	---	---	---	---	---	<0.01	<0.01	<0.01	---	---	<0.01	---	<0.01	---	---
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	---	---	---	---	---	---	<0.01	<0.01	<0.01	---	---	<0.01	---	<0.01	---	---
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluorene	15.4	---	62	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	---	---	---	---	---	---	<0.01	<0.01	<0.01	---	---	<0.01	---	<0.01	---	---
2-Methyl Naphthalene	---	---	0.99	---	0.0050	---	---	---	---	---	---	27	59	0.13	---	---	18	---	18	---	---
Naphthalene	0.013	---	0.6	---	0.0050	---	---	---	---	---	---	4.4	7.8	<0.01	---	---	2.4	---	2.2	---	---
Phenanthrene	0.046	---	6.2	---	0.0050	---	---	---	---	---	---	0.66	1.5	0.04	---	---	0.12	---	0.16	---	---
Perylene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	---	---	---	---	---	---	0.12	0.03	<0.01	---	---	0.01	---	0.01	---	---
Quinoline	---	---	---	---	0.010	---	---	---	---	---	---	<0.06	<0.06	<0.01	---	---	<0.06	---	<0.05	---	---
1-Methyl Naphthalene	---	---	1.2	---	0.01	---	---	---	---	---	---	22	45	0.09	---	---	14	---	10	---	---

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria			Risk Assessment	RDL	AEC B-2: IN-SITU LANDFARM 2008																
Sample Number	**Federal**		**Provincial**			**APEC B2-TP08-10**	**APEC B2-TP08-11**	**APEC B2-TP08-12**	**APEC B2-TP08-13**	**APEC B2-TP08-14**	**APEC B2-TP08-15**	**APEC B2-TP08-16**	**APEC B2-TP08-17**	**APEC B2-TP08-18**	**APEC B2-TP08-19**	**APEC B2-TP08-20**	**APEC B2-TP08-21**	**APEC B2-HA08-1**	**APEC B2-HA08-2**	**APEC B2-HA08-3**	**APEC B2-HA08-4**	**APEC B2-HA08-5**
Sampling Date	**Env. Health (non-carcinogenic effects)**	**Human health (carcinogenic effects)**	**MOE Table 2^3 Residential / Parkland**	**SSTL**		**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**20/08/2008**	**20/08/2008**	**20/08/2008**	**20/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**	**19/08/2008**
Sampling Depth (m)						1.4	1.2	1.4	1.3	1	1.2	1	0.7	1	1.3	1	1	0.7	0.8	0.8	0.45	0.8
BTEX Parameters (mg/kg)																						
Benzene	0.03	NC	NA	---	0.005	<0.005	0.014	0.015	<0.005	---	<0.005	<0.005	0.23	<0.005	<0.005	0.2	22	---	<0.005	<0.005	<0.005	<0.005
Toluene	0.37	NC	NA	---	0.01	0.09	<0.01	0.08	0.08	---	0.14	0.13	7.6	0.05	0.03	0.14	80	---	<0.01	<0.01	<0.01	<0.01
Ethylbenzene	0.082	NC	NA	---	0.01	0.04	0.01	0.12	0.08	---	0.47	0.16	2.2	<0.01	<0.01	1	25	---	<0.01	<0.01	<0.01	<0.01
Xylenes	11	NC	NA	---	0.02	1	0.16	2.1	0.88	---	3.6	1.4	60	<0.02	<0.02	1.6	220	---	<0.02	<0.02	<0.02	<0.02
Petroleum Hydrocarbons (mg/kg)																						
F1(C6-C10) - BTEX	NC	30	NC	---	12	370	<5	130	18	---	52	92	640	<5	<5	120	3700	---	<5	<5	<5	<5
F2 (C10-C16)	NC	150	NC	1374	10	2500	650	1400	110	<5	580	3300	8500	<5	11	500	8500	<5	<5	550	<5	<5
F3 (C16-C34)	NC	300	NC	---	10	650	110	120	35	41	64	420	510	73	66	62	1000	24	43	24	39	29
F4 (C34-C50)	NC	2800	NC	---	10	<5	<5	<5	41	47	22	<5	<5	23	21	<5	<5	8	35	6	22	18
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
% Moisture	NC	NC	NC	---	0.1	14	19	14	21	21	28	19	12	29	25	15	12	14	22	13	21	22
Polycyclic Aromatics (mg/kg)																						
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acridine	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	<0.01	0.01	<0.01	0.02	0.02	0.02	0.02	<0.01	---	---	0.02	---	---	---	---	0.01	<0.01
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.01	0.03	0.01	0.03	0.04	0.04	0.03	<0.01	---	---	0.03	---	---	---	---	0.02	<0.01
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	<0.01	---	---	---	---	<0.01	<0.01
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	<0.01	0.01	<0.01	0.01	0.01	0.01	0.01	<0.01	---	---	0.01	---	---	---	---	<0.01	<0.01
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	<0.01	---	---	---	---	<0.01	<0.01
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluorene	15.4	---	62	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	0.01	---	---	---	---	<0.01	<0.01
2-Methyl Naphthalene	---	---	0.99	---	0.0050	3.3	0.77	0.79	2.4	0.05	1.8	5.8	57	---	---	3.4	---	---	---	---	0.04	0.03
Naphthalene	0.013	---	0.6	---	0.0050	0.8	0.29	0.26	1.4	0.03	0.91	2.9	18	---	---	1.4	---	---	---	---	0.03	0.02
Phenanthrene	0.046	---	6.2	---	0.0050	0.43	0.12	0.1	0.14	0.07	0.1	0.18	0.67	---	---	0.13	---	---	---	---	0.05	0.04
Perylene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	0.02	0.06	0.03	0.06	0.06	0.06	0.06	0.03	---	---	0.06	---	---	---	---	0.04	0.02
Quinoline	---	---	---	---	0.010	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.04	---	---	<0.01	---	---	---	---	<0.01	<0.01
1-Methyl Naphthalene	---	---	1.2	---	0.01	2.6	0.45	0.56	1.2	0.03	1.1	3.6	45	---	---	2.3	---	---	---	---	0.02	0.01

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria			Risk Assessment	RDL	AEC B-2: IN-SITU LANDFARM 2008						APEC B-3: Potential Landfill 2009									
Sample Number	Federal		Provincial			APEC B2-HA08-6	DUP7 (APEC B2-HA08-6)	APEC B2-HA08-7	APEC B2-HA08-8	APEC B2-HA08-9	APEC B2-HA08-10	B3-TP09-1A	B3-TP09-1B	B3-TP09-2A	B3-TP09-2B	B3-TP09-3A	B3-TP09-DUP1A	B3-TP09-3B	B3-TP09-DUP1B	B3-TP09-4A	B3-TP09-4B
Sampling Date						**19/08/2008**	**19/08/2008**	**19/08/2008**	**20/08/2008**	**21/08/2008**	**21/08/2008**	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009
Sampling Depth (m)	**Env. Health (non-carcinogenic effects)**	**Human health (carcinogenic effects)**	**MOE Table 2^3 Residential / Parkland**	**SSTL**		0.6	0.6	0.5	0.4	0.6	0.6	0.5	1	0.5	1.2	0.5	0.5	1.3	1.3	0.5	0.9
BTEX Parameters (mg/kg)																					
Benzene	0.03	NC	NA	---	0.005	0.045	0.008	<0.005	0.15	<0.005	<0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Toluene	0.37	NC	NA	---	0.01	<0.01	<0.01	0.01	0.08	<0.01	<0.01	<0.050	<0.050	0.062	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Ethylbenzene	0.082	NC	NA	---	0.01	0.88	0.06	0.05	0.04	<0.01	<0.01	<0.015	<0.015	0.022	0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Xylenes	11	NC	NA	---	0.02	0.6	0.03	0.06	0.07	<0.02	<0.02	<0.10	<0.10	<0.10	<0.11	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Petroleum Hydrocarbons (mg/kg)																					
F1(C6-C10) - BTEX	NC	30	NC	---	12	320	69	56	<5	5	<5	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
F2 (C10-C16)	NC	150	NC	1374	10	11000	1100	4000	30	92	20	82	<20	<20	<20	<20	<20	<20	<20	<20	<20
F3 (C16-C34)	NC	300	NC	---	10	190	200	2000	76	110	76	24	<20	<20	<20	<20	45	47	38	<20	159
F4 (C34-C50)	NC	2800	NC	---	10	<5	47	<5	22	17	13	<20	<20	<20	<20	<20	<20	<20	<20	<20	24
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	YES	YES	YES	YES	YES	YES	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
% Moisture	NC	NC	NC	---	0.1	22	20	24	23	21	15	11	14.1	15.7	9.31	14.3	17.8	18.6	18.2	5.74	17.6
Polycyclic Aromatics (mg/kg)																					
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acridine	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	0.01	<0.01	<0.01	0.01	0.01	---	---	---	---	---	---	---	---	---	---	---
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	0.02	0.01	0.01	0.04	0.01	---	---	---	---	---	---	---	---	---	---	---
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	---	---	---	---	---	---	---
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	<0.01	<0.01	<0.01	0.01	<0.01	---	---	---	---	---	---	---	---	---	---	---
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	---	---	---	---	---	---	---	---	---
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluorene	15.4	---	62	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	<0.01	<0.01	<0.01	0.01	<0.01	---	---	---	---	---	---	---	---	---	---	---
2-Methyl Naphthalene	---	---	0.99	---	0.0050	4.3	1	3.1	0.44	0.12	---	---	---	---	---	---	---	---	---	---	---
Naphthalene	0.013	---	0.6	---	0.0050	2.3	0.25	0.38	0.96	0.05	---	---	---	---	---	---	---	---	---	---	---
Phenanthrene	0.046	---	6.2	---	0.0050	0.18	0.18	0.12	0.34	0.08	---	---	---	---	---	---	---	---	---	---	---
Perylene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	0.07	0.05	0.03	0.07	0.04	---	---	---	---	---	---	---	---	---	---	---
Quinoline	---	---	---	---	0.010	<0.06	<0.06	<0.01	<0.01	<0.01	---	---	---	---	---	---	---	---	---	---	---
1-Methyl Naphthalene	---	---	1.2	---	0.01	3.3	1.2	2.1	0.51	0.1	---	---	---	---	---	---	---	---	---	---	---

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria			Risk Assessment	RDL	APEC B-3: Potential Landfill 2009								APEC C-1: DND WAREHOUSE (HADCS BUILDING) LOCATED AT THE MAIN CAMP				AEC D-1: POWERHOUSE LOCATED AT THE MAIN CAMP 2009				
Sample Number	Federal		Provincial			B3-TP09-5A	B3-TP09-5B	B3-TP09-6A	B3-TP09-6B	B3-TP09-7A	B3-TP09-7B	B3-TP09-8A	B3-TP09-8B	APEC C1-TP08-1	APEC C1-TP08-2	APEC C1-TP08-3	APEC C1-HA08-1	APEC D1-TP08-1	APEC D1-TP08-2-1	APEC D1-TP08-2-2	DUP6 (APEC D1-TP08-2-2)	APEC D1-TP08-3
Sampling Date						08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	20/08/2008	20/08/2008	20/08/2008	20/08/2008	19/08/2008	19/08/2008	19/08/2008	19/08/2008	19/08/2008
Sampling Depth (m)	Env. Health (non-carcinogenic effects)	Human health (carcinogenic effects)	MOE Table 2^3 Residential / Parkland	SSTL		0.5	1.4	1	1.2	1	1.2	0.3	1.3	0.75	0.7	1	0.6	0.65	1	1	1	1
BTEX Parameters (mg/kg)																						
Benzene	0.03	NC	NA	---	0.005	<0.0050	<0.0050	<0.0050	0.0423	<0.0050	0.0074	<0.0050	<0.0050	---	<0.005	---	<0.005	<0.005	<0.005	0.071	0.029	0.027
Toluene	0.37	NC	NA	---	0.01	<0.050	<0.050	<0.050	<0.050	<0.050	0.101	<0.050	<0.050	---	<0.01	---	0.1	0.04	0.01	0.81	0.79	1.3
Ethylbenzene	0.082	NC	NA	---	0.01	<0.015	<0.015	<0.015	0.047	<0.015	0.02	<0.015	<0.015	---	<0.01	---	<0.01	0.03	<0.01	3	2.4	2
Xylenes	11	NC	NA	---	0.02	<0.10	<0.10	0.14	0.35	0.14	2.06	<0.10	<0.10	---	0.0358	---	0.1	0.14	<0.02	20	15	18
Petroleum Hydrocarbons (mg/kg)																						
F1(C6-C10) - BTEX	NC	30	NC	---	12	<10	<10	<10	<10	<10	533	<10	<10	---	7	---	71	210	<5	810	790	1900
F2 (C10-C16)	NC	150	NC	1374	10	<20	<20	26	<20	<20	617	<20	<20	<5	71	<5	5200	7000	11000	3100	6400	7000
F3 (C16-C34)	NC	300	NC	---	10	35	29	2080	59	<20	34	<20	<20	23	57	15	340	310	38000	160	<5	8
F4 (C34-C50)	NC	2800	NC	---	10	<20	<20	598	21	<20	<20	<20	<20	<5	6	<5	<5	<5	6500	<5	<5	<5
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	YES	YES	YES	YES	YES	NO	YES	YES	YES
% Moisture	NC	NC	NC	---	0.1	19.7	17.6	9.59	12.8	5.48	6.45	8.63	4.77	11	12	22	10	10	26	24	22	9.7
Polycyclic Aromatics (mg/kg)																						
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acridine	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	---	---	---	---	---	---	---	---	<0.01	<0.01	---	<0.01	<0.01	<0.06	0.01	0.02	<0.01
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	---	---	---	---	---	---	---	---	<0.01	<0.01	---	<0.01	<0.01	<0.06	0.02	0.03	<0.01
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	---	---	---	---	---	---	---	---	<0.01	<0.01	---	<0.01	<0.01	<0.06	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	---	---	---	---	---	---	---	---	<0.01	<0.01	---	<0.01	<0.01	<0.06	<0.01	0.01	<0.01
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	---	---	---	---	---	---	---	---	<0.01	<0.01	---	<0.01	<0.01	<0.06	<0.01	<0.01	<0.01
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluorene	15.4	---	62	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	---	---	---	---	---	---	---	---	<0.01	<0.01	---	<0.01	<0.01	<0.06	<0.01	0.01	<0.01
2-Methyl Naphthalene	---	---	0.99	---	0.0050	---	---	---	---	---	---	---	---	0.01	0.03	---	0.16	<0.05	<0.06	7.4	20	55
Naphthalene	0.013	---	0.6	---	0.0050	---	---	---	---	---	---	---	---	<0.01	0.02	---	0.09	0.34	0.15	2.9	6	21
Phenanthrene	0.046	---	6.2	---	0.0050	---	---	---	---	---	---	---	---	0.02	0.02	---	0.03	0.1	<0.06	0.16	0.24	0.38
Perylene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	---	---	---	---	---	---	---	---	<0.01	<0.01	---	0.02	0.02	0.21	0.05	0.1	0.02
Quinoline	---	---	---	---	0.010	---	---	---	---	---	---	---	---	<0.01	<0.01	---	<0.05	<0.05	<0.06	<0.06	<0.06	<0.05
1-Methyl Naphthalene	---	---	1.2	---	0.01	---	---	---	---	---	---	---	---	0.02	0.02	---	0.14	<0.05	<0.06	5.2	18	49

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria			Risk Assessment	RDL	AEC D: POWERHOUSE LOCATED AT THE MAIN CAMP 2009														
Sample Number	**Federal**		**Provincial**			**APEC D1-TP08-4**	**APEC D1-TP08-5**	**APEC D1-TP08-6**	**APEC D1-HA08-1**	**APEC D1-HA08-2**	**APEC D1-HA08-3**	**APEC D1-HA08-4**	**APEC D1-HA08-5**	**APEC D1-HA08-6**	**APEC D1-HA08-7**	**APEC D1-HA08-8**	**DUP 10 (APEC D1-HA08-8)**	**APEC D1-HA08-9**	**APEC D1-SURFACE 08-1**	**APEC D1-SURFACE 08-2**
Sampling Date						**19/08/2008**	**19/08/2008**	**19/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**22/08/2008**	**21/08/2008**	**21/08/2008**
Sampling Depth (m)	**Env. Health (non carcinogenic effects)**	**Human health (carcinogenic effects)**	**MOE Table 2^3 Residential / Parkland**	**SSTL**		1.1	1.2	0.7	0.4	0.6	0.6	0.35	0.4	0.4	1.8	0.85	0.85	0.6	surface	surface
BTEX Parameters (mg/kg)																				
Benzene	0.03	NC	NA	---	0.005	<0.005	0.01	0.11	0.008	<0.005	0.039	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Toluene	0.37	NC	NA	---	0.01	0.04	0.23	0.47	0.02	0.57	<0.01	<0.01	<0.01	<0.01	<0.01	0.36	0.45	<0.01	0.18	0.04
Ethylbenzene	0.082	NC	NA	---	0.01	0.02	0.34	0.35	0.04	4.7	0.37	<0.01	<0.01	<0.01	<0.01	0.03	0.06	<0.01	0.06	0.02
Xylenes	11	NC	NA	---	0.02	0.62	9	8.7	0.13	35	0.1	<0.02	<0.02	<0.02	<0.02	3.6	4.4	<0.02	0.53	0.1
Petroleum Hydrocarbons (mg/kg)																				
F1(C6-C10) - BTEX	NC	30	NC	---	12	490	510	320	30	1200	27	<5	<5	<5	<5	240	160	<5	62	82
F2 (C10-C16)	NC	150	NC	1374	10	5900	4000	3800	520	10000	730	<5	<5	44	5	2000	990	230	12000	10000
F3 (C16-C34)	NC	300	NC	---	10	88	240	78	60	580	75	<5	<5	97	97	1400	860	59	7700	4700
F4 (C34-C50)	NC	2800	NC	---	10	<5	<5	<5	<5	<5	<5	<5	<5	27	66	58	66	<5	620	<5
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES
% Moisture	NC	NC	NC	---	0.1	12	8.5	16	16	18	15	5.7	8.8	14	19	9.2	9.1	9.5	4.2	6.2
Polycyclic Aromatics (mg/kg)																				
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acridine	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	0.01	<0.01	<0.01	---	0.01	0.01
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	---	---	0.02	<0.01	<0.01	---	<0.01	0.03
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	<0.01	<0.01	<0.01	---	<0.01	<0.01
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	<0.01	<0.01	<0.01	---	<0.01	<0.01
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	<0.01	<0.01	<0.01	---	<0.01	<0.01
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluorene	15.4	---	62	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	---	---	<0.01	<0.01	<0.01	---	<0.01	<0.01
2-Methyl Naphthalene	---	---	0.99	---	0.0050	2	70	19	3.3	50	1.3	0.02	---	---	0.05	0.88	9.4	---	0.75	<0.05
Naphthalene	0.013	---	0.6	---	0.0050	0.28	22	5	0.48	23	0.43	0.01	---	---	0.04	3.2	39	---	0.46	0.35
Phenanthrene	0.046	---	6.2	---	0.0050	0.17	0.98	0.44	0.11	0.56	0.1	0.02	---	---	0.07	0.07	0.11	---	0.27	0.12
Perylene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	0.08	0.05	0.02	0.03	0.07	0.02	<0.01	---	---	0.03	0.03	0.03	---	0.25	0.22
Quinoline	---	---	---	---	0.010	<0.05	<0.05	<0.05	<0.01	<0.06	<0.01	<0.01	---	---	<0.01	<0.01	<0.05	---	<0.05	<0.05
1-Methyl Naphthalene	---	---	1.2	---	0.01	1.6	60	16	2.2	35	1	0.01	---	---	0.03	0.7	7.2	---	0.52	<0.05

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria				RDL	AEC D: Powerhouse 2009															
Sample Number	**Federal**		**Provincial**	**Risk Assessment**		**D1-TP09-1A**	**D1-TP09-1B**	**D1-TP09-2A**	**D1-TP09-2B**	**D1-TP09-3A**	**D1-TP09-3B**	**D1-TP09-4A**	**D1-TP09-4B**	**D1-TP09-5A**	**D1-TP09-5B**	**D1-TP09-6A**	**D1-TP09-DUP1A**	**D1-TP09-6B**	**D1-TP09-DUP1B**	**D1-HA09-1**	**D1-HA09-2**
Sampling Date						13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009
Sampling Depth (m)	**Env. Health (non-carcinogenic effects)**	**Human health (carcinogenic effects)**	**MOE Table 2^3 Residential / Parkland**	**SSTL**		0.5	1	1.75	1.8	0.5	1.3	1	1.2	1	1.1	1	1	1	1	0.8	0.5
BTEX Parameters (mg/kg)																					
Benzene	0.03	NC	NA	---	0.005	<0.0050	<0.0050	<0.0050	<0.0050	0.0215	0.0084	0.011	0.0197	0.0467	0.0278	<0.0050	0.0054	<0.0050	<0.0050	<0.0050	<0.0050
Toluene	0.37	NC	NA	---	0.01	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.057	<0.050	0.054	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Ethylbenzene	0.082	NC	NA	---	0.01	<0.015	<0.015	<0.015	<0.015	0.102	<0.015	0.224	0.349	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Xylenes	11	NC	NA	---	0.02	<0.10	<0.10	<0.10	<0.10	0.13	<0.10	1.59	2.12	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Petroleum Hydrocarbons (mg/kg)																					
F1(C6-C10) - BTEX	NC	30	NC	---	12	<10	<10	<10	<10	113	106	429	233	<10	<10	<10	<10	<10	<10	125	<10
F2 (C10-C16)	NC	150	NC	1374	10	<20	38	<20	31	3460	4180	3060	3610	161	159	32	59	40	27	853	50
F3 (C16-C34)	NC	300	NC	---	10	<20	<20	<20	<20	2150	3770	707	1690	109	60	141	89	57	137	63	49
F4 (C34-C50)	NC	2800	NC	---	10	<20	<20	<20	<20	67	249	69	<20	<20	<20	37	32	<20	39	<20	<20
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
% Moisture	NC	NC	NC	---	0.1	5.18	26.4	2.94	2.78	9.37	8.95	12.5	10.6	6.7	6.36	11.3	10.8	9.13	11.3	18.4	7.82
Polycyclic Aromatics (mg/kg)																					
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acridine	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	0.05	0.026	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.010	0.011	<0.010	<0.010	0.025	0.051	0.02	0.01	<0.010	<0.010	0.01	0.012	<0.010	<0.010	<0.010	<0.010
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	0.012	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluorene	15.4	---	62	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methyl Naphthalene	---	---	0.99	---	0.0050	0.085	0.815	0.011	0.014	3.33	4.33	6.08	5.49	0.029	0.112	0.06	0.025	0.467	0.553	3.201	0.018
Naphthalene	0.013	---	0.6	---	0.0050	0.022	0.098	<0.010	<0.010	0.5	0.887	3.98	2.09	0.032	0.031	0.028	0.015	0.316	0.493	0.462	<0.010
Phenanthrene	0.046	---	6.2	---	0.0050	0.011	0.051	0.011	<0.010	0.261	1.5	0.393	1.27	0.017	0.031	0.029	0.022	0.248	0.032	0.032	0.012
Perylene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	<0.010	0.026	<0.010	<0.010	0.06	0.285	0.152	0.072	<0.010	0.016	0.014	0.011	0.062	0.01	0.01	<0.010
Quinoline	---	---	---	---	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.050	<0.050	<0.050	<0.010	<0.010	<0.010	<0.010	<0.05	<0.010	<0.010	<0.010
1-Methyl Naphthalene	---	---	1.2	---	0.01	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria			Risk Assessment	RDL	AEC D: Powerhouse 2009										AEC D: Powerhouse 2010					
Sample Number	**Federal**		**Provincial**			**D1-HA09-3**	**D1-HA09-4**	**D1-HA09-5**	**D1-HA09-6**	**D1-HA09-7**	**D1-HA09-8**	**D1-HA09-9**	**D1-HA09-10**	**D1-HA09-11**	**D1-HA09-12**	**D1-HA10-1**	**D1-HA10-2**	**D1-HA10-DUP1**	**D1-HA10-3**	**D1-HA10-4**	**D1-HA10-5**
Sampling Date						13/8/2009	13/8/2009	13/8/2009	13/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	14/8/2009	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010
Sampling Depth (m)	**Env. Health (non-carcinogenic effects)**	**Human health (carcinogenic effects)**	**MOE Table 2^3 Residential / Parkland**	**SSTL**		0.5	0.7	0.3	0.2	0.1	0.1	0.15	0.1	0.1	0.1	0.55	0.95	0.95	1.1	0.8	0.65
BTEX Parameters (mg/kg)																					
Benzene	0.03	NC	NA	---	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.002	<0.002	0.004	<0.002	<0.002	<0.002
Toluene	0.37	NC	NA	---	0.01	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.002	0.004	0.016	<0.002	<0.002	<0.002
Ethylbenzene	0.082	NC	NA	---	0.01	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	0.003	0.010	0.029	0.003	0.003	<0.002
Xylenes	11	NC	NA	---	0.02	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.004	0.051	0.42	0.002	0.007	<0.002
Petroleum Hydrocarbons (mg/kg)																					
F1(C6-C10) - BTEX	NC	30	NC	---	12	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
F2 (C10-C16)	NC	150	NC	1374	10	67	<20	<20	<20	<20	<20	<20	<20	<20	<20	<10	53	64	<10	170	<10
F3 (C16-C34)	NC	300	NC	---	10	45	<20	22	175	31	115	39	39	55	111	<10	<10	<10	<10	<10	<10
F4 (C34-C50)	NC	2800	NC	---	10	<20	<20	<20	77	<20	43	<20	<20	<20	46	<10	<10	<10	<10	<10	<10
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
% Moisture	NC	NC	NC	---	0.1	5.57	7.65	3.47	3.37	8.65	17.2	7.46	5.1	4.87	3.27	7.3	11	12	12	9.7	13
Polycyclic Aromatics (mg/kg)																					
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	---	---	---	---	---	---	---	---	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	---	---	---	---	---	---	---	---	---	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Acridine	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	---	---	---	---	---	---	---	---	---	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.01	<0.005	0.008	0.008	0.008	0.007	0.013
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.005	<0.005	<0.005	<0.005	0.007	0.010
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	---	---	---	---	---	---	---	---	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.005	<0.005	<0.005	<0.005	<0.007	0.014
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	---	---	---	---	---	---	---	---	<0.005	<0.005	<0.005	<0.005	<0.01	0.008
Fluorene	15.4	---	62	---	0.0050	---	---	---	---	---	---	---	---	---	---	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.005	0.12	0.091	<0.005	0.034	0.011
2-Methyl Naphthalene	---	---	0.99	---	0.0050	0.012	<0.010	0.013	<0.010	<0.010	0.022	0.016	0.012	<0.010	0.027	<0.005	0.019	0.006	<0.005	<0.005	0.014
Naphthalene	0.013	---	0.6	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	0.011	<0.010	<0.010	<0.010	0.012	<0.005	0.82	0.17	<0.005	0.14	0.018
Phenanthrene	0.046	---	6.2	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	0.018	0.012	0.015	0.012	0.017	<0.005	<0.005	<0.005	<0.005	0.009	0.020
Perylene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	0.012	<0.010	<0.010	<0.010	0.018	0.016	0.035	0.022	0.012	0.032	0.027
Quinoline	---	---	---	---	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	---	---	---	---	---	---
1-Methyl Naphthalene	---	---	1.2	---	0.01	---	---	---	---	---	---	---	---	---	---	<0.005	0.31	0.08	<0.005	0.15	0.025

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria				RDL	AEC D: Powerhouse 2010												AEC D: Powerhouse 2012			
Sample Number	Federal		Provincial	Risk Assessment		D1-TP10-1	D1-TP10-DUP2	D1-TP10-2A	D1-TP10-2B	D1-TP10-3	D1-TP10-4	D1-TP10-5	D1-TP10-6	D1-TP10-7A	D1-TP10-7B	D1-TP10-8A	D1-TP10-8B	D1-TP12-1A	D1-TP12-1B	D1-TP12-2A	D1-TP12-2B
Sampling Date						17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	17/08/2010	13/08/2012	13/08/2012	13/08/2012	13/08/2012
Sampling Depth (m)	Env. Health (non-carcinogenic effects)	Human health (carcinogenic effects)	MOE Table 2^3 Residential / Parkland	SSTL		0.9	0.9	0.8	1.4	1	0.7	0.7	0.1	0.25	1	0.8	1.8	0.2 - 0.7	0.7 - 1.7	0.2 - 0.4	0.4 -1.3
BTEX Parameters (mg/kg)																					
Benzene	0.03	NC	NA	---	0.005	<0.002	<0.002	<0.002	<0.002	<0.02	<0.2	<0.2	<0.002	<0.2	<0.02	<0.002	<0.002	0.011	0.011	<0.0050	<0.0050
Toluene	0.37	NC	NA	---	0.01	<0.002	<0.002	<0.002	<0.002	0.02	4.1	1.6	<0.002	<0.2	2.4	<0.002	<0.002	0.036	0.023	<0.020	<0.020
Ethylbenzene	0.082	NC	NA	---	0.01	0.002	<0.002	<0.002	<0.002	<0.02	<0.2	<0.2	0.003	<0.2	0.17	<0.002	<0.002	0.014	0.011	<0.010	<0.010
Xylenes	11	NC	NA	---	0.02	0.005	0.003	<0.002	<0.002	0.17	28	14	0.009	1.9	15	<0.002	<0.002	0.11	0.071	<0.040	<0.040
Petroleum Hydrocarbons (mg/kg)																					
F1(C6-C10) - BTEX	NC	30	NC	---	12	<10	<10	<10	<10	350	920	1200	<10	1100	430	<10	<10	<12	14	<12	<12
F2 (C10-C16)	NC	150	NC	1374	10	<10	<10	<10	<10	5300	5800	8900	180	7000	4900	<10	<10	57	1100	<10	<10
F3 (C16-C34)	NC	300	NC	---	10	<10	<10	36	55	190	260	1200	52	400	330	<10	<10	250	61	29	31
F4 (C34-C50)	NC	2800	NC	---	10	<10	<10	<10	<10	63	57	74	<10	45	71	<10	<10	59	<10	<10	<10
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
% Moisture	NC	NC	NC	---	0.1	11	9.6	18	24	17	16	16	13	9.4	21	16	21	6.4	8.9	8.7	15
Polycyclic Aromatics (mg/kg)																					
Acenaphthene	0.28	---	7.9	---	0.0050	<0.005	<0.005	<0.005	<0.005	<0.01	<0.04	<0.1	<0.005	<0.2	<0.005	<0.005	<0.005	<0.0050	<0.0076 (1)	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	---	---	---	---	---	---	---	<0.10	<0.10	---	---
Acenaphthylene	320	---	0.15	---	0.22	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.047	0.022	<0.008	<0.005	<0.005	0.012	<0.0050	<0.0073 (1)	---	---
Acridine	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	<0.010	<0.010	---	---
Anthracene	2.5	---	0.67	---	0.0040	<0.005	<0.005	0.010	0.012	0.006	<0.005	0.019	0.026	<0.005	0.008	<0.005	0.014	<0.0040	<0.0040	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	<0.005	<0.005	0.008	0.010	0.013	<0.005	0.009	0.013	<0.005	0.006	<0.005	0.010	0.0055	<0.0050	---	---
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.005	<0.005	0.025	0.032	0.017	<0.005	0.017	0.011	<0.005	0.017	0.007	0.028	0.015	0.0085	---	---
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.005	<0.005	0.022	0.025	0.014	0.011	0.031	0.037	0.008	0.014	<0.005	0.026	<0.0050	<0.0050	---	---
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	<0.005	<0.005	0.006	0.010	0.006	<0.005	0.007	0.010	<0.005	<0.005	<0.005	0.009	0.015	0.010	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	<0.0050	<0.0050	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	<0.005	<0.005	0.019	0.020	0.010	0.007	0.017	0.021	<0.005	<0.005	<0.005	0.027	0.0051	<0.0050	---	---
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	0.012	0.0074	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0064	<0.0050	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	<0.005	<0.005	0.025	0.029	0.031	0.033	0.10	0.10	0.015	0.024	<0.005	0.039	<0.0050	<0.0050	---	---
Fluoranthene	15.4	---	0.69	---	0.0050	<0.005	<0.005	<0.005	<0.005	0.30	0.077	1.1	0.013	0.46	0.036	<0.005	0.013	0.0097	0.0060	---	---
Fluorene	15.4	---	62	---	0.0050	<0.005	<0.005	0.010	0.014	<0.005	<0.005	0.009	0.007	<0.005	<0.005	0.006	0.010	<0.0050	<0.011 (1)	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	<0.005	<0.005	0.015	0.015	0.43	1.3	4.9	0.036	<0.5 (2)	0.22	<0.005	0.035	<0.0050	<0.0050	---	---
2-Methyl Naphthalene	---	---	0.99	---	0.0050	<0.005	<0.005	<0.005	<0.005	0.12	0.11	0.84	0.012	0.55	0.032	0.007	0.007	0.11	0.15	---	---
Naphthalene	0.013	---	0.6	---	0.0050	<0.005	<0.005	0.028	0.022	3.6	3.9	13	0.029	14	0.51	0.011	0.041	0.053	0.080	---	---
Phenanthrene	0.046	---	6.2	---	0.0050	<0.005	<0.005	0.037	0.043	0.023	0.022	0.097	0.22	0.026	0.033	0.007	0.053	0.021	0.023	---	---
Perylene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	0.009	<0.005	0.071	0.072	0.15	0.13	0.82	0.037	0.43	0.052	0.012	0.066	0.017	0.0080	---	---
Quinoline	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	<0.010	<0.16 (1)	---	---
1-Methyl Naphthalene	---	---	1.2	---	0.01	<0.005	<0.005	0.021	0.025	3.0	3.9	22	0.054	1.4	0.68	0.015	0.055	---	---	---	---

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

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(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria			Risk Assessment	RDL	AEC D: Powerhouse 2012																
Sample Number	Federal		Provincial			D1-TP12-3A	D1-TP12-3B	D1-TP12-4A	D1-TP12-4B	DUP-1 Duplicate ot D1-TP12-4B	D1-TP12-5A	D1-TP12-5B	D1-TP12-6	DUP-2 Duplicate ot D1-TP12-6	D1-TP12-7A	D1-TP12-7B	D1-TP12-8A	D1-TP12-8B	D1-TP12-9A	D1-TP12-9B	D1-TP12-10A	D1-TP12-10B
Sampling Date						13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012	13/08/2012
Sampling Depth (m)	Env. Health (non-carcinogenic effects)	Human health (carcinogenic effects)	MOE Table 2^3 Residential / Parkland	SSTL		0.2 -0.5	0.5 - 1.2	0.3 - 0.8	0.8 -1.3	0.3 - 1.3	0.1 - 0.5	0.5 -1.6	0.1 - 0.8	0.1 - 0.8	0.3 - 0.6	0.6 - 1.5	0.4 - 0.7	0.8 - 1.2	0.2 - 0.5	0.5 - 1.1	0.1 - 0.5	0.5 - 1.0
BTEX Parameters (mg/kg)																						
Benzene	0.03	NC	NA	---	0.005	<0.0050	<0.0050	<0.0050	0.011	<0.0050	<0.0050	0.013	0.0093	0.045	<0.0050	<0.0050	<0.0050	0.088	<0.0050	<0.0050	0.02	<0.0050
Toluene	0.37	NC	NA	---	0.01	<0.020	<0.020	<0.020	0.2	0.16	0.021	0.084	0.13	0.18	<0.020	<0.020	<0.020	0.03	0.035	0.073	0.058	0.048
Ethylbenzene	0.082	NC	NA	---	0.01	<0.010	<0.010	<0.010	0.12	0.092	0.013	0.6	1.5	3.1	<0.010	<0.010	<0.010	1.5	0.018	0.047	0.029	0.025
Xylenes	11	NC	NA	---	0.02	<0.040	<0.040	<0.040	1	0.9	<0.040	2.7	13	27	<0.040	<0.040	<0.040	4.6	0.15	1.1	0.16	0.14
Petroleum Hydrocarbons (mg/kg)																						
F1(C6-C10) - BTEX	NC	30	NC	---	12	<12	<12	16	330	420	22	220	630	480	<12	<12	<12	330	350	590	160	89
F2 (C10-C16)	NC	150	NC	1374	10	14	<10	640	4700	4100	1400	5000	7300	8400	47	<10	16	2800	6800	4700	7700	5200
F3 (C16-C34)	NC	300	NC	---	10	<10	<10	41	190	210	360	150	580	340	81	32	65	2300	780	360	1200	780
F4 (C34-C50)	NC	2800	NC	---	10	<10	<10	<10	<10	<10	44	11	11	<10	<10	<10	<10	<10	<10	<10	<10	30
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
% Moisture	NC	NC	NC	---	0.1	5.3	6.7	6.9	16	17	8.5	16	12	15	8.5	19	7.4	15	4.3	14	5	5.3
Polycyclic Aromatics (mg/kg)																						
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	<0.0053 (1)	<0.080 (1)	0.11	---	---	0.43	<0.58 (1)	---	---	<0.0050	<0.27 (1)	<0.0050	0.25	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	<0.10	<0.10	<0.10	---	---	<0.10	<0.10	---	---	<0.10	<0.10	<0.10	<0.10	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	---	<0.0061 (1)	<0.039 (1)	<0.049 (1)	---	---	<0.22 (1)	<0.18 (1)	---	---	<0.0050	<0.088 (1)	<0.12 (1)	<0.12 (1)	---	---
Acridine	---	---	---	---	0.010	---	---	<0.010	<0.010	0.032	---	---	0.39	0.16	---	---	<0.010	0.16	0.14	0.11	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	---	<0.0040	<0.0040	<0.0040	---	---	<0.0040	<0.0040	---	---	<0.0040	<0.0040	<0.0040	<0.0040	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	---	---	<0.0050	0.012	0.027	---	---	0.0081	0.011	---	---	0.0053	0.010	<0.0050	0.012	---	---
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	---	---	0.0077	0.024	0.049	---	---	0.017	0.017	---	---	0.013	0.017	0.0066	0.027	---	---
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	---	---	<0.0050	<0.0086 (1)	<0.011 (1)	---	---	<0.0050	<0.0050	---	---	<0.0050	<0.0050	<0.0050	<0.0062 (1)	---	---
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	0.0082	0.023	0.035	---	---	0.013	0.016	---	---	0.012	0.012	<0.0050	0.022	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	<0.0050	<0.0050	<0.0050	---	---	<0.0050	<0.0050	---	---	<0.0050	<0.0050	<0.0050	<0.0050	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	---	---	<0.0050	0.0089	0.017	---	---	<0.0050	0.0057	---	---	<0.0050	0.0059	<0.0050	0.011	---	---
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	0.0059	0.016	0.031	---	---	0.012	0.012	---	---	0.0088	0.010	<0.0050	0.017	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	<0.0050	0.012	0.036	---	---	0.013	0.013	---	---	0.0062	0.0087	0.0061	0.010	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	---	---	<0.0050	<0.0050	<0.0050	---	---	<0.0050	<0.0050	---	---	<0.0050	<0.0050	<0.0050	<0.0050	---	---
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	<0.0050	0.035	0.076	---	---	0.049	0.058	---	---	0.011	0.029	0.033	0.044	---	---
Fluorene	15.4	---	62	---	0.0050	---	---	<0.0075 (1)	<0.090 (1)	<0.11 (1)	---	---	<0.57 (1)	0.71	---	---	<0.0050	0.52	<0.28 (1)	<0.43 (1)	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	---	---	<0.0050	0.0077	0.015	---	---	<0.0050	<0.0050	---	---	<0.0050	<0.0050	<0.0050	0.0096	---	---
2-Methyl Naphthalene	---	---	0.99	---	0.0050	---	---	0.038	0.60	1.2	---	---	13 (2)	25 (2)	---	---	0.041	19 (2)	<0.58 (1)	2.9	---	---
Naphthalene	0.013	---	0.6	---	0.0050	---	---	<0.028 (1)	<0.29 (1)	<0.41 (1)	---	---	4.8	11 (2)	---	---	0.020	9.5	<0.39 (1)	1.0	---	---
Phenanthrene	0.046	---	6.2	---	0.0050	---	---	0.027	0.15	0.33	---	---	0.53	0.44	---	---	0.054	0.43	0.33	0.50	---	---
Perylene	---	---	---	---	0.0050	---	---	0.015	0.24	0.28	---	---	0.051	0.084	---	---	0.050	0.096	0.014	0.19	---	---
Pyrene	7.7	---	78	---	0.0050	---	---	<0.0050	0.046	0.090	---	---	0.085	0.058	---	---	0.013	0.036	0.041	0.054	---	---
Quinoline	---	---	---	---	0.010	---	---	<0.051 (1)	<0.46 (1)	<0.48 (1)	---	---	<3.4 (1)	<1.1 (1)	---	---	<0.010	<0.55 (1)	<0.31 (1)	<0.64 (1)	---	---
1-Methyl Naphthalene	---	---	1.2	---	0.01	---	---	---	---	---	---	---			---	---	---	---	---	---	---	---

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria			Risk Assessment	RDL	AEC D: Powerhouse 2012							Delta 2012				Delta 2012				
Sample Number	**Federal**		**Provincial**			**D1-TP12-Geo1**	**D1-HA12-1A**	**D1-HA12-1B**	**DUP-4 Duplicate ot D1-HA12-1B**	**D1-HA12-2**	**DUP-5 Duplicate ot D1-HA12-2**	**D1-HA12-3**	**Delta-TP12-1A**	**Delta-TP12-1B**	**Delta-TP12-2**	**Delta-TP12-3A**	**Delta-TP12-3B**	**DUP-3 Duplicate ot Delta-TP12-3B**	**Delta-TP12-4**	**Delta-TP12-5**	**Delta-TP12-6**
Sampling Date						13/08/2012							14/08/2012	14/08/2012	14/08/2012	14/08/2012	14/08/2012	14/08/2012	14/08/2012	14/08/2012	14/08/2012
Sampling Depth (m)	**Env. Health (non-carcinogenic effects)**	**Human health (carcinogenic effects)**	**MOE Table 2[3] Residential / Parkland**	**SSTL**		0.1 - 2.0	0.1 - 0.7	0.7 - 0.9	0.7 - 0.9	0.2 - 1.0	0.2 - 1.0	0.2 - 0.7	1.0 - 1.0	1.0 - 1.5	0.5 - 1.0	0.1 - 0.6	0.6 - 1.5	0.6 - 1.5	0.5 - 1.6	0.3 - 0.8	0.1 - 0.6
BTEX Parameters (mg/kg)																					
Benzene	0.03	NC	NA	---	0.005	0.019	<0.0050	0.17	0.16	0.36	0.17	<0.0050	0.0071	<0.0050	8.7	<0.40	0.96	0.12	<0.0050	<0.0050	<0.0050
Toluene	0.37	NC	NA	---	0.01	0.16	0.48	6.5	7.6	3.2	2	<0.020	0.046	<0.020	0.31	1	0.032	0.024	<0.020	<0.020	<0.020
Ethylbenzene	0.082	NC	NA	---	0.01	0.28	1.1	9.3	9.9	4.8	3.6	0.055	0.028	<0.010	0.71	0.89	0.2	0.039	<0.010	<0.010	<0.010
Xylenes	11	NC	NA	---	0.02	5.1	1.5	73	54	29	22	0.12	0.16	<0.040	1.4	3.6	0.66	0.13	<0.040	<0.040	<0.040
Petroleum Hydrocarbons (mg/kg)																					
F1(C6-C10) - BTEX	NC	30	NC	---	12	780	4400	3500	1500	1500	530	73	1000	17	15	630	79	31	<12	<12	<12
F2 (C10-C16)	NC	150	NC	1374	10	5900	40000	19000	13000	12000	7700	1400	5900	820	11	5600	590	160	14	<10	<10
F3 (C16-C34)	NC	300	NC	---	10	280	1800	670	430	900	580	180	280	110	46	1500	150	76	76	40	21
F4 (C34-C50)	NC	2800	NC	---	10	<10	<10	<10	<10	290	51	12	<10	<10	<10	110	10	<10	<10	<10	<10
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
% Moisture	NC	NC	NC	---	0.1	16	17	16	20	21	21	17	15	18	18	6.2	18	18	17	17	15
Polycyclic Aromatics (mg/kg)																					
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	<1.6	1.3	---	---	---	<0.14 (1)	<0.027 (1)	---	<0.50 (1)	<0.052 (1)	---	0.0062	---	<0.0050
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	0.30	<0.10	---	---	---	<0.10	<0.10	---	<0.10	<0.10	---	<0.10	---	<0.10
Acenaphthylene	320	---	0.15	---	0.22	---	---	<0.51	<0.32 (1)	---	---	---	<0.075 (1)	<0.014 (1)	---	<0.24 (1)	<0.022 (1)	---	<0.0050	---	<0.0050
Acridine	---	---	---	---	0.010	---	---	<0.50	0.19	---	---	---	0.084	0.013	---	0.15	0.014	---	0.025	---	<0.010
Anthracene	2.5	---	0.67	---	0.0040	---	---	<0.20	<0.043 (1)	---	---	---	<0.0040	<0.0040	---	<0.0040	<0.0040	---	<0.0040	---	<0.0040
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	---	---	<0.25	0.0060	---	---	---	0.0074	0.024	---	0.0087	0.016	---	0.032	---	0.0083
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	---	---	<0.25	0.011	---	---	---	0.013	0.056	---	<0.015 (1)	0.034	---	0.058	---	0.018
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	---	---	<0.25	<0.0050	---	---	---	<0.0050	<0.012 (1)	---	<0.0050	<0.0079 (1)	---	<0.014 (1)	---	<0.0050
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	<0.25	0.022	---	---	---	0.0094	0.060	---	0.012	0.039	---	0.049	---	0.022
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	<0.25	<0.0050	---	---	---	<0.0050	<0.0050	---	<0.0050	<0.0050	---	<0.0050	---	<0.0050
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	---	---	<0.25	<0.0050	---	---	---	<0.0050	0.022	---	0.0070	0.014	---	0.029	---	0.0086
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	<0.25	0.0096	---	---	---	0.0081	0.049	---	0.014	0.025	---	0.036	---	0.015
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	<0.25	0.0096	---	---	---	0.0062	0.023	---	0.0093	0.016	---	0.025	---	0.0094
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	---	---	<0.25	<0.0050	---	---	---	<0.0050	0.0062	---	<0.0050	<0.0050	---	<0.0050	---	<0.0050
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	<0.25	0.022	---	---	---	0.035	0.045	---	0.023	0.035	---	0.068	---	0.019
Fluorene	15.4	---	62	---	0.0050	---	---	1.7	1.0	---	---	---	<0.32 (1)	<0.051 (1)	---	<0.82 (1)	<0.075 (1)	---	0.028	---	0.0072
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	---	---	<0.25	0.0072	---	---	---	<0.0050	0.017	---	0.0057	0.011	---	0.020	---	0.0077
2-Methyl Naphthalene	---	---	0.99	---	0.0050	---	---	99	63 (2)	---	---	---	3.7	0.53	---	25 (2)	2.9	---	0.25	---	0.035
Naphthalene	0.013	---	0.6	---	0.0050	---	---	45	32 (3)	---	---	---	<0.47 (1)	0.17	---	3.9	0.51	---	0.17	---	0.023
Phenanthrene	0.046	---	6.2	---	0.0050	---	---	0.77	0.61	---	---	---	0.20	0.14	---	0.55	0.13	---	0.19	---	0.035
Perylene	---	---	---	---	0.0050	---	---	<0.25	0.20	---	---	---	0.052	0.30	---	0.064	0.32	---	0.40	---	0.16
Pyrene	7.7	---	78	---	0.0050	---	---	<0.25	0.073	---	---	---	0.036	0.069	---	0.035	0.050	---	0.090	---	0.026
Quinoline	---	---	---	---	0.010	---	---	<7.1	<2.4 (4)	---	---	---	<0.55 (1)	<0.12 (1)	---	<1.1 (1)	<0.097 (1)	---	<0.010	---	<0.010
1-Methyl Naphthalene	---	---	1.2	---	0.01	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria			Risk Assessment	RDL	Delta 2012					Station Creek 2012					APEC E-1: HYDROGEN BUILDING 2008			APEC E-1: HYDROGEN BUILDING 2009	
Sample Number	Federal		Provincial			Delta-TP12-7	Delta-TP12-8A	Delta-TP12-8B	Delta-TP12-9A	Delta-TP12-9B	SC-TP12-1	SC-TP12-2	SC-TP12-3	DUP-6 Duplicate ot SC-TP12-3	SC-TP12-4	APEC E1-TP08-1	APEC E1-TP08-2	APEC E1-HA08-1	E-HA09-1A	E-HA09-1B
Sampling Date						14/08/2012	14/08/2012	14/08/2012	14/08/2012	14/08/2012	18/08/2012	18/08/2012	18/08/2012	18/08/2012	18/08/2012	**20/08/2008**	**20/08/2008**	**20/08/2008**	08/12/2009	08/12/2009
Sampling Depth (m)	Env. Health (non carcinogenic effects)	Human health (carcinogenic effects)	MOE Table 2^3 Residential / Parkland	SSTL		0.1 - 0.6	0.1 - 0.8	0.8 - 1.0	0.1 - 1.0	1.0 - 1.3	0.5 - 1.2	0.6 - 1.0	0.5 - 1.4	0.5 - 1.4	0.2 - 1.5	1.4	1	0.5	0.3	1.2
BTEX Parameters (mg/kg)																				
Benzene	0.03	NC	NA	---	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.014	<0.005	<0.005	<0.0050	<0.0050
Toluene	0.37	NC	NA	---	0.01	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.03	0.19	<0.01	<0.050	<0.050
Ethylbenzene	0.082	NC	NA	---	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	0.12	<0.015	<0.015
Xylenes	11	NC	NA	---	0.02	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.02	0.17	0.13	<0.10	<0.10
Petroleum Hydrocarbons (mg/kg)																				
F1(C6-C10) - BTEX	NC	30	NC	---	12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<5	<5	12	<10	<10
F2 (C10-C16)	NC	150	NC	1374	10	<10	<10	15	<20	<10	<10	<10	<10	<10	<10	<5	8	590	<20	<20
F3 (C16-C34)	NC	300	NC	---	10	<10	12	19	<20	14	34	38	39	44	41	14	49	78	62	77
F4 (C34-C50)	NC	2800	NC	---	10	<10	<10	<10	<20	<10	<10	<10	<10	<10	<10	<5	23	<5	23	30
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	YES	YES	YES	Yes	Yes
% Moisture	NC	NC	NC	---	0.1	9.7	13	17	9.7	20	17	19	23	22	19	7.6	25	15	14.7	18.6
Polycyclic Aromatics (mg/kg)																				
Acenaphthene	0.28	---	7.9	---	0.0050	---	<0.0050	<0.0050	---	---	<0.0050	---	<0.0050	---	---	---	---	---	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	<0.10	<0.10	---	---	<0.10	---	<0.10	---	---	---	---	---	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	<0.0050	<0.0050	---	---	<0.0050	---	<0.0050	---	---	---	---	---	---	---
Acridine	---	---	---	---	0.010	---	<0.010	<0.010	---	---	<0.010	---	<0.010	---	---	---	---	---	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	<0.0040	<0.0040	---	---	<0.0040	---	<0.0040	---	---	---	---	---	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	---	<0.0050	0.0086	---	---	0.011	---	0.023	---	---	---	---	---	---	---
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	---	0.0099	<0.016 (1)	---	---	0.027	---	0.056	---	---	---	---	---	---	---
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	---	<0.0050	<0.0050	---	---	0.0051	---	0.010	---	---	---	---	---	---	---
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	0.013	0.019	---	---	0.027	---	0.073	---	---	---	---	---	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	<0.0050	<0.0050	---	---	<0.0050	---	<0.0050	---	---	---	---	---	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	---	<0.0050	0.0061	---	---	0.011	---	0.024	---	---	---	---	---	---	---
Benzo[e]pyrene	---	---	---	---	0.0050	---	0.0081	0.010	---	---	0.017	---	0.055	---	---	---	---	---	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	<0.0050	0.0075	---	---	0.014	---	0.041	---	---	---	---	---	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	---	<0.0050	<0.0050	---	---	<0.0050	---	<0.0050	---	---	---	---	---	---	---
Fluoranthene	15.4	---	0.69	---	0.0050	---	0.0094	0.021	---	---	0.027	---	0.047	---	---	---	---	---	---	---
Fluorene	15.4	---	62	---	0.0050	---	<0.0050	0.0086	---	---	0.013	---	0.015	---	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	---	<0.0050	0.0060	---	---	0.013	---	0.028	---	---	---	---	---	---	---
2-Methyl Naphthalene	---	---	0.99	---	0.0050	---	0.018	0.036	---	---	0.038	---	0.17	---	---	---	---	---	---	---
Naphthalene	0.013	---	0.6	---	0.0050	---	0.012	0.021	---	---	0.025	---	0.11	---	---	---	---	---	---	---
Phenanthrene	0.046	---	6.2	---	0.0050	---	0.032	0.047	---	---	0.057	---	0.16	---	---	---	---	---	---	---
Perylene	---	---	---	---	0.0050	---	0.092	0.26	---	---	0.29	---	0.29	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	---	0.013	0.034	---	---	0.036	---	0.073	---	---	---	---	---	---	---
Quinoline	---	---	---	---	0.010	---	<0.010	<0.010	---	---	<0.010	---	<0.010	---	---	---	---	---	---	---
1-Methyl Naphthalene	---	---	1.2	---	0.01	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria			Risk Assessment	RDL	APEC E-1: HYDROGEN BUILDING 2009												AEC H: Old Maintenance Garage 2009			
Sample Number	Federal		Provincial			E-HA09-2A	E-HA09-2B	E-HA09-3A	E-HA09-3B	E-HA09-4A	E-HA09-4B	E-HA09-5A	E-HA09-5B	E-HA09-6A	E-HA09-6B	E-HA09-7A	E-HA09-7B	H-TP09-1A	H-TP09-1B	H-TP09-2A	H-TP09-2B
Sampling Date						08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	08/12/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009
Sampling Depth (m)	Env. Health (non-carcinogenic effects)	Human health (carcinogenic effects)	MOE Table 2^3 Residential / Parkland	SSTL		0.3	0.9	0.3	0.5	0.3	0.9	0.3	1	0	0.9	0.3	0.3	1	1.1	1.4	2
BTEX Parameters (mg/kg)																					
Benzene	0.03	NC	NA	---	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0199	0.03	<0.0050	<0.0050
Toluene	0.37	NC	NA	---	0.01	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Ethylbenzene	0.082	NC	NA	---	0.01	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	0.027	0.186	<0.015	<0.015
Xylenes	11	NC	NA	---	0.02	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.46	<0.10	<0.10
Petroleum Hydrocarbons (mg/kg)																					
F1(C6-C10) - BTEX	NC	30	NC	---	12	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	92	<10	23
F2 (C10-C16)	NC	150	NC	1374	10	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	348	3100	60	194
F3 (C16-C34)	NC	300	NC	---	10	92	72	41	48	47	69	<20	<20	<20	<20	<20	<20	57	284	270	298
F4 (C34-C50)	NC	2800	NC	---	10	32	31	<20	<20	<20	31	<20	<20	<20	<20	<20	<20	<20	<20	57	77
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
% Moisture	NC	NC	NC	---	0.1	12.6	15.2	4.28	4.77	12.4	14.8	4.61	4.61	4.36	4.58	4.66	4.9	8.56	8.65	6.87	7.04
Polycyclic Aromatics (mg/kg)																					
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthylene	320	---	0.15	---	0.22	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acridine	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Anthracene	2.5	---	0.67	---	0.0040	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	<0.010	<0.010	<0.010	<0.010
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	<0.010	<0.010	<0.010	<0.010
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	<0.010	<0.010	<0.010	<0.010
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	<0.010	<0.010	<0.010	<0.010
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	<0.010	<0.010	<0.010	<0.010
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluorene	15.4	---	62	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	<0.010	<0.010	<0.010	<0.010
2-Methyl Naphthalene	---	---	0.99	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	0.021	<0.010	0.012	0.054
Naphthalene	0.013	---	0.6	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	<0.010	<0.010	<0.010	0.019
Phenanthrene	0.046	---	6.2	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	0.014	0.012	0.017	0.016
Perylene	---	---	---	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	7.7	---	78	---	0.0050	---	---	---	---	---	---	---	---	---	---	---	---	<0.010	<0.010	<0.010	<0.010
Quinoline	---	---	---	---	0.010	---	---	---	---	---	---	---	---	---	---	---	---	<0.010	<0.010	<0.010	<0.010
1-Methyl Naphthalene	---	---	1.2	---	0.01	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-3: Soil Chemical Concentrations
- PHCs and PAH

PARAMETER	Soil Criteria			Risk Assessment	RDL	AEC H: Old Maintenance Garage 2009					Borrow Source 2012	
Sample Number	Federal		Provincial			H-TP09-3A	H-TP09-3B	H-HA09-1	H-HA09-2	H-HA09-3	Borrow-1	Borrow-2
Sampling Date						13/8/2009	13/8/2009	13/8/2009	13/8/2009	13/8/2009	17/08/2012	18/08/2012
Sampling Depth (m)	Env. Health (non-carcinogenic effects)	Human health (carcinogenic effects)	MOE Table 2^3 Residential / Parkland	SSTL		1.3	1.5	0.2	0.3	0.2	0.1 - 0.2	0.1 - 0.2
BTEX Parameters (mg/kg)												
Benzene	0.03	NC	NA	---	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Toluene	0.37	NC	NA	---	0.01	<0.050	<0.050	<0.050	<0.050	<0.050	<0.020	<0.020
Ethylbenzene	0.082	NC	NA	---	0.01	<0.015	<0.015	<0.015	<0.015	0.016	<0.010	<0.010
Xylenes	11	NC	NA	---	0.02	<0.10	<0.10	<0.10	<0.10	<0.10	<0.040	<0.040
Petroleum Hydrocarbons (mg/kg)												
F1(C6-C10) - BTEX	NC	30	NC	---	12	<10	<10	<10	<10	51	<12	<12
F2 (C10-C16)	NC	150	NC	1374	10	<20	<20	<20	<20	4050	<10	<10
F3 (C16-C34)	NC	300	NC	---	10	83	<20	334	48	651	10	27
F4 (C34-C50)	NC	2800	NC	---	10	<20	<20	104	<20	<20	<10	<10
Chromatogram to baseline at nC50	NC	NC	NC	---	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes
% Moisture	NC	NC	NC	---	0.1	5.94	12.1	7.46	7.92	4.85	6.9	5.3
Polycyclic Aromatics (mg/kg)												
Acenaphthene	0.28	---	7.9	---	0.0050	---	---	---	---	---	<0.0050	<0.0050
Benzo[a]pyrene equivalency	---	5.3	---	---	0.10	---	---	---	---	---	<0.10	<0.10
Acenaphthylene	320	---	0.15	---	0.22	---	---	---	---	---	<0.0050	<0.0050
Acridine	---	---	---	---	0.010	---	---	---	---	---	<0.010	<0.010
Anthracene	2.5	---	0.67	---	0.0040	---	---	---	---	---	<0.0040	<0.0040
Benzo(a)anthracene	6.2	B[a]P	0.5	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0050	0.0053
Benzo(b&j)fluoranthene	6.2	B[a]P	0.78	---	0.0050	0.017	<0.010	<0.010	<0.010	0.01	<0.0050	0.018
Benzo(k)fluoranthene	6.2	B[a]P	0.78	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050
Benzo(g,h,i)perylene	---	B[a]P	6.6	---	0.0050	---	---	---	---	---	<0.0050	0.021
Benzo(c)phenanthrene	---	---	---	---	0.0050	---	---	---	---	---	<0.0050	<0.0050
Benzo(a)pyrene	20	B[a]P	0.3	---	0.0050	0.011	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050
Benzo[e]pyrene	---	---	---	---	0.0050	---	---	---	---	---	<0.0050	0.012
Chrysene	6.2	B[a]P	7	---	0.0050	---	---	---	---	---	<0.0050	0.0083
Dibenzo(a,h)anthracene	1	B[a]P	0.1	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050
Fluoranthene	15.4	---	0.69	---	0.0050	---	---	---	---	---	<0.0050	0.010
Fluorene	15.4	---	62	---	0.0050	---	---	---	---	---	<0.0050	<0.0050
Indeno(1,2,3-cd)pyrene	1	B[a]P	0.38	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0050	0.0094
2-Methyl Naphthalene	---	---	0.99	---	0.0050	0.019	0.048	<0.010	<0.010	0.118	<0.0050	0.017
Naphthalene	0.013	---	0.6	---	0.0050	<0.010	<0.010	<0.010	<0.010	<0.050	<0.0050	0.0072
Phenanthrene	0.046	---	6.2	---	0.0050	0.02	0.023	<0.010	<0.010	0.044	0.0076	0.026
Perylene	---	---	---	---	0.0050	---	---	---	---	---	<0.0050	0.062
Pyrene	7.7	---	78	---	0.0050	0.027	0.011	<0.010	<0.010	0.023	<0.0050	0.014
Quinoline	---	---	---	---	0.010	<0.010	<0.010	<0.010	<0.010	<0.050	<0.010	<0.010
1-Methyl Naphthalene	---	---	1.2	---	0.01	---	---	---	---	---	---	---

Notes:

1 = CCME (2007), Canadian Environmental Quality Guidelines Summary Table, Soil Quality Guidelines for the Protection of Environmental and Human Health. Residential/Parkland, coarse grain soils

2 = CCME (2008) Canadian-Wide Standards for Petroleum Hydrocarbons in Soil - Table 1, Tier 1 levels for PHCs, Residential / Parkland Use in fine-grained surface soils: Protection of Eco Soil Contact from Table 3 - Technical Supplement.

3 = MOE (2011), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 2 - Full Depth Residential / Parkland Standards for Potable Ground Water.

A = CCME (2004) Benzene, Table 2 - Soil quality guidelines and check values for benzene, Toluene, Ethylbenzene, and Xylenes. Soil ingestion guideline, coarse-grained, surficial soil.

(1) = Raised Minimum Detection Limit due to interference
--- = No Criteria/Not analyzed
NA = Not applicable
RDL= Reportable Detection Limit
20 = Denotes concentration above criteria
20 = Denotes concentration above the SSTLs

Table B-4: Soil Chemical Concentrations - PCBs

PARAMETER		**RDL**	**APEC A-1-2-3: LANDFILL**							**APEC A-6: BARREL CRUSHING AREA AND BAREL LANDFILLS**		
Sample Number	**Federal**		**LANDFILL - HA08-2**	**LANDFILL - HA08-3**	**LANDFILL - HA08-4**	**LANDFILL - HA08-5**	**DUP1 (LANDFILL -HA08-5)**	**LANDFILL - HA08-6**	**LANDFILL - HA08-7**	**APEC A6-HA08-1**	**APEC A9-HA08-2**	**APEC A6-HA08-3**
Sample Date	**CCME 1999 [1]**		**16/08/2008**	**16/08/2008**	**16/08/2008**	**16/08/2008**	**16/08/2008**	**16/08/2008**	**16/08/2008**	**18/08/2008**	**18/08/2008**	**18/08/2008**
Sample Depth (m)	**Residential/ Parkland**		1	1.1	1.15	1	1	0.6	1.1	0.9	1.2	0.8
PCBs (mg/kg)												
Aroclor 1016	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1221	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1232	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1242	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1248	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1254	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1260	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1262	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1268	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total PCBs	1.3	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Notes:

1 = CCME (2007), Canadian Soil Quality Guidelines, Update 7.0, Table 1. Canadian Soil Quality Guidelines, Residential / Parkland Use, fine-grained soils.
NC = No Criteria
RDL= Reportable Detection Limit
20 = Denotes exceedances for Residential/Parkland landuse.

Table B-4: Soil Chemical Concentrations - PCBs

PARAMETER	Federal CCME 1999 [1] Residential/ Parkland	RDL	APEC A-9: FORMER FIRST AIR LEASE				APEC D-1: POWERHOUSE LOCATED AT THE MAIN CAMP							
Sample Number			**APEC A9-TP08-1**	**APEC A9-TP08-2**	**APEC A9-TP08-3**	**APEC A9-HA08-1**	**APEC D1-TP08-2-2**	**APEC D1-TP08-3**	**APEC D1-HA08-1**	**APEC D1-HA08-2**	**APEC D1-HA08-4**	**APEC D1-HA08-7**	**APEC D1-SURFACE 08-1**	**APEC D1-SURFACE 08-2**
Sample Date			**17/08/2008**	**17/08/2008**	**17/08/2008**	**17/08/2008**	**19/08/2008**	**19/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**	**21/08/2008**
Sample Depth (m)			0.9	0.6	0.8	1	1	1	0.4	0.6	0.35	1.8	surface	surface
PCBs (mg/kg)														
Aroclor 1016	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1221	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1232	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1242	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1248	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1254	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.11	0.16
Aroclor 1260	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
Aroclor 1262	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1268	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total PCBs	1.3	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.12	0.16

Notes:

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

NC = No Criteria

RDL= Reportable Detection Limit

20 = Denotes exceedances for Residential/Parkland landuse.

Table B-5: Surface Water Chemical Concentrations
- Background Metals

PARAMETER	Surface Water Criteria		RDL	Background 2009		Background 2010	Background 2012										Background Average
Sampling No.	**Federal^A**			**BG-SW09-1**	**BG-SW09-2**	**BK-SW10-1**	**BG-SW12-1**	**BG-SW12-2**	**BG-SW12-DUP1 (of BG-SW12-2)**	**BG-SW12-3**	**BG-SW12-4**	**BG-SW12-5**	**BG-SW12-6**	**BG-SW12-7**	**BG-SW12-8**	**BG-SW12-9**	
Sampling Date	**CCME 2007^1 FWAL**	**Canadian Drinking Water Quality^2**		15/8/2009	15/8/2009	18/08/2010	18/08/2012	18/08/2012	18/08/2012	18/08/2012	18/08/2012	18/08/2012	19/08/2012	19/08/2012	19/08/2012	19/08/2012	
Trace Metals (mg/L)																	
Aluminum (Al)	0.1	0.1**	0.0010	0.816	0.327	0.092	4.7	2.7	2.9	2.7	3.1	2.9	0.14	0.19	0.20	0.25	1.62
Antimony (Sb)	---	0.006	0.00060	<0.00040	<0.00040	<0.0001	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060
Arsenic (As)	0.005	0.01	0.00020	0.00114	0.00085	<0.0001	0.0067	0.0024	0.0024	0.0024	0.0026	0.0036	0.00037	0.00026	0.00025	0.00031	0.00194
Barium (Ba)	---	1	0.010	0.0435	0.0435	0.033	0.064	0.044	0.044	0.046	0.047	0.052	0.054	0.054	0.053	0.054	0.049
Beryllium (Be)	---	---	0.0010	<0.0010	<0.0010	<0.00005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Boron (B)	1500	5	0.020	<0.050	<0.050	0.05	0.044	0.036	0.038	0.037	0.039	0.040	0.054	0.055	0.056	0.058	0.046
Cadmium (Cd)	0.000018	0.005	0.000005	<0.000050	<0.000050	<0.00001	0.00012	0.000093	0.000096	0.00011	0.00012	0.00013	0.000073	<0.000005	<0.000005	<0.000005	0.007758
Calcium (Ca)	---	---	0.30	113	140	123	120	120	120	120	120	120	210	200	200	200	147
Chromium (Cr)	---	0.05	0.0010	<0.0050	<0.0050	<0.0005	0.0092	0.0032	0.0034	0.0031	0.0040	0.0044	<0.0010	<0.0010	<0.0010	<0.0010	0.0032
Cobalt (Co)	---	---	0.00030	<0.0020	<0.0020	<0.00005	0.014	0.011	0.011	0.012	0.012	0.013	0.0012	<0.00030	0.00031	<0.00030	0.00751
Copper (Cu)	0.002	1 (AO)	0.00020	0.0027	0.0022	<0.0001	0.020	0.013	0.013	0.014	0.014	0.015	0.0014	0.00075	0.00067	0.00078	0.00813
Iron (Fe)	0.3	0.3 (AO)	0.060	1.3	1.02	0.065	15	5.4	5.5	5.4	6.0	8.0	0.32	0.34	0.36	0.43	3.78
Lead (Pb)	0.001	0.01	0.00020	0.00111	0.00059	<0.00005	0.0083	0.0046	0.0044	0.0046	0.0051	0.0057	<0.00020	<0.00020	<0.00020	<0.00020	0.00293
Lithium (Li)	---	---	0.020	0.013	0.012	0.013	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.013
Magnesium (Mg)	---	---	0.20	45.5	55.4	50.1	40	39	39	39	40	41	92	91	91	93	58.2
Manganese (Mn)	---	0.050 (AO)	0.0040	0.0137	0.0108	0.016	0.40	0.32	0.33	0.36	0.34	0.37	0.016	0.017	0.019	0.018	0.172
Molybdenum (Mo)	0.073	---	0.00020	<0.0050	<0.0050	<0.0001	0.00087	<0.00020	<0.00020	<0.00020	<0.00020	0.00036	0.00021	<0.00020	<0.00020	<0.00020	0.00107
Nickel (Ni)	0.025	---	0.00050	0.0033	0.0036	0.002	0.034	0.024	0.024	0.029	0.027	0.029	0.0024	0.0022	0.0022	0.0022	0.0142
Phosphorus (P)	0.035-0.1*	---	0.10	---	---	<0.005	0.43	0.29	0.22	0.22	0.26	0.37	<0.10	<0.10	<0.10	<0.10	0.22
Potassium (K)	---	---	0.30	3.79	4.55	4	4.0	3.1	3.1	3.0	3.1	3.4	5.6	5.6	5.7	5.8	4.2
Selenium (Se)	0.001	0.01	0.00020	0.002	0.0021	<0.0002	0.00098	0.00091	0.00090	0.00086	0.00086	0.00087	0.0023	0.0023	0.0022	0.0023	0.0015
Silicon (Si)	---	---	0.10	---	---	0.945	7.1	2.7	2.8	3.2	3.0	4.0	0.83	0.83	0.94	1.1	2.65
Silver (Ag)	0.0001	---	0.00010	<0.00010	0.00019	<0.00001	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00011
Sodium (Na)	---	200 (AO)	0.50	57.8	69.4	67.5	58	57	58	57	59	61	170	170	170	170	94
Strontium (Sr)	---	---	0.020	---	---	0.511	0.38	0.36	0.36	0.37	0.37	0.38	0.82	0.82	0.82	0.83	0.55
Sulphur (S)	---	---	0.20	---	---	---	110	110	120	120	120	120	250	250	250	250	170
Thallium (Tl)	0.0008	---	0.00020	<0.00010	0.00013	<0.000005	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.00019
Tin (Sn)	---	---	0.0010	<0.050	<0.050	<0.0001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050
Titanium (Ti)	---	---	0.0010	0.0293	0.009	<0.0005	0.090	0.036	0.048	0.036	0.058	0.035	0.0095	0.0057	0.0091	0.011	0.031
Uranium (U)	0.015	0.02	0.00010	0.00088	0.00089	0.0007	0.0012	0.0010	0.00099	0.0010	0.0010	0.0011	0.0014	0.0014	0.0014	0.0014	0.0011
Vanadium (V)	---	---	0.0010	0.0037	0.0015	<0.0005	0.024	0.011	0.011	0.012	0.012	0.014	<0.0010	<0.0010	<0.0010	<0.0010	0.0078
Zinc (Zn)	0.03	5 (AO)	0.0030	0.0069	0.0119	<0.0005	0.16	0.15	0.17	0.20	0.28	0.52	2.4	<0.0030	<0.0030	<0.0030	0.3257

Notes:

1 = Canadian Council of Ministers of the Environment, Summary Table - Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (FWAL), 2007 Update.

2 = Canadian Council of Ministers of the Environment, Guidelines for Canadian Water Quality Summary Table (Table 4), 2006 Update.

NC= No Criteria

* = Range for Eutrophic conditions

** = Operational Guidance Value for conventional water treatment plant using aluminium-based coagulants.

AO = Aesthetic objective

RDL = Reportable Detection Limit

20 = Denotes exceedances.

Table B-6a: Drinking Water Reservoir Surface Water Chemical Concentrations - Metals

PARAMETER	**Surface Water Criteria**		**Established Background Level**	**RDL**	**Drinking Water 2008**		**Drinking Water Reservior 2009**		**Drinking Water Reservior 2010**		
Sampling No.	**Federal[A]**				**DW-PUMPHOUSE #1**	**DW-PUMPHOUSE #2**	**D1-SW09-7**	**D1-SW09-8**	**D1-SW10-6**	**D1-SW10-7**	**D1-SW10-DUP2**
Sampling Date	**CCME 2007[1] FWAL**	**Canadian Drinking Water Quality [2]**			22/08/2008	22/08/2008	15/8/2009	15/8/2009	18/08/2010	18/08/2010	18/08/2010
Trace Metals (mg/L)											
Aluminum (Al)	0.1	0.1[++]	4.544	0.01	0.14	0.76	0.1	0.099	0.0484	0.0603	0.0545
Antimony (Sb)	---	0.006	<0.00060	0.0004	<0.0004	<0.0004	<0.00040	<0.00040	<0.0001	<0.0001	<0.0001
Arsenic (As)	0.005	0.01	0.0122	0.0004	0.0006	0.0006	0.00056	0.00047	<0.0001	0.0001	0.0001
Barium (Ba)	---	1	0.0628	0.003	0.019	0.02	0.0204	0.0152	0.0174	0.0174	0.0174
Beryllium (Be)	---	---	<0.0010	0.001	<0.001	<0.001	<0.0010	<0.0010	<0.00005	<0.00005	<0.00005
Bismuth (Bi)	---	---	---	0.00005	---	---	---	---	<0.00005	<0.00005	<0.00005
Boron (B)	1500	5	0.0635	0.05	<0.05	<0.05	<0.050	<0.050	0.04	0.041	0.042
Cadmium (Cd)	0.000018	0.005	0.000152	0.0002	<0.0002	<0.0002	<0.000050	<0.000050	0.00001	0.00001	0.00001
Calcium (Ca)	---	---	219.3	0.5	60.9	62.7	49.8	50.4	61.8	63.4	62.3
Chromium (Cr)	---	0.05	0.0072	0.005	0.008	0.007	<0.0050	<0.0050	<0.0005	<0.0005	<0.0005
Cobalt (Co)	---	---	0.0172	0.002	<0.002	<0.002	<0.0020	<0.0020	<0.00005	0.00008	0.00005
Copper (Cu)	0.002	1 (AO)	0.021	0.001	0.001	0.011	0.0013	0.0012	0.0004	0.0006	0.0004
Iron (Fe)	0.3	0.3 (AO)	32.15	0.005	0.099	0.48	0.223	0.199	0.056	0.096	0.078
Lead (Pb)	0.0001	0.01	0.00795	0.0001	0.0001	0.0026	0.00017	0.00015	0.00007	0.00013	0.00009
Lithium (Li)	---	---	0.0128	0.01	0.01	0.01	<0.010	<0.010	0.0094	0.0095	0.0097
Magnesium (Mg)	---	---	102.2	0.1	25.2	26.1	21.1	21.1	27.4	27	27.6
Manganese (Mn)	---	0.050 (AO)	0.497	0.001	0.014	0.019	0.0134	0.013	0.0073	0.0101	0.01
Mercury (Hg)	0.000026	0.001	---	0.0001	<0.00010	<0.00010	<0.00010	<0.00010	<0.00001	<0.00001	<0.00001
Molybdenum (Mo)	---	---	0.000891	0.005	<0.005	<0.005	<0.0050	<0.0050	0.0001	0.0001	0.0001
Nickel (Ni)	0.025	---	0.0389	0.002	0.003	0.017	<0.0020	<0.0020	0.0012	0.0014	0.0013
Phosphorus (P)	0.035-0.1[+]	---	0.462	0.005	---	---	---	---	0.005	0.009	0.006
Potassium (K)	---	---	6.265	0.1	3.1	3.1	2.71	2.65	3.59	3.54	3.59
Selenium (Se)	0.001	0.01	0.00286	0.0004	0.0004	0.0005	<0.0020	<0.0020	0.0004	0.0004	0.0004
Silicon (Si)	---	---	8.057	0.10	---	---	---	---	0.368	0.375	0.37
Silver (Ag)	0.0001	---	<0.00010	0.0004	<0.0004	<0.0004	<0.00010	<0.00010	<0.00001	<0.00001	<0.00001
Sodium (Na)	---	200 (AO)	191.7	1	48	49	38.7	38.8	55.6	56.3	55.5
Strontium (Sr)	---	---	1	0.020	---	---	---	---	0.273	0.27	0.274
Tellurium (Te)	---	---	---	0.0001	---	---	---	---	<0.0001	<0.0001	<0.0001
Thallium (Tl)	0.0008	---	<0.00020	0.0001	<0.0001	<0.0001	<0.00010	<0.00010	<0.000005	0.00001	<0.000005
Thorium (Th)	---	---	---	0.0001	---	---	---	---	<0.0001	<0.0001	<0.0001
Tin (Sn)	---	---	<0.0010	0.05	<0.05	<0.05	<0.050	<0.050	<0.0001	<0.0001	<0.0001
Titanium (Ti)	---	---	0.0765	0.001	0.001	0.003	0.0027	0.0019	<0.0005	0.0005	0.0007
Tungsten (W)	---	---	---	0.0001	---	---	---	---	<0.0001	<0.0001	<0.0001
Uranium (U)	0.015	0.02	0.00154	0.0001	0.0003	0.0004	0.00031	0.00031	0.00032	0.00034	0.00034
Vanadium (V)	---	---	0.0209	0.001	0.003	0.002	<0.0010	<0.0010	<0.0005	<0.0005	<0.0005
Zinc (Zn)	0.03	5 (AO)	5.891	0.004	0.004	0.119	<0.0040	<0.0040	<0.0005	0.0022	0.0008
Zirconium (Zr)	---	---	---	0.0001	---	---	---	---	<0.0001	0.0001	0.0001

Notes

1 = Canadian Council of Ministers of the Environment, Summary Table - Canadian Water Quality Guidelines for
2 = Canadian Council of Ministers of the Environment, Guidelines for Canadian Water Quality Summary Table
--- No Criteria
+ = Indicates that the lowest guideline value was used as quality criterion where compound guideline is a function of pH, alkalinity or hardness.
++ = Operational Guidance Value for conventional water treatment plant using aluminium-based coagulants.
AO = Aesthetic objective
RDL = Reportable Detection Limit
20 = Denotes parameter above drinking water guidelines

Table B-6b: Surface Water Chemical Concentrations - Metals

PARAMETER	**Surface Water Criteria**		**Established Background Level**	**RDL**	**APEC A-7: Ex-Situ Biotreatment Cell**	**Drainage Pond 2008**		**Drainage Pond 2009**					**Drainage Pond 2010**				
Sampling No.	**Federal[A]**				**SW08-3**	**SW08-1**	**SW08-2**	**D1-SW09-3**	**D1-SW09-4**	**D1-SW09-5**	**D1-SW09-6**	**D1-SW09-DUP1**	**D1-SW10-1**	**D1-SW10-DUP1**	**D1-SW10-2**	**D1-SW10-3**	**D1-SW10-4**
Sampling Date	**CCME 2007[1] FWAL**	**Canadian Drinking Water Quality [2]**			21/08/2008	21/08/2008	21/08/2008	15/8/2009	15/8/2009	15/8/2009	15/8/2009	15/8/2009	18/08/2010	18/08/2010	18/08/2010	18/08/2010	18/08/2010
Trace Metals (mg/L)																	
Aluminum (Al)	0.1	0.1[++]	**4.544**	0.01	0.12	0.03	0.02	0.055	<0.010	<0.010	<0.010	0.011	0.033	0.036	0.248	0.037	0.288
Antimony (Sb)	---	**0.006**	<0.00060	0.0004	<0.0004	<0.0004	<0.0004	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Arsenic (As)	0.005	0.01	**0.0122**	0.0004	0.0018	0.0019	0.0017	0.002	0.00157	0.00145	0.00151	0.00132	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Barium (Ba)	---	**1**	0.0628	0.003	0.08	0.022	0.022	0.018	0.0184	0.017	0.0173	0.0174	0.023	0.023	0.025	0.018	0.017
Beryllium (Be)	---	---	**<0.0010**	0.001	<0.001	<0.001	<0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Bismuth (Bi)	---	---	---	0.00005	---	---	---	---	---	---	---	---	<0.00005	<0.00005	0.001	<0.00005	<0.00005
Boron (B)	1500	**5**	0.0635	0.05	1.45	0.1	0.09	0.136	0.112	0.107	0.107	0.106	0.107	0.109	0.112	0.161	0.397
Cadmium (Cd)	0.000018	0.005	**0.000152**	0.0002	<0.0002	<0.0002	<0.0002	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Calcium (Ca)	---	---	**219.3**	0.5	439	142	134	134	116	128	118	119	159	161	144	174	192
Chromium (Cr)	---	**0.05**	0.0072	0.005	0.014	0.006	<0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt (Co)	---	---	**0.0172**	0.002	0.008	<0.002	<0.002	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Copper (Cu)	0.002	**1 (AO)**	0.021	0.001	0.005	0.002	0.002	0.0025	0.0024	0.002	0.0023	0.0022	0.002	<0.0001	0.001	<0.0001	0.001
Iron (Fe)	0.3	0.3 (AO)	**32.15**	0.005	2.46	0.304	0.233	0.212	0.12	0.136	0.183	0.224	0.225	0.263	1.06	0.139	0.921
Lead (Pb)	0.0001	0.01	**0.00795**	0.0001	0.0007	<0.0001	<0.0001	0.00016	<0.00010	<0.00010	<0.00010	<0.00010	<0.00005	<0.00005	0.0007	<0.00005	0.0007
Lithium (Li)	---	---	**0.0128**	0.01	0.08	0.03	0.03	0.034	0.031	0.029	0.029	0.029	0.029	0.03	0.029	0.032	0.038
Magnesium (Mg)	---	---	**102.2**	0.1	212	77.2	73.8	73.8	65.2	72.6	66.9	67.6	102	103	88.1	110	171
Manganese (Mn)	---	0.050 (AO)	**0.497**	0.001	3.58	0.2	0.224	0.0528	0.0476	0.0633	0.0941	0.0957	0.104	0.105	0.124	0.067	0.034
Mercury (Hg)	0.000026	0.001	---	0.0001	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum (Mo)	---	---	**0.000891**	0.005	<0.005	<0.005	<0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel (Ni)	0.025	---	**0.0389**	0.002	0.018	0.003	0.003	0.0028	0.0022	<0.0020	0.002	0.002	<0.0001	<0.0001	0.001	0.001	0.002
Phosphorus (P)	0.035-0.1[+]	---	**0.462**	0.005	---	---	---	---	---	---	---	---	<0.005	<0.005	<0.005	<0.005	<0.005
Potassium (K)	---	---	**6.265**	0.1	22.3	7.4	7.3	9.14	7.83	8.67	7.89	7.94	8.94	9.06	8.84	13.7	36.1
Selenium (Se)	0.001	**0.01**	0.00286	0.0004	0.0005	<0.0004	<0.0004	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Silicon (Si)	---	---	**8.057**	0.10	---	---	---	---	---	---	---	---	0.184	0.195	0.611	0.724	0.398
Silver (Ag)	**0.0001**	---	<0.00010	0.0004	<0.0004	<0.0004	<0.0004	<0.00010	<0.00010	<0.00010	0.00023	0.00012	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Sodium (Na)	---	**200 (AO)**	191.7	1	630	189	188	213	171	187	171	171	253	250	223	347	935
Strontium (Sr)	---	---	1	0.020	---	---	---	---	---	---	---	---	0.523	0.518	0.49	0.617	0.997
Tellurium (Te)	---	---	---	0.0001	---	---	---	---	---	---	---	---	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Thallium (Tl)	**0.0008**	---	<0.00020	0.0001	<0.0001	<0.0001	<0.0001	<0.00010	<0.00010	0.00012	<0.00010	<0.00010	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Thorium (Th)	---	---	---	0.0001	---	---	---	---	---	---	---	---	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Tin (Sn)	---	---	**<0.0010**	0.05	<0.05	<0.05	<0.05	<0.050	<0.050	<0.050	<0.050	<0.050	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Titanium (Ti)	---	---	**0.0765**	0.001	0.005	<0.001	<0.001	0.0011	<0.0010	<0.0010	<0.0010	<0.0010	<0.0005	<0.0005	<0.0005	<0.0005	0.006
Tungsten (W)	---	---	---	0.0001	---	---	---	---	---	---	---	---	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Uranium (U)	0.015	**0.02**	0.00154	0.0001	0.0065	0.0004	0.0004	0.00044	0.0004	0.00037	0.00038	0.0004	0.0005	0.0005	0.0007	0.0006	0.0009
Vanadium (V)	---	---	**0.0209**	0.001	0.004	0.002	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Zinc (Zn)	0.03	5 (AO)	**5.891**	0.004	0.006	<0.004	0.022	0.0085	0.0111	0.0116	0.0183	0.0183	<0.0005	<0.0005	0.027	<0.0005	<0.0005
Zirconium (Zr)	---	---	---	0.0001	---	---	---	---	---	---	---	---	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Notes

1 = Canadian Council of Ministers of the Environment, Summary Table - Canadian Water Quality Guidelines for
2 = Canadian Council of Ministers of the Environment, Guidelines for Canadian Water Quality Summary Table
--- No Criteria
+ = Indicates that the lowest guideline value was used as quality criterion where compound guideline is a function of pH, alkalinity or hardness.
++ = Operational Guidance Value for conventional water treatment plant using aluminium-based coagulants.
AO = Aesthetic objective
RDL = Reportable Detection Limit
20 = Denotes guideline or threshold applied
▨ 20 = Denotes parameter above guidelines/threshold

Table B-7: Seep Water Chemical Concentrations - Metals

PARAMETER	Groundwater Criteria	RDL	Seep Water 2009		Seep Water 2010
Sampling No.	**Federal**		**D1-SW09-1**	**D1-SW09-2**	**D1-SW10-5**
Sampling Date	**FIGWQGS[1]**		14/8/2009	14/8/2009	18/08/2010
Trace Metals (mg/L)					
Aluminum (Al)	0.1	0.01	37.7	41.1	0.007
Antimony (Sb)	2	0.0004	0.00085	0.00063	<0.0001
Arsenic (As)	0.005	0.0004	0.0323	0.034	<0.0001
Barium (Ba)	0.5	0.003	0.439	0.823	0.037
Beryllium (Be)	0.0053	0.001	0.0044	0.0039	<0.00005
Bismuth (Bi)	---	0.00005	---	---	<0.00005
Boron (B)	5	0.05	1.08	1.01	1.03
Cadmium (Cd)	0.000017	0.0002	0.00154	0.002	<0.00001
Calcium (Ca)	---	0.5	343	1270	204
Chromium (Cr)	0.0089	0.005	0.0795	0.0816	<0.0005
Cobalt (Co)	---	0.002	0.0615	0.0851	0.0078
Copper (Cu)	0.002	0.001	0.143	0.122	<0.0001
Iron (Fe)	0.3	0.005	182	235	4.36
Lead (Pb)	0.0001	0.0001	0.11	0.0894	<0.00005
Lithium (Li)	---	0.01	0.171	0.183	0.073
Magnesium (Mg)	---	0.1	308	547	202
Manganese (Mn)	---	0.001	5.78	14.6	6.1
Mercury (Hg)	0.000026	0.0001	<0.00010	0.00016	0.00002
Molybdenum (Mo)	0.073	0.005	<0.0050	<0.0050	<0.0001
Nickel (Ni)	0.025	0.002	0.158	0.193	0.02
Phosphorus (P)	---	0.005	---	---	0.099
Potassium (K)	---	0.1	32.2	34	20.1
Selenium (Se)	0.001	0.0004	0.004	0.0042	<0.0002
Silicon (Si)	---	0.10	---	---	5.47
Silver (Ag)	0.0001	0.0004	0.00029	0.00029	<0.00001
Sodium (Na)	---	1	557	573	452
Strontium (Sr)	---	0.020	---	---	0.718
Tellurium (Te)	---	0.0001	---	---	<0.0001
Thallium (Tl)	0.008	0.0001	0.00068	0.00081	<0.000005
Thorium (Th)	---	0.0001	---	---	<0.0001
Tin (Sn)	---	0.05	<0.050	<0.050	<0.0001
Titanium (Ti)	0.1	0.001	0.289	0.307	<0.0005
Tungsten (W)	---	0.0001	---	---	<0.0001
Uranium (U)	0.015	0.0001	0.00529	0.00467	0.0015
Vanadium (V)	---	0.001	0.148	0.148	<0.0005
Zinc (Zn)	0.01	0.004	0.443	0.407	<0.0005
Zirconium (Zr)	---	0.0001	---	---	<0.0001

Notes

1 = Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites, Table 2 for Residential/Parkland land use, Tier 1, coarse-grained soil

--- No Criteria
* = Indicates that the lowest guideline value was used as quality criterion where compound guideline is a function of pH,
** = Operational Guidance Value for conventional water treatment
AO = Aesthetic objective
RDL = Reportable Detection Limit
20 = Denotes exceedances.

Table B-8: Surface Water Chemical Concentrations - PHCs and PAHs

PARAMETER	Surface Water Criteria		RDL	Background		APEC A-7: Ex-Situ Biotreatment	APEC D-1: Powerhouse Located at the Main Camp				
Sample Number	Provincial	Federal		BG-SW09-1	BG-SW09-2	SW08-3	SW08-1	DUP 1 (SW08-1)	SW08-2	DW-PUMPHOUSE #1	DW-PUMPHOUSE #2
Sampling Date	MOE Table 2[1] Potable Groundwater	CCME 2007[2] FWAL		15/8/2009	15/8/2009	21/08/2008	21/08/2008	21/08/2008	21/08/2008	22/08/2008	22/08/2008
Petroleum Hydrocarbons (mg/L)											
F1(C6-C10)	1	---	0.1	<0.10	<0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
F1-BTEX		---	0.1	<0.10	<0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
F2 (>C10-C16)		---	0.05	<0.25	<0.25	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
F3 (C16-C34)		---	0.05	<0.25	<0.25	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
F4 (C34-C50)		---	0.05	<0.25	<0.25	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Polycyclic Aromatics (mg/L)											
Naphthalene	0.021	0.0011	0.00002	<0.000010	<0.000010	---	---	---	---	0.00077	0.00001
Quinoline	NC	0.000025	0.00002	<0.000010	<0.000010	---	---	---	---	<0.00002	<0.00001
Acenaphthene	0.31	0.0058	0.00002	<0.000010	<0.000010	---	---	---	---	<0.00002	<0.00001
Fluorene	0.28	0.003	0.00002	<0.000010	<0.000010	---	---	---	---	<0.00002	<0.00001
Phenanthrene	0.063	0.0004	0.00002	<0.000010	<0.000010	---	---	---	---	0.00003	0.00003
Anthracene	0.012	0.000012	0.00002	<0.000010	<0.000010	---	---	---	---	<0.00002	<0.00001
Acridine	NC	0.0044	0.00002	<0.000010	<0.000010	---	---	---	---	<0.00002	<0.00001
Fluoranthene	0.13	0.00004	0.00002	<0.000010	<0.000010	---	---	---	---	<0.00002	0.00001
Pyrene	0.04	0.000025	0.00002	<0.000010	<0.000010	---	---	---	---	<0.00002	<0.00001
Benzo(a)anthracene	0.0002	0.000018	0.00002	<0.000010	<0.000010	---	---	---	---	<0.00002	<0.00001
Chrysene	0.0005	NC	0.00002	<0.000010	<0.000010	---	---	---	---	<0.00002	<0.00001
Benzo(b&j)fluoranthene	0.0002	NC	0.00002	<0.000010	<0.000010	---	---	---	---	<0.00002	<0.00001
Benzo(k)fluoranthene	0.0002	NC	0.00002	<0.000010	<0.000010	---	---	---	---	<0.00002	<0.00001
Benzo(a)pyrene	0.00001	0.000015	0.00002	<0.000010	<0.000010	---	---	---	---	<0.00002	<0.00001
Indeno(1,2,3-cd)pyrene	0.0002	NC	0.00002	<0.000010	<0.000010	---	---	---	---	<0.00002	<0.00001
Dibenzo(a,h)anthracene	0.0002	NC	0.00002	<0.000010	<0.000010	---	---	---	---	<0.00002	<0.00001

Notes:

1 = Ontario Ministry of the Environment, Guideline for Use at Contaminated Sites in Ontario, Table 2 - Full Depth Generic Site Condition Standards in a Potable Ground Water Conditions (2004).

2 = Canadian Council of Ministers of the Environment, Summary Table - Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (FWAL), 2007 Update.

--- = Not analysed or no criterion/guideline established.

20 = Denotes exceedances.

Table B-8: Surface Water Chemical Concentrations - PHCs and PAHs

PARAMETER	Surface Water Criteria		RDL	Drainage to Fjord 2009					Drinking Water Reservior 2009	
Sample Number	**Provincial**	**Federal**		**D1-SW09-3**	**D1-SW09-4**	**D1-SW09-5**	**D1-SW09-6**	**D1-SW09-DUP1**	**D1-SW09-7**	**D1-SW09-8**
Sampling Date	**MOE Table 2[1] Potable Groundwater**	**CCME 2007[2] FWAL**		15/8/2009	15/8/2009	15/8/2009	15/8/2009	15/8/2009	15/8/2009	15/8/2009
Petroleum Hydrocarbons (mg/L)										
F1(C6-C10)	1	---	0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
F1-BTEX		---	0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
F2 (>C10-C16)		---	0.05	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
F3 (C16-C34)		---	0.05	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
F4 (C34-C50)		---	0.05	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Polycyclic Aromatics (mg/L)										
Naphthalene	0.021	0.0011	0.00002	<0.000010	<0.000010	<0.000010	0.000041	<0.000010	<0.000010	<0.000010
Quinoline	NC	0.000025	0.00002	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Acenaphthene	0.31	0.0058	0.00002	<0.000010	<0.000010	<0.000010	0.000024	<0.000010	<0.000010	<0.000010
Fluorene	0.28	0.003	0.00002	<0.000010	<0.000010	0.000016	0.000028	<0.000010	<0.000010	<0.000010
Phenanthrene	0.063	0.0004	0.00002	<0.000010	0.000016	0.000054	0.000078	<0.000010	<0.000010	<0.000010
Anthracene	0.012	0.000012	0.00002	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Acridine	NC	0.0044	0.00002	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Fluoranthene	0.13	0.00004	0.00002	<0.000010	<0.000010	0.000013	0.00002	<0.000010	<0.000010	<0.000010
Pyrene	0.04	0.000025	0.00002	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Benzo(a)anthracene	0.0002	0.000018	0.00002	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Chrysene	0.0005	NC	0.00002	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Benzo(b&j)fluoranthene	0.0002	NC	0.00002	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Benzo(k)fluoranthene	0.0002	NC	0.00002	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Benzo(a)pyrene	0.00001	0.000015	0.00002	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Indeno(1,2,3-cd)pyrene	0.0002	NC	0.00002	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Dibenzo(a,h)anthracene	0.0002	NC	0.00002	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010

Notes:

1 =	Ontario Ministry of the Environment, Guideline for Use at Contaminated Sites in Ontario, Table 2 - Full Depth Generic Site Condition Standards in a Potable Ground Water Conditions (2004).
2 =	Canadian Council of Ministers of the Environment, Summary Table - Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (FWAL), 2007 Update.
--- =	Not analysed or no criterion/guideline established.
20 =	Denotes exceedances.

Table B-9: Seep Water Chemical Concentrations - PHCs and PAHs

PARAMETER	**Surface Water Criteria**		**RDL**	**Seep Water 2009**		**Delta 2012**	
Sample Number	**Provincial**	**Federal**		**D1-SW09-1**	**D1-SW09-2**	**DELTA-W12-1**	**DELTA-W12-2**
Sampling Date	**MOE Table 2[1] Potable Groundwater**	**FIGWQGS[2]**		14/8/2009	14/8/2009	14/08/2012	14/08/2012
Petroleum Hydrocarbons (mg/L)							
F1(C6-C10)	1	---	0.1	<0.10	0.51	---	---
F1-BTEX		0.81	0.1	<0.10	0.49	---	---
F2 (>C10-C16)		1.3	0.05	3.56	5.74	<0.10	<0.10
F3 (C16-C34)		---	0.05	0.7	0.55	<0.10	<0.10
F4 (C34-C50)		---	0.05	<0.25	<0.25	<0.10	<0.10
Polycyclic Aromatics (mg/L)							
Naphthalene	0.021	0.0011	0.00002	<0.00010	0.0151	---	---
Quinoline	---	---	0.00002	<0.00010	<0.00012	---	---
Acenaphthene	0.31	0.0058	0.00002	<0.00010	<0.00012	---	---
Fluorene	0.28	0.003	0.00002	<0.00010	<0.00010	---	---
Phenanthrene	0.063	0.0004	0.00002	<0.00010	<0.00010	---	---
Anthracene	0.012	0.000012	0.00002	<0.00010	<0.00010	---	---
Acridine	---	---	0.00002	<0.00010	<0.00010	---	---
Fluoranthene	0.13	0.0004	0.00002	<0.00010	<0.00010	---	---
Pyrene	0.04	0.000025	0.00002	<0.00010	<0.00010	---	---
Benzo(a)anthracene	0.0002	0.000018	0.00002	<0.000010	<0.000010	---	---
Chrysene	0.0005	0.0001	0.00002	<0.000010	<0.000010	---	---
Benzo(b&j)fluoranthene	0.0002	0.00048	0.00002	<0.000010	<0.000010	---	---
Benzo(k)fluoranthene	0.0002	0.00048	0.00002	<0.000010	<0.000010	---	---
Benzo(a)pyrene	0.00001	0.00001	0.00002	<0.000010	<0.000010	---	---
Indeno(1,2,3-cd)pyrene	0.0002	0.00021	0.00002	<0.000010	<0.000010	---	---
Dibenzo(a,h)anthracene	0.0002	0.00026	0.00002	<0.000010	<0.000010	---	---

Notes:

1 = Ontario Ministry of the Environment, Guideline for Use at Contaminated Sites in Ontario, Table 2 - Full Depth Generic Site Condition Standards in a Potable Ground Water Conditions (2004).

2 = Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites, Table 2 for Residential/Parkland land use, Tier 1, coarse-grained soil

--- = Not analysed or no criterion/guideline established.
20 = Denotes concentration above applicable guidelines
20 = Detection limit above applicable guidelines

Table B-10: Surface Water Chemical Concentrations - PCBs

PARAMETER	Surface Water criteria		RDL	APEC D-1: Powerhouse Located at the Main Camp	
	Federal	Provincial			
Sample Number				DW-PUMPHOUSE #1	DW-PUMPHOUSE #2
Sample Date	CCME 2007[1] FWAL	MOE PWQO[2]		22/08/2008	22/08/2008
PCBs (mg/L)					
Aroclor 1016	NC	NC	0.00002	<0.00002	<0.00002
Aroclor 1221	NC	NC	0.00002	<0.00002	<0.00002
Aroclor 1232	NC	NC	0.00002	<0.00002	<0.00002
Aroclor 1242	NC	NC	0.00002	<0.00002	<0.00002
Aroclor 1248	NC	NC	0.00002	<0.00002	<0.00002
Aroclor 1254	NC	NC	0.00002	<0.00002	<0.00002
Aroclor 1260	NC	NC	0.00002	<0.00002	<0.00002
Aroclor 1262	NC	NC	0.00002	<0.00002	<0.00002
Aroclor 1268	NC	NC	0.00002	<0.00002	<0.00002
Total PCBs	NC	0.0002	0.0001	<0.0001	<0.0001

Notes:

1 = Canadian Council of Ministers of the Environment, Summary Table - Canadian Water Quality Guidelines for the Protection of Freshwater

2 = Ontario Ministry of the Environment and Energy, Water Management - Policies, Guidelines, Provincial Water Quality Objectives, Table 2 - Table of PWQOs and Interim PWQOs, July 1994.

--- = Not analysed or no criterion/guideline established.

NC= No Criteria

20 = Denotes exceedances.

Table B-11: Sediment Chemical Concentrations
- Background Metals

PARAMETER	**Sediment Criteria**		**RDL**	**Background 2009**		**Background 2010**	**Background 2012**										**Average**
Sample Number	**Federal**			**BG-SED09-1**	**BG-SED09-2**	**BK-SD10-1**	**BG-SED12-1**	**BG-SED12-2**	**DUP-1**	**BG-SED12-3**	**BG-SED12-4**	**BG-SED12-5**	**BG-SED12-6**	**BG-SED12-7**	**BG-SED12-8**	**BG-SED12-9**	
Sample Date	**CCME 2002[1] ISQG**	**CCME 2002[1] PEL**		15/8/2009	15/8/2009	19/08/2010	**18/08/2012**	**18/08/2012**	**18/08/2012**	**18/08/2012**	**18/08/2012**	**18/08/2012**	**19/08/2012**	**19/08/2012**	**19/08/2012**	**19/08/2012**	
Total Metals (mg/kg)																	
Aluminum (Al)	---	---	10	---	---	3700	5300	13000	12000	11000	7000	4800	5700	5700	6700	6700	7418
Antimony (Sb)	---	---	1.0	0.63	0.55	<0.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.9
Arsenic (As)	5.9	17	1.0	**29**	**23.8**	13	9.2	12	12	11	8.0	6.1	9.4	11	10	9.9	12.6
Barium (Ba)	---	---	10	33.5	34	28	47	67	64	56	42	33	38	38	44	47	44.0
Beryllium (Be)	---	---	0.40	<1.0	<1.0	0.3	0.90	1.2	1.1	1.0	0.76	0.50	0.45	0.44	0.52	0.50	0.74
Bismuth (Bi)	---	---	1.0	---	---	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Boron (B)	---	---	2.0	---	---	<5	16	18	17	17	10	8.6	8.6	9.1	10	10	12
Cadmium (Cd)	0.6	3.5	0.10	<0.50	<0.50	<0.1	0.21	0.12	0.12	0.12	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.17
Calcium (Ca)	---	---	50	---	---	3400	9600	9800	8800	8500	7400	6100	3900	4500	5200	5700	6627
Chromium (Cr)	37.3	90	1.0	21.7	16	11	17	27	25	23	16	11	12	12	13	13	17
Cobalt (Co)	---	---	1.0	11.8	13.4	7	12	12	12	12	10	7.6	6.4	6.5	6.2	5.9	9.1
Copper (Cu)	35.7	197	5.0	31.1	37	17	31	35	34	36	22	20	16	20	27	24	27
Iron (Fe)	---	---	10	---	---	23000	19000	34000	32000	29000	21000	16000	21000	25000	20000	20000	23700
Lead (Pb)	35	91.3	1.0	15.8	16.8	10	12	15	14	13	9.8	7.4	8.4	8.7	9.3	9.0	11
Magnesium (Mg)	---	---	20	---	---	3000	3300	5300	4900	4600	3600	2600	3400	3600	4500	4800	3964
Manganese (Mn)	---	---	10	---	---	250	200	300	290	280	240	200	180	240	130	130	222
Mercury (Hg)	0.17	0.486	0.050	0.129	0.158	0.06	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.40
Molybdenum (Mo)	---	---	0.40	2.9	4.6	0.7	1.0	1.6	1.6	1.7	1.2	0.76	0.91	1.0	0.82	0.82	1.51
Nickel (Ni)	---	---	1.0	29.9	35.1	19	28	29	30	33	25	17	18	19	20	19	25
Phosphorus (P)	---	---	20	---	---	280	380	630	590	560	420	330	290	420	310	320	412
Potassium (K)	---	---	25	---	---	690	870	2000	1800	1700	1100	760	1200	1100	1500	1500	1293
Selenium (Se)	---	---	0.50	0.99	1.2	<0.5	<0.50	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.52	0.58	0.51	0.60
Silver (Ag)	---	---	1.0	<1.0	<1.0	<0.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium (Na)	---	---	50	---	---	130	<50	<50	<50	<50	<50	<50	240	230	170	250	204
Strontium (Sr)	---	---	10	---	---	18	60	83	76	72	49	37	32	32	42	42	49
Thallium (Tl)	---	---	0.30	<1.0	<1.0	0.07	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<1
Tin (Sn)	---	---	1.0	<5.0	<5.0	<5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1
Uranium (U)	---	---	1.0	<2.0	<2.0	0.67	<1.0	1.0	1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1
Vanadium (V)	---	---	1.0	98	60.4	34	34	49	46	41	30	22	25	26	19	18	39
Zinc (Zn)	123	315	10	65	58	53	53	76	72	63	48	37	46	51	54	54	56

Notes:

1 =	Canadian Council of Ministers of the Environment, Table 1 - Interim Freshwater Sediment Quality Guidelines (ISQG) for the protection of Aquatic Life, 2002 Update and Probable Effect Level (PEL).
--- =	Not analyzed
NC=	No criteria
RDL=	Reportable Detection Limit
20 =	Denotes exceedances for ISQG
20 =	Denotes exceedances for ISQG and PEL

Table B-12: Sediment Chemical Concentrations - Metals

PARAMETER	Sediment Criteria		Established Background Level	RDL	AEC D: Powerhouse 2009						AEC D: Powerhouse 2010				
Sample Number	Federal				D1-SED08-1	D1-SED08-2	D1-SED08-3	D1-SED08-4	DUP 9 (D1-SED08-4)	D1-SED08-5	D1-SD10-1	D1-SD10-DUP1	D1-SD10-2	D1-SD10-3	D1-SD10-4
Sample Date	CCME 2002[1] ISQG	CCME 2002[1] PEL			21/08/2008	21/08/2008	21/08/2008	21/08/2008	21/08/2008	21/08/2008	18/08/2010	18/08/2010	18/08/2010	18/08/2010	18/08/2010
Total Metals (mg/kg)															
Aluminum (Al)	---	---	**13322**	10	---	---	---	---	---	---	1600	1300	7100	3800	4200
Antimony (Sb)	---	---	**0.707**	1.0	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	0.2	<0.2
Arsenic (As)	5.9	17	**24.92**	1.0	5.6	9.1	12.3	11	20.4	9.8	1	1	10	11	11
Barium (Ba)	---	---	**66.32**	10	37	38	55	17	18	35	13	11	48	26	36
Beryllium (Be)	---	---	**1.204**	0.40	<1	<1	<1	<1	<1	<1	<0.2	<0.2	0.6	0.3	0.4
Bismuth (Bi)	---	---	**<1.0**	1.0	---	---	---	---	---	---	<1	<1	<1	<1	<1
Boron (B)	---	---	**20.67**	2.0	---	---	---	---	---	---	<5	<5	8	<5	10
Cadmium (Cd)	**0.6**	3.5	0.255	0.10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium (Ca)	---	---	**10997**	50	---	---	---	---	---	---	7500	5700	8600	2700	3200
Chromium (Cr)	**37.3**	90	27.12	1.0	10.6	16.3	21.7	6.7	9.1	12.5	2	2	17	10	12
Cobalt (Co)	---	---	**14.73**	1.0	5	9	12	7	10	9	2	1.7	10	8.3	7.5
Copper (Cu)	35.7	197	**40.85**	5.0	10	17	24	11	15	23	4	3.7	21	16	15
Iron (Fe)	---	---	**34487**	10	---	---	---	---	---	---	9300	8200	26000	23000	23000
Lead (Pb)	**35**	91.3	17.28	1.0	7	11	15	7	8	9	3	2	12	9	11
Magnesium (Mg)	---	---	**5643**	20	---	---	---	---	---	---	2300	2000	4400	2500	3200
Manganese (Mn)	---	---	**344.1**	10	---	---	---	---	---	---	300	250	550	420	210
Mercury (Hg)	**0.17**	0.486	0.129	0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06
Molybdenum (Mo)	---	---	**3.58**	0.40	<1	<1	<1	1	1	<1	<0.5	<0.5	0.7	0.9	1
Nickel (Ni)	---	---	**36.53**	1.0	13	19	28	14	22	20	5.1	4.9	27	20	18
Phosphorus (P)	---	---	**651.4**	20	---	---	---	---	---	---	160	130	470	330	320
Potassium (K)	---	---	**2122**	25	---	---	---	---	---	---	<200	<200	980	590	1000
Selenium (Se)	---	---	**1.031**	0.50	0.4	0.5	0.6	0.4	0.5	0.4	<0.5	<0.5	<0.5	<0.5	<0.5
Silver (Ag)	---	---	**<1.0**	1.0	<1	<1	<1	<1	<1	<1	<0.2	<0.2	<0.2	<0.2	<0.2
Sodium (Na)	---	---	**293.9**	50	---	---	---	---	---	---	150	150	350	290	780
Strontium (Sr)	---	---	**88.69**	10	---	---	---	---	---	---	23	19	33	19	41
Thallium (Tl)	---	---	**<1**	0.30	<1	<1	<1	<1	<1	<1	<0.05	<0.05	0.09	0.09	0.08
Tin (Sn)	---	---	**<1**	1.0	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Uranium (U)	---	---	**1.162**	1.0	<2	<2	<2	<2	<2	<2	0.13	0.11	0.63	0.46	0.71
Vanadium (V)	---	---	**84.26**	1.0	18	29	36	22	27	22	8	6	27	30	30
Zinc (Zn)	**123**	315	75.89	10	50	200	150	30	50	50	19	15	79	47	52

Notes:

1 = Canadian Council of Ministers of the Environment, Table 1 - Interim Freshwater Sediment Quality Guidelines (ISQG) for the protection of Aquatic Life, 2002 Update and Probable Effect Level (PEL).

--- = Not analyzed
NC= No criteria
RDL= Reportable Detection Limit
20 = Denote guideline/threshold used
20 = Denotes parameter above guidelines/threshold

Table B-13: Sediment Chemical Concentrations
- PHC and PAHs

PARAMETER	Sediment Criteria				Background 2009		Background 2010	APEC B-2: IN-SITU LANDFARM			Powerhouse 2008					
Sample Number	Federal		SSTL	RDL	BG-SED09-1	BG-SED09-2	BK-SD10-1	APEC B2-SED08-1	APEC B2-SED 08-2	APEC B2-SED 08-3	APEC D1-SED08-1	APEC D1-SED08-2	APEC D1-SED08-3	APEC D1-SED08-4	DUP 9 (APEC D1-SED08-4)	APEC D1-SED08-5
Sampling Date	CCME 2002[1] ISQG	CCME 2002[1] PEL			15/8/2009	15/8/2009	19/08/2010	19/08/2008	21/08/2008	21/08/2008	21/08/2008	21/08/2008	21/08/2008	21/08/2008	21/08/2008	21/08/2008
BTEX Parameters (mg/kg)																
Benzene	---	---	---	0.005	<0.0050	<0.0050	<0.002	<0.005	<0.01	<0.005	0.19	<0.005	<0.005	<0.005	<0.005	<0.005
Toluene	---	---	---	0.01	<0.050	<0.050	<0.002	<0.01	0.03	0.02	0.01	<0.01	0.02	<0.01	<0.01	<0.01
Ethylbenzene	---	---	1.46	0.01	<0.015	<0.015	<0.002	0.02	<0.02	<0.01	2.1	<0.01	0.02	<0.01	<0.01	<0.01
Xylenes	---	---	---	0.02	<0.10	<0.10	<0.002	0.02	0.07	0.04	2.5	<0.02	0.03	0.03	<0.02	<0.02
Petroleum Hydrocarbons (mg/kg)																
F1(C6-C10)	---	---	10	<12	<10	<10	<10	25	<5	<5	56	<5	8	7	7	<5
F2 (C10-C16)	---	---	12	5	<20	<20	<10	270	9	51	9700	160	1600	590	760	21
F3 (C16-C34)	---	---	---	5	<20	<20	<10	77	310	330	4200	310	1400	250	210	190
F4 (C34-C50)	---	---	---	5	<20	<20	<10	20	73	130	<5	91	270	69	55	110
Chromatogram to baseline at nC50	---	---	---	---	Yes	Yes	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES
% Moisture	---	---	---	0.1	14.1	12.9	14.1	30	49	33	44	28	39	23	25	28
Polycyclic Aromatics (mg/kg)																
Naphthalene	0.0346	0.391	---	0.01	---	---	0.011	0.21	---	0.09	3.4	0.09	0.06	<0.01	0.03	0.03
1-Methyl Naphthalene	NC	NC	3.6	0.01	---	---	0.014	0.45	---	0.09	4.9	0.09	0.06	<0.00	0.04	0.02
2-Methyl Naphthalene	0.0202	0.201	---	0.01	---	---	0.019	0.54	---	0.12	5.9	0.13	0.09	<0.01	0.06	<0.01
Quinoline	NC	NC	---	0.01	---	---	---	<0.01	---	<0.01	<0.06	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	0.0419	0.515	---	0.01	---	---	0.016	0.13	---	0.09	0.24	0.06	0.02	<0.01	0.02	0.04
Pyrene	0.053	0.875	---	0.01	---	---	0.009	0.04	---	0.02	0.08	0.02	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	0.0317	0.385	---	0.01	---	---	<0.005	<0.01	---	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b&j)fluoranthene	NC	NC	---	0.01	---	---	<0.005	0.02	---	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	NC	NC	---	0.01	---	---	<0.005	<0.01	---	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	0.0319	0.782	---	0.01	---	---	<0.005	<0.01	---	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	NC	NC	---	0.01	---	---	<0.005	<0.01	---	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(a,h)anthracene	0.00622	0.135	---	0.01	---	---	<0.005	<0.01	---	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

1 = Canadian Council of Ministers of the Environment, Table 1 - Interim Freshwater Sediment Quality Guidelines (ISQG) for the protection of Aquatic Life, 2002 Update and Probable Effect Level (PEL).

--- = Not analyzed / No guidelines

20 = Denotes exceedances of guidelines

20 = Donotes concentrations above SSTL

Table B-13: Sediment Chemical Concentrations
- PHC and PAHs

PARAMETER	Sediment Criteria		SSTL	RDL	Powerhouse 2010					Powerhouse 2012						
Sample Number	Federal				D1-SD10-1	D1-SD10-DUP1	D1-SD10-2	D1-SD10-3	D1-SD10-4	D1-SED12-1A	D1-SED12-1B	D1-SED12-2A	D1-SED12-2B	D1-SED12-DUP1 (of D1-SED12-2B)	D1-SED12-3A	D1-SED12-3B
Sampling Date	CCME 2002[1] ISQG	CCME 2002[1] PEL			18/08/2010	18/08/2010	18/08/2010	18/08/2010	18/08/2010	17/08/2012	17/08/2012	17/08/2012	17/08/2012	17/08/2012	17/08/2012	17/08/2012
BTEX Parameters (mg/kg)																
Benzene	---	---	---	0.005	0.1	0.08	<0.002	<0.002	<0.002	0.073	0.078	0.92	0.51	1.2	0.05	0.01
Toluene	---	---	---	0.01	0.4	0.25	0.003	<0.002	<0.002	<0.020	<0.020	0.14	0.067	0.12	0.075	<0.020
Ethylbenzene	---	---	1.46	0.01	0.91	0.75	<0.002	<0.002	<0.002	0.33	0.79	9.1	5.7	11	0.12	0.018
Xylenes	---	---	---	0.02	5.3	3.4	<0.002	<0.002	<0.002	0.21	0.6	9.4	13	12	0.29	<0.040
Petroleum Hydrocarbons (mg/kg)																
F1(C6-C10)	---	---	10	<12	59	19	<10	<10	<10	100	60	1500	1600	2000	<12	<12
F2 (C10-C16)	---	---	12	5	3900	2500	<10	<10	<10	3000	1200	16000	11000	18000	270	40
F3 (C16-C34)	---	---	---	5	690	680	83	39	38	480	160	1100	630	1400	130	61
F4 (C34-C50)	---	---	---	5	16	44	63	<10	<10	14	<10	<10	<10	<10	14	<10
Chromatogram to baseline at nC50	---	---	---	---	YES	YES	YES	YES	YES	YES	YES	Yes	Yes	Yes	Yes	Yes
% Moisture	---	---	---	0.1	---	---	---	---	---	26	15	18	15	23	24	23
Polycyclic Aromatics (mg/kg)																
Naphthalene	0.0346	0.391	---	0.01	1.1	0.87	0.055	0.019	0.008	---	---	---	---	---	---	---
1-Methyl Naphthalene	NC	NC	3.6	0.01	2.8	2.1	0.05	0.02	0.011	---	---	---	---	---	---	---
2-Methyl Naphthalene	0.0202	0.201	---	0.01	3.4	2.7	0.078	0.026	0.011	---	---	---	---	---	---	---
Quinoline	NC	NC	---	0.01	---	---	---	---	---	---	---	---	---	---	---	---
Phenanthrene	0.0419	0.515	---	0.01	0.17	0.14	0.072	0.038	0.02	---	---	---	---	---	---	---
Pyrene	0.053	0.875	---	0.01	0.033	0.03	0.028	0.015	0.013	---	---	---	---	---	---	---
Benzo(a)anthracene	0.0317	0.385	---	0.01	<0.005	<0.005	0.009	<0.005	<0.005	---	---	---	---	---	---	---
Benzo(b&j)fluoranthene	NC	NC	---	0.01	<0.005	<0.005	<0.005	0.009	<0.005	---	---	---	---	---	---	---
Benzo(k)fluoranthene	NC	NC	---	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	---	---	---	---	---	---	---
Benzo(a)pyrene	0.0319	0.782	---	0.01	<0.005	<0.005	0.008	<0.005	<0.005	---	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	NC	NC	---	0.01	<0.005	0.007	0.008	<0.005	<0.005	---	---	---	---	---	---	---
Dibenzo(a,h)anthracene	0.00622	0.135	---	0.01	<0.005	0.007	<0.005	<0.005	<0.005	---	---	---	---	---	---	---

Notes:

1 = Canadian Council of Ministers of the Environment, Table 1 - Interim Freshwater Sediment Quality Guidelines (ISQG) for the protection of Aquatic Life, 2002 Update and Probable Effect Level (PEL).

--- = Not analyzed / No guidelines

20 = Denotes exceedances of guidelines

20 = Donotes concentrations above SSTL

Table B-14: Sediment Chemical Concentrations - PCBs

PARAMETER	**Sediment Criteria**		**RDL**	**APEC D-1: POWERHOUSE LOCATED AT THE MAIN CAMP**		
Sample Number	**Federal**			**APEC D1-SED08-1**	**APEC D1-SED08-2**	**DUP 9 (APEC D1-HA08-4)**
Sample Date	**CCME 2002[1] ISQG**	**CCME 2002[1] PEL**		**21/08/2008**	**21/08/2008**	**21/08/2008**
PCBs (mg/kg)						
Aroclor 1016	NC	NC	0.01	<0.01	<0.01	<0.01
Aroclor 1221	NC	NC	0.01	<0.01	<0.01	<0.01
Aroclor 1232	NC	NC	0.01	<0.01	<0.01	<0.01
Aroclor 1242	NC	NC	0.01	<0.01	<0.01	<0.01
Aroclor 1248	NC	NC	0.01	<0.01	<0.01	<0.01
Aroclor 1254	0.06	0.34	0.01	0.02	<0.01	<0.01
Aroclor 1260	NC	NC	0.01	<0.01	<0.01	<0.01
Aroclor 1262	NC	NC	0.01	<0.01	<0.01	<0.01
Aroclor 1268	NC	NC	0.01	<0.01	<0.01	<0.01
Total PCBs	0.0314	0.277	0.05	<0.05	<0.05	<0.05

Notes:

1 = Canadian Council of Ministers of the Environment, Table 1 - Interim Freshwater Sediment Quality Guidelines (ISQG) for the protection of Aquatic Life, 2002 Update and Probable Effect Level (PEL).

--- = Not analyzed

NC= No criteria

RDL= Reportable Detection Limit

20 = Denotes exceedances of ISQG

▨ 20 = Denotes exceedances for ISQG and PEL

Table B-15: Indoor Air and Vapour Chemical Concentrations - PHCs

Parameter		Indoor Air		Lab RDL	Operation and Mainteance Buildings										
					Old Garage 2012	**Old transient Barracks 2012**	**Building 17 2012**	**Former Bunkhouse 2012**	**New Garage 2012**	**Watertanks 2012**	**Powerhouse 2012**	**DUP1**	**QA/QC Evaluation**	**Crawlspace 2012**	**Crawlspace 2 - 2012**
Sampling Date		**Health Canada[1]**	**Site Specific Threshold**		26/07/2011	26/07/2011	26/07/2011	26/07/2011	26/07/2011	26/07/2011	26/07/2011	26/07/2011		26/07/2011	26/07/2011
Description					24-hour indoor air	24-hour indoor air	24-hour indoor air	24-hour indoor air	24-hour indoor air	24-hour indoor air	24-hour indoor air	Duplicate of Powerhouse 2012		24-hour indoor air beneath the Powerhouse	20 minute indoor air beneath the Powerhouse
BTEX µg/m^3	Benzene	**3**	---	1.2	<1.2	<1.2	3.7	<1.2	9.2	<1.2	1.4	1.4	Acceptable	<1.2	<1.2
	Toluene	**760**	---	1.6	16.6	<1.6	17.1	<1.6	105	7.7	20.6	20.8	Acceptable	<1.6	<1.6
	Ethylbenzene	**200**	---	1.6	8.1	<1.6	3.7	<1.6	30.9	2.5	7.1	6.6	Acceptable	<1.6	<1.6
	Total Xylenes	**36**	---	2.2	37.2	2.8	18.6	<2.2	148	12.4	34.5	31.5	Acceptable	<2.2	<2.2
PHCs µg/m^3	F1-BTEX - C6-C10 (as Toluene)	10498	**848**	5	101	30.7	121	77.4	774	225	542	542	Acceptable	55.1	<5.0
	F2 - C10-C16 (as Decane)	840	**391**	5	483	53.3	1090	727	1020	186	406	408	Acceptable	56.7	329

Parameter		Indoor Air		Lab RDL	**Old Garage VP 2012**
Sampling Date		**Health Canada[1]**	**Site Specific Threshold**		26/07/2011
Description					Sub-slab vapour, attenuation factor of 0.02
BTEX µg/m^3	Benzene	**3**	---	46	<0.92
	Toluene	**760**	---	170	<3.4
	Ethylbenzene	**200**	---	61	4.02
	Total Xylenes	**36**	---	84	11.04
PHCs µg/m^3	F1-BTEX - C6-C10 (as Toluene)	10498	**848**	190	1678
	F2 - C10-C16 (as Decane)	840	**391**	190	480

Notes: All units in ug/m³.

1 = Health Canada's Health-Based Tolerable Daily Intakes/Concentrations and Tumorigenic Doses/Concentrations for Priority Substances. Using Table 3a (non-carcinogens) for toluene and xylenes and Table 3b (carcinogens) for benzene. Table 3b value divided by 5,000 for 10^{-5} risk approximation.

--- = No criterion/guideline established
ND = Analytical results are below laboratory
NC = Not calculated
RPD = Relative percent difference
RDL = Laboratory detection limit
20 = Denotes guidelines used to determine chemical exceedances
20 = Denotes chemical exceedances

APPENDIX C

Remedial Options Comparison

Table C-1
Remedial Option Comparison Matrix
Soils

Remedial Option	Effectiveness in meeting the selected remediation and/or risk management standards	Compatibility with Site Operations	Ease of implementation	Complexity	Exposure Pathways	Risk to Human Health and the Environment	Time Frame to Implement and Complete	Innovative Approach and Green/Sustainable Technology	Comparative cost	Scoring Total
Capping in place	The construction of a cap would allow for pathways to be eliminated.	The large area to be capped may required significant material and time. Equipment and labour use may conflict with other priorities at the site. The addition of 0.2 m of fill would cause problems with the building that are less than 0.2 m above the current grade, such as the operations and maintenance buildings. The amount of capping material required would increase the number of truck trips on the roads at Eureka, which will increase the wear and tear. Increased maintenance of the roads may be required. During the summer months, the roads to the gravel pits are frequently travelled by Station personnel. There would be an increased risk of collision.	If local borrow source is used, then there would be sufficient amounts. There may be a slope stability issue if adding a cap to the top and bottom of the slope. Access to the bottom of the slope might be difficult. Would require significant operator and equipment time due to the size of the area to be capped.	Capping soil in place is very well understood. Logistically, it may be difficult to obtain enough borrow materials in Eureka. Slope stability is an issue and maintain integrity of caps around slopes. Due to the freeze-thaw cycle, a high O&M component is required which is logistically challenging.	Human Health: No potentially unacceptable risk identified for humans at the site. Addition of the cap would limit soil ingestion, dermal contact pathways. Groundwater is not used as drinking water. Slab on grade indoor air pathway would still be operable. Ecological Health: Potentially unacceptable risk identified to plants and soil invertebrates. Capping would destroy any existing plants and remove the soil contact and soil and food ingestion pathways.	The risks would likely be limited. Risk reduction will be immediate as soon as cap is in place. Sand and gravel could prohibit ecological soil contact; however, because contamination remains in place, this option is less desirable from a human health/ecological perspective. However, this option will not decrease long term liability as natural attenuation will be untenable under these conditions.	Soil excavation, lining and capping could be complete in three weeks.	Capping in place has existed for quite some time; therefore, it is not an innovative technology. While the capping material would ideal be sources from nearby areas, the impacts would remain in place; therefore, this is not a very green or sustainable technology.	Capping is generally below average costs relative to other effective technologies. Costs for disposal and transportation of contaminated soil are eliminated. High O&M costs required.	
Score	**3**	**3**	**3**	**3**	**---**	**2**	**4**	**1**	**3**	**22**
In situ Treatment (chemical oxidation)	Many chemicals are highly subject to oxidation, including aromatic compounds like benzene. However, other fractions (like the F2 found on the site) may be more resistant to chemical oxidation.	Installation of injection wells would be required and may interfere as they are in the operation and maintenance areas (Delta and west of Powerhouse).	The area where the *in-situ* treatment would be set up is close to a building, which could impair safety. The volume of soils to be treated is likely too large to make this option viable.	Transportation of the chemicals required to the remote site would be difficult. Any work around the slope would be difficult due to slope stability issues.	Human Health: No potentially unacceptable risk identified for humans at the site. The addition of chemicals into the soil could increase the risk to human from the oxidation chemical through soil ingestion, dermal contact and inhalation. Ecological Health: Potentially unacceptable risk identified to plants and soil invertebrates. Addition of chemicals could pose a risk to plants and invertebrates in the area. Risk to birds and mammals could increase through soil contact and ingestion.	Transport of the chemicals of the type used in *in-situ* oxidation would pose a risk to human health. Their use on the site next to the station would also be a risk	Chemical oxidation proceeds quickly on easily oxidizable compounds and when it diffuses easily to contamination. Applicability to unsaturated zone impacts is less certain.	*In situ* Treatment though chemical oxidation is a well understood process as it has been in existence for some time. The introduction of chemicals to the site is not a green approach and the chemicals must be shipped from down south increasing fuel consumption Heavy equipment is required which uses fuel and has air emissions.	The American Federal Remediation Technologies Roundtable (FRTR) Screening matrix rates *in-situ* chemical oxidation "below average" for operation and maintenance costs, and "average" for capital costs[4].	
Score	**3**	**2**	**1**	**1**	**---**	**1**	**2**	**1**	**2**	**13**
Ex situ Treatment - Enhanced Landfarming	Have proven successful in arctic climates in the past1,2. Land treatment facilities such as landfarming have proven successful in arctic climates in the past1,2.Above average effectiveness for PHCs. Proven to be successful in treating heavier PHCs (F2) that can not be easily volatilized. Some impacted material may be left in place due to constraints on excavations (i.e., on-site structures). Will reduce concentrations but may not meet generic standards or SSTLs.	The stability of the roadway may be affected by the excavation in the nearby slope. Equipment and labour use may conflict with other priorities at the site.	Treatability studies should be reviewed or new ones conducted to evaluate design parameters. In Nunavut, permits will likely be required. Excavation of impacted material at the top and bottom of the slope would be difficult and require engineered shoring. As the existing landfarm does not have containments or liners, a new land treatment facility would be required.	The construction of landfarms is well understood. Excavation of the material at the top and bottom of the slope would be challenging given the site conditions (foundation, fuel line, and slope stability). The landfarm would required maintenance as studies have shown that tilling every four days and addition of fertilizer increases remediation effectiveness[3].	Human Health: No potentially unacceptable risk identified for humans at the site. Excavation would remove the soil ingestion, dermal contact near the site, but would still be applicable at the landfarm. Risk from inhalation of dust during excavation would increase the potential risk to human health. Groundwater is not used as drinking water. Slab on grade indoor air would still be a operable pathway as impacts beneath the buildings could not be removed; however, not potentially unacceptable risk was identified. Ecological Health: Potentially unacceptable risk identified to plants and soil invertebrates. Soil contact and ingestion would still be applicable pathways at the landfarm; however, no potentially unacceptable risk to birds and mammals.	Site disturbance will be high with inhalation of dust and direct contact with contaminants operable pathways. Excavation activities will require worker health and safety plan to limit exposure to chemicals. Presence of heavy equipment on site presents an increased safety risk.	Requires large area to construct treatment facility. The higher the PHC molecular weight, the slower the biological process proceeds.	*Ex situ* treatment is a well established treatment technology. It does use the microbes that already exist in the soil as a form of treatment; however, heavy equipment is required which uses fuel and has air emissions.	Below average costs relative to other effective technologies. Cost-effective for PHCs.	
Score	**4**	**2**	**1**	**1**		**2**	**2**	**2**	**3**	**17**
Ex situ Treatment - Biopile	Have proven successful in arctic climates in the past[1,2]. Above average effectiveness for PHCs. Will reduce concentrations but may not meet generic standards or SSTLs.	The stability of the roadway may be affected by the excavation in the nearby slope. Equipment and labour use may conflict with other priorities at the site.	Treatability studies should be reviewed or new ones conducted to evaluate design parameters. In Nunavut, permits will likely be required. Excavation of impacted material at the top and bottom of the slope would be difficult and require engineered shoring. As the existing landfarm does not have containments or liners, a new land treatment facility would be required. A effluent containment and treatment system would be required.	Nutrient and additive formulations are usually modified for site-specific conditions. Well understood process. May be able to use existing storage cell. Excavation of the material at the top and bottom of the slope would be challenging given the site conditions (foundation, fuel line, and slope stability). A new effluent treatment system would need to be designed.	Human Health: No potentially unacceptable risk identified for humans at the site. Excavation would remove the soil ingestion, dermal contact near the site, but would still be applicable at the landfarm. Risk from inhalation of dust during excavation would increase the potential risk to human health. Groundwater is not used as drinking water. Slab on grade indoor air would still be a operable pathway as impacts beneath the buildings could not be removed; however, not potentially unacceptable risk was identified. There maybe an increase in risk from contact with the effluent. Ecological Health: Potentially unacceptable risk identified to plants and soil invertebrates. Excavation would destroy existing plants and invertebrates. Soil contact and ingestions would remain at the biopile. Additional risk could be caused by the production of effluent.	Site disturbance will be high with inhalation of dust and direct contact with contaminants operable pathways. Excavation activities will require worker health and safety plan to limit exposure to chemicals. Presence of heavy equipment on site presents an increased safety risk. There maybe additional risk from the presence of effluent.	Biopile is a short-term technology for PHCs; duration of operation and maintenance may last a few weeks to several months to several years in colder climates and depending on contaminants. Treatment times can be expected to increase with the molecular weight of PAHs. On site area required for biocell construction.	*Ex situ* treatment is a well established treatment technology. It does use the microbes that already exist in the soil as a form of treatment; however, heavy equipment is required which uses fuel and has air emissions.	Below average costs relative to other effective technologies. Cost-effective for PHCs. Higher costs than landfarming due to design features such as venting, liner, effluent treatment.	
Score	**4**	**2**	**1**	**1**	**---**	**2**	**2**	**2**	**2**	**16**
Long-term Monitoring	Since the contaminants would remain on-site, there would be generally low acceptability from stakeholders. However, based on the updated risk assessment, plant and soil invertebrates are the ecological receptor and existing plants and invertebrates will not be disturbed by this remedial option.	Monitoring could be completely done via hand excavation; therefore, the operator and equipment would not be required. Collection of all other samples would not require assistance from the station operations and maintenance staff.	Monitoring is applicable to Eureka, due to the extreme remoteness and logistical challenges of other technologies. The monitoring program would be well established; however, travel in the north always presents logistical challenges.	The design of monitoring programs is simple and well understood.	Human Health: No potentially unacceptable risk identified for humans at the site. As there would be limited disturbance from the long-term monitoring, operable pathways would not change (soil ingestion, dermal contact, indoor air). Ecological Health: Potentially unacceptable risk identified to plants and soil invertebrates. As there would be limited disturbance from the long-term monitoring, operable pathways would not change (soil contact and soil and food ingestion); however, existing plants and invertebrates would remain in place.	Since the contaminants would remain on-site, there would be potential for future risk to the environment to develop if the environmental conditions change accordingly in the long-term, or if regulations and standards change.	Implementation of a long-term monitoring program is well understood and relatively fast; however, the program is assumed to be 25 years in duration.	Long-term monitoring is well established and does not remove the impacts from the current location; however, there is limited use of heavy equipment, fuel and damage to the environment.	Below average costs relative to other effective technologies.	
Score	**2**	**4**	**4**	**5**	**---**	**1**	**1**	**3**	**4**	**24**
Scoring Guide	1: Ineffective - 5: Completely Effective	1: Not Compatible - 5: Totally Compatible	1: Difficult- 5: Easy	1: Very Complex - 5: Simple	Not scored, information only	1: High Risk - 5: Low Risk	1: Very Slow - 5: Very Fast	1: Not innovative or green- 5: Very innovative and green	1: Very Expensive - 5: Inexpensive	**Total Possible: 40**

1: Wingrove, T. Diesel contamination remediation at a remote site in a cold climate *Practice Periodical of Hazardous, Toxic, and Radioactive Waste,* January 1997, pp. 30–34.

2: McCarthy, Kathleen *et al.* Remediation of spilled petroleum hydrocarbons by in situ landfarming at an arctic site. *Cold Regions Science and Technology.* Volume 40, Issues 1-2, 2004, Pages 31-39

3: Paudyn *et al.*, Remediation of hydrocarbon contaminated soils in the Canadian Arctic by landfarming *Cold Regions Science and Technology*. Volume 53, Issue 1, 2008, Pages 102-114.

4: Treatment Technologies Screening Matrix http://www.frtr.gov/matrix2/section3/table3_2.pdf

General:

Franz Environmental Inc., 2008. A review of the achievable soil and groundwater quality using remediation techniques commonly used at contaminated sites in Ontario.

US EPA's Federal Remediation Technologies Roundtable (FRTR), 1999.

Water Technology International Corp, 1997. Site Remediation Technologies: A Reference Manual. Contaminated Sites Management Working Group

Queens-Royal Military College of Canada Geo-environmental Research Group

Table C-2
Remedial Option Comparison Matrix
Sediment

Potential Remedial Option	Effectiveness in meeting the selected remediation and/or risk management standards	Compatibility with Site Operations	Ease of implementation	Complexity	Exposure Pathways	Risk to human health and the environment	Time frame to implement and complete	Innovative Approach and Green/Sustainable Technology	Comparative cost	Scoring Total
Excavation/Off-site Disposal	Above average effectiveness for PHCs, and PAHs. Waste characterization required to confirm waste classification of any excavated sediments.	Equipment and labour use may conflict with other priorities at the site. Due to the complexity of the site, excavation would take some time. Additionally, the road may have to closed during the excavation of sediments due to stability issues and reinstated after the excavation is complete.	The drainage pond is not easily accessible. Geomembrane and thin layer of gravel likely required. Approvals for work in water are often significant. The slope west of the Powerhouse presents a stability issue which would require a engineered shoring system that would present physical limitation on the areas that could be excavated. Water flowing from Station Creek to the drainage pond may have to be temporarily diverted in order to conduct the work.	Excavation and off-site disposal is a relatively simple process, with proven procedures; however, some pre-treatment of the contaminated media usually is required in order to meet land disposal restrictions. The complex nature of the location of the sediment on the site presents a challenge and could limit the effectiveness and extent of the excavation.	Human Health: No potentially unacceptable risk identified for humans at the site. Excavation would eliminate the dermal contact exposure pathway. While the excavation is in progress, there way be an increase risk of contact to impacted sediments. Ecological Health: Potentially unacceptable risk identified to benthic invertebrates and macrophytes. Excavation would destroy existing benthic invertebrates and macrophytes. Excavation would eliminate the exposure pathway.	Risk reduction will be immediate as soon as contaminated sediment is removed. Damage to the benthic invertebrates, littoral zone, and terrestrial plant adjacent to the Drainage Pond would occur during excavation.	While the volume of sediment is low, the preparation of the slope will add to the time requirements of the excavation. Shoring material will be required to be shipped in from the south. Slope stability measures would have to be prepared and implemented.	Excavation with off-site treatment is a well established treatment technology. Heavy equipment is required which uses fuel and has air emissions.	Costs are dependent upon specific contaminants and the disposal location. Construction of a suitable treatment facility is required. Cost of shipping shoring material would be high and detailed slope stability measures would have to be prepared and implemented.	
Score (1-5)	**3**	**1**	**1**	**1**	**---**	**4**	**3**	**1**	**2**	**16**
Excavation with hydrovac/Off-site Disposal	Above average effectiveness for PHCs, and PAHs. Waste characterization required to confirm waste classification of any excavated sediments.	Equipment and labour use may conflict with other priorities at the site. Due to the complexity of the site, excavation would take some time. Additionally, the road may have to closed during the excavation of sediments due to stability issues and reinstated after the excavation is complete.	The drainage pond is not easily accessible. Geomembrane and thin layer of gravel likely required. Approvals for work in water are often significant. The slope west of the Powerhouse presents a stability issue which would require a engineered shoring system that would present physical limitation on the areas that could be excavated. Water flowing from Station Creek to the drainage pond may have to be temporarily diverted in order to conduct the work.	Excavation and off-site disposal is a relatively simple process, with proven procedures; however, some pre-treatment of the contaminated media usually is required in order to meet land disposal restrictions. The complex nature of the location of the sediment on the site presents a challenge and could limit the effectiveness and extent of the excavation.	Human Health: No potentially unacceptable risk identified for humans at the site. Excavation would eliminate the dermal contact exposure pathway. While the excavation is in progress, there way be an increase risk of contact to impacted sediments. Ecological Health: Potentially unacceptable risk identified to benthic invertebrates and macrophytes. Excavation would destroy existing benthic invertebrates and macrophytes. Excavation would eliminate the exposure pathway.	Risk reduction will be immediate as soon as contaminated sediment is removed. Damage to the benthic invertebrates, littoral zone, and terrestrial plant adjacent to the Drainage Pond would occur during excavation.	While the volume of sediment is low, the preparation of the slope will add to the time requirements of the excavation. Hydrovac and Shoring material will be required to be shipped in from the south. Slope stability measures would have to be prepared and implemented.	Excavation with off-site treatment is a well established treatment technology. Heavy equipment is required which uses fuel and has air emissions. Shipping the hydrovac equipment from the south increases the consumption of fuel.	Costs are dependent upon specific contaminants and the disposal location. Construction of a suitable treatment facility is required. Cost of shipping shoring material and hydrovac would be high and detailed slope stability measures would have to be prepared and implemented.	
Score (1-5)	**3**	**1**	**1**	**1**	**---**	**4**	**3**	**1**	**1**	**15**
Capping in place	Above average effectiveness for PHCs, and PAHs.	Equipment and labour use may conflict with other priorities at the site.	The drainage pond is not easily accessible. Geomembrane and thin layer of gravel likely required. Approvals for work in water are often significant. The slope west of the Powerhouse presents a stability issue if capping material is added to the top and bottom. As excavation is not occurring, the engineered shoring may not be required. Water flowing from Station Creek to the drainage pond may have to be temporarily diverted in order to conduct the work.	Depth of water in Drainage Pond was observed to be low. Any additional capping materials may impede flows. This needs to be considered. Additionally, there is a risk of erosion of cap due to violent spring melting.	Human Health: No potentially unacceptable risk identified for humans at the site. Addition of the cap would limit dermal contact with sediment. Ecological Health: Potentially unacceptable risk identified to benthic invertebrates and macrophytes. Capping would eliminate exposure pathways via sediment contact; however, it will negatively impact the existing invertebrates and macrophytes.	Risk reduction (ecological) will be immediate as soon as cap is in place. Damage to the benthic invertebrates, littoral zone, and terrestrial plant adjacent to the Drainage Pond would occur during capping.	The area of sediment to be capped is low. The effective life of sediment caps can be extended by long-term inspection and maintenance. Slope stability mitigation measures maybe required.	Capping in place has existed for quite some time; therefore, it is not an innovative technology. While the capping material would ideal be sources from nearby areas, the impacts would remain in place; therefore, this is not a very green or sustainable technology.	Capping is generally below average costs relative to other effective technologies. The low volume of sediments would make this a relatively inexpensive option for sediments. High O& M required.	
Score (1-5)	**4**	**2**	**2**	**3**	**---**	**3**	**3**	**1**	**3**	**21**
Long-term Monitoring	Since the contaminants would remain on-site, there would be generally low acceptability from stakeholders.	Monitoring would be limited to collection of sediment by sediment core sampler and shovels; therefore, no station equipment would be required to monitor the sediments.	Monitoring is applicable to Eureka, due to the extreme remoteness and logistical challenges of other technologies. The monitoring program would well established; however, travel in the north always presents logistical challenges.	The design of monitoring programs is simple and well understood.	Human Health: No potentially unacceptable risk identified for humans at the site. As there would be limited disturbance from the long-term monitoring, operable pathways would not change (dermal contact). Ecological Health: Potentially unacceptable risk identified to benthic invertebrates and macrophytes. As there would be limited disturbance from the long-term monitoring, operable pathways would not change (sediment contact and ingestion); however, benthic invertebrates and macrophytes would remain in place.	Since the contaminants would remain on-site, there would be potential for future risk to the environment to develop if the environmental conditions change accordingly in the long-term, or if regulations and standards change.	Implementation of a long-term monitoring program is well understood and relatively fast; however, the program is assumed to be 25 years in duration.	Long-term monitoring is well established and does not remove the impacts from the current location; however, there will be lower equipment and fuel usage.	Below average costs relative to other effective technologies.	
Score (1-5)	**1**	**5**	**4**	**5**	**---**	**1**	**1**	**3**	**5**	**25**
Scoring Guide	1: Ineffective - 5: Completely Effective	1: Not Compatible - 5: Totally Compatible	1: Difficult- 5: Easy	1: Very Complex - 5: Simple	Not scored, information only	1: High Risk - 5: Low Risk	1: Very Slow - 5: Very Fast	1: Not innovative or green- 5: Very innovative and green	1: Very Expensive - 5: Inexpensive	**Total Possible: 40**

General:

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Water Technology International Corp, 1997. Site Remediation Technologies: A Reference Manual. Contaminated Sites Management Working Group

Queens-Royal Military College of Canada Geo-environmental Research Group

APPENDIX D

Updated Risk Assessment Model

HEALTH CANADA PQRA SPREADSHEET
USER INPUT SHEET

User Name:	Miguel Madrid	Site:	Eureka HAWS, Nunavut
Proponent:		File #:	1570-1001
Date:	March 22, 2011	Comment:	

PROBLEM FORMULATION

Potential Land Uses (Yes/No)		Default
Agricultural	No	Yes
Residential/urban parkland	Yes	Yes
Commercial	Yes	Yes
Industrial	Yes	Yes
Occupational - outdoors	No	Yes
Recreational	No	Yes
Other	Yes	No
specify:	O&M Work	

Operative Pathways (Yes/No)		Default
Inadvertent ingestion of soil		Yes
Inhalation of soil particles		Yes
Inhalation of indoor contaminant vapours	Yes	Yes
Inhalation of outdoor contaminant vapours	Yes	Yes
Ingestion of drinking water	Yes	Yes
Dermal contact with soil		Yes
Dermal contact with water		Yes
Ingestion of contaminated food	No	No

Exposure Scenario	O&M Work	O&M Work

Vapour Transport Modelling		
Vapour source for exposure calculations		Most Conservative

Indoor air concentrations entered over-ride modelling

Receptor Groups (Yes/No)		Default
General public or residents		Yes
Employees		Yes
Canadian native communities		No
Other		No
specify:		

Active Critical Receptors (Yes/No)		Default
Infant	No	Yes
Toddler	No	Yes
Child	No	Yes
Teen	No	Yes
Adult	No	Yes
Other	Yes	Yes
specify:	O&M Worker	

Contaminant Concentrations

Blue numbers exceed theoretical saturation/solubility limits; site should be evaluated for potential NAPL

Chemical Name	required	F1	F2	F3			
Soil (mg/kg)	required	325.5	2487	1618			
Groundwater - source (mg/L)	optional	1.2	5.74	***0.7***			
Drinking water (mg/L)	optional	0.1	0.25	0.25			
Bathing/swimming water (mg/L)	optional	0.1	0.125	0.125			
Indoor air - vapours (mg/m^3)	optional	1.678	1.09				
Outdoor air - vapours (mg/m^3)	optional						
Outdoor air - particulate (mg/m^3)	optional						
Root vegetables (mg/kg wet weight)	optional						
Other vegetables (mg/kg wet weight)	optional						
Fish (mg/kg wet weight)	optional						
Wild game (mg/kg wet weight)	optional						
		See also PHC Sheet	See also PHC Sheet	See also PHC Sheet			

Risk Assessment Endpoints		Default
Acceptable hazard index:	0.5	0.2
Acceptable cancer risk:		1.00E-05

Precluding Conditions for Fate and Transport Models	
Are non-aqueous phase liquids (NAPL) present?	No
Is groundwater contamination present in fractured bedrock?	No
Is groundwater contamination migrating through a confined aquifer?	No
Is there active pumping or drawdown of groundwater at the site?	No
Is contamination present within 1 m of building foundation?	No
Do any buildings within 5 m of contamination have earthen foundations?	No
Are any buildings constructed on very high permeability media?	No
Are there preferential vapour flow pathways connecting contamination to a building?	No

Fate and Transport Model Input

	Value	Default	Models Affected
Soil Type	coarse-grained	coarse-grained	PS, V-I, V-O, GW
Significant vehicle traffic on unpaved roads?		No	P-O
Site Characteristics			
Depth to Groundwater (m)	1.2	3	GW, V-O
Depth from Surface to Contamination (m)	0	0	GW, V-O
Distance - Contaminated Soil to Building (m)	1	1	V-I
Distance - Contaminated GW to Building (m)	1.2	1	V-I
Distance to potable water user (m)		0	GW
Distance to Bathing/Swimming Water (m)		0	GW
Particulate Concentration in Air (ug/m^3)		0.76	P-O
Building Type	Commercial/Industrial	Residential	V-I

Optional Sections

User-defined Chemicals

Note: user-defined chemicals should be named in this section before being selected in the 'Contaminant Concentrations' table above

Enter all applicable and appropriate toxicity benchmarks; values must be referenced and justified in the PQRA report.

	Chemical 1	Chemical 2	Chemical 3
Name			
CAS Number			
Chemical class (organic/inorganic)			
Tolerable daily intake (mg/kg/d) - infant			
Tolerable daily intake (mg/kg/d) - toddler			
Tolerable daily intake (mg/kg/d) - child			
Tolerable daily intake (mg/kg/d) - teen			
Tolerable daily intake (mg/kg/d) - adult			
Tolerable concentration (mg/m^3)			
Oral slope factor (mg/kg/d)$^{-1}$			
Inhalation slope factor (mg/kg/d)$^{-1}$			
Inhalation unit risk (mg/m^3)$^{-1}$			
Relative dermal absorption factor			
Organic carbon partitioning coefficient (mL/g) - Koc			
Log Kow (unitless)			
Henry's Law constant at 25^{o}C (unitless) - H'			
Henry's Law constant at 25^{o}C (atm-m3/mol) - H			
Water Solubility at 25^{o}C (mg/L)			
Molecular Weight (g/mol)			
Vapour Pressure at 25^{o}C (atm)			

Note: values in grayed cells will not be used; Health Canada default values are applied.

User-defined Receptor

Name	O&M Worker	Defaults
Age group	Adult	Toddler
Body weight (kg)		70.7
Soil ingestion rate (g/d)		0.02
Inhalation rate (m^3/d)		15.8
Water ingestion rate (L/d)		1.5
Skin surface area (cm^2)		
- hands		890
- arms		2500
- legs		5720
- total		17640
Soil loading to exposed skin (g/cm^2/event)		
- hands		0.0001
- surfaces other than hands		0.00001
Food ingestion (g/d)		
- root vegetables		188
- other vegetables		137
- fish		111
- wild game		0
Evaluate Cancer Risks (Yes/No)?		Yes

User-defined Land-Use / Exposure Scenario

Scenario name	O&M Work	Defaults
Hours per day (indoors)	10	22.5
Hours per day (outdoors)	2	1.5
Days per week	7	7
Weeks per year	12	52
Dermal exposure events/day		1
Water contact events per day		1
Duration of water contact event (h)	0.25	1
Days/year contaminated food ingestion	0	365
Exposure duration (years)	1	60
Years for carcinogen amortization		60

PHC Fraction Composition (%) Note: water and air defaults are calculated based on soil properties

	Soil		Water		Air (Vapour)	
Fraction 1		Default		Default		Default
Aliphatics C_6-C_8		55		60.5		85.3
Aliphatics $C_{>8}$-C_{10}		36		6.3		14.2
Aromatics $C_{>8}$-C_{10}		9		33.2		0.4
Total		100		100		100
Fraction 2						
Aliphatics $C_{>10}$-C_{12}		36		2.4		76.7
Aliphatics $C_{>12}$-C_{16}		44		0.1		20.6
Aromatics $C_{>10}$-C_{12}		9		60.3		2.3
Aromatics $C_{>12}$-C_{16}		11		37.1		0.5
Total		100		100		100
Fraction 3						
Aliphatics $C_{>16}$-C_{21}		56		9.54E-03		89.79
Aliphatics $C_{>21}$-C_{34}		24		2.58E-07		7.83
Aromatics $C_{>16}$-C_{21}		14		95		2.37
Aromatics $C_{>21}$-C_{34}		6		5		0.01
Total		100		100		100
Fraction 4						
Aliphatics $C_{>34}$		80		0		0
Aromatics $C_{>34}$		20		100		0
Total		100		100		0

HEALTH CANADA PQRA SPREADSHEET Version: March 16, 2009
OUTPUT SHEET - ADULT **RECEPTOR NOT ACTIVE**

User Name:	Miguel Madrid	**Site:**	Eureka HAWS, Nunavut
Proponent:		**File #:**	1570-1001
Date:	March 22, 2011	**Comment:**	

Exposure Scenario: **O&M Work**
Native population not considered

Chemical Properties	**Units**	**F1**	**F2**	**F3**			
Tolerable daily intake	mg/kg/d	NA	NA	NA	NA	NA	NA
Tolerable concentration	mg/m^3	NA	NA	NA	NA	NA	NA
Oral slope factor	(mg/kg/d)$^{-1}$	NA	NA	NA	NA	NA	NA
Inhalation slope factor	(mg/kg/d)$^{-1}$	NA	NA	NA	NA	NA	NA
Inhalation unit risk	(mg/m^3)$^{-1}$	NA	NA	NA	NA	NA	NA
Dermal slope factor	(mg/kg/d)$^{-1}$	NA	NA	NA	NA	NA	NA
Critical oral exposure benchmark		NA	NA	NA	NA	NA	NA
Critical inhalation exposure benchmark		NA	NA	NA	NA	NA	NA
Relative dermal absorption factor	unitless	0.2	0.2	0.2	1	1	1

Chemical Concentrations	**Units**	**F1**	**F2**	**F3**			
Soil	mg/kg	3.26E+02	2.49E+03	1.62E+03	0.00E+00	0.00E+00	0.00E+00
Drinking water	mg/L	1.00E-01	2.50E-01	2.50E-01	0.00E+00	0.00E+00	0.00E+00
Bathing/swimming water	mg/L	1.00E-01	1.25E-01	1.25E-01	0.00E+00	0.00E+00	0.00E+00
Indoor air vapours	mg/m^3	1.68E+00	1.09E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Outdoor air vapours	mg/m^3	1.68E+00	1.09E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Outdoor air particulate	mg/m^3	2.05E-07	1.88E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Amortized total air concentration	mg/m^3	1.94E-01	1.26E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Root vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Other vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Fish	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Wild game	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated

RESULTS

	Exposure (mg/kg/d)					
	F1	**F2**	**F3**			
Inadvertent ingestion of contaminated soil	2.12E-05	1.62E-04	1.06E-04	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminated soil particles	8.82E-10	8.07E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminant vapours - indoor	3.61E-02	2.34E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminant vapours - outdoor	7.21E-03	4.68E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated drinking water	4.90E-04	1.22E-03	1.22E-03	0.00E+00	0.00E+00	0.00E+00
Dermal contact with contaminated soil	3.64E-05	2.78E-04	1.81E-04	0.00E+00	0.00E+00	0.00E+00
Dermal contact with water	4.79E-03	8.47E-03	1.48E-02	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated food	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion exposure	5.11E-04	1.39E-03	1.33E-03	0.00E+00	0.00E+00	0.00E+00
Total dermal exposure	4.83E-03	8.75E-03	1.49E-02	0.00E+00	0.00E+00	0.00E+00
Ingestion + dermal exposure	5.34E-03	1.01E-02	1.63E-02	0.00E+00	0.00E+00	0.00E+00
Total inhalation exposure	4.33E-02	2.81E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Exposure (all pathways)	4.86E-02	3.82E-02	1.63E-02	0.00E+00	0.00E+00	0.00E+00

		Hazard/Risk Estimates					
		F1	**F2**	**F3**			
Hazard Quotient - Oral/Dermal		3.71E-02	1.84E-01	4.35E-01	NA	NA	NA
Hazard Quotient - Inhalation		4.09E-02	1.40E-01	3.73E-08	NA	NA	NA
Hazard Index - Total		7.80E-02	3.24E-01	4.35E-01	NA	NA	NA
Target Hazard Index:	0.5						
Cancer Risk - Oral		NA	NA	NA	NA	NA	NA
Cancer Risk - Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	NA	NA	NA	NA
Cancer Risk - Total		NA	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						