ENVIRONMENTAL SITE ASSESSMENT

ABANDONED HYDRANT AND DISTRIBUTION SYSTEM

APRON I, IQALUIT AIRPORT

FINAL

Iqaluit, Nunavut

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Submitted by

TRANSPORT CANADA

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EXECUTIVE SUMMARY

Dillon Consulting Limited (Dillon) was retained by Transport Canada (TC) to complete an Environmental Site Investigation (ESI) of Apron I, at the Iqaluit Airport, located in the City of Iqaluit, Nunavut. An underground pipeline and hydrant system (the "System") was put in place by the USAF to fuel aircraft on the eastern portion of Apron 1. The System consists of a total of ten concrete refuelling boxes and associated underground piping that were previously connected to four one million-litre above ground storage tanks (AST) and dispensing cabinets at the edge of the apron. In 1999, the ASTs and cabinets were removed and the land remediated under terms of transfer of the airport. However, the hydrant boxes and distribution pipes remain in place and were the subject of this ESI.

Dillon advanced boreholes and installed monitoring wells in select boreholes at locations adjacent to the concrete refuelling boxes and at other locations adjacent to these boxes in an attempt to determine if soil and or groundwater contamination was present near the System. Unfortunately, at the time of the field investigation, the layout of the underground piping in the System was not known. The choice of locations for the boreholes was based on a compromise between Dillon's desire to be as close as possible to the estimated location of the pipelines, Health and Safety needs, and the need to maintain pipeline integrity. Borehole locations were chosen in conjunction with TC personnel.

The contaminants of concern (COCs) for this project were identified as petroleum hydrocarbons, metals and glycols. Soil samples were collected and field screened for the presence of petroleum hydrocarbons. Select soil samples were sent to the project laboratory for analysis of concentrations of petroleum hydrocarbons, metals and glycols. Groundwater sample were collected from only two of six monitoring wells installed due to very slow recharge in four of the wells. The groundwater samples were submitted for analysis of petroleum hydrocarbons, metals and glycols. No estimates of hydraulic conductivity, flow direction, flow velocity or contaminant flux were possible due to the limited amount of groundwater that was encountered in the wells.

At the time of the field investigation, the existence of previous environmental investigations relating to the study area was not known. However, a report completed by Biogenie in 1994, was made available to Dillon following the completion of field work. The report detailed the extent of the underground system and presented the results of an environmental investigation completed on and around Apron 1. The results of the Biogenie (1994) investigation indicated the following:

- Analytical results for borehole soil samples collected from beneath the apron did not identify the presence of contaminants at concentrations exceeding historical guidelines. TPH concentrations exceeding historical guidelines were identified off-site to the south of the apron, in the location of the former USAF ASTs; and
- The analysis of one groundwater sample from a monitoring well near hydrant 10, indicated the presence of cadmium, copper, nickel, lead and zinc at concentrations exceeding historical guidelines. This area was identified as an area of environmental concern (AEC) for this project

based on the concentration of cadmium in Biogenie's analytical results exceeding current guidelines.

During the field work for this project, 22 boreholes were advanced: 10 adjacent to the 10 concrete hydrant boxes and 12 at other areas adjacent to the concrete hydrant boxes. The maximum depth of penetration of the boreholes was 2.9 metres below surface, however, all but one of the boreholes reached refusal at depths less than 2.4 metres below surface. Thirty-three soil samples (including three duplicates) were submitted for analysis. Four samples had concentrations of one or more COCs in excess of applicable CCME or CWS Tier II site-specific soil contact exposure pathway guidelines. Three samples collected from boreholes advanced adjacent to Hydrant 1, 6 and 9 at depths of 0.9 to 2.3 metres below surface, had concentrations of tin in excess of the CCME guidelines while one sample collected from a borehole advanced adjacent to Hydrant 9 at a depth of 1.5 to 2.3 metres below surface had a concentration of toluene in excess of the CCME guideline. In addition, elevated concentrations of PHC fractions were observed in several samples, however, concentrations were below site-specific guidelines.

The horizontal delineation of the extent of metals or PHC impacted soil was not completed. Despite the use of field screening techniques to provide indications of PHC impacts, the results of the field screening was not uable to effectively complete any additional delineation of PHC impacts. The lack of any field indications of metals impacts also limited the delineation of metals impacted soil during the program. The boreholes reached refusal on the permafrost layer. As such, vertical delineation of contaminated soil was also not completed. However, for PHCs, it is anticipated that the existence of permafrost would act to inhibit the vertical migration of PHCs to depths beyond which the permafrost was found. Elevated tin concentrations may reflect natural background concentrations. As such, pending further investigation, no broad generalizations about the vertical extent of tin can be made at this time.

The results of the analysis of groundwater samples indicated that toluene concentrations in sample MW-5 and the duplicate of this sample (dup 1) and cadmium concentration in sample MW-6 exceeded applicable guidelines. Given the regular airplane de-icing activities which may have occurred on Apron I, sample MW-5 was analyzed for glycol. The concentration of glycol in this well fell below the analytical detection limit. All other analysed parameters were below applicable guidelines. In addition, results from PHC fractions in samples MW-5 and MW-6, indicate that concentration were present at elevated levels. However, there are no applicable guidelines for comparison with concentrations of dissolved PHC fractions.

Due to the limited amount of groundwater that was encountered during the field work, no delineation of the extent of toluene or cadmium contamination in groundwater was possible.

As a result of this field investigation and the information contained in the Biogenie (1994) report, five AECs were identified at the Site. These AECs represent areas that should be addressed during any further investigation or remedial planning. These are summarised in the table below.

Areas of Environmental Concern

BH /MW	Location	Parameter	Matrix	Max Impact Depth (m)	Comments	AEC
BH-11	Hydrant 9	Toluene	Soil	2.3	Permafrost encountered below sample, while clean analytical results obtained from sample above.	AEC 1
BH-6 MW-6	Hydrant 6	Tin Cadmium	Soil GW	2.1 NA	No vertical or horizontal delineation of soil. Marginal cadmium exceedance	AEC 2
BH-2	Off-Site, SW Hydrant 1	Tin	Soil	2.3	Clean analytical results from samples collected beneath.	AEC 3
MW-5	Hydrant 4	Toluene	GW	NA	Toluene not present in MW-6, located at hydrant 6, no other proximal groundwater data.	AEC 4
PO-6	Hydrant 10	Cadmium	GW	NA	Historical cadmium concentration exceeded current guideline.	AEC 5

Notes:

NA = Not Applicable
AEC = Area of Environmental Concern

Dillon proposed two management options for the Site: the first one involved no further investigation, with the development of a risk management strategy after the completion of a risk assessment. The second management option would be to complete further delineation of soil and groundwater impacts and then decide on a remedial approach. This remedial approach could involve risk management, with a greater degree of comfort on the extent of the risks compared to the first option, or active remediation, with excavation and off-Site disposal likely a key component of this approach. Based on the findings of this investigation, Dillon recommends that TC determine whether they are willing to assume long-term liability for this Site. If so, then a management approach that involves no further investigation, the completion of a risk assessment and the development of risk management protocols may be a cost-effective approach for TC. If TC is not willing to assume long-term liability for this Site, then further delineation of the extent of soil and groundwater impact and the development of remedial action plans which involve active remediation of contaminated areas might be better suited to TC's needs.

Alternatively, if at some point in the future there are any resurfacing or reconstruction projects, it could be a good opportunity to remove any remaining in ground fuel distribution lines and address the residual impacted soils. The affected areas could be managed in-place until such time as a remediation program is considered.

TABLE OF CONTENTS

Embedded Tables

Appended Tables

Appended Figures

Appendices

1.0 INTRODUCTION

Dillon Consulting Limited (Dillon) was retained by Transport Canada (TC) to complete an Environmental Site Investigation (ESI) of Apron I, at the Iqaluit Airport, located in the City of Iqaluit, Nunavut. The Iqaluit Airport was transferred from TC to the Government of Northwest Territories (GNWT) on July 1 1995, and subsequently to the Government of Nunavut (GN), on April 1, 1999. As part of the transfer from TC to the territories, TC retained all liability pertaining to environmental impacts attributed to airport operations prior to July 1, 1995. This work represents TC's continued efforts to address this liability.

This investigation was initiated as a result of a funding request from the GN to complete upgrades on Apron I and Taxiway A, where mention was made that an area of the apron may be contaminated by hydrocarbons. The area of potential environmental concern (APEC) is associated with an abandoned underground hydrant refuelling system located beneath the eastern portion of Apron I. Prior to commencing this field investigation, neither TC nor Dillon, were aware of any previous investigations specifically pertaining to the abandoned hydrant system. However, following the completion of the field investigation, one report on the fuel hydrant system was found. The results of this previous report were incorporated into this report.

A site location map and site plan, are presented as Figures 1 and 2, respectively.

1.1 Objectives

The objective for this project was to undertake an ESI of subsurface conditions of the Apron I abandoned hydrant and distribution system, at the Iqaluit Airport. Following the completion of the ESI, a further objective was to investigate potential remedial options to address areas of environmental concern (AEC) at the Site.

1.2 Scope of Work

The scope of work was itemized in the terms-of-reference (TOR) and broken down into subtasks, as follows:

- Review existing reports/data pertaining to the areas under investigation;
- Establish a detailed intrusive program. Advance up to 30 boreholes and 10 monitoring wells in optimal locations throughout the apron, based on a review of existing information and onsite review;
- Re-sample existing monitoring wells, where required and possible;

- Conduct all sampling using industry standards, including QA/QC protocols. Groundwater testing, where applicable and possible, also includes water level measurements, a free product survey and hydraulic testing in addition to contaminate testing;
- Locate all sample locations on site drawings and provide the geographic coordinates;
- Define and identify the physical characteristics (soil / sediment / surface water / bedrock / groundwater) and conditions of the site;
- Characterize the type and concentration of the contaminants found in both soil and groundwater if applicable;
- Compare the results against the *CCME Canadian Environmental Quality Guidelines* and *Canada Wide Standards (CWS)* for Commercial fine-grained or coarse-grained soil zoned sites;
- Advance additional "step-out" boreholes to further define the horizontal and vertical extent of the contamination;
- Estimate the extent of impacted soil and groundwater based on available data;
- Identify and discuss the source(s) of the contamination; and,
- Assess potential contaminant pathways at site.

1.3 Project Personnel

The field investigation was completed by Mr, Alan Garand M.Sc. and reported by Mr. Martin Suchy B.Sc., GIT. The Project Manager was Mr. Martin Suchy, while Mr. Doug Bell, M.Sc., P.Geo., was the Technical Review Partner (Designate).

1.4 Disclaimer

Dillon completed this report, for the sole benefit of TC. The material within reflects Dillon's best judgment in light of the information available at the time of preparation. Any use that a third party makes of this report, or any reliance on or decisions made based on it, is the responsibility of said third party. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

2.0 SITE SETTING

2.1 Site Location and Description

The City of Iqaluit is located at the head of Frobisher Bay on Baffin Island at 63 degrees, 44 minutes North and 68 degrees, 28 minutes West. In 1989, the town, which had been called Frobisher Bay, was renamed Iqaluit, the original Inuit name for the site. The site of Iqaluit was a traditional Inuit fishing camp. Early European explorers include Martin Frobisher in 1576, who mined a sizable quantity of pyrite (fools gold) believing it to be gold; and C.F. Hall who mapped the area.

The Iqaluit airport (formerly known as Frobisher Bay Airbase) was established by the United States Army as a refuelling point for aircraft traveling from the US to Great Britain. Construction started in 1941 and was completed in 1943. On September 1, 1950 the Royal Canadian Air Force (RCAF) took over responsibility for the Frobisher Bay Airbase and operated the site until 1957. The airport was extended in 1955 to service the construction of the Distant Early Warning Line (DEW Line). From 1958-60 the Frobisher Bay airport runway was extended and new infrastructure was built to accommodate larger aircraft to support the Strategic Air Command (SAC) operations of the United States Air Force (USAF). The airport was run by the federal Department of Transport during this period and the site provided strategic refuelling under the SAC concept. In 1995, TC transferred ownership and operation of the airport to the GNWT. On April 1 1999, following the Nunavut Land Claims Agreement, Nunavut Territory was created, resulting in the transfer of the airport to the GN.

The USAF installed the underground hydrant and distribution system beneath the eastern portion of Apron I. There are a total of ten concrete refuelling boxes and associated underground piping that were previously connected to four one million-litre above ground storage tanks (AST), and dispensing cabinets at the edge of the apron. In 1999, the ASTs and cabinets were removed and the land remediated under terms of transfer of the airport. However, the hydrant boxes and distribution pipes remain in place. Figure 2 illustrates the location of the former USAF ASTs, the former dispensing cabinets, the hydrant piping and the hydrant boxes.

2.2 Topography

Iqaluit lies within the zone of continuous permafrost (French, 1976). Boreholes and test pits drilled in the course of previous field investigations at the airport indicated that the active layer above the permanently frozen ground ranges from 0.8 to 2.0m in thickness. The total thickness of permafrost was not determined for this study. The soils in the Iqaluit region are predominantly cryosols derived from sand and gravel parent materials.

2.3 Hydrogeology

The regional hydrogeology of the Iqaluit region is controlled by the presence of permafrost. During most of the year, the ground is frozen and no groundwater flow occurs except deep in the bedrock below the permafrost. During the brief summer, groundwater flow will occur in the active layer above the permanently frozen ground. Groundwater flow direction is topographically controlled, with Frobisher Bay as the ultimate destination of groundwater flow. At the Iqaluit Airport the water table is approximately 0.9 to 1.8 m below grade with groundwater flow to the south towards Frobisher Bay.

2.4 Hydrology

A drainage channel network, as illustrated on Figure 1, controls surface hydrology at the Iqaluit Airport. Surface water and any groundwater discharge in the vicinity of Apron I, is directed into one of two drainage channels located to the north and south of Apron I. Water is subsequently directed into one main channel, which discharges into Koojesse Inlet located approximately 1.5 km to the southeast.

2.5 Ecological Receptors

Koojesse inlet, located on the shores of the City of Iqaluit, is industrial in nature and anecdotally is not considered a fisheries habitat in terms of use as a subsistence or recreational fishery. However, Frobisher Bay provides important habitat to a wide variety of fish and other aquatic biota, which could potentially be exposed to contaminants of concern (COCs). Arctic Cod (arctic char) is an anadromous species, which return to freshwater, to spawn in the late summer or early fall. The Sylvia Grinnell River, located a few kilometres south of the city, drains into Frobisher Bay, and is used by Arctic Cod. Other species that inhabit Koojesse Inlet and Frobisher Bay include clams and sculpins.

2.6 Geology

The site is underlain by discontinuous permafrost, as in other areas of Iqaluit. Bedrock at Iqaluit consists primarily of granitic gneiss, Archean in age. A thin mantle of sand and gravel overlies the bedrock at the Iqaluit Airport, however, the depth to bedrock beneath the apron is not known.

2.7 Climate

Environment Canada's weather station at the Iqaluit Airport has accumulated data on a variety of environmental parameters, which document the climate of Iqaluit. The mean annual precipitation is 430 mm with approximately 50% occurring as snowfall. Mean annual temp is -14.9C; the monthly maximum mean temperature is 11.9C in July, and the monthly minimum mean is -25.0C in January. Prevailing winds are from the North and Northwest in the fall and from the Southeast in the summer. Iqaluit receives approximately 5 hours of sunshine daily in December compared to approximately 21 hours in June.

3.0 PREVIOUS INVESTIGATIONS

Transport Canada provided several environmental reports pertaining to the history and development of the Iqaluit Airport. In addition, Dillon has obtained additional environmental information pertaining to the Iqaluit Airport through other projects in Iqaluit. The following is a list of environmental reports, which Dillon is aware of at the time of writing this report:

- Environmental Assessment - Iqaluit Airport, Biogenie, 1994[*];
- Environmental Characterization - Iqaluit Airport, Biogenie, 1994[*];
- Environmental Baseline Study - Iqaluit Airport, Dillon Consulting Ltd., 1995[*⊗];
- Enhanced Phase I ESA - Iqaluit Airport, Dillon Consulting Ltd., 1996[*];
- Soil and Groundwater Investigation, EBA Engineering, 1997[⊗♦];
- Environmental Assessment Study UHF/DF Site, An-Geo Environmental Consultants, 1997[⊗♦];
- Environmental Site Investigation, An-Geo Environmental Consultants, 1998[⊗♦];
- Environmental Baseline Study Re-Audit - Iqaluit Airport, Dillon Consulting Ltd., 1999;
- Iqaluit Airport Fire Training Area Remediation, 2000[⊗♦];
- Iqaluit Airport Metal Dump Investigation, Earth Tech Consultants, 2000[⊗♦]; and,
- Desk Top Review of Scrap Metal Dump Iqaluit Airport, Earth Tech Consultants, 2001[⊗♦];

A review of available reports completed following the field investigation indicated that, in 1994, as part of the Iqaluit Airport Environmental Characterization, Biogenie Inc. (Biogenie) advanced six boreholes and installed three monitoring wells in Apron I to investigate the fuel hydrant system. Two other monitoring wells were installed between the southern edge of the apron and four USAF ASTs. The Biogenie results from soil samples collected beneath the apron do no indicate the presence of hydrocarbon impacts above applicable historical guidelines, while samples were not analysed for metals. The investigation reported that groundwater results from wells installed in the apron indicate; cadmium, copper, nickel and zinc exceeded freshwater aquatic life historical guidelines, while hydrocarbon impacts were not observed. Soil sample results from trenches advanced between the apron and ASTs indicate a TPH and copper exceedances above historical guidelines in two separate samples. Complete tabulated results from the Biogenie investigation are provided in Tables 1, 2 and 3, while borehole, trench and monitoring well locations are highlighted on Figures 3 and 4. A summary of results and findings is located in Table A, below. Relevant borehole and trench logs from the Biogenie investigation have been provided for reference in Appendix C. Based on verbal information provided by Transport Canada, it is understood that the former USAF ASTs and associated infrastructure (aside from the hydrant system) were remediated in 1998 and 1999. However, reports from those investigations were not made available to Dillon, and were not obtained independently. All other reports that were provided by TC, or obtained

[*] Obtained independently by Dillon, after field investigation completed.
[⊗] Listed in TOR.
[♦] Report made available to Dillon, after field investigation completed.

independently by Dillon, addressed areas of the Iqaluit Airport that were not of significance to this investigation.

Table A: Results / Findings from 1994 Biogenie Investigation

BH / MW	Location	Groundwater Results	Soil Results	Comments
Apron I				
F-1	Beside box 9	- No monitoring well.	-TPH and BTEX below historical guidelines, metals not analysed.	-Borehole advanced to 1.2 m, permafrost refusal.
F-2	Beside box 4	- No monitoring well.	-TPH and BTEX below historical guidelines, metals not analysed.	-Borehole advanced to 1.2 m, permafrost refusal.
F-3	Beside box 2	- No monitoring well.	-TPH and BTEX below historical guidelines, Metals not analysed.	-Borehole advanced to 1.5 m, permafrost refusal.
PO-6	Beside box 10	- MOG and BTEX below historical guidelines. - Cadmium, copper, nickel, lead and zinc exceeded historical guideline, chromium below historical guideline.	-TPH and BTEX below historical guidelines, metals not analysed.	-Borehole advanced to 1.0 m, permafrost refusal, and located partially up-gradient of box 10. -Select groundwater metals exceedances are above freshwater aquatic life guidelines, not marine levels.
PO-7	Beside box 5	- MOG, BTEX and metals not analysed.	-TPH and BTEX below historical guidelines, metals not analysed.	-Borehole advanced to 0.8 m, permafrost refusal.
PO-8	Beside box 1	- MOG, BTEX and metals not analysed.	-TPH and BTEX below historical guidelines, metals not analysed.	-Borehole advanced to 0.85 m, permafrost refusal.
Off-Apron				
PU-7	Closest to box 5	- MOG, BTEX and metals not analysed.	-TPH exceeded historical guideline, BTEX did not exceed historical guidelines. -Metals below historical guidelines.	-Trench / monitoring well location south (down-gradient) of Apron I. -Area suspected to have been remediated with USAF ASTs.
PU-31	Closest to box 1	- MOG and BTEX below historical guidelines. - Copper, lead and zinc exceeded historical guideline, chromium and nickel below historical guideline.	-TPH and BTEX did not exceed historical guidelines. -Metals below historical guidelines.	-Trench / monitoring well location south (down-gradient) of Apron I. -Area suspected to have been remediated with USAF ASTs.

4.0 APPLICABLE REGULATORY GUIDELINES AND STANDARDS

Environmental guidelines and standards applied to contaminated sites in Nunavut have changed significantly since the previous assessment work was completed in 1994. Specifically, the Canadian Council of Ministers of the Environment (CCME) has introduced the *Canadian Environmental Quality Guidelines (CEQG)(1999)* and the *Canada Wide Standards (CWS) for Petroleum Hydrocarbon Fractions (PHC)(2001)*, both of which have been adopted by the Government of Nunavut (GN) through harmonization agreements. Standards from the GNWT, Resource, Wildlife and Economic Development (RWED) *Environmental Guidelines for Contaminated Sites Remediation (2003)*, which are based on CCME and CWS documents, have also been included because of their applicability to northern climates. In addition, the GNWT Department of Renewable Resources (DRR) *Environmental Guidelines for Contaminated Sites Remediation (1994)*, which were previously applied, have been shown for comparison purposes.

For each of the above-mentioned guidelines and standards, land use is assigned according to the following categories: Industrial, Commercial, Residential/Parkland, and Agricultural. Based on information provided to Dillon, the Iqaluit airport property is zoned as Commercial.

Commercial Land Use is generally applicable where the primary activity is commercial, and there is free access to all members of the public, including children. Industrial Land Use is applicable where the primary activity involves the production, manufacturing, construction and handling of goods, and public access is restricted and children are not permitted. As such, because this is a paved restricted access site, the Industrial Land Use guidelines are more applicable, and will be applied for comparison with laboratory analytical data.

4.1 Soil Guidelines

Upon the creation of the Nunavut Territory on April 1, 1999, all GNWT legislation was transferred to the GN, including the GNWT *Environmental Guidelines for Contaminated Site Remediation (1994)*. The 1994 Environmental Characterization investigation compared select analytical results to these guidelines, while all others were compared against interim 1991 CCME guidelines.

The *Canadian Soil Quality Guidelines (CSQG)*, are provided by the *CCME CEQG* for the protection of human health and the environment. Detailed fact sheets for various compounds provide brief summaries of various parameter's chemical and physical properties, production and use in Canada, fate and behaviour in the environment, toxic effects, and a description of how the guidelines were developed. Separate guidelines are provided for the protection of human health and environmental health.

These fact sheets are updated when new information regarding the specific compounds is published. The fact sheets for Benzene, Ethyl benzene, Toluene and Xylenes (BTEX) were recently released as Draft in 2003, and are therefore not yet legally enacted. The draft guidelines specify the soil location (either subsoil or surface soil) and the soil texture (being either coarse or fine grained). This report relies on the 1997 provisional guidelines for BTEX, however the newly proposed BTEX Draft 2003 guidelines are identified for comparison purposes only.

Because the site surface is paved, the soil quality guidelines for the protection of Human Health SQG_{HH} are not considered applicable for this site. Only soil quality guidelines for the protection of Environmental Health (soil contact guideline) SQG_E are considered applicable.

CWS for PHC in soil have been established as a pursuant to the 1998 Canada-wide Accord on Environmental Harmonization of the CCME. The PHC CWS is a 3-tiered, risk based remedial standard for contaminated soils based on the same four land uses as the CEQG standards as well as soil texture (coarse or fine grained). The PHC properties differ in relation to the size of the PHC molecule. Therefore, the various PHCs have been grouped into four size fractions to effectively manage the risk they pose to environmental and human health. The fractions refer to the equivalent normal straight-chain hydrocarbon boiling point ranges and are subdivided as follows; Fraction #1 (nC_6 to nC_{10}), Fraction #2 ($>nC_{10}$ to nC_{16}), Fraction #3 ($>nC_{16}$ to nC_{34}) and Fraction #4 (nC_{35+}).

Generic Tier 1 levels that are protective of human and the environmental health have been derived for each fraction through a systematic evaluation of all pathways of exposure that apply to the receptors of concern identified under the land use. As mentioned above, separate Tier 1 levels for PHC are applicable for coarse or fine-grained soils, as determined using a particle distribution analysis, and for surface soils (<1.5 m deep) or subsoils (>1.5 m deep).

The derivation process of Tier 2 assessment guidelines entails the site-specific adjustment of the Tier 1 levels to accommodate unique site-specific exposure pathway characteristics. Tier 3 levels are developed, using a site-specific ecological and human health risk assessment, when assumptions inherent in the Tier 1 values are not appropriate for a site. As such, for the assessment of PHC F1 – F4 fraction concentrations in soil samples, the Tier 2 CWS for Industrial Land Use, Coarse-grained subsoils soils, Eco Soil Contact pathway, were selected. The following summarizes the site conditions in support of the above listed assessment criteria:

- Although the site is zoned commercial, the area is restricted to all public access, and is completely paved over, resulting in no human exposure pathway;
- Soil material is primarily composed of medium-coarse grained sand and gravel, confined by permafrost;
- Because the site is completely covered by asphalt, all results were compared against subsoil guidelines;
- Shallow groundwater within the active layer has no present or potential usage;
- There are no receptors presenting any risk with respect to indoor vapour inhalation;

- There are no major surface water bodies in the immediate vicinity (<10 m) of the impacted material. Small seasonal drainage ditches are located south of the apron, however, they are not located within 10 m, and there is no evidence suggesting impacted material is discharging into the ditch.

Table B summarizes the site-specific exposure pathways in terms of their availability and applicability. These are indicated as yes or no in the table. For complete description and explanation of each exposure pathway, refer to the appropriate reference document. Table C summarizes the applicable assessment guidelines.

Table B: Available and Applicable Site-Specific Exposure Pathways

(INDUSTRIAL LAND USE - COARSE-GRAINED SUBSURFACE SOILS)			
Site-Specific Factors	**GNWT 2003 (available / applicable)**	**CCME (CSQG) 1997/1999/2003 (available / applicable)**	**CWS PHC 2003 (available / applicable)**
Human Health			
Soil Ingestion	no / no	yes/ no	no / no
Dermal Contact	no / no	no / no	no / no
Vapour Inhalation (indoor)	yes / no	yes / no	yes /no
Environmental Health			
Protection of Potable GW	yes / no	yes / no	yes / no
Protection of GW for Aquatic Life (3)	yes / no	-	yes / no
Groundwater check (aquatic life)	-	yes / no	-
Nutrient Cycling	no / no	no / no	no / no
Soil Contact (2)	-	yes / yes	-
Eco Soil Contact (1)	yes / yes	-	yes /yes
Off-site movement of dust	yes / no	no / no	yes / no

Notes:

1. Tier 1 values based mainly on laboratory bioassay response to fractions derived from fresh Federated Crude Oil.
2. CCME CSQG Soil Quality Guideline for Environmental Health SQG_E
3. Assumes surface water body at 10 m from site.

In November 2003, the GNWT released updated remediation criteria, which were based on CCME and CWS documentation. The purpose of these guidelines was to help facilitate the resolution of contamination problems on properties by providing soil standards for site remediation. The GNWT remediation criteria are presented for the protection of human and environmental health for specified land use. For the purposes of this report, the GNWT guidelines for industrial land use, coarse-grained surface soils will be used to assess the presence of contamination. The criterion for Industrial land use is evaluated based on site-specific exposure pathway factors. These factors are listed in Table B, while Table C summarizes all applicable soil guidelines.

The GNWT 2003 remediation criteria for metals and Petroleum Hydrocarbon (Tier 1) in soil have been derived from the CCME 2003 guidelines, while those for BTEX are based on the previous interim and provisional CCME Soil Quality Guideline for Environmental Health SQG_E, and soil contact exposure pathway. The Draft CCME guidelines for BTEX have not been adopted by the GNWT.

Table C: Applicable Industrial Land Use Soil Quality Guidelines and Standards

Regulatory Body / Date / Factors	GNWT (1) 1994	GNWT (2) 2003 surface/ Coarse	CCME (3) 1991 Interim	CCME (4) 1997/1999 Provisional	CCME (5) 2002 / 2002 Subsoil / Coarse	CWS (6) 2001 Surface / Coarse	CWS (6) 2001 Subsoil / Coarse	Site Specific Applicable Guidelines
Monocyclic Aromatic								
Benzene	5	39	5	**39 (7)**	250 (8)	NS	NS	**39**
Toluene	30	14	30	**14 (7)**	250 (8)	NS	NS	**14**
Ethylbenzene	50	20	50	**20 (7)**	480 (8)	NS	NS	**20**
Total Xylenes	50	21	50	**21 (7)**	440 (8)	NS	NS	**21**
Petroleum Hydrocarbons								
F1 (C6-C10) -BTEX	NS	330/700	NS	NS	NS	**330 (9)**	**700 (10)**	**330 / 700**
F2 (C10-C16)	NS	760/2000	NS	NS	NS	**760 (9)**	**2000 (10)**	**760 / 2000**
F3 (C16-C34)	NS	1700/3500	NS	NS	NS	**1700 (9)**	**3500 (10)**	**1700 / 3500**
F4 (C34 +)	NS	3300/10,000	NS	NS	NS	**3300 (9)**	**10,000 (10)**	**3300 / 10,000**
TPH (C6-C34)	**2500 (11)**	NS	NS	NS	NS	NS	NS	2500
Polycyclic Aromatic								
Naphthalene	ns	22	50	**22 (12)**	nc	NS	NS	**22**
Phenanthrene	ns	50	**50**	nc	nc	NS	NS	**50**
Fluoranthene	ns	ns	ns	ns	nc	NS	NS	**ns**
Pyrene	ns	100	**100**	nc	nc	NS	NS	**100**
Benzo(a)anthracene	ns	10	**10**	nc	nc	NS	NS	**10**
Benzo(b)fluoranthen	ns	10	**10**	nc	nc	NS	NS	**10**
Benzo(k)fluoranthen	ns	10	**10**	nc	nc	NS	NS	**10**
Benzo(a)pyrene	ns	1.4	10	**1.4 (12)**	nc	NS	NS	**1.4**
Indeno(1,2,3-	ns	10	**10**	nc	nc	NS	NS	**10**
Dibenzo(a,h)anthrac	ns	10	**10**	nc	nc	NS	NS	**10**
Total Metals								
Silver (Ag)	ns	40	ns	ns	**40**	NS	NS	**40**
Arsenic (As)	ns	26	50	**26 (12)**	nc	NS	NS	**26**
Barium (Ba)	ns	2000	**2000**	nc	nc	NS	NS	**2000**
Beryllium (Be)	ns	8	ns	ns	**8**	NS	NS	**8**
Cadmium (Cd)	ns	22	20	**22 (12)**	nc	NS	NS	**22**
Cobalt (Co)	ns	300	ns	ns	**300**	NS	NS	**300**
Chromium (Cr)	ns	87	800	**87 (12)**	nc	NS	NS	**87**
Copper (Cu)	ns	91	500	**91 (12)**	nc	NS	NS	**91**
Mercury (Hg)	ns	50	ns	ns	**50**	NS	NS	**50**
Molybdenum (Mo)	ns	40	ns	ns	**40**	NS	NS	**40**
Nickel (Ni)	ns	50	500	ns	**50**	NS	NS	**50**
Lead (Pb)	1000	600	1000	**600 (12)**	nc	NS	NS	**600**
Selenium (Se)	ns	3.9	ns	ns	**3.9**	NS	NS	**3.9**
Tin (Sn)	ns	300	ns	ns	**300**	NS	NS	**300**
Thallium (Tl)	ns	3.6	ns	**3.6 (12)**	nc	NS	NS	**3.6**
Vanadium (V)	ns	130	ns	**130 (12)**	nc	NS	NS	**130**
Zinc (Zn)	ns	360	1500	**360 (12)**	nc	NS	NS	**360**

Notes:

NS = No Standard
NC = No Change

1. GNWT, Environmental Guideline for Contaminated Site Remediation (1994), adopted by GN.
2. GNWT, Environmental Guideline for Contaminated Site Remediation (2003).
3. CCME, Canadian Environmental Quality Guidelines (1991), Interim guidelines.
4. CCME, Canadian Environmental Quality Guidelines (1997 and 1999 updates), provisional guidelines.
5. CCME, Canadian Environmental Quality Guidelines (2003 updates),
6. CWS for petroleum hydrocarbons in soil (2001), from CCME.
7. Soil Quality Guideline – Environment Health
8. Guidelines only in draft stage, not yet implemented. Represents the soil contact guideline.
9. CCME / CWS Tier II levels for petroleum hydrocarbons for coarse-grained surface soils (i.e. 0 - 1.5 m below ground), Eco soil contact exposure pathway.
10. CCME / CWS Tier II levels for petroleum hydrocarbons for coarse-grained subsurface soils (i.e. > 1.5 m below ground), Eco soil contact exposure pathway.
11. Total Petroleum Hydrocarbon (TPH), no longer applicable, shown for comparison purposes only.
12. Provisional Soil Quality Guideline – Environment Health, soil contact guideline.

4.2 Groundwater Guidelines

Drainage ditches from the south side of the apron make there way into Koojesse Inlet, located approximately two kilometres to the south. Therefore, groundwater contaminant concentrations were compared against available *CCME CEQG* guidelines for the protection of marine aquatic life. The 1994 Biogenie investigation compared groundwater analytical results against *CCME 1991* freshwater aquatic life guidelines, which Dillon believe are not appropriate, considering that the groundwater discharges to a marine aquatic environment. Table D summarizes both previous and current freshwater and marine aquatic life guidelines.

Table D: Previous and Current Available / Applicable Groundwater Guidelines

	CCME 1991 Aquatic Life Freshwater	CCME 2002 Aquatic Life Freshwater	CCME 2002 Aquatic Life Marine	Applicable Guidelines
PHC				
F1-BTEX	NS	NS	NS	NS
F2(C10-16)	NS	NS	NS	NS
F3(C16-34)	NS	NS	NS	NS
F4(C34-50)	NS	NS	NS	NS
BTEX				
Benzene	300	370	**110**	**110**
Toluene	300	2	**215**	**215**
Ethylbenzene	700	90	**25**	**25**
Total Xylenes	300	NS	NS	NS
Glycols				
Ethylene Glycol	NS	192,000	NS	192000
Diethylene Glycol	NS	NS	NS	NS
Propylene Glycol	NS	500,000	NS	500000
Total Glycol	NS	NS	NS	NS

	CCME 1991 Aquatic Life Freshwater	CCME 2002 Aquatic Life Freshwater	CCME 2002 Aquatic Life Marine	Applicable Guidelines
Dissolved Metals				
Silver	-	0.1	NS	NS
Aluminum	-	5-100	NS	NS
Arsenic	-	5	**12.5**	**12.5**
Boron	-	NS	NS	NS
Barium	-	NS	NS	NS
Berylium	-	NS	NS	NS
Bismuth	-	NS	NS	NS
Calcium	-	NS	NS	NS
Cadmium	1.8	0.017	**0.12**	**0.12**
Cobalt	-	NS	NS	NS
Total Chromium	20	-	-	**1.5**
Cr(III)	-	8.9	56	-
Cr(VI)	-	1.0	**1.5**	-
Copper	4	2-4	NS	NS
Iron	-	300	NS	NS
Potassium	-	NS	NS	NS
Magnesium	-	NS	NS	NS
Manganese	-	NS	NS	NS
Molybdenum	-	73	NS	NS
Sodium	-	NS	NS	NS
Nickel	150	25 - 150	NS	NS
Phosphorus	-	NS	NS	NS
Lead	7	1 - 7	NS	NS
Antimony	-	NS	NS	NS
Selenium	-	1	NS	NS
Tin	-	NS	NS	NS
Strontium	-	NS	NS	NS
Titanium	-	NS	NS	NS
Thallium	-	0.8	NS	NS
Uranium	-	NS	NS	NS
Vanadium	-	NS	NS	NS
Zinc	30	30	NS	NS

Notes:

NS = No Standard
"-" = Not analysed as part of historical investigation

5.0 TECHNICAL APPROACH

5.1 Workplan

The purposes of this investigation was to target potential environmental impacts stemming from the abandoned underground fuel hydrant system, and delineate the impacted soils, if any. Up to 30 boreholes and 10 monitoring wells were planned; however, the investigation program was reduced with client input to 22 boreholes and 6 monitoring wells, due to the inability of the field screening techniques to provide indications of impacts. Select contaminants of concern include: petroleum hydrocarbons PHC fraction F1 to F4, polycyclic aromatic hydrocarbons (PAH), monocyclic aromatic hydrocarbons (MAH) (BTEX compounds), and metals.

Prior to conducting any intrusive work, Dillon met with Mr. John Graham, Iqaluit Airport Manager, and Mr. Darryl Pederson, Environmental Services – Transport Canada, to discuss the proposed borehole locations, obtain any available utilities plans, and obtain clearance for underground utilities in the targeted areas of investigation. The field investigation was completed between September 22 and 27, 2004. Mr. Pederson was present during the advancement of all boreholes.

5.2 Borehole Advancement

Because the fuel hydrants are located within concrete boxes and the apron is paved, a drilling technique was chosen that would minimize disturbance to air side activities and to permit the repair of the holes to smooth grade, suitable for normal aircraft operations. Boreholes were advanced using a gas-powered Pionjar®120 drill with standard 0.76 m long 5 cm diameter split-spoon samplers. The drill advanced the split spoon sampler into the ground in up to 0.76 m increments using percussion. The split-spoon was withdrawn, cracked open and the soil sample examined. The split spoon was cleaned between holes and run back down the hole to advance to the next interval. The split spoon samplers were modified such that slough could be extruded out of the top when advancing the sampler to the required depth. Care was taken to avoid collecting samples from the very top of the split spoon during the second and subsequent runs to avoid sampling slough material that might have come from higher up in the borehole. Sonic Soil Sampling Inc.® (Sonic) from Toronto, Ontario was contracted to advance the boreholes.

5.3 Soil Sampling Program

Soil samples were collected directly from the split-spoon. Each soil sample was collected over the length of the split-spoon. The soils from each borehole were field-classified according to soil type, moisture content, colour, and visual and olfactory evidence of hydrocarbon contamination.

Samples were field-screened for Hydrocarbon Vapour Emissions (HVE) using a MiniRAE® 2000 (Minirae) Photoionization Detector (PID). The Minirae was calibrated using Isobutylene. Volatile hydrocarbon vapours were measured using a fixed-volume headspace technique: soil was placed in a resealable polyethylene bag and after the contents had warmed to room temperature in the vehicle, the plastic bag was punctured and the headspace vapour level measured. The detector measured the concentration of combustible gases, including volatile hydrocarbons, and the highest headspace vapour level observed was recorded in ppmv. Representative samples were placed in pre-labelled, laboratory-prepared jars as required.

5.4 Monitoring Well Installation

Single peizometer monitoring wells were installed in 6 of the boreholes, using 32 mm diameter, #010 slot PVC. Standpipe-monitoring wells were installed to permit groundwater characterization. The upper portion of each monitoring well is composed of solid pipe and the lower length of slotted pipe. Locally sourced sand of appropriate quality was used in place of the typically used silica sand, as the drillers did not bring silica sand with them. The sand was placed outside the slotted well screen where possible, as the annular space between the screen and the borehole walls was minimal. A bentonite seal (plug) was placed above the screened section to prevent infiltration of surface runoff. The monitoring wells were completed at grade with a steel road box, and set with concrete into the apron asphalt. Wells were capped with a sealed J-plug.

5.5 Groundwater Sampling Program

All wells were monitored for depth to water level using a Heron® Interphase Meter, and were subsequently developed by hand using dedicated Waterra® LDPE tubing with an attached foot valve. Monitoring wells were developed following the installation of all monitoring wells. A minimum of five well volumes of groundwater was removed from the wells during development. Failing the removal of five well volumes, the wells were pumped until dry. The wells were then allowed to recover prior to sampling.

Following the initial well development, all wells were again monitored for depths to groundwater and the presence of free-phase petroleum hydrocarbons, and purged of approximately three well volumes (or until dry) of groundwater and allowed to recover. Once the monitoring wells had recharged, representative groundwater samples were recovered. Samples were placed in laboratory-supplied glass and HDPE vessels as required.

5.6 Survey

Dillon Staff conducted a horizontal and vertical survey of the newly installed monitoring wells. The horizontal survey was completed such that relative locations of monitoring wells could be plotted on the site plan, while a vertical survey was completed in order to obtain relative elevations of the piezometers such that groundwater elevations could be determined along with a local groundwater gradient. The monitoring well ground surface elevations are referenced to sea level, and were determined using an available digital survey of the Iqaluit Airport. Each monitoring well (ground surface and top of pipe) was also surveyed to a benchmark at the southeast corner of the apron.

5.7 Health and Safety Plan

A health and safety plan was prepared for the investigation and explained to all affected personnel. The development and implementation of the health and safety plan followed all of Dillon's internal protocols and standard ISO 9001 requirements. The essential factor was the identification and mitigation of hazards associated with site activities and potential contamination.

5.8 Quality Assurance / Quality Control

5.8.1 Analytical QA

PSC Analytical Services in Mississauga Ontario, a CAEAL-accredited laboratory was used to perform all soil and groundwater analyses requested as part of the environmental investigation.

5.8.2 Field QA

Samples were solely comprised of soil from distinct layers and were not composited from different sample locations. Using single-use Nitrile (powder-less) gloves, two 125 ml glass jars with Teflon lids were packed with soil from each sampling location. Soil samples were packed to eliminate headspace, wherever possible. All sampling equipment was thoroughly washed in a solution of Alconox cleaner and water between samples. Samples were stored outside in sub-zero temperatures under lock, and were transported via air-cargo in coolers with gel-packs to the laboratory under Chain of Custody for analysis.

An identical approach was used for the collection of all groundwater/water samples. The interphase meter was washed between monitoring wells in a solution of Alconox® cleanser and water to prevent cross-contamination. Groundwater sampling equipment and vessels were also handled using nitrile gloves and Waterra® tubing was dedicated to each monitoring well/piezometer sampled. Samples were stored in ice-packed coolers, and were delivered to the laboratory under Chain of Custody for analysis.

5.8.3 Laboratory QC

PSC Analytical Services conducted an internal QC program consisting of internal duplicates and spiked samples. QC certificates are provided with the laboratory certificates in Appendix E. The laboratory QC results were reviewed and compared against criteria supplied by PSC Analytical Services. Table E summarizes the acceptable range of laboratory blank spike; matrix spikes and laboratory duplicate Relative Percentage Difference (RPD) calculations.

The laboratory considers analytical results acceptable where the sample or duplicate concentrations are within 5 times the Methodology Detection Limit (MDL) but the RPDs are above the acceptable criteria. Analytical data within five times of the detection limit is subject to increased variability that may bias the RPD calculations.

Dillon reviewed the laboratory's internal QC investigations, consisting of analysis of blanks, lab duplicates, spikes and analysis of prepared standards. The laboratory acceptability criteria are summarized by matrix type in Section 7.3.

Table E: Summary of Acceptability Criteria

Parameters	Matrix	Lab Duplicate RPDs
Metals	Soil	30%
MAH	Soil	20%
PAH	Soil	40%
PHC (F1 - F4)	Soil	30%
Metals	Water	20%
MAH	Water	20%
PAH	Water	40%
PHC (F1 - F4)	Water	30%

5.8.4 Dillon QC

Dillon's investigation included a QC program comprising of blind field duplicate soil sample. RPDs were calculated for the sample and duplicate pair and compared against the same criteria (Table E) as the laboratory. The findings are summarized in Section 7.3.

6.0 FIELD INVESTIGATION

Selected site photographs are presented in Appendix D. Borehole and monitoring well locations are indicated on Figures 2, 3 and 4. Borehole logs, including monitoring well construction details, are provided in Appendix C.

6.1 Soil Program

The drilling program was conducted between September 22 and September 24, 2004. A total of 22 boreholes were advanced, and 33 soil samples, including three duplicate soil samples were collected. Boreholes were generally advanced as proposed by the workplan and were concentrated around the underground hydrant and distribution system.

10 boreholes were advanced in the immediate vicinity of the 10 hydrant boxes. The remaining 12 boreholes were used to step out from select boreholes where field indicators suggested potential hydrocarbon impacts. At the time of the investigation, the underground path of the distribution pipelines was not known. As a result, boreholes were not advanced along the estimated pipeline locations as a safety precaution in case some product remained in them. Table F summarizes the borehole locations and field observations, including HVE measurements.

The permafrost layer was reached at depths ranging between 1.27 m to 2.84 m, while premature borehole refusal occurred in one borehole (BH-3). Soil stratigraphy was very consistent from one borehole to the next consisting mainly of medium to coarse grain sand with minor amounts of pebbles and cobbles with saturation occurring at approximately 1.80 meters.

Table F: Borehole Soil Sample Field Observations

Test Pit ID	Sample ID	Location	Headspace Vapour	Sample Depth (m)	Soil Description	Visual / Olfactory Observations
BH-1	SS1	Hydrant Box 1	0 ppmv	0.1 – 0.8	Brown sand	No odours, or staining
	SS2		0 ppmv	0.8 – 1.2	Brown sand	No odours, or staining
	SS3		0 ppmv	1.2 – 1.7	Brown sand	No odours, or staining
	SS4		0 ppmv	1.7 – 2.0	Brown sand	No odours, or staining
	SS5		0 ppmv	2.0 – 2.3	Brown sand	No odours, or staining
BH-2	SS1	SW of Box 1	0 ppmv	0.1 – 0.8	Brown silty sand	No odours, or staining
	SS2		0 ppmv	0.8 – 1.5	Brown silty sand	No odours, or staining
	SS3		0 ppmv	1.5 – 2.3	Brown silty sand	No odours, or staining
	SS4		0 ppmv	2.3 – 2.9	Brown silty sand	No odours, or staining
BH-3	SS1	Hydrant Box 2	0 ppmv	0.2 – 0.9	Brown silty sand	No odours, or staining
BH-4	SS1	Hydrant Box 3	0 ppmv	0.2 – 0.8	Brown silty sand	No odours, or staining
	SS2		0 ppmv	0.8 – 1.5	Brown silty sand	No odours, or staining
	SS3		0 ppmv	1.5 – 2.3	Brown silty sand	No odours, or staining
BH-5	SS1	Hydrant Box 4	0.5 ppmv	0.2 – 0.9	Brown medium sand	Slight odours, no staining
	SS2		62.5 ppmv	0.9 – 1.7	Brown medium sand	Slight odours, no staining
	SS3		57.9 ppmv	1.7 – 2.1	Brown medium sand	Slight odours, no staining