PHASE II/III ENVIRONMENTAL SITE ASSESSMENT
CAMBRIDGE BAY AIRPORT, CAMBRIDGE BAY, NUNAVUT

Prepared for:

Public Works & Government Services Canada
800 Burrard Street
Vancouver, BC
V6Z 2V8

On behalf of Transport Canada

Prepared by:

Franz Environmental Inc.
308-1080 Mainland Street
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FRANZ ENVIRONMENTAL INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

Project No. 1748-0901
March 2010

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DRAFT FIELD REPORT

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EXECUTIVE SUMMARY

Franz Environmental Inc. (FRANZ) was retained by Public Works and Government Services Canada (PWGSC) and Transport Canada (TC), Prairie & Northern Region and Environmental affairs Division to complete a Phase II/III Environmental Site Assessment (ESA) at the Cambridge Bay Airport, Cambridge Bay, Nunavut. The work was completed to identify environmental liabilities and assess remediation/risk management options.

The Cambridge Bay Airport is near the West Arm of Cambridge Bay, 3km west of the Hamlet of Cambridge Bay on the southeast side of Victoria Island in Nunavut, Canada. The site covers an area of approximately 140 ha. The site has been used as an Airport since the 1950s. Operations conducted on site include: airline offices, airport manager office, petroleum/fuel storage and distribution, aircraft and vehicle maintenance.

The scope of the investigation addressed terms stipulated in the June 2009 request for proposal (RFP) and included:

- Reviewing historical environmental reports and archival information;
- Developing a detailed sampling and analytical plan; and
- Conducting intrusive soil, groundwater, and vegetation investigation to assess the level and extent of contamination from identified APECs

The work was completed to identify environmental liabilities and assess remediation/risk management options at 6 areas of potential environmental concern (APECs). Identified APECs and potential contaminants of concern (PCOCs) are summarized in Table A below:

Table A: Summary of APECs and PCOCs

APEC	DESCRIPTION	PCOCs
1	Historical Screening Plant / Boneyard	BTEX, F1-F4, PAH, VOC, Glycols, Metals, PCBs and Pesticides
2	TC Shoreline Disposal Area	BTEX, F1-F4, PAH, VOC, Metals, PCBs and Pesticides
3	Firefighter Training Area	BTEX, F1-F4, PAH, VOC, Lead, PCBs and PFOS.
4	Former F.H. Ross Tank Site	BTEX, F1-F4, PAH and Metals.
5	Former AST Location North of Building T-5	BTEX, F1-F4, PAH, VOC and Metals.
6	Former AST Location West of Building T-4	BTEX, F1-F4, PAH, VOC and Metals.

The intrusive site investigation conducted by FRANZ in 2009 included installing thirty seven (37) test pits, fifteen (15) groundwater monitoring wells installed, as well as collecting one (1) surface water sample and seven (7) aboveground foliage vegetation samples within the 6 APECs. The ESA identified the following 3 Areas of Environmental Concern (AECs):

Table B: Summary of AECs and COCs

AEC	Description	Contaminated Media	COC	Estimated Volume (m^3)	Estimated Area (m^2)
2	TC Shoreline Area	Soil	Cu and As	20	-
3	Firefighter Training Area	Soil	Benzene, Ethylbenzne and F2 fraction	15,000	-
		Groundwater	Benzene, Naphthalene and Pb	-	2,500
4	Former F.H. Ross Tank Site	Soil	BTEX, F1-F4 fractions and Pb	3,500	-
		Groundwater	Naphthalene, Toluene, and Zn	-	300

FRANZ recommends PHC contaminated soils and groundwater (including metals) in AEC 3, and 4 be excavated and treated in an onsite land treatment facility (LTF). PHC and lead co-

contaminated soils in AEC 4 should be segregated in the LTF and metals contamination disposed/treated offsite or managed (e.g., risk assessment) onsite. Additional investigation should be conducted at both AEC 3 and 4 to fully delineate the extent of the leading edge of PHC contaminated soil.

FRANZ recommends additional investigation at AECs 2 and 4 to delineate the extent of metals impacted soils and groundwater. Post-remediation groundwater monitoring should be conducted at AECs 3 and 4 to assess if COCs (e.g., Zn, naphthalene) attenuate following soil remediation activities. Chemical analytical results can be utilized in support of a detailed ecological and human health risk assessment for these AECs.

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1.0 INTRODUCTION

FRANZ Environmental Inc. (FRANZ) was retained by Public Works and Government Services Canada (PWGSC) and Transport Canada (TC), Prairie & Northern Region and Environmental affairs Division to complete a Phase II/III Environmental Site Assessment (ESA) at the Cambridge Bay Airport, Cambridge Bay, Nunavut (Figure 1).

This project was completed based on discussions with PWGSC/Transport Canada, a review of the Terms of Reference (ToR) and our July 2009 Proposal P-3027 titled "Proposal for Environmental Site Investigation, Cambridge Bay Landfill/Boneyard Cambridge Bay, Nunavut".

1.1 Purpose and Project Objectives

The purpose of this project was to undertake a Phase II and Phase III Environmental Site Assessment (ESA) at six areas of potential environmental concern (APECs) at the Cambridge Bay Airport, which are:

- APEC 1 – Screening Plant / Boneyard
- APEC 2 – TC Shoreline Disposal Area
- APEC 3 – Fire Training Area
- APEC 4 – Former F.H. Ross Tank Site
- APEC 5 – Former AST Location North of Building T-5
- APEC 6 – Former AST Location West of Building T-4

Transport Canada will use this report to demonstrate due diligence and reduce liabilities in order to direct remediation/risk management activities these sites. Project objectives include the following:

- Review of previous studies and reports for the site;
- Obtain representative soil, water and vegetation samples in all six APECs;
- Determine the source, type, and nature of potential contamination in soil, water, and vegetation and identify areas of environmental concern (AEC); and
- Calculate NCS scores for each AEC.

1.2 Site Background

The Cambridge Bay Airport is near the West Arm of Cambridge Bay, 3km west of the Hamlet of Cambridge Bay on the southeast side of Victoria Island in Nunavut, Canada. The Airport has been in operation since the 1950s and serves as a major transportation centre in the Central Arctic. The Airport's administration and control was transferred from Transport Canada to the Government of the Northwest Territories in 1995. Since 1999, the airport has been owned by the Government of Nunavut (GN).

The following buildings are present in the north-eastern part of the site: a terminal building, the airport maintenance garage as well as five other buildings used for storage. The Airport runway is located southwest of the buildings, parallel to the shore. A gravel road looping around the runway from the terminal building is also present onsite.

1.3 Project Team

This project was undertaken by a multi-disciplinary team of experienced professionals. Key individuals and their respective roles are summarized below:

- Steve Livingstone, M.Sc., P.Geo, Senior Hydrogeologist, Reviewer
- James Smith, B.Sc., Environmental Scientist, Project Manager
- Viviane Dubois Cote, M.Sc., P.Geo, Environmental Scientist
- Miguel Madrid, M.Sc., Environmental Scientist
- Jennifer Keenliside, HBSc., CEPIT, Junior Environmental Scientist
- Elliot Tonasket, Environmental Technician, Columbia Environmental Ltd.

2.0 STUDY AREA CHARACTERISTICS

2.1 Site Overview

The Airport is a civil airport located near the West Arm of Cambridge Bay, 3km west of the Hamlet of Cambridge Bay. The following buildings are present in the north-eastern part of the site: the Air Terminal Building (ATB), the airport maintenance garage as well as five other buildings used for storage. The Airport runway is located southwest of the buildings, parallel to the shore. A gravel road looping around the runway from the terminal building is also present onsite. The site covers an area of approximately 140 ha.

2.2 Current and Future Land Use

The site has been used as an Airport since the 1950s. Operations conducted on site include the following: airline offices, airport manager office, petroleum/fuel storage and distribution, aircraft and vehicle maintenance.

FRANZ understands that there are no current plans for development on the airport property.

2.3 Climate

Cambridge Bay is within a climatic zone characteristic of the Arctic Circle. The average daily temperature range is –33.0 ºC to 8.4 ºC. The average monthly temperature is below freezing for ten months of the year. The average annual precipitation is 138.8 mm. There is 69.6 mm annual rainfall and 82.1 mm annual snowfall (www.climate.weatheroffice.ec.gc.ca). The site is in the zone of continuous permafrost. Polar desert conditions limit vegetation to prostrate dwarf trees and lichens and mosses.

2.4 Natural Environment – Overview

The study area lies within the Arctic Lowlands physiographic region with local relief generally measuring less than 20 m. Several water bodies surround the Airport. The west arm of Cambridge Bay (marine environment) abuts the property boundary and is approximately 300 m south of the airport runway. An offsite freshwater lake abuts the north property boundary with several smaller freshwater bodies east and west of the runway.

Regionally, predominant vegetation consists primarily of tundra. Shrubs are less common, giving way to communities of grasses, sedge, lichens, mountain avens, and other flowers.

Mammalian species in the area include caribou, red fox, musk-ox, and brown and collared lemmings. Various bird species frequent the area on a regular/seasonal basis. Swans and geese were observed during the site visit. M.M. Dillon (1994) indicated geese and seagulls are likely attracted by the fact that the airport runway is clear of snow in the spring and must occasionally be chased off; historically, a few bird strikes have been reported.

Aquatic species, including ringed seals, inhabit the west arm and occasionally the shoreline to the south and west of the Airport. Char and lake trout return to inland freshwater to spawn in the late summer or early fall. Other fish in the freshwater bodies include cisco (M.M. Dillon, 1994). The most sensitive fisheries in the area include arctic char and lake trout.

There are no agriculture or forestry activities in the area.

2.4.1 Species at Risk

Data from available resources on regional species form the basis for developing a list of species that use or could potentially use or inhabit the sites. This list focused on species designated as protected under the federal Species at Risk Act (SARA).

The SARA database was searched for information on species at risk that may occupy the Cambridge Bay Airport sites and the risk status for each species (endangered, threatened and special concern). The following at-risk species was identified in the database as having habitat located in the vicinity of the Cambridge Bay Airport sites:

- Bowhead Whale *(Balaena mysticetus)* Bering-Chukchi - Beaufort population – Special Concern, Schedule 1.

3.0 PHYSICAL SITE CHARACTERISTICS

This section describes the physical setting of the site, including topography, drainage as well as subsurface and surficial geology.

3.1 Regional and Local Topography

Topographic Map 77D2 shows that the regional topography in the Cambridge Bay area is relatively flat, with elevations ranging between 0 and 80 m above mean sea level (amsl). A few peaks of higher elevation are observed on the topographic map. Mount Pelly, 17 km northeast of the Airport, is the highest peak in the area and reaches 600 m amsl.

The approximate elevation at the Airport is 15m amsl. The site topography is flat, except along the shores of Cambridge Bay, where it drops steeply to sea level.

3.2 Regional and Local Drainage

The Airport regional drainage is part of the Arctic Ocean Drainage Basin. Site surface water is inferred to follow topography and drain to the South and Southwest, towards the Cambridge Bay.

3.3 Geological Characterization

This section summarizes information collected with regards to regional and site specific bedrock and soil characteristics.

3.3.1 Regional Bedrock Geology

Regional bedrock geology consists of sedimentary rocks of the Arctic Platform. According to Geological Survey of Canada (Harrison et al., 2008), this formation is up to 3 km thick and is overlying the Canadian Shield. In and around the Airport, bedrock geology consists of Cambrian to Devonian flat-lying to gently dipping carbonates.

A study of the mineral potential of the Canadian Arctic islands, conducted by Dewing et al. (2007) indicated that although little exploration has been conducted on Victoria Island, it has mineral exploration potential for copper deposits, base metals volcanic massive sulphide (VMS) deposits and Zn-Pb Mississippi Valley Types (MVT) deposits. According to the Geological

Survey of Canada: Mineral Deposits of Canada website (http://gsc.nrcan.gc.ca/mindep/) VMS deposits are major sources of zinc, copper, lead, silver and gold, and significant sources for cobalt, tin, selenium, manganese, cadmium, indium, bismuth, tellurium, gallium, and germanium. They also indicate that lead and zinc are the primary commodities of MVT deposits, with arsenic, copper, cobalt, nickel, cadmium, silver, indium, germanium, gallium, antimony, bismuth, molybdenum, selenium, and gold commonly associated.

3.3.2 Regional Surficial Soils

The Geological Survey of Canada (Sharpe, 1993) indicates that glacial till deposits are predominant in the Airport area. The deposits are 1 to 5 m thick and are locally interbedded or underlaid by sand and gravel. The Canada Permafrost Map (NRCAN, 1995) indicates that the Airport is in a zone of continuous permafrost. Permafrost conditions have been documented throughout the airport property indicating an active layer of 1.5 to 2.4 m below ground surface (bgs) (M.M. Dillon, 1994).

3.3.3 Local Scale Geology

The geology of Cambridge Bay airport consists of a varying thickness of glacial and glaciofluvial deposits overlying a bedrock sequence of Silurian and Ordovician sediments. The surficial geology is characterized by the presence of extensive glacial and glaciofluvial deposits consisting primarily of sandy clay and silt tills containing abundant fragments of weathered bedrock.

Soils encountered during sampling conducted at the Airport in August 2009 are described in Section 9 and in the Test Pit and Borehole Logs (Appendix C). In some areas, peat or organic topsoil was observed as a surficial layer (no thicker than 0.15 m). Soils observed in the test pits conducted consist mostly of medium sand to sandy silt, with some gravel and cobbles, light grey to medium brown. Water seepage was encountered at depths ranging from 0.5 to 1.3m below ground surface (bgs) in some of the test pits. When possible, test pits were conducted to permafrost, which was encountered between 1.3 and 2.2 m bgs.

At shoreline sample locations, weathered clay overlying sand and silt was observed.

3.4 Hydrogeological Characterization

This section summarizes information collected with regards to regional and site specific hydrogeology.

3.4.1 Regional Hydrogeology

Victoria Island lies within the continuous permafrost zone. Permafrost occurs on the earth's surface where the ground has remained below 0°C continuously for a minimum of two years. In the continuous permafrost zone the ground remains frozen during the entire year, except for the uppermost soil layer which thaws out during the short summer. This upper layer of soil that is subjected to the annual freeze-thaw cycle is known as the active layer.

Groundwater in the continuous permafrost zone is confined to this shallow active layer. Based on the regional geology and the presence of permafrost, the groundwater flow is likely complex and controlled by topography, surface water bodies and bedrock structure. Vertical groundwater flow is limited by the shallow permafrost. The period of groundwater flow is highly influenced by climatic conditions and flow is likely also limited to the short summer season when the active layer thaws, thus allowing water to flow in this horizon. It is expected that the surface water bodies are expressions of the water table.

3.4.2 Site Hydrogeology

Land around the Cambridge Bay Airport is surrounded by lakes to the north and west, and the west arm of Cambridge Bay to the south. During subsurface investigation, permafrost was observed at depths between 1.3 and 2.1 m bgs. Groundwater flow is expected to follow surface topography, and appears to be directed towards the south and southeast, into Cambridge Bay, which is consistent with the local topography.

4.0 HISTORICAL ARCHIVAL REVIEW

This section presents information collected from various historical documents.

4.1 Sources of Information

The main sources of historical/archival information were obtained from aerial photographs and previous environmental reports. The historical reports reviewed include:

- M. M. Dillon Limited, 1994. Environmental Baseline Study.
- Dillon Consulting Limited, 1999. Cambridge Bay Environmental Baseline Study Reaudit. Proposal. August 1999.
- AGRA Earth & Environmental Limited, 1999. Remedial Action Plan Follow- Up, Cambridge Bay Airport, Nunavut Territory. Draft Report. November 1999.

4.2 Aerial Photographs

Aerial photographs were obtained from the National Air Photo Library in Ottawa, Ontario. Historical land use changes as well as potential sources of environmental impacts observed from the photographs were noted.

Aerial photographs of the area taken in 1951, 1960, 1965, 1969, 1976, 1981, 1985 and 1987 were available and are presented in Appendix B. Observations about current and historical land use for the subject properties and surrounding properties that were noted during the review of aerial photographs are summarized in Table 1.

Table 1: Summary of Aerial Photo Review

Date	Roll # (Scale)	Review
1951	A13313 – 376 (1:40,000)	The Site is vacant undeveloped land. No evidence of anthropogenic activity at or near the Site was identified.
1960	A17174-13, 33, 34, 35 (1:10,000)	The Airport has been constructed. A screening plant / boneyard is in use approximately 100m south of the runway; beyond the extent of APEC 1. A significant amount of grading is evident along the road that runs parallel to and between the runway and shoreline. Surface soils were graded towards the shoreline cliffs. Five ASTs (APEC 3) are present about 150m southeast of the ATB. The AST north of building T-5 (APEC 5) is present. The maintenance building is also now present.
1965	A19352 – 13, 14 (1:12,000)	The aircraft apron has been constructed between the runway and the Airport Terminal Building (ATB). Five ASTs (APEC 3) are present about 150m southeast of the ATB.
1969	A21284 – 16, 28 (1:12,000)	The 5 ASTs at APEC 3 are no longer present. . Three ASTs (APEC 4) are present about 60m south of the ATB.
1976	A24498 – 61, 68, 96 (1:5,000)	Machinery and gravel piles are observed directly south APEC 1. Metal drums and other structures are present along the shoreline parallel to the runway and at the northwest end of the Airport (APEC 2). The fire training area (FTA - APEC 3) is present along the west portion of the Airport.
1981	A25829 – 109, 112, 116 (1:5,000)	Machinery is observed south of APEC 1. The FTA (APEC 3) has been expanded and there is visual evidence of oil/diesel staining and a mock fuselage. A partial berm has been constructed around the tanks at APEC 4.
1985	A26791 – 15, 24, 78 (1:5,000)	The FTA (APEC 3) has increased significantly in size since 1981, and a berm has been built around fuselage area, where oil / diesel fuel appears to have accumulated. A small building has been built behind the 3 ASTs at APEC 4 to the northwest and the berm now encloses the ASTs.
1987	A27142 – 45, 47 (1:12,000)	The area of suspect soil staining at the FTA (APEC 3) has increased to about 1728m^2, almost reaching the berm on all sides. No other significant changes are observed.

4.3 Previous Environmental Investigations and Outcomes

Three environmental investigations have been conducted at the Airport over about the last 15 years to identify and delineate potential contamination. One report (Bonley, 1992) was not available for review; however, the following reports were reviewed and relevant information summarized:

- M. M. Dillon Limited, 1994. Environmental Baseline Study;
- AGRA Earth & Environmental Limited, 1999. Remedial Action Plan Follow-Up, Cambridge Bay Airport, Nunavut Territory. Draft Report. November 1999.

The following summarizes our review of historical reports:

M.M. Dillon Limited, 1994

M.M. Dillon (Dillon) conducted an Environmental Baseline Study (EBS) at the Airport in 1994. Most of the facilities operated by TC were visited as part of a site audit. The EBS also included a hydrogeological investigation designed to characterize the subsurface conditions and identify potential environmental concerns in APECs. Hazardous materials and fuels under TC operations were quantified and a storage tank inventory was prepared. Regulatory compliance was assessed and a mitigation action plan including cost estimates and priority rating was prepared.

Dillon identified potential environmental issues at 6 APECs. Preliminary soil and groundwater assessment were conducted at the site. For analysed parameters, soil concentrations were compared against Government of the Northwest Territories (GNWT) Environmental Guidelines for Site Remediation (Draft, 1994) and CCME Interim Canadian Environmental Guidelines for Contaminated Sites (1991). Groundwater concentrations where compared against Quebec Ministry of Environment (MOE) Summary of Contaminant Rehabilitation Policy (1988). Table 2 summarizes the findings and recommendations from subsurface investigation conducted at the APECs during the EBS.

Table 2: Findings and recommendations from subsurface investigation (Dillon, 1994)

APEC	Description	Investigation conducted	Investigation results		Recommendations
			Soil	Groundwater	
1	Screening Plant/ Boneyard	2 test pits, 1 installed as a monitoring well	No issues	Groundwater well dry.	Re-attempt groundwater sampling
2	TC Shoreline Disposal Area	1 test pit	No issues	Not sampled	Continue clean-up operations
3	Firefighting Training Area	1 grab sample and 3 test pits, 2 installed as monitoring wells	TPHC concentrations greater than GNWT guideline	TPHC, benzene and xylenes concentrations greater than Quebec MOE criteria	Annual monitoring and sampling of groundwater.
4	Former F.H. Ross Tank Site	1 test pit, installed as a monitoring well	No issues	No issues	Re-sampling of monitoring well
5	Former AST Location North of building T-5	1 test pit, installed as a monitoring well	TPHC concentrations greater than GNWT guideline.	TPHC benzene, toluene and xylenes concentrations greater than Quebec MOE criteria	Excavation and treatment of contaminated soil when upgrading existing AST. Annual monitoring of groundwater well until area is remediated.
6	Former AST Location West of Building T-4	1 test pit	No issues	Not sampled	No action recommended

*TPHC is for Total Petroleum Hydrocarbon in soil and Total Purgeable Hydrocarbon in groundwater

AGRA Earth & Environmental Limited, 1999

In 1999, AGRA Earth & Environmental Limited (AGRA) conducted a follow-up site investigation of the Airport to document the status of environmental mitigation activities, identify other areas of environmental non-compliance that were not assessed in the 1994 EBS, and to update the Airport remedial action plan .

Soil and groundwater assessment were conducted at the site. For analyzed parameters, soil concentrations were compared against Government of the Northwest Territories (GNWT) Environmental Guidelines for Site Remediation (Draft, 1994) and CCME Interim Canadian

Environmental Guidelines for Contaminated Sites (1991). Groundwater concentrations where compared against Guidelines for Canadian Drinking Water Quality (Health Canada, 1996) and CCME Interim Canadian Environmental Quality Criteria for Contaminated Sites (1991). Table 3 summarizes the findings and recommendations from subsurface investigation conducted at the APECs by AGRA.

Table 3: Findings and recommendations from subsurface investigation (AGRA, 1999)

APEC	Description	Investigation conducted	Investigation results		Other information	Recommendations
			Soil	Ground water		
1	Screening Plant/ Boneyard	No sampling conducted	-	-	Well damaged	Completion of a subsurface investigation
2	TC Shoreline Disposal Area	No sampling conducted	-	-	Debris identified along the shoreline behind DND Frontec facility.	Continue clean-up operations
3	Firefighting Training Area	Two grab soil samples collected; sampling of monitoring wells onsite and review of sampling conducted in 1998 by GNWT	HC[1] odours noted, soil not analysed	BTEX greater than GCDWQ and/or CCME guidelines	Tilling of surficial soils at the FTA was reportedly conducted 2 or 3 times over a period of 2 years before the AGRA investigation	Additional soil and groundwater monitoring to delineate the extent of hydrocarbon impacts.
4	Former F.H. Ross Tank Site	1 grab soil sample collected; and Sampling of monitoring well onsite	HC[1] staining and odours noted, soil not analysed	BTEX exceeding GCDWQ and/or CCME guidelines	-	Additional investigation to delineate the extent of hydrocarbon impacts.
5	Former AST Location North of building T-5	1 grab soil sample collected; and Sampling of monitoring well onsite and review of sampling conducted in 1998 by GNWT	HC[1] staining and odours noted, soil not analysed	BTEX exceeding GCDWQ and/or CCME guidelines	-	Additional investigation to delineate the extent of hydrocarbon impacts.
6	Former AST Location West of Building T-4	Not Investigated	-	-	-	-

A summary of the APECs and the potential contaminants of concern (PCOCs) are presented in section 5.

5.0 SUMMARY OF APECS AND PCOCS

Based on our review of historical information, FRANZ has prepared the following summary identifying relevant historical information for the 6 identified APECs. This information was used to prepare FRANZ's detailed sampling plan for our ESA. All of the APEC locations can be found on Figure 2.

5.1 APEC 1 – Historical Screening Plant / Boneyard

The Screening Plant / Boneyard is about 100m southwest of the Airport runway and was historically used for screening and stockpiling gravel and storing old discarded equipment. Aerial photographs did not identify screening plant/boneyard activities in APEC 1, however, a gap may exist in aerial photographs. FRANZ relied on previous sample locations identified by Dillon (1995) and AGRA (1999) to identify the location of APEC 1.

Based on our review, potential sources of contamination include petroleum hydrocarbons/ fuels, waste oil, metals, anti-freeze, Polychlorinated Biphenyls (PCBs), and pesticides. The following PCOCs were identified in soil and groundwater: Benzene, Toluene, Ethylbenzene and Xylenes (BTEX), Petroleum Hydrocarbon (PHC) fractions F1-F4, Polycyclic Aromatic Hydrocarbons (PAH), Volatile Organic Compounds (VOCs), glycols, metals, PCBs and pesticides. Historical investigation at this APEC did not identify any contaminants of concerns (COCs).

5.2 APEC 2 – TC Shoreline Disposal Area

The shoreline disposal area is found on the south side of airport lands, along the shoreline of Cambridge Bay's west arm. It extends for approximately 2km, from 300 m southwest of the Fire Fighting Training Area to downgradient of the Department of National Defence (DND) Frontec facility. FRANZ relied on previous sample locations identified by Dillon (1995) and AGRA (1999) to identify the location of APEC 2.

Based on our review, potential sources of contamination include petroleum hydrocarbons / fuels, waste oil, metals, anti-freeze, PCBs and pesticides. The following PCOCs were identified in soil and groundwater: BTEX, PHC fraction F1-F4, PAH, VOCs, glycols, metals, PCBs and pesticides. Historical investigation at this APEC did not identify any COCs.

5.3 APEC 3 – Fire Training Area

The former fire training area (FTA) is southwest of the runway along the west part of the airport. The former FTA consisted of an aircraft mock-up area where fuel and potentially other combustible/flammable waste liquids were burned for fire training exercises. It was enclosed in a containment berm about 40 cm high and constructed of local till material. ASTs were also historically present on site. According to AGRA (1999), tilling of the FTA to aerate the soil was to be completed by Transport Canada between 1995 and 1996 after it was taken out of use.

Based on the use of the FTA and historical investigation findings, the following potential sources of contamination include fuels (e.g., avgas, jet fuel), spent solvents, oils, and fire-fighting retardants. The following PCOCs were identified in soil and groundwater: BTEX, PHCs fraction F1-F4, PAHs, VOCs, lead, PCBs and Perfluoro Octane Sulfonates (PFOS). Historical investigation at this APEC identified BTEX as COCs in groundwater. The extent of contamination has not been delineated.

5.4 APEC 4 – Former F.H. Ross Tank Site

F.H. Ross and Associates conduct airport maintenance and aircraft fuelling. They formerly operated 3 bulk fuel ASTs about 60m south of the ATB. The ASTs were decommissioned in 1992; however, no formal decommissioning procedures were followed when the ASTs were relocated about 30m to the southeast (Dillon, 1995). Information regarding the former infrastructure was not available; however, the replacement system consists of three 100,000L ASTs containing Avgas and Jet B fuel.

Based on this information, potential sources of contamination are fuels (i.e., avgas, jet fuel). The following PCOCs were identified in soil and groundwater: BTEX, PHCs fraction F1-F4, PAHs and metals. Historical investigation at this APEC identified BTEX as COCs in groundwater. The extent of contamination has not been delineated.

5.5 APEC 5 – Former AST Location North of Building T-5

A former diesel AST (2,200L) associated with a fuel dispensing facility was present north of building T-5 (Powerhouse / Field Electrical Centre). The fuel dispensing facility was utilized by airport maintenance personnel for vehicle fuelling. Agra (1999) indicated the AST was installed on a concrete pad.

Based on this information, the potential source of contamination include petroleum hydrocarbons/fuels and metals. The following PCOCs were identified in soil and groundwater: BTEX, PHCs fraction F1-F4, PAH, VOCs and metals. Historical investigation at this APEC identified BTEX as COCs in groundwater. The extent of contamination has not been delineated.

5.6 APEC 6 – Former AST Location West of Building T-4

APEC 6 consists of a former AST installed west of the existing maintenance garage and fire-hall compound (Building T-4). Both Dillon (1995) and Agra (1999) noted that floor drains in Building T-4 drain onto the ground surface below the building. No indicators of contamination were noted and subsurface quality has not been investigated.

Based on this information, the potential source of contamination include petroleum hydrocarbons/fuels and metals. The following PCOCs were identified in soil and groundwater: BTEX, Hydrocarbon Fractions F1-F4, PAH, VOC and Metals. Historical investigation at this APEC did not identify any COCs.

5.7 APEC and PCOCs Summary

The APECs and PCOCs for each area are presented in Table 4.

Table 4: Summary of APECs and PCOCs

APEC	DESCRIPTION	PCOCs
1	Historical Screening Plant / Boneyard	BTEX, F1-F4, PAH, VOC, Glycols, Metals, PCBs and Pesticides
2	TC Shoreline Disposal Area	BTEX, F1-F4, PAH, VOC, Metals, PCBs and Pesticides
3	Firefighter Training Area	BTEX, F1-F4, PAH, VOC, Lead, PCBs and PFOS.
4	Former F.H. Ross Tank Site	BTEX, F1-F4, PAH and Metals.
5	Former AST Location North of Building T-5	BTEX, F1-F4, PAH, VOC and Metals.
6	Former AST Location West of Building T-4	BTEX, F1-F4, PAH, VOC and Metals.

6.0 REGULATORY REVIEW AND ENVIRONMENTAL QUALITY CRITERIA

In Nunavut, environmental site assessments and site remediation projects are typically based on the use of federally developed generic guidelines. Risk assessment principles have been used extensively in developing federal generic clean-up criteria for contaminated sites. However, as the term "generic" implies, they are intended for broad applications and are typically over-protective to avoid underestimating potential risks associated with a wide range of site conditions and potential land uses.

The following sections provide information and rationale with regards to the guidelines and standards used to assess the analytical results from samples collected by FRANZ in 2009 at Cambridge Bay Airport.

6.1 Federal Guidelines

The Contaminated Sites Management Working Group for federal government departments has defined a *contaminated site* as a site at which substances occur in concentrations that either: 1) are above background levels and pose, or are likely to pose, an immediate or long-term hazard to human health or the environment; or 2) exceed concentrations specified in guidelines and/or regulations

The federal CCME guidelines were derived based on potential impacts to humans and ecological receptors and also take into account potential risks to humans associated with the consumption of groundwater on the site. The CCME have not established an equivalent set of non-potable thresholds for federal lands.

The CCME Canadian Environmental Quality Guidelines (1999) publication compiles all previously released soil, sediment and surface water criteria and guidelines into one publication. Updates have been issued for selected chemicals over the past several years. Guidelines for soil and surface water are numerical limits intended to maintain, improve or protect environmental quality and human health at contaminated sites and were derived using toxicological data. There are four separate sets of guidelines for soil quality and five sets of guidelines for water quality. The guidelines are separated into groups for different types of land and water use.

Soil

The soil analytical results were compared to the CCME Canadian Environmental Quality Guidelines, specifically the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (CSQG), and with the Canada-Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in soil. These are applied to most federal contaminated sites. The guidelines are numerical limits intended to maintain, improve or protect environmental quality and human health at contaminated sites and were derived using toxicological data and aesthetic considerations.

The standards and guidelines adopted for this evaluation are as follows:

- Canadian Environmental Quality Guidelines (CEQGs; CCME, 2007) for commercial and industrial land use; and
- Canada-Wide Standards for Petroleum Hydrocarbon (CWS) in soil (CCME, 2008a) – Tier 1 Levels for commercial land use.

Surface Water

Canadian water quality guidelines are surface water guidelines intended to provide protection of freshwater and marine life from anthropogenic stressors such as chemical inputs or changes to physical conditions.

Groundwater

CCME guidelines apply at the “point of the consumption” indicating that AW guidelines apply to surface water quality and not directly to groundwater. Several jurisdictions (e.g., BC MOE) apply a conservative 10x dilution factor for the discharge of groundwater to surface water resulting in ground water guidelines/standards that are 10x greater than surface water guidelines/standards. In the absence of groundwater CCME AW standards and dilution directives, Franz applied provincial guidance when reviewing applicability of AW guidelines (see Section 6.2).

6.2 Territorial/Provincial Guidelines

In the absence of federal guidelines to assess the quality of groundwater at the site, water analytical results were compared against British Columbia Contaminated Sites Regulation (BC CSR) Standards. Standards from BC were selected over other nearby provinces as BC regulations include groundwater discharges to both freshwater and marine receptors. The legislation governing contaminated sites in British Columbia consists of the *Environmental Management Act (EMA, 2004*) and the *Contaminated Sites Regulation* (BC CSR, 1997). The Environmental Management Act creates a comprehensive framework for the assessment and remediation of contaminated sites. In British Columbia, a site is considered contaminated when the concentration of any substance found on that site is greater than the numerical standards defined in the BC CSR.

Under the BC CSR, water standards for groundwater are provided in Schedule 6 of the CSR and Protocol 7 which regulates petroleum hydrocarbons covered in both the BC Hazardous Waste Regulation, 2006 (HWR) and CSR. Depending on the use of the water at a contaminated site or site under investigation, the BC CSR designated four water-use categories including aquatic life, irrigation, livestock, and drinking water use.

The standards that were applied for this Site are the BC CSR Schedule 6 AW (aquatic life). For substances included in Schedule 6 of the BC CSR, one generic numerical water standard is provided for each regulated substance for each water use category. Standards for some substances are dependent on water pH or hardness.

Based on direction of groundwater flow and proximity to the water bodies around the Site, standards developed for protection of marine aquatic life were applied at all APECs while standards developed for protection of freshwater aquatic life were also applied at APECs 4, 5 and 6.

6.3 Other Guidelines

In absence of guidelines for perfluorooctane sulfonate (PFOS) in the CCME documents, PFOS analytical results were compared against the Minnesota Pollution Control Agency (MPCA) standards.

6.4 Designated Substances

Criteria, rationale and regulatory jurisdictions for each component of the designated substances property survey are presented in Table 5.

Table 5: Summary of Criteria for the Selection of Environmental Quality Guidelines

Material Type	Classifications	Evaluation Criteria
PCBs in Soils	PCBs in soils are regulated under the Canadian Environmental Protection Act (CEPA) and transported according to TDGA and CEPA.	PCB content >50 ug/g is considered a hazardous waste. Materials with PCBs above the CCME soil criteria (e.g., 1.3 ug/g) but below 50 ug/g is not hazardous waste
Liquids/Chemicals	Waste solvents and liquids are a contaminant under the EPA of Nunavut and must be managed as a hazardous waste.	Absence/presence of liquids/chemicals in containers.
Batteries	Waste batteries are a contaminant under the EPA of Nunavut and must be managed as a hazardous waste	Absence/presence of waste batteries.

6.5 Vegetation Evaluation Guidelines

In the absence of federal guidelines to assess the quality of vegetation at the site, the Ontario Ministry of the Environment (MOE) Upper Limit of Normal (UNL) guidelines were applied. The Ontario MOE ULN contaminant guidelines represent the expected maximum concentrations of contaminants in surface soil (non-agricultural), foliage (deciduous and current year coniferous trees and shrubs) grass, moss bags and/or snow from areas of Ontario not subject to the influence of point sources of emissions.

7.0 FIELD INVESTIGATION

7.1 Field Reconnaissance

Detailed site visits of all six APECs were conducted by FRANZ personnel on August 26, 2009 to confirm historical sample locations and potential and observed contaminant source areas. Photos of each APEC can be found in Appendix D. Table 6 summarizes the observations compiled during the site visit:

Table 6: Summary of Field Observations

APEC	Description	Observations
1	Screening Plant/ Boneyard	• No debris or material were stored onsite; site vacant; • No surficial staining observed; • Vegetation present, no sign of stress; and area was saturated.
2	TC Shoreline Disposal Area	• Small amount of debris such as wood and metal drums observed along the east end of the shoreline; • Abandoned excavation pit along northwest end of APEC; • No vegetation along the shoreline; • Vegetation present on upgradient slope of excavation pit at the northwest end of the APEC, no sign of stress; • No surficial staining observed; and • No evidence of sheen, refuse or debris was observed in the water.
3	Firefighting Training Area	• Site vacant; • Very little vegetation is present, no sign of stress; • No surficial staining observed; and • Hydrocarbon sheen observed in ponded water within the APEC.
4	Former F.H. Ross Tank Site	• Only structures present onsite are aboveground pipes linking the ASTs present east of the APEC to the dispensing cabinets located west of the APEC; • Gravel surface; ; • Gravel surface; and • No surficial staining observed.
5	Former AST Location North of building T-5	• Empty drums stored; • Gravel surface • No vegetation; and • No surficial staining observed.
6	Former AST Location West of Building T-4	• Building T-4 used as a maintenance garage; • Gravel surface; no surficial staining observed • No vegetation; and • No surficial staining observed.

7.2 Preparation of a Detailed Sampling Plan

FRANZ reviewed historical information and knowledge collected during the site visit to prepare a detailed sampling plan. The sampling plan was developed to perform a detailed assessment of the site with respect to soil, groundwater, and vegetation quality. It was based on discussions with PWGSC/Transport Canada, a review of the Terms of Reference (ToR) from the Request for Proposal (RF) dated June 2009 and a review of the available historical reports. The sampling plan described our proposed sampling methods and types of measurements/analyses to be conducted during the Phase II ESA including:

- Proposed sampling locations and quantities;
- Proposed sampling or measurement methods;
- Parameters being sampled;
- Description of objectives with rationale;
- Proposed QA/QC methods;
- Proposed background sampling protocols; and
- Proposed health and safety plan.

During the field activities, areas of environmental concern were assessed in accordance with the proposed scope of work. Following the initial site visit, sampling locations were modified as required to target the most likely impacted areas and/or to attempt coarse grid delineation of impacts.

7.3 Health and Safety Procedures

FRANZ field programs are always subject to a site-specific Health and Safety Plan (HSP). We use a Corporate Health and Safety Plan as a general guide in developing the site-specific plan to which all team members and subcontractors must adhere. Protection of the public and personnel from exposure to any contaminated materials at the site was priority during the field program.

Prior to conducting any of the onsite work, a site-specific health and safety plan was developed, distributed and discussed with all field personnel (see Appendix E). As a minimum, full personal protective equipment (e.g., hard hats, safety glasses, reflective vests and Nitrile gloves) was

worn at all times during field activities. Tyvek overalls and respirators were available to all field personnel.

7.4 Subsurface Sampling Methodology

7.4.1 Test Pit Excavations and Soil Sampling

Test-pitting was considered the appropriate method for conducting observations of soil conditions and collecting soil samples in the areas of potential environmental concern (APECs). Between August 29, 2009 and August 30, 2009, a total of 37 test pits were excavated by FRANZ personnel up to a maximum depth of 2.2 m. At least one soil sample from each test pit was collected and analyzed for PCOCs. Test pits were completed with a backhoe to the maximum achievable depth, with the exception of 2-TP-5 to -10, which were completed with a hand trowel.

At each test pit location (Figures 3 to 10), composite soil samples were collected using a decontaminated trowel and nitrile gloves. Depending on the depth of the test pit, the nature of the stratigraphy, and evidence of contamination, composite samples generally were collected over a range of 0.5 - 1.0m. Prior to sampling, soil descriptions including approximate grain size, colour, moisture content, stratigraphy and any evidence of contamination were recorded. Following the completion of the test pit field log (Appendix C) and prior to backfilling the pit to grade, soil samples were collected and stored in sealable polyethylene bags (for soil vapour headspace analysis) and dedicated glass sample containers (for laboratory analysis).

Two background soil samples for metals were collected in areas that appeared to be free of influence by human activities or land filling. Selected laboratory analyses for each sample are presented in Appendix G.

Following sample collection, the jarred soils were refrigerated and/or stored on ice in laboratory-supplied coolers from the day of collection until delivery to the Maxxam Analytics laboratory (for soil) in Vancouver, B.C.

7.4.2 Field Vapour Screening

Vapour screening is a frequently used method for detecting and measuring the quantity of volatile organic compounds present in soil. When taken continuously from the ground surface to the end of a test pit, vapour readings can provide an indication of the relative level of contamination and whether it derived from a localized source or migrated from a more distant one. As a result, field screening is a useful tool to facilitate selection of samples to be submitted for laboratory analysis. All soil samples collected by FRANZ were screened for soil vapour concentrations.

During the investigation, field vapour screening was completed in-situ by partially filling and sealing standard volumes of soil into dedicated polyethylene bags. Samples were stored at room temperature to equilibrate. Gas samples were retrieved by inserting a small tube into the sample bag and analyzed with an RKI Eagle organic vapour meter (calibrated to hexane), and the concentration of combustible gases present (other than methane) by volume (ppm) was measured. The results of the soil vapour headspace analyses are included in the test pit logs (Appendix C)

7.4.3 Groundwater Sampling

A total of fifteen groundwater samples were collected from the six APECs in 2009. No downgradient or background groundwater samples were collected.

The groundwater samples were collected from the monitoring wells in each APEC. Each well was purged and developed using a dedicated disposable PVC bailer (3X the volume), and allowed to sit for approximately 24 hours before sampling occurred. The monitoring well locations used during the field program corresponded with many of the test pit locations. Specific sample locations for each site are indicated on Figures 3 to 10.

The samples were collected from the monitoring wells into laboratory supplied sample containers. Field parameters including pH, temperature and conductivity were measured at each monitoring well (done within 24 hours of well installation). Each sample was labelled and refrigerated and/or kept on ice until they were delivered to the project laboratory. Water samples were delivered via Canadian North Cargo to the Maxxam Analytics laboratory in Yellowknife, NWT. Results of the field parameters are presented in Appendix H.

7.5 Surface Water Sampling

One surface water sample was collected from the shore of the pond area at the west edge of APEC 4, in order to investigate for potential impact from APEC 4 to surface water at the site (Figure 9).

The sample was collected from a depth of 0-15 cm below the water surface with dedicated disposable PVC bailers, and placed into laboratory supplied sample containers. Field parameters including pH, temperature and conductivity were measured at the time of sampling. The sample was labelled and refrigerated and/or kept on ice until it was delivered to the project laboratory in Yellowknife, NWT via Canadian North Cargo. Results of the field parameters are discussed in Section 9.

7.6 Vegetation Sampling

The ESA included collecting seven aboveground foliage vegetation samples at three APECs and one background location. Samples were not taken from the same species due to limited vegetation. Samples were refrigerated and/or kept on ice until they were delivered to the project laboratory in Yellowknife, NWT. Specific sample locations are indicated on Figures 3 to 10.

7.7 Selection Criteria for Soil and Groundwater Chemical Analyses

Soil and groundwater were analyzed based upon three distinct rationales:

1) To delineate, confirm or refute potential soil impacts related to historical or current land use;
2) To provide a better understanding of contaminant concentrations in the soil and groundwater; and
3) To generate a thorough understanding of environmental receptors, as well as fate and transport of the potential contaminants of concern (PCOCs).

Soil and groundwater sample selection for contaminant analyses was based on a review of previous soil analyses completed on site, as well as visual site inspection of potential source areas and natural environmental pathways and receptors.

7.8 Site Survey

A complete site survey consisting of georeferencing site features and sample locations with the use of a Differential Global Positioning System (DGPS) unit horizontally accurate to <30 cm was conducted. The survey data was placed on an air photo (Google Earth, 2009) and ortho-rectified to correspond with data points collected during the survey.

8.0 QA/QC

The purpose of the quality assurance/quality control (QA/QC) program was to confirm that field sampling methods and laboratory analyses were reliable. In implementing the QA/QC program, FRANZ verified that the quality of the reported results was suitable to support the environmental impact (and human health/ecological risk) conclusion drawn from the data.

The 2009 field program included the following QA/QC protocol elements:

- Decontamination (TSP wash and distilled water rinse) of sampling equipment/ instrumentation between all sample locations;
- New/disposable chemical-resistant nitrile gloves for each sampling event;
- Sampling in accordance with documented and generally accepted industry practices;
- Proper documentation of all aspects of the sampling program, with particular detail to the introduction of potential bias;
- Elimination of sample headspace for all volatile parameters (soils and water);
- Collection of one blind analytical duplicate for approximately every 10 samples of environmental media or per sample event;
- Calculation of the relative percent difference between a sample and its duplicate for comparison to acceptable variance guidelines; and
- Calibration of field instruments.

8.1 Data Reduction and Validation

Investigation results data reduction involved summary tabulation of analytical results and field observation transcriptions. Following data reduction, data validation was performed to ensure raw data was not altered and an audit trail was applied for managing data. Data validation was also performed to verify the quantitative and qualitative reliability of the information. A comparative review of sample collection records, chain-of-custody records, holding times, dilution factors, estimated quantitation limits (EQLs), and laboratory and field QC sample records were evaluated against original laboratory reports and found to be within control limits (Appendix G).

8.2 Data Validation of QA/QC Samples

FRANZ quantitatively assessed the analytical quality of the data through calculating the relative percent difference (RPD) between each sample and its corresponding duplicate using the following equation:

$$RPD = | X_1 – X_2 | / X_{avg} \text{ X } 100$$

Where X_1 and X_2 are the concentrations and X_{avg} is the mean of these two values, and RPD is the percent difference between each sample and its corresponding duplicate.

The target levels of precision for this project are:

1) Organics in soil: 50% for PAH; 40% for BTEX/VPH and EPH and glycols
2) Metals in soil: 30%
3) Organics in water: 30% for most volatile and other typical organics
4) Metals in water: 20%

These levels are specified in the Recommended Data Quality Objectives (DQOs) for Laboratory Duplicates which are derived from Measurement Uncertainty (MU) estimates obtained from four major BC analytical laboratories. MU values, according to the Technical Sub-committee of the BC Environmental Laboratory Quality Assurance Advisory Committee (BCELQAAC), which presented the recommendations, are lab estimates of the 95% confidence interval around chemical measurement results, as determined according to CAEAL and internationally recognized guidelines.

The recommendations for soil and groundwater were presented by the Technical Sub-committee of the BCELQAAC, in a letter to the Environmental Management Branch, MOE, dated October 24, 2005, as a revision to the Technical Guidance document, and are generally accepted throughout the industry.

- Relative percent difference was not calculated if either the sample or its duplicate were less than method detection limits, or if either the sample or its duplicate were less than five times the reported detection limits, for soil and groundwater.

- Both components of the sample/duplicate pair were assessed against Standards/ Guidelines.

The following discussion presents the results of the Relative Percent Difference (RPD) calculations. Duplicate analysis results can be found in Appendix G.

RPD result for sample/duplicate pair 2-09TP-5/ is greater than the target level of precision for Bismuth (33.3%). We attribute the marginally elevated RPD to sample heterogeneity, a function of co-located replicate sampling. Concentrations for all other sample/duplicate pair were all within the acceptable precision. Therefore, the sample results are considered valid and were kept as part of the assessment.

RPD result for sample/duplicate pair 6-09-MW1/FR-1 is greater than the target level of precision for Manganese (88.89%). RPD results for sample/duplicate pair 1-09-6M/FR3 is greater than the target level of precision for Calcium (25.00%), Iron (36.84%), Manganese (28.57%), Potassium (42.86%), Sodium (55.74%), Srontium (37.84%) and Uranium (73.68%). compliant levels for these metals are noted in both sample and duplicate, therefore the RPD value is not material to the classification of this sample against the Standard. The lab made a note with regard to the metals analysis, that detection limits for certain dissolved metals were increased due to high concentrations of other dissolved metals in the samples. This may account for the apparent dissymmetry between sample and duplicate results.

All other parameters for all other samples, including metals, PAHs, PHCs and VOCs remained within the acceptable precision and therefore the concentrations do not change the outcome of the assessment and have been kept as part of the assessment. All other parameters had acceptable RPD precision.

Duplicated analysis was completed on the vegetation samples for metals. All of the concentrations were all within the acceptable precision. Therefore, the sample results are considered valid and were kept as part of the assessment.

RPD calculation results indicate that we can rely on this data set for our assessment.

9.0 INVESTIGATION RESULTS AND DISCUSSION

Samples from soil, water and vegetation were collected at six identified APECs and analyzed for selected PCOCs. The analytical results can be found in Figures 3 to 10 and in Appendix G. Test pit logs are presented in Appendix C.

Background samples were collected for soil and vegetation in undisturbed areas 2-3 km west of the airport terminal building for comparison purposes (see Figures 3 to 10).

9.1 Background Metal Sampling

Two soil samples were collected in order to investigate for background metal levels in the area. Chemical analytical results (Figures 3 to 10, Appendix G) did not exceed the CCME guidelines. pH for background samples was elevated (between 8.17 and 8.34).

One vegetation sample was collected in order to investigate for background metal levels in the area. Chemical analytical results (Figures 3 to 10, Appendix G) did not exceed the Ontario MOE UNL guidelines.

9.2 APEC 1 –Screening Plant / Boneyard

Six test pits were conducted at APEC 1, and they were all installed as monitoring wells. At the test pit locations, the observed soil profile was described as sand and silt from 0.0 m to a maximum depth of 1.7 m bgs (Appendix C). Four test pits were conducted until permafrost was reached at depths of 1.2 to 2.5 m bgs.

Vegetation samples were collected at two locations within APEC 1 (1-09-VG1 and 1-09-VG2).

<u>Soil</u>

Analytical results (Figure 3, Appendix G) indicate all soil samples were less than the CCME guidelines; however, pH levels at four test pit locations were just above the CCME guideline. pH levels at both background soil sampling locations also had elevated pH levels, therefore, it appears to be naturally occurring and not from anthropogenic activities.

Groundwater

All analytical results (Figure 4, Appendix G) indicate that concentrations for all PCOCs were less than the BC CSR AW (Marine Life) standards.

Vegetation

Chemical analysis results (Figure 3, Appendix G) were less than the Ontario MOE "ULN Guidelines, with the exception of molybdenum (2.6 ug/g) at 1-VG-2. A molybdenum (Mo) concentration greater than the guideline could be a natural occurrence, and not from anthropogenic activities. As regional geology indicates that there is a potential for base metals deposit on Victoria Island which could impact the regional background metal levels.

Summary

No contaminants of concern (COCs) were identified in soil and groundwater at APEC 1. Molybdenum in vegetation is present in concentrations greater than the Ontario MOE ULN guideline. It is possible that elevated Mo concentrations in vegetation are a natural occurrence.

9.3 APEC 2 – TC Shoreline Disposal Area

A small amount of debris, including wood and metals drums were observed along the east end of the shoreline during the investigation conducted by FRANZ in 2009. No evidence of sheen, refuse or debris was observed in the water. Four test pits were conducted in the northwest end of the APEC, one of them being installed as a monitoring well. Soil profile from 0.0 m to 0.9 m bgs was described as sand with some silt (Appendix C). Six test pits were conducted in the southeast end of the APEC (along the shoreline), and the soil profile from 0.0 m to 0.6 m bgs was described as shale and sand with some debris in the area. Debris observed included empty rusted metal drum lids, plastic drums and wood debris. Vegetation samples were collected at two locations within APEC 2 (2-09-VG1 and 2-09-VG2).

Soil

Chemical analytical results (Figure 5 and Appendix G) indicate copper (Cu) and arsenic (As) in concentrations greater than the CCME guidelines at two test pit locations (2-09-TP5 and 2-09-TP6) along the shoreline between 0-0.6m bgs. Cu and As concentrations greater than the guidelines could be a natural occurrence, and not from anthropogenic activities, as regional geology indicates that there is a potential for base metals deposit on Victoria Island which could cause elevated regional background metal levels.

Concentrations for all other parameters were less than the CCME guidelines.

Groundwater

Analytical results (Figure 5 and Appendix G) indicate concentrations for all PCOCs were less than the BC CSR AW (Marine Life) standard.

Vegetation

Chemical analytical results (Figure 5, Appendix G) indicate all vegetation samples submitted for metals analysis were less than the Ontario MOE ULN guidelines.

Summary

Copper (Cu) and arsenic (As) were identified as COCs in soil at APEC 2. The depth of metal-impacted soil is 0-0.6m bgs. Cu and As contamination may be from anthropogenic sources from historical metal debris discarded at the site as although naturally occurring sources are not uncommon in the region, noted concentrations are elevated when compared to analyzed background concentrations. This APEC was retained as an AEC and the contamination is expected to be localized (about 50m^2- see figure 11). No COCs were identified in groundwater at APEC 2.

9.4 APEC 3 – Fire Training Area

At the time of the investigation conducted by FRANZ in 2009, empty drums were observed to be stored in the area. No surficial staining was observed. The 2,200 L diesel AST was not observed during the field work in 2009. Six test pits were excavated and three were installed as monitoring wells. The soil profile observed from 0.0 m to 2.1 m bgs was sand and gravel from 0 to 0.5m, underlain by sand to silty sand with some gravel (Appendix C). Hydrocarbon odour and staining were encountered in some test pits, and hydrocarbon sheen was observed in ponded water within the APEC during the site visit. Permafrost was encountered in test pit 3-09-5M at a depth of 2.1 m.

Soil

Chemical analytical results (Figure 6, Appendix G) indicate Benzene, Ethylbenzene and/or PHC fraction F2 exceed the CCME guidelines at 4 test pits (3-09-4M-1, 3-094M, 3-09-5M and 3-09-6M) between 0-2m bgs. Concentrations for all other PCOCs were less than the CCME guidelines.

Groundwater

Chemical analytical results (Figure 7, Appendix G) identified Benzene and lead (Pb) exceeding the BC CSR AW (Marine Life) standard in one (3-09-4M) monitoring well. Naphthalene is exceeding the BC CSR AW (Marine Life) standard in two (3-09-4M and 3-09-5M) monitoring wells. Elevated PHC F1 (3.5 mg/L) and F2 (3.8 mg/L) detected at the APEC is indicative of petroleum impact; however, there were no referenced standards/guidelines. Concentrations for all other parameters were less than the BC CSR AW (Marine Life) standards.

Vegetation

Chemical analytical results (Figure 6, Appendix G) were less than the Ontario MOE "ULN Guidelines.

Summary

Benzene, Ethylbenzene and F2 were identified as COCs in soil. The depth of hydrocarbon-impacted soil is from 0 to 2 m bgs. The estimated volume of hydrocarbon contaminated soil is 15,000 m^3; however, the extent of contamination has not been fully delineated to the south and east (Figure 12).

Pb, Benzene and Naphthalene were identified as COCs in groundwater. The estimated area of Pb and Benzene-impacted groundwater is about 1,600 m^2 while the estimated area of Naphthalene-impacted groundwater area is about 2,500m^2. Contaminated groundwater was only identified in the soil impacted zone and appears to be attenuating downgradient (south) as far as the leading edge of the soil contamination. The area of confirmed contamination has been identified as AEC 3.

The approximate extents of contamination are presented in Figure 12.

9.5 APEC 4 – Former F.H. Ross Tank Site

Eight test pits were excavated at APEC 4 and two were installed as monitoring wells. The soil profile observed from 0.0 m to 2.0 m was a silty sand to sand and gravel. Petroleum hydrocarbon-like odours and staining were observed in some test pits. Permafrost was encountered at depths ranging between 1.3 and 1.6 m across the site (Appendix C). One surface water sample was also collected in a ponded area adjacent to the south of the APEC.

Soil

Chemical analytical results (Figure 8, Appendix G) indicate Pb concentrations exceeded the CCME guideline at one test pit (4A-09-5) between 1.3-1.5m bgs. Benzene, Toluene, Ethylbenzene, Xylenes (BTEX) and/or PHC fractions F1-F4 concentrations were greater than the CCME guidelines at four test pits (4A-09-3M, 4A-09-4, 4A-09-5 and 4A-09-8) between 0-2m bgs. Concentrations for all other PCOCs were less than CCME guidelines.

Groundwater

Chemical analytical results (Figure 9, Appendix G) indicate Naphthalene and Toluene (monitoring well 4A-09-3M) and Zn (monitoring well 4A-09-2M) exceeded the BC CSR AW (Marine Life) standard. Elevated PHC F1 (1.6 mg/L) and F2 (1.4 mg/L) detected at the APEC is indicative of petroleum impact; however, there were no referenced standards/guidelines. Concentrations for all other PCOCs were less than the BC CSR AW (Marine and Freshwater Life) standards.

Surface Water

Chemical analytical results (Figure 9, Appendix G) indicate all PCOCs met the applicable CCME FWAL guidelines. The aluminum (Al) guidelines (CCME, YEAR) are pH dependant; however, FRANZ was unable to obtain field pH measurements. A pH of >7 was estimated for surface water based on field pH measurements for APEC groundwater, soil pH levels, and regional geology (Harrison, 2007).

Summary

Pb was identified as a COC in soil at APEC 4. The depth of Pb impacted soil is from 1.3 to 1.5 m bgs. Soil Pb concentrations were limited to one location despite the presence of considerably more PHC contamination and therefore, Pb contamination does not appear to be associated with historical use of avgas and therefore is probably a localized occurrence.

Although not fully delineated to the east and west, the volume of Pb contaminated soil on site is estimated to be 10 m^3.

Benzene, Ethylbenzene, Toluene, Xylenes and PHC fractions F1-F4 were identified as COCs in soil at APEC 4. The depth of PHC contaminated soil is from 0 to 2 m bgs. The estimated volume of contamination is 3,500 m^3; however, the extent of contamination has not been fully delineated (Figure 13).

Naphthalene was identified as a COC in groundwater at APEC 4. The estimated area covered by Naphthalene-impacted groundwater is estimated to be 300 m^2; however, the leading edge of the plume has not been fully delineated.

Zinc was identified as a COC in groundwater at APEC 4. The area covered by Zn-impacted groundwater is estimated to be about 300 m^2. Anthropogenic sources of Zn contamination were not identified; however, metals may be mobilizing through microbial oxidation/reduction associated with petroleum hydrocarbon degradation.

The area of soil and groundwater contaminated by petroleum, naphthalene, and zinc has been identified as AEC 4.

9.6 APEC 5 – Former AST Location North of Building T-5

Four test pits were conducted at APEC 5 and one was installed as a monitoring well. The soil profile observed from 0.0 m to 2.2 m was described as sandy gravel with organic layers (Appendix C). Petroleum hydrocarbons like odours were noted at 5-09-TP4.

Soil

Chemical analytical results (Figure 10, Appendix G) indicate sample concentrations for all PCOCs were less than the CCME guidelines.

Groundwater

Chemical analytical results (Figure 10, Appendix G) indicate all PCOCs in groundwater samples were less than the BC CSR AW (Marine and Freshwater Life) standards.

Summary

No COCs were identified in soil and groundwater at APEC 5.

9.7 APEC 6 – Former AST Location West of Building T-4

One test pit was conducted at APEC 6 and installed as a monitoring well. The soil profile observed from 0.0 m to 1.5 m was described as silt, sand and gravel with organics between 0.1 m and 0.2 m (Appendix C).

Soil

Chemical analytical results (Figure 10, Appendix G) indicate sample concentrations for all PCOCs were less than the CCME guidelines.

Groundwater

Chemical analytical results (Figure 10, Appendix G) indicate that concentrations for all PCOCs were less than the BC CSR AW (Marine and Freshwater Life) standards.

Summary

No COCs were identified in soil and groundwater at APEC 6.

10.0 AREAS OF ENVIRONMENTAL CONCERN

Table 7 lists the AECs present at the Cambridge Bay airport, as well as descriptions of the contaminated media.

Table 7: AECs at the Cambridge Bay Airport

AEC	Description	Contaminated Media	COC	Estimated Volume (m^3)	Area (m^2)
2	Cu and As exceedences in soil at the TC Shoreline Area	Soil	Cu and As	20	-
3	Firefighter Training Area	Soil	Benzene, Ethylbenzne and F2 fraction	15,000	-
		Groundwater	Benzene, Naphthalene and Pb	-	2,500
4	Former F.H. Ross Tank Site- HC in soil and groundwater	Soil	BTEX, F1-F4 fractions and Pb	3,500 (includes 10m^3 Pb)	-
		Groundwater	Naphthalene, Toluene, and Zinc	-	300

11.0 NCSCS SCORING

The NCSCS is a tool to aid in the evaluation of contaminated sites. The CCME National Classification System for Contaminated Sites (NCSCS) was revised in 2008 to supersede the 1992 NCS system and also the Federal Contaminated Sites Action Plan (FCSAP) scoring system (2005 version, developed by Franz Environmental Inc.). The revised system retains the general classification structure of Class 1, 2, 3, "I" or "N" based on the site's current or potential adverse impact on human health and/or the environment.

A score was generated for each APEC.

- The site score for AEC 2 (now AEC 2) is 55.6 which classifies the TC Shoreline Disposal Area as a Class 2 site (Medium Priority for Action) (See Appendix I).
- The site score for AEC 3 (now AEC 3) is 71.7 which classifies the FTA as a Class 1 site (High Priority for Action) (See Appendix I). Also, pre-screening also identifies the Site as a Class 1 Site.
- The site score for AEC 4 (now AEC 4) is 76.4 which classifies the Former F.H. Ross Tank Site as a Class 1 site (High Priority for Action) (See Appendix I).

12.0 CONCLUSIONS AND RECOMMENDATIONS

FRANZ was retained by Public Works and Government Services Canada (PWGSC) and Transport Canada (TC), Prairie & Northern Region and Environmental affairs Division to complete a Phase II/III Environmental Site Assessment (ESA) at the Cambridge Bay Airport, Cambridge Bay, Nunavut.

Review of historical documents identified the following Areas of Potential Environmental Concern (APECs) and Potential Contaminants of Concern (PCOCs) summarized in Table 8.

Table 8: APECs at the Cambridge Bay Airport

APEC	DESCRIPTION	PCOCs
1	Historical Screening Plant / Boneyard	BTEX, F1-F4, PAH, VOC, Glycols, Metals, PCBs and Pesticides
2	TC Shoreline Disposal Area	BTEX, F1-F4, PAH, VOC, Metals, PCBs and Pesticides
3	Firefighter Training Area	BTEX, F1-F4, PAH, VOC, Lead, PCBs and PFOS.
4	Former F.H. Ross Tank Site	BTEX, F1-F4, PAH and Metals.
5	Former AST Location North of Building T-5	BTEX, F1-F4, PAH, VOC and Metals.
6	Former AST Location West of Building T-4	BTEX, F1-F4, PAH, VOC and Metals.

The intrusive site investigation conducted by FRANZ in 2009 included a total of thirty seven (37) test pits, fifteen (15) groundwater samples collected from monitoring wells installed, one (1) surface water sample and seven (7) aboveground foliage vegetation samples within the 6 APECs. The ESA identified the following three Areas of Environmental Concern (AECs) as presented in Table 9.

Table 9: AEC Findings and Recommendations at the Cambridge Bay Airport

AEC	Description	Contaminated Media	COC	Estimated Volume (m^3)	NCS	Recommendation
2	Cu and As exceedences in soil along the Shoreline	Soil	Cu and As	20	56 Med Priority	- Additional investigation. Remediate (excavation and offsite disposal or risk assessment)
3	Fire-fighter Training Area	Soil	Benzene, Ethylbenzene and F2 fraction	15,000	72 High Priority	-Delineate PHC contaminated soils. -Excavate and treat in an onsite LTF.
		Groundwater	Benzene, Naphthalene and Pb	-		- Excavate with PHC contaminated soils
4	Former F.H. Ross Tank Site	Soil	BTEX, F1-F4 fractions and Pb	3,500 (includes $10m^3$ for Pb)	76 High Priority	-Delineate extent of PHC contamination. - Excavate and treat PHC contaminated soils in LTF. - Segregate Pb contaminated soils and disposed offsite or manage (risk assessment) onsite.
		Groundwater	Naphthalene, Toluene, and Zn	-		-Naphthalene and Toluene excavated and treated in LTF -Resample and delineate PHC and Zn contamination.

Relevant findings and conclusions identified during the ESA with respect to identified AECs includes:

- the estimated volume metals and PHC contaminated soil identified at the Cambridge Bay Airport is about $30m^3$ and $18,500m^3$ respectively. The extent of petroleum contamination has not been fully delineated in both AEC 3 and 4;
- some uncertainty exists with respect to the presence and extent of metals contaminated soil at AEC 2, and 4. Some of these elements (e.g., As) may be naturally occurring in the area; however, site concentrations exceed other site/background concentrations

suggesting contamination is from anthropogenic sources. If present, contamination is expected to be localized;

- PHC contaminated groundwater was identified in soils at both AECs 3, and 4. The leading edge of PHC groundwater contamination was not fully delineated at AEC 4 due to scope limitations, airport operations, and buried utilities. Indicators of unregulated petroleum (PHC F1 and F2) impact was also identified;
- metals contaminated groundwater was detected within the PHC soil contaminated zone in AECs 3 and 4. Anthropogenic contaminant sources were not identified and exceedences may have resulted from natural element mobilization from PHC contaminant degradation; and
- No evidence of PFOS impact was identified in AEC 3; however, the AEC was not fully characterized for this PCOC.

FRANZ recommends PHC contaminated soils and groundwater (including metals) at AECs 3, and 4 be excavated and treated in an onsite land treatment facility (LTF). We assume a 7,000m^3 capacity LTF could be constructed at the Airport. Considering prevailing climatic conditions at Cambridge Bay (relatively cold temperatures, short summer), we estimate that up to 3,500m^3 of PHC contaminated soil can be cycled through the LTF annually. Prior to initiating full-scale remediation, FRANZ recommends a bench-scale treatment program be completed to confirm treatment projections/feasibility. Also, additional soil and groundwater sampling should be conducted to fully delineate the extents of PHC contamination; however, the work can be completed before or concurrent with remediation activities. Groundwater monitoring should be conducted following soil remediation activities at AEC 3, and 4 as part of a natural attenuation assessment.

FRANZ recommends additional investigation to delineate the extent of metals contamination at AECs 2, and 4. Post-remediation groundwater monitoring should be conducted at AEC 4 to assess if COCs (i.e., Zn and naphthalene) attenuate following soil petroleum hydrocarbon remediation activities. Chemical analytical results can be utilized in support of an ecological and human health risk assessment for these AECs.

13.0 REFERENCES

Dewing, K., Turner, E. and Harrison, J.C., 2007. Geological History, Mineral Occurrences and Mineral Potential of the Sedimentary Rocks of the Canadian Arctic Archipelago *in* Goodfellow, W.D., ed., Mineral Deposits of Canada: A synthesis of Major Deposit-Types, District Metallogeny, the Evolution of Geological Provinces and Exploration Methods: Geological Association of Canada, Mineral Deposits Division, Special Publication No. 5, p. 733-753

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Harrison, J C; St-Onge, M R; Petrov, O; Strelnikov, S; Lopatin, B; Wilson, F; Tella, S; Paul, D; Lynds, T; Shokalsky, S; Hults, C; Bergman, S; Jepsen, H F; Solli, A, 2008

Natural Resources Canada, 1995. National Atlas of Canada, 5th Edition, MCR 4177

Ontario Ministry of the Environment, 1989. "Upper Limits of Normal" Contaminant Guidelines for Phytotoxicology Samples.

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14.0 LIMITATIONS

The conclusions in this report are based on information collected from the investigation locations chosen for this study. The locations were selected based on the best information available to us at the time of this study. This does not preclude the possibility that different conditions may be present elsewhere on the property. No investigative method can completely eliminate the possibility of obtaining partially imprecise or incomplete information; it can only reduce this possibility to an acceptable level.

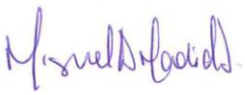
Professional judgement was exercised in gathering and analysing the information obtained. Like all professional persons rendering advice, we cannot act as absolute insurers of the conclusions we reach; we commit ourselves to care and competence in reaching those conclusions. Our undertaking therefore, is to perform our work, within the limits prescribed by our client, with the usual thoroughness and competence of the profession. No other warranty or representation, expressed or implied, is included or intended in this report.

Sincerely,

Franz Environmental Inc.

Jennifer Keenliside, HBSc., CEPIT

Viviane Dubois-Côté, M.Sc., P. Geo



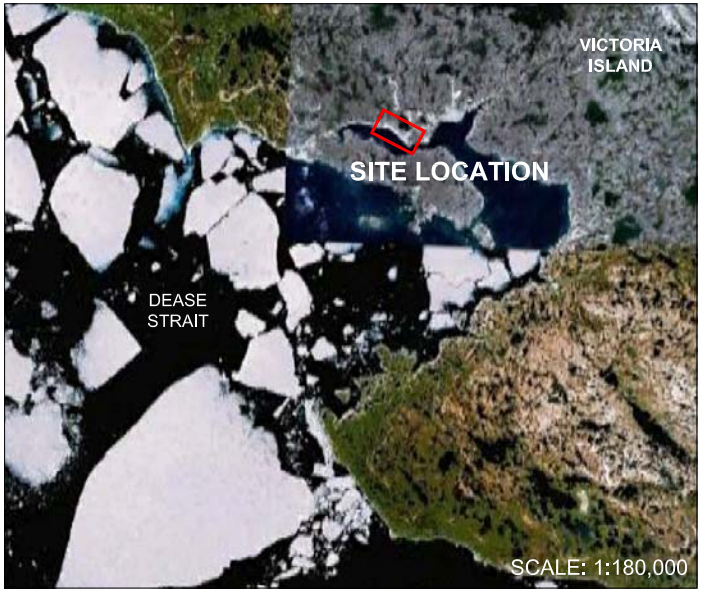
Miguel Madrid, M.Sc.

Steve Livingstone, M.Sc., P.Geo.

James Smith, B.Sc.

APPENDIX A

Figures



LEGEND

Extent of Study Area

References:

Google Earth satellite image, 2009
Site location based on dGPS coordinates (NAD 83)

Title: STUDY AREA

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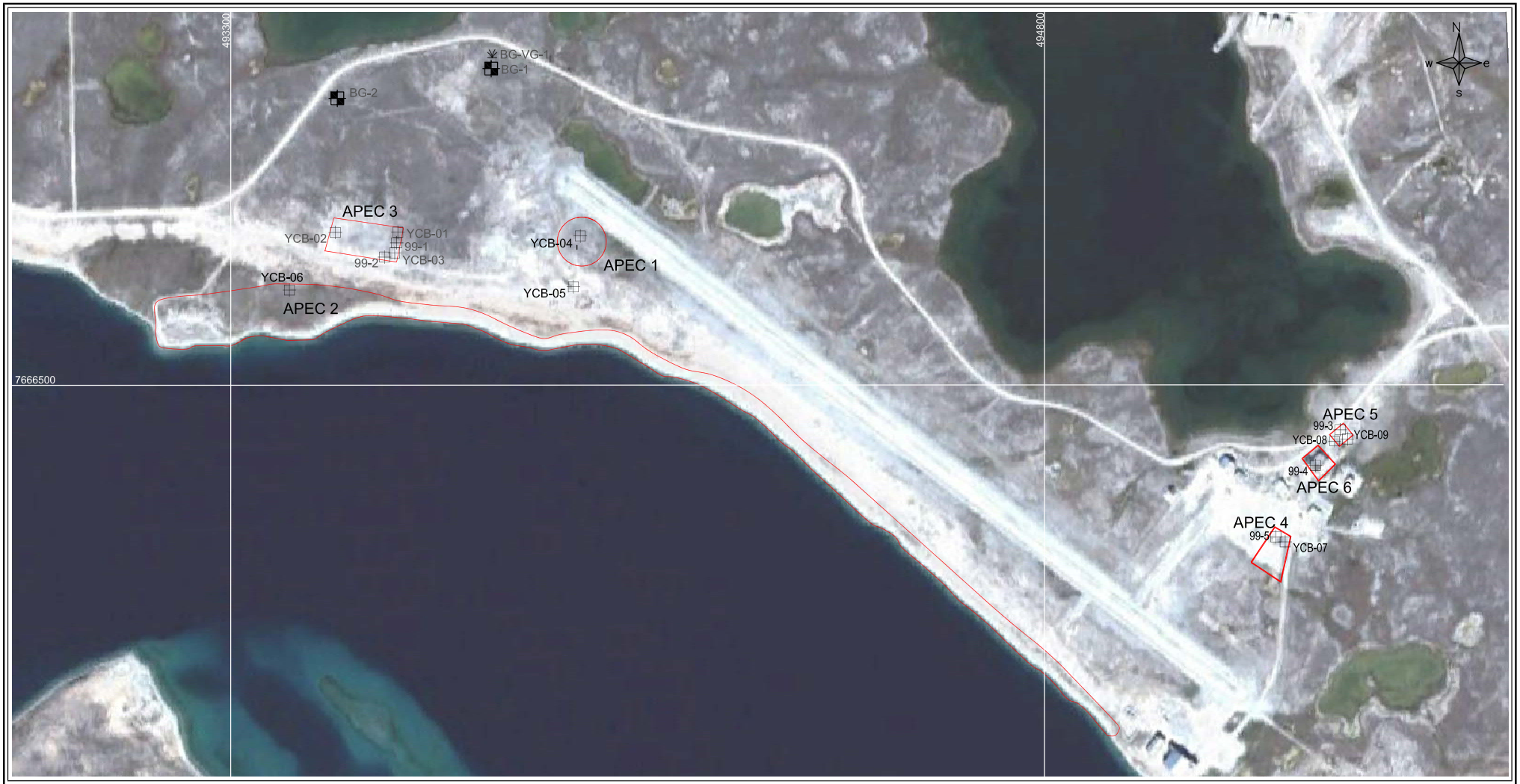
Scale: See figures for scale

FIGURE 1

1748-0901/CAD/Cambridge Bay.dwg FINAL Mar 1/10



LEGEND

- Area of Potential Environmental Concern (APEC)
- Background Soil Sampling Location (Franz 2009)
- Background Vegetation Sampling Location (Franz 2009)
- YCB-01 Soil/Groundwater Sample Location - Dillon 1995
- 99-1 Soil/Groundwater Sample Location - AGRA 1999

APEC #	Description
1	Screening Plant / Boneyard
2	Shoreline Disposal Area
3	Former Fire Training Area
4	Former F.H. Ross Tank Farm
5	Former AST North of Building T-5
6	Former AST West of Building T-4

APPROXIMATE SCALE 1:6,800

200 150 100 50 0 200 metres

References:
Google Earth satellite image, 2009
APEC locations based on dGPS coordinates (UTM - NAD 83)
Sampling locations derived from historical reports

Title: APEC LOCATIONS

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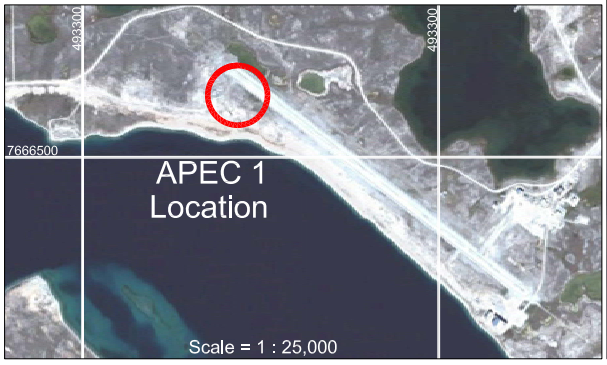
Scale: 1 : 6,600

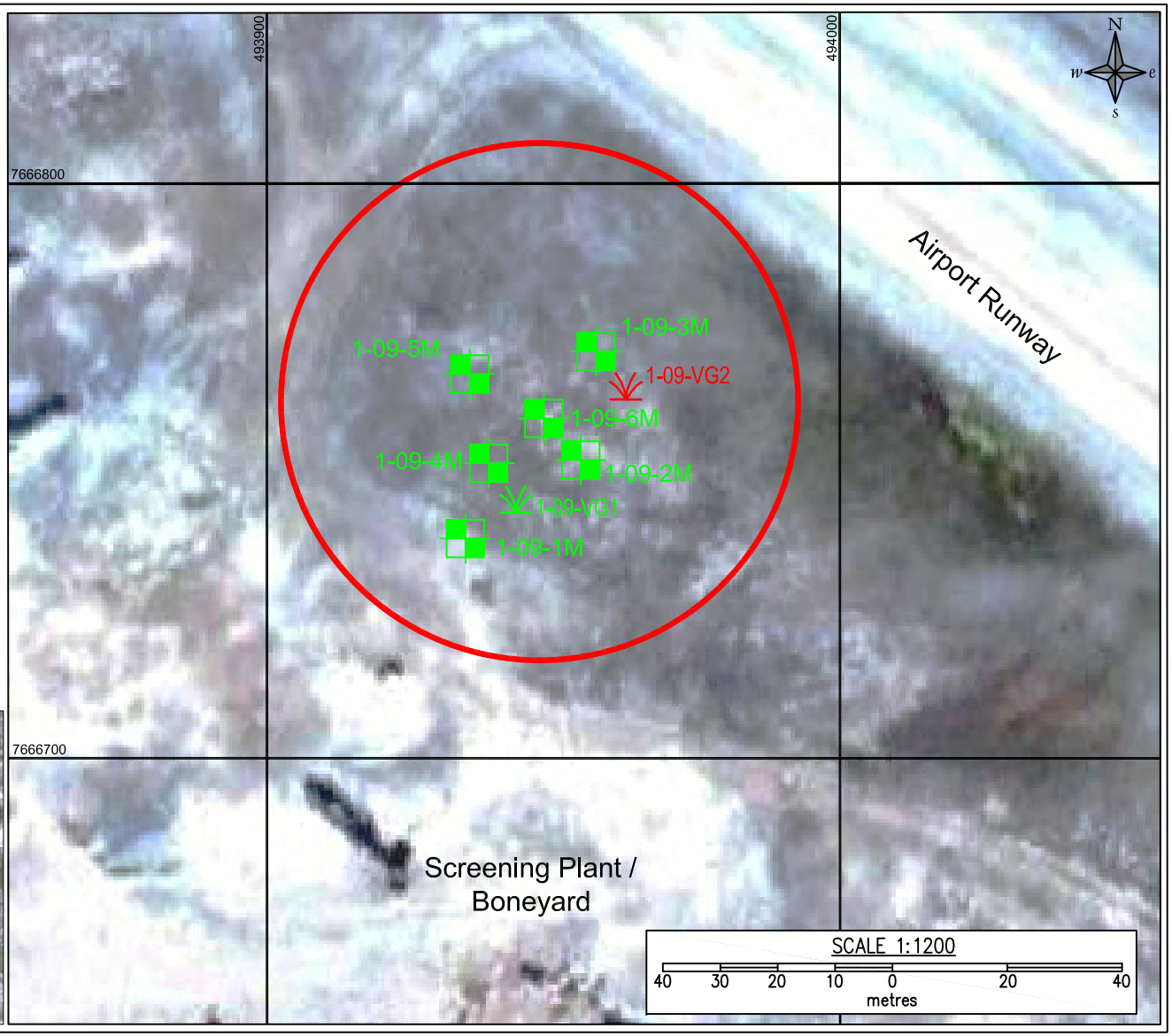
FIGURE 2

1748-0901/CAD/Cambridge Bay.dwg FINAL Mar 1/10

VEGETATION

Station ID	MOE Vegetation Guidelines (ppm)	1-09-VG2
Duplicate ID		
Date		2/Sep/09
Lab report ID		A948579
Molybdenum	1.5	2.6





LEGEND

- Extent of APEC
- Soil Sample (TP); compliant with CCME guidelines
- Vegetation Sample (VG); compliant with Ontario MOE guidelines
- Vegetation Sample (VG); exceeds Ontario MOE guidelines

References:
Google Earth satellite image, 2009
No exceedances were found for soil in APEC 1
Analytical results for soil and vegetation are in ug/g and can be found in Appendix G
Site locations based on dGPS coordinates (UTM - NAD 83)
CCME Soil Guidelines for Commercial land use (2008)
Vegetation analytical results compared to Ontario MOE Vegetation Guidelines

Title: APEC 1 - Screening Plant / Boneyard Sampling Locations and Analytical Results (Soil & Vegetation)

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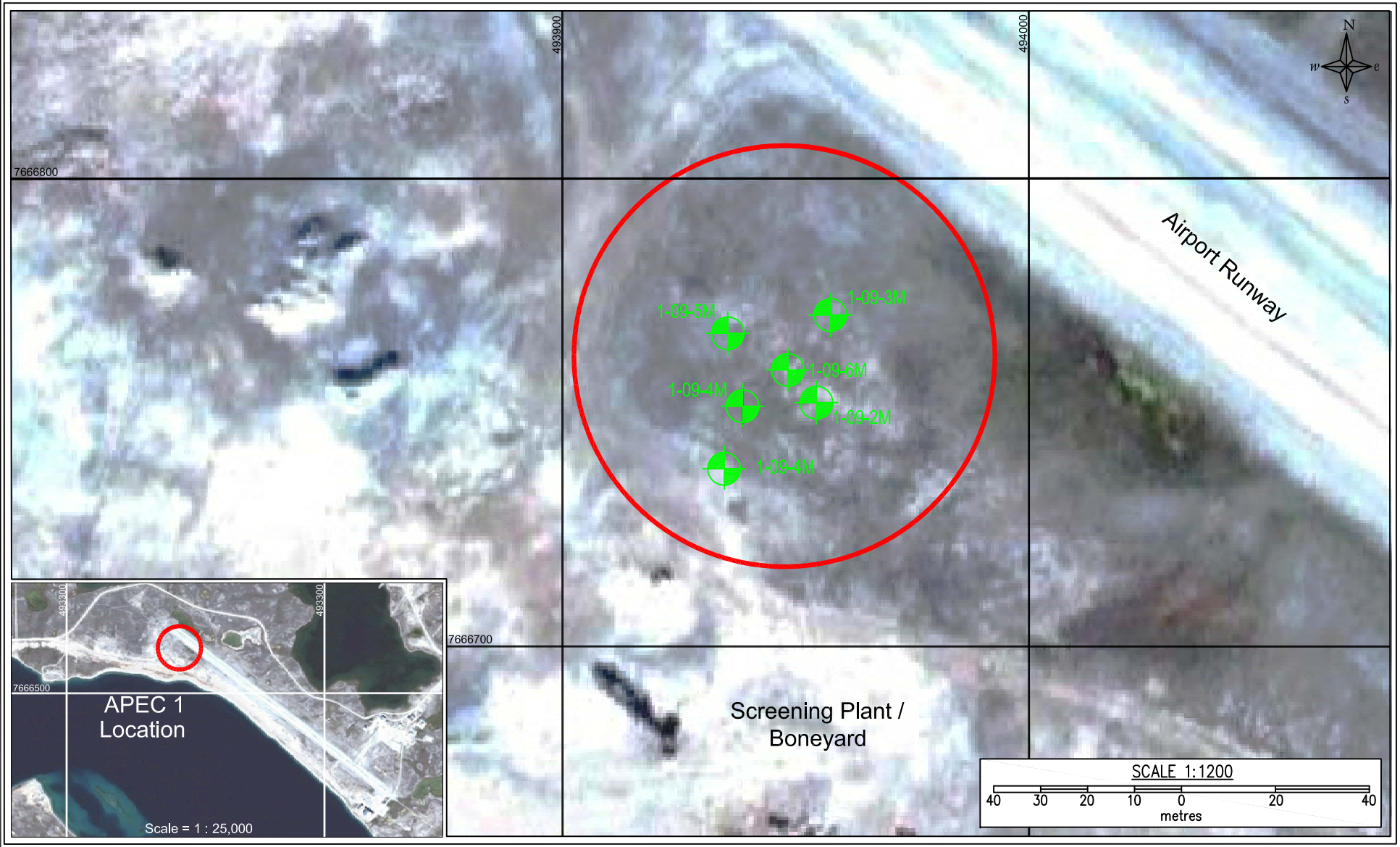
Scale: 1 : 1,200

FIGURE 3

1748-0901/CAD/Cambridge Bay.dwg FINAL Mar 31/10



LEGEND

Extent of APEC

Groundwater Sample (GW); compliant with BC-CSR guidelines

References:
Google Earth satellite image, 2009
No exceedances were found for groundwater in APEC 1
Analytical results for groundwater are in ug/L and can be found in Appendix G
Site locations based on dGPS coordinates (UTM - NAD 83)
British Columbia Contaminated Site Regulation (CSR) for Marine Receptors (2009)

Title: APEC 1 - Screening Plant / Boneyard Sampling Locations and Analytical Results - Groundwater

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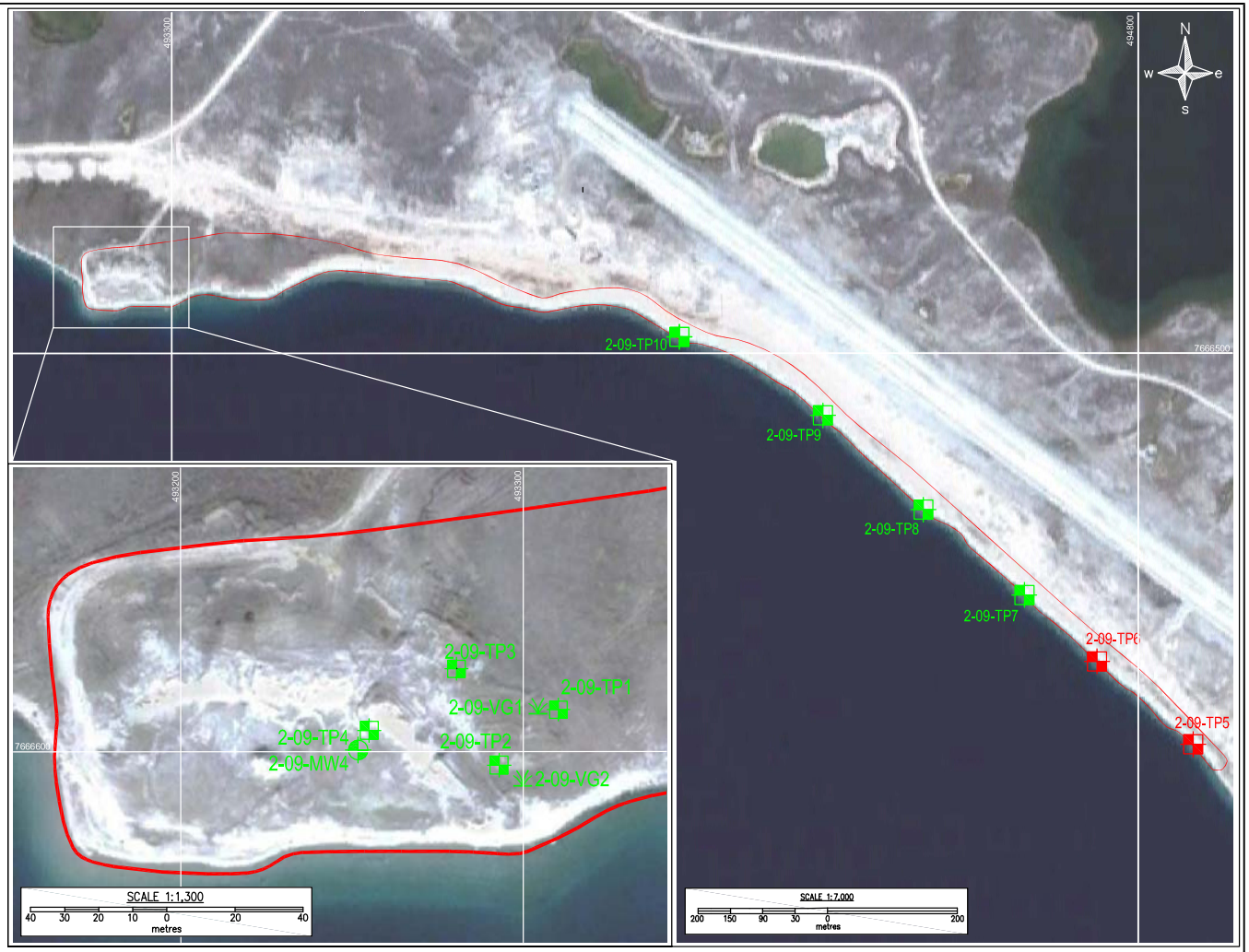
Scale: 1 : 1,200

FIGURE 4

1748-0901/CAD/Cambridge Bay.dwg FINAL Mar 31/10

SOIL

Station ID	CCME Soil (Commercial)	2-09-TP5	2-09-TP5	2-09-TP6
Field label		2-09-TP5-1	GR2	2-09-TP6-1
Duplicate ID		GR2	2-09-TP5-1	
Date		29/Aug/09	29/Aug/09	29/Aug/09
Lab report ID		A947822	A947822	A947822
Depth (m)		0.4 – 0.6	0.4 – 0.6	0.2 – 0.6
Metals				
Arsenic	12	3.3	2.0	40.6
Copper	91	94.5	102.0	24.5



LEGEND

- Extent of APEC
- Soil Sample (TP); compliant with CCME guidelines
- Soil Sample (TP); exceeds CCME guidelines
- Groundwater Sample (GW); compliant with BC-CSR guidelines
- Vegetation Sample (VG); compliant with Ontario MOE guidelines

References:
Google Earth satellite image, 2009
No exceedances were found in vegetation or groundwater at APEC 2
Analytical results/guidelines for soil and vegetation are in ug/g and can be found in Appendix G
Analytical results/guidelines for groundwater are in ug/L and can be found in Appendix G
Site locations based on dGPS coordinates (UTM - NAD 83)
CCME Soil Guidelines for Commercial land use (2008)
British Columbia Contaminated Sites Regulations (CSR) for Marine Receptors (2009)
Vegetation analytical results compared to Ontario MOE Vegetation Guidelines

Title: APEC 2 - Shoreline Disposal Area Sampling Locations and Analytical Results - Soil, Vegetation & Groundwater

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Scale: See figures for scale

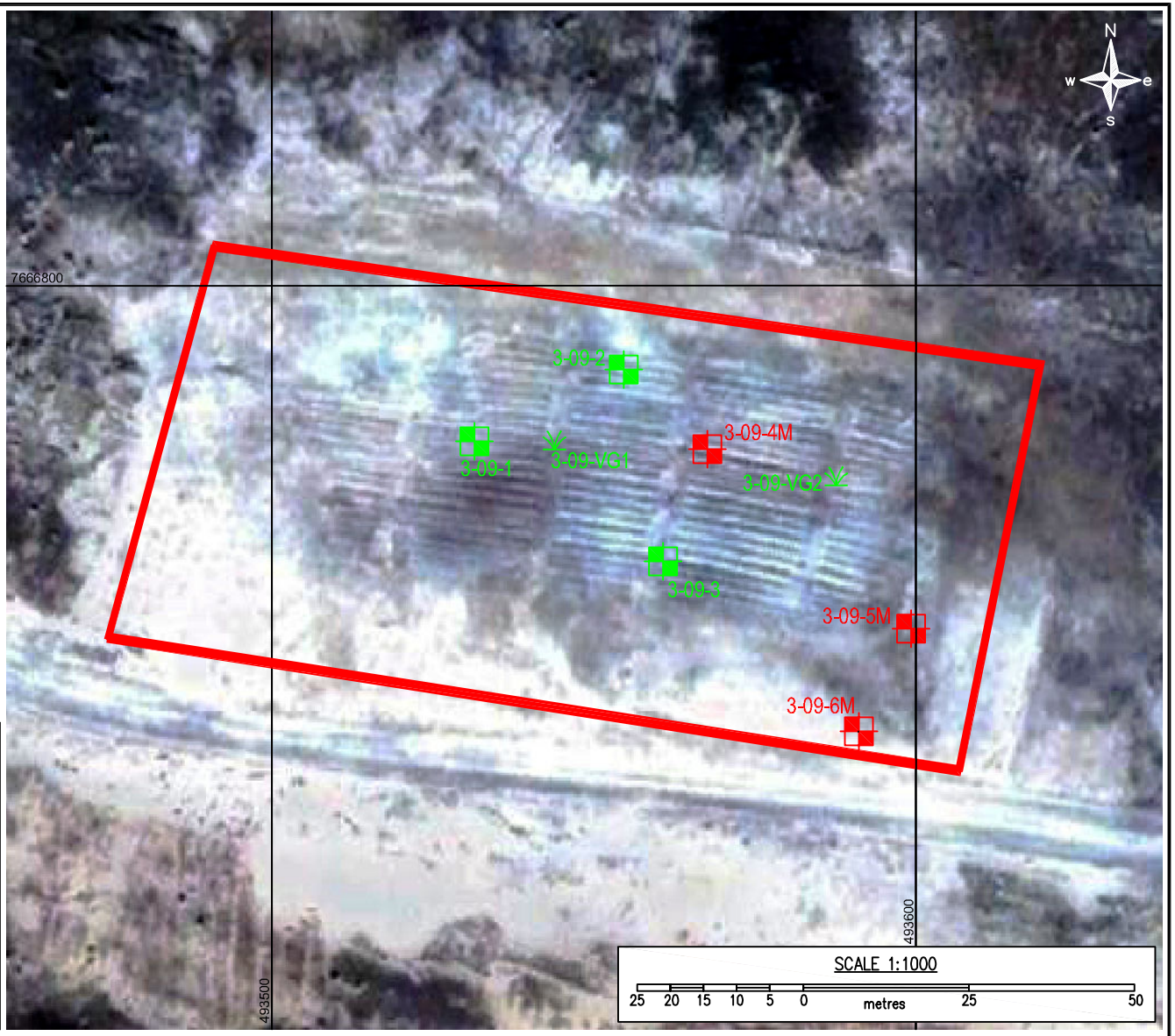
FIGURE 5

1748-0901/CAD/Cambridge Bay.dwg FINAL Mar 1/10

SOIL

Station ID	CCME Soil (Commercial)	3-09-4M	3-09-4M	3-09-5M
Field label		3-09-4M-2	3-09-4M-3	3-09-5M-2
Duplicate ID				
Date		29/Aug/09	29/Aug/09	29/Aug/09
Lab report ID		A947822	A947822	A947822
Depth (m)		0.5 – 2	2 – 2.1	0.5 – 1
PHCs				
Benzene	0.03	0.86	1.2	<0.005
F2 (C10-C16)	260*	16	27	1700

Station ID	CCME Soil (Commercial)	3-09-6M	3-09-6M
Field label		3-09-6M-3	3-09-DUP-2
Duplicate ID		3-09-DUP-2	3-09-6M-3
Date		29/Aug/09	29/Aug/09
Lab report ID		A947822	A947822
Depth (m)		1 – 2	1 – 2
PHCs			
Ethylbenzene	0.082	0.08	0.10
F2 (C10-C16)	260*	850	860



LEGEND

- Extent of APEC
- Soil Sample (TP); compliant with CCME guidelines
- Soil Sample (TP); exceeds CCME guidelines
- Vegetation Sample (VG); compliant with Ontario MOE guidelines

References:
Google Earth satellite image, 2009
No exceedances were found in vegetation in APEC 3
Analytical results/guidelines for soil and vegetation are in ug/g and can be found in Appendix G
Site locations based on dGPS coordinates (UTM - NAD 83)
CCME Soil Guidelines for Commercial land use (2008)
Vegetation analytical results compared to Ontario MOE Vegetation Guidelines

Title: APEC 3 - Former Fire Training Area Sampling Locations and Analyticals Results - Soil & Vegetation

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Scale: 1 : 1,000

FIGURE 6

1748-0901/CAD/Cambridge Bay.dwg FINAL Mar 1/10

GROUNDWATER

Station ID	BC CSR (Marine)	3-09-4M	3-09-5M
Field label		3-09-4M	3-09-5M
Duplicate ID			
Date		2/Sep/09	2/Sep/09
Lab report ID		A948731	A948731
Metals			
Lead	20	100	<2
BTEX / PHCs			
Benzene	1000	1700	670.0
PAHs			
Naphthalene	10	330	84

LEGEND

- Extent of APEC
- Groundwater Sample (GW); compliant with BC-CSR guidelines
- Groundwater Sample (GW); exceeds BC-CSR guidelines

SCALE 1:1000

25 20 15 10 5 0 metres 25 50

References:
Google Earth satellite image, 2009
Analytical results/guidelines for groundwater are in ug/L and can be found in Appendix G
Site locations based on dGPS coordinates (UTM - NAD 83)
British Columbia Contaminated Site Regulations (CSR) for Marine Receptors (2009)

Title: APEC 3 - Former Fire Training Area Sampling Locations and Analytical Results - Groundwater

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Scale: 1 : 1,000

FIGURE 7

1748-0901/CAD/Cambridge Bay.dwg FINAL Mar 1/10

SOIL

Station ID	CCME Soil (Commercial)	4A-09-3M	4A-09-4	4A-09-5	4A-09-8
Field label		4A-09-SM-1	4A-09-4-1	4A-09-5-1	4A-09-8-1
Duplicate ID					
Date		30/Aug/09	30/Aug/09	30/Aug/09	30/Aug/09
Lab report ID		A947622	A947622	A947622	A947622
Depth (m)		0.5 – 1	1.5 – 2	1.5 – 1.5	1 – 1.7
Metals					
Lead	260	15.5	14.4	294.0	-
BTEX / TPHCs					
Benzene	0.05	1.0	2.9	4.6	0.046
Ethylbenzene	0.082	5.6	6.6	6.5	0.07
Toluene	0.37	15.00	37.0	1.5	0.06
Xylenes (total)	11	29.0	140.0	76.0	2.5
F1 (C6-C10)	320*	4600	4600	4400	-
F1 (C6-C10) minus BTEX	320*	4700	4400	4000	150
F2 (C10-C16)	260*	740	3100	12000	150
F3 (C16-C34)	1700*	140	520	6400	120
F4 (C34-C50)	3300*	<100	11	3900	<100

* CCME Canada-Wide Standards for Petroleum Hydrocarbons in Soil

LEGEND

- Extent of APEC
- Soil Sample; compliant with CCME guidelines
- Soil Sample; exceeds CCME guidelines

SCALE 1:1000

25 20 15 10 5 0 metres 25 50

References:
Google Earth satellite image, 2009
Analytical results/guidelines for soil are in ug/g and can be found in Appendix G
Site locations based on dGPS coordinates (UTM - NAD 83)
CCME Soil Guidelines for commercial land use (2008)
CCME Canada-Wide Standards for Petroleum Hydrocarbons in soil (2008)

Title: APEC 4 - Former F.H. Ross Tank Site Sampling Locations and Analytical Results - Soil

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Date: MARCH 2010

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Scale: 1 : 1,000

FIGURE 8

1748-0901/CAD/Cambridge Bay.dwg FINAL Mar 1/10

GROUNDWATER

Area ID	BC CSR (Freshwater)	BC CSR (Marine)	APEC 4	APEC 4
Station ID			4A-09-2M	4A-09-3M
Field label			4-09-2M	4-09-3M
Duplicate ID				
Date			2-Sep-09	2-Sep-09
Lab report ID			A948579	A948579
Metals				
Zinc	2400	100	280	<30
PAHs				
Naphthalene	10	10	<0.10	14.0
PHCs				
Toluene	390	3300	<0.4	1000.0

SURFACE WATER

Area ID	BC CSR (Freshwater)	CCME AW (Freshwater)	APEC 4
Station ID			4-09-SW1
Field label			4-09-SW1
Duplicate ID			
Date			2-Sep-09
Lab report ID			A948579
Screen depth (m)			A948579
Aluminum	-	5	20

LEGEND

- Extent of APEC
- Groundwater Sample (GW); compliant with BC-CSR guidelines
- Groundwater Sample (GW); exceeds BC-CSR guidelines
- Surface Water sample (SW); exceeds CCME guidelines

References:
Google Earth satellite image, 2009
Analytical results/guidelines for groundwater are in ug/L and can be found in Appendix G
Site locations based on dGPS coordinates (UTM - NAD 83)
British Columbia Contaminated Site Regulations (BC-CSR) for Freshwater and Marine Receptors (2009)

Title: APEC 4 - Former F.H. Ross Tank Site Sampling Locations and Analytical Results - Groundwater

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Scale: 1 : 1,000

FIGURE 9

1748-0901/CAD/Cambridge Bay.dwg FINAL Mar 1/10

LEGEND

- Extent of APEC
- Soil Sample; compliant with CCME guidelines
- Soil sample (TP); compliant with CCME guidelines
- Groundwater sample (GW); compliant with BC-CSR guidelines

References:
Google Earth satellite image, 2009
No exceedances were found for soil or groundwater in APECs 5 & 6
Analytical results for soil are in ug/g and can be found in Appendix G
Analytical results for groundwater are in ug/L and can be found in Appendix G
Site locations based on dGPS coordinates (UTM - NAD 83)
British Columbia Contaminated Site Regulations (CSR) for Marine Receptors (2009)

Title:
APECs 5 & 6 Sampling Locations and Analytical Results - Groundwater

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ENVIRONMENTAL SITE ASSESSMENT
FINAL REPORT

Date:
MARCH 2010

Client:
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
TRANSPORT CANADA

Scale:
1 : 1,000

FIGURE 10

1748-0901/CAD/Cambridge Bay.dwg FINAL Mar 1/10

LEGEND

Approximate extent of contamination

Extent not fully delineated

References:
Google Earth satellite image, 2009
Site locations based on dGPS coordinates (UTM - NAD 83)

Title: AEC 2 - Estimated Extent of Contamination

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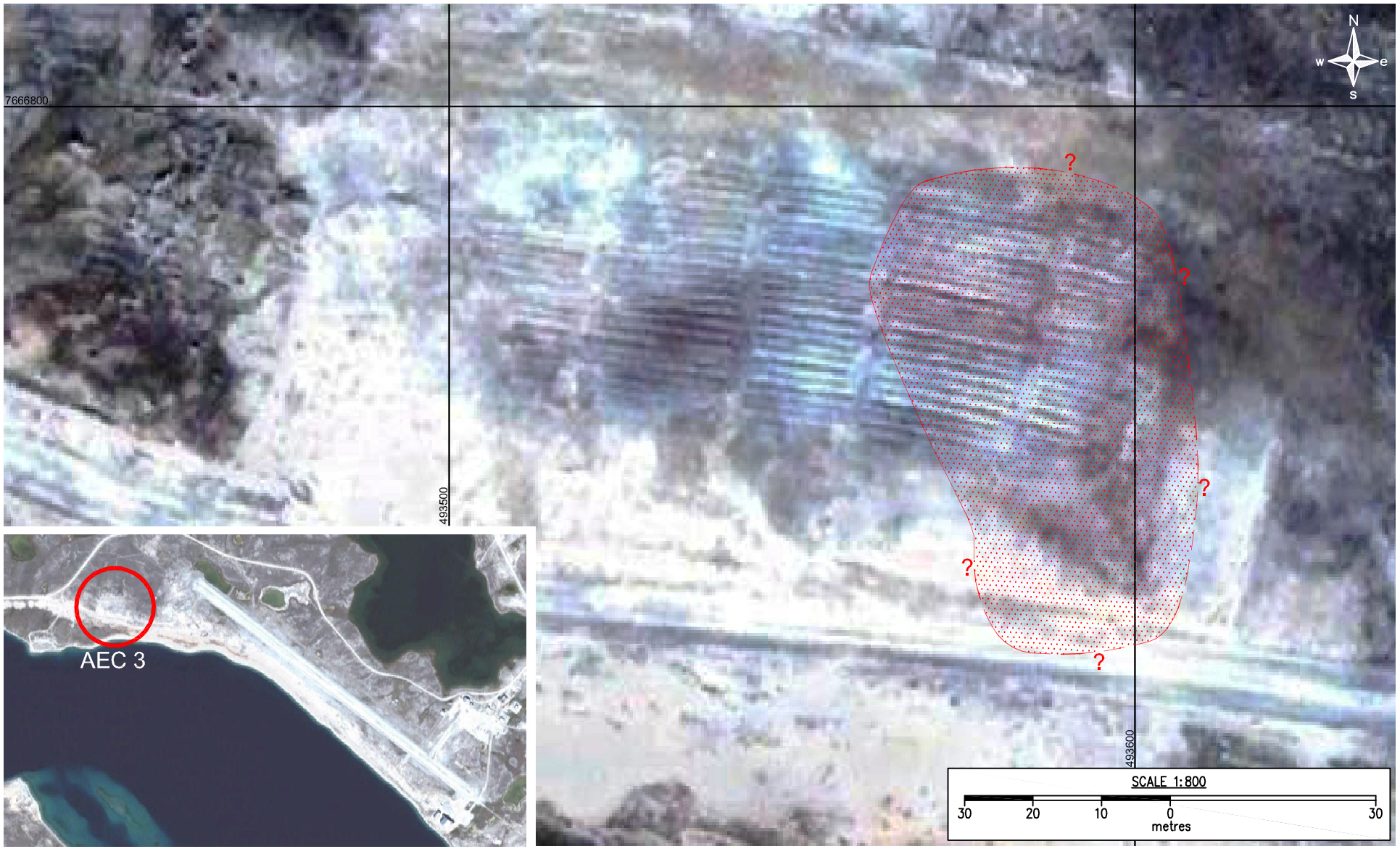
Scale: See figures for scale

FIGURE 11

1748-0901/CAD/Cambridge Bay.dwg FINAL Feb 22/10



LEGEND

Approximate extent of contamination

Extent not fully delineated

References:
Google Earth satellite image, 2009
Site locations based on dGPS coordinates (UTM - NAD 83)

Title: AEC 3 - Estimated Extent of Contamination

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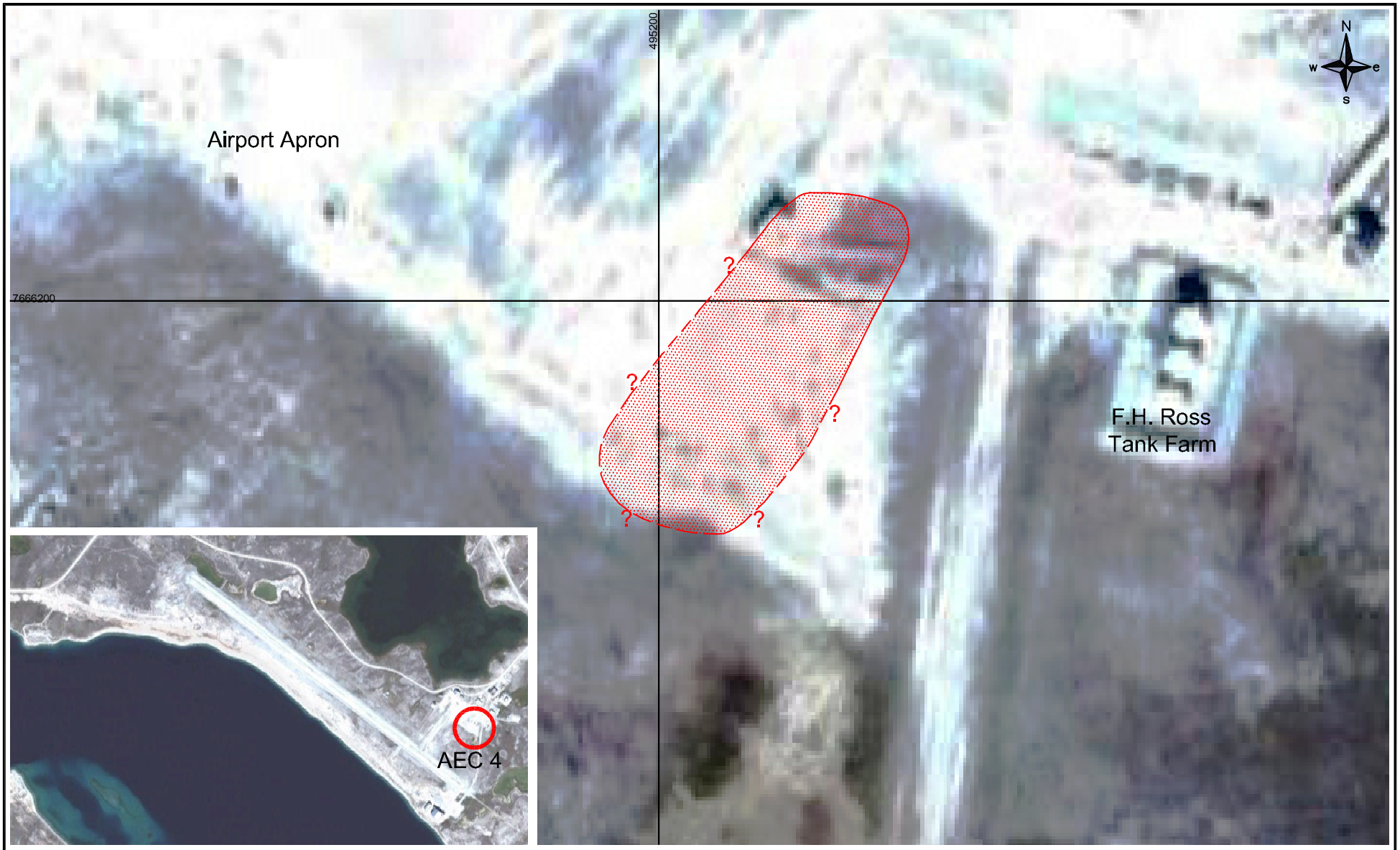
Date: MARCH 2010

Client: PUBLIC WORKS AND GOVERNMENT SERVICES CANADA / TRANSPORT CANADA

Scale: 1 : 800

FIGURE 12

1748-0901/CAD/Cambridge Bay.dwg FINAL Feb 22/10



LEGEND

Approximate extent of contamination

Extent not fully delineated

SCALE 1:800

30 20 10 0 30

metres

References:
Google Earth satellite image, 2009
Site locations based on dGPS coordinates (UTM - NAD 83)

Title: AEC 4 - Estimated Extent of Contamination

FRANZ ENVIRONMENTAL INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

Project: CAMBRIDGE BAY AIRPORT PHASE II/III ENVIRONMENTAL SITE ASSESSMENT FINAL REPORT

Date: MARCH 2010

Client: PUBLIC WORKS AND GOVERNMENT SERVICES CANADA / TRANSPORT CANADA

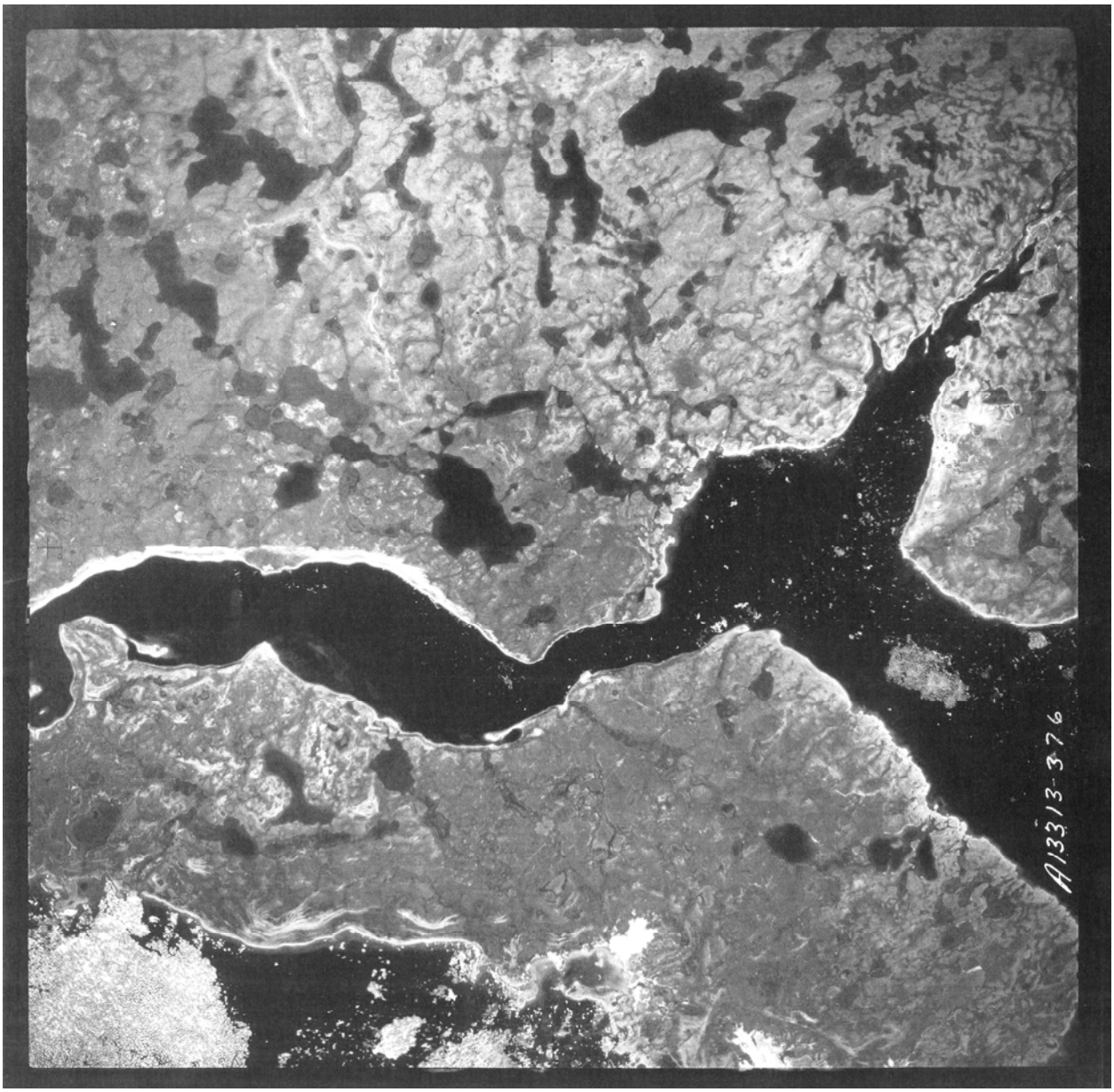
Scale: 1 : 800

FIGURE 13

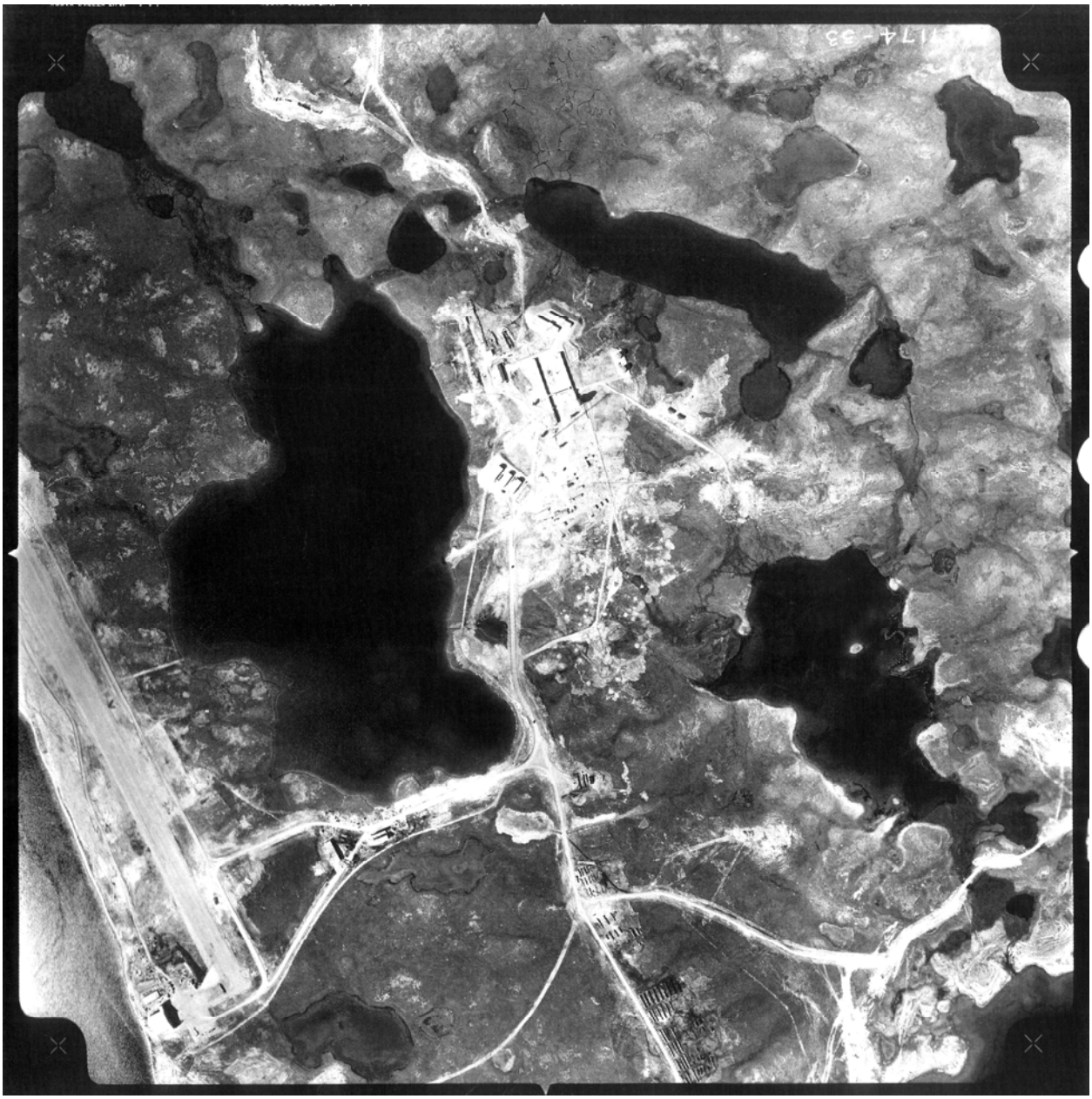
1748-0901/CAD/Cambridge Bay.dwg FINAL Feb 22/10

APPENDIX B

Aerial Photographs



Aerial Photograph Date: 1951
Photo Number: A13313-376
Scale: 1: 40,000



Aerial Photograph Date: 1960
Photo Number: A17174-13
Scale: 1: 10,000

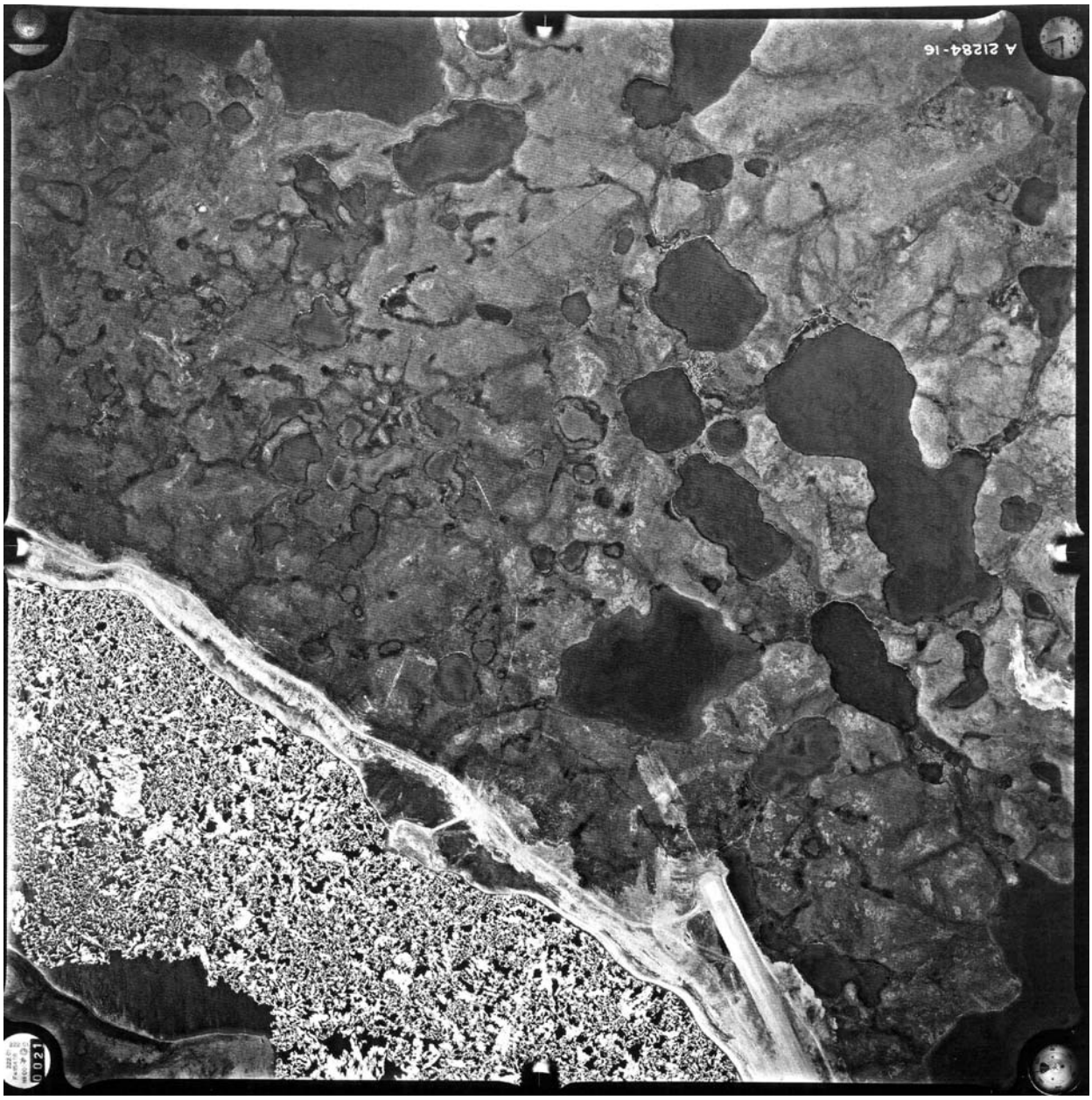
Aerial Photograph Date: 1960
Photo Number: A17174-13
Scale: 1: 10,000

Aerial Photograph Date: 1960
Photo Number: A17174-34
Scale: 1: 10,000

Aerial Photograph Date: 1960
Photo Number: A17174-35
Scale: 1: 10,000

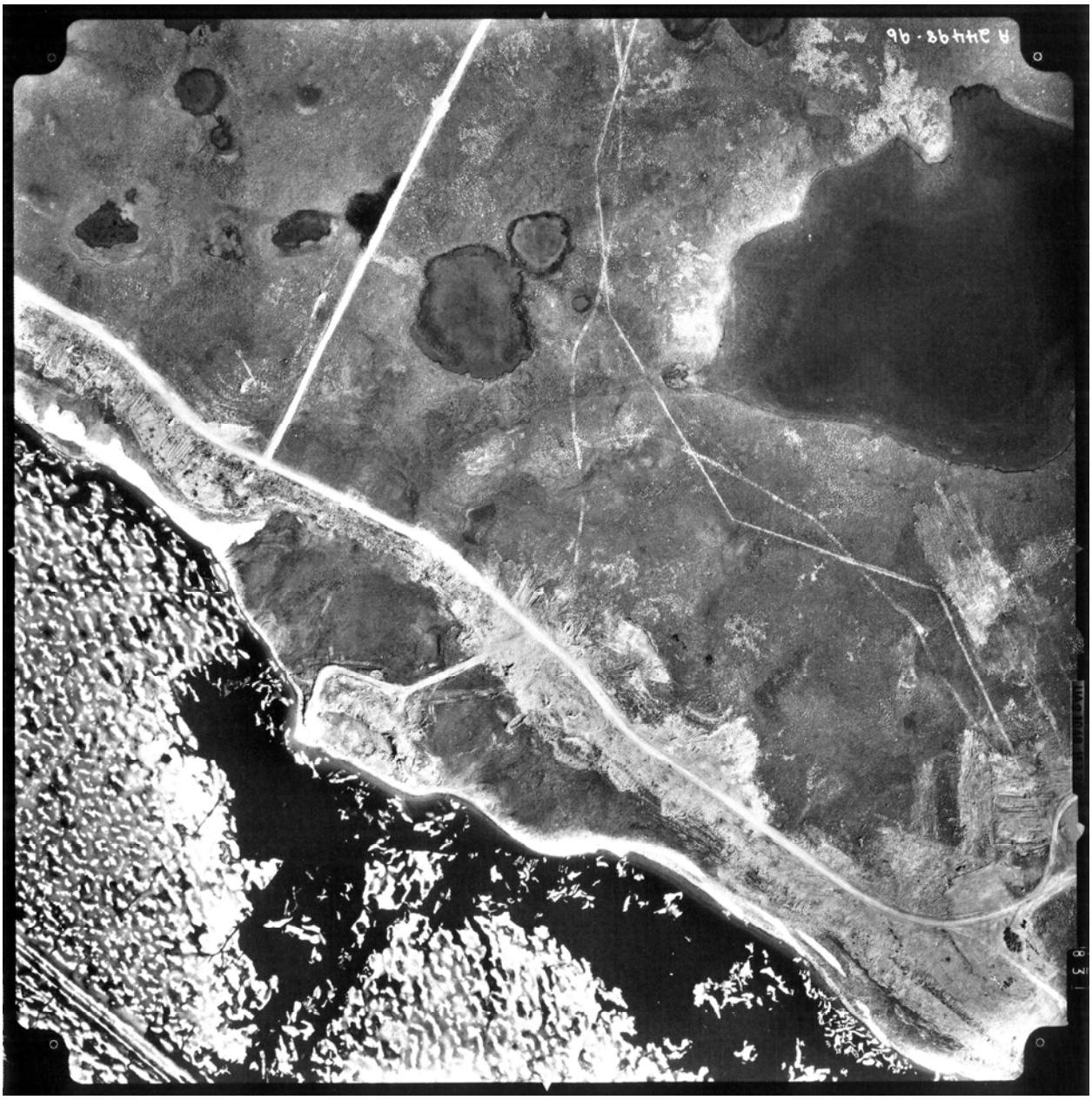
Aerial Photograph Date: 1965
Photo Number: A19352-13
Scale: 1: 12,000

Aerial Photograph Date: 1965
Photo Number: A19352-14
Scale: 1: 12,000



Aerial Photograph Date: 1969
Photo Number: A21284-16
Scale: 1: 12,000

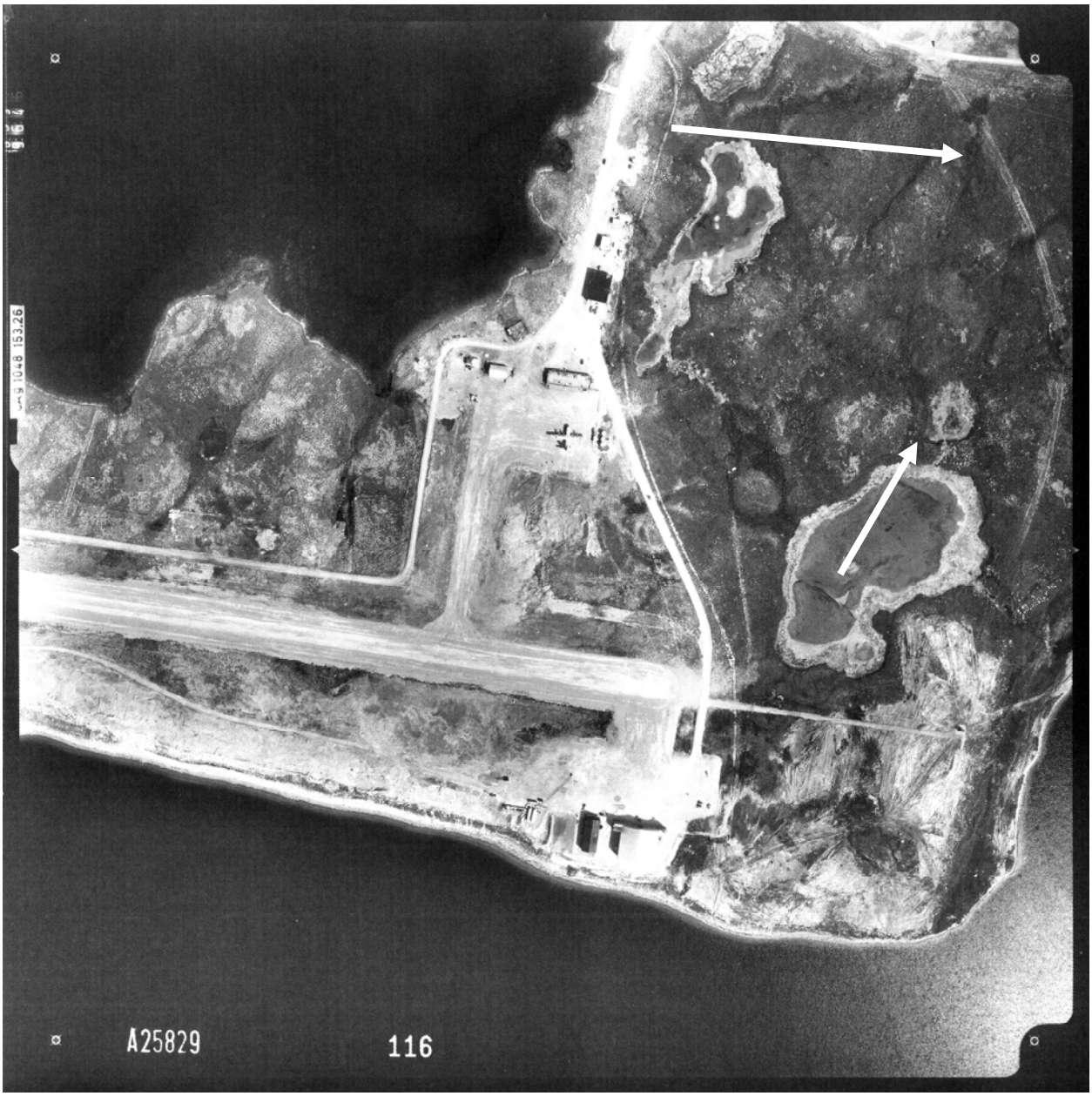
Aerial Photograph Date: 1969
Photo Number: A21284-28
Scale: 1: 12,000



Aerial Photograph Date: 1976
Photo Number: A24498-96
Scale: 1: 5,000

Aerial Photograph Date: 1976
Photo Number: A24498-61
Scale: 1: 5,000

Aerial Photograph Date: 1976
Photo Number: A24498-68
Scale: 1: 5,000



Aerial Photograph Date: 1981
Photo Number: A25829
Scale: 1: 5,000

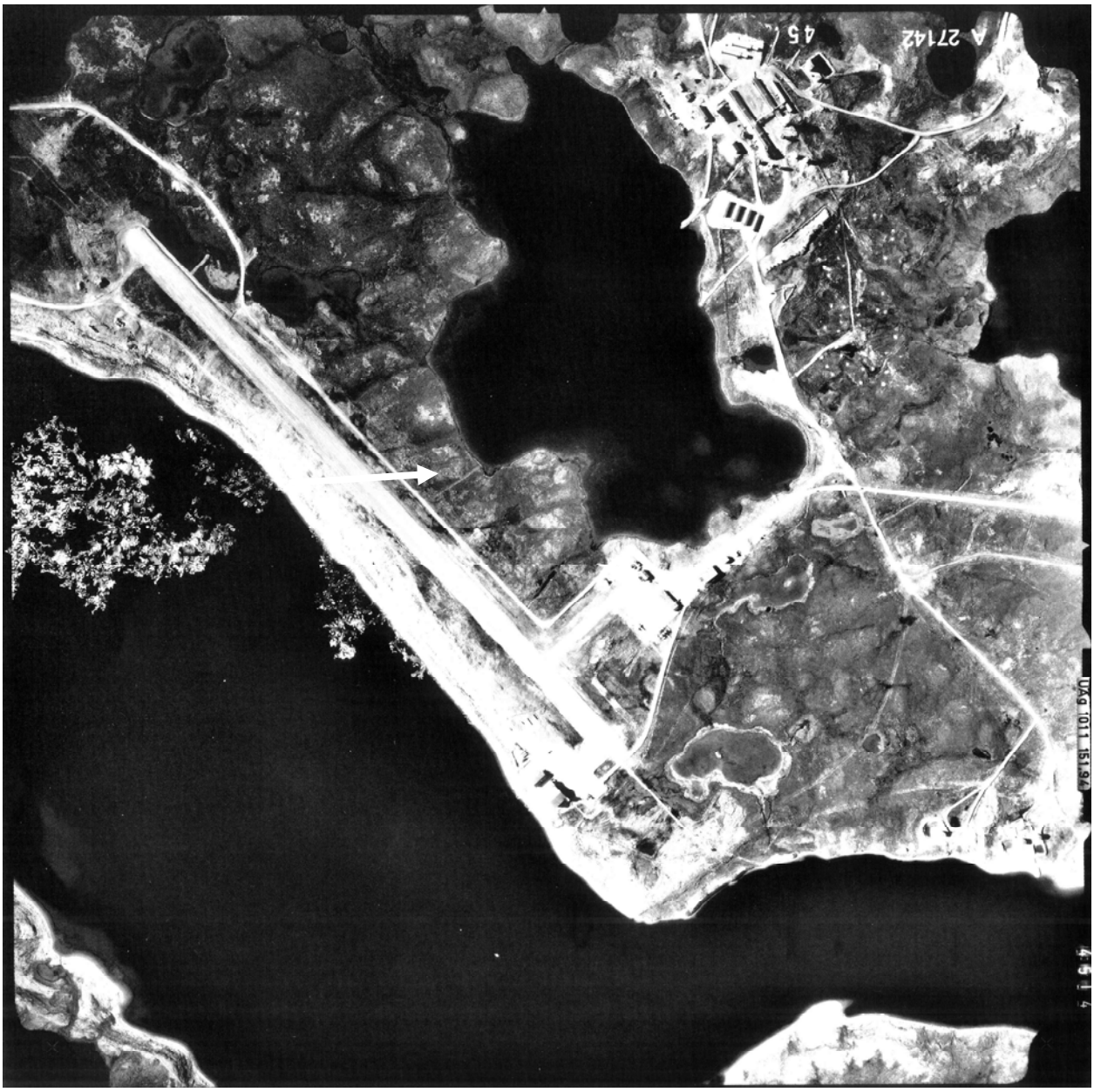
Aerial Photograph Date: 1981
Photo Number: A25829-112
Scale: 1: 5,000

Aerial Photograph Date: 1981
Photo Number: A25829-109
Scale: 1: 5,000

Aerial Photograph Date: 1985
Photo Number: A26791-78
Scale: 1: 5,000

Aerial Photograph Date: 1985
Photo Number: A26791-24
Scale: 1: 5,000

Aerial Photograph Date: 1985
Photo Number: A26791-15
Scale: 1: 5,000



Aerial Photograph Date: 1987
Photo Number: A27142-45
Scale: 1: 12,000

Aerial Photograph Date: 1987
Photo Number: A27142-47
Scale: 1: 12,000

APPENDIX C

Test Pit and Borehole Logs

TEST PIT BOREHOLE LOGS
Cambridge Bay, Nunavut

Date:	29-Aug-09	**Easting:**	493936		SAMPLES		
Logged by:	VDC	**Northing:**	7666738				
Method:	Backhoe			**Test Pit: 1-09-1M**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 1 - Screening Plant / Boneyard**						
Depth (m)	Description						
0-1.7	SANDY SILT and gravel, brown, stiff, dry; sampled at 0.9m (1-09-1M-1)				0	PHC	Monitoring well installed Riser: 0-0.9 m Screen: 0.9-1.7 m
	EOT @ 1.7 m						

Date:	29-Aug-09	**Easting:**	493954		SAMPLES		
Logged by:	VDC	**Northing:**	7666752				
Method:	Backhoe			**Test Pit: 1-09-2M**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 1 - Screening Plant / Boneyard**						
Depth (m)	Description						
0.0-0.1	ORGANIC - black, fine				-	PHC, Metals, PCB/Pesticides, VOC, PAH, Glycol	Monitoring well installed Riser: 0-0.45 m Screen: 0.45-1.5 m
0.1-1.5	SILT - light brown, some gravel, trace sand, medium stiffness, moist; sampled between 0.5-1 m (1-09-2M-1)				0		
	EOT @ 1.5 m - permafrost						

Date:	29-Aug-09	**Easting:**	493957		SAMPLES		
Logged by:	VDC	**Northing:**	7666771				
Method:	Backhoe			**Test Pit: 1-09-3M**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 1 - Screening Plant / Boneyard**						
Depth (m)	Description						
0.0-0.1	ORGANIC - black, fine				-	PHC, Metals	Monitoring well installed Riser: 0-0.45 m Screen: 0.45-1.3 m
0.1-1.3	SILT - light brown, trace sand, some gravel, medium stiffness, moist, water at bottom of test pit; sampled between 0.5-1 m (1-09-3M-1)				0		
	EOT @ 1.3 m - permafrost						

Date:	30-Aug-09	**Easting:**	493938		SAMPLES		
Logged by:	VDC	**Northing:**	7666751				
Method:	Backhoe			**Test Pit: 1-09-4M**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 1 - Screening Plant / Boneyard**						
Depth (m)	Description					1-09-4M-1	
0.0-0.1	ORGANIC - black, fine, moist				-	PHC, Metals	Monitoring well installed Riser: 0-0.6 m Screen: 0.6-1.5 m
0.1-1.5	SILT - light brown, some sand, some gravel & cobbles, medium stiff, moist; sampled between 0.5-1 m (1-09-4M-1 & 1-09-DUP-1)				0	1-09-DUP-1 PHC	
	EOT @ 1.5 m - permafrost						

Date:	29-Aug-09	**Easting:**	493935		SAMPLES		
Logged by:	VDC	**Northing:**	7666767				
Method:	Backhoe			**Test Pit: 1-09-5M**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 1 - Screening Plant / Boneyard**						
Depth (m)	Description						
0.0-0.1	ORGANIC - black, fine, moist				-	PHC, Metals, VOC	Monitoring well installed Riser: 0-0.35 m Screen: 0.35-1.2 m
0.1-1.5	SILT - light brown, some sand, some gravel and cobbles, medium stiff, moist; sampled between 0-0.5 m (1-09-5M-1)				0		
	EOT @ 1.5 m - permafrost						

Date:	29-Aug-09	**Easting:**	493948		SAMPLES		
Logged by:	VDC	**Northing:**	7666759				
Method:	Backhoe			**Test Pit: 1-09-6M**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 1 - Screening Plant / Boneyard**						
Depth (m)	Description						
0.0-0.1	ORGANIC				-	PHC, Metals, PCB, VOC, PAH, Sieve	Monitoring well installed Riser: 0-0.5 m Screen: 0.5-1.3 m
0.1-1.3	SILT - light brown, some sand, some gravel & cobbles, medium stiff; sampled between 0.5-1 m (1-09-6M-1)				0		
	EOT @ 1.3 m						

Notes:
GR= Grab Sample
EOT= End of Testpit
OVM = Organic Vapour Measurement

TEST PIT BOREHOLE LOGS
Cambridge Bay, Nunavut

Date:	29-Aug-09	**Easting:**	493311		SAMPLES		
Logged by:	JK	**Northing:**	7666612				
Method:	Shovel & loader			**Test Pit: 2-09-TP1**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 2 - Shoreline Disposal Area**						
Depth (m)	Description						
0.0-0.05	TOPSOIL - bushes, grasses, lichens, moss; SAND - greyish brown, medium-grained with some gravel				-	2-09-TP1-1 PCB	Organic layer at 0.4 m appears to be historical top of ground; Test pit was deepened by loader
0.05-0.4	SAND - dark grey/brown medium-grained with some silt and gravel; lenses of reddish-brown medium-grained sand; sample taken - 2-09-TP1-1				0	2-09-TP1-2 PHC, Metals, VOC	
0.4-0.5	ORGANIC - black sand with some gravel; sample taken - 2-09-TP1-2				0		
	EOT @ 0.5 m						

Date:	29-Aug-09	**Easting:**	493293		SAMPLES		
Logged by:	JK	**Northing:**	7666596				
Method:	Shovel & loader			**Test Pit: 2-09-TP2**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 2 - Shoreline Disposal Area**						
Depth (m)	Description						
0.0-0.05	TOPSOIL - bushes, grasses, lichens, moss				-	2-09-TP2-2 PHC, Metals, PCB/Pesticides, VOC, PAH	
0.05-0.3	SAND - light grey, medium-grained with silt, some clay; sampled between 0.2-0.3 m (2-09-TP2-1)				0		
0.3-0.5	SAND - grey, fine-grained, with silt and clay, moist; sampled between 0.3-0.5 m (2-09-TP2-2)				0		
	EOT @ 0.5 m						

Date:	29-Aug-09	**Easting:**	493281		SAMPLES		
Logged by:	JK	**Northing:**	7666624				
Method:	Shovel & loader			**Test Pit: 2-09-TP3**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 2 - Shoreline Disposal Area**						
Depth (m)	Description						
0.0-0.1	SAND - light brown with gravel				-	2-09-TP3-1 PHC, Metals, PCB, VOC, PAH	
0.1-0.7	SAND - lenses of light brown sand with gravel & grey clay with sand; samples taken from each lense between 0.1-0.7 m (2-09-TP3-1 & 2-09-TP3-2)				0		
	EOT @ 0.7 m						

Date:	29-Aug-09	**Easting:**	493252		SAMPLES		
Logged by:	JK	**Northing:**	7666600				
Method:	Loader			**Test Pit: 2-09-TP4**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 2 - Shoreline Disposal Area**						
Depth (m)	Description						
0.0-0.15	SILT/CLAY - light brown, trace fine sand, damp/moist, rootlets				-	PHC, Metals, VOC	Monitoring well installed w/ filter sock over screen Riser = 0.75 m Screen = 0.75 m
0.15-0.55	SAND - light brown, with gravel, trace clay, damp/moist				-		
0.55-0.9	GRAVEL - light brown, sandy, wet at 0.7 m; sampled (2-09-TP4)				0		
	EOT @ 0.9 m						

Date:	29-Aug-09	**Easting:**	494885		SAMPLES		
Logged by:	JS/ET	**Northing:**	7665891				
Method:	Trowel			**Test Pit: 2-09-TP5**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 2 - Shoreline Disposal Area**						
Depth (m)	Description						
0.0-0.4	SHALE - weathered chips and gravel, grey, dry				-	PHC, Metals, VOC	
0.4-0.6	SAND - silt and weathered shale, damp, moist, trace organic silt; sampled (2-09-TP5-1 & GR-2)				-		
	EOT @ 0.6 m						

Date:	29-Aug-09	**Easting:**	494736		SAMPLES		
Logged by:	JS/ET	**Northing:**	7666019				
Method:	Trowel			**Test Pit: 2-09-TP6**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 2 - Shoreline Disposal Area**						
Depth (m)	Description						
0.0-0.2	SHALE - weathered chips and gravel, grey, dry				-	PHC, Metals, VOC	
0.2-0.6	SAND - light brown with silt and weathered shale, damp/moist; sampled (2-09-TP6-1)				-		
	EOT @ 0.6 m						

Notes:
GR= Grab Sample
EOT= End of Testpit
OVM = Organic Vapour Measurement

TEST PIT BOREHOLE LOGS
Cambridge Bay, Nunavut

Date:	29-Aug-09	**Easting:**	494623		SAMPLES		
Logged by:	JS/ET	**Northing:**	7666122				
Method:	Trowel			**Test Pit: 2-09-TP7**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 2 - Shoreline Disposal Area**						
Depth (m)		Description					
0.0-0.2	SHALE - weathered chips and gravel, gret, dry				-	PHC, Metals, VOC	
0.2-0.4	SAND - light brown with silt and weathered shale, damp/moist; sampled (2-09-TP7-1)				-		
	EOT @ 0.4 m						

Date:	29-Aug-09	**Easting:**	494467		SAMPLES		
Logged by:	JS/ET	**Northing:**	7666255				
Method:	Trowel			**Test Pit: 2-09-TP8**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 2 - Shoreline Disposal Area**						
Depth (m)		Description					
0.0-0.3	SHALE - weathered with chips and gravel, grey, dry				-	PHC, Metals,	
0.3-0.5	SHALE and trace sand, silt, damp/moist; sampled (2-09-TP8-1)				-	Pesticides	
	EOT @ 0.5 m						

Date:	29-Aug-09	**Easting:**	494311		SAMPLES		
Logged by:	JS/ET	**Northing:**	7666402				
Method:	Trowel			**Test Pit: 2-09-TP9**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 2 - Shoreline Disposal Area**						
Depth (m)		Description					
0.0-0.2	SHALE - weathered chips and gravel, grey, dry				-	PHC, Metals,	
0.2-0.4	SHALE chips and gravel with sand and silt, moist; sampled (2-09-TP9-1)				-	PCBs, PAH	
	EOT @ 0.4 m						

Date:	29-Aug-09	**Easting:**	494089		SAMPLES		
Logged by:	JS/ET	**Northing:**	7666523				
Method:	Trowel			**Test Pit: 2-09-TP10**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 2 - Shoreline Disposal Area**						
Depth (m)		Description					
0.0-0.2	SHALE - weathered chips and gravel, grey, dry				-	PHC, Metals, VOC	
0.2-0.4	SILT - light brown, some sand, shale, damp/moist; sampled (2-09-TP10-1)				0		
	EOT @ 0.4 m						

Date:	29-Aug-09	**Easting:**	493531		SAMPLES		
Logged by:	VDC/ET	**Northing:**	7666776				
Method:	Backhoe			**Test Pit: 3-09-1**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 3 - Former Fire Training Area**						
Depth (m)		Description					
0.0-0.45	SAND and gravel, some silt, grey, loose, clay, boulder at 0.45 m; sampled (3-09-1-1 & 3-09-DUP-1				0	PHC, VOC, PAH, PFOS	
	EOT @ 0.45 m - boulder						

Date:	29-Aug-09	**Easting:**	493554		SAMPLES		
Logged by:	VDC/ET	**Northing:**	7666787				
Method:	Backhoe			**Test Pit: 3-09-2**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 3 - Former Fire Training Area**						
Depth (m)		Description					
0.0-0.5	SAND and gravel, brown, some organics, silty, loose, moist; sampled (3-09-2-1)				0	3-09-2-1 Sieve	
0.5-1.5	SILT - some gravel, grey, stiff, dry; sampled (3-09-2-2)				0	3-09-2-2 PHC	
	EOT @ 1.5 m						

Date:	29-Aug-09	**Easting:**	493560		SAMPLES		
Logged by:	VDC/ET	**Northing:**	7666757				
Method:	Backhoe			**Test Pit: 3-09-3**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 3 - Former Fire Training Area**						
Depth (m)		Description					
0.0-0.5	SAND and gravel, brown, silt, some organics, loose, moist; sampled (3-09-3-1)				0	3-09-3-2	
0.5-1.5	SANDY SILT, brown, some gravel, stiff, dry; sampled (3-09-3-2)				0	PHC, PFOS	
	EOT @ 1.5 m						

Notes:
GR= Grab Sample
EOT= End of Testpit
OVM = Organic Vapour Measurement

TEST PIT BOREHOLE LOGS
Cambridge Bay, Nunavut

Date:	29-Aug-09	**Easting:**	493567		SAMPLES		
Logged by:	VDC/ET	**Northing:**	7666774				
Method:	Backhoe			**Test Pit: 3-09-4M**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 3 - Former Fire Training Area**						
Depth (m)	Description						
0.0-0.5	SAND and gravel, brown, some organics, some silt, moist; sampled (3-09-4M-1)				15	3-09-4M-2 PHC, Sieve 3-09-4M-3 PHC, PCB, VOC, PAH, PFOS	Monitoring well installed Riser: 0-0.6 m Screen: 0.6-2.1 m
0.5-2.0	SANDY SILT - grey, some gravel, moist, stiff, strong hydrocarbon odour and staining, sampled (3-09-4M-2)				5		
2.0-2.1	SANDY SILT - grey, some gravel, moist, stiff, strong hydrocarbon odour and staining, wet at 2 m; sampled (3-09-4M-3)				150		
	EOT @ 2.1 m						

Date:	29-Aug-09	**Easting:**	493599		SAMPLES		
Logged by:	VDC/ET	**Northing:**	7666746				
Method:	Backhoe			**Test Pit: 3-09-5M**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 3 - Former Fire Training Area**						
Depth (m)	Description						
0.0-0.5	SAND and gravel, brown, some organics, trace silt, loose, moist; sampled (3-09-5M-1)				0	3-09-5M-2 PHC	Monitoring well installed Riser: 0-0.6 m Screen: 0.6-2.1 m
0.5-1.0	SAND - medium-grained, light brown, some gravel, very loose, moist, slight hydrocarbon odour; sampled between 0.5-1.0 m (3-09-5M-2)				15		
1.0-2.1	CLAY/SILT - grey, some gravel, stiff, moist to wet at 1.5 m; sampled (3-09-5M-3)				0		
	EOT @ 2.1 m - permafrost						

Date:	29-Aug-09	**Easting:**	493591		SAMPLES		
Logged by:	VDC/ET	**Northing:**	7666730				
Method:	Backhoe			**Test Pit: 3-09-6M**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 3 - Former Fire Training Area**						
Depth (m)	Description						
0.0-0.5	SAND and gravel, brown, loose, moist; sampled (3-09-6M-1)				0	3-09-6M-2 PHC, PFOS 3-09-DUP-2 PHC	Monitoring well installed Riser: 0-0.3 m Screen: 0.3-1.8 m
0.5-1.0	SILTY SAND - brown, gravel, loose, moist; sampled (3-09-6M-2)				0		
1.0-2.0	SILTY SAND - brown, some gravel, loose, wet @ 1.5 m, hydrocarbon staining and odour @ 1.5 m; sampled (3-09-6M-3 & 3-09-DUP-2)				0		
	EOT @ 2.0 m						

Date:	30-Aug-09	**Easting:**	495240		SAMPLES		
Logged by:	VDC/ET	**Northing:**	7666203				
Method:	Backhoe			**Test Pit: 4A-09-1M**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 4 - Former F.H. Ross Tank Farm**						
Depth (m)	Description						Monitoring well installed Riser: 0-0.85 m Screen: 0.85-1.6 m
0.0-1.6	SILTY SAND - brown, some gravel, moist, loose, hydrocarbon staining & odour; sampled at 0.5-1 m (4A-09-1M-1)				0	PHC	
	EOT @ 1.6 m - permafrost						

Date:	30-Aug-09	**Easting:**	495243		SAMPLES		
Logged by:	VDC/ET	**Northing:**	7666189				
Method:	Backhoe			**Test Pit: 4A-09-2M**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 4 - Former F.H. Ross Tank Farm**						
Depth (m)	Description						Monitoring well installed Riser: 0-0.75 m Screen: 0.75-1.5 m
0.0-1.5	SILTY SAND and gravel, brown, loose, water @ 0.5 m, organic layer observed @ 0.5 m (0.1 m thick); sampled between 0.6-1 m (4A-09-2M-1 & 4A-09-DUP-1)				0	PHC	
	EOT @ 1.5 m - permafrost						

Date:	30-Aug-09	**Easting:**	495230		SAMPLES		
Logged by:	VDC/ET	**Northing:**	7666211				
Method:	Backhoe			**Test Pit: 4A-09-3M**	RKI (ppm)	Analysis	NOTES/COMMENT
Location:	Cambridge Bay Airport						
Work area:	**APEC 4 - Former F.H. Ross Tank Farm**						
Depth (m)	Description						Monitoring well installed Riser: 0-0.5 m Screen: 0.5-1.3 m
0.0-1.3	SILTY SAND and gravel, grey, moist, loose, hydrocarbon staining and colour from 0.5 m to 1.3 m; sampled between 0.5-1 m (4A-09-3M-1)				240	PHC, Metals, VOC, PAH	
	EOT @ 1.3 m - permafrost						

Notes:
GR= Grab Sample
EOT= End of Testpit
OVM = Organic Vapour Measurement

TEST PIT BOREHOLE LOGS
Cambridge Bay, Nunavut

Date:	30-Aug-09	**Easting:**	495217		SAMPLES		
Logged by:	VDC/ET	**Northing:**	7666198		RKI (ppm)	Analysis	NOTES/COMMENT
Method:	Backhoe			**Test Pit: 4A-09-4**			
Location:	Cambridge Bay Airport						
Work area:	**APEC 4 - Former F.H. Ross Tank Farm**						
Depth (m)	Description						
0.0-2.0	SAND & GRAVEL, light brown, loose, some boulders, dry, strong hydrocarbon staining and odour below 0.5 m; sampled @ 2.0 m (4A-09-4-1)				1150	PHC, Metals, VOC, PAH	
	EOT @ 2.0 m						

Date:	30-Aug-09	**Easting:**	495214		SAMPLES		
Logged by:	VDC/ET	**Northing:**	7666186		RKI (ppm)	Analysis	NOTES/COMMENT
Method:	Backhoe			**Test Pit: 4A-09-5**			
Location:	Cambridge Bay Airport						
Work area:	**APEC 4 - Former F.H. Ross Tank Farm**						
Depth (m)	Description						
0.0-1.5	SAND & GRAVEL - light brown, loose, dry, some boulders, moderate hydrocarbon staining between 0.5-1.5 m; sampled @ 1.5 m (4A-09-5-1)				420	PHC, Metals, VOC, PAH	
	EOT @ 1.5 m						

Date:	30-Aug-09	**Easting:**	495235		SAMPLES		
Logged by:	VDC/ET	**Northing:**	7666216		RKI (ppm)	Analysis	NOTES/COMMENT
Method:	Backhoe			**Test Pit: 4A-09-6**			
Location:	Cambridge Bay Airport						
Work area:	**APEC 4 - Former F.H. Ross Tank Farm**						
Depth (m)	Description						
0.0-1.8	SAND & GRAVEL - light brown, some silt, some boulders, dry, hydrocarbon staining and odour @ 1 m; sampled between 0.5-1 m (4A-09-6-1) and between 1-1.5 m (4A-09-6-2)				0	4A-09-6-1 - PHC 4A-09-6-2 - PHC	
	EOT @ 1.8 m						

Date:	30-Aug-09	**Easting:**	495245		SAMPLES		
Logged by:	VDC/ET	**Northing:**	7666212		RKI (ppm)	Analysis	NOTES/COMMENT
Method:	Backhoe			**Test Pit: 4A-09-7**			
Location:	Cambridge Bay Airport						
Work area:	**APEC 4 - Former F.H. Ross Tank Farm**						
Depth (m)	Description						
0.0-1.8	SAND & GRAVEL - light brown, some silt, medium loose, dry, thin organic layer between 1-1.1 m; sampled @ 1.5 m (4A-09-7-1)				0	PHC	
	EOT @ 1.8 m						

Date:	30-Aug-09	**Easting:**	495205		SAMPLES		
Logged by:	VDC/ET	**Northing:**	7666175		RKI (ppm)	Analysis	NOTES/COMMENT
Method:	Backhoe			**Test Pit: 4A-09-8**			
Location:	Cambridge Bay Airport						
Work area:	**APEC 4 - Former F.H. Ross Tank Farm**						
Depth (m)	Description						
0.0-1.7	SAND & GRAVEL - brown, some silt, some boulders, loose, dry, hydrocarbon staining and odour below 1 m; sampled between 1-1.7 m (4A-09-8-1)				60	PHC	
	EOT @ 1.7 m						

Date:	30-Aug-09	**Easting:**	495335		SAMPLES		
Logged by:	JS/JK	**Northing:**	7666410		RKI (ppm)	Analysis	NOTES/COMMENT
Method:	Backhoe			**Test Pit: 5-09-TP1**			
Location:	Cambridge Bay Airport						
Work area:	**APEC 5 - Former AST north of maintenance building**						
Depth (m)	Description						
0.0-0.2	SANDY GRAVEL - trace clay, light grey/brown, dry, compacted				-	5-09-TP1-1 PHC, Metals, VOC, PAH	
0.2-0.5	SANDY GRAVEL - light brown, dry, with cobbles and shale fragments; sampled (5-09-TP1-1)				0		
0.5-0.6	ORGANICS - dark brown, dry; sampled (5-09-TP1-2)				0		
0.6-1.4	CLAY - grey, damp/moist, with coarse sand and cobbles; sampled (5-09-TP1-3)				0		
	EOT @ 1.4 m						

Notes:
GR= Grab Sample
EOT= End of Testpit
OVM = Organic Vapour Measurement

TEST PIT BOREHOLE LOGS
Cambridge Bay, Nunavut

Date:	30-Aug-09	**Easting:**	495344	SAMPLES		NOTES/COMMENT
Logged by:	JS/JK	**Northing:**	7666402			
Method:	Backhoe		**5-09-TP2**	OVM (ppm)	Analysis	
Location:	Cambridge Bay Airport					
Work area:	**APEC 5 - Former AST north of maintenance building**					
Depth (m)	Description					
0.0-0.2	SANDY GRAVEL - trace clay, light grey/brown, dry, compacted			-		
0.2-0.5	SANDY GRAVEL - light brown with cobbles and shale fragments; sampled (5-09-TP2-1)			0	5-09-TP2-1	
0.5-0.7	Lenses of organics, dark brown, dry; sampled (5-09-TP2-2)			5	PHC, Metals,	
0.7-1.1	CLAY - grey, damp, with coarse sand and cobbles; sampled (5-09-TP2-3)			30	VOC, PAH	
1.1-1.5	COBBLES/BEDROCK - grey, dry, with sand					
	EOT @ 1.5 m					

Date:	30-Aug-09	**Easting:**	495352	SAMPLES		NOTES/COMMENT
Logged by:	JS/JK	**Northing:**	7666408			
Method:	Backhoe		**Test Pit: 5-09-TP3**	OVM (ppm)	Analysis	
Location:	Cambridge Bay Airport					
Work area:	**APEC 5 - Former AST north of maintenance building**					
Depth (m)	Description					
0.0-0.2	SANDY GRAVEL - light grey/brown, trace clay, dry, compacted			-		Monitoring well installed
0.2-0.5	SANDY GRAVEL - light brown, dry, with cobbles and shale fragments, hydrocarbon odour; sampled (5-09-TP3-1)			0	5-09-TP3-1 PHC, Metals, VOC, PAH	Riser: 0-0.25 m Screen: 0.25-2.06 m
0.5-0.6	ORGANICS - dark brown; sampled (5-09-TP3-2)			0		
0.6-1.5	CLAY - light grey/brown, damp, with coarse sand and cobbles; sampled (5-09-TP3-3)			0		
1.5-2.2	SHALE - grey, weathered with some clay and trace coarse sand, dry			-		
	EOT @ 2.2 m					

Date:	30-Aug-09	**Easting:**	495343	SAMPLES		NOTES/COMMENT
Logged by:	JS/JK	**Northing:**	7666417			
Method:	Backhoe		**Test Pit: 5-09-TP4**	OVM (ppm)	Analysis	
Location:	Cambridge Bay Airport					
Work area:	**APEC 5 - Former AST north of maintenance building**					
Depth (m)	Description					
0.0-0.3	SANDY GRAVEL - light grey/brown, trace clay, dry, compacted			-		
0.3-1.0	SANDY GRAVEL - light brown, with cobbles and shale fragments, dry; sampled (5-09-TP4-1)			5	5-09-TP4-3	
1.0-1.2	ORGANICS - dark brown; sampled (5-09-TP4-2)			10	PHC, Metals,	
1.2-1.8	SILT TILL - light brown, travel clay, gravel and sand, damp; sampled (5-09-TP4-3)			-	VOC, PAH	
1.8-2.2	SHALE - grey, weathered shale and bedrock, dry with trace clay and coarse sand			-		
	EOT @ 2.2 m					

Date:	30-Aug-09	**Easting:**	495305	SAMPLES		NOTES/COMMENT
Logged by:	JS/JK	**Northing:**	7666327			
Method:	Backhoe		**Test Pit: 6-09-TP1**	OVM (ppm)	Analysis	
Location:	Cambridge Bay Airport					
Work area:	**APEC 6 - Beside maintenance building**					
Depth (m)	Description					Monitoring well installed
0.0-0.1	GRAVELLY SAND with rootlets, light grey/brown; sampled (6-09-TP1-1)			0	6-09-TP1-3	Riser: 0-0.5 m
0.1-0.2	TOPSOIL - organic silt, dark brown, damp, rootlets; sampled (6-09-TP1-2)			0	PHC, Metals,	Screen: 0.5-1.876 m
0.2-1.5	SANDY SILT with fractured shale and boulders, wet at 0.8 m (6-09-TP1-3)			0	VOC, PAH	
	EOT @ 1.5 m					

Date:	30-Aug-09	**Easting:**	493780	SAMPLES		NOTES/COMMENT
Logged by:	JS/JK	**Northing:**	7667081			
Method:	Backhoe		**Test Pit: BG-1**	OVM (ppm)	Analysis	
Location:	Cambridge Bay Airport					
Work area:	**Approx. 1 km west of airport terminal building on main road**					
Depth (m)	Description					
0.0-0.15	PEAT - dark brown and fibrous, spongy, damp, cold			-	Metals	
0.15-0.6	SANDY SILT - light brown, with gravel and weathered shale at 0.5 m; sampled at 0.3 m (BG-1)			-		
	EOT @ 0.6 m					

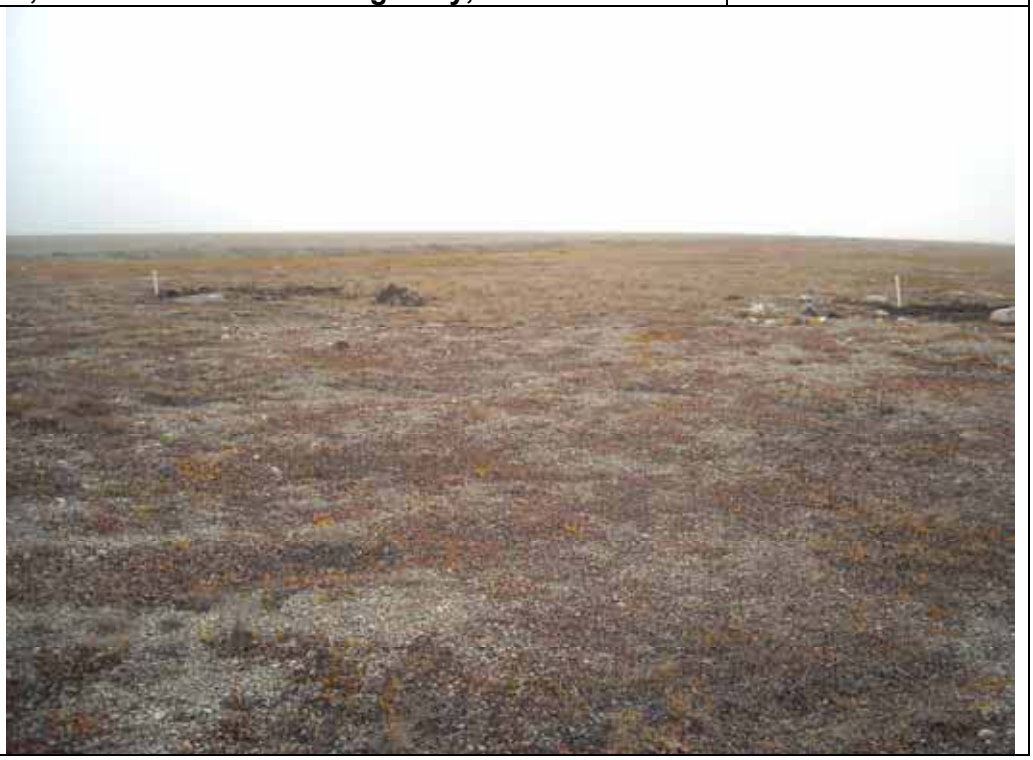
Date:	30-Aug-09	**Easting:**	493497	SAMPLES		NOTES/COMMENT
Logged by:	JS/JK	**Northing:**	7667026			
Method:	Backhoe		**Test Pit: BG-2**	OVM (ppm)	Analysis	
Location:	Cambridge Bay Airport					
Work area:	**Approx. 2 km west of airport terminal building, 500 m west of end of runway**					
Depth (m)	Description					
0.0-0.1	PEAT - dark brown, fibrous, spongy, damp			-	Metals	
0.1-0.5	SAND - light brown, medium-grained with gravel and weathered shale below 0.45 m; sampled @ 0.4 cm (BG-2); duplicate sample (BG-3)			-		
	EOT @ 0.5 m					

Notes:
GR= Grab Sample
EOT= End of Testpit
OVM = Organic Vapour Measurement

APPENDIX D

Site Photos

APEC 1 – Screening Plant; Phase I/II ESA Cambridge Bay, Nunavut	1748-0901
Photo ID: 1	
Date: August 29, 2009	
Direction: N	
Description: Excavation of test pit 1-09-2M in APEC 1	

APEC 1 – Screening Plant; Phase I/II ESA Cambridge Bay, Nunavut	1748-0901
Photo ID: 2	
Date: August 29, 2009	
Direction: NE	
Description: Monitoring wells 1-09-2M and 1-093M at APEC 1	

APEC 2 – Shoreline Disposal Area; Phase I/II ESA Cambridge Bay, Nunavut	1748-0901
Photo ID: 3	
Date: September 2, 2009	
Direction: S	
Description: Location of test pit 2-09TP-5 at APEC 2.	

APEC 2 – Shoreline Disposal Area; Phase I/II ESA Cambridge Bay, Nunavut	1748-0901
Photo ID: 4	
Date: September 2, 2009	
Direction: S	
Description: Location of test pit 2-09TP-5 at APEC 2.	

APEC 3 – Former Fire Training Area; Phase I/II ESA Cambridge Bay, Nunavut	**1748-0901**
Photo ID: 5	
Date: August 29, 2009	
Direction: S	
Description: Excavation of test pit 3-09-2 at APEC 3	

APEC 3 – Former Fire Training Area; Phase I/II ESA Cambridge Bay, Nunavut	**1748-0901**
Photo ID: 6	
Date: August 29, 2009	
Direction: NE	
Description: Installation of monitoring well 3-09-4M at APEC 3	

APEC 4 – Former F.H. Ross Tank Farm; Phase I/II ESA Cambridge Bay, Nunavut	1748-0901
Photo ID: 7	
Date: August 30, 2009	
Direction: N	
Description: View of APEC 4, with the airport terminal building in the background	

APEC 4 – Former F.H. Ross Tank Farm; Phase I/II ESA Cambridge Bay, Nunavut	1748-0901
Photo ID: 8	
Date: August 30, 2009	
Direction: N	
Description: Excavation of test pit 4-09-7 at APEC 4	

APEC 5 – Former AST north of T-5; Phase I/II ESA Cambridge Bay, Nunavut	**1748-0901**
Photo ID: 9	
Date: August 30, 2009	
Direction: NE	
Description: Monitoring well 5-09-MW3 at APEC 5	

Background Sampling ; Phase I/II ESA Cambridge Bay, Nunavut	**1748-0901**
Photo ID: 10	
Date: August 30, 2009	
Direction: E	
Description: Test pit at background location BG-1	