Remediation Work Plan
CAM-F Sarcpa Lake
Intermediate DEW Line Site

Prepared by:
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Mr. Jared Buchko, P.Eng.
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Dear Mr. Buchko:

RE: Final Remediation Work Plan for the CAM-F DEW Line Site

UMA Engineering Ltd. (UMA) is pleased to provide this final work plan for the remediation of the CAM-F Intermediate DEW Line site. As discussed in the attached report, the rationale for decisions for remediation are provided, as well as the location of various program components (i.e. debris clean up, demolition, landfill areas, contaminated soil, etc.).

If you have any questions or wish to discuss the information presented in the attached report, please do not hesitate to contact the undersigned.

Sincerely,

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Table of Contents

1.0 Introduction 1-1

2.0 Site Description 2-1

2.1 Location and Site Facilities 2-1
2.2 Climate 2-1
2.3 Geology 2-2
2.4 Previous Environmental Assessments 2-2
2.5 Summary of Major Findings 2-3

3.0 Implementation and Design/Engineering 3-1

3.1 Site Access and Transportation Methods 3-1
3.2 Contaminated Soil Disposal Requirements 3-1
3.2.1 Contaminated Soil Types 3-2
3.2.2 Tier I Soil Disposal Facility Requirements 3-3
3.2.3 Secure (Tier II) Soil Disposal Facility Requirements 3-4
3.2.4 CEPA Contaminated Soil Disposal Requirements 3-4
3.2.5 Hydrocarbon Contaminated Soil Disposal Requirements 3-4
3.2.6 Proposed Contaminated Soil Remediation 3-5
3.3 Proposed Landfill Construction 3-5
3.3.1 Non-Hazardous Waste (NHW) Landfill 3-6
3.3.2 Secure Soil Disposal Facility 3-7
3.4 Description of Existing Debris/Dump Areas 3-8
3.4.1 Dump A 3-8
3.4.2 Dump B 3-8
3.5 Disposal of Site Debris 3-9
3.6 Barrel Disposal Requirements 3-10
3.7 Demolition of Facilities 3-11
3.8 Removal of Hazardous Material 3-12
3.9 Transportation of Hazardous Materials Off Site 3-13
3.10 Grading and Addition of Fill Materials 3-13
3.11 Contractor Support Activities 3-13

4.0 Proposed New Landfills 4-1

4.1 NHW Debris Landfill 4-1
4.1.1 NHW Debris Landfill Design Parameters 4-1
4.2 Secure Soil Disposal Facility 4-2
4.2.1 Secure Soil Storage Facility Design Parameters 4-2
4.3 Development of Borrow Areas 4-3

5.0 Schedule 5-1

6.0 Summary and Recommendations 6-1

6.1 Contaminated Soil Remediation 6-1
6.2 Dump/Debris Area Remediation 6-3
6.3 Summary of Non-Hazardous Demolition and Debris 6-3
6.4 Summary of Hazardous Demolition and Debris 6-5

7.0 References 7-1

List of Tables

Table 3-1: DCC Tier I Contaminant Criteria 3-2
Table 3-2: DCC Tier II Contaminant Criteria 3-2
Table 3-3: Hazardous Waste Material Disposal Requirements 3-12
Table 6-1: Recommended Remediation Options for Contaminated Soil Areas 6-2
Table 6-2: Recommended Remediation Options 6-3
Table 6-3: Summary of Demolition/Debris Areas – Non- Hazardous Materials 6-4
Table 6-4: Summary of Demolition/Debris Areas - Hazardous Materials 6-5

List of Appendices

Appendix I - Drawings
Appendix II - Photographs
Appendix III - Sarcpa Lake Community Meeting - Questions and Answers

List of Drawings (Within Appendix I)

413334-C01 Location Plan
413334-C02 Overall Site Plan
413334-C03 Station Area Site Plan
413334-C04 East Station Area Site Plan
413334-C05 Former Construction Camp Area
413334-C06 Non-Hazardous Waste Landfill Section and Detail
413334-C07 Secure Soil Disposal Facility Section and Detail; Key Trench Excavation Plan
413334-C08 Secure Soil Disposal Facility Section and Detail

1.0 Introduction

UMA Engineering Ltd. (UMA) was retained by Public Works and Government Services Canada (PWGSC) on behalf of Indian and Northern Affairs Canada (INAC) to develop a remediation work plan for the former Intermediate DEW Line site at Sarcpa Lake (designated CAM-F), Territory of Nunavut. The purpose of the project is to develop remediation strategies for issues of environmental concern that remain as a result of the operation of the former DEW Line site. Specifically, remediation will mitigate and/or control the release of contaminants into the environment.

The Phase II Environmental Assessment was completed by the Environmental Sciences Group, UMA and Queens University in 1995/1996 and in 2004; Earth Tech Canada Inc. was retained to conduct a Phase III Environmental Site Assessment. The geotechnical investigations were conducted by EBA Engineering Consultants Ltd in 1995 and 2004.

The work plan involves several components:

- The existing site infrastructure will be demolished and the demolition wastes will be segregated into hazardous and non-hazardous materials and disposed of appropriately.
- Contaminated soil areas, identified during the previous field investigations, will be remediated.
- All hazardous materials and soil will be disposed of at an off site licensed disposal facility.
- Scattered surface debris and partially buried debris on the site is to be collected and disposed of.
- New landfills will be constructed to contain the non-hazardous contaminated soil and demolition waste generated during the clean up.
- Existing landfills on this site will be remediated, as required. Disturbed areas will be physically restored to a stable condition and shaped to match the existing terrain.

The scope of work for this work plan is summarized as follows:

- Provide a summary of the major findings from the site investigation program.
- Summarize the clean up protocols including the proposed remediation criteria.
- Provide a summary of contaminated soil areas from the investigation program(s).
- Provide a conceptual remedial design for various decisions for remediation including those related to remediation of existing debris/landfill areas.
- Provide preliminary design drawings indicating the locations of various remediation program components (i.e. non-hazardous landfill, secure disposal facilities, site debris, demolition components, etc.).

- Develop remediation design recommendations.
- Identify proposed sources of fill materials required for remediation facilities.
- Provide a preliminary estimate of quantities and costs for various remediation elements.
- Outline the overall remediation schedule for the site.

A site inspection was carried out between August 10th and 16th, 2004. UMA's representative for the work was Mr. Tom Jacklin, M.Eng., P.Eng.

2.0 Site Description

2.1 Location and Site Facilities

The CAM-F site (68° 33' N, 83° 19' W) is located on the Melville Peninsula, approximately 85 km west of Hall Beach, and 100 km south-west of Igloolik in the Territory of Nunavut. The site is landlocked limiting site access to helicopters, small aircraft and a winter CAT train from Hall Beach.

CAM-F was constructed in 1957 as an intermediate site for the DEW Line system. It was used for a short period of time until it was abandoned in 1963. It was converted to a scientific research station in 1977 under the Science Institute of the Northwest Territories and Canada, Department of Indian and Northern Affairs and operated seasonally until 1988. A key plan and overall site plan of the CAM-F DEW Line Site is provided on Drawings 413334-C01/C02 in Appendix I.

The CAM-F site consists of two main parts including the station area and former construction camp areas at Sarcpa Lake. Site facilities consist of an airstrip, small module train, warehouse, garage, Quonset, Inuit house, two former landfill areas, and oil and lubricants (POL) storage facilities. The site contains approximately 9,160 barrels, a radar tower that has been knocked down and other site debris. The station is accessed via 3 km by road from the shores of Sarcpa Lake. The beach area at Sarcpa Lake includes a former construction camp. The former camp area consists primarily of scattered barrels and abandoned construction equipment, a small machine shop and generator pad. The general layout of the station and former construction camp facilities are shown on Drawings 413334-C02 and 413334-C05 respectively.

2.2 Climate

Climatic data information was obtained from the closest weather stations at Hall Beach, elevation 8 m, 85 km east of Sarcpa Lake and Mackar Inlet, elevation 395 m, 100 km west of Sarcpa Lake as no weather station was available from Sarcpa Lake. In total, approximately 215 mm and 189 mm of precipitation occur per year at Hall Beach and Mackar Inlet respectively, of which 60% is rainfall and 40% is snowfall. Generally, the wettest months are July through September.

The mean annual air temperature at Hall Beach is -14.7 °C, and at Mackar Inlet -14.4 °C. Daily temperature ranges from 6.0°C in July to -32.7°C in February. Winds are primarily from the northwest, with an average wind speed of 21 km/hr.

2.3 GEOLOGY

Regionally, the terrain is undulating to hilly with numerous bedrock outcrops. Landscape is characterized by a surficial veneer or blanket of glacial drift. Occasional small water ponds or thaw lakes occur throughout the area. The ponds are generally small and irregular in shape and follow valleys in the bedrock terrain. Drainage channels and patterns are generally well developed throughout the area, with drainage directed toward the Kingaroo River and Sarcpa Lake.

Sarcpa Lake is within the zone of continuous permafrost. No ground temperature measurements were made at the site; however, ground temperatures have been measured at Hall beach. The mean annual ground temperatures at Hall Beach varied from -9°C to -10°C.

The CAM-F site sits on a ridge approximately 1,000 m north of Sarcpa Lake. Surface drainage around the station flows off the ridge outward to the southwest and north. Surface water drains either overland or in short, drainages which follow the bedrock valleys towards Sarcpa Lake.

Elevation at the main site is 260 m above sea level and the shoreline of Sarcpa Lake is approximately 165 m above sea level.

2.4 PREVIOUS ENVIRONMENTAL ASSESSMENTS

Environmental investigations at Sarcpa Lake began in 1987 with an initial polychlorinated biphenyl (PCB) sampling program. Subsequent investigations were conducted by Royal Roads Military College in 1994, Queens University and UMA Engineering in 1996. Remediation of one of the landfill areas (designated Dump A) was conducted in the summers of 1996 and 1997. Additional maintenance/remedial work were conducted in 1999.

In 2004, Earth Tech Canada Inc. was retained to conduct a Phase III Environmental Site Assessment and EBA Engineering Consultants Ltd. was retained to complete a geotechnical investigation at CAM-F. Also in 2004, INAC/PWGSC transported 174 barrels of PCB contaminated soils to a licensed disposal site in Ontario.

Community meetings were facilitated by PWGSC in Hall Beach and Igloolik in 2004. A summary of issues brought up at these community meetings is provided in Appendix III.

2.5 SUMMARY OF MAJOR FINDINGS

The environmental and geotechnical site investigations have identified the following major findings:

- The primary station infrastructure identified to be demolished includes a module train, warehouse, garage and two 75,000 litre POL storage tanks at the upper station. Hazardous materials, including asbestos, paint amended with PCBs and hydrocarbon product, were identified in the site infrastructure.
- Two existing concentration debris areas were investigated including "Dump A" and "Dump B", located northeast of the station area.
- Various contaminated soil areas were identified at the barrel cache(s), vehicle piles, warehouse, module station, former construction camp and Dump A and Dump B areas. The primary contaminants were PCBs, hydrocarbons and metals.
- Numerous debris areas were identified at the station areas and along the access road, airstrip and former construction camp. This debris includes approximately 9,160 barrels located on this site. Some of the barrels contain hydrocarbon product.

3.0 Implementation and Design/Engineering

The purpose of the project is to remediate the site to an acceptable level of environment risk by:

- Removing contaminated soils.
- Stabilizing existing dumps.
- Developing engineered landfill facilities.
- Collecting and disposing surface debris.
- Demolishing and removing existing site facilities.
- Physically restoring the site.

The remediation plan and procedures are outlined in the following sections. Selected photographs of the clean up areas at CAM-F are provided in Appendix II.

3.1 Site Access and Transportation Methods

Off site activities in support of this project will be in the form of transportation associated with the transport of materials, equipment and personnel to the site. These activities are described below:

- **Air Transport** - Most personnel transportation by air is expected to utilize existing commercial services to Hall Beach and charter services in and out of the site.
- **Sealift Transport** - It is anticipated that contractors will utilize sealift to transport bulk materials and equipment (vehicles, construction equipment, fuel, etc.) to/from Hall Beach. This would potentially result in the increase in sealift traffic by one or two sailings per year (one early and one late summer). Otherwise, no additional vessel traffic is anticipated.
- **Land Transport** - It is anticipated that overland transport will be required between the Hall Beach landing area and the station via winter CAT Train for mobilization/demobilization of materials and equipment.

3.2 Contaminated Soil Disposal Requirements

The analytical results for inorganic elements and PCBs can be interpreted using the established DEW Line Clean Up Criteria (DCC) (Table 3-1). The DCC protocol defines two concentration tiers of soil contamination for metals and PCBs, including Tier I Contaminated Soil, which is either placed in an on-site landfill or buried beneath a minimum of 0.3 m of clean fill, and Tier II Contaminated Soil, which requires disposal in a manner that provides additional measures to permanently segregate these contaminants from the Arctic ecosystem. Soils exceeding federal legislative limits (i.e. Canadian Environmental Protection Act and Chlorobiphenyl Regulations) require disposal off site at a licensed disposal or destruction facility.

For soils contaminated with hydrocarbons, the Canada Wide Standards for Petroleum Hydrocarbons (CWS PHC) defines criteria for a Residential Parkland application for fine-grained soil. The generic Tier 1 values were assumed for the residential/parkland land uses using the default set of exposure assumptions. Although the Tier 1 guidelines were developed for a more typical "southern exposure and land use", the use of these generic guidelines for the DIAND Intermediate DEW Line Sites is considered suitable. It should be noted that the reader should not confuse references to the CCME Tier 1 values with those referenced in the DCC protocol.

The contaminated soil at CAM-F has been divided into several categories depending on the type and severity of the contamination. Generally, non-hazardous surface contaminants are covered or excavated. Excavations left by soil removal are backfilled with clean fill.

3.2.1 Contaminated Soil Types

There are a variety of contaminated soil types that require disposal at CAM-F. Definitions of the types of contamination and contaminated soils potentially found at the CAM-F site are as follows:

DCC Tier I Contaminated Soil: Soils containing concentrations of any or all contaminants listed as follows:

Table 3-1: DCC Tier I Contaminant Criteria

Parameter	Criteria
Lead	200 to 500 ppm
PCBs	1 to <5 ppm

DCC Tier II Contaminated Soils: Soils containing concentrations equal to or in excess of any or all of the contaminants listed as follows:

Table 3-2: DCC Tier II Contaminant Criteria

Parameter	Criteria
Arsenic	30 ppm
Cadmium	5 ppm
Chromium	250 ppm
Cobalt	50 ppm
Copper	100 ppm
Lead	500 ppm
Mercury	2 ppm
Nickel	100 ppm
Zinc	500 ppm
PCBs	>5 to <50 ppm

Petroleum Hydrocarbons: Hydrocarbon products include those described by laboratory analyses as lubricating oil and grease, fuel oil, diesel and/or gasoline.

Hydrocarbon Contaminated Soil: Soil containing concentration of hydrocarbons greater than the Canada Wide Standards for Petroleum Hydrocarbons (CWS PHC) Residential Parkland criteria for fine grained soil.

The CWS PHC Tier 1 levels are divided into four fractions which refer to the carbon range: Fraction 1 nC6 to nC10; Fraction 2 >nC10 to nC16; Fraction 3 >nC16 to nC34 and Fraction 4 >nC35+. These are referred to F1, F2, F3 and F4 hydrocarbons respectively.

Clean Soil: Soil that has been sampled, analyzed, and determined to have contaminant concentrations less than DCC Tier I, DCC Tier II and CWS PHC Tier I levels.

Hazardous Contaminated Soil: Contaminated soil is classified as hazardous in accordance with the Transportation of Dangerous Goods Act and Regulations (including Canadian Environmental Protection Act (CEPA) and leachable soil).

CEPA Contaminated Soil: Soil containing concentrations of PCBs equal to, or in excess of, 50 mg/kg. Materials contaminated with PCBs at concentrations equal to, or greater than, 50 mg/kg are legislated as hazardous materials.

Leachable Soil: Soil containing contaminants that when subject to the leachate test prescribed in the Transportation and Dangerous Goods Act (TDGA) and Regulations, leaches concentrations greater than those listed in Part V of the regulations.

3.2.2 Tier I Soil Disposal Facility Requirements

Soils exceeding Tier I contaminated criteria but not classified as Tier II contaminated soil do not pose a leachate risk and therefore may be disposed of in an on-site, non-hazardous waste (NHW) landfill. NHW landfills are also used to dispose of non-hazardous site debris and demolition materials. Typical constructions of a NHW landfill consists of gravel perimeter berms surrounding layers of interbedded waste and intermediate cover soil. A layer of granular material, minimum one metre thick, is placed as final cover for the landfill and graded to promote positive drainage. A more detailed description of a NHW Landfill is provided in Section 3.3.1.

3.2.3 Secure (Tier II) Soil Disposal Facility Requirements

Secure (Tier II) Soil Disposal Facilities have been utilized at the DND DEW Line sites for disposal of soils exceeding the DCC Tier II concentrations. The construction of these Secure Soil Disposal Facilities at the DND DEW Line sites has been cost effective because of the large volume of Tier II contaminated soil that requires segregation in a manner which precludes their continued contact with the Arctic ecosystem. These facilities utilize a double containment system, consisting of permafrost to limit leachate generation and synthetic liners to prevent migration of contaminants into the surrounding environment.

3.2.4 CEPA Contaminated Soil Disposal Requirements

Contaminated soils which contain levels of contaminants exceeding CEPA and associated regulations are considered hazardous material and will not be placed in the secure soil disposal facility. These materials will be excavated, removed from the site and transported to a licensed disposal facility. Some of the soils may also contain petroleum hydrocarbons. In addition, wastes determined to be leachable are also removed from the site to a licensed disposal facility.

3.2.5 Hydrocarbon Contaminated Soil Disposal Requirements

The remediation requirements for hydrocarbon contaminated soils at the main DEW Line sites have included excavation and disposal in a NHW landfill or re-grading of soils containing F3 and/or F4 hydrocarbon fractions and excavation, treatment and/or disposal of BTEX, F1 and/or F2 fraction hydrocarbons into a secure soil disposal facility.

Where the primary hydrocarbon present was F3 and/or F4 hydrocarbon fraction, covering with 0.75 m of fill and regrading or disposal in a NHW landfill was considered acceptable to reduce the possibility of impact to potential receptors due to the low solubility and volatility of these compounds.

For contaminated soils that contain BTEX, F1 and/or F2 fraction hydrocarbons, regrading or disposal in a NHW landfill is generally not considered acceptable due to the concern of solubility and migration of dissolved hydrocarbon compounds. Several options have been used for treatment and disposal of these types of materials based on location and site specific factors. The most feasible and environmentally sound disposal options are placement in a secure soil disposal facility; passive land-treatment (landfarming); and containerization and transport off site to a licensed disposal facility.

The treatment of excavated F1 and F2 PHC at a constructed landfarm is a demonstrated method of remediation that has been implemented at other DEW Line sites. When significant volumes of PHC contaminated soil require treatment, then the economics of landfarming are easily demonstrated. For CAM-F, a preliminary comparison of costs for construction and closure of a

landfarm vs. disposal in a secure soil disposal facility was made for an assumed 1,000 m^3 of soil. The estimated costs to construct, operate and the closure of the landfarm varied from $150,000 to $250,000 vs. the increased construction costs of a secure landfill of approximately $200,000. Further uncertainties with respect to treatment achieving the remediation criteria within the construction window proposed (two years) may be difficult for some hydrocarbon fractions.

Based on the above factors, no landfarm is proposed for Sarcpa Lake. PHC contaminated soils that required excavation will be disposed into a secure soil disposal facility.

The generic risk reduction strategies for hydrocarbon contaminated soil areas include:

- Excavation of the source of contamination to a depth where PHC F1, F2, F3 and F4 fractions are less than 260 mg/kg, 900 mg/kg, 800 mg/kg and 5,600 mg/kg respectively.
- Excavation of the contamination to a 50 cm depth or to a depth at which PHC concentrations are less than the above criteria, whichever is encountered first. The 50 cm depth is considered protective of the ecological soil contact and soil ingestion pathways.
- Covering of soils with 0.75 m of fill where the PHC F3 and F4 fractions exceed 800 mg/kg and 5,600 mg/kg respectively.
- No action required.

3.2.6 Proposed Contaminated Soil Remediation

A summary of the contaminated soils and proposed remediation solutions for CAM-F is provided in Table 6-1 in Section 6 of this report:

3.3 PROPOSED LANDFILL CONSTRUCTION

Two types of specialized facilities are to be constructed to dispose of waste on-site due to the demolition of existing structures, removal of contaminated soil and site debris, and landfill excavation. Only soils exceeding CEPA standards (Hazardous) will be disposed of off site.

EBA Engineering Consultants Ltd. identified several potential sites for new disposal facilities. Generally no new roads will have to be constructed to access these areas; however, the contractor may be required to make special provisions to improve roadways and to protect vegetation where applicable. The contractor will have to provide adequate drainage for all excavations.

No reclamation or upgrading of the airstrip is proposed at this time.

3.3.1 Non-Hazardous Waste (NHW) Landfill

The Non-Hazardous Waste (NHW) Landfill is designed on the premise that they will contain non-hazardous materials only and will not generate leachate. Therefore, it is not necessary to eliminate all moisture migration into and out of the landfill. The NHW Landfill is also not designed to maintain the contents in a perennially frozen state.

The following materials are proposed for disposal in a non-hazardous landfill at CAM-F:

- Tier I contaminated soil.
- F3 and F4 fraction hydrocarbon contaminated soil, where applicable.
- Non-hazardous demolition debris.
- Non-hazardous site debris.
- Non-hazardous debris/soils excavated from landfills.
- Creosote timbers.
- Double-bagged asbestos.

A NHW Landfill consists of a perimeter containment berm and granular cover to minimize erosion and infiltration in order to provide long-term stability. A NHW Landfill is generally established on native ground (stripped of any organic matter). No base cover or liner is required for a NHW landfill. The development and closure of a NHW landfill includes the following work:

- Construction of exterior berms.
- Placement of Tier I and PHC soils and non-hazardous demolition waste and site debris in the landfill.
- Compaction of landfill debris.
- Placement and compaction of intermediate granular cover.
- Placement and compaction of final granular cover.
- Grading to promote drainage away from the landfill.
- Survey of the locations of the asbestos and creosote-treated timbers.

One NHW landfill is proposed for the station area for disposal of site demolition, debris and contaminated soil.

During construction of these facilities, the gradation, moisture content and compaction are monitored to construct the landfill in accordance with the design parameters.

3.3.2 Secure Soil Disposal Facility

The design of this facility was based on the characteristics of the contaminants in the soils, the geothermal properties of the area and the local permafrost regime. The design utilizes permafrost as the primary containment barrier - both the Tier II contaminated soil and the perimeter berms are designed to be continuously frozen. Geothermal analysis has been conducted on other Dewline to determine the time required for freeze-back of the facility and the long-term thermal regime of the facility. The thickness of the cover material was calculated to prevent thaw of the contaminated soil even after 10 consecutive 1 in 100 warm years.

A high-density polyethylene (HDPE) liner is placed at the base and side slopes of the facility to provide secondary containment. The liner is chemically compatible with the contaminated soils and will prevent the potential movement of contaminants during the period required for permafrost aggradation. A second HDPE liner is to be placed over the contaminated soils and seamed to the base liner to prevent precipitation from percolating down through the cover fill and into the contaminated soils.

The secure soil disposal facility is designed to contain contaminated soil exceeding the DCC Tier II Criteria. The development and closure of the secure facility at CAM-F will include the following work:

- Preparation of subgrade.
- Construction of exterior berms with saturated silty gravel.
- Supply and installation of geotextile and HDPE liners, as indicated on the drawings.
- Placement of Tier II and PHC contaminated soils (BTEX, F1 and F2) in the landfill.
- Placement and compaction of intermediate granular cover over the soil.
- Installation of the top HDPE liner.
- Placement and compaction of final granular cover on the landfill.
- Grading to promote drainage away from the landfill.
- Supply and installation of thermister strings and groundwater monitoring wells in and around the landfill, as indicated on the drawings.

During construction of this facility, the gradation, moisture content and compaction are monitored to verify the facility is constructed in accordance with the design.

3.4 DESCRIPTION OF EXISTING DEBRIS/DUMP AREAS

3.4.1 Dump A

Dump A is located 200 m northeast of the module train, as shown on Drawing 413334-C03. The dump was originally constructed by tipping debris over the edge of a small bedrock outcrop. The dump area contained loose debris including barrels, equipment, domestic waste, electronic parts, etc. Most of the loose debris was removed from the area by a clean up team under the direction of Queens University during the summer of 1996. The clean up of the loose debris was in conjunction with the excavation and removal of soil contaminated with PCB concentrations greater than CEPA standards.

The surface area of the dump is approximately 1,500 m^2. As most debris has been removed and stockpiled, the depth is limited to some scattered, partially buried debris and residual contaminated soil. The geophysical survey conducted at Dump A indicated that the debris was spread over six lobes.

Drainage from the area of Dump A flows northward between the toe of the dump and a large bedrock outcrop located east of the dump and then flows towards small ponds 100 m further north. The ponds connect to intermittent drainages eventually connecting to Sarcpa Lake 3 km east. The small ponds immediately north of the dump area are not anticipated to support aquatic life.

The analytical data showed there was limited or no evidence of leachate migration from the dump area.

Based on the information collected, the results of the environmental screening of this dump area indicate a low risk to the surrounding environment. Therefore, the remediation option for this area is to remove surficial debris to a non-hazardous waste landfill and excavate pockets of contaminated soil. All contaminated soil would be transferred to the secure disposal facility and the site then backfilled and graded to match existing topography.

3.4.2 Dump B

Dump B is located 170 m north of the module train, as shown on Drawing 413334-C03. The dump primarily contains building material from the demolished warehouse, barrels, steel beams, electrical parts, cable reels, and construction debris. The geophysical survey conducted at Dump B indicated that the debris was spread over two lobes.

The dump was constructed over a bedrock ledge 4 m to 5 m high. A limited portion of the debris is partially buried. The analytical data showed there was limited or no evidence of contaminated leachate or leachate migration from the dump area.

The surface area of the dump is less than 500 m^2. Bedrock outcrops are present throughout the area, limiting the potential for large volumes of contaminated soil. Drainage from the area flows from the toe of the debris area down to ponds located 50 m further north. The ponds connect to intermittent drainages eventually connecting to Sarcpa Lake 3 km east. The small ponds immediately north of the dump area are not anticipated to support aquatic life.

Based on the information collected, the results of the environmental screening of this dump area indicate a low risk to the surrounding environment. Therefore, the remediation option for this is to remove surficial debris to a non-hazardous waste landfill and excavate pockets of contaminated soil. All contaminated soil would be transferred to the secure disposal facility and the site then backfilled and graded to match existing topography.

3.5 DISPOSAL OF SITE DEBRIS

Several areas of debris not included within Dumps A/B were also investigated in 2004. These debris areas are outlined as follows:

- Former construction camp debris area
- Vehicle pile (south of warehouse)
- Vehicle dump north of Dump A
- Debris near runway
- Tower debris area/sewer outfall debris area
- West barrel cache
- Domestic garbage dump
- Sarcpa Lake borrow areas

All debris will be sorted and classified as hazardous and non-hazardous debris. Hazardous materials will be shipped off site for disposal; non-hazardous materials will be placed in the NHW landfill.

Asbestos containing materials will be double-bagged and disposed of in the NHW landfill. PCB painted material will be segregated and disposed of off site at a disposal facility.

Where scattered or partially buried debris is removed, the area will be reshaped if necessary and any voids left by removal of debris will be backfilled with granular material and graded to match the natural topography.

3.6 BARREL DISPOSAL REQUIREMENTS

In order to determine the correct disposal method for barrels and their contents, the contents must first be identified. A representative number of barrels containing liquids will be sampled and analyzed. Barrels containing only rust and sediment shall be treated as empty barrels.

Barrel contents comprising water only (less than 2% glycols or alcohols) shall be transferred to an open vessel such as a utility tub or half-barrel and any organic material removed by agitation with a pillow or segment of oil absorbent material. The water may then be discarded on to ground that is a minimum of 30 m distance from natural drainage courses. Used oil absorbent material shall be treated as described in the following sections.

Barrel contents which are comprised of water with glycols and/or alcohols or organic phases, and which contain less than 2 mg/L PCBs, 100 mg/L chlorine, 2 mg/L cadmium, 10 mg/L chromium, and 100 mg/L lead, may be disposed of by incineration. Alternatively, these contents may be disposed of off site at a licensed facility. The solid residual material resulting from incineration shall be subjected to a leachate extraction test. Material found to be non-leachate toxic shall be disposed of as contaminated soil. Leachate toxic material will be treated as hazardous waste and disposed of off site at a licensed disposal facility.

Barrel contents which contain greater than 2 mg/L PCBs, 1,000 mg/L chlorine, 2 mg/L cadmium, 10 mg/L chromium or 100 mg/L lead will be disposed of off site at a licensed disposal facility. Contents may be combined with compatible materials for shipping purposes. Flash points may be required to be determined if they cannot be inferred from the product identification.

Used oil absorbent material will be treated as hazardous waste and disposed of off site at a licensed disposal facility. If it is shown to be uncontaminated with PCBs (<2 mg/L), chlorine (<1,000 mg/L), cadmium (<2 mg/L), chromium (<10 mg/L), and lead (<100 mg/L), it may be incinerated on-site.

Empty barrels will be crushed or shredded and landfilled as non-hazardous waste after they have been cleaned in an appropriate manner. The barrels shall be crushed in such a manner so as to reduce their volume by a minimum of 80%. Shredded barrels may be disposed of in the NHW Landfill or off site as recycled metals.

3.7 DEMOLITION OF FACILITIES

The work to be conducted at the CAM-F site includes the demolition, removal and disposal or containerization of all structures and utilities and includes the following:

- Removal and disposal of all contents of buildings identified for demolition, including storage tanks. Tanks and pipes containing fuel must be pumped out or drained prior to cleaning and disposal.
- Removal, segregation and containerization of building facility components coated with PCB amended paint at PCB concentrations in excess of 50 mg/kg.
- Removal and disposal of asbestos material in accordance with the asbestos abatement program. Asbestos must be removed and disposed of in a method that eliminates the risk of exposure to friable asbestos. Proper personal protective equipment and specialized equipment is required when removing asbestos. Asbestos materials are bagged in polyethylene prior to placement in a NHW landfill.
- Removal and disposal of concrete contaminated with PCBs at concentrations greater than 1 mg/kg and less that 50 mg/kg.
- Removal and containerization of concrete contaminated with PCBs at concentrations in greater than 50 mg/kg.
- Removal and placement of hazardous demolition waste material in containers in accordance with the Hazardous Waste Regulations. Hazardous demolition waste is segregated and disposed of according to CEPA Guidelines.
- Removal and disposal of creosote treated timbers in the NHW landfill. Creosote coated power poles or foundations are to be cut off 300 mm below ground level.
- Removal and disposal of drainage culverts.
- Disconnecting and capping of services, as required.
- Non-hazardous materials require no special treatment and can be crushed and placed in the NHW Landfill.

Demolition debris to be disposed of on-site will be cut into shapes and sizes which will minimize void space when landfilled. Concrete foundations are largely left intact except where coated with PCB paints. Following the removal of site structures, demolition areas are reshaped or backfilled with granular fill to a height flush with the remaining foundations.

3.8 REMOVAL OF HAZARDOUS MATERIAL

"Hazardous" waste materials are defined as waste materials that are designated as 'hazardous' under Nunavut Territorial or Federal legislation; or as 'dangerous goods' under the Transportation of Dangerous Goods Act (TDGA). The Canadian Environmental Protection Act (CEPA) regulates material containing PCBs at greater that 50 mg/kg. Specifically identified hazardous materials include: batteries, asbestos, fuel tank bottom sludges, solvents, PCB-containing liquids, fuels and lubricating oils, alcohols and glycols, and heavy metal contaminated liquids. Disposal requirements of these hazardous waste materials are presented in Table 3-2.

Table 3-3: Hazardous Waste Material Disposal Requirements

Hazardous Waste Material	Disposal Requirement

• Batteries
• Metal contaminated organic liquids
  - Cadmium > 2 mg/L
  - Chromium > 10 mg/L
  - Lead > 100 mg/L
• Liquids containing organic compounds with chlorine concentrations > 1,000 mg/L
• Liquids containing organic compounds with PCB concentrations > 2 mg/kg and > 50 mg/kg
• Liquids containing organic compounds other than those described above
	Off site licensed treatment/disposal facility.

• Fuel tank bottom sludges • Fuels, lubricating oils, alcohols and glycols	Off site licensed treatment/disposal facility. OR On-site incineration.
• Liquids and solids containing organic compounds with PCB concentration > 50 mg/kg	Off site licensed treatment and disposal facility.

All hazardous materials are to be shipped off site to a licensed hazardous material disposal facility. The exception to this is asbestos, which will be double-bagged and placed in the NHW Landfill. The location of this material within the landfill will be marked on "as-built" drawings.

The paint on many of the building materials contains PCBs in concentrations greater than 50 mg/kg. The paint and substrate will be collected using suitable equipment for the task, containerized and transported off site for disposal. Temporary storage of these materials on-site will be in accordance with the Temporary Storage of PCB Waste Regulations under CEPA.

3.9 TRANSPORTATION OF HAZARDOUS MATERIALS OFF SITE

Hazardous materials will be placed in environmental suitable containers at an approved containment facility developed on-site as per Environment Canada Guidelines. The hazardous materials will be removed by CAT/Train/sealift in accordance with the Transportation of Dangerous Goods Act.

3.10 GRADING AND ADDITION OF FILL MATERIALS

There were numerous areas identified that require grading and possibly addition of fill material. These areas generally consist of piles of buried or partially buried, non-hazardous debris that will be covered with additional fill material and shaped to blend in with the natural terrain and promote positive drainage. These areas are identified on the drawings.

3.11 CONTRACTOR SUPPORT ACTIVITIES

The following activities will occur on-site to support the remediation work:

- Use of existing beach landing area, airstrip and roads for equipment transport, movement and access to work areas.
- Set-up of the site for camp and equipment storage. Demobilization of clean up of the camp following project completion.
- Sewage from the camp will be handled with, at minimum, primary treatment (settling tank and lagoon) and discharged to ground surface.
- Domestic waste to be disposed (as is, or incinerated as specified by the Land Use Permit) in the new Non-hazardous Waste Landfill.
- Labour and equipment requirements are anticipated to include 15 - 25 personnel, 10 pieces of heavy construction equipment and 2 support vehicles.
- Duration of work is anticipated to be approximately 4 months, not including winter shutdown period, over a period of two years.

4.0 Proposed New Landfills

New landfills are required for both non-hazardous site debris and hydrocarbon F1/F2 and Tier II contaminated soils. The locations of these facilities were based on a variety of factors including:

- Size of the area available.
- Acceptable soil and foundation conditions.
- Limited surface runoff through the area.
- Relatively level topography.
- Does not impede natural drainage in the area.
- Set back from natural water bodies or water courses.
- Groundwater conditions that could affect the ability of the permafrost to function as a containment system.

Two potential debris landfill locations, three potential secure soil disposal facilities and one potential landfarm location were evaluated in 2004.

4.1 NHW Debris Landfill

EBA assessed three possible locations for siting of the NHW debris landfills. Debris landfill location #2, east of the module station between two shallow bedrock features was the preferred and recommended site. This location was close to a source of borrow material, near the majority of site debris (except perhaps for debris from the construction camp) and had suitable soil and groundwater conditions. This location is shown on Drawing 413334-C03.

4.1.1 NHW Debris Landfill Design Parameters

These design parameters for the NHW landfill are outlined as follows:

- Constructed on grade using containment berms around the perimeter of the landfill area. The containment berms should have a maximum outside slope of 3H:1V and an inside slope of 1.5H:1V. The top of the berm should have a minimum width of 2.0 m.
- Debris should be placed in 0.5 m thick lifts with suitable intermediate fill worked into the voids in the debris. The maximum debris thickness should not exceed 2 m.
- The landfill should be capped with a layer of fill compacted to 95% of the Standard Proctor density. The surface will be graded to a slope of between 2% and 4% and contoured to blend into the existing topography.
- A landfill cover of 1 m thick is required.

- The NHW landfill will contain an airspace volume of 4,300 m^3 to include an allowance for 1,000 m^3 of intermediate cover material (assuming a ratio of intermediate cover of 1 part cover to 3 parts debris) and 10% contingency for volume estimate.
- 8,000 m^3 of suitable borrow material will be required for construction of the containment berms and cover.

4.2 SECURE SOIL DISPOSAL FACILITY

EBA assessed three possible locations for secure soil disposal facilities. Location 2, located southeast of the module station, was the preferred and recommended site. This location was close to a source of suitable borrow material, near the majority of contaminated soil and had suitable soil and groundwater conditions. In addition, the site soils had a lower natural moisture content which should reduce concerns regarding constructability issues with wet soils. This location is shown on Drawing 41334-C04.

4.2.1 Secure Soil Storage Facility Design Parameters

The design parameters for the secure soil storage facility are outlined as follows:

- The landfill is to be constructed using a combination of freezeback of the landfilled material and geomembrane cover and liner to ensure secure storage. The soil will be covered with a synthetic cover and sufficient granular cover to ensure that it freezes back and remains in a frozen condition.
- A leachate collection and monitoring system will not be incorporated into the design as it has been shown that they do not function well in a permafrost environment. The combination of freezeback and geomembrane cover and liner will ensure little or no moisture migration into or out of the landfill.
- A key trench will be constructed at the perimeter of the landfill. This detail is illustrated on Drawing 41334-C07.
- The landfill liner system will consist of a HDPE liner. This will be underlain by a non-woven geotextile. This detail is illustrated on Drawing 41334-C08.
- The landfill cover system will consist of 2.4 m granular fill (including bedding material) overlying a HDPE liner. This detail is illustrated on Drawing 41334-C08.
- Constructed on grade using containment berms around the perimeter of the landfill area. The containment berms should have maximum inside/outside slopes of 3H: 1V. The top of the berm should have a minimum width of 3 m.

- Contaminated soil should be placed in 0.3 m thick lifts with a maximum thickness of 2 m.
- The landfill should be capped with a layer of fill compacted to 95% of the Standard Proctor density. The surface will be graded to a slope of between 2% and 4% and contoured to blend into the existing topography.
- The landfill will contain an airspace volume of 3,700 m^3; including an allowance for intermediate cover (3:1 waste/cover ratio) and 10% contingency for volume estimate.
- 18,000 m^3 of suitable borrow material will be required for construction of the containment berms and cover.

4.3 DEVELOPMENT OF BORROW AREAS

Approximately 33,000 m^3 of fill material is required for site clean up. Fill is required for upgrading of the access roads during construction, backfilling contaminated soil areas and general site grading purposes. Additional fill is required for the development of the new non-hazardous waste landfill and the secure soil disposal facility. Sufficient borrow areas were identified in the geotechnical report completed by EBA. Further details on borrow area sources are contained in EBA's geotechnical report.

5.0 Schedule

Detailed site investigations were conducted at CAM-F in 2004, and are scheduled for remediation beginning in 2006, with completion expected in 2007. The contractor will mobilize to Hall Beach in September 2005, by barge or sealift and set up temporary storage in Hall Beach until winter. During the winter of 2005/2006, remediation equipment will be mobilized from Hall Beach into Sarcpa Lake via CAT train. Clean up activities are expected to begin in 2006 and continue through to the summer of 2007, depending on the contractors' approach and weather conditions. In the winter of 2007/2008, equipment will be demobilized from the site to Hall Beach and then from Hall Beach to Montreal via sealift in the summer of 2008.

The expected duration of remedial activities on-site will generally be from July to October. During the winter months, work will cease and equipment and facilities on-site will be winterized. It is expected the contractors' workforce and accessory personnel will mobilize to and from the site from nearby northern communities. Completion of the site remediation and demobilization of the contractors' facilities and equipment is anticipated for 2007/2008.

Long-term monitoring of the landfills will begin upon completion of the clean up (2008) and will continue for a 25-year period. After 25 years, the monitoring requirements will be re-evaluated.

6.0 Summary and Recommendations

A remediation work plan has been developed for the CAM-F Sarcpa Lake site. The major components of the work plan included:

- Contaminated soil excavation/remediation.
- Dump area remediation.
- Collection and disposal of hazardous and non-hazardous debris.
- Demolition and disposal of site facilities.

6.1 CONTAMINATED SOIL REMEDIATION

The following (Table 6-1) summarizes the location, type of contaminant, estimated volume and proposed remediation for contaminated soils at the CAM-F Sarcpa Lake Intermediate DEW Line site:

Table 6-1: Recommended Remediation Options for Contaminated Soil Areas

Location	Contaminant of Concern	Tier I Volume (m^3)	Tier II Volume (m^3)	Comment	Remediation Option
Module Station	PCBs (Tier I&II), PHCs (BTEX, F1, F2), PAHs, metals	0	500	Tier I and Tier II Soil.	Regrade Tier I soils or dispose in the NWH facility. Excavate and dispose Tier II and CCME soils in the secure disposal facility.
Stain NW of Module Station	PCBs, PHCs (F3, F4), metals	0	5	Three small discrete pockets of contamination were grouped together near sewage outfall pipe.	Regrade PHC soils Excavate and dispose Tier II soils in the secure disposal facility.
Sewage Outfall	PCBs (Tier II), metals (Tier II)	0	30	Contamination at end of sewage outfall pipe. More delineation required.	Excavate and dispose Tier II soils in the secure disposal facility.
Warehouse	PCBs, PHCs (F2), metals	20	20	20 m^3 contamination near loading dock.	PHC below 0.5 m, regrade area. Excavate and dispose Tier II soils in on site Secure Disposal Facility.
Garage	PCBs, PHCs (F2, F3), metals (Tier I)	9	20	20 m^3 contamination at north end of garage.	Cover with fill and regrade Tier I metals contamination. Excavate and dispose Tier II and CCME soils in on site Secure Disposal Facility.
Vehicle Pile	PCBs, PHCs (F2, F3), metals (Tier II)	10	100	Contaminated soil beneath old vehicles pile; south of garage.	Excavate and dispose Tier II and CCME soils in on site Secure Disposal Facility.
West Barrel Cache	PHCs (BTEX, F1, F2, F3), PAHs	0	450	Contaminated soil between 0.8 m and 1 m below grade. Some surface stains.	Cover with fill and regrade area.
POL Tanks	PHCs (BTEX, F1, F2, F3), PAHs, metals	0	700	Most PHC contaminated soil between 0.8 m and 1.2 m below grade. Limited volume of BTEX, F1, F2 in shallow soils.	Cover with fill and regrade metals contamination. Excavate and dispose Tier II and CCME soils in on site Secure Disposal Facility.
Dump A	PCBs (Tier I and II, possibly CEPA), metals	133	510	Including estimated 430 m^3 remaining after 1997 clean up.	Cover Tier I soils with fill and regrade. Excavate and dispose Tier II and CCME soils in on site Secure Disposal Facility. If necessary, excavate and dispose CEPA soils off site.
Dump B	PCBs, PHCs (F3, F4), metals (Tier II)	140	120	Further delineation required once debris is removed.	Excavate and dispose Tier II in on site Secure Disposal Facility. Cover Tier I soils with fill and regrade.
Construction Camp	PHCs (F2, F3), PAHs, metals (Tier II)	0	71	11 m^3 former generator site 60 m^3 former machine shop – assume contamination limited to area of former shop.	Cover and regrade Tier I PHCs and metals. Excavate and dispose Tier II and CCME soils in on site Secure Disposal Facility.
		312	**2526**	**TOTAL VOLUME REQUIRING REMEDIATION**	

6.2 DUMP/DEBRIS AREA REMEDIATION

The following (Table 6-2) summarizes the recommended remediation options related to the dump areas at CAM-F Sarcpa Lake Intermediate DEW Line site.

Table 6-2: Recommended Remediation Options

Designation	Recommended Option	Comments
Dump A	Remove surface debris, excavate contaminated soil and buried debris, backfill excavated areas and regrade with clean fill.	Loose debris stockpiled including 550 barrels; 53 wrangler bags of Tier II soil stockpiled. Areas of Tier I and II soil contamination to be removed to a secure soil storage facility. Possible CEPA soils remaining from 1996/97 clean up.
Dump B	Remove surface debris, excavate contaminated soil and buried debris, backfill excavated areas and regrade with clean fill.	Area of equipment/building materials tipped over a small bedrock ledge. Small area of contaminated soil found on surface to be removed to a secure soil storage facility.

6.3 SUMMARY OF NON-HAZARDOUS DEMOLITION AND DEBRIS

The following table (Table 6-3) summarizes the recommended remediation options related to the debris areas at CAM-F Sarcpa Lake site.

Table 6-3: Summary of Demolition/Debris Areas – Non- Hazardous Materials

Debris Area Designation	Approximate Volume (m^3)	Description of Non-Hazardous Debris
Garage	16	Aluminium claddings, structural steel, scrap wood and steel, cement mixer, barrels (concrete floor to remain in place).
Warehouse	11	2 fuel tanks (1,080 L), structural steel, aluminium cladding, scrap wood and steel, barrels, wooden stairs (concrete floor to remain in place).
Module train	177	Building materials (wood, cladding, timbers, flooring insulation etc.), empty high pressure cylinders, office furnishing, small fuel tanks.
Outfall area	4	Pipe, cable and misc. domestic waste.
Quonset Building	24	Building materials (wooden remains from other Quonsets), weathered canvas, empty heating oil tank (1,400L). Bags of asbestos.
Antenna Base area	86	135 m antenna, cables, scattered wood and metal debris (concrete footing to remain in place).
Inuit house area	29	Building materials, stoves, house contents, concrete footings, scrap steel and wood.
Fuel storage area	73	2-75,000 L ASTs, concrete tank pad, piping, pump house, scattered debris including barrels, bombardier track, flat bed trailer etc.
Stained area NW of Module train	7	Steel cable, barrels, scattered wood and metal debris.
Vehicle pile (south of warehouse)	38	Approximately 30 empty barrels, heavy equipment and miscellaneous metal.
West Barrel Cache	450	Includes approximately 5,000 barrels.
Debris near runway	39	Debris scattered near the runway and aircraft crash site includes 150 barrels.
Beach area borrow site	4	Approximately 40 empty barrels.
Dump A	1,119	Steel debris, misc. electrical equipment, wood, 585 empty barrels.
Dump B	159	Cable, wood and metal debris, cat tracks, vehicle parts, domestic waste
Vehicle dump north of Dump B	37	Heavy equipment (grader, truck, 150 scattered barrels etc.) pushed off a small bedrock ledge.
Former construction camp	258	Two small areas of contaminated soil require excavation, backfilling and regrading. Includes approximately 1,970 barrels road construction equipment etc.
Domestic Garbage Dump.	227	Mainly domestic refuse including 700 barrels, glass, wire, wood crates.
Sarcpa Lake Borrow Areas	16	Approximately 100 empty barrels in east borrow area across lake.
	2,774	**TOTAL NON-HAZARDOUS DEBRIS**

6.4 SUMMARY OF HAZARDOUS DEMOLITION AND DEBRIS

The following (Table 6-4) summarizes the hazardous materials at the various demolition/debris areas at the CAM-F Sarcpa Lake site.

Table 6-4: Summary of Demolition/Debris Areas - Hazardous Materials

Debris Area Designation	Approximate Volume (m^3)	Description of Hazardous Debris
Garage	5	PCB paint on metal cladding and surface of concrete floor.
Warehouse	5	PCB paint on fuel tanks, interior plywood and surface of concrete floor.
Module train	25	PCB paint on interior plywood and concrete pad in generator room. Some asbestos piping insulation and tile. Small volumes of miscellaneous fuels/glycols/batteries. Eighteen compressed gas cylinders.
Inuit house area	2	PCB paint on interior wood surfaces. 20 barrels with fuel/POL waste.
Fuel storage area	1.3	PCB paint on exterior of tank. Small volumes of batteries and one barrel of oil near tanks.
Dump B	2.5	15 lead acid batteries, some asbestos containing materials, potential PCB paint on metal.
Vehicle dump north of Dump A	0.24	8 lead acid batteries.
Former construction camp	0.71	21 lead acid batteries
Domestic Garbage Dump.	0.08	3 lead acid batteries
Sarcpa Lake Borrow Areas	0.03	1 lead acid battery
	41.86	**TOTAL HAZARDOUS DEBRIS**

Asbestos containing materials (ACM) will be handled in accordance with standard industry protocols and disposed of in the NHW landfill. ACM are not considered hazardous waste requiring disposal off site.

7.0 References

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Appendix I -
Drawings