AECOM

Remedial Action Plan

PIN-C, Bernard Harbour Intermediate DEW Line Site

Public Services and Procurement Canada

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Executive Summary

PIN-C, Bernard Harbour is a former intermediate DEW Line site (the Site) located in the Kitikmeot Region of Nunavut, on the shores of Dolphin and Union Strait. The Site is composed of two distinct areas: the Main Station and the Beach. Historical facilities at the Site consist of the following: a Garage; a Warehouse; a Module Train; an Inuit House; petroleum, oil, and lubricants (POL) tank concrete foundations at the Main Station and Beach; a dismantled POL pipeline; and a downed Radar Antenna.

AECOM Canada Ltd. (AECOM) completed a Phase III Environmental Site Assessment (ESA) in 2022 to collect the data necessary to identify environmental/physical hazards at the Site, to identify remedial actions, and to collect sufficient information to prepare detailed remedial designs in accordance with the Abandoned Military Site Remediation Protocol (AMSRP). The following are the items requiring remedial action at the Site and the recommended remedial option for each:

Item	Quantity[1]	Recommended Remedial Option
DCC Tier I	73.0 m^3	Cap in place using clean granular material
Type A PHC	-	
DCC Tier II	293.0 m^3	Excavate to clean limits (i.e., until below objective), containerize, and transport off site for disposal at a licensed facility
Hazardous	8.0 m^3	
Type B PHC	942.0 m^3	Excavate to clean limits (i.e., until below objective) and treat onsite (ex-situ) in a CSTF
BDA-1a, -1b, -4a, and -4b	-[2]	Excavate to their full depth/extent and re-grade to match the existing topography
BDA-1c, -1d, -2a, -3a, and -3b	-	Re-grade to accommodate a minimum fill thickness of between 0.5 and 0.75 m
Non-hazardous	871.0 m^3	Collect, containerize, and transport off site for disposal at a licensed facility following volume reduction (e.g., crushing, shredding, and/or incineration)
Hazardous	215.0 m^3	Collect, containerize, and transport off site for disposal at a licensed facility
Type 2	10,893.0 m^3	Use in the construction of the CSTF and to re-grade contaminated soil areas and BDAs
Type 3	1,943.0 m^3	Use to backfill excavated BDAs and contaminated soil excavations
Type 5	968.0 m^3	Use in the construction of the CSTF
Geotextile	7741.0 m^2	
Geomembrane	3871.0 m^2	

Note: cubic metres (m^3), metres (m), contaminated soil treatment facility (CSTF), buried debris area (BDA),

[1]Quantities include a design contingency and bulking factor (where appropriate).

[2]Excavation quantities included in DCC Tier I and DCC Tier II contaminated soil quantities and non-hazardous/hazardous waste quantities.

It is anticipated, based on the assumption that the Contractor will mobilize to the Site via barge, that the Contractor will mobilize during the fall of the first calendar year (Year 1) and initiate the construction of critical items at this time. Most of the remediation activities are anticipated to be completed during the second calendar year (Year 2) prior to demobilization in the fall of Year 2.

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1. Introduction

AECOM Canada Ltd. (AECOM) was retained by Public Services and Procurement Canada (PSPC), on behalf of Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC), to prepare a Remedial Action Plan (RAP) for the PIN-C, Bernard Harbour former intermediate Distant Early Warning (DEW) Line site (the Site). The goal of the RAP is to provide the foundation for the development of a remedial design that will address the environmental liabilities that were identified during the Phase III Environmental Site Assessment (ESA) (AECOM, 2022). Based on the results of the Phase III ESA, remedial options for each clean-up item (e.g., treatment and/or disposal of contaminated soil, disposal of debris and demolition waste, closure of existing buried debris areas, etc.) were developed. Where multiple remedial options were evaluated, a cost estimate was prepared to compare the options. The RAP is structured as follows:

- Section 2 outlines the background information for the Site that forms the basis for the remedial option evaluations and recommendations
- Section 3 summarizes the results of the contaminated soil investigation and presents an assessment of the remedial options for the types of contaminated soil identified
- Section 4 summarizes the results of the buried debris assessment and presents an assessment of the remedial options for the identified buried debris areas
- Section 5 summarizes the results of the hazardous materials inventory/demolition assessment and waste survey and presents an assessment of the remedial options
- Section 6 summarizes the results of the non-hazardous materials inventory/demolition assessment and waste survey and presents an assessment of the remedial options
- Section 7 provides evaluations of onsite versus offsite treatment and/or disposal options
- Section 8 provides a discussion of implementation considerations related to the recommended remedial options presented in Sections 3 to 6
- Section 9 provides a summary of the community engagement (i.e., community-level RAP workout meeting) that was completed in finalizing the RAP
- Section 10 provides a summary of the final design quantities and remedial recommendations

2. Background

PIN-C, Bernard Harbour is a former intermediate DEW Line site located in the Kitikmeot Region of Nunavut, on the shores of Dolphin and Union Strait (Figure 1 and Figure 2). The Site was constructed in 1958 and subsequently abandoned in 1963. CIRNAC became the custodian of the Site in 1965. The Site is composed of two distinct areas: the Main Station (Figure 3 and Figure 4) and the Beach (Figure 5). Historical facilities at the Site consist of the following: a Garage; a Warehouse; a Module Train; an Inuit House; petroleum, oil, and lubricants (POL) tank concrete foundations at the Main Station and Beach; a dismantled POL pipeline; and a downed Radar Antenna. The POL tanks at the Main Station and Beach have been removed since abandonment of the Site. There is an unnamed lake located approximately 1 kilometre (km) northwest of the Main Station that historically served as a drinking water source (the Drinking Water Lake) and another lake, the East Lake (Figure 6), located approximately 1 km southeast of the Main Station. There is also a North Warning System (NWS) short-range radar (SRR) installation located approximately 5 km southwest of the Site. Two contemporary NWS POL tanks are located at the Beach within the same footprint as the historic POL foundations.

Assessment and remediation activities at the Site since its abandonment have included the following:

- A hazardous material clean-up program, conducted jointly in 1995 by the Department of National Defence (DND), Environment Canada, and the Department of Indian Affairs and Northern Development, focused on removal of equipment considered hazardous or containing hazardous materials (ESG, 1993). Abandoned fuels were also removed and burned (ESG, 1993; Holtz et al., 1986).
- An environmental investigation to ascertain the environmental status of the Site and to propose clean-up plans was conducted by the Environmental Sciences Group in 1992 (ESG, 1993).
- A supplemental environmental investigation, to better characterize contaminants of concern at the Site, was conducted by WESA Inc. in 2011 (WESA, 2011).
- A Phase III ESA, to collect the data necessary to identify environmental/physical hazards at the Site, to identify remedial actions, and to collect sufficient information to prepare detailed remedial designs in accordance with the Abandoned Military Site Remediation Protocol (AMSRP), was conducted by AECOM in 2022 (AECOM, 2022). The scope of work for the Phase III ESA included the following:
    - Delineating contaminated soil areas
    - Conducting a hazardous and non-hazardous materials inventory, demolition assessment, and waste survey (i.e., building materials, surface debris areas, barrel contents)
    - Conducting a buried debris assessment including completing a geophysical survey of suspected buried debris areas
    - Completing a borrow source assessment to identify borrow sources that may be used by a Contractor during remediation
    - Identifying potential locations for the construction of engineered facilities (e.g., non-hazardous waste landfill, contaminated soil treatment/disposal facility)
    - Evaluating site access including site access roads, beach landing area, and airstrip
    - Completing a detailed topographic survey of the Site
    - Sampling surface water from the two lakes found at the Site
    - Evaluating the potential logistical challenges associated with mobilization, site remediation, and demobilization activities

2.1 Remedial Protocols/Criteria

The remedial recommendations provided herein are based primarily on the AMSRP (INAC, 2009). The remedial protocols outlined in the AMSRP were developed through the review of previous work at DND and Indian and Northern Affairs Canada (INAC) sites and take into consideration the unique characteristics of the INAC sites. The primary components of the clean-up of INAC abandoned military sites includes the following:

- The treatment and/or disposal of contaminated soil (contaminated with inorganic elements, polychlorinated biphenyls (PCBs), and/or petroleum hydrocarbons (PHCs))
- The disposal of debris (e.g., surface debris, barrels, barrel contents) and demolition waste (including non-hazardous and hazardous waste) associated with the demolition of structures and facilities
- The closure of existing buried debris areas as identified by geophysical surveys
- The construction of new engineered landfills, soil treatment facilities, and/or soil disposal facilities
- The development of borrow sources and site grading activities

There are no criteria for the classification of hazardous waste at federal sites except for materials regulated under the Canadian *Environmental Protection Act* and the *Cross-border Movement of Hazardous Waste and Hazardous Recyclable Material Regulations*. Additionally, the *Transportation of Dangerous Goods Act* and *Regulations*, the Northwest Territories *Guideline for Hazardous Waste Management*, and the Nunavut *Guideline for the General Management of Hazardous Waste* were used in hazardous material classification and in developing remedial options related to the disposal of these materials.

Additional details related to the remedial guidelines and/or requirements used in developing and evaluating remedial options are provided in Sections 3 to 6.

2.2 Site-Specific Remedial Considerations

The following sections provide details related to the site-specific considerations that have been considered in the development of the RAP.

2.2.1 Offsite Access

The shoreline at the Beach is composed of well-draining, coarse-grained beach deposits which are competent and are not expected to pose a problem for beaching or using heavy equipment in the area for movement of materials upon landing. There is a road from the Beach to the Main Station which could be used for off-loading operations. Aerial footage of the near shore environment indicates a short continental shelf with good depth of water which should not pose an issue for on-shore barge access. The Beach area shows little topographic relief with a maximum elevation change of 3 to 5 metres (m) from the shore. Eroded slope faces approximately 1 to 1.5 m high were observed 5 to 7 m from the shore during the Phase III ESA. A steeper slope on the north side of the bay showed signs of weathering, likely from storm surges.

When developing and implementing a RAP, the AMSRP states that climate change in an Arctic setting needs to be considered as a key consideration. As detailed in the Phase III ESA (AECOM, 2022), sea level rise predictions are expected to vary from 0 to 0.2 m and 0.2 to 0.4 m, depending on the climate change scenario. These sea level rise predictions are based on the Fifth Assessment Report(s) of the Intergovernmental Panel on Climate Change (IPCC) and on the NAD83v70VG National Crustal Velocity Model. Projections are relative to 1986-2005 and are given for the median value (and 5th and 95th percentiles) for Representative Concentration Pathway (RCP) scenarios RCP2.6, RCP4.5, and RCP8.5. The climate change considerations presented in the Phase III ESA used a compilation of global circulation models and included consideration of both the RCP4.5 and RCP8.5 scenarios; the RCP8.5 scenario (worst-case scenario) is the recommended one for Arctic environments. This methodology is consistent with the recommendations presented in the AMSRP.

Given the low relief of the Beach area and the potential sea level rise projections, sea level rise extending further inland compounded with seawater saturating the ground from storm surges, an increase in active layer depth, and associated beach erosion is likely.

The onsite Airstrip, located north of the Main Station, is approximately 1,000 m long, 32 m wide, and is generally in good condition. The surface of the Airstrip consists of sandy gravel with trace silt and clay and sparse vegetation. Frost wedge cracking was noted at several locations along its length during the Phase III ESA. Two test pits were excavated at the Airstrip during the Phase III ESA. Subsurface soils encountered in both test pits included sand and gravel underlain by silty-sand. In-situ dynamic cone penetrometer tests were also performed at five locations, which consistently indicated an increase in California Bearing Ratio value with depth. In-situ tests and lab tests indicated that the surfacing consists of a competent granular material even in saturated conditions. Following repairs of the frost wedges, the existing gravel Airstrip has the capacity to support aircraft with an aircraft loading rating up to 8 such as a de Havilland Canada DHC-3 Otter, DHC-6 Twin Otter, DHC-5 Buffalo, Shorts Skyvan, DC-3, DC-4, and DC-9. It is also possible to use a Hercules C130 on the airstrip; however, access should be limited to dry conditions. It is recommended that the airstrip be inspected by aircraft crew familiar with necessary gravel surface requirements prior to its use by any aircraft.

It should be noted that both the Beach landing area and the Airstrip are located within a DND reserve boundary; as such, access to the Beach area and/or Airstrip requires approval from DND.

It has been assumed that mobilization/demobilization of materials and equipment by the Contractor will be primarily by barge. There are currently no nearby mining operations; therefore, there is limited potential for independent development of an ice road that could be used for Contractor mobilization. Overland mobilization (i.e., Cat train) is also an unlikely Contractor mobilization option due to the extended distance from the nearest community. Additionally, it has been assumed that aircraft access to the Site (i.e., mobilization of personnel) would not be an issue, especially given the assumption that primary mobilization/demobilization of Contractor materials and equipment will be via barge.

2.2.2 Onsite Access

The Site has two roads connecting to the Main Station and a secondary road from the Main Station to the Drinking Water Lake. The primary road is approximately 3,100 m long, 8 m wide, and has an east-west orientation, which connects the Beach to the Main Station. The surface of the road consists of cobbles and gravel with sandy gravel and trace silt and clay. Small patches of vegetation were observed on the roadway. The road is generally in good condition except for a drainage crossing located north of the East Lake. A previously placed culvert is no longer functional, and some minor erosion and settlement has occurred. The section is still readily passable but will require culvert replacement and addition of competent granular material prior to heavy vehicle traffic.

The road from the Airstrip to the Garage at the Main Station is approximately 400 m long, 7.5 m wide, and has a northeast-southwest orientation for 220 m before curving northwest-southeast for another 160 m. The elevation increases from 17 to 30 m and has the same surface structure as the main road. The road is generally in good condition.

The secondary road connecting the Main Station to the Drinking Water Lake is approximately 1,300 m long, and 5.5 m wide, with a relatively east-west orientation. The road has the same surface structure as the main road to the Beach, and is relatively flat, with a few gentle slopes. The condition of the road is generally good.

Vehicles used during the Phase III ESA included ATVs and a backhoe mounted Kubota tractor, all of which could travel along the two main roads. The ATVs were also used for site reconnaissance activities to the Drinking Water Lake. It is recommended that future construction at the Site include the installation of a new culvert at the East Lake and some general grading of all roads.

2.2.3 Environmental Considerations

Information on land use of the Site was obtained during the Phase III ESA from Fredd Taptuna and Jeffrey Niptanatiak, experienced local wildlife monitors and members of the Kugluktuk Hunters and Trappers Association. The overall Bernard Harbour area is a common camping location when Kugluktuk residents are caribou hunting or fishing.

Characteristic wildlife of the Bernard Harbour area includes muskox, caribou, arctic hare, arctic fox, snowy owl, raptors, polar bear, seal, seabirds, and waterfowl. Caribou were observed near the Main Station during the Phase III ESA which had been using the open garage for shelter, as evidenced by odour and widespread presence of hair on the floor. Arctic hare and ground squirrels were also regularly observed around the Main Station. A stoat (likely tundra stoat) was observed by one of the wildlife monitors emerging from a burrow underneath the Garage slab. Several species of birds were observed including horned larks, savannah sparrows, Canada geese and two species of gulls (ESG, 1992).

Vegetation in the Bernard Harbour area is characterized by a nearly continuous cover of dwarf tundra vegetation including dwarf birch, willow, northern Labrador tea, Dryas spp., and Vaccinium spp. During the Phase III ESA, it was observed that the Site was sparsely vegetated in worked locations, and that vegetation was patchy to continuous in less worked and low-lying areas (e.g., south of the Main Station). Plants consisted mainly of low-lying willows, sedges, grasses, and a variety of wildflowers. Numerous lichens and mosses were also found around the Site.

2.2.4 Geology/Geomorphology/Hydrology

The Bernard Harbour area lies within the zone of continuous permafrost. Based on observations made during the Phase III ESA, permafrost is present at the Site between approximately 1.3 to 1.7 m below ground surface; however, it should be noted that depth of permafrost is highly variable across the Site. Bedrock geology is comprised of carbonates with intermingled siliciclastic sedimentary deposits and is overlain by glacial deposits. The Main Station area is dominated by glacial depositional landforms in the form of drumlins. Glacier flow has re-worked till into oblong shapes (with glacial flow direction likely from east to west). The Beach area is dominated by marine depositional features. Intervals of rapid isostatic uplift combined with changes in sea level have resulted in a series of beach ridges. Permafrost patterned ground of varying types is present across the Site and surrounding areas. Low-lying terrain to the south of the Main Station includes small ponds and bogs, many of which appear to contain water only periodically.

No areas exhibiting signs of erosion due to existing site drainage were observed during the Phase III ESA. None of the soil types identified are particularly prone to erosion; however, areas near the coast will likely be subject to future erosion by storm surges in the event of climate change associated sea level rise (see Section 2.2.1 for additional details). At this time, site operations are not expected to be at risk of significant erosion.

High local natural concentrations of various trace metals have been observed at several DEW Line sites (e.g., BAR-3, PIN-1, DYE-M, FOX-2, and FOX-3). Since naturally elevated concentrations of trace metals may affect assessment and subsequent remediation activities, the AMSRP (Volume II) requires that further characterization of background concentrations is warranted to properly differentiate between natural and anthropogenic levels of trace metals and assist in defining the boundaries of contamination at certain sites. Although the AMSRP (Volume II) does not list PIN-C as one of the sites where background geochemical sampling is recommended, based on guidance provided in the AMSRP, a review of other similar DEW Line sites where there is a likelihood of encountering naturally elevated concentrations of inorganic elements, and a review of available information on the regional geology and geochemistry of Bernard Harbour, the Site is not expected to have naturally occurring inorganic element concentrations above the AMSRP clean-up criteria. This corresponds well with the results from over 100 samples collected by AECOM during the background geochemical survey at PIN-2, Cape Young where no sample results collected across geomorphological units had concentrations exceeding the clean-up criteria for the DEW Line contaminants of concern. PIN-2 is located less than 100 km from PIN-C and is in the same geologic setting as PIN-C.

2.2.5 Archaeological Features

AECOM contracted ERM Consultants Canada Ltd. (ERM) to conduct an Archeological Impact Assessment (AIA) of the Site to support the remedial planning. The objectives of the Archaeological Impact Assessment (AIA) were to identify any heritage sites affected by previous or planned activities at the Site, evaluate the existing or potential effects to these sites, and develop appropriate archaeological avoidance strategies and/or mitigation options for these sites.

The field component of the AIA was completed on July 28 and 29, 2022 under Nunavut Class 2 Archaeologist Permit 2022 16A issued to Brent Murphy of ERM. Fredd Taptuna and Jeffrey Niptanatiak, members of the Kugluktuk Hunters and Trappers Association, participated in the fieldwork.

No archaeological sites or materials were observed or recorded.

The AIA (*PIN-C Bernard Harbour Remediation Project: Archaeological Impact Assessment Final Report, NU Permit 22-016A*) was submitted under separate cover.

3. Contaminated Soil Remediation

3.1 Remedial Criteria and Clean-up Protocols

The investigation and delineation of contaminated soil at the Site was completed for the contaminants of concern identified in the *Abandoned Military Sites Remediation Protocol* (INAC, 2009). This allows for a consistent approach to be used across all former DEW Line sites and is generally considered protective of the Arctic ecosystem.

Two sets of inorganic soil criteria (i.e., As, Cd, Cr, Co, Cu, Pb, Hg, Ni, Zn, PCBs) are presented in the AMSRP: Tier I, which apply to a depth of 0.3 m below ground surface, and Tier II, which apply at all depths.

The AMSRP also identifies criteria applicable to petroleum hydrocarbon (PHC) contaminated soil. PHCs are made up of 4 fractions based on equivalent normal straight-chain hydrocarbon boiling point ranges. In the AMSRP, Type A PHCs, which are typically found in heavy end products (e.g., lubricating oils), are defined as consisting of the sum of the F3 and F4 fractions whereas Type B PHCs, which are typically found in lighter end or more volatile hydrocarbon products (e.g., gasoline, jet fuel, diesel), are defined as consisting of the sum of the F1 through F3 fractions. The AMSRP specifies different numerical clean-up criteria based on the type of PHCs present, the proximity of the impact to significant water bodies, and the depth of the impact.

Table 1 provides a summary of contaminated soil remedial criteria and Table 2 outlines the contaminated soil remedial and disposal options outlined in the AMSRP. In accordance with the AMSRP, where multiple contaminants are present in the soils, the most conservative remedial option that addresses all contaminant types shall be applied. The remedial options and disposal options listed in Table 2 include those outlined in the AMSRP as well as additional options that may be applicable specifically to PIN-C (e.g., containerize and transport offsite for disposal DCC Tier I contaminated soil).

Table 1: Contaminated Soil – Remedial Criteria

Criteria	Contaminants	Objective (mg/kg)	Applicable Depth (mbgs)
DCC Tier I	Lead (Pb) PCBs	>200, <500 >1, <5	0.0 to 0.3 (surficial objective)
DCC Tier II	As Cd Cr Co Cu Pb Hg Ni Zn PCBs	30 5 250 20 100 500 2 100 500 >5, <50	Until below objective
Hazardous	PCBs Leachable Pb	50 5 mg/L	Until below objective
Type B PHCs	F1+F2+F3 (>30 m from waterbody)	2,500 5,000	0.0 to 0.5 >0.5
	F1 F2 (<30 m from waterbody)	1290 330	Until below objective
Type A PHCs	F3+F4	20,000	0.0 to 0.5 (surficial objective)

Note: mg/kg – milligrams per kilogram, mbgs – metres below ground surface, m^3 – cubic metres.

Table 2: Contaminated Soil – Remedial and Disposal Options

Criteria	Remedial Option(s)	Disposal Option(s)
DCC Tier I	• Excavate to 0.3 m below ground surface and dispose of (contaminated waste) OR • Cap in place under 0.3 m of clean fill (if in a stable location)	• Dispose of in onsite Non-Hazardous Waste Landfill (NHWL) OR • Containerize and transport offsite for disposal at a licensed facility (contaminated waste)
DCC Tier II	• Excavate until below objective (i.e., clean limits) and dispose of (contaminated waste)	• Dispose of in onsite Tier II Soil Disposal Facility (Tier II SDF) OR • Containerize and transport offsite for disposal at a licensed facility (contaminated waste)
Hazardous	• Excavate until below objective (i.e., clean limits) and dispose of (hazardous waste)	• Containerize and transport offsite for disposal at a licensed facility (hazardous waste)
Type B PHCs (within 30 m of a water body)	• Excavate until below objective (i.e., clean limits) and dispose of (contaminated waste)	• Treat onsite (ex-situ) in land-farm (or similar) OR • Containerize and transport offsite for treatment (ex-situ) or disposal at a licensed facility (contaminated waste)
Type B PHCs (surface soils and depth soils where moderate to high risk for migration or receptor impact)	• Excavate until below objective (or until 0.5 m below ground surface) and dispose of (contaminated waste) OR • Treat in-situ (exceptional cases)	• Treat onsite (ex-situ) in land-farm (or similar) • Containerize and transport offsite for treatment (ex-situ) or disposal at a licensed facility (contaminated waste)
Type B PHCs (below 0.5 m depth, where low risk for migration or receptor impact)	• Excavate until below objective* (i.e., clean limits) and dispose of (contaminated waste) OR • Treat in-situ (exceptional cases) *Excavate until below objective with reason – where impacts extend into permafrost, evaluate whether risk management is an acceptable option	• Treat onsite (ex-situ) in land-farm (or similar) • Containerize and transport offsite for treatment (ex-situ) or disposal at a licensed facility (contaminated waste)
Type A PHCs	If >4m^2 and above criteria: • Excavate to 0.5 m below ground surface and dispose of (contaminated waste) OR • Cap in place under 0.5 m of clean fill (if in a stable location) If < 4 m^2 and/or meets criteria: • Scarify surficial staining	• Dispose of in onsite NHWL OR • Containerize and transport offsite for disposal at a licensed facility (contaminated waste)

3.2 DCC Tier I / Type A PHC Contaminated Soil

The total estimated volume of DCC Tier I Contaminated Soil is 149.3 cubic metres (m^3) (including contingency). It should be noted that this volume includes contaminated soil from both contaminated soil areas (91.5 m^3) and buried debris areas (57.8 m^3) (see Section 4.2 for additional details). Table 3 presents a summary of the DCC Tier I contaminated soil volumes expected from the excavation of contaminated soil areas. Additional details for each of the DCC Tier I contaminated soil areas is provided in Appendix B.

Table 3: DCC Tier I Contaminated Soil Areas – Summary

Location	Area (m^2)	Depth (m)	Contingency	Volume (m^3)
Garage – Area 2 (Figure 10)	18.2	0.3	30%	7.1
Garage – Area 4 (Figure 10)	6.2	0.3	30%	2.4
North of Garage – Area 2 (Figure 10)	7.6	0.3	20%	2.7
Warehouse – Area 1 (Figure 11)	36.4	0.3	10%	12.0
Module Train – Area 1 (Figure 11)	88.3	0.3	30%	34.4
Module Train – Area 3 (Figure 11)	20.3	0.3	30%	7.9
Module Train – Area 4 (Figure 11)	6.2	0.3	50%	2.8
Module Train – Area 5 (Figure 11)	28.1	0.3	10%	9.3
Module Train – Area 6 (Figure 11)	38.7	0.3	10%	12.8
Total				91.5

The total estimated volume of Type A PHC contaminated soil is 2.6 m^3 (including contingency). Table 4 presents a summary of the Type A PHC contaminated soil volumes expected from the excavation of contaminated soil areas. Additional details for each of the Type A PHC contaminated soil areas is provided in Appendix B.

Table 4: Type A PHC Contaminated Soil Areas – Summary

Location	Area (m^2)	Depth (m)	Contingency	Volume (m^3)
SDA-4 (Figure 14)	4.3	0.5	20%	2.6

The remedial/disposal options for DCC Tier I and Type A PHC contaminated soil are presented in Table 2. In accordance with the AMSRP and based on the fact that the construction of a non-hazardous waste landfill is not recommended at the Site (see Section 7.1 for additional details), it is recommended that DCC Tier I and Type A PHC contaminated soil be capped in place using clean granular material (see Section 7.2 for additional details).

3.3 DCC Tier II Contaminated Soil

The total estimated volume of DCC Tier II Contaminated Soil is 233.9 m^3 (including contingency). It should be noted that this volume includes contaminated soil from both contaminated soil areas (151.5 m^3) and buried debris areas (82.4 m^3) (see Section 4.2 for additional details). Table 5 presents a summary of the DCC Tier II contaminated soil volumes expected from the excavation of contaminated soil areas. Additional details for each of the DCC Tier II contaminated soil areas is provided in Appendix B.

Table 5: DCC Tier II Contaminated Soil Areas – Summary

Location	Area (m^2)	Depth (m)	Contingency	Volume (m^3)
Garage – Area 1 (Figure 10)	0.8	0.6	50%	0.7
Garage – Area 3 (Figure 10)	5.5	0.6	30%	4.3
North of Garage – Area 1 (Figure 10)	76.9	0.3	20%	27.7
Module Train – Area 1 (Figure 11)	116.2	0.6	30%	90.6
Module Train – Area 2 (Figure 11)	15.6	0.3	10%	5.1
Module Train – Area 3 (Figure 11)	44.2	0.4	30%	23.0
Total				151.5

It should be noted that the hazardous contaminated soil in Module Train – Area 3 is underlain by approximately 0.4 m of DCC Tier II contaminated soil.

The remedial/disposal options for DCC Tier II contaminated soil are presented in Table 2. In accordance with the AMSRP, it is recommended that DCC Tier II contaminated soil be excavated to clean limits (i.e., until below objective), containerized, and transported offsite for disposal at a licensed facility (see Section 7.3 for additional details).

3.4 Hazardous Contaminated Soil

The total estimated volume of hazardous contaminated soil is 6.2 m^3 (including contingency). Table 6 presents a summary of the hazardous contaminated soil volumes expected from the excavation of contaminated soil areas. Additional details for each of the hazardous contaminated soil areas is provided in Appendix B.

Table 6: Hazardous Contaminated Soil Areas – Summary

Location	Area (m^2)	Depth (m)	Contingency	Volume (m^3)
Module Train – Area 3 (Figure 11)	15.8	0.3	30%	6.2

It should be noted that the hazardous contaminated soil in Module Train – Area 3 is underlain by approximately 0.4 m of DCC Tier II contaminated soil.

The remedial/disposal options for hazardous contaminated soil are presented in Table 2. In accordance with the AMSRP, it is recommended that hazardous contaminated soil be excavated to clean limits (i.e., until below objective), containerized, and transported offsite for disposal at a licensed facility.

3.5 Type B PHC Contaminated Soil

The total estimated volume of Type B PHC contaminated soil is 753.0 m^3 (including contingency). Table 6 presents a summary of the Type B PHC contaminated soil volumes expected from the excavation of contaminated soil areas. Additional details for each of the Type B PHC contaminated soil areas is provided in Appendix B.

Table 7: Type B PHC Contaminated Soil Areas – Summary

Location	Area (m^2)	Depth (m)	Contingency	Volume (m^3)
Station POL – Area 1 (Figure 12)	14.3	1.3	30%	24.2
Station POL – Area 2 (Figure 12)	101.3	0.8	30%	105.4
Station POL – Area 3 (Figure 12)	400.2	1.0	30%	520.3
Beach POL – Area 1 (Figure 15)	58.7	0.5	30%	38.2
Beach POL – Area 2 (Figure 15)	43.4	1.0	50%	65.1
Total				753.0

One continuous plume was identified at the Station POL with three areas distinguished based on depth of contamination: Area 1 has a depth ranging from surface to 1.3 mbgs, Area 2 has a depth ranging from 0.5 mbgs to 1.3 mbgs, and Area 3 has a depth ranging from 0.5 mbgs to 1.5 mbgs.

Beach POL – Area 1 and Beach POL – Area 2 are likely connected at depth; this factor was considered when applying the design contingency to these two areas.

It should be noted that the Type B PHC contaminated soil identified in Beach POL – Area 2 is subject to a more stringent AMSRP criterion (nearshore) than the Type B PHC contaminated soil from other locations.

Based on this, the contaminated soil from Beach POL – Area 2 could potentially be re-located to a suitable storage area outside of the nearshore zone with no treatment needed.

The remedial/disposal options for Type B PHC contaminated soil are presented in Table 2. In accordance with the AMSRP, it is recommended that Type B PHC contaminated soil be excavated to clean limits (i.e., until below objective) and treated onsite (ex-situ) in a contaminated soil treatment facility (see Section 7.4 for additional details). Treated Type B PHC contaminated soil could either be used for backfilling contaminated soil excavations and/or buried debris excavations (dependent on treatment timing) or spread out and re-shaped in the area immediately next to the contaminated soil treatment facility (CSTF).

Additionally, it is recommended that the 65.1 m^3 of contaminated soil in Beach POL – Area 2 be transported to a designated area outside of the nearshore zone to reduce the amount of Type B PHC contaminated soil to be treated.

3.6 Summary

Table 8 summarizes the recommended remedial option for each type of contaminated soil as well as the associated material quantities (including contingency). Design contingency was applied to each contaminated soil area on a case-by-case basis to account for the unique nature of each area and to properly reflect the uncertainty associated with the environmental information collected from each area (see Sections 3.2 to 3.5 and Appendix B for additional details). A design contingency of 10% was applied to the volume of clean granular material required for backfilling and re-grading contaminated soil areas.

Table 8: Contaminated Soil – Material Quantities Summary

Type of Contaminated Soil	Recommended Remedial Option	Volume of Contaminated Soil (m^3)	Backfill / Re-grade Volume (m^3)[1]
DCC Tier I	Re-grade Capped in place using clean granular material.	-	158.9
Type A PHC		-	3.1
DCC Tier II	Excavate Containerize and transport offsite for disposal.	151.5	151.5
Hazardous		6.2	6.2
Type B PHC	Excavate Treat onsite in a contaminated soil treatment facility.	753.0	753.0
Subtotal		910.7	1072.7
Design Contingency (10%)		-	107.3
Total		910.7	1180.0

[1]Refer to Section 8.6 for a discussion of granular material types.

4. Buried Debris Remediation

Solid waste disposal areas on CIRNAC DEW Line sites are generally smaller in extent than those located on DND DEW Line sites and may be more appropriately referred to as buried debris areas (BDAs). The assessment of BDAs was completed with the goal of defining lateral extents of buried debris and classifying the identified BDAs into one of the three classes specified in the AMSRP:

- Class A: the BDA is in an unstable, high erosion location or at an elevation of less than two metres above mean sea level
- Class B: the BDA is in a suitable, stable location but there is evidence of contaminant migration
- Class C: the BDA is in a suitable, stable location, with no evidence of contaminant migration

Based on a review of available historical air photos, six potential BDAs were identified. The six potential BDAs were visually assessed during the Phase III ESA to confirm whether they were suspected of containing buried debris, and to then define more accurately the specific areas for geophysical survey. Visual assessment eliminated two of the potential areas, with geophysical survey boundaries set up for the remaining four areas. The geophysical survey was completed using a GEM GSM 19G Overhauser Magnetic Gradiometer with integrated GPS. All four BDAs were broken up into several smaller areas (e.g., BDA-3a, BDA-3b) based on the results of the geophysical survey.

Soil samples were collected, both up-gradient and down-gradient of each laid out magnetic anomaly perimeter to investigate whether any of the BDAs were acting as contaminant sources. Down-gradient concentrations of inorganic elements were compared with up-gradient concentrations, as well as the average concentrations for all buried debris samples, to identify potential contaminant migration. Where a down-gradient concentration was three or more times the average up-gradient concentration, it was flagged as potential evidence of contaminant migration and further investigated in terms of its location, whether there was continued evidence of contaminant migration further down-gradient, and whether there were multiple elevated contaminants.

The following additional information was also noted at each BDA: down-gradient aquatic and terrestrial receptors, physical characteristics that could affect the potential for contaminant migration, geotechnical stability, evidence of (or potential for) erosion or slope failure, and constructability concerns for potential remedial options.

4.1 Remedial Criteria and Clean-up Protocols

Table 9 outlines the buried debris remedial and disposal options outlined in the AMSRP. Sections 4.1.1 to 4.1.3 describe in further detail the remedial approaches applicable to each of the three classes of buried debris areas identified in the AMSRP. For all BDAs, regardless of classification, it is recommended that all surface contaminated soil be excavated, and all surface debris and exposed buried debris be collected and removed prior to starting the selected remedial approach.

Table 9: Buried Debris – Remedial and Disposal Options

Class	Remedial Option(s)	Disposal Option(s)
All	• Excavate contaminated soil (surface) AND • Collect and segregate surface debris and exposed buried debris	• Dispose of contaminated soil (surface) in accordance with Section 3 • Dispose of surface debris and exposed buried debris in accordance with Section 5 and Section 6
Class A BDA is in an unstable, high erosion location	• Excavate buried debris area to full depth/extent and segregate buried debris to allow classification of the various waste streams	• Dispose of waste streams in accordance with Section 3, Section 5, and Section 6
Class B BDA is in a suitable, stable location but there is evidence of contaminant migration	• Construct a suitably engineered containment system[1] OR • Excavate buried debris area to full depth/extent and segregate buried debris to allow classification of the various waste streams	• For excavation remedial option, dispose of waste streams in accordance with Section 3, Section 5, and Section 6
Class B (less than 1000 m^2)	If contaminants are present above criteria: • Excavate buried debris area to full depth/extent and segregate buried debris to allow classification of the various waste streams If contaminants are present below criteria and no sensitive receptors are present downgradient: • Cut-off and remove buried debris within the upper 0.5 m of the ground surface AND • Re-grade buried debris area to promote surface water run-off, prevent erosion, and mitigate against settlement	• For excavation remedial option, dispose of waste streams in accordance with Section 3, Section 5, and Section 6
Class C	• Construct an engineered cover (generally 0.75 m thick, depending on presence of existing cover) designed to promote surface water run-off, prevent erosion, and mitigate against settlement – Where required, change slope and/or incorporate geotextiles into the granular cover OR • Excavate buried debris area to full depth/extent and segregate buried debris to allow classification of the various waste streams IF there are constructability challenges with constructing the cover	• For excavation remedial option, dispose of waste streams in accordance with Section 3, Section 5, and Section 6

Class	Remedial Option(s)	Disposal Option(s)
BDA is: • located at an elevation of less than 2 m higher than an ocean • consists of unconsolidated wastes at surface • less than 1000 m^2 scoring a total of 89 points or more (or greater than 23 points in the contaminant source category)	• Excavate buried debris area to full depth/extent and segregate buried debris to allow classification of the various waste streams	• Dispose of waste streams in accordance with Section 3, Section 5, and Section 6

[1]Permafrost containment shall be designed following the geothermal requirements outlined in the AMSRP (Section 5.4.2). The remedial solution will be based on a cost benefit analysis that includes consideration of construction costs and long-term monitoring costs. This option is generally not cost effective for buried debris areas <1000 m2.

4.1.1 Excavation (Class A)

Class A BDAs are classified as high potential environmental risk. The risk associated with these BDAs is generally a result of the ecological sensitivity of the area and/or the geometry and surrounding topography of the BDA, which precludes the development of a cost-effective and long-term design solution (i.e., pathway intervention and/or stabilization). In general, the remediation approach for Class A BDAs includes excavating the BDA to the full extent/depth of the buried debris, collecting, and segregating the excavated debris to allow classification and proper disposal of the debris, and backfilling the excavation with clean granular material.

All BDAs have the potential to contain buried hazardous debris and/or contaminated soil, in addition to the expected non-hazardous buried debris. Because of this, where the recommended remedial approach is excavation, the contents of the BDA will require segregation during excavation to allow classification of the various waste streams encountered. Soil is segregated from debris, with the debris being further segregated into hazardous and non-hazardous components. The soil is sampled to identify the presence of any contaminants. Any contaminated soil identified during sampling is disposed of in accordance with the requirements outlined in the AMSRP (see Section 3.1 for additional details).

If excavation is selected as the remedial approach, the BDA should be excavated to the full extent/depth of buried debris. Where contaminated soil has been detected in the excavated contents, it is also recommended that confirmatory testing of the excavation base be completed to ensure no contaminated soil remains. The excavation should be backfilled and graded to conform to surrounding terrain and to promote surface water run-off, prevent erosion, and mitigate against settlement.

Based on earlier work at both DND and CIRNAC DEW Line sites, AECOM has developed the following standard excavation proportions that can be reliably applied to the excavation of buried debris areas:

- 15% Tier I contaminated soil
- 20% Tier II contaminated soil
- 15% non-hazardous debris
- 2% hazardous debris
- 52% clean fill

AECOM has typically applied these standard proportions during the detailed remedial design for BDA excavations; however, where site-specific information suggests a higher or lower level of contaminated soil (e.g., based on environmental sampling), a higher or lower level of hazardous debris (e.g., based on exposed debris observations), or different debris proportions (e.g., based on extent of cover and/or geophysical signal strength), the proportions are modified accordingly.

4.1.2 Leachate Containment (Class B)

Class B BDAs are classified as moderate potential environmental risk. In general, the remediation approach for Class B BDAs includes the construction of an engineered leachate containment system to mitigate against potential contaminant migration from the BDA.

Typical leachate containment system design at DEW Line BDAs involves the excavation of a trench just beyond the buried debris limits. The trench extends into either ice rich permafrost or saturated ground. A geosynthetic liner system is placed extending from the base of the trench over the buried debris area. The trench is backfilled with low permeability granular material which may also extend upslope of the trench. Well-graded sand and gravel is placed and compacted over the surface to a thickness that will promote permafrost aggradation through the key trench and into the BDA contents themselves. The primary long-term containment system is the saturated granular material; once the material freezes, it becomes a low-permeability containment barrier. The geosynthetic liner provides essential short-term containment until permafrost aggrades into the BDA.

In cases where an engineered leachate containment system cannot be constructed and/or is not considered to be cost-effective, an evaluation of excavation is conducted with the objective of determining whether complete excavation (or partial excavation) is recommended.

It should be noted that this remedial approach has needed significant post-remediation monitoring related to the installed thermistors which monitor that the contents are frozen. To confirm that no further contaminant migration is occurring, groundwater monitoring wells are installed upgradient and downgradient and soil samples are collected next to the monitoring wells. Monitoring is typically conducted annually for the first five years (which is the estimated time needed to achieve thermal equilibrium) and then at a reduced frequency following the first five years.

Because of the complicated construction requirements for the contractor and the need for long-term monitoring, this remedial option is oftentimes not cost-effective, when compared to excavation, especially in the case of smaller BDAs.

4.1.3 Re-grading (Class C)

Class C BDAs are classified as low potential environmental risk. In general, the remediation approach for Class C BDAs includes the collection, sorting, and proper disposal of debris from the surface; excavation, and disposal of any surface contaminated soil; and placement of an engineered cover (re-grading). The cover is designed to promote surface water run-off, prevent erosion, and mitigate against settlement. It is typically recommended that the extent of re-grading be extended slightly beyond the extent of the identified buried debris limits (i.e., a 2 m offset has historically been used). The cover should be well graded granular material that is erosion resistant and well compacted to limit infiltration. Where there is the potential for erosion from surface drainage, it is typical to strategically place armouring material. The placement of fill should be configured in such a way so as not to promote ponding of water and graded to conform to surrounding terrain. Typically, a fill thickness of 0.75 m has been used for Class C BDAs, but for smaller areas with no appreciable topographic expression, a smaller fill thickness of 0.5 m can be applied.

It should be noted that constructability considerations and cost-effectiveness may sometimes prompt consideration of excavation rather than re-grading.

4.2 Buried Debris Areas

Each of the BDAs was evaluated using the Environmental Risk Evaluation Matrix presented in the AMSRP. Based on the results, all BDAs are classified as Class C (low potential environmental risk).

4.2.1 Buried Debris Area 1

Buried debris area 1 (BDA-1) is found along the Main Station ridge approximately 230 m southwest of the Main Station (Figure 13). Table 4 presents a summary of the characteristics of BDA-1 that were evaluated using the Environmental Risk Evaluation Matrix.

Table 10: Buried Debris Area 1 (BDA-1) – Characteristics

BDA	BDA-1a	BDA-1b	BDA-1c	BDA-1d	BDA-1e
Areal Extent (m^2)	186	136	108	74	125
Contaminant Characterization	No concentrations elevated compared to up-gradient. No concentrations exceeding DCC Criteria.				
Presence of Surface Debris	Minimal surface debris. Surface debris includes, but is not limited to, the following: metal barrels, and miscellaneous debris.				
Surface Contamination	No surface soil contamination or leachate identified.				
Topography	Flat	Steep slope	Moderate slope		
Presence of Exposed Buried Debris	Minimal debris. Exposed buried debris includes, but is not limited to, the following: metal barrels, and miscellaneous debris.				
Cover Material Type	Historical cover material used at the Site consists predominantly of poorly graded sands (SP) and poorly graded gravels/gravel-sand mixtures (GP).				
Evidence of Erosion	No evidence of erosion.				
Down-gradient surface water	Distance to seasonal drainage channel is approx. 310 m. Distance to East Lake is approx. 1,100 m.				
Estimated Habitat Usage	East Lake has a low biodiversity of freshwater organisms. Caribou pass through the area (i.e., migratory); however, area is unlikely to be significant habitat.				
Extent of Vegetation	A nearly continuous cover of dwarf tundra vegetation including sedges, grasses, wildflowers, lichens, and mosses exists around BDA-1.				
Land Use	Current land use includes summer/winter camps and/or travel routes. Activities include hunting, trapping, and fishing. No drinking water source found down-gradient of BDA-3.				

The following remedial considerations for BDA-1 were outlined in the Phase III ESA:

- BDA-1a. BDA 1a consists of the historic main station food cache. These food caches were typically constructed as earthen mounds or excavations into the earth using wood and/or metal construction materials to support the excavated cavity. As such, it is not a location of buried debris. There is an open entranceway with stairs going down into the cache and the wooden framing at the entrance to the cache was visibly collapsing.
- BDA-1b. Due to its location on a steep slope (greater than 40% grade), it would be difficult to construct an engineered cover over BDA-1b (to reduce the grade for effective construction and long-term stability would require considerable fill).
- BDA-1c, BDA-1d, and BDA-1e. There is no evidence of contaminant migration from these areas, the areas are geotechnically stable (i.e., stable slopes, no evidence of erosion), the existing grades are amenable to re-grading, and there is limited surface debris/exposed buried debris in these areas.

Based on the remedial considerations outlined in the Phase III ESA, the following remedial options are recommended:

- BDA-1a. Due to the challenge of effectively backfilling or stabilizing BDA-1a, and because of the expected framing collapse and resulting settlement, it is recommended that BDA-1a be excavated to its full depth/extent, backfilled with clean granular material, and re-graded to match the existing topography. It should be noted that due to the unique nature of this BDA, the standard excavation proportions outlined in Section 4.1.1 were modified to the following: 10% non-hazardous debris, 10% clean fill, and 80% void space.

- BDA-1b. Due to its location on a steep slope, it is recommended that BDA-1b be excavated to its full depth/extent and re-graded to match the existing topography. It should be noted that due to there being no evidence of contaminant migration and only a relatively small amount of surface debris in this area, the standard excavation proportions outlined in Section 4.1.1 were modified to the following: 15% non-hazardous debris, 1% hazardous debris, 12.5% Tier I contaminated soil, 17.5% Tier II contaminated soil, and 46% clean fill.
- BDA-1c. Because there is no evidence of contaminant migration from BDA-1c and it is in a geotechnically stable area, it is recommended that BDA-1c be treated as a Class C BDA and re-graded to accommodate a minimum fill thickness of 0.75 m. It is recommended that the final grades of the engineered cover match natural topographic contours to promote surface water runoff and prevent erosion. Slopes should be kept between 2% (minimum) and 33% (maximum).
- BDA-1d, and BDA-1e. BDA-1d and BDA-1e were combined into a single BDA (i.e., BDA-1d) due to their relatively small size and proximity to each other. Because there is no evidence of contaminant migration from BDA-1d and it is in a geotechnically stable area, it is recommended that BDA-1d be treated as a Class C BDA. It is recommended that BDA-1d be re-graded to accommodate fill thicknesses of 0.5 m along the upgradient portion of the BDA and 0.75 m along the downgradient portion of the BDA. By transitioning from a fill thickness of 0.5 m to 0.75 m in the direction of natural grade, the overall grade of the engineered cover is reduced thereby limiting the potential for erosion. Slopes should be kept between 2% (minimum) and 33% (maximum).

4.2.2 Buried Debris Area 2

Buried debris area 2 (BDA-2) is found along the Main Station ridge approximately 170 m west of BDA-1 (Figure 9). Table 11 presents a summary of the characteristics of BDA-2 that were evaluated using the Environmental Risk Evaluation Matrix.

Table 11: Buried Debris Area 2 (BDA-2) – Characteristics

BDA	BDA-2a	BDA-2b	BDA-2c
Areal Extent (m^2)	855	91	117
Contaminant Characterization	No concentrations elevated compared to up-gradient. No concentrations exceeding DCC Criteria.		
Presence of Surface Debris	Minimal surface debris. Surface debris includes, but is not limited to, the following: metal barrels, scrap metal (e.g., equipment components, rubbish), scrap wood (e.g., pallets, plywood), and miscellaneous debris.		
Surface Contamination	No surface soil contamination or leachate identified.		
Topography	Moderate slope	Gentle slope	
Presence of Exposed Buried Debris	Exposed buried debris includes, but is not limited to, the following: metal barrels, heavy equipment track, scrap metal (e.g., equipment components, cables, rubbish), and miscellaneous debris (see Appendix C for photographs).		
Cover Material Type	Historical cover material used at the Site consists predominantly of poorly graded sands (SP) and poorly graded gravels/gravel-sand mixtures (GP).		
Evidence of Erosion	No evidence of erosion.		
Down-gradient surface water	Distance to seasonal drainage channel is approx. 320 m. Distance to East Lake is approx. 1,300 m (conservative estimate).		
Estimated Habitat Usage	East Lake has a low biodiversity of freshwater organisms. Caribou pass through the area (i.e., migratory); however, area is unlikely to be significant habitat.		
Extent of Vegetation	A nearly continuous cover of dwarf tundra vegetation including sedges, grasses, wildflowers, lichens, and mosses exists around BDA-1.		
Land Use	Current land use includes summer/winter camps and/or travel routes. Activities include hunting, trapping, and fishing. No drinking water source found down-gradient of BDA-3.		

The following remedial considerations for BDA-2 were outlined in the Phase III ESA:

- BDA-2a, BDA-2b, and BDA-2c. There is no evidence of contaminant migration from these areas, the areas are geotechnically stable (i.e., stable slopes, no evidence of erosion), the existing grades are amenable to re-grading, and there is limited surface debris/exposed buried debris in these areas.

Based on the remedial considerations outlined in the Phase III ESA, the following remedial options are recommended:

- BDA-2a, BDA-2b, and BDA-2c. BDA-2a, BDA-2b, and BDA-2c were combined into a single BDA (i.e., BDA-2a) due to their relatively small size and proximity to each other. Because there is no evidence of contaminant migration from BDA-2a and it is in a geotechnically stable area, it is recommended that BDA-2a be treated as a Class C BDA. It is recommended that BDA-2a be re-graded to accommodate fill thicknesses of 0.5 m along the upgradient portion of the BDA and 0.75 m along the downgradient portion of the BDA. By transitioning from a fill thickness of 0.5 m to 0.75 m in the direction of natural grade, the overall grade of the engineered cover is reduced thereby limiting the potential for erosion. Slopes should be kept between 2% (minimum) and 33% (maximum).

4.2.3 Buried Debris Area 3

Buried debris area 3 (BDA-3) is found along the Main Station ridge approximately 390 m west of BDA-2 (Figure 7). Table 12 presents a summary of the characteristics of BDA-3 that were evaluated using the Environmental Risk Evaluation Matrix.

Table 12: Buried Debris Area 3 (BDA-3) – Characteristics

BDA	BDA-3a	BDA-3b
Areal Extent (m^2)	135	562
Contaminant Characterization	One As concentration elevated compared to up-gradient (see below). No concentrations exceeding DCC Criteria.	No concentrations elevated compared to up-gradient. No concentrations exceeding DCC Criteria.
Presence of Surface Debris	Surface debris includes, but is not limited to, the following: metal barrels, scrap metal (e.g., rubbish), and miscellaneous debris (see Appendix C for photographs).	
Surface Contamination	No surface soil contamination or leachate identified.	Surface soil contamination identified (see below).
Topography	Moderate slope	Steep slope
Presence of Exposed Buried Debris	Exposed buried debris includes, but is not limited to, the following: metal barrels, scrap metal (e.g., piping, rebar, rubbish), scrap wood (e.g., framing), and miscellaneous debris (see Appendix C for photographs).	
Cover Material Type	Historical cover material used at the Site consists predominantly of poorly graded sands (SP) and poorly graded gravels/gravel-sand mixtures (GP).	
Evidence of Erosion	No evidence of erosion.	
Down-gradient surface water	Distance to seasonal drainage channel is approx. 200 m. Distance to East Lake is approx. 1,650 m.	
Estimated Habitat Usage	East Lake has a low biodiversity of freshwater organisms. Caribou pass through the area (i.e., migratory); however, area is unlikely to be significant habitat.	
Extent of Vegetation	A nearly continuous cover of dwarf tundra vegetation including sedges, grasses, wildflowers, lichens, and mosses exists around BDA-1.	
Land Use	Current land use includes summer/winter camps and/or travel routes. Activities include hunting, trapping, and fishing. No drinking water source found down-gradient of BDA-3.	

The following remedial considerations for BDA-3 were outlined in the Phase III ESA:

- BDA-3a. The arsenic concentration at one down-gradient sampling location was observed to be elevated when compared to up-gradient concentrations (i.e., at least three times greater). The concentration of arsenic (2.5 mg/kg depth average) is well below both the Tier II criterion (30 mg/kg) and below the CCME Soil Quality Guidelines (12 mg/kg for human health and 17 mg/kg for environmental health). Arsenic is present naturally in terrestrial environments from the weathering and eroding of rock and soil. In areas of arsenic enriched bedrock, background concentrations can be significantly elevated. It should be noted that the arsenic concentration detected down-gradient of BDA-3a is only elevated when compared to the up-gradient concentration taken at BDA-3a; when compared to the other up-gradient sample locations (i.e., BDA-1, BDA-2, and BDA-4), the concentration is less than two times greater than up-gradient. As such, it is not expected that this “exceedance” is representative of contaminant migration from BDA-3a. The area is geotechnically stable (i.e., stable slopes, no evidence of erosion), the existing grade is amenable to re-grading, and there is limited surface debris/exposed buried debris in this area.
- BDA-3b. Surface soil contamination was observed at BDA-3b in the form of spilled barrel contents at the toe of the slope of this buried debris area. Soil samples were taken for analysis of PHCs (below criterion); however, samples were not taken for analysis of metals and PCBs which may be present if the spilled contents were waste oil. It is recommended that the stain be sampled for metals and PCBs in advance of remediation to identify if soil excavation is required in advance of BDA remediation. There is no evidence of contaminant migration from this area, the area is geotechnically

stable (i.e., stable slopes, no evidence of erosion), the existing grade is amenable to re-grading, and there is limited surface debris/exposed buried debris in this area.

Based on the remedial considerations outlined in the Phase III ESA, the following remedial options are recommended:

- BDA-3a. Because there is no evidence of contaminant migration from BDA-3a and it is in a geotechnically stable area, it is recommended that BDA-3a be treated as a Class C BDA. It is recommended that BDA-3a be re-graded to accommodate fill thicknesses of 0.5 m along the upgradient portion of the BDA and 0.75 m along the downgradient portion of the BDA. By transitioning from a fill thickness of 0.5 m to 0.75 m in the direction of natural grade, the overall grade of the engineered cover is reduced thereby limiting the potential for erosion. Slopes should be kept between 2% (minimum) and 33% (maximum).
- BDA-3b. Because there is no evidence of contaminant migration from BDA-3b and it is in a geotechnically stable area, it is recommended that BDA-3b be treated as a Class C BDA and re-graded to accommodate a fill thickness of 0.75 m. It is recommended that the final grades of the engineered cover match natural topographic contours to promote surface water runoff and prevent erosion. Slopes should be kept between 2% (minimum) and 33% (maximum). Prior to re-grading, additional sampling (metals and PCBs) should be completed to identify if soil excavation is needed in advance of re-grading.

4.2.4 Buried Debris Area 4

Buried debris area (BDA-4) is found at the Beach (Figure 14). Table 13 presents a summary of the characteristics of BDA-4 that were evaluated using the Environmental Risk Evaluation Matrix.

Table 13: Buried Debris Area (BDA-4) – Characteristics

BDA	BDA-4a	BDA-4b	BDA-4c
Areal Extent (m^2)	53	23	80
Contaminant Characterization	No concentrations elevated compared to up-gradient. No concentrations exceeding DCC Criteria.		
Presence of Surface Debris	Surface debris includes, but is not limited to, the following: metal barrels, scrap metal (e.g., mechanical parts, rubbish), scrap wood (e.g., plywood), and miscellaneous debris (see Appendix C for photographs).		
Surface Contamination	No surface soil contamination or leachate identified.		
Topography	Flat slope		
Presence of Exposed Buried Debris	Exposed buried debris includes, but is not limited to, the following: metal barrels, scrap metal (e.g., framing), and miscellaneous debris (see Appendix C for photographs).		
Cover Material Type	Historical cover material used at the Site consists predominantly of poorly graded sands (SP) and poorly graded gravels/gravel-sand mixtures (GP).		
Evidence of Erosion	No evidence of erosion.		
Down-gradient surface water	Distance to Dolphin and Union Strait is approx. 60 m.		
Estimated Habitat Usage	Dolphin and Union Strait has a high biodiversity of marine organisms. Caribou pass through the area (i.e., migratory); however, area is unlikely to be significant habitat.		
Extent of Vegetation	A nearly continuous cover of dwarf tundra vegetation including sedges, grasses, wildflowers, lichens, and mosses exists around BDA-1.		
Land Use	Current land use includes summer/winter camps and/or travel routes. Activities include hunting, trapping, and fishing. No drinking water source found down-gradient of BDA-3.		

The following remedial considerations for BDA-1 were outlined in the Phase III ESA:

- BDA-4a, BDA-4b, and BDA-4c. There is no evidence of contaminant migration from these areas, the areas are geotechnically stable (i.e., stable slopes, no evidence of erosion), the existing grades are amenable to re grading, and there is limited surface debris/exposed buried debris in these areas. Although these BDAs are found more than 60 m away from and more than 6 m above Dolphin and Union Strait, projected long-term sea-level rise and the concurrent increased risk of storm surges and flooding could potentially increase the risk of localized erosion along the beach.

Based on the remedial considerations outlined in the Phase III ESA, the following remedial options are recommended:

- BDA-4a. Due to its location near the shores of Dolphin and Union Strait, it is recommended that BDA-4a be treated as a Class A BDA and excavated to its full depth/extent and re-graded to match the existing topography. It should be noted that due to there being no evidence of contaminant migration and only a relatively small amount of surface debris in this area, the standard excavation proportions outlined in Section 4.1.1 were modified to the following: 15% non-hazardous debris, 1% hazardous debris, 10% Tier I contaminated soil, 15% Tier II contaminated soil, and 59% clean fill.
- BDA-4b and BDA-4c. BDA-4b and BDA-4c were combined into a single BDA (i.e., BDA-4b) due to their relatively small size and proximity to each other. Due to its location near the shores of Dolphin and Union Strait, it is recommended that BDA-4b be treated as a Class A BDA and excavated to its full depth/extent and re-graded to match the existing topography. It should be noted that due to there being no evidence of contaminant migration and only a relatively small amount of surface debris in this area, the standard excavation proportions outlined in Section 4.1.1 were modified to the following: 15% non-hazardous debris, 1% hazardous debris, 10% Tier I contaminated soil, 15% Tier II contaminated soil, and 59% clean fill.

4.3 Summary

Table 14 summarizes the recommended remedial option for each buried debris area as well as the associated material quantities (including contingency). Design contingency was applied to each buried debris area by including a 2 m offset to either the are to be excavated or to the final re-grade design perimeter (as applicable). AECOM has historically applied this offset on other DEW Line sites to account for the uncertainty inherent in delineating buried debris limits. Additionally, where the recommended remedial option is excavation, a conservative assumption was made as to the depth of buried debris. This was done to account for the uncertainty associated with estimating the depth of buried debris without any type of physical measurement obtained from an intrusive investigation (or otherwise). A design contingency of 10% was applied to the volume of clean granular material required for backfilling and re-grading buried debris areas.

Table 14: Buried Debris – Material Quantities Summary

Buried Debris Area	Recommended Remedial Option	Volume of Non-hazardous Material (m^3)	Volume of Hazardous Material (m^3)	Volume of Tier I Contaminated Soil (m^3)	Volume of Tier II Soil (m^3)	Backfill / Re-grade Volume (m^3)[1]
BDA-1a	Excavate Food cache. Challenging to effectively backfill or stabilize	31.5	0.0	0.0	0.0	283.5
BDA-1b	Excavate Located on a steep slope.	52.1	3.5	43.4	60.8	159.9
BDA-1c	Re-grade No evidence of contaminant migration. Geotechnically stable area.	-	-	-	-	414.0
BDA-1d		-	-	-	-	705.0
BDA-2a		-	-	-	-	1672.0
BDA-3a		-	-	-	-	273.0
BDA-3b		-	-	-	-	835.0
BDA-4a	Excavate Located near the shores of Dolphin and Union Strait. Increased risk of storm surges and flooding (projected long-term sea level rise).	7.2	0.5	4.8	7.2	19.7
BDA-4b		14.4	1.0	9.6	14.4	39.4
Subtotal		105.2	4.9	57.8	82.4	4401.4
Design Contingency (10%)		-	-	-	-	440.1
Total		105.2	4.9	57.8	82.4	4841.5

Note: Estimated excavation quantities are based standard excavation proportions which AECOM developed based on earlier work at both DND and CIRNAC DEW Line sites.

[1]Refer to Section 8.6 for a discussion of granular material types.

5. Hazardous Waste Remediation

5.1 Remedial Criteria and Clean-up Protocols

The AMSRP defines hazardous waste as any material(s) that are designated as “hazardous” or “dangerous goods” under territorial and/or federal legislation. Table 15 outlines the hazardous waste remedial and disposal options outlined in the AMSRP.

5.1.1 Asbestos

According to the *Occupational Health and Safety Regulations* (Nunavut), an asbestos-containing material (ACM) is defined as a material that contains or is likely to contain 1% or more asbestos by weight at the time of manufacture, or 1% or more asbestos as determined using microscopy in accordance with the *National Institute for Occupational Safety and Health, Manual of Analytical Methods, Method 9002*.

The *Code of Practice for Asbestos Abatement* (the Code of Practice), prepared by the Workers’ Safety and Compensation Commission, describes the principles to be followed when selecting the most appropriate asbestos abatement techniques. It also describes the requirements for worker protection, safe work procedures, and inspection criteria that must be followed at all workplaces covered by the *Safety Act* and the *Occupational Health and Safety Regulations* of Nunavut. The Code of Practice states that if an area within a building is being altered or renovated, asbestos containing materials that have the potential for releasing asbestos fibres must be removed, enclosed, or encapsulated, while in buildings that are being demolished, ACMs having the potential for releasing asbestos fibres must first be removed.

In the interest of due diligence and worker safety, any material found to contain trace quantities of asbestos fibres (i.e., less than 1%) is treated as an ACM. While vermiculite itself is not an asbestos containing mineral, it is very commonly “contaminated” with asbestos; as such, vermiculite is treated as an ACM.

5.1.2 Lead-Containing Paint

The *Environmental Guideline for Waste Lead and Lead Paint* provides guidance on the proper management of waste lead and lead paint products in Nunavut. The guideline states that waste lead paint is a hazardous waste when the concentration of lead is greater than 5.0 milligrams per litre (mg/L) when subjected to the US Environmental Protection Agency’s toxicity characteristic leaching procedure (TCLP). The test procedure is designed to simulate the characteristics a material may exhibit if placed in a landfill.

It should be noted that many regulatory guidance documents related to lead paint are focused on the paint itself, as lead paint derived during paint abatement work. The painted substrate sampling procedure used by AECOM for classifying leachable-lead painted items follows the approach used at abandoned military sites and other abandoned mines in the territories under the jurisdictions of DND and CIRNAC; the procedure and rationale are documented in the AMSRP.

5.1.3 Polychlorinated Biphenyls

PCBs are listed as toxic substances under the Canadian *Environmental Protection Act* (Schedule 1), and as dangerous goods under the *Transportation of Dangerous Goods Regulations* (Schedule 1). To protect the health of Canadians and the environment and accelerate the phasing out of these substances, the Canadian Government brought into force the *PCB Regulations* in 2008. These regulations state that no person shall release PCBs to the environment in a concentration of 50 mg/kg or more.

Table 15: Hazardous Waste – Remedial and Disposal Options

Waste Type	Parameter(s)	Criteria	Remedial Option(s)	Disposal Option(s)
Concrete / General Debris/ Demolition Waste	CEPA PCBs	≥50 ppm	• Collect (including PCBs-amended paint), containerize, and transport offsite, in accordance with the Transportation of Dangerous Goods Act and the Canadian Environmental Protection Act, for disposal at a licensed facility (hazardous waste)	• Dispose of at a licensed PCB disposal facility.
General Debris / Demolition Waste	Leachable Pb (TCLP)	≥5 mg/L	• Collect (including Pb-amended paint), containerize, and transport offsite, in accordance with the Transportation of Dangerous Goods Act and the Canadian Environmental Protection Act, for disposal at a licensed facility (hazardous waste)	• Dispose of at a licensed hazardous waste disposal facility.
General Debris / Demolition Waste	Asbestos	>0%	• Collect, double-bag, and dispose of (non-hazardous waste)	• Dispose of in onsite NHWL OR • Containerize and transport offsite for disposal at a licensed facility (non-hazardous waste)
Petroleum Products (e.g., gasoline, diesel)	Non-Hazardous		• Incinerate onsite under appropriate emissions controls	
Petroleum Products (e.g., lubricating oil)			• Mix with lighter petroleum products (see above) and incinerate onsite under appropriate emissions controls	• Collect, containerize, and transport offsite for disposal at a licensed facility (hazardous waste)
Filled / Partially Filled Barrels (aqueous phase)	Alcohol/Glycols	<2% Wastewater Discharge Criteria (Water Licence)	• Transfer to an open vessel and remove any organic material (e.g., agitation with an oil absorbent material) AND • Test in accordance with wastewater discharge criteria (water licence)	If aqueous phase meets criteria: • Discharge to the ground a minimum of 30 m from natural drainage courses If aqueous phase does not meet criteria: • Treat until aqueous phase meets criteria OR • Containerize and transport offsite for disposal at a licensed facility (contaminated waste)

Waste Type	Parameter(s)	Criteria	Remedial Option(s)	Disposal Option(s)
Filled / Partially Filled Barrels (aqueous phase)	Alcohol/Glycols PCBs Cl Cd Cr Pb	>2% 2 ppm 1000 ppm 2 ppm 10 ppm 100 ppm	If below criteria and flash point between 25°C and 225°C: • Incinerate onsite under appropriate emissions controls	If below criteria and flash point between 25°C and 225°C: • Containerize and transport offsite for disposal at a licensed facility (contaminated waste) If above criteria or flash point below 25°C or above 225°C: • Containerize and transport offsite for disposal at a licensed facility (hazardous waste)
Filled / Partially Filled Barrels (organic phase)	PCBs Cl Cd Cr Pb	2 ppm 1000 ppm 2 ppm 10 ppm 100 ppm	If below criteria and flash point between 25°C and 225°C: • Incinerate onsite under appropriate emissions controls	If below criteria and flash point between 25°C and 225°C: • Containerize and transport offsite for disposal at a licensed facility (contaminated waste) If above criteria or flash point below 25°C or above 225°C: • Containerize and transport offsite for disposal at a licensed facility (hazardous waste)
Absorbent Material	PCBs Cl Cd Cr Pb	2 ppm 1000 ppm 2 ppm 10 ppm 100 ppm	If below criteria and flash point between 25°C and 225°C: • Incinerate onsite under appropriate emissions controls	If below criteria and flash point between 25°C and 225°C: • Containerize and transport offsite for disposal at a licensed facility (contaminated waste) If above criteria or flash point below 25°C or above 225°C: • Containerize and transport offsite for disposal at a licensed facility (hazardous waste)
Solid Residual Material		Leachate Extraction Criteria		If below criteria: • Dispose of in onsite Tier II SDF OR • Containerize and transport offsite for disposal at a licensed facility (contaminated waste) If above criteria: • Containerize and transport offsite for disposal at a licensed facility (hazardous waste)

5.2 Surface Debris/Barrels

A surface debris inventory (including barrels) was completed onsite by assessing the primary locations of surface debris (scattered and concentrated) at the Site. A description of the debris type(s) (i.e., non-hazardous and hazardous) and the total estimated volume of debris in each surface debris area (SDA) was recorded. Photographs were also taken of each area. Additional surface debris was identified using the high -resolution imagery obtained from the completed drone survey. It should be noted that although most of the surface debris present onsite has been included in the inventory, small surface debris may not have been fully documented.

To determine the correct disposal method for barrels and their contents (i.e., discharge in accordance with wastewater discharge criteria, incineration, offsite at a licensed disposal facility), the contents must first be identified in accordance with the Barrel Protocol outlined in the AMSRP. The barrel assessment was completed at the same time as the surface debris inventory. Disposable 43" (1/4" diameter) WHEATON® drum thieves, manufactured from soda lime glass, were used to assess barrel contents (where applicable) to identify whether contents were aqueous or hydrocarbon containing. The total number of barrels found at each location was recorded and photographs were also taken of each area.

Thirteen surface debris areas were identified during the Phase III ESA. The identified limits of these areas cover approximately 162,000 m^2. The total estimated volume of hazardous waste associated with surface debris collection (including barrel contents) is 4.5 m^3 (including contingency). The hazardous waste consists primarily of asbestos containing materials (ACMs) and barrel contents. A total of approximately 440 barrels were identified at the Site; most of them are located at the beach (SDA-4 and SDA-5) and along the historic POL line (between the Main Station POL pad and the Beach POL pad). Based on the barrel contents assessment, it is estimated that 1.5 m^3 of organic barrel contents are present in SDA-4 and 0.8 m^3 of aqueous barrel contents are present in SDA-10 and SDA-11. The results of the Phase III ESA indicate that most barrels are empty and will require no sampling or processing during clean-up.

A summary of surface debris areas and volumes is provided in Appendix B. See Section 5.5 for a discussion of the recommended remedial option(s) and disposal option(s).

5.3 Demolition Wastes

The demolition assessment included conducting an inventory of the site facilities that would require dismantling for disposal. The assessment noted the construction of each facility and any anticipated special disposal requirements (i.e., hazardous materials) associated with each facility. The demolition assessment included the following:

- Completing an inventory of the existing buildings (confirming size, foundation, construction material).
- Confirming the location and interior configuration of existing buildings.
- Identifying and estimating the quantity of hazardous and non-hazardous materials.
- Recording construction materials painted with PCB-amended paint (PAP) and/or collecting paint samples to confirm whether paint is PCB amended. Recording paint colour(s), substrate type, paint coverage (%), and paint condition.
- Recording asbestos -containing materials (ACMs) and/or collecting material samples to confirm whether material is asbestos containing. Recording material condition and whether material is painted or not.
- Recording construction materials painted with lead-amended paint (LAP) and/or collecting substrate/paint samples to confirm whether paint is lead amended. Recording paint colour(s), substrate type, paint coverage (%), and paint condition.

Sampling results from the Phase III ESA, as well as those from previous site investigations, were used to assess the quantity of hazardous materials with special disposal requirements. AECOM's paint sample database (which includes nearly 400 paint samples, including sample ID, location, colour, and description, collected from various DEW Line sites.) was also referenced in determining the quantity of hazardous materials at the Site.

The total estimated volume of hazardous waste associated with structure demolition is 161.9 m^3 (including contingency). The hazardous waste consists primarily of construction materials painted with PCB-amended paint and a small amount of unpainted asbestos containing material(s). Most of the asbestos containing pipe wrap identified during the Phase III ESA was painted; because all interior paint is classified as hazardous, any painted asbestos containing pipe wrap is by extension also classified as hazardous.

A summary of demolition quantities is provided in Appendix B. See Section 5.5 for a discussion of the recommended remedial option(s) and disposal option(s).

5.4 Buried Debris

Details of the buried debris assessment conducted as part of the 2022 Phase III ESA are presented in Section 4.

The total estimated volume of hazardous waste associated with buried debris excavation is 4.9 m^3 (including contingency).

A summary of BDA excavation quantities is provided in Appendix B. See Section 5.5 for a discussion of the recommended remedial option(s) and disposal option(s).

5.5 Summary

The total estimated volume of hazardous waste associated with surface debris collection, structure demolition, and buried debris excavation is 171.2 m^3 (including contingency). Table 16 summarizes the material quantities (including contingency) associated with hazardous waste remediation at the Site. A design contingency of 15% was applied to the volume of hazardous waste associated with surface debris collection and structure demolition (design contingency for buried debris excavation was accounted for in Section 4.2).

Table 16: Hazardous Waste – Material Quantities Summary

Volume (m^3)	Surface Debris Collection	Structure Demolition	Buried Debris Excavation	Total
Total Estimated Volume of Hazardous Waste	3.8	140.8	4.9	149.5
Design Contingency (15%)	0.6	21.1	-	21.7
Total Estimated Volume of Hazardous Waste (including contingency)	4.4	161.9	4.9	171.2

In accordance with the AMSRP, it is recommended that all hazardous waste be collected, containerized, and transported offsite, in accordance with the *Cross-border Movement of Hazardous Waste and Hazardous Recyclable Material Regulations* and the *Transportation of Dangerous Goods* Act and Regulations, for disposal at a licensed facility. Additionally, the following applies to the various hazardous waste material streams:

- Asbestos waste (e.g., mechanical insulation, transite boards, asbestos core doors, floor tiles) should be collected, double-bagged, containerized, and transported offsite for disposal at a licensed facility
- Petroleum products, such as gasoline or diesel, which do not contain hazardous products according to the AMSRP Barrel Protocol (e.g., chlorine, PCBs, heavy metals, etc.), should either be incinerated

onsite under appropriate emissions controls or containerized and transported offsite for disposal at a licensed facility

- Petroleum products which contain hazardous products according to the AMSRP Barrel Protocol (e.g., chlorine, PCBs, heavy metals, etc.), should be containerized and transported offsite for disposal at a licensed facility
- Construction materials painted with PAP should be collected, containerized, and transported offsite for disposal at a licensed facility

6. Non-Hazardous Waste Remediation

6.1 Remedial Criteria and Clean-up Protocols

Table 17 outlines the non-hazardous waste remedial and disposal options outlined in the AMSRP.

6.2 Surface Debris/Barrels

Details of the surface debris inventory conducted as part of the 2022 Phase III ESA are presented in Section 5.2.

The total estimated (crushed) volume of non-hazardous waste associated with surface debris collection is 45.3 m^3 (including contingency).

During the Phase III ESA, wooden cabins were observed in SDA-7, SDA-8, and SDA-9. All three cabins observed had fallen into disrepair with two of them having fully collapsed. According to the local wildlife monitors, the cabins are not used by the local community while hunting or fishing near the Site. As such, the cabins have been treated as surface debris to be collected, containerized, and transported off site for disposal at a licensed facility following volume reduction. It should be noted that only the cabin in SDA-7 was assessed as part of the AIA. It is recommended that the cabins in SDA-8 and SDA-9 be assessed for their value as “heritage resources” prior to being collected, containerized, and transported offsite for disposal. It is recommended that this assessment occur during the mobilization year (Year 1) as there will be wildlife monitors on site and it is not anticipated that any surface debris collection will take place during that first year (i.e., not on the critical path).

A summary of surface debris areas and volumes is provided in Appendix B. See Section 6.5 for a discussion of the recommended remedial option(s) and disposal option(s).

6.3 Demolition Wastes

Details of the demolition assessment conducted as part of the 2022 Phase III ESA are presented in Section 5.3.

The total estimated (crushed) volume of non-hazardous waste associated with structure demolition is 545.4 m^3 (including contingency).

A summary of demolition quantities is provided in Appendix B. See Section 6.5 for a discussion of the recommended remedial option(s) and disposal option(s).

6.4 Buried Debris

Details of the buried debris assessment conducted as part of the 2022 Phase III ESA are presented in Section 4.

The total estimated (crushed) volume of non-hazardous waste associated with buried debris excavation is 105.2 m^3 (including contingency).

A summary of BDA excavation quantities is provided in Appendix B. See Section 6.5 for a discussion of the recommended remedial option(s) and disposal option(s).

Table 17: Non-hazardous Waste – Remedial and Disposal Options

Waste Type	Parameter(s)	Criteria	Remedial Option(s)	Disposal Option(s)
General Debris/Demolition Waste	Non-Hazardous	N/A	• Collect surficial items, cut off at 0.3 m below grade if partially imbedded, minimize volume through crushing, shredding, or incineration, and dispose of (non-hazardous waste)	• Dispose of in onsite NHWL OR • Containerize and transport offsite for disposal at a licensed facility (non-hazardous waste)
Compressed Gas Cylinders	Non-Hazardous		• Vent onsite and dispose of empty cylinders (non-hazardous waste)	• Dispose of in onsite NHWL OR • Containerize and transport offsite for disposal at a licensed facility (non-hazardous waste)
Concrete Slabs (on grade)	Non-Hazardous		• Cover with clean fill (only if not stained or painted with hazardous paint) and grade into surrounding topography OR • Grade surrounding soil to tie into slab grade OR • Leave as is OR • Demolish into manageable pieces and dispose of (non-hazardous waste)	• Dispose of in onsite NHWL OR • Containerize and transport offsite for disposal at a licensed facility (non-hazardous waste)
Concrete POL Tank Foundations	Non-Hazardous		• Break (as required) and bury as part of Type B PHCs contaminated soil excavation OR • Demolish into manageable pieces and dispose of (non-hazardous waste)	• Dispose of in onsite NHWL OR • Containerize and transport offsite for disposal at a licensed facility (non-hazardous waste)
Empty Barrels (no contents)	Non-Hazardous	N/A	• Crush/shred and dispose of (non-hazardous waste)	• Dispose of in onsite NHWL OR • Containerize and transport offsite for disposal at a licensed facility (non-hazardous waste/recyclable material)
Empty Barrels (contents removed)	Non-Hazardous	N/A	• Rinse, crush/shred, and dispose of (non-hazardous waste)	• Dispose of in onsite NHWL OR • Containerize and transport offsite for disposal at a licensed facility (non-hazardous waste/recyclable material)

6.5 Summary

The total estimated (crushed) volume of non-hazardous waste associated with surface debris collection, structure demolition, and buried debris excavation is 696.0 m^3 (including contingency). summarizes the material quantities (including contingency) associated with non-hazardous waste remediation at the Site. A design contingency of 15% was applied to the volume of non-hazardous waste associated with surface debris collection and structure demolition (design contingency for buried debris excavation was accounted for in Section 4.2).

Table 18 summarizes the material quantities (including contingency) associated with non-hazardous waste remediation at the Site. A design contingency of 15% was applied to the volume of non-hazardous waste associated with surface debris collection and structure demolition (design contingency for buried debris excavation was accounted for in Section 4.2).

Table 18: Non-hazardous Waste – Material Quantities Summary

Volume (m^3)	Surface Debris Collection	Structure Demolition	Buried Debris Excavation	Total
Total Estimated Volume of Non-hazardous Waste	39.4	474.3	105.2	618.9
Design Contingency (15%)	5.9	71.1	-	77.0
Total Estimated Volume of Hazardous Waste (including contingency)	45.3	545.4	105.2	696.0

In accordance with the AMSRP and based on the fact that the construction of a non-hazardous waste landfill is not recommended at the Site (see Section 7.1 for additional details), it is recommended that all non-hazardous waste be collected, containerized, and transported offsite for disposal at a licensed facility following volume reduction (e.g., crushing, shredding, and/or incineration).

7. Evaluation of Onsite versus Offsite Treatment / Disposal Options

Sections 7.2 to 7.3 provide evaluations of onsite versus offsite treatment and/or disposal options related to the following:

- Non-hazardous waste – dispose onsite in a non-hazardous waste landfill versus containerize and transport offsite for disposal at a licensed facility
- DCC Tier I / Type A PHC contaminated soil – cap in place under clean granular material versus excavate, containerize, and transport offsite for disposal at a licensed facility
- DCC Tier II contaminated soil – dispose of in onsite Tier II contaminated soil disposal facility versus containerize and transport offsite for disposal at a licensed facility
- Type B PHC contaminated soil – treat onsite (ex-situ) in a contaminated soil treatment facility versus containerize and transport offsite for treatment (ex-situ) or disposal at a licensed facility

7.1 Non-hazardous Waste Landfill

The following disposal options for non-hazardous waste were outlined in Table 17 (Section 6.1):

- Dispose of in onsite non-hazardous waste landfill (NHWL) OR
- Containerize and transport offsite for disposal at a licensed facility.

The total estimated (crushed) volume of non-hazardous waste associated with surface debris collection, structure demolition, and buried debris excavation is 696.0 m3 (including contingency).

Preliminary costing information associated with onsite versus offsite disposal was developed to allow for a cost comparison between these two disposal options (Appendix C). The costing information was developed using the waste volume identified above and the estimated quantity of granular material (i.e., berm construction) required for the construction of the NHWL. Construction cost estimates from other similar DEW Line sites (e.g., CAM-A, BAF-5, CAM-E, FOX-D, and BAR-B) were used to verify the reasonableness of the generated estimates.

Due to the relatively small difference in cost between onsite disposal and offsite disposal (approximately 19%), it is recommended that all non-hazardous waste be containerized and transported offsite for disposal. Although the option for onsite disposal is slightly less expensive, this option does carry with it additional long-term liability inherent with keeping waste materials contained at a remote site. It should also be noted that the cost estimate for onsite disposal does not consider any potential future repairs required to keep the containment facility operational.

In the instance that onsite disposal is selected as the favoured option, the recommended location for the NHWL is approximately 400 m west of the Main Station, on the north side of the access road to the Drinking Water Lake, and just outside of the DND reserve boundary. The area consists of undisturbed ground and the approximate size of this area is 260 m by 120 m (Figure 16). For the purposes of evaluating future monitoring data, it is preferred to construct the NHWL on undisturbed ground.

The total volume of non-hazardous waste, from all sources (including DCC Tier I and Type A PHC contaminated soil), corresponds to a landfill airspace requirement of approximately 1,062 m^3 (including contingency and bulking factors). The estimated footprint (including containment berms) for a NHWL to accommodate this volume is approximately 45 x 45 m.

7.2 DCC Tier I / Type A PHC Contaminated Soil Capping

The following remedial and disposal options for DCC Tier I and Type A PHC contaminated soil were outlined in Table 2 (Section 3.1):

- Cap in place under 0.3 m (DCC Tier I) or 0.5 m (Type A PHC) of clean granular material
- Excavate to 0.3 m (DCC Tier I) or 0.5 m (Type A PHC) below ground surface AND dispose of in onsite non-hazardous waste landfill
- Excavate to 0.3 m (DCC Tier I) or 0.5 m (Type A PHC) below ground surface AND containerize and transport offsite for disposal at a licensed facility

The total estimated volume of DCC Tier I and Type A PHC contaminated soil is 94 m^3 (including contingency).

Based on the fact that the construction of a non-hazardous waste landfill (NHWL) is not recommended at the Site (see Section 7.1 for additional details), preliminary costing information for capping versus offsite disposal of the contaminated soil was calculated to allow for a cost comparison between these two remedial/disposal options (Appendix C). Preliminary costs associated with capping included the cost to supply and place Type 2 granular material to a thickness of 0.3 m (DCC Tier I) or 0.5 m (Type A PHC). Preliminary costs associated with offsite disposal included the cost to supply contaminated soil containers, the cost to excavate and containerize the contaminated soil, and the cost to transport and dispose of the contaminated soil at a licensed disposal facility. Construction cost estimates from other similar northern projects (e.g., BAF-5, Eureka) were used to verify the reasonableness of the generated preliminary costing information. Based on a comparison of the preliminary costing information, the cost associated with capping DCC Tier I and Type A PHC contaminated soil is significantly less expensive (approximately 70% less expensive) than for the offsite disposal option.

In accordance with the AMSRP, it is recommended that DCC Tier I and Type A PHC contaminated soil be capped in place using clean granular material. It should be noted that during the Phase III ESA it was observed that all DCC Tier I and Type A PHC contaminated soil is located in stable areas outside of any observable drainage pathways.

DCC Tier I levels were established for PCBs and lead because these contaminants have the potential to bio-magnify and bio-accumulate in Arctic fauna (including humans) and were also identified as having been aerially dispersed away from the associated DEW Line sites. Tier I concentrations were established for surficial impacts to mitigate aerial transport, and to a lesser degree, to guard against plant uptake (which is more of a concern at the higher Tier II concentrations). By placing DCC Tier I soil under a 0.3 m cap, the contaminated soil is removed from the root zone of vascular plants typical of the Canadian Arctic and is protected from wind erosion, thereby eliminating the aerial dispersion exposure pathway. Type A contaminated soils are characterized by limited mobility and solubility; as such, remedial targets presented in the AMSRP are based on the protection of human health (direct contact). By placing Type A PHC contaminated soil under a 0.5 m cap, surface exposure to the contaminated soil is removed, thereby eliminating the direct contact exposure pathway. In both cases, capping the contaminated soil represents an acceptable means of remediation.

In terms of residual risk associated with capping, it is worth noting that the largest Tier I or Type A area to cap is approximately 90 m^2 and according to the AMSRP, buried debris areas, which are considered to contain contaminated soil at Tier I and Tier II levels and potentially hazardous materials, only require monitoring when they are greater than 1000 m^2. When below this size, the risk is considered sufficiently low as to not require post-remediation monitoring. The residual risk associated with capping Tier I or Type A soil is therefore considered extremely low and would not prompt post-remediation monitoring, according to the AMSRP and CIRNAC's practice to date.

7.3 DCC Tier II Contaminated Soil Disposal Facility

The following disposal options for DCC Tier II contaminated soil were outlined in Table 2 (Section 3.1):

- Dispose of in onsite Tier II contaminated soil disposal facility (CSDF)
- Containerize and transport offsite for disposal at a licensed facility (contaminated waste)

The total estimated volume of DCC Tier II contaminated soil is 233.9 m^3 (including contingency). This volume includes DCC Tier II contaminated soil excavated from both contaminated soil areas as well as buried debris areas. If a bulking factor of 25% is applied, the estimated “design” volume of DCC Tier II contaminated soil that would require disposal is 293.0 m^3.

The decision of whether to dispose of DCC Tier II contaminated soil onsite in a contaminated soil disposal facility (CSDF) or transport the contaminated soil offsite for disposal is volume dependent, with the critical volume ranging from approximately 500 m^3 to 1250 m^3. For volumes less than approximately 500 m^3, shipping contaminated soil offsite for disposal is generally more economical (INAC, 2008). Based on the quantity and quality of the environmental sampling information gathered during the Phase III ESA (AECOM, 2022), the risk of overrun is low to moderate.

PIN-C was originally identified as having only moderate general fill material availability, where moderate is defined as “[m]aterial present near site, requires some processing or minor transportation”, and poor saturated fil material availability, where poor is defined as “[p]resent predominantly as small, scattered deposits or deposits far from site” (INAC, 2008). A borrow assessment was conducted during the Phase III ESA and four potential borrow areas were identified containing an estimated 125,120 m^3 of Type 2/2A granular material. The construction of a CSDF requires an adequate supply of suitable granular material (i.e., Type 2, 2A, 4, and 5). Based on these material requirements, the availability of suitable granular material imposes a constraint on the potential future construction of an CSDF at the Site.

Based on the estimated design volume of DCC Tier II contaminated soil, granular material constraints, and concerns expressed about the long-term liability associated with constructing a Tier II CSDF at the Site, it is recommended that all DCC Tier II contaminated soil be containerized and transported offsite for disposal at a licensed facility. Although the risk of overrun is low to moderate, there is still the potential for the volume of Tier II contaminated soil derived from buried debris area excavations to be higher than estimated. It is therefore recommended that an appropriate contingency be carried for offsite disposal during the design phase to ensure that there are sufficient containers onsite for soil containerization during remediation so as not to delay project completion.

There is some inherent risk associated with transporting the containerized Tier II contaminated soil offsite for disposal; however, the likelihood of occurrence is unlikely since marine accidents and incidents in the Arctic occur considerably less frequently than elsewhere in Canada, as would be expected with the limited amount of vessel movement in this region.

7.4 Type B PHC Contaminated Soil Treatment Facility

The following remedial and disposal options for Type B PHC contaminated soil were outlined in Table 2 (Section 3.1):

- Excavate until below objective (i.e., clean limits) AND treat onsite (ex-situ) in a contaminated soil treatment facility (CSTF)
- Excavate until below objective (i.e., clean limits) AND containerize and transport offsite for treatment (ex-situ) or disposal at a licensed facility
- Treat in-situ (exceptional cases)

Table 19 outlines the applicability, advantages, and disadvantages (limitations) of the three remedial and disposal options. Based on the applicability of the various options to the Site, the most applicable options were narrowed down to treat onsite (ex-situ) in a CSTF or containerize and transport offsite for treatment or disposal at a licensed facility.

The total estimated volume of Type B PHC contaminated soil is 753.0 m^3 (including contingency). If a bulking factor of 25% is applied, the estimated "design" volume of Type B PHC contaminated soil that would require treatment/disposal is 942.0 m^3.

Preliminary costing information for onsite treatment versus offsite disposal of the contaminated soil was calculated to allow for a cost comparison between these two options (Appendix C). Preliminary costs associated with onsite treatment included the construction costs of the CSTF (e.g., granular material, geosynthetics), the cost to excavate and place the contaminated soil in the CSTF and the cost to treat the contaminated soil (including nutrient application, tilling, monitoring). Preliminary costs associated with offsite disposal included the cost to supply contaminated soil containers, the cost to excavate and containerize the contaminated soil, and the cost to transport and dispose of the contaminated soil at a licensed disposal facility. Construction cost estimates from other similar northern projects (e.g., BAF-5, Eureka) were used to verify the reasonableness of the generated preliminary costing information.

Because the onsite treatment of Type B PHC contaminated soil in a CSTF is considerably cheaper than disposing of the contaminated soil offsite (approximately 70% cheaper), and transportation costs are sensitive to changes in soil volume, it is recommended that Type B PHC contaminated soil be excavated until below objective (i.e., clean limits) and treated onsite in a CSTF.

The estimated footprint (including containment berms) for a CSTF to accommodate the volume of Type B PHC contaminated soil is approximately 100 m by 45 m. Two potential CSTF locations were identified during the Phase III ESA and are presented in Figure 16:

- Area 1 is located immediately adjacent to the Main Station POL pad, which is the location of the largest volume of Type B PHC contaminated soil requiring treatment. The area is already disturbed and there is a stockpile of granular material (i.e., BA-03) that could be used for construction. The approximate size of the area is 100 m by 120 m.
- Area 2 is located approximately 400 m west of the Main Station, on the north side of the access road to the Drinking Water Lake, and just outside of the DND reserve boundary. The area consists of undisturbed ground and the approximate size of this area is 260 m by 120 m.

Because of its proximity to the primary Type B PHC contaminated soil area and its present disturbed state, it is recommended that the CSTF be constructed in Area 1; however, some consideration should be given to the prevailing wind direction versus contractor camp location for final selection to avoid placing the camp downwind of the CSTF.

Based on the total volume of impacted Type B PHC contaminated soil, moderate hydrocarbon concentrations observed during the Phase III ESA, and monitoring results from biological treatment operations at other similar DEW Line sites (e.g., FOX-C and PIN-D), it is anticipated that ex-situ biological treatment may be completed within a three-month period, provided site conditions are monitored and optimized (e.g., soil pH, moisture content, nutrient concentration).

Table 19: Type B PHC Contaminated Soil – Remedial Options

Remedial Option	Description / Requirements	Applicability	Advantages	Disadvantages / Limitations	Implementation
In-situ Biological Treatment / Chemical Oxidation	Application of ozone, peroxide or permanganate through instrumentation within the impacted area.	Amendable to light and medium end hydrocarbons (F1, F2, F3 fractions).	• Under optimal conditions can reduce concentrations below criteria. • Minimize excavation and disturbance of existing vegetation	• Monitoring required. • Difficult to confirm that target concentrations are met throughout contaminated area. • Not applicable to metal contaminated soil.	• Not appropriate for hydrocarbon areas located in close proximity to water bodies (Beach POL).
Onsite, Ex-situ PHC Soil Treatment / Bioremediation	Hydrocarbon contaminated soils are excavated and placed within bermed treatment area. Soils are periodically turned, and nutrients added to optimize treatment conditions.	Hydrocarbon contaminated soils including F1, F2, and F3 fractions.	• Contaminant concentrations reduced. • No environmental risks associated with potential spills during offsite transportation.	• More effective on light end hydrocarbons. • Generally, requires 2-3 treatment seasons for contaminant reduction to criteria. • Restricts use of the site during treatment operations. • Impermeable membrane/low permeable soils required for containment.	• Adequate location and granular material identified for construction. • Geosynthetic liner required for perimeter containment.
Offsite Treatment and Disposal	Contaminated soils are transported offsite for treatment or disposal.	All contaminated soil types.	• Contaminated soils removed from site eliminating risk of exposure.	• Considerable costs associated with offsite transport. • Project costs are sensitive to contaminated soil volumes. • Potential environmental risk during transport.	• Shipment and disposal offsite is technically appropriate, but at considerable costs.

7.5 Greenhouse Gas Emissions Estimates for Onsite versus Offsite Treatment / Disposal Options

Preliminary greenhouse gas (GHG) emissions estimates were prepared for the various treatment/disposal option presented in Sections 7.1 to 7.4. For all offsite disposal options, the GHG emissions associated with transporting the contaminated soil/non-hazardous waste from the Site via sealift represented the single largest contribution to the emissions totals (greater than 70% of the total). This contribution became more pronounced as the total quantity of material being removed from the Site increased. The following general statements can be made about the various onsite and offsite treatment/disposal options:

- Tier I / Type A PHC Contaminated Soil. Due to the relatively simple nature of the work that would have to be completed onsite to remediate the contaminated soil (i.e., cap construction), it is anticipated that capping the contaminated soil in place would result in GHG emissions that are an order of magnitude less than if the contaminated soil were transported offsite for disposal.
- Type B PHC Contaminated Soil. The onsite remedial option for Type B PHC contaminated soil (i.e., construction of a CSTF and treatment) requires more intensive construction and treatment efforts when compared to the Tier I and Type A PHC contaminated soil option; however, the quantity of contaminated soil that would have to be transported offsite is also greater than in the case of Tier I and Type A PHC contaminated soil. In this case, the onsite remedial option is anticipated to result in approximately one-third the total GHG emissions associated with transport of the contaminated soil for offsite disposal.
- Non-Hazardous Waste. As in the case of the Type B PHC contaminated soil options, it is anticipated that the onsite remedial option (i.e., construction of a NHWL) will produce fewer GHG emissions than the offsite disposal option; however, long-term monitoring would be required of the constructed facilities. When accounting for this long-term monitoring and the associated transportation to and from the Site that would be required, the anticipated emissions associated with transport offsite for disposal are only approximately 30% greater than those associated with onsite disposal.

8. Implementation

8.1 Schedule

It is anticipated, based on the assumption that the contractor will mobilize to the Site via barge, that the contractor will mobilize during the fall of the first calendar year (Year 1) and initiate the construction of critical items at this time. Most of the remediation activities are anticipated to be completed during the second year (Year 2). It is reasonable to assume that, at minimum, the contractor would be able to set up their construction camp, develop borrow sources, upgrade roadways (as required), complete construction of the CSTF, and excavate and transport Type B PHC contaminated soil to the CSTF during Year 1 to allow subsequent remedial activities to commence early during Year 2. It is recommended that Type B PHC soil be excavated and placed in the CSTF during Year 1 (if possible) to avoid delays associated with frozen ground early in Year 2.

Year 1 (August 4 to September 28, 2024)

- Contractor confirms the logistics of shipping materials and equipment to PIN-C with selected commercial shipping and aircraft charter companies.
- Contractor prepares and submits a Worker Orientation Seminar, a detailed step by step Work Plan for executing the Work, a Site-Specific Health and Safety Plan (SSHSP), and all other required submittals prior to mobilization.
- Contractor mobilizes materials and equipment to Bécancour by August 1st (based on the NEAS 2023 preliminary schedule) for commercial shipment to PIN-C (departing mid-August and arriving early September).
- Contractor deploys a small crew to PIN-C (for a construction season of approximately three (3) weeks) to meet the sea lift and move materials and equipment from the Beach to the Contractor's designated camp area.
- Contractor sets up camp and waste disposal/storage area and operates and maintains all camp facilities and equipment including water treatment, sewage treatment, and onsite mobile communication equipment.
- Contractor repairs/upgrades haul road from the Main Station to the Beach.
- Contractor develops granular borrow sources.
- Contractor completes construction of the CSTF including, but not limited to, the following:
    - Supplying, placing, and compacting Type 2 and Type 5 granular material.
    - Supplying and installing geotextiles and a geomembrane liner.
    - Supplying and installing groundwater monitoring wells.
- Contractor excavates and transports Type B PHC Contaminated Soil to the CSTF for treatment.
- Contractor winterizes materials and equipment and demobilizes personnel from PIN-C.

Year 2 (June 1 to September 6, 2025)

- Contractor mobilizes personnel to PIN-C for a construction season of approximately fourteen (14) weeks.
- Contractor sets up camp and waste disposal/storage area and operates and maintains all camp facilities and equipment including water treatment, sewage treatment, and onsite mobile communication equipment.
- Contractor operates the CSTF including, but not limited to, the following:
    - Supplying and applying a granular nutrient amendment.

  - Tilling the contaminated soil in the CSTF at regular intervals.
  - Removing, treating, and discharging contact water.
- Contractor demolishes, packages, and containerizes the Garage, Warehouse, Module Train, Inuit House, and Radar Antenna including, but not limited to, the following:
  - Removing, segregating, and packaging of asbestos materials.
  - Removing, segregating, and containerizing PCB amended painted materials including providing containment of paint chips.
  - Removing and containerizing fluorescent lamp ballasts, florescent light tubes, and any other hazardous materials encountered.
  - Demolishing, removing, segregating, and packaging of non-hazardous waste.
  - Containerizing and onsite transport to the Temporary Storage Area of all hazardous demolition debris.
  - General re-shaping of areas disturbed by demolition activities.
- Contractor excavates and containerizes Tier II and hazardous contaminated soil.
- Contractor excavates and transports Type B PHC contaminated soil from nearshore to the CSTF for treatment.
- Contractor excavates buried debris including, but not limited to, the following:
  - Excavating buried debris areas (BDAs).
  - Installing erosion, drainage, and sediment control (as required).
  - Dewatering buried debris excavations including all accessory areas (as required).
  - Constructing, operating, and decommissioning a buried debris processing area to handle material from all buried debris areas.
  - Transporting all excavated buried debris and soil to the buried debris processing area.
  - Spreading buried debris and soil within the buried debris processing area, segregating and stockpiling buried debris and soil, and containerizing hazardous and non-hazardous debris, and Tier I, Tier II, and hazardous contaminated soil.
  - Replacing and compacting clean soil excavated from the buried debris areas as backfill.
- Contractor supplies, places, and compacts Type 3 granular material to backfill excavated buried debris areas and contaminated soil areas.
- Contractor supplies, places, and compacts Type 2 granular material to re-grade BDAs and Tier I and Type A PHC contaminated soil areas.
- Contractor collects, packages and/or containerizes surface debris including, but not limited to, the following:
  - Processing barrels and barrel contents including supplying and operating a barrel crusher and providing sorbent materials required to contain spills and/or contaminated run-off during barrel processing.
- Contractor decommissions the CSTF including, but not limited to, the following:
  - Treating and discharging all remaining contact water.
  - Re-shaping the perimeter berms and treated soil to provide positive drainage.
  - Removing and containerizing all geosynthetic liner components for offsite disposal.

  - Applying any remaining granular nutrients over the newly re-shaped area to promote re-vegetation by local flora.
  - Decommissioning the groundwater monitoring wells.
- Contractor reclaims the granular borrow sources and access roads.
- Contractor re-shapes work areas to blend with the natural terrain and provide positive drainage.
- Contractor stages materials, equipment, and packaged/containerized waste/contaminated soil at the Beach for retrograde shipment via sea lift.
- Contractor demobilizes materials, equipment, and personnel from PIN-C.
- Contractor receives, inspects, and verifies packaged/containerized waste/contaminate soil in Montreal as they are off loaded by the commercial shipper. Contractor transfers custody to the waste hauler and signs all applicable shipping manifests and other required paperwork.
- Contractor transports packaged/containerized waste/contaminated soil from the marine terminal in Montreal (via commercial hauler) to the Contractor's Designated Non-Hazardous Waste Disposal Facility, Contaminated Soil Disposal Facility, or Hazardous Waste Disposal Facility (as appropriate).

8.2 Contaminated Soil Remediation

The following should be taken into consideration to ensure effective and timely completion of contaminated soil remediation activities:

- The construction of the CSTF and the treatment of Type B PHC contaminated soil should be given a high priority during remediation; delay in either of these activities could delay the contractor's demobilization from the Site.
- DCC Tier II and hazardous contaminated soil excavation should be completed early in Year 2 to allow time for additional containers to be brought to the Site if quantity overruns are encountered (the risk of overrun is low to moderate).
- The re-grading of DCC Tier I and Type A PHC contaminated soil areas should be given a low priority as this work item is simple, low-risk, and there are no other work items that depend on the completion of this one.

8.3 Buried Debris Remediation

The following should be taken into consideration to ensure effective and timely completion of buried debris remediation activities:

- For all buried debris areas (regardless of the recommended remedial option), all surface contaminated soil should be excavated, and all surface debris and exposed buried debris should be collected and removed prior to initiating the selected remedial approach.
- For buried debris area where the recommended remedial option is excavation, work should commence early in Year 2 to allow enough time for segregation and containerization of the excavated waste streams. Because offsite disposal is recommended for all excavated waste streams and given that there is a certain degree of uncertainty regarding excavation proportions from BDAs, the contractor should ensure that sufficient containers are brought to the Site during mobilization to avoid delays. Should sufficient containers not be available during mobilization, excavated contaminated soil from BDA excavations can be stockpiled on an impermeable liner or on the surface of existing contaminated soil areas until additional containers can be airlifted to the Site.
- For buried debris areas where the recommended remedial option is re-grading, work can commence at any time as this work item is simple, low-risk, and there are no other work items that depend on the completion of this one.

8.4 Surface Debris/Barrel Clean-up

The following should be taken into consideration to ensure effective and timely completion of surface debris/barrel clean-up activities:

- Collection and containerization of surface debris can commence at any time as this work item is simple, low-risk, and there are no other work items that depend on the completion of this one.
- All surface debris perimeters should be expanded during the design phase to ensure that all accessible surface debris is collected during remediation. Based on the quantity and quality of the information gathered during the Phase III ESA (AECOM, 2022), the risk of overrun is low.
- In addition to the identified SDAs, a provision should be made to include the collection and containerization of all surface debris within 50 m of existing pads and roadways (where appropriate). This approach is typical to that applied by AECOM at other DEW Line sites in the past. A small contingency for additional surface debris volume should be included during the design phase.
- The contents of all barrels should be inspected and assessed prior to disposal to ensure that the contents are being disposed of in accordance with the AMSRP Barrel Protocol. Due to the requirement for barrel contents sampling, it is recommended that the collection of barrels, with consolidation of like products, be completed early during Year 2 to allow for sampling, and ultimately disposal, in a timely manner.

8.5 Structure Demolition

The following should be taken into consideration to ensure effective and timely completion of structure demolition activities:

- Hazardous building materials, including ACMs and construction materials painted with PAP, should be removed and containerized early in Year 2 (prior to demolition) to ensure adequate time is provided for full structure demolition.
- Additionally, other hazardous materials, including batteries and potential glycol containing liquids within building heating systems, should be collected and containerized early in Year 2 in conjunction with general abatement activities. While no PCB-containing equipment or mercury switches were noted during the Phase III ESA, if these materials are identified during remediation, they should also be collected and containerized.
- Because all interior paint at the Site is classified as hazardous, any painted ACMs should also be classified as hazardous.
- Past samples of vermiculite collected at other DEW Line sites have shown trace asbestos as being present. In accordance with the PSPC *Asbestos Management Standard*, vermiculite with any concentration of asbestos is considered an ACM; therefore, the vermiculite present in the Module Train is classified as an ACM. Due to its friable nature, vermiculite should be removed in a manner consistent with a moderate risk (Type 2) abatement.
- Building foundations at the Site consist of timber piles and sills (i.e., at the Module Train) and concrete slabs (i.e., at the Garage, Warehouse, and POL pumphouse). Timber piles and sills should be containerized and transported offsite for disposal at a licensed facility following volume reduction whereas concrete slabs can remain in place once all paint has been removed from the surface of the slabs. Clean granular material should be placed over the concrete slabs and re-graded around the foundations to match the existing topography.

8.6 Borrow Sources

To confirm that sufficient sources of granular material were identified during the Phase III ESA, an estimate of the required granular material volumes was completed for the recommended remedial options identified. Details are summarized in Table 20. The locations of the borrow areas identified during the Phase III ESA are shown in Figure 16 (Appendix A).

The following should be taken into consideration when managing the onsite borrow sources and the granular material from these borrow sources:

- The use of Type 2 granular material as excavation backfill material (i.e., contaminated soil areas and BDAs) is considered an acceptable alternative to Type 3 granular material as the specifications for Type 2 granular material are more restrictive than those for Type 3 granular material.
- There will be a requirement to selectively mine, blend, crush and/or screen granular material from the borrow sources to satisfy the specifications for Type 5 granular material.

Table 20: Granular Material Requirements – Summary

Granular Material Type / Description	Estimated Volume Available (m^3)	Estimated Volume Required (m^3)
Type 1 Typically consists of coarse gravel or cobble size material that is used for erosion protection on finished slopes or within drainage courses	0	0
Note: No requirement for Type 1 granular material.		
Type 2A Coarse material encountered in all borrow areas that is a suitable alternative to Type 1 material Type 2 Well-graded sand and gravel that is used for construction of berms and covers	125,000	14,800
Note: Required for the construction of the CSTF and for re-grading contaminated soil areas and BDAs. Available in borrow areas BA-01, BA-02 and BA-03 (Main Station) and borrow area BA-04 (Beach).		
Type 3 Select material with a maximum particle size of 200 mm that is used for backfilling excavations and general site grading	0	1,000
Note: Required for the backfilling excavated BDAs and contaminated soil excavations. It should be noted that a volume of 315 m^3 of clean fill is expected from BDA excavations. This clean fill will likely contain small pieces of debris and is only recommended for use as intermediate backfill. The use of Type 2 material as excavation backfill is considered an acceptable alternative to Type 3.		
Type 4 Consists of non-saline, well-graded sand and silt with some gravel that is used for the construction of containment berms and backfill of key trench excavations for Tier II SDFs	0	0
Note: No requirement for Type 4 granular material.		
Type 5 Consists of rounded particles with a maximum size of 5 mm free from angular particles, stones larger than 25 mm in diameter, and deleterious material that is used as geomembrane bedding material in Tier II SDF or PHC soil treatment facility construction	0	600
Note: Required for the construction of the CSTF.		
Type 6 Consists of gravel or sand in an unfrozen state and free of deleterious material that is used as intermediate cover within landfills	0	0
Note: No requirement for Type 6 granular material.		

9. Community Engagement

A community-level RAP workout meeting was held in Kugluktuk on February 28, 2023. The meeting was held at the Kugluktuk Community Complex at 18:00 and was attended by Dele Morakinyo (CIRNAC), Cathy Corrigan (AECOM), Paula Petkovic (AECOM), Claire Brown (PSPC), and sixty (60) members of the community. The objective of the meeting was to present and discuss the various remedial options for the Site and the preferred technical recommendations, take questions and obtain comments from community members, and receive input on remedial preferences and final site use.

Based on the presentation materials prepared for the community and based on the questions and comments received from the community during the meeting, the remedial options presented in this RAP are deemed acceptable to the community.

10. Summary of Design Quantities and Recommendations

10.1 Design Quantities

Table 21 summarizes the granular and liner material quantities (including contingency and bulking factor) required to complete the remedial work outlined in this RAP and Table 22 summarizes the contaminated soil, non-hazardous waste, and hazardous waste material quantities (including contingency and bulking factor) that require containerization and transportation offsite for disposal at a licensed facility.

To account for material bulking, a uniform bulking factor of 25% was added to all material quantities (except geotextile and geomembrane materials).

Table 21: Granular Material and Liner Material – Material Quantities Summary

Item	Granular Material (m^3)			Liner Material (m^2)	
	Type 2	Type 3	Type 5	Geotextile	Geomembrane
Contaminated Soil Remediation	178.2	1001.8	-	-	-
Buried Debris Remediation	4288.9	552.6	-	-	-
CSTF Construction	4247.2	-	774.3	7741.0	3870.5
Subtotal	8714.3	1554.4	774.3	7741.0	3870.5
Bulking Factor (25%)	2178.6	388.6	193.6	-	-
Total	10893.0	1943.0	968.0	7741.0	3871.0

Table 22: Contaminated Soil, Non-hazardous/Hazardous Debris – Material Quantities Summary

Item	Contaminated Soil (m^3)				Debris (m^3)	
	DCC Tier I	DCC Tier II	Type B PHC	Hazardous	Non-hazardous	Hazardous
Contaminated Soil Remediation		151.5	753.0	6.2		
Buried Debris Remediation	57.8	82.4			105.2	4.9
Surface Debris/Barrel Clean-up					45.3	4.4
Structure Demolition					545.4	161.9
Subtotal	57.8	233.9	753.0	6.2	696.0	171.2
Bulking Factor (25%)	14.5	58.5	188.3	1.6	174.0	42.8
Total	73.0	293.0	942.0	8.0	871.0	215.0

10.2 Recommendations

It is anticipated, based on the assumption that the contractor will mobilize to the Site via barge, that the contractor will mobilize during the fall of the first calendar year (Year 1) and initiate the construction of critical items at this time. Most of the remediation activities are anticipated to be completed during the second and third calendar years (Year 2 and Year 3).

The recommended remedial options presented in this RAP are as follows:

- It is recommended that DCC Tier I and Type A PHC contaminated soil be capped in place using clean granular material.
- It is recommended that DCC Tier II contaminated soil be excavated to clean limits (i.e., until below objective), containerized, and transported offsite for disposal at a licensed facility. Based on the estimated design volume of DCC Tier II contaminated soil, granular material constraints, and concerns expressed about long-term liability, the construction of a Tier II contaminated soil disposal facility at the Site is not recommended.
- It is recommended that hazardous contaminated soil be excavated to clean limits (i.e., until below objective), containerized, and transported offsite for disposal at a licensed facility.
- It is recommended that Type B PHC contaminated soil be excavated to clean limits (i.e., until below objective) and treated onsite (ex-situ) in a contaminated soil treatment facility. Additionally, it is recommended that the 65.1 m^3 of contaminated soil in Beach POL – Area 2 be transported to a designated area outside of the nearshore zone to reduce the amount of Type B PHC contaminated soil to be treated.
- It is recommended that BDA-1a, BDA-1b, BDA-4a, and BDA-4b be excavated to their full depth/extent and re-graded to match the existing topography.
- It is recommended that BDA-1c, BDA-1d, BDA-2a, BDA-3a, and BDA-3b be re-graded to accommodate a minimum fill thickness of between 0.5 and 0.75 m. It is recommended that the final grades of the engineered covers match natural topographic contours to promote surface water runoff and prevent erosion. Slopes should be maintained between 2% (minimum) and 33% (maximum).
- For all buried debris areas (regardless of the recommended remedial option), all surface contaminated soil should be excavated, and all surface debris and exposed buried debris should be collected and removed prior to initiating the selected remedial approach.
- It is recommended that all hazardous waste be collected, containerized, and transported offsite for disposal at a licensed facility.
  - Because all interior paint at the Site is classified as hazardous, any painted ACMs should also be classified as hazardous.
  - Due to its friable nature, vermiculite should be removed from the Module Train in a manner consistent with a moderate risk (Type 2) abatement.
- It is recommended that petroleum products which contain hazardous products according to the AMSRP Barrel Protocol (e.g., chlorine, PCBs, heavy metals, etc.) be containerized and transported offsite for disposal at a licensed facility.
- It is recommended that all non-hazardous waste be collected, containerized, and transported offsite for disposal at a licensed facility following volume reduction (e.g., crushing, shredding, and/or incineration). Due to the relatively small difference in cost between on site disposal and offsite disposal (approximately 19%), the construction of a non-hazardous waste landfill at the Site is not recommended.
- It is recommended that petroleum products, such as gasoline or diesel, which do not contain hazardous products according to the AMSRP Barrel Protocol (e.g., chlorine, PCBs, heavy metals,

etc.) either be incinerated onsite under appropriate emissions controls or containerized and transported offsite for disposal at a licensed facility.

- Timber piles and sills should be containerized and transported off site for disposal at a licensed facility following volume reduction whereas concrete slabs can remain in place once all paint has been removed from the surface of the slabs. Clean granular material should be placed over the concrete slabs and re graded around the foundations to match the existing topography.

The implementation considerations presented in this RAP are as follows:

- With respect to contaminated soil remediation, the construction of the CSTF and the treatment of Type B PHC contaminated soil should be given a high priority during remediation; delay in either of these activities could delay the contractor’s demobilization from the Site. DCC Tier II and hazardous contaminated soil excavation should be completed early in Year 2 to allow time for additional containers to be brought to the Site if quantity overruns are encountered. The re-grading of DCC Tier I and Type A PHC contaminated soil areas should be given a low priority as this work item is simple, low-risk, and there are no other work items that depend on the completion of this one.
- For buried debris area where the recommended remedial option is excavation, work should commence early in Year 2 to allow enough time for segregation and containerization of the excavated waste streams. Because off site disposal is recommended for all excavated waste streams and given that there is a certain degree of uncertainty regarding excavation proportions from BDAs, the contractor should ensure that sufficient containers are brought to the Site during mobilization to avoid delays.
- For buried debris areas where the recommended remedial option is re grading, work can commence at any time as this work item is simple, low-risk, and there are no other work items that depend on the completion of this one.
- Collection and containerization of surface debris can commence at any time as this work item is simple, low-risk, and there are no other work items that depend on the completion of this one.
- All surface debris perimeters should be expanded during the design phase to ensure that all accessible surface debris is collected during remediation. In addition to the identified SDAs, a provision should be made to include the collection and containerization of all surface debris within 50 m of existing pads and roadways (where appropriate).
- Due to the requirement for barrel contents sampling (AMSRP Barrel Protocol), it is recommended that the collection of barrels, with consolidation of like products, be completed early during Year 2 to allow for sampling, and ultimately disposal, in a timely manner.
- Hazardous building materials, including ACMs and construction materials painted with PAP, should be removed, and containerized early in Year 2 (prior to demolition) to ensure adequate time is provided for full structure demolition. Additionally, other hazardous materials, including batteries and potential glycol containing liquids within building heating systems, should be collected, and containerized early in Year 2 in conjunction with general abatement activities. While no PCB containing equipment or mercury switches were noted during the Phase III ESA, if these materials are identified during remediation, they should also be collected and containerized.
- The use of Type 2 granular material as excavation backfill material (i.e., contaminated soil areas and BDAs) is considered an acceptable alternative to Type 3 granular material.
- There will be a requirement to selectively mine, blend, crush and/or screen granular material from the borrow sources to satisfy the specifications for Type 5 granular material.

11. References

AECOM Canada Ltd. 2022. *Phase III Environmental Site Assessment, PIN-C, Bernard Harbour Intermediate DEW Line Site.*

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Indigenous and Northern Affairs Canada (INAC). 2009. *Abandoned Military Site Remediation Protocol* (AMSRP).

Royal Roads Military College (RRMC) Environmental Sciences Group (ESG). 1993. *Five Intermediate Sites from the Western and Central Arctic*.

WESA Inc (WESA). March 2012. *Limited Environmental Investigation WK150 Bernard Harbour, PIN-C*.

Appendix A

Figures

Last saved by: EROSC(2023-03-28) Last Plotted: 2023-03-28 Project Management Initials: Designer: Checked: Approved: ANSI B 279.4mm x 431.8mm
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0 125 250
km

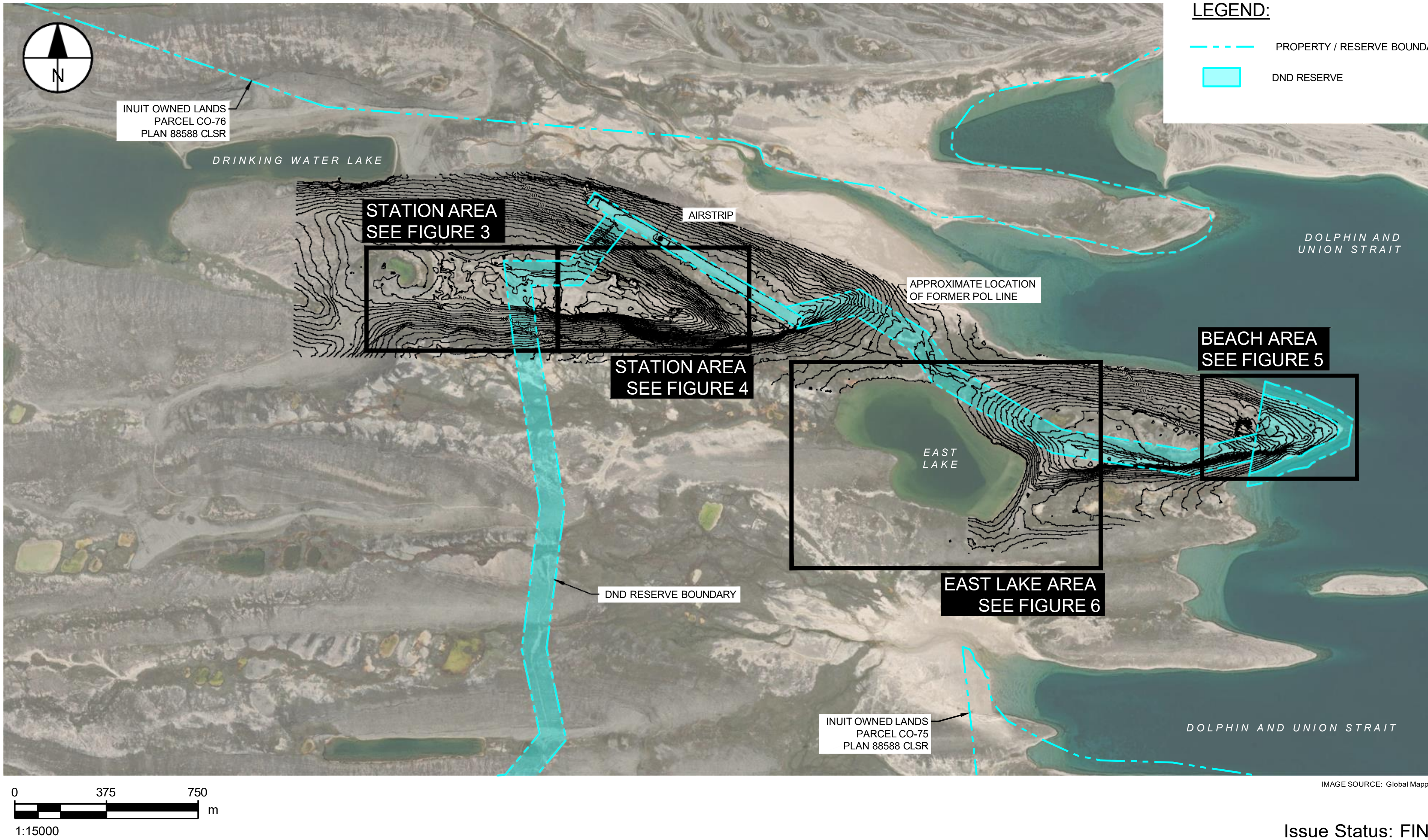
Issue Status: FINAL

PIN-C Bernard Harbour
Remedial Action Plan
Public Services and Procurement Canada
Project No.: 60688145 Date: 2023-03-31

SITE LOCATION PLAN

AECOM

Figure 1



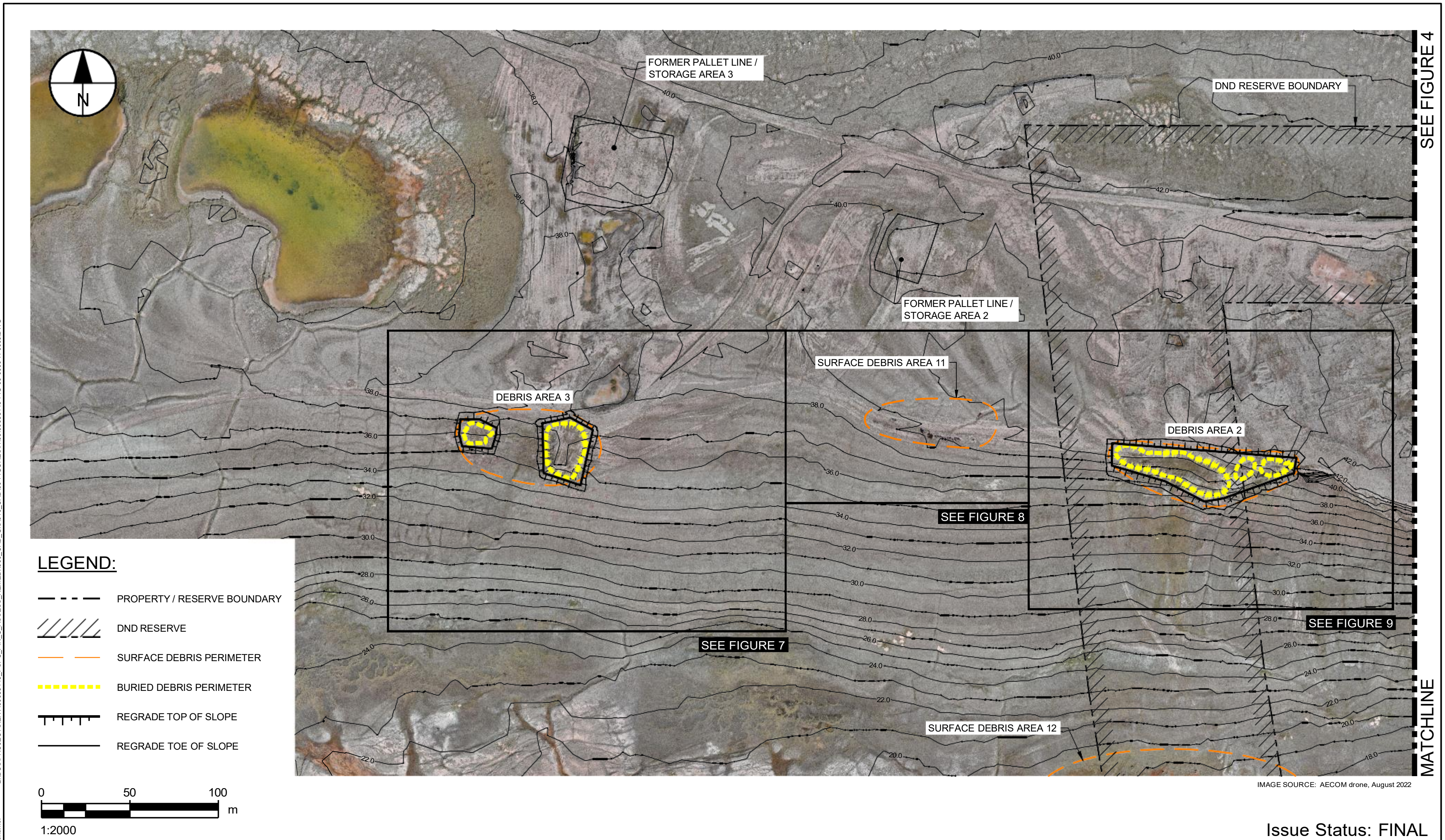
Issue Status: FINAL

PIN-C Bernard Harbour
Remedial Action Plan
Public Services and Procurement Canada
Project No.: 60688145 Date: 2023-03-31

OVERALL SITE PLAN

AECOM

Figure 2



Issue Status: FINAL

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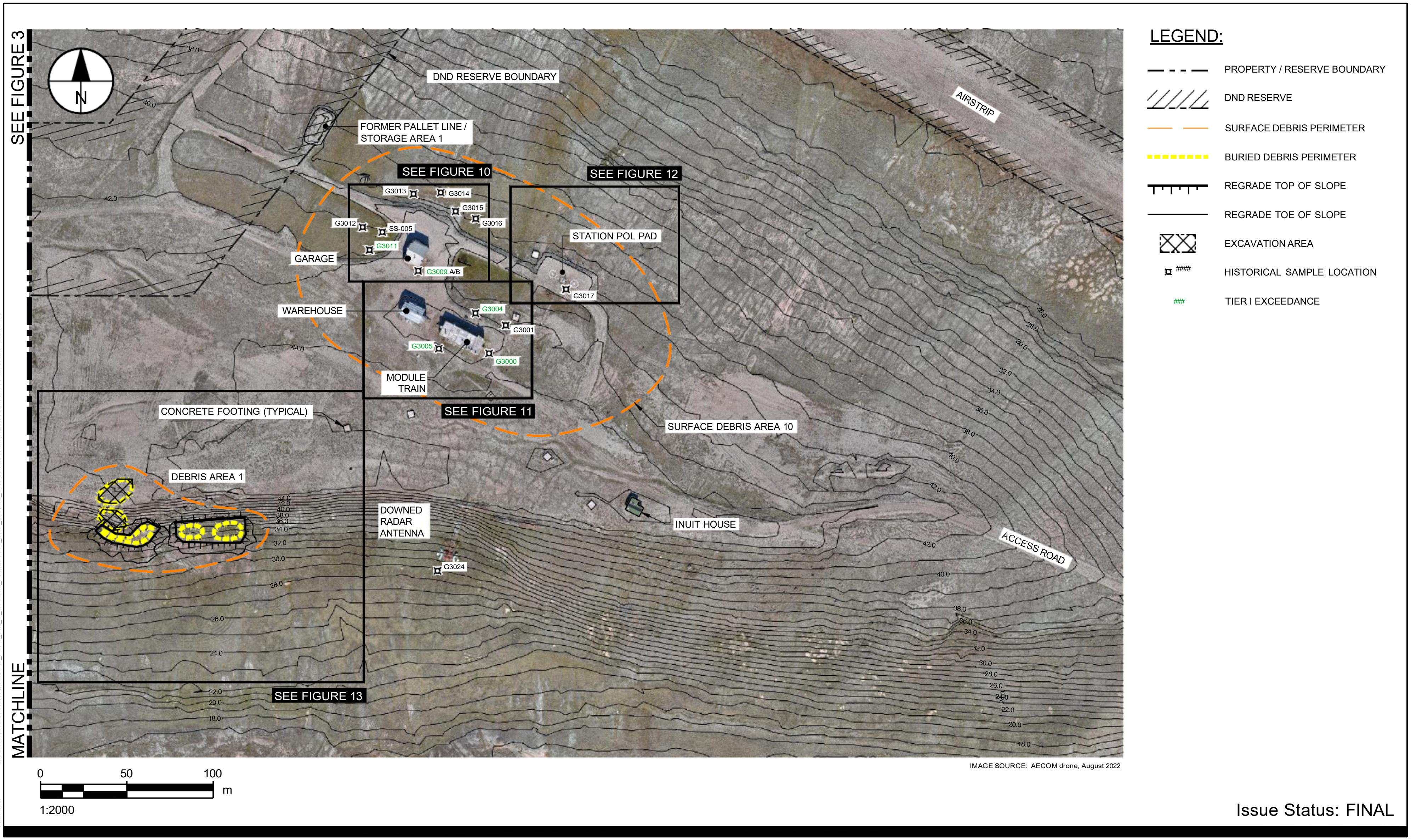
Project No.: 60688145 Date: 2023-03-31

STATION AREA
SITE PLAN - SHEET 1 OF 2

AECOM

Figure 3



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PIN-C Bernard Harbour
Remedial Action Plan
Public Services and Procurement Canada
Project No.: 60688145 Date: 2023-03-31

STATION AREA
SITE PLAN - SHEET 2 OF 2

AECOM

Figure 4