AECOM

Public Works and Government Services Canada

Remedial Action Plan
PIN-B, Clifton Point DEW Line Site

Prepared by:

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Project Number:

2977-343-02-4.6.1

Date:

November 9, 2009

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Michael Bernardin
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Edmonton AB T5J 1S6

Dear Michael:

Re: Remedial Action Plan, PIN-B Clifton Point DEW Line Site - Revision

Please find attached the Remedial Action Plan for the PIN-B Clifton Point DEW Line Site. This RAP is an update of the previously submitted report, updated based on the revised Abandoned Military Site Protocol (INAC 2009), the Canadian Environmental Protection Act (CEPA), and the Transportation of Dangerous Goods (TDG) Act and Regulations.

We trust this report meets your requirements. Please contact the undersigned if you have any questions or concerns.

Sincerely,
AECOM Canada Ltd.

Nick Oke, P.Chem. (Alberta)
Senior Environmental Scientist/Project Manager
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Encl. Remedial Action Plan PIN-B, Clifton Point DEW Line Site

Distribution List

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Revision Log

Revision #	Revised By	Date	Issue / Revision Description
Draft	Cathy Corrigan	November 16, 2007	Draft (INAC 2005 Criteria)
Final	Cathy Corrigan	May 2008	Final (CCME CWS PHC criteria)
Final	Jennifer Singbeil	October 27, 2009	Revision (INAC 2009 criteria)

Signature Page

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PERMIT TO PRACTICE
AECOM Canada Ltd.

Signature

Date Nov 12/09

PERMIT NUMBER: P639
NWT/NU Association of Professional Engineers and Geoscientists

Executive Summary

PIN-B, Clifton Point is located on the Amundsen Gulf coast in Nunavut (69°12'N,118°37'W). The nearest communities are Paulatuk, located 220 km to the northwest, and Kugluktuk, approximately 220 km to the southeast. The nearest air charter bases are located in Cambridge Bay, 550 km to the east on Victoria Island, and in Yellowknife, located approximately 800 km to the south.

UMA (now AECOM) completed a Phase III Environmental Site Assessment (ESA) at PIN-B in August 2007. The objective of the ESA was to collect all data necessary to develop a detailed clean-up design in accordance with the Abandoned Military Site Protocol (INAC 2005). The results of this assessment formed the basis for the original Remedial Action Plan (RAP), issued in May, 2008. This RAP is an update of the previously submitted report, updated based on the revised Abandoned Military Site Protocol (INAC 2009), the Canadian Environmental Protection Act (CEPA), and the Transportation of Dangerous Goods (TDG) Act and Regulations.

The PIN-B site areas are connected via gravel roads. The roads are generally in good condition, but will require some upgrading during construction for heavy equipment use and two-way traffic. Some areas are currently accessible only via poorly developed trails which will require upgrading. The airstrip is in good condition and generally suitable for use by aircraft as large as a Hercules C-130 under dry conditions. During wet conditions, the granular structure may not be sufficient to accommodate the largest of the aircraft considered (Hercules C-130). Aircraft with wide tires are best suited to the sandy gravel surface that by its nature may tend to rut. There is barge access to the site along the coast of the Amundsen Gulf, and a suitable beach landing area is present. Barge landing is not expected to be a concern.

Three archaeological areas were identified at the site: a suspected grave (PIN-B 1), a cluster of three tent rings and potential blind (NhPt-2, and an abandoned camp area NhPt-1). The former two features will require avoidance during construction activity, with the need for erection of barriers at NhPt-2 because the features are located in close proximity to a work area. The latter feature - the camp - has been identified for demolition because it was built from salvaged materials from the DEW Line site and contains hazardous waste items. Approval from the owner (an elder from Kugluktuk, interviewed during the traditional knowledge survey) was obtained for demolishing the camp. Prior to its demolition, a detailed archaeological documentation of the site will be required.

The investigation and delineation of contaminated soil at PIN-B was completed for the contaminants of concern listed in the INAC Abandoned Military Site Remediation Protocol. This protocol specifies numerical clean-up criteria for inorganic elements, and PCBs. Delineation of petroleum hydrocarbon (PHC) impacts was originally completed using the CCME Canada Wide Standards (CWS) for PHC in Soil, but has been revised in accordance with the 2009 INAC Abandoned Military Site Remediation Protocol, which specifies clean-up criteria for PHCs.

Seven existing dump sites and three small areas of buried debris were investigated during the 2007 ESA. The total area of buried debris within the dump sites is approximately 14,000 m^2. Based on the location and condition of the dumps and contaminant migration assessment results, each dump site was assigned as a Class A, B or C dump according to the INAC protocol. The remedial requirements for each dump were initially assessed according to the recommended remedial method specified in the INAC protocol for the various dump classifications. In addition, for development of remedial recommendations, site specific information for each dump was considered, such as proximity to surface water bodies, presence and sensitivity of down-gradient receptors (terrestrial and aquatic), and long term geotechnical stability potential. Where two remedial options were considered appropriate, a cost comparison was also completed to be factored into the decision. Based on these evaluations four dumps/areas of buried debris have been recommended for regrading: Station West Dump, Construction Camp Dump A, West Beach POL Buried Debris, and the Inuit Camp Meat Cache. The total area for regrading is 6,800 m^2. Five dumps have been recommended for excavation: Construction Camp Dump B, Construction Camp Dump C, Beach Dump, Beach Dump South A, and Beach Dump South B. The total volume for excavation is estimated at 6,600 m^3. An estimate on waste stream breakdown (percent debris, contaminated soil, non-hazardous and hazardous debris, and clean fill) was completed for dump excavation; these quantities have been included in the derivation of remedial recommendations for contaminated soil treatment and non-hazardous waste disposal.

Based on the surface debris assessment, demolition inventory and sampling, barrel inventory and sampling, and the estimated component to be derived from dump excavations, the volume of hazardous waste identified at PIN-B is 194 m^3. The estimated volume of non-hazardous waste is 2,180 m^3.

Based on the volume of non-hazardous waste, the quantities and types of granular materials identified during the 2007 investigation, and the identification of several suitable sites for new landfill development, it is recommended that a Non-Hazardous Waste Landfill (NHWL) be constructed at PIN-B. The preferred location for construction of this facility is at Proposed Landfill 1, located in the station vicinity.

The following volumes of contaminated soil were identified at PIN-B:

- Tier I soil: 576 m^3, of which 550 m^3 is estimated to be derived from dump excavations.
- Tier II soil: 1,211 m^3, of which 880 m^3 is from dump excavations.
- Type A soil: No volume, scarify surface of impacted area.
- Type B soil: 1,383 m^3.

Tier I soil can be disposed of in the on-site NHWL. Based on the observed concentrations, Type A soil can be scarified and left in place. A cost estimate was completed to compare off-site disposal of Tier II soil versus on-site disposal in a Secure Soil Disposal Facility (SSDF). Based on the results of that cost estimate, and consideration of long-term liability issues, it is recommended that Tier II soil be disposed of off-site. The recommended remedial option for treatment of Type B soil is landfarming. The recommended location for landfarm construction is the Proposed Landfarm located at the abandoned airstrip.

Based on the above remedial recommendations, it is estimated that the cleanup at PIN-B will require two full construction seasons. When considering the timing for contractor mobilization, the clean-up would require three years. Contractor mobilization would be completed by barge during the fall of season one. Primary construction activities would be completed during seasons two and three, with contractor demobilization in the fall of season three. The number one priority for the contractor, in terms of main work elements, will be completion of the landfarm as early as possible during season two, to allow treatment of PHC-impacted soils to commence as soon as possible and to facilitate achieving the remedial endpoint criteria by the end of season three. Following construction of the landfarm, the construction activity focus should switch to construction of the NHWL. Hazardous waste segregation from demolition components is also recommended for completion as early as possible while facility construction is occurring to allow building demolition to proceed once the NHWL is completed. Because of some unknowns related to barrel contents, barrel consolidation is recommended to be completed as much as possible during season two to allow for collection of samples and analysis. Given the unknowns associated with Tier II soil volumes that may be derived during dump excavation, it is recommended that the larger dump areas at the beach be the initial focus, with completion of as much excavation as possible during season two to allow for transport of additional containers to site for season three, if required. For this same reason, it is desirable to complete excavation of known Tier II soil areas during season two.

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1. Introduction

UMA Engineering Ltd. (UMA) was retained by Public Works and Government Services Canada (PWGSC), on behalf of Indian and Northern Affairs Canada (INAC), Nunavut Regional Office Contaminated Sites Program, to complete a Phase III Environmental Site Assessment (ESA) at, and a Remedial Action Plan (RAP) with Class C Cost Estimate for, the PIN-B Clifton Point former intermediate DEW Line site.

Since that time, UMA, combined with Earth Tech, Gartner Lee, and TSH in October 2008 became known collectively as AECOM Canada Ltd. (AECOM).

The scope of work for the Phase III ESA included the assessment of:

- Contaminated soil areas;
- Surface water and sediment quality;
- Building materials and demolition requirements, including identification of hazardous materials;
- Existing dumps (aided by the completion of a geophysical survey of the area);
- Barrel contents;
- Areas of surface debris;
- Any other potentially hazardous materials on-site other than barrels or demolition items;
- The sources and volume of non-hazardous waste materials;
- Site access roads, barge landing areas, and airstrip;
- Borrow sources for use during clean-up activities; and
- Traditional knowledge regarding past and present land use of the site from the elders of the nearby communities.

The results of the Phase III ESA have been reported previously (UMA 2007).

This report discusses remedial options for site issues identified during the Phase III ESA, and provides recommendations for the preferred option. Where different remedial options have been evaluated, a cost estimate comparing the options has been prepared. These estimates have been appended to the Class C cost estimate for overall site remediation, which is provided under separate cover from this report. This report has been structured as follows:

- Section 2.0 outlines the background information that forms the basis of the remedial option evaluations and recommendations;
- Section 3.0 discusses remedial options for site dumps;
- Section 4.0 identifies remedial requirements for hazardous waste elements at the site;
- Section 5.0 summarizes the sources of non-hazardous waste at the site and provides recommendations for disposal;

- Section 6.0 summarizes the findings of the contaminated soil investigation, and assesses remedial options for the various types of contaminated soil;
- Finally, Section 7.0 discusses issues related to the implementation of the recommended remedial options - for dumps, demolition of buildings, surface debris pick-up, treatment of barrel contents, the construction of new containment facilities (landfills and/or landfarm), hazardous waste disposal, and availability of required granular borrow sources.

Figures are presented in Appendix A.

2. Background

2.1 Site Location and History

PIN-B, Clifton Point was constructed as an Intermediate DEW Line site in 1957 by the Department of National Defence (DND). The station was abandoned as part of the DEW Line system in 1963, at which time site responsibility was assumed by INAC. The site is located in Nunavut, at 69º13'N,118º38'W, along the coast of the Amundsen Gulf, near the discharge of the Dolphin and Union Strait. The nearest communities are Kugluktuk, located approximately 200 km to the southeast and Paulatuk, located approximately 220 km to the west in the Northwest Territories (NWT). The nearest air charter bases are located in Cambridge Bay, 550 km to the east on Victoria Island and Yellowknife, located approximately 800 km to the south. Only smaller planes, such as DCH-6 Twin Otter, Embraer Bandeirante ("Bandit"), and possibly Beechcraft King Air are available out of Cambridge Bay, while in Yellowknife there are multiple size aircrafts available, including large aircrafts such as DC-3, DC-4, DCH-5, and Hercules.

The PIN-B station area is comprised of a five-module building train (the "module train"), a warehouse, a garage, a small house for Inuit staff (the "Inuit House"), a petroleum, oil, and lubricants (POL) storage facility with associated distribution system, and a downed radar tower. In addition to the Station facilities, a cargo beaching area was constructed at the beach area. A second POL storage facility was located at the beach, in the vicinity of the beach (cargo) landing area. Two airstrips were constructed at the site. The primary (operational) airstrip is approximately 1 km long and is located south of the beach area. The second (abandoned) airstrip is about 300 m long and located a short distance northwest of the primary airstrip. Gravel roads were built linking the airstrip, water supply lake and beach landing area to the station area. A small construction camp was erected during building of site facilities, but was demolished once site construction was completed. The former camp of an Inuit family is located approximately 1.5 km southeast of the PIN-B site; the demolition and clean-up of this camp is to be included as part of the PIN-B site remediation.

2.2 Remedial Protocols and Criteria

The remedial recommendations provided herein are based primarily on the INAC Abandoned Military Site Remediation Protocol (AMSRP) (INAC 2009). This protocol provides assessment and remedial guidelines for dumps, disposal of barrel contents, and provides clean-up criteria for contaminated soil. There are no criteria for the classification of hazardous waste at federal sites, except for materials regulated under the Canadian Environmental Protection Act (CEPA), including the Inter-provincial Movement of Hazardous Waste Regulations. The classification and remedial recommendations for materials not covered under CEPA has been based on the Transportation of Dangerous Goods (TDG) Regulations and the Nunavut/NWT Guideline for the General Management of Hazardous Waste (1998), under the territorial Environmental Protection Act (R.S.N.W.T 1998 c.E-7). More detailed information related to remedial guidelines or requirements under the sources noted above is provided in the issue-specific sections below.

2.3 Site Specific Remedial Considerations

The following sections provide site specific considerations that have been applied in the development of this remedial action plan.

2.3.1 Off-Site Access

The site is located along the coast. It is clear from historical air photo review and site layout along the coastal (beach) area that there was barge access to the site, and the landing area appears to have been northwest of the Beach POL pad. Information obtained from a local elder whose family lived at the nearby Inuit Camp during site operation indicates that barge access to the site was never a problem during operation. The ground at the beach is comprised of generally well-drained, 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. The area to the southeast of the Beach POL pad, however, has softer conditions due to discharge of groundwater and is therefore not a preferred landing area. The depth of water in the near shore environment could unfortunately not be assessed from air photo review because of ice presence at the time the photos were taken. However, no significant change in the position of shoreline due to tidal influences was noted during the 2007 investigation, suggesting that the near shore water conditions are not excessively shallow. Tidal prediction rates for August and September were available for two nearby sites - Bernard Harbour to the east and Tysoe Point to the west - from the Department of Fisheries and Oceans (DFO) website. For this time of year, tidal fluctuations are in the order of approximately 0.5 m.

Barge refueling of beach POL tanks was observed during our site investigation in 2003 at the DND PIN-2 Cape Young site, located 50 miles to the east. No difficulties were observed, but there was no actual beaching completed at that time, since the refueling was completed via a fuel line from the barge and no other materials were being off-loaded. A review of air photos from the PIN-2 site taken in 1985; however, does not show any dredging of the near shore sediments in the area of continued barge landing for the operation of the operational North Warning System PIN-2 site. Based on the above information, barge landing at Clifton Point is not expected to pose a significant challenge.

There are no nearby mining operations, and therefore, no potential for independent development of an ice road that would be of use for contractor mobilization. Because of the long distance from any communities, combined with the availability of barge access, it is considered unlikely that overland mobilization (i.e. cat train) would be considered a viable option for contractor mobilization. It has therefore been assumed for the preparation of this RAP, and its associated cost estimate, that primary access to the site for mobilization and demobilization of contractor equipment and supplies during remediation will be via barge.

An inspection of the primary airstrip at the site was completed during the 2007 Phase III ESA. The airstrip is about 1,000 m long. The granular materials at the airstrip are well compacted. There are no significant erosion channels and rutting is minimal. Small mounds of vegetation have become established on the entire surface of the airstrip. These mounds are typically 300 mm across and mounded up to about 75 mm in some cases.

The Arctic SunWest Chief Pilot present during the 2007 site assessment considered the airstrip to be in good condition with the exception of the vegetation mounds. Landing a Twin Otter did not present any difficulties and he concluded that it was possible to land a Buffalo (DCH-5) should it be necessary for demobilization from the site. A sample was collected for CBR testing to confirm the suitability of the airstrip for larger and heavier aircraft. Results of the CBR testing indicate a very competent gravel surfacing and subgrade material, even in a saturated condition. The testing suggests that all of the following aircrafts (with full loads) would be able to use the airstrip during dry conditions at the site: DC-3, DC-4, Hercules C-130, Otter DHC-3, Twin Otter DHC-6, Shorts Skyvan, and Buffalo DHC-5. Under saturated conditions, all of the noted aircrafts would still be able to land, with the exception of the Hercules C-130. However, because the testing did not consider the internal stability of the rounded (pit run) granular fill and potential for rutting, it is nonetheless considered essential that the airstrip be inspected by aircraft crews familiar with the necessary gravel surfacing requirements prior to its use, in particular for aircraft the size and weight of a Hercules C-130.

For the purposes of this RAP, it has therefore been assumed that aircraft access to the site will not be an issue, especially given the assumption that the primary mobilization of contractor equipment will be via barge.

2.3.2 On-Site Access

There are a number of gravel roads throughout the site connecting the Station Area with the Airstrip and Beach Areas. There are also several trails where vehicular and tracked equipment have traveled in the past. All of the major roadways and significant trails were surveyed during the site investigation. The gravel roads are well elevated and in good condition with the exception of localized areas on the main access road where bears burrowing for ground squirrels have created a low spots in the road surface. There are only two culverts crossing the access roads; one on the main access road and the second on the road into the Beach Dump Area.

The roads are in good condition for heavy equipment; although, regular grading will be required. The low areas where bear burrows are present will require infilling prior to gaining access from the airstrip to the Station Area. The top width of the roads varies from 3.7 to 6 m with an average of about 5.0 m. These widths are satisfactory for single lane traffic. The construction of widened or pull out sections will be required for two way heavy equipment traffic. The existing trails would require upgrading if considered for hauling routes. Small extensions of the existing road system will be required to access some of the other site areas; these are noted in detailed discussions below.

Access for trucks and heavy equipment e.g. excavator to the Inuit Camp east of the site will be required. It is unlikely that an overland route to the Station Area will be possible without construction of a haul road, the development of which will require numerous low areas to be bridged. Access along the beach between the Beach POL and Inuit Camp with tracked equipment is also possible although there are a number of shallow flowing creeks that would have to be crossed. Truck access along the beach may be difficult and best attempted later in the season when low creek flows would be expected. The preferred approach may be to use only track mounted equipment along the beach and skid demolition material to the non-hazardous waste landfill or to a staging area for containerization (PAP). If an overland route is contemplated, it should follow the existing trail between the Station and the Inuit Camp to minimize damage to undisturbed tundra.

2.3.3 Environmental Considerations

Information regarding traditional knowledge and land use of the site was obtained during the site investigation from residents of Kugluktuk. People interviewed included Logon Pigalak (site assessment bear monitor from Kugluktuk), George Taptuna (site assessment equipment operator) and elders John and Ida Kapakatoak. Mr. Kapakatoak and his family had lived in the Inuit Camp at the site between 1955 and 1964, while Mrs. Kapakatoak's family had lived nearby in the Cape Young area in the same time frame. The following information was recorded regarding on-site receptors and traditional land use of the area. Most of the information was provided by Mr. Kapakatoak.

- Fishing is very poor at the site. No fishing was done along the coast. No lakes at the PIN-B site have fish in them. Fish were only found in a lake much further south of the site. The big lake between the station and airstrip is relatively shallow, with an estimated depth of five feet and was thought to freeze to the bottom in winter.
- It was stated by all four locals interviewed that no one from Kugluktuk came by the site to hunt or fish anymore because it is too far.
- Sometimes the Rangers from Paulatuk pass by the site in winter to check on the Short Range Radar Site at PIN-2, and overnight at the Inuit house at PIN-B.
- Caribou are typically gone from the area by October, and the area is generally poor for hunting in winter; the only land fauna remaining during winter were foxes, and the only viable hunting was for seals off-shore.

During the 2007 Phase III ESA investigation, the following fauna (or evidence of their presence) were observed:

- Grizzly bears
- Caribou
- Arctic foxes
- Ground squirrels
- Lemmings
- Rough-legged hawks
- Tundra swans
- Loons (Arctic)
- Plovers (semi-palpated)
- Bowhead whales (remains along shoreline)

During the 2007 assessment in mid to late-August, large flocks of snow geese passed over the site, but they did not appear to land in the vicinity. In addition to the bird species noted above, the 1994 ESG assessment also noted the presence of common eider, lesser golden plover, savannah sparrow, lapland longspur, and snow bunting.

Vegetation at the site is moderate to abundant in undisturbed areas and consists primarily of grasses and sedges, with willows and some flowering plants also present. A detailed list of vegetation species identified at the PIN-B site was completed as part of the 1994 Phase II ESG (ESG 1995). More specific information related to vegetative cover is described in area-specific discussion below.

2.3.4 Geology/Geomorphology/Hydrology

Bedrock at the Clifton Point Area is comprised of limestone and dolostone. Outcrops are present along the beach area, north of the Beach Dump, and south of the Beach POL pad. Limestone observed in this area was vuggy and weathered.

The primary soil type at the Clifton Point site is comprised of stratified sand and gravel - beach deposits derived from marine re-working of till . Soil at lower elevations off the beach ridges has not been subjected to the same sort of washing and is generally finer-grained, comprised of sand and silt grading to silt and clay at depth. The effects of frost action are prevalent across the site, with well-developed frost wedges within the beach ridge areas near the Station, and frost boils in the finer-grained soil areas off the beach ridges.

There are several shallow lakes on inland beach terraces at the site. Regional overland drainage from the site is generally towards the Amundsen Gulf to the northeast. Approaching the existing shoreline, surface drainage becomes concentrated into creeks flowing within well-developed gullies cutting through the lower-elevation beach deposits at several locations southeast of the site.

The overall grade for the site is described as gentle. However, since the site terrain consists of a series of beach terraces and strands grading towards the existing shoreline, there are localized areas of drops in elevation where the grade would be considered as moderate.

Based on the results of the 2007 investigation, there are no areas of site activities exhibiting signs of erosion as a result of existing site drainage. None of the soil types identified are particularly prone to erosion. However, areas near the coast may be subject to future erosion by wave action in the event of sea level rise with global warming. Any borrow development in the vicinity of the beach or airstrip areas may require drainage control to prevent sediment loading to the coastal area. Areas identified for new development (borrow and potential new landfill construction) in the Station Area are not considered at risk of any significant erosion.

2.3.5 Archaeological Features

An on-site archaeological investigation of the site was completed by Golder Associates in conjunction with the UMA Phase III ESA during the early stages of the site work. The purpose of the study was to identify heritage features needing protection or avoidance during site remedial activities. As such, the field inspection focused on locations identified for remediation or potential new development areas (borrow areas and proposed landfill/landfarm construction locations). These locations were provided by UMA at the start of the field program and were based on a review of previous site assessment data and terrain evaluation regarding potential borrow sources or new landfill development sites. Any changes to these initial locations or the identification of new areas were communicated to the archaeologist while he was still on-site.

A review of the existing database of archaeological sites, maintained by the Nunavut Department of Culture, Language, Elders and Youth (CLEY), was completed by Golder prior to site work. This review indicated that two archaeological sites (NhPt-1 and -2) had previously been recorded in the site vicinity. During the course of the field program, a new site - PIN-B 1 - was also identified. The features are described below, with information regarding the need for mitigative measures during site clean-up. All information below is based on the draft report submitted by Golder (2008).

- NhPt-1: This site is located on the edge of a stream where it discharges into the Dolphin and Union Strait. The site was recorded as a campsite with both prehistoric and historic components. Features include cabins, tent rings, and a beached schooner (the "Gertrude E"). The location of these features is shown on Figure 2 in Appendix A. Only one tent ring was identified during the 2007 inspection, and assessed to date prior to the occupation of the cabins. Information obtained from elder John Kapakatoak indicated that his mother had built the cabins and their family lived there from approximately 1955 to 1964. The cabins were built using information salvaged from the DEW Line site. An assessment of hazardous materials at the cabins was completed by AECOM, and indicated that there was asbestos present and that cabins had been painted using PCB-amended paint. Because of the hazardous materials present, it has been recommended that the cabins be demolished as part of the PIN-B site clean-up. Approval for their demolition was obtained from Mr. Kapakatoak, given the poor condition of the buildings and that his family no longer uses the camp. In advance of the demolition of the camp buildings and removal of associated surface debris, it is recommended that mapping and detailed documentation of features be completed. Systematic shovel testing should be completed to determine whether there are precontact features in the affected areas.
- NhPt-2: This site is situated on a bedrock ridge above the beach, approximately 820 m northeast of the north end of the airstrip. It is prehistoric in age and consists of three tent rings and a possible blind. The tent rings are complete, with some rocks buried in moss and wind-blown sediments. The features are in close to an area with surface debris requiring pick-up and a Tier II contaminated soil area requiring excavation. One tent ring is particularly close - within 15 m of the identified Tier II area. It is recommended that barricades be erected around the feature to delineate them for avoidance prior to commencing remedial activity in the area.
- PIN-B 1: This previously unrecorded feature is located approximately 125 m east-northeast of the airstrip. It is comprised of a large elongated stone cairn (3.4 m x 2.3 m), several tiers of rocks thick, and has a few associated lithic flakes and machine cut planks. The rocks are covered in a significant amount of lichen, with the lowest level of rocks well buried. The cairn is visible in a 1964 air photo, but not clearly apparent in a 1950 one. Community members from Kugluktuk were asked about the cairn, but did not recall it from the time of site operation. It is suspected that the cairn is a grave site. There is no remedial activity planned for this general area, so it is not expected that the feature will be disturbed. However, it is in a potentially high traffic area during remediation, so will likely require flagging-off prior to commencement of site remedial activities to ensure avoidance.

2.3.6 Site Assessment Information

The preparation of this RAP has been based on data from the following reports:

- UMA, October 2007, Draft Phase III Environmental Assessment Report, PIN-B Clifton Point DEW Line Site, prepared for Public Works and Government Services Canada;
- ESG, March 1995 - Environmental Study of Abandoned DEW Line Sites: One Auxiliary and Eight Intermediate Sites in the Canadian Arctic, prepared for Department of National Defence.

3. Dump Remediation

3.1 Dump Remedial Protocol

The assessment of dumps at PIN-B Clifton Point was completed with the goal of classifying the dumps according to the three categories specified under the INAC Abandoned Military Site Remediation Protocol:

- ***Class A:*** buried debris is located in an unstable, high erosion location. Remediation will involve relocation of dump contents to an engineered landfill.
- ***Class B:*** the dump is in a suitable, stable location, but there is evidence of contaminant migration. Remedial solutions include the installation of an engineered containment system, or relocation, whichever is deemed more cost effective.
- ***Class C:*** the dump is in a suitable, stable location, and there is no evidence of contaminant migration. In such cases, the debris may be left in place, with the placement of additional granular cover as required.

Dump assessment involved the collection of soil samples up and down-gradient of the dumps, at surface and depth. Contaminant concentrations obtained from down-gradient samples were compared to those from up-gradient samples, and also to average levels of contaminants from all of the dump assessment samples. Where down-gradient samples were consistently higher than up-gradient (by at least two times the concentration of average or up-gradient samples), and elevated concentrations were present over a significant proportion of the total sample locations (i.e. more than one isolated event), the dump was evaluated to have evidence of contaminant migration. The potential for surface soil contamination was also assessed by noting any staining or the presence of types of debris that might act as a contaminant sources (such as battery debris). In areas where contamination was suspected, surface and shallow depth soil samples were collected to assess and delineate the extent of contamination.

The following sections describe specifics related to the three recommended requirements for each of the three classes of dumps. For all dumps, it is recommended that any surface debris or surface contaminated soil be removed prior to initiating the dump remediation remedial requirements outlined above.

3.1.1 Excavation/Relocation (Class A Dump)

All dumps have the potential to contain buried hazardous waste materials and contaminated soil, in addition to the expected non-hazardous waste debris. For this reason, where the recommended remedial action is excavation and relocation of dump contents, the contents of the dump will require segregation during excavation to allow classification of the various waste streams. Debris should be separated from soil, with segregation of hazardous and non-hazardous waste. Soil should be sampled to identify any contaminant levels. Contaminated soil identified during sampling should be disposed of according to the requirements outlined in the INAC AMSRP.

Through our work on the DND DEW Line sites, AECOM has developed and maintained a database recording the breakdown in dump excavation components. This database is currently comprised of dump excavation information from 15 sites. From this database, the average excavation volume breakdown is as follows:

- Tier II soil: 20%
- Tier I soil: 15%
- Non-hazardous debris: 20%
- Hazardous debris: 2%
- Clean fill: 43%

For excavation of dumps on DND DEW Line sites, we have typically applied these standard percentages during the design stage. However, where site-specific information suggests a higher or lower level of contaminated soil (based on the results of environmental sampling), a higher level of hazardous debris component (based on exposed debris observations), or different concentration of debris (i.e. higher or lower debris content based on extent of cover or a weak and/or spotty geophysical anomaly), the percentages have been modified accordingly.

Based on observations from other intermediate DEW Line sites under INAC's jurisdiction, and on observations from historical air photo review completed at DND DEW Line sites, it was common during the early stages of site operation that debris disposal at dumps did not, generally, involve the placement of cover over debris upon disposal. Dumps in these circumstances were typically comprised almost entirely of debris and oftentimes had contaminated soil associated with them as a result of the type of debris disposed, but there was little-to-no surface cover. At the DND sites, however, where the sites were in operation over a longer period of time, dump operations gradually evolved such that debris began to be covered with granular fill, with the common implementation of excavation of existing ground, stockpiling of excavated granular material and placement of debris, with subsequent debris backfilling with the stockpiled granular material. The DND dumps typically have reasonably good surface cover overlying debris, with the majority of debris exposure restricted to along the toe, where backfilling was not so thorough. Observations from PIN-B, both on-site, and through historical air photo review, indicate that this "trench and cover" debris disposal methodology was implemented from the start during operations at this site. For this reason, the same design principles applied at DND DEW Line sites, regarding dump excavation component breakdown, have been applied for the evaluation of dump excavation quantities at PIN-B.

However, a review of the site and dump-specific quantity breakdowns from the DND dump excavation database was undertaken to further determine the appropriateness for applying these average concentrations to dumps at PIN-B. It was noted during this review that the component breakdown from excavations, particularly related to contaminated soil quantities, could be fairly well correlated with the amount of contaminated soil identified at the landfill surface or down-gradient, and/or with the strength of evidence regarding contaminant migration. The results could also be well correlated with the other factors such as the strength of the geophysical anomaly (which is indicative of the density of debris within the dump). This suggests that the average component concentrations noted above should be more strictly used as a starting point for evaluation, with ultimate component breakdown derived from much more consideration of dump-specific information (where that information is available from the site investigations).

The results of the geophysical surveys at PIN-B dumps (in terms of anomaly strength) suggest that a lower concentration of debris is present in these landfills, compared to typical DND site landfills, which is consistent with their operation over a much shorter timeframe. However, a definitive comparison could not be completed because the geophysical method used at PIN-B was slightly different than that which has been used at DND sites. However, contaminated soil was rarely identified at the PIN-B dumps, and contaminant levels observed down-gradient were never at significantly high concentrations. These observations suggest that a lower level of contaminated soil should be expected from within landfill contents, as well as a lower level of debris. The standard component breakdown for dumps at the PIN-B site has therefore been assumed as the following:

- Tier II soil: 15%
- Tier I soil: 10%
- Non-hazardous debris: 20%
- Hazardous debris: 1%
- Clean fill: 54%

The volume of non-hazardous debris has assumed to be the same as the average breakdown from DND sites because of the inability to compare the geophysical survey results directly. This is felt to be a conservative measure. The percentages of Tier II and Tier I soils, and hazardous debris has been decreased, with a corresponding increase in the volume of clean fill. And as noted above, these standard percentages have been further modified where warranted by dump-specific information.

Dumps should be excavated to the limits of debris burial noted on drawings. 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 area should be backfilled and graded to conform to surrounding terrain, and provide positive drainage.

3.1.2 Leachate Containment (Class B Dump)

The typical design that has been used for leachate containment at existing DEW Line dumps involves the excavation of a trench just beyond the limits of the buried debris. The trench extends into either ice rich permafrost or saturated ground, typically at a depth of about 1.5 m at the PIN-B site. A geosynthetic liner system is placed extending from the base of the trench over the dump area. The trench is then backfilled with low-permeability (Type 4) granular fill which may also extend upslope of the trench. Well graded sand and gravel (Type 2 fill) is placed and compacted over the surface to a thickness that will promote permafrost aggradation through the key trench and into the landfill contents. A schematic diagram showing a typical leachate containment system is provided in Figure 16 in Appendix A. The primary long-term containment system is the saturated granular fill. Once the material freezes, it becomes a low-permeable containment barrier. The geosynthetic liner provides essential short-term containment until permafrost aggrades into the landfill and continues to provide longer-term containment following freeze back.

Geothermal modelling completed for the remedial design at the nearby PIN-2 Cape Young site, where terrain and vegetative cover is similar, specified a design thickness of 4.0 m of Type 2 fill for freeze back of contents. Geothermal modelling considered soil type, soil thermal properties, presence or absence of insulating cover (vegetation or snow drift), measured ground temperatures at the site or at nearby sites, measured air temperature and climatic data (from 1959-1999 from Environment Canada), an estimated 1 in 100 warm year air temperatures, and an estimate of the effect of global warming. The effect of global warming was estimated using the most recently published data summarizing global warming rate estimates for Arctic environments (ACIA 2005). The design cover thickness specified for PIN-2 has been used for consideration of remedial options at PIN-B.

While the specific requirements for long-term dump monitoring at INAC abandoned military sites have not yet been agreed upon, at DND DEW Line sites, this remedial option has initiated the need for significant post clean-up monitoring, with the installation of thermistors within the dump to confirm that contents are frozen. To confirm that no further contamination migration is occurring, groundwater monitoring wells are installed up and down-gradient for the collection of groundwater samples, and soil samples are collected adjacent to the monitoring wells. This monitoring has typically been done on a yearly basis for the first five years following site clean-up (which is the estimated time required to achieve thermal equilibrium), and then upon a reduced yearly frequency.

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, for smaller dumps. For this reason, the option of excavation has also been evaluated in discussions below for dumps classified as Class B.

3.1.3 Regrading (Class C Dump)

For dumps located in a geotechnically stable location, with no evidence of contaminant migration, the recommended remedial action is regrading with the placement of additional granular cover. It is typically recommended that the extent of regrading be extended slightly beyond the extent of the identified limits of debris (a 2 m offset has been used historically). The granular fill cover placed over the dump should be well-graded (Type 2), erosion resistant, and well-compacted to limit infiltration of water. Where there is the potential for erosion from surface drainage, it is typical to strategically place armouring material (Type 1 granular fill). 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, but for smaller areas, with no appreciable topographic expression, a smaller fill thickness of 0.5 m has been applied.

3.2 Station West Dump (Figure 5)

The Station West Dump is located approximately 500 m northwest of the Station, along the west side of the main access road to the airstrip. Two lobes of buried debris were identified - Lobe A and Lobe B. Lobe A is the primary lobe, comprising the majority of buried debris, with an area of 3,150 m^2. Lobe B is a small lobe immediately up-gradient of Lobe A, with an area of 400 m^2.

The debris has been buried along the edge of a former beach ridge. The northern portion of Lobe A has a well-defined toe located at the base of the beach ridge, while the southern part of the lobe has spotty buried debris extending onto the low-lying tundra off the ridge and is not as well-defined topographically. Lobe B has no topographic expression. Buried debris exposure is primarily along the toe of Lobe A; cover over the majority of the lobe is good. No debris exposure was noted at Lobe B. An area of scattered battery and copper surface debris is present at the southern margin of Lobe A.

Substrate for most of the lobe is comprised of well-drained sand and gravel beach deposits. Down-gradient of the beach deposit, the soil consists of low-lying, wet, silt and sand grading to silt and clay at depth, with well-developed frost boils present. Ponded water is common. The average grade across the dump is approximately 6% towards the west-southwest. No erosion was noted.

Vegetative cover along the beach ridge is sparse to moderate. Off the beach ridge, vegetation is much more lush, at 100% coverage, with an organic mat at surface. A fairly large lake is located approximately 150 m down-gradient of the dump. Loons and tundra swans were noted at the lake during the 2007 investigation; although, information from the local elder who lived at the site indicated that the lake does not contain fish. Nesting plovers were identified up-gradient of the dump, across the road. Ground squirrel burrows were present within the dump, along with signs of grizzly bear activity evidenced by burrowing around ground squirrel holes.

The environmental investigation of the dump did not indicate that it was leaching contaminants. Soil samples collected at the location of the surficial battery and copper debris at the southern edge of the dump identified localized Tier II lead contamination in the vicinity of this debris, with an estimated extent of 42 m^2, to an estimated depth of 0.5 m. This contaminated soil area is just outside of the limits of buried debris, therefore excavation of contaminated soil is not expected to encounter dump debris.

Based on the results of the 2007 investigation, the Station West Dump is considered a Class C landfill, with a recommendation for regrading. It is felt that this dump is sufficiently removed from the nearby lake (approximately 100 m down-gradient at its closest point) so as not to be considered an environmental risk, particularly since no evidence of contaminant migration was noted. The Tier II soil must be excavated prior to regrading. There are no special considerations with respect to regrading at this dump, beyond the typical requirements noted in Section 3.1.3.

3.3 Construction Camp Dump A (Figure 6)

The Construction Camp Dump A area is located 350 m northwest of the station, off the northern edge of the main barrel storage pad for the station. The geophysical survey identified a dump size of 320 m^2.

Debris was buried off the edge of the barrel storage pad where the substrate is primarily sand. A fairly well-developed drainage channel towards the east is present approximately 5 m down-gradient of the toe. Water was present at or slightly below grade in shallow (up to 0.6 m) test pits excavated down-gradient of the dump, while no groundwater was encountered up-gradient. Grade across the dump is approximately 6%. No evidence of erosion was noted. The environmental investigation did not indicate contaminant migration from the dump. The Construction Camp Dump A was therefore assessed as a Class C dump, with a recommended remedial action of regrading.

Observations from 2007 indicate that the down-gradient drainage channel does not convey a significant volume of water. However, if the dump is regraded to a fill thickness of 0.75 m (which is recommended), with an offset of two metres, then the toe of the granular fill may intersect the drainage channel. It is therefore recommended that armouring be put in place along the toe. It should be noted that there are some pieces of debris (cable and pipe) exposed at this dump that may be more feasible to cut at surface rather than attempting complete removal prior to regrading.

3.4 Construction Camp Dump B (Figure 7)

The Construction Camp Dump B is located along the north-eastern edge of the former Construction Camp Area, approximately 500 m north of the Station. Access is via the road to the Construction Camp from the Station, although a road extension will be required to reach the dump. A geophysical survey identified a dump size of 230 m^2.

Debris is buried within a low-lying, wet area, with sandy, silty soil. Ponded water is present up-gradient and down-gradient of the dump. The overall area is within a broad drainage area migrating towards the shallow lake between the Station and airstrip. Drainage channels are present along the north and south edges of the dump, and one drainage channel cuts through the centre of the dump. Grade is gentle to flat, at approximately 3%. No erosion was noted at the dump, although this is likely due to the surface protection offered by the relatively lush vegetative cover. The drainage channel cutting through the dump appears to be in an area with no debris burial.

The results of the 2007 environmental investigation suggest that no contaminant migration is occurring from the dump. Geotechnically, the dump also appears stable, despite the drainage conditions in the area. For these reasons, it would be classified as a Class C dump. However, because of the dump position within a drainage basin receiving significant water, with well-developed drainage channels passing adjacent or through the area, the potential for erosion is considered high in the event of regrading, where the existing vegetated surface (which is likely providing existing stability) would be covered with new granular fill. For this reason, the classification of this dump has been upgraded to a Class A, and it is recommended that it be excavated. The estimated depth of debris is 0.5 m, with an excavation volume of approximately 120 m^3.

Up-gradient drainage control will be required for the excavation of this dump. Because no contamination or hazardous waste materials were observed at the dump, the estimated excavation component breakdown has been assumed as the average values: 15% Tier II, 10% Tier I, 20% non-hazardous debris, 54% clean fill, with a hazardous waste allowance of 1%.

3.5 Construction Camp Dump C (Figure 7)

The Construction Camp Dump C is located east of the former Construction Camp, approximately 350 m north of the Station. There is no direct road access to the area and remediation will require construction of a road. The dump is approximately 230 m east of the Construction Camp access road. The dump size is estimated at 180 m^2.

Substrate at the dump area is primarily composed of sand with cobbles and boulders. An organic mat of approximately 0.1 m was present. In shallow test pits surrounding the dump, groundwater seepage was encountered at 0.4-0.5 m. The overall area is flat, with an estimated grade of 2%. There is no evidence of erosion at the dump.

The shallow lake between the Station and airstrip (described in Section 2.3.3) is the aquatic receptor for this dump. The high water mark for the lake is 20 m down-gradient from the toe of the dump. No animal burrows were identified at the dump, likely because of soil saturation levels.

The geotechnical and environmental data collected during the 2007 investigation indicate that the dump is stable and not leaching contaminants, which would classify it as a Class C dump. However because of its proximity to the lake, it is nonetheless recommended that the dump be excavated. The estimated depth of debris is 0.5 m, for an excavation volume of 90 m^3. The estimated excavation component breakdown has been assumed as the average values: 15% Tier II, 10% Tier I, 20% non-hazardous debris, 54% clean fill, with a hazardous waste allowance of 1%.

3.6 Beach Dump (Figure 10)

The Beach Dump is located approximately 230 m east-northeast of the north end of the airstrip. The results of the 2007 ESA identified an area of 2,550 m^2.

The debris has been buried along the slope of a former beach ridge. The existing ground has apparently been excavated for debris placement, with stockpiling of soil along the northeastern limit. The edge of ground excavation is well-defined along the down-gradient toe by the position of this stockpiled soil. Some debris was noted within the stockpiled soil near the south end of the dump; however, the geophysical survey indicated that debris is not present within this mounded soil area along the northern half of the dump area. Some ponded water, estimated as approximately 0.5 m deep, is present between the main beach ridge to the east, and the stockpiled soil to the west.

Substrate consists of gravel with sand and cobbles. No groundwater was encountered in shallow test pits excavated close to the dump perimeter, but groundwater seepage was noted in the second row of down-gradient samples at a depth varying between 0.4 to 0.5 m. The average grade across the area is approximately 8%. The dump is located on a former beach deposit located some 3 m higher than the existing water level, and approximately 50 m away from the marine storm surge line. No evidence of erosion was noted in 2007.

The results of the 2007 ESA showed elevated zinc levels down-gradient of the dump at three locations along the southeast edge. The elevated zinc levels were present in the first row of samples collected near the dump toe, and in the second row of samples collected closer to the ocean shoreline. Contaminant levels decreased in the second row of samples which provided some confirmation that the dump was the source. This was therefore evaluated as evidence of contaminant migration.

The ocean is located approximately 70 m away from the existing dump toe. It is understood from the traditional knowledge survey that seals frequent the area, but fishing conditions are not good. Bowhead whale remains were identified along the shoreline indicating that they also pass through the area. Some ground squirrel burrows were noted in the area, with grizzly bear burrowing around the holes. Bear tracks were also noted along the beach. Because of the evidence of contaminant migration, the Beach Dump has been classified as a Class B landfill, requiring either leachate containment or excavation. While not a criterion according to the INAC protocol, the close proximity of the ocean has also been considered as a compelling argument to add to this classification.

Because of its relatively small size, a cost comparison has been completed comparing the options of leachate containment versus excavation for this dump. Assumptions used for this cost estimate are as follows:

- A fill thickness of 4 m is required to achieve and maintain frozen conditions over the long term, consistent with geothermal modelling conducted at the nearby PIN-2 Cape Young site;
- A slope configuration of 4H:1V will be used for final, overall slope;
- Landfill monitoring requirements will be the similar to DND DEW Line sites;
- The dump excavation volume (2,570 m^3) has been estimated assuming a conical frustum-type configuration for debris buried along the slope, while the debris volume buried within the linear mounded area along the east side has been estimated by integration from the detailed topographic survey, using the area of horizontal slices of equal elevation from the detailed topographic survey; and
- The component breakdown for excavation waste stream has been estimated using the average values identified above.

The cost estimate indicates that excavation will be significantly less costly than leachate containment. In addition to cost, however, the geotechnical issues related to long term stability with the leachate containment design have also been considered.

While the dump is currently considered geotechnically stable because of distance and elevation difference from the existing high water mark, this will not necessarily be the case for the final dump configuration with a leachate containment system put in place. In particular, based on an approximate down-gradient key trench position, the required fill thickness to achieve freeze back, and a final slope configuration of 4H:1V, the final toe position for this dump will be located approximately 30 m from and about 0.75 to 1.0 m higher than the high water mark. With the high potential for sea level rise associated with global warming, an elevation difference of 1 m or less is considered at risk for future erosion. Effective monitoring may also be problematic, as monitoring wells will be located in close proximity to the high water mark, where groundwater chemistry will be influenced by sea water. Soil in this area is primarily gravel and cobbles, which cannot be properly characterized for contaminant levels; contaminants are unlikely to sorb to this material, and laboratories typically cannot perform proper contaminant analyses on material this coarse.

Based on all of the considerations noted above, it is recommended that the Beach Dump be excavated.

3.7 Beach South Dump A (Figure 9)

The Beach Dump South A is located approximately 120 m southeast of the Beach Dump. The 2007 investigation identified a dump size of 3,930 m^2.

As with the Beach Dump, debris has been buried along the edge of a beach ridge. Buried debris exposure is little to moderate. There are some small lush, wet areas within the limits of the dump and areas of groundwater discharge along the north edge. Receptors are the same as for the Beach Dump.

Substrate consists of sand and gravel with cobbles. Groundwater was encountered in the up-gradient test pit at 0.5 m. No groundwater was encountered in the first row of test pits away from the dump toe, but was present in the second row of test pits near surface. The average grade across the dump is approximately 8%. No evidence of erosion was noted. The toe is located approximately 40 m from the high water mark and is at an elevation 2.5 m higher. The shoreline is approximately 60 m from the toe.

Some battery and copper debris is present within the dump near the north edge. Tier II lead and copper contamination was detected in this area. The size of the contaminated area is 82 m^2, to a depth of 0.3 m.

A review of contaminant levels for down-gradient samples yielded several samples that had elevated levels of metal impacts. This information suggests that there has been contaminant migration from the dump. The dump proximity to the shoreline further elevates the environmental risk associated with the suggested contaminant migration. Based on these factors, the dump has been classified as a Class B dump, requiring either leachate containment or excavation.

Because of its relatively small size, a cost comparison has been completed comparing the options of leachate containment versus excavation for this dump. The same assumptions used for the Beach Dump cost estimate leachate containment costing have been applied to the Beach Dump South A. The dump excavation volume is estimated at 1,620 m^3 (also derived from assuming a conical frustum-type configuration for debris buried along the slope), and the component breakdown has assumed the average percentages identified above.

The cost estimate indicates that excavation will be significantly less costly than leachate containment. In addition to cost; however, the geotechnical issues related to long term stability with the leachate containment design have also been considered.

Similar to the Beach Dump, when the final toe position for the implementation of a leachate containment system, there are concerns related to long-term geotechnical stability. At the worst location, the estimated final toe position with leachate containment is located approximately 20 m from the high water mark, at an elevation of only 0.75 m higher than the storm surge limit. This position is considered at risk for long term geotechnical stability. The same issues related to effective long term monitoring that were discussed for the Beach Dump also apply here.

Based on the considerations noted above, it is recommended that the Beach Dump South A be excavated.

3.8 Beach South Dump B (Figure 9)

The Beach Dump South B is located immediately south of the Beach Dump South A. The estimated size of the dump is 3,170 m^2.

The position of debris burial is the same as for the other Beach Dumps, off the edge of the beach ridge. Debris burial at this dump appears spotty, particularly along the eastern edge, and there is no well-defined toe. Substrate is comprised of sand and gravel with cobbles. Seepage was observed into several test pits at 0.6 m depth. Average grade is 8%. No evidence of erosion was identified. The toe of the dump is located within 15 m of the high water mark - at an elevation approximately 0.8 m higher - and 30 m from the shoreline. Receptors are the same as those described for the Beach Dump.

The results of the environmental investigation did not suggest that this dump is leaching. Samples were collected in the vicinity of copper debris, but no concentrations above criteria were detected.

While the dump does not appear be leaching, because of its proximity to the high water mark, it is considered at potential risk for erosion, particularly in the long term in the event of sea level rise. It is therefore considered a Class A landfill, and it is recommended that the dump be excavated.

The dump excavation volume has been estimated assuming a conical frustum-type configuration for debris buried along the slope. The estimated volume for excavation is 2,150 m^3, with an excavation depth of 1.0 m. Because debris appeared to be spotty at this dump and because no contaminated soil or evidence of contaminant migration was identified, the estimated component breakdown has been modified from the average values. The following waste stream breakdown has been assumed: 10% Tier II, 5% Tier I, 15% debris, 69% clean fill, with a 1% hazardous waste allowance.

3.9 Beach POL Buried Debris (Figure 8)

There is an area where a large number of surficial or partially buried barrels are located along the toe of the north edge of the POL pad. The barrels appear to have been placed along the edge of the POL pad, with subsequent burial by wind action. It is expected that some completely buried barrels are also present at that location, but a geophysical survey to delineate the area would not have been useful because of the prevalence of overlying surficial barrels. The estimated size of the area is 100 m^2. The visible barrels are within the limits of an area identified for contaminated soil excavation. There is the possibility, however, that the lateral extent of the barrels at depth may extend beyond the limits of the contaminated soil excavation. The contaminated soil excavation is recommended to a depth of 1.2 m. Therefore, it is expected that the majority of buried barrels will be excavated during the course of contaminated soil excavation. Because the barrels were mostly partially buried and could not be moved, an assessment of potential contents was not feasible. The 1994 ESG report did note hydrocarbon product in soil in the vicinity of the barrels, suggesting that the barrels may have contents.

The barrels are located within approximately 40 m of the coastal shoreline. It is therefore recommended that all buried barrels at this location be excavated. Any barrels excavated with contents will require assessment according to the DLCU Barrel Protocol (INAC 2007). Because this excavation is taking place within a documented hydrocarbon-impacted area, no segregation and testing of soil is considered required, aside from that already required under the INAC AMSRP confirmatory testing for contaminated soils.

3.10 Beach Inuit Camp Meat Cache (Figure 2)

While this location does not constitute a dump, the remedial recommendations for this area are consistent with dump remedial requirements. The area comprises a mounded area, approximately 1.5 above surrounding grade, that was a meat cache “freezer,” constructed by the Inuit living at the camp, with assistance from a DEW Line station staff member using a dozer. A compartment exists within the earthen mound, created and stabilized with the use of empty barrels and wood. A cavity is present, with an opening at surface. The opening forms a physical hazard and the cavity should be in-filled and the opening closed-off. Some additional fill placement is recommended along the surface of this area following in-filling to account for settlement. An estimated 1 m^3 of fill will be required to fill in the cavity. A fill thickness of 0.5 m is recommended for placement over an overall area of 125 m^2.

3.11 West Beach POL Buried Debris (Figure 8)

The West Beach POL Buried Debris consists of a small, rectangular mound of buried debris located approximately 100 m west of the Beach POL pad. Geophysics was not completed at the location; debris limits were identified visually. The size is 22 m^2, and the debris mound is raised 0.5 m or less above surrounding grade, which is flat. Debris noted includes rusted paint cans, small drums, and wood. No environmental investigation was completed because of its small size and limited potential environmental impact. The debris is considered primarily an aesthetic concern.

Because of its small size and limited topographic expression, it is recommended that the area be regraded with the placement of 0.5 m of granular fill, with an offset of only 1 m from the edge of the debris.

4. Hazardous Waste Remediation

4.1 Protocols and Regulatory Requirements

The Abandoned Military Site Remediation Protocol (AMSRP 2009) defines hazardous waste materials as any materials, which are designated as "hazardous" under Nunavut Territorial or Federal legislation; or as "dangerous goods" under the Transportation of Dangerous Goods Act (TDGA) and regulations.

As part of the assessment of PIN-B Clifton Point, an inventory of hazardous waste materials was compiled and supplemented with sampling during the 2007 site investigation. Various hazardous waste materials identified during the survey included: demolition and site debris consisting of asbestos and PCB/lead amended painted materials, batteries, barrel contents and electrical components and miscellaneous chemicals.

The storage, treatment, and destruction of PCB materials in concentrations of greater than 50 mg/kg are regulated under the Chlorobiphenyls Regulations (PCBs) which are governed by the Canadian Environmental Protection Act (CEPA).

In addition to these regulations, stakeholders including INAC, DND, Environment Canada and Health Canada recognized that it was technically feasible to landfill demolition debris coated with PCB-amended paint in an environmentally sound safe manner (EC 1999). PCBs in paints, affixed to a solid substrate, leach at a very slow rate and, as such, do not present a threat to the environment if properly contained. Accordingly, calculations factoring in the mass of the painted substrate were completed to determine the total PCB concentration for the painted substrate as a whole. Painted substrate with total concentrations greater than 50 mg/kg were deemed hazardous and regulated by CEPA. It should be noted, however, that recent regulatory changes may no longer allow for the factoring in of substrate mass in assessment of PCB concentrations where painted substrates are concerned. This issue is currently under review.

Previously, where materials were not regulated under CEPA, classification of hazardous waste defaulted to the federal TDG Act and Regulation under Guideline for the General Management of Hazardous Waste. At PIN-B, materials classified under these regulations tend to be associated with painted materials where PCB concentrations were not in excess of CEPA concentrations, but where lead concentrations may be in excess of the leachate criterion stipulated under the TDG regulations. Since the time of the original RAP submission, the TDG regulations have been amended (Amendment 6 - SOR/2008-34) so there is no longer a classification of materials with toxic leachate. Regulation regarding movement of these materials now falls to Environment Canada (EC) under the following two regulations: Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (1999, 2005 amendment), and Interprovincial Movement of Hazardous Waste and Hazardous Recyclable Material Regulations (1999, 2002 amendment). Both EC documents specify a criterion for lead leachate at 5 mg/L, which was the same criterion previously specified under the TDGR.

Projects that will result in the disturbance of asbestos-containing materials (ACMs) including vermiculite must satisfy the regulatory requirements under the Canada Labour Code - Part II and the Nunavut Environment Protection Act. In addition, the Canadian Occupational Safety and Health Regulations, Part X - Hazardous Substances would be applicable to asbestos-containing materials. The Environmental Guideline for Waste Asbestos (GN 2002) defines asbestos-containing materials as any type of material with greater than 1% asbestos by weight.

Treated or creosote-impregnated waste materials (poles) are only considered "toxic", as defined under Section 11 of CEPA, if the waste creosote or its component compounds enter or are likely to enter the environment in a concentration or quantities or under conditions that could lead to exposure of humans or other biota at levels that could cause adverse effects. At DEW Line sites, these components have been determined to be non-hazardous as the components leach at a very slow rate and as such, do not present a threat to the environment if properly contained.

4.2 Surface Debris Component

Surface debris inventory was completed by dividing the site into sections, with coverage of the areas completed on foot or by ATV. The limits of debris were identified by hand-held GPS by collecting waypoints at each transect where no further debris was visible, or in areas where debris was more sporadic, by collecting waypoints at debris locations. The GPS waypoints were downloaded onto the site plan drawing and the debris area perimeters were drawn by connecting the debris limit waypoints, or by grouping individual debris locations accordingly. The areas of surface debris created by these debris limits or groupings were assigned a numerical label. Along transects, debris types were noted, and volumes were tracked, with a total volume and description of all types of debris recorded for each debris area.

The survey identified approximately 4.5 m^3 of hazardous site debris, including barrel contents, and demolition wastes consisting primarily of asbestos containing materials and batteries. A summary of hazardous waste components identified from the surface debris inventory is provided in Table 1 of Appendix C. Specifics related to barrel contents are discussed below.

4.3 Barrel Component

The classification of barrel contents and remedial requirements is based on the Barrel Protocol outlined in the INAC AMSRP. This protocol provides specifics related to when hydrocarbon-containing barrels may be safely incinerated on-site, may be safely discharged (in the case of aqueous contents), and where contents require off-site disposal. The specifics of the protocol are provided in Appendix E.

The assessment of barrels was completed at the same time as the inventory of surface debris; contents were identified as either aqueous or hydrocarbon-containing, and their classification was noted on the barrel with a paint marker. A representative number of samples were collected from the main barrel stockpiles, as well as other barrels at the site that were identified as having non-aqueous contents.

The 2007 inventory of barrels at PIN-B indicates there are 820 barrels on-site, including marker barrels. Of these, 124 were identified with aqueous contents, seven with mixed phase contents (oil or fuel and water), and 38 with hydrocarbon contents.

There are four primary barrel stockpiles at the site:

- Barrel Stockpile A is located on what appears to the have been the main barrel storage area for the site, on a pad north of the Station. Thirty barrels are stockpiled; 19 have oil contents (mostly partial), 5 are a mix of oil and water, 2 are empty, 1 has only sludge remaining, and 3 have aqueous contents. Two samples - 910 and 911 - were collected from barrels with primarily oil contents. Both samples met incineration criteria.
- Barrel Stockpile B is located at the former Construction Camp. Seventy-eight barrels were present; 54 of these were empty and 24 had minimal aqueous contents, estimated to be the equivalent of one barrel volume. No samples were collected from this stockpile because the contents were all aqueous and the total volume was minimal.
- Barrel Stockpile C is located off the south end of the airstrip. The barrels were all painted orange, suggesting that they were marker barrels. There are 32 barrels present. All are quite rusted and most are rusted through in some locations. Eleven of the barrels had partial aqueous contents. Because it appeared that the barrels had been markers and because they were rusted through, it is likely that the aqueous contents are all from precipitation. No samples were therefore collected here.
- Barrel Stockpile D is located east of the airstrip, adjacent to the POL line. There are 157 drums in total at this location, all lying on their sides. Where the label was visible, it stated "fuel oil-diesel". Forty-six barrels had partial contents, all of which were aqueous. Most were deteriorated and rusted through. Because there was a fairly large volume of aqueous contents present at this location, five barrels were sampled, one of which was sampled in duplicate. No samples exceeded criteria, indicating that aqueous contents can be discharged.
- The Beach POL area had a large number of barrels present. Just off the north edge of the POL tank pad, 95 barrels were present, partially buried. All are quite rusted and in poor condition. Because they were partially buried, an assessment of their contents could not be made. The 1995 report had noted that there appeared to be free-phase product in their vicinity, but a test pit excavated at the edge of the barrels had no samples exceeding PHC criteria. It is likely that additional barrels are present at this location and are fully buried. The total number of barrels present at this location has been assumed as 100. Barrels were also stockpiled on the top of the pad; these barrels apparently had lubricating oil contents, as a small area of staining was present in their vicinity. One sample - 906 - was collected from one barrel that had sufficient contents for a sample to be collected. This sample exceeded the total organic halides criterion and cannot be incinerated. Based on the inventory completed at this location, it is anticipated that there are two additional barrels in this vicinity that also will exceed criteria. A second sample - sample 907 - was collected from a barrel with oil contents at the toe of the POL bladder pad. This sample met incineration criteria.

Based on the 2007 survey, it is estimated that 9,500 litres of liquids are present in the barrels at the PIN-B site. The majority of barrels identified are empty and will require no sampling or processing during clean-up. In particular, the main Barrel Stockpile Areas (A-D) have no exceedences. Based on the results of sampling, those with aqueous contents can be discharged, while those with hydrocarbon contents can be incinerated.

The samples identified with hydrocarbon concentrations exceeding the barrel criteria tend to be isolated occurrences: a few barrels on the Beach POL pad; one barrel near the Beach Dump; and one barrel by the water supply lake. These barrels will require consolidation for off-site disposal. The estimated total volume for off-site disposal is 530 L.

It should be noted that much of the scattered barrels, particularly along the beach in Site Debris 13, and along the water supply lake at Site Debris 12, did not have contents assessed as thoroughly as those from the main areas outlined above (bungs were not opened). For these areas, the contents should be consolidated and sampled to confirm disposal requirements.

The most significant portion of this volume that has not been classified is associated with 95 partially buried barrels located immediately north of the Beach POL tank pad. Because they were partially buried, an assessment of their contents could not be made to confirm the 5,000 litres assumed for this area.

A summary of the analytical results for the samples collected from barrels is provided in Appendix D.

4.4 Demolition Component

The demolition investigation conducted an inventory of all site buildings and other facilities that would require dismantling for disposal. The investigation noted their construction, and any anticipated special disposal requirements, with the collection of samples for applicable analysis to confirm disposal requirements. Samples were collected from painted substrate to identify whether the materials were PCB-containing in excess of CEPA regulations. All locations of asbestos were identified, and it was noted, in particular, where asbestos was covered with PCB-containing paint. Following receipt of paint analytical data, a calculation was completed to factor in the mass of the painted substrate to determine the total PCB concentration for the painted substrate as a whole. Based on paint analytical data, and observations related to asbestos content, the hazardous versus non-hazardous component of demolition materials was calculated.

The results of paint analytical sampling indicate that the majority of paint on structural materials associated with the module train, warehouse and garage contain PCBs in excess of 50 mg/kg. Calculations factoring in the mass of the painted substrate for these materials identified total PCB concentrations greater than 50 mg/kg in the majority of structural materials sampled in the module train and only select materials in the warehouse. A summary of the results of paint sampling, showing PCB concentrations for the paint samples themselves, and also showing PCB concentrations when the substrate has been factored in, are provided in Table 3 of Appendix C. As noted above, recent changes to CEPA have identified that inclusion of substrate mass for calculation of total PCB concentrations may no longer be allowed; this is currently under review. The assessment of PCB waste in this RAP has been based on the assumption that inclusion of substrate mass to determine total PCB concentrations is feasible.

While lead-containing paint is a common occurrence on DEW Line sites, the disposal requirements for most painted material are generally superseded by PCB concentration under CEPA. However, based on findings on other DEW Line sites, there are some materials where PCB concentrations in paint are low, and disposal requirements are ultimately dictated by lead content. These are generally associated with POL facilities where the paint is typically silver colour, or on other exterior metal substrates. At PIN-B, two samples were collected where this typical silver paint colour was present: on the Station POL pumphouse, and on the warehouse loading bay door. Because the lead paint criterion is based on a leachable lead content, painted substrate samples were collected to properly assess the potential for leachate generation from the overall material. Neither of the samples exceeded leachate criteria for any metals.

In areas of PCB-oil storage or in the vicinity of transformers, it is common that the concrete floor may be contaminated with PCBs. Concrete floor samples were collected from the powerhouse end of the module train, the generator room of the garage, and from the warehouse. Only one sample - collected from the module train powerhouse - contained PCBs in excess of the 50 mg/kg criteria. The analytical data for these samples is provided in Table 3 of Appendix C.

The 1994 ESG investigation had collected two samples for asbestos analysis. The samples consisted of floor tile and pipe insulation from the module train. Both samples exceeded chrysotile asbestos content (ESG 1995). During the 2007 investigation, no samples were collected for asbestos analysis, because no materials were identified that were not already known to be asbestos containing, based on experience from other DEW Line sites. In many cases, however, asbestos-containing material - particularly pipe wrap insulation - was painted with PCB-amended paint. These specific instances were noted during the 2007 demolition inventory, as this material will require disposal as PCB waste, but must be segregated during packaging for off-site disposal to allow for proper handling at the PCB-waste disposal facility.

While potential PCB-containing electrical equipment, including transformers, capacitors and fluorescent light ballasts are commonly present on DEW Line sites, it was clear during the 2007 investigation that a dedicated removal of these materials had been completed at an earlier date. At the module train in particular, it was noted that a sweep of each room had been completed, with removal of PCB-containing equipment, and subsequent notation on doorways or walls that PCBs had been removed. No PCB-containing electrical equipment was identified during the 2007 investigation.

There is the potential for mercury-containing switches and thermostats at DEW Line sites, but none were identified at PIN-B in 2007.

A summary of hazardous materials identified during demolition inventory is provided in Table 2 of Appendix C. The total volume identified is 79 m^3. From this, the estimated breakdown of hazardous material types is as follows:

- Asbestos: 8 m^3
- PCB-amended painted materials: 63 m^3
- PCB-amended paint over asbestos: 8 m^3
- Batteries: 0.2 m^3

4.5 Estimated Dump Excavation Component

Nominal volumes of hazardous material are typically encountered during dump excavation, including but not limited to battery waste, electrical components, asbestos, and petroleum products. As noted above, based on experience from other DEW Line sites, it is anticipated that a small quantity of hazardous soil will be encountered during excavation of dump sites, generally in the range of 1% of the overall excavation volume.

Based on the volume of dumps where the recommended remedial action is excavation, the estimated volume of hazardous waste to be derived is 66 m^3.

4.6 Remedial Requirements

Generally, all hazardous materials identified at the site will be collected and transported off site, in accordance with the Transportation of Dangerous Goods Act (TDGA) (TC 2002) and Regulations, and the CEPA Inter-provincial Movement of Hazardous Waste Regulations (SOR/2002-301), to a licensed hazardous waste disposal facility.

Particulars are described below:

- Asbestos: Asbestos waste will be collected, double bagged and disposed of in an on-site engineered landfill, in accordance with the appropriate legislation;
- Petroleum Products: Petroleum products, such as gasoline or diesel, which do not contain other hazardous products according to the Barrel Protocol (chlorine, PCB, heavy metals, etc.) will be incinerated on-site under appropriate emissions controls. Heavier petroleum products such as lubricating oil will be disposed of off-site or mixed with lighter petroleum products and incinerated on-site under appropriate emissions controls;
- Compressed Gas Cylinders: Compressed gas cylinders with known contents will be vented. Once empty, the metal cylinder will be disposed on-site in an engineered landfill;
- Creosote Treated Timbers: Timbers will be wrapped in polyethylene sheets and disposed on-site in an engineered landfill;
- PCB Paint on Building Components: PCB paint and PCB painted components which are regulated under the CEPA, will be collected and transported off-site, in accordance with the Transportation of Dangerous Goods Act and CEPA, to a licensed PCB disposal facility; and
- Lead-Based Paint on Building Components: Lead-based painted components which are classified as hazardous material will be collected and transported off-site, in accordance with the CEPA Inter-provincial Movement of Hazardous Waste Regulations, to a licensed hazardous waste disposal facility.

5. Non-Hazardous Waste Remediation

5.1 Surface Debris Component

The method for completion of the surface debris inventory is described above. Based on the 2007 ESA inventory, the majority of surface debris was identified as non-hazardous, including barrel contents. The estimated volume (crushed) is 380 m^3. A summary of surface debris areas and volumes is provided in Table 1 of Appendix C.

5.2 Demolition Component

The method employed for demolition inventory and characterization of waste is described above. The results of this investigation and calculations related to ultimate classification of PCB waste indicate that the volume of non-hazardous waste materials from demolition is approximately 590 m^3. A summary of demolition quantities is provided in Table 2 of Appendix C.

5.3 Estimated Dump Excavation Component

As note above, the estimated volume of non-hazardous waste from dump excavations has been based on-site-specific modification of average values obtained from dump excavations at other DEW Line sites. In certain cases, based on the results of the geophysical survey and ground truthing, this number has been modified. The total volume estimated to arise from dump excavations has been estimated as 1,210 m^3.

5.4 Remedial Recommendations

The total volume of material identified as non-hazardous waste during the 2007 Phase III ESA is approximately 2,180 m^3. According to the INAC AMSRP, the assessment of the need for construction of an on-site Non-Hazardous Waste Landfill should consider primarily the availability of suitable locations to build such a facility at the site. Additional considerations include the availability of appropriate granular borrow materials, and the volume of non-hazardous waste identified for disposal. At PIN-B Clifton Point, several locations were identified during the Phase III ESA site investigation that would be suitable for construction of a new facility. Furthermore, no granular borrow material constraints were identified which would preclude any new development. Finally, based on information from DEW Line intermediate sites, the volume of demolition and surface debris at this site does suggest that construction of an on-site facility for disposal is warranted. It is therefore recommended that a Non-Hazardous Waste Landfill be constructed at the PIN-B site during clean-up.

6. Contaminated Soil Remediation

6.1 Remedial Criteria and Clean-up Protocols

The investigation and delineation of contaminated soil at Clifton Point was completed for the contaminants of concern identified under the INAC AMSRP: arsenic, cadmium, cobalt, copper, lead, nickel, zinc, and PCBs. The protocol identifies two levels of contamination - Tier I soil which is considered an environmental risk only when located at surface, and Tier II soil which is considered an environmental risk at any depth of impact. Delineation of petroleum hydrocarbon (PHC) impacts was originally completed using the CCME Canada Wide Standards (CWS) for PHC in Soil. The delineation has been revised in accordance with the 2009 INAC Abandoned Military Site Remediation Protocol. This protocol specifies different numerical clean up criteria for total petroleum hydrocarbons (TPH) based on the type of hydrocarbons present. TPH soil analyses are typically completed using a methane extraction method, and measure concentrations of carbon chain sizes between C_6 and C_{34}. This analysis method is comparable to the combination of the F1 to F3 fractions under the CCME Canada Wide Standards (CWS) analyses, although this methodology uses different extraction methods. Type A hydrocarbons are defined as impacts comprised of 70% or more of the heavier fractions (F3 and F4), which corresponds to impacts derived from lubricating (lube) oil or grease spills. Type B hydrocarbons are defined as those impacts comprised primarily of lighter end components (F1-F3), derived from fuel spills. The INAC AMSRP process specifies different numerical cleanup criteria based on the type of hydrocarbon impacts (Type A versus Type B), proximity to significant water bodies, and depth of impacts. Table A below provides a summary of contaminated soil remedial criteria and volumes identified during the Phase III ESA and re-evaluated based on the 2009 INAC criteria. Volumes estimated to arise from dump excavations have also been noted, as these volumes have also been considered for evaluation of contaminated soil disposal options below. The total volumes noted below combine the volumes from these two sources, with the volume derived from dump excavation estimates noted in parentheses below.

Table A - Summary of Contaminated Soil Remedial Criteria and Quantities

Contaminant Designation	Description	Soil Volume (m^3)
Tier I Contaminated Soil	Soils containing concentrations of any or all contaminants listed as follows: • Lead..........................200 to 499 ppm • PCBs........................1 to <5 ppm	576 (550 from dump excavations)
Tier II Contaminated Soil	Soils containing concentrations equal to or greater than any or all contaminants listed as follows: • Arsenic......................30 ppm • Cadmium..................5 ppm • Chromium.................250 ppm • Cobalt.......................50 ppm • Copper ....100 ppm • Lead..........................500 ppm • Mercury ....2 ppm • Nickel ....100 ppm • Zinc...........................500 ppm • PCBs........................>5 ppm;<50 ppm	1,211 (880 from dump excavations)
TPH Type A Soils F3 and F4 fractions	Soils contaminated with hydrocarbons consisting primarily of oil and grease at concentrations equal to or greater than: • TPH, Sum of F3 and F4 fractions.........20,000 ppm	None, scarify areas and leave in place
TPH Type B Soils F1-F3 fractions	Soils contaminated with hydrocarbons consisting primarily of fuel oil, and/or diesel, and/or gasoline, with concentrations equal to or greater than the following concentrations : • Beach POL Area: TPH, Sum of F1 and F2 fractions................330 ppm • Station Area: Surface soils to 0.5 m depth ....2500 ppm (TPH, sum of F1 through F3 fractions) Subsurface soils below 0.5 m in depth............ 5000 ppm (TPH, sum of F1 through F3 fractions)	1,383

The specified remedial requirements under the INAC AMSRP are as follows:

- ***Tier I soil:*** cap in place with a minimum of 0.3 m of granular fill, or dispose in on-site Non-Hazardous Waste Landfill.
- ***Tier II soil:*** dispose in SSDF or transport off-site for disposal in engineered territorial or provincial Non-Hazardous Waste Landfill;
- ***Type A Soils:*** scarify and leave in place if under criteria, or dispose in on-site Non-Hazardous Waste Landfill; and
- ***Type B Soils:*** excavate and treat ex-situ through landfarming, treat in-situ with landfarming, or dispose of in SSDF. Note that disposal in the SSDF is only considered appropriate if concentrations are sufficiently low that there are no concerns for inhibiting freezing of contents and/or with free-product development, which could compromise the liner integrity at the facility.

6.2 Tier I and Type A Soil

The total estimated volume of Tier I soil is 576 m^3. This includes Tier I soil area located at the garage and module train. This volume also includes the estimated Tier I component of soil that will be encountered during dump excavations, as noted above. A detailed breakdown showing area-specific volumes of Tier I and Type A soil is provided in Appendix B. It is recommended that the Tier I soil be disposed of in the on-site Non-Hazardous Waste Landfill, constructed during site clean-up. The Type A soil areas should be scarified and left in place.

6.3 Type B Soil

Two areas of Type B impacted soil requiring remedial action were identified as part of the 2007 investigation: the garage, and beach POL. The total volume of PHC Type B soil identified for remediation 1,383 m^3. A summary of contaminated soil volumes by area is presented in Appendix B.

Remedial options applicable to the hydrocarbon impacted soil include:

- On-site disposal in a secure soil disposal facility (SSDF);
- In-situ biological treatment or chemical oxidation;
- Ex-situ, on-site biological treatment; and
- Ex-situ, off-site treatment and/or disposal in a Licensed Disposal Facility.

In-situ treatment of the hydrocarbon impacted soil at the beach POL is not considered an option due to its close proximity to the shoreline.

Advantages and disadvantages of each treatment option are described in Table B. Based on the applicability of the various treatment options at the Clifton Point site, the recommended remedial option is on-site ex-situ treatment, i.e. landfarming.

Recent monitoring results from landfarm operations at another former DEW Line site (FOX-C Ekalugad Fjord) have indicated that treated soil criteria are achievable through on-site biological treatment methods; however, more highly contaminated soils may take extended periods of treatment to meet the treatment criteria. Based on the volume of impacted soil and moderate hydrocarbon concentrations observed during the 2007 investigation, it is anticipated that ex-situ biological treatment may be completed within a 1 year period provided site conditions are monitored and optimized where possible (i.e., moisture conditioning, nutrient amendment).

Table B - Summary of Remedial Options - Hydrocarbon Contaminated Soil

Remedial Option	Description/ Requirements	Applicability	Advantages	Disadvantages/ Limitations	Implementation
Secure Soil Disposal Facility	• Contaminated soils are excavated and placed in SSDF with Tier II inorganic and PCB impacted soil. • SSDF utilizes geosynthetic liner and frozen core berms for containment. Contents remain frozen.	• Inorganic and PCB contaminated soils. • Type A and low concentration of Type B hydrocarbon soil	• Removes soils from contact with ecosystem. • Environmental risks associated with potential spills during off-site transport.	• Long term monitoring required. • Not applicable to highly contaminated light end hydrocarbons.	• Acceptable borrow types and quantities available for construction with limited material processing.
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 the contaminated area. • Not applicable to metal contaminated soil.	• Not appropriate for hydrocarbon areas located in close proximity to water bodies (Beach POL).
On-Site, Ex-situ Landfarming / 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 off-site transport.	• More effective on lighter 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 materials identified for construction. • Geosynthetic liner required for perimeter containment.
Off-Site Treatment and Disposal	• Contaminated soils are transported off-site for treatment or disposal.	• All contaminated soil types.	• Contaminated soils removed from site eliminating risk of exposure.	• Considerable costs associated with off-site transport. • Project costs are very sensitive to contaminated soil volumes. • Potential environmental risks during transport.	• Shipment and disposal off-site is technically appropriate, but at considerable costs.

6.4 Tier II Soil

The 2007 site investigation identified Tier II levels of PCBs and/or inorganic elements in nine areas of the site, including the module train (2), sewage outfall, incinerator, garage, POL battery debris area, north of the airstrip, Station West Dump, and Beach Dump South A. Individual Tier II contaminated soil areas ranged in size typically extended to 0.3 m in depth. The total volume of Tier II soil identified for remediation is 1,211 m^3, of which 880 m^3 is the estimated Tier II soil component from dump excavations, and 311 m^3 is from delineated contamination areas. A summary of contaminated soil by area is presented in Appendix B.

The INAC AMSRP indicates that all soils with metal and/or PCB concentrations exceeding the DLCU Tier II Criteria (but not regulated by CEPA) will be disposed of according to the following options:

- On-site disposal within a secure soil disposal facility (SSDF) consisting of double containment within permafrost encapsulation and a geosynthetic liner system in the base and cover of the facility; or
- Off-site disposal at a licensed southern disposal facility.

Assessments carried out during the 2007 investigation identified two suitable locations for the development of a SSDF, including Proposed Landfill 2 situated immediately east of the station and Proposed Landfill 3 situated at the end of the road in the Construction Camp area. Assessment of existing and new potential granular borrow sources was completed during the 2007 investigation. The assessment identified various locations where suitable borrow types (Type 2, 4, and 5) and quantities are available for construction of a SSDF. Therefore, based on the results of the 2007 assessment, there are no site specific constraints for building an SSDF at PIN-B.

An evaluation was completed comparing the relative construction costs associated with developing an on-site SSDF capable of accommodating the identified volume of Tier II soil versus costs associated with off-site disposal of the same volume of soil. The cost estimate was based on recently tendered pricing from nearby DEW Line sites and was consistent with pricing used by Golder and UMA (2007) in the study regarding feasibility of on-site disposal of Tier II soil at abandoned military sites under the jurisdiction of INAC, modified to reflect site specific conditions at PIN-B. Assumptions made in the evaluation include:

Option 1: On-site Disposal within a SSDF

- Square footprint;
- 1.5 m deep key trench backfilled with Type 4 granular fill;
- Perimeter berms constructed with Type 2 granular fill incorporating a core of Type 4 granular fill;
- 2.5:1 interior side slopes and 2:1 exterior side slopes;
- HDPE geosynthetic liner system on the base and cover;
- Final cover of 4.0 m over the contaminated soil to ensure freezeback;
- Instrumentation including four thermistors and four monitoring wells; and
- Long term facility monitoring over a 25 year period (DLCU schedule).

Option 2: Off-site Transport and Disposal

- Excavation and containerization of Tier II soil;
- Off-site transport by barge (sea accessible) to Hay River and truck transport to the disposal facility; and
- Disposal of soil in a licensed southern disposal facility (i.e.: High Level, Alberta).

The results of the cost evaluation indicate that on-site disposal is only slightly less expensive than off-site disposal. Given that approximately 70% of the Tier II soil quantity used in the evaluation is an estimated volume from dump excavations, that the cost comparison did not indicate a significant savings with on-site disposal, and that INAC has concerns related to long-term liability with constructing such a facility on-site, off-site disposal is considered the preferred remedial option for disposal of Tier II soil. It should be stressed, however, that there is the potential for the volume of Tier II derived from dump excavations to be higher than that estimated. It is therefore recommended that a significant contingency be carried in terms of volume for off-site disposal to ensure that there are sufficient containers on-site for soil containerization during remediation, so as not to delay project completion.

6.5 Summary

Remedial options evaluations for the remediation of contaminated soils was completed as part of the 2007 investigation. Based on the estimated volumes of contaminated soils and technical considerations, for locating and developing suitable disposal and/or treatment facilities, it is recommended that all Tier I and PHC soils at Clifton Point be disposed of or treated on-site, while Tier II soils be containerized and disposed of off-site. Based on the applicability of the various disposal and treatment options, the following recommendations are made:

- Soils contaminated with Tier I levels of PCBs and inorganic elements should be excavated and placed in the on-site Non-Hazardous Waste Landfill. The total volume of Tier I soil, including approximately 95% from dump excavations, is estimated at 576 m^3. These soils may be utilized as intermediate fill during placement of non-hazardous waste within the landfill.
- Soils contaminated with Type A fractions should be scarified.
- Soils contaminated with Tier II levels of PCB and/or inorganic elements should be excavated, containerized, and shipped off-site for disposal. The total volume of Tier II soil, including approximately 70% from dump excavations is estimated at 1,211 m^3.
- Soils contaminated with Type B fractions should be excavated and treated ex-situ by biological treatment methods in an on-site landfarm facility. Soils concentrations should be reduced to meet the 2009 INAC Criteria. The total volume of hydrocarbon impacted soil requiring remediation is estimated at 1,383 m^3.

7. Implementation

7.1 Schedule

It is expected, based on the assumption of barge access, that the contractor would mobilize to the site in the fall of season one. During this timeframe, it is reasonable to assume that the contractor would be able to set-up their camp, potentially investigate recommended borrow sources, and upgrade roadways as required. It is also recommended that during this season the contractor remove the existing nest on the module train which was being used by rough-legged hawks, to prevent nesting on the module train early during the main construction period, which would restrict timing of building demolition. It is understood, however, from past DEW Line experience, that when the existing structure still remains, that hawks will rebuild the nest. It should be made clear to the contractor; however, that structures which hold nests with young shall not be demolished until the young birds have left the nest.

Based on the recommended remedial actions outlined above, construction activities will require a full two seasons of clean-up activity, following contractor mobilization to site. Specifics related to timing and prioritization of contractor activities is described in the sections below.

7.2 Dump Remediation

Table C below summarizes the recommended remedial requirements for dumps at PIN-B. Where the recommended remediation is excavation, waste segregation during excavation is recommended to separate hazardous and non-hazardous waste. Non-hazardous waste can be disposed of in the Non-Hazardous Waste Landfill on-site. Hazardous waste will require off-site disposal and must be segregated based on PCB-containing waste (for disposal at a licensed PCB disposal facility), or other hazardous waste, which can be disposed of in a licensed Hazardous Waste Landfill. It is recommended that soil be separated from debris during excavation, and stockpiled in such a manner to allow sampling and classification according to the contaminant criteria outlined under the INAC AMSRP. Soil that does not exceed any contaminant criteria may be used as for backfilling excavations, but based on the difficulty with removing small pieces of debris during waste segregation, it is recommended that this soil be used for intermediate fill and not be used for surface backfilling.

In terms of timing for excavation, because of the anticipated contaminated soil and debris components from excavation, the implementation of dump excavations should not proceed until the construction of the Non-Hazardous Waste Landfill (NHWL) is completed. This should be able to commence late during season 2.

Because no on-site containment facility will be completed, excavation of Tier II soil could commence early during season 2. Furthermore, because of the uncertainty regarding Tier II contaminated soil volumes from dump excavations, it would be preferred that the contractor commence excavation at the larger dumps (i.e. the Beach area) in season two (following completion of the NHWL), to ensure that there are ultimately sufficient containers on-site. This would allow for mobilization of additional containers during the second year. If required, the stockpiling of Tier II soils (preferably on a liner or on the surface of an existing Tier II soil contaminated area) beyond the containerization volume could be completed until additional containers are brought to site.

For dumps where the recommended remedial action is regrading, this work can likely commence upon completion of the NHWL construction, when surface debris pickup at the dumps can be completed efficiently.

Table C - Summary of Recommended Dump Remedial Requirements

Dump	Size (m^2) & Depth (m)	Environmental and Geotechnical Investigation	Dump Classification	Recommended Remediation Based on Engineering Considerations
Station West	3,550 0.8	• No evidence of contaminant migration. • Small area of Tier II soil associated with surface debris near edge of dump. • Lush vegetation down-gradient. • Lake located 150 m down-gradient. • No evidence of erosion.	Class C	Excavate Tier II contaminated soil. Regrade dump.
Construction Camp Dump A	320 0.5	• No evidence of contaminant migration and no potential for surface contaminated soil identified. • Drainage channel located near toe.	Class C	**Regrade dump.** **Provide armouring along toe in vicinity of drainage channel.**
Construction Camp Dump B	240 0.5	• No evidence of contaminant migration and no potential for surface contaminated soil identified. • Well-vegetated. • Within drainage basin with drainage channels cutting through and adjacent to dump. • No existing erosion, but likely due to existing vegetation.	Class C, upgraded to A	**Excavate because within significant drainage basin and potential for erosion when additional cover placed overlying existing stabilizing vegetation.**
Construction Camp Dump C	180 0.5	• No evidence of contaminant migration and no potential for surface contaminated soil identified. • Moderate vegetation. • Existing dump toe located within 20 m of a large lake. • No erosion noted.	Class C, upgraded to A	**Excavate because of proximity to lake**
Beach Dump	2,550 2.0	• Some evidence of contaminant migration. • No potential for surface contaminated soil identified. • No erosion noted.	Class B	**Excavate, based on results of cost estimate and concerns with long-term geotechnical stability with leachate containment.**

Dump	Size (m^2) & Depth (m)	Environmental and Geotechnical Investigation	Dump Classification	Recommended Remediation Based on Engineering Considerations
		• Existing toe is located 50 m from high water mark at an elevation of 3 m higher. • Leachate contain toe will be within 1 m elevation difference from existing high water mark so is considered at potential risk for long-term erosion.		
Beach Dump South A	3,930 0.75-1.0	• Some evidence of contaminant migration. • Localized Tier II surface contamination detected associated with surface debris. • No erosion noted. • Existing toe is located 40 m from high water mark and 2.5 m higher. • Leachate contain toe will be within less than 1 m elevation difference from existing high water mark so is considered at potential risk for long-term erosion. .	Class B	**Excavate, based on results of cost estimate and concerns with long-term geotechnical stability with leachate containment.**
Beach Dump South B	3,170 0.75-1.0	• No evidence of contaminant migration. • Potential for surface contamination investigated near suspect surface debris, but no contamination detected. • No evidence of erosion. • Existing toe is located within 15 m of high water mark; with 0.75 m elevation difference so is considered at risk for long-term erosion.	Class A	**Excavate because of concerns with long-term geotechnical stability.**
Beach POL Buried Debris	100 1.2	• Within an area of PHC contaminated soil identified for excavation. • It could not be discerned whether barrels had contents. • The quantity of fully buried barrels could not be identified because of the large quantity of overlying partially buried barrels.	Class C	**Will be mostly excavated with contaminated soil excavation at Beach POL. Excavate any remaining debris along contaminated soil excavation margins.**
Beach Inuit Camp	125 2.0	• Is comprised of a meat cache freezer, with portal from surface and internal void. • Should be infilled for long-term geotechnical stability and to remove physical hazard.	Class C	**Backfill subsurface void. Regrade surface.**
West Beach POL Buried Debris	25 0.5	• No investigation of contaminants because of its small size. • Primarily an aesthetic concern. .	Class C	**Regrade**

7.3 Demolition

The demolition inventory for Clifton Point identified approximately 79 m^3 of hazardous and 589 m^3 of non-hazardous demolition debris. These volumes are based on segregation of hazardous and non-hazardous building components during demolition and do not include bulking factors that may be attributed to off-site packaging volumes or with on-site disposal volumes.

Hazardous building materials and related components, including asbestos containing materials (ACMs) and PCB wastes will be removed prior to demolition of the structures. ACMs generally include mechanical insulation on pipes and chimneys, transite board, and fire asbestos core doors. ACMs that are painted are to be treated as PCB wastes and containerized separately for off-site disposal. Non-painted ACMs will be double bagged and disposed of in an on-site landfill. Vermiculite insulation contained within the inter-module wall cavities is not considered asbestos-containing (<1% asbestos); however, due to its friable nature should be removed in a manner consistent with a moderate risk (Type 2) abatement.

Other hazardous materials, including batteries and potential glycol containing liquids within the building heating systems will be containerized for off-site disposal or recycling in accordance to TDGA requirements. While no PCB-containing equipment or mercury switches were noted during the 2007 investigation, if these materials are identified during clean-up, they will also require containerizing for off-site disposal.

The majority of painted components in the module train and select materials in the warehouse and Inuit camp buildings are considered PCB wastes and are regulated under the Canadian Environmental Protection Act (CEPA). Loose and flaking paint is to be removed from all painted surfaces and collected for off-site disposal as PCB waste. Similarly, paint on concrete floors in the module train, garage and warehouse contains PCBs in excess of 50 mg/kg and will be removed and treated as PCB waste. Consistent with CEPA and INAC's AMSRP, PCB amended painted material will be containerized in accordance with the TDGA and Regulations, and removed from site. These materials will be transported to a licensed facility for PCB destruction and disposal.

Non-hazardous wastes from demolition include unpainted wood and metal construction materials and concrete in foundations following surface paint removal. Painted structural materials with calculated PCB-substrate concentrations less than 50 mg/kg can be disposed of in an on-site landfill following removal of any loose or flaking paint. If cutting torches will be used to dismantle structural steel components, paint must be removed from the surface in the locations to be cut.

Building foundations at PIN-B consist of wood post and beam (module train), concrete slab on grade (garage, warehouse, and POL pumphouse). Wood posts and beams can be disposed of in the on-site landfill whereas the concrete slabs can remain in place once all paint has been removed from the surface of the slab. The preferred remediation option from the technical perspective is to place additional fill material and regrade around the foundations to match existing topography.

It is recommended that the segregation and containerization of hazardous waste components be commenced early during season two. This will facilitate the completion of full demolition, which can be commenced once construction of the Non-Hazardous Waste Landfill is completed.

7.4 Surface Debris

Fourteen surface debris areas were identified during the 2007 Phase III ESA. The identified limits of these areas cover approximately 1,730,900 m^2. The volume of hazardous materials identified is 5 m^3, while the volume of non-hazardous waste is 374 m^3. Both of these volumes represent crushed volume estimates. These volumes also include barrels and their contents, based on results of barrel inventory and sampling. A detailed breakdown of surface debris areas and debris volumes is provided in Table 1 of Appendix C. The limits of surface debris areas are shown on Figure 1. Non-hazardous waste can be disposed of in the Non-Hazardous Waste Landfill. Hazardous waste must be packaged in accordance with TDGA regulations for shipping to an off-site licensed hazardous waste disposal facility.

In addition to the identified surface debris areas, it is also typically noted in clean-up specifications that all debris within 50 m of existing pads and roadways is picked up. The surface debris investigation generally covered off all of the areas near roadways, and the existing perimeters were drawn to include debris identified in this vicinity. Nonetheless, it is recommended that a small contingency for additional volume of debris to be collected under the 50 m from roadway criterion be carried for design of the Non-Hazardous Waste Landfill.

Collection of surface debris can proceed upon completion of the NHWL construction. This can likely begin mid-season during season two.

7.5 Barrel Remediation

The 2007 inventory of barrels at PIN-B indicates there are 820 barrels on-site, including marker barrels. Of these, 124 were identified with aqueous contents, seven with mixed phase contents (oil or fuel and water), and 38 with hydrocarbon contents.

There are four primary barrel stockpiles at the site.

The results of the Phase III ESA indicate that the majority of barrels are empty and will require no sampling or processing during clean-up. In particular, the main Barrel Stockpile Areas (A-D) have no exceedences. Based on the results of sampling, those with aqueous contents can be discharged, while those with hydrocarbon contents can be incinerated.

The samples identified with hydrocarbon concentrations exceeding the barrel criteria tend to be isolated occurrences: a few barrels on the Beach POL pad; one barrel near the Beach Dump; and one barrel by the water supply lake. These barrels will require consolidation and packaging according to TDGA regulations for off-site disposal. The estimated total volume for off-site disposal is 530 L.

As noted above, many of the scattered barrels, particularly along the beach in Site Debris 13, and along the water supply lake at Site Debris 12, did not have contents assessed as thoroughly as those from the main areas outlined above (bungs were not opened). For these areas, the contents should be consolidated and sampled to confirm disposal requirements. In addition, the estimated 100 partially or fully buried barrels at the Beach POL will require assessment of their contents following removal.

Because of the need to classify some barrels that could not be properly assessed during the ESA, it is recommended that collection of barrels, with consolidation of like products, be completed during the season two to allow for sampling of contents in a timely manner, with incineration or additional consolidation for off-site transport completed during the third season of clean-up.

7.6 Proposed New Containment Facilities

7.6.1 Non-Hazardous Waste Landfill (NHWL)

The total volume of non-hazardous waste, from all sources (including Tier I soil), is estimated at approximately 3,500 m^3. The estimated footprint for a non-hazardous waste landfill (NHWLF) to accommodate this volume is approximately 75 x 75 m. Based on this size, Proposed Landfill 4 is not sufficiently large to accommodate the facility. The preferred location is, therefore, Proposed Landfill 1. When considering the perimeter of the area identified from the Phase III ESA and existing ground conditions, it is considered preferable to place the landfill as close as possible to the northwestern limit during design; ground in this area is already disturbed. Furthermore, it is preferable to locate the landfill as close as possible to the existing pad to minimize transport costs and need for road development. Of note, there are no contaminated soil areas for excavation in the near up-gradient area. Therefore, there is no requirement for provision of sufficient buffer to avoid complication of long-term landfill monitoring data interpretation.

In terms of contractor priorities for construction of new facilities during clean-up, construction of the NHWL is considered the second priority, behind the landfarm (see below). It is expected that construction of the facility can be completed during season two, with disposal of waste also commencing this same season.

7.6.2 Landfarm

The total volume of Type B soil identified for remediation is approximately 1,383 m^3. The majority of this soil is at the Beach POL area. Based on this, it is preferable to locate the landfarm facility as close as possible to the Beach POL. The Proposed Landfarm area at the airstrip is considered the preferred location because it is in a previously disturbed area, already has some containment built-in, and will not restrict usage of the potential borrow source located in the vicinity of Proposed Landfill 2.

The construction of the landfarm is a priority as the treatment of soil could potentially delay contractor's demobilization from site.

7.7 Contaminated Soil Excavation

- Tier I soil: Excavation of this soil may commence as soon as the NHWL is constructed.
- Type A soil: Scarification can proceed at any time.
- Tier II soil: Because of the uncertainty regarding ultimate Tier II soil volumes that will be derived from dump excavations, it is recommended that excavation and containerization of Tier II soils commence early during the first full season (season two). This will allow a better assessment of the ultimate number of containers that will be required for shipping off-site, and will allow the contractor opportunity to bring in additional containers for the following season.
- Type B soil: Excavation of this soil should be completed immediately upon landfarm construction, which should be the number one priority for the contractor, as noted above.

7.8 Borrow Sources

To confirm that sufficient sources of the various granular material types were identified during the Phase III ESA, an estimate of the required granular material volumes was completed for the recommended remedial options discussed above. The following summarizes the estimated volumes for each granular material type:

- ***Type 1:*** the estimated volume required is approximately 35 m^3, based on use during regrading at Construction Camp Dump A.
- ***Type 2:*** the estimated volume required is approximately 20,400 m^3, which includes construction of the Non-Hazardous Waste Landfill, and the Landfarm (under the CWS methodology). Volumes required for regrading of dumps have also been included in this consideration.
- ***Type 3:*** the estimated volume required is in the order of 5,100 m^3, which includes backfilling of dump and contaminated soil excavations. It should be noted here, that, based on our estimate of clean fill that will be derived from dump excavations, the majority of the dump backfilling requirements will likely be met by using this soil. However, as noted above, the clean soil derived from dump excavations will likely contain small pieces of debris, so this material is only recommended for intermediate backfill.
- ***Type 4:*** no requirement since no SSDF or leachate containment of existing dumps will be constructed.
- ***Type 5:*** again, no requirement, similar to Type 4.
- ***Type 6:*** the intermediate fill requirements for the construction of the NHWL are estimated as 1,170 m^3. Some of the requirements for intermediate fill may be met by using Tier I/Type A soil.

Based on these estimates, it is anticipated that sufficient granular material sources were identified during the Phase III ESA. As noted in that report, there will likely be a requirement for screening to produce Type 1 materials.

8. References

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Appendix A

Figures

GENERAL NOTES:

1. CONTOURS ARE SHOWN AT A 0.5m INTERVAL.

LEGEND:

- PROPOSED LANDFILL
- BORROW AREA
- DEBRIS AREA
- BURIED DEBRIS
- TEST PIT LOCATION — TP
- SURVEY CONTROL POINT — ▲CP101

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PIN-B DEW Line Site

INAC RAP Update

OVERALL SITE PLAN

Figure 1.0

GENERAL NOTES:

1. CONTOURS ARE SHOWN AT A 0.25m INTERVAL.

LEGEND:

PROPOSED LANDFILL	(solid line)
BORROW AREA	(dashed line)
DEBRIS AREA	(dash-dot line)
BURIED DEBRIS	(cross-hatched)
SURVEY CONTROL POINT	▲CP101

0 40 80 m SCALE 1:4000

AECOM

Public Works and Government Services Canada
PIN-B Dew Line Site
INAC RAP Update

Station Area Plan

Figure 2.

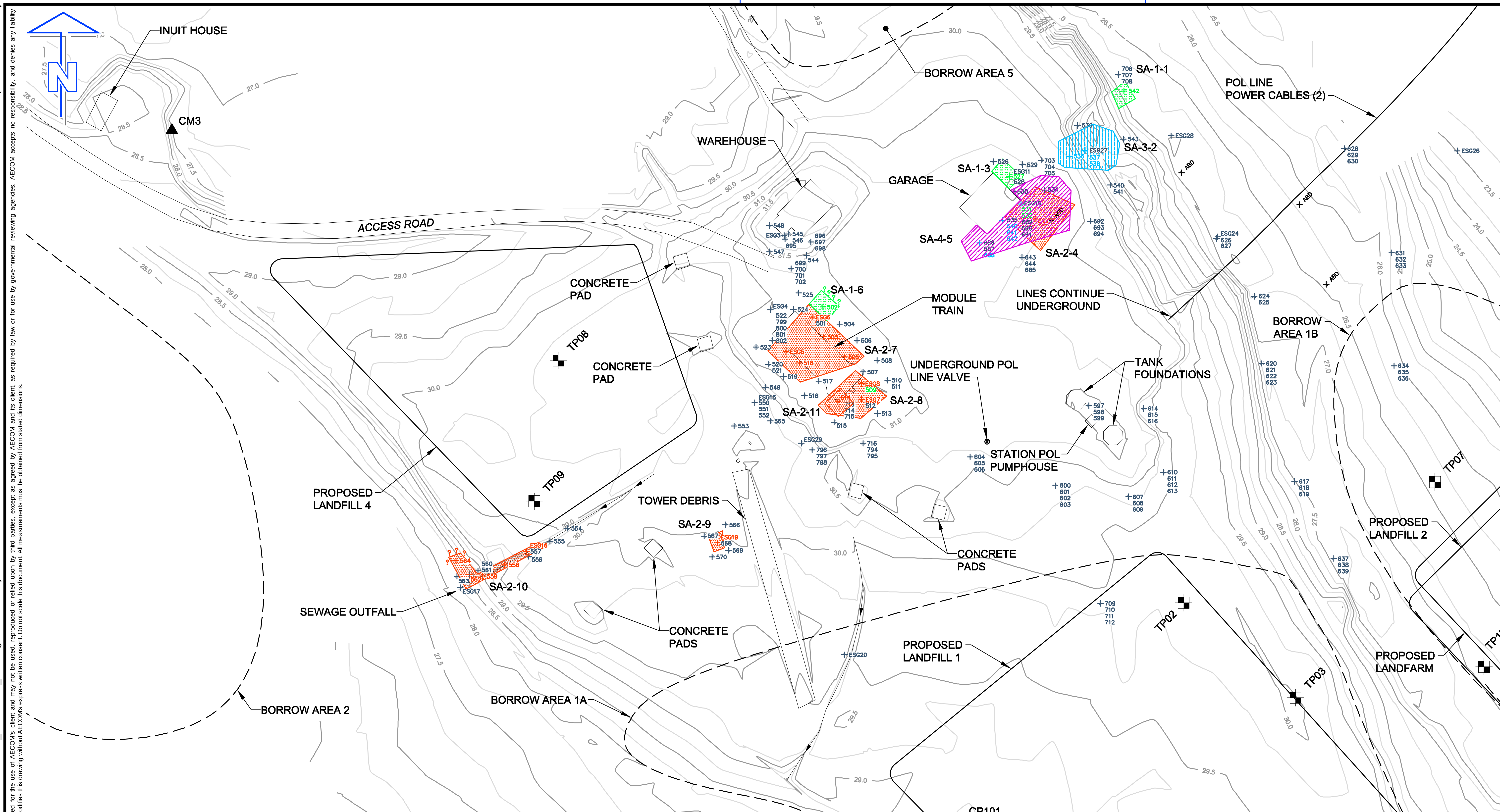
Public Works and Government Services Canada

PIN-B DEW Line Site

INAC RAP Update

Beach Area Plan

Figure 3.0



GENERAL NOTES:

1. CONTOURS ARE SHOWN AT A 0.25m INTERVAL.

0 10 20 m SCALE 1:1000

LEGEND:

PROPOSED LANDFILL	(solid line)	TIER I IMPACTS	
BORROW AREA	(dashed line)	TIER II IMPACTS	
TEST PIT LOCATION	TP	TYPE A IMPACTS	
SAMPLE POINT	+513	TYPE B IMPACTS	
SURVEY CONTROL POINT	▲CP101		

Public Works and Government Services Canada
PIN-B Dew Line Site
INAC RAP Update

Station Area

AECOM

Figure 4.0

B SIZE 11" x 17" (279.4mm x 431.8mm)
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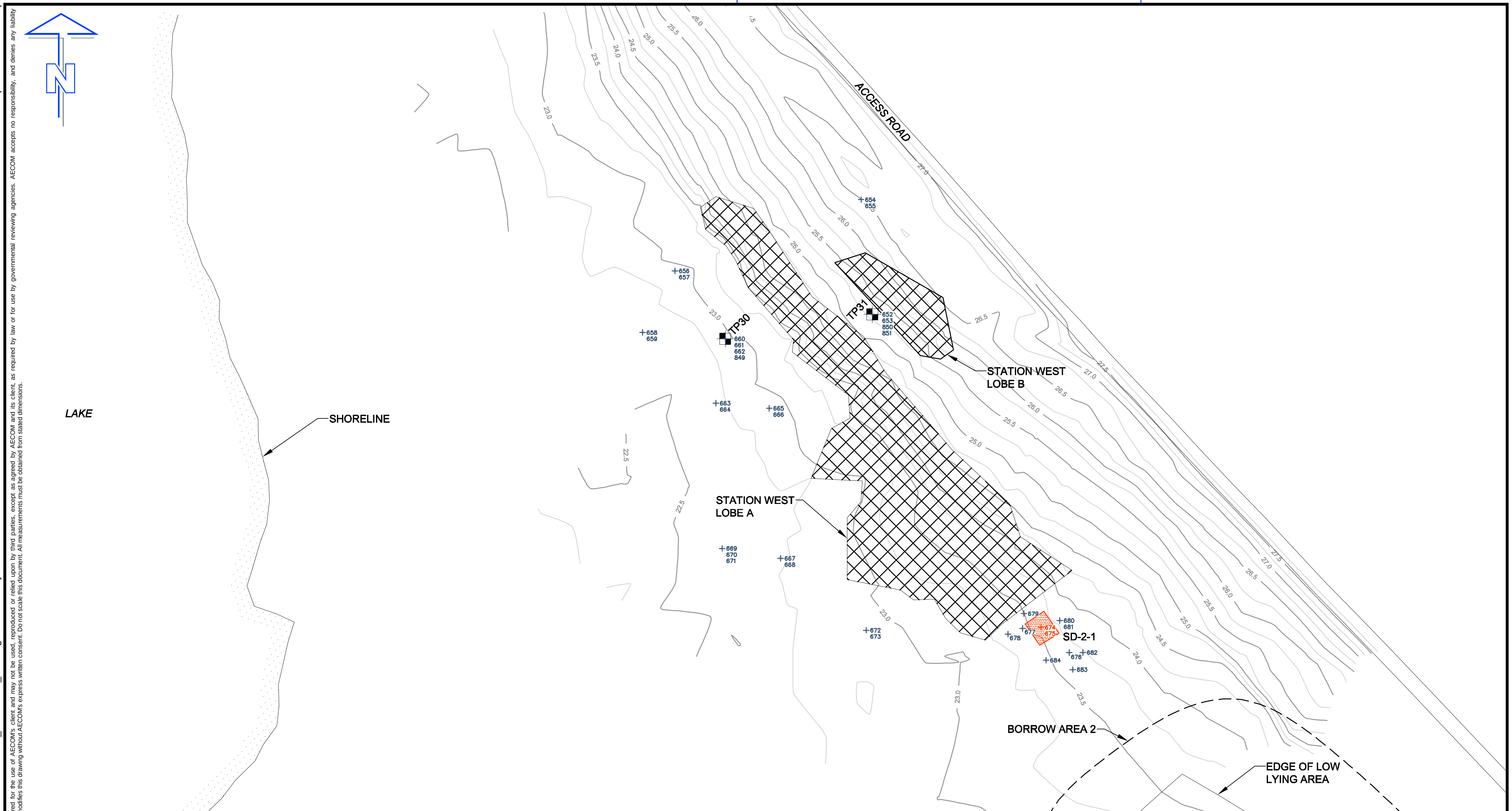

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GENERAL NOTES:

1. CONTOURS ARE SHOWN AT A 0.25m INTERVAL.

LEGEND:

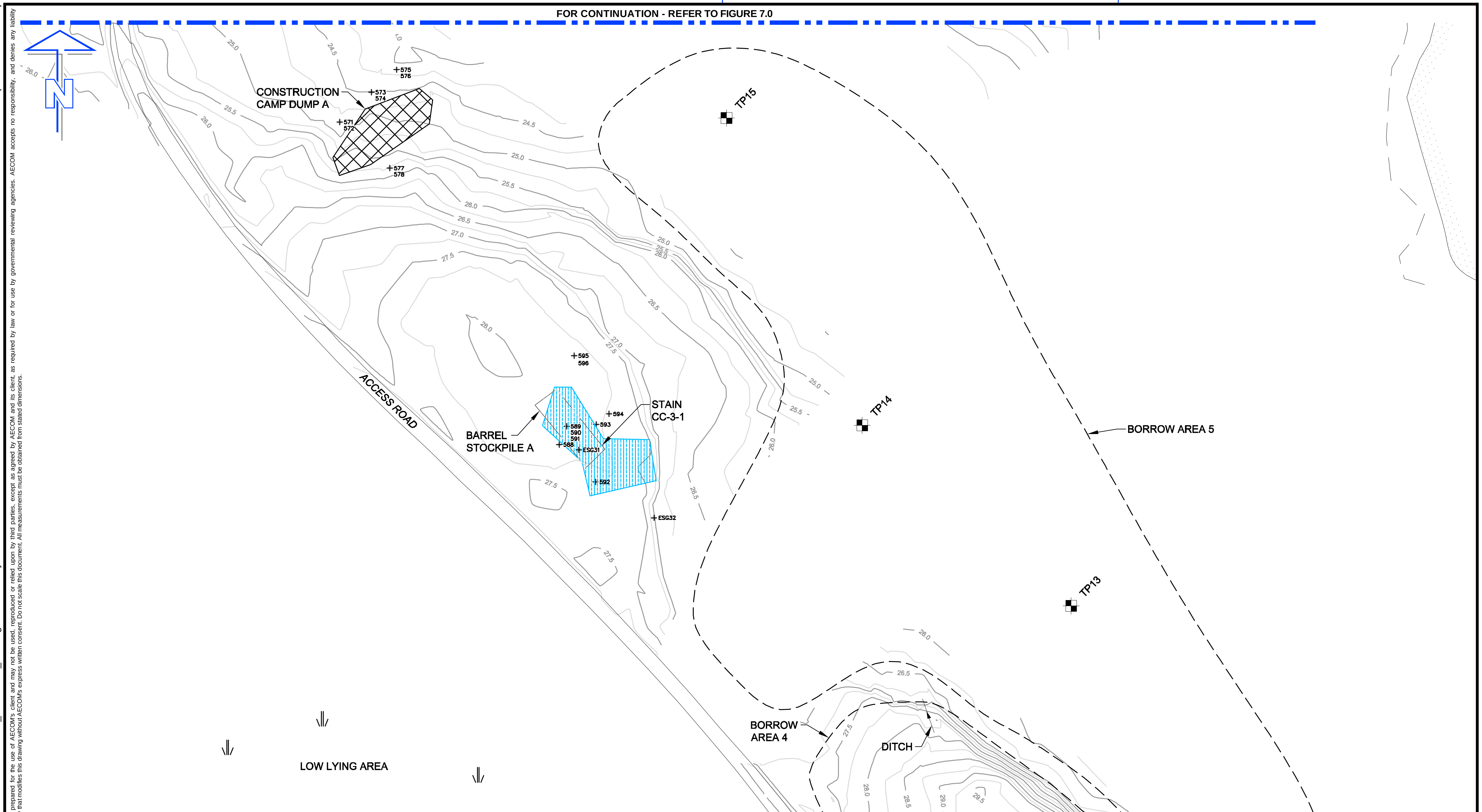
BORROW AREA	
BURIED DEBRIS	
TEST PIT LOCATION	TP
SAMPLE POINT	+513
TIER II IMPACTS	

AECOM

Public Works and Government Services Canada
PIN-B Dew Line Site
INAC RAP Update

Station West Dump Area

Figure 5.0



0 10 20 m SCALE 1:1000

GENERAL NOTES:

1. CONTOURS ARE SHOWN AT A 0.25m INTERVAL.

LEGEND:

BORROW AREA
BURIED DEBRIS
TEST PIT LOCATION — TP
SAMPLE POINT — 513
TYPE A IMPACTS

Public Works and Government Services Canada
PIN-B Dew Line Site
INAC RAP Update

Construction Camp Area South

Figure 6.0

AECOM

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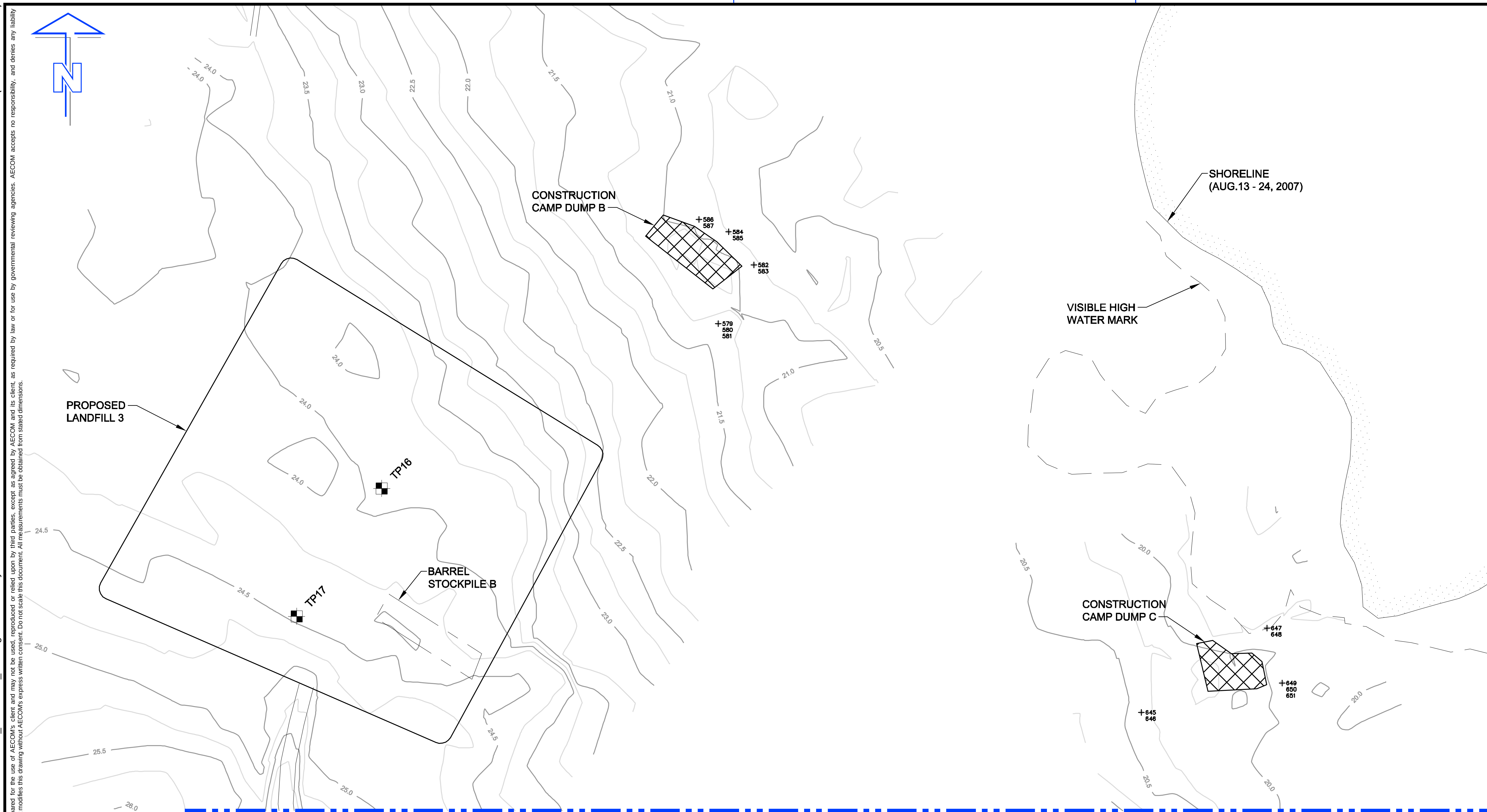

FOR CONTINUATION - REFER TO FIGURE 6.0

0 10 20 m SCALE 1:1000

GENERAL NOTES:

1. CONTOURS ARE SHOWN AT A 0.25m INTERVAL.

LEGEND:

PROPOSED LANDFILL	
BURIED DEBRIS	
TEST PIT LOCATION	TP
SAMPLE POINT	513

B SIZE 11" x 17" (279.4mm x 431.8mm)

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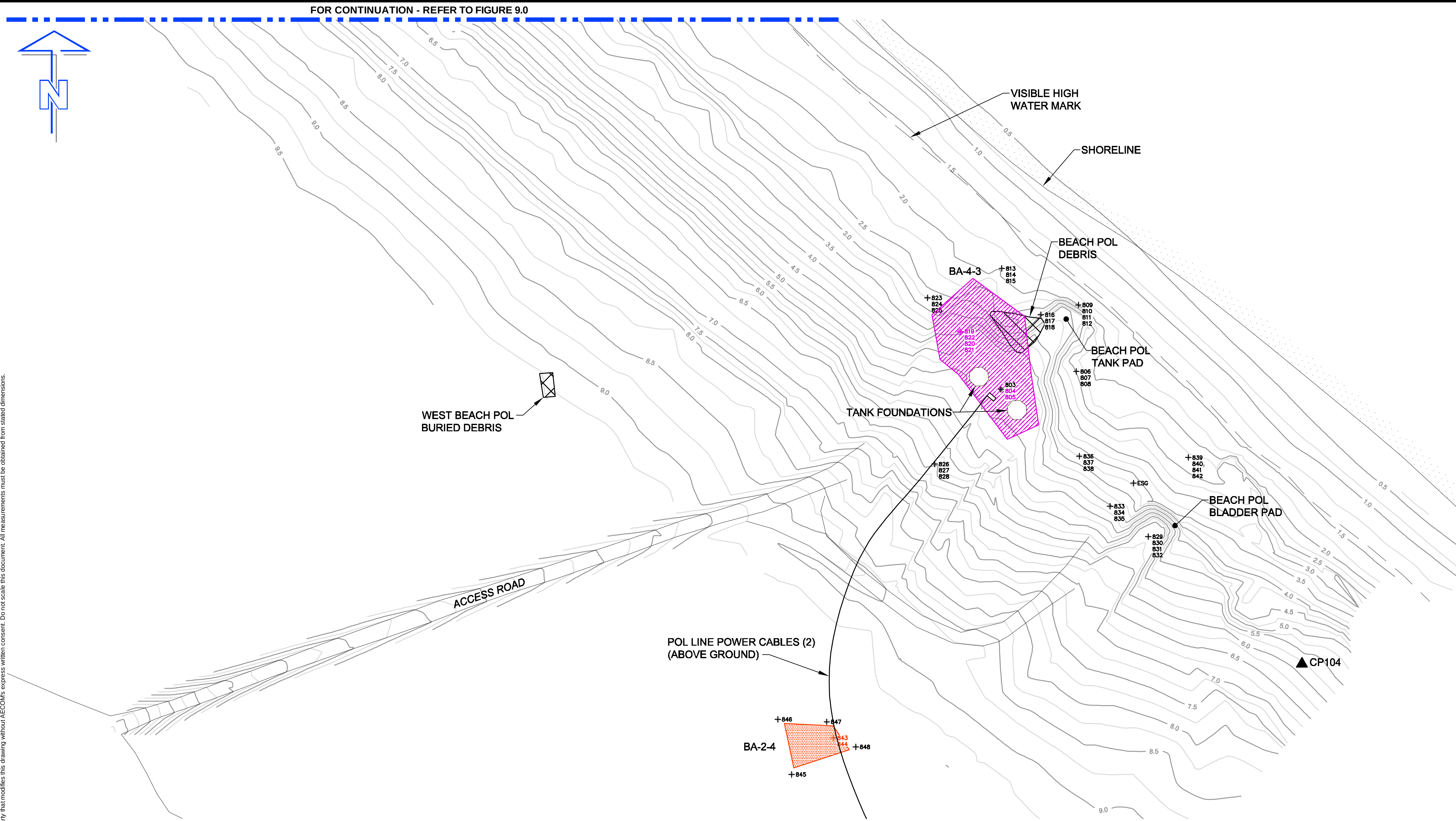
ISS/REV: A

AECOM

Public Works and Government Services Canada
PIN-B Dew Line Site
INAC RAP Update

Construction Camp Area North

Figure 7.0



0 10 20 m SCALE 1:1000

GENERAL NOTES:

1. CONTOURS ARE SHOWN AT A 0.25m INTERVAL.

LEGEND:

BURIED DEBRIS	(cross-hatched box)	TIER II IMPACTS	(orange fill)
SAMPLE POINT	+513	TYPE B IMPACTS	(magenta hatch)
SURVEY CONTROL POINT	▲CP101		

Public Works and Government Services Canada
PIN-B Dew Line Site
INAC RAP Update

Beach POL Area

AECOM

Figure 8.0

B SIZE 11" x 17" (279.4mm x 431.8mm)
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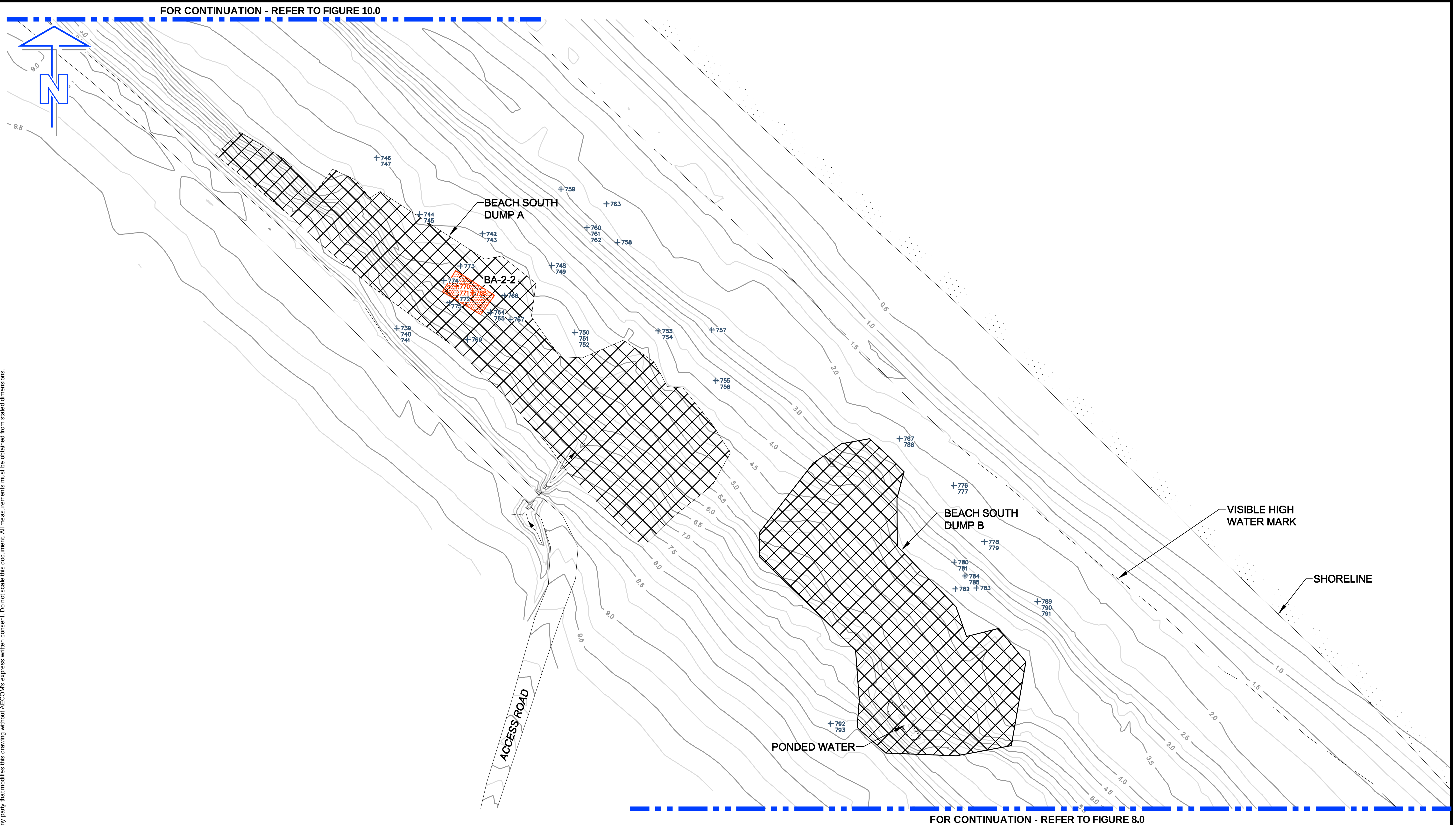

SCALE 1:1000

0 10 20 m

GENERAL NOTES:

1. CONTOURS ARE SHOWN AT A 0.25m INTERVAL.

LEGEND:

BURIED DEBRIS

SAMPLE POINT +513

TIER II IMPACTS

Public Works and Government Services Canada
PIN-B Dew Line Site
INAC RAP Update

Beach South Dump Area

Figure 9.0

AECOM

B SIZE 11" x 17" (279.4mm x 431.8mm)

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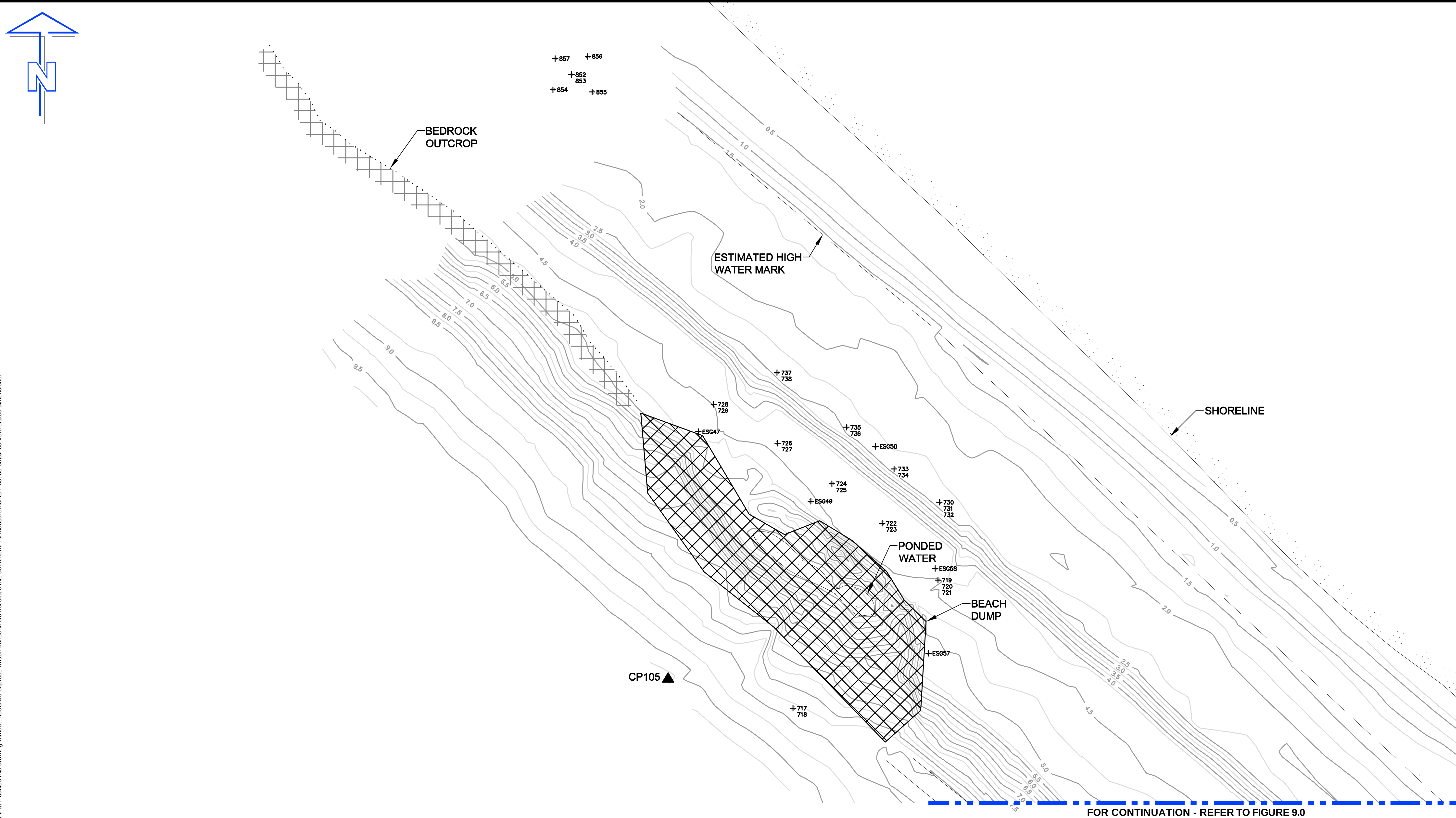

0 10 20 m
SCALE 1:1000

GENERAL NOTES:

1. CONTOURS ARE SHOWN AT A 0.25m INTERVAL.

LEGEND:

BURIED DEBRIS	(cross-hatch)
SAMPLE POINT	+513
SURVEY CONTROL POINT	▲CP101

B SIZE 11" x 17" (279.4mm x 431.8mm)

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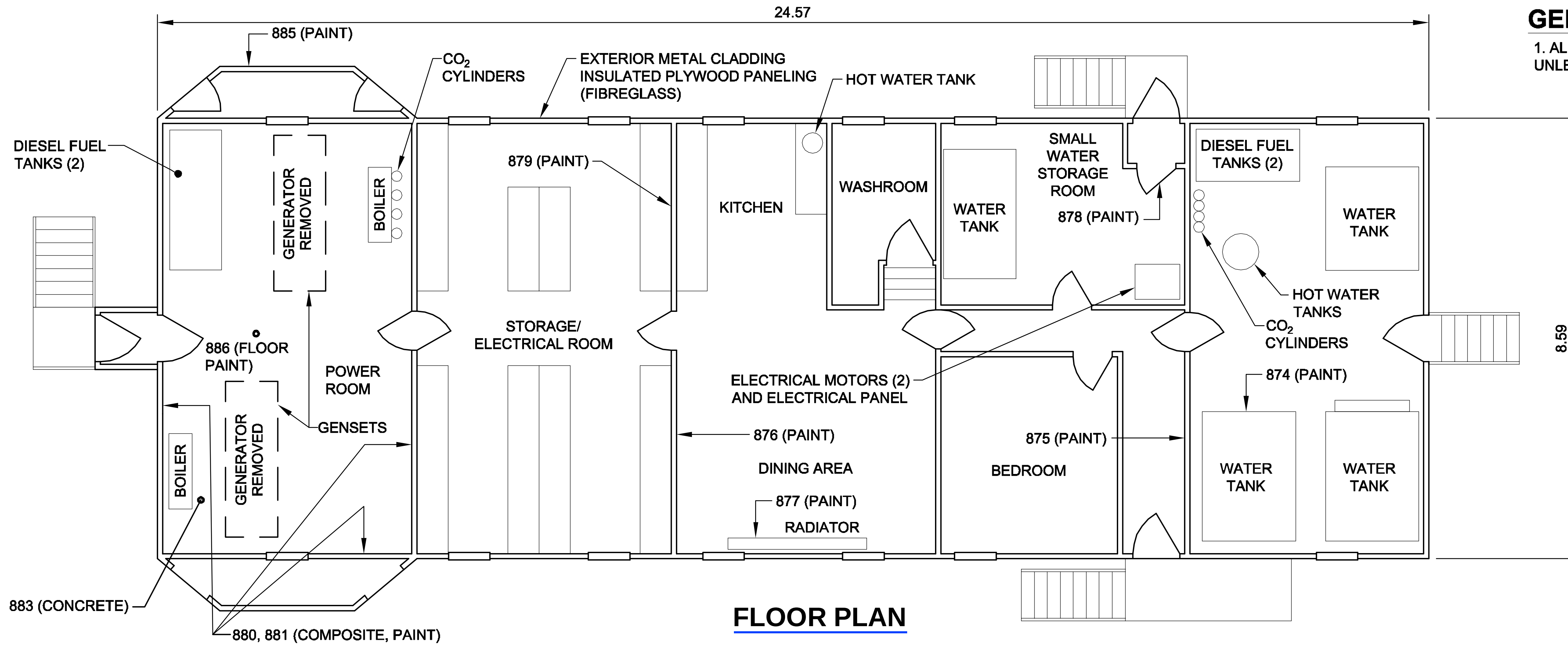
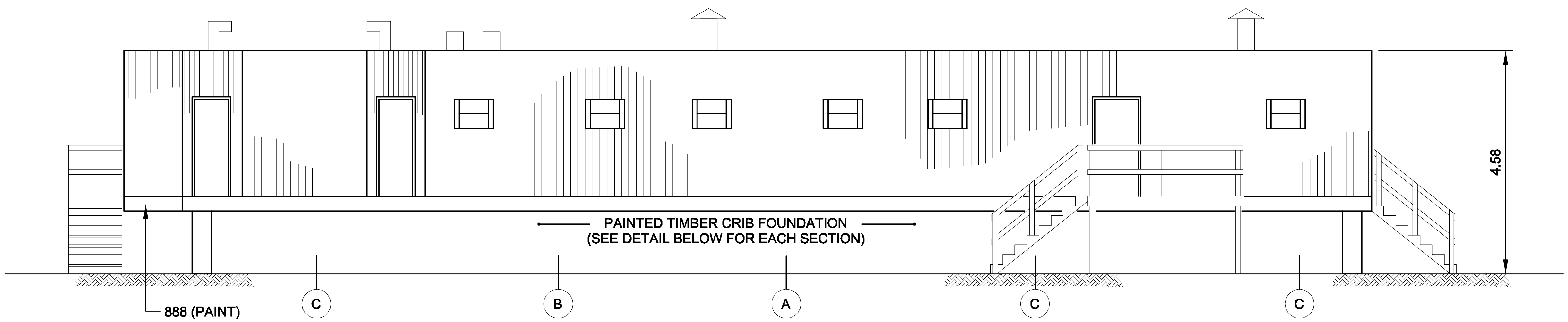
Public Works and Government Services Canada
PIN-B Dew Line Site
INAC RAP Update

Beach Dump Area

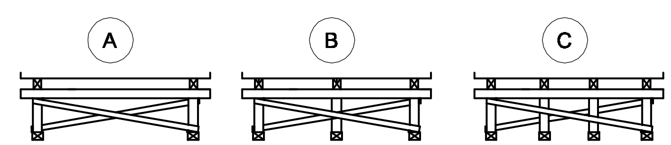
Figure 10.0



FLOOR PLAN



ELEVATION



BUILDING BASE CROSS SECTIONS

SCALE: NTS

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.

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AECOM

Public Works and Government Services Canada
PIN-B Dew Line Site
INAC RAP Update

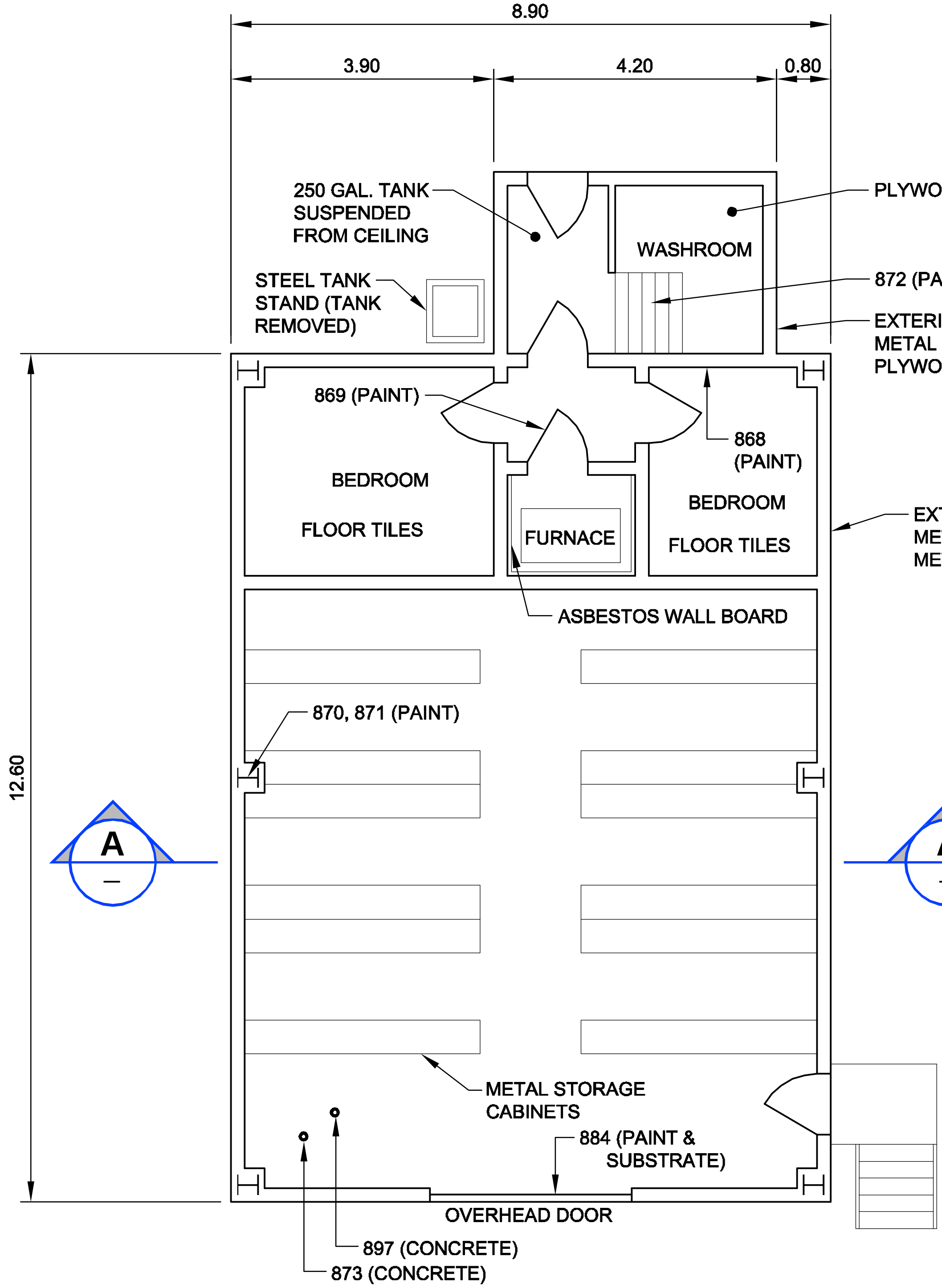
Module Train

Floor Plan and Elevation

Figure 11.0

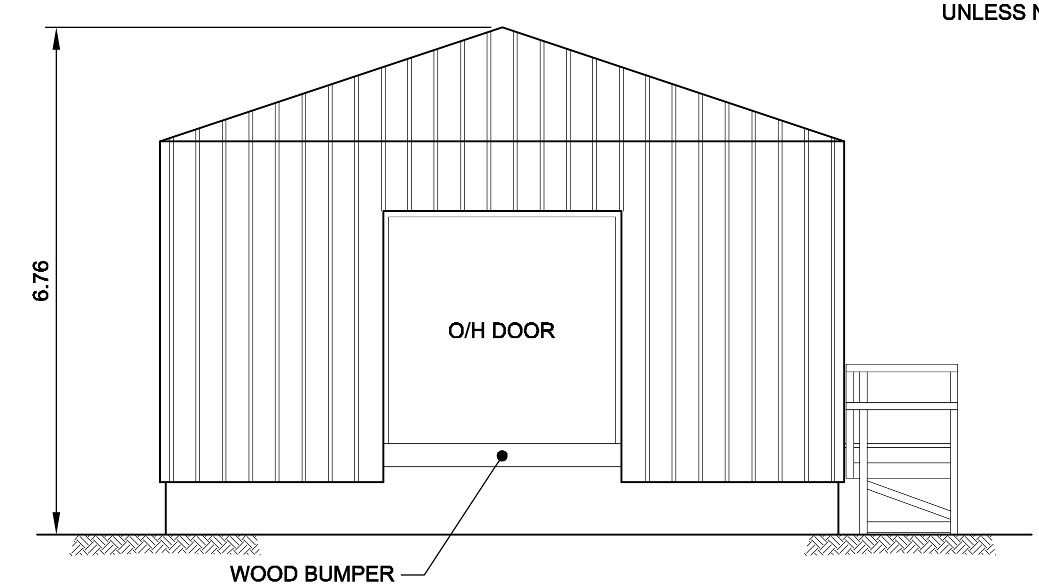
GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.



FLOOR PLAN

0 1 2 m SCALE 1:100



ELEVATION

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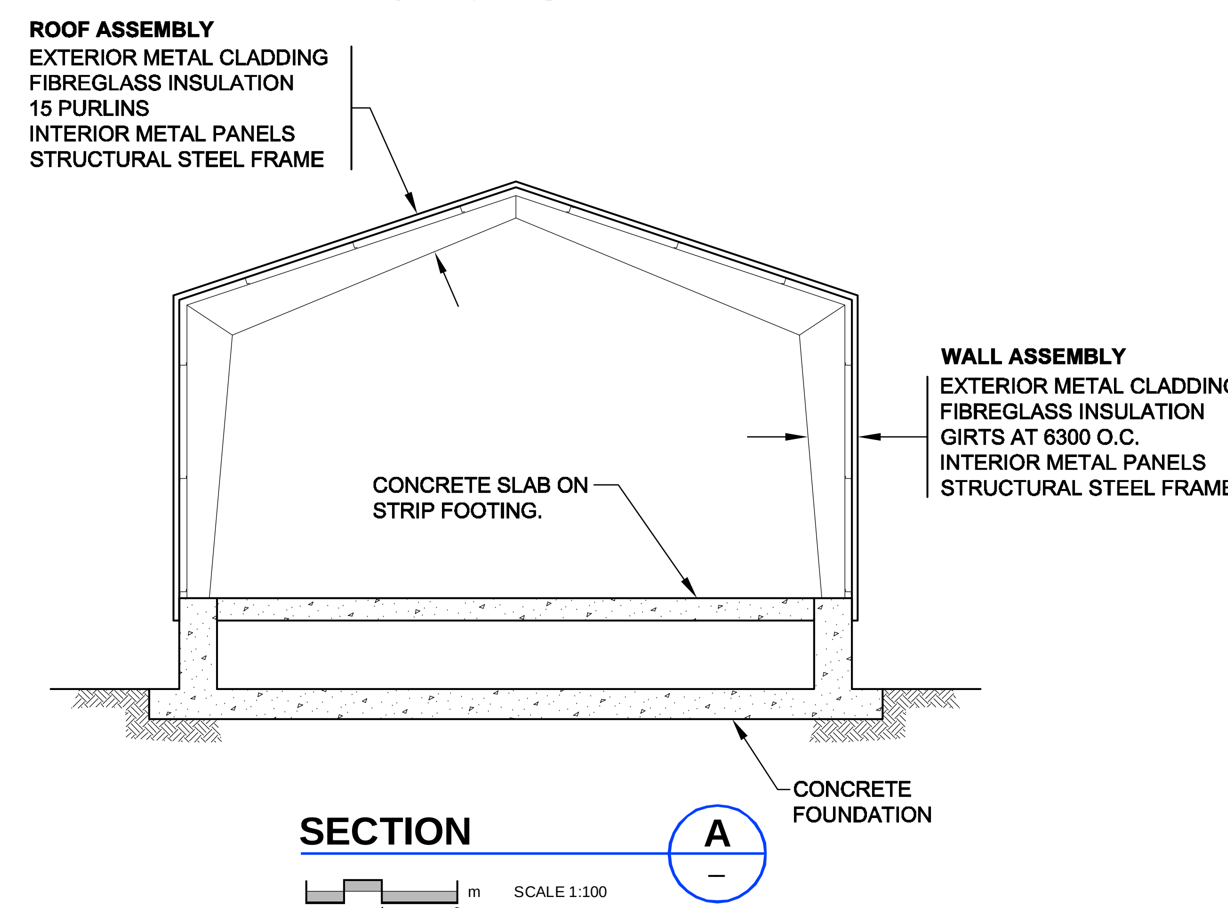

SECTION A

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AECOM FILE NAME: 2977-343-02_00-B-F012_RA.dwg

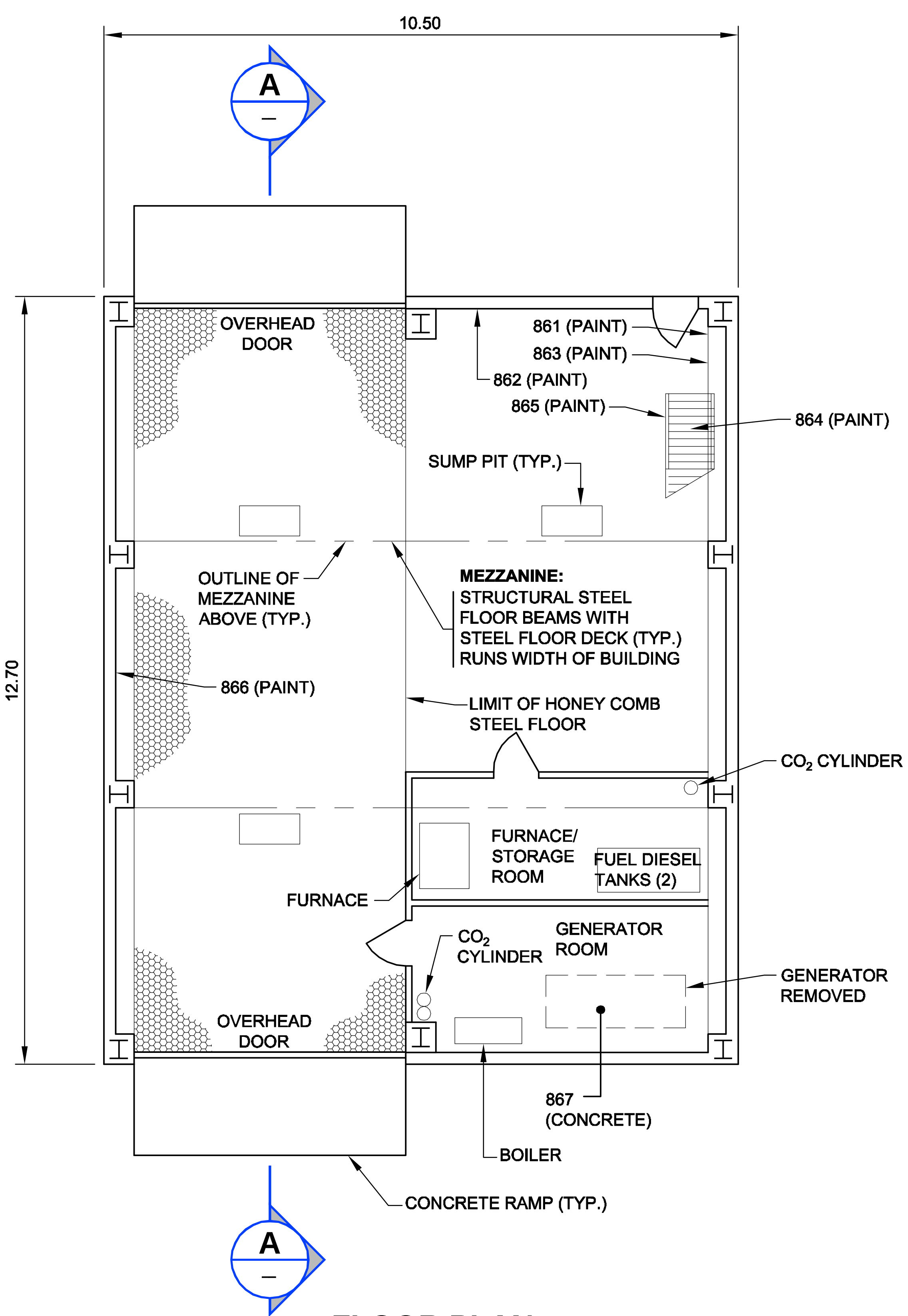
AECOM

Public Works and Government Services Canada
PIN-B Dew Line Site
INAC RAP Update

Warehouse
Floor Plan, Elevation, and Section
Figure 12.0

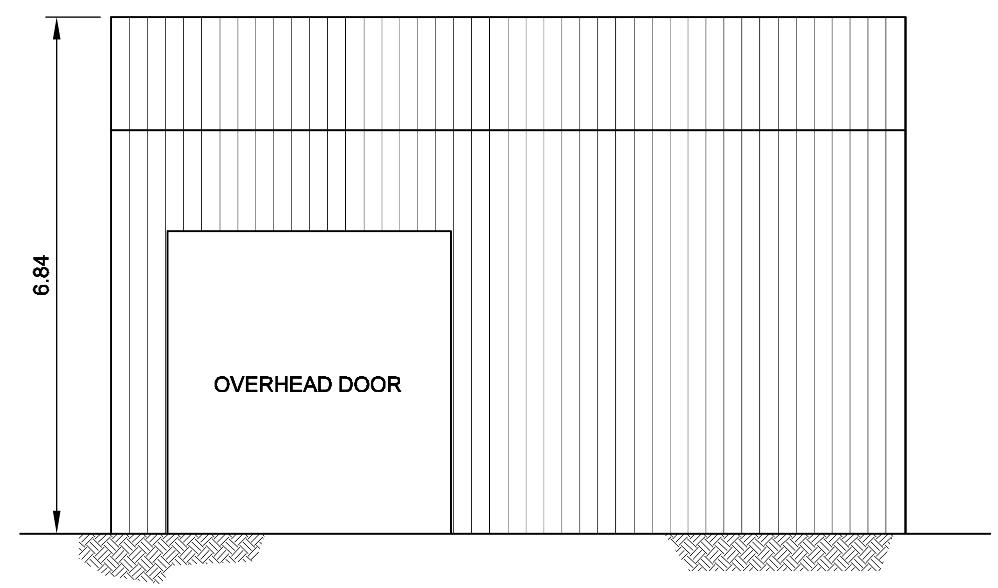
GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.



FLOOR PLAN

0 1 2 m SCALE 1:100



ELEVATION

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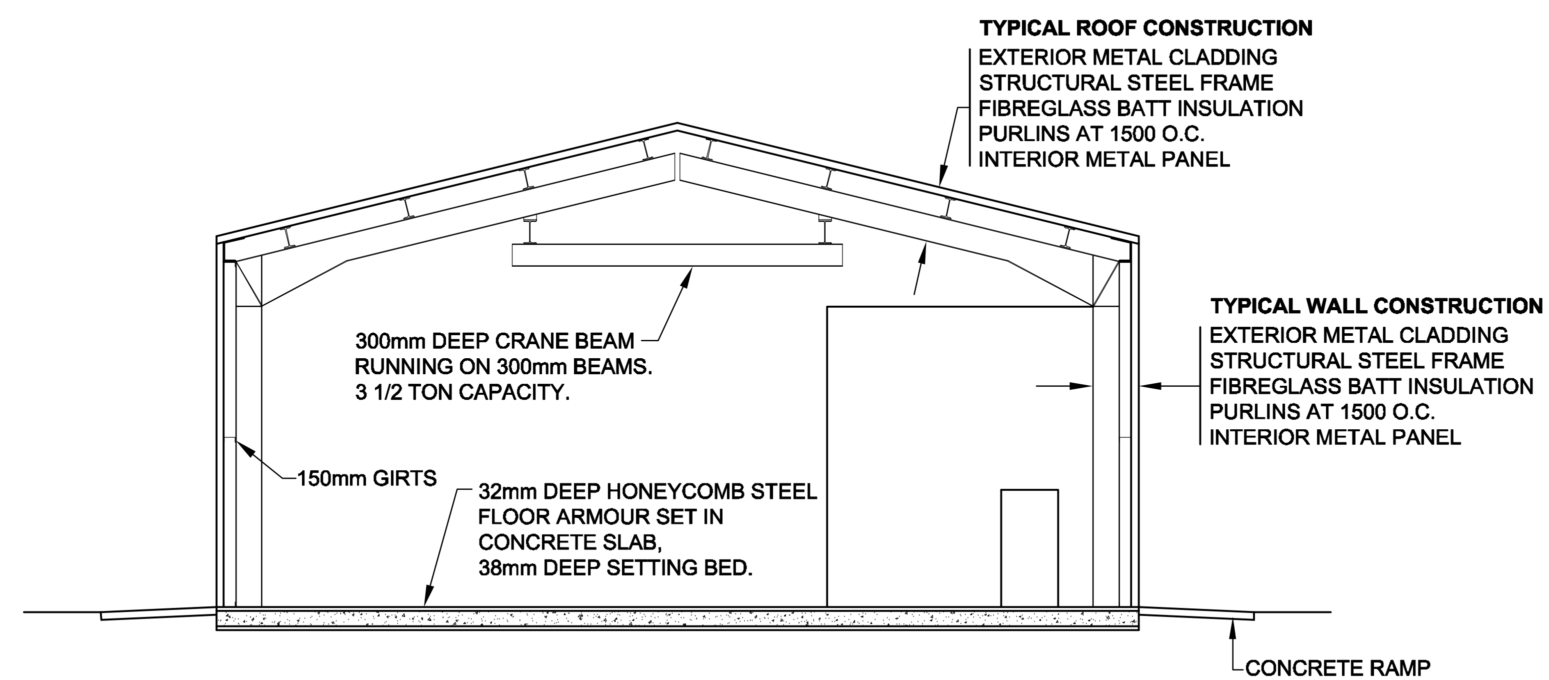

SECTION A

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ISS/REV: A

AECOM

Public Works and Government Services Canada
PIN-B Dew Line Site
INAC RAP Update

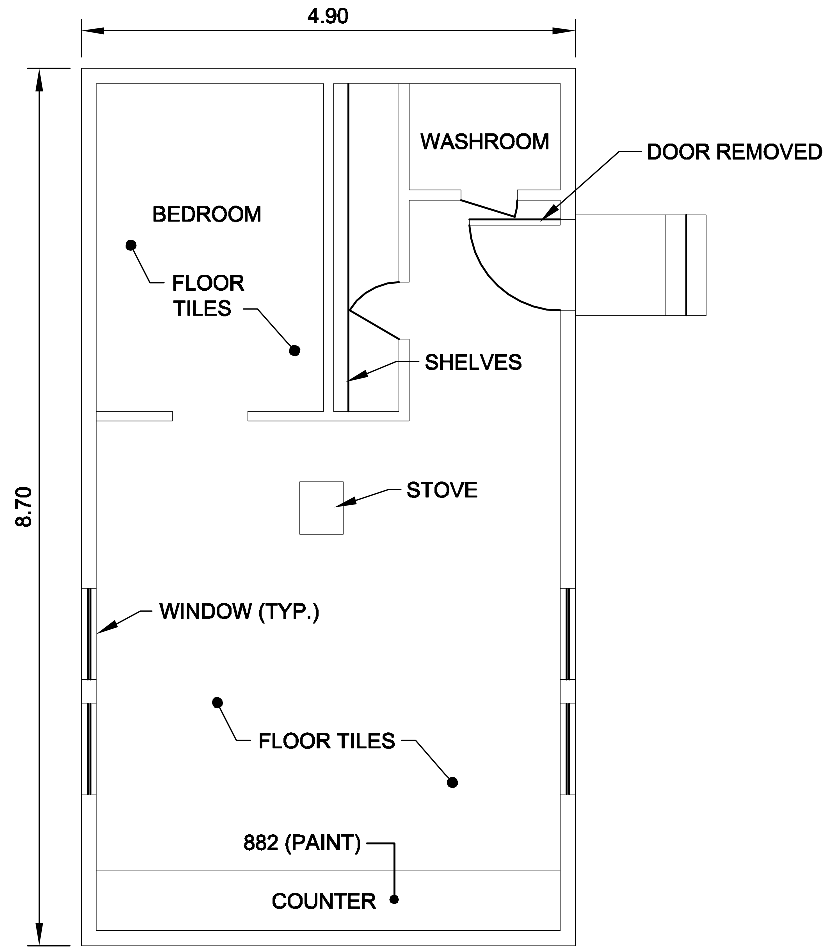
Garage

Floor Plan, Elevation, and Section

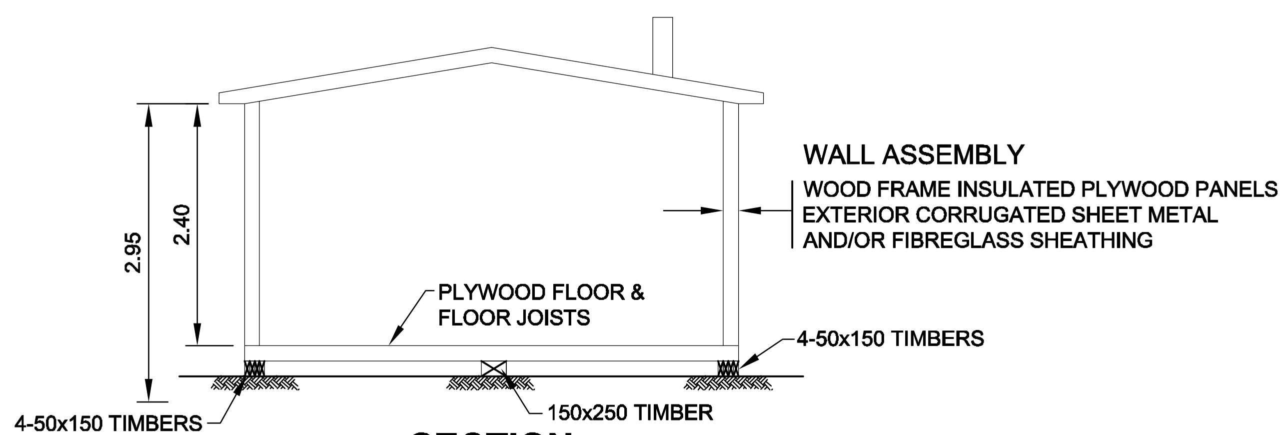
Figure 13.0

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.



FLOOR PLAN



SECTION

DORMITORY

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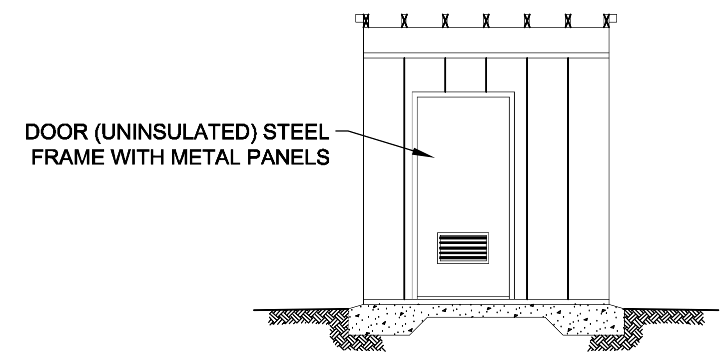
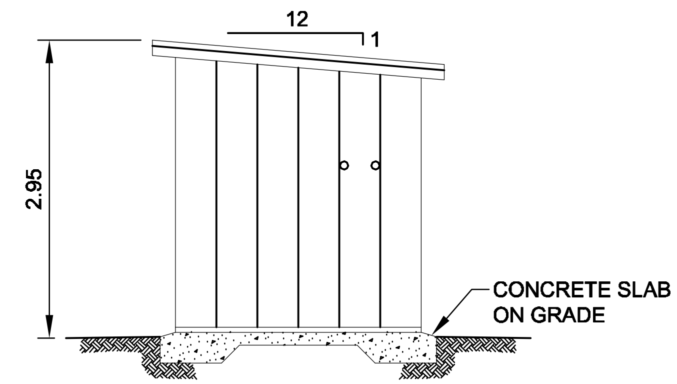
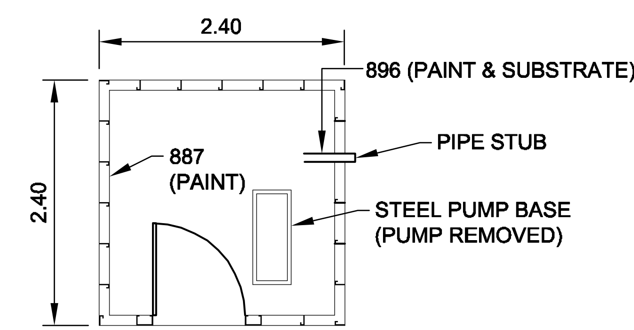


FRONT ELEVATION



SIDE ELEVATION



FLOOR PLAN

POL PUMPHOUSE

0 0.75 1.5 m SCALE 1:75

COMMENTS
SEE SPECIFICATIONS FOR IDENTIFICATION OF PCB CONTENT IN PAINT/BUILDING COMPONENTS

AECOM

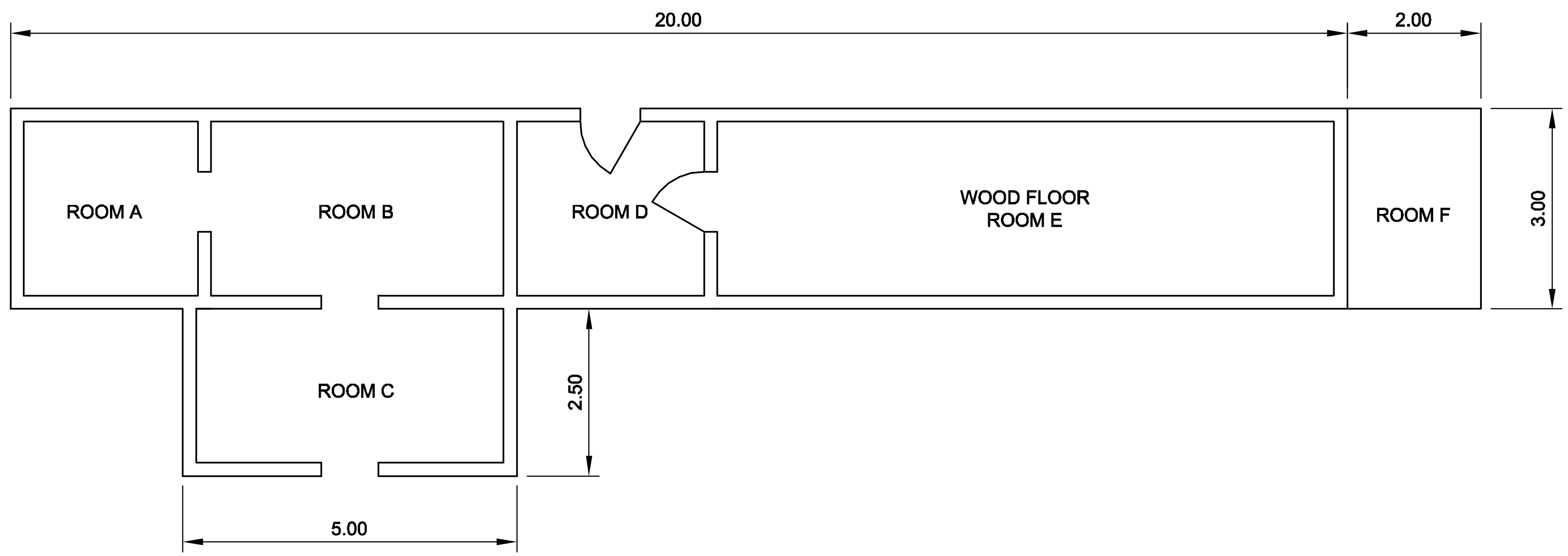
Public Works and Government Services Canada
PIN-B Dew Line Site
INAC RAP Update

Garage
Floor Plan, Elevation, and Section

Figure 14.0

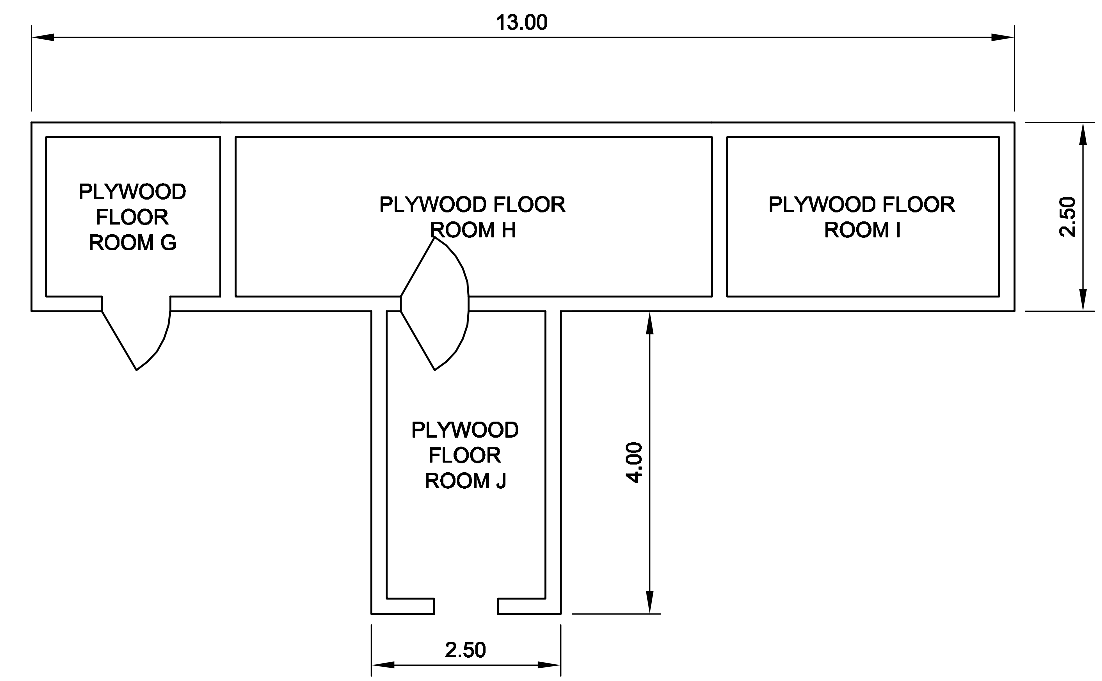
GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.



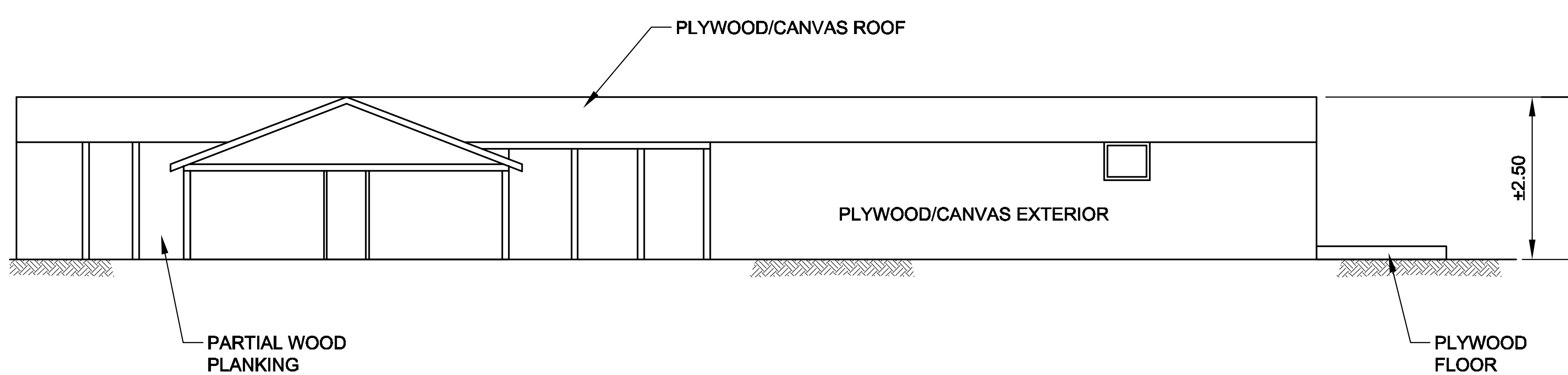
BUILDING 1 FLOOR PLAN

0 1 2 m SCALE 1:100



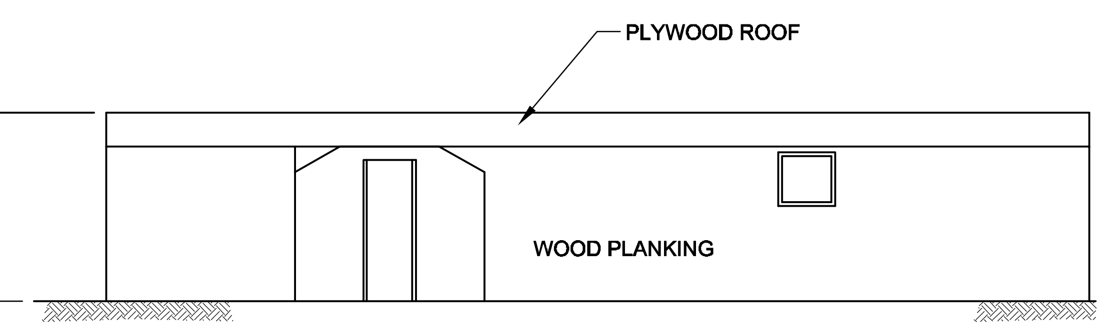
BUILDING 2 FLOOR PLAN

0 1 2 m SCALE 1:100



BUILDING 1 ELEVATION

0 1 2 m SCALE 1:100



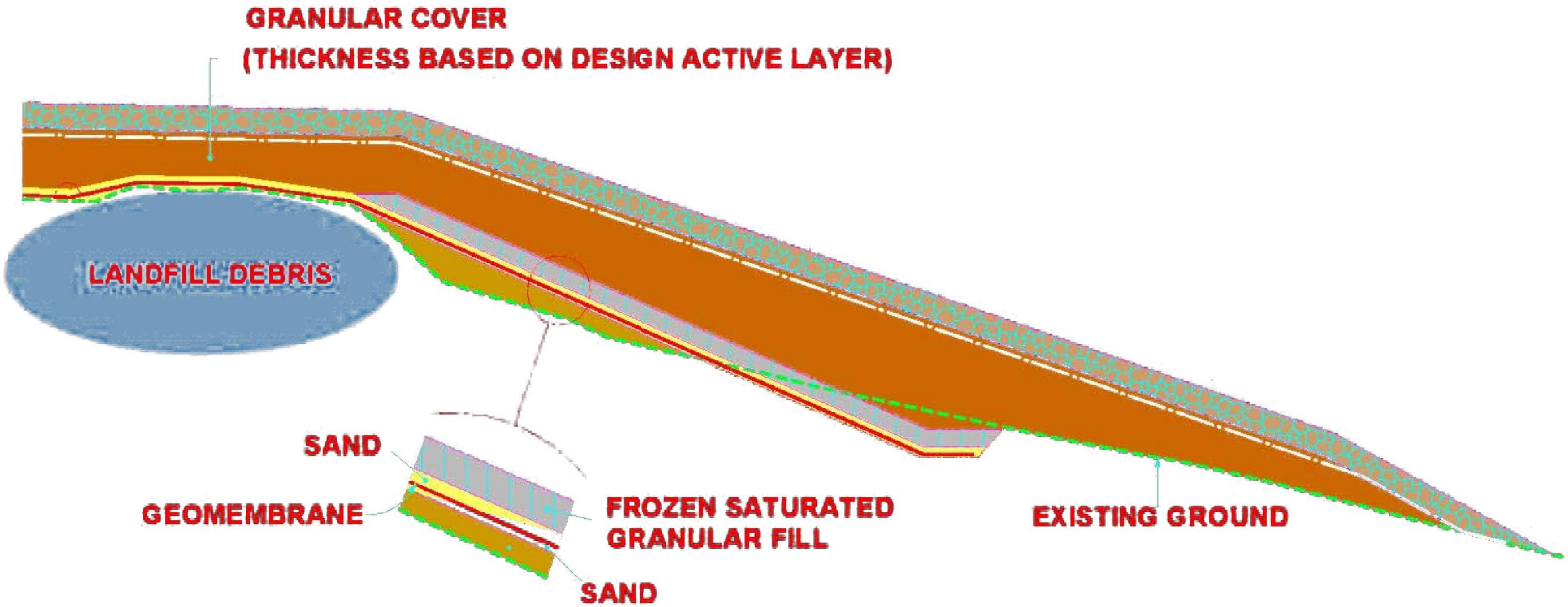
BUILDING 2 ELEVATION

0 1 2 m SCALE 1:100

Public Works and Government Services Canada
PIN-B Dew Line Site
INAC RAP Update

AECOM

Inuit Camp Building 1 and 2
Plan and Elevation
Figure 15.0



Public Works and Government Services Canada
PIN-B DEW Line Site
INAC RAP Update

Leachate Containment Cross-Section

AECOM

Figure 16.0

AECOM

Appendix B

Summary of Contaminated Soil Areas

Summary of Contaminated Soil Areas - 2008 INAC PHC Evaluation

Location	Area (Ref. by Tag Number)	Contaminants	Tier I Area m^2	Tier I Depth m	Tier II Area m^2	Tier II Depth m	PHC Type A Area m^2	PHC Type A Depth m	PHC Type B Area m^2	PHC Type B Depth m	Comments	Tier I Volume m^3	Tier II Volume m^3	PHC Type A Volume m^3	PHC Type B Volume m^3
Module Train	SA-2-7	Zn, PCBs			280	0.3						0	105	0	0
Module Train	SA-2-8	Zn, PCBs			130	0.3					Tier I at depth to be backfilled	0	49	0	0
Module Train	SA-1-6	PCBs	30	0.3							Eastern limits not delineated	12	0	0	0
Module Train	SA-2-11	PHC F2			28	0.2					Impacts limited to the depth interval of 0.8-1.0	0	7	0	0
Sewage Outfall	SA-2-10	Cu			75	0.3					Northern limit not delineated	0	28	0	0
Incinerator	SA-2-9	Cu			15	0.3						0	6	0	0
Garage	SA-1-3	PCBs	30	0.3								11	0	0	0
Garage	SA-2-4	PCBs			162	0.3						0	61	0	0
Garage	SA-1-1	PCBs	25	0.3							Eastern limit not delineated	9	0	0	0
Garage	SA-3-2	PHC A					155	0			Scarify, no excavation required	0	0	0	0
Garage	SA-4-5	PHC B							330	1.5	Western limit not delineated	0	0	0	644
Barrel Stockpile A	CC-3-1	PHC A					425	0			Scarify, no excavation required	0	0	0	0
Beach POL	BA-4-3	PHC B							740	1.2		0	0	0	1110
POL Line Battery Debris	BA-2-4	Pb			138	0.5					Depth delineation not achieved	0	86	0	0
North of Airstrip	BA-2-1	Cu			40	0.3						0	15	0	0
Station West Dump	SD-2-1	Pb			42	0.5						0	27	0	0
Beach Dump South A	BA-2-2	Pb, Cu			82	0.3						0	31	0	0
											CONTAMINATED SOIL AREAS	**33**	**415**	**0**	**1754**

Summary of Contaminated Soil Areas - 2008 INAC PHC Evaluation

Location	Area (Ref. by Tag Number)	Contaminants	Tier I		Tier II		PHC Type A		PHC Type B		Comments	Tier I Volume m^3	Tier II Volume m^3	PHC Type A Volume m^3	PHC Type B Volume m^3
			Area m^2	Depth m	Area m^2	Depth m	Area m^2	Depth m	Area m^2	Depth m					
Module Train	SA-2-7	Zn, PCBs			280	0.3						0	92	0	0
Module Train	SA-2-8	Zn, PCBs			130	0.3					Tier I at depth to be backfilled	0	43	0	0
Module Train	SA-1-6	PCBs	30	0.3							Eastern limits not delineated	10	0	0	0
Module Train	SA-2-11	PHC F2			28	0.2					Impacts limited to the depth interval of 0.8-1.0	0	6	0	0
Sewage Outfall	SA-2-10	Cu			75	0.3					Northern limit not delineated	0	25	0	0
Incinerator	SA-2-9	Cu			15	0.3						0	5	0	0
Garage	SA-1-3	PCBs	30	0.3								10	0	0	0
Garage	SA-2-4	PCBs			162	0.3						0	53	0	0
Garage	SA-1-1	PCBs	25	0.3							Eastern limit not delineated	8	0	0	0
Garage	SA-3-2	PHC A					155	0			Scarify, no excavation required	0	0	0	0
Garage	SA-4-5	PHC B							330	1.5	Western limit not delineated	0	0	0	569
Barrel Stockpile A	CC-3-1	PHC A					425	0			Scarify, no excavation required	0	0	0	0
Beach POL	BA-4-3	PHC B							740	1.2		0	0	0	977
POL Line Battery Debris	BA-2-4	Pb			138	0.5					Depth delineation not achieved	0	76	0	0
North of Airstrip	BA-2-1	Cu			40	0.3						0	13	0	0
Station West Dump	SD-2-1	Pb			42	0.5						0	24	0	0
Beach Dump South A	BA-2-2	Pb, Cu			82	0.3						0	27	0	0
											CONTAMINATED SOIL AREAS	**29**	**365**	**0**	**1547**

Summary of Contaminated Soil Areas - 2008 INAC PHC Evaluation

Location	Area (Ref. by Tag Number)	Contaminants	Tier I		Tier II		PHC Type A		PHC Type B		Comments	Tier I Volume m^3	Tier II Volume m^3	PHC Type A Volume m^3	PHC Type B Volume m^3
			Area m^2	Depth m	Area m^2	Depth m	Area m^2	Depth m	Area m^2	Depth m					
Module Train	SA-2-7	Zn, PCBs			280	0.3						0	84	0	0
Module Train	SA-2-8	Zn, PCBs			130	0.3					Tier I at depth to be backfilled	0	39	0	0
Module Train	SA-1-6	PCBs	30	0.3							Eastern limits not delineated	9	0	0	0
Module Train	SA-2-11	PHC F2			28	0.2					Impacts limited to the depth interval of 0.8-1.0	0	6	0	0
Sewage Outfall	SA-2-10	Cu			75	0.3					Northern limit not delineated	0	23	0	0
Incinerator	SA-2-9	Cu			15	0.3						0	5	0	0
Garage	SA-1-3	PCBs	30	0.3								9	0	0	0
Garage	SA-2-4	PCBs			162	0.3						0	49	0	0
Garage	SA-1-1	PCBs	25	0.3							Eastern limit not delineated	8	0	0	0
Garage	SA-3-2	PHC A					155	0			Scarify, no excavation required	0	0	0	0
Garage	SA-4-5	PHC B							330	1.5	Western limit not delineated	0	0	0	495
Barrel Stockpile A	CC-3-1	PHC A					425	0			Scarify, no excavation required	0	0	0	0
Beach POL	BA-4-3	PHC B							740	1.2		0	0	0	888
POL Line Battery Debris	BA-2-4	Pb			138	0.5					Depth delineation not achieved	0	69	0	0
North of Airstrip	BA-2-1	Cu			40	0.3						0	12	0	0
Station West Dump	SD-2-1	Pb			42	0.5						0	21	0	0
Beach Dump South A	BA-2-2	Pb, Cu			82	0.3						0	25	0	0
											CONTAMINATED SOIL AREAS	**26**	**331**	**0**	**1383**

Appendix C

Tables

Table 1: Summary of Surface Debris Areas

Debris Area	Description	Location	Estimated Areal Extent (m^2)	Estimated Uncrushed Volume (m^3)	Estimated Crushed Volume (m^3)	Hazardous Volume Component (m^3)	Comments
Site Debris 1	Tin cans, canvas, metal siding, stove pipe, tent frame, metal strapping, wood, electrical cable, pipe, braided metal cable, incinerator barrel on stand, barrel culvert and pipe at outfall, barrel barbecue, day tank stand, bathroom sink and fixtures, 1 x1 m asbestos board, pallet, qamotiq (1/2), water tank, toilet seat, plastic kid's toboggan, cat tracks, filters, metal posts, spool and cable, window frames, asbestos tile, glass, pail, rebar, rubber, chair, 2x6" wood barrel stand, heavy equipment cab, power pole (creosote). Wash house remains: 1.5x1x5x1.5 m square tank, propane tank (2 m by 0.5 m dia.), metal shower stall, copper piping, plywood and 2x4" construction, electrical panel and cables. Barrels: 37 empty, 6 marker barrels, 9 with aqueous contents, 2 mixed phase, 1 oil.	Station Area	213,100	44.0	27.0	0.2 (asbestos) 2 (creosote pole)	Scattered debris away from station area, more concentrated piles at station. Volume and description does not include debris within buildings
Site Debris 2	Includes Barrel Stockpiles A and B. Barrel Stockpile A: 22 marker barrels with signposts, 30 stacked barrels, bulging, leaking, 19 oil contents, 5 oil/water mix, 2 empty, 1 sludge, 3 aqueous. Barrel Stockpile B: 78 barrels, 54 empty, 24 with minimal aqueous contents (all could likely be consolidated into 1 barrel). Debris: pipe sections, snow fencing, 1x1 m asbestos board and smaller scattered pieces, plywood, rebar, metal strapping, metal pail, 2x2"'s, metal grating, tins, cable, rubber, mesh, roller and toe bar, pallets, canvas, metal siding, wire, angle iron, wood fragments.	Construction Camp Area	97,000	40.0	25.0	0.3 (asbestos)	Debris is mostly scattered, locally more concentrated in vicinity of dumps
Site Debris 3	Tin cans, glass, tire, wood, cable, 1 barrel (empty), metal strapping, oil filter, battery fragments	Station West Dump Area	1,600	3.0	2.0	0.1 (battery)	Debris is concentrated mainly near the dump toe (some partially buried) and scattered away from dump
Site Debris 4	metal pail, piece of stovepipe, empty barrel	0.8 km Southeast of Station	1,900	0.4	0.2		
Site Debris 5	1 piece aluminum siding	0.5 km East-southeast of Station	1,400	0.2	0.1		
Site Debris 6	2 empty barrels	0.6 km East of Station	2,900	0.5	0.2		
Site Debris 7	4 barrels, piece of metal sheeting. 2 barrels are approx. 1/4 full but are rusted through so contents are likely aqueous. 1 barrel in pond	0.4 km East of Station	7,200	1.0	0.5		
Site Debris 8	1 empty barrel at edge of dried up pond	0.4 km East of Station, along old trail	1,300	0.3	0.1		
Site Debris 9	1 sheet of plywood	0.4 km East-northeast of Station	1,000	0.1	0.1		
Site Debris 10	scattered wood debris, wood box, tins, barrel with aqueous contents, metal sheet, cylinder, metal pails, rubber	0.080 km east of POL Line, mid-way between station and airstrip	15,000	1.0	0.8		
Site Debris 11	Includes Barrel Stockpile C, 5 airstrip approach marker barrels, end of airstrip signs, lights, recent fuel cache. Barrel Stockpile C: 32 barrels, barrels painted orange (so may have been marker barrels), all quite rusted, many rusted through in locations, 11 with apparent aqueous contents. Recent fuel cache: 4 barrels at end of airstrip with contents, labels read Jet-B fuel, 5th barrel (empty) in creek bed nearby.	At southeast end of airstrip, extending to southeast	60,300	12.0	6.0		
Site Debris 12	5 airstrip approach marker barrels, end of airstrip signs, lights, Three recent fuel caches (Jet-B): 2 small stockpiles by abandoned airstrip: 8 in total, 3 full, remainder empty. Third cache on east side of water lake: 7 barrels, Jet-B, "INA" spray painted on sides, 5 with contents, equivalent of 2 full drums. Remainder of barrels: 16 empty, 4 with aqueous contents, 1 mostly full of fuel (sample 914). Other debris: pallets, pipe, tins, copper pipe, sheets, melted metal fragments, bolts, pail, pot, water pump, wood, barrel raft constructed with 6 drums, a tire, metal rods, and asbestos core door as platform, signpost, plastic, metal cable, misc. small scattered debris.	Around abandoned airstrip, shoreline of water lake and extending north of lake and airstrip	644,500	19.0	13.0	0.3 (barrel sample 914), 0.5 (asbestos core door)	Debris is located along shoreline and is not submerged within lake itself
Site Debris 13	Includes Barrel Stockpile D. Debris: misc. engine pieces, plastic jugs, wood timbers, mechanical equipment, cable reels, wire, metal pails, misc. rusted out metallic debris, glass, garbage pails, rubber, angle iron, cement pails, wooden washboard, vacuum hose, runway lights, plywood, intact battery at Beach Dump, 2 intact batteries at Inuit camp, partially filled jerry can, tires, metal shelving, skid, mesh fabric, 2 4'x8' asbestos board, inner tube, pallets, radiator, bolts, canvas . Barrel Stockpile D: 157 drums in total; visible labels stated "fuel oil-diesel"; 46 had partial contents - all aqueous, most were deteriorated and rusted through, 5 samples collected. Other scattered barrels: 276 empty, 62 marker barrels (52 at north end of Beach Dump), 43 with contents (mostly aqueous), 10 with suspected hydrocarbon contents, 2 with confirmed fuel contents (samples 908 and 909). Beach POL Area: 95 barrels partially buried and visible, some more expected to be buried (assume 100), some with oil contents on top of tank pad and beside bladder pad (samples 906 and 907).	Along beach from north of Beach Dumps to Inuit camp, extending west to airstrip	682,300	197.0	109.0	0.3 (battery) 0.6 (barrel samples 906 and 909) 0.2 (asbestos)	Debris is more concentrated along the beach in the vicinity of the POL pad, dumps, and Inuit Camp, then scattered towards airstrip and along beach to north and south of site
POL Line	POL line, 51 marker barrels, 2 power cables	POL line between Station POL and Beach POL	1,400	200.0	190.0		
TOTALS			**1,730,900**	**519.0**	**374.0**	**4.5**	

Table 2: Demolition Debris Inventory

Structure	Quantity	Description of Components	Hazardous Material	Building Contents (during 2007 survey)	Non-Haz. (m^3)	Hazard. (m^3)	Comments
POL Pumphouse	1	Painted steel clad, steel frame	None	None	4.8		Concrete foundations may require removal for contaminated soil excavation, depending on the PHC remedial criteria selected.
		Concrete foundation			2.0		
Inuit House	1	Prefabricated wood and metal clad panels with rigid insulation. Structure 10m L x 5m W x 2.5m H on shallow wood foundation.	Likely asbestos in chimney components and stove and potentially in floor tiles	Shelving, bed frames, stove	21	3	
Radar Tower	1	Steel pipe and beam construction with associated communication cables. Triangular cross-section: 65 m L x 5 m B x 5 m H	None - see comments	N/A	160		Paint and substrate samples collected from CAM-F and FOX-C were below criteria for PCBs and leachable Pb
Module Train Five joined 4.9m L modules. Total dimensions 25.2m L x 8.6m W x 3.7 m H. Constructed timber crib foundation. Wood frame construction	1	**Module 1 - Powerhouse**					
		Foundation		Heat exchanger, mechanical and electrical conduits, 2 x 275 gal fuel tanks, nitrogen cylinders, exhaust piping	7.9		
		Floor/Ceiling	PAP interior and exterior		18.4	0.5	
		Concrete Floor	PCB contaminated concrete		1.5	0.5	
		Walls	PAP interior and exterior		12.2	2.0	
		Fuel Tanks	PAP			3.0	
		Misc. Mechanical and Piping	PAP over asbestos wrap		2.0	3.0	
		Misc. Electrical			0.0	1.0	
		Module 2 - Storage/Electrical Room					
		Foundation		Communication panels and cabinets, electrical and mechanical, shelving	4.0		
		Floor/Ceiling	PAP interior and exterior		17.4	1.5	
		Walls	PAP interior and exterior		10.7	1.5	
		Shelving	PAP			2.0	
		Electrical Panels			7.0		
		Misc. Mechanical and Piping	PAP over asbestos wrap		0.5	1.5	
		Misc. Electrical			0.5	1.5	
		Module 3 - Kitchen/Dining/Washroom					
		Foundation		Shelving, hot water tank, sink, radiators, mechanical and electrical components	5.2		
		Floor/Ceiling	PAP interior and exterior		17.4	1.5	
		Walls	PAP interior and exterior		11.4	2.3	
		Fixtures/Shelving	PAP		1.0	2.0	
		Misc. Mechanical and Piping	PAP over asbestos wrap		0.5	1.0	
		Misc. Electrical	PAP		0.5	0.5	
		Module 4 - Tank Room/Bedroom					
		Foundation		Water tank, bed frames, radiators	6.6		
		Floor/Ceiling	PAP interior and exterior		17.4	1.5	
		Concrete Floor	PCB Paint to be removed		1.1	0.1	
		Walls	PAP interior and exterior		12.6	2.6	
		Tanks	PAP		0.6	3.0	
		Misc. Mechanical and Piping	PAP over asbestos wrap		0.5	1.0	
		Misc. Electrical	PAP			1.0	
		Module 5 - Tank Room					
		Foundation		3 water tanks, mechanical and electrical components	6.6		
		Floor/Ceiling	PAP interior and exterior		17.4	1.5	
		Walls	PAP interior and exterior		10.2	2.0	
		Tanks	PAP			9.8	
		Misc. Mechanical and Piping	PAP over asbestos wrap		0.5	1.5	
		Misc. Electrical	PAP			1.0	
		Doors	Asbestos core	11 total		2.5	
		Vermiculite		4 compartments	4.1		
		Exterior Stairs	PAP	4 total		9.0	
Warehouse 12.6 m L x 8.9 m W x 6.8 m H on concrete footings. Structural steel braced frame with corrugated aluminium cladding.	1	Exterior Walls with Metal Cladding/Rigid Insulation		Furnace, metal shelving, toilets, hot water tank, electrical panels, ducting	20	1.0	Concrete foundation to be left in place and regraded
		Interior walls, partitions, ceiling, doors	PAP on partial interior metal cladding walls, all plywood walls, and ceiling		2.0	0.5	
		Structural Steel			5.0		
		Access steps	PAP			3.0	
		Vestibule	PAP on interior walls		8.5	1.5	
		Furnace and Chimney	Asbestos containing materials in chimney, fire doors and furnace room wall panels		1.0	1.5	
		Shelving			2.0		
		Floor	PAP on plywood floors in dormitory and vestibule area			0.6	
		Misc. Mechanical, ducting	Asbestos wrap had been removed		2.0		
		Misc. Electrical			1.5		
Garage 12.6 m L x 8.9 m W x 6.6 m H on concrete footings. Structural steel braced frame with exterior metal cladding.	1	Building envelope (includes cladding and insulation)			81		Concrete foundation to be left in place and regraded
		Overhead doors			4.5		
		Interior walls, partitions, ceiling, doors			3.7		
		Piping, hoist beams, interior shelving, ladders, etc.					
		Structural Steel			7.0		
		Floor (paint only)	PCB Paint to be removed			0.1	
		Mezzanine - stairs, deck, beams			4.5		
		Furnace and Chimney	Asbestos wrap		0.5	1.0	
		Fuel Tanks			3.0		
		Misc. Mechanical			1.0		
		Misc. Electrical			1.0		
Camp Building 1	1	Wood frame structure (16.5m x 3m x 2.5m) with partial wood/canvas roof on shallow wood foundation	4 batteries	Desks, bed frames, cans, misc. domestic waste, pump, cable spool	22	0.2	
			PAP plywood walls and ceiling			3.0	
Camp Building 2	1	Wood frame structure (16.5m x 3m x 2.5m) with partial canvas/wood roof on shallow wood foundation	Asbestos containing sheeting (1 piece)	Shelving, bed frames, misc domestic waste	14	0.1	
			2 Paint cans			2.0	
			PAP plywood walls and ceiling				
Boat	1	Wood frame structure with plywood wood siding, metal keel. Main body: 12m L x 2m H x 2.5m W. Cabin: 2m L x 2m H x 2m W	None - see comments	Rope, canvas, plastic, metal clamp, wood, engine	21		Main body painted orange, but this paint typically not PAP
TOTAL (Crushed) Volume					**589**	**79**	

Table 3: Summary of Paint and Concrete Demolition Samples

Tag Number	Date Sampled	Sampled By	Building / Location	Structure	Substrate	Paint Colour	Paint Condition	% Paint Coverage on Structure	Paint Thickness - Field Measurement (mm)	PCB Paint Concentration (mg/kg)	PCB Paint / Substrate Concentration (mg/kg)
Paint											
861	19-Aug	Leigh	Garage	Wall	Metal	Bluish Grey	Flaking	60	0.22	376	7.6
862	19-Aug	Mark	Garage	Wall	Metal	Khaki grey	Flaking	99	0.15	153	3.5
863	19-Aug	Mark	Garage	Wall	Metal	White	Flaking	40	0.18	194	2.1
864	19-Aug	Leigh	Garage	Stairs	Metal	Black	Good	95	0.2	325	4.0
865	19-Aug	Mark	Garage	Hand Rail	Metal	Red	Slight Flaking	90	0.25	288	4.2
866	19-Aug	Mark	Garage	Wall	Metal	Brown	Flaking	15	0.13	155	0.5
868	19-Aug	Dan	Warehouse	Bedroom Wall	Metal	Yellowy Beige	Flaking	95	0.22	71100	2287
869	19-Aug	Leigh	Warehouse	Furnace Room Door	Metal	Red	Good	100	0.15	1900	43.9
870	19-Aug	Mark	Warehouse/Duplicate of 871	I-Beam	Metal	Brown	Flaking	85	N/A*	5.1	
871	19-Aug	Mark	Warehouse/Duplicate of 870	I-Beam	Metal	Brown	Flaking	85	N/A	3.28	
872	19-Aug	Mark	Warehouse	Washroom Stairs	Wood	Grey	Good	99	N/A	28800	3880
874	19-Aug	Mark	Module Train	Water Tank	Metal	Dark Grey	Flaking	95	0.27	17700	146
875	19-Aug	Dan	Module Train	Hallway Partition Wall	Wood	Grey	Flaking	50	N/A	15000	124
876	19-Aug	Leigh	Module Train	Wall	Wood	Mint Green	Flaking	95	N/A	37100	2066
877	19-Aug	Mark	Module Train	Radiant Heater	Dark Metal	Grey	Flaking	25	N/A	23100	92.9
878	19-Aug	Leigh	Module Train	Interior Door	Wood	Grey	Flaking	60	N/A	3660	129
879	19-Aug	Dan	Module Train	Wall	Wood	Grey	Flaking	60	N/A	8830	311
880	19-Aug	Dan	Module Train/ Duplicate of 881	Composite from 3 walls	Wood	Pale Beigy Grey	Flaking	95	N/A	15800	880
881	19-Aug	Dan	Module Train/ Duplicate of 880	Composite from 3 walls	Wood	Pale Beigy Grey	Flaking	95	N/A	36500	2033
882	19-Aug	Mark	Inuit House	Counter Top	Wood	Grey	Flaking	80	N/A	399	13.8
885	19-Aug	Dan	Module Train	Exterior Powerhouse Wall	Metal	Cream	Flaking	50	N/A	4240	65.3
886	19-Aug	Ken	Module Train	Concrete Floor	Concrete	Grey	Good	90	N/A	14100	14100
887	19-Aug	Leigh	POL pumphouse	Wall	Metal	Silver	Good	90	N/A	3.89	
888	19-Aug	Leigh	Module Train	Foundation Cribbing	Wood	Cream	Flaking	75	N/A	144	1.2
Concrete											
867	19-Aug	Ken	garage	Floor	concrete		Minor staining			6.54	6.54
873	19-Aug	Ken	warehouse	Floor	concrete		No staining			6.77	6.77
883	20-Aug	Ken	MT-powerhouse	Floor	concrete		Minor staining			1300	1300
897	24-Aug	Ken	warehouse	Floor	concrete		Floor not painted			3.58	3.58

* N/A = not available

Appendix D

Analytical Results

Barrel Sample Summary

Sample Number	Location	% Full	Contents Description	Label	Comments	Analytical Results
900	Barrel Stockpile D	20	Aqueous, single phase	none		Meets criteria
901	Barrel Stockpile D	20	Aqueous, single phase	none	Duplicate of 900	Meets criteria
902	Barrel Stockpile D	15	Aqueous, single phase	none	Sheen on surface	Meets criteria
903	Barrel Stockpile D	10	Aqueous, single phase	none		Meets criteria
904	Barrel Stockpile D	20	Aqueous, single phase	none		Meets criteria
905	Barrel Stockpile D	10	Aqueous, single phase	none	Sheen on surface	Meets criteria
906	Beach POL, top of pad	35	Two phases - oil and aqueous	none	Oil component analyzed	Exceeds Total Organic Halides (Cl) criterion
907	Beach Bladder pad toe	40	Two phases - oil and aqueous	none	Oil component analyzed	Meets criteria
908	Between Beach Dump South B and Beach POL	65	Aqueous, single phase	none		Meets criteria
909	Along beach near Beach Dump	85	Oil, single phase	none	Suspected hydraulic or transmission fluid	Exceeds Total Organic Halides (Cl) criterion
910	Barrel Stockpile A	35	Two phases, primarily oil with some water	none	Lube oil	Meets criteria
911	Barrel Stockpile A	20	Two phases, primarily oil with some water	none	Lube oil	Meets criteria
912	West of garage	20	Oil, single phase	none	Lube oil	Meets criteria
913	East of Station POL	50	Two phases, fuel and aqueous	none	Fuel oil, fuel component analyzed	Meets criteria
914	Water Lake	70	Fuel, single phase	none	Fuel oil	Exceeds lead criterion

AECOM

Appendix E

INAC Protocols

Affaires indiennes et du Nord Canada
Indian and Northern Affairs Canada

Abandoned Military Site Remediation Protocol

Volume I – Main Report

Indian and Northern Affairs Canada
Northern Affairs Organization
Contaminated Sites Program

Final
March 2009

Canada

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

Abandoned Military Site Remediation Protocol

Volume I – Main Report

March 2009

Indian and Northern Affairs Canada

ACKNOWLEDGMENTS

This Protocol is an update on the previous Indian and Northern Affairs Canada (INAC) Abandoned Military Site Remediation Protocol, which was produced in 2005. Considerable intellectual effort has gone into the revisions and updates contained in this new Protocol and INAC wishes to recognize and thank the organizations involved in its development.

This document, which is comprised of Volume I (Main Report) and Volume II (Supporting Technical Documentation) is a product of the collaborative efforts by the following organizations:

- Environmental Sciences Group, Royal Military College of Canada
- Golder Associates Ltd.
- EBA Engineering Consultants Ltd.
- UMA Engineering Ltd. (now AECOM)
- Qikiqtaaluk Environmental Inc.
- Jacques Whitford Ltd.
- Dept. of Geological Sciences and Geological Engineering, Queen's University

INAC also wishes to recognize and thank the members of the Technical Advisory Working Group who provided invaluable input to development of this Protocol.

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1 INTRODUCTION

In the 1950s, at the height of the Cold War, a number of facilities were constructed in the Canadian Arctic to provide surveillance of northern approaches to the continent. The largest installation was the Distant Early Warning (DEW) Line, a series of radar stations spanning the northern coastline from Alaska to Greenland. In total, 63 stations were constructed, 42 of which were located in Canada. In 1963, due to advances in technology, installations at 21 of the sites were considered redundant and these sites were abandoned. All buildings, vehicles, Petroleum Oil Lubricant (POL) storage tanks and miscellaneous debris were left in place. Administration of these sites was transferred to Indian and Northern Affairs Canada (INAC) (Fletcher 1989; INAC 2002). Other abandoned military sites include those associated with the Pole Vault line in the eastern Arctic. Locations of INAC military sites in the Canadian Arctic are indicated on Figure 1. The remainder of the installations on the DEW Line continued to operate until the early 1990s, at which point most of them were converted to the North Warning System (NWS). Decommissioning and cleanup of these 21 sites, excluding facilities that are required for the operation of the NWS, is the responsibility of the Department of National Defence (DND).

Several environmental issues were at these abandoned military sites based on previous preliminary and detailed assessments at the INAC and DND sites (ESG 1991, 1993). These issues include physical hazards related to unconsolidated debris and aged structures, and environmental impacts associated with soil contamination. In 1996, DND initiated remediation of the DEW Line sites under its jurisdiction and cleanup of these sites is on going. The cleanup follows the conditions of the DEW Line Cleanup Protocol (ESG, 1993 and ESG/UMA, 1995) and the co-operation agreements between DND and Nunavut Tunngavik Inc. (NTI) (DGE 1998) and DND and the Inuvialuit Regional Corporation (IRC) (DGE 1996).

INAC has completed the remediation of a number of sites across the Canadian Arctic namely Iqaluit Upper Base, Resolution Island (BAF-5), Horton River (BAR-E), Sarcpa Lake (CAM-F), and Pearce Point (PIN-A). The approach adopted for remediation of these sites has generally been consistent with the methodology applied at the DND DEW sites (PWGSC 2001 to 2003). Due to the commitment of the Federal Government to future funding of contaminated site clean up, INAC recognizes the need for a consistent protocol for abandoned military site cleanup (INAC 2002).

A number of factors must be considered when determining the most suitable approach to site remediation for remote sites in the Arctic environment. The Abandoned Military Site Remediation Protocol (AMSRP) is based on an approach that addresses legal requirements, INAC's Contaminated Sites Policy (including risk management requirements), and standard environmental management practices (INAC 2002).

This Protocol also takes into consideration financially prudent methodologies that address environmental issues while striking a balance with remedial cost. An over-arching principle has been to balance the environmental benefits of remediation activities with potential negative physical impacts to the Arctic environment.

The primary objectives of this document are to provide sufficient background information to understand the environmental issues present at these sites, and to describe the guiding principles for their assessment and remediation. AMSRP, Volume 2 (INAC 2009) provides additional supporting technical information.

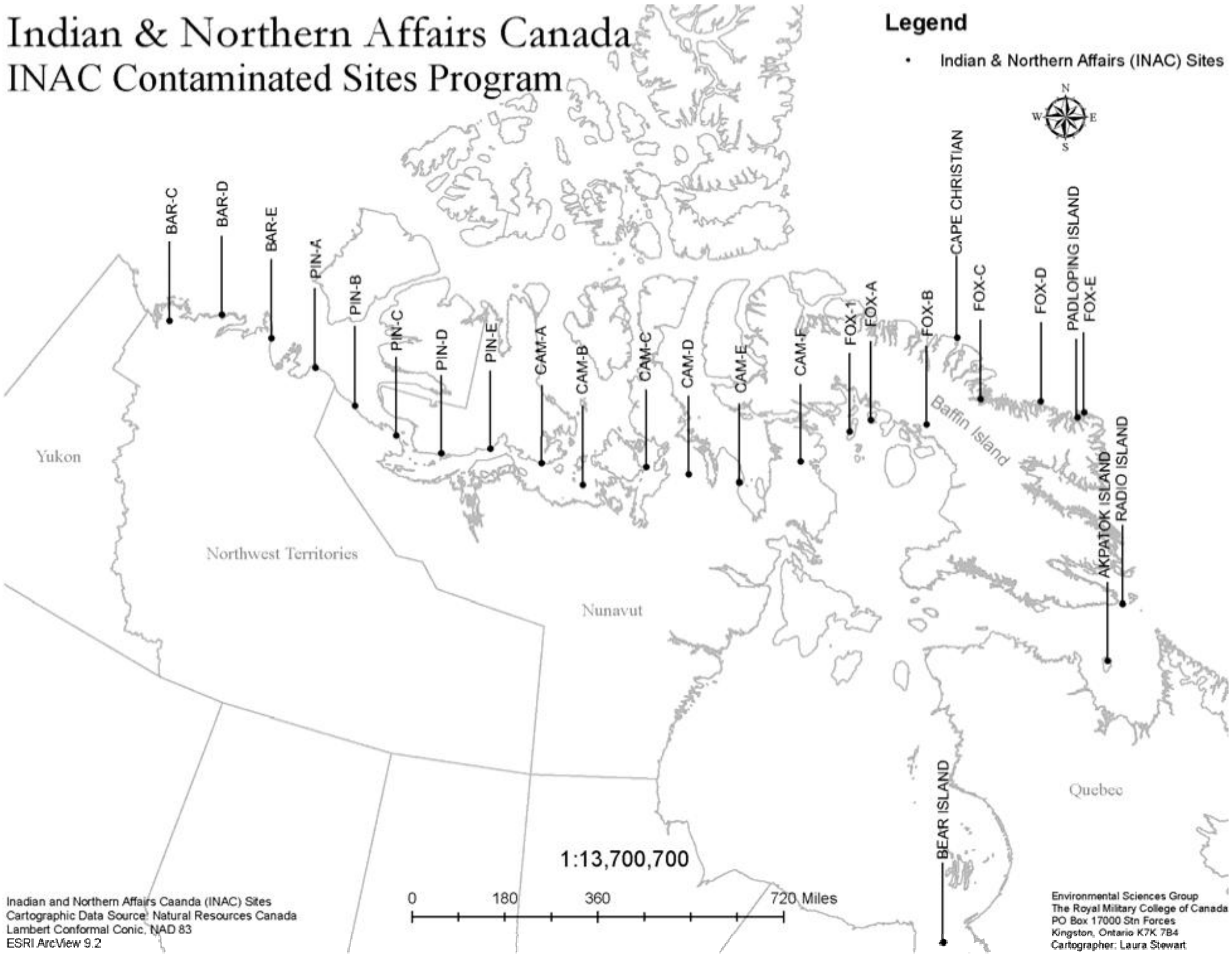

Figure 1 Location of INAC Military Sites

1.1 Scope of Document

This document is structured in a manner generally consistent with the steps outlined in the Federal Contaminated Sites Action Plan (CSM 2000) as shown in Figure 2. As previously indicated, issues of environmental concern have been identified at the INAC DEW Lines (Step 1). Extensive historical data (Steps 2 and 3) from initial environmental assessments, as well as detailed information collected through assessment of DEW sites under the jurisdiction of DND, has been used to develop the requirements for the detailed assessment of the INAC sites (Step 5), as described in Section 4. Guidelines for development of a remediation strategy (Step 7) are provided in Section 5. Implementation related issues, such as confirmatory sampling, waste manifesting, construction quality assurance/quality control measures (Step 9) are described in Section 6. Post-implementation monitoring requirements are described in Section 7 (Step 10).

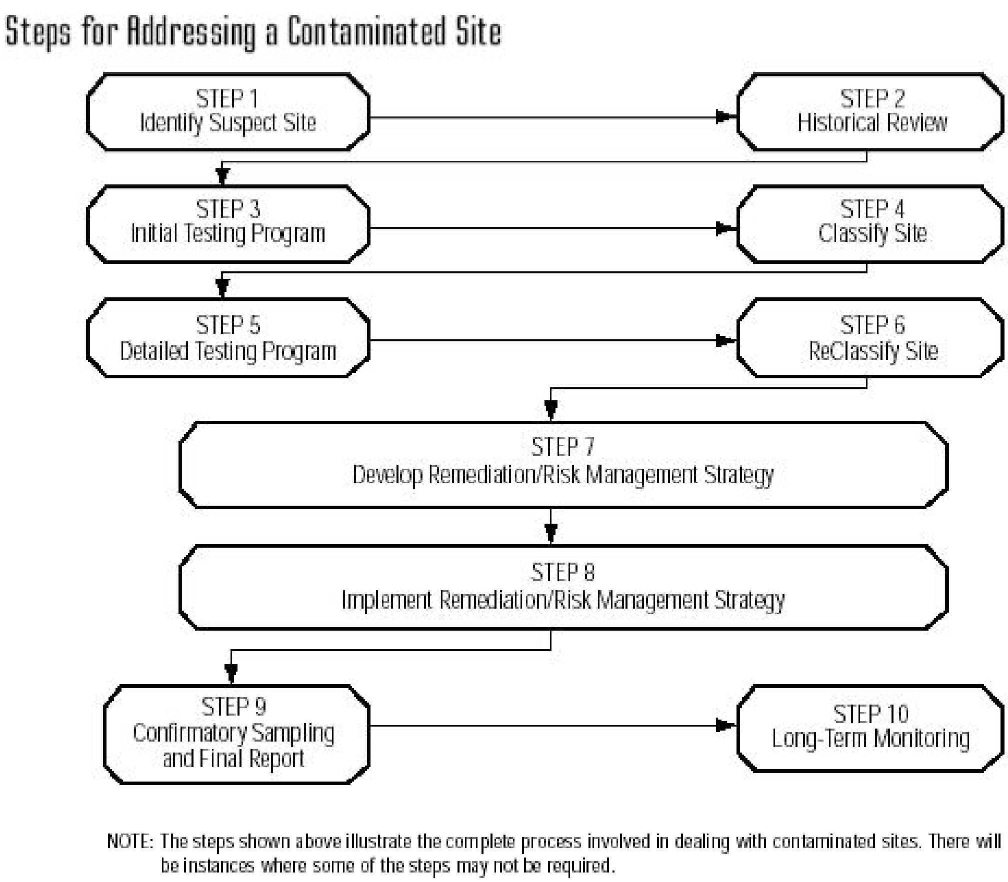

Figure 2 Steps for Addressing a Contaminated Site

2 BACKGROUND

2.1 CCME Environmental Quality Guidelines

Where remediation of federal real property is carried out, departments and agencies are to set remediation objectives in accordance with the most applicable of the three methods developed by the Canadian Council of Ministers of the Environment (CCME) (CCME 1997):

CCME Tier 1: Follow CCME Environmental Quality Guidelines (CCME 1997, 1999), as amended from time to time, and, where applicable, the *Canada-wide Standard for Petroleum Hydrocarbons in Soil* (CCME 2008), as amended from time to time. To the extent that guidelines do not exist for a particular type of contamination, or are technically or economically inappropriate for a particular situation, departments and agencies may follow equivalent guidelines or standards (e.g. provincial);

CCME Tier 2: Follow modified CCME Environmental Quality Guidelines where site conditions, land use, receptors, or exposure pathways differ only slightly from the protocols used in the development of the guidelines; and

CCME Tier 3: Develop site-specific remediation objectives based on a site-specific risk assessment, as outlined by the CCME, or equivalent, where site conditions are unique or particularly sensitive.

Although the CCME Environmental Quality Guidelines are broad in application and address a wide variety of land uses and potential contaminants from diverse sources, they do not specifically address the environmental conditions representative of the Arctic, as discussed in AMSRP Volume 2 (INAC 2009).

2.2 Department of National Defence (DND) DEW Line Cleanup (DLCU) Protocol

The initial environmental assessment of DEW Line sites under the jurisdiction of DND was one of the first major contaminant investigations in the Arctic related to point source contaminants. Following these assessments in the early 1990s, DND developed a remedial protocol in consultation with other government agencies and stakeholders (ESG 1991, 1993), and referred to it as the DEW Line Cleanup (DLCU) Protocol. This Protocol was developed at a time when no remediation standards and criteria specific to the Canadian Arctic existed. The remedial criteria were developed using a contaminant source and pathway targeted approach, consistent with CCME's Tier 3 method. A broad suite of chemicals was investigated and contaminants of concern at DEW Line sites were identified as those contaminants that were consistently elevated relative to the site background levels and the available Canadian federal or provincial guidelines (CCME 1991). The rationale for selection of contaminants of concern is provided in AMSRP Volume 2 (INAC 2009). Engineering input with respect to remediation strategies was used to refine the cleanup protocol (ESG/UMA 1995) prior to its implementation at the first DND sites in 1996.

Cleanup of Arctic sites presents a number of unique challenges, including but not limited to:

- Remote site location, with access limited to sea-lift and small aircraft during the summer months, and over-land during winter;
- Short construction season, typically from July to September, which may limit the technical feasibility of remedial options;
- Lack of centralized waste disposal facilities;
- High costs associated with mobilization of equipment and personnel to the sites, both during the site assessment and remedial phases; and
- Sensitivity of the Arctic ecosystem to changes in physical habitat.

Experience gained since 1996 at the DND sites has been reviewed annually to evaluate lessons learned and to incorporate new information and methodologies as they become available. The DLCU protocol therefore is the culmination of scientific and engineering expertise that has been applied across the Arctic at the DND sites.

Although there are many similarities between INAC and DND DEW sites, the INAC sites were in operation for a significantly shorter period of time, and environmental issues tend to differ in scale. In addition, there may have been other land use subsequent to the DEW Line activities. INAC sites and the associated known land uses are summarized in Table 2.1

Table 2.1 Summary of INAC Military Sites and Historic Land Use

Site Designation/Name	Location	Other Historic Land Use/ or Issues
BAR-C Tununuk Camp	NWT	Imperial Oil as Lessee
BAR-D, Atkinson Point	NWT	Canadian Marine Drilling (CANMAR) Canadian Reindeer Ltd. (note: cleanup on-going)
BAR-E Horton River	NWT	SRR, (note: cleanup completed, monitoring on-going)
PIN-A Pearce Point	NWT	Biological Research Station (note: cleanup completed, monitoring ongoing)
PIN-B Clifton Point	Nunavut/Kitikmeot	
PIN-C Bernard Harbour	Nunavut/Kitikmeot	
PIN-D Ross Point	Nunavut/Kitikmeot	
PIN-E Cape Peel	Nunavut/Kitikmeot	
CAM-A Sturt Point	Nunavut/Kitikmeot	
CAM-B Hat Island	Nunavut/Kitikmeot	Short Range Radar (SRR) as part of North Warning System
CAM-C Matheson Point	Nunavut/Kitikmeot	
CAM-D Simpson Lake	Nunavut/Kitikmeot	SRR (module train dismantled and buried on site)
CAM-E Keith Bay	Nunavut/Qikiqtaaluk	Module train gone/some evidence of burning
CAM-F Sarcpa Lake	Nunavut/ Qikiqtaaluk	Research Station (note: cleanup completed, monitoring ongoing)
FOX-1 Rowley Island	Nunavut/Qikiqtaaluk	SRR (large burn area, module train gone)
FOX-A Bray Island	Nunavut/Qikiqtaaluk	SRR (module train gone)
FOX-B Nudluardjuk Lake	Nunavut/Qikiqtaaluk	SRR (module train gone)
FOX-C Ekalugad Fiord	Nunavut/Qikiqtaaluk	
FOX-D Kivitoo	Nunavut/Qikiqtaaluk	Fire destroyed main building train in 1963
FOX-E Durban Island	Nunavut/Qikiqtaaluk	Partially burned building

Site Designation/Name	Location	Other Historic Land Use/ or Issues
Cape Christian	Nunavut/Qikiqtaaluk	LORAN Site
Padloping Island	Nunavut/Qikiqtaaluk	Navigational aid and weather station
Radio Island	Nunavut/Qikiqtaaluk	Navigational aid and weather station (note: cleanup completed, no monitoring required)
Bear Island	Nunavut/Qikiqtaaluk	Mid-Canada site
BAF-5 Resolution Island	Nunavut/Qikiqtaaluk	Pole-Vault site (note: cleanup completed, monitoring ongoing)
Iqaluit, Upper Base	Nunavut/Qikiqtaaluk	Pole-Vault site (note: cleanup completed, monitoring ongoing)

Cleanup objectives were set for the INAC sites, and the INAC AMSRP was developed as outlined in the following sections.

3 CLEANUP OBJECTIVES

Cleanup objectives, which are consistent with the Federal Contaminated Sites Management Working Group (CSMWG) objective to "integrate sustainable development and pollution prevention principles while meeting environmental regulations and protecting public health" (CSM 2000, TB 1998, 2000, 2002), are as follows:

- To restore sites to meet the environmental objectives established for northern sites;
- To prevent migration of contaminants into the Arctic ecosystem;
- To remove physical hazards for the protection of human health and safety; and
- To implement a cost effective remediation solution.

These objectives are consistent with those applied in the remediation of DEW Line sites under the jurisdiction of DND (DGE 1996, 1998). The following considerations need to be taken into account when developing and implementing a Remedial Action Plan (RAP) for INAC sites:

- Respect all historical agreements and obligations in a fair and reasonable manner;
- Ensure consistency with federal guidelines for management of contaminated sites;
- Apply the Canadian Council of Ministers of the Environment (CCME) environmental protection and management approaches (CCME 1996, 1997, 1999, 2001, 2008) as applicable;
- Apply simple, practical remedial solutions wherever possible, with flexibility as necessary to adjust to site-specific conditions when they are identified;
- Establish cost effective solutions through use of best practices to ensure appropriate levels of environmental protection for all sites;
- Recognize the concerns of climate change in an Arctic setting; and
- Ensure long-term effectiveness of the environmental remedial measures.

It is Canadian government policy that all federal departments and agencies ensure sound environmental stewardship with respect to property in their care by avoiding contamination and managing contaminated sites in a consistent and systematic manner that recognizes the principle of risk management and results in the best value for the Canadian taxpayer (TB 1998, 2000, 2002). The following section identifies the primary factors that have been considered in developing a remediation approach.

3.1 Biophysical Environment

The INAC abandoned military sites are located across the Arctic in the Southern Arctic Ecozone in the western Arctic, in the Northern Arctic Ecozone in the central and eastern Arctic, and the Arctic Cordillera along the east coast of Baffin Island. The majority of the sites are located along the coastline. (Agriculture and Agri-Food Canada, 1996).

Mean annual temperatures are in the range of -11^{0}C in the western Arctic and tend to be colder in the central and eastern Arctic. Accordingly, all sites are located within the zone of continuous permafrost. Much of the Arctic region is classified as polar desert as annual precipitation, predominantly as snow, is generally within the range of 100 to 300 mm. One exception is the eastern coastline of Baffin Island near Cumberland Peninsula, where precipitation can be in the order of 400 to 600 mm annually.

As indicated, the Arctic ecosystem is characterized by extreme environmental conditions, including cold temperatures, large seasonal fluctuations in incoming solar radiation, extensive snow and ice cover, and short growing seasons. These conditions affect the productivity, species diversity, wildlife behaviour (e.g., migration), and food chain characteristics of Arctic ecozones. For example, productivity in terrestrial, freshwater, and marine environments is reduced due to limited nutrient availability, low light, low temperatures, ice cover, and short growing seasons. Compared to most other ecosystems, the Arctic is characterized by relatively low reproduction, organisms that are slower to reach sexual maturity and are generally longer lived, lower species diversity, and distinctive sub-ice biological communities. Relatively short food chains, which are characteristically known for their dominance of marine mammals and birds, are associated with simple predator-prey relationships (e.g. phytoplankton-zooplankton-fish-seal-polar bear or phytoplankton-zooplankton-whale). The combination of all these physical factors affect the sparse distribution and number of Arctic biological communities and makes them very sensitive to physical disturbances such as habitat destruction (AMAP 1998, CACAR 2003).

The assessment and remedial protocols developed are cognizant of striking a balance between the physical disturbances of existing impacted areas versus the physical disturbances of developing new areas required to support remediation activities.

4 ASSESSMENT PROTOCOL

The elements of the assessment protocol have been developed through the review of previous work at related sites (eg. PWGSC 2001a-c, 2002a-f, IEG 2001, EWG 1998, 1999, UMA 1994) and take into consideration information of particular relevance to the unique character of the INAC sites. Typical environmental issues at abandoned military sites include:

- Contaminated soils;
- Existing solid waste disposal areas;
- Debris on surface and in waters near the sites;
- Debris associated with the demolition of structures/facilities; and
- Hazardous waste.

The objective of the environmental assessment of these sites is to collect sufficient information to allow development of a Remedial Action Plan (RAP).

Issues related to implementation, including but not limited to: environmental screening, permitting, and construction, also require information to be collected at the assessment stage. These information requirements can include:

- Geotechnical site information relating to potential development areas for landfills and/or hydrocarbon contaminated soil treatment area, and available borrow sources;
- Site access, such as condition of roadways, the airstrip, barge landing areas, requirements for winter roads or CAT train routes;
- Potable water supply and seasonal fluctuations of potable water supply;
- Siting of camp facilities and temporary storage areas;
- Natural Environment Assessment;
- Traditional Knowledge Surveys/Assessment; and
- Archaeological Assessment.

This section of the protocol provides guidance related to conducting an environmental site assessment that meets the requirements of the INAC cleanup objectives.

4.1 Background Geo-Chemical Assessment

Application of remedial criteria must take into account background concentrations of inorganic elements, as naturally elevated concentrations of a select number of inorganic elements may impact assessment and subsequent remedial activities. High natural variability in concentrations of inorganic elements on a local scale has been observed at several DND DEW Line sites (PIN-1, DYE-M, FOX-2, FOX-3). Based on a desk-top study of the geochemistry and surficial and bedrock geology, a detailed investigation of background concentrations is required in conjunction with the environmental site assessment of the following sites:

- Ross Point (PIN-D)
- Nadluarjuk Lake (FOX-B),
- Kivitoo (FOX-D),
- Durban Island (FOX-E) and
- Padloping Island.

A statistically valid approach must be used to design a sampling program for the collection of representative samples from background areas. Guidance for the background geochemistry investigation is provided in AMSRP Volume 2 (INAC 2009).

4.2 Contaminated Soils

4.2.1 Inorganic Elements and PCBs – DCC Criteria

The contaminants of concern for INAC abandoned military sites, where historic land use is limited to former DEW Line operations, is based on a detailed review of data collected to date from DND and INAC site assessment and delineation programs. The DEW Line Cleanup (DLCU) Protocol, which includes criteria for a specific, limited set of contaminants, is considered appropriate for INAC sites. Supporting documentation for selection of these criteria is provided in AMSRP Volume 2 (INAC 2009).

This provides a consistent approach across all sites, and is generally considered protective of the Arctic ecosystem as described in AMSRP Volume 2 (INAC 2009). Table 4.1 identifies the parameters and criteria.

Table 4.1 DEW Line Cleanup Criteria (DCC) for Soil[a]

Parameter in Soil	**CRITERIA[b]** mg/kg	
Inorganic Elements	*DCC Tier I [c]*	*DCC Tier II[d]*
Arsenic (As)		30
Cadmium		5.0
Chromium		250
Cobalt		50
Copper		100
Lead	200	500
Mercury		2.0
Nickel		100
Zinc		500
Polychlorinated biphenyls		
PCBs	*1.0*	*5.0*

a. These criteria were adopted specifically for the cleanup of Arctic DEW Line Sites from the 1991 versions of the Quebec Soil Contamination Indicators and the Canadian Council of Ministers of the Environment Interim Canadian Environmental Criteria for Contaminated Sites. They were validated by an assessment of the soil concentration at which the substance was taken up by vascular plants and thereby constituted an input to the Arctic ecosystem.

b. Soil criteria are given in parts per million, ppm.

c. Soils containing lead and/or PCBs at concentrations in excess of DCC Tier I, but less than DCC Tier II, may be landfilled in a Non-Hazardous Waste Landfill,

d. Soils containing one or more substrates in excess of DCC Tier II are to be treated/disposed of in a manner that precludes contact with the Arctic ecosystem.

A review of data collected on INAC sites with land use other than DEW Line activities indicated that the likelihood of other parameters occurring systematically at concentrations exceeding applicable criteria in the absence of other contaminants of concern is low (AMSRP Volume 2 (INAC 2009)).

Based on historic patterns of waste disposal and contamination observed at other abandoned military sites, soils contaminated in excess of the DCC criteria are typically found in the following locations:

- In the vicinity of buildings;
- Former sewage discharge areas;
- Former open storage areas;
- Where surface debris is present;
- Solid waste disposal areas; and
- Petroleum, Oil, Lubricant (POL) bulk storage areas and along fuel lines and transfer locations.

Delineation of the lateral extent and depth of contamination is required to determine quantities of sufficient accuracy to develop a RAP and the subsequent Contractual Drawings and Specifications. A detailed sampling plan shall be developed for each potential area of concern identified as part of historic review, and shall include the following information:

- Description of the objective for each potential area of concern;
- Sampling locations;
- Sampling methodology;
- Proposed number of samples and media;
- Parameters for analyses; and
- Analytical requirements and Quality Assurance/Quality Control measures.

Delineation shall be achieved by sampling in a grid pattern over the affected area. The estimated size of the area determines the grid spacing: the larger the estimated area, the larger the grid spacing. Test pits shall be excavated to determine the depth of contamination. Test pits shall also be excavated outside the area of surface contamination to evaluate whether sub-surface migration of contaminants has occurred. Greater sample density may be warranted based on site specific conditions, particularly in areas where soils contaminated with PCB concentrations in excess of 50 ppm are suspected; such as near buildings where electrical transformers were housed, vehicle maintenance structures, and near exit doors of facilities. It is recommended that a reasonable degree of over-sampling and an iterative approach to analyses be employed to provide greater confidence that closure is achieved during the assessment phase, recognizing that the cost of analyses is only a fraction of disposal costs.

Additional samples shall be collected and analysed to determine transport and disposal requirements should off-site disposal of contaminated soils be required.

4.2.2 Hydrocarbon Contaminated Soils

Where free product is encountered, the free phase liquid will be addressed prior to the application of a qualitative risk assessment method for establishing remediation requirements.

A review of the assumptions used for the derivation of the CCME CWS for Petroleum Hydrocarbons (PHC) as well as the need to minimize physical disturbance suggests that direct application of criteria for the protection of all receptors may not be appropriate at the INAC sites AMSRP Volume 2 (INAC 2009). A revised set of criteria are provided in Table 4.2. These criteria incorporate the CWS PHC as appropriate, as well as previous quantitative risk assessment results. Two classes of hydrocarbons were identified, Type A – non-mobile, and Type B – mobile. Type A refers to heavy end products, such as lubricating oils, and are easily differentiated by dark staining. Relative to the CWS PHC, Type A consists of the sum of F3 and F4 constituents. Type B includes lighter end or more volatile hydrocarbon products such as MoGas, jet fuel and diesel, and is approximately equal to the sum of the F1 through F3 fractions. When all four fractions are present, the dominant hydrocarbon type is defined by the percentage of the sum of F3 and F4, relative to the sum of F1 to F4 (total TPH). For Type A contaminated soil, the sum of F3 plus F4 must be greater than 70% of the total TPH concentration **and** the F2 concentration must be less than the F4 concentration.

Table 4.2 Remedial Objectives – Hydrocarbon Contaminated Soil – INAC Abandoned Military Sites

Exposure Pathway	F1	F2	F3	F4	Type B Hydrocarbon Contamination	Type A Hydrocarbon Concentration
Protection of Freshwater Aquatic Life[(a)]	1290[(a)]	330[(a)]	NA	NA	330[(a)]	NA
Direct Soil Eco-Contact	Not utilized – See AMSRP Volume 2 (INAC 2009)					
Protection of Terrestrial Wildlife					2500[(b)]	
Human Health		11000	20000			20,000
Management Limit					5000[(c)]	

Notes:

(a) Within 30 m of a water body

(b) For surface soils to 0.5 metres depth.

(c) Below 0.5 m depth, a value of 5000 mg/kg may be applied based on professional judgement.

Based on historic patterns of contamination observed at other abandoned military sites, soils contaminated with hydrocarbons are typically found in the following locations:

- In the vicinity of buildings near fuel distribution lines, fuel dispensing tanks;
- Former open storage areas and/or debris areas where barrels may be present;
- Petroleum, Oil, Lubricant (POL) bulk storage areas; and
- Solid waste disposal areas.

Delineation of the lateral extent and depth of contamination is required to determine quantities of sufficient accuracy to develop a RAP and the subsequent Contractual Drawings and Specifications. A detailed sampling plan shall be developed for each potential area of concern identified as part of historic review, and must include the following information:

- Description of the objective for each potential area of concern;
- Sampling locations;
- Proposed sampling methods for shallow and depth samples, where the depth sampling should achieve a depth consistent with the estimated active layer thickness;
- Proposed number of samples and media;
- Parameters for analyses in accordance with Table 4.2;
- Sampling methodology, analytical requirements, Quality Assurance/Quality Control measures.

At minimum, the information requirements as outlined in Table 4.2 shall be incorporated into the Sampling Plan.

Table 4.3 Hydrocarbon Contaminated Soil Information Requirements

Item	Comments
Hydrocarbon Contaminated Soils – Stained Soils (F3/F4 fraction) – Type A	
Areal Extent -Visible surface staining	Topographic survey and location/coordinates of stained areas and sample locations Provide sketches with measurements
Topography	Examine for evidence of erosion (drainage channels)
Soil Description	Include description of grain size distribution, well graded or poorly graded. Fine grained, coarse grained, maximum particle size
Sampling	Collect soil samples for analyses of F1 to F4 fractions to characterize contamination, analyses for presence of co-contaminants such as PCBs.
Confirm Depth of Staining	Testpit to extent of stain, collect soil sample for PHC analyses at 0.5 m depth.
In areas of multiple staining	Identify and survey extent of stains Collect individual samples from most visibly stained areas to represent “worst” case. Focus on stained areas larger than 4 m^2
Evidence of residual or free product	
Hydrocarbon Contaminated Soils – Near Fuel Storage, Distribution or Dispensing Areas (F1-F3 fraction) Type B	
Within 30 m of water body supporting aquatic life	
Describe surrounding environment	Consulting locals and elders who use the area may prove to be useful.
Sampling – Hydrocarbons	Delineate **laterally and at depth** to 330 mg/kg as per on-site analytical capabilities Collect sufficient samples for laboratory analyses of hydrocarbon fractions to confirm correlation with on-site analytical results. Over-sampling (within reason) and iterative analyses may be required where there is poor correlation with test-kits (organic materials)
Sample groundwater in testpit excavation in source zone.	Collect groundwater samples and analyze for dissolved hydrocarbons (F1, F2) and wastewater discharge criteria (Section 6). Measure water levels, and presence of free product, if applicable

Item	Comments
Greater than 30 m distant of water body supporting aquatic life	
Sampling – Hydrocarbons	Delineate **laterally and at depth** to 2500 mg/kg as per on-site analytical capabilities. Collect sufficient samples for laboratory analyses of hydrocarbon fractions to confirm correlation with on-site analytical results For the purposes of comparison, use the summation of F1 to F3 concentrations.
Collect soil samples for grain size distribution	Representative samples should be taken of soils within and downgradient of the source zone for determination of grain size distribution, and water content.
All Hydrocarbon Contaminated Soil Areas	
Topography	Survey sample locations and topography of source zone and surrounding area. Include min. 25 m buffer zone around contaminated areas. Document seepage zones (toe of embankments), if applicable. Evidence of erosion
Evidence of impacted vegetation	Note presence and extent of vegetation; identify areas of stressed vegetation if applicable.
Wildlife	Note presence or evidence of wildlife (nests, burrows, etc.) within impacted and surrounding area. Review in context with overall Natural Environment Survey (Section 4.9)

Additional representative samples shall be collected and analysed to assist in the determination of treatment requirements. Samples should be collected from areas representing the largest contributions to the PHC contaminated soil volumes (such as bulk fuel storage areas). These analyses include, but are not limited to:

- Water content
- Total Available Nutrients; Total Organic Carbon
- Treatability tests to assess bioremediation potential (bacterial counts, hydrocarbon degraders).

4.3 Solid Waste Disposal Areas

Solid Waste Disposal Areas (WDA) on INAC abandoned military 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 or dump sites. As part of the historic review, areas of ground disturbance/landfill activity will be identified for further investigation. A detailed investigation/sampling plan shall be developed for each area, and must include the following information:

- Description of the objective for each potential area of concern
- Methodology for determining extent of buried debris using non-intrusive geophysical surveys, such as Electro-Magnetic Surveys (EM) or Ground Penetrating Radar (GPR), and associated ground-truthing. The consultant is to indicate the type of geophysical survey to be used based on anticipated ground conditions. In general, a grid-survey pattern shall be used that provides adequate coverage of the area. Identification of areas of surface debris within the geophysical survey area is required to allow correlation with geophysical survey results. All geophysical surveys must be referenced to a UTM coordinate system.
- Identification of sampling locations both up- and down-gradient of the landfill, debris area or dump site.
- Proposed sampling methods for shallow and depth samples, where depth sampling should achieve a depth consistent with the estimated active layer thickness.
- Proposed number of samples and media.
- Parameters for analyses.
- Sampling methodology, analytical requirements, and Quality Assurance/Quality Control measures.

In addition, general site information shall be collected as outlined in Section 4.9 and 4.10, as well as specific information for each WDA as described below to support the evaluation of the potential environmental risk associated with the WDA (Annex A).

Physical Characteristics:

Areal Extent of WDA Extent

Depth of Buried Debris, as applicable

Contaminant Characterization (concentrations/extent)

Volume and extent of exposed debris, where exposed debris is defined as surface and/or partially buried debris within 0.5 meters of the surface.

Pathway/Transport Mechanisms

Surface expressions of contaminated soil and/or leachate.

Grades/Topography

Surface cover materials type and depth

Evidence of erosion

Precipitation

Distance to downgradient perennial surface water bodies

Receptor Characteristics

Distance to freshwater/marine habitat and habitat usage.

Terrestrial Habitat

Traditional Land Use

Minor modifications to the evaluation matrix prepared by the DND/NTI Environmental Working Group (EWG 1998) will be used for the assessment of potential environmental risk (Annex A). These modifications included:

- Addressing remedial requirements for dump sites and debris areas (generally smaller in size than landfills)
- Modifying contaminant characterization to include leachate migration and the presence of contaminants as one category.
- Including consideration of snow pack as well as annual precipitation.

Additional detail regarding the evaluation of WDAs is provided in Annex A.

4.4 Surface Debris

Surface debris is present on many of the sites, and may consist of a variety of waste materials including:

- Scrap metal and wood wastes (painted/unpainted);
- Barrels, potentially containing product; and
- Asbestos, batteries, and electrical equipment.

All areas of debris shall be inventoried to the extent possible to provide volume estimates and characterization of waste materials. Site debris shall be classified as inert, non-hazardous wastes or hazardous wastes in accordance with the following Acts and Regulations.

- Federal Transportation of Dangerous Goods Act and Regulations
- The Canadian Environmental Protection Act
- The Nunavut or Northwest Territories Environmental Protection Act

The number of barrels containing product shall be inventoried where it is safe to do so. However, it is impractical to sample and analyse contents of all barrels on site during the assessment phase. To provide information required for the Remedial Action Plan, a statistically relevant number of barrels shall be sampled and analysed. The actual number of barrels sampled will depend on the total number of barrels at the site, and should be determined using professional judgement. Samples will be analysed for parameters in accordance with the barrel protocol, and as summarized below:

Organic Phase: Total Chlorine, PCBs, Cadmium, Chromium, Lead

Aqueous Phase: % Alcohols and Glycols, Total Chlorine, Cadmium, Chromium, Lead

If the aqueous phase is less than 2% alcohols or glycols, water shall be analysed in accordance with waste water discharge criteria. Annex B provides further information on the Barrel Protocol.

4.5 Submerged Debris

Debris may be present in the near shore marine environment and/or lakes that are present on the site. Observations of debris in water shall be recorded to the extent possible and supplemented with local and anecdotal knowledge. Previous studies have confirmed that such debris is primarily a risk to navigation in shallow waters (AMSRP Volume 2 (INAC 2009)).

4.6 Buildings/Structure Inventory

Existing buildings and infrastructure at a site will be demolished down to their foundations as part of the cleanup. To assist in the development of the RAP, an inventory of building contents, foundation construction materials and details, and building/structure construction materials and dimensions are required. Building contents, where present, shall be inventoried and classified as non-hazardous or hazardous wastes. Hazardous building materials may include, but not be limited to: PCB and lead-amended paint, asbestos containing materials (ACMs), fluorescent lights, and mercury containing switches.

Painted building materials shall be tested for total lead and PCBs, and leachable lead and PCBs in order to determine disposal requirements. The thickness and density of the paint and substrate material shall be recorded as it may be required to calculate total PCB concentrations. Samples of concrete, excluding paint, shall be collected and analysed for PCBs. The locations and number of samples are to be determined in the field. Samples should be collected from both stained and non-stained areas on concrete on surface and at depth. Over-sampling and iterative analyses is recommended. As part of the assessment, a detailed waste inventory shall be prepared that includes: dimensions, building materials, foundation materials (concrete slab, timber piles, timber crib), estimated volume and mass of wastes, and the basis of any assumptions used in the estimate. Painted materials must be specifically identified and the extent of paint coverage and adherence quantified.

4.7 Geotechnical Requirements

4.7.1 Potential Development Areas

New engineered landfills and hydrocarbon treatment areas may be required during cleanup. Potential locations shall be identified and surveyed during the site assessment phase. Guidelines for the siting of potential development areas include:

- Avoidance of permafrost sensitive areas, vegetated areas and archaeological features.
- Avoidance of contaminated areas.
- Maintain a distance of 300 m or more from downgradient permanent water features.
- Locate at elevations greater than 2 metres above sea level or storm surge level
- Ground surface topography with grades of 6% or less.
- Proximity to borrow sources, waste materials.

The INAC sites are all located within the zone of continuous permafrost. The sensitivity of permafrost to climate warming consists of two components, the thermal response to warming and the impact of thaw (physical response) (Smith, Burgess, 2004) as cited in AMSRP Volume 2 (INAC 2009). The physical response of the terrain to permafrost degradation is mainly dependent on the ice content of the frozen material (Dyke et al., 1997). Warming of ice-rich perennially frozen ground would eventually lead to its thawing and the resultant thaw settlement, slope instability, thaw slumping, thermokarst, and other permafrost degradation-related processes. Excess ground ice can be identified by landforms at surface, such as patterned ground. An evaluation of the potential for impacts due to climate change is provided in AMSRP Volume 2 (INAC 2009).

Potential development areas shall be surveyed to provide detailed topographic information to allow generation of ground contours. A buffer zone of a minimum of 50 m should be surveyed around all proposed development areas. In previously disturbed areas, soil sampling and analyses shall be carried out to confirm or disprove the presence of any historic contamination using a targeted approach. Additional sampling should be carried out over a grid with spacing of approximately 50 m x 50 m.

4.7.2 Borrow Sources

During cleanup, borrow material is required for construction of new landfills, development of treatment areas, backfilling of contaminated soil excavation, closure of existing landfills, general regrading and for road construction/maintenance.

Available existing sources of borrow material should be exhausted before exploiting new areas. Areas of excess ground ice or of biophysical significance (denning/nesting areas) are to be avoided. Use of abandoned gravel pads and road infrastructure as granular source material is preferable, wherever possible. Existing gravel pads shall be screened for the presence of contaminants during the assessment phase.

Borrow sources shall be identified and characterized and estimated quantities developed. Test-pits shall be excavated to confirm subsurface stratigraphy, seepage, depth to permafrost table or bedrock, and ground ice conditions. Select soil samples shall be retained for geotechnical laboratory testing to assist in the development of Specifications. Testing shall include, but not be limited to: water content, grain size distribution, and moisture density relationships. At sites where background inorganic element concentrations are elevated, additional samples shall be collected for geo-chemical characterization of the borrow material.

4.7.3 Site Access

Access to the sites is typically by barge/ship and aircraft and on site by existing access roads. A limited number of sites are land-locked. Use of the airstrip is essential to mobilize materials and equipment required for site activities. An inspection and sampling of the airstrip fill materials shall be completed during the assessment phase to determine the load capacity to support a variety of aircraft. Drainage and erosion features shall be documented in order to assess the useable length, and/or upgrading requirements.

Investigation of potential CAT Train and/or other equipment mobilization options shall be investigated for the mobilization of heavy equipment. Construction records for Short Range Radar (SRR) sites located in the vicinity may be available as reference. Suitability of the beach for barge landing/sea lift access shall also be assessed. Local knowledge and Traditional Knowledge (TK) may prove useful in evaluating potential CAT train routes as well as suitable barge landing sites.

Helicopter landing pads, associated with Short Range Radar sites, are within the DND reserve. Only a non-intrusive visual inspection should be carried out to document the physical status of these areas.

4.7.4 Siting of Camp Facilities and Temporary Storage areas.

Laydown areas are required for temporary camp structures, equipment and storage during the cleanup. Potential locations shall be identified during the site assessment phase. Where possible, these will be located in previously disturbed areas such as borrow or storage areas, to minimize any new disturbances.

4.8 Potable Water Supply

A suitable drinking water supply shall be identified during the site assessment phase. A qualitative assessment of the flow rates (as applicable) shall be made at the time of the site assessment, as flow will vary throughout the season, with higher flows typically in spring run-off. Identifying the high water mark, and estimating depth of the stream/lake, as applicable, will aid in this evaluation. The Contractor will be advised that water withdrawal rates may not exceed 10% of the flow volume or 10% of the water volume in a lake, and to modify consumption as appropriate. Water samples shall be collected and analysed for criteria in accordance with the latest edition of the CCME Guidelines for Drinking Water Quality.

4.9 Natural Environment Assessment

A thorough assessment of the natural environment of the site and surrounding area shall be conducted as part of the detailed environmental site assessment. This assessment shall be carried out mainly by a biologist with input from a local community representative, where appropriate. This study shall consist of describing the regional and local setting, local ecosystems, species assemblage as well as potential impacts to vegetation and wildlife from cleanup activities and proposed mitigation measures. Additional information requirements are outlined in the following subsections.

4.9.1 Regional and Local Setting

The report should address the following information requirements.

- Location (site coordinates, main natural and man-made features present);
- Ecosetting (ecozones and ecoregions);
- Climate (mean temperature and precipitation data);
- Vegetation;
- Landforms and soils (main land features, soil types, general topography); and
- Human usage and disturbance (TK input will be valuable to assess human usage of the area).

4.9.2 Local Ecosystems

This subsection should describe 1) the various inland ecosystems; 2) the ecosystems present in the former operational areas (*i.e.*, disturbed areas and areas with infrastructure); as well as, if applicable, 3) the shore/coastline ecosystem; and the 4) open ocean ecosystem.

Each identified ecosystem should be described in terms of the various terrestrial and freshwater habitats, the vegetation and wildlife species present in those habitats, as well as past and current impacts and disturbances to habitats. Local and traditional knowledge from people who use these areas for hunting and fishing may provide useful information on plant and wildlife species present as well as ecosystem health.

4.9.3 Species Assemblage

This subsection should describe the various species at risk (*i.e.*, extirpated, endangered, threatened, or special concern) according to the Species at Risk Act (SARA) that occur in the general vicinity of the site, as well as any migratory species that known to breed or nest in the area (Migratory Birds Convention Act).

All species (*i.e.*, birds, mammals, fish, and plants) observed or known to use the site and surrounding areas should be documented. Observations should be described in terms of numbers and behaviour during sighting (*e.g.*, migrating, nesting/breeding, feeding, etc.). Species not observed on site but known to use the area may be documented by consulting local community representatives as well as various studies and reports.

4.9.4 Impacts and Mitigation

Potential impacts to vegetation and wildlife from site investigation and remediation activities should be clearly identified. Proposed constraints and other recommendations should also be presented as part of the Natural Environment Assessment, in order to incorporate these requirements into the Environmental Protection Plan.

4.10 Traditional Knowledge Surveys/Assessment

Traditional Knowledge (TK) forms an integral part of the development of the RAP. Incorporating TK during the assessment phase can provide guidance on targeting specific areas of concern to local residents. Qualitative knowledge provided by local residents can be used to complement and enhance the largely quantitative information provided by the physical studies completed.

TK can be efficiently obtained through a local community representative (*i.e.*, local TK consultant) who can liaise between the Consultant and various TK holders in the community. The local TK consultant may either be an Elder or someone else who knows the site well (*e.g.*, hunter, ranger). The ideal local TK consultant possesses some TK, but more importantly knows who to consult in the community to obtain relevant site information and TK.

4.10.1 Typical TK and Local Knowledge

TK may be grouped into four main categories:

1. Historical and Archaeological Features
2. Wildlife Use
3. Land Use
4. Site Specific Information

Historical and archaeological features provide information on traditional land use of the area. These features, often hidden from the untrained eye, will be identified by local TK holders as to their use and relative age, and can complement the work of the archaeological assessment.

Wildlife use of the land in and around the site includes migration routes, mating and calving grounds, as well as summer and winter-feeding areas of large land mammals. Nesting, moulting, and summer feeding grounds of migratory birds such as geese and ducks, as well as migration routes and feeding areas of sea mammals must also be identified.

Land use relates to traditional usage of the land and sea for hunting, fishing, camping, and harvesting products on land (*e.g.*, berries, eggs, medicine, tea, drinking water), and harvesting of sea products (*e.g.*, clams, kelp).

Site-specific information about the military site while it was under construction or in operation, including events (spills, accidents), waste management practices (storage, dumping), as well as natural occurrences, should also be documented.

4.11 Archaeological Assessment

The overall purpose of the archaeological assessment is to obtain the necessary archaeological regulatory approval at the assessment stage as required to implement the remediation program. The scope of the archaeological assessment shall include:

- Preparation and submission of permit applications to the Department of Culture, Language, Elders and Youth (Nunavut) or the Prince of Wales Northern Heritage Centre (NWT).
- Completion of an Overview for each site, which would include file searches to determine the number, nature and terrain associations of previously recorded sites.
- Completion of a field inventory and assessment of each site;
- Completion of a heritage features or structures evaluation for consideration of heritage value;
- Provision of a heritage resource impact assessment for each site
- Implementation of more detailed investigations at key sites and appropriate mitigation at significant sites affected by proposed projects (if required); and
- Preparation of a final permit report for each site and, if required, provides a summary of these results suitable for inclusion in a screening document.

Areas of high and moderate archaeological potential for containing cultural material will require detailed examination during the assessment phase, to ensure the protection and if required, development of mitigation measures to be implemented prior to or during cleanup.

5 REMEDIATION PROTOCOL

The elements of the remediation protocol have been developed through the review of previous work at related sites by DND and INAC, and take into consideration information of particular relevance to the unique character of the INAC sites.

The primary components of cleanup on the INAC abandoned military sites include:

- Treatment/Disposal of Contaminated Soil
- Disposal of Debris/Demolition Waste
- Closure of Existing Solid Waste Disposal Areas
- Construction of New Landfills
- Development of Borrow Sources and Site Grading Activities

The goals of a RAP are to provide the foundation for development of a cleanup design that will reduce the environmental liabilities present at the site, maximize benefits to local communities and provide good value to the Crown. More specifically, the RAP is to identify and evaluate options applicable to the treatment and/or disposal of waste materials present at a site. These waste materials typically include:

- Soil contaminated with inorganic elements, PCBs and/or petroleum hydrocarbons;
- Non-hazardous and hazardous wastes associated with building/facility demolition;
- Visible/accessible debris including barrel contents; and
- Buried debris/landfills as identified by geophysical surveys

The estimated volume of waste materials in each stream shall be determined and options evaluated on the basis of effectiveness to reduce and/or mitigate environmental risks in the short and long term, long term liability or residual risks, relative costs, monitoring costs and community acceptance. The costs associated with implementing remedial solutions include, but are not limited to: resources, such as materials, equipment, and personnel, and site logistics. Mobilization and site access constitute a significant cost for remote site cleanups, and can have significant impact on selection of the preferred remedial option. The evaluations shall be summarized and preferred remedial options identified for each waste stream. Options shall be integrated to finalize the recommended approach for site remediation.

During remediation planning public community consultations are conducted in surrounding communities to obtain feedback on the draft RAP.

5.1 Contaminated Soils

Contaminated soils are considered in three primary categories: soils that are regulated; soils classified as hazardous; and, soils classified as contaminated but not hazardous waste. Contaminated soils that are regulated shall be remediated and/or disposed of in compliance with the applicable regulations. Hazardous contaminated soils are defined as those that exceed criteria as provided in the Transportation of Dangerous Goods Act and Regulations. Contaminated soils that are not regulated or hazardous shall be excavated to the depth and extent to meet the DCC (see section 4.2.1) or PHC remedial targets (Section 4.2.2).

Three primary contaminated soil types have been identified; inorganic element contaminated soil, PCB contaminated soil and hydrocarbon contaminated soil. Where multiple contaminants are present in the soils, the most conservative remedial option that addresses all contaminant types shall be applied. A summary of remedial options for contaminated soils is presented in Table 5.1.

Table 5.1 Summary of Remedial Options – Contaminated Soil

Contaminated Soil	Remedial Options
DCC Tier I	▪ Excavate and place in an on-site engineered landfill or ▪ Cap in place under 0.3 m of clean fill if in a stable location
DCC Tier II	• Excavate and dispose of in an on-site Tier II facility or • Containerize for off-site disposal[1]
Inorganic Elements Leaching	• Transport in accordance with the TDGA for disposal at an off-site facility
PCB Contaminated Soil in excess of CEPA	• Store in accordance with PCB Regulations pending a decision regarding disposal
Type A TPH (Non-Mobile Hydrocarbon Contaminated Soil)	• Excavate and place in an on-site engineered landfill or • Scarify surficial stains that meet PHC criteria.
DCC Tier I -Type A TPH	• Excavate and place in an on-site engineered landfill or • Cap in place under 0.3 m of clean fill if in a stable location
DCC Tier II -Type A TPH	• Excavate and place in an on-site Tier II disposal facility or • Containerize for off-site disposal[1]
Type B TPH (Mobile Hydrocarbon Contaminated Soil)	• *In-situ* or *ex-situ* treatment to reduce environmental risk to meet guidelines
DCC Tier I -Type B TPH	• Ex-situ treatment to meet guidelines and place in an on-site engineered landfill or cap under 0.3 m of clean fill in a stable location after treatment. • Small areas of contamination may be excavated and disposed of in a Tier II disposal facility
DCC Tier II -Type B TPH	• Excavate and place in an on-site Tier II Facility or • Containerize for off-site disposal[1]
Hazardous Soil	• Dispose in compliance with applicable regulations

[1] Decision of whether to dispose of on or off-site is based on cost –benefit analyses (see Section 5.4.2).

5.2 Debris – Site Debris and Demolition Wastes

Site debris shall be collected and segregated into hazardous and non-hazardous waste streams for disposal:

Non hazardous waste: The volume of the non-hazardous materials shall be minimized through crushing, shredding, or incineration, prior to placement in an on-site engineered landfill. If there is no existing landfill on-site, and no suitable location for a new engineered landfill, non-hazardous materials shall be disposed of off-site; and

Hazardous waste: These materials shall be disposed of off-site, in accordance with the current regulations governing the handling and disposal of hazardous materials.

Hazardous materials referred to in this section are defined as any materials, which are, designated "hazardous" or "dangerous goods" under Territorial or Federal legislation. Generally, all hazardous materials identified at the site shall be collected and transported off site, in accordance with the Transportation of Dangerous Goods Act (TC 2002), to a licensed hazardous waste disposal facility.

Hazardous materials that are typical of abandoned military sites and require special consideration include the following:

PCB Contaminated Concrete: Concrete (excluding paint) with PCB concentrations in excess of 50 ppm is regulated under the CEPA, and shall be collected and transported off-site, in accordance with the Transportation of Dangerous Goods Act and CEPA to a licensed hazardous waste disposal facility.

PCB Paint on Building Components: PCB paint and PCB painted components that are regulated under the CEPA, shall be collected and transported off site, in accordance with the Transportation of Dangerous Goods Act and CEPA, to a licensed hazardous waste disposal facility. The thickness and density of the paint and substrate material shall be recorded as it may be required to calculate total PCB concentrations. Loose paint materials/paint chips are regulated under CEPA when PCB concentrations in the paint are greater than 50 ppm.

Lead-Based Paint on Building Components: Lead-based painted components that are classified as hazardous material shall be collected and transported off site, in accordance with the Transportation of Dangerous Goods Act to a licensed hazardous waste disposal facility. Painted components that exceed the relevant federal or Territorial criteria but are not considered hazardous shall be collected and disposed in an on-site engineered landfill. Lead-based painted materials are considered hazardous when the lead leachate concentrations from a test of the component (paint and substrate) exceed 5 mg/L or the concentration as provided in the latest schedule of the TDGA. Additional discussion related to the classification of painted material is provided in AMSRP Volume 2, (INAC 2009).

There are also a few exceptions, which are described below:

Asbestos: Asbestos waste shall be collected, double bagged and disposed of in an on-site engineered landfill, in accordance with the appropriate legislation. Where no on-site facility is available, asbestos waste shall be shipped off-site for disposal. Where asbestos materials are painted, disposal requirements are based on paint analyses.

Petroleum Products: Petroleum products, such as gasoline or diesel, which do not contain other hazardous products (chlorine, PCB, metals, etc.) will be incinerated on-site under appropriate emissions controls. Heavier petroleum products such as lubricating oil will be disposed of off-site or mixed with lighter petroleum products and incinerated on-site under appropriate emissions controls in accordance with the Barrel Protocol provided in Annex B.

Compressed Gas Cylinders: Compressed gas cylinders with known contents shall be vented. Once empty, the metal cylinder shall be disposed on-site in an engineered landfill. Where no on-site facility is available, compressed gas cylinders shall be shipped off-site for disposal.

Creosote Treated Timbers: Timbers shall be wrapped in polyethylene sheets and disposed on-site in an engineered landfill. Where no on-site facility is available, creosote treated timbers shall be shipped off-site for disposal.

5.2.1 Submerged Debris

Submerged debris shall be removed from the near-shore environment to a depth of 2 metres or 30 metres off-shore, whichever is encountered first. Work in marine and freshwater environments shall be in accordance with all stipulations as provided by the Department of Fisheries and Oceans. Debris, once removed, shall be classified as hazardous or non-hazardous and disposed of as indicated in the previous sub-section.

5.2.2 Barrels

Barrels shall be handled according to the Barrel Protocol (Annex B) and as outlined below:

Empty Barrels: Empty barrels shall be crushed and disposed in an on-site engineered landfill;

Filled or Partially Filled Barrels: Barrel contents shall be inspected and tested if necessary and disposed of appropriately (off-site or incinerated). The empty barrel shall be rinsed, crushed and disposed on-site in an engineered landfill. The spent rinse liquid shall be tested and disposed of appropriately. Absorbent materials used as part of this process shall be incinerated if incineration criteria are met, or disposed of as hazardous material, as required; and

Buried Empty Barrels: Areas containing buried empty barrels will be inspected to determine if any of the barrels contain material and characterized through a geophysical survey. If the barrels are found to be empty, the area will be stabilized through compaction to crush any corroded barrels, if the area is deemed suitable from a geotechnical perspective. A cover of borrow material shall be placed over the area and compacted.

The criteria used to determine the acceptability of product for on-site incineration are summarized in Table 5.2 as follows:

Table 5.2 Barrel Protocol Criteria and Disposal Summary

Phase	% Alcohol or Glycols	PCBs	Chlorine ppm	Cadmium ppm	Chromium ppm	Lead ppm	Disposal
Organic		<2	<1000	<2	<10	<100	On-Site Incineration
Organic		>2	>1000	>2	>10	>100	Ship South
Aqueous	>2		>1000	>2	>10	>100	Ship South
Aqueous	>2		<1000	<2	<10	<100	On-Site Incineration
Aqueous	<2						Discard in accordance with wastewater discharge criteria

Wastewater generated during barrel cleaning shall be treated to meet discharge criteria in accordance with permits and licences issued for cleanup activities.

5.2.3 Buildings and Infrastructure

Existing buildings and infrastructure shall be demolished to concrete foundations. Above-grade timber foundations shall be removed. Where concrete foundations are above grade, the area will be re-graded with the placement of additional granular fill to match surrounding topography. Exposed timber piles shall be removed to a minimum of 0.3 m below ground surface. All hazardous materials shall be segregated prior to or during demolition. Non-hazardous demolition materials and asbestos shall be collected and disposed in an on-site engineered landfill. If there is no existing landfill on site and no suitable location for a new engineered landfill, the non-hazardous materials shall be disposed of off-site. Hazardous demolition materials shall be disposed off-site.

PCB amended painted material shall be containerized in accordance with the Transportation of Dangerous Goods Act, and transported off-site to a licensed treatment disposal facility.

Only in exceptional circumstances will existing buildings remain intact on site following the remediation program. These structures may remain as emergency shelters only once clear transfer of ownership has been established.

5.3 Solid Waste Disposal Area (WDA) Closure

The following section applies to landfills, dumps and debris areas, collectively referred to as WDA.Using the WDA evaluation matrix (Annex A), WDA can be classified into one of three broad categories. Actions associated with each category of WDA have been identified. Where a WDA exists on INAC abandoned military sites, the condition of the WDA shall be evaluated to determine the most appropriate action;

Class A: If the WDA is located in an unstable, high erosion location, it shall be relocated to a properly engineered landfill. A WDA located at an elevation of less than two metres above mean sea level will be removed. During the relocation process, any identified hazardous materials shall be segregated for off-site disposal.

Class B: If the WDA is located in a suitable, stable location, but there is evidence of contaminant migration, potential remedial solutions include excavation or provision of a suitably engineered containment system. Permafrost containment shall be designed in accordance with the geothermal requirements outlined in Section 5.4.2. The remedial solution selected shall be based on a cost-benefit analyses that includes consideration of construction costs and long-term monitoring costs.

Class C: If the WDA is located in a suitable, stable location, with no evidence of contaminant migration, it may be left in place. If required, additional granular fill shall be placed to ensure erosion protection and proper drainage. Consideration must be given to surrounding topography (to blend into existing terrain) and long term monitoring costs.

Additional information related to landfill design and closure is provided in AMSRP Volume 2, (INAC 2009).

5.4 Landfill Development

New engineered landfills may be required for the disposal of non-regulated contaminated soils and non-hazardous debris collected or generated during cleanup. Two classes of landfills are provided:

- Non-Hazardous Waste (NHW) Landfill
- Tier II Contaminated Soil Landfill

5.4.1 Non-Hazardous Waste Landfill

A NHW Landfill is a new landfill constructed for the disposal of non-hazardous debris and building demolition waste. Tier I contaminated soils and Type A PHC soil may also be disposed of in these landfills. Landfills constructed to date at DND DEW sites are predominately above ground facilities. These landfills do not rely on permafrost for containment nor do they include a geosynthetic liner.

The general design parameters include a perimeter berm and landfill cover constructed of a well graded sand and gravel. Clay is generally not available at the abandoned military sites. The sand and gravel should have a minimum of 8% fines (<0.08 mm) and be compacted to a minimum of 95% maximum dry density (ASTM D698). The landfill should have a maximum debris thickness of 3 m and minimum cover thickness of 1.0 m.

To reduce settlement and ground subsidence, debris should be placed in maximum 0.5 m thick lifts with granular fill placed over each lift of debris to fill the voids (intermediate fill). Intermediate fill should be a minimum of 0.15 m thick and worked into the underlying debris. The final landfill surface must be graded such that water ponding does not occur. Ponding and infiltration could increase the seasonal thaw depth or contribute to leachate generation. The landfill surface must not be so steep that it promotes erosion of the cover materials, which could expose debris.

Fill material for the landfill cap should be a well-graded material that is relatively erosion resistant and will have moderate water infiltration. Alternative designs or surface treatments, such as imported coarser gravels and cobbles, vegetation covers at sites where it is possible to vegetate the sites, roller compacted concrete or other synthetic surfaces, are required if erosion resistant materials are not present on site.

Final landfill design parameters including granular fill specifications, side slopes, cover thickness, and maximum height of landfill are dependent on site specific ground conditions and borrow availability. Designs must be reviewed by a geotechnical engineer with permafrost experience.

5.4.2 Tier II Contaminated Soil Landfill

The decision as to whether to construct a Tier II Contaminated Soil Landfill on site is based on a number of factors, including but not limited to those summarized in Table 5.3. These criteria were based on generic designs and relative cost estimates and may not accurately reflect site-specific conditions. These are provided as a guideline only.

Table 5.3 Decision Criteria Tier II Contaminated Soil Landfill

Is the site landlocked?	For landlocked sites, off-site transport costs increase significantly. Consideration should be given to on-site disposal facility.
Is landfill excavation required.	Landfill excavations pose contracting risks due to unknown quantities of waste material. To mitigate risks, an on-site Tier II disposal facility should be considered.
Are known contaminated soil volumes less than 300 to 500 m^3.	If yes, evaluate contingency factors and potential over-runs. If significant risk of quantity overrun is present, construct landfill on-site. If volume of contaminated soil estimated to be below these values, ship off-site for disposal.
Are known volumes of contaminated soil between 500 and 1000 m^3	Evaluate site specific conditions, and develop preliminary design and cost estimate for an on-site disposal facility using site specific information. Confirm availability and quality of borrow material.
Are known volumes of contaminated soil greater than 1000 m^3.	If yes, confirm availability and quality of granular borrow. If granular borrow sufficient, develop preliminary design and cost estimate for an on-site disposal facility, using site specific conditions. Re-evaluate on-site disposal costs versus off-site disposal and confirm cost-benefit.

The Tier II Contaminated Soil Landfill design is based on the containment of contaminated soil in a landfill provided with a geo-synthetic liner and a granular fill cover of sufficient thickness to maintain the contaminated soil in a frozen condition. The required fill thickness is a function of the climatic conditions selected as the design criteria.

Geothermal analyses are required to substantiate the use of permafrost as a means of containment for the landfills. Analyses are carried out to predict the short-term and long-term ground temperatures for the Tier II Contaminated Soil Landfill to determine:

- Length of time for landfill freezeback;
- Short-term and long-term thermal regime in the landfill; and
- Depth of annual thaw (active layer) in the cover material.

Geothermal analyses should be carried out for the landfills using two-dimensional finite element computer models. The models simulate transient, two-dimensional heat conduction with a change of phase for a variety of boundary conditions. Heat exchange at the ground surface should be modeled with an energy balance equation that considers air temperatures, wind velocity, snow depth, and solar radiation. The models should include the temperature phase change relationships for saline soils, such that freezing depression and unfrozen water content variations can be explicitly modeled.

Soil thermal properties required to carry out geothermal analyses include: porewater composition, latent heat, specific heat (frozen and unfrozen), and thermal conductivity (frozen and unfrozen). These properties are determined indirectly from well-established correlations with soil index properties, moisture content, grain size distribution, bulk density, salinity, etc. (Farouki, 1986; Johnston, 1981). Soil index properties are based on information collected during the site investigations.

Climatic data required for the thermal model include monthly mean air temperature, wind speed, solar radiation, and snow cover. The thermal analysis should be calibrated to measured temperatures and/or observed active layers thicknesses. The landfill designs include analyses for mean temperature conditions, warm conditions and long-term climate change. Statistical analyses are carried out to determine mean monthly temperatures representative of a 1 in 100 warm year. The freezing index and thawing index for each year are calculated from the recorded air temperature data. The index for each year is ranked in ascending order and plotted. A “best-fit” line is drawn through the set of points to estimate the 1 in 100 warm year index. Mean monthly air temperatures are increased by the ratio of the 1 in 100 warm year freezing or thawing index to the mean year freezing or thawing index to estimate the mean monthly temperatures of a 1 in 100 warm year. The influence of climate change should be evaluated by similar methods presented in ACIA (2005). This includes the average estimated seasonal temperature changes by various Global Circulation Models (GCMs).

Given the uncertainties in climate change and the cost of returning to a site at a future date, it is recommended that the Soil Disposal Facility be designed for 100 years of long-term climate warming (average of four GCMs) as a minimum. With this design condition, the active layer could penetrate the contaminated soil if a warm year occurred. Containment during this condition would be provided by the thick soil cover and the geomembrane liner. Additional factors of safety can also be applied to account for uncertainties in the geothermal model, soil input parameters, and climate input parameters, or the facilities can be designed for climate change plus one 1 in 100 warm year.

5.5 Borrow Source Development

Granular borrow material will be required for the development of new landfills and general site grading purposes.

5.5.1 Site Grading

Grading operations generally consist of the shaping and regrading of disturbed areas to blend in with the natural contours, in accordance with all applicable licenses. Disturbed areas may include:

- contaminated soil excavation areas,
- existing and new landfill areas,
- debris areas,
- areas disturbed during demolition activities,
- granular borrow areas, and
- any area disturbed during establishment and operation of the camp, equipment storage and maintenance activities.

5.6 Contractor Support Activities

For implementation of remedial activities, a Contractor will establish a camp and storage areas on-site, where required. Where possible, these will be located in previously disturbed areas such as borrow or storage areas, to minimize any new disturbances in accordance with all applicable licenses.

Domestic refuse generated by the camp shall be incinerated and disposed of on-site in an engineered landfill. Sewage shall be handled by an appropriately sized sewage treatment system, in accordance with applicable legislation and all applicable licenses.

Wastewater generated by the Contractor, shall be treated to meet discharge criteria as stipulated in permits and licenses issued for the project.

Potable water supplies at the site will be tested and used, only if they meet the Canadian Drinking Water Quality Standards (CCME 2002) or the latest edition thereof, in accordance with all applicable licenses.

Fuel required for the operation of the camp will be stored on-site in accordance with applicable legislation and licenses.

All hazardous materials shall be segregated prior to or during demolition. Non-hazardous demolition materials and asbestos shall be collected and disposed in an on-site engineered landfill. Hazardous demolition materials shall be disposed off-site.

Only in exceptional circumstances shall existing buildings remain intact on site following the remediation program. These structures may remain as emergency shelters once clear transfer of ownership has been established.

6 CONSTRUCTION RELATED IMPLEMENTATION REQUIREMENTS

Consistent with Step 9 of the Federal Contaminated Sites Action Plan, confirmation that the objectives of the RAP have been met is required. Based on the issues typically associated with the remediation of INAC sites, confirmatory testing encompasses a wider range of activities. These include, but are not necessarily limited to:

- Confirmatory testing of contaminated soils;
- Quality Assurance testing of earthworks associated with the remediation and construction of landfills;
- Testing as required for waste manifesting to allow for shipment and disposal of materials off-site; and
- Testing as required to meet the requirements of Land Use Permits, and/or other Licences/Permits issued for the cleanup program.

The requirements and/or guidelines for these testing programs are outlined in the following sub-sections.

6.1 Confirmatory Testing Contaminated Soils

Following excavation of contaminated material confirmatory samples shall be collected and analyzed to ensure that cleanup objectives have been met. Sampling will be conducted by a third party qualified to carry out such work. A detailed sampling plan shall be developed for each area of concern identified for excavation in the RAP, and must include the following information:

- Description of the objective for each potential area of concern
- Sampling locations
- Sampling methodology
- Proposed number of samples and media
- Parameters for analyses
- Analytical requirements, and Quality Assurance/Quality Control measures.

6.1.1 Tier I contaminated soils

Tier I criteria were developed to address aerial transport of contaminants; excavation and backfilling precludes this pathway. If, during the site assessment, sufficient evidence has been collected to demonstrate that soils at depths of greater than 0.3 m below surface do not exceed Tier II levels for inorganic elements or PCBs, confirmatory sampling will not be required.

6.1.2 Tier II contaminated soils

Confirmatory sampling shall be carried out using a systematic grid sampling design following the DND DLCU Confirmatory Sampling Protocol as summarized in Table 6.1. This design provides a practical and simple method for designating sample locations and ensures uniform coverage of a site. Discrete samples should be collected at every point on the grid. For small areas, all samples shall be analyzed, whereas for larger areas only a fraction of the interior grid samples shall be analyzed. When choosing sample locations for analysis, consideration shall be given to areas of previously high concentrations. No single sample result or the mean of a duplicate/replicate sample shall exceed the cleanup objectives. In cases where field analytical methodology is used, 10-20% of the samples analyzed in the field should also be analyzed in the laboratory for quality control purposes.

Table 6.1 Confirmatory Testing Grid Sizes

Size of area	Grid size	# Perimeter samples analyzed	# Interior grid samples analyzed
<100 m^2	3x3 m	all	all
>100 m^2, <2500 m^2	6x6 m	50%	40%
>2500 m^2	12x12 m	50%	40%

6.1.3 Hazardous Soils

Confirmatory sampling following excavation of soils considered hazardous according to CEPA (PCBs >50 ppm) or the TDGA may require a more closely spaced grid than outlined in Table 6.1 to minimize the overall volume of materials requiring off-site disposal.

6.1.4 Type B TPH (Fractions F1 to F3)

Confirmatory sampling following excavation of petroleum hydrocarbon impacted soils within 30 m of a water body supporting aquatic life will follow the confirmatory sampling protocol outlined in section 6.1.2. The remedial solution for petroleum hydrocarbon impacted soils further removed from surface water bodies involves excavation of source areas. In cases where field analytical methodology is used, 10-20% of the samples analyzed in the field should also be analyzed in the laboratory for quality control purposes. For comparison purposes, total petroleum hydrocarbons (TPH) data obtained by hexane extraction can be compared to data generated using the CCME analytical procedure for PHC in soils by summing fractions F1 to F3. The presence of residual petroleum hydrocarbon contamination is expected following excavation to design limits as outlined in the RAP. Representative samples from the base of the excavation will be collected and analyzed for record keeping purposes using the CCME analytical procedure for PHC in soils.

6.1.5 Ex-situ Confirmatory Sampling

Soils excavated from landfills and dumps will be classified ex-situ. Excavated soils will be placed in windrows or stockpiles with a maximum stockpile size of 20 m^3 (B.C. Environment, 1995). Debris is separated from the soil and sorted as potentially hazardous and non-hazardous under the supervision of the Hazardous Materials Specialist. Stained soil and soil associated with potentially contaminated debris such as battery waste or barrels must be stockpiled separately from other soil to prevent dilution and facilitate disposal.

As part of the sampling protocol, two types of soil samples shall be collected from stockpiles: discrete and composite. Sample locations are selected at various surface and depth locations in each stockpile to obtain samples that are representative of the entire pile. Five discrete samples are collected and analyzed for the first 20 stockpiles and every 20th stockpile thereafter. Composite samples shall be collected and analyzed at all stockpiles. Composite samples consist of approximately equal volumes of soil collected from five discrete sample locations.

The standard deviation for each stockpile shall be calculated based on discrete sample results. These standard deviations are then used to calculate the average standard error for all stockpiles (Equation 1). Twice the average standard error is added to the analytical result for the composite sample to provide a 95% upper confidence limit (Equation 2).

$$SE_{avg} = \frac{\sum_{1}^{m}\left(\frac{SD}{\sqrt{n}}\right)}{m}$$ **(Equation 1)**

$$UCL = [Composite_x] + 2(SE_{avg})$$ **(Equation 2)**

n = number of sample values,

SE_{avg} = average standard error,

SD = standard deviation of the sample values,

m = number of stockpiles,

UCL = upper confidence limit and

x = the stockpile number.

Classification of stockpiles for disposal is based on a comparison of the 95% upper confidence limit values and the relevant clean up objectives. The first 20 stockpiles shall be analyzed for the eight inorganic elements for which the DCC criteria are applicable and PCBs. Selection of samples for analysis for petroleum hydrocarbon will be based on visual and/or olfactory evidence. This process shall be repeated for every 20th stockpile thereafter. All the remaining stockpiles will be tested for copper, lead and zinc and any other analyte that exceeded the DCC criterion previously until it is no longer present (Table 6.2). Field analysis can provide adequate detection limits for statistical classification of certain contaminants (PCBs and PHC), while others (inorganic elements) must be analyzed in CAEAL accredited laboratories for more precise results.

Table 6.2 Analytical Requirements for Stockpile Sampling

Stockpile No.	Samples Collected	Analytical Suite	Samples for Analyses
1 through 20	**5 discrete** 1 composite	**PCBs, Cu, Ni, Co, Cd, Pb, Zn, Cr, As** PHC and Hg where evident	All discrete and all composite samples are analyzed for first 20 stockpiles
Every 20th thereafter	**5 discrete** 1 composite	**PCBs, Cu, Ni, Co, Cd, Pb, Zn, Cr, As** PHC and Hg where evident	All discrete and all composite samples are analyzed
Remaining stockpiles	**1 composite**	**PCBs, Cu, Pb, Zn** PHC, Hg and other inorganic elements where evident	Every composite sample is analysed.

Once the excavation is complete, the base of the landfill excavation must be sampled in accordance with confirmatory sampling protocol for Tier II soils.

6.1.6 Confirmatory Sampling of Material Processing Areas

Residual contamination may be present at barrel processing areas, hazardous materials processing areas, and stockpile lay down areas after clean up activities are complete. Once an area is no longer in use, a detailed inspection for evidence of staining and other indicators of contamination such as visible debris or paint flakes shall be carried out. Samples must be collected in these areas in a grid pattern based on the size of the area (see Table 6.1). In cases where field analytical methodology is used, 10-20% of the samples analyzed in the field should also be analyzed in the laboratory for quality control purposes.

6.2 Quality Assurance Testing of Earthworks

At most sites, earthworks will be carried out as part of the construction of new landfills, remediation of existing landfills, and/or development of hydrocarbon contaminated soil treatment areas. Contract Specifications developed for the project will identify specific requirements for fill gradation and compaction standards. As part of the testing to be carried out during cleanup, quality assurance (QA) testing is required to confirm that the earthworks are in conformance with the Specifications. The number and type of testing will be dependent on the volume of fill to be placed and the number of different material types employed in the cleanup. A QA program shall be developed in conjunction with the design engineer to determine the optimal number of tests required.

6.3 Testing Related to Permits/Regulatory Requirements

The Owner representative and the Contractor will be required to carry out testing to confirm that the requirements of the Land Use Permits and Water Licenses issued for the project are met.

This testing typically includes:

- Effluent testing for waste water generated from camp operations.
- Testing to confirm potability of drinking water supplies
- Testing of waste water generated from cleanup operations.

7 POST-CONSTRUCTION MONITORING

7.1 Introduction

A post-construction landfill monitoring program was developed by DND in conjunction with the Inuvialuit in the Western Arctic and the Inuit in Nunavut for landfills remediated and/or constructed during the cleanup of DEW Line sites. DND initiated cleanup of their DEW Line sites in 1996 and have collected a significant volume of landfill monitoring data since that time. Indian and Northern Affairs Canada, INAC, have initiated cleanup of abandoned military sites under their jurisdiction, and will implement a site monitoring program following remedial construction activities.

This section describes the recommended monitoring plan. It has been based on the DND landfill monitoring program and on landfill monitoring data collected at DND and INAC DEW Line sites to date. Additional monitoring requirements related to the natural environment and traditional knowledge have been added to the program.

A detailed description of the post-construction monitoring program is provided in AMSRP Volume 2 (INAC 2009).

7.2 Monitoring Program

The recommended monitoring program for abandoned military sites consists of:

- Baseline Geo-chemical Monitoring.
- Natural Environment Monitoring.
- Landfill Monitoring.

These are briefly described in the following subsections.

7.2.1 Baseline Geo-Chemical Monitoring

Geochemical Characterization of Soil Conditions

In all proposed development areas, and existing landfill areas (with the exception of existing landfills to be excavated), it is recommended that geochemical characterization of soil conditions be carried out during the assessment or remediation phase. For proposed development areas, sampling should be carried out on a grid spacing of approximately 50 m by 50 m. For existing landfills, testpits should be excavated at a minimum spacing of 50 m of landfill perimeter with a minimum of five testpits per area. Soil stratigraphy is to be logged in accordance with the Unified Soil Classification System, and evidence of seepage and or soil staining recorded. Soil samples should be collected at surface and at 50 cm intervals to the maximum depth of the active layer, and analysed for the following parameters:

- PCBs (polychlorinated biphenyls);
- Hydrocarbon Fractions, F1, F2, F3 and F4; and
- Inorganic elements: arsenic, cadmium, chromium, cobalt, copper, lead, nickel, and zinc.

These data supplement information collected during the assessment phase of a site.

Geochemical Characterization of Groundwater Quality

In proposed landfill development areas or at landfills requiring leachate containment, it is recommended that a detailed characterization of groundwater quality be carried out. A minimum of three wells per area is recommended; however, this may be increased if the size of the landfill warrants increased coverage. The locations of monitoring wells should be selected based on the potential for groundwater (based on the testpit program for soil characterization), and to be representative of both up and downgradient areas. The depth of the monitoring well will be based on anticipated maximum depth of thaw. The monitoring wells should be located no further than 10 m beyond the final construction perimeter as defined by the design.

For baseline water quality, water samples should be collected at minimum monthly for one full season to allow assessment of changes in water quality as the active layer deepens. The wells for baseline sampling are typically installed in the final construction season. This minimizes the potential for damage during construction.

Recommended analytical requirements are outlined below:

- Petroleum Hydrocarbon Fractions, F1 and F2
- Total and dissolved metals.
- Major ions, hardness, total dissolved solids, total suspended solids.
- pH and conductivity.

Given the low solubility of PCBs, analyses of PCBs may be limited to once over the season, near the time of maximum thaw.

For each monitoring event, water level, pH, conductivity, and turbidity should be measured.

If significant variability is observed in groundwater monitoring data, a second season of baseline monitoring should be carried out following remedial activities.

Typically, only dissolved metals are measured in groundwater monitoring programs; however, previous concerns existed with respect to transport of contaminants with colloidal material. The requirement for total metal analyses should be reviewed at the completion of baseline monitoring, and eliminated if concentrations can be correlated with Total Suspended Solids (TSS) concentrations.

7.2.2 Natural Environment Monitoring

A natural environment assessment (NEA) conducted during the ESA phase of site remediation will serve as a reference for post-construction site monitoring. Local and traditional knowledge will be obtained from a local community representative familiar with the site (ideally the same person who assisted with the NEA). Natural environment data will be collected during the site visit as well as during community meetings with people who use or visit the site/area frequently (*i.e.*, year-round). The purpose of collecting this new data is not to find correlations with landfill monitoring data but rather to provide anecdotal data related to the presence of wildlife and changes over time.

Site specific data to be collected during the site visit should try to include as many of the following items:

- Wildlife sightings (species, number, gender, juveniles)
- Other evidence of recent presence of wildlife (droppings, tracks, feathers/fur, carcass remains, etc.)
- Wildlife activity (summering/nesting/denning, migratory/passing through)
- Qualitative assessment of relative numbers versus previous years (more, same, less)
- Revegetation of disturbed areas versus previous years (more, same, less)

Regional information to be collected during visits to the area throughout the year should include as many of the following items as possible:

- Use by people for traditional activities
- Season(s)
- Activities (hunting, fishing, trapping, camping, other harvesting)
- Relative frequency versus previous years (more, same, less)
- Wildlife species present (sightings or evidence)
- Wildlife presence versus previous years (more, same, less)
- Health of wildlife observed or harvested (good, average, poor)

- Relative health of wildlife versus previous years (better, same, worse)

7.2.3 Landfill Monitoring

In general, there are four types of landfills that require monitoring:

- New landfills for non-hazardous materials and Tier I soil;
- Landfills to be closed by the addition of granular fill and regraded;
- Landfills to be closed with leachate containment; and
- Tier II soil disposal facilities.

Based on site conditions at INAC's abandoned military sites, it is considered unlikely that leachate containment would be considered; however, it is included for consistency with previous monitoring plans at military sites. A summary of requirements is provided in Table 7.1.

Table 7.1 Summary of Landfill Monitoring Requirements

	Monitoring Requirements				
Landfill Type	**Baseline Monitoring** S- Soil GW - groundwater	**Visual Inspection**	**Soil Sampling**	**GW Sampling**	**Thermal Monitoring**
New Non-Hazardous Waste (NHW) Landfill (LF)	S, GW	✓	as required[a]	✓	
Regraded LF (low potential risk)	S	✓	as required[a]		
Leachate Contained LF (moderate potential risk)	S, GW	✓	as required[a]	✓	✓
New Tier II Soil Facility	S, GW	✓	as required[a]	✓	✓

[a] Refer to Section 7.3.4 for details.

Baseline monitoring requirements were described in Section 7.2.1. The details of the other four landfill monitoring elements are described in the following subsections.

7.3 Specific Monitoring Requirements

7.3.1 Visual Inspection

The physical integrity of the landfill should be inspected and reported using photographs (from the air, when possible, as well as ground level) and hand drawn sketches. Documented observations should at minimum include the items identified in Table 7.2. It is recommended that Table 7.2 be adapted for use as a field checklist to facilitate this data collection.

Table 7.2 Visual Inspection Requirements - Landfills

Item	**Presence/ Absence**	**Extent**	**Description** **Photographic Reference**
Settlement Erosion Frost Action Animal Burrows Vegetation Staining Vegetation Stress Seepage Points Exposed Debris Condition of Monitoring Instruments Other features of note	Yes or No	Provide dimensions, as applicable of: Length Width Depth	Features of note, photographic reference with scale, view point and direction

7.3.2 Groundwater Sampling

Results of analyses of groundwater samples from landfills should be compared to the baseline and background samples as this is indicative of changing environmental conditions at the site. In general, a minimum of three to four groundwater monitoring wells will be associated with Non-Hazardous Waste Landfills, Tier II landfills and Existing Landfills – Leachate Containment.

Consistent with the baseline analyses, groundwater samples should be tested for:

- Petroleum Hydrocarbon Fractions, F1 and F2
- Total and dissolved metals.
- Major ions, hardness, total dissolved solids, total suspended solids.
- pH and conductivity.
- PCBs

For each monitoring event, water level, pH, conductivity, and turbidity should be measured in-situ. The evaluation of whether both total and dissolved metals are required will be evaluated after baseline monitoring.

Given the low solubility of PCBs in water, analyses of PCBs may be discontinued if not detected in the first five years of monitoring.

7.3.3 Thermal Monitoring

One component of the leachate containment system incorporates aggradation of the permafrost through the landfill contents such that the active layer does not penetrate the waste materials. Geothermal analyses were carried out to predict the length of time for freezeback of the landfill; long-term and short-term thermal regime in the ground; and the depth of the active layer in the cover material. The analyses have shown that it takes several years for the landfill temperatures to equilibrate and stabilize.

A thermal monitoring system provides measurement of sub-surface ground temperatures, which allows comparison to and verification of the predicted ground temperatures. The thermal monitoring system consists of installation of thermistor strings, with “thermistor beads” at select intervals to provide ground temperature profiles at various locations within the landfill. The thermistor strings are attached to automated data-loggers which allow for remote data collection. In general, a minimum of three thermistors is placed; this is evaluated on a landfill-specific basis. Thermistor installation follows standard engineering practice.

7.3.4 Soil Sampling

As previously indicated, soil sampling and analyses provide limited information with respect to the performance of a landfill. Soil sampling will be limited to locations where seepage or staining has been identified as part of the visual inspection. Analytical requirements include:

- Petroleum Hydrocarbon Fractions, F1 to F4
- Arsenic, Cadmium, Cobalt, Copper, Chromium, Lead, Nickel, and Zinc
- PCBs
- Soil samples should be collected over the interval of 0 to 0.15 m, and 0.35 to 0.50 m depth.

7.4 Monitoring Frequency

Conceptually, three phases have been identified for landfill monitoring as described in the following sub-sections. Natural environment monitoring may be conducted according to the same schedule.

Phase I: Monitoring of conditions to confirm that thermal equilibrium and physical stability criterion are achieved.

During Phase I, monitoring would take place in years 1, 3, 5. The five-year term was selected on the basis that ground-temperature thermal regimes at these specific landfills would require three to five years to reach equilibrium.

Visual and thermal monitoring should be carried out on Tier II soil facilities and leachate contained landfills.

Visual inspections of the constructed and remediated landfills would also be carried out. It is anticipated that, if there is settlement or erosion within the initial years following remediation, it is likely attributable to construction quality. Changes after the first three years are more likely attributable to changes in the site conditions (i.e. warmer temperatures, changes in surface water drainage patterns).

It is recommended that groundwater monitoring take place in Years 3 and 5. The timing of the groundwater sampling event should consider the variability of water quality measured during the baseline monitoring.

An evaluation of the Phase I data would be carried out at the end of five years to confirm that thermal equilibrium has been achieved, and that no stability issues had been identified. The Phase I monitoring program may be extended, if required.

Phase II: Verification of equilibrium conditions established during Phase I.

At the completion of Phase I monitoring and review of the results, the Phase II monitoring frequency may be modified or downgraded. If no significant issues are identified for landfills of low potential environmental risk (as defined by the landfill evaluation matrix), monitoring may be discontinued at the conclusion of Phase I. If additional monitoring is warranted based on the thermal, groundwater or physical inspection, it is recommended that the monitoring frequency in Phase II be carried out according to the following schedule: Year 7, Year 10, Year 15, and Year 25. Year 25 would mark the end of Phase II monitoring.

Physical inspections of all landfills would be carried out at each monitoring event. The requirement for continued thermal monitoring would be based on Phase I results, or if significant climate changes had been recorded in the region.

Groundwater monitoring would be carried out at each monitoring event. The optimal time period for sampling would be based on the results obtained during baseline and Phase I monitoring.

Phase III: Monitoring for long term issues such as liner integrity, permafrost stability, and significant storm events.

At the end of Phase II, 25 years after implementation of the remedial actions for a given landfill, a re-evaluation of the monitoring program should be carried out prior to initiating Phase III. It is difficult to predict beyond 25 years how world events and improvements in technology may impact monitoring requirements.

7.5 Interpreting Monitoring Results

Landfill monitoring results (thermal, chemical and visual) have to be interpreted in concert with one another as described in AMSRP Volume 2 (INAC 2009).

7.6 Reporting Format

To provide a basis for comparison between monitoring events, it is recommended that a consistent format be used in reporting.

An outline is provided as follows:

1 Introduction. The introduction should provide an outline of the work elements, the timing of and weather conditions during field work, and describe the scope of the document.

For each individual landfill, the following information is to be provided.

2a. Landfill Summary: For each landfill, a summary should be prepared that describes the monitoring carried out, any notable groundwater analytical results, and any associated staining, seepage, exposed debris, and/or evidence of vandalism. In addition, visual inspection issues identified as significant or unacceptable should be identified. The overall performance rating of the landfill should be provided.

2b. Completed Visual Inspection Report.

2c. A preliminary stability assessment, as described in Section 4.

2d. Annotated drawings on a tabloid paper, indicating all visual inspection features.

2e. Completed thermistor inspection reports, where appropriate.

2f. Photographic records.

2g. Thermal monitoring data, where appropriate.

2h Groundwater analytical data.

2i. Monitoring well sampling logs.

In Annexes to the report, the following information is to be provided.

- Formal laboratory results.
- QA/QC evaluation of the analytical results.
- Handwritten field notes.

Example field note templates are provided in AMSRP Volume 2 (INAC 2009).

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Annex A – Dump site, landfill and debris area (waste disposal area – WDA) evaluation

SUMMARY

In 1997, the DEW Line Cleanup Environmental Working Group (EWG), comprised of members representing Nunavut Tungaavik Inc. (NTI) and the Department of National Defence (DND) / Defence Construction Canada (DCC), was formed to address environmental issues associated with the DEW Line sites under the jurisdiction of DND. One of their tasks was the development of a matrix to assess potential environmental risk associated with existing landfills at the DEW Line sites. The evaluation matrix considered three primary categories, contaminant source, exposure pathways and potential receptors. In the development of the matrix, landfills typical of the DND DEW Line sites were considered. The DND DEW Line sites were in operation for nearly 40 years, and landfill activity was generally extensive.

By comparison, most INAC Abandoned Military Sites were generally only operational for a much shorter period of time, approximately five to six years. Accordingly, waste disposal practices were different. At many sites, waste materials were not consolidated in a single area, and dump sites and/or isolated areas of partially buried debris are common. These areas are collectively referred to as Waste Disposal Areas (WDA).

This current document presents an Evaluation Matrix for WDAs that considers conditions more specific to INAC Abandoned Military sites.

1 INTRODUCTION

To address the varied nature of landfills at abandoned military sites, a consistent method for the assessment of their potential risk to the arctic environment, in the form of a risk evaluation matrix, was developed by the DND/NTI EWG in 1997 (EWG 1998). Since that time, the matrix has been utilized to develop recommendations for landfill remediation at DND DEW Line sites. This document provides a modified evaluation matrix to address the dump sites, landfills and buried debris areas more typical of the abandoned military sites under the jurisdiction of INAC. As a whole, these are referred to as Waste Disposal Areas (WDAs).

The DND/NTI evaluation matrix was based on the CCME National Classification System for Contaminated Sites, and adapted to address the particular concerns of the Arctic environment. This revised version also references the Federal Contaminated Site Action Plan (FCSAP) Contaminated Site Classification Guidance Document. The matrix is divided into three categories of equal weight: contaminated source, pathways, and receptors. The interaction of these three elements results in environmental risk. Each category is assigned 50 points, which are distributed among several factors. Each of these factors has been made as specific as possible in order to reduce the subjectivity of the matrix to a minimum. In addition, each of the three main categories is assigned a highly subjective "special considerations" factor according to the method described in the CCME Classification System. As it is unlikely that any classification system could address all possible factors, a special considerations factor allows the user to increase or decrease the score "to emphasize important concerns about a site and should be used as an exception rather than as a rule" (CCME 1992, p.6-7).

The intended purpose of the matrix is to evaluate the potential environmental risk posed by WDAs in their current condition.

Two conservative assumptions are made during the evaluation of all WDAs

- The contents of WDAs are generally unknown and all potential contaminants may be present.
- If contaminants come into contact with receptors, they could have adverse effects on the receptors.

2 MATRIX FACTORS

2.1 Contaminant Source – Category A

Four factors were considered under Contaminant Source to describe specific disposal areas as follows:

A.1 Areal extent of waste disposal.

A.2 Estimated depth of buried debris

A.3 Contaminant Characteristics – combined presence of leachate and surface contaminated soil.

A.4 Presence of Surface Debris

Contaminant characteristics were assigned the greatest weighting in this category as it is a strong indicator of potential environmental risk associated with the WDAs. The volume of a WDA is considered to be related to its potential to be contaminated – the greater the volume, the greater the risk that contaminants are present. The volume of the waste disposal area is divided into two parameters, area and depth. The area is relatively easy to measure; the estimated depth of the buried waste is given less weight in the matrix as it is difficult to measure using non-intrusive techniques.

A.1 Areal Extent of Waste Disposal

The larger the area impacted by waste disposal, the greater the potential for contaminants to be present exists. The areal extent of dump sites can be easily surveyed based on the presence of surface wastes. Landfill or buried debris areas are based on the results of geotechnical/geophysical site surveys and visual observations. A value of 10 000 m^2 is used as the basis for comparison. All WDAs greater than 10 000 m^2 are awarded the maximum points for this category. Scoring for all other WDAs is prorated relative to 10 000 m^2. WDAs less than 1000 m^2 are referred to as debris areas.

Scores are provided for all WDAs following the detailed field investigations that are carried out prior to cleanup/construction. The objectives of these investigations are to delineate the extent of known contamination, and confirm existing site and WDA conditions.

A.2 Estimated Depth

The depth of landfills and debris areas can be estimated by visual inspection of surrounding topographic features. The average depth of the active layer is used as a qualifier for the description of landfill depth, as this is generally the maximum depth of investigation. The depth of the active layer may range from one to two meters at these sites, depending on material type; therefore an average depth of 1.5 meters was used in the rating. Landfills and buried debris with estimated depths of greater than 1.5 meters were scored higher than those with estimated depths of less than 1.5 meters. For the majority sites, it is anticipated that the depth of buried waste is 1.5 metres or less. Exceptions to this may include dumping within ravine areas or other natural depressions. A minimum score of 2 is allotted to all WDAs in the absence of specific data.

A.3 Contaminant Characteristics

Contamination associated with WDAs may be elevated with respect to background concentrations, but less than applicable criteria. In this case, elevated concentrations may be indicative of chronic low levels of contaminants leaching from the WDA, as a result of infiltration and percolation of surface water, or flow of active layer groundwater through areas of buried debris. In some cases, contamination on the surface may exceed applicable criteria as a result of direct spills or leaking containers.

With consideration of the FSCAP Hazard Ranking of contaminants and the DCC Criteria, all contaminants included in the DCC are considered high concern, with the exception of Petroleum Hydrocarbon Fractions F3 and F4. The F3 and F4 fractions are considered essentially insoluble and are therefore immobile. In the scoring of this category, four categories are provided:

- Concentrations not elevated with respect to background; however, the potential for contamination is considered possible.
- Concentrations elevated with respect to background; but less than DCC criteria. Elevated with respect to background refers to a concentration in excess of the three times the mean background concentration. With respect to organic contaminants, such as hydrocarbons and PCBs, the method detection limit is assumed to represent background concentrations.
- Concentrations in excess of DCC Tier I guidelines.
- Concentrations in excess of DCC Tier II guidelines.

A.4 Presence of surface debris

At some WDAs, in particular dump sites, surface debris is very extensive, while at others there is almost no debris. Scoring needs to be quantitative; therefore the percentage of the surface area of the landfill that is covered with debris is used as the basis for scoring. A WDA that has surface debris covering more than 50% of its surface receives a full score. Debris areas, and dump sites as implied by the designation, generally receive full score for this category.

2.2 Pathways – Category B

The primary transport mechanisms for contaminants at these sites are considered to be:

B.1 Aerial transport of fine particles; and

B.2 Dissolved phase and/or colloidal transport in water, both as surface water run-off or subsurface water flow.

B.1 Aerial Transport of Contaminants

All contaminants can be transported as particles. Windblown debris is not considered in this category, as debris pickup is inherent in any cleanup. Surface contamination or surface expressions of leachate impacted soils imply the potential for aerial transport. This factor is given a low weight because the quantity of contaminated soil on the surface is generally low relative to the quantity of contaminated soil at the site as a whole. In addition, it is anticipated that relative to the effect of water movement, aerial transport contributes less to the transport of contaminants away from a landfill.

B.2 Water Movement

Dissolved phase and/or colloidal transport in water includes movement of surface water and subsurface water within the active layer. "Groundwater" is not addressed as an issue separate from surface water, as the movement of water within the active layer is generally subject to the same driving forces or gradients as surface water. The intent of this sub-category is to examine factors that affect migration away from the WDA – slope, runoff, extent and type of cover on below grade disposal areas, annual precipitation and distance to surface water. Among these factors, topography, runoff potential and proximity to surface water are given the greatest weight.

B.2.1 Topography

The degree of the slope on which the WDA is located is one of the major factors contributing to transport of contaminants. Scoring is carried out on a progressive scale. In cases where there are different slopes in the area, a weighted average is used.

B.2.2 Cover Material – Depth

The extent to which contaminants are available for transport is also dependent on the depth and type of cover material, where present. The potential for leachate generation and correspondingly, leachate migration, is related to infiltration of water. Cover over the WDA helps mitigate infiltration of water into the landfill contents. As the thickness of the cover increases, the likelihood that potential contaminants will be released decreases. If the active layer is contained in the cover material above the debris, then the potential for surface water infiltration into the WDA is small; this circumstance is assigned the lowest score.

B.2.3 Cover Material – Type

The erosion potential of a WDA is partly based on the type of cover material. Erosion can eventually lead to the exposure of the waste. Some cover materials are more susceptible to erosion than others; well graded gravels are the least susceptible, and silty materials are the most susceptible. In cases where there is no cover, this factor is assigned the highest score. Where the cover materials consist of a combination of soil types, the scoring should reflect the more conservative or higher score.

B.2.4 Surface Water/Run-Off Potential

This factor aims to describe the destructive potential of water action on the WDA, which could take the form of waves; streams, rivers or lakes; or seasonal drainage. Where there is significant seasonal drainage, the run-off potential is high. "Significant seasonal drainage" is defined as run-off that has the potential to transport large quantities and concentrations of contaminants to surface water courses over a short period of time (CCME 1992, p.23). Significant seasonal drainage also includes consideration of major snow drifting in the area.

B.2.5 Precipitation

The amount of precipitation received, either as rain or snow fall, affects the amount of surface water infiltration or run-off, and potentially erosion. The majority of the abandoned military sites receive less than 500 mm of precipitation annually, with the exception of sites on the lower east coast of Baffin Island. Typically, the amount of precipitation at any site is relatively low. Any given rainfall event is unlikely to generate major run-off; however, spring thaw and corresponding run-off may be significant at some sites. Detailed precipitation data is not available for the INAC sites; therefore data was interpolated from the Hydrological Atlas of Canada Maps [accessed on line: http://atlas.nrcan.gc.ca/site/english/maps/archives/5thedition] as summarized below for various areas. For sites not listed below, the aforementioned maps should be consulted.

Sites	Annual Precipitation (mm)	Annual Snowfall (cm)	Average Maximum Snow Pack depth (cm)
Clifton Point	100-200	100	30
Bernard Harbour east to Matheson Point	100-200	80	30
Simpson Lake to Sarcpa Lake	150-200	100	50
Bray Island, Rowley Island	150-200	100	60
Nadlaurdjuk Lake	200-300	100	60
Ekalugad Fiord	200-300	200	70
Kivitoo	350	240	100
Durban Island	+400	240	100

As spring run-off likely represents the maximum precipitation event, scoring is provided relative to the maximum snow pack depth, with a score of 4 allotted to snow pack depth of 100 cm. If site specific factors, such as drifting in the WDA are present, the score may be increased to 5, the maximum allotted to this category.

B.2.6 Distance to Down-gradient Perennial Surface Water/Seasonal Drainage Channel

The distance to surface water will affect the probability of contaminants reaching the watercourse. This factor can include streams, seasonal or perennial, running directly through the WDA, or streams and lakes downgradient from the WDA, but it is intended to exclude small ponds with no outflow. On very steep slopes, this distance should consider the horizontal distance to the water body rather than the elevation difference. The impact of drainage with respect to contaminant exposure is not considered in this category (it is considered under Receptors); this factor determines whether there is a drainage pathway away from the WDA.

2.3 Receptors – Category C

This section addresses the potential for impact on receptors, specifically, aquatic and terrestrial habitats, as well as human exposure. Impact on humans is the primary consideration; however, it should be recognized that impact on humans is implicit in the scoring of factors addressing ecosystem impact. The scoring within each category is to be based on recorded data, as well as local knowledge of the land use in the area, and therefore requires local input.

C.1 Potential Impact on Receiving Freshwater/Marine Habitat

Selection of the water body in this category is based on potential effects on the receiving habitat. Consideration must be given to the regional drainage patterns. For example, where the drainage from a WDA is overland (i.e. there is no direct connection between the WDA and the downgradient water body), water bodies beyond two kilometers should not be used in the evaluation. This is based on the premise that natural attenuation of any potential contamination will occur with overland flow. Where a direct connection between a WDA and a downgradient water body exists, via a stream or interconnected ponds, the two-kilometre limit should not be used.

C.1.1 Proximity to Receiving Freshwater/Marine Habitat

“Receiving habitat” is considered to be a significant body of water near the limit of the WDA where contaminants are likely to have an impact. The water body may support freshwater or marine life and/or may be used by avifauna and/or terrestrial mammals as a water source. It is not necessarily the seasonal drainage course or perennial water body closest to the limit of the WDA toe. The objective is to select a habitat that supports receptors rather than identify the closest body of water. It is assumed that only habitat downgradient from the WDA is to be considered (given that aerial transport of contaminants to habitat upgradient from the WDA will be addressed by the remediation of contaminated soil).

C.1.2 Estimated Habitat Usage – Freshwater/Marine

The score within this category is based on the frequency of usage within the selected receiving environment and considers the level of biodiversity and the occurrence of calving/spawning grounds. Freshwater and/or marine wildlife are potentially more at risk compared with terrestrial wildlife or avifauna, the latter of which are exposed through water ingestion. Thus, when terrestrial wildlife or avifauna are the primary receptor, the score for this factor should fall into the moderate or low category based on the potential frequency of usage. Otherwise, when the selected water body sustains freshwater and/or marine wildlife, the level of biodiversity should be used to evaluate the score. It should be noted that the most conservative approach - in the selection of the receiving water body - must be used when scores from section C.1.1 and C.1.2 are combined. Finally, "biologically sensitive" areas such as bird sanctuaries and/or endangered, threatened or vulnerable populations should be considered as "special considerations".

C.2 Potential Impact on Receiving Terrestrial Habitat

C.2.1 Extent of Vegetation

The extent of vegetation considers the area within 300 metres downgradient of the WDA. Within this distance, vegetation is expected to be most susceptible to uptake of contaminants if they are leaching from the WDA. However, topography and the potential for run-off must be considered and a greater or lesser distance could be considered.

C.2.2 Estimated Habitat Usage – Terrestrial/Avifauna

The same criteria as for usage of aquatic habitat are to be applied.

C.3 Potential Human Exposure Through Land Use

C.3.1 Presence/Occupation

This factor addresses strictly dermal exposure and inhalation; consumption of food and water from the area are dealt with in subsequent factors. The risk of dermal exposure or inhalation is much lower when soil is frozen; therefore winter occupation of the site is assigned a low risk. "Summer" in this factor is intended to include the spring, summer and fall periods when the ground surface is not frozen. Within this factor, the scoring takes into account the likelihood and the duration of contact. Using this method, proximity to a community is considered (high likelihood of contact), although proximity to a community does not necessarily trigger a high score if visits are infrequent (low duration of contact).

The likelihood of contact considers proximity to community or to a camp, as well as proximity to "travel routes". The duration of contact considers full time residences (i.e. permanent community for high, summer camp for moderate, winter camp or travel routes as low). Scores may be interpolated between the allocated points, according to Table 1 below. Unmanned Short Range Radar (SRR) sites, part of the North Warning System, are co-located at some of the former abandoned military sites, and periodic maintenance of these facilities is carried out. As a conservative approach, it may be considered that maintenance workers may have a low likelihood of contact and low duration of contact.

Table 1: Scoring Guide for Section C.3.1

	High Likelihood of Contact	Moderate Likelihood of Contact	Low Likelihood of Contact
High Duration of Contact	8	6	4
Moderate Duration of Contact	6	4	2
Low Duration of Contact	4	2	1

Different areas on a site may need to be considered individually.

C.3.2 Proximity to Drinking Water Source

Regardless of whether the source is seasonal or perennial, an established community or a summer camp water source located downgradient of the WDA is to be considered in this factor.

C.3.3 Food Consumption

This factor is divided into two sub-sections, and the score is the sum of the score for each of the two sub-sections.

Sedentary organisms are more susceptible to local inputs as their exposure is greater if they are downgradient from the WDA. These organisms can include bottom-dwellers such as sculpins, mussels, sea urchins etc., as well as terrestrial vegetation, which can be used for medicinal purposes. This kind of contamination "is quite localized when considered on a broad regional scale" (DIAND 1997, pg. 5).

Migratory marine animals may have body burdens of contaminants; these are not directly attributable to local contaminant sources, as the vast majority of organochlorines, for instance, arrive in the Arctic via long range transport. Caribou living in the general area of DEW sites do not have elevated levels of contaminants, as they feed over a very wide area. The Canadian Arctic Contaminant Assessment Report (DIAND, 1997) describes these results in more detail.

It is recognized, however, that sources such as abandoned military sites do contribute contaminants to the Arctic ecosystem. For the purpose of scoring the matrix, therefore, a high consumption of animals from the area surrounding the site has the potential to pose a higher risk than a low consumption, although in general the risk remains low.

2.4 Special Considerations

As indicated in the introduction to the matrix, each of the three main categories includes a "*special considerations*" factor. The proposed value of the special considerations factor is a maximum of ten percent of the overall score for each category. It is intended that no circumstance will allow a user to assign a special considerations score that will cause the score for that category to exceed the maximum allotted. To avoid undue bias, it is also suggested that the user should complete the entire evaluation form and score a site before addressing special considerations in the total score.

The Environmental Working Group (EWG) based their landfill risk evaluation matrix on the CCME model which defines three categories: contaminant source, pathways and receptors. Within those three categories, the EWG tried to address all of the possible factors contributing to risk. Recognizing that even a thorough matrix could never address all possible risk factors, special considerations were included to address specific risk factors that are not general to all of the abandoned military sites.

As noted in the CCME document, the special considerations factor is not intended to be applied on a regular basis, as it addresses very site-specific risk factors. In fact, if the special consideration factor was being consistently applied in the scoring of a WDA, it would indicate that the matrix itself was incomplete. Special considerations should be site-specific characteristics that can be documented.

Three examples of how special considerations could be applied are provided to clarify the use of such a classification:

Example 1. Wildlife on site

It may be that "special considerations" points would be assigned to the Receptors category when endangered, threatened and/or vulnerable species (COSEWIC, 1997) are known to visit the WDA.

Example 2. Proximity to a community

In the WDA risk evaluation matrix, human exposure to a WDA is measured in the following way: people can spend time at the WDA (potential dermal exposure), they can drink water from an area near the WDA (potential ingestion), they could live very close to the WDA (potential exposure through aerial transport) or they could eat animals that feed near the WDA (potential ingestion). These considerations form section C.3 of the risk evaluation matrix. If a WDA is located near a community, there is a greater likelihood that people will spend time at the site than there is for areas far from a community. It is not necessarily the case, however, that WDAs near communities receive frequent visits; therefore, instead of creating a special section addressing proximity to a community, the risk of human exposure (see Table 1-1) is more accurately evaluated by measuring time spent at a WDA. In these cases, however, "special considerations" points may be added to the receptors category to address a community's specific concerns, such as the physical hazards associated with an exposed dump site.

2.5 Traditional Knowledge

The matrix for the evaluation of potential environmental risk was developed recognizing that local input would be relied upon in the scoring of WDAs. Additional guidance on the collection of Traditional Knowledge is provided in Section 4.10 of the protocol.

3 INTERPRETATION OF SCORES

The score obtained through the application of the matrix is intended to represent the potential environmental risk posed by a given WDA in its current state. The objective of remediation is to mitigate the risk associated with a WDA by preventing the migration of contaminants that may be present in the landfill, and by removing physical hazards.

During the development of the matrix by the EWG, WDAs at four different sites were evaluated by environmental scientists and engineers to assess the applicability of the matrix and to determine cut-off values between categories. WDA scoring 105 points or more is classified as potentially high risk (Class A) and require excavation. The high score accorded to these WDAs is generally a result of the ecological sensitivity of the area and the geometry and surrounding topography of the landfill, which precludes the development of a cost-effective and long-term design solution such as pathway intervention and/or stabilization of the landfill. WDAs with a score of 100-104 points must be considered on a case by case basis – some may require complete excavation while others may be considered Class B landfills. WDAs that score less than 105 require excavation/removal if one or more of the following conditions are met:

- The WDA is located at an elevation of less than 2 m higher than an ocean.
- The WDA consists of unconsolidated wastes at surface. Debris should be removed, classified, and sorted, and non-hazardous contents placed in an engineered landfill.
- WDA, with areal extent of less than 1000 m^2 and scoring a total of 89 points or more are classified as potentially high risk and require excavation to the full extent/depth of the debris. In addition, if these WDAs score greater than 23 points in the contaminant source category, complete excavation of the area is recommended.

A WDA with a score in the range 75 to 99 points is classified as moderate potential environmental risk (Class B). An engineered leachate containment system will be provided for these WDAs to mitigate against potential environmental risks. In specific cases where an engineered leachate containment system cannot be constructed, an evaluation of excavation will be carried out with the objective of determining whether complete excavation or partial excavation with a leachate containment system is required.

For WDAs of less than 1000 m^2, it is considered unlikely that leachate containment will be cost-effective when compared to excavation and removal of debris. Consideration must therefore be given to the level of contamination present. If contaminants are present in excess of criteria, it is recommended that the debris area be excavated to its full extent. If contamination does not exceed criteria, debris should be cut-off and removed within the upper 0.5 metres of the ground surface. The area should then be regraded to match surrounding topography.

A WDA with a score of 75 or less is classified as low potential environmental risk (Class C). In general, the remediation approach for these areas includes placement of an engineered cover, following collection, sorting, and appropriate disposal of debris from the surface, and excavation and disposal of any surface contaminated soils from the area. Some of the factors to be considered in the design of the cover include: thickness and type of the existing cover materials; slopes on the landfill; surrounding topography and available granular fill. The cover is designed to promote surface water run-off (i.e. no areas of standing water), prevent erosion, and mitigate against settlement. Where required, the slope of the WDA may be modified and/or geotextiles may be incorporated into the granular cover to provide a long-term solution. Generally, the final thickness of cover material is approximately 0.75 metres, and may be greater, dependent on site specific conditions. The granular cover material is to be placed in layers and compacted before the placement of the next layer of granular fill, until the design thickness is reached.

Overall, it is to be stressed that the matrix is to be used in the assessment of potential environmental risks associated with a specific WDA. It is not intended to be used as the sole criterion in determining the remediation solution for a WDA. The results of the matrix, both total score and the score from each major category, are to be considered in conjunction with the engineering evaluation of site conditions, to determine appropriate design solutions. Review of the individual category scores relative to the total score will highlight particular areas of concern that are to be addressed during the design process.

The potential impacts of climate change are also to be considered in evaluating remedial solutions.

It should be emphasized that the total score has an error associated with it of approximately 5 points; there is inevitable subjectivity in the scoring process and scores that fall near decision points should be considered on a case by case basis.

4 REFERENCES

BC Environment. June 1996. Guideline #1 Contaminated Sites: Site Characterization and Confirmation Testing. Draft.

CCME. 1992 National Classification System for Contaminated Sites.

COSEWIC, 1997, Categories of the Committee on the Status of Endangered Wildlife in Canada, Canadian Wildlife Service, Environment Canada.

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ATTACHMENT 1

WASTE DISPOSAL AREA

EVALUATION MATRIX

	ENVIRONMENTAL RISK EVALUATION MATRIX WASTE DISPOSAL AREAS - ABANDONED MILITARY SITES	Maximum Score
A. **A.1**	**CONTAMINANT SOURCE** **AREAL EXTENT OF WASTE DISPOSAL AREA**	
	>10,000 m2	10
	For areas less than 10,000 = Area of Waste Disposal Area X 10 / 10 000	2-9
	Minimum Score	1
A.2	**ESTIMATED DEPTH OF BURIED WASTES**	
	greater than 1.5 m	5
	less than 1.5 m	2-4
A.3	**CONTAMINANT CHARACTERIZATION**	
	Concentrations in excess of DCC Tier II Criteria	25
	Concentrations in excess of DCC Tier I Criteria	20
	Concentrations elevated relative to background	10
	Potential Contamination	5
A.5	**PRESENCE OF SURFACE DEBRIS**	
	>50% of surface area	10
	<50% of surface area, pro-rated	1-9
	No debris observed	0
	SPECIAL CONSIDERATIONS	+/- 5
	TOTAL SCORE - CONTAMINANT SOURCE	

	ENVIRONMENTAL RISK EVALUATION MATRIX WASTE DISPOSAL AREAS - ABANDONED MILITARY SITES	Maximum Score
B.	**PATHWAY/TRANSPORT MECHANISMS**	
B.1	**AERIAL TRANSPORT OF CONTAMINANTS**	
	All Waste Disposal Areas Scored as 2, if surface sol contamination (A.4) or leachate (A.3) has been identified.	
B.2	**WATER MOVEMENT**	
B.2.1	**TOPOGRAPHY**	
	Steeply Slope (>40 % Grade)	12
	Sloping (10% to 40% Grade)	4-11
	Subdued to 10% Slope	2-3
	Flat (< 3%)	1
B.2.2	**COVER MATERIALS –DEPTH**	
	No to little existing cover	4
	Greater than 50% exposed/surface debris	3
	Occasional exposed/surface debris	2
	Existing cover, minimal debris,	1
	Cover thickness > average active layer thickness	0
B.2.3	**COVER MATERIAL – TYPE**	
	No cover	5
	Silty/Sandy Material	4
	Sandy/Gravel Material	3
	Gravel Material	1-2

B.	**PATHWAY/TRANSPORT MECHANISMS continued**	
B.2.4	**SURFACE WATER/RUN-OFF POTENTIAL**	
	Very High - evidence of erosion, continuing run-off, or wave action	12
	High - evidence of erosion, seasonal, widespread, storm waves	10
	Moderate - % area affected by erosion	3-9
	Low - no evidence of erosion, slight slopes	1-2
B.2.5	**PRECIPITATION**	
	> 100 cm snow pack	4
	< 100 cm snowpack (pro-rated)	1-4
	Snow Drifting	1
B.2.6	**DISTANCE TO DOWNGRADIENT PERENNIAL SURFACE WATER/SEASONAL DRAINAGE CHANNEL**	
	0 to 100 m	10
	100 to 300 m	7-9
	300 to 1 km	2-6
	greater than 1 km	1
	SPECIAL CONSIDERATIONS	+/- 5
	TOTAL SCORE – PATHWAYS	

	ENVIRONMENTAL RISK EVALUATION MATRIX **WASTE DISPOSAL AREAS - ABANDONED MILITARY SITES**	Maximum Score
C.	**RECEPTORS**	
C.1	**POTENTIAL IMPACT ON RECEIVING FRESHWATER/MARINE HABITAT**	
C.1.1	**PROXIMITY TO RECEIVING FRESHWATER/MARINE HABITAT**	
	0 to 100 m	6
	100 to 300 m	4-5
	300 to 1 km	2-3
	greater than 1 km	1
C.1.2	**ESTIMATED HABITAT USAGE - FRESHWATER/MARINE**	
	High; High Biodiversity/ High Occurrence/Calving or Spawning Area	5-6
	Moderate: Moderate Biodiversity, Migratory	3-4
	Low: Low biodiversity; rare sightings	1-2
C.2	**POTENTIAL IMPACT ON RECEIVING TERRESTRIAL HABITAT**	
C.2.1	**Extent of Vegetation**	
	Extensive vegetation growth, (80 to 100 % ground cover)	6
	Moderate vegetation growth (40 to 80% ground cover)	4-5
	Low vegetation growth (20 to 40% ground cover)	2-3
	Sparse vegetation (<20% ground cover)	1
C.2.2	**ESTIMATED HABITAT USAGE - TERRESTRIAL/AVIFAUNA**	
	High; High Biodiversity/ High Occurrence/Calving, Denning or Nesting Area	5-6
	Moderate: Moderate Biodiversity, Migratory	3-4
	Low: Low biodiversity; rare sightings	1-2

C.	**RECEPTORS continued.**	
C.3	**POTENTIAL HUMAN EXPOSURE THROUGH LAND USE**	
C.3.1	**Presence/Occupation** Duration of Contact /Likelihood of Contact	7-8
	see chart and provide rationale for scoring	4-6
		1-3
C.3.2	**Proximity to Drinking Water Source**	
	0 to 100 m	8
	100 to 300 m	5-7
	300 to 1 km	2-4
	greater than 1 km	1
C.3.3	**Food Consumption**	
	High quantity of sedentary organisms - marine & plant life	8
	Moderate quantity of sedentary organisms - marine & plant life	6
	Low quantity of sedentary organisms - marine & plant life	4
	No consumption	0
	High quantity of migratory organisms	2
	Moderate quantity of migratory organisms	1
	Low quantity of migratory organisms	0.5
	No consumption	0
	SPECIAL CONSIDERATIONS ***TOTAL SCORE – RECEPTORS***	+/-5
	TOTAL SCORE	

Annex B – Barrel Protocol

1 INTRODUCTION

In order to determine the correct disposal method for barrels and their contents, the contents must first be identified. All barrel contents should be sampled and analyzed according to DND DEW Line Cleanup standard procedures, as described in this section.

Analytical data obtained for the samples collected from barrels located at the site should be compared to the criteria included in Table 1, below. Barrel contents are identified as organic or aqueous and the concentrations of glycols, alcohols, PCBs, chlorine, cadmium, chromium and lead are determined. The flash point of organic waste and aqueous waste (> 2% glycols/alcohols) must also be determined. Uncontaminated aqueous phases can be disposed of on the land according to the discharge criteria; uncontaminated organic phases can be incinerated; contaminated aqueous material should be scrubbed free of organic material; and contaminated organic material should be disposed of as hazardous material.

During the delineation phase of the site investigation, an inventory of the number and locations of barrels at the site is to be compiled. This inventory should include buried or partially buried barrels that will be taken out of the landfills during excavation. Where significant numbers of barrels are present on a site, and if safe to do so, representative samples shall be collected to provide a preliminary indication of whether on-site incineration is a viable alternative. Otherwise, barrels are only sampled during the cleanup phase and as such, the handling, transportation and opening of barrels is the responsibility of the site Contractor.

Other waste fuels and oils are also sampled according to this protocol. These may come from a variety of sources including, but not necessarily limited to, old generators, fuel tanks and pipelines, and transformers.

2 INSPECTION

All barrels are to be inspected to address the following items which shall be recorded and used as a guide prior to opening barrels.

- Symbols, words, or other marks on the barrel that identify its contents, and/or that its contents are hazardous: e.g. radioactive, explosive, corrosive, toxic, flammable.

- Symbols, words, or other marks on the barrel that indicate that it contains discarded laboratory chemicals, reagents, or other potentially dangerous materials in small-volume containers.

- Signs of deterioration or damage such as corrosion, rust, or leaks at seams, rims, and V grooves, or signs that the barrel is under pressure such as bulging and swelling.

- Spillage or discoloration on the top and sides of the barrel.

3 SAMPLING

Barrels shall not be transported until it has been determined that they are not under pressure, do not leak, and are sufficiently sound for transport.

Barrels to be sampled should be set in an upright position, provided that this does not cause them to leak and that it is physically possible.

Barrels should only be opened according to accepted procedures and under qualified supervision, preferably using remotely operated, non-sparking equipment.

Once open, barrels will be sampled by personnel wearing proper personal protective equipment as described below. Samples of the contents of all barrels shall be extracted using a drum thief and placed into a pre-labelled glass vial. The number and type of liquid phases, and their respective thickness, and the size of each barrel are to be recorded.

In instances where there are a large number of barrels with obviously similar contents, these can be grouped together and 30 to 40% of the barrels in the group sampled. Barrels containing less than 50 mm of liquid may be combined with compatible material prior to sampling; samples inferred to contain only water on a visual examination shall be tested prior to this consolidation. Barrel contents, which consist of black oil, shall not be consolidated.

All barrels shall be clearly numbered using spray paint or other suitable paint marker. The number on this label should be the only sample coding provided to the laboratory.

The barrel locations and barrel sample descriptions should be recorded.

Samples should be kept at ambient temperatures and shipped by guaranteed freight to laboratories where they should be kept cold pending analysis.

4 TESTING

Liquid samples shall be inspected and classified as either containing water or organic materials. Samples thought to contain water shall be analyzed to confirm that they are indeed water, and contain less than 2% glycols or alcohols.

The contents of barrels containing organic materials, including aqueous samples which contain more than 2% glycols or alcohols, shall be tested for flash point, PCBs, total chlorine, cadmium, chromium and lead following the targeted barrel testing approach presented in Figure 1. Analyses will be conducted on a rush basis where indicated. In addition, major organic components should be identified e.g. fuel oil, lubricating oil.

If on site incineration of waste is not planned, waste samples need only be tested for flash point, PCB, and pH (at regular turnaround time) in order to classify the waste for transport and disposal options.

Contents of barrels which contain two or more phases shall have all phases analyzed; the organic phases as described above and the aqueous phase to ascertain whether it contains less than 2% organic substances. In addition, the aqueous phase shall be tested for any components found in the organic phases above the criteria provided in the protocol.

5 DISPOSAL OF BARREL CONTENTS

Barrels containing only rust and sediment shall be treated as empty barrels.

Barrel contents comprising water only (less than 2% glycols or alcohols) shall be transferred to an open vessel such as a utility tub or half-barrel and any organic material removed by agitation with a pillow or segment of oil absorbent material. The water shall be tested prior to discharge in accordance with wastewater discharge criteria. Where water meets criteria, it may be discharged to the ground a minimum of 30 meters distance from natural drainage courses. Used oil absorbent material shall be treated as described in the following subsection.

Barrel contents which are composed of water with glycols and/or alcohols or organic phases, and which contain less than 2 ppm PCBs, 1000 ppm chlorine, 2 ppm cadmium, 10 ppm chromium, 100 ppm lead, and that have a flash point between 25°C and 225°C, may be disposed of by incineration. Alternatively these contents may be disposed of off-site at a licensed disposal facility. The solid residual material resulting from incineration shall be subjected to a leachate extraction test. Material found to not be leachable shall be disposed of as DCC Tier II contaminated soil. Leachable material shall be treated as hazardous waste and disposed of off-site at a licensed disposal facility.

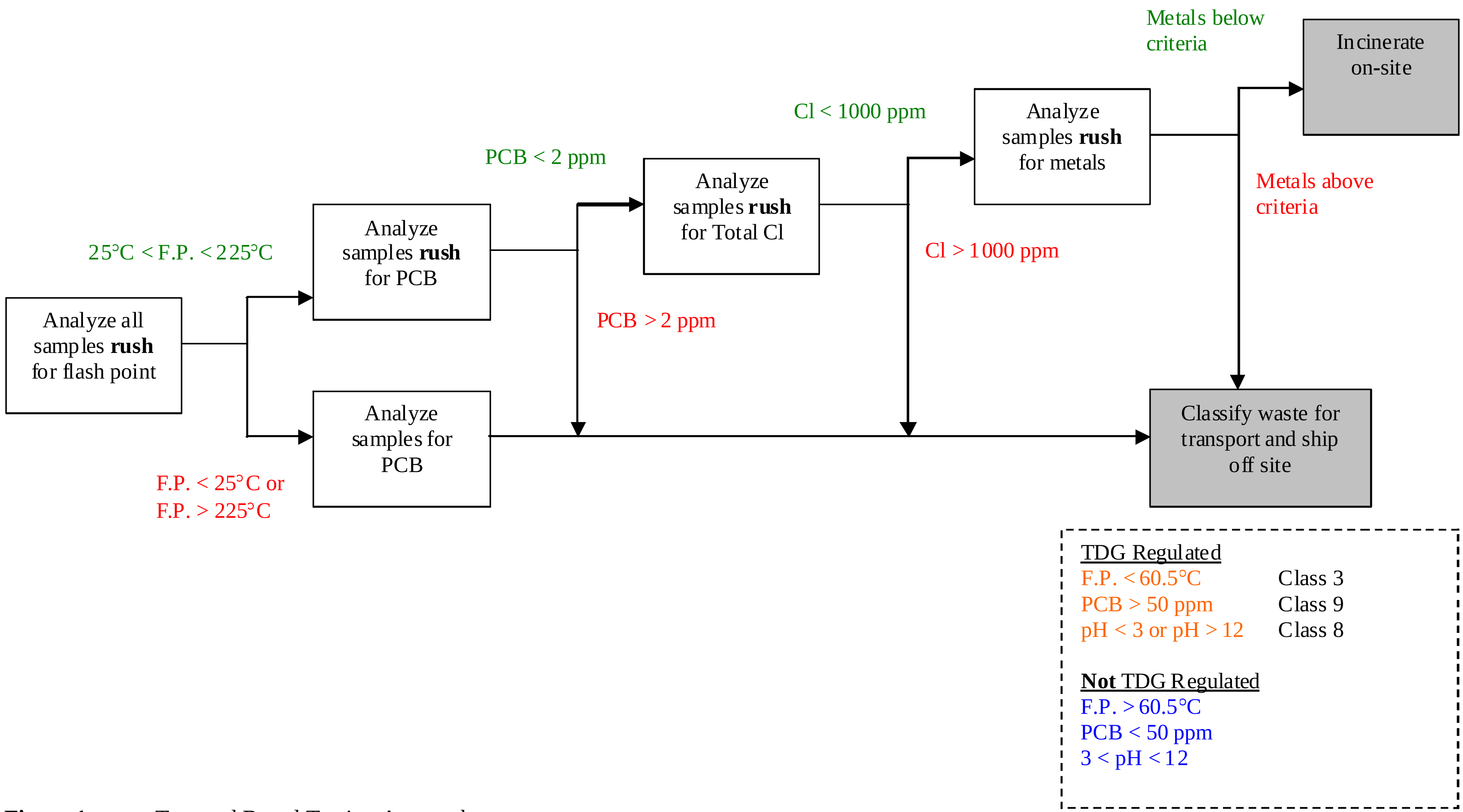

Figure 1   Targeted Barrel Testing Approach

Barrel contents, which contain greater than 2 ppm PCBs, 1000 ppm chlorine, 2 ppm cadmium, 10 ppm chromium or 100 ppm lead, or that have a flash point below 25°C or greater than 225°C shall be disposed of off-site at a licensed disposal facility. Contents may be combined with compatible materials for shipping purposes.

Used oil absorbent material should be treated as hazardous waste and disposed of off-site at a licensed disposal facility. If it is shown to be uncontaminated with PCBs (< 2 ppm), chlorine (< 1000 ppm), cadmium (< 2 ppm), chromium (< 10 ppm) and lead (< 100 ppm), it may be incinerated on-site.

6 DISPOSAL OF BARRELS

Empty barrels may be crushed or shredded and landfilled on-site as non-hazardous waste after they have been cleaned in an appropriate manner. The barrels shall be crushed in such a manner so as to reduce their volume by a minimum of 75%. Shredded barrels may be disposed of off-site as recycled metals.

7 PERSONNEL PROTECTIVE EQUIPMENT

Safety equipment required includes a respirator with organic vapour cartridges, safety glasses, a hard hat, rubber safety boots, double gloves (chemically resistant on the outside, and latex or vinyl on the inside) and disposable Syranex-coated coveralls.

A decontamination procedure should be established at the barrel sampling area(s) to prevent tracking potentially contaminated liquids outside of the sampling area(s).

It is advisable to have one person outside of the sampling area to observe the sampler(s) in case of unexpected hazards, and also to record the samplers' observations.