Public Services and Procurement Canada

REMEDIAL ACTION PLAN

PIONEER HIGH ARCTIC BUNDLE, NUNAVUT – LARGE SITE PACKAGE

On behalf of Northern Contaminated Sites Program, Nunavut Region, Crown-Indigenous Relations and Northern Affairs Canada

Skybattle Bay, Stupart Island, and Cape Ahnighito

Final Report

March 2023

P2021-10 Task H

Executive Summary

Dillon Consulting Limited and Outcome Consultants in joint venture (Dillon-Outcome or DOJV) have complete two Remedial Action Plans (RAPs) for the seven sites in the Pioneer High Arctic Bundle in Nunavut. This RAP includes the three sites of larger remedial scope, which are: Stupart Island, Skybattle Bay and Cape Ahnighito. A separate RAP for the four sites of smaller remedial scope (Playfair Point, Pioneer Island, Cape Isachsen and Kristoffer Bay) is a companion document. Management options for the waste streams present at each site have been assessed. Sections 2.0 through 4.0 of this report contain the remedial options analysis for each of the sites, by waste stream and Section 5 provides an integrated work plan for these three sites.

The waste streams, quantities and recommended remedial action, by site are as follows:

Table ES-1 Stupart Island Remedial Actions

Waste Stream	Quantity	Recommended Remedial Action
Contaminated soil	4 m^3 / 8T of PHC impacted soil (on and under a tent platform)	Contaminated soil waste (oily soil) on/under the Tent Platform is to be excavated manually, placed in soil bags and removed by aircraft for off-site, out-of-Territory disposal.
Non-hazardous waste	10 m^3 / 10 T (after incineration of wood) and metal debris	Non-hazardous wood waste is to be burned on site to reduce the weight, the ash would be collected, along with metal debris, and removed from site and sent out of Territory for disposal in the South. The total weight and volume is 10m^3 and 10T.
Waste fuel	1,600 L waste fuel 200 L of lubricating oil Total of 1,800 L	Waste fuel is to be removed from the site for disposal off-site.
Drums	58 drums, 2 x 20 L steel jerry cans, 3 oil stoves. un-crushed volume: ~14 m^3 empty weight of drums: ~1,100 kg.	The 58 drums and 2 jerry cans and 3 oil stoves are to be removed off-site by aircraft to Resolute Bay then out of the Territory by sealift for disposal.
Hazardous Waste - Propane cylinders	11 propane cylinders; empty weight: 325 kg	The eleven propane cylinders (considered hazardous waste) would be removed off-site by aircraft, then moved out of the Territory for disposal.

Table ES-2 Skybattle Bay Remedial Actions

Waste Stream	Quantity	Recommended Remedial Action
Wood Waste (APEC 4 and at random)	24 cubic metres / 24 tonnes	The wood waste is unpainted and is not a contaminant. The wood randomly scattered at APEC 1 does not need be moved. The wood waste at APEC 4 which is pallets and heavy lumber is to consolidated in a single location on top of one of the soil platforms at APEC 4, at a safe distance from the washouts present at APEC 4.
Metal Waste (at Drum Cache 1 and Oil Drilling Platform)	15 cubic meters / 30 tonnes	The lighter metal pieces are to be removed from the site however the heavier pieces such as the flywheels are to be consolidated to a single location and left on-site. The quantity of steel to be removed is approximately 15 cubic meters/ 30 tonnes.
Waste Fuel (APEC 1 and 2)	2,000 litres / 2 tonnes	Waste fuel and water from drums is to be collected in sturdy containers and transported first to Stupart Island by helicopter, and then to Resolute Bay for sending out of Territory for disposal. The waste fuel samples tested were a mixture of fuel and water.
Drums (APECs 1,2 and 4 and airstrip)	281 drums empty weight of drums: 6 tonnes	The 281 waste drums are to be removed from site, with over-packs used for drums with explosive vapours, first to Stupart Island by helicopter and then to Resolute Bay by fixed-wing aircraft, where they would be processed (cleaned and crushed), if it is advantageous to do so, then sent out of the Territory for recycling or disposal.

Table ES-3 Cape Ahnighito Actions

Waste Stream	Quantity	Recommended Remedial Action
Non-hazardous debris	Non-painted wood, metal, glass, canvas, airplane parts and plastic 12 m^3 / 12 T (reduced to 10m^3 / 10T with burning of wood)	Wood is to be incinerated to achieve volume reduction. The ash and all other waste are to be collected and sent off site and out of Territory for disposal.
Waste fuel	900 L at South Drum Cache and 400 L at Northwest Drum Cache 1,300 litres	Waste fuel is to be collected in sturdy containers and transported to Stupart Island by helicopter then to Resolute Bay by fixed-wing for either burning, if facilities exist, or sending out of Territory.
Drums	92 at Main Site and 11 at Northwest Drum Cache 103 drums empty weight of drums: 2.4 T.	The 103 waste drums are to be removed from site, with over-packs used for any drums with explosive vapours, first to Stupart Island by helicopter then to Resolute Bay by fixed-wing aircraft, where they would be processed (cleaned and crushed) if it is advantageous to do so, then sent out of the Territory for recycling or disposal.

The three sites would be serviced from a temporary camp and staging location to be installed at Stupart Island. That location was selected because it is accessible by both fixed-wing and helicopters. It is expected that the Contractor will set up a camp and equip it with environmental protection to temporarily store the wastes and transfer them to Resolute Bay during the work period. Once at Resolute Bay the waste drums may be crushed if it is efficient to do so, and waste fuel may be used as heating oil there, if there is opportunity to do so. All remaining wastes would then be transported out of Territory for disposal or recycling at licenced facilities in the South.

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1.0 Overall Introduction

1.1 Description of Project

Dillon Consulting Limited and Outcome Consultants Inc. in joint venture (Dillon-Outcome or DOJV) were retained by Public Services and Procurement Canada (PSPC) to develop Remedial Action Plans (RAPs) for the Pioneer High Arctic Bundle Sites in Nunavut. The work was generally completed as outlined in the Scope of Work as part of the Terms of Reference ("ToR") entitled "Terms of Reference for Consulting Services for Pioneer Sites Assessment Various Locations, Nunavut", dated June, 2021. The work was carried out for PSPC on behalf of Crown-Indigenous Relations and Northern Affairs Canada's (CIRNAC's) Northern Contaminated Sites Program, as call-up order no. 700596804 under the Standing Offer Agreement #EW699-170520/003/NCS.

This RAP report is a component of the scope of work being carried out under two fiscal years (2021/22 and 2022/23) for the Pioneer Sites. Other components of the scope of work include a Phase III Environmental Site Assessment (ESA), Site-wide Hazard Assessment (SWHA), Human Health and Ecological Risk Assessment (HHERA), Archaeological Impact Assessment (AIA) and Cost Estimate and Environmental Impact Assessment (EIA).

The Pioneer High Arctic Bundle consists of seven sites on Arctic Islands to the north and west of Resolute Bay, Nunavut which include: Playfair Point, Pioneer Island, Stupart Island, Skybattle Bay, Cape Ahnighito, Cape Isachsen and Kristoffer Bay. They are relics of historic oil exploration drilling activity and scientific research stations, with remnants of debris, wastes and fuel drums used to support those activities. The site locations are provided in Figure 100. The hamlet of Resolute Bay on Cornwallis Island and the Isachsen High Arctic Weather Station (HAWS) were used as staging points for the field operations.

Types and quantities of the wastes to be removed from the seven sites are the outputs of the Phase III ESAs conducted at the sites over the 2021 and 2022 field seasons. Impacted soils have been screened by the HHERA. Means and methods for executing the RAP have been developed in consideration of the site access constraints of these extremely remote sites.

1.2 Structure of this Report

The Remedial Action Plans of the seven Pioneer Sites have been grouped into two packages for the procurement of contracting services. The three sites with larger remedial scopes are covered in this RAP while the four sites with smaller remedial scope are covered in a separate RAP. This report details the RAPs for the Pioneer High Arctic Bundle sites of Stupart Island, Skybattle Bay, and Cape Ahnighito which are planned for implementation in 2024. Sections 2.0 through 4.0 can be considered as individual self-contained sections for each site within the covers of the overall report. Each section is complete with the waste streams and quantities present by Site, remediation objectives and evaluation method, remedial options analysis by waste stream and integrated work plan. Figures for each site follow the

text for the site. Section 6.0 presents the integrated Remedial Work Plan for efficient execution of the three sites planned for this remediation contract. The Work Breakdown Structure and Project Schedule for the Large Site Package (2024) contract is in Appendix A. Waste Fuel analytical results of the waste fuel sampled at the sites is contained in Appendix B.

The Sections are assigned as follows:

Table 1-1 Structure of Report

Site within the Pioneer Bundle	Section
Stupart Island	2.0
Skybattle Bay	3.0
Cape Ahnighito	4.0

130° 0' 0" W | 125° 0' 0" W | 120° 0' 0" W | 115° 0' 0" W | 110° 0' 0" W | 105° 0' 0" W | 100° 0' 0" W | 95° 0' 0" W | 90° 0' 0" W | 85° 0' 0" W | 80° 0' 0" W | 75° 0' 0" W | 70° 0' 0" W | 65° 0' 0" W

75° 0' 0" N

CAPE ISACHSEN

ISACHSEN WEATHER STATION

ELLEF RINGNES ISLAND

AMUND RINGNES ISLAND

KRISTOFFER BAY

CAPE AHNIGHITO

LOUGHEED ISLAND

SKYBATTLE BAY

PIONEER ISLAND

STUPART ISLAND

BATHURST ISLAND

DEVON ISLAND

MELVILLE ISLAND

CORNWALLIS ISLAND

PLAYFAIR POINT

RESOLUTE BAY

115° 0' 0" W | 110° 0' 0" W | 105° 0' 0" W | 100° 0' 0" W | 95° 0' 0" W | 90° 0' 0" W | 85° 0' 0" W | 80° 0' 0" W

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FILENAME: C:\CAD\21-2370 PIONEER SITES\PLAYFAIR POINT 2141\PLAYFAIR POINT.DWG
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DESIGN	GS
REVIEWED BY	GS
DRAWN	TPW
CHECKED BY	GS
DATE	NOVEMBER 2021
SCALE	AS SHOWN

ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

PIONEER SITE LOCATIONS AND STAGING LOCATION

SHEET NO. 100

2.0 Stupart Island Remedial Action Plan

2.1 Executive Summary

The Stupart Island site is designated as NB070 – Stupart Island in the Northwest Territories/Nunavut contaminated site database. Its federal contaminated site inventory (FCSI) number is 00000298. It is located about 400 km northwest of Resolute Bay and is a low-lying island about 2 kilometres (km) in diameter, just south of Lougheed Island. The contaminated site is near the centre of the island on a dorsal ridge. It consists of the remains of an Arctic research camp. The site is currently uninhabited by humans. There is no officially designated airstrip at Stupart Island, however, a suitable landing strip was selected on the dorsal ridge near the centre of the island.

A Phase I and II ESA site visit was conducted in 2011 with the report dated 2012 by Water and Earth Sciences Associated Inc. (WESA 2012b). WESA described the site as containing the remains of a historic camp which included two (2) tent platforms, approximately 60 drums (36 empty, nine (9) partially full, seven (7) full, and five (5) of unknown status) located at one main cache, one smaller cache and scattered throughout the site, wood and metal debris that included stoves, and a burn area. The Phase II ESA results indicated that there were soil exceedances above the applicable criteria for copper, naphthalene and PHC-F1, F2, and F3 at the burn pit and debris area.

The Phase III ESA (Dillon-Outcome, 2022a) conducted at Stupart Island, identified four APECs, three which were previously identified in the WESA Phase II ESA (i.e., APEC 1: Large Drum Cache, APEC 2 Smaller Drum Cache, and APEC 3 Burn Area and Debris Field), and an additional APEC identified through site reconnaissance (APEC 4 Oily Soil on a tent platform). The Phase III ESA results indicated that there were soil exceedances above the applicable CCME criteria for PHC F2, F3, F4 and/or select PAHs at APEC 2: the smaller drum cache, APEC 3: burn area/debris field and at APEC 4: the oily soil on a tent platform. The results of the Risk Assessment indicated that only the soil at APEC 4 warranted remedial action.

A summary of wastes which require remediation at the Stupart Island site is as follows:

Table 2-1– Summary of Waste Streams at Stupart Island Requiring Remediation

Waste Stream	Quantity
Contaminated soil	4 m^3 / 8T of PHC impacted soil (on and under a tent platform)
Non-hazardous waste	10 m^3 / 10 T of wood and metal debris
Waste fuel	1,600 L waste fuel 200 L of lubricating oil Total of 1,800 L

Waste Stream	Quantity
Drums	58 drums, 2 x 20 L steel jerry cans, 3 oil stoves. un-crushed volume: ~14 m^3 empty weight of drums: ~1,100 kg.
Hazardous Waste - Propane cylinders	11 propane cylinders; empty weight: 325 kg

Although soil with contaminant concentrations in excess of the applicable CCME Guidelines has been found at the Stupart Island, the Human Health Risk Assessment results indicated there is negligible potential for human health risk from the contaminants. The Ecological Risk Assessment also concluded that there is no need for corrective action or risk management on the site, in relation to communities or populations of ecological receptors. However, the Risk Assessment stated that it would be prudent to address the heavily contaminated soil pile on a tent platform in the RAP to reduce potential exposures to human and ecological receptors. Based on the results of the HHERA there is an assumed total of 4 m^3 of contaminated soil at Stupart Island. The soil is located at APEC 4 - Oily Soil Pile on and below the tent platform.

Remedial Options Analysis

A remedial options analysis was conducted for each waste stream requiring remediation. Evaluation criteria were the same for the analysis of options for each waste stream: i) Reduction of Environmental Risk; ii) Value to the Crown; iii) Resources Required; iv) Reduction of Environmental Risk; and v) Local Benefits. Several viable management options were conceived for each waste stream, and they were evaluated according to the evaluation criteria. Options were scored under each evaluation criterion as favourable, neutral or unfavourable, according to the degree to which the criterion was satisfied. The objective is to develop and recommend a solution which is protective of the environment and does not require on-going monitoring or maintenance, i.e., a “walk-away” solution.

The integrated remedial plan is comprised of the highest-ranking options from the multi-criteria decision analysis of each waste stream requiring remediation. The integrated preferred remedial option consists of:

1. Contaminated soil waste (oily soil) from APEC 4 Tent Platform would be excavated manually, placed in soil bags and removed by aircraft for off-site, out-of-Territory disposal. The total volume is estimated to be a maximum of 4 m^3 and weight is 8T.
2. Non-hazardous wood waste would be burned on site to reduce the weight, the ash would be collected, along with metal debris, and removed from site and sent out of Territory for disposal in the South. The total weight and volume is 10m^3 and 10T.
3. Waste fuel would be removed from the site for disposal off-site. The waste fuel volume is 1,600 L gasoline and 200 L oil.

4. The 58 drums and 2 jerry cans and 3 oil stoves would be removed off-site by aircraft for processing/disposal in Resolute Bay or out of the Territory for disposal by sealift. The weight and volume of empty waste drums etc. is approximately 14 m^3 / 1.1 T.

5. The eleven propane cylinders (considered hazardous waste) would be removed off-site by aircraft, then moved out of the Territory for disposal. The combined weight of the propane cylinders is estimated to be 325 kilograms (0.325 T).

With this plan approximately 20 tonnes of waste will require removal from the site, and transportation to waste receiving sites outside of the territory as deemed appropriate. With this integrated set of actions for the waste streams, the solution would be "walk-away", with no on-going requirements. Aircraft is the most viable method of transporting the contaminated soil, waste drums and hazardous waste (propane cylinders) out of Stupart Island to Resolute Bay. From Resolute Bay all of the wastes would then be transported by sealift for final disposal at a facility in the South.

The on-site work of collection of waste fuel, waste wood incineration and preparation of drums for transportation should take place in the summer months, but it may be more efficient to remove the 20 T of waste off-site via a larger plane than a Twin Otter, such as a DC-3 which has a payload of about 3T, and that would best be accomplished in the winter months when it could land at the site on skis.

There is usually one sealift stop in Resolute Bay per year and it is in September. Thus, the total duration of the remediation work at Stupart Island would include summer work on-site, flying out of wastes, and sealift transportation out of Territory in September.

2.2 Introduction

2.2.1 Objectives of the Remedial Action Plan

The objectives of the site remediation are to reduce the environmental risks to an acceptable level for all current and envisaged future site uses and reduce the environmental liability with a "walk-away" solution. The objectives of the remedial action plan (RAP) are to:

- Develop remedial and/or risk management options for each waste stream at the site;
- Evaluate each remedial/risk management option according to its expected degree of success in achieving outcomes of: i) reduction of environmental risk; ii) providing value to the Crown; iii) utilizing resources reasonably available; iv) reduction of the environmental liability; and v) providing local benefits, both during and following remediation;
- Detail the resources required to complete the remediation project; and
- Recommend optimal scheduling of work such that the entire Pioneer Bundle can be addressed in the current phase of the Federal Contaminated Sites Action Plan, ending in March 2025.

2.3 Background of Stupart Island and Features

The Stupart Island site is located about 400 km northwest of Resolute Bay at approximately 77º 07' 53.71'' N latitude and 104º 26' 32.32'' W longitude. Its FCSI number is 00000298. It is a low-lying island about 2 kilometres (km) in diameter, just south of Lougheed Island. The contaminated site is near the centre of the island on a dorsal ridge. It consists of the remains of an Arctic research camp, including two old tent platforms, fuel drums piled in caches and scattered around the site, and debris piles with evidence of burning. There is no officially designated airstrip at Stupart Island.

The Phase I ESA for the Stupart Island site (WESA 2012b) did not find any evidence linking the site to a responsible party; there was no information on it in the Nunavut Mineral Database (NUMIN). The only aerial photograph of the site was taken in 1960 and did not show any evidence of human activity. The Phase I ESA site visit noted the remains of a historic camp which included two (2) tent platforms, approximately 60 drums (36 empty, nine (9) partially full, seven (7) full, and five (5) of unknown status) located at one main cache, one smaller cache and scattered throughout the site, wood and metal debris that included stoves, and a burn area.

The Phase II ESA field work was done concurrently with the Phase I site visit on July 10, 2011. It consisted of seven hand-dug test pits to a maximum depth of 0.30m, including a background test pit. Targeted features for soil sampling were the main drum cache, the smaller drum cache, the burn pits and the debris area. The Guidelines used for comparison were CCME Agricultural Land Use. Petroleum hydrocarbon and polycyclic aromatic hydrocarbon (PAH) exceedances were only reported for the samples at the burn pits. The main burn pit also had an exceedance of copper above that Guideline.

There were no other metals exceedances. The Background sample had no exceedances of any parameter.

The Phase III ESA (Dillon-Outcome, 2022a) conducted at Stupart Island, identified 4 APECs, three which were previously identified in the Phase II ESA (WESA, 2012) (i.e., APEC 1 Large Drum Cache, APEC 2 Smaller Drum Cache, and APEC 3 Burn Area and Debris Field), and an additional APEC identified through site reconnaissance (i.e., APEC 4 Oily Soil on a tent platform). The results of the Phase III ESA for contaminated soil assessment and waste material characterization are contained in the following sections.

2.3.1 Physical Setting and Site Reconnaissance

A ground-level reconnaissance of the Stupart Island site was the first task performed. The Site was found to be consistent with the description in the previous report (WESA 2012b). Its principal features were: one large drum cache, numerous other drums placed at random around the site, two wooden tent platforms, metal debris and one burn pit, and a small number of drums found randomly at distances of up to 30 m from the main area of the Site. The entire perimeter of the island was visible from the Site since it is on a central ridge in the middle of the island. The ground was barren with no vegetation other than discontinuous patches of lichen. There was no standing or flowing water on the island. A drive around the perimeter of the island on an ATV did not encounter any wildlife. Site hazards were sharp metal debris, loose drums on the drum cache, and tripping on semi-buried debris.

The areas of potential environmental concern (APECs) targeted in the Phase III ESA were:

APEC 1: Main Drum Cache

APEC 2: Smaller Drum Cache

APEC 3: Burn Area and Debris Field

APEC 4: Oily Stained Soil on Tent Pad.

2.3.2 Site Access Conditions

Although the Site could potentially be reached by boat from Resolute Bay, the only practical means for accessing the site is by air, given the distance and presence of sea ice.

A reconnaissance flight to Stupart Island was completed on July 6, 2021 by Kenn Borek Airways using a Twin Otter on tundra tires to assess its landing conditions for fixed wing aircraft. The reconnaissance flight did not land because of soft and wet conditions but noted that the strip was drying out and could be used soon if there were not heavy rains.

The field team for this Phase III ESA reached Stupart Island from Resolute Bay in August by Twin Otter and landed on a dorsal ridge that runs by the abandoned camp. This ridge is maximum elevation on the island therefore it dries out first. The usable airstrip was long and smooth.

Site access constraints are the potential softness of the landing strip in the non-frozen condition, and the limited time period during which it can support an aircraft in summer months, even on tundra tires. The landing strip at Stupart Island would have fewer limitations under frozen conditions, as long as there were no snow drifts.

2.3.3 Waste Streams and Quantities Present

The Phase III ESA (DOJV 2022a) assessed the APECs at the Stupart Island site via soil sampling and inventorying the other waste streams. The soil analytical results were compared to CCME guidelines in the Phase III ESA, and then analyzed in the HHERA (DOJV, 2021b). The results of both assessments are summarized below.

2.3.4 Impacted Soil Assessment

The Phase III ESA soil sampling was by test pits dug manually with a shovel. Test pits were dug to refusal on permafrost or as deep as possible if permafrost was not encountered. Bedrock was not encountered in any test pit at Stupart Island.

The approach in planning the test pit locations was to target the previously identified APECs, plus any areas that Dillon-Outcome identified as data gaps based on the site reconnaissance, with a set of close and stepped-out test pits around the APEC. APECs were sampled on the up and down-gradient sides. The stepped-out test pits were 2 m out in order to have assurance of achieving lateral delineation. The stratigraphy observed in each test pit was logged in terms of soil type, evidence of contamination (staining or odour) presence of debris, moisture, water inflow, and colour. A total of 33 test pits were carried out including three background test pits, three geotechnical test pits and 27 environmental test pits at the APECs.

The soil analytical results were compared to CCME Agricultural guidelines in the Phase III ESA, and then analyzed in the HHERA. The results of both assessments are summarized below.

2.3.4.1 Impacted Soil Quantities by Generic Guidelines

The generic guidelines used to screen for soil exceedances were:

- **Soil – BTEX, metals and PAH:** CCME Soil Quality Guidelines, Agricultural Land Use, coarse-grained soil, shallow depth (<1.5 metres);
- **Soil – Petroleum Hydrocarbons:** CCME Canada-Wide Standards for Petroleum Hydrocarbons, Tier 1, Agricultural land use, coarse grained soil, Eco soil contact, more than 10 m from aquatic habitat.

Agricultural land use was deemed appropriate given CCME agricultural/wildland use is defined as "land on which the primary activity is related to the productivity capability of the land and includes lands that provide habitat for wildlife and birds".

Background Soil Testing: There were three background test pits dug and sampled: ST000, ST001, ST002. ST000 was 60 m to the southeast of the main drum cache. ST001 was 50 m to the east of the main drum

cache and ST002 was 50 m to the north of the main drum cache. All background samples were analyzed for metals. Chemical analysis revealed that the metals concentrations in all background samples were below the CCME Agricultural guidelines.

APEC 1 Main Drum Cache (Area 100): There were six test pits completed around the main drum cache. Figure 403 shows the sample locations at this APEC. Test pits ST100 was located immediately beside the drum cache. Test pits ST101, ST102, ST103 and ST1-4 were within 2 m of the drum cache and ST105 was stepped out 5 m from the drum cache. The area was flat and at the high point on the island, so the down-gradient direction was inferred to be radially outward from the drum cache. There was no odour detected in the soil samples and no high soil vapour readings. The chemical analysis revealed no detection of BTEX, PHC or PAH in any samples at the main drum cache, and metals concentrations in all samples were below the CCME Agricultural guidelines. There was no indication of a contaminated site at the Main Drum Cache.

APEC 2 Smaller Drum Cache (Area 200): There were five test pits completed around the smaller drum cache. All drums were empty. Figure 404 shows the sample locations at this APEC. Test pits ST200 was located in the centre of the drum cache, immediately beside two drums on their side. Test pits ST201, ST202, ST203 and ST204 were done to the east, north, west and south of the drums. Petroleum hydrocarbon concentrations exceeded the guideline at ST200's duplicate and on the average between the original and duplicate sample in the PHC-F2 range (165 mg/kg compared to 150 mg/kg) and at ST204 on the south side (410 mg/kg compared to 150 mg/kg). ST204 also had PAH exceedances. An impacted zone has been interpreted at this APEC to include the drums and extend southward past ST204. It is delineated by clean samples on the north, east and west sides but not to the south. The depth extent is determined by permafrost, encountered at 0.5 m BGS. An area of 32 m^2 and a volume of 16 m^3 have been estimated for the contaminated soil at the Smaller Drum Cache.

APEC 3 Burn Area and Debris Field (Area 300): There were five test pits completed at the burn area and another 10 completed in the debris field around the tent platforms. Figure 405 shows the sample locations at this APEC. Test pit ST300 was located in the centre of the burn area and test pits ST301, ST302, ST303 and ST304 were done to the north, northwest, southeast and southwest, respectively, outside of the burn area. Lab testing in the burn area consisted of metals and PAH on all samples, with PHC and BTEX additionally in the centre of the burn area. The previous ESA results showed only an exceedance in copper at the burn area. In this investigation the central sample ST300 displayed a marginal exceedance in PHC-F2 (165 mg/kg compared to 150 mg/kg) and ST303 at 5 m southeast of the centre had an exceedance in PAH compounds naphthalene and phenanthrene. The impacted zone at the burn area is delimited by clean samples at ST301 to the north, ST302 to the northwest, and ST304 to the southwest. Permafrost was encountered at 0.45 m BGS in ST304. An area of 40 m^2 and a volume of 20 m^3 have been estimated for the contaminated soil at the burn area in APEC 3.

Test pit ST305, which was between an overturned oil stove and an overturned drum, displayed petroleum hydrocarbon impact in its lab results (PHC-F2: 3,600 mg/kg compared to 150 mg/kg, and PHC-F3: 320 mg/kg compared to 300 mg/kg). Its depth to permafrost was 0.4 m BGS. The closest clean

sample was ST306C (and duplicate ST306 QA/QC 3) which were both non-detect for PHC. An area of 20 m^2 and an additional volume of 10 m^3 have been estimated for the contaminated soil at the oil stove in APEC 2.

APEC 4 Oily Soil Pile (Area 400): A stockpile of stained and obviously oily soil on the southeast tent platform was sampled as ST400. There were several cans of motor oil within the sandy soil in the pile. Lab results confirmed its impact (PHC-F3 22,000 mg/kg compared to 300 mg/kg and PHC-F4: 24,000 mg/kg compared to 2,800 mg/kg). The volume of the soil pile on the platform is estimated at 2 m^3. Sampling under the tent platform was not carried out but an equal amount of contaminated soil is considered possible underneath the platform, for a total of 4 $m^3$of contaminated soil at APEC 4.

A summary of the contaminated soil volume estimates at the four APECs, defined by generic CCME guidelines, and the degree of certainty in the delineation is provided below.

Table 2-2 Stupart Island Impacted Soil Areas

Defined Area	Surface Area of Impact (m^2)	Depth (m)	Impacted Volume (m^3)	Contaminant of Concern	Certainty of delineation
APEC 1 - Main Drum Cache	None	None	None	n/a	High; no contamination found.
APEC 2 - Smaller Drum Cache	32	0.5	16	PHC, PAHs	Medium, clean limit not certain to the south.
APEC 3 - Burn Area	40	0.5	20	PHC, PAH	Medium, clean limit not certain to the southeast.
APEC 3 - Debris Field (oil stove)	20	0.5	10	PHC	Low, delineated only to the south
APEC 4 - Oily Soil Pile	4	0.5 above 0.5 below	4	PHC	High on top of platform, unknown beneath the platform
Totals	**96 m^2**		**50 m^3**	**PHC, PAH**	**Range: Low to High.**

2.3.4.2 Human Health Risk Assessment of Soil

The soil data reviewed in the Risk Assessment (HHERA) and Ecological Risk assessment (ERA) were compiled from the Phase II ESA (WESA, 2012b) and the present Phase III soil sampling program (DOJV 2022a).

The purpose of the HHERA was used to evaluate whether there are unacceptable environmental risks to human health at the site based on possible exposure scenarios and pathways, identification of receptors of potential concern and identification of contaminants of potential concern (COPC).

The HHRA conservatively assumed the following for Stupart Island:

- Human Exposure Pathways/Routes: Inhalation, Ingestion and/or Dermal contact with outdoor soils/dusts;
- Receptors: Outdoor Site Visitor (an adult or toddler receptor; or lifetime receptor for non-threshold chemicals).

The overall exposure scenario selected for the HHRA was:

- Outdoor Site Visitor Scenario (toddler, adult): This scenario assumes that a hypothetical person visits the Pioneer Island site for hunting, recreational or research purposes, for up to 4 weeks per year.

The following chemicals were identified as initial COPCs for human health:

- PHC F2
- PHC F3

The maximum PHC F2 and PHC F3 soil concentrations exceeded their respective SQG_{HH} only from sample (ST400) which is the APEC 4: Oily Soil Pile on the Tent Platform. Risk characterization results indicated there is a negligible potential for human health risks at Stupart Island based on measured site soil concentrations and the potential for exposure to contaminated soils. Although the potential human exposure to the oily soil stockpile would be considered unlikely, it would be prudent to address this stockpile, and to investigate further the soils under the tent platform and address any staining. This would reduce the potential for human exposures to hazardous levels of PHC in the soils.

2.3.4.3 Ecological Risk Assessment

The Ecological Risk Assessment was conducted in similar fashion to the Human Health Risk Assessment process as described in detail in the HHERA report (DOJV 2021b).

The likelihood of potential risk to terrestrial vegetation and soil invertebrate communities and mammalian wildlife populations on the site is considered to be negligible. With the exception of the soils under the southeast tent platform, the site is considered to be adequately characterized, as the portions that could be sampled provide good spatial coverage of the property. Further sampling is considered unlikely to alter outcomes and conclusions of the current ERA even if soils below the tent platform are elevated given the small size of potential impact to vegetation related to this contamination.

2.3.4.4 Conclusions of the Risk Assessment

The likelihood of potential risk to outdoor site visitors, terrestrial vegetation and soil invertebrate communities, and mammalian wildlife populations on the site is considered to be negligible. With the exception of the area under the south east tent platform, the site is considered to be adequately characterized, as the portions that could be sampled provide good spatial coverage of the property.

This conclusion is assumed based on current site conditions. As such, if concentrations were to increase in the future (e.g., if leaking barrels are not removed and remain on site, resulting in increased PHC concentrations in soil), the results of the HHERA would need to be reassessed to see if they still apply.

As such, hazardous waste (fuel and oil) on site should be addressed in a comprehensive RAP. In addition, given the uncertainty in the oily soil pile and stained areas below the tent platform, it would be prudent to address the area in the RAP to reduce potential exposures to human and ecological receptors.

Based on the results of the HHERA there is an assumed total of 4 m^3 of contaminated soil at Stupart Island at APEC 4 - Oily Soil Pile, which require an assessment for remedial options.

2.3.5 Non-Hazardous Waste

An inventory of non-hazardous materials was conducted. The non-hazardous debris included:

- Two tent platforms: both are made of panels of wood totalling 2 x (4.8m x 4.8m x 0.2m) = 9.2 m^3
- Sheet of plywood 1.2 x 2.4 x 0.2 m = 0.05 m^3
- Tent ribs and sides = 2 m^3
- Large galvanized hot water tank = 3 m^3
- Bed frames = 1 m^3
- Wooden tool box = 1 m^3
- Table and chairs (metal) =1 m^3

Total non-hazardous waste = 17 m^3, rounded up to 20 m^3, with half of it wood and half of it metal.

2.3.6 Drum and Fuel Waste

An inventory of drums and fuel waste at the Stupart Island site was conducted. A numeric ID was spray-painted on each drum. The inventory results are listed below.

Table 2-3– Quantities of Drums and Waste Fuel

Area	Number of Drums and ID	Number of Drums assumed full	Drum Sampled	Estimated Volume/Type	Drum Weight (assumed 18kg empty/drum) and Volume
Main Drum Cache	39 (Drums 1-39)	5	n/a	~1,000 L gasoline	702 kg and 9 m^3 uncrushed
Drums to the west	3 (Drums 40-42)	1	#40 (Reddish Color Drum)	~200 L gasoline	54 kg and ~0.75 m^3 uncrushed
Drums in the debris field	5 (Drums 43-47)	1	#43 (Dark Color Drum)	~200 L oil	90 kg and ~1.5 m^3 uncrushed
Smaller Drum Cache	3 (Drums 48-50)	0	n/a		54 kg and ~0.75 m^3 uncrushed

Area	Number of Drums and ID	Number of Drums assumed full	Drum Sampled	Estimated Volume/Type	Drum Weight (assumed 18kg empty/drum) and Volume
Drums outside of central area	8 (Drums 51-58)	2	n/a	~400 L gasoline	144 kg and ~2 m^3 uncrushed
Totals	**58**	**9**		**~1,600 L gasoline** **~200 L oil**	**~1,100 kg and ~14 m^3 uncrushed**

As well, there were two empty 20 L steel jerry cans and three oil stoves located in the debris field.

There were just two-color patterns present at Stupart Island: reddish brown, and all dark.

The analysis of product taken from drum #40 showed that it had a spectrum similar to a gasoline mixture with 0% water. Flashpoint was 20°C. Specific gravity was 0.7498. There was no PCB, lead, cadmium or chromium detected.

The analysis of product taken from drum #43 showed that it had a spectrum similar to industrial mineral oil with 30% water. Flashpoint was 140°C. Specific gravity was 0.8801. There was no PCB, lead, cadmium or chromium detected.

The analytical report on waste fuel testing from PetroLab is included in Appendix B.

2.3.7 Hazardous Waste - Propane Cylinders

An inventory of hazardous materials was conducted. Eleven propane cylinders (100 lbs cylinders) were discovered and are considered household hazardous waste. The total weight (empty cylinders) of 11 cylinders estimated at about 325 kg.

2.3.8 Summary of Waste Streams

A summary of wastes which require remediation at the Stupart Island site is as follows:

Table 2-4– Summary of Waste Streams Requiring Remediation

Waste Stream	Quantity
Contaminated soil	4 m^3 / 8T of PHC impacted soil (on and under a tent platform)
Non-hazardous waste	20 m^3 / 20 T of wood and metal debris

Waste Stream	Quantity
	10 m3 / 10 T (after incineration of wood) and metal debris
Waste fuel	1,600 L waste fuel 200 L of lubricating oil Total of 1,800 L
Drums	58 drums, 2 x 20 L steel jerry cans, 3 oil stoves. un-crushed volume: ~14 m^3 empty weight of drums: ~1,100 kg.
Hazardous Waste - Propane cylinders	11 cylinders; empty weight: 325 kg

2.4 Remedial Options Analysis by Waste Stream

2.4.1 Evaluation Method

The process used to assess and select remedial options was a qualitative, multi-variant criteria decision matrix. This process is useful to arrive at an optimal decision when multiple criteria must be considered. The outcome of such an analysis is a solution which is the best compromise solution for balancing the degree of satisfaction of all (and often competing) considerations. The process was implemented by developing a set of potentially viable management options for each waste stream requiring remediation, including a base case (left as is) option, and evaluating the degree to which each option satisfied each evaluation criteria.

The evaluation criteria were evenly weighted in the comparison. Each management option was scored as favourable, neutral or unfavourable under each evaluation criterion to indicate its degree of satisfaction of the individual criterion. A favourable score was assigned if the evaluation criteria was well, or very well, satisfied. A neutral score is given if the evaluation criteria is somewhat satisfied, and an unfavourable score is assigned if the evaluation criterion is poorly or very poorly satisfied.

To determine the most favourable option per waste stream, a numeric value was given to the favorability score as follows: each favourable score was given a value of +1, each neutral score was given a numerical value of 0, and each unfavourable score was given a value of -1. The overall score for each option was tallied and expressed as *favourable* if the numeric tally is greater than zero, *neutral* if the numeric tally is zero, and *unfavourable* if the numeric tally is less than zero. The numerical score is also given in order to highlight the most favourable option, in the event that more than one receives a favourable overall score.

The evaluation criteria that the options were scored against reflect the overall remediation objectives for the site and remained the constant for the analysis of each waste stream. They were:

Reduction of Environmental Risks: This criterion focuses on the reduction of potential environmental risks as evaluated in the HHERA. It ranks how successful an option is in reducing potential risks to the receiving environment and uptake by humans or the natural environment. A positive ranking indicates that environmental risk will be very successfully reduced by the option; a neutral ranking indicates that the environmental risk will be somewhat reduced by the option, and an unfavourable ranking indicates that the option likely does not adequately reduce the environmental risk.

Value to Crown: This criterion is a qualitative comparison of overall cost of each option. It considers the overall closure costs (Capital) and longer-term monitoring and maintenance (LTM) if the option requires it. As a qualitative score, the evaluation it is not proportional to actual costs. The cheapest option(s) are scored as favourable and the most expensive score as unfavourable. A neutral ranking indicates an option that is in between the high and low-cost options under consideration.

Resources Required: This criterion encompasses the engineering and scientific complexity of each option such as the ability to achieve physical and chemical stability and construction complexity. This criterion also considers the remoteness of the site and that all equipment required for the work will need to be brought on and off-site by air, and that the closest community to the site is 400 km distant. Options that require mobilization of significant resources will be ranked as unfavourable. Solutions requiring a moderate mobilization of resources will be ranked neutral and solution with a lower degree of resources required will score favourably. Although cost is somewhat related to resources required, this criterion focuses strictly the resources required and technical complexity.

Reduction of Environmental Liability: This is considered satisfied when environmental liability can be considered as zero once the option has been implemented. Options which are "walk-away" with no future monitoring requirements are scored as favourable, whereas those with on-going monitoring and maintenance obligations are scored lower (unfavourable). A neutral ranking indicates that the liability has been significantly reduced but not entirely extinguished.

Local Benefits: This criterion considers the local economic benefits derived during the remedial work and the long-term benefit from potential future use of the site by local stakeholders. Local stakeholders are defined as residents of the area who may be employed in the remedial work program and who may use the site as part of their traditional hunting, fishing and food gathering land. It is important to note that this criterion has been scored from an anticipatory perspective, as the stakeholder consultation component of this project has not yet taken place, and the stakeholders' opinions on the integrated option which is the output of the remedial options analysis have not been heard.

2.4.2 Contaminated Soil Waste

A total of ~4 m^3 of PHC contaminated soil is present at Stupart Island.

The most viable management option for the contaminated soil waste is to remove the soil from the small, affected area on and below the tent platform (APEC 4). Impacted soils could be excavated by hand and placed in soil bags for off-site disposal. This option removes the (limited) Environmental risk

and liability, is achievable with modest resources (workers, ATVs, trailers), is cost effective, and provides offers local benefits in terms of employment and delivering a clean site when completed.

2.4.3 Non-Hazardous Waste: Wood and Metal Debris

There is a total of ~12 m^3 of wood debris (tent platforms, plywood, toolbox) and 8 m^3 of metal debris (tent ribs/sides, hot water tank, bed frames, table and chairs) scattered across the site that is considered to be non-hazardous. The identified options for management are:

1) Leaving as is: The wood and metal waste would be left in one consolidated location.
2) Incineration of wood and removal of ash and metal waste: The wood would be burned on a constructed incineration pad in a monitored and controlled burn. The burn pad could be located at the previously used burn area and would not require any borrow material. A burn pad and cage would be used to minimize mixing of ash and the underlying soil. The ~12 m^3 of wood would be reduced in volume to 5-10% of the original volume, i.e. ~1.2 m^3 of ash with a weight of <0.7T. The existing 8 m^3 of metal debris (expected to weigh 8 T because not solid metal per cubic metre) would also be removed to Resolute Bay (total weight and volume of 10m^3 and 10T), and out of Territory by sealift to a disposal facility in the South.
3) Off-site disposal of wood and metal waste: The wood and metal waste would be moved off-site for disposal. The 12 m^3 of wood and 8 m^3 metal waste would be expected to weigh about 20 tonnes and would require multiple aircraft flights to accomplish removal from the site to Resolute Bay. From there the wood could be made available as firewood. Any remaining wood and the waste metal would be shipped south for disposal.

The three options for the wood and metal waste have been evaluated and the results are tabulated below.

Table 2-5- Evaluation of Options for Wood and Metal Waste

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score*
	Reduction of Environmental Risk	Value to Crown	Resources Required	Reduction of Liability	Local Benefits	
Leaving on-site (wood/metal debris)	Unfavourable	Favourable	Favourable	Unfavourable	Neutral	Neutral (0)
Incineration of wood waste and off-site disposal of ash and metal	Favourable	Neutral	Neutral	Favourable	Neutral	Favourable (+2)
Off-site disposal of wood and metal waste	Favourable	Unfavourable	Unfavourable	Favourable	Favourable	Favourable (+1)

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

Leaving the wood and metal debris on-site in a consolidated location is the minimal intervention option. It does not remove the environmental or physical risk of the debris (unfavourable). Although the wood and metal debris are non-hazardous, deliberately leaving it would constitute initiating a waste site and would require a permit and further site visits (unfavourable for Reduction of Liability). It has a very low resource requirement in gathering the wastes in one location and is low-cost and therefore scores favourably on those criteria. There would be some minor local benefit from general labour required for consolidating the waste, but the community would not be gaining a cleaned-up site. Local benefits are rated neutral. The overall score is neutral (0).

Incineration of the wood waste with off-site disposal of ash and metal scores favourably on Reduction of Environmental Risk because the waste will be removed, and favourably on Reduction of Liability because no monitoring visits will be required. The Local Benefit score is neutral because the labour content is seen as between the Leave on-site option and Removal without incineration option. It is also between the lowest and highest cost and is ranked neutral in Value to Crown. Overall, it ranks as Favourable with a score of +2.

The off-site disposal without incineration option would remove the Environmental Risk and Liability (favourable), however it would be more costly and require more resources (flights) to move 20 tonnes of wood and metal waste off site than the other options (unfavourable). The local benefits are favourable as this has higher local labour content than the options (more handling) and once the wood has been brought to Resolute Bay, some may be reused as firewood. Overall, this option is favourable (+1).

The optimum waste management solution for the non-hazardous waste is for the wood to be burned on site to reduce the weight, and for the ash to be collected, along with metal debris, and removed from site and sent out of Territory for disposal in the South.

Stupart Island is planned to be used as a staging location for wastes being brought from Skybattle Bay and Cape Ahnighito within the same contract. The tent platforms could therefore serve their original purpose once again during the remediation contract, and only be incinerated in the wind down phase of work at Stupart Island.

2.4.4 Waste Fuel

A quantity of approximately 1,600 L of fuel and 200 L of oil are present at Stupart Island. The identified options for management are:

1. Leaving as-is: Leaving the waste fuel in its current situation.
2. Incineration on-site: An incinerator would be mobilized to Stupart Island and the waste fuel would be brought to the incinerator for burning. The feasibility of using small incinerators on-site to burn the waste fuel was assessed. There are at least two small/ low weight incinerators on the market that are transportable by aircraft and capable of burning aviation fuel. Two SmartAsh units with an optional drum transfer pump or a single Total Combustion Inc, model DCL would be capable of incinerating the volume of waste fuel in 6-8 days (at 300 L per day) and could be transported to the site in a single Twin Otter aircraft flight. On-site incineration reduces the number of times the fuel would be handled compared to off-site transportation and disposal, and therefore reduces the environmental risk. The small incinerator would require additional labour and skill to operate. Incineration would take place while the camp and transfer station are active at Stupart Island.
3. Removal off-site for disposal. Given that the structural integrity of the drums is unknown, they may have corroded and weakened to the point of near perforation or could in the future. For this reason, it is not envisaged to move any of the full or partially full drums from their present location.

The contents would be pumped from all non-empty drums into alternative sturdy containers, transported to the aircraft, and transported via aircraft to Resolute Bay for processing (possible incineration) or transfer out of the territory for disposal. Removal of the waste fuel from the site for disposal out of the Territory has no technical uncertainty, its movement would be tracked via manifests, and proof of disposal would be documented. The 1,600 L of waste fuel and 200 L of oil could be transferred to two 1,000 L totes or 10 new drums for transportation off-site. The totes or new drums would be handled by heavy equipment such as a loader with forklift upon arrival to Resolute Bay, and subsequently be shipped via sealift to an appropriate disposal facility in Bécancour, Quebec or nearby, once offloaded from the sealift at its final destination.

Waste drum management is analyzed separately from waste fuel management (see next section).

The three options for waste fuel have been evaluated and the results are tabulated below.

Table 2-6 - Evaluation of Options for Waste Fuel

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score*
	Reduction of Environmental Risk	Value to Crown	Resources Required	Reduction of Environmental Liability	Local Benefits	
Leaving as-is	Unfavourable	Favourable	Favourable	Unfavourable	Unfavourable	**Unfavourable (-1)**
Incineration on-site	Favourable	Unfavourable	Unfavourable	Favourable	Favourable	**Favourable (+1)**
Removal off-site for disposal	Favourable	Unfavorable	Neutral	Favourable	Neutral	**Favourable (+1)**

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

Leaving the waste fuel on site significantly increases the environmental risk and liability at the site. Drums which have not yet leaked may eventually do so and create more contaminated soil. This option scores unfavourably under the Reduction of Environmental Risk and Reduction of Environmental Liability. It does not create any local socio-economic benefits. It is not a viable option, and its overall score is unfavourable (-1).

With incineration on-site, the reduction of environmental risk scores favourably because not only would the risk be removed but the fewer number of times the fuel would be handled for disposal reduces the risk of mishap in transit. Incineration of the waste fuel on-site would extinguish the liability (favourable) but is seen as unfavourable in terms of Value to Crown (cost) and Resources Required given that operation of the incinerators may be complex and would require training. There would be logistical challenges and significant costs in sourcing them from locations as far as the United States.

The Resources Required and Value to the Crown evaluation criteria were scored as unfavourable. Burning of the fuel also requires setup of the incinerator and a designated burn area which can take up as long as a day for a crew not well versed in setup. The local benefits are favourable because there would be local labour involved in the operation. Its overall score is favourable (+1) which renders it equal to the third option.

Removal of the waste fuel off-site would completely eliminate the Environmental Risk and Environmental Liability because if fulfills the objective of creating a "walk-away" solution. It scores favourably for Reduction of Liability. Off-site removal is considered neutral in terms of resources required. The costs are expected to be the greatest of all remedial options and accordingly it scores unfavourably under Value to Crown. Local benefits are deemed to be neutral since the degree of local involvement would be less than on-site incineration but more than leaving as-is. Much of the efforts for removal of the waste fuels from site would encompass logistics for transportation. The removal for off-site disposal option scores weakly favourable (+1) overall and equal to on-site incineration.

On-site incineration scores even with removal of the fuel off-site however there is a risk that the fuel quality may not match that of the test result. If some drums of fuel have been contaminated by water, it would not burn, and the Contractor would have to resort to the off-site removal option. Thus, for greater certainty of success it is recommended that the fuel be managed by off-site removal.

2.4.5 Waste Drums

A total of 58 drums are present at Stupart Island. Drums containing fuel must be pumped out where they lie, to avoid any leakage due to shifting them in their potentially weakened state. The dry weight per drum is 18 kg, and the total weight is calculated to be 1,100 kg. As well, two 20 L steel jerry cans and three oil stoves are included as part of the drum waste. The identified options for their management are:

1. Left as is: The waste drums would be consolidated in one location at the Stupart Island site after they had all been emptied and the fuel dealt with as recommended in the preceding option.

2. Burial on-site: The empty drums would be opened at one end and washed inside using a pressure washer or steam cleaner. Wash water would be collected and treated prior to disposal. The drums would then be crushed to half of their volume, using a drum crusher or other capable equipment. A crushed volume of 0.5 m^3 per drum can be anticipated. The crushed drums would be placed in an on-site encapsulation cell. An encapsulation cell would require long-term monitoring.

3. Removal off-site for disposal. The drums would be emptied but not cleaned on-site. They would be tested for residual vapours inside using a photo-ionization detector and any drum with explosive vapours would be placed in an over-pack container. Dry drums would be loaded as-is into the plane and the drums with vapour would be loaded in an over-pack to not release vapour when inside the cargo bay of the plane. The drums would be transported to Resolute Bay for cleaning and crushing and then transferred to the sealift for disposed outside of the territory.

The three management options for waste drums have been evaluated and the results are tabulated below.

Table 2-7 - Evaluation of Options for Waste Drums

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score*
	Reduction of Environmental Risk	Value to Crown	Resources Required	Reduction of Liability	Local Benefits	
Left as is	Unfavourable	Favourable	Favourable	Unfavourable	Unfavourable	**Unfavourable (-1)**
Burial on-site	Neutral	Unfavourable	Unfavourable	Unfavourable	Favourable	**Unfavourable (-2)**
Removal off-site for disposal	Favourable	Neutral	Neutral	Favourable	Favourable	**Favourable (+3)**

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

Leaving the emptied waste drums on-site consolidated at one location is low-cost and requires few resources and therefore scores favourably on those criteria. However, this option does not remove the liability as the drums would constitute a waste site and require permitting. This fails the "walk-away" solution objective and scores unfavourably in the Reduction of Environmental Liability criteria. As well, the local community would not benefit (unfavourable) in terms of employment or having a cleaned-up site. This option scores unfavourable (-1).

Burying the drums on-site has greater resource requirements than the other two options (unfavourable). It would require: building a wash pad for water retention, cutting open one end of each drum, washing with a pressure washer, crushing the drums, burial in an encapsulation cell and treating the oily wash water. The burial of empty steel drums in an encapsulated waste cell would require on-going monitoring and as a result the liability would not be completely extinguished. Thus, it scores unfavourably in terms of Resources Required, Liability Reduction and Value to Crown

The Reduction of Environmental Risk objective would be met because the drums would be cleaned prior to burial, although the metal waste would remain on-site (neutral). Local benefits are considered to be favourable given that the labour component of this option is the highest. Overall, this option scores unfavourable (-2).

Removal of drum for off-site disposal accomplishes the Reduction of Environmental Risk objective (favourable) and scores favourably under Reduction of Liability because it is a "walk-away" solution. It scores neutrally on Resources Required because it is more easily accomplished than burial but has more steps than leaving them as is. Off-site removal of drums and is expected to benefit the local community in terms of leaving a clean site and providing a local labour component in achieving it (favourable). Value to the Crown is seen as neutral since costs will be incurred during offsite transportation, however, empty drums could be transported off-site via aircraft during the 6-8 days during which the fuel is incinerated. Overall, this option scores favourable (+3).

The recommended option for waste drums is therefore removal off-site for disposal. With off-site removal, crushing the drums prior to their movement offers no apparent benefit. There is not expected to be any heavy equipment on site and therefore no effective means for crushing for volume reduction. A drum crushing operation would require a spill containment area and drum washing. This could potentially be completed in Resolute Bay. Alternatively, the drums could be sent south on the sealift without crushing, as the cost for shipping drums by sealift is the same whether they are crushed or not.

2.4.6 Hazardous Waste

Eleven propane cylinders were discovered on Stupart Island and are considered hazardous waste. The total empty weight is estimated at about 325 kg. Any propane remaining in the cylinders will be released prior to moving the cylinders.

The most viable management option for the hazardous waste (propane cylinders) is off-site disposal along with the drums. This option removes the liability, is not technically challenging or expensive, provides environmental protection and offers local benefits (general labour) when done in conjunction with the other waste management activities for the site.

2.4.7 Integrated Remedial Plan

The integrated remedial work plan is comprised of the highest-ranking options from the multi-variant criteria decision matrix analysis for each waste stream requiring remediation. It is comprised of:

1. Contaminated soil waste (oily soil) from APEC 4 Tent Platform would be excavated manually, placed in soil bags and removed by aircraft for off-site, out-of-Territory disposal. The total weight is estimated to be a maximum of 4m^3 and 8T.
2. Non-hazardous wood waste would be burned on site to reduce the weight, the ash would be collected, along with metal debris, and removed from site and sent out of Territory for disposal in the South. The final weight and volume is 10m^3 and 10T.

3. Waste fuel would be removed from the Site. The waste fuel volume is 1,600 L gasoline and 200 L oil.
4. The 58 drums and 2 jerry cans/3 oil stoves would be removed off-site by aircraft and out of the Territory by sealift for disposal. Drum crushing in Resolute Bay is optional. The weight and volume of empty waste drums etc. is approximately volume: 14 m^3 / 1.1 T.
5. The eleven propane cylinders (considered hazardous waste) would be removed off-site by aircraft, then moved out of the Territory for disposal. The combined weight of the cylinders is estimated to be 325 kilograms (0.325 T).

With this integrated set of actions for the waste streams, the solution would be "walk-away", with no on-going requirements. Aircraft is the most viable method of transporting the contaminated soil, waste drums and hazardous waste (propane cylinders) out of Stupart Island to Resolute Bay. From Resolute Bay all of the wastes would then be transported by sealift for off-site disposal at a facility in the South. Drum crushing may be done in Resolute Bay if the facilities exist, and there is an advantage to doing so.

2.4.8 Scheduling

Stupart Island with its good landing strip is planned as the staging point for wastes not only from the site itself but for the two sites on Lougheed Island. A camp and a transfer station would be established at this Site and the expected duration of a camp at Stupart Island would be about a month. Thus, the work at Stupart Island can be done concurrently with the other sites and on no-fly days. Eight to ten days of on-site work is anticipated.

There is usually one sealift stop in Resolute Bay per year. The 2021 sealift's departure from Resolute Bay was September 7th. The on-site work and transportation to Resolute Bay needs to be complete by the end of August 2024.

2.5 Scope of Work for Proposed Remedial Solution

The scope of work required to implement the remedial options at Stupart Island and the other two large sites has been resolved into a Work Breakdown Structure (WBS) included in Appendix A. The WBS conveys in a graphical form the work that will be required of a contractor who successfully meets the screening, selection and bidding process that is being developed for remediation of the sites in this bundle. The WBS contains four main tasks: 1 Balance of Project Costs and Project Meetings, 2 Health, Safety and Environment, 3 Transportation and Logistics, and 5 Stupart Island Remediation.

Task 5 breaks down the work required to implement the remedial options for Stupart Island defined in the previous section into work packages which will be further defined in the Tender Specifications and verifiable by the on-site PSPC Construction Representative.

The work packages for Remediation are as follows, with details being provided in the Tender Specification:

1 Contaminated Soil Management

Excavation (by manual means) of contaminated soil above and below the wooden platform, and packaging into soil bags.

Transportation off-site and out of Territory and disposal at a licensed disposal facility.

2 Non-Hazardous Wood and Waste Metal Management

Incinerate wood on-site, package ash and metal to send off-site and out of Territory for disposal at a licensed disposal facility.

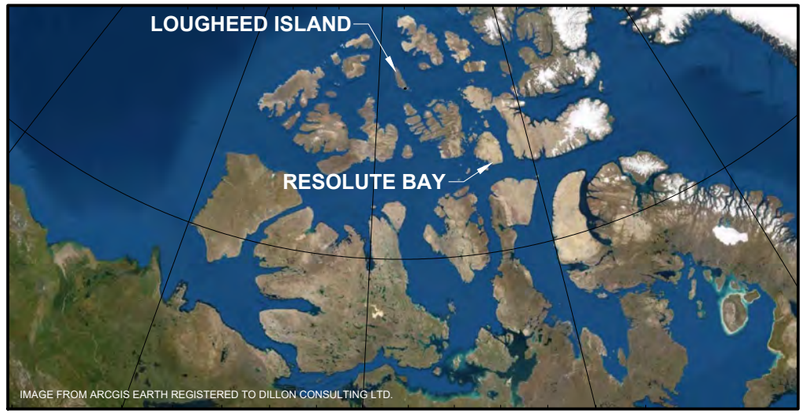
3 Waste Fuel Management

Packaging waste fuel into sturdy containers for off-site disposal. Transferring waste fuel off-site and out of Territory for disposal.

4 Drum and Propane Cylinder Management

Empty, consolidate and package for off-site removal.

Transportation off-site and out of Territory and dispose at licensed disposal facility.



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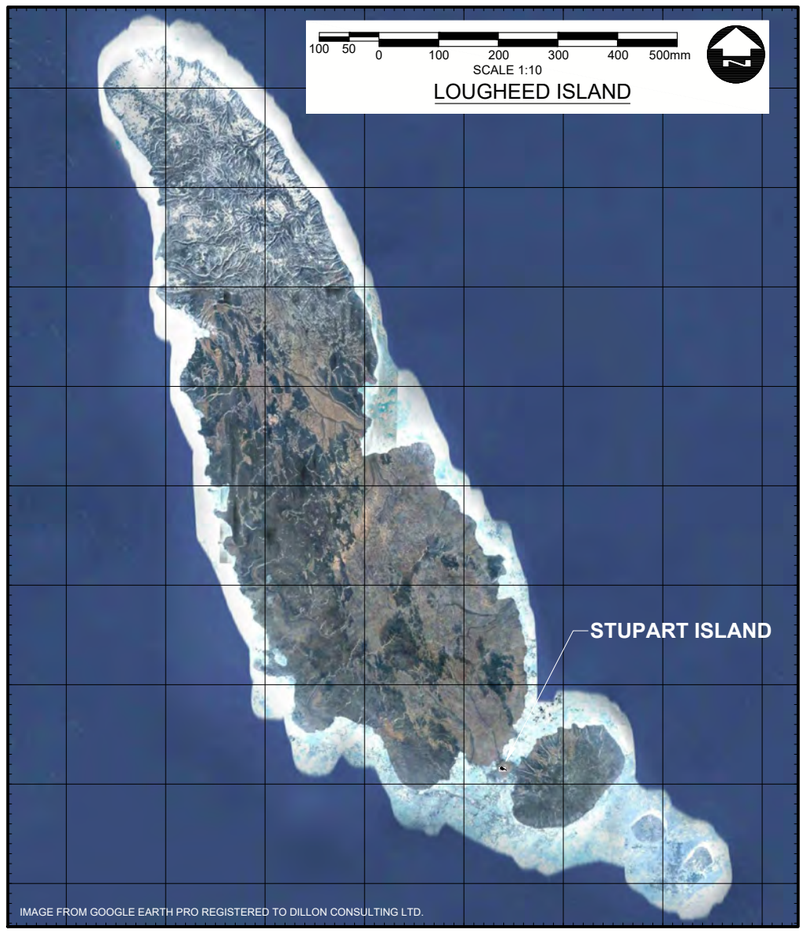

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1	ISSUED FOR INTERNAL REVIEW	10/12/21	TPW

DESIGN: DP | REVIEWED BY: DP
DRAWN: TPW | CHECKED BY: DP
DATE: NOVEMBER 2021
SCALE: AS SHOWN

ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

STUPART ISLAND
SITE LOCATION PLAN

SHEET NO. 400

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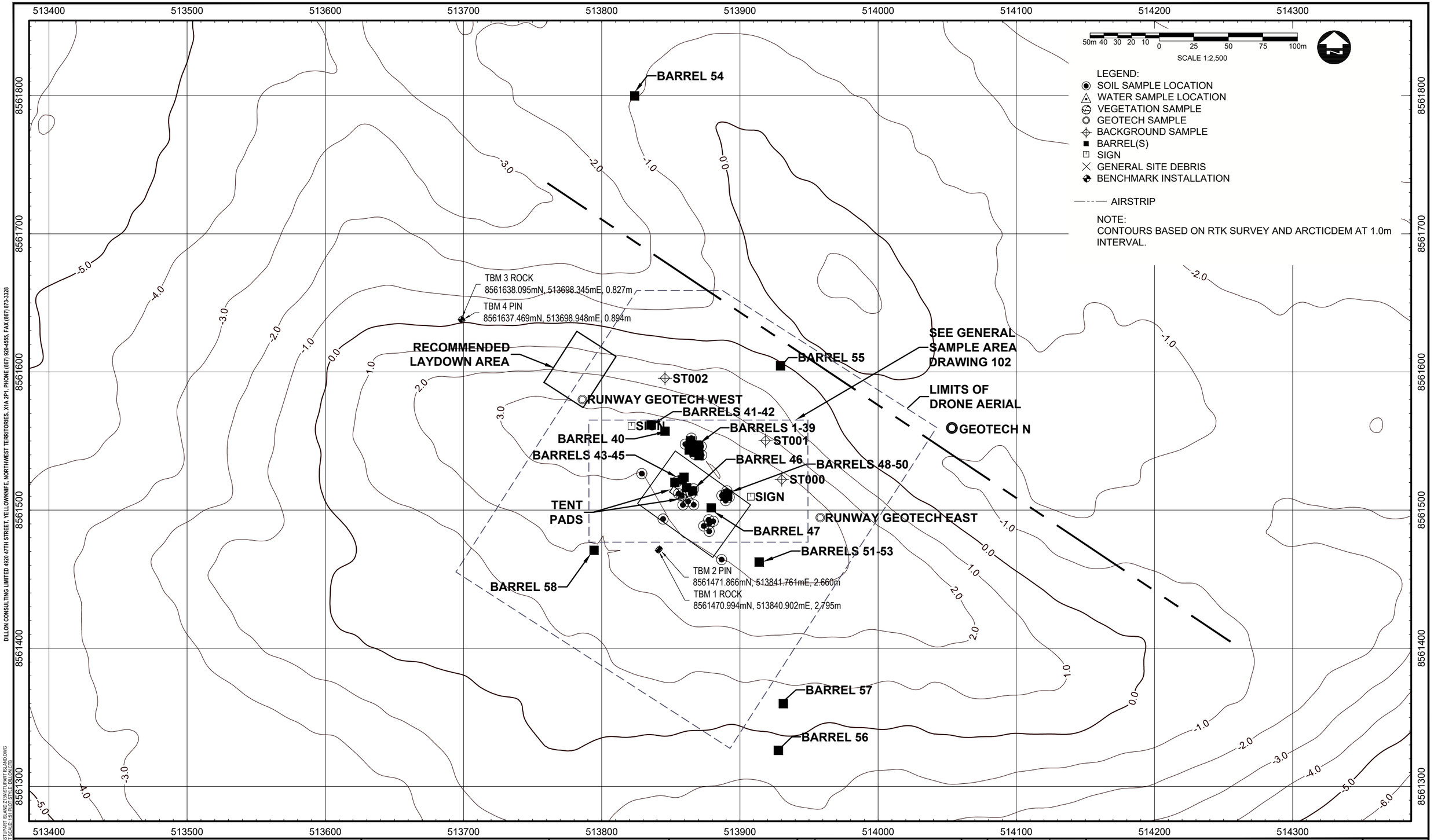
FILENAME: C:\CAD\21370 PIONEER SITES\STUPART ISLAND 21\NST\STUPART ISLAND.DWG
PLOT DATE: 2021-11-09 @ 10:57:05 PM PLOT SCALE: 1:51 PLOT STYLE: DILLON.CTB



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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. **21-2370**

STUPART ISLAND
SURVEYED LIMITS

SHEET NO. **401**

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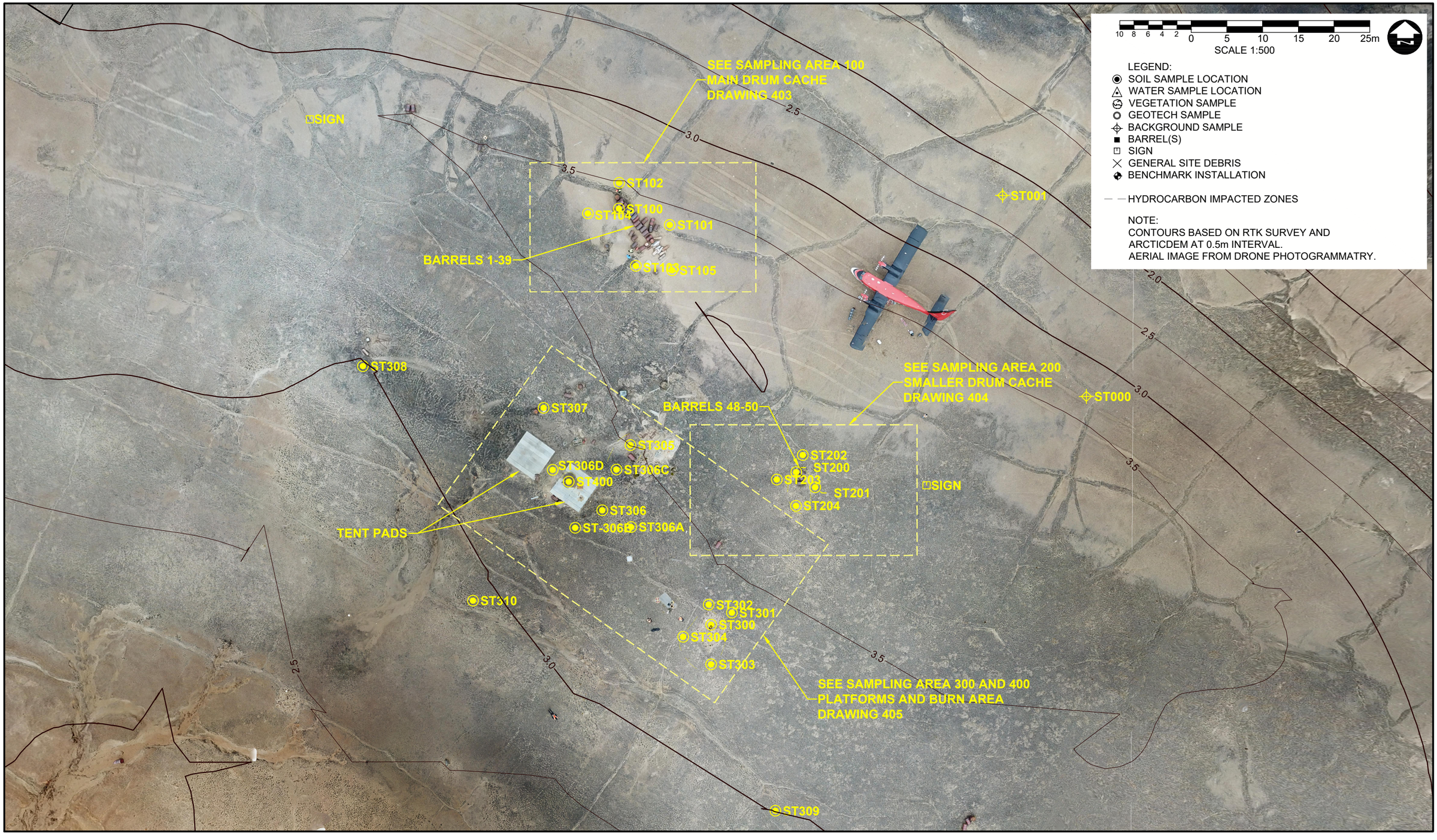

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

STUPART ISLAND
GENERAL SAMPLE AREA
INCLUDING BACKGROUND SAMPLES

SHEET NO. 402

513855 513860 513865 513870 513875 513880

8561555 8561550 8561545 8561540

0.8m 0.4 0 1.0 2.0 3.0 4.0m
SCALE 1:80

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

HYDROCARBON IMPACTED ZONES

NOTE:
CONTOURS BASED ON RTK SURVEY AND ARCTICDEM AT 0.1m INTERVAL.
AERIAL IMAGE FROM DRONE PHOTOGRAMMATRY.

ST102

Drums to be collected. Any drums with explosive vapours to be put in over-packs.

Drums must be removed from site and disposed of out of Territory.

DRUM #40 SAMPLED

ST100

NO CONTAMINATION IDENTIFIED

ST104

ST101

Waste fuel to be collected from any non-empty drum into sturdy containers and taken off-site for disposal.

PROPANE CYLINDERS

Propane cylinders to be verified as empty.

Cylinders to be removed from site and disposed of out of Territory.

ST103

ST105

513855 513860 513865 513870 513875 513880

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

STUPART ISLAND
SAMPLING AREA 100
MAIN DRUM CACHE

SHEET NO. 403

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513875 513880 513885 513890 513895 513900 513905

8561515 8561510 8561505 8561500

0.8m 0.4 0 1.0 2.0 3.0 4.0m
SCALE 1:80

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

HYDROCARBON IMPACTED ZONES

NOTE:
CONTOURS BASED ON RTK SURVEY AND ARCTICDEM AT 0.1m INTERVAL.
AERIAL IMAGE FROM DRONE PHOTOGRAMMATRY.

ST202

ST200
PHC,F2

BARRELS 48-50

ST203

ST201

ST204
PHC,F2
PAH

Waste fuel to be collected from any non-empty drum and put into sturdy containers and taken off-site for disposal. .

Drums to be collected. Any drums with explosive vapours to be put in over-packs.

Drums must be removed from site and disposed of out of Territory.

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FILENAME: C:\CAD\21237O PIONEER SITES\STUPART ISLAND 21\NSTUPART ISLAND.DWG
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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

STUPART ISLAND
SAMPLING AREA 200
SMALLER DRUM CACHE

SHEET NO. 404

513860 513870 513880 513890

8561520 8561500 8561490 8561510 8561480

513840 513850 513860 513870

2.0 1.2 0.4 0 1 2 3 4 5m
SCALE 1:120

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

HYDROCARBON IMPACTED ZONES

NOTE:
CONTOURS BASED ON RTK SURVEY AND ARCTICDEM AT 0.1m INTERVAL.
AERIAL IMAGE FROM DRONE PHOTOGRAMMATRY.

TENT PARTS
ST305 PHC,F2
ST307
DRUM #43 SAMPLED
ST306C
ST306D
ST400 PHC,F3-F4
NW PLATFORM
SE PLATFORM
ST306
ST-306B
ST301
ST302
ST300 PHC,F2
BURN AREA
ST304
ST303 PAH

Tent platform to be demolished and incinerated.

Ashes collected and removed from site for disposal.

Oily soil above and below tent platform to be placed in soil bags for off-site removal.

Soil to be disposed out of Territory

Tent platform to be demolished and incinerated.

Ashes collected and removed from site for disposal.

All wood debris to be collected and incinerated at burn area.

Ashes to be collected after burning has been completed and disposed of out of Territory

3.4 3.3 3.2 3.1 3.6 3.5 3.4 3.3 3.4 3.3 3.2

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FILENAME: C:\CAD\21370 PIONEER SITES\ST.UPART ISLAND 21\MXD\UPART ISLAND.DWG
PLOT DATE: 2021-11-22 @ 10:45:19 AM PLOT SCALE: 1:51 PLOT STYLE: DILLON.CTB

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT CIRNAC

STUPART ISLAND SAMPLING AREA 300 AND 400 PLATFORMS AND BURN AREA

PROJECT NO. 21-2370

SHEET NO. 405

3.0 Skybattle Bay Remedial Action Plan

3.1 Executive Summary

Skybattle Bay site is designated NB034 in the Northwest Territories/Nunavut contaminated site database. Its federal contaminated site inventory (FCSI) number is 00024260. The site is located on the southwest portion of Lougheed Island, about 410 km northwest of Resolute Bay. Skybattle Bay is a former Panarctic Oils Ltd. site, where exploration for oil and gas reserves was carried out in the past. The oil drilling site consists of raised soil platforms, disturbed ground, dug sumps and some debris. The airstrip associated with Skybattle Bay is referred to as a Hercules Strip, given its large width and long length, however it is best used in winter when it is hard-frozen because it is underlain by soft silty soil.

A Phase I and II ESA for the Skybattle Bay site was conducted by Water and Earth Science Associates Inc., with the field work in 2011 and the report dated in 2012 (WESA, 2012c). Panarctic Oils Ltd. conducted drilling at the site to explore and prove oil and gas reserves in the Canadian arctic islands. The Phase I ESA described the presence of caches containing approximately 100 drums (mostly empty) beside the airstrip, and a minimal amount of wood and metal debris scattered around the site. Two APECs were identified: i) APEC 1 -the airstrip and drum caches; ii) APEC 2 – the Panarctic C-15 well site. The Phase II ESA field work was done concurrently to the Phase I site visit on July 10, 2011. Only the two large drum caches along the airstrip, and a waste burning area were investigated. Petroleum hydrocarbon (PHC) and polycyclic aromatic hydrocarbon (PAH) exceedances were reported at Drum Cache 1 on the north side of the airstrip. PHC, BTEX and arsenic exceedances were reported at the Drum Cache #2 on the south side of the airstrip. Arsenic, copper, lead, tin and zinc, and a single PAH (naphthalene) were reported for the sample at the burn pit. The Background sample had no exceedances of any parameter. The oil well site was not assessed.

The Phase III ESA (DOJV 2022a) at Skybattle Bay, re-assessed the two large drum depots as APEC 1 and 2, and burn area (APEC 3), and also assessed the Oil Drilling Platforms (APEC 4). A total of thirty test pits were carried out for contaminated soil delineation and water was sampled at the two sumps at the Oil Drilling Platform and in a river upgradient of the site. Comparing the soil chemical results to generic CCME guidelines, contaminated soil was identified at Drum Cache 1 (APEC 1: 100 m^3) and at the Burn Area (APEC 3: 20m^3). and at two locations at the Oil Drilling Platforms (APEC 4: 850m^3) for a total of approximately 1000 m^3. Water in the two sumps was not indicated to be impacted in comparison to the upstream river.

Although soil with contaminant concentrations in excess of the applicable CCME Guidelines has been found at Skybattle Bay, the Human Health Risk Assessment results indicated there is negligible potential for human health risk from the contaminants (DOJV 2021b). The site-specific target levels derived by the Risk Assessment were not exceeded in the chemical results of the Phase III Environmental Site Assessment. The Ecological Risk Assessment concluded that there is no need for corrective action or risk management on the site, in relation to communities or populations of ecological receptors. The Risk

Assessment results therefore do not indicate a compelling human or ecological risk-driven rationale for any management of contaminated soil at the Skybattle Bay site.

A summary of all waste streams at Skybattle Bay is given below.

Table 3-1– Summary of Waste Streams at Skybattle Bay Requiring Remediation

Waste Stream	Quantity
Wood Waste (APEC 4 and at random)	24 cubic metres / 24 tonnes
Metal Waste (at Drum Cache 1 and Oil Drilling Platform)	15 cubic meters / 30 tonnes
Waste Fuel (APEC 1 and 2)	2,000 litres / 2 tonnes
Drums (APECs 1,2 and 4 and airstrip)	281 drums empty weight of drums: 6,000 kilograms.

Remedial Options Analysis

A remedial options analysis was conducted for each waste stream requiring remediation. The evaluation criteria were the same for the analysis of options for each waste stream: i) Reduction of Environmental Risk; ii) Value to the Crown; iii) Resources Available; iv) Reduction of Environmental Liabilities; and v) Local Benefits. Several viable management options were conceived for each waste stream, and they were evaluated according to the evaluation criteria. Options were scored under each evaluation criterion as either favourable, neutral or unfavourable, according to the degree to which the criterion was satisfied. The objective is to develop and recommend solutions which are protective of the environment and do not require on-going monitoring or maintenance, i.e., “walk-away” solutions.

The integrated remedial plan is comprised of the highest-ranking options from the multi-criteria decision analysis of each waste stream requiring remediation. The integrated preferred remedial option consists of:

1. The wood waste is unpainted and is not a contaminant. The wood at APEC 1 and randomly scattered would not be moved. The wood waste at APEC 4 which is pallets and heavy lumber would be consolidated in a single location on top of one of the soil platforms at APEC 4, thus a safe distance from the washouts that are present at APEC 4. The wood waste quantity is 24 cubic meters/ 24 tonnes.

2. Metal waste (not including drums) would be consolidated to a single location. The lighter pieces would be removed from the site however the heavier pieces such as the flywheels would be left on-site. Approximately half of the steel would be removed 15 cubic meters/ 30 tonnes (T).

3. Waste fuel and water from drums would be collected in sturdy containers and transported first to Stupart Island by helicopter, and then to Resolute Bay for sending out of Territory for disposal. The waste fuel samples tested were a mixture of fuel and water. The waste fuel/water volume is 2,000 litres (L) (2 T).

4. The 281 waste drums would be removed from site, with over-packs used for drums with explosive vapours, first to Stupart Island by helicopter and then to Resolute Bay by fixed-wing aircraft, where they would be processed (cleaned and crushed), if it is advantageous to do so, then sent out of the Territory for recycling or disposal. The combined weight of empty waste drums is approximately 6,000 kilograms (kg) (6 T).

In summary, the waste fuel/water (2 T), the 281 empty drums (6 T) and the lighter pieces of scrap metal (30 T) will require removal from the site. The wood and large pieces of metal waste would be left on-site. Adding soil cover to this waste is not possible given the lack of granular borrow material and the shallow (0.3m) depth to permafrost. The APEC 1 location is in a slight depression, which makes it a favourable location for consolidating the wood and metal wastes. Both are unpainted and the metal is already corroded. Given the inert waste we are proposing to leave on-site no monitoring will be required. With this integrated set of actions for the waste streams, the solution would be “walk-away”, with no on-going requirements.

The waste would be moved to a transfer site at Stupart Island by helicopter, a distance of 20km, and then by fixed-wing aircraft 375 km to Resolute Bay for processing and onward transportation.

The work at Skybattle is expected to take approximately 20 days of good flying weather and must be done in the summer months.

3.2 Introduction

3.2.1 Objectives

The objectives of the site remediation are to reduce the environmental risks to an acceptable level for all current and envisaged future site uses and reduce the environmental liability with a "walk-away" solution. The objectives of the remedial action plan (RAP) are to:

- Develop remedial and/or risk management options for each waste stream at the site;
- Evaluate each remedial/risk management option according to its expected degree of success in achieving outcomes of: i) reduction of environmental risk; ii) providing value to the Crown; iii) utilizing resources reasonably available; iv) reduction of the environmental liability; and v) providing local benefits, both during and following remediation;
- Detail the resources required to complete the remediation project; and
- Recommend optimal scheduling of work such that the entire Pioneer Bundle can be addressed in the current phase of the Federal Contaminated Sites Action Plan, ending in March 2025.

3.3 Background of Skybattle Bay Site and Features

Skybattle Bay is designated NB034 in the Northwest Territories/Nunavut contaminated site database and has a FCSI number 00024260 The site is located on the southwest portion of Lougheed Island, about 375 km northwest of Resolute Bay at approximately 77º 14' 41.95'' N latitude and 105º 07' 51.72'' W. Skybattle Bay is a former Panarctic Oils Ltd. site, where explorations for oil and gas reserves was carried out in the past. The oil drilling site consists of raised soil platforms, disturbed ground, dug sumps and some debris. The airstrip associated with Skybattle Bay is a mapped landing strip known to aviators as a Hercules Strip, given its large width and long length.

The Phase III ESA (DOJV 2022a) at Skybattle Bay, re-assessed the two large drum depots as APEC 1 and 2, and burn area (APEC 3), and also assessed the Oil Drilling Platform (APEC 4). A total of thirty test pits were carried out for contaminated soil delineation and water was sampled at the two sumps at the Oil Drilling Platform and in a river upgradient of the site. The wastes were inventoried, and two samples of waste fuel were analyzed.

3.3.1 Physical Setting and Site Reconnaissance

The Site was found to have one large drum cache located to the north of the airstrip (APEC 1: Drum Cache 1) and another to the south of the airstrip (APEC 2: Drum Cache 2). The drums were piled up to four high and were potentially unstable since the bottom layer had obviously subsided into the ground. In addition to drums at APEC 1 there is a significant amounts of metal debris piled up on the north side of the drum cache. The ground around Drum Cache 1 was soft and wet, and the site assessor would sink about 15 cm into the soil. The wet area surrounding the drum cache extended to the west for about 50

m and appeared to be permafrost degradation. Several pieces of lumber were strewn at random to the north of APEC 1. APEC 2 was a slightly smaller drum cache than APEC 1, and the ground was less soft. There was no other debris at APEC 2. APEC 3 was a small burn area with melted plastic evident. APECs 1, 2 and 3 were well-vegetated with grass and peat moss, whereas APEC 4 was not.

APEC 4 (Oil Drilling Platform) was an area of about 200 x 200 m of disturbed ground where the surface layer had been stripped and used to create two raised areas for the drilling operations. The ground was soft and silty. The former C-15 Wellhead was present as a pipe sticking vertically out of the ground surrounded by bags of drilling mud, at the southwest corner of the south pad. There were two dug sumps: Sump 1 and Sump 2. Sump 1 was just west of the north pad and appeared clean. Sump 2 was 75 m south of the south pad and had rusted drums and other metal debris in the water. The ground around Sump 2 appeared oily. There were a few other drums at random at APEC 4, a metal drill rod, and a line of wooden pallets and chunks of Styrofoam.

The airstrip was marked by drums lining each side. The drums lining both sides of the airstrip are about 30 m apart. The airstrip is 1800 m long according to aviation sources, with approximately 61 drums lining each side of the airstrip and a row of four drums marking each end. Thus, there are a total of approximately 130 drums lining the airstrip. All of the drum checked were empty and had sunk 10 to 20 cm into the ground.

Figure 501 shows the Skybattle Bay site with the airstrip and APECs 1, 2, 3 and 4 as Sample Areas 100, 200, 300 and 400, respectively.

Physical hazards present were the high unstable piles of drums at APECs 1 and 2. Drums were piled four rows high and due to permafrost melting the stability of the top drums is precarious. At APEC 4 there was wood and metal debris strewn around which constitutes a physical hazard.

3.3.2 Site Access Conditions

A reconnaissance flight to Skybattle Bay on Lougheed Island was completed on July 6, 2021 by Kenn Borek Airways using a Twin Otter on tundra tires, to assess its landing conditions for fixed wing aircraft. The reconnaissance identified the Hercules strip but could not land because of soft and wet conditions. It noted that the airstrip needed drying out before being safe to land with a Twin Otter.

The field team completed another aerial assessment of the Hercules strip at Skybattle Bay on August 6 to assess landing conditions. On August 10, 2021 a firm, dry portion at the west end of the Hercules strip was tested by several touch-and-go approaches, and was deemed firm enough to land on. The same portion of the Hercules strip was used in all succeeding flights to the site to carry out the field work. Using the landing strip at Skybattle Bay under frozen conditions would have much less limitation.

3.3.3 Waste Streams and Quantities Present

The Phase III ESA (DOJV 2022a) assessed the APECs at the Skybattle Bay via soil sampling and inventorying the other waste streams.

3.3.4 Impacted Soil Assessment

Soil sampling was by test pits dug manually with a shovel. Test pits were dug to refusal on permafrost or as deep as possible if permafrost was not encountered. Bedrock was not encountered in any test pit at Skybattle Bay.

The approach in planning the test pit locations was to target the previously identified contaminated locations, plus any areas that Dillon-Outcome felt were data gaps to be filled, with a set of inner and stepped-out test pits around the APEC. APECs were sampled on the up and down-gradient sides. The stepped-out test pits were in order to have assurance of achieving lateral delineation. The stratigraphy observed in each test pit was logged in terms of soil type, evidence of contamination (staining or odour) presence of debris, moisture, water inflow, and colour. A total of 33 test pits were carried out including two background test pits, four geotechnical test pits and 27 environmental test pits at the APECs.

The soil analytical results were compared to CCME guidelines in the Phase III ESA, and then analyzed in the HHERA. The results of both assessments are summarized below.

The table below provides the characteristics of the test pit soil sampling program by APEC, and the parameters analyzed.

3.3.4.1 Impacted Soil Quantities by Generic Guidelines

The generic guidelines used to screen for soil exceedances were:

- **Soil – BTEX, metals and PAH:** CCME Soil Quality Guidelines, Agricultural Land Use, fine-grained soil, shallow soil (<1.5 metres);
- **Soil – Petroleum Hydrocarbons:** CCME Canada-Wide Standards for Petroleum Hydrocarbons, Tier 1, Agricultural land use, fine grained soil, Eco soil contact, more than 10 m from aquatic habitat.

Agricultural land use was deemed appropriate given CCME agricultural/wildland use is defined as "Land on which the primary activity is related to the productivity capability of the land and includes lands that provide habitat for wildlife and birds".

Background Soil Testing: There were two background test pits dug and sampled: SB000 and SB001. SB000 was about 100 m to the northeast of Drum Cache 1 and SB001 was about 50 m to the north of Burn Area. SB000 coincided with vegetation sample Veg 2 and SB001 coincided with vegetation sample Veg 4. Background sample SB000 was analyzed for BTEX, PHC, metals and PAH.

Chemical analysis of SB000 revealed a trace presence of PHC F2, F3 and F4, but no components above CCME Agricultural (fine-grained) Guidelines. PHC is not expected to be present in a background sample unless it is unaffected by a contaminant source. This suggests that some low-level petroleum hydrocarbon migration has occurred from Drum Cache 1 extending outward for a significant distance from the cache. Arsenic also exceeds the Guideline (As: 26 mg/kg compared to 12 mg/kg); however arsenic concentrations of the same proportion are ubiquitous across all APECs suggesting it is a naturally occurring soil mineral at concentrations of two to three times the Agricultural Guideline.

The background sample SB001 was analyzed for PAH only, as it was a background for the Burn Area and PAH was the previously reported parameter group in exceedance at that location. SB001 had no detections of any PAH compounds.

APEC 1 Drum Cache 1 (Area 100). Six test pits (SB101 to SB106) were completed to delineate the previously reported contamination at Drum Cache 1. SB101 was on the south side, immediately beside the row of drums. SB102 was just north of the west extent of the cache; SB103 was 5 m to the north of the row of drums beside a wooden platform with five drums on it. SB104 was off the southeast corner of the cache, SB105 was on the south side of the cache, while SB106 was 7.5 m to the south of the cache. The up and down-gradient directions were not evident by topography. The land was flat with a depression due to permafrost melting around the drums. The soil type was water saturated silt over clay with permafrost at 0.25 to 0.3 m BGS. SB102 had the highest PHC impact (PHC-F2: 8,400 mg/kg compared to 150 mg/kg). Location SB101 and its duplicate also had a high level of PHC-F2 (2,215 mg/kg compared to 150 mg/kg), while SB103 and SB104 located to the east had marginal exceedances of PHC-F2 (170 mg/kg and 160 mg/kg, compared to the Guideline of 150 mg/kg), along with benzene at SB103 and benzene, ethylbenzene and xylenes at SB104. A similar pattern of exceedances is traced with PAH compounds; exceedances in SB101 to 104, with no detection in SB105 and SB106. Test pits SB105 and SB106 had no exceedances in any parameter, therefore represent clean limits to the south. The contaminated zone is interpreted to be the width of the line of drums (20m) and extend to the north just beyond the marginal exceedances at SB103 and SB104, to a depth to permafrost at 0.3 m BGS, for an area of 300 m^2 and a volume of 100 m^3 of impacted soil. Figure 502 shows the sample locations and delineation of the impacted soil zone.

APEC 2 Drum Cache 2 (Area 200). There were five test pits (SB200 to SB204) completed to delineate the previously reported PHC, BTEX and arsenic exceedances at Drum Cache 2. Test pit SB200 was adjacent to the cache on the south side. Test pits SB201, SB202, SB203 and SB204 were stepped out 3 to 4 m from the cache to the northeast, northwest, southwest and southeast of the cache, respectively. There was no obvious up or down-gradient direction indicated by topography. The soil was water saturated silt over clay with permafrost at 0.3 m BGS. No BTEX compounds were detected in any sample. PHC fractions F2, F3 and F4 were detected at levels below Guidelines. Arsenic was reported in every sample at concentrations consistent with background and APEC 1, so is not considered a contaminant. No impacted soil is interpreted at APEC 2. Figure 503 shows the test pits at APEC 2.

APEC 3 Burn Area (Area 300). The burn area is located approximately 50 m to the east of APEC 2 and has an appearance of blackened soil with some melted plastic. It was investigated with four test pits (SB300 to SB303) to delineate the previously identified PAH and metals impact. Test pit SB300 was in the centre of the burned area and the other test pits were outside of the visible burn area. Test pit SB301 was 4.2 m to the north, SB302 was 3 m to the southwest and SB303 was 2 m to the southeast. There was no obvious up or down gradient direction due to the flat-lying topography. The soil has a surface veneer of peat followed by wet silty clay with permafrost at 0.25 m BGS. There was no buried debris observed at any sample; the melted plastic was found at the surface and extended with a radius of about 1 m outward from SB300.

PAH exceedances were reported in each sample, except at the centre (SB300) and PHC-F2 exceedances were reported in each sample, except SB301 where it was not analyzed. Arsenic also had exceedances in each sample, however the concentrations were consistent with background. There were no other metals above Guideline. The contaminant distribution is complex. To estimate the extent of soil contamination at the burn area, the worst-case location in PHC-F2 concentrations is assumed to lie between the two highest samples (SB300 and SB303). The average PHC-F2 concentration of these two samples is 600 mg/kg, or four times the Guideline value of 150 mg/kg. The decrease in PHC-F2 from this assumed worst-case location to SB302 is 380 mg/kg over a distance of 3 m. Assuming a linear decrease in with distance outward from the worst-case, the PHC-F2 concentration would drop below the Guideline value of 150 mg/kg in one more meter further out from the worst-case in a straight line towards SB302. A contaminated zone at the burn area has been shown on Figure 503 based on this assumption. The area covers 80 m^2. The depth to permafrost is 0.25 m, thus a volume of 20 m^3 of contaminated soil was interpreted for APEC 3.

APEC 4 Oil Drilling Platform (Area 400) The 2021 sampling program was the first investigation conducted at the Oil Drilling Platform therefore the investigation targets defined in the Detailed Sampling Plan consisted of the overall disturbed area and the two sumps. In this area the up-gradient direction was to the north and down-gradient was to the south, as evidenced by drainage patterns. Test pits were excavated at the well head (SB400) and in the centre of the two raised platforms North Pad (SB401) and South Pad (SB-402). Lateral definition to the east of the pads was explored via SB403. A wash-out was evident from the wellhead, leading southeast and the initial test pit in the washout (SB404) had strong odour of diesel or heating oil, therefore five step-out test pits SB404A, AB404B, SB404C, SB404D and SB404E were carried out up-gradient and down-gradient to trace the extent of the hydrocarbon contamination. SB405 was downgradient of the observed contamination and established the southeastern extent. SB406 was carried out in visibly oily soil beside Sump 2. Given that this was the first assessment of this area, soil samples were analyzed for the full suite of chemical of potential concern: BTEX, PHC, metals, plus PAH where there was evidence of contamination.

The test pits in the centre of each platform reported trace presence of PHC-F2 and F3 at concentrations below Guidelines. BTEX was not detected. Metals were present at concentrations above guidelines for arsenic (at similar concentration to those generally found everywhere at Skybattle) and boron at concentrations of 6.2 mg/kg at SB401 and 5 mg/kg at SB402, compared to a Guideline concentration of 2 mg/kg. Boron at similar concentrations was reported in all samples at this APEC except for the sample at the well head, and the duplicate of SB404, so arsenic and boron at these levels may be due to naturally occurring soil mineralization. The two platforms are not inferred to be impacted.

Soil results at the wellhead (SB400) indicated a strong hydrocarbon impact (PHC-F2: 2,700 mg/kg compared to 150 mg/kg and PHC-F3: 6,000 mg/kg compared to 1,300 mg/kg). The well head sample also had lead (Pb) above Guideline (150 mg/kg compared to 70 mg/kg) and several PAH compounds above Guideline. Six down-gradient test pits from the wellhead were dug in an outwash. They are SB404, SB404A - AB404E. SB404 had the strongest hydrocarbon odours and was sampled at two depths (0.0 to 0.3 m BGS) and (0.3 to 0.4 m BGS). The upper sample and its duplicate exceeded Guidelines in

PHC-F1, F2, F3, ethylbenzene, xylene and PAHs. The lower sample (SB404-2) had PHC-F1 and F2 concentrations of one-quarter to one-third of the upper sample, but still exceeded Guidelines, and PAH also exceeded Guidelines. Delineation test pits SB404B, SB404C and SB404D had no PHC or PAH exceedances, although they had arsenic, boron and other metals, and are considered un-impacted. SB404E had PHC-F1 and F2 and PAH but at a reduced concentration from SB404 and is considered farthest down-gradient extent of the contamination identified at the well head and SB404. Test pit SB405 was farther down-gradient in the washout than SB404E and was below Guidelines for PHC and had only a very marginal exceedance for one PAH compound, naphthalene (0.014 mg/kg compared to 0.013 mg/kg). The contaminated area is interpreted to extend from the well head along the outwash head for a distance of 180 m with a width of 10 m and a depth of 0.4 m for a volume of 720 m^3.

The Sump 2 area appeared oily had several rusted drums and a soil pile beside it. The soil pile was sampled as SB406 and confirmed to have a high concentration of PHC-F1, F2, F3, F4, BTEX and PAH above Guidelines. Delineation test pits were not conducted outward from SB406 but by appearance it is considered representative of blackish soil surrounding Sump 2 with a diameter of 20 m. The area of this contaminated zone is 314 m^2 with an assumed depth of 0.4 m for a volume of 125 m^3. The depth of water in Sump 2 is only about 1 m.

A summary of the contaminated soil volume estimates at the four APECs at Skybattle Bay defined by generic guidelines and the degree of certainty in the delineation is provided below.

Table 3-2 Skybattle Bay Impacted Soil Areas by Generic Guidelines

Defined Area	Surface Area of Impact (m^2)	Depth (m)	Impacted Volume (m^3)	Contaminant of Concern	Certainty of delineation
APEC 1 – Drum Cache 1	300	0.3	100	PHC, PAH	High. Delineation by clean samples and marginal exceedance samples.
APEC 2 – Drum Cache 2	0	0	0	N/A	N/A
APEC 3 – Burn Area	80	0.25	20	PHC, PAH	Low. Test pits on all sides of the centre had PAH impacts.
APEC -4 Well head and outwash	1,800	0.4	720	PHC, metals, PAH	Fair, down-gradient limit mapped. Width estimated by outwash dimensions. Depth to permafrost not mapped.
APEC 4 – Sump 2	320	0.4	130	PHC	Low. Contamination confirmed beside sump. Extent taken visually.
Totals	**2,500 m^2**		**970 m^3**	**PHC, BTEX, PAH, metals**	**Range: Low to High.**

Defined Area	Surface Area of Impact (m^2)	Depth (m)	Impacted Volume (m^3)	Contaminant of Concern	Certainty of delineation
			Rounded to 1000 m^3		

3.3.4.2 Impacted Soil by Site Specific Human Health Risk Assessment

The Human Health Risk Assessment (HHRA) results indicated there is negligible potential for human health risk at Skybattle Bay site. This conclusion is supported by consideration of the various conservative assumptions and approaches used in the HHRA, which resulted in what are believed to be conservative estimates of potential exposure and risk. Site specific target levels (SSTL) were derived for PHC F2, PHC 3, Arsenic and Lead, for a toddler receptor at Skybattle Bay for hypothetical visits of up to 4 weeks per year.

As such, there is no human risk-driven need for remediation or risk management on the subject site in relation to any of the parameters exceeding generic guidelines, as long as the future land use and time on-site assumptions (i.e., exposure frequency and duration) do not exceed that which was assumed in the HHRA for the assessed human receptors and assuming that remaining sources (i.e., barrels) are removed.

3.3.4.3 Ecological Risk Assessment

The Ecological Risk Assessment (ERA) was done conducted in a similar fashion to the HHRA. It concluded that the likelihood of potential risk to terrestrial vegetation and soil invertebrate communities, and mammalian wildlife populations on the site is considered to be negligible, with the exception of vegetation and soil invertebrates in APEC 4. It is likely that the physical and possibly chemical presence of the drill muds have resulted in the continued absence of vegetation in muddy areas of APEC 4. It is likely that without addressing the drill muds, vegetation may be unlikely to return to the area.

The removal of the barrels, burn debris and other debris from the site in APECs 1, 2 and 3 would remove the physical disturbances to vegetation habitat, and could potentially reduce chemical exposures to vegetation in these areas.

This conclusion reflects current site conditions. As such, if concentrations of site-related contaminants were to increase in the future (e.g., if drums which still contain fuel were to perforate due to corrosion and release liquid hydrocarbons in soil), the results of the ERA may would need to be reassessed.

3.3.4.4 Conclusions of the HHERA

The likelihood of potential risk to outdoor site visitors, terrestrial vegetation and soil invertebrate communities, and mammalian wildlife populations on the site is considered to be negligible, with the

exception of vegetation and soil invertebrates in the vicinity of APEC 4. No soil remediation is proposed for Skybattle Bay.

3.3.5 Non-Hazardous Waste

An inventory of hazardous and non-hazardous building materials was conducted. The assessor was looking for painted materials, asbestos containing material and potential PCB containing equipment.

No painted wood, asbestos containing material or electrical transformers were observed anywhere at the site.

Unpainted wood debris was present at APEC 1 and APEC 4. At APEC 1 it consisted of around 30 planks strewn at random to the northeast of the Drum Cache 1 which have partially sunk into the soft surface and a wooden platform of 2 x 2 m on which there five upright drums were positioned. The total volume of wood at APEC 1 is estimated as 4 m^3.

At APEC 4 it consisted of sheets of plywood at the Wellhead, wooden planks at both sumps, and a row of cribbing to the east of the North Pad. The total volume estimate is around 20 m^3.

The total observed volume of non-hazardous wood waste is on the order of 24 m^3.

A volume of 30 cubic meters (approximately 60 tonnes) of metal waste was observed at the APEC 1 on the north side of Drum Cache 1. It is shafts, pipes, a large metal wheel, chain-link fencing. One metal drill rod was also observed at APEC 4 and two large steel flywheels could be seen underwater at Sump 2. The overall tonnage of waste metal is on the order of 70 tonnes. The large steel pieces are not planned for off-site removal. The quantity for removal is 15 m^3 / 30T.

3.3.6 Waste Fuel and Drums

An inventory of waste fuel and waste fuel drums at Skybattle Bay was conducted. The count was:

Table 3-3 Fuel Drum Inventory at Skybattle Bay

Defined Area	Number of Drums	Full Drums	Estimated Volume	Sampled
APEC 1 – Drum Cache 1	71	5	1,000 L	#1
APEC 2 – Drum Cache 2	51	5	1,000 L	#50
APEC 3 – Burn Area	0	0	0	No drums
APEC -4 Oil Drilling Platform	20	0	0	No
Minor Cache west end of Airstrip	9	0	0	No

Defined Area	Number of Drums	Full Drums	Estimated Volume	Sampled
Airstrip	130	0	0	No
Totals	**281**		**2,000 L**	**2 samples**

Not all drums at Skybattle Bay were uniform or the same colour. Some were uniformly dark red. Some had a central band of white, blue or black. Panarctic Rae Point was the most frequently observed label. The drums sampled were upright full drums.

The results of the analysis of product taken from one drum at APEC 1 (drum #1), yielded a total chlorine of 4811 ppm and a specific gravity of 1.006. The sample was found to be 97% water by volume and as such, there was not enough sample to test for flashpoint. There was negligible PCB, lead, cadmium or chromium detected.

The results of the analysis of product taken from one drum at APEC 2, (drum #50) yielded no PCBs, and a total chlorine of 31 ppm. The sample was found to be 99.9% water by volume and as such, there was not enough sample to test for flashpoint. There was negligible PCB, lead, cadmium or chromium detected. The pH was measured to be 6.15.

The analytical report on waste fuel testing from PetroLab is included in Appendix B.

3.3.7 Summary of Waste Streams

A summary of all waste streams at Skybattle Bay requiring remediation is given below.

Table 3-4 Summary of Waste Streams Requiring Remediation at Skybattle Bay

Waste Stream	Quantity
Wood Waste (APEC 4 and at random)	24 cubic metres / 24 tonnes
Metal Waste (at Drum Cache 1 and Oil Drilling Platform)	15 cubic meters / 0 tonnes
Waste Fuel (APEC 1 and 2)	2,000 litres
Drums (APECs 1,2 and 4 and airstrip)	281 drums empty weight of drums: 5,000 kilograms.

3.4 Remedial Options Analysis by Waste Stream

3.4.1 Evaluation Method

The process used to assess and select remedial options was a qualitative, multi-variant criteria decision matrix. This process is useful to arrive at an optimal decision when multiple criteria must be considered. The outcome of such an analysis is a solution which is the best compromise solution for balancing the degree of satisfaction of all (and often competing) considerations. The process was implemented by developing a set of potentially viable management options for each waste stream requiring remediation, including a base case (left as is) option, and evaluating the degree to which each option satisfied each evaluation criteria.

The evaluation criteria were weighted evenly in the comparison. Each management option was scored as favourable, neutral or unfavourable under each evaluation criterion to indicate its degree of satisfaction of the individual criterion. A favourable score was assigned if the evaluation criteria was well, or very well, satisfied. A neutral score is given if the evaluation criteria is somewhat satisfied, and an unfavourable score is assigned if the evaluation criterion is poorly or very poorly satisfied.

To determine the most favourable option per waste stream, a numeric value was given to the favorability score as follows: each favourable score was given a value of +1, each neutral score was given a numerical value of 0, and each unfavourable score was given a value of -1. The overall score for each option was tallied and expressed as *favourable* if the numeric tally is greater than zero, *neutral* if the numeric tally is zero, and *unfavourable* if the numeric tally is less than zero. The numerical score is also given in order to highlight the most favourable option, in the event that more than one receives a favourable overall score.

The evaluation criteria that the options were scored against reflect the overall remediation objectives for the site and remained the constant for the analysis of each waste stream. They were:

Reduction of Environmental Risks: This criterion focuses on the reduction of potential environmental risks as evaluated in the HHERA. It ranks how successful an option is in reducing potential risks to the receiving environment and uptake by humans or the natural environment. A positive ranking indicates that environmental risk will be very successfully reduced by the option; a neutral ranking indicates that the environmental risk will be somewhat reduced by the option, and an unfavourable ranking indicates that the option likely does not adequately reduce the environmental risk.

Value to Crown: This criterion is a qualitative comparison of overall cost of each option. It considers the overall closure costs (Capital) and longer-term monitoring and maintenance (LTM) if the option requires it. As a qualitative score, the evaluation it is not proportional to actual costs. The cheapest option(s) are scored as favourable and the most expensive score as unfavourable. A neutral ranking indicates an option that is in between the high and low-cost options under consideration.

Resources Required: This criterion encompasses the engineering and scientific complexity of each option such as the ability to achieve physical and chemical stability and construction complexity. This

criterion also considers the remoteness of the site and that all equipment required for the work will need to be brought on and off-site by air, and that the closest community to the site is 410 km distant. Options that require mobilization of significant resources will be ranked as unfavourable. Solutions requiring a moderate mobilization of resources will be ranked neutral and solution with a lower degree of resources required will score favourably. Although cost is somewhat related to resources required, this criterion focuses strictly the resources required and technical complexity.

Reduction of Environmental Liability: This is considered satisfied when environmental liability can be considered as zero once the option has been implemented. Options which are "walk-away" with no future monitoring requirements are scored as favourable, whereas those with on-going monitoring and maintenance obligations are scored lower (unfavourable). A neutral ranking indicates that the liability has been significantly reduced but not entirely extinguished.

Local Benefits: This criterion considers the local economic benefits derived during the remedial work and the long-term benefit from potential future use of the site by local stakeholders. Local stakeholders are defined as residents of the area who may be employed in the remedial work program and who may use the site as part of their traditional hunting, fishing and food gathering land. It is important to note that this criterion has been scored from an anticipatory perspective, as the stakeholder consultation component of this project has not yet taken place, and the stakeholders' opinions on the integrated option which is the output of the remedial options analysis have not been heard.

3.4.2 Wood Waste

There is a total of 24 m^3 of wood waste present at Skybattle Bay. All wood waste was observed to be unpainted and is present around APEC 1 and at APEC 4. At APEC 1 it consisted of around 30 planks strewn at random to the northeast of the drum cache and a wooden platform of 2 x 2 m on which there were five upright drums. The volume of wood at APEC 1 is 4 m^3.

At APEC 4 it consisted of sheets of plywood at the well head, planks at both sumps, and a row of cribbing to the east of the North Pad. The volume of wood at APEC 4 is around 20 m^3.

Options for managing the wood waste are:

1) Leave as-is: The wood at random locations around APEC 1 would not be moved. The wood waste at APEC 4 would be consolidated in a single location at Skybattle Bay, which is away from the washouts at APEC 4. The wood waste quantity is 24 cubic meters/ 24 tonnes.

2) Incineration of wood: The wood would be burned on a constructed incineration pad in a monitored and controlled burn. The incineration could be done at one of the earth mounded platforms at APEC-4 where there is no vegetation to catch fire and would not require any borrow material. A burn pan would be used to minimize mixing of ash and the underlying soil and ash could be collected for off-site disposal.

3) Off-site disposal of wood: The wood would all be cut and consolidated and moved off-site for disposal. The 24 m^3 of wood would be expected to weigh about 20 to 24 tonnes and would require multiple aircraft flights to accomplish removal from the site. It could be offered for firewood in Resolute Bay.

The three options for wood waste have been evaluated and the results are tabulated below.

Table 3-5 Evaluation of Options for Wood Waste

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score
	Reduction of Environmental Risk	Value to Crown	Resources Required	Reduction of Liability	Local Benefits	
Leaving on-site	Neutral	Favourable	Favourable	Neutral	Neutral	Favourable (+2)
Incineration of Wood Waste, removal of ashes	Neutral	Neutral	Unfavourable	Neutral	Favourable	Neutral (0)
Off-site disposal of Wood Waste	Neutral	Unfavourable	Unfavourable	Neutral	Favourable	Unfavourable (-1)

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

The Environmental Risk in leaving the wood waste on-site is seen as a neutral because there is no environmental risk with this waste stream. The Value to the Crown with this option is favourable as it is the lowest cost option. Resources required are minimal, the wood at APEC 1 would not be touched; the wood at APEC 4 would just be consolidated (favourable). There is no environmental liability for unpainted wood as it has no contaminants, so the reduction of liability achieved by leaving it on-site is neutral. The is negligible local labour involved in this option, but it does not detract from future site use so its rating under Local Benefits is neutral. The overall score is favourable (+2).

Incineration of the wood waste with off-site removal and disposal of ash scores neutrally on Reduction of Environmental Risk because there is no environmental risk with this waste stream. The Value to the Crown (cost) is between leaving it on-site and removing it from site without burning, therefore neutral. The resources required would be greater than leaving it on-site, therefore scores unfavourably. Reduction of Liability, similar to the first criterion, is neutral because unpainted wood does not classify as a liability. The favourable score under Local Benefits was assigned because there is moderate local labour content in the incineration and ash removal tasks. Its overall score is neutral (0).

The off-site disposal option scores neutrally on Reduction of Environmental Risk and Reduction of Liability criteria because there is no environmental risk or liability with this waste stream. Value to the Crown is unfavourable because flying out the waste wood would be the costliest option. The local benefits are ranked as favourable as there would be local involvement in cutting the wood in preparation to transportation it to the aircraft and it could potentially be reuse as timber or firewood in Resolute Bay, but overall, this option is unfavourable (-1).

The optimum waste management solution for the waste wood is for it to be left as it lays at APEC 1 with some gathering and consolidation on one of the soil platforms away from washouts at APEC 4. There is no liability in its current location, and this has a much lower cost relative to the other two options, and there is no long-term monitoring or maintenance required therefore leaving it on site is justifiable.

3.4.3 Metal Waste

Approximately 70 tonnes of metal waste are present at Skybattle Bay. The metal is unpainted, rusty and considered to be non-hazardous. The identified options for its management are:

1. Left as is: The metal would be consolidated at APEC 1 at Skybattle Bay, where most of it lies and is not near to any streams, or outwashes or standing water bodies. The minor amount of metal at APEC 4 would be brough to APEC 1.
2. Burial on-site: The metal would be consolidated and cut or crushed to reduce its volume and placed in an on-site encapsulation cell. Given the shallow depth to permafrost, the only place where there is sufficient soil to bury the metal is at the piled soil platforms at the wellhead area. Such an encapsulation cell would require permitting as a waste site and require long-term monitoring.
3. Removal off-site for disposal. The metal would be collected and transported to Resolute Bay for transfer to the sealift and then disposed of outside of the territory. Transport would be by helicopter to Stupart Island and then by cargo plane landing to Resolute Bay.
4. Remove lighter/smaller item off-site but leave large/heavy items such as the flywheels in one consolidated location. The weight of steel to be removed would be reduced to approximately 30T. This material would be slung to the waste transfer facility at Stupart Island by helicopter and then to Resolute Bay by fixed-wing aircraft, and then sent out of Territory for recycling or disposal.

The four management options for metal waste have been evaluated and the results are tabulated below.

Table 3-6 - Evaluation of Options for Metal Waste

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score*
	Removal of Environmental Risk	Value to Crown	Resources Required	Reduction of Liability	Local Benefits	
Left as is	Neutral	Favourable	Favourable	Unfavourable	Unfavourable	**Neutral (0)**
Burial on-site	Neutral	Unfavourable	Unfavourable	Unfavourable	Favourable	**Unfavourable (-2)**
Removal off-site for disposal	Neutral	Unfavourable	Unfavourable	Favourable	Favourable	**Neutral (0)**
Removal of light items, heavy items remain	Neutral	Neutral	Neutral	Favourable	Favourable	**Favourable (+2)**

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

The Environmental Risk in leaving the metal waste on-site is seen as a neutral because the bare metal is non-hazardous and has no contaminated site risk. This option proposes to bring all the metal to APEC 1 and the cost involved in this is related to bringing the metal from APEC 4 to APEC 1. It is the least costly of the options (favourable). Resources requirements are favourable as this could be done with light vehicles that are transportable in a Twin Otter and presents no technical challenge. This option involves leaving waste on site, which would have to go through a permitting process, and on-going monitoring would be required, hence it is not a "walk-away" solution (unfavourable). Local Benefits was graded as unfavourable as this option has the lowest degree of local labour and leaves metal on -site, albeit at one area. Leaving it as-is scores neutral (0) overall.

For the burial on-site option, the reduction of Environmental Risk with burial on site is seen as a neutral because bare metal is not a contaminant. The costs would be great (Value to Crown unfavourable). Burying the metal waste on-site has problematic resource requirements (unfavourable) since it would require the use of excavation equipment to construct and encapsulate the metals in a constructed cell. Given the shallow depth to permafrost at the Site, the only place where this could be done would be at the mounded soil platforms at APEC 4. The ground is very soft, and this would necessitate winter work. If the metal waste is buried in a waste cell it would require on-going monitoring and as a result the liability would not be extinguished with this option, thus, it scores unfavourably in Liability Reduction. Local benefits are considered to be favourable given that the labour component of this option is the highest. Overall, this option scores unfavourably (-2).

For the removal off-site for disposal option, the reduction of Environmental Risk is seen as a neutral because bare metal is not a contaminant. This option however scores favourably under Reduction of Liability because it is the "walk-away" solution. The local benefits are scored as favourable because the local community would benefit by having an unincumbered site, the local labour would be involved in cutting and preparing the metal off-site removal. Removal off-site for such a large quantity of waste metal would be challenging from a logistics perspective when considering the availability of cargo aircraft capable of landing at the Skybattle strip and able to transport significant tonnage off-site in a reasonable timeframe. The most readily available cargo aircraft in Northern Canada, is the Douglas DC-3, with a payload of 3 to 3.75 T. A welder would be needed to cut up long drill pipes and heavy flywheels to be loaded thus for Resources Required it was rated as unfavourable. Alternatively, a Lockheed C130 Hercules aircraft, which has no domestic availability in Northern Canada, and must be sourced from Alaska, has a bigger payload of 20 T and verification would be required to confirm that the airstrip when frozen can still receive a Hercules. Value to Crown was assessed to be unfavourable due to the high cost. Off-site transport via boat was also considered, however the availability of commercial marine cargo service that far north is usually limited to sealift to communities. Overall, this option scores neutral (0).

The fourth option is a variation on full-scale removal. Like all the other options it scores neutrally on reduction of environmental risk. In Value to the Crown, it is also neutral because its cost is between the highest and lowest. In Resources Required it is neutral because it is less complicated (does not require cutting) than the full-scale removal but is more resource intense than leaving the metal "as-is". For Reduction of Liability, it is rated as favourable because it would not have any on-going commitment. Local Benefit was scored as positive too because it enhances the site while incurring local labour for its execution. The final score is favourable (+2).

The recommended option for remediation of waste metals is therefore to remove the smaller easily moved items and consolidate the heavy item leaving them on-site. The flywheels should be moved from the drill sump and put with the other ones and left at Drum Cache 1.

3.4.4 Waste Fuel Options

A quantity of approximately 2,000 L of waste fuel is present at Skybattle Bay. Both fuel samples indicated a high proportion of water 97-99%. This gives a volume of actual fuel of only about 60 L.

Options for management include:

1. Leaving as is: Leaving the waste fuel in its current situation.
2. Incineration on-site: An incinerator would be mobilized to Skybattle Bay, and the waste fuel would be brought to the incinerator for burning. Given that the drums which were sampled contained a large proportion of water, the fuel would have to be decanted to separate it from water. The product would be transferred to sturdy containers such as translucent drums or totes and the fuel would have to be carefully decanted off the top (being lighter than water) before incineration could be attempted. There are small/light weight incinerators on the market that are transportable by aircraft and capable of burning aviation fuel. Either of the incinerators investigated (SmartAsh with an optional drum transfer pump, or a Total Combustion Inc, model DCL) would be capable of incinerating a volume of 66 L of combustible fuel in less than a day and could be transported to the site in a single Twin Otter aircraft flight. The incinerator would require additional labour and skill to operate them, and burning of such poor quality of fuel that is likely to present some difficulty.
3. Removal off-site for disposal. Given that the structural integrity of the drums is unknown, they may have corroded and weakened to the point of near perforation. For this reason, it is not envisaged to move any of the full or partially full drums from their present location. The contents would be pumped from the non-empty drums into alternative sturdy containers and consolidated at each drum depot during a summer phase of work, and then brough off site to Resolute Bay during a winter phase of work, for either local incineration, or transfer out of the Territory for disposal. Removal of the waste fuel from the sites for disposal has no technical uncertainty, its movement would be trackable via manifests, and proof of disposal would be documented. The 2,000 L of waste fuel and water could be contained in two or three 1,000L totes or 10-11 new drums, depending on the on-site equipment used for transportation to the aircraft. Upon arrival in Resolute Bay the drums or totes would be handled by heavy equipment such as a loader with forklift, and subsequently be shipped via sealift to an appropriate disposal facility near to Bécancour, Quebec the terminus of the sealift.

The three options for waste fuel have been evaluated and the results are tabulated below.

Table 3-7- Evaluation of Options for Waste Fuel

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score*
	Reduction of Environmental Risk	Value to Crown	Resources Required	Reduction of Environmental Liability	Local Benefits	
Left as is	Unfavourable	Favourable	Favourable	Unfavourable	Unfavourable	**Unfavourable (-1)**
Incineration on-site	Favourable	Unfavourable	Unfavourable	Favourable	Favourable	**Favourable (+1)**
Removal off-site for disposal	Favourable	Neutral	Neutral	Favourable	Favourable	**Favourable (+3)**

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

Leaving the waste fuel on site incurs environmental risk of eventual perforation and future contamination of soil (unfavourable). The cost is least (favourable) but the environmental liability would not be reduced (unfavourable). It does not create any local socio-economic benefits. It is not a viable option, and its overall score is unfavourable (-1).

Incineration of the waste fuel at this site is complicated by the fact that the fuel appears to be contaminated with water. The two fuel samples analyzed had only 1-3% fuel. The technical challenge and resources required to decant the fuel into a combustible portion are unfavourable and the effort for this, and the fact that only a 3% volume reduction could be expected results in its cost (Value to the Crown) being greater than the next option of removing the fuel without attempting on-site incineration. The local benefits in terms of employment and betterment of the site for future use are favourable and it extinguishes the environmental liability (favourable). This option scores overall weakly favourable (+1).

Removal of the waste fuel off-site removes the environmental risk (favourable) and eliminates the environmental liability (favourable). Its cost is expected to be less than on-site incineration because it does not involve bringing incinerators to the site or the effort of decantation of product and water or attempts to burn the fuel. The volume is little changed by not incinerating on-site, but of course it is more costly than the leaving as-is option (neutral). The resource requirements are expected to be less than on-site incineration but greater than leaving it as-is (neutral). The local benefits in terms of employment and betterment of the site for future use are on-par with the preceding option and are favourable. The removal for off-site disposal option scores most favourably overall (+3).

The recommended remedial option is to proceed with collection of the fuel/water on-site and removing it to Resolute Bay for onward shipment and disposal out of the Territory.

3.4.5 Waste Drums

A total of 281 fuel drums are present at Skybattle Bay, most of which are empty. The drums lining the landing strip (130 drums) were empty, with intentional perforations (pickaxe holes), and so were the ones at minor drum cache (9 drums). The drums at the drilling site were mostly rusted shells (20 drums). There were five drums at Drum Cache 1 and Drum Cache 2 which contained product/water. Non-empty drums must be pumped out where they are, to avoid any leakage due to shifting them in their potentially weakened state. The dry weight per drum is 20 kg, and the total weight is calculated to be 5.6 tonnes. The options investigated for their management are:

1. Left as is: The waste drums would be left in one consolidated location at Skybattle Bay after they had all been emptied.

2. Burial on-site: The empty drums would be opened at one end and cleaned inside using a pressure washer or steam cleaner. Wash water would be collected and treated prior to disposal. The drums would then be crushed, using a drum crusher or other capable equipment. An intact drum has a volume of 0.2 m^3 and crushed volume of 0.05 m^3 per drum can be anticipated. The crushed drums would be placed in an on-site encapsulation cell. An encapsulation cell would require long-term monitoring.

3. Removal off-site for disposal. All non-empty drums would be emptied as best possible, but not cleaned on-site as above. They would be tested for residual vapours inside using a photo-ionization detector and any drum with explosive vapours would be placed in an over-pack container with an airtight lid. Drums would be moved by helicopter to Stupart Island and then moved to Resolute Bay by fixed-wing aircraft (Twin Otter or DC-3). Dry drums (with no vapours) would be loaded as-is into the plane as-is and the drums with vapour would be kept in over-packs so as to not release fuel vapour when inside the cargo bay of the plane. The squared dimensional volume of a standard drum is 0.324 m^3. 281 drums have a volume of 91 m^3 (over-packs would add to this volume). The cargo volume of a DC-3 is 27 m^3 so the waste drums could be flown to Resolute Bay in four DC-3 flights. Once in Resolute Bay, the drums would be cleaned and crushed in a dedicated drum crusher and then moved out of the Territory for disposal.

Table 3-8- Evaluation of Options for Waste Drums

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score*
	Reduction of Environmental Risk	Value to Crown	Resources Required	Reduction of Environmental Liability	Local Benefits	
Left as is	Unfavourable	Favourable	Favourable	Unfavourable	Unfavourable	**Unfavourable (-1)**
Burial on-site	Neutral	Unfavourable	Unfavourable	Unfavourable	Neutral	**Unfavourable (-3)**
Removal off-site for disposal	Favourable	Neutral	Neutral	Favourable	Favourable	**Favourable (+3)**

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

Leaving the waste drums on-site at a consolidated location does not remove the environmental risk or liability as the drums would not have been washed clean and would contribute to environmental degradation. The on-going liability fails the "walk-away" solution objective therefore is unfavourable in Reduction of Liability. This option is the cheapest therefore scores favourably in Value to Crown. It also does not require many resources. The local community would not benefit (unfavourable). This option scores unfavourably (-1).

Burying the drums on-site has greater technical complexity than the other two options. Resources required scores unfavourably. It would require: building a wash pad for water retention, cutting open one end of each drum, washing with a pressure washer, crushing the drums, burial in an encapsulation cell and treating the oily wash water. The burial of empty steel drums in an encapsulated waste cell would require on-going monitoring and as a result the liability would not be completely extinguished. Thus, it scores unfavourably in terms of Liability Reduction, Technical Challenges and Value to Crown. The environmental objectives (safe disposal) would be met, although the metal waste would remain on-site (neutral). Local benefits are considered to be favourable given that the labour component of this option is the highest. Overall, this option scores unfavourably (-2).

Drum removal off-site favourably reduces the Environmental Risk and extinguishes the liability because it is a "walk-away" solution. Value to the Crown is score as neutral since costs are expected to be less than burial but more than leaving them as-is. It scores neutrally on Resources Required because it is more easily accomplished than burial but has more steps than leaving them as-is. Off-site removal of drums benefits the local community through leaving a clean site and providing a local labour component (favourable). Overall, this option scores favourably (+3).

The recommended option for waste drums is therefore removal off-site for disposal outside of the territory. Drums would be brought to a staging area on Stupart Island and then brought to Resolute Bay. Over-packs would be used for any drum which are not sealed and have high internal vapours. Washing and crushing facilities exist in Resolute Bay in Resolute Bay. The benefits of washing and crushing prior to sealift transport would be assessed.

3.4.6 Integrated Remedial Plan

The integrated remedial option is comprised of the highest-ranking options from the multi-variant criteria decision matrix analysis, for each waste stream requiring remediation. The integrated preferred remedial option for Skybattle Bay consists of:

1. The wood waste is unpainted and is not a contaminant. The wood at APEC 1 and randomly scattered would not be moved. The wood waste at APEC 4 which is pallets and heavy lumber would be consolidated in a single location on top of one of the soil platforms at APEC 4, thus a safe distance from the washouts that are present at APEC 4. The wood waste quantity is 24 cubic meters/ 24 tonnes.

2. Small scrap metal waste would be removed from site by helicopter to Stupart Island and at the end of the on-site work would be brought to Resolute Bay by fixed-wing aircraft and sent out of Territory by sealift for disposal or recycling. The large metal objects would remain on-site at one designated location. The quantity of metal waste for transportation off-site is approximately 15 cubic meters / 30 tonnes.

3. Waste fuel and water from drums would be collected in sturdy containers and transported first to Stupart Island by helicopter, and then to Resolute Bay for off-site disposal. The waste fuel/water volume is 2,000 litres (L) (2 T).

4. The 281 waste drums would be transported first to Stupart Island by helicopter and then to Resolute Bay by fixed-wing aircraft, where they would be processed (cleaned and crushed), if it is advantageous to do so, then sent out of the Territory for recycling or disposal. The combined weight of empty waste drums is approximately 5,000 kilograms (kg) (6 T).

In summary, the metal waste (30T), waste fuel/water (2T) and the 281 empty drums (6 T) will require removal from the site. Only the wood waste would be left on-site at APEC 1 where it is partially sunken

into the peat moss and consolidated on one of the soil platforms at APEC 4. Once completed, this solution will be "walk-away", with no on-going monitoring requirements or liability.

Remediation at Skybattle will have three stages: heli-transport to Stupart Island, then fixed-wing transportation to Resolute Bay, and finally sealift to appropriate disposal facilities in the South. There is usually one sealift stop in Resolute Bay per year. The 2021 sealift date of departure from Resolute Bay was September 7th. The anticipated departure time of the sealift should be integrated into the timing of remedial activities.

3.5 Scope of Work for Proposed Remedial Solution

The scope of work required to implement the remedial options for Skybattle Bay and the other two large sites has been resolved into a Work Breakdown Structure (WBS) included in Appendix A. The WBS describes in a graphical form the work that will be required of a contractor that successfully complies with the screening, selection and bidding process that is being developed for this site. The WBS contains four main tasks for Skybattle Bay: 1 Balance of Project Costs and Project Meetings, 2 Health, Safety and Environment, 3 Transportation and Logistics, and 4 Skybattle Bay Remediation.

Task 4 breaks down the work required to implement the remedial options defined in the previous section into work packages as defined in the Tender Specifications and verifiable by the on-site PSPC Construction Representative.

The work packages are as follows, with details being provided in the Tender Specification:

1 Waste Drum Management

Drums will be emptied of any liquid while on-site. They will be tested for explosive vapours as per Waste Fuel Management Scope section and subsequently packaged as required for off-site movement. The packaged drums will be moved off-site by helicopter to Stupart Island and then by fixed-wing aircraft to Resolute Bay. In Resolute Bay they may be washed and crushed, if there is an advantage in doing so, and then transported out of Territory by sealift to a disposal facility in the South.

2 Waste Fuel Management

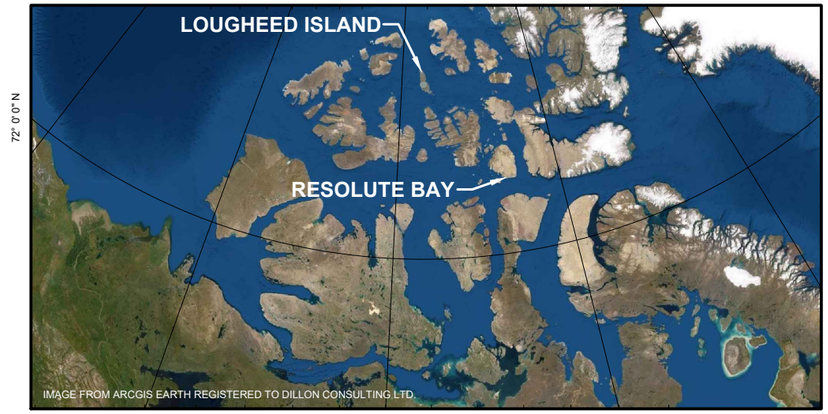
Waste fuel mixed with water will be pumped out of any non-empty drum into sturdy new containers and transported by helicopter to Stupart Island and then by fixed-wing aircraft to Resolute Bay, then sent out of Territory by sealift to a disposal facility in the South.

3 Metal Waste Management

Large metal objects from APEC 4 will be brought to the APEC 1 location and consolidated. Smaller, easily moved metal objects will be initially brought by helicopter to Stupart Island and then to Resolute Bay where it will then be shipped out of Territory by sealift for recycling or disposal out of the Territory .

4 Wood Waste Management

Waste wood at APEC 4 will be gathered and consolidated on top of one of the soil platforms. Wood waste strewn around at APEC 1 will not be disturbed.



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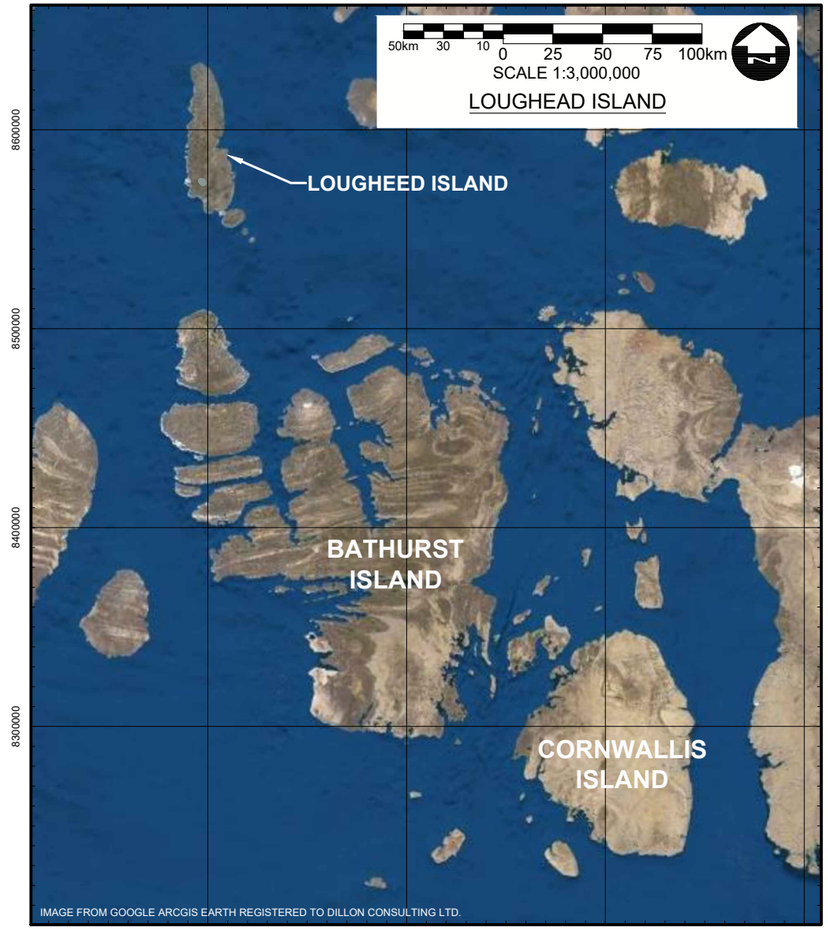
72° 0' 0" N



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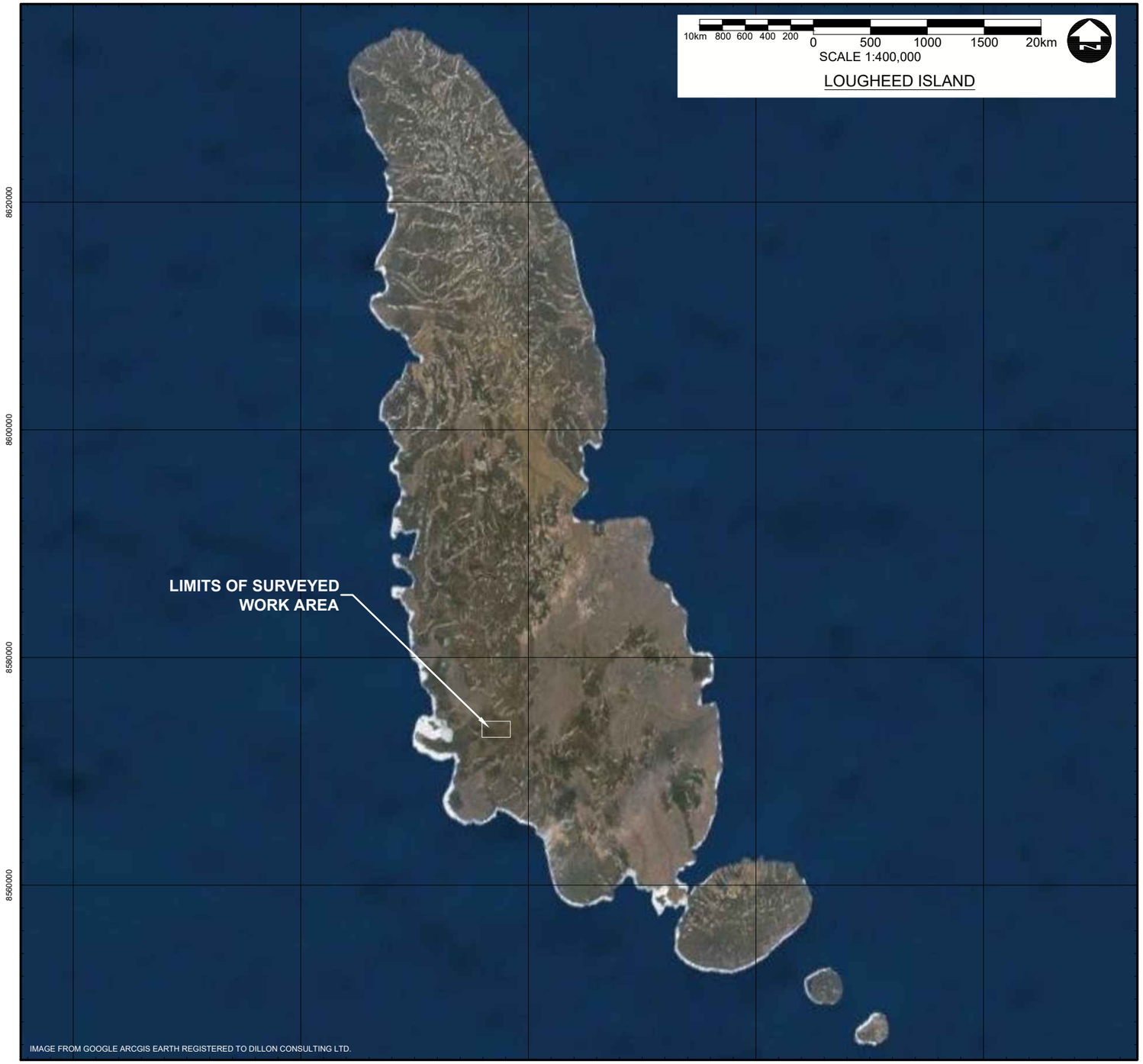

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. **21-2370**

SKYBATTLE BAY
SITE LOCATION PLAN

SHEET NO. **500**

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FILENAME: C:\CAD\21237\0 PIONEER SITES\SKYBATTLE 21\NSKY BATTLE 21SN.DWG
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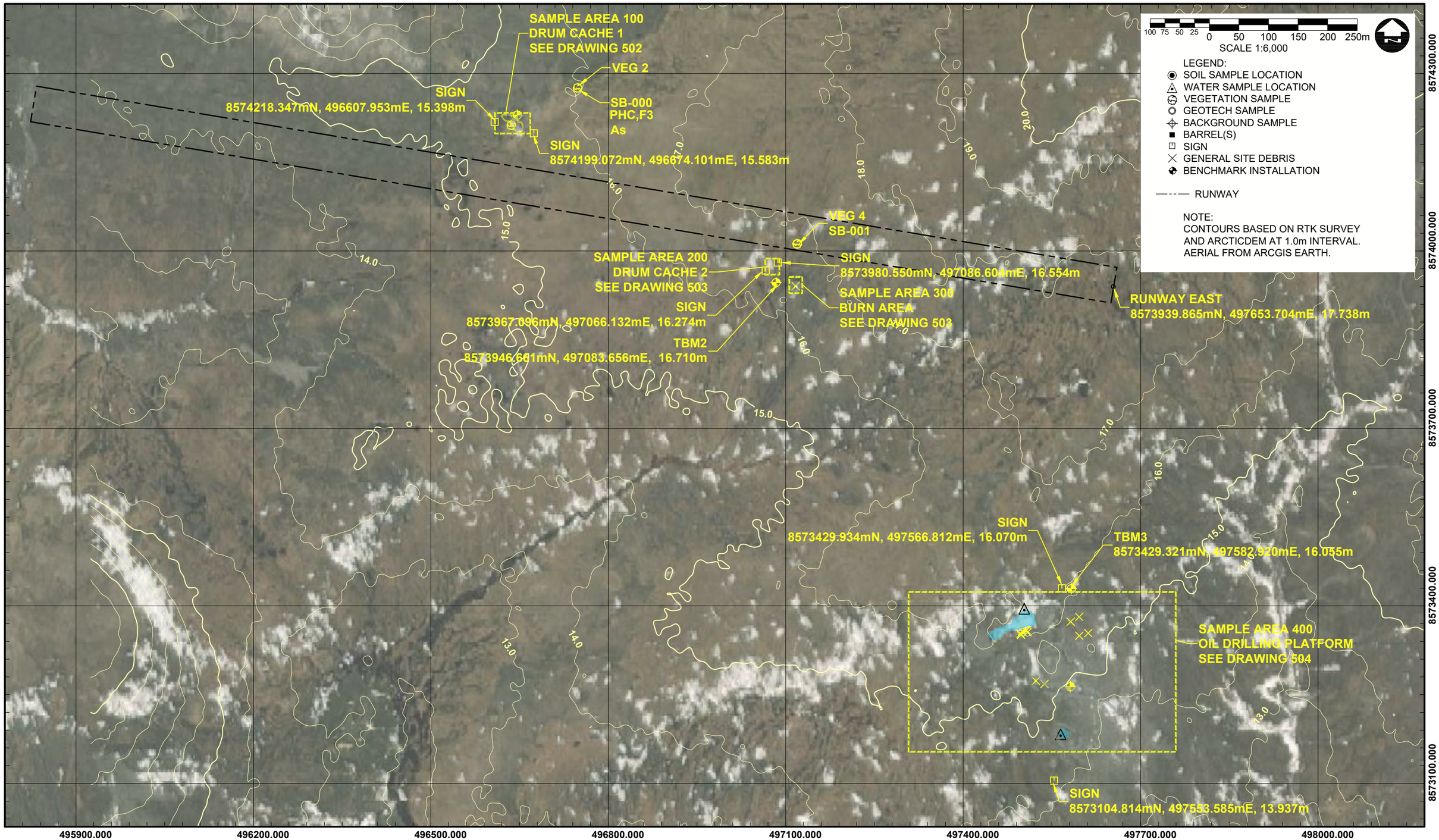

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

SKYBATTLE BAY
SURVEYED LIMITS
INCLUDING VEGETATION AND BACKGROUND SAMPLES

SHEET NO. 501

496616 496624 496632 496640 496648 496656 496664

8574232 8574224 8574216 8574208 8574200

2.5m 1.5 0.5 0 1 2 3 4 5m
SCALE 1:150

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

HYDROCARBON IMPACTED ZONES
PERMAFROST DEGRADATION

NOTE:
CONTOURS BASED ON RTK SURVEY AND ARCTICDEM AT 0.1m INTERVAL. AERIAL FROM ARCGIS EARTH.

WOOD DEBRIS

Wood waste: leave as is

TBM1
8574229.844mN, 496646.235mE, 15.860m

15.5

15.6

15.7

PERMAFROST DEGRADATION

LIMITS OF 360 IMAGERY

Metal waste: Consolidate, cut for ease of movement. Remove small metal objects from site and dispose of out of Territory. Flywheels to remain.

Collect waste fuel mixed with water in sturdy containers and remove from site and dispose of out of Territory.

WOOD DEBRIS

SB1
PHC-F2,PAH

SAMPLED DRUM (#1)

SB-103
PHC-F2,B,PAH

SB VEG 1

SB 101
PHC-F2,B,PAH

SB-105

SB-104
PHC-F2,B,E,X,PAH

Waste drums are to be collected. Any drums with explosive vapours to be put in over-packs.

Drums must be removed from site and disposed of out of Territory.

SB-106

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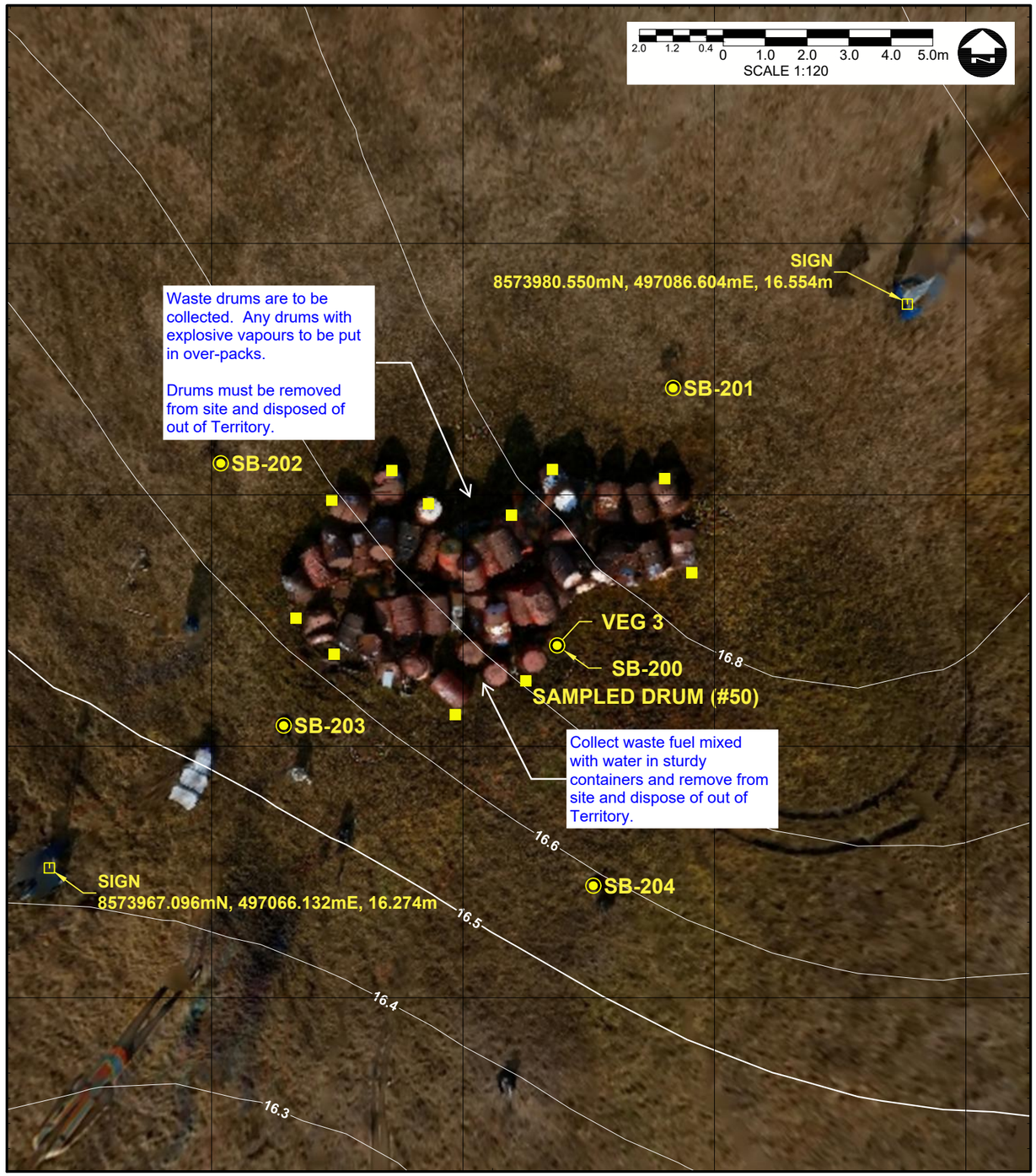
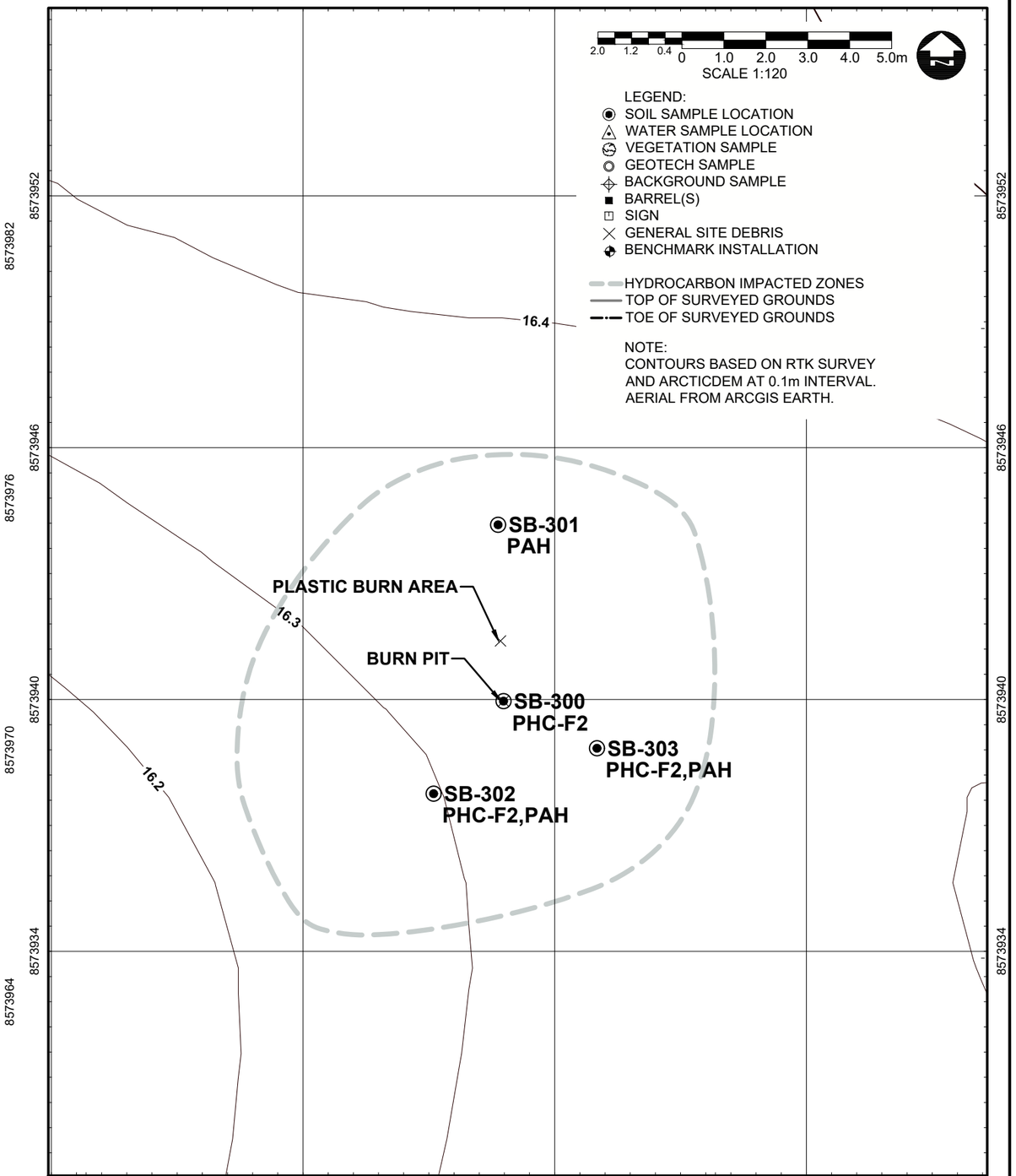
SKYBATTLE BAY
SAMPLE AREA 100
DRUM CACHE 1

PROJECT NO. 21-2370

SHEET NO. 502





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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

SKYBATTLE BAY
SAMPE AREA 200 AND 300
DRUM CACHE 2 AND BURN PIT

SHEET NO. 503

497340 497400 497460 497520 497580 497640 497700 497760

8573400 8573340 8573280 8573220 8573160

20 16 12 8 4 0 10 20 30 40 50m
SCALE 1:1200

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

HYDROCARBON IMPACTED ZONES
TOP OF SURVEYED GROUNDS
TOE OF SURVEYED GROUNDS

NOTE:
CONTOURS BASED ON RTK SURVEY AND ARCTICDEM AT 0.1m INTERVAL. AERIAL FROM ARCGIS EARTH.

Samp 1
SB-401
NORTH PAD
WOOD CRIBBING
WOOD DEBRIS
SB-403
SB-402
SOUTH PAD
SB-404 A
SB-404 B
TBM4
8573263.593mN, 497581.021mE, 14.429m
SB-400
PHC F2,F3,PAH
WELLHEAD
SB-404 C
SB-404 E
PHC F1,F2,F3
SB-404
PHC F1,F2,F3,E,PAH
SB-404 D
IMPACTED SOIL ZONES
SB-405
SB-406
PHC F1-F4,BTEX
Samp 2

Collect waste wood and place it on South Pad.

Collect metal waste from Sump 2, consolidate with waste metal at Drum Depot 1.

Remove small metal objects from site. Dispose of out of Territory Flywheels to remain

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FILENAME: C:\CAD\21370 PIONEER SITES\SKYBATTLE Z10N\SKY BATTLE Z10N.DWG
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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

SKYBATTLE BAY
SAMPLE AREA 400
OIL DRILLING PLATFORM

SHEET NO. 504

4.0 Cape Ahnighito Remedial Action Plan

4.1 Executive Summary

Cape Ahnighito site is designated NB048 in the Northwest Territories/Nunavut contaminated site database and its federal contaminated site inventory (FCSI) number is 00000289. The site is located on the northern tip of Lougheed Island, about 480 km northwest of Resolute Bay and 130 km southwest of the Isachsen High Arctic Weather Station. Cape Ahnighito is a former Panarctic Oils Ltd. supply depot, where fuel drums were stored, and a camp was established. There was no oil and gas exploration conducted at the Site. There is no identifiable airstrip at Cape Ahnighito.

There are two parts to the Cape Ahnighito site: Main Site and the Northwest Drum Cache. The Main Site is located one kilometre east of the shoreline of the Arctic Ocean and stretches southward from an unnamed river which flows westward into the ocean. It covers an area of about 350 m on its north-south axis by 200 m on its east-west axis. At the Main Site there are North and South drum caches plus random drums strewn about for a total of 92 drums and several debris areas. The Northwest Drum Cache is about 800 m northwest of the Main Site and had 11 drums strewn at random over an area of 150m by 90m.

The Phase III ESA (DOJV 2022a) of Cape Ahnighito was carried out in the summer of 2022 and included soil sampling, chemical analysis and waste inventories of eight APECs:

- APEC 1 North Drum Cache,
- APEC 2 South Drum Cache
- APEC 3 Debris Areas 3, 4, and 5
- APEC 4 Drainage Channel,
- APEC 5 Northwest Drum Cache
- APEC 6 the Debris Area 2(oily tent material)
- APEC 7 Debris Area 6 (Burn Area)
- APEC 8 an Incinerator Oil Drum

There was no petroleum hydrocarbon impacted soil found at any of the APECs. The sediment found in the rivulet that drains the Main Site had arsenic concentrations exceeding CCME generic Agricultural Guidelines with an increasing concentration in the down-stream direction. The surface water samples at the Main Site and the Northwest Drum Cache had no contamination but pH outside of the acceptable range on the acidic side, which is not interpreted to be a result of the Site.

The Human Health Risk Assessment concluded that there is negligible potential for human health risk from the only contaminant present (arsenic in sediments) since the site-specific target levels derived by the Risk Assessment were not exceeded in the findings of the Phase III Environmental Site Assessment. The Ecological Risk Assessment similarly concluded that there is no need for corrective action for the sediments.

Hazardous material is present with residual fuel in drums at both drum caches. There was no hazardous building material (lead paint, asbestos) found at the Site.

Non-hazardous debris is present in the form of wood, metal, glass, canvas, airplane parts and plastic in several debris areas.

A summary of all waste streams at Cape Ahnighito is given below.

Table 4-1– Summary of Waste Streams at Cape Ahnighito Requiring Remediation

Waste Stream	Quantity
Contaminated Soil or Sediments (PHC, PAH or metals)	None
Non-hazardous debris	Non-painted wood, metal, glass, canvas, airplane parts and plastic 12 m^3 / 12 T (reduced to 10m^3 / 10T with burning of wood)
Waste fuel	900 L at South Drum Cache and 400 L at Northwest Drum Cache 1,300 litres
Drums	92 at Main Site and 11 at Northwest Drum Cache 103 drums empty weight of drums: 2.4 T.

Remedial Options Analysis

A remedial options analysis was conducted for each waste stream requiring remediation. The evaluation criteria were consistent for the options analysis for each waste stream: i) Reduction of Environmental Risk; ii) Value to the Crown; iii) Resources Available; iv) Reduction of Environmental Liabilities; and v) Local Benefits. Several viable management options were conceived for each waste stream, and they were evaluated according to the evaluation criteria. Options were scored under each evaluation criterion as either favourable, neutral or unfavourable, according to the degree to which the criterion was satisfied. The objective is to develop a solution which is protective of the environment and does not require on-going monitoring or maintenance, i.e., a “walk-away” solution.

The integrated remedial plan is comprised of the highest-ranking options from the multi-criteria decision analysis of each waste stream requiring remediation. The integrated preferred remedial option for Cape Ahnighito consists of:

1. The non-hazardous waste debris would be managed by incineration of wood to achieve volume reduction and off-site disposal of other waste. The quantity of debris for off-site disposal is 10 m^3 (ten soil bags at one cubic meter each) / 10 tonnes.

2. Waste fuel from drums would be collected in sturdy containers and transported off-site to Stupart Island by helicopter then to Resolute Bay by fixed-wing for either burning if facilities exist or sending out of Territory. The waste fuel volume is 1,300 litres (L). Assuming 7 drums are used for the waste fuel the total weight and containers would be 1.5 tonnes.

3. The 103 waste drums would be removed from site, with over-packs used for any drums with explosive vapours, in two steps, first to Stupart Island by helicopter then to Resolute Bay by fixed-wing aircraft, where they would be processed (cleaned and crushed) if it is advantageous to do so, then sent out of the Territory for recycling or disposal. The combined weight of empty waste drums is approximately 2,400 kilograms (kg) (2.4 T).

In summary, the non-hazardous waste (10T), waste fuel (1.5T) and the 103 empty drums (2.4 T) will require removal from the site. The small quantity of ash from incinerating the wood would be collected with the non-hazardous waste.

Remediation at Cape Ahnighito would be done in a single phase of work over about 7 days during the summer work season of 2024. On-Site activities will be the incineration of the wood, collection of non-hazardous debris into 1 m^3 soil bags, consolidation of waste fuel into sturdy containers and clustering the empty drums into sling-transportable groups.

All of the waste would be heli-transported 80km down to Stupart Island where a waste transfer station would be established. At Stupart Island it would be transferred to fixed-wing aircraft and flown to Resolute Bay for processing and onward transportation by sealift.

From Resolute Bay, the wastes would be transported by sealift for final disposal at licensed waste disposal facilities in the South. There is usually one sealift stop in Resolute Bay per year and it is in September. The anticipated departure time of the sealift should be integrated into the timing of remedial activities. This solution will be “walk-away”, with no on-going monitoring requirements or liability.

4.2 Introduction

4.2.1 Objectives

The objectives of the site remediation are to reduce the environmental risks to an acceptable level for all current and envisaged future site uses and reduce the environmental liability with a "walk-away" solution. The objectives of the remedial action plan (RAP) are to:

- Develop remedial and/or risk management options for each waste stream at the site;
- Evaluate each remedial/risk management option according to its expected degree of success in achieving outcomes of: i) reduction of environmental risk; ii) providing value to the Crown; iii) utilizing resources reasonably available; iv) reduction of the environmental liability; and v) providing local benefits, both during and following remediation;
- Detail the resources required to complete the remediation project; and
- Recommend optimal scheduling of work such that the entire Pioneer Bundle can be addressed in the current phase of the Federal Contaminated Sites Action Plan, ending in March 2025.

4.3 Background of Cape Ahnighito Site and Features

Cape Ahnighito is designated NB048 in the Northwest Territories/Nunavut contaminated site database and 00000289 in the FCSI. The site is located on the northern tip of Lougheed Island, about 480 km northwest of Resolute Bay and 130 km southwest of the Isachsen High Arctic Weather Station at approximately 77º 43' 43.53'' N latitude and 106º 03' 59.92'' W longitude. Cape Ahnighito is a former Panarctic Oils Ltd. supply depot, where fuel drums were stored, and a camp was established. There was no oil and gas exploration conducted at the Site. There is no identifiable airstrip at Cape Ahnighito.

The Phase I ESA for the Cape Ahnighito site (WESA, 2012d) revealed that the site was used as a supply and staging area by Panarctic Oils Ltd. to support their exploration for oil and gas reserves in the Canadian arctic islands. The combined Phase I-II site visit was on July 7, 2011. WESA (2012d) divided the site into two APECs: APEC 1 Main Site and APEC 2 Northwest Drum Cache. They identified two drum caches (North Drum Cache and South Drum Cache) along with multiple debris areas and scattered drums at the Main Site and counted nine drums at the Northwest Drum Cache. The debris areas around the Main Site contained wood, scrap metal, oil and metal cans, scrap fabric, building materials, battery remains and broken glass debris. The Northwest Drum Cache, is located about 800 m west-northwest of Main Site.

The Phase II ESA sampling program which was concurrent with the Phase I site visit, included 10 soil samples plus 1 duplicate and one background sample. The Guidelines used for comparison were CCME Agricultural Land Use. The results revealed:

- Main Site: There was one soil sample collected at the North Drum Cache and four at debris areas. None were impacted. There were two soil samples at the South Drum Cache and metals impacts were found but no PHC. Debris Area 6 was sampled, and it was found to be impacted in PHC and PAH.

- Northwest Drum Cache. There was one soil sample collected at the Northwest Drum Cache and it showed no impacts.

The Phase III ESA (DOJV 2022a) with field work in June and July 2022 at Cape Ahnighito, re-assessed the North and South Drum Caches, each of the Debris Areas, and the Northwest Drum Cache. A total of thirty test pits were carried out for contaminated soil investigation and delineation. Water was sampled from a rivulet draining the Main Site and from a separate rivulet draining the Northwest Drum Cache. A product sample was taken from a drum and analyzed. The results of the Phase III ESA for contaminated soil assessment and waste material classification are contained in the following sections.

4.3.1 Physical Setting and Site Reconnaissance

A ground-level site reconnaissance of Cape Ahnighito was the first task performed. The Site consists of two parts: the Main Site and the Northwest drum cache. The Main Site is located one kilometre east of the shoreline of the Arctic Ocean and stretches southward from an unnamed river which flows westward into the ocean. It covers an area of about 350 m on its north-south axis by 200 m on its east-west axis. It is characterized by two concentrated drum caches, many randomly located drums and several debris areas.

DOJV's site reconnaissance resulted in dividing the site into 8 APECs: APEC 1 North Drum Cache; APEC 2 South Drum Cache; APEC 3 Debris Areas (3, 4 and 5); APEC 4 Drainage Channel; APEC 5 Northwest Drum Cache; APEC 6 Debris Area 2 (oily canvas tent material and oil cans); APEC 7 former debris area 6 (burn area); and APEC 8 an Incinerator Drum. APEC 3 was not sampled as it was determined to be simply clusters of dry debris (tin cans and bottles). Figure 600 shows the Cape Ahnighito site on Lougheed Island and the location of Lougheed Island in the Arctic archipelago. Figure 601 shows the location of the Main Site and Northwest Drum Cache and the unnamed river. Figures 602 shows surveyed limits and all sampling locations, including background samples at the Main Site. Figure 603 shows APECs 1 and 6 sample locations. Figure 604 APEC 2 and 7 sample locations. Figure 605 shows the Northwest Drum Cache's sample locations.

Physical hazards were present in the unstable piles of drums at the South Drum Cache (APEC 2). Drums were piled on top of each other and due to soft ground, the stability of the top drums is precarious. In the debris areas there is wood (with nails), and metal debris strewn around which constitutes a physical hazard. Finally, the remnant fuel in some drums may create an explosive atmosphere in the presence of spark.

4.3.2 Site Access Conditions

Reconnaissance flights over Cape Ahnighito on Lougheed Island were completed by Kenn Borek Air in August 2021 and April 22, May 10 and May 18, 2022. The reconnaissance flights identified no suitable landing areas for a Twin Otter aircraft on skis or tundra tires. It was thus determined that the best means of accessing Cape Ahnighito was by helicopter. The helicopter charter company stated that Cape Ahnighito could be accessed from the Isachsen weather station but that the water crossing from Ellef Ringnes Island to Lougheed Island would be limited to flying only on very good weather days, and they required that the crossings be done while the sea ice was continuous between Ellef Ringnes Island and Lougheed Island. The field program was therefore scheduled as early as feasible from all considerations including good sea-ice, the ability to dig test pits with a hand shovel, inspect the area for debris, count drums and sample surface water. The flying time from the Isachsen weather station to Cape Ahnighito in the AStar 350 B2 is about 25 minutes each way.

4.3.3 Waste Streams and Quantities Present

The Phase III ESA (DOJV 2022a) assessed the APECs at the Cape Ahnighito via soil sampling and inventorying the other waste streams.

4.3.4 Impacted Soil Assessment

Soil sampling was by manually dug test pits. Test pits were dug to refusal on permafrost or as deep as possible if permafrost was not encountered. Bedrock was not encountered in any test pit at Cape Ahnighito.

The approach in planning the test pit locations was to target the previously identified contaminated soil locations, plus any areas that Dillon-Outcome felt were data gaps to be filled, with a set of inner and stepped-out test pits around the APEC. APECs were sampled on the up and down-gradient sides. The stepped-out test pits were in order to have assurance of achieving lateral delineation. The stratigraphy observed in each test pit was logged in terms of soil type, evidence of contamination (staining or odour) presence of debris, moisture, water inflow, and colour. A total of 27 environmental test pits, three geotechnical test pits and three background test pits were conducted at Cape Ahnighito.

The soil analytical results were compared to CCME Agricultural guidelines in the Phase III ESA, and then analyzed in the Human Health and Ecological Risk Assessment. The results of both assessments are summarized below.

4.3.4.1 Impacted Soil Quantities by Generic Guidelines

The generic guidelines used to screen for soil exceedances were:

- **Soil – BTEX, metals and PAH:** CCME Soil Quality Guidelines, Agricultural Land Use, fine-grained soil, shallow soil (<1.5 metres);

- **Soil – Petroleum Hydrocarbons:** CCME Canada-Wide Standards for Petroleum Hydrocarbons, Tier 1, Agricultural land use, fine grained soil, Eco soil contact, more than 10 m from aquatic habitat.

Agricultural land use was deemed appropriate given CCME agricultural/wildland use is defined as "Land on which the primary activity is related to the productivity capability of the land and includes lands that provide habitat for wildlife and birds".

Background Soil Testing: There were three background test pits dug and sampled: CA000, CA001 and CA002. CA000 was about 60 m to the northeast of North Drum Cache, CA001 was about 70 m to the east between the North and South Drum caches, and CA002 was 60 m east of the South Drum Cache. CA002 coincided with vegetation sample with the same identifier. Background samples CA001 and CA002 were analyzed for BTEX, PHC, metals and PAH, while CA000 was analysed for BTEX, PHC and metals (no PAH).

Chemical analysis of the background soil samples revealed no detection of any BTEX components or PHC fractions. Some metals were consistently detected but below Agricultural Guidelines across all background samples (arsenic, barium, chromium, cobalt, copper, lead, molybdenum, nickel, vanadium and zinc), with the concentrations not varying by more than a factor of two. No metals were above guidelines. A single PAH parameter (perylene) was detected in both samples, CA001 or CA002, however there is no CCME Guideline for that PAH parameter. The background chemistry results show that the soil in this location is not highly mineralized and is not contaminated.

APEC 1 North Drum Cache: Five test pits (CA101 to CA105) were completed to investigate for contamination at the North Drum Cache. The previous study had no samples in this area. Test pit CA101 was in the centre of the cache. CA102 was on the north side of the cache, CA013 was on the east side of the cache, CA104 was to the south and CA105 was to the northwest. The soil encountered was sand under a 5 cm organic layer, with permafrost at an average of 0.15 m below ground surface. There were no odours or sheen in the soil.

None of the samples in these five test pits had any BTEX detected. The centre location (CA101) had PHC detected in the F2 and F3 ranges, at approximately one-tenth of the Agricultural Guideline level. Two samples were tested for PAHs, and both had detection of perylene for which there is no CCME Guideline. There were no BTEX or PHC, metals or PAH exceedances in soil at this APEC thus the North Drum Cache has no contaminated soil associated with it.

APEC 2 South Drum Cache: There were five test pits (CA201 to CA205) completed to investigate the South Drum Cache. The previous study had two samples in this area and reported a metals (arsenic) exceedance on the west side of the cache (14 mg/kg compared to the Guideline of 12 mg/kg). Test Pit CA201 was at the centre of the south cache. CA202 was to the north of the cache, CA203 was on the west side, CA204 was on the southwest side and CA205 was to the east. In the due south direction, there was no exposed ground to sample within a reasonable distance from the South Drum Cache. The soil encountered at APEC 2 was an organic layer from 2 to 5 cm thick, underlain by silty sand with permafrost encountered at 0.15 m below ground surface. There were no odours or sheen in the soil.

None of the samples at the South Drum Cache had any BTEX components detected. The sample at CA203 was the only one with any PHC detected with PHC-F3 at 86 mg/kg compared to the Guideline of 1,300 mg/kg. All samples were tested for metals to compare to the previous study which had an arsenic exceedance on the west side of the cache. There were no metals exceedances in the five samples tested. One sample (and its duplicate) were tested for PAHs, and both had detection of perylene for which there is no CCME Guideline. There were no BTEX or PHC, metals or PAH exceedances in soil at this APEC thus there is no contaminated soil associated associate with the South Drum Cache.

APEC 3 Debris Areas: APEC 3 was defined for the debris areas 3, 4 and 5 identified in the previous study however visual inspection revealed that they were simply dry waste with no indication of contamination. The waste volumes estimated but soil was not sampled.

APEC 4 Drainage Channel Sediments: The Main Site at Cape Ahnighito drains northward towards a shallow river. There are drainage gullies on the east and west side of the Site, but it was the western gully that had a traceable rivulet from the South Drum Cache, passing by the North Drum Cache to the river. Two sediment samples and one water sample were collected to assess the impact of the Main Site on drainage and sediment movement. CA-SED-BKGD is a background location at the south extremity of the Site. CA-SED1 is in a location that is close to, but down-gradient of both Drum Caches. It coincides water sample CA-SW-UP. The sediment description is fine silt (wet).

The sediment samples had no BTEX or PHC detected but both had CCME exceedances for arsenic. The background sample had arsenic at 9.1 mg/kg arsenic and the sample downgradient of the drum depots had arsenic at 31 mg/kg, compared to the CCME Guideline value of 7.24 mg/kg in *sediments*, which is more stringent that for soil metals. There were no other metals exceedances and no PAH exceedances. The three background *soil* samples had arsenic concentrations of 10, 6.4 and 6.1 mg/kg, therefore the concentration of arsenic in the sediment background sample CA-SED-BKGD (9.1 mg/kg) is on the same order but the CA-SED1 sample is three times the background concentration in soil.

The sediment guidelines are for the protection of aquatic life and may be overly conservative for the small rivulet in which the sediment samples were taken since it has no aquatic life. Never-the-less, sediments appear to be concentrating arsenic in the drainage channels of the Site. The drainage channel on the east side of the Main Site from CA-SED-BKGD to the point where it joins the river is about 300 metres. The channel is on the average about 0.3 metres wide. The sediments are shallow, about 0.15 m deep. An approximate volume of arsenic impacted sediments is on the order of 15 cubic metres.

APEC 5 Northwest Drum Cache: Nine test pits (CA501 to CA509) were completed at the Northwest Drum Cache. The previous study had two soil samples in this area; one beside a drum and one background sample, there were no exceedances noted. The test pits in the current program were dug on the downgradient side of the drums. There were 11 drums inventoried and at two locations there were two drums close together. The soil encountered was silty sand or sand without an organic layer. Permafrost was at an average of 0.2 m below ground surface. There were no odours or sheen in the soil.

None of the samples at any of the test pits had any BTEX detected. Only sample (CA502) had PHC F2 and F3 detected but below guidelines. Metals were analyzed in three samples: CA503, CA508, CA509 and there were no exceedances of the CCME Agricultural Guidelines. PAH was analyzed in two samples: CA503 and CA508 and there were no exceedances.

There was no contaminated soil identified at the Northwest Drum Cache.

APEC 6 Debris Area 2: Three test pits (CA600, CA601 and CA602) were completed at the previously defined Debris Area 2, which was oily canvas and nine one-quart cans of engine oil. This area is approximately 5 m southeast of the North Drum Cache. The previous investigation did not sample this area, but the appearance of oil-soaked canvas made it worth sampling. Test pit CA600 was in the centre of the area, Test pit CA601 was to the north and test pit CA602 was to the southeast. The soil encountered was silty sand to permafrost at 0.25 to 0.3 m below ground surface.

All samples were analyzed for BTEX and PHC, and sample CA600 was also analyzed for metals. There was not detection of BTEX or PHC and metals were below Guidelines. There was no contaminated soil identified at Debris Area 2.

APEC 7 Debris Area 6 (Burn Pit): This area is a suspected burn pit, identified as debris area 6 in the previous investigation and had exceedances in PHC and PAH reported in that study. It is west of the South Drum Cache. Two test pits (CA701 and CA702) were completed at this burn pit. The soil encountered was silty sand with organics at the surface. A light sheen was noticed on the soil. Permafrost was at 0.15 m below ground surface.

Given that it was a suspected burn pit, the samples were analyzed for BTEX, PHC, metals and PAH. There were no detections of BTEX or PHC, and metals and PAH were all below CCME Agricultural Guidelines. There was no contaminated soil identified at the Debris Area 7.

APEC 8 Incinerator Drum : This APEC was a drum lying on its side with an air duct welded to the side. It contained debris inside including some oil cans. A single test pit CA801 was excavated adjacent to it. The soil encountered was wet silty sand with a slight sheen on the soil. Permafrost was at 0.2m below ground surface.

Sample CA801 was analyzed for BTEX, PHC and metals There were no detections of BTEX or PHC, and the metals were all below CCME Agricultural Guidelines. There was no contaminated soil identified at the Debris Area 8.

A summary of the contaminated soil volume estimates (comparing to CCME Guidelines) for the APECs at Cape Ahnighito and the degree of certainty in the delineation is provided below.

Table 4-2 Cape Ahnighito Impacted Soil Areas by Generic Guidelines

Defined Area	Surface Area of Impact (m^2)	Depth (m)	Impacted Volume (m^3)	Contaminant of Concern	Certainty of delineation
APEC 1 – North Drum Cache	none	none	0	n/a	n/a
APEC 2 – South Drum Cache	none	none	0	n/a	n/a
APEC 3 – Debris Areas 3, 4 and 5	none	none	0	n/a	n/a
APEC -4 Drainage channels	100	0.15	15	Arsenic	Low. Based on two sample points.
APEC 5 – North-west Drum Cache	none	none	0	n/a	n/a
APEC 6 - Debris area 2	none	none	0	n/a	n/a
APEC 7 – Burn Area	none	none	0	n/a	n/a
APEC 8 – Incinerator Drum	none	none	0	n/a	n/a
Totals	**100 m^2**	**0.15 m**	**15 m^3**	**Arsenic**	**Range: Low to High.**

4.3.4.2 Impacted Soil by Risk Assessment

The Human Health Risk Assessment concluded that there is negligible potential for human health risk from the only contaminant present (arsenic in sediments) as the site-specific target levels derived by the Risk Assessment were not exceeded with the results of the Phase III Environmental Site Assessment. The Ecological Risk Assessment similarly concluded that there is no need for corrective action for the sediments. As such, there is no human or ecological risk-driven need for remediation or risk management on the subject site in relation to the single parameter (arsenic) exceeding generic guidelines, as long as the future land use and time on-site assumptions (i.e., exposure frequency and duration) do not exceed that which was assumed in the HHRA for the assessed human receptors and assuming that remaining sources (i.e., drums containing fuels) are removed.

4.3.5 Hazardous and Non-Hazardous Waste

An inventory of hazardous and non-hazardous building materials was conducted.

For hazardous wastes, the assessor was looking for painted materials, asbestos containing material and potential PCB containing equipment. Wood was only observed in APEC 6/Debris Area 2 and none of it was painted. Pink fibrous material was observed in this area; however, this material was previously analyzed for asbestos (WESA, 2012d) and the results revealed no asbestos fibers. No electrical transformers or equipment was observed anywhere at the site. No hazardous building material was identified.

Each of the debris areas were assessed for types and volumes of debris present. All of the debris was non-hazardous. The descriptions and volumes are presented below.

Table 4-3 Debris Volumes and Descriptions

Debris Area	Type of Debris	Estimated Volume (m^3)
Debris Area 1	Aircraft parts (cowling, manifold) 5 gal. pail and debris.	2
Debris Area 2	Oily tent canvas, insulation wooden boxes,9 one-quart cans of oil, intact	4
Debris Area 3	Rusted tin can, glass, some plastic.	1
Debris Area 4	One continuous debris area. Rusted tin cans, wood.	3
Debris Area 5		
Debris Area 6	Debris and small burn pit	1
Debris Area 7	Rusted tin cans, cooking pot, plates, wood, stovepipe.	1
Totals		**12 m^3**

The total observed volume of non-hazardous waste is on the order of 12 m^3. Wood makes up half of the waste volume at Debris Area 2. The quart cans of oil would be managed with the non-empty fuel drums.

4.3.6 Waste Fuel and Drums

An inventory of waste fuel and waste fuel drums at Cape Ahnighito was conducted. Drums at the Main Site were numbered from 1 to 92. Drums at the Northwest Drum Cache were numbered A to K. The count was:

Table 4-4 Fuel Drum Inventory at Cape Ahnighito

Defined Area	Number of Drums	Full Drums	Estimated Volume	Sampled
APEC 1 – North Drum Cache	28	0	0	None
APEC 2 – South Drum Cache	30	0 9 partial full	900 L Assumed half full	1 sample
Random at Main Site	34	0	0	None
APEC 5 – Northwest Drum Cache	11	2	400 L	None; all drums were on their side and mired in soft ground so could not be stood upright to sample.
Totals	**103**	**2 full** **9 partially full**	**1,300 L**	**1 sample**

Of the partially full drums at the South Drum Cache only one could be opened for sampling (Drum 42). A product sample was pumped out and put in 1 L plastic bottles and sent to Petro Lab for analysis. It had a reddish colour and smelled like gasoline.

The results of the analysis of product testing from drum #42 showed that it had a flashpoint of 28°C, no PCBs, total chlorine of 38 ppm and a specific gravity of 0.6899, 0.1% water, a similar spectrum to diesel or jet fuel, and had lead 39 ppm, no cadmium or chromium.

The analytical report on waste fuel testing from PetroLab is included in Appendix B.

4.3.7 Summary of Waste Streams

A summary of all waste streams at Cape Ahnighito requiring remediation is given below.

Table 4-5 Summary of Waste Streams at Cape Ahnighito Requiring Remediation

Waste Stream	Quantity
Contaminated Soil (PHC, PAH or metals)	None
Non-hazardous debris	Non-painted wood, metal, glass, canvas and plastic 12 m^3 / 12 tonnes
Waste fuel	900 L at South Drum Cache and 400 L at Northwest Drum Cache 1,300 litres
Drums	92 at Main Site and 11 at Northwest Drum Cache 103 drums empty weight of drums: 2,400 kilograms.

4.4 Remedial Options Analysis by Waste Stream

4.4.1 Evaluation Method

The process used to assess and select remedial options was a qualitative, multi-variant criteria decision matrix. This process is useful to arrive at an optimal decision when multiple criteria must be considered. The outcome of such an analysis is a solution which is the best compromise solution for balancing the degree of satisfaction of all (and often competing) considerations. The process was implemented by developing a set of potentially viable management options for each waste stream requiring remediation, including a base case (left as is) option, and evaluating the degree to which each option satisfied each evaluation criteria.

The evaluation criteria were weighted evenly in the comparison. Each management option was scored as favourable, neutral or unfavourable under each evaluation criterion to indicate its degree of satisfaction of the individual criterion. A favourable score was assigned if the evaluation criteria was well, or very well, satisfied. A neutral score is given if the evaluation criteria is somewhat satisfied, and an unfavourable score is assigned if the evaluation criterion is poorly or very poorly satisfied.

To determine the most favourable option per waste stream, a numeric value was given to the favorability score as follows: each favourable score was given a value of +1, each neutral score was given a numerical value of 0, and each unfavourable score was given a value of -1. The overall score for each option was tallied and expressed as *favourable* if the numeric tally is greater than zero, *neutral* if the numeric tally is zero, and *unfavourable* if the numeric tally is less than zero. The numerical score is also given in order to highlight the most favourable option, in the event that more than one receives a favourable overall score.

The evaluation criteria that the options were scored against reflect the overall remediation objectives for the site and remained the constant for the analysis of each waste stream. They were:

Reduction of Environmental Risks: This criterion focuses on the reduction of potential environmental risks as evaluated in the HHERA. It ranks how successful an option is in reducing potential risks to the receiving environment and uptake by humans or the natural environment. A positive ranking indicates that environmental risk will be very successfully reduced by the option; a neutral ranking indicates that the environmental risk will be somewhat reduced by the option, and an unfavourable ranking indicates that the option likely does not adequately reduce the environmental risk.

Value to Crown: This criterion is a qualitative comparison of overall cost of each option. It considers the overall closure costs (Capital) and longer-term monitoring and maintenance (LTM) if the option requires it. As a qualitative score, the evaluation it is not proportional to actual costs. The cheapest option(s) are scored as favourable and the most expensive score as unfavourable. A neutral ranking indicates an option that is in between the high and low-cost options under consideration.

Resources Required: This criterion encompasses the engineering and scientific complexity of each option such as the ability to achieve physical and chemical stability and construction complexity. This criterion also considers the remoteness of the site and that all equipment required for the work will need to be brought on and off-site by air, and that the closest community to the site is 480 km distant. Options that require mobilization of significant resources will be ranked as unfavourable. Solutions requiring a moderate mobilization of resources will be ranked neutral and solution with a lower degree of resources required will score favourably. Although cost is somewhat related to resources required, this criterion focuses strictly the resources required and technical complexity.

Reduction of Environmental Liability: This is considered satisfied when environmental liability can be considered as zero once the option has been implemented. Options which are "walk-away" with no future monitoring requirements are scored as favourable, whereas those with on-going monitoring and maintenance obligations are scored lower (unfavourable). A neutral ranking indicates that the liability has been significantly reduced but not entirely extinguished.

Local Benefits: This criterion considers the local economic benefits derived during the remedial work and the long-term benefit from potential future use of the site by local stakeholders. Local stakeholders are defined as residents of the area who may be employed in the remedial work program and who may use the site as part of their traditional hunting, fishing and food gathering land. It is important to note that this criterion has been scored from an anticipatory perspective, as the stakeholder consultation component of this project has not yet taken place, and the stakeholders' opinions on the integrated option which is the output of the remedial options analysis have not been heard.

4.4.2 Non-Hazardous Waste Debris

There is a total of 12 m^3 of non-hazardous debris in the seven (7) debris areas at Cape Ahnighito. It consists of non-painted wood, canvas, tin cans, plastic and glass. Due to random shapes and sizes, it has been estimated to have an average density upon collection of 1 tonne per m^3.

Options for managing the non-hazardous debris are:

1) Consolidation on-site: The wastes in the seven debris area at the Main Site would be brought to a single location at the upland side of the Site, 300 m from the un-named river, and flattened but left on-site. The debris material is not a contaminant and therefore would not create impacted leachate. The wood, metal and canvas would continue to degrade over time. A moderate degree of physical hazard would be present to wildlife, and it would constitute an unlicensed waste disposal area. There is no debris at the Northwest Drum Cache which would need to be collected.

2) Incineration of wood, and off-site disposal of other waste: Wood waste would be burned on site at the former burn area (Debris Area 6) and the remainder of the waste would be removed via soil bag by helicopter. A volume reduction of about 2 m^3 could potentially be achieved, but ashes and residue would still have to be collected. The incineration would have to be monitored and if all wood was not burned during a workday it would have to be extinguished and restarted the next day. The remaining volume would be 10 m^3 and would be collected into soil bags. The soil bags have a volume of one cubic meter each but should be filled to a weight within the sling capacity of the helicopter being used. As an example, an AStar 350 B2 has a sling capacity of about 800 kg, so about 12 sling loads would be required.

3) Off-site disposal of all non-hazardous debris: The debris would all be collected and put into soil bags and removed off-site for eventual disposal of out of Territory. Material from all seven debris area would be put collected by hand. There is no waste that is over 1 m in length so no cutting would be needed. The total debris volume is about 12 m^3. Bags would be filled with debris at each area and then lifted in a helicopter sling when full. No ground movement of the soil bags would be necessary. About 14 sling loads would be required.

The three options for management of non-hazardous debris have been evaluated and the results are tabulated below.

Table 4-6 Evaluation of Options for Non-Hazardous Debris

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score
	Reduction of Environmental Risk	Value to Crown	Resources Required	Reduction of Liability	Local Benefits	
Consolidation on-site	Neutral	Favourable	Favourable	Unfavourable	Unfavourable	Neutral (0)
Incineration of wood and off-site disposal of other waste	Favourable	Neutral	Unfavourable	Favourable	Favourable	Favourable (+2)
Off-site disposal of all non-hazardous debris	Favourable	Unfavourable	Unfavourable	Favourable	Favourable	Favourable (+1)

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

The Environmental Risk in consolidating the non-hazardous debris on-site in one location is seen as a neutral because there is no environmental contamination associated with this waste stream; it is non-leachable solid waste. Consolidation does not rate a favourable score because there is some physical risk to wildlife with leaving it on-site. The Value to the Crown with this option is favourable as it is the lowest cost option. Resources required are the least (favourable); the debris would be transported manually, possibly in wheelbarrows, to an upland location in work spanning 3 or 4 days. No air lift is involved, contrary to the other options. Reduction of liability however is unfavourable. With the debris including wastes such as plastic, glass, airplane parts it would constitute a waste disposal site, and have some on-going monitoring requirements and may not receive Territorial approval. There is negligible local labour involved in this option, and it somewhat detracts from future site use so its rating under Local Benefits is unfavourable. The overall score is neutral (0).

Incineration of the wood waste and off-site disposal of other waste scores favourably on Reduction of Environmental Risk because the non-hazardous debris waste stream would be eliminated from the site. The Value to the Crown (cost) is slightly less than the third option due to the savings from one or two fewer helicopter trips with waste. The cost of the labour required to conduct incineration as per the Nunavut environmental Guideline for the Burning and Incineration of Solid Waste would be less than the cost of one or two fewer helicopter trips. The resources required are significantly greater than consolidation on-site (helicopter use), and essentially equal to the third option, thus is scores unfavourably. Reduction of Liability is favourable because it is a "walk-away" solution; there would be no on-going monitoring commitments. The favourable score under Local Benefits was assigned because there is moderate local labour content in preparing the waste for off-site movement and incineration of the wood waste and the final condition is ideal. This option's overall score is favourable (+2).

The off-site disposal of all non-hazardous waste option (with no incineration) differs only in the criterion of Value to the Crown. It scores unfavourable because higher helicopter use and cost for flying out the waste wood, along with the handling and disposal cost of moving the wood waste through to its final destination out of Territory. Saving one or two helicopter trips to Stupart Island would amount to $5,000, and the cost of incineration would be about a day of labour ($1,000) and would be concurrent with other activities on-site so would not increase the duration at Cape Ahnighito. Overall, this option scores one point less favourable than Option 2 (+1).

The optimum waste management solution for the non-hazardous waste is to incinerate the wood waste on-site and transport the rest of the waste in soil bags off-site and out of the Territory.

4.4.3 Waste Fuel Options

A quantity of approximately 1,300 L of waste fuel is present in drums at Cape Ahnighito. The fuel sample analyzed from a drum at the South Drum Cache indicated gasoline or diesel fuel with only 0.1% water. There is an estimated 900 L in partially full drums at the South Drum Cache and 400 L in two drums at the Northwest Drum cache.

Options for management include:

1. Leaving as is: Leaving the waste fuel in its current situation.

2. Incineration on-site: An incinerator would be mobilized to Cape Ahnighito and the waste fuel would be brought to the incinerator for burning. Given that the drum which was sampled was pure fuel, it would readily burn. The two drums suspected of being full at the Northwest Drum Cache could not be sampled there for their composition is unknown. Small/light weight incinerators that are transportable by aircraft exist on the market and capable of burning fuel however a power source and secondary fuel source are required. The lightweight incinerators investigated (SmartAsh with an optional drum transfer pump, or a Total Combustion Inc, model DCL) can burn about 60-70 L of fuel in a day so the duration of incineration would be too long to be feasible, plus the incinerator would

require additional labour operate and monitor. This option has poor feasibility for the small volume at this Site.

3. Removal off-site for disposal. In this option the contents of all non-empty drums would be pumped into alternative sturdy containers, such as new drums, and consolidated on-site in groups of two for off-site removal by helicopter. The 1,300 L of waste fuel could be contained in 7 new drums. Removal of the waste fuel from the site for off-site disposal carries no technical uncertainty and the waste would be trackable right to disposal via manifests. It would be removed first to a staging location at Stupart Island by helicopter, then flown to Resolute Bay by fixed wing aircraft. Upon arrival in Resolute Bay the waste fuel containers would be handled by forklift, and subsequently be shipped via sealift to an appropriate disposal facility near to Bécancour, Quebec the terminus of the sealift.

The three options for waste fuel have been evaluated and the results are tabulated below.

Table 4-7- Evaluation of Options for Waste Fuel

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score*
	Reduction of Environmental Risk	Value to Crown	Resources Required	Reduction of Environmental Liability	Local Benefits	
Left as is	Unfavourable	Favourable	Favourable	Unfavourable	Unfavourable	**Unfavourable (-1)**
Incineration on-site	Favourable	Unfavourable	Unfavourable	Favourable	Favourable	**Favourable (+1)**
Removal off-site for disposal	Favourable	Neutral	Neutral	Favourable	Favourable	**Favourable (+3)**

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

Leaving the waste fuel on site incurs environmental risk of eventual drum perforation from corrosion leading to contamination of soil (unfavourable). The cost is least (favourable) but the environmental liability would not be reduced (unfavourable). It does not create any local socio-economic benefits. It is not a viable option, and its overall score is unfavourable (-1).

Incineration of the waste fuel at this site is technically feasible and would extinguish the environmental risk (favourable) but the resources required and value to the crown in transporting an incinerator to the site are not worthwhile for this small amount of fuel (unfavourable). in its cost (Value to the Crown) being greater than the next option of removing the fuel without attempting on-site incineration. The local benefits in terms of employment and betterment of the site for future use are favourable and it extinguishes the environmental liability (favourable). This option scores overall weakly favourable (+1).

Removal of the waste fuel off-site removes the environmental risk (favourable) and eliminates the environmental liability (favourable). Its cost is expected to be less than on-site incineration because it does not involve the effort of mobilizing an incinerator to Cape Ahnighito to burn the fuel (neutral). The resource requirements are expected to be less than on-site incineration but greater than leaving it as-is (neutral). The local benefits in terms of employment and betterment of the site for future use are on-par with the preceding option and are favourable. The removal for off-site disposal option scores most favourably overall (+3).

The recommended remedial option is to collect the waste fuel into sturdy containers and move it off-site for disposal. The process envisaged is to sling it by helicopter to Stupart Island in a summer work program along with waste fuel from Skybattle Bay and transport it to Resolute Bay by fixed-wing aircraft for onward shipment and disposal out of the Territory.

4.4.4 Waste Drums

A total of 103 fuel drums are present at Cape Ahnighito, most of which are empty or nearly empty. There are 92 drums at the Main Site and 11 at Northwest Drum Cache. As stated above, non-empty drums must be pumped out where they lie, to avoid any leakage due to shifting them in their potentially weakened state. The average dry weight per drum is 22.5 kg, and the total weight is calculated to be about 2,400 kg. The options investigated for their management are:

1. Left as is: The waste drums would be left in one consolidated location at Cape Ahnighito after they had all been emptied of fuel and water.

2. Burial on-site: The empty drums would be opened at one end and cleaned inside using a pressure washer or steam cleaner. Wash water would have to be collected and treated prior to disposal. Burial would require mechanical equipment for excavating and covering the drums, which would have to be brought to the site. Crushing, using the mechanical equipment, would reduce the overall volume. is planned for the remediation at Cape Ahnighito so crushing or volume reduction is not possible. An intact drum has a volume of 0.2 m^3 and crushing could reduce the volume to one quarter (0.05 m^3 per drum). A single burial location should be determined at the Main Site, and as far from the unnamed river as possible. Sandy borrow material is available in scattered pockets at the site to construct an encapsulation cell for the crushed drums. An encapsulation cell would require long-term monitoring.

3. Removal off-site for disposal. All non-empty drums would first be emptied as best possible, but not cleaned on-site. They would be tested for residual vapours inside using a photo-ionization detector and any drum with explosive vapours would be placed in an over-pack container with an airtight lid. Drums which are mired in soft ground would be extracted and stacked on pallets. The drums would be transported by helicopter sling to Stupart Island, then flown from Stupart Island to Resolute Bay by fixed wing aircraft. Once in Resolute Bay, the drums would be cleaned and crushed in a dedicated drum crusher and then moved out of the Territory for disposal. They would be shipped via sealift to an appropriate disposal facility near to Bécancour, Quebec the terminus of the sealift.

The three management options for waste drums have been evaluated and the results are tabulated below.

Table 4-8 Evaluation of Options for Waste Drums

Evaluation Criteria / Remedial Options	EVALUATION CRITERIA					Overall Score*
	Reduction of Environmental Risk	Value to Crown	Resources Required	Reduction of Environmental Liability	Local Benefits	
Left as is	Unfavourable	Favourable	Favourable	Unfavourable	Unfavourable	**Unfavourable (-1)**
Burial on-site	Neutral	Unfavourable	Unfavourable	Unfavourable	Neutral	**Unfavourable (-3)**
Removal off-site for disposal	Favourable	Neutral	Neutral	Favourable	Favourable	**Favourable (+3)**

*Favourable scores are assigned +1; Neutral scores are assigned zero; and Unfavourable scores are assigned -1. The overall score is favourable if the tally is greater than zero, neutral if the tally is zero and unfavourable it the tally is less than zero.

Leaving the waste drums on-site at a consolidated location does not remove the environmental risk or liability as the drums would not have been washed clean and would contribute to environmental degradation. The on-going liability fails the "walk-away" solution objective therefore is unfavourable in Reduction of Liability. This option is the cheapest therefore scores favourably in Value to Crown. It also does not require many resources. The local community would not benefit (unfavourable). This option scores unfavourably (-1).

.

Drum removal off-site favourably reduces the Environmental Risk and extinguishes the liability because it is a "walk-away" solution. Value to the Crown is score as neutral since costs are expected to be less than burial but more than leaving them as-is. It scores neutrally on Resources Required because it is more easily accomplished than burial but has more steps than leaving them as-is. Off-site removal of drums benefits the local community through leaving a clean site and providing a local labour component (favourable). Overall, this option scores favourably (+3).

The recommended option for waste drums is therefore removal off-site for disposal outside of the Territory. Drums would be emptied prior to air transport to Resolute Bay and over-packs would be used for any drum which are not sealed and have high internal vapours. Washing and crushing facilities exist in Resolute Bay in Resolute Bay. The benefits of washing and crushing prior to sealift transport would be assessed.

4.4.5 Integrated Remedial Plan

The integrated remedial option is comprised of the highest-ranking options from the multi-variant criteria decision matrix analysis, for each waste stream requiring remediation. The integrated preferred remedial option for Cape Ahnighito consists of:

1. The non-hazardous waste debris would be managed by incineration of wood and off-site disposal of other waste. The quantity of debris for off-site disposal is 10 m^3 (twelve soil bags at 800 kg each) / 10 tonnes.

2. Waste fuel from drums would be collected in sturdy containers and transported off-site to Stupart Island by helicopter then to Resolute Bay by fixed-wing for either burning or sending out of Territory. The waste fuel volume is 1,300 litres (L). Assuming 7 drums are used for the waste fuel the total weight would be 1.5 tonnes.

3. The 103 waste drums would be removed from site, with over-packs used for any drums with explosive vapours, in two steps to Resolute Bay like the other wastes, where they would be processed (cleaned and crushed), if it is advantageous to do so, then sent out of the Territory for recycling or disposal. The combined weight of empty waste drums is approximately 2,400 kilograms (kg) (2.4 T).

In summary, the non-hazardous waste (10T), waste fuel (1.5T) and the 103 empty drums (2.4 T) will require removal from the site (13.9T). The small quantity of ash from incinerating the wood would be collected with the non-hazardous waste.

Remediation at Cape Ahnighito would be done in a single phase of work over about 7 days during the summer work season of 2024. On-Site activities will be the collection of non-hazardous debris into 1 m^3 soil bags, incineration of the wood waste, collection of residual fuel into sturdy containers and clustering the empty drums into sling-transportable groups.

All of the waste would be heli-transported down to Stupart Island where a waste transfer station would be established. At Stupart Island it would be transferred to fixed-wing aircraft and flown to Resolute Bay for processing and onward transportation by sealift.

From Resolute Bay, the wastes would be transported by sealift for final disposal at licensed waste disposal facilities in the South. There is usually one sealift stop in Resolute Bay per year and it is in September. The anticipated departure time of the sealift should be integrated into the timing of remedial activities. This solution will be "walk-away", with no on-going monitoring requirements or liability.

4.5 Scope of Work for Proposed Remedial Solution

The scope of work required to implement the remedial options for Cape Ahnighito and the other two large sites has been resolved into a Work Breakdown Structure (WBS) and is included in Appendix A. The WBS describes in a graphical form the work that will be required of a contractor that successfully complies with the screening, selection and bidding process that is being developed for this site. The WBS contains four main tasks: 1 Balance of Project Costs and Project Meetings, 2 Health, Safety and Environment, 3 Transportation and Logistics, and 6 Cape Ahnighito Remediation.

Task 6 breaks down the work required to implement the remedial options defined in the previous section into work packages which would be defined in the Tender Specifications and verifiable by the on-site PSPC Construction Representative.

The work packages are as follows, with details being prescribed in Tender Specification:

1 Non-hazardous Debris Management

Waste wood will be gathered from all debris areas at Cape Ahnighito and consolidated at APEC 7/Debris Area 6 which was a former burn area. It will be set on fire (without adding liquid accelerant) and burned until it is reduced to ash. The ash will be collected along with debris from this area.

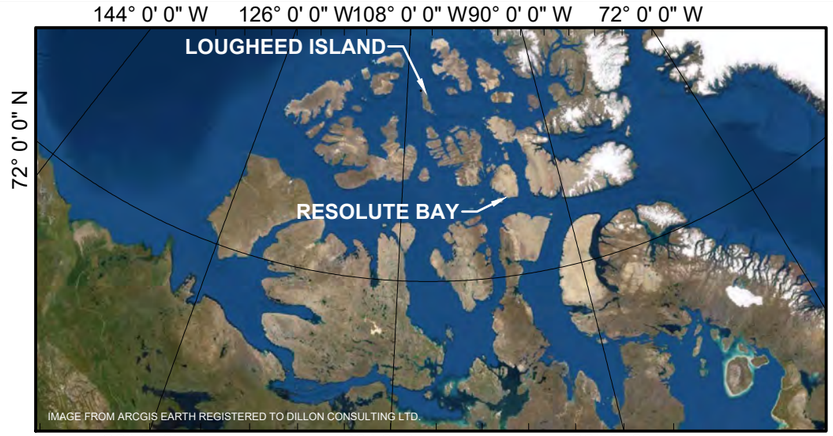
Non-hazardous debris from the Site will be collected into 1 m^3 soil bags. The maximum weight per bag will be within the sling capacity of the helicopter being used. The debris will be heli-transported to Stupart Island, then by fixed-wing to Resolute Bay. From Resolute Bay it will be transported out of the Territory by sealift to a licensed disposal facility in the South.

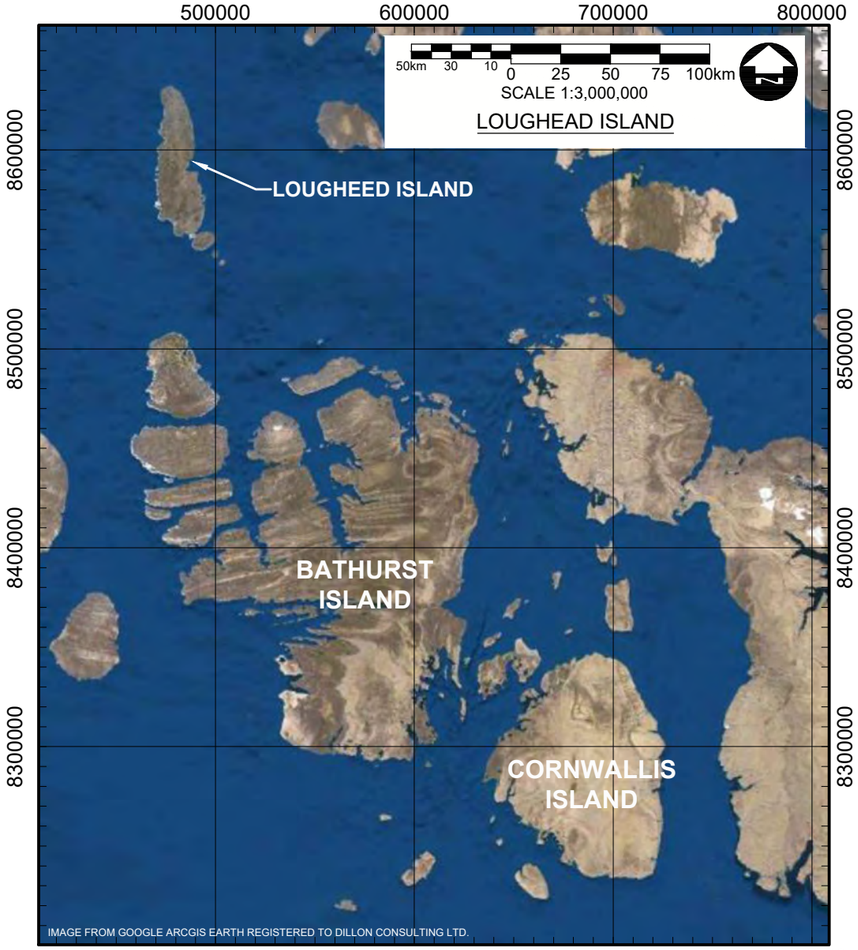
2 Waste Fuel Management

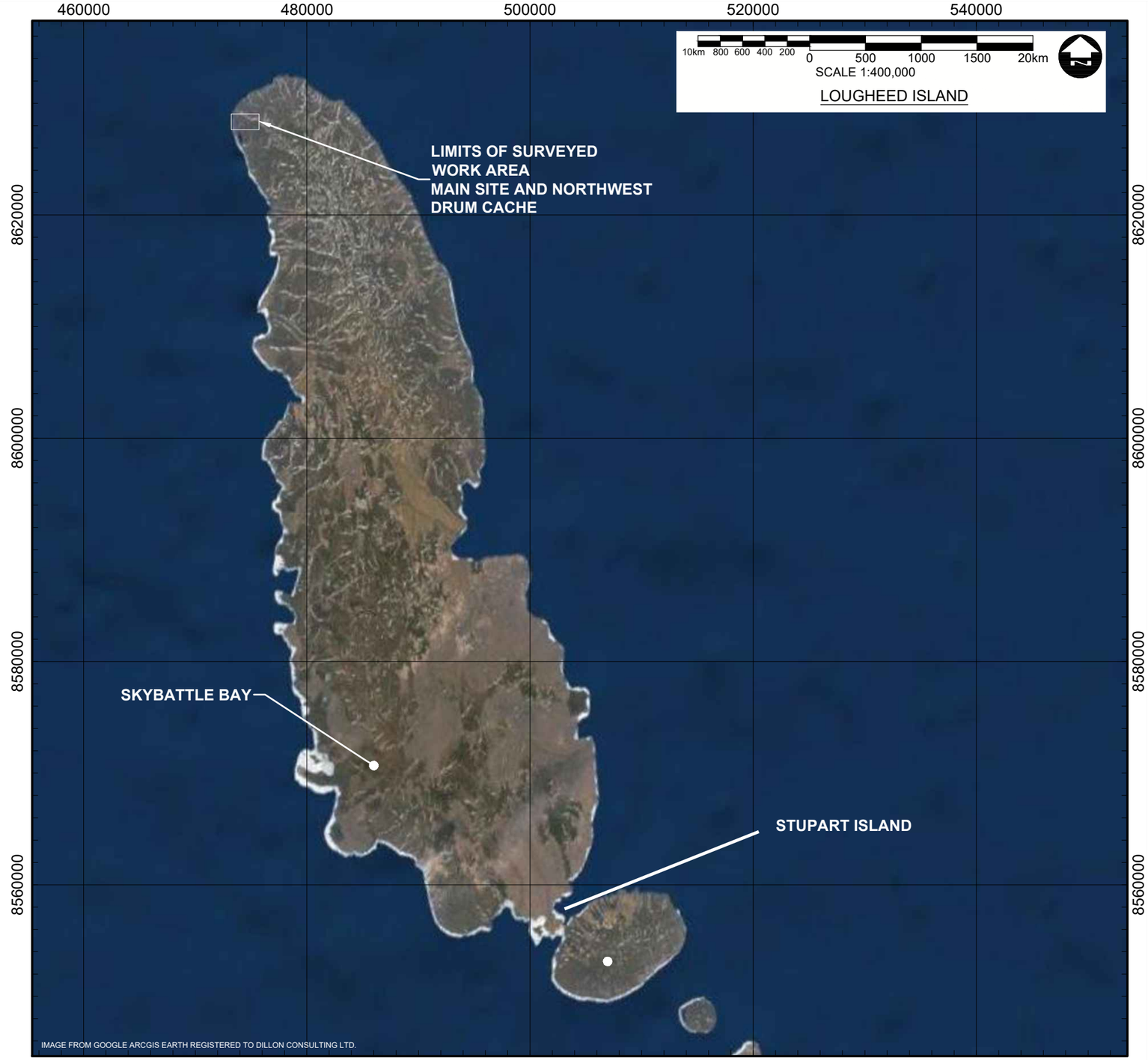
Waste fuel will be pumped out of any non-empty drum into sturdy containers and transported by aircraft to Resolute Bay. It may be burned as a heat source in Resolute Bay or sent out of Territory by sealift to a disposal facility in the South.

3 Waste Drum Management

All drums will be emptied of liquid while on-site. They will be tested for explosive vapours as per Waste Fuel Management Scope section and subsequently packaged as required for off-site movement. The packaged drums will be moved off-site by helicopter to Stupart Island, then by fixed-wing to Resolute Bay. In Resolute Bay they may be washed and crushed, if there is an advantage in doing so, and then transported out of Territory by sealift to a licensed disposal facility in the South.







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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

CAPE AHNIGHITO
SITE LOCATION PLAN

SHEET NO. 600

DILLON CONSULTING LIMITED 4920 47TH STREET, YELLOWKNIFE, NORTHWEST TERRITORIES, X1A 2P1, PHONE (867) 920-4555, FAX (867) 873-3328

FILENAME: C:\CAD\21370 PIONEER SITES\CAPE AHNIGHITO\CAPE AHNIGHITO Z13N.DWG
PLOT DATE: 2022-10-17 @ 11:08:46 AM PLOT SCALE: 1:3 PLOT STYLE: DILLON.CTB

473600 474000 474400 474800

8628800 8628400 8628000

CA-SW DOWN
8628634.152mN, 473921.509mE, -4.562m

NORTHWEST DRUM CACHE
SEE DRAWING 605

MAIN SITE SURVEYED LIMITS
AND APECS 7 & 8
SEE DRAWING 602

0 50 100 150 200m
SCALE 1:4,000

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

NOTE:
AERIAL FROM ARCGIS EARTH.

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FILENAME: C:\CAD\21370 PIONEER SITES\CAPE AHNIGHITO\CAPE AHNIGHITO Z19N.DWG
PLOT DATE: 2022-10-17 @ 11:13:53 AM PLOT SCALE: 1:51 PLOT STYLE: DILLON.CTB

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO.: 21-2370

CAPE AHNIGHITO
SURVEYED LIMITS,
MAIN SITE AND NORTHWEST DRUM CACHE

SHEET NO.: 601

474600 474700 474800 474900

8628400 8628300 8628200

CA-GEO-1

CA-000

SIGN

LIMITS OF
HIGH RESOLUTION
IMAGERY/CONTOURS

SOUTH DRUM CACHE AND
APECS 2 & 7
SEE DRAWING 604

92 drums require collection and removal

Drums in South Drum Cache partially full

CA-001

CA-005

CA-004

CA-002

CA-GEO-002

MAIN SITE NORTH DRUM CACHE
AND APECS 1 & 6
SEE DRAWING 603

SIGN

CA-SED-BKGD

0 10 20 30 40 50m
SCALE 1:1200

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

HYDROCARBON IMPACTED ZONES
PERMAFROST DEGRADATION

NOTE:
CONTOURS BASED ON RTK SURVEY AND DRONE PHOTOGRAMMETRY AT 0.5m INTERVAL.
AERIAL FROM DRONE.

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

CAPE AHNIGHITO
MAIN SITE SURVEYED LIMITS AND APECS 7 & 8

SHEET NO. 602

474690 474720 474750 474780

8628390 8628360

CA-102
CA-SED1
CA-SW-UP
CA-105
CA-101
CA-103
CA-601
CA-600
CA-602
CA-104

Debris requires Removal
Debris requires removal
Debris requires removal
Debris requires removal

7.3 7.4 7.5 7.6 7.7 7.8 7.9 8.0 8.1 7.7 7.8 7.9 8.1 8.2 8.3 8.4 8.5 8.6

5m 4 3 2 1 0 2 4 6 8 10m
SCALE 1:250

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

HYDROCARBON IMPACTED ZONES
TOP OF SURVEYED GROUNDS
TOE OF SURVEYED GROUNDS

NOTE:
CONTOUR INTERVAL 0.1m AND 0.5m (DERIVED FROM RTK SURVEY AND DRONE PHOTOGRAMMETRY)
AERIAL IMAGE FROM DRONE COMPOSITE

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FILENAME: C:\CAD\21370 PIONEER SITES\CAPE AHNIGHITO\CAPE AHNIGHITO Z13N.DWG
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DATE: OCTOBER 2022	
SCALE: AS SHOWN	

ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

CAPE AHNIGHITO
MAIN SITE NORTH DRUM CACHE AND APECS 1 & 6

SHEET NO. 603

474690 474720 474750

8628330

8628240

8628300

474750 474780

CA-701

CA-702

CA-203

CA-202

CA-801

CA-204

CA-201

CA-205

9.0 9.1 8.9 9.0 9.4 9.3 9.2 9.1 8.9 9.0 9.2

Fuel in drums at South Drum Cache must have fuel transferred to sturdy

5m 4 3 2 1 0 2 4 6 8 10m
SCALE 1:250

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

HYDROCARBON IMPACTED ZONES
TOP OF SURVEYED GROUNDS
TOE OF SURVEYED GROUNDS

NOTE:
CONTOUR INTERVAL 0.1m AND 0.5m (DERIVED FROM RTK SURVEY AND DRONE PHOTOGRAMMETRY)
AERIAL IMAGE FROM DRONE COMPOSITE

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FILENAME: C:\CAD\21370 PIONEER SITES\CAPE AHNIGHITO\CAPE AHNIGHITO 21SN.DWG
PLOT DATE: 2022-10-17 @ 11:41:37 AM PLOT SCALE: 1:51 PLOT STYLE: DILLON.CTB

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

CAPE AHNIGHITO
SOUTH DRUM CACHE AND APECS 2 & 7

SHEET NO. 604

8628440 8624880 8624920 8624960

473880

473920

LIMITS OF HIGH RESOLUTION IMAGERY/CONTOURS

0 5 10 15 20m
SCALE 1:400

LEGEND:
- SOIL SAMPLE LOCATION
- WATER SAMPLE LOCATION
- VEGETATION SAMPLE
- GEOTECH SAMPLE
- BACKGROUND SAMPLE
- BARREL(S)
- SIGN
- GENERAL SITE DEBRIS
- BENCHMARK INSTALLATION

HYDROCARBON IMPACTED ZONES
PERMAFROST DEGRADATION

NOTE:
CONTOUR INTERVAL 0.5m AND 1.0m (DERIVED FROM RTK SURVEY AND DRONE PHOTOGRAMMETRY)
AERIAL IMAGE FROM DRONE COMPOSITE

CA-507
CA-508
CA-GEO-003
SIGN
CA-505
CA-503
CA-502
CA-501
CA-504
SIGN
CA-506

11 drums to be collected
2 containing fuel to be transferred to sturdy containers for transport

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ASSESSMENT AND REMEDIAL PLAN OF PIONEER SITES NUNAVUT
CIRNAC

PROJECT NO. 21-2370

CAPE AHNIGHITO
NORTHWEST DRUM CACHE

SHEET NO. 605

5.0 Remedial Work Plan

The seven sites comprising the Pioneer High Arctic Bundle represent a large amount of site remediation work at high Northern latitudes with short work seasons. The work requires Regulatory permits to be applied for and in place before it can commence, remote camps to be mobilized for the workers, terms of reference and specifications to be drafted and contracts to be tendered, all for successful implementation. The seven Pioneer Sites has been grouped in to two packages for procurement purposes. This report details the Large Site Package which includes work at Stupart Island, Skybattle Bay and Cape Ahnighito planned for the summer of 2024:

5.1 Large Site Package (2024)

The Large Site Package includes site remediation at Stupart Island, Skybattle Bay and Cape Ahnighito and would be serviced from a staging location to be set up at Stupart Island. These three sites each have large number of drums, some waste fuel and some debris. This work package will involve bringing waste from Cape Ahnighito and Skybattle Bay to the transfer station and work camp at Stupart Island by helicopter, then moving it from Stupart Island to Resolute Bay. The work breakdown structure for activities comprising the Large Site Package is included in Appendix A.

5.1.1 Regulatory Requirements

An application for a land use permit must be filed with the Lands Administration Branch of CIRNAC for the use of Stupart Island for habitation in support of environmental remediation activities. It must also allow Stupart Island to be used as a temporary transfer station for waste from the two sites on Lougheed Island. It is planned that all of the waste would be flown out before the end of the 2024 season, but being permitted to hold it for one year would be prudent, in case the 2024 season closes early due to bad weather.

Little or no water will be drawn from Cape Ahnighito, Skybattle Bay or Stupart Island however an approval for Use of Waters Without a License will have to be secured by the Department Representative from the Nunavut Water Board. Water for the camp would need to be brought in.

A Notice of Project must be filed by the contractor with the Nunavut Workers Safety & Compensation Commission (WSCC)

A health and safety and environmental protection plan will be required from the contractor to submit to the project authority. A dedicated Medic will be required to be on the work team.

5.1.2 Camp Requirements

A camp will be required at Stupart Island to serve as a base of operations for these three sites. Accommodations for the work crew and departmental representatives will be required. A helicopter

will be based at this camp and fuel will have to be available at the camp and any over-stock removed at the completion of the work. There are currently only two tent platforms at Stupart Island, one of which is contaminated with oily soil. There is no water available on this island. The central part of Stupart Island offers good fixed-wing landing characteristics.

5.1.3 Logistics

A logistics plan will be a requirement from the successful remediation contractor. It will have to include:

- Installation of a temporary camp on Stupart Island, with environmental protection of the site for the wastes to be received and transferred;
- Mobilizing a work team and helicopter support team to Stupart Island;
- Operation over a sufficient duration to remove all waste from Cape Ahnighito and Skybattle Bay to Stupart Island by helicopter;
- Removal of all relocated wastes plus the waste at Stupart Island to Resolute Bay by fixed-wing aircraft;
- Securing space at Resolute Bay to stage and prepare the wastes for sealift;
- Incineration of waste fuel or use as heating oil at Resolute Bay, if possible;
- Shipment of wastes out of Territory by sealift; and
- Certification of disposal of all waste types.

5.1.4 Schedule

A schedule in the form of a Gantt chart for all activities related to the Large Site Package is included in Appendix A.

6.0 Limitations and Closing Remarks

Dillon-Outcome has completed this Remedial Action Plan of three of the Pioneer High Arctic Bundle Sites in Nunavut based on the findings of site visits conducted in field season during 2021 and 2022 with the standard of care generally expected of environmental consultants for a study of this nature.

This RAP has been prepared for the use of the Government of Canada and may be shared with third party uses (contractors and other stakeholders).

Changes to the physical setting of the Site, surrounding area and applicable guidelines and regulations governing contaminated sites in Nunavut have the potential to influence the interpretation presented in this RAP.

Sincerely,

DILLON-OUTCOME JOINT VENTURE

Don Plenderleith, M.Sc., P.Eng (NU).
Environmental Division Manager

7.0 References

Dillon-Outcome Joint-Venture, *Phase III Environmental Site Assessment Pioneer High Arctic Bundle, Nunavut,* October 2022. (DOJV 2022a)

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Water and Earth Sciences Associates Ltd. (WESA), *Integrated Phase I and Phase II Environmental Site Assessment of Cape Isachsen, Nunavut,* WESA, February 2012 (WESA 2012e)

Water and Earth Sciences Associates Ltd. (WESA), Integrated Phase I and Phase II Environmental Site Assessment of NB048 Kristoffer Bay Nunavut, WESA, February 2012 (WESA 2012f)

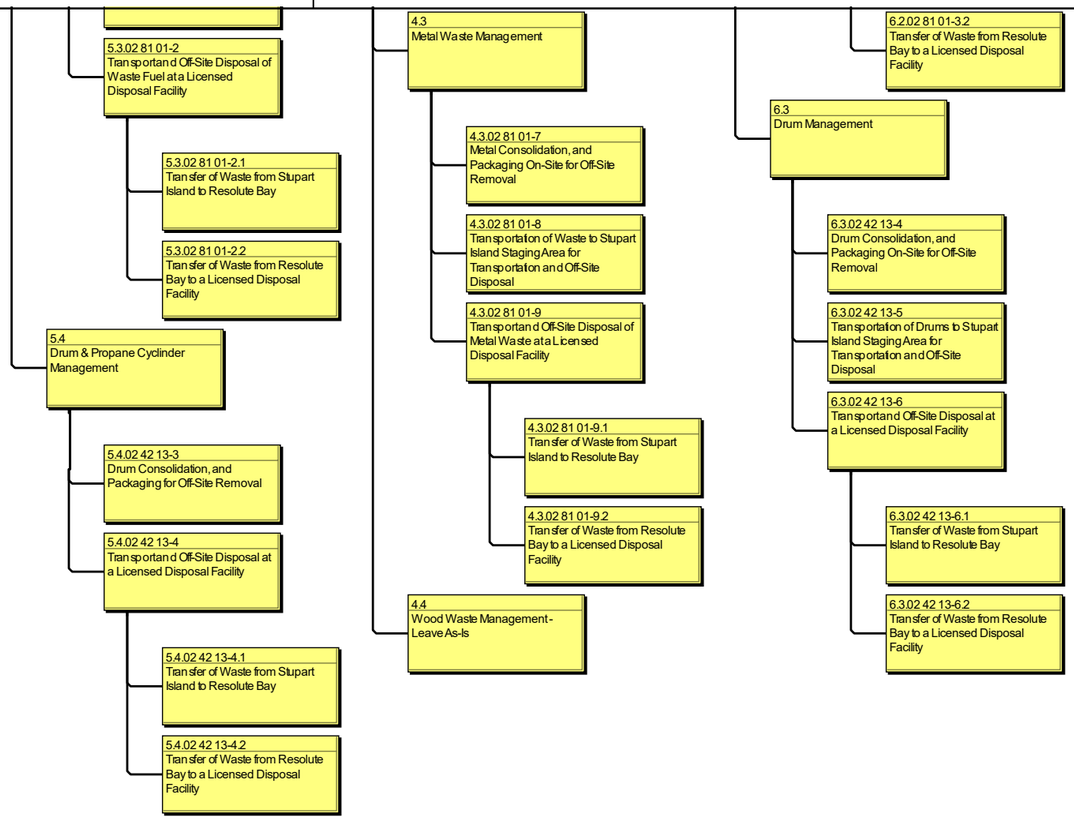
Appendix A

WBS and Schedule Large Site Package (2024)

- Pioneer HAB 2024
  Pioneer High Arctic Bundle: Cape Ahnighito, Skybattle Bay, Stupart Island 2024-25
  - 0 Consultant Services
    - 0.1 Remedial Action Plan
    - 0.2 Environmental Impact Assessment
    - 0.3 Specification Development
    - 0.4 Regulatory Land Use Permit for Remediation Activities and Stupart Island Waste Transfer
    - 0.5 Procurement & Tendering
  - BOPC-1 Balance of Project Costs
    - BOPC-1.01 33 00 Submittals
    - BOPC-1.01 32 16 19 Construction Progress Schedule
    - BOPC-1.01 78 00-1 Closeout Submittals, Project Records
    - BOPC-1.01 41 00 Regulatory Requirements
  - 1 Project Meetings
    - 1.01 31 19-1 On-Site Project Meetings
    - 1.01 31 19-2 Off-Site Project Meetings
  - 2 Health Safety, and Environment
    - 2.01 35 29 13-1 Site Specific Health and Safety Plan, and Emergency Response Plan
    - 2.01 35 29 13-2 COVID 19 Mitigation Plan
    - 2.01 35 29 13-3 Worker Orientation Seminar
    - 2.01 35 29 13-4 Medic Services
  - 3 Logistic, Transportation and Facilities
    - 3.01 53 00-1 Pre-Mobilization Site Visit
    - 3.01 53 00-2 Mobilization of Personnel, Equipment, and Supplies
    - 3.01 53 00-3 Demobilization of Personnel, Equipment and Supplies
    - 3.01 53 00-4 Establish Work Camp and Waste Transfer Station at Stupart Island
    - 3.01 53 00-5 Establish Temporary Facilities at Cape Ahnighito
    - 3.01 53 00-6 Establish Temporary Facilities at Skybattle Bay
    - 3.01 53 00-7 Supply of Helicopter Flights to Cape Ahnighito and Skybattle Bay from Stupart Island
    - 3.01 53 00-8 Supply of Fixed Wing Aircraft Flights to Stupart Island from Resolute Bay
    - 3.01 54 00-1 Worker Accommodations & Meals
  - 5 Stupart Island Remediation
    - 5.1 Contaminated Soil Management
      - 5.1.02 55 13-1 Excavation and Packaging of Contaminated Soil
      - 5.1.02 55 13-2 Transportand Off-Site Disposal of Contaminated Soil at a Licensed Disposal Facility
        - 5.1.02 55 13-2.1 Transfer of Waste from Stupart Island to Resolute Bay
        - 5.1.02 55 13-2.2 Transfer of Waste from Resolute Bay to a Licensed Disposal Facility
    - 5.2 Non-Hazardous (Wood & Metal) Waste Management
      - 5.2.02 42 13-1 Incineration of Non-Hazardous Wood On-Site
      - 5.2.02 42 13-2 Packaging of Non-Hazardous Ashes & Metal Waste, and Transportation Off-Site for Disposal
        - 5.2.02 42 13-2.1 Transfer of Waste from Stupart Island to Resolute Bay
        - 5.2.02 42 13-2.2 Transfer of Waste from Resolute Bay to a Licensed Disposal Facility
    - 5.3 Waste Fuel Management
      - 5.3.02 81 01-1 Transferring and Packaging of Waste Fuel for Off-Site Disposal
  - 4 Skybattle Bay Remediation
    - 4.1 Drum Management
      - 4.1.02 42 13-1 Drum Consolidation, and Packaging On-Site for Off-Site Removal
      - 4.1.02 42 13-2 Transportation of Drums to Stupart Island Staging Area for Transportation and Off-Site Disposal
      - 4.1.02 42 13-3 Transportand Off-Site Disposal of Drums at a Licensed Disposal Facility
        - 4.1.02 42 13-3.1 Transfer of Waste from Stupart Island to Resolute Bay
        - 4.1.02 42 13-3.2 Transfer of Waste from Resolute Bay to a Licensed Disposal Facility
    - 4.2 Waste Fuel Management
      - 4.2.02 81 01-4 Transferring and Packaging of Waste Fuel On-Site for Off-Site Disposal
      - 4.2.02 81 01-5 Transportation of Waste Fuel to Stupart Island Staging Area for Transportation and Off-Site Disposal
      - 4.2.02 81 01-6 Transportand Off-Site Disposal of Waste Fuel at a Licensed Disposal Facility
        - 4.2.02 81 01-6.1 Transfer of Waste from Stupart Island to Resolute Bay
        - 4.2.02 81 01-6.2 Transfer of Waste from Resolute Bay to a Licensed Disposal Facility
  - 6 Cape Ahnighito Remediation
    - 6.1 Non-Hazardous Waste Management
      - 6.1.02 42 13-1 Incineration and Consolidation of Wood Waste On-Site
      - 6.1.02 42 13-2 Non-Hazardous Waste Consolidation, and Packaging On-Site for Off-Site Removal
      - 6.1.02 42 13-3 Transportation of Waste to Stupart Island Staging Area for Transportation and Off-Site Disposal
      - 6.1.02 42 13-4 Transportand Off-Site Disposal of Non-Hazardous Waste to a Licensed Disposal Facility
        - 6.1.02 42 13-4.1 Transfer of Waste from Stupart Island to Resolute Bay
        - 6.1.02 42 13-4.2 Transfer of Waste from Resolute Bay to a Licensed Disposal Facility
    - 6.2 Waste Fuel Management
      - 6.2.02 81 01-1 Transferring and Packaging of Waste Fuel On-Site for Off-Site Disposal
      - 6.2.02 81 01-2 Transportation of Waste Fuel to Stupart Island Staging Area for Transportation and Off-Site Disposal
      - 6.2.02 81 01-3 Transportand Off-Site Disposal of Waste Fuel at a Licensed Disposal Facility
        - 6.2.02 81 01-3.1 Transfer of Waste from Stupart Island to Resolute Bay

WBS Path
WBS Name

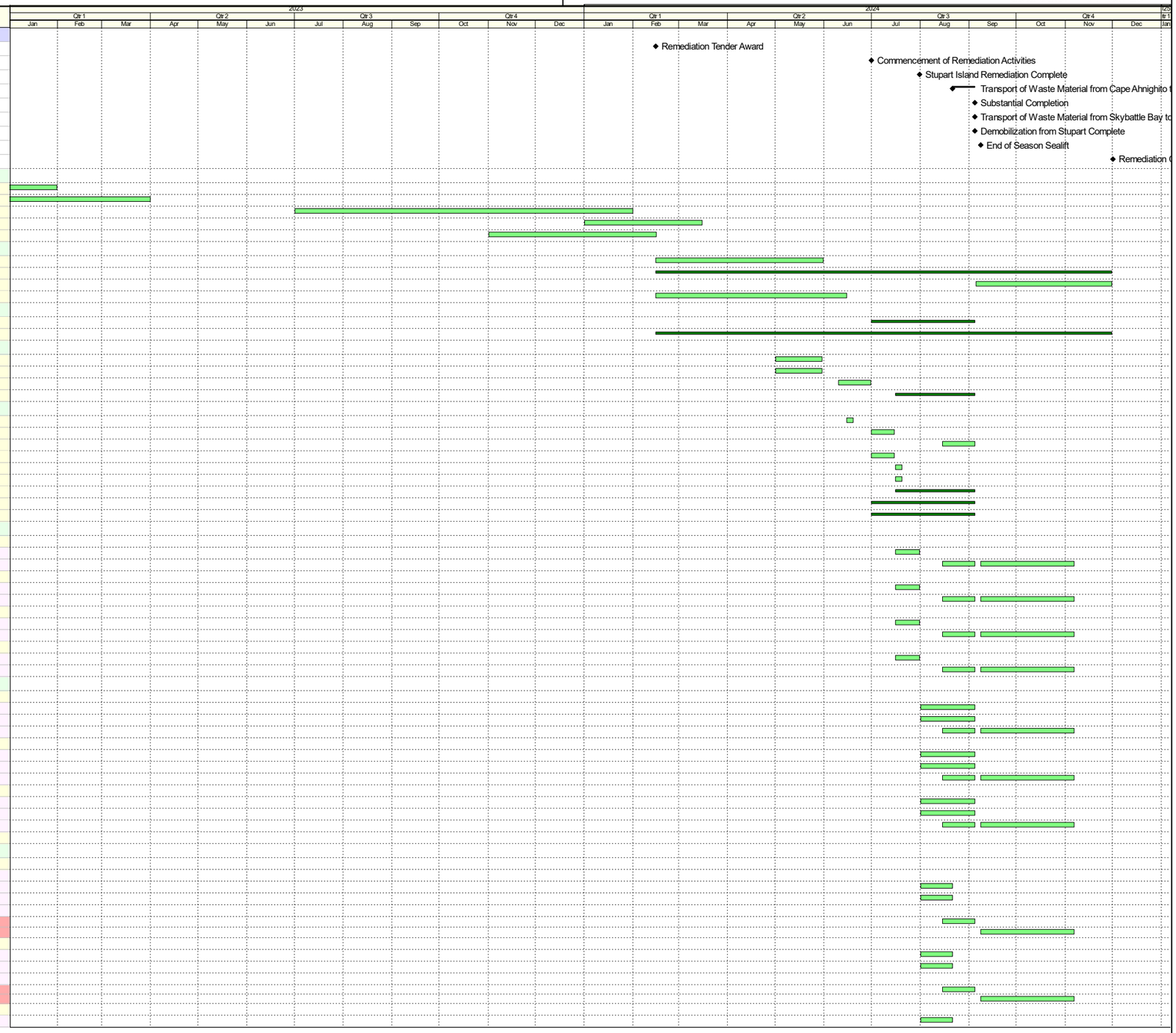
Work Breakdown Structure


5.3.02 81 01-2
Transportand Off-Site Disposal of Waste Fuel at a Licensed Disposal Facility
5.3.02 81 01-2.1
Transfer of Waste from Stupart Island to Resolute Bay
5.3.02 81 01-2.2
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility
5.4
Drum & Propane Cyclinder Management
5.4.02 42 13-3
Drum Consolidation, and Packaging for Off-Site Removal
5.4.02 42 13-4
Transportand Off-Site Disposal at a Licensed Disposal Facility
5.4.02 42 13-4.1
Transfer of Waste from Stupart Island to Resolute Bay
5.4.02 42 13-4.2
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility
4.3
Metal Waste Management
4.3.02 81 01-7
Metal Consolidation, and Packaging On-Site for Off-Site Removal
4.3.02 81 01-8
Transportation of Waste to Stupart Island Staging Area for Transportation and Off-Site Disposal
4.3.02 81 01-9
Transportand Off-Site Disposal of Metal Waste at a Licensed Disposal Facility
4.3.02 81 01-9.1
Transfer of Waste from Stupart Island to Resolute Bay
4.3.02 81 01-9.2
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility
4.4
Wood Waste Management - Leave As-Is
6.2.02 81 01-3.2
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility
6.3
Drum Management
6.3.02 42 13-4
Drum Consolidation, and Packaging On-Site for Off-Site Removal
6.3.02 42 13-5
Transportation of Drums to Stupart Island Staging Area for Transportation and Off-Site Disposal
6.3.02 42 13-6
Transportand Off-Site Disposal at a Licensed Disposal Facility
6.3.02 42 13-6.1
Transfer of Waste from Stupart Island to Resolute Bay
6.3.02 42 13-6.2
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility

Pioneer High Arctic Bundle: Cape Ahnighito, Skybattle Bay, Stupart Island 2024-25

data date: 01-Jan-23

Activity ID	Activity Name	At Completion Duration	Start	Finish
Pioneer High Arctic Bundle: Cape Ahnighito, Skybattle Bay, Stupart Island 2024-25		700	01-Jan-23	01-Dec-24
PHAB-4000	Remediation Tender Award	0	15-Feb-24*	
PHAB-4010	Commencement of Remediation Activities	0	01-Jul-24*	
PHAB-4030	Stupart Island Remediation Complete	0		31-Jul-24
PHAB-4570	Transport of Waste Material from Cape Ahnighito to Stupart Island Complete	0		21-Aug-24
PHAB-4060	Substantial Completion	0		04-Sep-24
PHAB-4020	Transport of Waste Material from Skybattle Bay to Stupart Island Complete	0		04-Sep-24
PHAB-4520	Demobilization from Stupart Complete	0		04-Sep-24
PHAB-4070	End of Season Sealift	0	08-Sep-24*	
PHAB-4080	Remediation Contract Closeout	0		01-Dec-24*
Consultant Services		440	01-Jan-23	15-Mar-24
Remedial Action Plan		31	01-Jan-23	31-Jan-23
Environmental Impact Assessment		90	01-Jan-23	31-Mar-23
Specification Development		215	01-Jul-23	31-Jan-24
Regulatory Land Use Permit for Remediation Activities and Stupart Island Waste Transfer		75	01-Jan-24	15-Mar-24
Procurement & Tendering		107	01-Nov-23	15-Feb-24
Balance of Project Costs		290	15-Feb-24	30-Nov-24
Submittals		107	15-Feb-24	31-May-24
Construction Progress Schedule		290	15-Feb-24	30-Nov-24
Closeout Submittals, Project Records		87	05-Sep-24	30-Nov-24
Regulatory Requirements		122	15-Feb-24	15-Jun-24
Project Meetings		290	15-Feb-24	30-Nov-24
On-Site Project Meetings		66	01-Jul-24	04-Sep-24
Off-Site Project Meetings		290	15-Feb-24	30-Nov-24
Health Safety, and Environment		127	01-May-24	04-Sep-24
Site Specific Health and Safety Plan, and Emergency Response Plan		30	01-May-24	30-May-24
COVID 19 Mitigation Plan		30	01-May-24	30-May-24
Worker Orientation Seminar		21	10-Jun-24	30-Jun-24
Medic Services		51	16-Jul-24	04-Sep-24
Logistic, Transportation and Facilities		82	15-Jun-24	04-Sep-24
Pre-Mobilization Site Visit		5	15-Jun-24	19-Jun-24
Mobilization of Personnel, Equipment, and Supplies		15	01-Jul-24	15-Jul-24
Demobilization of Personnel, Equipment and Supplies		21	15-Aug-24	04-Sep-24
Establish Work Camp and Waste Transfer Station at Stupart Island		15	01-Jul-24	15-Jul-24
Establish Temporary Facilities at Cape Ahnighito		5	16-Jul-24	20-Jul-24
Establish Temporary Facilities at Skybattle Bay		5	16-Jul-24	20-Jul-24
Supply of Helicopter Flights to Cape Ahnighito and Skybattle Bay from Stupart Island		51	16-Jul-24	04-Sep-24
Supply of Fixed Wing Aircraft Flights to Stupart Island from Resolute Bay		66	01-Jul-24	04-Sep-24
Worker Accommodations & Meals		66	01-Jul-24	04-Sep-24
Stupart Island Remediation		114	16-Jul-24	06-Nov-24
Contaminated Soil Management		114	16-Jul-24	06-Nov-24
Excavation and Packaging of Contaminated Soil		16	16-Jul-24	31-Jul-24
Transport and Off-Site Disposal of Contaminated Soil at a Licensed Disposal Facility		84	15-Aug-24	06-Nov-24
Non-Hazardous (Wood & Metal) Waste Management		114	16-Jul-24	06-Nov-24
Incineration of Non-Hazardous Wood On-Site		16	16-Jul-24	31-Jul-24
Packaging of Non-Hazardous Ashes & Metal Waste, and Transportation Off-Site for Disposal		84	15-Aug-24	06-Nov-24
Waste Fuel Management		114	16-Jul-24	06-Nov-24
Transferring and Packaging of Waste Fuel for Off-Site Disposal		16	16-Jul-24	31-Jul-24
Transport and Off-Site Disposal of Waste Fuel at a Licensed Disposal Facility		84	15-Aug-24	06-Nov-24
Drum & Propane Cyclinder Management		114	16-Jul-24	06-Nov-24
Drum Consolidation, and Packaging for Off-Site Removal		16	16-Jul-24	31-Jul-24
Transport and Off-Site Disposal at a Licensed Disposal Facility		84	15-Aug-24	06-Nov-24
Skybattle Bay Remediation		98	01-Aug-24	06-Nov-24
Drum Management		98	01-Aug-24	06-Nov-24
Drum Consolidation, and Packaging On-Site for Off-Site Removal		35	01-Aug-24	04-Sep-24
Transportation of Drums to Stupart Island Staging Area for Transportation and Off-Site Disposal		35	01-Aug-24	04-Sep-24
Transport and Off-Site Disposal of Drums at a Licensed Disposal Facility		84	15-Aug-24	06-Nov-24
Waste Fuel Management		98	01-Aug-24	06-Nov-24
Transferring and Packaging of Waste Fuel On-Site for Off-Site Disposal		35	01-Aug-24	04-Sep-24
Transportation of Waste Fuel to Stupart Island Staging Area for Transportation and Off-Site Disposal		35	01-Aug-24	04-Sep-24
Transport and Off-Site Disposal of Waste Fuel at a Licensed Disposal Facility		84	15-Aug-24	06-Nov-24
Metal Waste Management		98	01-Aug-24	06-Nov-24
Metal Consolidation, and Packaging On-Site for Off-Site Removal		35	01-Aug-24	04-Sep-24
Transportation of Waste to Stupart Island Staging Area for Transportation and Off-Site Disposal		35	01-Aug-24	04-Sep-24
Transport and Off-Site Disposal of Metal Waste at a Licensed Disposal Facility		84	15-Aug-24	06-Nov-24
Wood Waste Management - Leave As-Is		0		
Cape Ahnighito Remediation		98	01-Aug-24	06-Nov-24
Non-Hazardous Waste Management		98	01-Aug-24	06-Nov-24
Incineration and Consolidation of Wood Waste On-Site		0		
Non-Hazardous Waste Consolidation, and Packaging On-Site for Off-SIte Removal		21	01-Aug-24	21-Aug-24
Transportation of Waste to Stupart Island Staging Area for Transportation and Off-Site Disposal		21	01-Aug-24	21-Aug-24
Transport and Off-Site Disposal of Non-Hazardous Waste to a Licensed Disposal Facility		84	15-Aug-24	06-Nov-24
Transfer of Waste from Stupart Island to Resolute Bay		21	15-Aug-24	04-Sep-24
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility		60	08-Sep-24	06-Nov-24
Waste Fuel Management		98	01-Aug-24	06-Nov-24
Transferring and Packaging of Waste Fuel On-Site for Off-Site Disposal		21	01-Aug-24	21-Aug-24
Transportation of Waste Fuel to Stupart Island Staging Area for Transportation and Off-Site Disposal		21	01-Aug-24	21-Aug-24
Transport and Off-Site Disposal of Waste Fuel at a Licensed Disposal Facility		84	15-Aug-24	06-Nov-24
Transfer of Waste from Stupart Island to Resolute Bay		21	15-Aug-24	04-Sep-24
Transfer of Waste from Resolute Bay to a Licensed Disposal Facility		60	08-Sep-24	06-Nov-24
Drum Management		98	01-Aug-24	06-Nov-24
Drum Consolidation, and Packaging On-Site for Off-Site Removal		21	01-Aug-24	21-Aug-24



Remaining Level of Effort

Remaining Work

Milestone

Float Bar

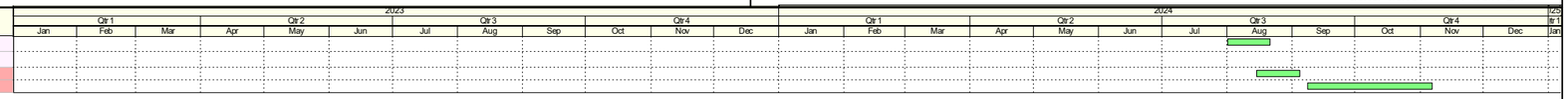
outcome CONSULTANTS

Date	Revision	Checked	Approved
09-Dec-22	Preliminary Schedule	M.Mathews	D.Plenderleith

Pioneer High Arctic Bundle: Cape Ahnighito, Skybattle Bay, Stupart Island 2024-25

data date: 01-Jan-23

Activity ID	Activity Name	At Completion Duration	Start	Finish
	Transportation of Drums to Stupart Island Staging Area for Transportation and Off-Site Disposal	21	01-Aug-24	21-Aug-24
	Transport and Off-Site Disposal at a Licensed Disposal Facility	84	15-Aug-24	06-Nov-24
	Transfer of Waste from Stupart Island to Resolute Bay	21	15-Aug-24	04-Sep-24
	Transfer of Waste from Resolute Bay to a Licensed Disposal Facility	60	08-Sep-24	06-Nov-24



Remaining Level of Effort
Remaining Work
Milestone
Float Bar

outcome CONSULTANTS

Date	Revision	Checked	Approved
09-Dec-22	Preliminary Schedule	M.Mathews	D.Plenderleith

Appendix B

Waste Fuel Test Results

Petro Laboratories Inc.

1295 Matheson Blvd. East, Mississauga, Ontario, L4W 1R1 Tel: (905) 361-2388 Fax: (905) 361-2411
E-mail: petrolab@gmail.com

Laboratory Report

Outcome Consultants Inc.
151 Holland Ave., Suite 200
Ottawa, Ontario
K1Y 0Y2

Lab no.: 16556-1 ,2
Date report: Sept 15, 2021
Sample in: Sept 2, 2021
P.O. no.: 2021-10

Attn: Don Plenderleith

Re : Pioneer Sites Stupart Island

Two liquid samples from Drums for testing.

TESTS		RESULTS	
	Lab No.		**16556 -2**
	Sample ID		**Stupart West Drum #40**
	Date		**Aug 10,2021**
1. Flash Point ,°C ASTM D93			20
2. PCB's in ppm ASTM D4059			<1
3.Total Chlorine, in ppm ASTM D808			24
4. Appearance (Visual)			Clear liquid
5. Specific gravity ASTM D289			0.7498
6. Viscosity, cst @40°C ASTM D445			0.8
7. pH (water fraction) Electrode			Not Applicable to solvent
8. Infra- Identification FTIR scan			Spectrum similar to gasoline mixture
9. Metals in ppm by ICP			
Cadmium			<1
Lead			<1
Chrominum			<1
10. Water, % volume			0

Remarks: The samples are both volatile solvent mixed with gasoline.

Tested by: PS./ S.I. (chemist)

Approved by: James Szeto

Memebr of ASTM
JS:LN

James Szeto, B.Sc.
Chief chemist

Petro Laboratories Inc.

1295 Matheson Blvd. East, Mississauga, Ontario, L4W 1R1 Tel: (905) 361-2388 Fax: (905) 361-2411
E-mail: petrolab@gmail.com

Laboratory Report

Outcome Consultants Inc.
151 Holland Ave., Suite 200
Ottawa, Ontario
K1Y 0Y2

Lab no.: 16556-5
Date report: Sept 15, 2021
Sample in: Sept 2, 2021
P.O. no.: 2021-10

Attn: Don Plenderleith

Re: One liquid sample from Drums at Pioneer Sites ,for testing.

TESTS	RESULTS	
Lab No.	**16556-5**	Drum Cache 1
Sample ID	**Skybattle Depot1, Drum 1**	
Date	**Aug 11,2021**	
1. Flash Point ,°C ASTM D93	* N/A	* N/A - not enough sample for the test.
2. PCB's in ppm ASTM D4059	<1	
3.Total Chlorine, in ppm ASTM D808	4811	
4. Appearance Visual	Cloudy Liquid	
5. Specific gravity ASTM D289	1.006	
6. Viscosity, cst @40°C ASTM D445	*N/A	* N/A - not enough sample for the test.
7. pH (water fraction) Electrode	* N/A	
8. Infra- Identification FTIR scan	* N/A	* N/A - not enough sample for the test.
9. Metals in ppm by ICP		
Cadmium	<1	
Lead	<1	
Chrominum	<1	
10. Water, % volume	97	

Remarks: Sample jar was broken, liquid has a strong odour of gasoline.

Tested by: PS./ S.I. (chemist)

Approved by: James Szeto

James Szeto, B.Sc.
Chief chemist

Memebr of ASTM
JS:LN

Petro Laboratories Inc.

1295 Matheson Blvd. East, Mississauga, Ontario, L4W 1R1 Tel: (905) 361-2388 Fax: (905) 361-2411
E-mail: petrolab@gmail.com

Laboratory Report

Outcome Consultants Inc.
151 Holland Ave., Suite 200
Ottawa, Ontario
K1Y 0Y2

Lab no.: 16556-3 ,4
Date report: Sept 15, 2021
Sample in: Sept 2, 2021
P.O. no.: 2021-10

Attn: Don Plenderleith

Re : Pioneer Sites , two liquid samples from Drums for testing. Drum Cache 2

TESTS		RESULTS	
	Lab No.		**16556 -4**
	Sample ID		**Skybattle Depot Drum 50**
	Date		**Aug 13,2021**
1. Flash Point ,°C ASTM D93			No Flash Point
2. PCB's in ppm ASTM D4059			<1
3.Total Chlorine, in ppm ASTM D808			31
4. Appearance (Visual)			oil film on top of water
5. Specific gravity ASTM D289			0.997
6. Viscosity, cst @40°C ASTM D445			1.0
7. pH (water fraction) Electrode			6.15
8. Infra- Identification FTIR scan			Trace amount of oil , rest are water
9. Metals in ppm by ICP			
Cadmium			0.0
Lead			0.0
Chrominum			0.0
10. Water, % volume			99.9

Remarks: Sample # 3 contains 70 % brown lube oil and 30 % Clear free water

Sample #4 is mainly free water with thin film of oil on top and sediment at the bottom.

Tested by: PS./ S.I. (chemist)

Approved by: James Szeto

Memebr of ASTM
JS:LN

James Szeto, B.Sc.
Chief chemist

Petro Laboratories Inc.

1295 Matheson Blvd. East, Mississauga, Ontario, L4W 1R1 Tel: (905) 361-2388 Fax: (905) 361-2411
E-mail: petrolab@gmail.com

Laboratory Report

Outcome Consultants Inc.
151 Holland Ave., Suite 200
Ottawa, Ontario
K1Y 0Y2

Lab no.: 18523-1 ,2
Date report: Aug 9, 2022
Sample in: July 26, 2022
P.O. no.: 2021-10

Attn: Don Plenderleith

Re : Pioneer Sites , two samples taken from drums for testing.

Cape Ahnighito

TESTS	RESULTS
Lab No.	**18523-1**
Sample ID	**CA PROD 1**
Date	**June 28,2022**
1. Flash Point ,°C ASTM D93	28
2. PCB's in ppm ASTM D4059	<1
3.Total Chlorine, in ppm ASTM D808	38
4. Appearance (Visual)	Clear Red liquid
5. Specific gravity ASTM D289	0.6899
6. Viscosity, cst @40°C ASTM D445	0.71
7. pH (water fraction) Electrode	N/A
8. Infra- Identification FTIR scan	Spectrum similar to diesel or jet fuel
9. Metals in ppm by ICP	
Cadmium	0
Lead	39
Chrominum	0
10. Water, % volume	0.1
Remarks:	All Fuel

Tested by: PS./ A.CI. (chemist)

Approved by: James Szeto

Memebr of ASTM
JS:LN

James Szeto, B.Sc.
Chief chemist