

NTI/DND ENVIRONMENTAL WORKING GROUP

PROGRESS REPORT #3

RECORD OF RECOMMENDATIONS – LANDFILLS &
HYDROCARBON CONTAMINATED AREAS

CAM-4 PELLY BAY
FOX-M HALL BEACH
FOX-5 BROUGHTON ISLAND
DYE-M CAPE DYER

PREPARED BY THE ENVIRONMENTAL WORKING GROUP
MARCH 2000

APR

ENVIRONMENTAL WORKING GROUP PROGRESS REPORT #3

29 Feb 2000

1 INTRODUCTION

In accordance with The DND/NTI Environmental Working Group (EWG) Terms of Reference document (January 1999), the following provides a progress report of the EWG to the Steering Committee.

Progress Report Number	Reporting Period
#1: April 30, 1999	October 1998 to April 30, 1999
#2: September 30, 1999	May 1, 1999 to September 30, 1999
#3: February 29, 2000	October 1, 1999 to February 29, 1999

In the progress report submitted at the end of September 1999, the following elements of work were identified for the period October 1999 to March 2000:

- Review of the results of the 1999 CAM-4 Site Investigation by DND.
- Completion of the documentation for the Record of EWG Recommendations for the CAM-4 - Pelly Bay, FOX-M - Hall Beach and DYE-M - Cape Dyer sites.
- Update to the FOX-5 - Broughton Island draft report previously circulated
- Review of Landfill Monitoring - FOX-4 Cape Hooper.
- Preliminary Planning for the Year 2000 Field Investigations at CAM-3 Shepherd Bay and CAM-5 Mackar Inlet.

2 SUMMARY OF MEETINGS

The EWG met frequently, by conference call, from mid-October to December 1999 to discuss hydrocarbon contaminated areas at DYE-M.

The EWG met several times, also by conference call, in January and early February, to evaluate the landfills and hydrocarbon contaminated areas at CAM-4.

3 SUMMARY OF WORK COMPLETED

3.1 DYE-M Site Report

All of the hydrocarbon-contaminated areas at DYE-M were evaluated over the course of the fall. The landfills had been evaluated previously, at the EWG in-person meeting in May 1999. All of the EWG evaluations of both landfills and hydrocarbon-contaminated areas have been documented in a site report, according the standard format established for FOX-5. The report is included with this progress report.

3.2 CAM-4 Site Report

Landfills and hydrocarbon-contaminated areas at CAM-4 were evaluated in January and February. The attached site report documents all of the EWG evaluations of both landfills and hydrocarbon-contaminated areas.

3.3 FOX-5 and FOX-M Site Reports

The EWG decisions for landfills and hydrocarbon-contaminated areas at FOX-5 and FOX-M had been largely finalized at the time of the last progress report: at that time the draft FOX-5 site report, which documented these decisions, was submitted to the Steering Committee. In the interim, the FOX-5 report has been finalized and the FOX-M decisions have been documented in a FOX-M site report. Both reports follow the standard format established by the EWG.

4 WORK PLANNED (March 2000 to September 2000)

- Preliminary Planning for the Year 2000 Field Investigations at CAM-3 Shepherd Bay and CAM-5 Mackar Inlet. Due to the module train fire during 10-15 January at PIN-3 Lady Franklin Point this has been added to the list of sites to be investigated in order to allow for an advanced cleanup of the site.
- Review of Landfill Monitoring – FOX-4 Cape Hooper
- Re-evaluation of the FOX-M Hall Beach and DYE-M Cape Dyer landfill and hydrocarbon contaminated areas following the collection of additional data during Year 2000 Field Investigations.

**NTI/DND DEW LINE CLEANUP
ENVIRONMENTAL WORKING GROUP**

**RECORD OF RECOMMENDATIONS
FOX-5 Broughton Island**

Landfills and Hydrocarbon Contaminated Areas

DRAFT FINAL

Prepared by:
Environmental Working Group, March 2000

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1. INTRODUCTION

1.1 Background

This report has been provided to summarize the recommendations of the Nunavut Tunngavik Incorporated /Department of National Defence (NTI/DND) DEW Line Cleanup Environmental Working Group (EWG) regarding the evaluation of landfills and hydrocarbon contaminated areas at the FOX-5 Broughton Island DEW Line site.

The Environmental Sciences Group (ESG) carried out the preliminary assessment of the FOX-5 site in 1992. In August 1998, ESG conducted a detailed environmental investigation to delineate known and suspected areas of contamination, including those contaminated with hydrocarbons, as well as to provide a more detailed assessment of the environmental status of the existing landfill areas. The results and interpretation of the environmental investigation are provided in the FOX-5 Report, (ESG, April 1999). As identified in this report, a number of hydrocarbon contaminated areas may require additional information to confirm or complete the evaluation. ESG intends to carry out additional investigation of the FOX-5 site in the year 2000, if required, to collect these outstanding information requirements.

In conjunction with the environmental assessment, UMA Engineering Ltd. (UMA) carried out an engineering site investigation. The objectives of this investigation were to survey soil sampling locations, as marked by ESG, review and evaluate existing and proposed landfill areas from a geotechnical perspective, and complete demolition and debris inventories, as required to prepared Drawings and Specifications for the cleanup of the site. Concept Drawings for FOX-5 were prepared in June 1999.

In accordance with the DND/NTI agreement, technical and local representatives of the NTI inspected the FOX-5 site during the field investigation by ESG. The objective of this inspection was to confirm that the conclusions reached by ESG and UMA during the site investigations demonstrate an environmental standard that ensures long term preservation of the Arctic Environment. A report, prepared by Vista Engineering (Vista, 1998), summarized the observations and conclusions of this inspection.

The recommendations contained herein, are based on a review of the documents, as listed blow, which were provided to the EWG as reference materials.

- **FOX-5, Broughton Island - Site Remediation - Phase One: Delineation**, Environmental Sciences Group (ESG) - Royal Military College of Canada, RMC-CCE-ES-99-11, April 1999.
- **DEW Line Cleanup Project FOX-5 Broughton Island - Conceptual Design Drawings**, For the Department of National Defence. UMA Engineering Ltd., June 1999.
- **DEW Line Cleanup Project. FOX-5 Broughton Island. Pre-Construction Site Survey**. For UMA Engineering Ltd., EBA Engineering Consultants Ltd. 1999.

- *FOX-5 DEW Line Site - Pre-construction Delineation Phase*, NTI Technical Representative Report, prepared by Vista Engineering, August 1998.
- *Environmental Work Group Report* (March 1998)
- *Addendum to the Environmental Working Group Report* (May 1999)

The documents were distributed and reviewed as part of the May 5 and 6, 1999 Annual EWG meeting. During this meeting, preliminary recommendations for remediation of existing landfills and risk mitigation measures for hydrocarbon contaminated soils at the site were developed. Subsequent to the meeting, the EWG met by conference call and electronic mail to finalize the recommendations for the FOX-5 site.

1.2 Site Description

The FOX-5 site is located on Broughton Island, on the east side of Baffin Island, which is within the land claim region of Baffin in Nunavut. The main site facilities are located atop a summit, approximately 14 kilometres northeast of the hamlet of Broughton Island. The main DEW site was connected by road to the lower site, where POL storage, vehicle maintenance, and airstrip facilities were located. The airstrip at Broughton Island, now under the jurisdiction of Arctic Airports, serviced both the community and the DEW Line site. An overall location plan is provided in Figure 1.

FOX-5 was an auxiliary DEW Line Station, which was decommissioned in 1991. A new Short Range Radar (SRR) North Warning Site (NWS) was constructed approximately 100 metres south of the original DEW Line facilities at the summit.

The site has two main landfills, located at the Upper and Lower Sites respectively, as shown on Figures 2 and 3. Small localized debris areas are present along the road between the Upper and Lower Site at the location of the original construction camp.

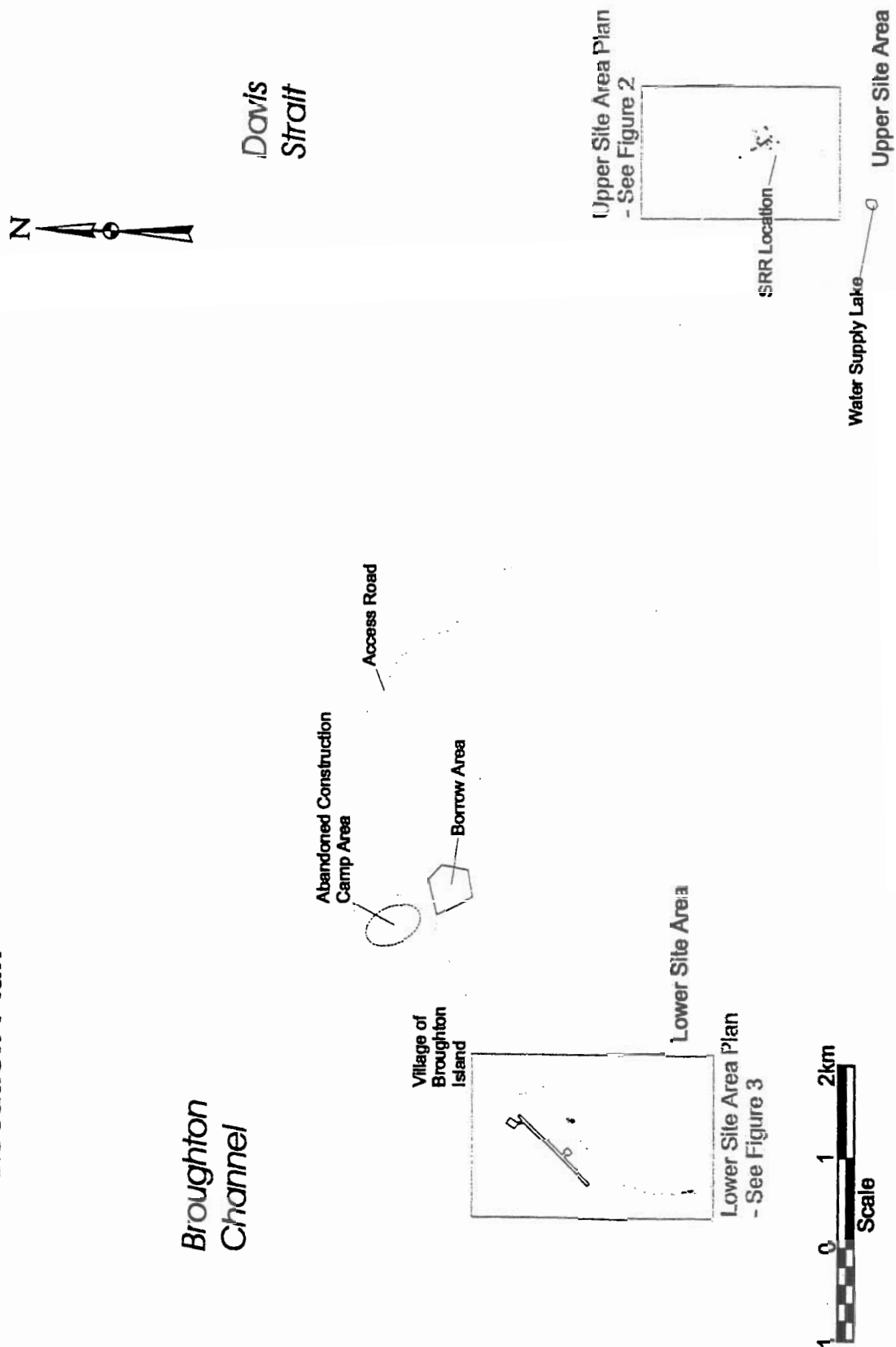
Hydrocarbon contaminated soil has been identified at the POL bulk storage facility, garage and vehicle maintenance areas, the area near the powerhouse (end of module train) and discrete staining associated with buildings, and former open storage areas. A total of 13 areas, potentially contaminated with hydrocarbons were evaluated. Locations of hydrocarbon contaminated areas are identified on Figures 2 and 3.

1.3 Scope of Report

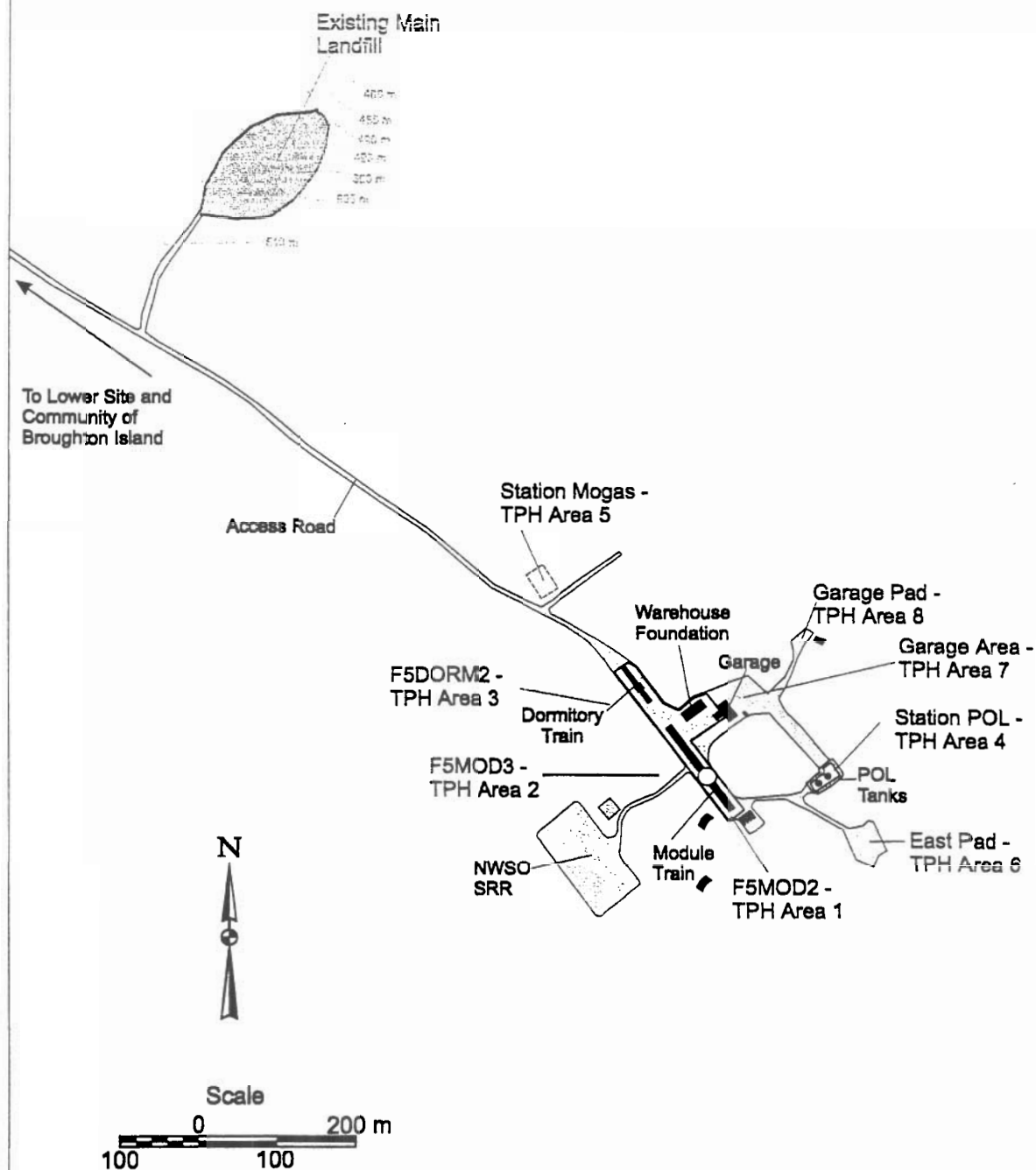
The remainder of this report is structured as follows:

- Section 2 provides a summary of the evaluation of the landfills at the FOX-5 site, including the corresponding recommendations for remediation.
- Section 3 identifies areas, potentially contaminated with hydrocarbons, and provides recommendations for environmental risk mitigation measures, as appropriate.
- In Annex A, an overview of the biophysical environment is presented, as it relates to the evaluation of landfill and hydrocarbon contaminated areas.
- Annex B presents a description of each of the landfills at the site, and the detailed scoring for the landfill evaluation.
- The detailed evaluation of hydrocarbon contaminated areas is provided in Annex C.

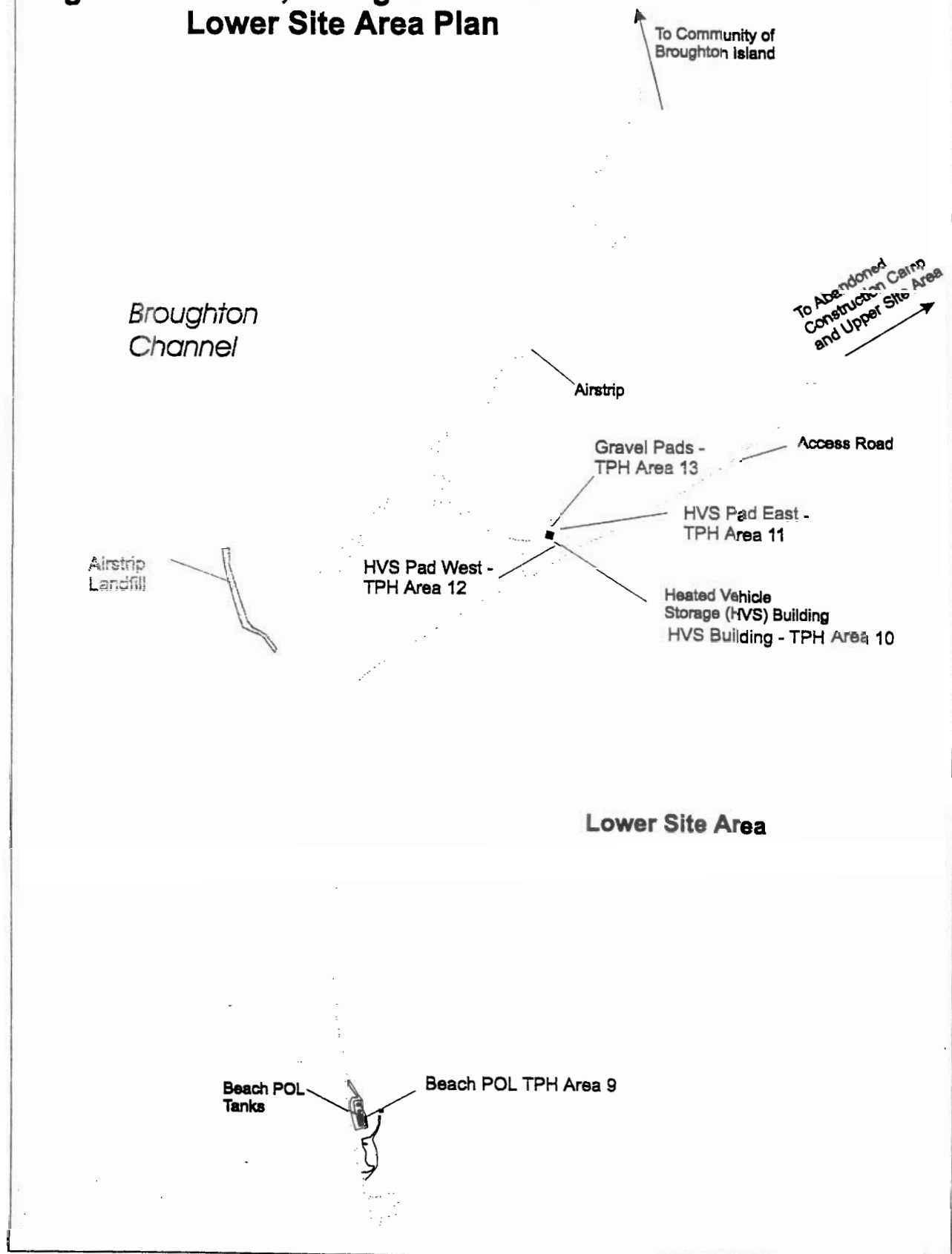
**Figure 1: FOX-5, Broughton Island DEW Line Site
Location Plan**



**Figure 2: FOX-5 Broughton Island
Upper Site Area Plan**



**Figure 3: FOX-5, Broughton Island
Lower Site Area Plan**



2. LANDFILL EVALUATIONS

The two existing landfills at FOX-5 were evaluated in accordance with the DEW Line Landfill Evaluation Matrix, as provided EWG (1998) report. A summary of the evaluation is provided in Table 2.1, with supplemental information provided in Annexes A and B. The landfill locations are identified on Figures 2 and 3.

Table 2.1: Summary of Landfill Remediation Recommendations for FOX-5 Broughton Island

Landfill Scoring/ Landfill Name	Scoring A. Contaminant Source B. Pathways C. Receptors	Total Score	Classification Potential Environmental Risk	Recommendations	Comments
Main Landfill (upper site)	A. 39 B. 28 C. 21	88	Moderate	Provide leachate containment system.	Surface water run-off is of concern, and is to be addressed as part of the containment design.
Airstrip Landfill - West (lower site)	A. 40 B. 33 C. 32	105	High	Excavation of landfill.	

3. HYDROCARBON CONTAMINATED AREAS - EVALUATION

Hydrocarbon contaminated areas at the FOX-5 site were assessed in accordance with the Hydrocarbon Evaluation Method (EWG, 1999). A total of 13 areas, potentially contaminated with hydrocarbons, were evaluated. These areas are identified on Figures 2 and 3. The Airstrip Apron area was also investigated by ESG in 1998, and no evidence of contamination was found. As this area is under the jurisdiction of Arctic Airports, an evaluation sheet has not been prepared. A summary of the evaluation of the other 13 areas is provided in Table 3.1. As outlined in the Hydrocarbon Evaluation Method, the evaluation considers the likelihood of exposure and receptor sensitivity for three major pathways; atmosphere, soil and water. Only the primary pathway, which determines the recommended risk mitigation measures, is identified in the summary table. The detailed evaluation of all hydrocarbon contaminated areas is appended in Annex C.

Table 3.1 Summary of Evaluation of Hydrocarbon Contaminated Areas at FOX-5 Broughton Island

Area ID	Hydrocarbon Evaluation		Recommended Risk Mitigation Measures ¹	Comments
	Primary Pathway	Likelihood of Exposure	Receptor Sensitivity	
1. F5MOD2	Atmosphere	Moderate	Low	- Excavate to 30 cm depth. - Backfill with clean fill.
2. F5MOD3	N/A	Low	Low	Scarify for aesthetic reasons
3. F5IDORM2	Soil and Water	High	Low	- Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. - Backfill with clean fill.
4. Station POL	Soil and Water	High	Low	- Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. - Backfill with clean fill.
5. Station Mogas	N/A	Low	Low	No action required.
6. East Pad	N/A	Low	Low	Scarify for aesthetic reasons.
7. Garage	Soil and Water	High	Low	- Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. - Backfill with clean fill.

¹ Recommendations presented in *italics* are provisional pending review of additional investigation results.

Table 3.1 continued

Area ID	Hydrocarbon Evaluation		Recommended Risk Mitigation Measures ¹		Comments
	Primary Pathway	Likelihood of Exposure	Receptor Sensitivity		
8. Garage Pad	N/A	Low	Low	No action required.	Area co-contaminated with Tier I and Tier II soil. These contaminated soils will be excavated, thus mitigating risks from hydrocarbon contamination.
9. Beach POL	Water	High	Moderate	- Excavate source of contamination to the depth and extent where TPH concentrations are less than 2500 ppm. - Backfill with clean fill.	- Surface materials are co-contaminated with Tier I and Tier II. - Additional investigation is required to determine the extent of contamination and to confirm risk mitigation measures.
10. HVS Building	Soil	Moderate	Moderate	Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first.	- Surface soils are co-contaminated with Tier I. - The final land use to this area is to be determined and evaluated relative to remediation requirements.
11. HVS Pad East	Soil	Moderate	Moderate	- Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. - Backfill with clean fill.	Three stained areas; over 50% of area is lubricating oil and grease.
12. HVS Pad West	Soil	Moderate	Moderate	- Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. - Backfill with clean fill.	
13. Gravel Pads	Soil	moderate	moderate	Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first.	

¹ Recommendations presented in *italics* are provisional pending review of additional investigation results.

ANNEX A

General Biophysical Environment Summary

FOX-5 BROUGHTON ISLAND

Summary of Overall Biophysical Environment

The following provides a brief summary of the important characteristics of the biophysical environment at Broughton Island.

- Important migratory route for whales and seals exists along eastern Baffin Island.
- The area is also an over-wintering area for some whales and seals.
- World Wildlife Federation has identified an important summering area for bowhead whales at Isabella Bay, approximately 200 kilometres north of the station.
- The offshore waters of Davis Strait provide an important breeding and migration area for the hooded seal.
- Large populations of Arctic char constitute a significant food source for domestic and commercial use.
- Large populations of seabirds occur in this area.
- An important polar bear denning area occurs 120 kilometres south-east of Broughton Island; and a summering area is located 150 km to the north.
- Polar bear sightings in the area have been noted as a common occurrence.
- The Broughton Island site is characterized by sparse vegetation consisting mainly of lichens. Mosses may occur at the site within large boulder fields.
- Annual precipitation is approximately 280 mm annually (snowfall converted to equivalent rainfall).

ANNEX B

Detailed Landfill Evaluation

Landfill Descriptions

Landfill Scores

MAIN LANDFILL

A. CONTAMINANT SOURCE DESCRIPTION

- The Main Landfill encompasses an area of approximately 18 000 m².
- Estimated depth of the landfill is greater than 1.5 metres.
- There is evidence of contaminated leachate; however, no contaminated soil is identified in excess of DCC Criteria (low levels of PCBs).
- Scattered debris covers approximately 40 percent of area.

B. PATHWAYS/TRANSPORT MECHANISMS

- Leachate and low level contaminated soil has been identified, therefore potential for aerial transport is provided for in the evaluation.
- Topography: The landfill surface slopes at 5 to 10 percent grade, with portions of the landfill at approximately 12 percent grade.
- Cover materials consist of gravelly sand, with some cobbles overlying sand and gravel. .
- Surface water run-off is considered moderate due to slopes. Area is also subject to snow drifting. There is localized evidence of erosion on portions of the landfill with finer grained materials and steeper slopes, likely associated with periods of high run-off.
- Annual precipitation is 280 millimetres.
- Drainage from the landfill goes overland to the north-northeast towards Davis Strait, approximately 1.4 kilometres distant.

C. RECEPTORS

- The receiving aquatic environment is Davis Strait, a known harvest area supporting diverse marine life, approximately 1.4 kilometres distant.
- Vegetation cover is sparse in the area of the landfill, with patches of vegetation including mosses, grass and heather in interstices between boulders.
- Terrestrial wildlife biodiversity is considered low to moderate. Caribou may occur in the region. As well, it is an area of known or suspected denning/wintering for polar bears. Arctic fox and lemmings are likely present.
- Raptors, including falcons, hawks and owls, are known to occur in the region.
- Fishing occurs off the coast for Arctic Char.
- The community of Broughton Island is approximately 14 kilometres by road from the landfill. Residents are known to visit the site; however, the duration of the stay is limited.
- No drinking water supplies are located within one kilometre of the landfill.

AIRSTRIP LANDFILL

A. CONTAMINANT SOURCE DESCRIPTION

- The Airstrip Landfill encompasses an area of approximately 3000 m².
- The estimated depth of the landfill is approximately one metre (based on elevation above sea level).
- There is evidence of contaminated leachate; and contaminated soil is identified in excess of DCC Tier II Criteria.
- Partially buried debris is present over majority of area.

B. PATHWAYS/TRANSPORT MECHANISMS

- Contaminated soil and leachate have been identified, therefore the potential for aerial transport is provided for in the evaluation.
- Topography: The landfill surface is flat with grades less than 3 percent..
- Cover materials consist of gravely sand to cobbles and boulders.
- Surface water run-off is considered low due to flat terrain; however, erosion due to wave action occurs on a near continuous basis.
- Annual precipitation is 280 mm.
- Drainage from the landfill flows directly into Broughton Channel.

C. RECEPTORS

- The receiving aquatic environment is Broughton Channel, a known harvest area supporting diverse marine life, (within 100 metres).
- Vegetation cover is negligible in the area of the airstrip landfill.
- Terrestrial wildlife biodiversity is considered low. The general region is an area of known or suspected denning/wintering areas for polar bears, however the proximity to the commercial airstrip, and corresponding disturbance, limits the use of the area by wildlife.
- Raptors including falcons, hawks and owls are known to occur in the region.
- Fishing occurs off the coast for Arctic Char.
- Community of Broughton Island approximately two kilometres by road from landfill.
- No drinking water supplies are located within one kilometre of the landfill.

POTENTIAL ENVIRONMENTAL RISK - EVALUATION MATRIX DEW LINE LANDFILLS IN THE NUNAVUT REGION					FOX-5 MAIN LANDFILL	FOX-5 AIRSTRIP LANDFILL
A.	CONTAMINANT SOURCE			Maximum Score		
A.1	LANDFILL EXTENT					
	> 10,000 m2			10		
	For areas less than 10,000 = Area of Landfill X 10 / 10 000			2-9		
	Minimum Score			1	10	3
A.2	ESTIMATED DEPTH OF LANDFILL					
	greater than 1.5 m			5		
	less than 1.5 m			2-4	5	2
A.3	PRESENCE OF LEACHATE					
	Evidence of Leachate			10		
	No Evidence of Leachate			0	10	10
A.4	PRESENCE OF SURFACE CONTAMINATED SOIL					
	> DCC Tier II Stains			15		
	> DCC Tier I < DCC Tier II, Stains			10		
	Contaminated suspected, no surface contamination noted			5	5	15
A.5	PRESENCE OF SURFACE DEBRIS AT LANDFILL					
	>50% of surface area			10		
	<50% of surface area, pro-rated			1-9		
	No debris observed			0	9	10
	SPECIAL CONSIDERATIONS					
				+/- 5		
	TOTAL SCORE - CONTAMINANT SOURCE				50	40

POTENTIAL ENVIRONMENTAL RISK - EVALUATION MATRIX DEW LINE LANDFILLS IN THE NUNAVUT REGION							FOX-5 MAIN LANDFILL	FOX-5 AIRSTRIIP LANDFILL
B.	PATHWAY/TRANSPORT MECHANISMS					Maximum Score		
B.1	AERIAL TRANSPORT OF CONTAMINANTS					2	2	2
	All Landfills Scored as 2 if Surface Soil Contamination (A.4) or leachate (A.3) has been identified							
B.2	WATER MOVEMENT							
B.2.1	TOPOGRAPHY					12	5	1
	Steep Slope (>40 % Grade)							
	Sloping (10% to 40% Grade)							
	Subdued to 10% Slope							
	Flat (< 3%)					1		
B.2.2	COVER MATERIALS -DEPTH					4	3	2
	No to little existing cover							
	Greater than 50% exposed/surface debris							
	Occasional exposed/surface debris							
	Existing cover, minimal debris,							
	Cover thickness > average active layer thickness					0		
B.2.3	COVER MATERIAL - TYPE					5	4	3
	No cover							
	Silty/Sandy material							
	Sandy/Gravel material							
	Gravel material					1-2		
B.2.4	SURFACE WATER/RUN-OFF POTENTIAL					12	10	12
	Very High - evidence of erosion, continuing run-off, or wave action							
	High - evidence of erosion, seasonal, widespread, storm waves							
	Moderate - % area affected by erosion							
	Low - no evidence of erosion, slight slopes					1-2		
B.2.5	PRECIPITATION					5	3	3
	> 500 mm annual precipitation							
	< 500 mm annual precipitation (pro-rated)							
B.2.6	DISTANCE TO DOWNGRAIDENT PERENNIAL SURFACE/ SEASONAL DRAINAGE CHANNEL					10	1	10
	0 to 100 m							
	100 m to 300 m							
	300 m to 1 km							
	greater than 1 km					1		
	SPECIAL CONSIDERATIONS					+/- 5		
	TOTAL SCORE - PATHWAYS					50	28	33

POTENTIAL ENVIRONMENTAL RISK - EVALUATION MATRIX DEW LINE LANDFILLS IN THE NUNAVUT REGION										
RECEPTORS										
C.								Maximum Score	FOX-5 MAIN LANDFILL	FOX-5 AIRSTRIIP LANDFILL
C.1	POTENTIAL IMPACT ON RECEIVING FRESHWATER/MARINE HABITAT									
C.1.1	PROXIMITY TO RECEIVING FRESHWATER/MARINE HABITAT									
	0 to 100 m							6		
	100 m to 300 m							4-5		
	300 m to 1 km							2-3		
	greater than 1 km							1	6	
C.1.2	ESTIMATED HABITAT USAGE - FRESHWATER/MARINE									
	High: High Biodiversity/ High Occurrence/Calving or Spawning Area							5-6		
	Moderate: Moderate Biodiversity, Migratory							3-4		
	Low: Low biodiversity; rare sightings							1-2	6	
C.2	POTENTIAL IMPACT ON RECEIVING TERRESTRIAL HABITAT									
C.2.1	Extent of Vegetation									
	Extensive vegetation growth, (80 to 100 % ground cover)							6		
	Moderate vegetation growth (40 to 80% ground cover)							4-5		
	Low vegetation growth (20 to 40% ground cover)							2-3		
	Sparse vegetation (<20% ground cover)							1	6	
C.2.2	ESTIMATED HABITAT USAGE - TERRESTRIAL/AVIFAUNA									
	High: High Biodiversity/ High Occurrence/Calving, Denning or Nesting Area							5-6		
	Moderate: Moderate Biodiversity, Migratory							3-4		
	Low: Low biodiversity; rare sightings							1-2	6	
C.3	POTENTIAL HUMAN EXPOSURE THROUGH LAND USE									
C.3.1	Presence/Occupation									
	Duration of contact									
	High - Numerous visits, summer camp					high	moderate	low		
	Moderate - occasional summer camp					8	6	4		
	Low - Infrequent visits or winter camp					6	4	2	8	
						4	2	1		
C.3.2	Proximity to Drinking Water Source									
	0 to 100 m							8		
	100 m to 300 m							5-7		
	300 m to 1 km							2-4		
	greater than 1 km							1	8	
C.3.3	Food Consumption									
	High quantity of sedentary organisms - marine & plant life							8		
	Moderate quantity of sedentary organisms - marine & plant life							6		
	Low quantity of sedentary organisms - marine & plant life							4		
	No consumption							0	8	
	High quantity of migratory organisms							2		
	Moderate quantity of migratory organisms							1		
	Low quantity of migratory organisms							0.5		
	No consumption							0	2	
	SPECIAL CONSIDERATIONS									

ANNEX C

Detailed Hydrocarbon Contaminated Area Evaluations

Summary Sheet

Hydrocarbon Contaminated Area Description

HYDROCARBON CONTAMINATION EVALUATION
DEW Line sites in Nunavut

Site:

Location:

Summary of areas

Area #	ID	Estimated Surface Area (m ²)	Estimated Volume (m ³)	Max. TPH Value (ppm)	Average TPH (ppm)
Area1	F5MOD2	1700	850	20000	10400
Area2	F5MOD3	72	36	11000	11000
Area3	F5DORM2	1000	1000	34000	20330
Area4	Station POL	3400	3400	15000	7700
Area5	Station MoGas	600	600	3900	3700
Area6	East Pad	210	84	38000	14644
Area7	Garage	7500	7500	41000	15200
Area8	Garage Pad	140	70	30000	19250
Area9	Beach POL	1000	1000	8000	5270
Area10	HVS Building	210	126	39000	14500
Area11	HVS Pad East	80	80	13000	7175
Area12	HVS Pad West	140	84	28000	15900
Area13	Gravel Pads	120	120	28000	7175

TPH = Total Petroleum Hydrocarbons
 ppm = parts per million = mg/kg

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area1

FOX-5 Broughton Island

Name:

F5MOD2

Map reference:

B-1

Description of physical parameters

Maximum TPH concentration	20000	ppm
Number of surface samples analysed	5	
Number of depth samples analysed	6	
Approximate area of contamination	1700	m ²
Approximate depth of contamination	0.5	meter
Estimated volume	850	m ³
Number of samples used for average (>2500 ppm)	7	
Average TPH concentration	10400	ppm
Normalized volume factor	8840	
Type of hydrocarbon contamination	fuel	
Percentage of fuel oil	100	%

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate slope of the area	<10	>10<20	>20<40	>40	%
Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100	>100 <500	>500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60	>60	%	
Approximate distance to marine/freshwater environment	<100	>100 <500	>500	meter	

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area1

FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Moderate	Low	Excavate to 30 cm depth, and backfill with clean fill.
Soil (dermal contact, ingestion, vegetation uptake)	Low	Low	No action required.
Water (dermal contact, ingestion)	Low	Low	No action required.

Additional information required for evaluation:
Additional information required for remediation design

no
Yes

(yes or no)

Recommended remediation solution:

Excavate to 30 cm depth, and backfill with clean fill.
--

Special factors to be considered:

Most contamination is at depth.

Other comments

--

Mitigating circumstances:

Cover material has to be maintained.

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area2

FOX-5 Broughton Island

Name:

F5MOD3

Map reference:

B-1

Description of physical parameters

Maximum TPH concentration	11000	ppm
Number of surface samples analysed	1	
Number of depth samples analysed	0	
Approximate area of contamination	72	m ²
Approximate depth of contamination	0.5	meter
Estimated volume	36	m ³
Number of samples used for average (>2500 ppm)	1	
Average TPH concentration	11000	ppm
Normalized volume factor	396	
Type of hydrocarbon contamination	Lube Oil & Grease	
Percentage of fuel oil	0	%

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate slope of the area	<10	>10<20	>20<40	>40	%
Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100	>100 <500	>500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60	>60		%
Approximate distance to marine/freshwater environment	<100	>100 <500	>500		meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area2

FOX-5 Broughton Island

	Likelihood of Exposure	Receptor Sensitivity	Remediation Requirements
Atmosphere (inhalation of vapors)	Low	Low	No action required.
Soil (dermal contact, ingestion, vegetation uptake)	Low	Low	No action required.
Water (dermal contact, ingestion)	Low	Low	No action required.

Additional information required for evaluation:

no	(yes or no)
no	(yes or no)

Additional information required for remediation design

Recommended remediation solution:

Scarfify for aesthetic reasons

Special factors to be considered:

No receptors identified in general area.

Other comments

On flat pad surface.

Mitigating Circumstances:

Lubricating Oil and grease are not easily mobilized.

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area4

FOX-5 Broughton Island

Name:

Station POL
B-4

Map reference:

Description of physical parameters

Maximum TPH concentration	15000	ppm
Number of surface samples analysed	24	
Number of depth samples analysed	11	
Approximate area of contamination	3400	m ²
Approximate depth of contamination	1	meter
Estimated volume	3400	m ³
Number of samples used for average (>2500 ppm)	18	
Average TPH concentration	7700	ppm
Normalized volume factor	26200	
Type of hydrocarbon contamination	Fuel	
Percentage of fuel oil	100	%
Approximate slope of the area	<10	>10<20 >20<40 >40

Area is estimated based on available data.
Depth is estimated based on available data.

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100	>100 <500	>500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60	>60	>60	%
Approximate distance to marine/freshwater environment	<100	>100 <500	>500	>500	meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area4

FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Moderate	Low	Excavate to 30 cm depth, and backfill with clean fill.
Soil (dermal contact, ingestion, vegetation uptake)	High	Low	Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. Backfill with clean fill.
Water (dermal contact, ingestion)	High	Low	Provide containment of source of contamination and/or reduce concentrations of contamination in situ.

Additional information required for evaluation:

No

(yes or no)

Additional information required for remediation design

No

(yes or no)

Recommended remediation solution:

Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. Backfill with clean fill. See Mitigating circumstances

Special Factors to be considered

Other Comments

Mitigating circumstances:

The POL pad and berms are to be reshaped/regrading following removal and demolition of the tanks. The removal of hydrocarbon contaminated soil (50 cm or 2500 ppm) is to be from the final reshaped surface. The area is to be backfilled with clean soil.

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area5

Name:

Map reference:

FOX-5 Broughton Island

Station Mogas
B-8

Description of physical parameters

Maximum TPH concentration		3900 ppm
Number of surface samples analysed		11
Number of depth samples analysed		8
Approximate area of contamination		600 m ²
Approximate depth of contamination		1 meter
Estimated volume		600 m ³
Number of samples used for average (>2500 ppm)		2
Average TPH concentration		3600 ppm
Normalized volume factor		2160
Type of hydrocarbon contamination		fuel
Percentage of fuel oil		100 %
Approximate slope of the area		<10 >10<20 >20<40 >40 %

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat		<30 >30 <100 >100 <500 >500 meter
Estimated extent of vegetation cover in the vicinity		<20 >20 <60 >60 %
Approximate distance to marine/freshwater environment		<100 >100 <500 >500 meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area5

FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Low	Low	No Action Required.
Soil (dermal contact, ingestion, vegetation uptake)	Low	Low	No Action Required.
Water (dermal contact, ingestion)	Low	Low	No Action Required.

Additional information required for evaluation:

Additional information required for remediation design

no	(yes or no)
no	(yes or no)

Recommended remediation solution:

No Action Required. If hydrocarbon contaminated soil is exposed during reshaping of POL berms, scarify surface to 30 cm depth.

Special factors to be considered:

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Other comments

Contamination is at depth, therefore likelihood of exposure (atmosphere) is considered low.

Mitigating circumstances:

Evaluate area during construction when hydrocarbon contaminated soil may be exposed during reshaping of POL berms.

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area6

FOX-5 Broughton Island

Name:

East Pad

Map reference:

B-5

Description of physical parameters

Maximum TPH concentration		38000	ppm
Number of surface samples analysed		7	
Number of depth samples analysed		2	
Approximate area of contamination		210	m ²
Approximate depth of contamination		0.4	meter
Estimated volume		84	m ³
Number of samples used for average (>2500 ppm)		9	
Average TPH concentration		14644	ppm
Normalized volume factor		1230	
Type of hydrocarbon contamination		Lube Oil & Grease	
Percentage of fuel oil		0	%
Approximate slope of the area		<10	>10<20 >20<40 >40 %

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat		<30	>30 <100 >100 <500 >500	meter
Estimated extent of vegetation cover in the vicinity		<20	>20 <60 >60	%
Approximate distance to marine/freshwater environment		<100	>100 <500 >500	meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area6

FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Low	Low	No action required
Soil (dermal contact, ingestion, vegetation uptake)	Low	Low	No action required
Water (dermal contact, ingestion)	Low	Low	No action required

Additional information required for evaluation:

Additional information required for remediation design

no	(yes or no)
no	(yes or no)

Recommended remediation solution:

Scarify for aesthetic reasons.

Special factors to be considered:

Small isolated stains.

Other comments

Mitigating circumstances:

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area7

FOX-5 Broughton Island

Name:

Map reference:

Garage
B-6

Description of physical parameters

Maximum TPH concentration	41000	ppm
Number of surface samples analysed	20	
Number of depth samples analysed	22	
Approximate area of contamination	7500	m ²
Approximate depth of contamination	1	meter
Estimated volume	7500	m ³
Number of samples used for average (>2500 ppm)	26	
Average TPH concentration	15200	ppm
Normalized volume factor	114000	
Type of hydrocarbon contamination	fuel	
Percentage of fuel oil	90	%
Approximate slope of the area	<10	>10<20 >20<40 >40 %

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100	>100 <500	>500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60	>60	>60	%
Approximate distance to marine/freshwater environment	<100	>100 <500	>500	>500	meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area7 FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Moderate	Low	Excavate to 30 cm depth, and backfill with clean fill.
Soil (dermal contact, ingestion, vegetation uptake)	High	Low	Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. Backfill with clean fill.
Water (dermal contact, ingestion)	High	Low	Provide containment of source of contamination and/or reduce concentrations of contamination in situ.

Additional information required for evaluation:

Additional information required for remediation design

yes	(yes or no)
yes	(yes or no)

Recommended remediation solution:

Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. Backfill with clean fill. **See Mitigating Circumstances.**

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area7

FOX-5 Broughton Island

Special factors to be considered:

A large area that has hydrocarbon contamination in isolated areas on surface and is potentially extensive at depth.

Other comments

Mitigating circumstances:

The extent of contamination needs to be better defined. Approximately 500 m² are co-contaminated with Tier I. TPH at depth will attenuate over time, and the process may be accelerated with in situ remediation techniques. Evaluation of requirement for containment to be carried out when additional information on the extent of contamination is reviewed.

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area8

FOX-5 Broughton Island

Name:

Garage Pad

Map reference:

B-7

Description of physical parameters

Maximum TPH concentration	30000	ppm
Number of surface samples analysed	8	
Number of depth samples analysed	5	
Approximate area of contamination	140	m ²
Approximate depth of contamination	0.5	meter
Estimated volume	70	m ³
Number of samples used for average (>2500 ppm)	4	
Average TPH concentration	19250	ppm
Normalized volume factor	1350	
Type of hydrocarbon contamination	Lube Oil & Grease	
Percentage of fuel oil	<10	%
Approximate slope of the area	<10	%
	>10<20	%
	>20<40	%
	>40	%

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100	>100 <500	>500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60	>60		%
Approximate distance to marine/freshwater environment	<100	>100 <500	>500		meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area8

Name:

Map reference:

FOX-5 Broughton Island

Garage Pad
B-7

Description of physical parameters

Maximum TPH concentration	30000	ppm
Number of surface samples analysed	8	
Number of depth samples analysed	5	
Approximate area of contamination	140	m ²
Approximate depth of contamination	0.5	meter
Estimated volume	70	m ³
Number of samples used for average (>2500 ppm)	4	
Average TPH concentration	19250	ppm
Normalized volume factor	1350	
Type of hydrocarbon contamination	Lube Oil & Grease	
Percentage of fuel oil	<10	%
Approximate slope of the area	<10	%
	>10<20	%
	>20<40	%
	>40	%

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100	>100 <500	>500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60	>60	>500	%
Approximate distance to marine/freshwater environment	<100	>100 <500	>500	>500	meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area9	FOX-5 Broughton Island
Special factors to be considered:	Area co-contaminated with Tier I and Tier II soils. The extent of hydrocarbon contamination at depth is not determined. A minimum area of contamination of 1000 m ² over an average depth of 1.0 metres (may be deeper in the pad) is assumed.
Other Comments	
Mitigating circumstances:	Tier I and Tier II soils on surface will be excavated. The POL area is to be reshaped following removal and demolition of the tanks. Require extent of contamination to be determined prior to confirming risk mitigation measures.

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area10

FOX-5 Broughton Island

Name:

HVS Building

Map reference:

B-11(b)

Description of physical parameters

Maximum TPH concentration	39000	ppm
Number of surface samples analysed	11	
Number of depth samples analysed	1	
Approximate area of contamination	210	m ²
Approximate depth of contamination	0.6	meter
Estimated volume	126	m ³
Number of samples used for average (>2500 ppm)	5	
Average TPH concentration	14500	ppm
Normalized volume factor	1830	
Type of hydrocarbon contamination	fuel & lube oil	
Percentage of fuel oil	& grease	
Approximate slope of the area	50	%
	<10	>10<20
	>20<40	>40
		%

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100	>100 <500	>500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60	>60		%
Approximate distance to marine/freshwater environment	<100	>100 <500	>500		meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area10

FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Moderate	Low	For surface lubricating oil contamination, scarify surface to 30 cm depth. For surface fuel oil contamination, excavate to 30 cm depth, and backfill with clean fill.
Soil (dermal contact, ingestion, vegetation uptake)	Moderate	Moderate	Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first.
Water (dermal contact, ingestion)	Low	Moderate	No action required.

Additional information required for evaluation:

no
Yes

Additional information required for remediation design:

Additional depth sampling may be required.

Recommended remediation solution:

Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. The final land use of this area is to be determined and evaluated relative to the remediation requirements.

Special factors to be considered:

The area is co-contaminated with Tier I soils. This only includes the area within the HVS building. High contaminant levels of TPH associated typically with lubricating oil.

Other comments

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Mitigating circumstances:

Community uses building for storage, limited access. Tier I soils on surface will be excavated are co-contaminated with lube oil & grease. Fuel oil contamination is detected at depth; however, steel grate prevented more detailed depth sampling.

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area11

Name:

Map reference:

FOX-5 Broughton Island

HVS Pad East

B-11(b)

Description of physical parameters

Maximum TPH concentration	13000	ppm
Number of surface samples analysed	1	
Number of depth samples analysed	5	
Approximate area of contamination	80	m ²
Approximate depth of contamination	1	meter
Estimated volume	80	m ³
Number of samples used for average (>2500 ppm)	4	
Average TPH concentration	7175	ppm
Normalized volume factor	574	
Type of hydrocarbon contamination	both	Fuel & Lubricating Oil and Grease
Percentage of fuel oil	40%	%
Approximate slope of the area	<10	>10<20
	>20<40	>40
		%

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100	>100 <500	>500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60	>60	>500	%
Approximate distance to marine/freshwater environment	<100	>100 <500	>500	>500	meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

FOX-5 Broughton Island

Area11

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Moderate	Low	For surface lubricating oil contamination, scarify surface to 30 cm depth. For surface fuel oil contamination, excavate to 30 cm depth, and backfill with clean fill.
Soil (dermal contact, ingestion, vegetation uptake)	Moderate	Moderate	Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first.
Water (dermal contact, ingestion)	Low	Moderate	No action required.

Additional information required for evaluation:

no	(yes or no)
no	(yes or no)

Additional information required for remediation design:

Recommended remediation solution:

Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. Backfill with clean fill.
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Special factors to be considered:

Three hydrocarbon stains, with over 50 percent of the area with lubricating oil and grease contamination.

Other comments

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Mitigating Circumstances

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HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area12

FOX-5 Broughton Island

Name:

HVS Pad West

Map reference:

B-11(b)

Description of physical parameters

Maximum TPH concentration	28000	ppm
Number of surface samples analysed	3	
Number of depth samples analysed	4	
Approximate area of contamination	140	m ²
Approximate depth of contamination	0.6	meter
Estimated volume	84	m ³
Number of samples used for average (>2500 ppm)	5	
Average TPH concentration	15900	ppm
Normalized volume factor	1340	
Type of hydrocarbon contamination	lube oil & grease	
Percentage of fuel oil	<10	%
Approximate slope of the area	<10	%
	>10<20	%
	>20<40	%
	>40	%

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100	>100 <500	>500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60	>60	>60	%
Approximate distance to marine/freshwater environment	<100	>100 <500	>500	>500	meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area12

FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Low	Low	No action required.
Soil (dermal contact, ingestion, vegetation uptake)	Moderate	Moderate	Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first.
Water (dermal contact, ingestion)	Low	Moderate	No action required.

Additional information required for evaluation:

Additional information required for remediation design

no	(yes or no)
no	(yes or no)

Recommended remediation solution:

Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. Backfill with clean fill.

Special factors to be considered:

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Other comments

Area to the immediate west of the HVS Building.

Mitigating circumstances:

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