



Final Report:

# Remedial Action Plan: **OUTPOST ISLAND MINE**

Prepared For:

**Public Works and Government Services Canada**  
Northern Contaminated Sites Group  
and  
**Aboriginal Affairs & Northern Development Canada**  
Contaminants and Remediation Directorate

Prepared By:

**SENES Consultants**

August 2013

**- FINAL -**

# **REMEDIAL ACTION PLAN**

**FOR**

## **OUTPOST ISLAND MINE**

**NORTHWEST TERRITORIES**

**Prepared for:**

**Public Works and Government Services Canada  
Western Region**

**On Behalf of:**

**Aboriginal Affairs and Northern Development Canada -  
Contaminants and Remediation Directorate**

**Prepared by:**

**SENES Consultants  
121 Granton Drive, Unit 12  
Richmond Hill, Ontario  
L4B 3N4**

**August 2013**

**- FINAL -**

# **REMEDIAL ACTION PLAN**

**FOR**

## **OUTPOST ISLAND MINE**

**NORTHWEST TERRITORIES**

**Prepared for:**

**Public Works and Government Services Canada**

**On Behalf of:**

**Aboriginal Affairs and Northern Development Canada**

**Prepared by:**

**SENES Consultants**



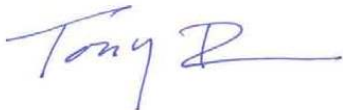
---

Charles Gravelle, M.A.Sc., P.Eng.  
Senior Engineer



---

Claire Brown, B.Sc., GIT  
Environmental Scientist



---

Tony Brown, M.Sc., P.Eng.  
Senior Project Manager



---

Gerd Wiatzka, B.Sc., P.Eng.  
Project Director

August 2013

## **EXECUTIVE SUMMARY**

### ***Site and Project Introduction***

The abandoned Outpost Island Mine is located on Great Slave Lake in the Northwest Territories. The remote site occupies two islands within the western margin of the East Arm of Great Slave Lake, and is currently unoccupied with access limited to plane (float or skis), helicopter, boat, or snowmobile. The mine operated intermittently from 1935 to 1952, with two shafts, two raises, several trenches, and mine buildings supporting the mining of copper, gold and tungsten. A fire in 1955, a partial remediation in 1994, and 50 years of inactivity have left minimal infrastructure remaining on either Outpost Island (primary site of mining activities), or the adjacent East Island (minimal site infrastructure or historical activities).

Aboriginal Affairs and Northern Development Canada (AANDC) has the responsibility to manage a number of contaminated sites that are no longer maintained by the original occupant. AANDC's portfolio of contaminated sites in the north originates from private sector mining, oil and gas activities, government, military activity and other users of the land dating back over half a century, many years before the environmental impacts of such activities were adequately understood. The abandoned Outpost Island Mine is one of these legacy sites.

### ***Community Concerns***

Prior to the development of the Outpost Island Mine, Aboriginal people lived throughout the area for centuries. The site lies within the traditional Akaitcho lands and is part of the Interim Measures Agreement (IMA) area of the Akaitcho Dene First Nations (AKDFN) of the Northwest Territories. It is also situated within the IMA for the Northwest Territories Métis Nation (NWTMN). While the site is remote with no road access, residents from Aboriginal communities closest to the site (e.g., N'dilo, Dettah, and Lutsel K'e) continue to hunt, trap and gather traditional foods throughout the region. In addition to traditional land use, portions of Great Slave Lake are visited by non-Aboriginal residents and tourists.

Throughout the Northwest Territories, Aboriginal residents have expressed significant concerns regarding abandoned mine sites on their traditional lands. Although the Outpost Island Mine is very small relative to other historic mining developments in the region (e.g., Giant, Con and Pine Point mines), there remains a general concern associated with historic mining and exploration activities. The potential contamination of water and soils, as well as impacts to fish, wildlife and vegetation are commonly cited as the top priorities for attention. Physical hazards such as unsecured openings and debris have also been identified as concerns with respect to human and wildlife health.

### ***Remediation Planning Process***

This document presents a proposed Remedial Action Plan (RAP) which was developed on behalf of AANDC's Contaminants and Remediation Directorate (CARD). The objective of the RAP is to address potential human health and environmental risks associated with the former Outpost Island Mine. The RAP considers the findings of Phase I, II, III and IIIa Environmental Site Assessments (ESAs), a Human Health and Ecological Risk Assessment (HHERA), best practices in mine closure and current land uses in the project area to select technically suitable approaches for the management of site risks.

Earlier drafts of the RAP included remedial options and technical recommendations which formed the basis of a community involvement and engagement process. The process was implemented to ensure that Aboriginal stakeholders and Northern residents were active participants in the selection of the preferred closure options for the final remediation of the site. Results of the community engagement process and Remedial Options Analysis Workout were used to select the preferred remedial options contained within this final version of the RAP. The RAP will be used to guide the development of detailed engineering and logistics plans for potential remedial actions and monitoring of the site.

Following implementation of the RAP, long-term monitoring and reporting will be carried out at the site to provide ongoing assurance that the remediation works perform as intended.

### ***Proponents and Regulators***

AANDC is the project proponent for the RAP and is responsible for securing appropriate approvals and resources. The implementation of the plan will be managed by Public Works and Government Services Canada (PWGSC). SENES Consultants (SENES) has been hired by PWGSC on behalf of AANDC to prepare the RAP. The proposed works are anticipated to require regulatory authorizations from the Mackenzie Valley Land and Water Board prior to implementation.

### ***Findings of Previous Studies***

The ESA process identified the physical aspects of the mine and any contamination of soil, vegetation, water and sediment. This information served as input to the HHERA which was used to provide perspective on potential risks associated with the site that may impact human and environmental health. The results of these studies, in combination with AANDC guiding principles, were used to determine what issues and concerns should be addressed in the RAP. The following aspects of the Outpost Island Mine are discussed in the RAP:

- **Mine Openings:** Two shafts and two raises on Outpost Island represent a potential physical concern.

- Buildings: Dilapidated structures on East Island may represent a physical hazard to those who enter.
- Refuse and Debris: Metal debris and scrap machinery represent an aesthetic concern as well as a potential physical hazard.
- Hazardous Waste Materials: Broken batteries and a small (< 2 L) bottle of an unknown oil based liquid are the only potentially hazardous materials located at the site.
- Tailings/Waste Rock in Mill Area: Acid generating and metal leaching concerns associated with the intermixed tailings/waste rock deposit represent a source of metal loadings to the surrounding environment.
- Waste Rock: Acid generating and metal leaching concerns associated with additional waste rock deposits are minor relative to the intermixed tailings/waste rock, but do represent a potential source of metal loadings to the surrounding environment.
- Soils - Metals: Metal concentrations are elevated in soils, with the greatest metal enrichments associated with tailings, former mine areas (e.g., assay labs), and with broken batteries.
- Soils – PHCs: A relatively small volume of soil (< 23 m<sup>3</sup>) was determined to have petroleum hydrocarbon (PHC) concentrations above applicable criteria.
- Former Dock: A dock was constructed on the southern shore of Outpost Island and used during the operational period of the mine. A wooden crib is filled with rock and contains steel supports, some of which have detached from the structure.
- Sediment/Water: Concentrations of metals in surface water and sediments within the North Bay and, to a lesser extent the South and East bays, are elevated due to the storage of tailings in the aquatic environment.

### ***Proposed Remediation Plan***

Based on a comprehensive review of site conditions, evaluation of feasible remedial options and feedback of community representatives during the Remedial Options Analysis Workout, the preferred remedial option for each component are as follows:

- Mine Openings – Upgrade caps using foam seals for small openings and concrete for the larger #1 Shaft, seal Main Raise;
- Former Buildings/Structures – Demolish and burn;
- Non-Hazardous Refuse – Consolidate and dispose in an off-site facility; excluding milling equipment which is to remain in-situ and concrete for fill where possible;
- Hazardous Waste Materials – Consolidate and dispose in an off-site facility;
- Tailings/Waste Rock (mixed) – Consolidate and re-slope;
- Waste Rock (small distributed deposits) – Leave as is with monitoring, and use as fill where necessary and accessible;

- Metal-Impacted Soils – Off-site management of impacted soils from discrete areas impacted by batteries and metal refuse (excludes soils impacted by mine wastes);
- Hydrocarbon-Impacted Soils - Consolidate and dispose in an off-site facility;
- Dock – Remove Debris and Naturalize Shoreline; and,
- Surface Water and Sediments – Leave as is with monitoring.

Monitoring activities will form an integral part of the comprehensive remedial plan for the site. Monitoring will occur during active remedial works to ensure the remedial measures do not result in unexpected impacts to the environment and to protect the health and safety of workers. At the completion of the remediation, ongoing monitoring will be conducted that the remedial measures perform as intended.

## **TABLE OF CONTENTS**

	<u>Page No.</u>
GLOSSARY OF TERMS .....	G-1
UNITS AND ABBREVIATIONS .....	U-1
CHEMICAL SYMBOLS .....	CS-1
1.0 INTRODUCTION .....	1-1
1.1 Overview of the Project .....	1-1
1.1.1 Location and Access .....	1-1
1.1.2 History of the Mine .....	1-3
1.1.3 Community Concern .....	1-6
1.2 Designated Responsibilities .....	1-6
1.2.1 Approach to Preparation of the Remedial Action Plan .....	1-6
1.2.1.1 Overview .....	1-6
1.2.1.2 Regulatory Considerations .....	1-7
1.2.1.3 Federal Policies .....	1-8
1.2.1.4 Aboriginal Involvement .....	1-8
1.2.1.5 Principles Associated with Aboriginal Interests .....	1-9
1.2.1.6 Site Objectives .....	1-9
1.2.1.7 Remediation Planning Team .....	1-10
1.2.2 Community Involvement and Engagement .....	1-10
1.2.2.1 Guiding Principles to Community Involvement and Engagement .....	1-10
1.2.2.2 Outpost Island Mine Community Involvement and Engagement .....	1-11
1.2.2.3 Evaluation of Remedial Options .....	1-11
1.2.2.4 Future Community Involvement and Engagement .....	1-12
1.3 Overview of Available Information .....	1-12
1.4 Report Structure .....	1-14
2.0 LAND USE AND CLAIMS .....	2-1
2.1 Historical Aboriginal Land Uses .....	2-1
2.2 Current Land Uses .....	2-1
2.3 Land Tenure .....	2-2
2.4 Mineral Leases and Claims .....	2-2
2.5 Mining Heritage Values .....	2-3
3.0 DESCRIPTION OF THE MINE SITE FEATURES .....	3-1
3.1 Area 1 – Southwest and Central Portion of Outpost Island (APECs 4, 5, 6 and 7) .....	3-3
3.2 Area 2 – Northeast End of Outpost Island (APECs 1, 2 and 3) .....	3-7
3.3 Area 3 – East Island (APECs 9 and 10) .....	3-12



4.0	NATURAL ENVIRONMENT .....	4-1
4.1	Topography and Physical Features .....	4-1
4.2	Geology.....	4-1
4.2.1	Regional Geology .....	4-1
4.2.2	Local Bedrock Geology .....	4-1
4.3	Soils.....	4-1
4.4	Climate.....	4-2
4.4.1	Temperature .....	4-2
4.4.2	Precipitation .....	4-2
4.4.3	Climate Change.....	4-2
4.5	Permafrost.....	4-3
4.6	Air Quality .....	4-3
4.7	Ecology .....	4-4
4.7.1	Classification.....	4-4
4.7.2	Vegetation Observations.....	4-4
4.7.3	Wildlife Observations .....	4-4
4.7.4	Species at Risk in Canada .....	4-4
4.8	Hydrology .....	4-5
4.8.1	Regional Hydrology.....	4-5
4.8.2	Site Hydrology .....	4-6
4.9	Hydrogeology .....	4-6
5.0	ENVIRONMENTAL SITE ASSESSMENT FINDINGS .....	5-1
5.1	Mineralization and Metal Enrichment in the Environment .....	5-1
5.2	Mine Openings.....	5-3
5.3	Buildings.....	5-5
5.4	Refuse .....	5-5
5.4.1	Non-Hazardous Refuse .....	5-5
5.4.2	Hazardous Waste Materials .....	5-7
5.5	Tailings .....	5-7
5.6	Waste Rock .....	5-13
5.7	Soil Findings .....	5-18
5.8	Vegetation Findings.....	5-22
5.9	Surface Water Findings.....	5-22
5.10	Sediment Findings .....	5-25
5.11	Aquatic Biota Findings .....	5-27
5.11.1	Aquatic Vegetation .....	5-27
5.11.2	Sediment Toxicity and Benthic Community Analysis.....	5-27
5.12	Site Access Routes.....	5-28
5.13	Potential Borrow Sources .....	5-28
5.14	Potential Landfill Locations.....	5-29
5.15	Potential Soil Treatment Locations.....	5-29
6.0	ECOLOGICAL AND HUMAN HEALTH RISKS .....	6-1
6.1	Risk Assessment Approach and Methodology .....	6-1
6.1.1	Human Health Risk Assessment Methodology .....	6-2

6.1.2	Ecological Risk Assessment Methodology.....	6-4
6.2	Human Health Risk Assessment Findings.....	6-5
6.3	Ecological Risk Assessment Findings .....	6-6
6.4	Overall Conclusion .....	6-7
7.0	PROPOSED REMEDIAL ACTION PLAN.....	7-1
7.1	Process for Selection Of Remediation Activities.....	7-1
7.1.1	Process Approach and Considerations.....	7-1
7.1.2	Typical Remedial Objectives and Considerations.....	7-2
7.1.3	Listing of Remedial Components and Features at the Outpost Island Mine .....	7-3
7.1.4	Review of Industry Standard Remedial Options .....	7-4
7.2	Remedial Assumptions .....	7-5
7.3	Remedial Options.....	7-6
7.3.1	Mine Openings.....	7-8
7.3.1.1	Key Issues .....	7-8
7.3.1.2	Potential Remedial Options .....	7-8
7.3.1.3	Preferred Remedial Option .....	7-9
7.3.1.4	Monitoring and Contingencies.....	7-10
7.3.2	Buildings / Structures.....	7-10
7.3.2.1	Key Issues .....	7-10
7.3.2.2	Potential Remedial Options .....	7-10
7.3.2.3	Preferred Remedial Option .....	7-12
7.3.2.4	Monitoring and Contingencies.....	7-12
7.3.3	Non-Hazardous Refuse .....	7-13
7.3.3.1	Key Issues .....	7-13
7.3.3.2	Potential Remedial Options .....	7-13
7.3.3.3	Preferred Remedial Option .....	7-15
7.3.3.4	Monitoring and Contingencies.....	7-15
7.3.4	Hazardous Waste Materials .....	7-15
7.3.4.1	Key Issues .....	7-15
7.3.4.2	Potential Remedial Options .....	7-15
7.3.4.3	Preferred Remedial Option .....	7-16
7.3.4.4	Monitoring and Contingencies.....	7-17
7.3.5	Tailings/Waste Rock in Mill Area (APEC 2) .....	7-17
7.3.5.1	Key Issues .....	7-17
7.3.5.2	Potential Remedial Options .....	7-17
7.3.5.3	Preferred Remedial Option .....	7-21
7.3.5.4	Monitoring and Contingencies.....	7-23
7.3.6	Waste Rock .....	7-23
7.3.6.1	Key Issues .....	7-23
7.3.6.2	Potential Remedial Options .....	7-23
7.3.6.3	Preferred Remedial Option .....	7-25
7.3.6.4	Monitoring and Contingencies.....	7-25
7.3.7	Soil - Metals.....	7-25
7.3.7.1	Key Issues .....	7-25

7.3.7.2	Potential Remedial Options .....	7-26
7.3.7.3	Preferred Remedial Option .....	7-28
7.3.7.4	Monitoring and Contingencies.....	7-28
7.3.8	Soil – Petroleum Hydrocarbons .....	7-28
7.3.8.1	Key Issues .....	7-28
7.3.8.2	Potential Remedial Options .....	7-28
7.3.8.3	Preferred Remedial Option .....	7-30
7.3.8.4	Monitoring and Contingencies.....	7-31
7.3.9	Former Dock Area .....	7-31
7.3.9.1	Key Issues .....	7-31
7.3.9.2	Potential Remedial Options .....	7-31
7.3.9.3	Preferred Remedial Option .....	7-33
7.3.9.4	Monitoring and Contingencies.....	7-34
7.3.10	Surface Water and Sediments .....	7-34
7.3.10.1	Key Issues .....	7-34
7.3.10.2	Potential Remedial Options .....	7-34
7.3.10.3	Preferred Remedial Option .....	7-38
7.3.10.4	Monitoring and Contingencies.....	7-39
8.0	MONITORING AND LONG-TERM MEASURES .....	8-1
8.1	Health and Safety Monitoring.....	8-1
8.2	Remediation Monitoring.....	8-1
8.3	Performance Monitoring.....	8-4
8.4	Long-Term Monitoring (Environmental Monitoring) .....	8-4
8.5	Care and Maintenance.....	8-5
8.6	Contingency Planning.....	8-5
9.0	REMEDICATION SCHEDULE.....	9-1
10.0	REFERENCES .....	10-1
Appendix A	Remedial Action Plan Options Analysis Workout Transcript	
Appendix B	Remedial Action Plan Options Analysis Workout Minutes	
Appendix C	Remedial Action Plan Options Analysis Workout Tables	
Appendix D	Wasterock and Tailings Erosion Control Options	

## **LIST OF TABLES**

	<u>Page No.</u>
Table 1	List of Species at Risk with a Range Extending into the Project Area..... 4-5
Table 2	Summary of Outpost Island Mine Non-Hazardous Refuse ..... 5-6
Table 3	Summary of Outpost Island Mine Hazardous Refuse ..... 5-7
Table 4	Summary of Outpost Island Mine Tailings ..... 5-8
Table 5	Tailings – Acid Base Accounting Analyses ..... 5-10
Table 6	Tailings – Metals Analyses..... 5-11
Table 7	Tailings – Shake Flask Analyses ..... 5-12
Table 8	Summary of Outpost Island Mine Waste Rock ..... 5-13
Table 9	Waste Rock – Acid Base Accounting Analyses ..... 5-15
Table 10	Waste Rock – Metal Analyses ..... 5-16
Table 11	Waste Rock – Shake Flask Analyses ..... 5-17
Table 12	Soil Summary – Metals Analyses..... 5-20
Table 13	Soil Summary – Organic Compound Analyses ..... 5-21
Table 14	Surface Water Summary – Metal Analyses..... 5-24
Table 15	Sediment Summary – Metals Analyses ..... 5-26
Table 16	Review of Remedial Components and Options for Outpost Island Mine ..... 7-7
Table 17	Remedial Options – Mine Openings..... 7-9
Table 18	Remedial Options - Buildings ..... 7-12
Table 19	Remedial Options – Non-Hazardous Refuse ..... 7-14
Table 20	Remedial Options – Hazardous Refuse ..... 7-16
Table 21	Remedial Options – Tailings/Waste Rock in Mill Area ..... 7-21
Table 22	Remedial Options – Waste Rock ..... 7-24
Table 23	Remedial Options – Soil (Metals)..... 7-27
Table 24	Remedial Options – Soil (Petroleum Hydrocarbons) ..... 7-30
Table 25	Remedial Options – Former Dock ..... 7-33
Table 26	Remedial Options – Surface Water and Sediments ..... 7-38

## **LIST OF FIGURES**

	<u>Page No.</u>
Figure 1 Site Location Plan.....	1-2
Figure 2 Output Island Mine Historical Plan .....	1-5
Figure 3 Outpost Island Mine Site Plan .....	3-2
Figure 4 Area 1 Plan .....	3-4
Figure 5 Area 1: APEC 7 – Shaft #2.....	3-5
Figure 6 Area 1: APEC 7 – Trench and Waste Rock.....	3-5
Figure 7 Area 1: APEC 6 – Can Dump.....	3-6
Figure 8 Area 1: APEC 5 – Ore Raise .....	3-6
Figure 9 Area 1: APEC 5 – Trench.....	3-7
Figure 10 Area 1: APEC 4 – Cookhouse Foundation .....	3-7
Figure 11 Area 2 Plan .....	3-9
Figure 12 Area 2: APEC 1 – Concrete Piers.....	3-10
Figure 13 Area 2: APEC 2 – Mill Equipment.....	3-10
Figure 14 Area 2: APEC 2 – Main Raise.....	3-11
Figure 15 Area 2: APEC 2 – Waste Rock and Tailings .....	3-11
Figure 16 Area 2: APEC 3 – Boilers.....	3-12
Figure 17 Area 3 Plan .....	3-13
Figure 18 Area 3: APEC 9 – Blast Trench.....	3-14
Figure 19 Area 3: APEC 9 – Battery Dump .....	3-14
Figure 20 Area 3: APEC 9 – Outhouse .....	3-15
Figure 21 Human Health Risk Assessment – Conceptual Site Model.....	6-3
Figure 22 Ecological Risk Assessment – Conceptual Site Model .....	6-5
Figure 23 AANDC’s Approach to Remediation.....	7-1

## GLOSSARY OF TERMS

**Aboriginal land claim:** A claim to a specific area of land based on legal concepts of land title and the traditional use and occupancy of that land by aboriginal peoples who did not sign treaties, nor were displaced due to war or other means.

**Acid generating:** Material capable of or actually producing acidic drainage.

**Acid Producing Potential (APP):** The potential of a material to produce acid, generally stated as kg CaCO<sub>3</sub> equivalent per tonne of rock.

**Acid Rock Drainage (ARD):** Drainage of low pH water from mineral areas as a result of the oxidation of sulphur-bearing materials that may release metals into the environment and result in significant environmental impacts.

**Adit:** A nearly horizontal passage from the surface by which a mine is entered and dewatered. A blind horizontal opening into a mountain with only one entrance.

**Aerial photography:** Photographs taken from an aircraft either obliquely or vertically.

**Aggregate:** Sand, gravel, or crushed rock.

**Alkalinity:** The aggregate measure of the concentration of hydroxyl, carbonate and bicarbonate ions, and dissolved CO<sub>2</sub>. Therefore, it is a general indicator of the acid-buffering capacity of the water body.

**Ambient:** The natural surrounding (background) conditions in a given area.

**Analyte:** A compound or element being analyzed.

**Analytic detection limit:** The limit of measurement of a given parameter, below which variations in concentration are indistinguishable from one another.

**Asbestos:** A naturally occurring soft fibrous mineral commonly used in fireproofing materials and considered to be highly carcinogenic.

**Assessment endpoint:** A quantitative or quantifiable expression of the environmental value considered to be at risk in a risk assessment.

**Baseline:** See “Environmental baseline”.

**Bedrock:** The solid rock that underlies gravel, soil or other surficial material.

**Benthic:** Refers to the bottom of a lake or river and/or the organisms that inhabit it.

**Benthos:** The whole assemblage of plants or animals living on the lake or river bottom; distinguished from *plankton*.

**Best Management Practice (BMP):** Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from non-point sources.

**Bioaccumulation:** The net accumulation of a chemical by an organism as a result of uptake from all routes of exposure.

**Bioavailability:** Degree of ability to be absorbed and ready to interact in organism metabolism.

**Biological diversity (biodiversity):** The variety of different species, the genetic variability of each species, and the variety of different ecosystems that they form.

**Biomagnification:** The tendency of some chemicals to accumulate to higher concentrations at higher levels in the food web through dietary accumulation.

**Biota:** The animal and plant life of a region.

**Boreal Forest:** The predominantly coniferous forest of northern Canada.

**Buffering capacity:** The degree to which a given volume of water or soil is able to neutralize acids.

**Carbonate:** Any mineral containing carbonate ions ( $\text{CO}_3^{2-}$ ).

**Carcinogen:** An agent that has the potential to cause cancer.

**Carnivore:** An animal that eats the flesh of other animals.

**Clay:** Soil particles that are smaller than silt (less than 0.002 mm in diameter).

**Conductivity:** A measurement of the electrical conductivity of a water body or sample in order to determine the amount of dissolved material present.

**Conservative:** As used in the term *conservative estimates*. A cautious or moderate estimate to avoid underestimation of the level, effect or hazard.

**Contaminant migration:** The movement of contaminants from one location to another.

**Contamination:** Elements both radioactive and non-radioactive that are present at levels above those normally found (i.e., above background).

**Contingency plan:** A prearranged plan to be implemented in the event of some unforeseen happening of serious concern.

**Crown or surface pillar:** A body of rock of variable geometry, which may or may not contain minerals, located above the underground operations, it supports the surface above stopes.

**Decommissioning:** The act of removing a regulated facility from operation and operational regulation. This usually entails a certain amount of cleanup (decontamination).

**Decontamination:** The process of removing contaminants from equipment, personnel, buildings or water.

**Delineate:** To determine the outer limits and size of something (i.e., an ore body).

**Dip:** A vertical angle measured downward from the horizontal plane to the level of an inclined plane such as a tilted sedimentary rock unit (see strike).

**Discharge:** The volume of water passing a given point per unit time, usually expressed as m<sup>3</sup>/s.

**Dose:** A general term used to describe the amount of radiation or chemical absorbed by a person or in some cases a particular organ.

**Drainage basin:** The area of land and water bodies therein, draining to a given point, usually a lake or river.

**Ecological Risk Assessment:** The application of a formal framework, analytical process, or model to estimate the effects of human actions(s) on a natural resource and to interpret the significance of those effects in light of the uncertainties identified in each component of the assessment process. Such analysis includes initial hazard identification, exposure and dose response assessments, and risk characterization.

**Ecosystem:** Any natural system in which there is an interdependence upon and interaction between living organisms and their physical environment. This interdependence is characterized by the transfer of energy between the organisms themselves and their physical environment in a complex series of cycles.

**Environment:** The sum of all external conditions, influences and forces affecting the development and life of organisms.

**Environmental baseline:** The data collection characterizing the “natural” environment in its pre-development or pre-impact state. This data is used as a base for determining potential and actual impacts in the defined impact area.

**Environmental Assessment:** An environmental analysis to determine whether a site/facility would significantly affect the environment and thus require a more detailed environmental impact statement.

**Environmental Impact:** A change in environmental conditions resulting from an action or development, which may be negative, positive, or neutral.

**Environmental Site Assessment (ESA):** A systematic process to determine whether a site/facility has or has the potential to significantly impact the environment. The degree of impact is often based on comparisons to established environmental quality criteria. ESAs are performed in a phased approach, subject to the findings of prior assessments (Phase I: preliminary review; Phase II: intrusive testing to identify presence/absence of concerns; Phase III: delineation of known concerns).

**Erosion:** The wearing down (weathering) and removal of soil, rock fragments and bedrock through the action of rivers, glaciers, sea and wind.

**Exposure:** The amount of radiation or pollutant present in a given environment that represents a potential health threat to living organisms.



**Exposure Assessment:** Identifying the pathways by which toxicants may reach individuals, estimating how much of a chemical an individual is likely to be exposed to, and estimating the number likely to be exposed.

**Exposure Concentration:** The concentration of a chemical or other pollutant representing a health threat in a given environment.

**Exposure Pathway:** The path from sources of pollutants via, soil, water, or food to man and other species or settings.

**Fault:** A fracture in bedrock along which movement has taken place.

**Foot wall:** The underlying surface of an inclined fault plane.

**Fracture (geological):** A crack, joint, fault or other break in rocks.

**Rock fracture:** The general term given to any non-sedimentary mechanical discontinuity thought to represent a surface or zone of mechanical failure.

**Geochemistry:** Refers to the chemical analysis of surface and subsurface water, rock alluvium, soil and plants.

**Grading:** The process of making a surface level or evenly sloped.

**Groundwater:** Water beneath the earth's surface, accumulating as a result of infiltration and seepage, and serving as a source of springs and wells.

**Habitat:** The natural home of a plant or animal.

**Hanging wall:** The overlying surface of an inclined fault plane.

**Hazard:** Potential for radiation, a chemical or other pollutant to cause human illness or injury. Hazard identification of a given substance is an informed judgment based on verifiable toxicity data from animal models or human studies.

**Hazard Assessment:** Evaluating the effects of a contaminant or determining a margin of safety for an organism by comparing the concentration that causes toxic effects with an estimate of exposure to the organism.

**Heavy metals:** Any metal with a high atomic weight (usually greater than 100). They are poisonous and tend to persist in living tissue once ingested, e.g., mercury, lead, cadmium and chromium.

**Human Health Risk Assessment:** The process of quantifying risks and determining the acceptability of those risks to humans.

**Hydraulic head:** A combined measure of the elevation and the water pressure at a point in an aquifer that represents the total energy of the water; since ground water moves in the direction of lower hydraulic head (i.e., toward lower energy), and hydraulic head is a measure of water pressure, groundwater can and often does flow 'uphill'.

**Hydrogeology:** The study of subsurface waters and related geologic aspects of surface water.

**Hydrology:** The study of the characteristics, occurrence, movement and utilization of water on or below the earth's surface and within its atmosphere.

**Impervious liner:** A layer of clay or manmade material such as High-Density Polyethylene (HDPE), used to seal the bottom of containment structures in order to prevent percolation and migration of potential contaminants.

**Incremental:** Small increase.

**Leachate:** The water that percolates through a porous medium such as soil and transports any salts or other dissolvable materials that may be found in the soil.

**Leaching:** Washing out of soluble substances by water passing down through rock or soil. In a milling sense, indicates the dissolving of ore minerals from the ground ore.

**Limnological:** Referring to the scientific study of lakes and their physical, chemical and biological components.

**Loadings:** Total mass of contaminants to a water body or to the land surface over a specified time.

**Macrophytes:** Rooted aquatic vascular plants.

**Mean:** The average value of the data.

**Measurement endpoint:** A quantitative summary of the results of a toxicity test, a biological monitoring study, or other activity intended to reveal the effects of a substance.

**Mineral:** A naturally occurring inorganic, crystalline solid that has a definite chemical composition and characteristic physical properties.

**Mineralization:** The process by which a valuable mineral or minerals are introduced into a rock, resulting in a potential or actual ore deposit.

**Mitigation:** An action or design intended to reduce the severity or extent of an environmental impact.

**Modeling:** Using mathematical principles, information is arranged in a computer program to model conditions in the environment and to predict the outcome of certain operations.

**Monitoring:** Sampling, measurement, and/or inspection of a setting or structure.

**Neutralizing potential (NP):** The potential of material to neutralize an acid or a base.

**Ore:** Naturally occurring rock material from which a mineral or minerals of economic value can be profitably mined.

**Ore body:** A continuous well-defined mass of material containing enough ore to make extraction economically feasible.

**Outcrop:** The part of a rock formation that appears at the surface of the earth, uncovered by water or overburden.

**Overburden:** Unconsolidated soil and rock material overlying bedrock.

**Oxidation:** The process of combining with oxygen, especially at the atomic level.

**Particulate:** Consisting of particles.

**Pathway:** The physical course a chemical or pollutant takes from its source to the exposed organism.

**Pathways analysis:** A method of estimating the transfer of contaminants (e.g., metals in water) and subsequently accumulating up the food chain to fish, vegetation, mammals and humans and the resulting dose to humans.

**PCB's:** A group of manufactured chemicals including 209 different, but closely related, compounds made up of carbon, hydrogen, and chlorine.

**Permafrost:** Thermal conditions remaining below 0 °C continuously for more than one year.

**Permeability:** Describes the ability of subsurface features to transport water.

**pH:** A number expressing the degree of alkalinity or acidity of a substance according to the hydrogen ion concentration. A substance is said to be “neutral” if its pH is 7, acidic if less than 7 and alkaline if greater than 7.

**Phase I, II and III:** See Environmental Site Assessment definition.

**Phytoplankton:** Any microscopic or near microscopic, free-floating autotrophic aquatic plant.

**Population:** A group within a single species, the individuals of which can and do freely interbreed.

**Porosity:** The relative volume of open spaces within a rock or soil. (usually expressed as a percentage of the total volume of the material occupied by the open spaces, or interstices)

**Porewater:** Water contaminated and trapped within void spaces in soils or rocks.

**Precipitation:** The deposition of atmospheric moisture as rain, sleet, snow, hail, frost or dew.

**Pyrite:** A common yellow mineral with a brilliant metallic lustre often crystallizing into cubes. It is an important sulphur ore and is often associated with gold and copper.

**Receptor:** A human or ecological entity exposed to a contaminant released to the environment.

**Reclamation:** Restoration of a site to a beneficial use that may be for purposes other than the original use.

**Remediation:** The improvement of a contaminated site to prevent, minimize or mitigate damage to human health or the environment. Remediation involves the development and application of a planned approach that removes, destroys, contains or otherwise reduces the availability of contaminants to receptors of concern.

**Remediation Issue:** Issues of concern for a specific aspect of the site.

**Risk:** A measure of the probability that damage to life, health, property, and/or the environment will occur as a result of a given hazard.

**Risk Assessment:** Qualitative and quantitative evaluation of the risk posed to human health and/or the environment by the actual or potential presence and/or use of specific pollutants.

**Risk Characterization:** The last phase of the risk assessment process that estimates the potential for adverse health or ecological effects to occur from exposure to a stressor and evaluates the uncertainty involved.

**Screening:** A preliminary stage of the assessment process for quick evaluation of relatively simple and routine activities, or for determining the level of effort required for evaluating more complex projects.

**Sediment:** Loose, solid particles resulting from the breakdown of rocks, chemical precipitation or from organisms.

**Seismic:** Pertaining to, characteristic of, or produced by earthquakes.

**Stopes:** Underground mine working from which ore has been extracted for processing and metal recovery.

**Strike:** Refers to the direction taken by a structural surface as it intersects the horizontal plane e.g., bedding or fault plane. The strike is at right angles to the direction of dip.

**Structure (geological):** Features produced by deformation or displacement of the rocks, such as a fold or fault.

**Sulphides:** Any mineral compound characterized by the chemical linkage of sulphur with a metal e.g., galena (PbS), pyrite (FeS<sub>2</sub>).

**Taiga:** The northern forest of coniferous trees that lies just south of the arctic tundra.

**Tailings:** Finely ground rock particle material rejected from a mill after most of the recoverable ore minerals have been extracted.

**Tailings Containment Area or TCA:** An area designated for the purpose of receiving and containing milling residues.

**Tank farm:** An area designed to contain various size tanks holding various types of liquids or gases, most commonly propane or petro-chemicals.

**Till:** An unsorted heterogeneous mixture of rock debris carried and deposited directly by a glacier, with very little subsequent reworking by melt water.

**Traditional knowledge:** Refers to the ancient understanding of philosophy, events and things passed on orally through generations by aboriginal people.

**Traditional land use:** Refers to land use by aboriginal people that reflect the historic activities of their people prior to European settlement (i.e., hunting, fishing, gathering).

**Traditional lifestyle:** Refers to the lifestyle of aboriginal people prior to European settlement.

**Uncertainty:** A quantitative expression of error.

**Uptake:** The process/act by which a contaminant (e.g., arsenic) enters a biological organism (e.g., inhalation, ingestion by humans).

**Vent:** An (vertical) opening used for input of fresh air or exhausting used air from underground.

**Waste rock:** That rock material that must be removed from a mine to access ore-grade minerals.

**Watershed:** A drainage area or basin into which all surface water from a particular area collects and is transported.

## **UNITS AND ABBREVIATIONS**

g/m <sup>3</sup>	grams per cubic metre
kg CaCO <sub>3</sub> /t	kilogram calcium carbonate per tonne
m	metre
m <sup>2</sup>	square metre
m <sup>3</sup>	cubic metre
mg/kg	milligram per kilogram
mg/L	milligram per litre
t	tonne
ACM	Asbestos Containing Material
AEC	Area of Environmental Concern
APEC	Area of Potential Environmental Concern
AEC	Area of Environmental Concern
COPC	Constituents (or Contaminants) of Potential Concern
COC	Constituents (or Contaminants) of Concern
DQRA	Detailed Quantitative Risk Assessment
EQG	Environmental Quality Guideline
ESA	Environmental Site Assessment
HHERA	Human Health and Ecological Risk Assessment
HQ	Hazard Quotient
masl	metres above sea level
mbsl	metres below sea level
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl Compound
PHC	Petroleum Hydrocarbon
ppm	parts per million
SI	Screening Index
TCLP	Toxicity Characteristic Leaching Procedure
TF	Transfer Factor
TRV	Toxicity Reference Value

## **CHEMICAL SYMBOLS**

Aluminum	Al	Manganese	Mn
Antimony	Sb	Mercury	Hg
Arsenic	As	Molybdenum	Mo
Barium	Ba	Nickel	Ni
Beryllium	Be	Nitrogen	N
Bismuth	Bi	Oxygen	O
Boron	B	Phosphorus	P
Bromine	Br	Potassium	K
Cadmium	Cd	Radium	Ra
Calcium	Ca	Selenium	Se
Carbon	C	Silicon	Si
Chromium	Cr	Silver	Ag
Cobalt	Co	Sodium	Na
Copper	Cu	Sulphur	S
Gold	Au	Thallium	Tl
Hydrogen	H	Tin	Sn
Iodine	I	Titanium	Ti
Iridium	Ir	Tungsten	W
Iron	Fe	Uranium	U
Lead	Pb	Vanadium	V
Lithium	Li	Zinc	Zn
Magnesium	Mg	Zirconium	Zr

## **1.0 INTRODUCTION**

### **1.1 OVERVIEW OF THE PROJECT**

Aboriginal Affairs and Northern Development Canada (AANDC<sup>1</sup>) has the responsibility to manage a number of contaminated sites that are no longer maintained by the original occupant. AANDC's portfolio of contaminated sites in the north originates from private sector mining, oil and gas activities, government, military activity and other users of the land dating back over half a century, many years before the environmental impacts of such activities were adequately understood. The abandoned Outpost Island Mine is one of these legacy sites.

SENES Consultants (SENES) has been retained by Public Works and Government Services Canada (PWGSC) on behalf of AANDC's Contaminants and Remediation Directorate (CARD) to complete a Remedial Action Plan (RAP) for the abandoned Outpost Island Mine in the Northwest Territories. The RAP was developed to address human health, ecological, and environmental concerns associated with the former nickel/cobalt mine.

The RAP considers the findings of Phase I, II, III and IIIa Environmental Site Assessments (ESAs), a Human Health and Ecological Risk Assessment (HHERA), best practices in mine closure and current land uses in the project area to select technically suitable approaches for the management of site risks.

The DRAFT RAP formed the basis of a community involvement and engagement process that was implemented to ensure that Aboriginal stakeholders and Northern residents are active participants in the selection of the preferred closure options for the final remediation of the site. With community opinions now incorporated, this Final RAP will be used as a supporting document to assist with regulatory and funding decisions, and will provide the basis for development of tender documents and technical designs for the implementation of remediation.

#### **1.1.1 Location and Access**

The Outpost Island Mine, also known as the Philmore Mine, is located approximately 88 km southeast of Yellowknife, NT and occupies two islands, Outpost Island (West Island) and East Island (Figure 1).

---

<sup>1</sup> AANDC was previously referred to as the Department of Indian Affairs and Northern Development (DIAND) and Indian and Northern Affairs Canada (INAC). The current acronym AANDC is used throughout this document, except when citing specific documents that were prepared by predecessor departments.





The islands are within the most westerly archipelago of islands in the East Arm of Great Slave Lake. Coordinates for the site are approximately 61° 44' 10" N, 113° 27' 30" W, on NTS mapsheet 85H11 (Franz/EcoMetrix 2010). Outpost Island Mine is a very remote site, with access limited to boat, helicopter, float/ski equipped plane and snowmobile. The nearest communities to the mine are as follows:

- Yellowknife and N'dilo 93 km to the northwest;
- Dettah 87 km to the northwest;
- Lutsel K'e 160 km to the northeast;
- Fort Resolution 85 km to the southwest; and
- Hay River 165 km to the southwest.

### **1.1.2 History of the Mine**

The Outpost Island claims were first staked in 1935 by members of the Athabasca Syndicate, later to become the Slave Lake Mines Limited, for mining interests in copper and gold. N.A. Timmons Corporation Limited optioned the claims and began to erect mine buildings and sink the main shaft with a terminal depth of 137 m. In 1938, the company failed to exercise its option on the claim (the erratic nature of the deposit proved to be too financially uncertain), and the property reverted back to Slave Lake Mines Limited (Silke 2009). Assessments in 1938 revealed the economic importance of tungsten in the Outpost Island Mine deposit, due in part to rising tungsten prices in support of war efforts. Mine operations resumed at the site in 1940 and concentrate was first produced in 1941. Financial difficulties resulted in the closure of the mine in the fall of 1942. The mine was reopened again in 1951 by the Tungsten Corporation of Canada Limited. Approximately 3,256 tons of ore were milled from 1951 to 1952 (EBA 2009). The work stopped in 1952, and the mine structures on Outpost and Eastern Islands were burned to the ground in 1955.

The original claims on the site had lapsed by 1990. A new 'Fox' claim was staked in 1999 by Mr. Dave Nickerson to cover the old mine site and tailings pond (Columbia 2006). Mr. Hendrick Falck also recorded the 'Outpost' claim in 1999 to cover the entire Outpost Archipelago; however, this claim lapsed in 2001. There are no current mineral claims for Outpost Island (effective October 2012).

Approximately 23,580 tons of ore were milled on site from 1941 to 1942 (Franz/EcoMetrix 2010).<sup>2</sup> Gold, copper, and tungsten were mined at the site with the gold extracted using an amalgam mercury extraction process. There is a potential that some of the mercury used in the process was lost to the environment during processing. However, in an effort to control mercury costs, it is likely that losses were controlled to the greatest degree possible (Varkonyi 2010).

---

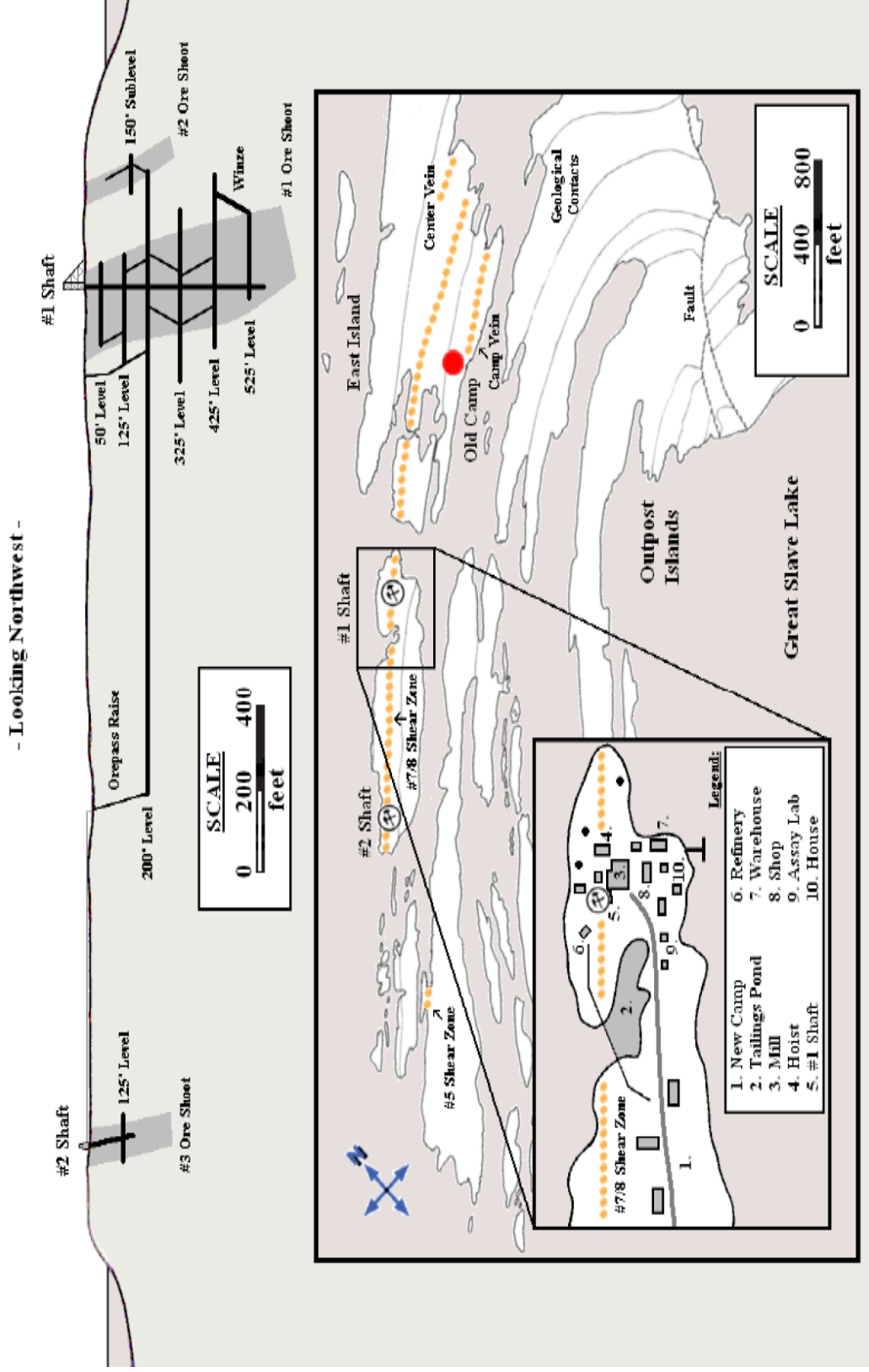
<sup>2</sup> Silke (2009) reports production of 10,185 oz of gold, 35,436 lbs of tungsten tri-oxide and 119,763 lbs of copper.

During mining operations at Outpost Island the tailings were deposited under water in bays of the island (North, South and East). There is a natural saddle in the bedrock across the northern limit of North Bay that acted as a barrier to tailings migration and effectively contained the tailings within the North Bay (Franz/EcoMetrix 2010). This saddle is believed to have been raised during the operational period but was subsequently breached, thereby allowing the inflow of lake water and the re-establishment of a bay.

Historical structures on Outpost Island included a large mill, a head frame, a combined hoist room and powerhouse, a water tower, a boiler house, a cookhouse-mess hall, several large bunk houses, and various other workshops, offices, and technical buildings (Columbia 2006). In August 1992, the concrete foundations of the head frame, mill, and powerhouse building were located and two empty above-ground fuel storage tanks (ASTs – one large vertical, cylindrical AST and a smaller AST of unknown size) were reportedly located north of the mill building. It is suspected that the fuel oil was used for various heating units, boilers, and compressors while the mine was active. There are exploration pits and trenches on East Island as well as the remnants of burned buildings believed to be a camp (Franz/EcoMetrix 2010). Figure 2 provides a map of the historical Outpost Island Mine infrastructure that was present during the operational period of the mine.

Decommissioning of the Outpost Island Mine was conducted under a program funded by the Arctic Environmental Strategy on behalf of AANDC in 1994. One ore raise and Shaft #2 were capped with a concrete seal, and Shaft #1 covered with waste rock (the exact location has yet to be confirmed). As noted previously, the combustible structures associated with the mining operation are assumed to have burned in a 1955 fire or were removed from site.

Figure 2    Outpost Island Mine Historical Plan



Source: Silke 2009

### **1.1.3 Community Concern**

Throughout the Northwest Territories, Aboriginal people have expressed significant concerns regarding abandoned mine sites on their traditional lands. Although the Outpost Island Mine is very small relative to other historic mining developments in the region (e.g., Giant, Con and Pine Point mines), there remains a general concern associated with historic mining and exploration activities. The potential contamination of water and soils, as well as impacts to fish, wildlife and vegetation are commonly cited as the top priorities for attention. Physical hazards such as unsecured openings and debris have also been identified as concerns with respect to human and wildlife health.

## **1.2 DESIGNATED RESPONSIBILITIES**

AANDC is the project proponent for the remediation of the Outpost Island Mine and, as such, it is the responsibility of AANDC to develop the RAP, obtain appropriate approvals, secure resources, and ensure the plan is implemented in a manner consistent with the remediation of other AANDC contaminated sites in the Northwest Territories. Furthermore, AANDC will retain custodial responsibility for the site post-remediation, which will include conducting any long-term monitoring if necessary to confirm the ongoing performance of remedial measures that are intended to address potential risks to human health and the environment.

PWGSC provides support to AANDC throughout the planning and implementation phases of the remediation project. Environment Canada (EC), the Department of Fisheries and Oceans Canada (DFO) and Health Canada (HC) also assist AANDC through the provision of environmental science expertise required for the selection of appropriate remedial measures.

### **1.2.1 Approach to Preparation of the Remedial Action Plan**

#### **1.2.1.1 Overview**

Section 39 of the *Northwest Territories Waters Act* (1992) identifies AANDC's authority to manage environmental contamination and risk to human health and safety. Abandoned contaminated sites are properties where historic proponents cannot be identified or held responsible to address existing environmental contamination. AANDC works within a broader management system for all northern contaminated sites. This being the case, AANDC follows several guiding documents in developing RAPs for contaminated sites such as the Outpost Island Mine. The following federal policies or guidance documents provide a broad context as to how AANDC approaches remediation of contaminated sites in Northern Canada:

- A Federal Approach to Contaminated Sites (CSMWG 2000);

- Northern Affairs Program Contaminated Sites Management Policy (INAC 2002a); and,
- Treasury Board Federal Contaminated Sites Management Policy (Treasury Board 2002).

Although the AANDC Mine Site Reclamation Policy for the Northwest Territories (INAC 2002b) and the Mine Site Reclamation Guidelines for the Northwest Territories (INAC 2006a) were not intended for abandoned properties such as the Outpost Island Mine, some parts of the policy are generally applicable and have also been considered. The overall responsibility of AANDC is to minimize health and safety and environmental risks associated with the site by implementing a RAP that meets the needs and concerns of AANDC, Aboriginal people and all Northerners.

#### ***1.2.1.2 Regulatory Considerations***

There are currently no active land use permits or water licenses associated with the former Outpost Island Mine. The remedial measures implemented, and the approach proposed by the selected contractor, will determine the type of permits required by the Mackenzie Valley Land and Water Board. A Land Use Permit will be required in accordance with Sections 4 and 5 of the *Mackenzie Valley Land Use Regulations* (1998). Should the final RAP detailed design require the alteration of a water course, diversion of a water course, erosion control, or the deposit of waste, either a “Class A” or “Class B Water License” will be required as specified by the *Northwest Territories Water Regulation* (1993).

Due consideration of the Federal *Fisheries Act* (1985) will be required in the assessment of remedial options within or near to a water body. Consultation with the Department of Fisheries and Oceans Canada (DFO) has been considered during preparation of this RAP to identify potential impacts to the aquatic environment and to determine if remedial measures may result in violation of the Federal *Fisheries Act* (1985). Examples of regulations within the *Fisheries Act* which may affect remedial planning and implementation include the prohibition to block the passage of fish, destruction of habitat, or release of “deleterious substances”. These activities are regulated and, if they are implemented as part of remediation, are likely to require authorization.

Should the selected remedial approach require the use of borrow material from the site, a Quarry Permit (issued by AANDC) will be required for associated earth works.

Certain remedial options may require burning of wooden debris and structures. Burning of such materials will require a Permit to Burn which is issued by the Northwest Territories Department of Environment and Natural Resources.

Once the remediation of the site is complete, long-term monitoring suitable for the site conditions and remedial options will occur as identified through the Federal Approach to Contaminated Sites (CSMWG 2000).

#### **1.2.1.3 Federal Policies**

The following principles were adopted for the Outpost Island Mine RAP from federal policy and guidance documents referenced above. Specifically:

- Meet the overall AANDC objective to contribute to a safer, healthier, sustainable environment for Aboriginal peoples and northern residents by striving to preserve and enhance the ecological integrity of the environment (INAC 2002a);
- Take immediate and reasonable action to protect the environment and the health and safety of persons (Treasury Board 2002);
- Meet federal and AANDC policy requirements and legal obligations regarding the management of contaminated sites (INAC 2002a);
- Ensure sound environmental stewardship of federal real property by avoiding contamination and by managing contaminated sites in a consistent and systematic manner that recognizes the principle of risk management and results in the best value for the Canadian taxpayer (Treasury Board 2002);
- Provide a scientifically valid, risk management based framework for setting priorities, planning, implementing and reporting on the management of contaminated sites (INAC 2002a);
- Develop a RAP to be sufficiently flexible to allow adjustments as the remediation progresses, including the flexibility to adapt to new and improved technologies and methodologies (INAC 2002b); and
- Adopt solutions tailored to the northern environment and peoples wherever possible (INAC 2006b).

#### **1.2.1.4 Aboriginal Involvement**

The following principles regarding involvement with Aboriginal persons were adopted from the policy and guidance documents referenced above for the Outpost Island Mine RAP:

- Promote Aboriginal and northern participation and partnership (INAC 2002a; INAC 2006b);
- Promote respect and sharing of knowledge, experience and resources in partnerships/teamwork with clients and partners;
- Promote the social and economic benefits that may accrue to Aboriginal people and northern communities (INAC 2002a);

- Plan, where appropriate, the scale and pace of remediation/risk management in keeping with northern and Aboriginal capacity to be involved (INAC 2002a);
- Incorporate economic opportunities, to the extent possible, for northern and Aboriginal communities in the management and remediation of the site (INAC 2002a); and
- In keeping with the above policies, community representatives were requested to participate in consultations and engagement regarding this RAP. Records of community participation, the options reviewed, and preferred options selected by the community are presented in the appendices of this final version of the RAP.

#### ***1.2.1.5 Principles Associated with Aboriginal Interests***

The Outpost Island Mine lies within the Interim Measures Agreement (IMA) area of the Akaitcho Dene First Nations (AKDFN) of the Northwest Territories. The IMA details the requirements for proposed projects to undergo screening by the AKDFN to identify environmental concerns associated with work activities. As such, the RAP is subject to review by the AKDFN.

The Akaitcho Dene IMA serves to guide stakeholders during the negotiations of a permanent Akaitcho Land Claim; however, the IMA does not provide guidance in regard to long-term land use and community objectives. In the absence of a specific Akaitcho guidance document, the following principles have been adopted from similar remedial projects within the Tlicho settled land claim (e.g., the North Inca Remediation Project):

- To protect and conserve the wildlife and environment of the settlement area for present and future generations;
- To directly involve communities and designated Aboriginal organizations in land use and planning; and,
- To encourage self-sufficiency of Aboriginal peoples and to enhance their ability to participate fully in all aspects of the economy, specifically by protecting and promoting the existing and future social, cultural and economic well being of Aboriginal people.

The site also lies within the asserted territories of the Northwest Territories Métis Nation (NWTMN).

#### ***1.2.1.6 Site Objectives***

The site-specific objectives of the Outpost Island Mine RAP were developed in accordance with regulatory considerations, Federal Policies, Aboriginal input on RAPs for similar abandoned properties and the natural environment at the site. The following generic objectives have been used for the development of the RAP:



- Minimize human health and safety risks associated with the site in its current condition;
- Minimize human health and safety risks associated with remedial activities;
- Protect fish, wildlife, and vegetation;
- Protect the water quality of Great Slave Lake;
- Minimize environmental impacts during remediation;
- Minimize long-term care and maintenance;
- Return the site to its original condition where possible; and
- Be cost effective.

#### **1.2.1.7 Remediation Planning Team**

The technical team responsible for the development of the RAP includes representatives from the following groups:

- Aboriginal Affairs and Northern Development Canada (AANDC), Contaminants and Remediation Directorate (CARD);
- Public Works and Government Services Canada (PWGSC); and
- SENES Consultants (SENEC).

It is also envisioned that Akaitcho representatives will be identified as members of the working group responsible for the finalization of the remedial strategy for the site.

### **1.2.2 Community Involvement and Engagement**

In keeping with the design and implementation of other remedial projects at abandoned mining properties by AANDC, this final iteration of the RAP presents remedial options presented to the communities and preferred remedial options identified through the collaborative process. Aboriginal and non-Aboriginal community members were encouraged to provide feedback and to work collaboratively with AANDC to identify and mitigate concerns and risks.

#### **1.2.2.1 Guiding Principles to Community Involvement and Engagement**

As discussed above, the Northern Affairs Program Contaminated Sites Management Policy specifies that AANDC “... will promote First Nation, Inuit, and northerner participation and partnership in the identification, assessment, decision-making and remediation/risk management process relating to contaminated sites” (INAC 2002a).

In addition to the federal policies and guidelines, a major objective of modern land claims in the NWT is to provide Aboriginal people with meaningful opportunities to participate in decision making concerning the use, management and conservation of land, water and resources. This

objective is addressed in the NWT's environmental management framework, as described in the *Mackenzie Valley Resource Management Act* (MVRA 1998). The overall engagement approach under the MVRMA includes:

- Providing the party to be consulted with:
  - notice of the matter in sufficient form and detail to allow the party to prepare its views on the matter;
  - a reasonable period for the party to prepare those views; and
  - an opportunity to present those views to the party having the power or duty to consult.
- The party with the duty to consult must:
  - consider, fully and impartially, any views so presented.

#### ***1.2.2.2 Outpost Island Mine Community Involvement and Engagement***

A community involvement and engagement process for the Outpost Island Mine RAP was undertaken to ensure the priorities and insights of Aboriginal parties were considered during remediation decision-making. During this process, the site assessment findings and proposed remedial options were reviewed. Presentations and records of the engagement events are included in Appendix A through C.

#### ***1.2.2.3 Evaluation of Remedial Options***

The overall approach to evaluating remedial options for the site was as follows:

1. The site was divided into various aspects and issues as outlined in the Mine Site Reclamation Guidelines for the Northwest Territories (INAC 2006b).
2. For each aspect and issue, remedial options were developed by SENES with input from AANDC and PWGSC.
3. A review of the draft RAP was conducted by Federal Contaminated Sites Action Plan advisors with edits incorporated where appropriate.
4. A Traditional Knowledge study was conducted by AANDC to ascertain the uses of the land by local First Nations and relevant observations of the natural environment, flora and fauna.
5. A Remedial Options Analysis Workout was lead by AANDC on June 13-14, 2013 in Fort Resolution, NT. Representatives of the Lutsel K'e Dene First Nation, Deninu Kue First Nation and Fort Resolution Metis Councils were present and worked with representatives from AANDC, PWGSC and SENES to determine the preferred remedial options. The Remedial Options Analysis Workout was conducted using the following framework:
  - a) The project objectives and current status were presented;

- b) The workout framework was discussed with participants to ensure the process is clear and transparent;
- c) A site overview was presented identifying the features of the sites and primary environmental concerns;
- d) The potential remedial options were then presented for each issue followed by a discussion of advantages/disadvantages of the option and response to any questions presented;
- e) Each participant was given the opportunity to identify their recommendation for a preferred remedial option;
- f) Incorporating the recommendation of each individual participant, the remedial options were classified as either:
  - i. P = preferred;
  - ii. A = acceptable; or,
  - iii. NA = not acceptable.

#### ***1.2.2.4 Future Community Involvement and Engagement***

Local communities will be kept informed of key developments throughout the planning and implementation of remediation at the Outpost Island Mine. This includes seeking additional input if there are any significant deviations from the preferred remedial options. To assist in communicating progress being made in the resolution of site concerns, there are anticipated opportunities for site tours throughout the remediation and post remediation phases of the project.

In addition to participating in the planning process, Aboriginal involvement during the remediation phase of the project will be encouraged through the use of “Aboriginal Opportunities Considerations” (AOC). All contractors bidding on the remediation project will be required to submit an AOC describing their commitment to Aboriginal employment, subcontracting and training. The commitments of the successful bidder will be enforced through contractual obligations.

### **1.3 OVERVIEW OF AVAILABLE INFORMATION**

The development of a RAP for the Outpost Island Mine requires an integrated approach to incorporate site specific characteristics, assessment findings, hazards/concerns, stakeholder policies, federal regulations, and the results of consultations with Aboriginal peoples and northern communities. The Outpost Island Mine site has been the subject of on-going environmental assessment works since 2005, with Phase I, II, III, and IIIa ESAs completed. The

findings of the ESAs were compiled and served as the primary data source of current conditions at the former mine site. An overview of ESA findings is provided in Section 5.0.

A Phase I Environmental Site Assessment (Columbia 2006) prepared by Columbia Environmental Consulting Ltd in 2006 summarized the information found in reports prepared by Thurber Environmental Consultants Ltd in 1993, the Abandoned Gold Mines report by D. Sutherland and S. Thompson in April 1986, a historic mine development report by Ryan Silke in 1999 and information available through the Northwest Territories Geoscience Office. The Phase I ESA identified ten Areas of Potential Environmental Concern (APEC) based on the presence of Constituents of Potential Concern (COPC).

A Phase II Environmental Site Assessment was completed by EBA Engineering Consultants Ltd. (EBA 2009). The assessment included a historical review, site visit, sample collection and analysis, and National Classification System for Contaminated Sites (NCSCS) scoring. Components of the Phase II sampling program were as follows: soil samples analyzed for metals, BTEX and PHCs; sediment and surface water sample analysis for metals; groundwater sample analysis for BTEX, PHCs and metals; as well as waste rock sampling and tailings analysis for acid base accounting.

A Phase III Environmental Site Assessment was carried out in 2009 by Franz Environmental Inc. and EcoMetrix Incorporated (Franz/EcoMetrix 2010). The objective of the Phase III ESA was to further delineate the current environmental and physical conditions at the site. This included the identification and quantification of environmental impacts to soil, sediment, surface water, benthic invertebrates, groundwater and vegetation. Hazardous and non-hazardous building materials at the site were also identified and quantified. During the site visit, surface water samples from ponded water and Great Slave Lake, sediment samples, soil samples, vegetation samples, waste rock and groundwater samples were collected and analyzed.

A supplemental ESA was carried out in 2010 by SENES Consultants Ltd. and Franz Environmental Inc. (SENES/Franz 2011). Confirmatory sampling was carried out during the site visit, targeting the APECs and COPCs identified in the Phase III ESA, and addressing the environmental issues that required further investigation based on previous studies. Surface water, soil, sediment, benthic invertebrates, vegetation, and tailings were collected and analyzed.

In 2010 and 2011, results of the ESAs were used to complete a Human Health and Ecological Risk Assessment (HHERA) to evaluate potential impacts to ecological populations and human health. The HHERA was further updated in 2013 and represents the most current iteration of the assessment (SENES 2013). The findings of the HHERA are provided in Section 6.0.

Supplemental surface water and sediment sampling was conducted during summer 2013 by SENES on behalf of AANDC/PWGSC. While an extensive dataset existed, sampling activities at nearby sites provided an opportunity to collect additional data at select locations prior to the implementation of the RAP. The report is currently under production; however, a preliminary review of the data is discussed in applicable sections of this report.

## **1.4 REPORT STRUCTURE**

This report has been structured into several distinct sections, each of which describes the following specific aspects of the RAP:

**Chapter 1 – Introduction:** Introduction to the project, Outpost Island Mine, designated responsibilities and the objectives of the RAP.

**Chapter 2 – Land Use and Claims:** Documents the relevant uses of the land by local Aboriginal peoples, as well as current land and mineral claims.

**Chapter 3 – Description of the Mine Site Features:** Provides the current mine infrastructure remaining at the site.

**Chapter 4 – Natural Environment:** Description of the natural environment in the regional and project areas.

**Chapter 5 – Environmental Site Assessment Findings:** Gives an overview of the findings of the site assessments and the identification of concerns specific to the Outpost Island Mine.

**Chapter 6 – Ecological and Human Health Risks:** Presents the findings of the HHERA.

**Chapter 7 – Proposed Remedial Action Plan:** Identifies the key issues, potential remedial methods, and preferred remedial plan for each of the hazards and concerns identified at the mine.

**Chapter 8 – Monitoring and Long-Term Measures:** Proposes a performance monitoring plan, an environmental monitoring plan, and care/maintenance measures following the implementation of the RAP.

**Chapter 9 – Remediation Schedule:** Proposes a schedule of remediation activities in consideration of tasks and seasonal restrictions.

**Chapter 10 – References:** A list of references used in support of this document.

## **2.0 LAND USE AND CLAIMS**

### **2.1 HISTORICAL ABORIGINAL LAND USES**

The Outpost Island Mine lies within the traditional land use areas of the Akaitcho peoples. Historically, land users would at times stay resident in a given area for several months, depending on the season and access to traditional food. During the early winter and late spring, Aboriginal groups travelled through the region to harvest caribou. The other important large animal harvested by the Akaitcho was moose. However, it should be noted that the small size, location and habitat of Outpost Island (as well as adjacent islands) is generally not considered appropriate for large herbivores. Specifically, the site is approximately 30 km from the nearest shoreline, with only minimal evidence of vegetation in bedrock depressions. As such, ecological populations are small and the islands are not believed to represent prime hunting territory. The Islands also lie outside of the traditional migratory route of the Bathurst caribou, and the presence of caribou at the site would be a rare occurrence and only a possibility in the winter months. Taking all of these factors into consideration, it is unlikely that the site of the Outpost Island was used extensively during historical times.

Previous environmental site assessments of the Outpost Island Mine have not identified evidence of traditional burial grounds at or in the vicinity of the site. While no traditional burial grounds have been documented, applicable regulatory authorizations (e.g., the Land Use Permit) will provide protection should any traditional burial grounds be found in the course of remedial activities.

A traditional knowledge (TK) study was conducted by AANDC in 2013 in the form of a questionnaire provided to six Elders from Lutsel K'e and six Elders from Fort Resolution. Results confirm that traditional pursuits (e.g. fishing, hunting and berry picking) were conducted in the project areas, although more commonly before (up to 50 years ago) and during mining operations. However, approximately half of responses indicated they had never visited the site. The questionnaire also focussed on the presence/absence of wildlife species, of which most species common to the East Arm region were documented to have been sighted within the project area, including caribou and moose. Respondents were not aware of any traditional burial grounds at the site (AANDC-CARD 2013).

### **2.2 CURRENT LAND USES**

Visits to the site may occur on an occasional basis from local Aboriginal communities, as well as members of the non-Aboriginal population. Some Aboriginal residents from the nearest communities continue to use the land and water surrounding the site for traditional pursuits, such as hunting, fishing, trapping and the collection of plants. While moose, caribou and fish are

harvested most frequently, water fowl and various plants and berries are also important traditional foods. In addition, ongoing contact with the land provides the spiritual and cultural sustenance that comes from practicing the skills and lifestyle of their ancestors.

The East Arm of Great Slave Lake is also visited by non-Aboriginal residents and tourists. Camping, snowmobiling, boating, hunting, fishing and climbing all attract visitors to this remote area of the lake.

While the visible disturbance to the site would discourage visitors from establishing a camp within the footprint of the mine, it is assumed that Aboriginal and non-Aboriginal visitors to Outpost Island will explore the mine site.

### **2.3 LAND TENURE**

The land surrounding Outpost Island Mine lies within the Interim Measures Agreement (IMA) area of the Akaitcho Dene First Nations (AKDFN). The AKDFN communities, all of which are situated on Great Slave Lake, include the following: Lutsel K'e, Deninu Kue (Fort Resolution), N'dilo and Dettah. The Akaitcho are descendents of the T'satsaot'ine tribe (trans. copper people) and are named after the historic T'satsaot'ine leader Akeh-Cho (1786-1838). The Akaitcho were signatories to Treaty 8, which was signed at Fort Resolution in 1900. In July 2000, the Akaitcho, as represented by the Treaty 8 Tribal Corporation, signed a framework agreement with the Governments of Canada and the Northwest Territories to work towards a land, resource and self-government agreement.

Outpost Island Mine also lies within the asserted territories of the Northwest Territories Métis Nation (NWTMN). A separate IMA was established in 2002 and land claim negotiations are ongoing.

There are no federal land leases or special land reserves in effect in the project area (AANDC 2011), and no Land Use Permits or Water Licences issued for Outpost Island Mine (MVLWB 2011). Any Land Use Permits or Water Licences that are required to implement the remedial action plan would be issued by the Mackenzie Valley Land and Water Board. AANDC-CARD does not currently hold any permits for the former mine site, as the limited extent of work previously conducted at the site has not necessitated a permit.

### **2.4 MINERAL LEASES AND CLAIMS**

The original claims had lapsed by 1990. A new 'Fox' claim was staked in 1999 by Mr. Dave Nickerson to cover the old mine site and tailings pond (Columbia 2006). Mr. Hendrick Falck also recorded the 'Outpost' claim in 1999 to cover the entire Outpost

Archipelago; however, this claim lapsed in 2001. There are no current mineral claims for Outpost Island (AANDC 2011).

## **2.5 MINING HERITAGE VALUES**

Silke (2012) identified the following equipment located on site as having heritage value: a horizontal Ruston diesel engine and a compressed-air driven mine hoist.

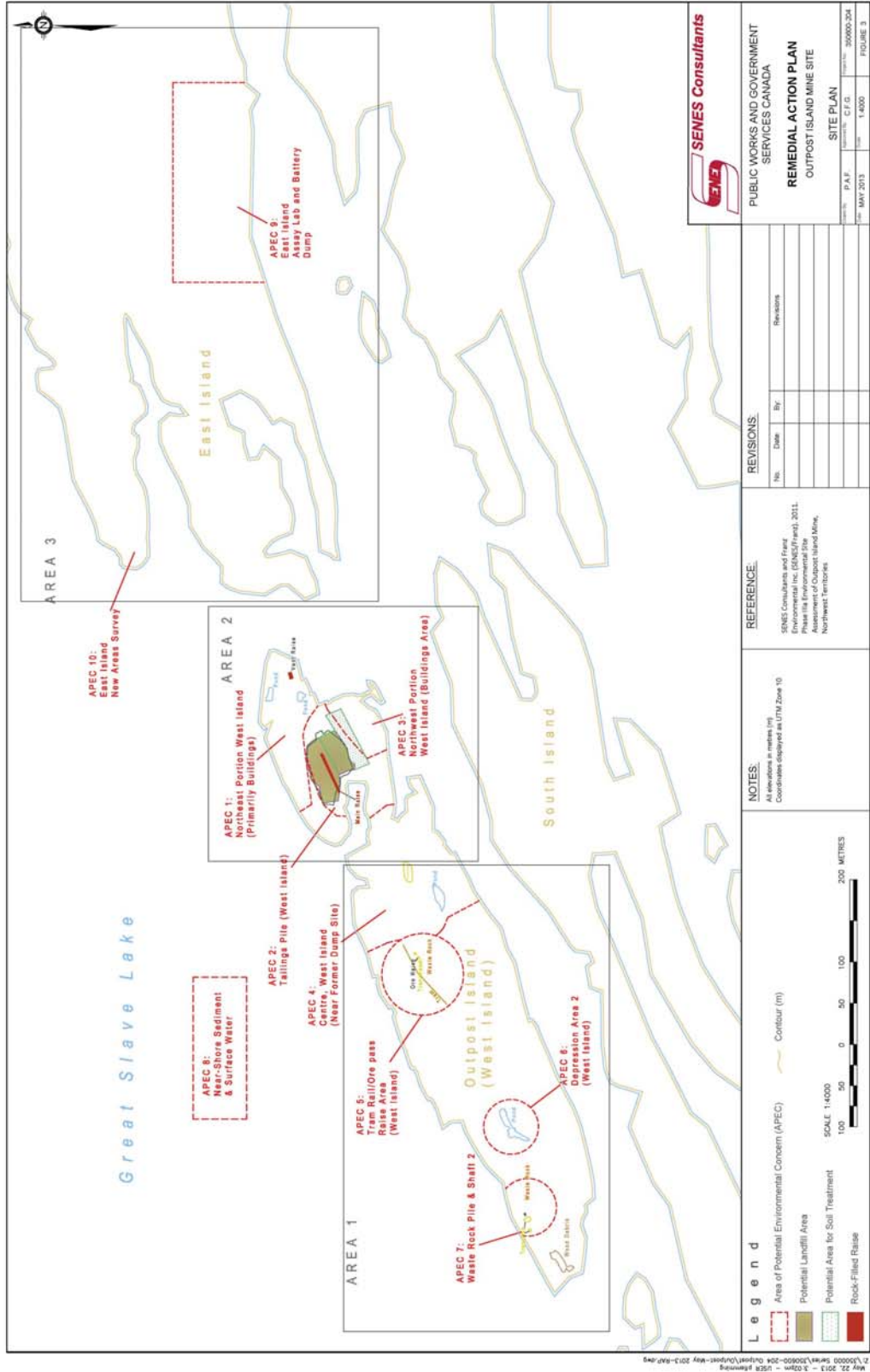


### **3.0 DESCRIPTION OF THE MINE SITE FEATURES**

The Outpost Island Mine covers an area of approximately 50 hectares over two islands: Outpost Island and the adjacent East Island. Minimal infrastructure remains at the site due to a fire in 1955, a partial site clean-up in 1994 (funded by AANDC) and 50 years of inactivity. For the purposes of this report, the various aspects of the Outpost Island Mine have been grouped into the following three areas (Figure 3):

- Area 1** - The central section of Outpost Island where the former staff house, cookhouse, and bunkhouse were located (no buildings remain), and the southwest portion of island where there was evidence of a tram line, Ore Pass Raise, surface exploration pits, Shaft #2, and waste rock piles;
- Area 2** - The north-eastern portion of Outpost Island where the tailings area, former assay laboratory, former mill area, head frame, Shaft #1, the Main Raise, boiler house, oil tanks, dock, water tower, road, and the newer camp facilities were located; and
- Area 3** - The East Island with a battery dump, outhouse, shed, former assay laboratory and the former camp facilities.

Figure 3 Outpost Island Mine Site Plan



### **3.1 AREA 1 – SOUTHWEST AND CENTRAL PORTION OF OUTPOST ISLAND (APECs 4, 5, 6 AND 7)**

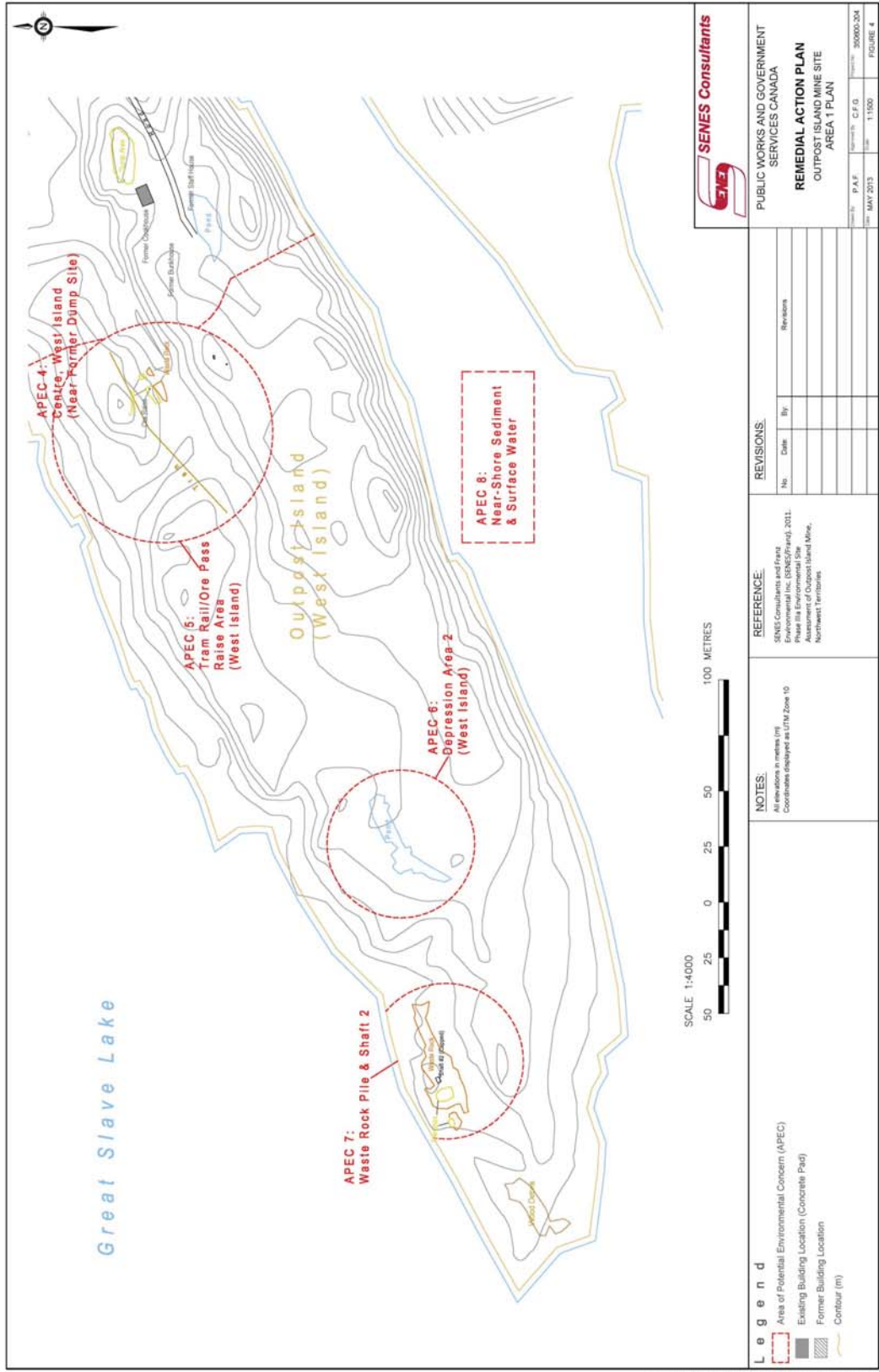
Area 1, the southwest and central portion of Outpost Island, is summarized in Figure 4. APEC 7 at the southwestern end of the island includes Shaft #2, two trenches and associated waste rock piles. Shaft #2 was capped with concrete during 1994 remedial efforts; however, metal pipes and wood debris were lodged in an exposed corner of the cap (Figure 5) and there is no information available regarding its design. Waste rock piles surround the shaft, and an east-west oriented shallow blast trench (<0.5 m depth) lies directly south of the waste rock pile (Figure 6). A large pile of driftwood and lumber is located on the southwest tip of the island, as well as minor volumes of metal debris.

A large topographic depression is classified as APEC 6, with a small tin can dump (Figure 7), shallow exploration trench (<0.5 m depth) and waste rock pile. A pond has filled the topographic low in the bedrock, with trees, shrubs and aquatic vegetation surrounding the pond.

Nearing the center of Outpost Island, classified as APEC 5, the topography consists almost exclusively of bare bedrock ridges. The former tram line, a large trench (approximately 2 m in depth), the Ore Pass Raise and waste rock pile are situated in this area. Although the tram line rail ties have been removed from the site, evidence of the former structure includes railway tie nails scattered on the ground. The Ore Pass Raise is situated directly upgradient and north of the depression area that extends from APEC 6, and the raise entry point has been capped with concrete (Figure 8). Surrounding the Ore Pass Raise, the exposed trench strikes southwest-northeast and measures approximately 15 m long and 2 m deep. A waste rock pile lies along the southern margin of the trench (Figure 9).

APEC 4 is located in the centre of Outpost Island, and represents the northern extent of Area 1. The major features of the APEC include the former locations of the cookhouse, staff house, bunkhouse, and small dump area. A concrete slab and dirt floor footprint are all that currently remains of the cookhouse (Figure 10). There is no evidence of the former bunk house or staff house (i.e., no structure or concrete slab). A small dump, composed mostly of domestic waste, is located near a marshy area bounded by bedrock outcrops to the north of the cookhouse.

Figure 4 Area 1 Plan



**Figure 5**      **Area 1: APEC 7 – Shaft #2**



**Figure 6**      **Area 1: APEC 7 – Trench and Waste Rock**





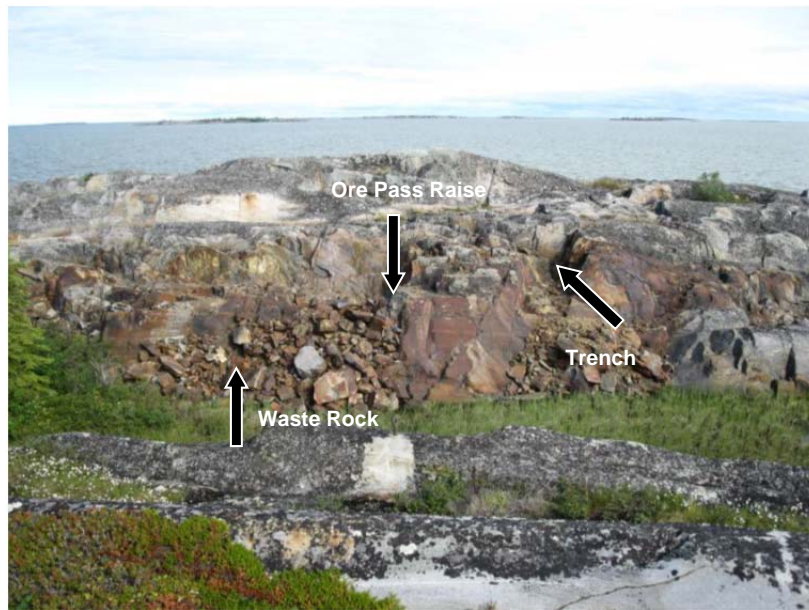
**Figure 7      Area 1: APEC 6 – Can Dump**



**Figure 8      Area 1: APEC 5 – Ore Raise**



**Figure 9      Area 1: APEC 5 – Trench**



**Figure 10      Area 1: APEC 4 – Cookhouse Foundation**



### **3.2 AREA 2 – NORTHEAST END OF OUTPOST ISLAND (APECs 1, 2 AND 3)**

The location of features in the northeast end of Outpost Island (Area 2) are mapped in Figure 11. Major features within APEC 1 include the former locations of fuel and water storage, hoist and power house (no buildings or concrete foundations remain), several unknown building areas, a potential vent raise and two ponds with drainage to Great Slave Lake. The suspected fuel area is

a topographic high covered with trees and shrubs. Along the northern edge of Outpost Island there is a circle of eight concrete piers suspected to have served as the base of the former water tower (Figure 12). The northeast tip of the island is primarily exposed bedrock and minimal evidence of former buildings exists.

Major features of APEC 2 include the tailings/waste rock pile, the former mill area, Shaft #1, the Main Raise, the former assay lab and two unknown building footprints (i.e., no structures remain). The former mill area is located at a localized high point and there is a steep decline of exposed bedrock to the south. Four concrete pedestals supporting steel equipment (Figure 13), Shaft #1 and a wood pad are also located in the vicinity of the former mill. While the exact location of Shaft #1 has not been determined (it is covered with tailings/waste rock), the approximate location was inferred from historical pictures and a wooden pad secured with steel pins/rods. There is the potential that the Main Raise was excavated to Shaft #1, although the Main Raise is currently partially filled with waste rock and partially open at the west end (Figure 14). To the east of the mill equipment, were two concrete piers that served as foundations for mill equipment (Figure 13).

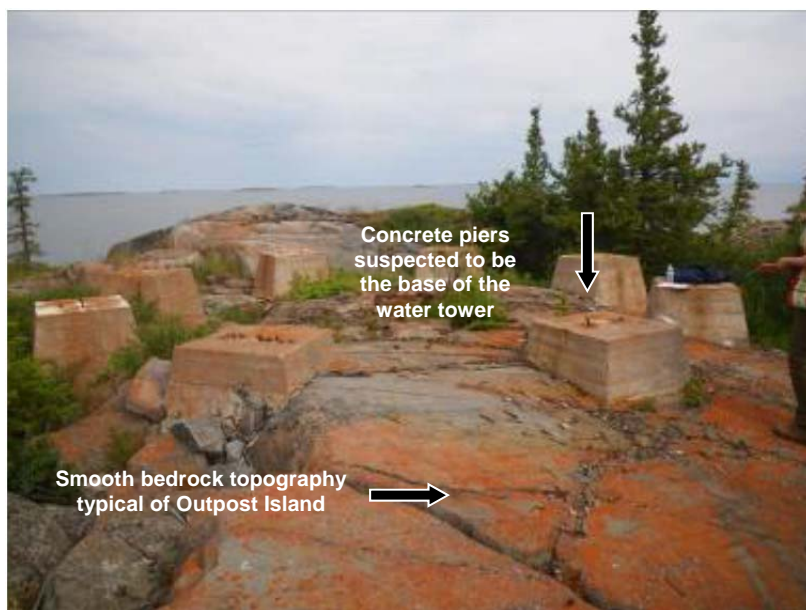
A tailings/waste rock pile is located in the western half of APEC 2 (Figure 15). The deposit occupies an area of approximately 3,000 m<sup>2</sup> and contains approximately 9,000 m<sup>3</sup> of well mixed waste rock and tailings. To the west of the tailings/waste rock is the North Bay within Great Slave Lake, into which tailings were deposited. There is a natural saddle in the bedrock across the northern limit of North Bay that acted as a barrier to tailings migration and effectively contained the tailings within the North Bay (Franz/EcoMetrix, 2010). This saddle is believed to have been raised during the operational period but was subsequently breached, thereby allowing the inflow of lake water and the re-establishment of a bay.

The major features of APEC 3 include the road, former warehouse, former unknown building, former boiler house, former house, and former assay lab. In addition, a former dock, small battery dump and areas of stained rock are located within this area. The stained rock is in a small depression in the bedrock in the south section of APEC 3, and the 1 m<sup>2</sup> battery dump was located at the bottom of a bedrock depression, surrounded by vegetation. Glass and wood debris are scattered near the dump area and in the bedrock cracks south of the stained rock. There are two boilers on brick foundations in APEC 3, with wood scraps next to the boilers (Figure 16). Both boilers were inspected for any potential asbestos containing material (ACM); however, none was observed. In the southwest portion of APEC 3, the South Bay within Great Slave Lake transects much of the island. A docking area constructed of aggregate is also located along the southern shore. A wooden crib houses the aggregate, and is reinforced and anchored to the shoreline with dilapidated steel reinforcements.

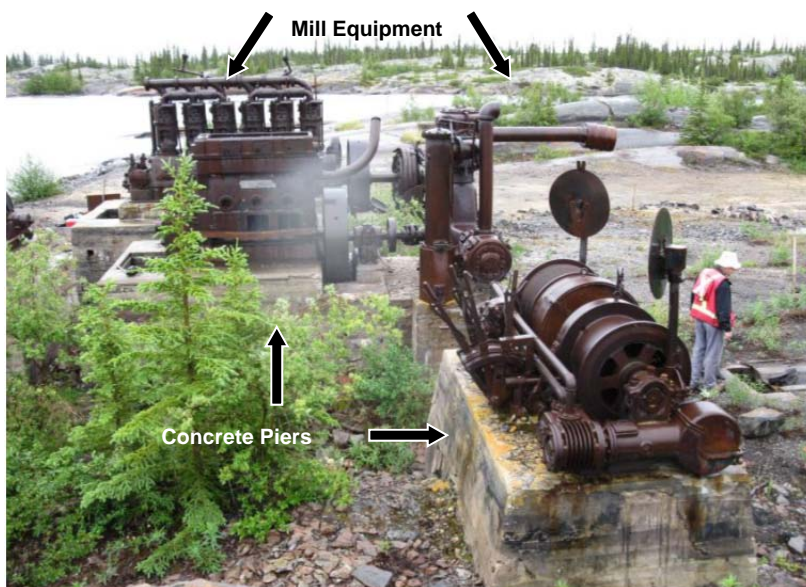




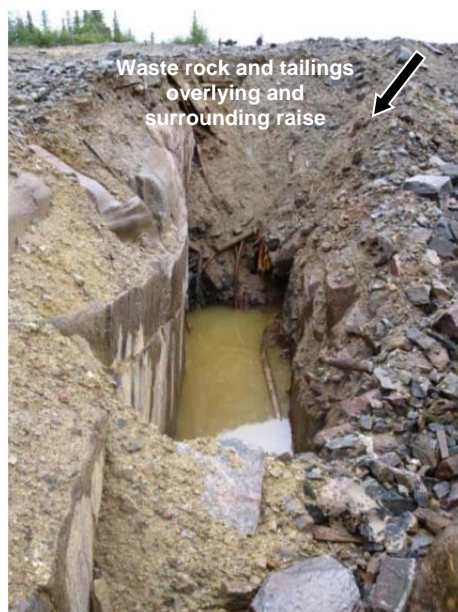
**Figure 12      Area 2: APEC 1 – Concrete Piers**



**Figure 13      Area 2: APEC 2 – Mill Equipment**



**Figure 14      Area 2: APEC 2 – Main Raise**



**Figure 15      Area 2: APEC 2 – Waste Rock and Tailings**





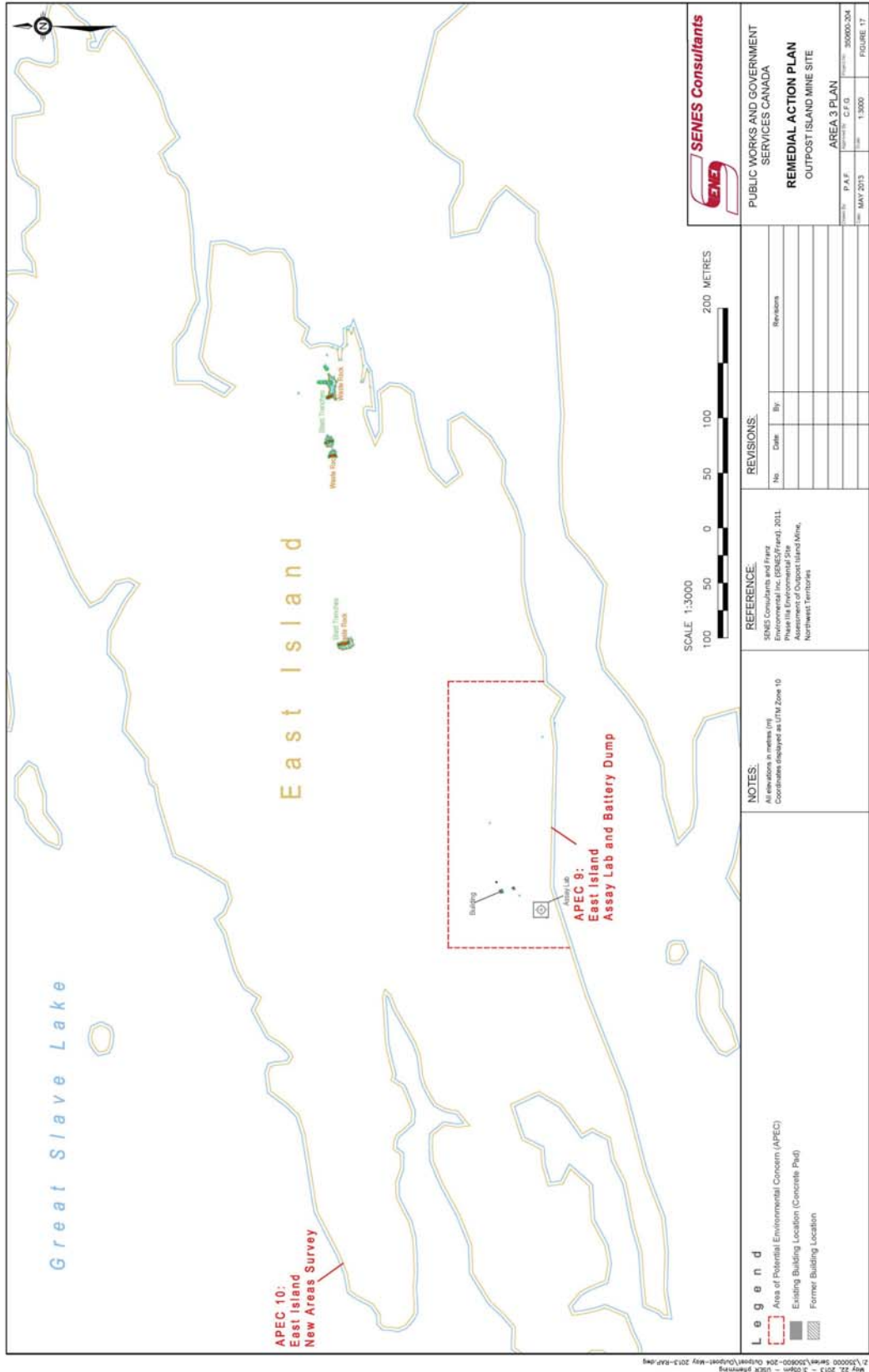
**Figure 16      Area 2: APEC 3 – Boilers**



### **3.3    AREA 3 – EAST ISLAND (APECs 9 AND 10)**

Investigations of the East Island have been in two general areas: APEC 9 the terrestrial environment, and APEC 10 the aquatic environment (Figure 17). Several groupings of up to three blast trenches were documented on the East Island, in addition to a battery dump, a potential former assay laboratory (i.e., no structure remains but there is evidence of assay lab equipment/materials), a can dump, an outhouse and a shed (outhouse and shed structures remain). Each blast trench was over two metres deep, with waste rock adjacent (Figure 18). The trenches are near to or in the water of Great Slave Lake; however, no other site infrastructure is reported in the aquatic environment of East Island. The battery dump occupied an area less than 0.5 m<sup>2</sup> and is located in an area of very little soil (Figure 19). There is a small can dump and miscellaneous scattered debris near the can dump. Evidence of the original mine camp and assay lab remain in the form of wood debris. The roof of the outhouse has partially collapsed and the walls are constructed of unpainted logs with no hazardous building materials identified (Figure 20). The shed is dilapidated with the majority of the structure collapsed, and minimal paint remaining on the wood planks.

Figure 17 Area 3 Plan



**Figure 18      Area 3: APEC 9 – Blast Trench**



**Figure 19      Area 3: APEC 9 – Battery Dump**



**Figure 20      Area 3: APEC 9 – Outhouse**



## **4.0 NATURAL ENVIRONMENT**

### **4.1 TOPOGRAPHY AND PHYSICAL FEATURES**

The Outpost Island archipelago is a series of parallel islands with a northeast-southwest orientation and steep sided bedrock ridges rising approximately 5-10 m from Great Slave Lake. The elevation of Great Slave Lake is approximately 156 m above sea level (masl), and the maximum elevation on Outpost Island is 164 m. Detailed surveying was not conducted on the East Island; however, elevations are approximately consistent with Outpost Island. The ridges have been rounded and polished by glacial action and are largely barren of trees and vegetation.

### **4.2 GEOLOGY**

#### **4.2.1 Regional Geology**

The Outpost Islands are underlain by metamorphosed sedimentary rocks belonging to the Wilson Island phase of the Point Lake-Wilson Island Group (Columbia 2006). As indicated by EBA (2009), the lower Proterozoic Wilson Island Group is exposed in a northeast trending belt in the East Arm of Great Slave Lake. Deposits are made of intercalated basalt flows, felsic flows and related intrusions, volcaniclastics, braided alluvial arkose and conglomerates. Overlying the volcanic assemblage is a debris flow paraconglomerate, which grades vertically into fluvial to marginal marine or lacustrine arkose and dolostone (Johnson 1985). Sheared and silicified zones with disseminated metallic minerals occur along Outpost Island in eight major zones (Silke 1999). The zones cover an area over 2,130 m long and 230 m wide and encompass four islands of the Outpost Island group of islands. The zones dip southerly at angles between 75 and 85 degrees (SENES/Franz 2011).

#### **4.2.2 Local Bedrock Geology**

The bedrock throughout Outpost Island consists of micaceous metasedimentary rocks (Franz/EcoMetrix 2010). The bedrock has been glacially polished, with clear northeast southwest striations observed. The majority of ore zones are within silicified, sheared, and or brecciated greywackes and pelitic schists. Mineralized zones are 0.7-1.8 m in width and up to 55 m in length, containing the minerals chalcopyrite, pyrite, gold, scheelite, ferberite, marcasite and bornite (SENES/Franz 2011).

### **4.3 SOILS**

Surficial soil is minimal on Outpost and East Island, and generally only observed in bedrock depressions. Where present, soil occurs as a thin veneer of organic material overlying shallow



mineral soils. The surficial topsoil in these depressions consists of sand, gravel, and organic-rich peat material that is generally moist to wet. Recorded thickness of native soils varied from approximately 0.05 m to 0.4 m, ranging in colour from light brown to light and dark grey (Franz/EcoMetrix 2010).

#### **4.4 CLIMATE**

##### **4.4.1 Temperature**

As part of the Sub-Arctic Climatic Zone, Outpost Island Mine experiences short cool summers and long cold winters. Environment Canada maintains climate statistics in Yellowknife (the nearest weather station), and climate averages are available from 1943 through to 2007. The lowest temperatures in the region are observed in January, documenting an average daily temperature of -27.3°C, and an extreme minimum of -51.1 °C (1947). The highest average temperatures are in July (16.5°C), with a recorded extreme maximum of 32.5 °C in 1989 (Environment Canada 2011).

##### **4.4.2 Precipitation**

Average annual precipitation in Yellowknife is 269.1 mm, and the average annual snowfall and rainfall are 139.1 cm and 155.3 mm respectively. The maximum snowfall is observed in November (average of 30.8 cm), while rainfall peaks in August (average of 39.8 mm). On average, April is the driest month with an average total precipitation of 10.5 mm (Environment Canada 2011).

##### **4.4.3 Climate Change**

The meaning of the term “climate change” within this report is consistent with its definition by the United Nations Framework Convention on Climate Change (1992):

*“... a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.”*

The Outpost Island Mine is within the Mackenzie climate region for which an overall warming trend is recorded of approximately 1.5 °C/century. In the Mackenzie District, warming has occurred mainly in winter and spring, and warming temperatures accompanied by a decrease in winter precipitation. The available data set for summer precipitation displays a minor increase in volume and variability (SENES 2005). Climate trends at the Outpost Island Mine have the potential to result in changes to freshwater ice thickness and duration, snow conditions, precipitation, permafrost, and habitat for plants and animals. Climate trends have been

considered in the design of the RAP to ensure remedial measures function as intended over the long-term.

#### **4.5 PERMAFROST**

Permafrost is defined by the International Permafrost Association (IPA 2012) as:

*‘Ground (soil and rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years’.*

The presence/absence of permafrost is dependent on many factors, such as air temperature, vegetation, snow cover, orientation of the terrain and ice content. Below 0° C any soil moisture present will take the form of ice.

The Outpost Island Mine lies approximately at the convergence of the zone of Extensive Discontinuous Permafrost with the zone of Sporadic Discontinuous Permafrost; however, there is no documentation of detailed permafrost mapping at the site (NRC 1995). Extensive Discontinuous Permafrost is defined as an area with 50-90% of the ground surface underlain by permafrost, while Sporadic Permafrost has 10-50%. Indications of permafrost were not observed during ESAs; however, field investigations were conducted in the summer months when the active layer (the uppermost soil horizon which freezes and thaws annually) is at its deepest (SENES/Franz 2011). The talik effects of Great Slave Lake, thermal gain from bedrock outcrops (in the summer months), and the shallow soil profiles in bedrock depressions may contribute to the lack of permafrost evidence.

Clearing of vegetation and disturbance of the sub-surface may result in increased soil temperatures and thawing of permafrost. The loss of permafrost may cause a decrease in soil cohesion, creating increased erosion and differential settlement of the ground surface. The degradation of permafrost may occur through impacts of increasing temperatures due to climate change, in addition to physical disturbances associated with remedial measures.

#### **4.6 AIR QUALITY**

Site-specific air quality measurements have not been collected at the Outpost Island Mine during the ESA field investigations. Environment and Natural Resources (ENR) of the Northwest Territories monitors air quality at four stations, one of which is Yellowknife. Parameters measured vary by station, but include sulphur dioxide (SO<sub>2</sub>), hydrogen sulphide (H<sub>2</sub>S), fine particulate matter (PM<sub>2.5</sub>), ground level ozone (O<sub>3</sub>), carbon monoxide (CO) and nitrogen oxides (NO<sub>x</sub>), as well as wind speed, wind direction and temperature (GNWT 2010).

Current air quality trends have been reported within the 2010 Status of the Environment Report (SENES 2011), with suspended particulate, SO<sub>2</sub> and NO<sub>x</sub> on downward trends; ground level ozone consistent with background conditions; and a general decrease in the levels of Persistent Organic Pollutants (POPs).

## **4.7 ECOLOGY**

### **4.7.1 Classification**

Using the tiered classifications of the federal Ecological Framework for Canada (Ecological Stratification Working Group 1995), Outpost Island Mine lies within the Taiga Shield Ecozone, Western Taiga Shield Ecoprovince, and finally the Tazin Lake Upland Ecoregion. The territorial Ecosystem Classification Group (2008) nomenclature classifies this region as part of the Great Slave Upland Low Subarctic Ecoregion. Dominant tree species in the ecoregion are black spruce and paper birch, with dwarf birch woodlands typical in low-lying areas or bedrock depressions. Peat plateaus are common in the ecoregion, with fens being observed on lake shorelines (Ecosystem Classification Group 2008). Wildlife common to the ecoregion include black bear, wolf, caribou, moose, beaver, muskrat, snowshoe hare, and spruce grouse (Ecological Stratification Working Group 1995).

### **4.7.2 Vegetation Observations**

Vegetation observed during the ESA investigations included: spruce willow, poplar, dwarf birch, cinquefoil, raspberry, rose, Labrador tea, arctic cotton, mosses, and lichens.

### **4.7.3 Wildlife Observations**

Evidence of (tracks, scat or sighting) the following wildlife species were documented during the ESA field investigations: chipmunks, arctic fox, common terns, herring gulls, red-throated loon, common loon, common merganser, jaeger, ptarmigan, scaup, sandpiper, plover, northern pike, whitefish and sculpin. There was no evidence of moose or caribou on Outpost Island or East Island during the 2009 or 2010 site investigations. While it is feasible for both of these species to access the site during the winter months (when Great Slave Lake is frozen) the islands do not represent suitable habitat for long-term occupation.

### **4.7.4 Species at Risk in Canada**

To determine the potential presence of any Species at Risk (SAR) at the site, information from the *Species at Risk in the Northwest Territories 2010 Edition* (Environment Canada 2010) was consulted. Table 1 summarizes the classified species that were found to have a range that may overlap with the project area. It is noted that an exact determination of the presence/absence of

wildlife and vegetative SAR at the site would require a specific biological reconnaissance of the site. Such an investigation has not been conducted.

**Table 1 List of Species at Risk with a Range Extending into the Project Area**

Common Name	Scientific Name	NWT General Status Ranking	COSEWIC	Species At Risk	General Habitat Discussion
Common nighthawk	<i>Chordeiles minor</i>	At risk	Threatened	Threatened	Nests in a variety of habitats
Horned grebe	<i>Podiceps auritus</i>	Secure	Special concern – western population	No Status	Small ponds, marshes and wetlands
Peregrine falcon	<i>Falco peregrine, anatum</i>	Not-assessed	Threatened	Threatened	Sheltered ledges or crevices near water
Rusty blackbird	<i>Euphagus carolinus</i>	May be at risk	Special concern	Special Concern	Wetland areas in the boreal forest in spring, summer, fall
Short-eared owl	<i>Asio flammeus</i>	Sensitive	Special concern	No Status	Open (non-forested) areas
Short-jaw cisco	<i>Coregonus zenithicus</i>	At risk	Threatened	No Status	Great Slave Lake; deep water and spawning >9m depth
Wolverine	<i>Gulo gulo</i>	Sensitive	Special concern – western population	No Status	Wide variety
Yellow Rail	<i>Corturnicops</i>	May be at risk	Special Concern	Special Concern	Nests in marshes dominated by sedges and grasses, wet meadows, and shrubby wetlands
Olive-Sided Flycatcher	<i>Contopus cooperi</i>	At risk	Threatened	Threatened	Boreal forests near open areas

Source: Environment Canada 2010

## 4.8 HYDROLOGY

### 4.8.1 Regional Hydrology

With a surface area of 25,568 km<sup>2</sup> and an estimated volume of 2,088 km<sup>3</sup>, Great Slave Lake represents the principal hydrologic system in the region. The average depth of Great Slave Lake is 73 m and the maximum depth is 614 m, making it the deepest lake in North America. The Slave River is the largest freshwater source to Great Slave Lake, contributing approximately 77% of total inflow. The Mackenzie River represents the principal outflow (MRBB 2003).

The Great Slave Lake Sub-Basin (part of the larger Mackenzie River Basin) has a catchment area of 379,000 km<sup>2</sup>, stretching from Alberta and British Columbia and covering the majority of the central Northwest Territories. The sub-basin straddles the Precambrian Shield to the east and the

Interior Plains to the west, with the Outpost Island Mine located in the erosion resistant Precambrian Shield.

Great Slave Lake was formed through glacial scouring and several distinct arms and islands were created in the process. The East Arm has deep waters (up to 614 m) and lower dissolved minerals than observed elsewhere in the lake. The large Western Basin is shallower and contains elevated concentrations of dissolved minerals and solids (i.e., silt) deposited in the lake via the Slave River. The oligotrophic lake is low in both planktonic crops and benthic invertebrate diversity (Biodiversity Institute of Ontario 2008).

#### **4.8.2 Site Hydrology**

The Outpost Island Mine lies near to the centre of Great Slave Lake and is surrounded by several other small islands. The island chain would be partially inundated with waves during some storm conditions and is assumed to be subject to ice scour. Lake effects would be most prominent on the northern shores of Outpost and East Islands which face the open lake (i.e., the southern shores are protected by other islands in the chain).

No active streams or water courses have been identified on Outpost Island or East Island. Water on the site flows either directly into Great Slave Lake or into rock depressions found throughout the islands. Some mining features, such as rock trenches and raises, are partially filled with ponded water resulting from precipitation, melt water, and/or wave action from Great Slave Lake. Two small scale drainage paths exist near the former mill area, one flowing northeast and the second flowing southeast towards Great Slave Lake. The drainage terminates at small ponds in bedrock depressions before flowing into the lake. The ponds in the southern reaches of Outpost Island (one in APEC 4 near the former dump area and a larger pond in APEC 6 near Shaft #2), are of greater size and have vegetation on shallow soils within and surrounding the ponds. While benthic invertebrates and aquatic vegetation may survive in the ponds, they do not serve as fish habitat and would not be drinking water sources for humans visiting the site. There are no other aquatic environments within or surrounding the footprint of the mine.

#### **4.9 HYDROGEOLOGY**

Outpost Island and East Island are composed almost exclusively of competent bedrock. As such, significant groundwater flow is unlikely. The limited groundwater movement in the subsurface may occur in surficial overburden, and/or in large and small scale fractures in bedrock. Shallow overburden groundwater flow at the Outpost Island Mine site is likely dominated by direct infiltration of precipitation into soils located between bedrock outcroppings, with vertical fluid migration. The flow of groundwater in bedrock units would be largely controlled by regional shearing, creating large scale fractures as well as small scale fissures. Based on the topography,

groundwater flow is expected to flow radially outwards from the topographic highs to Great Slave Lake, which acts as a discharge zone for the entire groundwater flow system of the site (Franz/EcoMetrix 2010).

## **5.0 ENVIRONMENTAL SITE ASSESSMENT FINDINGS**

The following sections provide a summary of findings from the various ESAs conducted at the Outpost Island Mine. A small scale sampling program was implemented as part of the 2008 Phase II ESA (EBA 2009); however, the majority of observational, physical, and chemical data have been obtained from the 2009 Phase III ESA (Franz/EcoMetrix 2010) and 2010 Phase IIIa ESA (SENES/Franz 2011).

The objective of the ESA process is to characterize the site and its features; and to identify and delineate impacts to the terrestrial and aquatic environments. To accomplish these objectives, Areas of Potential Environmental Concern (APECs) and the identification of Constituents of Potential Concern (COPC) were initially identified during the Phase I and II ESA investigations. Where impacts to the environment were confirmed (Phase III and IIIa ESAs), the APECs were reclassified as an Area of Environmental Concern (AEC) due to a known Constituent of Concern (COC). For the sake of consistency with previous reporting and ease of interpretation, findings have been discussed with respect to APECs identified in the ESA reports.

### **5.1 MINERALIZATION AND METAL ENRICHMENT IN THE ENVIRONMENT**

As is discussed in subsequent sections, elevated metal concentrations have been measured in soils, sediment and surface water at the Outpost Island Mine. The primary metals of concern associated with the mining operation are copper and mercury, although a mercury amalgam process was used during mineral processing. Underground mining was conducted at the site, exposing ore and waste rock from the subsurface to atmospheric conditions and resulting in increased rates of metal leaching and loadings to the surrounding environments.

While mining activities have undoubtedly enhanced metal loadings to soil, surface water and sediments, natural metal leaching from the bedrock in the mine area was likely occurring prior to mining activities. The fact that the mineral exploration industry uses metal concentrations in surface materials to help locate mineral deposits (Hamilton 2007) illustrates the extent to which metal concentrations can be affected by natural weathering. For example, naturally elevated metal concentrations in lake and stream sediments are a primary exploration tool, although soil and water sampling is also used (Moon et al. 2006).

In the case of the Outpost Island Mine, there is unfortunately no baseline environmental quality data that can be used to differentiate between naturally elevated and enhanced metal concentrations in environmental media. Throughout the ESA process, samples have been collected from areas unaffected by mine infrastructure (i.e. background samples); however, the areas are therefore not adjacent to mineralized bedrock and do not illustrate the natural metal enrichment typical in environmental media at such locations. In the absence of this site-specific

information, the following overviews of the proposed Nechalacho and NICO Mines are provided to illustrate the extent to which highly mineralized zones can result in naturally elevated metal concentrations. While the details of these sites are not directly transferable to the Outpost Island Mine (e.g., due to different mineralization, physical conditions and environmental factors), they serve as evidence that elevated concentrations at the Outpost Island Mine are partially attributable to natural mechanisms. This includes the possibility that metal concentrations were above applicable EQG prior to the mining operation.

### **Nechalacho Project**

The Nechalacho Project (formerly known as the Thor Lake Project), is a proposed rare earth mine approximately 60 km northeast of the Outpost Island Mine. As part of the baseline assessment, metal concentrations were analyzed in sediment and surface water in small and large water bodies. The deposit is rich in rare earth elements, and copper is not the primary element of mineralization at the site. The study sampled 23 lakes and reported that 16% of sediment stations exceeded CCME guidelines for copper and 32% for silver (as well as 60% for arsenic and 28% for nickel). The maximum reported copper concentration in sediments was approximately 55 mg/kg (CCME-Interim Sediment Quality Guideline (ISQG) of 35.7 mg/kg). All reported water concentrations were below copper guidelines, and metal concentrations in soil were not available (Stantec 2010).

### **NICO Mine**

The baseline assessment for the proposed NICO Mine (cobalt-gold-bismuth-copper) was also reviewed. The development is roughly 260 km northwest of Outpost Island Mine and is not the same deposit type; however, the proponent has collected an extensive suite of baseline data within a mineralized zone. Concentrations of copper in small ponds near the mineralized zone showed the greatest copper concentration (Grid Ponds), which decreased with distance from the ore body. Sediment grab samples from the Grid Ponds ranged from 549-1080 mg/kg copper, and 53-65 mg/kg in the larger downstream Nico Lake (CCME-ISQG of 35.7 mg/kg). Copper concentrations in sediments further downstream were highly variable, although are generally below or near the guideline. All surface water samples collected from the Grid Ponds exceeded copper guidelines, although by a maximum factor of five. The copper concentrations in surface water from Nico Lake and other downstream water bodies are generally below guidelines (Golder 2010a). A total of 26 soil samples were also collected for metals analysis, of which 8 exceeded the CCME guideline of 63 mg/kg copper. Concentrations ranged from 4.8-1147 mg/kg and reported a mean of 154 mg/kg (Golder 2010b).



## **Summary**

The results of metal analysis from the Nechalacho and NICO projects identifies the range and variability of baseline metal concentrations in environmental media. The mineralization has resulted in elevated metal loadings to the environment through natural processes. While it is impossible to determine the pre-mining conditions at the Outpost Island Mine, it is predicted that soils, surface water and sediment would have displayed some degree of natural metal enrichment. This factor should be considered during the interpretation of ESA findings and in designing remediation objectives.

## **5.2 MINE OPENINGS**

The main mine workings were on Outpost Island, on which there are two shafts, two confirmed ore raises (plus a possible additional raise), and blast/exploration trenches. While there are no mine openings on the East Island, there are several blast/exploration trenches. A crown pillar assessment was conducted by a qualified professional as part of the Phase IIIa ESA, and is provided as an appendix in the Phase IIIa ESA (SENES/Franz 2011). The following represents a summary of the Phase IIIa ESA geotechnical inspection and assessment of the mine openings.

### **Shafts**

Shaft #1 was located near the former hoist and power house (APEC 1); however, the area is now covered with waste rock/tailings and the exact shaft location could not be confirmed. However, the general location can be inferred from old site photographs and the location of existing site features. The Phase IIIa concluded that Shaft #1 is either connected to the main raise via the underground workings or the vein was mined up to the surface immediately west of this shaft. There is currently no evidence of subsidence or settling of the waste rock/tailings over the approximate location of Shaft #1 and, on this basis, it has been assumed that the cap is in good condition. Excavation equipment would be required to confirm the mine cap conditions at this location. There were no apparent safety hazards identified at the time of inspection.

Shaft #2 is located on the western end of Outpost Island (APEC 7) and was capped with concrete as part of the 1994 remedial efforts. The current concrete cap is in poor condition and represents a safety hazard. The cap is constructed of a 1.8 m wide by 3 m long concrete pad approximately 0.1 m thick and reinforced with rebar and wire mesh. The northwest corner of the cap is caved in and the shaft opening is exposed. The shaft contained water at the time of inspection; although the depth from the ground surface to the water surface could not be determined. Based on its proximity to Great Slave Lake, the water level in the shaft is assumed to be coincident with the elevation of the lake. An iron pipe and partially burned wooden beams protrude out of the shaft. Competent bedrock exists beneath the waste rock that surrounds the shaft.

### Raises

Two mine raises, the Ore Pass Raise and Main Raise, were inspected on Outpost Island. A possible third raise was investigated on the east end of Outpost Island. No raises were identified on the East Island.

The Ore Pass Raise is located in APEC 6 on the southern side of a bedrock ridge adjacent to the depression in the centre portion of the island. The Ore Pass Raise was capped and appeared in good condition. Based on visual evidence, it was determined that the cap was installed at the same time (1994) as the cap for Shaft #2. The concrete cap was tied into the bedrock with steel wires with no evidence of rebar reinforcement anchored into the surrounding rock. Although the cap is performing adequately at this time, it has not been constructed to standards that would typically be applied today (e.g., mine cap design specifications applied in Ontario). The bedrock surrounding the Ore Pass Raise appeared competent and suitable for restoration of the existing cap, if deemed necessary.

The Main Raise is located on the western side of the tailings pile (APEC 2), adjacent to the North Bay and was likely used for transport of workers and/or equipment to the underground workings. The excavation for the raise is about 4.5 to 6 m deep from the highest point (to the east). The raise support structure is partially collapsed with evidence of waste rock and debris backfilling overlying the support structures. The raise is surrounded by loose waste rock, and the condition of the sidewalls varies from competent bedrock to the north to unstable bedrock to the south, with the lower level filled with over 1 m of water. The raise represents a safety hazard in its current condition.

Based on the field observations and document reviews, there is uncertainty whether there is an additional raise to surface from a stope known to exist at the east end of the Outpost Island. However this could not be confirmed during the course of the supplemental program as the location of the possible raise was underwater and filled with waste rock.

### Blast/Exploration Trenches

Numerous blast trenches exist on both Outpost Island and East Island, appearing to follow a general east-west orientation. Three primary trenches have been noted on Outpost Island: two within APEC 7 adjacent to the waste rock stockpile and Shaft #2, and one in APEC 5 near the tram line. The trenches are small and unlikely to represent significant physical hazards; however, unstable and loose blast rock scattered on the bedrock represented a minor safety hazard.

Blast/exploration trenches exist in two main areas on East Island. Nine trenches were identified on the interior of the island, considered to be small and unlikely to represent an appreciable physical hazard, although unstable and loose blast rock scattered on the bedrock was considered

a minor safety hazard. Five additional trenches are documented at the east end of East Island, all of which are approximately 3 m deep and 1.5 m wide. The side walls exhibited some fracturing and highly weathered blast rock was noted in the floors of the trenches. The trench walls did not exhibit signs of collapse at the time of the field investigation. While the trenches represent theoretical physical hazards, they are similar to naturally occurring topographic features at the site.

### **5.3 BUILDINGS**

There are currently no buildings on Outpost Island and only two small structures on East Island. An Outhouse and Shed represent the only structures remaining from the suspected original camp and assay area in the southwest of East Island. The structures are in poor physical condition and represent a hazard to anyone entering. The approximate volume of debris associated with the structures is 11m<sup>3</sup> (mainly wood) and no hazardous building materials have been identified.

Although existing structures are limited to the Shed and Outhouse on East Island, several concrete foundations for former buildings remain at the site. Minor waste debris consistent with the original uses of the buildings surrounds several of the foundations (e.g., crucibles near the assay lab foundation). Building and waste materials associated with the structures and foundations are considered to be non-hazardous waste and are itemized in Section 5.4.1.

### **5.4 REFUSE**

#### **5.4.1 Non-Hazardous Refuse**

Minimal refuse remains at the Outpost Island Mine. These materials were not burned in the 1955 fire, were not removed from site in the 1994 remediation, and have a slow rate of decomposition. The non-hazardous refuse identified in the ESA investigations are summarized in Table 2 below.

**Table 2 Summary of Outpost Island Mine Non-Hazardous Refuse**

APEC/ AEC	Site Feature	Item	Volume (m <sup>3</sup> )			
			Wood	Metal	Concrete	Total
1	Water tower base	Eight concrete piers (0.78 m x 0.78 m x various heights)			3	3
2	Mill Area – First equipment block	- Concrete base (7 m x 1.7 m x 2.8 m) - Metal from the mill equipment (6.2 m x 2.4 m x 1.4m) occupies approximately 50% of the calculated volume		10	33	43
	Mill Area – Second equipment block	- Concrete base (2.4 m x 1.9 m x 2.7 m) - Metal from the mill equipment (2.4 m x 1.9 m x 1.3 m) occupies approximately 20% of the calculated volume		1	12	13
	Mill Area – Third equipment block	- Concrete base (5.4 m x 1.0 m x 2.8 m) - Metal from the mill equipment (5.4 m x 2.2 m x 2.8 m) occupies approximately 30% of the calculated volume		10	15	25
	Mill Area – Fourth equipment block	- Concrete base (2.9 m x 0.9 m x 1.8 m) - Metal from the mill equipment (2.9 m x 1.0 m x 1.8 m) occupies approximately 80% of the calculated volume		4	5	9
	Concrete Piers	- Two concrete piers (0.3 m x 0.3 m x 0.8 m and 0.7 m x 0.7 m x 0.5 m)			0.3	0.3
	Assay Laboratory	- Concrete foundation pad (3.6 m x 4.8 m x 0.1 m)			1.7	1.7
	Unknown Building	- Concrete foundation pad (4.6 m x 4.0 m x 0.1 m)			1.9	1.9
3	Boilers	- Metal from two boilers ( 2.9 m x 1.0 m x 2.6 m) on a brick base (2.9 m x 1.0 m x 0.25 m )		7.5	0.8	8.3
	Scrap Wood	- Scrap wood surrounding the boiler	1			1
	Metal	- Metal canister		0.1		0.1
4	Cookhouse	- Concrete foundation pad (5.6 m x 8.9 m x 0.1 m)			5	5
	Metal Debris	- Metal debris, including tin cans and pieces of scrap-metal.		2		2
6	Metal Debris	- Tin can dump		0.5		0.5
7	Scrap Wood	- Scrap wood and Lumber		5		5
	Metal Debris	- Metal Pipe		0.1		0.1
9	Metal Debris	- Can Dump		0.5		0.5
	Outhouse, shed, and former building	- Wood from outhouse, shed and former unknown building	10			10
<b>TOTAL</b>			<b>11</b>	<b>40.7</b>	<b>77.7</b>	<b><u>130</u></b>

## 5.4.2 Hazardous Waste Materials

Hazardous materials have been interpreted as defined by the 2004 Guideline for Industrial Waste Discharges in the Northwest Territories (GNWT 2004):

*“A contaminant which is a dangerous good that is no longer used for its original purpose and is intended for storage, recycling, treatment or disposal.”*

By this definition, discarded lead batteries represent the only confirmed hazardous material present at the Outpost Island Mine (Table 3). In addition, a small bottle (< 2 L) of an unknown oil based liquid was identified near the former mill area (APEC 2). Hazardous waste common to abandoned mine sites (e.g., insulation containing asbestos, lead based paints) were not observed at the Outpost Island Mine.

**Table 3 Summary of Outpost Island Mine Hazardous Refuse**

APEC/ AEC	Item	Hazardous Concern	Volume (m <sup>3</sup> )
2	Unknown Liquid	Uncertain	0.025
3	Decaying Batteries	Lead	0.25
9	Decaying Batteries	Lead	0.25
<b>TOTAL</b>			<b>0.53</b>

It is important to note that quantity of hazardous materials on site is relatively small due to earlier remedial efforts. Specifically, remediation by Terra Verra in 1994 is reported to have removed forty drums of calcium carbonate, four drums of asbestos and two drums of corrosive chemicals. Approximately 1,000 litres of residual fuels were also incinerated at that time (Terra Verra 1994).

## 5.5 TAILINGS

Tailings were created during the mining and milling operations at the Outpost Island Mine and extraction accomplished using a mercury amalgam process. In the amalgamation technique, gold is dissolved into elemental mercury to form a solution, called an amalgam. The amalgam is then heated, causing the mercury to evaporate and liberating the metal of interest.

During the original operational phase of the mine, tailings are believed to have been deposited in North Bay. Some tailings were relocated during the 1994 remedial works and are currently located near the former mill within APEC 2 and in the North Bay and South Bay. Tailings deposited in the aquatic environment, and in the lower tailings area (between the two bays and adjacent to the roadway) are considered to be relatively pure in composition and contain minimal waste rock. In contrast, the upper deposit adjacent to the former mill and Main Raise is a mix of waste rock with an increasing proportion of tailings at depth and tailings infilling void spaces.

The total volumes of tailings at the Outpost Island Mine are estimated in Table 4 below. Potential impacts associated with tailings in the terrestrial and aquatic environment are detailed in subsequent sections of this report.

**Table 4            Summary of Outpost Island Mine Tailings**

<b>APEC/ AEC</b>	<b>Item</b>	<b>Area (m<sup>2</sup>)</b>	<b>Volume (m<sup>3</sup>)</b>
2	Waste Rock/Tailings Mix in Upper Area	3,020	9,000
2	Tailings in Lower Area	1,125	340
8	Tailings in Aquatic Environment	18,040 *	1,840 *
<b>TOTAL</b>		<b>22,185</b>	<b>11,180</b>

\* Aquatic tailings volume estimates have been provided from the Phase III ESA (Franz/EcoMetrix 2010). This volume is substantially higher than is indicated on Figure 11; however, the figure displays only the primary location of tailings, which may be found in small isolated pockets as well. It is predicted that the actual volume estimate of aquatic tailings is lower than reported, although as a conservative measure the higher estimate will be reported..

As part of the Phase III ESA, five test pits were excavated in the tailings area. Samples were analyzed for ABA, metals in solids, whole rock analyses, shake flask analyses and humidity cell testing. An additional 12 samples were collected from the tailings area in the Phase IIIa ESA for paste pH measurement, with six samples selected for laboratory metal analysis (shake flask and metals in solids). Samples were collected from both the upper area (tailings and waste rock mixture, with fines or tailings used for analyses) and the lower area (pure tailings).

ABA analyses conducted in the Phase III ESA indicated that the tailings/waste rock are acidic and have the potential to generate more acidic drainage in the future (Table 5). Laboratory measured paste pH values were between 4.2 and 5.6 and the NP values were relatively low and ranged from approximately 1 to 5 kg CaCO<sub>3</sub>/t. Total sulphur content ranged from about 0.2% to 0.7% and was primarily present as sulphide sulphur. The AP of the samples therefore ranged from approximately 6 to 21 kg CaCO<sub>3</sub>/t, resulting in NP/AP ratios of less than 1 for all samples. The samples are therefore considered likely to produce acid when exposed to air and water at the ground surface (Franz/EcoMetrix 2010).

Concentrations of metals in tailings were assessed (Table 6) and evaluated using Canadian Council of Ministers of the Environment (CCME) soil criteria for residential/parkland soils, a very conservative evaluation criteria considering the majority of elemental concentrations in the tailings are locked in stable mineral form. Tailings were also evaluated using 3x the average crustal abundance for shale (the dataset nearest to the protolith of the rock mass). Analytical results indicated that concentrations of arsenic, cobalt, chromium, and antimony exceed CCME criteria in a low number of samples (i.e., less than six); however, the average concentration for each element was below CCME criteria. In contrast, copper, molybdenum, lead, and selenium exceed the CCME criteria in the majority of samples and calculated average concentrations are

also above the CCME criteria. With respect to crustal abundance, concentrations of tungsten demonstrate the greatest enrichments, although there are no Canadian soil guidelines against which to assess measured concentrations. Concentrations of the COCs were not consistent or predictable throughout the waste rock and tailings deposits (Franz/EcoMetrix 2010 and SENES/Franz 2011). The inconsistencies are assumed to be attributable to naturally occurring variation in the mineralogical properties of the samples.

Results of the Phase III shake flask/leaching tests showed a general decreasing trend of leachability with depth for all metals (Table 7). Shake flask analyses were also conducted in the Phase IIIa ESA to confirm the potential for metal leaching. Leachate pH values were acidic, ranging between 3 and 4. Leachable concentrations of copper exceeded the Metal Mining Effluent Regulations (MMER)<sup>3</sup> Maximum Allowable Monthly Mean Concentration (0.3 mg/L) in all samples, with a maximum concentration of 94 mg/L. Concentrations of nickel, lead, and zinc exceed the MMER guidelines in less than three of the 25 shake flask samples. MMER guidelines are unavailable for the majority of elements (it is inappropriate to apply aquatic or drinking water guidelines to shake flask leachate). Potential effects of metal leaching from the tailings is best determined by assessing the water chemistry of Great Slave Lake in the vicinity of the site which has been receiving the tailings leachate for the preceding 40 years (Franz/EcoMetrix 2010 and SENES/Franz 2011). An overview of surface water quality is presented in Section 5.9.

Kinetic (humidity cell) testing was completed on a composite tailings sample collected from 0-40 cm depth in 2009 to estimate potential mass loadings of COCs to the environment over time. Results are available for seven weeks of testing only. The pH of the humidity cell leachate for the tailings was generally steady and averaged around a pH value of 3, with the pH increasing to about 3.6 at week 2. Sulphate concentrations showed a decrease from 93 mg/L at the start of testing to 16 mg/L after seven weeks, and were typical of the rinsing of pre-existing soluble products from the material. A similar trend was noted for acidity, with concentrations decreasing from 66 to 18 mg/L as CaCO<sub>3</sub> equivalent. Concentrations of most metals including mercury, antimony, arsenic, cadmium, chromium, molybdenum, selenium and uranium were below detection in the humidity cell leachates. Loading rates of other COCs including cobalt, copper, nickel, lead and zinc exhibited decreasing trends with time (Franz/EcoMetrix 2010).

---

<sup>3</sup> The MMER are cited solely for comparative purposes and are not considered to represent appropriate regulatory controls for the abandoned Outpost Island Mine.

**Table 5 Tailings – Acid Base Accounting Analyses**

Sample ID	A2-TAIL09-01A	A2-TAIL09-01B	A2-TAIL09-01C	A2-TAIL09-02A	A2-TAIL09-02B	A2-TAIL09-02C	A2-TAIL09-02D	A2-TAIL09-03A	A2-TAIL09-03B	A2-TAIL09-03C
<b>Depth</b>										
Paste pH	4.4	4.5	5	4.7	5.3	4.8	4.4	5.5	5.6	5.5
Neutralization Potential (Sobek)	5	3	4	4	4	5	1	4	4	4
Neutralization Potential (Carbonate)	<4.5	<4.5	4.5	<4.5	<4.5	4.5	<4.5	<4.5	<4.5	4.5
Acid Generating Potential	20.9	13.8	14.7	9.1	9.7	18.8	18.1	12.8	8.8	7.2
Net Neutralization Potential	16	11	11	5	6	14	17	9	5	3
Ratio (NP/AP)	0.24	0.22	0.27	0.44	0.41	0.27	0.06	0.31	0.46	0.56
Total Sulphur	0.67	0.44	0.47	0.29	0.31	0.6	0.58	0.41	0.28	0.23
Sulphate Sulphur	0.08	0.1	0.15	0.07	0.08	0.19	0.14	0.03	0.01	0.03
Sulphide Sulphur	0.59	0.34	0.32	0.22	0.23	0.41	0.44	0.38	0.27	0.2
Inorganic Carbon (as C)	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Inorganic Carbon (as CO <sub>2</sub> )	<0.2	<0.2	0.2	<0.2	<0.2	0.2	<0.2	<0.2	<0.2	0.2
<b>Sample ID</b>										
<b>Depth</b>										
Paste pH	5.6	5.3	4.7	4.8	5.1	4.2	4.2	4.5	4.6	
Neutralization Potential (Sobek)	4	3	1	2	2	1	1	2	2	
Neutralization Potential (Carbonate)	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	
Acid Generating Potential	8.8	11.9	5.9	14.4	10.3	10	17.8	13.8	11.6	
Net Neutralization Potential	5	9	5	12	8	9	17	12	10	
Ratio (NP/AP)	0.46	0.25	0.17	0.14	0.19	0.1	0.06	0.15	0.17	
Total Sulphur	0.28	0.38	0.19	0.46	0.33	0.32	0.57	0.44	0.37	
Sulphate Sulphur	0.01	0.22	0.08	0.11	0.08	0.24	0.22	0.16	0.15	
Sulphide Sulphur	0.27	0.16	0.11	0.35	0.25	0.08	0.35	0.28	0.22	
Inorganic Carbon (as C)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
Inorganic Carbon (as CO <sub>2</sub> )	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	

Source: Phase III ESA (Franz/EcoMetrix 2010)



**Table 6 Tailings – Metals Analyses**

SAMPLE		CCME ^	3x Crustal Abundance "	Number of Samples	Maximum Concentration	Average Concentration	Number Samples > CCME Criteria	Number Samples > Crustal Abun. Criteria
Depth (m)								
Ag *	ppm	20	0.21	25	1.3	0.3	0	10
Al	%	NC	24	25	4.51	3.57	0	0
As	ppm	12	39	25	61.0	9.2	5	1
Au	ppm	NC	***	6	23.5	8.5	0	0
Ba	ppm	500	1740	25	170	96	0	0
Be *	ppm	4	9	25	2.0	0.8	0	0
Bi	ppm	NC	***	25	35.8	9.6	0	0
Ca	%	NC	6.63	25	0.48	0.10	0	0
Cd	ppm	10	0.9	25	0.10	0.03	0	0
Ce	ppm	NC	177	25	89	56	0	0
Co *	ppm	50	57	25	57.3	24.3	2	1
Cr	ppm	64	270	25	129	39	6	0
Cs	ppm	NC	5	19	1.02	0.77	0	0
Cu	ppm	63	135	25	4,939	1,454	25	25
Fe	%	NC	14.16	25	5.37	4.15	0	0
Ga	ppm	NC	19	19	16.8	13.3	0	0
Ge	ppm	NC	1.6	19	0.270	0.139	0	0
Hf	ppm	NC	8.4	25	5.7	3.2	0	0
Hg	ppm	6.6	0.4	19	1.60	0.28	0	4
In	ppm	NC	0.1	19	0.162	0.111	0	12
K	%	NC	7.98	25	1.92	1.55	0	0
La	ppm	NC	276	25	47.6	29.8	0	0
Li	ppm	NC	198	25	9	4	0	0
Mg	%	NC	4.5	25	0.73	0.56	0	0
Mn	ppm	NC	2550	25	160	61	0	0
Mo *	ppm	10	7.8	25	204.6	49.7	24	25
Na	%	NC	2.8	25	0.090	0.066	0	0
Nb	ppm	NC	33	25	10.6	5.7	0	0
Ni *	ppm	50	204	25	39.7	7.9	0	0
P	%	NC	0.21	25	0.039	0.026	0	0
Pb	ppm	140	60	25	2,477.8	184.7	5	6
Rb	ppm	NC	420	25	124	88.568	0	0
Re	ppm	NC	***	19	0.022	0.010	0	0
S	ppm	NC	2400	19	0.68	0.42	0	0
Sb *	ppm	20	4.5	25	79.50	3.44	1	1
Sc	ppm	NC	39	25	6.2	4.0	0	0
Se	ppm	1	0.6	19	17	7	19	19
Sn	ppm	50	18	25	38.9	15.7	0	6
Sr	ppm	NC	900	25	12.0	7.2	0	0
Ta	ppm	NC	2.4	25	0.79	0.40	0	0
Te	ppm	NC	***	19	19.25	3.15	0	0
Th	ppm	NC	36	25	17.6	9.2	0	0
Ti	%	NC	1.38	25	0.170	0.118	0	0
Tl	ppm	1	1.4	19	0.70	0.35	0	0
U *	ppm	23	11.1	25	4.7	2.7	0	0
V	ppm	130	390	25	37	27	0	0
W	ppm	NC	5.4	25	3,580	1,445	0	25
Y	ppm	NC	78	25	8.4	5.2	0	0
Zn	ppm	200	285	25	165	14	0	0
Zr	ppm	NC	160	25	191	113	0	1

Where concentration is < detection limit, ½ of detection limit is used for calculation

" = 1997 DRAFT Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia: 3x Average Crustal Abundance in Shale (Price 1997)

\* = CCME (2007), Canadian Soil Quality Guidelines, Update 7.0, Table 2.

\*\*\* Average concentration not available.

NC = No Criteria

Source: Franz/EcoMetrix 2010 and SENES/Franz 2011

**Highlight** Indicates exceedance of CCME criteria

**Table 7 Tailings – Shake Flask Analyses**

Analysis	Units	MMER *	Number of Samples	Number of Samples < RDL **	AVERAGE	MAXIMUM	Number of Samples > MMER *
Electric Conductivity	µS/cm		4	0	739	1960	NC
Dissolved Fluoride	mg/L		4	0	1	2	NC
Dissolved Chloride	mg/L		4	4	0	0	NC
Total Dissolved Solids	mg/L		4	0	715	2200	NC
Dissolved Hardness (CaCO <sub>3</sub> )	mg/L		4	0	376	1330	NC
pH (24h)	pH Units		25	0	3	4	NC
Acidity (to pH 8.3)	mg CaCO <sub>3</sub> /L		25	3	56	173	NC
Dissolved Sulphate	mg/L		25	0	183	1542	NC
Dissolved Al	mg/L		25	0	3	16	NC
Dissolved Sb	mg/L		25	25	0	0	NC
Dissolved As	mg/L	0.5	25	17	0	0	0
Dissolved Ba	mg/L		25	9	0	0	NC
Dissolved Be	mg/L		25	6	0	0	NC
Dissolved Bi	mg/L		25	25	0	0	NC
Dissolved B	mg/L		25	9	0	2	NC
Dissolved Cd	mg/L		25	9	0	0	NC
Dissolved Cs	mg/L		4	3	0	0	NC
Dissolved Cr	mg/L		25	22	0	0	NC
Dissolved Co	mg/L		25	0	0	2	NC
Dissolved Cu	mg/L	0.3	25	0	12	94	25
Dissolved Fe	mg/L		25	4	1	5	NC
Dissolved La	mg/L		4	0	0	0	NC
Dissolved Pb	mg/L	0.2	25	11	0	3	1
Dissolved Li	mg/L		25	4	0	0	NC
Dissolved Mn	mg/L		25	0	0	1	NC
Dissolved Hg	mg/L		25	23	0	0	NC
Dissolved Mo	mg/L		25	23	0	0	NC
Dissolved Ni	mg/L	0.5	25	0	0	1	2
Dissolved P	mg/L		25	23	0	0	NC
Dissolved Rb	mg/L		4	0	0	0	NC
Dissolved Se	mg/L		25	1	0	0	NC
Dissolved Si	mg/L		25	1	6	9	NC
Dissolved Ag	mg/L		25	25	0	0	NC
Dissolved Sr	mg/L		25	0	0	0	NC
Dissolved Te	mg/L		25	23	0	0	NC
Dissolved Tl	mg/L		25	13	0	0	NC
Dissolved Th	mg/L		25	24	0	0	NC
Dissolved Sn	mg/L		25	25	0	0	NC
Dissolved Ti	mg/L		25	25	0	0	NC
Dissolved W	mg/L		25	22	0	0	NC
Dissolved U	mg/L		25	0	0	0	NC
Dissolved V	mg/L		25	25	0	0	NC
Dissolved Zn	mg/L	0.5	25	0	0	1	1
Dissolved Zr	mg/L		25	25	0	0	NC
Dissolved Ca	mg/L		25	0	40	502	NC
Dissolved Mg	mg/L		25	0	7	20	NC
Dissolved K	mg/L		25	2	5	8	NC
Dissolved Na	mg/L		25	2	1	2	NC

\* Metal Mining Effluent Regulations (MMER 2011): Maximum Authorized Monthly Mean Concentration

\*\* Reportable Detection Limit

NC = No Criteria

**137** Denotes exceedance of MMER Guideline

Source: Franz/EcoMetrix 2010 and SENES/Franz 2011

## 5.6 WASTE ROCK

Waste rock was assessed as part of the Phase III ESA (Franz/EcoMetrix 2010). In general, waste rock characteristics are consistent with local bedrock geology, which are reported as metamorphosed sedimentary units (e.g. quartzite and schist). Variable mineralization is documented as green/blue staining on waste rock surfaces. Laboratory analyses focussed on: acid-base accounting, metals analysis, shake flask testing and humidity cell testing. Volume and tonnage estimates are provided in Table 8 below.

**Table 8 Summary of Outpost Island Mine Waste Rock**

APEC/ AEC	Item	Mass (tonne)	Volume (m <sup>3</sup> )
2	Waste Rock/Tailings Mix in Upper Area	13,500	9,000
5	Surrounding Blast Trench *	<15	<10
6	Surrounding Blast Trench *	<1.5	<1
7	Shaft #2 Waste Rock Pile *	450	300
9	Surrounding Blast Trenches (East Island)	150	100
<b>TOTAL</b>		<b>~ 14,100</b>	<b>~ 9,400</b>

\* The volumes cited in this table differ from those provided in the Phase IIIa ESA (quantities reported in the Phase IIIa ESA were incorrect). The volumes reported in the current document take precedence.

ABA analysis was conducted on all waste rock samples collected, and are summarized in Table 9 below. Paste pH values ranged from 4.3 from one of the East Island samples (APEC 9), to 7.8 from the waste rock found near the tailings and mill (APEC 2). The NP was between 2 and 12 kg CaCO<sub>3</sub>/t, and total sulphur contents had a mean of 0.9%, ranging from 0.25% to 2.32%. Sulphur was primarily present as sulphide sulphur and the resultant AP values ranged from 7.8 to 72.5 kg CaCO<sub>3</sub>/t. The NNP of samples ranged from -2 to -68 kg CaCO<sub>3</sub>/t, with all NP/AP ratios less than 1. All waste rock was classified as likely acid generating.

Metal analyses of waste rock samples revealed several enrichments with respect to 10x the Average Crustal abundance (Faure 1998), as displayed in Table 10. Concentrations of bismuth (1 to 37 µg/g), copper (285 – 17,000 µg/g), selenium (1-3 µg/g) and tungsten (300 -1,700 µg/g) exceed the screening criteria in most, if not all, of the waste rock samples. Concentrations of arsenic, cadmium, lead, molybdenum, and zinc exceed in a small number of samples (three or less). Metal concentrations in waste rock do not necessarily indicate a potential for impact, as the metals may be hosted within stable minerals. The loading rates to the surrounding environment are based on weathering processes and the potential for the specific minerals within the waste rock to leach these metals.

Shake flask extraction analyses measure the leach potential of metals from the waste rock samples (Table 11). Concentrations of copper exceed the screening MMER guidelines of 0.3 mg/L in samples from the mill area (APEC 2) and from the East Island (APEC 9). The MMER criteria are in reference to direct discharge of mining effluent, which would serve as a highly conservative screening criteria. Shake flask analyses involve 24 hour agitation followed by elemental analysis. These results are not a direct measure of the leachate concentrations which would be entering surrounding aquatic systems under normal weathering conditions. However, shake flask results do provide an indication of contaminants of concern and the scale of leachate concentrations.

As MMER criteria are only available for a small number of parameters, CCME Freshwater Aquatic Life (FAL) criteria were also used, again providing a very conservative estimate of potential leachate impacts. In addition to copper, concentrations of chromium, iron, nickel and selenium exceed CCME FAL guidelines for waste rock collected from the East Island only. All other leachate concentrations are below detection and/or below CCME FAL criteria intended for use in the aquatic environment directly (Franz/EcoMetrix 2010). This indicates that, excluding copper, metal leaching from the waste rock is not a significant concern.

Humidity cell testing was conducted on waste rock samples collected from APEC 2, 7 and 9. The pH of the humidity cell leachates ranged between 3.3 and 4.0, demonstrating a decreasing trend with time. Similarly, sulphate concentrations peaked in week 1 at 35mg/L, decreasing to <10 mg/L at week 7. Concentrations of cobalt, copper, and zinc reached maximum concentrations of 0.11 mg/L, 4.4 mg/L, and 0.006 mg/L in week 1, decreasing throughout the testing procedure. Acidity values decreased from a peak at week 1 of 34 mg CaCO<sub>3</sub> equivalent/L to <10 mg CaCO<sub>3</sub> equivalent/L. Concentrations of antimony, arsenic, cadmium, lead, molybdenum, selenium and uranium in leachate were generally below detection during the first 7 weeks of testing (Franz/EcoMetrix 2010).

Results of humidity cell testing indicate that concentrations of copper, cobalt and zinc in waste rock may present theoretical concerns to surrounding aquatic systems. It is important to clarify, however, that humidity cell testing aims to estimate mass loadings to the environment, through 10 week laboratory controlled test work. In the case of the Outpost Island Mine, waste rock has been exposed to surface elements for the past 60 years. Within this context, current site conditions in the terrestrial and aquatic environments are considered to provide a more accurate measure of the metals of concern and loading rates from the waste rock.

**Table 9 Waste Rock – Acid Base Accounting Analyses**

Sample Number	Units	A2-WR09-01	A6-WR09-01	A7-WR09-01	A7-WR09-01	A7-WR09-02	A9-WR09-01	A9-WR09-02	A9-WR09-03
APEC		2	5	7	7	7	9	9	9
Sample Depth (m)		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Paste pH		7.8	7.3	6.9	6.9	5.5	6.2	6.5	4.3
Neutralization Potential (Sobek)	kg CaCO <sub>3</sub> /t	10	9	6	6	5	6	12	2
Neutralization Potential (Carbonate)	kg CaCO <sub>3</sub> /t	11.4	6.8	4.5	4.5	4.5	4.5	<4.5	<4.5
Acid Generating Potential	kg CaCO <sub>3</sub> /t	13.1	21.9	7.8	7.8	72.5	20.3	29.1	31.3
Net Neutralization Potential	kg CaCO <sub>3</sub> /t	-3	-13	-2	-2	-68	-14	-17	-29
Ratio (NP/AP)	---	0.76	0.41	0.77	0.77	0.07	0.3	0.41	0.06
Total Sulphur	%	0.42	0.7	0.25	0.25	2.32	0.65	0.93	1.0
Sulphate Sulphur	%	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.47
Sulphide Sulphur	%	0.39	0.67	0.22	0.22	2.28	0.61	0.88	0.53
Inorganic Carbon (as C)	%	0.13	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Inorganic Carbon (as CO <sub>2</sub> )	%	0.5	0.3	0.2	0.2	0.2	0.2	<0.2	<0.2
ARD Classification	---	Likely Acid Generating	Likely Acid Generating	Likely Acid Generating	Likely Acid Generating	Likely Acid Generating	Likely Acid Generating	Likely Acid Generating	Likely Acid Generating

Source: Phase III ESA (Franz/EcoMetrix 2010)

**Table 10 Waste Rock – Metal Analyses**

Sample Number	10x Average Crustal Abundance *	A2-WR09-01	A6-WR09-01	A7-WR09-01	A7-WR09-02	A9-WR09-01	A9-WR09-02	A9-WR09-03
		2	6	7	7	9	9	9
Metals (ug/g)								
Aluminum (Al)	840,000	36,900	23,000	20,800	25,200	33,600	40,200	32,500
Antimony (Sb)	2	0.2	0.18	0.08	0.27	0.38	0.58	0.1
Arsenic (As)	10	2.5	5.2	1.4	10	7.1	25.1	4.4
Barium (Ba)	2,500	80	40	30	40	150	180	90
Beryllium (Be)	15	1.04	0.64	0.52	0.54	0.6	0.72	0.82
Bismuth (Bi)	0.6	2.29	1.07	0.92	3	37.3	4.34	3.33
Cadmium (Cd)	1	1.67	0.86	0.03	0.32	0.02	0.02	0.05
Calcium (Ca)	530,000	1,500	1,100	400	800	500	700	100
Cesium (Cs)	10	0.79	0.53	0.4	0.42	0.36	0.5	0.74
Chromium (Cr)	1,850	28	27	33	36	40	41	29
Cobalt (Co)	290	30.8	16.4	21.9	43	42.5	69.5	60.9
Copper (Cu)	750	1,050	4,970	1,360	16,700	2,340	1,230	285
Indium (In)	0.5	0.105	0.099	0.04	0.17	0.091	0.074	0.046
Iron (Fe)	710,000	32,300	25,200	21,000	39,500	32,100	37,000	27,500
Lanthanum (La)	160	24	19.8	15.4	13.6	15.2	27	13.4
Lead (Pb)	80	1,195	734	23	287	43.7	11.7	48.7
Lithium (Li)	130	3.7	2.4	5.4	5.8	2.7	5.6	1.7
Magnesium (Mg)	320,000	5,700	2,700	3,300	3,300	4,200	6,800	1,300
Manganese (Mn)	14,000	98	71	43	53	57	98	49
Mercury Hg	0.1 to 4	0.02	0.02	<0.01	0.01	0.01	0.01	0.01
Molybdenum (Mo)	10	49.4	1.46	0.76	2.21	50.7	5.69	8.53
Nickel (Ni)	1,050	5.4	4.6	7.3	8.8	4.8	8.5	4.3
Niobium (Nb)	110	5.2	2.9	1.5	1.8	2.5	3	2.8
Phosphorus (P)	No Value	2,300,000	1,900,000	1,400,000	1,700,000	2,200,000	3,100,000	400,000
Potassium (K)	90,000	14,000	10,100	8,500	10,000	12,700	14,800	15,800
Selenium (Se)	0.50	3	3	1	3	2	2	2
Silver (Ag)	0.8	0.32	0.24	0.08	0.19	0.07	0.03	0.09
Sodium (Na)	230,000	700	300	400	500	800	900	700
Strontium (Sr)	2,600	6.3	19.8	11.5	9.9	4.7	9.6	7.6
Sulphur (S)	No Value	4,300	6,800	2,700	21,900	7,000	9,800	10,200
Tantalum (Ta)	10	0.43	0.22	0.13	0.12	0.22	0.21	0.21
Thallium (Tl)	3.6	0.23	0.17	0.11	0.28	0.13	0.17	0.28
Thorium (Th)	35	10.5	6.9	7.4	6.2	6.7	9.7	3.1
Tin (Sn)	25	8.6	4	3.4	4.3	1.4	2.4	2.7
Titanium (Ti)	53,000	1,080	650	370	400	820	1,160	710
Tungsten (W)	10	309	188	29.1	1,650	9.5	6.8	10.2
Uranium (U)	9.1	3.1	1.3	1.2	1.3	1.7	1.8	1.1
Vanadium (V)	2,300	23	14	10	10	17	34	13
Zinc (Zn)	800	1,050	529	17	163	34	13	35
Zirconium (Zr)	1,000	85	65	51.8	46.5	64.9	93.6	96

\* From Faure 1998

No Value = No criteria available

**Highlight** indicates exceedance of 10x Crustal Abundance Criteria

Source: Phase III ESA (Columbia/Franz 2010)

**Table 11 Waste Rock – Shake Flask Analyses**

SAMPLE	Units	MMER *	CCME FAL **	A2- WR09-01	A6- WR09-01	A7- WR09-01	A7- WR09-02	A9- WR09-01	A9- WR09-02	A9- WR09-03
APEC				2	6	7	7	9	9	9
pH	---	NC	NC	3.85	6.39	3.88	5.79	3.67	3.48	2.43
Conductivity	mS	NC	NC	0.05	0	0	0	0.04	0.05	1.43
Acidity as CaCO3	mg/L	NC	NC	<20	<20	<20	<20	21	26	498
Dissolved Sulphate (SO4)	mg/L	NC	NC	24	3	2	2	15	17	500
Mercury (Hg)	ug/L	NC	0.026	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<b>Dissolved Metals</b>										
Aluminum (Al)	mg/L	NC	NC	0.009	0.03	0.018	0.008	0.38	0.45	24
Antimony (Sb)	mg/L	NC	NC	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Arsenic (As)	mg/L	0.5	0.005	<0.001	0.002	<0.001	<0.001	0.002	<0.001	0.002
Barium (Ba)	mg/L	NC	NC	<0.005	<0.005	0.006	<0.005	<0.005	<0.005	<0.005
Beryllium (Be)	mg/L	NC	NC	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Bismuth (Bi)	mg/L	NC	NC	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (B)	mg/L	NC	NC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium (Cd)	mg/L	NC	0.017	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Calcium (Ca)	mg/L	NC	NC	7.1	0.43	0.43	0.31	0.23	0.27	23
Chromium (Cr)	mg/L	NC	0.0089	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<b>0.024</b>
Cobalt (Co)	mg/L	NC	NC	0.059	0.0028	0.0007	0.0038	0.023	0.027	1.8
Copper (Cu)	mg/L	0.3	0.002	<b>0.84</b>	<b>0.22</b>	<b>0.068</b>	<b>0.041</b>	<b>0.85</b>	<b>0.75</b>	<b>7.2</b>
Iron (Fe)	mg/L	NC	0.3	<0.1	<0.1	<0.1	0.27	<b>2.6</b>	<b>3</b>	<b>51</b>
Lead (Pb)	mg/L	0.2	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Lithium (Li)	mg/L	NC	NC	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.006
Magnesium (Mg)	mg/L	NC	NC	1.7	0.13	0.12	0.12	0.3	0.44	11
Manganese (Mn)	mg/L	NC	NC	0.044	0.002	0.004	0.003	0.004	0.007	0.067
Molybdenum (Mo)	mg/L	NC	0.073	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (Ni)	mg/L	0.5	0.025	0.008	0.002	0.002	0.001	0.004	0.004	<b>0.03</b>
Phosphorus (P)	mg/L	NC	NC	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium (K)	mg/L	NC	NC	0.47	0.24	0.37	<0.2	0.94	0.46	3.3
Selenium (Se)	mg/L	NC	0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<b>0.003</b>
Silicon (Si)	mg/L	NC	NC	0.36	0.54	0.22	0.26	0.83	0.96	9.1
Silver (Ag)	mg/L	NC	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Sodium (Na)	mg/L	NC	NC	0.22	0.21	0.19	0.19	0.21	0.2	0.55
Strontium (Sr)	mg/L	NC	NC	0.007	0.004	0.002	0.002	0.001	0.001	0.016
Tellurium (Te)	mg/L	NC	NC	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium (Tl)	mg/L	NC	0.0008	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Thorium (Th)	mg/L	NC	NC	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.013
Dissolved Tin (Sn)	mg/L	NC	NC	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium (Ti)	mg/L	NC	NC	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.11
Tungsten (W)	mg/L	NC	NC	<0.001	0.012	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium (U)	mg/L	NC	0.015	0.0007	<0.0001	<0.0001	<0.0001	0.0002	0.0005	0.005
Vanadium (V)	mg/L	NC	NC	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002
Zinc (Zn)	mg/L	0.5	0.03	0.006	<0.005	0.006	<0.005	<0.005	0.008	0.016
Zirconium (Zr)	mg/L	NC	NC	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.007

NC = No Criteria

\* Metal Mining Effluent Regulations (MMER 2011) - Maximum Allowable Monthly Mean Concentration

\*\* CCME Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CCME 2012)

**Bold** indicates exceedance of CCME FAL

**Highlight** indicates exceedance of MMER

Source: Phase III ESA (Franz/EcoMetrix 2010)

## **5.7 SOIL FINDINGS**

Soil samples were collected throughout the disturbed areas of the former Outpost Island Mine during the Phase II and III ESA field sampling programs. Additional sampling was conducted during the Phase IIIa ESA to characterize background concentrations. The sampling programs of disturbed areas focused on locations where impacts were suspected and, as a consequence, the results do not provide a representation of the site as a whole. Results from metal analyses in soil are summarized in Table 12, and organic compounds in Table 13. Results from volatile organic compound analyses have not been included, as all samples were below applicable criteria (detailed results are presented in SENES/Franz 2011).

### *Background*

In general, the soil in the background sampling area was high in organics and peat. These organic constituents are a potential cause of elevated PHC F3 concentrations in background soil (O’Sullivan et al. 2010), reporting as high as 1,300 mg/kg when compared to the CCME guideline value of 300 mg/kg. Selenium concentrations were also elevated in multiple background samples, with concentrations as high as 2.8 mg/kg reported (CCME guideline value of 1 mg/kg). The Outpost Islands are composed of highly mineralized bedrock which may explain the presence of higher-than-average metal concentrations in soil.

### *APEC 1- Former Fuel Storage Area*

As with all mines, elevated metal concentrations were expected due to the high mineralization in the area and the tailings pile. All soil samples submitted for metals analysis contained copper concentrations above the applicable guideline (up to 66 times the CCME criteria). Concentrations of selenium (up to 9 times the guideline) and molybdenum (up to 10 times the guideline) were also elevated in the soil. A small number of samples had elevated concentrations of arsenic, cobalt, mercury, tin and zinc (Franz/EcoMetrix 2010).

PHC exceedances were measured in surface drainage pathways that are down-gradient of the former tank area (northeast and southwest). Concentrations of PHC fractions F2 reached a maximum of 55,000 mg/kg (360 times guideline), F3 a maximum of 260,000 mg/kg (870 times guideline) and F4 a maximum of 120,000 mg/kg (43 times guideline).

### *APEC 2 – Tailings/Waste Rock and Mill Area*

The majority of soil samples collected in APEC 3 were within the tailings/waste rock area or near the former assay laboratory. All samples submitted for metals analysis within APEC 2 contained copper exceedances (up to 68 times the guideline), as well as selenium exceedances (up to 38 times the guideline). High concentrations of lead were also observed in several samples collected from the tailings area and near the former assay laboratory (up to 38 times the



guideline). Arsenic, cobalt, mercury, and molybdenum concentrations also exceeded their respective guidelines, although to a lesser degree.

The areas to the south and west of the mill had PHC exceedances of F2 and F3 (12 and 26 times guidelines respectively). The elevated PHC concentrations in this area are assumed to be associated with the operation of the mill equipment.

PAH compounds were documented in two soil samples collected from APEC 2: the first near the stained rock area and second to the northeast of the former assay lab. Concentrations are less than 4 times applicable guidelines, and are localized in spatial extent.

#### *APEC 3 – Buildings Area*

Most soil samples collected from APEC 2 had elevated concentrations of copper, molybdenum, and selenium (107, 5 and 8 times guidelines respectively). A single soil sample collected from the battery dump had tin concentrations approximately 100 times the applicable guideline. All other metal enrichments were small in scale and observed in fewer than three samples.

A sample collected south of the road area contained F2 PHCs slightly above the guidelines. Soil near the stained rock area had concentrations of F3 PHCs slightly above the applicable guideline. This confirms the Phase II ESA conclusion that the stain is petroleum-based.

#### *APEC 5*

The soil of APEC 5 was characterized by elevated concentrations of copper, molybdenum, and selenium, up to 68, 4, and 20 times applicable guidelines respectively. A sample collected north of the tram line had a mercury concentration slightly above the applicable guideline.

#### *APEC 9 – East Island*

Concentrations of metals in soil samples from the East Island were generally lower than observed on Outpost Island. The soil near the battery dump contained concentrations of copper, mercury, and selenium exceeding the guideline by 28, 5, and 3 times the applicable guidelines respectively. Soil near the suspected East Island assay laboratory is characterized by exceedances of many of the same metals as in the Outpost Island assay laboratory location, most notably concentrations of lead (approximately 12 times the guideline). A previous environmental investigation documented soil samples collected near the battery dump that contained high concentrations of zinc, which were not found in the samples collected during the Phase III ESA. An elevated concentration of F3 PHCs was detected in one sample, indicating that fuel handling took place near the battery dump area.

**Table 12 Soil Summary – Metals Analyses**

Analyte	CCME ^	Background			APEC 1			APEC 2			APEC 3			APEC 5			APEC 9								
		N	N> CCME	Avg.	Max.	N	N> CCME	Avg.	Max.	N	N> CCME	Avg.	Max.	N	N> CCME	Avg.	Max.	N	N> CCME	Avg.	Max.				
Metals (mg/kg)																									
B **	NC	4	0	0.36	0.50	7	0	0.7	1.0	19	0	0.5	3.9	8	0	0.6	2.8	0	NA	NA	8	0	3.5	14.0	
Cr 6+	0.4	4	0	0.75*	0.75*	7	0	0.075	0.075	19	0	0.075	0.075	8	0	0.075	0.075	8	NA	NA	8	0	0.075	0.075	
Sb	20	7	0	0.5	0.5	7	0	1.4	3.0	19	0	0.6	2.0	8	0	2.0	10.0	2	0	0.5	0.5	8	0	0.6	1.0
As	12	7	0	3	4	7	1	9	30	19	3	6	18	8	1	9	59	2	0	7	8	8	0	6	9
Ba	500	7	0	91	170	7	0	151	420	19	0	22	56	8	0	115	420	2	0	31	56	8	0	146	240
Be	4	7	0	0.2	0.2	7	0	0.2	0.4	19	0	0.2	0.2	8	0	0.2	0.2	2	0	0.2	0.2	8	0	0.4	0.7
Cd	10	7	0	0.4	0.6	7	0	0.5	1.2	19	0	0.1	0.3	8	0	0.5	3.0	2	0	0.1	0.2	8	0	0.4	0.7
Cr	64	7	0	6	22	7	0	9	29	19	0	13	53	8	2	50	190	2	0	22	35	8	0	18	40
Co	50	7	0	2	4	7	1	17	69	19	3	35	180	8	2	33	67	2	0	12	16	8	0	9	21
Cu	63	7	0	18	32	7	7	1,531	4,200	19	19	1,649	4,300	8	8	2,363	6,800	2	2	2,468	4,300	8	3	298	1,800
Pb	140	7	0	2	3	7	0	37	100	19	3	501	5,300	8	1	188	1,400	2	0	5	5	8	1	243	1,700
Hg	6.6	7	0	0.23	0.74	7	1	2	11	19	7	6	16	8	3	6	14	2	1	6	9	8	1	4	29
Mo	10	7	0	0.5	1.1	7	2	30	100	19	16	48	140	8	6	24	47	2	1	22	37	8	0	1	4
Ni	50	7	0	4	12	7	0	12	25	19	0	7	31	8	1	23	84	2	0	11	17	8	0	17	30
Se	1	7	3	1.2	2.8	7	5	3	9	19	19	10	29	8	8	5	8	2	2	13	20	8	3	1	3
Ag	20	7	0	0.5	0.5	7	0	0.9	2.0	19	0	0.5	1.0	8	0	0.5	0.5	2	0	1.0	1.5	8	0	0.9	2.0
Tl	1	7	0	0.15	0.15	7	0	0.17	0.30	19	0	0.16	0.30	8	0	0.15	0.15	2	0	0.15	0.15	8	0	0.15	0.15
Sn	50	7	0	1	1	7	2	35	150	19	1	8	51	8	1	628	5,000	2	0	4	4	8	0	6	25
U	23	7	0	1	3	7	0	4	8	19	0	2	5	8	0	2	4	2	0	4	4	8	0	3	9
V	130	7	0	4	15	7	0	14	21	19	0	14	28	8	0	13	23	2	0	6	8	8	0	20	31
Zn	200	7	0	25	59	7	2	122	330	19	0	18	90	8	2	133	720	2	0	10	15	8	1	100	340

Table 13 Soil Summary – Organic Compound Analyses

Analyte	CCME *	Background			APEC 1			APEC 2			APEC 3			APEC 9												
		N	N> CCME	N< MDL	Avg.	Max.	N	N> CCME	N< MDL	Avg.	Max.	N	N> CCME	N< MDL	Avg.	Max.	N	N> CCME	N< MDL	Avg.	Max.					
Petroleum Hydrocarbons (mg/kg)																										
F1 (C6-C10) - BTEX	210	7	0	7	10	25	12	0	4	57	160	8	0	5	31	170	7	0	7	12	4	0	4	6	6	
F2 (C10-C16 Hydrocarbons)	150	7	0	6	25	40	12	7	1	8,158	55,000	9	2	5	255	1,800	7	1	6	28	160	4	0	3	10	25
F3 (C16-C34 Hydrocarbons)	300	7	2	4	370	1,300	12	11	0	57,308	260,000	9	4	0	1,371	7,800	7	1	0	103	350	4	1	1	338	1,200
F4 (C34-C50 Hydrocarbons)	2,800	7	0	4	115	430	12	6	0	31,566	120,000	9	0	2	396	2000	7	0	2	35	150	4	0	3	354	1400
BTX Parameters (mg/kg)																										
Benzene	0.03	7	0	7	0.00	0.01	12	1	11	0.015	0.105	7	0	7	0.003	0.0032	0	2	0.003	0.0034	0	0	4	0.003	0.003	
Toluene	0.37	7	0	7	0.01	0.04	12	0	12	0.023	0.047	7	0	7	0.010	0.0102	0	2	0.010	0.0104	0	1	0.120	0.280		
Ethylbenzene	0.082	7	0	7	0.01	0.02	12	0	12	0.012	0.023	7	0	7	0.005	0.0052	0	2	0.005	0.0054	0	4	0.005	0.005		
Total Xylenes	11	7	0	7	0.03	0.08	12	0	12	0.047	0.095	7	0	7	0.020	0.0202	0	2	0.020	0.0204	0	4	0.020	0.020		
Polycyclic Aromatics (mg/kg)																										
Acenaphthene	7.9	0	NA	NA	NA	NA	6	0	6	0.05	0.18	8	0	7	0.00	0.01	1	0	1	0.00	0.00	0	NA	NA	NA	NA
Acenaphthylene	0.15	0	NA	NA	NA	NA	6	1	5	0.05	0.18	8	1	5	0.08	0.60	1	0	1	0.00	0.00	0	NA	NA	NA	NA
Acridine	NC	0	NA	NA	NA	NA	6	0	6	0.09	0.36	8	0	6	0.10	0.54	1	0	1	0.01	0.01	0	NA	NA	NA	NA
Anthracene	2.5	0	NA	NA	NA	NA	6	0	5	0.038	0.145	8	0	6	0.090	0.600	1	0	1	0.002	0.0020	0	NA	NA	NA	NA
Benzo(a)anthracene	1	0	NA	NA	NA	NA	6	0	5	0.05	0.18	8	2	3	0.76	4.70	1	0	1	0.00	0.00	0	NA	NA	NA	NA
Benzo(b&i)fluoranthene	1	0	NA	NA	NA	NA	6	0	4	0.10	0.23	8	2	2	0.59	3.50	1	0	0	0.01	0.01	0	NA	NA	NA	NA
Benzo(k)fluoranthene	1	0	NA	NA	NA	NA	6	0	4	0.06	0.18	8	1	2	0.34	2.20	1	0	1	0.00	0.00	0	NA	NA	NA	NA
Benzo(g,h,i)perylene	6.6	0	NA	NA	NA	NA	6	0	5	0.05	0.18	8	0	2	0.28	1.70	1	0	1	0.00	0.00	0	NA	NA	NA	NA
Benzo(c)phenanthrene	NC	0	NA	NA	NA	NA	6	0	5	0.05	0.18	8	0	6	0.03	0.18	1	0	1	0.00	0.00	0	NA	NA	NA	NA
Benzo(a)pyrene	20	0	NA	NA	NA	NA	6	0	5	0.05	0.18	8	0	2	0.66	4.40	1	0	1	0.00	0.00	0	NA	NA	NA	NA
Benzo(e)pyrene	NC	0	NA	NA	NA	NA	6	0	4	0.6	3.6	8	0	2	0.4	2.7	1	0	0	0.0	0.0	0	NA	NA	NA	NA
Chrysene	7	0	NA	NA	NA	NA	6	0	4	0.07	0.18	8	0	2	0.99	6.00	1	0	0	0.03	0.03	0	NA	NA	NA	NA
Dibenz(a,h)anthracene	1	0	NA	NA	NA	NA	6	0	5	0.05	0.18	8	0	5	0.09	0.72	1	0	1	0.00	0.00	0	NA	NA	NA	NA
Fluoranthene	7.8	0	NA	NA	NA	NA	6	0	4	0.08	0.18	8	1	3	1.29	8.40	1	0	0	0.01	0.01	0	NA	NA	NA	NA
Fluorene	62	0	NA	NA	NA	NA	6	0	6	0.05	0.18	8	0	6	0.01	0.06	1	0	1	0.00	0.00	0	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1	0	NA	NA	NA	NA	6	0	5	0.05	0.18	8	1	2	0.33	2.20	1	0	1	0.00	0.00	0	NA	NA	NA	NA
2-Methylnaphthalene	0.99	0	NA	NA	NA	NA	6	0	4	0.06	0.18	8	0	6	0.00	0.01	1	0	1	0.00	0.00	0	NA	NA	NA	NA
Naphthalene	0.6	0	NA	NA	NA	NA	6	0	4	0.06	0.18	8	0	5	0.01	0.03	1	0	1	0.00	0.00	0	NA	NA	NA	NA
Phenanthrene	5	0	NA	NA	NA	NA	6	0	4	0.08	0.18	8	0	3	0.32	2.30	1	0	0	0.01	0.01	0	NA	NA	NA	NA
Perylene	NC	0	NA	NA	NA	NA	6	0	5	0.05	0.18	8	0	5	0.12	0.74	1	0	1	0.00	0.00	0	NA	NA	NA	NA
Pyrene	10	0	NA	NA	NA	NA	6	0	2	0.4	2.1	8	0	2	1.1	7.3	1	0	0	0.0	0.0	0	NA	NA	NA	NA
Quinoline	NC	0	NA	NA	NA	NA	6	0	6	0.09	0.36	8	0	8	0.01	0.01	1	0	1	0.0	0.01	0	NA	NA	NA	NA

\* CCME Soil Guidelines (2007) Residential/Parkland Criteria

MDL = Method Detection Limit

NC = No Criteria

NA = Not Available

Highlight indicates exceedance of CCME criteria

Source: Phase III ESA (Franz/EcoMetrix 2010) and Phase IIIa ESA (SENES/Franz 2011)

## **5.8 VEGETATION FINDINGS**

Vegetation sampling was conducted as part of the Phase III and IIIa ESAs (i.e., Franz/EcoMetrix 2010 and SENES/Franz 2011). While there are no guidelines governing metal concentrations in vegetation, the Ontario Ministry of the Environment (MOE) Upper Limits of Normal (ULN) were used throughout the ESA process (MOE 1993). These limits are not based on toxicological studies, nor are they necessarily applicable to northern species. However, the limits do provide a point of comparison for use in identifying vegetation that may be at risk due to mining-related contaminants.

Vegetation samples collected from the tailings/waste rock/mill area (APEC 2), the former buildings area (APEC 3), the former dump site (APEC 4) and East Island (APEC 9) demonstrated elevated metal concentrations corresponding to elevated metal concentrations in soil. The results of terrestrial vegetation sampling indicated that impacts are localized to the areas where the majority of the mining activities occurred (i.e., the mill, tailings pile, and tram area) and that they are generally not widespread throughout the rest of the site. Antimony, arsenic, chromium, copper, cobalt, lead, molybdenum, nickel, selenium and zinc concentrations were enriched in vegetation, with the greatest concentrations observed for samples collected from the tailings/waste rock area and the battery dumps. Concentrations are generally less than 4 times the MOE ULN values, and the vegetative stress observed may be partially attributable to natural conditions (e.g., climate, drought, insufficient nutrients). Additional details on metal concentrations in vegetation are presented in the Phase III ESA (Franz/EcoMetrix 2010) and Phase IIIa ESA reports (SENES/Franz 2011). The human health and ecological implications of the elevated metal concentrations in vegetation were also evaluated in the risk assessment of the site (SENES 2013).

## **5.9 SURFACE WATER FINDINGS**

Surface water sampling was conducted during the various field investigations (i.e., Columbia 2006, EBA 2009, Franz/EcoMetrix 2010 and SENES/Franz 2011). The studies focused on Great Slave Lake, with a particular emphasis on the North, South and East bays. Samples were also collected from four small ponds on Outpost Island, as well as background lake and ponded water sources.

Tailings are known to have been deposited in the North Bay, as confirmed through sediment sampling. The historical uses of the South and East bays are not known; however, tailings are currently stored on the adjacent shoreline and fuel storage is believed to have occurred in the area. A summary of metals analyses is provided in Table 14. No exceedances of PHCs, PAHs, or VOCs have been reported in any of the surface water samples.

Surface water collected from background locations in Great Slave Lake were below applicable criteria during all site investigations, excluding minor exceedances of aluminum and dissolved hexavalent chromium (EBA 2009, Franz/EcoMetrix 2010 and SENES/Franz 2011). Metal concentrations in ponded water collected from background locations showed a high degree of variability. One sample reported no exceedances of criteria, while the other displayed concentrations of aluminum, arsenic, chromium, iron and vanadium above guidelines (SENES/Franz 2010). The variability is presumed to be attributable to natural and site-specific factors (proximity to mineralized zones, geochemical properties of host rock, etc.).

Surface water collected from the near shore environment of Outpost Island had elevated metal concentrations which are assumed to be partially attributable to mining activities and materials. Copper displayed the greatest enrichments in the former tailings areas (North and South bays) with concentrations up to 160 times the applicable CCME guideline. Similarly, dissolved hexavalent chromium concentrations exceed guidelines in the majority of near shore samples (up to 17 times the guideline). Generally, the most elevated metal concentrations were observed in the North Bay, with the South Bay and East bays exhibiting lower levels of metals in surface water. Metal concentrations typically decreased with distance from shore. Concentrations of silver exceed guidelines by up to a factor of four, although only in six samples. Concentrations of cadmium, aluminum, iron, lead, zinc, and dissolved hexavalent chromium were elevated; however, guidelines were exceeded by a factor of three or less and in a small number of samples (less than 5). These findings were relatively consistent throughout the ESA process. Concentrations of mercury in surface water reported as part of the Phase III sediment core collection program are considered anomalous and are not reported herein.<sup>4</sup>

Areas draining the depression, trenches and Shaft #2 generally exhibited high concentrations of copper, silver and hexavalent chromium in the surface water, although these areas do not serve as aquatic habitat or the most likely source of drinking water to ecological receptors (Franz/EcoMetrix 2010).

A total of four ponds on Outpost Island were sampled throughout the ESA process. At the end of each of the drainage pathways in APEC 1, there was a depression area where ponded water had collected downgradient of the former fuel storage area. The north and south drainage pathways did not contain PHCs at levels exceeding freshwater criteria (SENES/Franz 2010), although metal analyses indicate elevated concentrations of copper, iron and strontium in the northern pond.

---

<sup>4</sup> The three water samples collected in conjunction with sediment core extraction are approximately 100x all other reported results in the North, South and East bays (excluding one sample from the Phase IIIa with a markedly high turbidity). It is likely that the mercury concentrations reported are a consequence of sediment disruption during core extraction, analytical error, or contamination of sampling implements.

On the East Island, staining of bedrock in the vicinity of exploration trenches suggests that some leaching of metals may be occurring from waste rock and/or excavations. However, based on the results of samples collected from the vicinity of the site and from background stations, there is limited evidence to suggest that leaching from the trenches has resulted in adverse impacts to surface water in Great Slave Lake. Elevated metal concentrations were measured in standing water collected near to the former camp area but this location does not represent a source of drinking water or aquatic habitat.

**Table 14 Surface Water Summary – Metal Analyses**

Total Metals	Units	CCME *	Lake Water					Pond Water				
			N	N<MDL	N >CCME	Max	Mean	N	N<MDL	N> CCME	Max	Mean
Cadmium (Cd)	ug/L	0.017	28	4	3	0.03	0.01	7	0	6	3.5	0.56
Mercury (Hg)	ug/L	0.026	28	5	1	0.043 ^	0.004	7	0	1	1,980	282.864
Methyl Mercury	ng/L	4	10	3	0	0.27	0.14	2	2	0	0.07	0.07
Aluminum (Al)	mg/L	0.1	28	0	2	0.305	0.065	7	0	6	1.3	0.556
Antimony (Sb)	mg/L	0.006	28	17	0	0.0014	0.0003	7	4	0	0.003	0.0007
Arsenic (As)	mg/L	0.005	28	13	0	0.0006	0.0003	7	1	2	0.01	0.0037
Barium (Ba)	mg/L	1	28	1	0	0.05	0.04	7	1	0	0.09	0.02
Beryllium (Be)	mg/L	-	28	28	0	0.0005	0.0005	7	7	0	0.005	0.001714
Boron (B)	mg/L	5	28	28	0	0.01	0.01	7	7	0	0.01	0.01
Calcium (Ca)	mg/L	-	28	0	0	29	27	7	0	0	36	10
Chromium (Cr)	mg/L	0.0089	28	28	0	0.005	0.001	7	6	1	0.016	0.004
Cobalt (Co)	mg/L	-	28	22	0	0.0175	0.0008	7	0	0	0.027	0.0121
Copper (Cu)	mg/L	0.002	28	0	15	0.325	0.015	7	0	7	2.6	0.786
Iron (Fe)	mg/L	0.3	28	5	0	0.3	0.1	7	0	6	13	3.8
Lead (Pb)	mg/L	0.001	28	22	0	0.001	0.000	7	3	2	0.2	0.029
Lithium (Li)	mg/L	-	28	28	0	0.01	0.01	7	7	0	0.01	0.01
Magnesium (Mg)	mg/L	-	28	0	0	7.65	6.36	7	0	0	8.8	2.99
Manganese (Mn)	mg/L	0.05	28	27	0	0.018	0.003	7	0	2	0.19	0.054
Molybdenum (Mo)	mg/L	0.073	28	0	0	0.0014	0.0008	7	6	0	0.001	0.0004
Nickel (Ni)	mg/L	0.025	28	0	0	0.0034	0.00124	7	1	0	0.015	0.00407
Phosphorus (P)	mg/L	-	28	27	0	0.1	0.1	7	5	0	1.2	0.3
Potassium (K)	mg/L	-	28	0	0	1.1	1.0	7	3	0	1.9	0.8
Selenium (Se)	mg/L	0.001	28	20	0	0.0003	0.0001	7	6	1	0.002	0.0006
Silicon (Si)	mg/L	-	28	0	0	1.7	1.4	7	1	0	6.3	2.4
Silver (Ag)	mg/L	0.0001	28	22	6	0.0004	0.0001	7	6	4	0.0008	0.0003
Sodium (Na)	mg/L	200	28	0	0	8.35	7.59	7	3	0	1.6	0.94
Strontium (Sr)	mg/L	-	28	0	0	0.14	0.13	7	3	0	0.06	0.02
Sulphur (S)	mg/L	-	28	0	0	10	7	7	0	0	11	3
Thallium (Tl)	mg/L	0.0008	28	28	0	0.0001	0.0001	7	7	1	0.001	0.0003
Tin (Sn)	mg/L	-	28	24	0	0.003	0.001	7	6	0	0.005	0.002
Titanium (Ti)	mg/L	-	28	8	0	0.004	0.002	7	4	0	0.014	0.004
Uranium (U)	mg/L	0.02	28	0	0	0.0011	0.0004	7	3	0	0.0039	0.0010
Vanadium (V)	mg/L	-	28	23	0	0.003	0.001	7	7	0	0.005	0.002
Zinc (Zn)	mg/L	0.03	28	17	1	0.039	0.004	7	2	1	1.5	0.226
Dissolved Hex. Chromium (Cr 6+)	mg/L	0.001	28	4	20	0.053	0.007	7	1	5	0.036	0.009

\*Lowest of the CCME Freshwater Aquatic Guidelines or the CCME Drinking Water Guidelines (CCME 2007)

^ Mercury concentration from a single sample collected at the shore with extreme turbidity

Source: Phase III ESA (Franz/EcoMetrix 2010) and Phase IIIa ESA (SENES/Franz 2011)

Supplemental surface water and sediment sampling was conducted during summer 2013 at select locations (by SENES at the request of AANDC/PWGSC). The program was not a comprehensive aquatic assessment, and aimed to refine the spatial distribution of metal impacts. The report of findings is pending; however, a preliminary review of data was conducted. There are no exceedances of CCME guidelines for site COCs (e.g. copper, mercury, silver) in any of the surface water samples collected. It is also noted that for many COCs the dissolved metal concentrations are an order of magnitude lower than total metal concentrations

## **5.10 SEDIMENT FINDINGS**

A small scale sediment sampling program was conducted as part of the Phase II ESA, during which eight samples were collected from the North and South bays of Outpost Island. Sediment sampling was continued in the Phase III and Phase IIIa ESAs, analyzing for metals, PHCs, PAHs and VOCs where appropriate.

A summary of metal analyses of sediment samples is provided in Table 15. Background concentrations of arsenic, cadmium, chromium, mercury and nickel in sediment were above the applicable guidelines, indicating that the aquatic environment reflects natural enrichment of metals in the local geology (Franz/EcoMetrix 2010).

Sediment sampling focused on the North Bay, which is known to be a location where tailings were deposited during the operational phase of the mine. Copper and mercury showed the highest exceedances in the near-shore sediments of the North Bay. As part of the Phase IIIa, sediment sampling extended southwest from the South Bay all the way to the South Island. Analytical results showed that exceedances over applicable criteria and/or background were detected for six metals, although concentrations were generally comparable to other far-shore sediments on the north, south and east sides of the island. Sediment samples from the East Bay displayed lower metal concentrations than either the North or South bays. Overall, copper concentrations exceeded applicable criteria in a total of 16 of 22 samples, with a maximum value 67 times applicable criteria. Similarly, mercury concentrations exceeded criteria in 17 of 21 samples, with a maximum value 38 times applicable criteria. Chromium, molybdenum, nickel, selenium and vanadium displayed minor exceedances in samples collected from Great Slave Lake. While arsenic concentrations are elevated with respect to applicable guidelines, values are consistent with background concentrations.

The sediment sampling programs have confirmed that the historic deposition of tailings in Great Slave Lake has likely resulted in elevated metals concentrations in sediment. However, the sampling results also suggest that the area of influence is likely limited to the near vicinity of Outpost Island. Although metal exceedances near the shore are clearly associated with tailings, far-shore exceedances are likely attributable to one or more of the following:

- Dispersal of tailings with movement of water and/or ice;
- Dissolution of metals from tailings, and subsequent binding to organic matter or precipitation with iron and manganese oxides and other solid phases in natural sediments of the surrounding area; and
- Naturally elevated concentrations of metals in native rock.

An elevated concentration of F3 PHCs was detected in one sediment sample collected from the East Bay. The result is assumed to be associated with a tarry substance observed in the sediment. A nearby sample also exceeded guidelines for two PAHs (SENES/Franz 2011).

**Table 15 Sediment Summary – Metals Analyses**

Analyte	Background Mean	Criteria *	N	N >MDL	N >CCME	Max	Mean
<b>Total Metals (mg/kg)</b>							
Boron, hot water soluble (B)	1	NC	20	15	NA	0.9	0.3
Chromium (Cr 6+)	0.075	NC	22	0	NA	0.075	0.075
Antimony (Sb)	0.6	NC	22	1	NA	1	1
Arsenic (As)	9.3	5.9	22	21	4	7	4
Barium (Ba)	215.2	NC	22	18	NA	350	110.7
Beryllium (Be)	0.72	NC	22	8	NA	1.1	0.4
Cadmium (Cd)	0.42	0.6	22	16	0	0.5	0.2
Chromium (Cr)	34.1	37.3	22	22	9	100	31
Cobalt (Co)	12.8	NC	22	22	NA	81.5	23.4
Copper (Cu)	32.3	35.7	22	22	16	2,400	338
Lead (Pb)	13.6	35	22	22	0	29	8
Mercury (Hg)	0.147	0.17	22	21	17	6.5	1.8
Methyl Mercury	0.265	NC	11	10	NA	5.34	1.14
Molybdenum (Mo)	1.3	13.8	22	22	8	69	14
Nickel (Ni)	37.5	23.4	22	22	9	57	24
Selenium (Se)	0.66	1.9	22	8	5	15	2
Silver (Ag)	0.5	NC	22	1	NA	2	1
Thallium (Tl)	0.18	NC	22	3	NA	0.3	0.2
Tin (Sn)	0.7	NC	22	19	NA	38	4
Uranium (U)	1.3	104.4	22	15	0	3	1
Vanadium (V)	61.5	35.2	22	22	7	79	28
Zinc (Zn)	81.6	123	22	17	0	79	36

\* CCME Interim Sediment Quality Guidelines

As previously mentioned, a supplemental surface water and sediment sampling program was conducted by SENES during summer 2013 at select locations. The report of findings is pending; however, a preliminary review of data was conducted and indicates that the sediment samples exhibit COCs consistent with previous sampling programs. Tailings were also observed at the mouth of North Bay, although samples further offshore are lower in metal concentrations. The presence of the primary COCs in sediment (e.g. copper, mercury and nickel) will be used to provide baseline data prior to the initiation of remedial activities.



## **5.11 AQUATIC BIOTA FINDINGS**

### **5.11.1 Aquatic Vegetation**

Aquatic vegetation collected as part of the Phase III ESA in tailings-impacted sediments showed evidence of uptake of aluminum, arsenic, cobalt, copper, mercury, molybdenum, nickel, selenium and vanadium (Franz/EcoMetrix 2010).

Phase IIIa results from vegetation collected from the North Bay showed that cobalt, copper and/or sodium exceeded the Ontario MOE ULN values (SENES/Franz 2011). Vegetation samples collected from the South Bay contained concentrations of aluminum, cobalt, copper and iron at higher than the MOE ULN values and background levels. Variability in concentration of contaminants between samples may be partially attributed to differences in metal uptake rates among macrophyte species and/or spatial differences in metal bioavailability within the submerged tailings areas (SENES/Franz 2011).

Copper levels in APEC 4 aquatic vegetation also displayed enrichment (SENES/Franz 2011). Barium was marginally enriched in vegetation collected from APEC 6 in the Phase III and Phase IIIa ESAS.

### **5.11.2 Sediment Toxicity and Benthic Community Analysis**

To assess potential impacts to the aquatic environment surrounding the Outpost Island Mine, benthic community analysis was conducted in the Phase III and Phase IIIa ESA, as well as sediment toxicity testing in the Phase IIIa ESA. Two sediment samples were collected from each of the North, South, and East bays of Outpost Island, as well as three samples in background locations. Benthic community descriptors including total invertebrate density, taxon richness, and diversity indices were calculated for background and potentially impacted areas. A statistical comparison between exposure and background areas was then conducted to detect any significant differences (SENES/Franz 2011).

Sediment toxicity analyses conducted with North Bay tailings caused toxic effects in all four toxicity tests, and had fewer benthic invertebrates, fewer taxa represented and lower diversity than the background sample. Results were consistent in both the Phase III and Phase IIIa ESA.

Sediment collected from the near shore environment of the South Bay was composed primarily of tailings. Sediments showed less evidence of toxic impact than those in the North Bay, with significant impacts on both survival and growth of *H.azteca*. In the Phase III ESA, benthic population analyses were approximately consistent with background. However, in the Phase IIIa

ESA, lower numbers of invertebrates and of taxa were reported when compared with background.

Phase III benthic population analyses in the East Bay found a high mean density of organisms (greater than background locations), although the lowest diversity and evenness, reflecting the fact that the benthic community in this location was dominated by one taxon. These results were consistent in both the Phase III and Phase IIIa ESAs. Adverse effects on growth of both toxicity test organisms were observed in East Bay; however, these effects were of lesser magnitude than those observed in the North and South bays (SENES/Franz 2011).

## **5.12 SITE ACCESS ROUTES**

On the basis of the site reconnaissance work done in 2009 and 2010, there is evidence of only one main site access road which linked the main mine site to the former cookhouse on Outpost Island. This route was approximately 4 m wide and covered in a thin veneer of waste rock (when not on bedrock). The route is generally stable with minor evidence of small scale washouts. In addition to this route, there is evidence to suggest there was a road/path between the Ore Pass Raise and the main site access route; however, the vegetation has started to regenerate in this section making it difficult to confirm this observation.

Access to other areas of Outpost Island, and to the East Island, will have to be from the water or new access roads will need to be constructed. Construction of access roads would prove difficult due to the predominance of bare bedrock ridges, especially on Outpost Island. Getting tracked or wheeled equipment across either of the islands would be impractical, except potentially in the winter over the snow and ice. Water access will also be challenging at the Shaft #2 location given the variations in the bedrock elevations in the area. Similarly, any future access to the East Island will have to consider the elevation change and topography between the lake and areas that may require remedial action. The blast/exploration trenches at the east side of East Island could be approached from the water or land, however, moving from this location to other parts of the site would require the cutting of a new site access road (SENES/Franz 2011).

## **5.13 POTENTIAL BORROW SOURCES**

A visual reconnaissance was conducted during the Phase IIIa ESA field campaign to identify potential borrow sources on the Outpost Islands. With the exception of the waste rock and tailings found in close proximity to the Shaft #1, there are no viable sources of borrow material on the islands. On the basis of analytical work completed on the tailings and waste rock, this material is not recommended for use as borrow due to the potential for acid generation and metal leaching (SENES/Franz 2011).

AANDC has recently implemented a borrow assessment program at the former Blanchet Island Mine in the East Arm Region, which is also projected for remediation. Results of the ongoing analytical program will determine if the borrow source at the site may potentially be used at the Outpost Island Mine as well. However, throughout this document it has been assumed that this option is unavailable due to physical properties and/or logistic considerations.

#### **5.14 POTENTIAL LANDFILL LOCATIONS**

An assessment of potential landfill locations was conducted as part of the Phase IIIa ESA. The assessment was based on the current location of debris, proximity of borrow material as well as the topography and stratigraphy of the potential landfill locations (SENES/Franz 2011).

Only one viable landfill location was identified on site and that is within the tailings/waste rock of Outpost Island, near where the main mine workings are located. The size of the landfill is limited by the size of the tailings/waste rock stockpile and the surrounding topography. The stockpile is in close proximity to the shores of Great Slave Lake and, as such, is not an ideal location for a landfill (due to the difficulty of obtaining the necessary regulatory approvals). However, there is evidence to suggest that material has already been buried within the stockpile (SENES/Franz 2011).

There are potential landfill areas on the East Island; however, the volume of debris on the East Island is minor relative to the debris on Outpost Island. Furthermore, there are no viable borrow sources on the East Island and access is likely to prove challenging. These factors eliminate the East Island as a potential landfill site (SENES/Franz 2011).

The South Island was not impacted by the mine operations and, although there is space available for a landfill on the island, the lack of borrow material and the potential for damage to the natural environment eliminate this location as a potential area for a site landfill (SENES/Franz 2011).

#### **5.15 POTENTIAL SOIL TREATMENT LOCATIONS**

The results of the analytical work completed on the surficial soils from both Outpost Island and East Island has determined that there is only a minor amount of petroleum hydrocarbon impacted material on site. It is, therefore, unlikely that on-site soil treatment would be the preferred option for management of soils with elevated concentrations of PHCs. Nonetheless, if on-site treatment were to be considered, the only location with a suitable work area is located on top of the tailings/waste rock stockpile on Outpost Island.

## **6.0 ECOLOGICAL AND HUMAN HEALTH RISKS**

At the conclusion of the ESA process, SENES was commissioned by PWGSC (on behalf of AANDC-CARD) to conduct a Human Health and Ecological Risk Assessment (HHERA) of the Outpost Island Mine. The draft risk assessment was completed by SENES in January 2011 as part of a comprehensive Detailed Quantitative Risk Assessment (DQRA). The findings of the draft risk assessment prompted the following supplemental studies that have been used to further assist in evaluating potential risks at the site: 1) a desk-top review of background mercury concentrations in fish tissues collected throughout Great Slave Lake; and 2) a sensitivity analysis of assumptions used in the risk assessment. The updated HHERA was produced in February 2013. The following sections present the risk assessment methodology and findings as taken directly from the Final HHERA (SENES 2013).

### **6.1 RISK ASSESSMENT APPROACH AND METHODOLOGY**

The Outpost Island Mine human health risk assessment was conducted according to Health Canada guidance on DQRA (Health Canada 2010a) to evaluate the probability of adverse health consequences to humans caused by the presence of contaminants in the environment. The ecological risk assessment was carried out using the framework as provided by the Canadian Council of the Ministers of the Environment (CCME 1996). Assumptions made throughout all stages of the risk assessment were selected to err on the side of caution in over-estimating intakes and exposures. This level of conservatism is consistent with the approach typically adopted in the risk assessment process.

A detailed review of the multi-year ESA findings was conducted to obtain the data for use in the risk assessment. It should be noted that the ESA data were biased towards areas of contamination and, therefore, are not representative of the entire site. Contaminants of Potential Concern (COPCs) were selected by comparing maximum measured concentrations in soil, surface water and sediment to the CCME guidelines (where available) and/or appropriate background measurements. The COPC that were evaluated at the Outpost Island Mine include the following:

Arsenic	Mercury	Zinc	1,2,4-trimethylbenzene
Boron	Molybdenum	Acenaphthylene	PHCs >C10-C16 (F2)
Cadmium	Selenium	Benzo(a)pyrene	PHCs >C16-C34 (F3)
Cobalt	Silver	Benzo(a)anthracene	PHCs >C34-C50 (F4)
Copper	Strontium	Benzo(b&j)fluoranthene	
Iron (aquatic only)	Tin	Fluoranthene	
Lead	Titanium	Ideno(1,2,3-cd)pyrene	

To determine the risk to human and ecological receptors, exposure point concentrations were calculated for soil, terrestrial vegetation, water, sediment and aquatic vegetation. The exposure point concentrations were calculated for each area of the former Outpost Island Mine, as well as background conditions. It was assumed that individuals would be present on both the main island (Outpost Island) and the East Island, and would be exposed to the reasonable maximum exposure concentrations for the different media, presenting a highly conservative assessment of risks.

### **6.1.1 Human Health Risk Assessment Methodology**

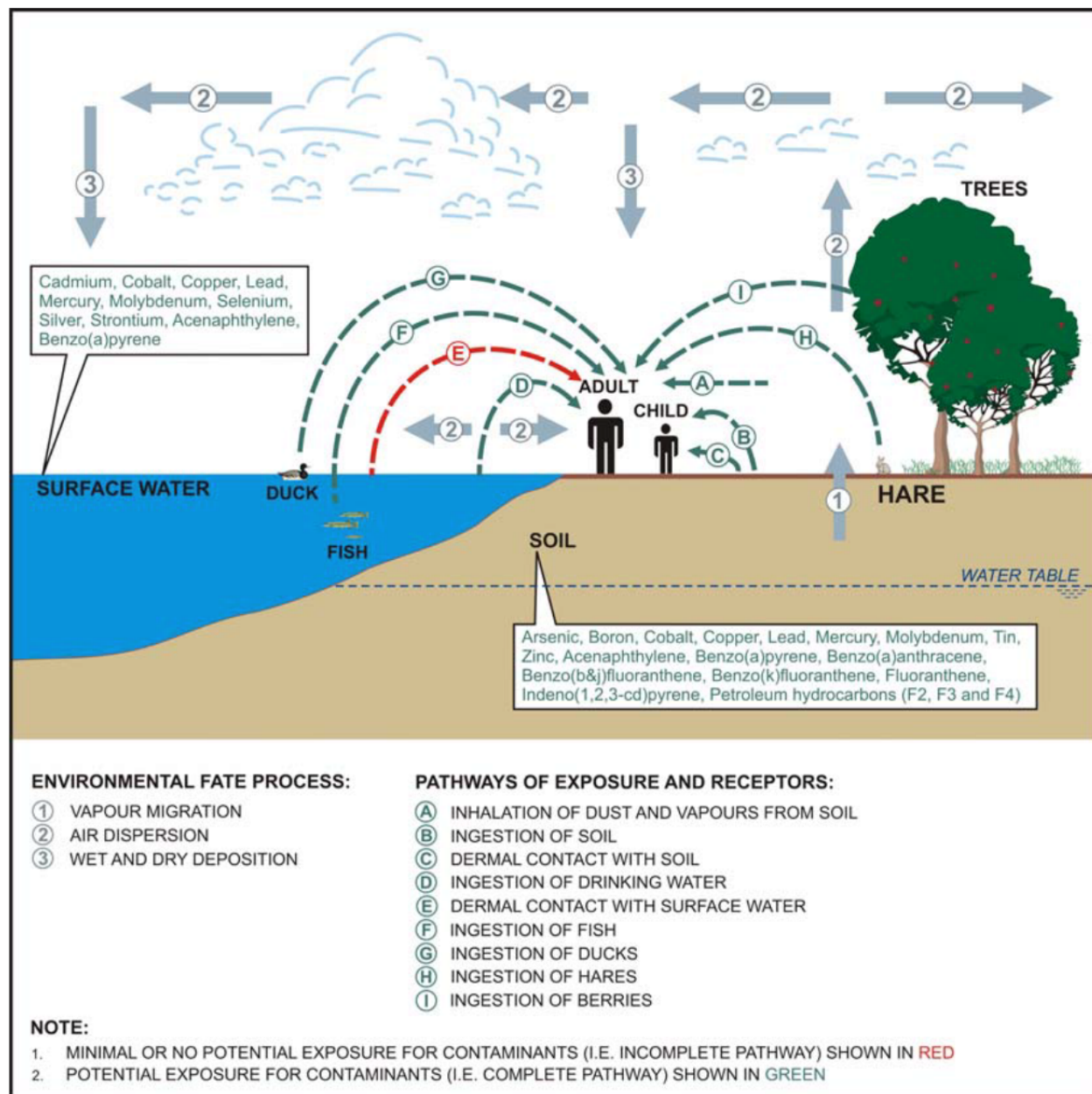
The Human Health Risk Assessment (HHRA) was undertaken to determine the potential for adverse human health effects from COPC present at the site. Although the site is currently unoccupied, it was assumed for the assessment that the site is used under the recreational land use scenario as described by Health Canada (2010b) with various age ranges present (toddlers, children, teens, adults) for a total of 200 hours per year. During the time the receptors are on site, it was assumed they would obtain all fish, game and berries from the site and would take meat back to their community, with a highly conservative estimate of 6 months food supply obtained. The pathways considered in the assessment included ingestion (soil, water, fish, ducks, hare and berries), dermal contact with soil, and inhalation of dust and vapours. Conservative assumptions were made in the characterization of human receptors for all aspects of the assessment. A graphical representation of exposure and contaminant pathways is provided in Figure 21.

The dose response assessment involved the identification of potentially toxic effects and the determination of the appropriate toxicity reference values (TRVs) for the various COPC. The TRV is defined as the amount of constituent exposure that can occur without resulting in the production of any adverse health effects (for threshold or non-cancer causing constituents). Toxicity reference values from Health Canada (2010c) were selected where available. The estimated exposures (or intakes) by the human receptors were divided by the TRVs to determine a hazard quotient (HQ) value. A HQ benchmark of 0.5 was selected to account for the various exposure pathways (inhalation, and ingestion of soil, water and food) that were evaluated in the assessment.

Carcinogenesis is generally assumed to be a "non-threshold" type phenomenon whereby any level of exposure to a carcinogen poses a finite probability of generating a carcinogenic response (i.e., for carcinogens, no threshold is assumed to exist and every dose presents some risk). An incremental risk is calculated by multiplying the estimated dose by the appropriate slope factor for dermal and oral exposures and the amortized air concentration by the appropriate unit risk for inhalation. The calculated risk is then compared to acceptable benchmarks. In this assessment,

an incremental risk level of  $1 \times 10^{-5}$  was used to assess carcinogenic effects. Health Canada considers this value to represent an “essentially negligible” risk (Health Canada 2010b).

**Figure 21 Human Health Risk Assessment – Conceptual Site Model**



Source: SENES 2013

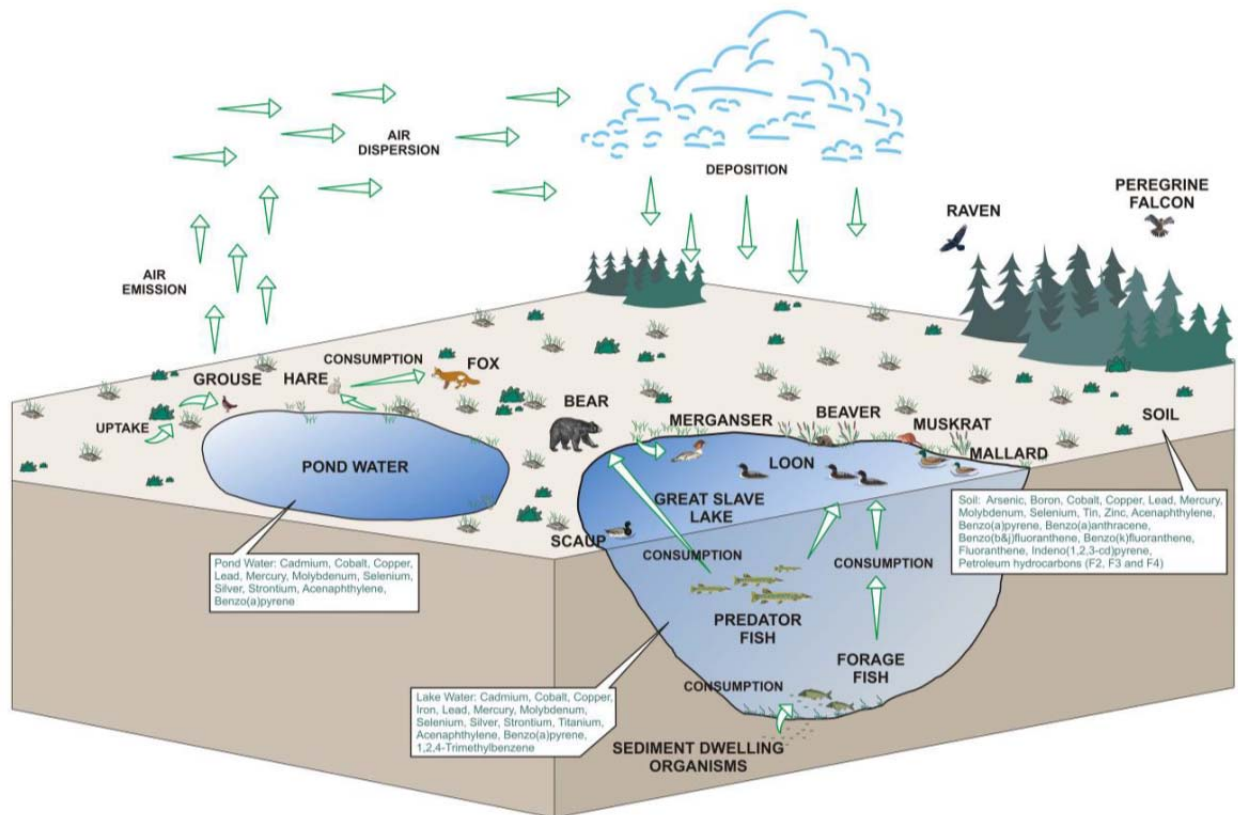
### 6.1.2 Ecological Risk Assessment Methodology

An Ecological Risk Assessment (ERA) was undertaken for the Outpost Island Mine, examining the potential exposure to ecological receptors that may be exposed to contaminated soil, sediment, surface water and vegetation. It should be noted that ERAs are concerned with the protection of populations and not individual species. Aquatic receptors chosen for analysis in the ERA cover all trophic levels in the lake system and include aquatic plants, phytoplankton (e.g. *Chlorophyta*), zooplankton (e.g. *Cladocerans*), benthic invertebrates (e.g. midge), forage fish (e.g. whitefish), and predator fish (e.g. trout). Terrestrial receptors were chosen to assess the exposure to COPCs of herbivores, omnivores, and carnivores potentially present at Outpost Island Mine and included: beaver, hare, muskrat, spruce grouse, bear, waterfowl (i.e. mallard, merganser, scaup, and loon), Peregrine Falcon, and fox. Ecological receptor characteristics were assumed to represent a maximum exposure scenario, in that cautious assumptions were made regarding the receptor's behaviour and home range. For example, it was assumed that the Peregrine Falcon obtained all its food from the maximum concentration location while on site. This is very conservative since the home range of a Peregrine Falcon is larger than the mine site. A Conceptual Site Model of ecological pathways at the Outpost Island Mine is provided in Figure 22.

Examination of potential pathways of exposure determined the most significant pathway of exposure to ecological receptors is through ingestion of soil, sediment and contaminated food sources at the Outpost Island site (dermal exposure less significant due to feather and fur). The food sources and the animals that ingest them include: aquatic vegetation (muskrat, mallard, scaup and beaver), benthic organisms (muskrat, mallard and scaup), fish (bear, merganser and loon), terrestrial vegetation (hare, grouse, bear, fox, beaver and raven), earthworms (raven), hare (raven, fox and Peregrine Falcon), ducks (fox and Peregrine Falcon), grouse (Peregrine Falcon) and birds (Peregrine Falcon).

Transfer factors were used to determine COPC concentrations in different dietary components in the food chain (i.e., concentrations in fish calculated using transfer factors from water). These calculated intakes were divided by intake levels considered to be protective of the species (i.e., toxicity reference values or TRVs) to obtain a screening index (SI) value for comparison to appropriate benchmarks. SI values greater than the applicable benchmark, were highlighted for further interpretation.

**Figure 22 Ecological Risk Assessment – Conceptual Site Model**



Source: SENES 2013

## 6.2 HUMAN HEALTH RISK ASSESSMENT FINDINGS

For this site, both non-carcinogens and carcinogens were present in the soil and surface water. For many non-carcinogenic effects, protective biological mechanisms must be overcome before an adverse effect is manifested from exposure to the COPC. This is known as a "threshold" concept.

The risk assessment determined that hazard quotient values for mercury are above the benchmark of 0.5 for all human receptors on both Outpost Island and East Island and that the major route is fish ingestion. Exposure to all other COPC results in HQ values below the benchmark of 0.5. It should be noted that mercury concentrations in fish were calculated using literature derived transfer factors, and not from site specific fish tissue samples. In addition, the mercury concentrations in fish were driven by three water samples collected in 2009 in the vicinity of the South Bay; these samples were at least two orders of magnitude higher than any other samples collected in the area.



A sensitivity analysis was carried out to examine the influence of the assumptions used in the risk assessment on the calculated results. The scenarios considered in the sensitivity analysis included: varying mercury concentrations in fish based on regional data from Great Slave Lake, varying fish consumption rates based on advisories from Health Canada and varying the fraction of the time humans consumed food from site. In the more realistic scenarios, where the mercury in fish concentrations were based on measured concentrations in Great Slave Lake fish, the HQ values were all below the benchmark, with the exception of the scenario associated with the high fish consumption rate and eating the fish for a period of 6 months. In addition, given that the predicted mercury in fish samples were driven by three elevated concentrations of mercury in the water near South Bay, a sensitivity analysis was conducted to examine the effect of removal of these seemingly anomalous samples from the data set. The sensitivity analysis of the revised data set demonstrated that the HQ values were below the benchmark. The weight of evidence therefore suggests that mercury is not a concern at the Outpost Island Mine.

For carcinogenic COPC, all calculated risk levels were below the Health Canada negligible risk limit ( $1 \times 10^{-5}$ ) for an individual that is present at the site for 200 hrs/year and harvests food from the site for consumption over a six month period. Therefore, there is no concern for humans related to exposure to carcinogenic COPC at the Outpost Island Mine.

### **6.3 ECOLOGICAL RISK ASSESSMENT FINDINGS**

Based on the surface water maximum concentrations in Great Slave Lake, copper concentrations in the near shore of North Bay, East Bay and South Bay (where the submerged tailings and mining operation were located) result in SI values above 1 for aquatic receptors. Cobalt concentrations also exceed an SI value of 1 for zooplankton in North Bay; however, the exceedance is limited spatially, as North Bay is a very small water body, and thus zooplankton populations in the vicinity of the Outpost Island mine site are not expected to experience any adverse effects. Maximum measured concentrations of copper and mercury in sediment exceed the SI threshold at a variety of locations. However, concentrations of copper and mercury in sediments from the North Bay, East Bay, South Bay and dock areas are elevated relative to background and are reflective of the submerged tailings in these areas. It is, therefore, expected that there may be adverse effects on benthic organisms in these small spatial areas, but not in other areas around the Outpost Island Mine. These findings were confirmed by sediment toxicity and benthic population analyses conducted during the ESA process.

With respect to avian receptors, SI values for raven exposed to the maximum lead levels on Outpost Island and maximum lead and mercury levels on East Island exceed the SI benchmark value. This is primarily attributable to the small scale battery dump, displaying elevated lead and mercury concentrations in soil, and consequently in earthworms and raven. Lead exposure in grouse from the tailings area (APEC 2) was more than 99% attributable to the soil ingestion

pathway, which resulted in the SI equal to the benchmark of 1. All other SI calculations in avian receptors were below the benchmark, and thus, the tailings do not represent a major source of risk to avian receptors. Elevated copper exposure in scaup within the North Bay (location of submerged tailings) is attributable to benthic invertebrate ingestion. Literature transfer factors were used to calculate the benthic invertebrate concentrations and may lead to an over-estimate of exposure and risk. In addition, this area is limited spatially and therefore it is not expected that populations of waterfowl which consume benthic invertebrates will experience adverse effects (i.e., the small areas affected by the mine are insufficient to support *populations* of these species).

Mammals assessed as part of the HHERA displayed minor elevations of SI values above the benchmark value of 1. Specifically, hare exposed to the reasonable maximum concentrations for copper have SI values above 1 on Outpost Island. Areas with elevated concentrations of copper are small and adverse effects to the local hare population are not anticipated.

#### **6.4 OVERALL CONCLUSION**

In summary, it is not expected that there will be risks to humans using the site for 200 hours and taking back food and consuming it over a six month period. High soil concentrations of lead in APEC 2 on Outpost Island and high lead and mercury concentrations in soil related to the battery dump at East Island resulted in exceedances of benchmarks for two avian species; however, it is not expected that populations of avian species would be affected. In addition, high localized copper concentrations in soil on Outpost Island resulted in SI values above 1 for hare. Given the limited spatial extent of areas with elevated copper concentrations, it is not expected that populations of hare would experience adverse effects.

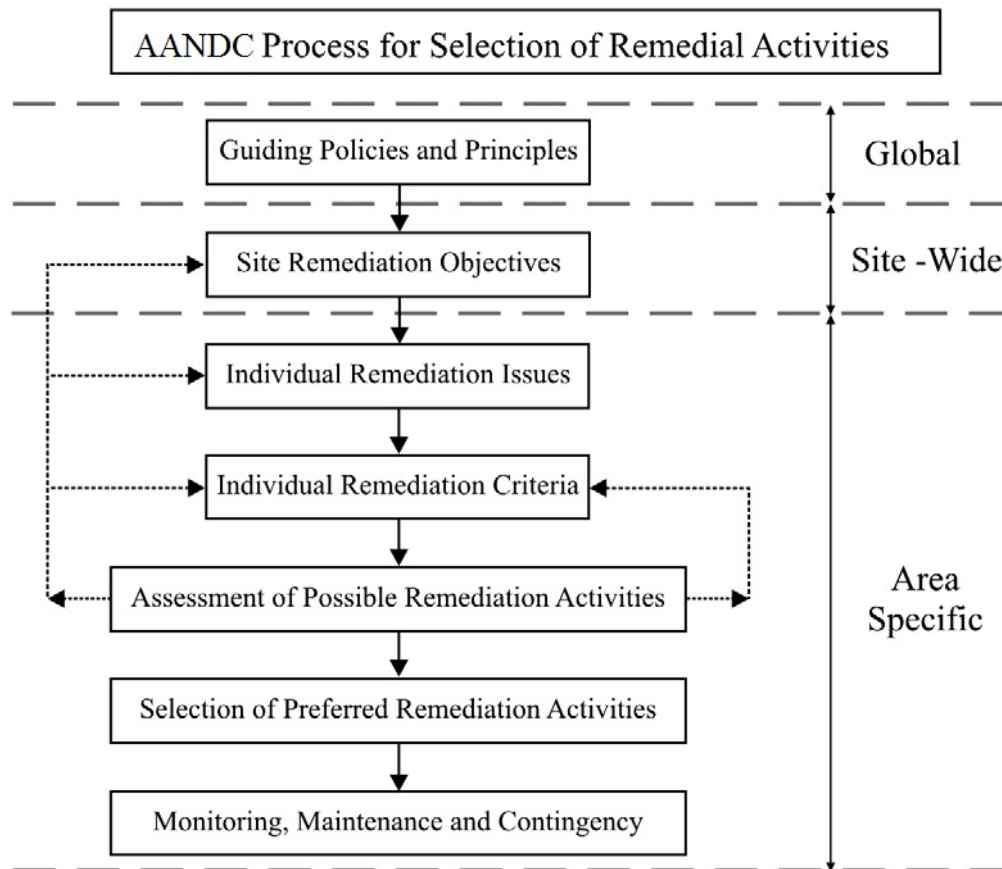
The battery dump on East Island is a source of elevated lead and mercury concentrations and remedial actions such as removal or cover are necessary to manage this exposure. Elevated copper concentrations are more widespread but it is unlikely that populations of ecological receptors will be affected.

## 7.0 PROPOSED REMEDIAL ACTION PLAN

### 7.1 PROCESS FOR SELECTION OF REMEDIATION ACTIVITIES

The general AANDC approach to remediation is illustrated in Figure 23. The specific process components carried out for the Outpost Island Mine and the development of remediation activities is provided in the following discussion.

**Figure 23 AANDC's Approach to Remediation**



#### 7.1.1 Process Approach and Considerations

The site consists of a number of features that have similar remediation issues. To enable the development of a coherent RAP, these features were grouped into like components that share similar characteristics and remedial issues. For each of these components, remedial issues and concerns were identified based on input from field studies and risk assessments. Remedial options were identified that can be used to address the concerns and hazards. The remedial options were assessed with respect to their ability to fulfill the overall framework and site-specific remedial objectives.

A Technical Recommendation was subsequently developed by evaluating factors such as: scientific merit, best practices, technical feasibility, ease of implementation and the documented performance of similar measures at abandoned mines throughout the Northwest Territories. This version of the RAP presents the Preferred Remedial Option which has been identified through technical recommendations and community engagement meetings. AANDC conducted traditional knowledge studies and a Remedial Options Analysis Workout meeting to determine community values and traditional knowledge as it pertains to the Outpost Island Mine. Upon conclusion of the community meetings, Preferred Remedial Options were chosen to address each of the components. The Preferred Remedial Option will then be finalized in the specifications or as required during the remediation.

Monitoring, maintenance and contingency plans are necessary to: 1) monitor for possible impacts and quality control while the remediation work is underway (*monitoring activities*); 2) to ensure health and safety of workers during remediation (*health and safety monitoring*); 3) monitor the effectiveness of the work that was done after its completion (*performance monitoring*); 4) ensure that any required maintenance work is done to keep the remediation work up to specifications (*maintenance activities*); and 5) make sure that backup plans are ready in case something unexpected takes place (*contingency plan*).

### **7.1.2 Typical Remedial Objectives and Considerations**

In general, the objective for any mine closure strategy is to assure:

- The protection of human health;
- Minimization of environmental impacts; and
- To the extent possible, restoration of the land to pre-mine conditions or a suitable alternative land use.

As noted previously, the Outpost Island Mine is situated in a relatively inaccessible location, where the key long-term issues for the site include assurances that the site is not causing material environmental damage; and the site is free of significant physical hazards. To address these issues, the following technical reclamation guidance was considered appropriate for the remediation of the site.

#### ***Physical Stability and Health and Safety***

- Ensure all surface openings are sealed to industry/engineering standards; and
- Minimize physical risks associated with other physical hazards (slopes, buildings, etc.).

### ***Environmental Effects***

- Reduce the potential for direct exposure of human and ecological receptors to hazardous media and materials; and
- Reduce environmental effects to levels that are as low as reasonably achievable.

### ***Land Use***

- Limit the volume of waste material present on site (good housekeeping); and
- Allow natural use of the land.

## **7.1.3 Listing of Remedial Components and Features at the Outpost Island Mine**

The ESA process identified the physical aspects of the mine and potential contamination of soil, vegetation, water and sediment. The HHERA determined the risk to humans and ecological populations from the environmental conditions. The results of these studies, in combination with AANDC guiding principles, were used to determine what issues and concerns should be addressed in the RAP. The following components and features of the Outpost Island Mine are discussed in the RAP:

- **Mine Openings:** Two shafts and two raises on Outpost Island represent a potential physical concern.
- **Buildings:** Dilapidated structures on East Island may represent a physical hazard to those who enter.
- **Refuse and Debris:** Metal debris and scrap machinery represent an aesthetic concern as well as a minor physical hazard.
- **Hazardous Waste Materials:** Broken batteries and a small (< 2 L) bottle of unknown oil based liquid are the only potentially hazardous materials located at the site.
- **Tailings/Waste Rock in Mill Area:** Acid generating and metal leaching concerns associated with the intermixed tailings/waste rock represent a source of metal loadings to the surrounding environment.
- **Waste Rock:** Acid generating and metal leaching concerns associated with the waste rock may represent a source of metal loadings to the surrounding environment.
- **Soils - Metals:** Metal concentrations are elevated in soils associated with tailings, former mine areas (e.g., assay labs) and broken batteries.
- **Soils – PHCs:** Small scale PHC impacts to soils (< 23 m<sup>3</sup>) were not identified as a source of risk in the HHERA, but are elevated above applicable soil criteria.

- Dock: A dock was constructed on the southern shore of Outpost Island and used during the operational period of the mine. A wooden crib is filled with rock and contains steel supports, some of which have detached from the structure.
- Sediment/Water: Concentrations of metals in surface water and sediments within the North Bay, and to a lesser extent the South and East bays, are elevated relative to background conditions.

#### **7.1.4 Review of Industry Standard Remedial Options**

Closure options are determined on a site-specific basis, but generally include the following options:

***Do Nothing*** – This option is considered where the site component poses negligible risk to human or ecological health, and where there is limited potential for worsening conditions with time. This option is typically included for all facilities and may be adopted where:

- Facilities are stable and do not represent a physical or ecological hazard;
- An area has been, or is being, naturally reclaimed by native vegetation; and,
- The facility has historic or archaeological value.

***Leave As Is with Monitoring*** – This option involves the application of a monitoring/inspection program to ensure physical or chemical conditions do not degrade with time; however, no remedial actions are implemented as part of the RAP.

***Consolidation and On-Site Disposal*** – This option would involve the consolidation of potential contaminant sources in an engineered facility to be constructed on or in the near vicinity of the Outpost Island Mine. Issues to be considered include proper location, availability of borrow material, long-term stability, leaching potential and cover options.

***Consolidation, Transport, and Off-Site Disposal*** – This would require consolidation, shipment off-site, and disposal in an appropriately licensed facility.

***Burning*** – Burning of wood can be used as a means to reduce the quantity of waste requiring disposal or transport. Ash residual is disposed of appropriately in either an on-site landfill or transferred off-site to a licensed waste disposal facility. Incineration of fuels may also be considered, however, the burning of other combustibles such as plastics is generally not acceptable.

***Restricted Access/Fencing*** – Fencing is used to prevent people and animals from accessing potential hazards. Fences require long-term care and maintenance, and are typically only considered as an interim measure or in cases where no viable alternative is available.

***Backfilling and/or Grading*** – Backfilling of shafts, adits, trenches, and pits is a common practice to reduce physical hazards at mine sites. Waste rock is often a candidate backfill material, which is used to reduce the footprint of the surface waste disposal area. Grading of waste rock piles may also be desirable to reduce physical risks and improve site aesthetics. Re-vegetation of graded surfaces is considered when feasible and appropriate.

***Dry Cover*** – Dry covers are often used as a means of isolating mine wastes (e.g., tailings and sometimes waste rock) from the environment. These covers may be simple barriers to intrusion, low permeability covers to reduce infiltration, or covers to support vegetation. Cover materials may include local borrow, imported clays and synthetic materials and waste rock. The selection of the cover material depends on the requirements for the cover and the availability of local borrow sources.

***Concrete Capping*** – Various designs of cast-in-place, or pre-cast concrete plugs and caps are used to prevent access to mine workings. The selection of the preferred method is a function of design requirements (e.g., bearing capacity) and characteristics of the opening (depth to bedrock, accessibility, size, availability of materials, etc.).

***Alternate Seals*** – Expanding foam has been used throughout Canada and the United States to seal mine openings, providing a viable option where access is limited. After hardening, seals are typically covered with granular material to protect against ultraviolet light and fire. Alternate sealing techniques could include metal cages frames for elevated remote locations, etc. as may be acceptable to the mines inspector based on site conditions.

## **7.2 REMEDIAL ASSUMPTIONS**

For the purpose of conceptual planning, the following assumptions were used in the evaluation of the various remedial options:

- Materials and equipment required for the remedial work would be transported to/from the site using a barge system on Great Slave Lake operating out of Hay River or Yellowknife.
- During barge access, due consideration should be given to the potential for the disruption of contaminated sediments and soils. This could occur during the docking process and in the unloading of equipment and supplies. For these reasons, such remedial activities

should be avoided in the vicinity of the tailings deposits within the South Bay or East Bay (North Bay is not accessible by barge).

- There are limited access routes within the islands due to the bedrock topography and the presence of steep ridges.
- Some options require heavy equipment. It is assumed that if heavy equipment is brought to the site, then it will be used strategically to remediate other portions of the site that would otherwise be managed by a risk management approach. As such, there will be common costs (e.g., excavator, bulldozer, mobilization) associated with a remedial approach.
- The camp size is estimated to consist of approximately 4-8 workers, the appropriate number of tents, a cooking area and a waste disposal area. The camp would be seasonal.

### **7.3 REMEDIAL OPTIONS**

The following sections present the proposed and preferred remedial options for the Outpost Island Mine. The general operating principles, characteristics, benefits and costs are discussed for each option and formed the basis of discussions during community engagement meetings. The remedial options are summarized in Table 16, with further discussion in the subsequent sections.

It is noted that Site Specific Target Levels (SSTLs) for use during remediation are currently under production. The development of SSTLs employs the findings of the ESAs and HHERAs to identify contaminant thresholds which may result in potentially unacceptable risks to human health or the environment. Upon completion of the SSTLs, the volume of impacted environmental media to be remediated will be refined and reflected in the technical specifications. The SSTLs will result in a decrease in volume of materials to be remediated (which are currently based on CCME criteria); however, are not anticipated to result in a substantive change or require refinement of remedial options.



**Table 16 Review of Remedial Components and Options for Outpost Island Mine**

COMPONENT	SUB-COMPONENT/ISSUE	REMEDIATION OPTIONS
<b>Mine Openings</b>		
Shaft #1 – Outpost Island	Unknown physical hazards as shaft is currently covered with waste rock and tailings.	1) Leave As Is; 2) Retrofit Caps and Raise Fill In; <b>3) Replace /Upgrade All Existing Seals and Seal Main Raise (Shaft #1 with concrete, all others with foam).</b>
Shaft #2 – Outpost Island	Concrete cap in poor condition representing a physical hazard.	
Ore Pass Raise – Outpost Island	Concrete cap stable; however, not constructed to current standards posing a physical hazard.	
Main Raise – Outpost Island	Main Raise within open cut poses a physical hazard.	
<b>Buildings</b>		
Outhouse – East Island	Dilapidated small wooden structures pose a minor physical hazard.	1) Do Nothing; 2) Leave As Is With Monitoring; <b>3) Demolish and Burn.</b>
Shed – East Island		
<b>Non Hazardous Refuse</b>		
Metal Debris – Site Wide	Abandoned mining equipment, and small can dumps are the primary metal debris, with. Minor physical hazard and aesthetic concern.	1) Do Nothing; 2) <b>Consolidate and Transport to an Off-Site Facility (excluding concrete and mill equipment);</b> 3) Consolidate and Dispose in an On-Site Landfill
Concrete Piers and Foundations – Site Wide	Concrete piers supporting the mining equipment, the former water tower, and building foundations represent an aesthetic concern.	
Wood Debris – Site Wide	Miscellaneous scraps of milled lumber. No significant physical hazard or aesthetic concern.	
Former Dock Area	Dilapidated dock with partially detached steel frame represents a physical hazard.	
<b>Hazardous Waste Materials</b>		
Broken Batteries in Dump Areas (APECs 3 and 9) and Small Bottle of Unknown Liquid (APEC 2)	Chemical hazards associated primarily with lead concentrations from broken batteries, and undetermined hazards with respect to unknown liquid.	1) Do Nothing; 2) <b>Consolidate and Dispose in an Off-Site Facility.</b>
<b>Mined Materials</b>		
Tailings/Waste Rock – Former Mill Area (APEC 2)	Well mixed deposit of waste rock/tailings with a potential to generate acid and leach metals.	1) Leave As Is; <b>2) Consolidate and Re-Slope;</b> 3) Consolidate, Re-Slope and Cover.
Waste Rock – Shaft #2 (APEC 7) and East Island (APEC 9)	Acid generating and metal leaching potential.	<b>1) Leave As Is;</b> 2) Deposit in Excavations on Surface.
<b>Impacted Environmental Media</b>		
Metal Impacted Soils – Multiple Discrete Locations	Elevated metal contents in soils associated with battery dumps. (general site soils not included in remedial measures)	1) Do Nothing; 2) Leave As Is with Monitoring; <b>3) Off-Site Management of Soils from Discrete Areas;</b> 4) Capping.
PHC Impacted Soils – Former Fuel Storage Area (APEC 1), Roadway (APEC 2), and Stained Rock (APEC 3)	Small scale impacts to soils, associated with former fuel usage.	1) Do Nothing; 2) Leave As Is with Monitoring; <b>3) Off-Site Disposal;</b> 4) On-Site Disposal; 5) On-Site Treatment.
Surface Water and Sediments – North, South, and East Bays of Outpost Island (APEC 8)	Elevated metal concentrations in a relatively small area within the near shore environment.	1) Do Nothing; <b>2) Leave as Is with Monitoring;</b> 3) Remove Sediments; 4) Cap Sediments; and 5) Isolate North Bay.

### **7.3.1 Mine Openings**

#### **7.3.1.1 Key Issues**

Although some mine openings were sealed during remedial efforts in 1994, additional measures may be required to mitigate current and/or future risks associated with the openings. The openings of potential concern include: Shaft #1, Shaft #2, the Ore Pass Raise and the Main Raise, all of which are located on Outpost Island. With regard to exploration trenches on both Outpost and East Islands, these features are similar to naturally occurring topographic features on the islands. On this basis, remediation of the trenches has not been considered.

#### **7.3.1.2 Potential Remedial Options**

Several options have been considered for management of the risks associated with the mine openings (Table 17). For context, current AANDC policy is that mine openings must be closed in accordance with the *Mine Health and Safety Act* of the Northwest Territories (1994). However, given the limited amount of design details in this legislation, precedent practice at other abandoned mine sites in the NWT (e.g., Port Radium, North Inca, Hidden Lake) has been to close mine openings in accordance with design specifications that are applied in other jurisdictions (e.g., Ontario).

##### ***Option 1 – Leave As Is with Monitoring***

This option assumes no remedial work would be completed. A long-term monitoring and inspection program would be adopted to ensure that adequate barriers (e.g., potentially fencing) and/or signage are maintained at the openings. Fencing is typically not recommended (due to ongoing care and maintenance requirements) when other viable solutions are available.

##### ***Option 2 – Retrofit Caps and Raise Fill-In***

This would involve locating and exposing Shaft #1. If deemed necessary, the opening would be sealed with an engineered concrete cap. Shaft #2 would be retrofitted with foam injected under the currently exposed concrete cap. The Main Raise would be filled with surrounding waste rock. The current cap on the Ore Pass Raise is adequate and no additional work at this location would be performed.

##### ***Option 3 – Upgrade all Existing Seals and Seal Main Raise***

This option provides the most comprehensive and permanent solution to the physical hazards posed by the mine openings. Shaft #1 would be exposed and fit with an engineered concrete cap. The existing caps over Shaft #2 and the Ore Pass Raise would be upgraded to current mine closure standards (e.g. foam). The trench in which the Main Raise would be further investigated (by excavating, to the extent feasible) to determine the location and condition of the opening.

The most appropriate closure method of the Main Raise would be determined following completion of this investigation and could include: a) backfilling with coarse fill; b) placement of a foam plug; or c) concrete cap. Based on current information, a foam seal is recommended.

**Table 17 Remedial Options – Mine Openings**

CRITERIA	Option 1 Leave As Is with Monitoring	Option 2 Retrofit Caps and Raise Fill-In	Option 3 Replace/Upgrade All Existing Seals & Seal Main Raise
Goals	Reduce the physical hazard with a permanent solution.		
Operating Principle	Regular monitoring of barriers, signage and conditions.	Retrofit shaft caps if determined to be a potential safety hazard. Leave Ore Pass raise in current conditions. Backfill the Main Raise with waste rock.	Replace/upgrade all existing concrete caps to current mine closure standards. Investigate Main Raise and seal as appropriate
Protection of Human Health and Environment	Moderate	High	High
Long Term Effectiveness	Moderate	Moderate-High (uncertainty regarding Main Raise)	High
Level of Confidence	Moderate	High	High
Potential Remedial Impacts	None	None	None
Implementation time for Remediation	1 Day / Year (inspection)	1 Week	2 Weeks
Site Disruption	Low	Low	Low
Ease of Implementation	High	Moderate	Low-Moderate (uncertainty regarding Main Raise)
Historical Community and Regulatory Acceptance	Moderate	High	High
Cost	Low (Moderate if long-term costs are included)	Moderate	High

### 7.3.1.3 Preferred Remedial Option

While mine openings at the Outpost Island Mine represent a theoretical hazard, the risks to humans under the “leave as is” scenario (Option 1) are very low. Nonetheless, best practices justify that additional work be performed to ensure the openings will remain secure over the long-term.

Option 2 would evaluate the openings on a case-by-case basis to determine if improvements are warranted. Such improvements would be guided by engineering judgement that considers the unique characteristics of the site, but would not necessarily comply with formal design requirements for mine openings. Based on the nature of risks and land uses at the site (e.g., remoteness, infrequent access and absence of heavy equipment that might compromise caps), Option 2 is considered acceptable. However, taking into consideration the opinions expressed during the Remedial Options Analysis Workout, and relatively modest cost premiums associated with sealing all openings to current mine closure standards, Option 3 has been selected as the preferred remedial option (Replace/Upgrade All Existing Seals and Seal Main Raise).

During the Remedial Options Analysis Workout meeting, community members indicated an acceptance for a hybrid approach. Following recommendations from technical advisors, it was suggested that a concrete cap be designed and constructed for the larger Shaft #1 and foam seals be used at the smaller openings (Shaft #2, the Ore Pass Raise and the Main Raise). While Option 3 was accepted as the preferred remedial option (upgrade and seal all openings), a hybrid approach will be applied using both foam and concrete.

#### ***7.3.1.4 Monitoring and Contingencies***

The condition of the foam plugs and concrete caps will require routine visual inspections in both the short and long term by a suitably qualified engineer (i.e. performance monitoring). Any concerns identified during the inspections may require maintenance and/or replacement. The technical design specifications will incorporate best practices to extend the lifespan of the seals.

### **7.3.2 Buildings / Structures**

#### ***7.3.2.1 Key Issues***

There are no buildings present on Outpost Island, and two small buildings on East Island. Located in the southwest of East Island, the outhouse and shed represent the only structures remaining from the suspected original camp and assay area. Both structures are constructed from wood and no hazardous building materials have been identified (e.g., asbestos or PCBs).

#### ***7.3.2.2 Potential Remedial Options***

Both of the structures at the site are beyond the limit of repair, and pose no material asset to surrounding communities, historical societies, or for use during the remediation program. Consequently, remedial options focus on the destruction or monitored deterioration of the buildings (Table 18).

***Option 1 – Do Nothing***

The “Do Nothing” approach would require no remedial measures and no subsequent monitoring or inspection activities. The size of the two small structures found on the remote East Island is minimal and represent negligible risk. The “Do Nothing” approach is considered to be a viable option for the structures.

***Option 2 – Leave As Is with Monitoring***

This option assumes no remedial work would be conducted and that structures would be allowed to deteriorate naturally. Although the residual risk would be very minor, a periodic monitoring and inspection program could be conducted to confirm that adequate barriers and/or signage are maintained to reduce the physical hazard to visitors. Based on the deterioration rate observed since buildings/structures were abandoned 40 years ago, it is anticipated that a minimum of 20 additional years is required before the structures have decomposed to a state of posing no physical hazard. Leaving structures to decay naturally is typically avoided when other remedial options are available to immediately and effectively address physical hazards.

***Option 3 – Demolish and Burn***

This option would involve removing the contents of the buildings/structures, demolishing the wooden structures and consolidating the waste materials. The wood could be burned on site and the residual ash collected for off-site disposal or placed into an on-site non-hazardous landfill. Non combustible materials would be consolidated and managed as part of the non-hazardous refuse (Section 7.3.3). This approach has been implemented for other wooden structures at remote northern mines, such as the former Hidden Lake Mine and the Discovery Mine. This remedial option is cost effective and manages all materials within the footprint of the site.

**Table 18 Remedial Options - Buildings**

CRITERIA	Option 1 Do Nothing	Option 2 Leave As Is with Monitoring	Option 3 Demolish and Burn
Goals	Reduce the physical hazard with a permanent solution.		
Operating Principle	No remedial actions and no inspection or monitoring activities.	Signage would be posted indicating hazards, and a long-term inspection program implemented to monitor the deterioration.	Wooden structures would be demolished, materials consolidated and burned on-site. Residual ash would be collected and managed either on or off-site.
Protection of Human Health and Environment	Low	Moderate	High
Long Term Effectiveness	Moderate	Moderate	High
Level of Confidence	Moderate	Moderate	High
Potential Remedial Impacts	None	None	Air emissions from burning, although minimal.
Implementation time for Remediation	None	1 Day/Year (inspection)	3 Days
Site Disruption	None	Low	Moderate
Ease of Implementation	High	High	High
Historical Community and Regulatory Acceptance	Low	Moderate	High
Cost	None	Low (Moderate if long-term monitoring costs are included)	Moderate

### 7.3.2.3 Preferred Remedial Option

The preferred remedial option is for the structures to be demolished and burned (Option 3). The wood could be burned on site and the residual ash collected for off-site disposal. Non combustible materials would be consolidated and managed as part of the non-hazardous refuse (Section 7.3.3). This approach has proven effective at remote sites to immediately remove the physical hazard from deteriorating structures, with minimal disruption to the natural environment at the site and was met with community acceptance.

### 7.3.2.4 Monitoring and Contingencies

Demolishing and burning the building structures will effectively remove all associated hazards and risks; although will require management during burning and work activities to minimize hazards and risks from burning in a remote environment. At the completion of remediation, long-term monitoring and contingency planning is not required for this component.

### **7.3.3 Non-Hazardous Refuse**

#### **7.3.3.1 Key Issues**

The Outpost Island Mine contains a small volume of non-hazardous refuse which is largely composed of concrete foundations, mill equipment, concrete piers supporting equipment and small can and debris dumps. The non-hazardous refuse represents a minor physical hazard and an aesthetic concern only. There is approximately 41 m<sup>3</sup> of metal, 78 m<sup>3</sup> of concrete and 1 m<sup>3</sup> of wood found on site (not including 10 m<sup>3</sup> of wood associated with the two dilapidated structures).

As described in the previous section, it has been recommended that wooden structures be demolished and burned along with other combustible refuse.

#### **7.3.3.2 Potential Remedial Options**

Three options have been proposed to address the residual non-hazardous materials at Outpost Island Mine (Table 19). The “leave as is with monitoring” approach has not been assessed, as the condition of the materials is not predicted to change substantively in the future and monitoring is not required.

##### ***Option 1 – Do Nothing***

With the exception of minor physical hazards, there are no human health or environmental risks associated with the non-hazardous refuse currently on site. In this regard, the primary concern related to the material is aesthetics. Option 1 would involve leaving the non-hazardous refuse distributed on surface, without any effort to consolidate, manage or dispose the material. No monitoring or inspection activities would be conducted, as the aesthetic concerns are not predicted to worsen with time.

Based on the assumption that other remedial works will be occurring on site, the “Do Nothing” option is not considered acceptable for non-hazardous refuse. With a minimal amount of additional effort the waste can be effectively managed, thereby improving the aesthetic quality of the site.

##### ***Option 2 – Consolidate and Transport to an Off-Site Facility***

In this option, all waste debris and materials (excluding concrete, which would be left as is or used as fill) would be consolidated and placed into transportation bins for shipment (by barge) to an off-site licensed disposal facility. In the past, the Yellowknife Municipal Landfill indicated it would not accept significant quantities of industrial scrap metal sourced from beyond the city limits (threshold volumes are not known); however the Hay River landfill (of comparable barging distance) has received industrial wastes in the past. Although recycling of metal refuse

is the preferred off-site disposal method, there are currently no recycling facilities in Yellowknife or the surrounding area that would accept industrial metal debris. The total volume of material requiring management is very small relative to other remedial projects in the area.

This option provides a long-term and permanent solution to remediating non-hazardous refuse and would be consistent with other aesthetic clean-up operations in the region.

***Option 3 – Consolidate and Dispose in an On-Site Landfill***

In this option, all non-hazardous waste would be consolidated and placed in an engineered on-site landfill. Large metal mill equipment would require cutting into smaller, more manageable pieces, and concrete broken into reasonable sizes. The refuse would be covered with local waste rock or with a geotextile (or equivalent) and a surface layer of soil (from a local borrow source).

As described in Section 5.13, there are very few (if any) locations in the near vicinity of the Outpost Island Mine that would be appropriate for the construction of an on-site landfill. Furthermore, there are no viable sources of locally available borrow material that would be required to economically construct an on-site landfill. Taking these factors into consideration, on-site disposal is not considered to be an acceptable option.

**Table 19      Remedial Options – Non-Hazardous Refuse**

<b>CRITERIA</b>	<b>Option 1 Do Nothing</b>	<b>Option 2 Consolidate and Transport to an Off- Site Facility</b>	<b>Option 3 Consolidate and Dispose in an On-Site Landfill</b>
Goals	Reduce the physical hazard and aesthetic concerns with a permanent solution.		
Operating Principle	Material left in place, without consolidation or management.	Wood consolidated and burned; metal and refuse shipped to an approved waste disposal facility.	Wood consolidated and burned; metal and concrete disposed of in an on-site landfill.
Protection of Human Health and Environment	Moderate - High	High	High
Long Term Effectiveness	Moderate	High	High
Level of Confidence	Moderate	High	Moderate
Potential Remedial Impacts	None	Low	Moderate
Implementation time for Remediation	None	1 Week	2 Weeks and 1Days/Year
Site Disruption	Low	Low	Moderate
Ease of Implementation	High	Moderate	Low
Historical Community and Regulatory Acceptance	Low	High	Moderate
Cost	None	Moderate	High



### **7.3.3.3 Preferred Remedial Option**

For aesthetic reasons, leaving refuse distributed throughout the Outpost Island Mine is not considered an acceptable option as confirmed in community consultations. Similarly, based on the minimal volumes of refuse requiring management, as well as an absence of good disposal locations and borrow sources, construction of an on-site landfill is not recommended. The referred Remedial Option is, therefore, to burn all wood and dispose additional non-hazardous refuse in an off-site facility (Option 2).

As part of the Remedial Options Analysis Workout, the historical significance of the mill equipment in APEC 2 was discussed. It was the opinion of those present that due to the long history of mining on Outpost Island the mill equipment should remain on site as it does not pose physical or chemical hazards. Such measures have been incorporated into the current version of the RAP.

Community members expressed interest to see that the concrete slabs (i.e., building footprints) be broken up and used as fill material where necessary. Technical advisors have confirmed that this is a viable option where the location may be reasonably accessed by machinery, and have incorporated this with remedial measures.

### **7.3.3.4 Monitoring and Contingencies**

Consolidation and removal of the refuse materials will leave no residual hazard or risk. Long-term monitoring and contingency measures are therefore not required for this component.

## **7.3.4 Hazardous Waste Materials**

### **7.3.4.1 Key Issues**

Broken lead batteries are the only confirmed hazardous materials present at the site, with an estimated volume of 0.5 m<sup>3</sup>. A small bottle (< 2 L) of an unknown oil based liquid was also identified. Due to an absence of markings the bottle is conservatively assumed to contain hazardous material.

### **7.3.4.2 Potential Remedial Options**

Two options were considered for the management of hazardous materials at Outpost Island Mine: the “Do Nothing” approach and “Consolidate and Transport Off-Site” (Table 20). Materials are to be shipped according to relevant regulatory considerations.

### ***Option 1 – Do Nothing***

The volume of hazardous materials at the Outpost Island Mine is minimal, and in a form unlikely to result in a toxic exposure. The 2 L bottle of unknown liquid is sealed, and the broken lead batteries are on the remote islands in isolated locations. There is negligible risk posed by these materials, although it is recommended that during the Outpost Island Mine remediation program, the incremental effort required to remediate these materials is minimal and should be implemented to maintain best practices.

### ***Option 2 – Consolidate and Transport Off-Site***

This option involves the consolidation of the broken lead batteries and bottle of unknown liquid for subsequent transport to an appropriately licensed facility. Minimal effort is required in this regard and may be easily added to the remedial program. It is estimated that a waste management facility in Yellowknife will accept the lead batteries; however, confirmation will be required prior to implementation.

**Table 20 Remedial Options – Hazardous Refuse**

<b>CRITERIA</b>	<b>Option 1 Do Nothing</b>	<b>Option 2 Consolidate and Transport to an Off-Site Facility</b>
Goals	Reduce the physical hazard with a permanent solution.	
Operating Principle	Material left in place, without consolidation or management.	Lead batteries and bottle of unknown liquid consolidated, and sent to appropriately licensed facility.
Protection of Human Health and Environment	Low (although minimal risks from materials)	High
Long Term Effectiveness	Moderate	High
Level of Confidence	Moderate	High
Potential Remedial Impacts	None	Low
Implementation time for Remediation	None	2 days
Site Disruption	None	Low
Ease of Implementation	High	Moderate
Historical Community and Regulatory Acceptance	Low	High
Cost	None	Moderate

#### ***7.3.4.3 Preferred Remedial Option***

As per best practices, hazardous waste materials will be collected and removed to an appropriately licensed facility (Option 2). This measure is protective of human health and the environment, may be implemented with ease and minimal cost and was met with community acceptance.

#### **7.3.4.4 Monitoring and Contingencies**

Consolidation and removal of the hazardous materials will leave no residual hazard or risk. Long-term monitoring and contingency measures are therefore not required for this component.

### **7.3.5 Tailings/Waste Rock in Mill Area (APEC 2)**

#### **7.3.5.1 Key Issues**

As noted previously, on land tailings are currently located in two main areas: 1) an upper deposit adjacent to the former mill area and Main Raise which is a mixture of tailings and waste rock; and 2) a lower deposit of tailings between the two bays and adjacent to the roadway. Approximately 9,000 m<sup>3</sup> of tailings/waste rock is located in the upper deposit and a further 340 m<sup>3</sup> (tailings only) is located in the lower deposit. Tailings located in the aquatic environment (i.e., North Bay and South Bay) are discussed separately in Section 7.3.10.

The evaluation of remedial options presented in this section presumes that the waste rock and tailings in the upper deposit require a single management option. Although segregating the two materials and managing them separately is technically feasible, it is not considered practical or necessary given the relatively small quantities involved.

#### **7.3.5.2 Potential Remedial Options**

Table 21 and the following sections present the remedial options that have been evaluated for management of tailings/waste rock. Prior to discussing these options, a brief overview of potential environmental concerns associated with the material is warranted. As noted in Sections 5.5 and 5.6, metal concentrations in both tailings and waste rock are naturally elevated and there is a potential that acid generation and metal leaching may occur. However, the HHERA determined that adverse effects to humans and ecological receptors are not anticipated, even if conservative assumptions are applied. The options considered for the management of tailings/waste rock present on land have been selected accordingly.

#### ***Option 1 – Do Nothing***

The “Do Nothing” approach requires no remedial action, and no subsequent monitoring or inspection. Erosion has been exacerbated by ice and wave action, thereby increasing the environmental risk posed by the materials. Due to the current location of the tailings/waste rock within the active shoreline of Great Slave Lake, the “Do Nothing” approach is not recommended.

***Option 2 – Leave As Is with Monitoring***

This option assumes no remedial work would be conducted; however, a monitoring/inspection program would be implemented to confirm that chemical impacts to the downstream environment (e.g., Great Slave Lake water and sediment) are not increasing. The inspection would also be used to confirm the physical stability of the tailings/waste rock deposits.

In general, the current and long-term environmental risks associated with the tailings/waste rock do not represent a substantive concern. However, there remains a potential that a minor amount of leaching and/or erosion of fine grained tailings will result in additional metal loadings to Great Slave Lake. While it is unlikely that future metal loadings would measurably degrade the aquatic environment, best practices would typically involve efforts to minimize the possibility that such a situation would occur. On this basis, the “leave as is” option for the management of on-land tailings/waste rock is not recommended.

***Option 3 – Consolidate and Re-Slope***

This option aims to reduce the effects of wave action and erosion to minimize the movement of the tailings. Exposed tailings found in the lower tailings area (between the bays), would be consolidated and relocated to a more stable location near the former Mill Area in the vicinity of the Upper Tailings Area. Eroding tailings adjacent to the Main Raise would be pulled back to a topographically higher and more stable location. Where possible, bedrock surfaces would be used to provide partial containment, including the bedrock scarp face below the Mill equipment. Relocated tailings/waste rock would be graded to avoid standing water and to enhance runoff from the deposit, while minimizing overland flow contact with the mine wastes. If feasible, coarse waste rock could be placed as armour in areas of the consolidated deposit that are vulnerable to erosion.

As described in Appendix D, consideration could also be given to the construction of a retaining wall to limit erosion of tailings in the vicinity of North Bay. However, based on the information presented therein, this expenditure is not justified given the relatively minor incremental benefits that would be achieved. Over the long-term, the co-mingled tailings and waste rock would reduce the potential that fine grained tailings are eroded by surface run-off or wind.

***Option 4 – Consolidate, Re-Slope and Cover***

This option would involve the placement of a cover constructed from natural granular material over the consolidated and re-sloped tailings/waste rock pile (see Option 3). This type of cover is used extensively and can be designed for a variety of purposes including reduced water infiltration, physical stabilization and protection from direct contact by human and ecological receptors. Such covers are viable options in situations where sufficient quantities of granular materials (with appropriate physical properties) are located in close proximity. However, due to

an absence of suitable borrow sources in the vicinity of the Outpost Island Mine, this option would require the transportation of large quantities of borrow material (by barge or ice road).

Consideration could also be given to covering the consolidated tailings/waste rock with a synthetic cover system. Typically, woven and/or non-woven textile geosynthetics are used, but polyethylene, geomembrane layers and/or geogrid geotextile materials have also been incorporated in designs. The installation of such systems can require skilled trades and capital costs can be significantly higher than natural covers, depending on the circumstance. Furthermore, similar to covers constructed from natural materials, there would remain a requirement for borrow material to be transported to the site (e.g., as a bedding layer and surface armour). Care and maintenance costs for this type of cover system can also be very high, particularly at remote sites.

Construction of a cover system would utilize design considerations provided within the Cold Regions Cover System Design Technical Guidance Document (MEND 2012). Such considerations include impacts due to frost action, permafrost features, surface water management to reduce infiltration and techniques to minimize erosion. Where appropriate, the cover may be revegetated with native plant species. Revegetation is a preferred option to restore the site to pre-mining conditions; however, unlike contemporary mining projects, there is no cache of suitable overburden to serve as a growing medium.

Overall, the relatively minor environmental risks associated with the land-based tailings/waste rock do not justify the significant costs and complex logistics of placing a natural or synthetic cover over the consolidated deposit.

#### ***Option 5 – Subaqueous Disposal***

Subaqueous disposal of tailings is a commonly used technique to manage tailings at historic and active mining properties. The water cover reduces the exposure of the tailings to oxygen, thereby limiting acid rock drainage and metal leaching. The necessary depth of water is calculated based on the minimum depth to protect from wave activity and ice entrainment; design events (e.g. severe storms); and to ensure there is sufficient water height to prevent oxidation (MEND 1998). The required water height must be calculated on a site specific basis, although a height of 1 m is commonly used (MEND 2004). Subaqueous disposal was used during the operational period of the mine. The bedrock berm at the mouth of the North Bay was likely raised and the area used as an aqueous tailings impoundment.

An important consideration in the use of this technique is the aged and heavily weathered nature of the tailings. The materials have been exposed to atmospheric conditions for decades, resulting in oxidation and weathering. Should the aged tailings be deposited in an aquatic environment,

the materials could rapidly release stored acidity and leached metals into the surrounding aquatic environment.

Subaqueous disposal of the mixed tailings/waste rock will therefore need to be conducted within a contained impoundment area to prevent impacts to the larger aquatic environment. In addition to environmental impacts, due consideration must also be given to the Fisheries Act and potential violation due to the release of “deleterious substances” (Fisheries Act 1985). The only suitable impoundment area at the Outpost Island Mine is the North Bay (a historic tailings containment area), which could, in theory, be isolated by raising the existing bedrock berm to prevent dispersal of pore water metals and acidity. The berm would also limit the movement of the tailings/waste rock into Great Slave Lake proper. The South Bay and East Bay have limited possibility for containment.

Excavation of the tailings and waste rock material would require consideration of the underlying mine workings in APEC 2 and the subsequent exposure of any potential hazards.

Approximately 9,340 m<sup>3</sup> of tailings/waste rock is currently located in APEC 2. Deposition of this material into the North Bay (which contains a total surface area of approximately 1,750 m<sup>2</sup>), would result in a depositional layer of approximately 5 m. As previously noted, a necessary component of subaqueous tailings disposal is sufficient water height to limit oxidation. A small scale bathymetric survey of the North Bay was conducted as part of the Phase IIIa ESA, which found the depth current depth of water was 0.3 m to 1 m. This water depth is insufficient to cover the tailings/waste rock. Subaqueous disposal of the terrestrial tailings/waste rock is consequently not technically feasible at Outpost Island Mine and further consideration is not warranted. For this reason, the option has not been included in Table 21.

For reference, a thickness of 5 m of tailings/waste rock would also prevent the use of North Bay as a dry storage area, as the bay contains insufficient storage capacity to house the material.

**Table 21 Remedial Options – Tailings/Waste Rock in Mill Area**

CRITERIA	Option 1 Do Nothing	Option 2 Leave As Is with Monitoring	Option 3 Consolidate and Re-Slope	Option 4 Consolidate, Re- Slope and Cover
Goals	Mitigate chemical hazards (to the extent justified).			
Operating Principle	No remedial actions or subsequent monitoring/inspection.	A monitoring program would be implemented to confirm that significant adverse effects to the receiving environment are not occurring.	All land-based tailings/waste rock would be consolidated and graded to minimize standing water and promote drainage.	Building off of Option 2, the consolidated tailings/waste rock deposit would be capped with a natural or synthetic cover.
Protection of Human Health and Environment	Low	Moderate (minor risks only)	Moderate – High	High
Long Term Effectiveness	Low	Moderate	Moderate	Moderate
Level of Confidence	Low	Moderate	Moderate	Moderate
Potential Remedial Impacts	None	None	Moderate (site disturbance during consolidation)	High (site disturbance during consolidation, sourcing of borrow material, transportation of borrow material).
Implementation time for Remediation	None	1 Day / Year	1 Week	4 Weeks (mainly for transportation of borrow)
Site Disruption	None	Low	Moderate	Moderate
Ease of Implementation	High	High	Moderate	Low (due to borrow requirements)
Historical Community and Regulatory Acceptance	Low	Low	High (due to low environmental risks)	High
Cost	None	Low (Moderate if long-term monitoring costs are included)	Moderate	High

### 7.3.5.3 Preferred Remedial Option

As indicated above, leaving the tailings/waste rock in its current condition (Option 1 and Option 2) is not considered an appropriate option from a technical perspective. Consolidating and re-sloping (Option 3) would improve the physical stability of the tailings/waste rock, reduce the extent to which water comes in contact with potentially leachable materials, and prevent the continued erosion and transportation of exposed tailings in the lower tailings area. The

tailings/waste rock could also be covered with a natural or synthetic cap (Option 4); however, there are a number of logistical challenges and significant costs associated with this option.

The Remedial Options Analysis Workout identified two options acceptable to community members: Leave as Is with Monitoring (Option 2) and Consolidate/Reslope (Option 3).

A site visit was implemented by AANDC in July 2013 with members of the Lutsel K'e and Fort Resolution communities. The presence of exposed tailings in the lower areas adjacent to the North and South bays was identified as a primary concern. Measures were recommended to reduce wave action and erosion to minimize the transportation of tailings. One such recommendation was the placement of large gauge boulders at the mouth of the North Bay to reduce wave energy. Alternatively, a breakwater / retaining wall could be constructed adjacent to the tailings and wasterock deposit along the shoreline of North Bay.

A technical memorandum assessing the potential to conduct such measures (including associated limitations) is presented in Appendix D. In summary, due to the absence of suitable large gauge boulders onsite, blasting would be required to generate suitable material. Blasting activities will result in additional impacts, further disruption to the site, and potential hazards during work activities.

The use of prefabricated concrete blocks and/or poured concrete barriers have been suggested as alternatives. The installation of an energy dissipating mat at the mouth of the North Bay would require placement of concrete blocks (approximately 0.6 m by 0.9 m and 1.5 m long) in a series of rows behind the bedrock saddle that separates the North Bay from the deeper Great Slave Lake waters. A large area (approximately 200 m<sup>2</sup>), would be covered with these blocks designed to reduce the potential for tailings to be washed out from the North Bay. A non-woven geotextile would be laid down in advance of the block placement. In the case of a breakwater / retaining wall adjacent to the tailings and wasterock deposit, the most efficient means would likely be to construct a poured concrete wall that is pinned to bedrock.

These measures will result in significant alteration of the current environment and will create a highly unnatural appearance within the bay. These factors, in combination with the significant increase to project timelines and cost, must be considered when assessing the appropriateness of such measure. Furthermore, there would remain a significant potential that ice and wave action would eventually compromise any barrier that might be put in place.

In summary, it is predicted that the previously assessed remedial options, and preferred remedial option will provide the most suitable response to address the mixed tailings/waste rock at the site. Specifically, as selected during the Remedial Options Analysis Workout, consolidation and resloping of exposed tailings, was considered a preferred remedial option (Option 3). Exposed



tailings from the lower tailings area will be relocated to a higher more stable location, and work activities will be done to pull back and stabilize eroding surfaces.

#### **7.3.5.4 *Monitoring and Contingencies***

During consolidation and grading activities, monitoring will be required to ensure additional impacts to the surrounding aquatic environment are minimized (e.g. silt curtains), that incremental loadings are documented through water sampling, and that best practices are used in the operation of machinery (e.g. fuel management and spill contingency). At completion, performance monitoring will be required to ensure there is a reduction in surface erosion and impacts of wave activity. A long-term monitoring program is necessary to report metal concentrations in surface water and sediment to document any post-remediation changes to the aquatic environment.

### **7.3.6 Waste Rock**

#### **7.3.6.1 *Key Issues***

This section addresses waste rock found throughout Outpost Island and East Island, excluding the tailings/waste rock pile identified in the former Mill Area (see Section 7.3.5). Approximately 300 m<sup>3</sup> of waste rock is located at Shaft #2 (APEC 7) and there is a further 100 m<sup>3</sup> in various locations surrounding blast trenches on the East Island (APEC 9).

Lab testing indicates that the waste rock in APEC 7 and 9 has a potential to produce acid and leach metals that would be released to the surface water environment. Notwithstanding this potential, there is no evidence to suggest that significant effects on the environment have occurred in the past or are likely to develop in the future.

#### **7.3.6.2 *Potential Remedial Options***

Remedial options proposed for the management of the waste rock focus on the removal of materials from exposure to surface water, thereby reducing the metal leaching potential from the materials. Three potential options are proposed to accomplish these tasks (Table 22).

##### ***Option 1 – Do Nothing***

The “Do Nothing” approach indicates that no remedial actions would be conducted, and no monitoring or inspection programs implemented. Due to the limited risks posed by the materials, this approach is considered a viable option.

### **Option 2 – Leave As Is with Monitoring**

This option assumes no remedial work would be conducted and that a monitoring/inspection program would be implemented to confirm that chemical impacts to the downstream environment are not increasing. Based on the negligible potential impacts associated with the waste rock, the “leave as is” option is considered to be a viable alternative.

### **Option 3 –Filling Excavations on Surface**

Under this option, waste rock would be used to fill excavations on surface such as exploration trenches, pits and raises. In addition to partially limiting the leaching potential of the waste rock, this option would return the topography of the trenches to conditions that existed prior to the mining operation. It should be noted, however, that disturbances associated with surface mining are relatively small and that they also resemble some natural features that are present on the islands (e.g., steep bedrock slopes and natural depressions). An added consideration is the difficulty of mobilizing heavy equipment across the islands to the various locations where surface excavations would need to be filled.

**Table 22 Remedial Options – Waste Rock**

<b>CRITERIA</b>	<b>Option 1 Do Nothing</b>	<b>Option 2 Leave As Is With Monitoring</b>	<b>Option 3 Filling Excavations on Surface</b>
Goals	Manage chemical concerns and hazards, as justified.		
Operating Principle	No remedial actions, monitoring or inspections would be implemented.	A monitoring program would be implemented to confirm that significant adverse effects to the receiving environment are not occurring.	In fill pits, trenches and raises with waste rock.
Protection of Human Health and Environment	Low	High (only negligible risks exist)	High
Long Term Effectiveness	Moderate	High (only negligible risks exist)	High
Level of Confidence	Moderate	High	High
Potential Remedial Impacts	None	None	Moderate (due to site access)
Implementation time for Remediation	None	1 Day / Year	1 week
Site Disruption	None	Low	Moderate (due to site access)
Ease of Implementation	High	High	Moderate (difficulty accessing work areas)
Historical Community and Regulatory Acceptance	Low	Moderate	High
Cost	None	Low (Moderate if long-term monitoring costs are included)	Moderate

### **7.3.6.3 Preferred Remedial Option**

Based on the negligible environmental risks associated with waste rock, Option 2 (Leave As Is With Monitoring) is considered the preferred technical option and was similarly selected by community representatives.

Community members also suggested that the waste rock be used as necessary for a fill material as there is no viable borrow source on the Outpost Island. For example, the waste rock may be suitable for use in backfilling mine openings or to stabilize tailings materials, where the waste rock deposits may be safely accessed by machinery.

### **7.3.6.4 Monitoring and Contingencies**

Leaving the waste rock in-situ or moving for use as a fill material will require some level of future monitoring. The environment surrounding waste rock piles may be monitored to identify any changes to metal loadings; although this should only be conducted on an opportunistic basis as the waste rock is not considered a primary concern. Surface water and sediment sampling for metal concentrations would provide the greatest indication of increased metal leaching rates. These sampling activities should be incorporated into the long-term monitoring plan and in the unlikely event results indicate rising metal concentrations, additional measures may be required to manage the waste rock (e.g. relocate to more isolated location on island).

## **7.3.7 Soil - Metals**

### **7.3.7.1 Key Issues**

Elevated concentrations of metals have been measured in soils at the Outpost Island Mine. Although these elevated concentrations are assumed to be partially attributable to the presence of a mineralized zone, it is likely that mining operations have also contributed to the elevated metal concentrations. For example, isolated areas of enrichment were documented primarily downgradient of the fuel storage area (APEC 1), surrounding the waste rock and tailings area and former mill (APEC 2), at the battery dump and stained rock (APEC 3), at the cookhouse and dump area (APEC 4), in the Ore Pass Raise area (APEC 5) and the East Island battery dump and assay lab (APEC 9). Low levels of enrichment were observed for arsenic, tin, zinc, nickel, cobalt and chromium, while the metals demonstrating the greatest enrichments above applicable criteria were copper, lead, mercury, molybdenum and zinc.

The significance of elevated metal concentrations at the Outpost Island Mine was evaluated in the HHERA, as described in Section 6.0. Overall, the HHERA concluded that, under current conditions, there are no significant human health or ecological risks to populations associated

with the site. This includes potential exposures of receptors to metals present in soil. This situation is not anticipated to change in the future as there are no mechanisms by which metal concentrations in soil (or other media) would increase significantly with time.

#### ***7.3.7.2 Potential Remedial Options***

The following four remedial options have been proposed to address metal enriched soils within the site (Table 23).

##### ***Option 1 – Do Nothing***

The “Do Nothing” option has been assessed for metal impacted soils, and requires no remedial actions, inspections or monitoring.

##### ***Option 2 – Leave As Is with Monitoring***

As indicated above, there are no significant risks (both current and future) associated with metal concentrations in soils at the Outpost Island Mine. On this basis, leaving the soils in their current condition is considered an acceptable alternative. As a precautionary measure, a long-term monitoring/inspection program would be implemented to confirm that chemical impacts to the downstream environment are not increasing.

##### ***Option 3 – Off-Site Management of Soils from Discrete Areas***

Although current concentrations of metals in soils are not predicted to have significant effects on humans or ecological receptors, there are several discrete locations with elevated concentrations that could be effectively managed through excavation and disposal at an off-site location. The option would only be justified for small volumes of soils demonstrating elevated metal concentrations. Specifically, soils beneath the battery dumps would be excavated and placed in transportation bins for transfer to an off-site facility.

This option is not considered appropriate for other soils with elevated metal concentrations which should be left “as is” (similar to Option 1). In particular, it would not be feasible to manage general site soils that have elevated metal concentrations (either due to natural mineralization and/or influence from tailings/waste rock). The risks associated with metal concentrations at the site do not justify such an intervention and widespread excavation would result in undue impacts to habitat.

##### ***Option 4 – Capping***

In this option, the dermal contact, inhalation, and incidental ingestion routes for metals in soil would be eliminated by placing a cap of granular materials above soils with elevated metals concentrations. The use of fine grained, low permeability cover material (i.e., clays) could also assist in reducing potential leaching of metals from the soils.

As indicated above, elevated metal concentrations in soils do not represent significant risks to humans or ecological receptors. Furthermore, there are no sources of borrow material in the vicinity of the Outpost Island Mine that could be used to cap the soils. Transporting borrow material to the site (by barge or ice road) is technically feasible but would be extremely costly and achieve negligible environmental benefit.

**Table 23 Remedial Options – Soil (Metals)**

<b>CRITERIA</b>	<b>Option 1 Do Nothing</b>	<b>Option 2 Leave As Is with Monitoring</b>	<b>Option 3 Excavation and Off- Site Management of Specific Metal Sources</b>	<b>Option 4 Capping</b>
Goals	Manage chemical concerns, as justified.			
Operating Principle	No remedial measures, inspections or monitoring programs would be conducted.	A monitoring program would be implemented to confirm that significant adverse effects to the receiving environment are not occurring.	Discrete areas of soils impacted by metals (excluding metals from tailings) would be excavated, containerized and transported for off-site management.	Areas of metal impacted soils would be capped to limit exposure to receptors and infiltration by water.
Protection of Human Health and Environment	Moderate	High (only negligible risks exist)	High (only negligible risks exist)	High
Long Term Effectiveness	Moderate	High (only negligible risks exist)	High (only negligible risks exist)	High
Level of Confidence	Moderate	High	High	High
Potential Remedial Impacts	None	None	Low (minor excavations)	High (sourcing and transportation of borrow material).
Implementation Time for Remediation	None	1 Day / Year	2 days	2 Weeks (transportation of borrow)
Site Disruption	None	None	Low	Moderate
Ease of Implementation	High	High	High	Low (due to borrow requirements)
Historical Community and Regulatory Acceptance	Low	Moderate	High	High
Cost	None	Low	Low	High (due to transportation of borrow material)

#### **7.3.7.3 Preferred Remedial Option**

Soils underlying broken batteries (East Island) were identified as a localized concern in the HHERA (SENES 2013). Remediating these materials is protective of human health and the environment; however, site-wide excavation of lower risk soils would result in significant remedial impacts and costs. Based on the negligible environmental risks associated with elevated metal concentrations, the preferred remedial option selected from a technical perspective and during community consultations, is to excavate soils from beneath the battery dumps for off-site management (Option 3). All other soils with elevated metals concentrations would remain “as is”.

#### **7.3.7.4 Monitoring and Contingencies**

Removal of metal impacted soil underlying the former battery cache may require verification testing to ensure that the areas of significant impact have been excavated. At the conclusion of work activities, the risk associated with the battery impacted soil will be removed from site and ongoing monitoring may not be necessary.

### **7.3.8 Soil – Petroleum Hydrocarbons**

#### **7.3.8.1 Key Issues**

Elevated concentrations of petroleum hydrocarbons have been measured in soil samples collected from small isolated areas of the site. In particular, soils in two surface drainage pathways down-gradient of the former tank area have concentrations well above the applicable criteria for the F2, F3 and F4 hydrocarbon fractions. Using conservative assumptions, the total volume of impacted soil is estimated to be less than 23 m<sup>3</sup>.

#### **7.3.8.2 Potential Remedial Options**

Five remedial options have been assessed to manage the PHC impacted soils at the Outpost Island Mine (Table 24).

##### ***Option 1 – Do Nothing***

The PHC impacted soils would be left *in-situ* and no inspection or monitoring programs would be implemented. The small volume of PHC impacted material (23 m<sup>3</sup>) is not a primary COC and the HHERA did not identify potential human health or ecological effects from PHCs at the site.

***Option 2 – Leave As Is with Monitoring***

Within the context of site conditions and land use at the Outpost Island Mine, the quantity of material and environmental risks associated with PHC impacted soils is considered to be relatively minor. Based on the amount of time that has passed since the original spill, it is also assumed that natural degradation has occurred and that the hydrocarbon source is relatively immobile.

This option would involve leaving the hydrocarbon impacted soils in their current location. The spill sites and surrounding environment would be subjected to periodic inspections as part of a long-term monitoring program in an effort to identify any signs of environmental degradation.

***Option 3 – Off-Site Disposal***

This option would involve consolidating the petroleum hydrocarbon impacted soils into transportation bins and moving them off site for disposal. The City of Yellowknife will accept soils contaminated with hydrocarbons; however, if the metal concentrations are elevated the soils may not be accepted by the City. If required, hydrocarbon-impacted soils with elevated metal concentrations could be shipped to appropriate facilities in other jurisdictions (e.g., Alberta).

***Option 4 – On-Site Disposal***

Under this option, the hydrocarbon impacted soils would be excavated and placed in an engineered landfill cell on site. The cell would be lined and capped to assist in preventing the release of hydrocarbons to groundwater. This approach could be problematic due to a need to transport borrow material to the site.

***Option 5 – On-Site Treatment***

A number of *in-situ* and *ex-situ* methods are used to treat hydrocarbon impacted soils. These methods include bio-venting, vapour extraction, bioremediation, chemical oxidation and soil washing. The performance of most treatment technologies is sub-optimal in northern environments. Furthermore, on-site treatment is often cost-prohibitive when small volumes of soil require management and the methods are less effective for the management of higher end PHCs.

**Table 24 Remedial Options – Soil (Petroleum Hydrocarbons)**

CRITERIA	Option 1 Do Nothing	Option 2 Leave As Is with Monitoring	Option 3 Off-Site Disposal	Option 4 On-Site Disposal	Option 5 On-Site Treatment
Goals	Mitigate chemical hazards and concerns.				
Operating Principle	No remedial measures, inspections, or monitoring programs would be conducted.	Impacted soils remain in place and are subjected to long-term monitoring.	Impacted soils are consolidated into transportation bins and transported off-site for management.	Impacted soils are consolidated and placed in an on-site engineered facility that limits mobility and exposure.	Hydrocarbon concentrations in soils are reduced to acceptable levels through <i>in-situ</i> or <i>ex-situ</i> treatment on-site.
Protection of Human Health and Environment	Low	Moderate (negligible risks)	High	High	Moderate
Long Term Effectiveness	Moderate	High	High	Moderate-High	Moderate
Level of Confidence	Moderate	Moderate	High	Moderate-High	Low-Moderate
Potential Remedial Impacts	None	None	Minor due to site disturbance and hauling.	Minor due to site disturbance.	Minor due to site disturbance and ongoing presence during treatment.
Implementation time for Remediation	None	1 Day / Year	1/4 week	1 week	Potentially multiple field seasons.
Site Disruption	None	None	Moderate	Moderate	Moderate
Ease of Implementation	High	High	High	Moderate (no borrow)	Low
Historical Community and Regulatory Acceptance	Low	Moderate	High	Moderate	Moderate
Cost	None	Low (Moderate if monitoring included)	Moderate	Moderate	Potentially high

### 7.3.8.3 Preferred Remedial Option

Leaving the hydrocarbon-impacted soils in their current condition (Options 1 and 2) is not recommended due to the ease of implementing other alternatives. On-site disposal (Option 4) is anticipated to be technically challenging and costly due to an absence of readily available borrow material. Similarly, on-site treatment (Option 5) is technically more complex and costs could be significantly higher.



Excavating the contaminated soil and transporting it off-site for management in an appropriately licensed facility (Option 3) would eliminate any potential risks and was selected as the preferred remedial option during the Remedial Options Analysis Workout. This recommendation is conditional on the volume of impacted material remaining approximately equivalent to current estimates. Once excavation equipment is on site, the volume of impacted material can be confirmed. In the unlikely event the quantity increases significantly, alternative remedial measures may need to be considered.

#### **7.3.8.4 *Monitoring and Contingencies***

Confirmation testing may be required to confirm that the PHC impacted soil has been removed to the degree possible. During remediation, surface water samples may be analyzed for hydrocarbon compounds in the unlikely event that remedial measures resulted in an inadvertent release of contaminants. However, such monitoring measures are considered to be highly conservative given the small volume of impacted soil. Consolidation and removal of the hydrocarbon impacted soils is expected to leave no residual hazard or risk. Long-term monitoring and contingency measures are therefore not required for this component; however, hydrocarbon analysis may be opportunistically incorporated with surface water and sediment sampling.

### **7.3.9 *Former Dock Area***

#### **7.3.9.1 *Key Issues***

A former dock area/wharf is found on the southern shore of Outpost Island and throughout the ESA process has been classified within APEC 3. The dock served as a wharf for ships during the operational period of the mine and has since been deteriorating. The dock is constructed of a wooden crib filled with rock and reinforced with steel rods. These rods have in some locations detached from the wooden structure and pose an impediment to boat and float plane docking. For this reason, the dock area was not used during the site investigations. The structure is anchored to the bedrock at the shoreline with steel rods which also may pose a hazard.

#### **7.3.9.2 *Potential Remedial Options***

It is noted within the Phase II and Phase III ESAs that there was no sediment offshore of the dock area and there is no evidence of the rock within the cribs eroding into the aquatic environment. Similarly, there is currently no evidence to suggest that the crib frame is made of treated wood. While there are no chemical concerns reported from the dock, the metal reinforcements adjacent to and offshore of the dock do represent a potential physical hazard to boats and floatplanes.

Three remedial options have been assessed to manage dock structure (Table 25).

***Option 1 – Do Nothing***

The “Do Nothing” approach assumes that no remedial measures, inspections or monitoring would be conducted. The presence of the crib, rock fill and steel reinforcements would remain in-situ and will continue to represent a potential physical hazard.

***Option 2 – Leave As Is with Monitoring***

This option would leave the existing dock structure in place, to be augmented with an inspection program to verify the physical conditions of the structure are not degrading. The inspection program would be designed to ensure that the wooden crib is not at risk of collapse and the steel reinforcements continue to remain visible. The dock structure is currently stable; however, it is predicted that in time the wooden crib will fail and may result in dispersal of the rock fill. As there are no chemical concerns identified, a water and sediment monitoring program is not required.

***Option 3 – Remove Debris and Naturalize Shoreline***

This option would involve removing the physical hazards posed by the steel reinforcements and restoration of the shoreline to pre-mine conditions as much as reasonably possible. The crib structure would be removed and the wood managed as per wooden building materials at the site (Section 7.3.2). The rock fill would be excavated to the extent possible, limited by health and safety concerns and water depth. The material would be relocated to a suitable on-land location and managed as per other waste rock on Outpost Island (Section 7.3.6). It is predicted that some portion of the rock may not be removed and will require grading. The steel reinforcements found in the aquatic environment and connecting the dock to the adjacent shoreline would be removed where conditions permit, and/or remediated to reduce physical hazards (e.g. cut off). In addition to the reduction of physical hazards, these measures would result in a more natural shoreline. Sediment and erosion control measures would be implemented during remedial works. Nonetheless it is predicted that this option would result in minor disruption of the aquatic environment and potential loss of current habitat that has established since the closure of the mining operation.

**Table 25 Remedial Options – Former Dock**

<b>CRITERIA</b>	<b>Option 1 Do Nothing</b>	<b>Option 2 Leave As Is with Monitoring</b>	<b>Option 3 Remove Debris and Naturalize Shoreline</b>
Goals	Mitigate physical hazards posed by the former dock.		
Operating Principle	No remedial measures, inspections, or monitoring programs would be conducted.	The dock structure would remain as is and an inspection program would be implemented to ensure physical conditions do not degrade.	Metal and wood debris would be removed and rock fill excavated and/or graded to naturalize shoreline.
Protection of Human Health and Environment	Low (negligible risks)	Moderate (negligible risks)	High
Long Term Effectiveness	Moderate	Moderate (negligible risks)	High
Level of Confidence	Low	Moderate	High
Potential Remedial Impacts	None	None	Moderate
Implementation time for Remediation	None	1 Day / Year	½ Week
Site Disruption	None	None	Moderate
Ease of Implementation	High	High	Moderate
Historical Community and Regulatory Acceptance	Low	Moderate	High
Cost	None	Low (Moderate if long-term monitoring costs are included)	Moderate

### 7.3.9.3 Preferred Remedial Option

The steel supports surrounding the dock structure present a potential physical hazard to passing boats and to float equipped aircraft accessing the site. For this reason, the “Do Nothing” approach is not considered a suitable remedial option. The dock structure is currently stable and, while there is no evidence of impending crib failure, the wooden and steel supports will in time degrade and result in collapse of the structure. A monitoring program to identify any incremental hazards posed by the steel and wood debris may anticipate failure of the dock.

The hazards posed by the dock are minimal as the debris is near to the shoreline; however, it is recommended that remediation of the dock could be incorporated with other remedial measures with minimal incremental effort. Removal of debris and naturalizing the shoreline (Option 3) is therefore considered the preferred remedial option.

#### **7.3.9.4 Monitoring and Contingencies**

Removal of the dock will require the use of remediation monitoring and contingency planning suitable for in-water work. This may include such measures as periodic water sampling, spill contingency plans and Sediment and Erosion Control plans. Upon completion, regular performance inspections may be necessary to ensure there is no increase in surface erosion and to document the naturalization of the shoreline. Where necessary, additional refinements may be required to enable the dock location to rehabilitate.

### **7.3.10 Surface Water and Sediments**

#### **7.3.10.1 Key Issues**

Historic operations at the Outpost Island Mine involved the deliberate and inadvertent discharge of tailings to the bays along the perimeter of the island (North Bay, South Bay and East Bay). This practice has resulted in elevated metal concentrations in near-shore sediments and, to a lesser degree, surface water. Although evidence of localized impacts to benthic organisms has been observed, the HHERA concluded that risks to humans and other aquatic receptors are not significant under current conditions. The quality of the aquatic environment is not anticipated to degrade in the future; to the contrary, there is a potential that any effects associated with tailings discharged to the aquatic environment will reduce with time (e.g., through ongoing sedimentation processes).<sup>5</sup>

#### **7.3.10.2 Potential Remedial Options**

As noted in previous sections, some of the recommended remedial options may result in a decrease of metal loadings to the aquatic environment. For example, the recommended option for tailings/waste rock deposits is intended to reduce the release of metals to Great Slave Lake (primarily through physical stabilization and reduced erosion of surface tailings). It is important to note, however, that terrestrial sources are likely making relatively minor contributions of metals to the aquatic environment. Instead, the sub-aqueous tailings are expected to be the primary source of elevated metals concentrations in sediment and surface water.

To be effective, remedial options to manage sub-aqueous tailings need to clearly demonstrate that they are capable of achieving a net-benefit. In the case of the Outpost Island Mine, it is unlikely that such a benefit could be achieved through active interventions that result in the disturbance of the aquatic environment. First, the current impacts to the environment have been

---

<sup>5</sup> Of note, concentrations of metals in the four small ponded water areas on Outpost Island were not considered within the remedial action plan, as the ponds are not considered to represent aquatic habitat. Furthermore, due to the surrounding bedrock topography, there are no suitable remedial options for these small ponds.

demonstrated to be low (as per the HHERA). Second, active interventions typically result in significant remedial impacts to aquatic habitat.

Five remedial options have been assessed to address the chemical impacts observed in the surface water and sediments within the Great Slave Lake shoreline (Table 26). Despite the potential remedial effects of intrusive measures, these options have been assessed to ensure a comprehensive and complete assessment of remedial options.

***Option 1 – Do Nothing***

The “Do Nothing” approach would involve leaving the aquatic environment as is, and no inspection or monitoring programs would be implemented. While the ESAs did identify chemical exceedances of applicable guidelines, the HHERA indicated that these concentrations pose a minimal hazard to human and ecological receptors. The highest metal concentrations observed are within the North Bay, which is partially isolated from the main lake by a natural bedrock berm. This natural feature minimizes the relocation of tailings from the North Bay.

***Option 2 – Leave As Is with Monitoring***

This option would also leave the current aquatic environment as is; however a long-term monitoring program would be implemented in areas of concern. The goal of the long-term monitoring program (as described in Section 8.0) is to confirm that remedial measures perform as intended and to verify that environmental quality is not degrading. Specifically, the program will involve periodic monitoring of:

- Water and sediment quality.
- The physical condition of remedial infrastructure that has the potential to affect the surface water environment (e.g., physical stability of the land-based tailings/waste rock deposit).

Depending on the findings of the above monitoring, the scope and frequency may be adjusted to respond to changes that are being observed.

***Option 3 – Remove Sediments (Dredge or Excavate)***

Sediment excavation is a technique which may be employed to physically remove the sediments, thereby providing a “Walk Away” solution in the aquatic environment. Sediments may be removed while wet (dredging), or by diverting/draining water and removing sediments (excavating). Excavation is considered more successful in removing contaminated sediments (US-EPA 2005); however, it presents challenges due to the need to construct dams and diversions in a remote location. Many of the same advantages and disadvantages apply to both techniques.

While these measures may address the concerns in the long term, there is considerable uncertainty with respect to their implementation at the Outpost Island Mine. The bedrock berm at the North Bay could be raised using a temporary structure which would allow for dewatering of the bay. However, the volume of water requiring treatment would be significant and, due to the bedrock topography, would require treatment and discharge back into Great Slave Lake. Contaminated sediments at the South Bay are not confined by bedrock topography and have dispersed into deep water locations. These areas cannot be isolated and dewatered, and therefore sediment excavation is not feasible in these bays. Sediment removal at these locations would require the use of dredging.

Dredging of the sediments will inevitably result in habitat impacts. Best practices would be employed to limit the spread of contaminated sediments (e.g. silt curtains), which may be effective in the North Bay. Sediment dredging in the South Bay would require deeper water dredging equipment and techniques over a large area. Disruption and resuspension of impacted sediments, and more widespread impacts to the current habitat would be likely in the South Bay.

Dredged sediments would require dewatering to allow for disposal. This water will need to be treated prior to discharge, which will present significant challenges in a remote site. A management plan will also need to be in place to address the disposal of the sediments. The bedrock topography of Outpost Island would not permit the on-site disposal of the sediments and all sediments would therefore require off-site disposal. The Phase IIIa ESA estimates that 2,000 m<sup>3</sup> of tailings may be within the aquatic environment, in addition to impacted sediments underlying and offshore of the tailings.

#### ***Option 4 – Placement of a Sediment Cap***

Use of a sediment cap within the North Bay and South Bay has been assessed as a measure to reduce the exposure of aquatic organisms to elevated metal concentrations. The technique typically employs the use of clean borrow material of engineered thickness. The granular material is ideally a clean natural sand (i.e. with fine fractions and organics), which may be armored with coarser fractions in high energy erosive environments. Geotextiles may be used to supplement the granular material, and minimize mixing between the cap and the contaminated sediments below. The geotextile may have a core of engineered clay or other reactive/absorptive materials, though are not designed as an impermeable membrane. Placement of a sediment cap requires the use of sediment and erosion control measures (e.g. silt curtains), an engineered design to ensure the shear strength of the contaminated sediments is not exceeded thereby resulting in sediment mobilization, and detailed placement methodology to limit the release of contaminated pore water during cap placement (US-EPA 2005).

A primary limitation of this technology at the Outpost Island Mine, is the absence of a suitable granular material. Placement of a sediment cap would require that borrow material is barged to the site. Heavy wave and ice action on the Great Slave Lake shore would require a thicker cap and more extensive armour. These measures may be effective within the North Bay; however, a sediment cap may be subject to extensive erosion in the South and East bays and would involve capping an extensive area of habitat.

***Option 5 – Isolate North Bay***

There is evidence to suggest the bedrock berm at the mouth of the North Bay was raised during mining operations, allowing for the bay to be used as a tailings management area. As a result, the metal concentrations within the surface water and sediment are greatest within the North Bay; however, any structures which were previously located at the mouth of the bay are no longer present (presumably due to wave action and ice scour).

This option would involve raising the bedrock berm at the mouth of the bay, thereby isolating the North Bay and any tailings therein. Isolation of the North Bay would reduce the transport of tailings into Great Slave Lake proper and limit the entrance of large bodied fish and other aquatic biota into the bay.

To raise the berm at the mouth of North Bay would require construction of a structure to isolate the work area, which could then be dewatered. It is unlikely that a sheet piling cofferdam (a temporary dam structure used for hydraulic isolation), would be suitable as there is no means to seal to the underlying bedrock. An earthen dam is also not feasible due to the absence of suitable borrow material.

If the area could be isolated and dewatered, raising of the bedrock berm would subsequently require the construction of a large engineered concrete wall tied into the underlying bedrock. The concrete wall would need to withstand wave action and the impacts of heavy ice movement. The dam would require long-term inspection, management and maintenance in perpetuity.

Following the isolation of the North Bay, it is predicted that metal concentrations in surface water would rise considerably due to hydraulic isolation, and treatment options may be required.

**Table 26 Remedial Options – Surface Water and Sediments**

<b>CRITERIA</b>	<b>Option 1 Do Nothing</b>	<b>Option 2 Leave As Is with Monitoring</b>	<b>Option 3 Excavate Sediments</b>	<b>Option 4 Cap Sediments</b>	<b>Option 5 Isolate North Bay</b>
Goals	Minimize exposure of the aquatic environment (and its receptors) to chemicals of concern.				
Operating Principle	No remedial measures, inspections, or monitoring programs implemented	Conduct monitoring of surface water and sediment to ensure no degradation in environmental quality.	Removal of tailings and contaminated sediments through sediment dredging, reducing exposure of aquatic biota to metals.	Capping of tailings and contaminated sediments with a granular cap (and potentially synthetic material), reducing exposure of aquatic biota to metals.	Raise bedrock berm at mouth of North Bay with concrete structure to prevent spread of tailings and contaminated sediments into Great Slave Lake and reducing exposure of aquatic biota to metals.
Protection of Human Health and Environment	Moderate (due to localized effects)	Moderate (due to localized effects)	High (removal of tailings/sediments)	Moderate (unlikely to cap all areas of concern)	Low (north bay metal concentrations expected to rise)
Long Term Effectiveness	Moderate (localized effects)	High	Moderate	Low (cap materials in South Bay expected to disperse)	Moderate (dam structure will require maintenance and may fail in time)
Level of Confidence	Low	Moderate	Low	Low	Low
Potential Remedial Impacts	None	None	High	High	High
Implementation time for Remediation	None	One monitoring event every three years for a minimum of 12 years	> 4 weeks	> 4 weeks	> 4 weeks
Site Disruption	None	None	High	High	High
Ease of Implementation	High	High	Low	Low	Low
Historical Community and Regulatory Acceptance	Low	Moderate	High	Moderate	Moderate
Cost	None	Moderate	High	High	Very High

### 7.3.10.3 Preferred Remedial Option

Due to the implementation of terrestrial remedial measures and the potential for releases to the aquatic environment, there is a need to ensure that metal concentrations in the surface water and sediment do not increase. The “Do Nothing” approach (Option 1) is therefore not recommended.



Three intrusive remedial options have been assessed: dredge sediments, cap sediments and isolate the North Bay. Sediment dredging (Option 3) would remove much of the tailings and contaminated sediments from the aquatic environment; however, due to the bedrock surface and the deeper water environment offshore of the South Bay, much of the material would likely remain in place. There is also considerable potential for resuspension and dispersal of the contaminants and, as a result, sediment dredging is not recommended.

Application of a sediment cap (Option 4) would reduce the exposure of aquatic biota to contaminants, although there is no suitable granular material present on site and this would need to be barged to Outpost Island. The cap might remain in place within the partially isolated North Bay, but is predicted to be disturbed and washed out of the South Bay and/or East Bay. Due to the unlikely long-term success, sediment capping is not recommended.

Isolation of the North Bay is not considered a feasible or long-term option (Option 5). A dam suitable to withstand the wave and ice action of an exposed island on Great Slave Lake would be an extensive structure and require maintenance in perpetuity. Construction would be cost prohibitive and metal concentrations within the North Bay surface water are predicted to increase once isolated.

The implementation of a long-term monitoring program (Option 2) was selected during the Remedial Options Analysis Workout as the preferred remedial option to address concerns within the aquatic environment. The program would be designed to ensure remedial measures do not result in adverse effects to surface water or sediment, and that conditions do not deteriorate in the following years. The results of the HHERA indicate that the metal concentrations due to the deposition of tailings will result in adverse effects of benthic organisms in the localized bays (North Bay, South Bay and East Bay). However, it is not predicted that effects will be observed in fish or human populations. While this option does not provide a “Walk Away” solution, it is appropriate given the nature of impacts associated with the site in its current condition.

#### ***7.3.10.4 Monitoring and Contingencies***

Application of a long-term monitoring plan will provide assurances that terrestrial remedial measures are performing as intended and not resulting in increased metal loadings to the aquatic environment. An adaptive approach is recommended, and may begin with an initial five year monitoring plan for surface water and sediments at select locations. While remedial measures are predicted to result in a net decrease of metal loadings to the aquatic environment, metal concentrations may remain above background. Due to the highly mineralized nature of the Outpost Island bedrock and the presence of tailings in the aquatic environment, metal concentrations are not expected to rapidly decline and may decrease over a longer time frame.

## 8.0 MONITORING AND LONG-TERM MEASURES

Monitoring, maintenance, and contingency plans are essential in the successful implementation of a RAP, serving the following key functions:

1. To ensure health and safety of workers during remediation (*health and safety monitoring*);
2. Monitor for possible impacts and quality control while the remedial work is underway (*remediation monitoring*);
3. Monitor the effectiveness and condition of the remedial work that was done after its completion (*performance monitoring*);
4. Monitor environmental media to document physical and chemical conditions following the remediation (*long-term monitoring*);
5. Ensure that any required maintenance work is done to keep the remedial work up to specifications (*care and maintenance*); and,
6. Make sure that backup plans are ready in case something unexpected takes place (*contingency plan*).

The remedial actions outlined in Section 7.0 will require a commitment to monitoring, both during the implementation phase of the project, and after the remediation is complete. As a first step and in keeping with AANDC's "*Mine Site Reclamation Guidelines for the Northwest Territories*" (INAC 2006a) a 'Reclamation Completion Report' will be completed following the remediation of the site which will compare the actual remedial works completed at the Outpost Island Mine to the remedial specifications to ensure consistency.

### 8.1 HEALTH AND SAFETY MONITORING

Health and Safety monitoring is required during the remediation of the Outpost Island Mine. A designated health and safety officer will be on-site at all times during implementation, with the primary role of monitoring the health and safety of the workers. The monitoring could include activities such as confirmation dust monitoring, safety audits/inspections, ensuring the use of proper personal protective equipment, reviewing the use of standard operating procedures, etc. All measures will be detailed in the Site-Specific Health and Safety Plan to be drafted by the selected contractor and subject to review and approval.

### 8.2 REMEDIATION MONITORING

While the remedial options have been selected to provide projected net benefits in environmental quality, some of these measures have the potential to result in impacts to the terrestrial and aquatic environment. Some of these impacts may be predicted and are an unavoidable

consequence of the larger remedial plan, such as vegetation damage during equipment movement. Other impacts may be avoided through the use of best practices and will require the implementation of regulatory controls, a monitoring program and detailed project planning.

A Remediation Monitoring Program will be required to assist proponents in identifying remediation activities that may have an adverse impact on the natural environment. The program will focus on potential discharges to receiving waters in the near vicinity of remedial works. This should include the North and South Bay, and at the former dock area. During the construction of remedial works, it is recommended that no less than two small scale monitoring campaigns be conducted. These campaigns are not intended to serve as a comprehensive assessment of environmental conditions, but should be used to confirm that remedial activities are not causing new impacts. Observational monitoring of potential impacts to local wildlife would be conducted by on-site personnel employed as wildlife monitors for the duration of the site remediation.

It is recommended that a detailed Remediation Monitoring Plan be drafted in conjunction with the Long-Term Monitoring Plan and State of Environment Plan. The use of this phased approach to monitoring identifies potential remedial impacts and benefits during and following the remediation of the site. This approach will also permit the opportunistic combination of site monitoring activities at adjacent mining properties, ensuring consistency in approach and overall cost savings.

For context, a number of mechanisms already exist to control and monitor construction-related releases to the environment. These include:

1. Regulatory Authorizations - At least one Land Use Permit, Water Licence or Quarry Permit will be issued for the project. These authorizations will identify controls necessary to mitigate potentially adverse environmental impacts (e.g., use of silt curtains to control suspended sediments). These regulatory authorizations may also specify criteria for the release of potential contaminants to the receiving environment (e.g., for wastewater discharge) and reporting requirements for inadvertent releases (e.g., spill reporting).
2. Contractual Measures - As "proponent" and licensee, AANDC will be responsible for ensuring compliance with all regulatory authorizations. At a functional level, this responsibility will be transferred to the remediation contractor through contractual obligations. An example of a general measure to be imposed on the contractor is:  
*"Comply with all applicable environmental laws, regulations and requirements of Federal, Territorial and other regional authorities, and acquire and comply with such permits, approvals and authorizations as may be required."*

A more specific example is:

*"Provide an erosion and sediment control plan that identifies the type and location of erosion and sediment controls to be provided. Plan to include monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Territorial, and Municipal laws and regulations"*

The Crown Representative (i.e. Resident Engineer) will oversee the implementation of these obligations. This will include the authority to approve any monitoring requirements specific to individual construction activities. Throughout this process, AANDC will be given opportunities to comment on the monitoring requirements. Compliance with the authorizations will also be monitored and enforced by Land Use Inspectors.

3. Environment, Health and Safety Procedures - The remediation contractor will be required to submit a comprehensive Environment, Health and Safety Plan that will identify procedures to control and address potential impacts to the environment. Where appropriate, these procedures will include provisions for environmental monitoring. For example, in the event of a fuel spill, the procedures will define emergency response and remedial approaches that are to be followed. The Crown's Resident Engineer will have the responsibility and discretion to define requirements for confirmatory sampling which could include sampling within the receiving environment.
4. Standing Regulation - In addition to project-specific authorizations, environmental legislation of general application will also be enforced during the remediation project. Examples of such legislation include the Fisheries Act, Species at Risk Act, the Canadian Environmental Protection Act and the Northwest Territories Environmental Protection Act. Appropriate regulatory agencies including the Department of Fisheries and Oceans, Environment Canada and the Government of the Northwest Territories will have the authority to inspect and enforce against these pieces of legislation.

As evidenced above, a number of measures are in place to ensure that individual remediation activities are not having a deleterious effect on the receiving environment. Notwithstanding the conclusion above, there remains a possibility that limited additional monitoring will be required during the implementation of remediation. While it is difficult to predict the nature and scope of these requirements (e.g., sampling locations and required analyses), responsibilities for identifying such requirements should be clearly assigned. Prior to deciding how to implement any construction activity monitoring, the realities of operating at a remote field location need to be considered. Specifically, the schedules of individual construction activities are typically very fluid, as are the nature and timing of potential environmental concerns. It is therefore very difficult to anticipate when and what monitoring requirements will arise. In this context, the

Resident Engineer should be given authority to request that the remediation contractor conduct additional monitoring on an "as and when needed" basis to address potential environmental concerns if they arise. Collectively, these requirements are expected to be minimal.

### **8.3 PERFORMANCE MONITORING**

Performance monitoring is recommended for all remedial measures constructed, including any drainage controls, slopes and the seals/barriers for mine openings. The performance of the remedial works should be measured in terms of physical stability, erosion and sedimentation. Performance monitoring is recommended on an annual basis for a period of a minimum of five years following completion of the remedial works. Based on the results of initial monitoring, the frequency and scope of the long-term monitoring program could be adjusted accordingly. The performance monitoring will include annual inspections by an appropriately qualified engineer, which are typically implemented as part of the annual Long-Term Monitoring Program. Detailed inspection requirements should be clarified within the Long-Term Monitoring Plan.

### **8.4 LONG-TERM MONITORING (ENVIRONMENTAL MONITORING)**

Upon completion of remedial measures, a scheduled Long-Term Monitoring Plan is recommended. This should be drafted and approved prior to the completion of remedial measures.

An adaptive management approach would be taken in determining the long-term requirements of the environmental monitoring program. As initial monitoring results become available, the monitoring program would be evaluated to confirm it is capable of detecting and evaluating any substantive changes in site conditions that have the potential to result in adverse environmental impacts.

In similar remedial projects, AANDC has implemented this approach through an initial five year monitoring plan. The timing of annual campaigns should be fixed to reduce the influence of seasonal variation on the monitoring data set. The analytical parameters proposed for the Long-Term Monitoring Program may be selected based on: a) historic land-use; b) contaminants of concern identified prior to remediation; and, c) anticipated post-remediation site conditions. To the extent possible, analytes should be selected to be consistent with previous monitoring activities at the sites. Details on sampling analytes, assessment criteria, sampling location and frequency will be required within the site specific long-term monitoring plan.

## **8.5 CARE AND MAINTENANCE**

Long-term care and maintenance could include any activities that are required to ensure the ongoing integrity and performance of the remedial works. Additional works may be required to ensure that the impacts of past site activities are mitigated within the context of best practice and the specific commitments of this RAP. Examples of care and maintenance activities include: re-grading of aggregate covers, repairs to adit seals, and re-posting of signage.

## **8.6 CONTINGENCY PLANNING**

Contingency planning provides a prescribed course of action for unforeseen events during remediation. Such plans are used to mitigate effects to human health and environment and to allow personnel to adhere to regulatory guidelines and best practices in an effective and efficient manner.

During remediation, contingency planning must address the potential that despite planning and the use of controls, remedial measures present risk. The contingency plan must identify regulatory authorities, reporting protocols and a clear course of action (INAC 2007). The contingency planning must at minimum provide specific protocols to address petroleum hydrocarbons or chemical spills, releases to the aquatic environment, wildlife encounters and fires. Additional planning may be required upon determination of the remedial approach and consultation with regulatory authorities. Production of contingency plans is most commonly tasked to the remedial contractor prior to the initiation of the remedial program.

## **9.0 REMEDIATION SCHEDULE**

Remediation of the Outpost Island Mine is a relatively small-scale project when compared to other AANDC-CARD remedial projects. The implementation of the RAP, under any combination of remedial options, is projected to require a maximum of one summer season and site activities are currently planned for spring/summer 2014.

The primary modes of mobilizing heavy equipment and materials to/from the site are barge transport and winter ice roads. It is currently assumed that barge transport between the mine and either Yellowknife or Hay River is the preferred option for equipment and material transport. Barge travel has been used extensively throughout Great Slave Lake, including during the operation of the Outpost Island Mine. The primary limitations with respect to barge travel are seasonal, with the eastern half of Great Slave Lake ice free from late May to October, and inclement weather more likely in the early spring and late fall. Current project timelines estimate remedial activities may start as early as spring/summer 2014, and a projected general schedule is provided below assuming barge transport:

- June: One week required to mobilize all equipment and materials to the site. One week required to establish camp facilities for the remediation workforce.
- July: Approximately one month is required to complete the remediation. This estimate is subject to change based on the preferred remedial approach, with a maximum time allotment of two months based on the current remedial approach.
- August: Approximately two weeks is required to de-mobilize all equipment and materials and transport mine materials to landfill (as selected in the preferred remedial options). Deconstruction of camp facilities will require approximately one week, which may be conducted concurrently with material transport.

If a winter road is selected as the method of equipment and material transport, mobilization and demobilization would occur during the winter months (typically between January and March), thereby resulting in project duration of one year. The construction of a winter road is expensive, time consuming, and accompanied by uncertainties due to weather and ice conditions. For these reasons, it is unlikely an ice road will be constructed or utilized by the remedial contractors.

The schedule is subject to revision and refinement based on procurement approach, contract award and regulatory approval.

## **10.0 REFERENCES**

- Aboriginal Affairs and Northern Development Canada (AANDC) 2011. *SID Viewer*. [Online] <http://ismsid.inac.gc.ca/website/sidvh1/viewer.htm>
- Aboriginal Affairs and Northern Development Canada – Contaminants and Remediation Directorate (AANDC-CARD) 2013. *Traditional Knowledge Questionnaire Summary*.
- Biodiversity Institute of Ontario 2008. *Great Slave Lake – Northwest Territories*. Encyclopaedia of Earth.
- Canadian Council of Ministers of the Environment (CCME) 2012. *Canadian Environmental Quality Guidelines*. On-line version accessed May 2012 from <http://st-ts.ccme.ca/>.
- Canadian Councils of Ministers of Environment (CCME) 2007. *Canadian Soil Quality Guidelines, Update 7.0, Table 1 and 2*. Canadian Soil Quality Guidelines, Residential / Parkland Coarse Grained Soils.
- Canadian Council of Ministers of the Environment (CCME) 1996. *A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines*. Report CCME EPC-101E, CCME. March.
- Canadian Sites Management Working Group (CSMWG) 2000. *A Federal Approach to Contaminated Sites*.
- Columbia Environmental Consulting Ltd. 2006. *Enhanced Phase I Environmental Site Assessment for the Abandoned Outpost Island Mine Greats Slave Lake, Northwest Territories*.
- EBA Engineering Consultants Limited 2009. *Phase II Environmental Site Assessment Outpost Island Mine (Philmore Mine) – SM 204/238 Northwest Territories*.
- Ecological Stratification Working Group 1995. *A National Ecological Framework for Canada*. Agriculture and Agri-Food Canada. Research Branch, Centre for Land and Biological Resource Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa/Hull. 125 pp.
- Ecosystem Classification Group 2008. *Ecological Regions of the Northwest Territories –Taiga Shield*. Department of Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, NT, Canada. viii + 146 pp. + insert map.
- Environment Canada 2011. *National Climate Data and Information Archive - Canadian Climate Normals* [Online] <http://www.climate.weatheroffice.gc.ca>



- Environment Canada 2010. *Species at Risk in the Northwest Territories 2010 Edition*. Canadian Wildlife Service.
- Environment Canada 2009. *National Inventory Report 1990-2008. Part 3 – Greenhouse Gas Sources and Sinks in Canada*. The Canadian Government's Submission to the UN.
- Faure, Gunter 1998. *Principles and Applications of Geochemistry*. Prentice Hall. New Jersey.
- Fisheries Act* 1985. R.S.C., 1985, c. F-14. Last Amended 2012-06-29.
- Franz Environmental Incorporated and EcoMetrix Incorporated (Franz/EcoMetrix) 2010. *Phase III Environmental Site Assessment of Outpost Island Mine – SM 467 Northwest Territories*. March.
- Golder Associates 2010a. *Aquatic Baseline Report for the Proposed NICO Project*. Submitted to Fortune Minerals Limited. Retrieved from the Mackenzie Valley Review Board Public Registry.
- Golder Associates 2010b. *Baseline Soil and Vegetation Chemistry for the Proposed NICO Project*. Submitted to Fortune Minerals Limited. Retrieved from the Mackenzie Valley Review Board Public Registry.
- Government of the Northwest Territories (GNWT) 2010. *Northwest Territories Air Quality Report 2009*. Department of Environment and Natural Resources.
- Government of the Northwest Territories (GNWT) 2004. *Guideline for Industrial Waste Discharges in the NWT*. Developed by the Environmental Protection Service (EPS) of the Department of Resources, Wildlife and Economic Development (RWED).
- Hamilton, S.M. 2007. *Major Advances in Soil Geochemical Exploration Methods for Areas of Thick Glacial Drift*. Proceedings of Exploration 07: Fifth Decennial International Conference on Mineral Exploration. 2007. p.263-280
- Health Canada 2010a. *Federal Contaminated Site Risk Assessment in Canada. Part V: Guidance on Human Health Detailed Quantitative Risk Assessment (DQRA) for Chemicals*. September.
- Health Canada 2010b. *Federal Contaminated Site Risk Assessment in Canada. Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA)*. September.
- Health Canada 2010c. *Federal Contaminated Site Risk Assessment in Canada. Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical Specific Factors*. September.

- Health Canada 2007. *Federal Contaminated Site Risk Assessment in Canada. Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA)*. Draft. June.
- Indian and Northern Affairs Canada (INAC) 2007. *Guidelines for Spill Contingency Planning*.
- Indian and Northern Affairs Canada (INAC) 2006a. *Mine Site Reclamation Guidelines for the Northwest Territories*.
- Indian and Northern Affairs Canada (INAC) 2006b. *New Corporate Procedures Manual (Management Framework)*. Northern Affairs Contaminated Sites Program.
- Indian and Northern Affairs Canada (INAC) 2002a. *Northern Affairs Program Contaminated Sites Management Policy*.
- Indian and Northern Affairs Canada (INAC) 2002b. *Mine Site Reclamation Policy for the Northwest Territories*.
- International Permafrost Association (IPA) 2012. *What is Permafrost?* [online] <http://ipa.arcticportal.org/resources/what-is-permafrost>
- Johnson, B.J. 1985. *Stratigraphy, Sedimentology, and Structural Style of the Wilson Island Group, Northwest Territories*. Geological Society of America. 1998 Conference. Volume 17. 28 October 1995.
- Mackenzie River Basin Board (MRBB) 2003. *State of the Aquatic Ecosystem Report: Great Slave Lake Sub-Basin*.
- Mackenzie Valley Land and Water Board (MVLWB) 2011. *Interactive Map of Land and Water Permit Applications*. [Online] <http://www.mvlwb.ca/mv/pages/maps.aspx>
- Mackenzie Valley Resource Management Act*. S.C. 1998. 1998.
- Mackenzie Valley Land Use Regulations*. SOR/98-429. 1998.
- Metal Mining Effluent Regulations* (MMER). SOR/2002-222. 2011.
- Mine Environment Neutral Drainage Program (MEND) 2012. *Cold Region Cover System Design Technical Guidance Document*. MEND Report 1.61.5c
- Mine Environment Neutral Drainage Program (MEND) 2004. *Covers for Reactive Tailings Located in Permafrost Regions Review*. MEND Report 1.61.4.
- Mine Environment Neutral Drainage Program (MEND) 1998. *Design Guide for the Subaqueous Disposal of Reactive Tailings in Constructed Impoundments*. MEND Project 2.11.9.

*Mine Health and Safety Act*. SNWT 1994. c 25. Northwest Territories.

Moon, C.J., Whately, M.E.G. and Evans, A.M. 2006. *Introduction to Mineral Exploration*. Blackwell Publishing, MA.

Natural Resources Canada (NRC) 1995. *The National Atlas of Canada 5<sup>th</sup> Edition – Canada Permafrost Map*. MCR 4177. Produced by the National Atlas Information Service, Canada Centre for Mapping, Geomatics Canada, and the Terrain Services Division, Geological Survey of Canada.

NORMIN 2010. *Northwest Territories Geoscience Office NORMIN Database* [Online], Showing ID 085HNW0034, Outpost Island Mine [Online] <http://ntgomap.nwtgeoscience.ca/>

*Northwest Territories Water Act*. S.C. 1992. 1992.

*Northwest Territories Water Regulation*. SOR/93-303. 1993.

Ontario Ministry of Environment (MOE) 1993. *Ontario Typical Range Of Chemical Parameters In Soil, Vegetation, Moss Bags And Snow*.

O’Sullivan, G., Bilyk, and Sandau, C.D. 2010. *Differentiating Aged Petroleum Hydrocarbons from Modern Phytogenic Hydrocarbons in High Organic Content Soils Using Biomarkers*. Environmental Forensics – Proceedings of the 2009 INEF Annual Conference. The Royal Society of Chemistry, United Kingdom.

Price, W. 1997. *Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia*. BC Ministry of Energy and Mines.

SENES Consultants Limited (SENES) 2013. *FINAL Report - Human Health and Ecological Risk Assessment for Outpost Island Mine Site, Northwest Territories – 2013 Update*

SENES Consultants Limited (SENES). 2011. *2010 Northwest Territories Environmental Audit – Status of the Environment Report*.

SENES Consultants Limited (SENES) 2005. *Northwest Territories Environmental Audit 2005–Supplementary Report on the Status of the Environment*.

SENES Consultants Limited and Franz Environmental Incorporated (SENES/Franz) 2011. *Phase IIIa Environmental Site Assessment of Outpost Island Mine, Northwest Territories*.

- Silke, R. 2009. *The Operational History of Mines in the Northwest Territories Canada*, Northwest Territories Geoscience Office.
- Silke, R. 2012. *Personal Communication*.
- Stantec 2010. *Thor Lake Rare Earth Metals Baseline Project. Environmental Baseline Report: Volume 3 – Aquatics and Fisheries. Final Interim Report*. Prepared for Avalon Rare Metals Inc. Retrieved from the Mackenzie Valley Review Board Public Registry.
- Terra Verra Co. 1994. *The 1994 Clean-Up of Great Slave Lake*.
- Treasury Board 2002. *Treasury Board Federal Contaminated Sites Management Policy*. June.
- United Nations 1992. *United Nations Framework Convention on Climate Change*.
- United States Environmental Protection Agency (US-EPA) 2005. *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*. Produced by the Office of Solid Waste and Emergency Response.
- Varkonyi, Bert. 2010. *Personal communication*.

## **APPENDIX A**

### **REMEDIAL ACTION PLAN OPTIONS ANALYSIS WORKOUT TRANSCRIPT**



## AKAITCHO REGION COMMUNITY ENGAGEMENT

### GREAT SLAVE LAKE PROJECT REMEDIAL OPTIONS ANALYSIS WORKSHOP MEETING TRANSCRIPT

DATE: JUNE 13-14, 2013  
PLACE: FORT RESOLUTION, NT.

**PARTICIPANTS;** Ron Breadmore (RBr), Project Manager, CARD  
Joel Gowman (JB), Project Officer, CARD  
George Lafferty (GL), Consultation Officer, CARD  
Kaitlyn Vician (KV), Student, CARD  
Jessie Hoyt (JH), PWGSC  
Charles Gravelle (CG), SENES  
Claire Brown (CB), SENES

August Enzoe (AE), LKDFN  
Mike Tollis (MT), LKDFN, Tech Adv June 14 only  
Ernest Boucher (EB), LKDFN, June 14 only  
Arthur Beck (AB), FRMC  
Tom Unka (TU), FRMC, Tech Adv  
Pete King (PK), FRMC  
Kara King (KK), FRMC, President, June 14 only  
Ann Biscaye (ABi), DKFN, Translator  
Robert Beaulieu (RBe), DKFN  
Paul Smith (PSm), DKFN  
Stanley Beck (SB), DKFN  
Patrick Simon (Psi), DKFN, Lands Mgr June 14 only  
Rosy Bjornsen (RBj), DKFN, Manager

#### DAY ONE – JUNE 13, 2013

**Opening Prayer** August Enzoe,

**Introduction** George, Ron & Everyone (introduced themselves)

**Presentation Project Objective and Status** Ron Breadmore

**AB** This is your first time in our community?

**RBr** We were here last week, for a meeting (*AB was not part of the meeting*)

**AB** Was not aware of the TK study and would like to opportunity to provide some information.

**RBr** We did the mapping exercise and maps were brought to Ft. Res last week; this gave an opportunity for other Elders to provide addition information such as, yourself.

Canada



- AB** How are people going to visit the site; are they going to fly or by boat some people don't fly.
- RBr** We are getting two twin otters on floats so it will be by flight.
- AB** I have one question. You say you are going to have two twin otters there but you are going to three different islands I would suggest that you have a boat out there so ... not audible.
- RBr** Thanks Arthur, we will consider that.
- Marc E'ntremont phones in from BC**
- RBr** ***AANDC presents the Workout Framework for the meeting.***
- TU** I have a question, here. You're referring to your water license to the MVLWB I know sometimes these process are may take a long time, have you considered that? It seems that you are timing whole bunch of stuff here looking at options and so forth yet you will require a license to work on some of the stuff you're working on. Did you look at that option also? Please describe the options a little for the rest of the people, here. Has the length of time required to get a water license been considered during planning? This may impact the schedule.
- RBr** Yes, the permitting process they can be quite lengthy and that's why we build the timing into our schedule to allow for that so what we are doing the technical specifications to tie the lose ends together we will have the application in. We'll have the site tour with the Board. I think we will be in good shape. This is a model we have used on other sites. I'll get to that slide in minute and talk about that hybrid. Just for discuss with our observation on meetings to date with the TK workout, public update and executive update in Lutsel K'e and here in Fort Resolution. We got a really good sense of cooperation between the communities and between the groups and we would like that to continue on through the meeting and we think that is going to happen. What we also like to see is this collaboration or combination of technical approach and TK; the two come together. We have a lot projects with great success where that has worked; Colomac comes to mind.
- TU** Do you think the whole clean up effort will go through an Environmental Process?
- RBr** The size of these clean up project I do not that as a risk. The biggest risk we have so far was on the Colomac Project and we had done a sufficient consultation and we had input from the communities and we build a very strong Remedial Action Plan so there was no trigger for EA. I am pretty that will be the case, here.
- PK** I want to say something before we start. We're talking about old mines but we don't say anything about O'Connor Lake Mine, east of Rocher River. I thought we would talk about that mine; it is still there. East of Rocher River called O'Conner Lake Mine.
- RBr** Thank you, Pete. That's right, O'Connor Mine is on our inventory that was assessed and we are working through that assessment process. So, it is on our list and we'll be looking at that within the next couple of years. We won't be talking about O'Conner today, but we do have it on our list. Thank you.
- CG** ***SENES technical presentation - Outpost Island Mine***
- ?** Can you show on the blueprint where the tailings was?
- CG** Ok, so what the question was where was the tailings. So, what they did in the original mining operations that went on in the 40s, correct me if I am wrong on this one. They were basically working in this are and just discharging the tailing right onto the land and that is not to say that some of it did not go into the north bay. When they went back in 51, 52 they actually went and re-processed some of those tailings and waste rock. So the tailings in most part are in this area; there is bit of spillage over here and a bit of spillage over here.
- AB** Who was there during the 1994?



- CG** We can find out who it was. I can't remember the name of the outfit right now but basically a couple of construction manager types working with the youth I believe and I think it was the Métis group. Their names are all welded onto a plate at the outpost island so if you want to I could, we have a photograph somewhere.
- AB** You talked about a lot stuff there but talking about small animals and whatnot. All of that waste rock and the rain, snow and melt all that goes into the GSL and that's one of the main fishing habitats. We use the lake for fishing which is important to the community. Have fish been assessed?
- CG** That's right that is being considered in the study right now. We'll take that one and have dialogue because it's one of the better issues. Ok, do you want to go right into Blanchet or take two
- RBr** Are there any questions on Outpost before we go into Blanchet?
- TU** Yes, there probably is because we do have other metals like the old equipment sitting there that sort of belongs to the NWT Mining Heritage. What are you going to do with it? Are you going to just let it sit there; it does have some historical value to it. It's not going anywhere and some of the Elders are saying why you don't just leave it there.
- RBr** Tom, good question. We've discussed that and we will discuss further during the options on debris on site. What we are going to try and do if we can do it safely and cost effectively is to bring those units back out as a whole, probably in pieces for the mine heritage society they are collecting all these artefacts from our mine sites in Yellowknife because they present a hazard on site and the concrete that's left from the foundation we try to break down. The impacted concrete, the hydrocarbons, oil, lube that would be consolidated under a cap at one of the sites with other hydrocarbon soils and the clean concrete we may have an option to use as break wall, in North Bay for example. The plan is get the equipment off-site.
- CG** Ok, if there aren't anymore question on Outpost, we will move onto Blanchet Mine so we moved a little further in the Hearne Channel now
- AB** If you don't mind, after we do one mine site we take a break so we can chat with our Elders. I think we should do one mine site at a time.

## **BREAK**

### **CG** *SENES technical presentation continued – Blanchet Mine*

- RBr** I'll start. That is a concern for traditional user for sure. What's difficult in Great Slave Lake is that it's such a huge water body and the fish move around so much it is really hard to make any connection with any impacts with these fish with these three sites. It may be a little easier at Copper Pass we got a small lake that would be easy to do. Great Slave Lake is a little trickier. Jessie, could you explain the process we used.
- JH** That is the consideration we are trying to find out how we can tackle that so we talked to experts we spoke with DFO, EC. We talked about how to best handle the fish issue and collectively what is decided was it will be very difficult to find out because of small impact on GSL. It's hard to actually pinpoint how this affects your fish. We have ongoing fish sampling in GSL region and we will continue with the fish study. What we have to do is address on site contaminants and the sources that is actually going into the GSL. When it comes to fish it is very hard to associate our sites with those fish because the fish have a large roaming area but we will continue monitoring the GSL. .
- AB** I understand all that. Let's do another one, let's sample the soil. There's current there, let's sample the soil right at the drop off at least. We should actually sample the soil at the bottom even at the drop off. It's not going to be that deep. We should check the soil, thank you.
- JH** We have checked the soil and when we mention sediment we are talking about soil at the bottom of the lake. We have done our test as far as the sediment is and have calculated our risk and we spoke with DFO and EC about our results there as while so. That was taken into consideration and sampling done.





- AB** You should bring some of those samples. ... non audible
- JH** You want to see the actual physical substance ...
- AB** Not the substance itself, but the results. It would make it a lot easier the people would trust you a lot more when you have something to show. Back in a day, we trust each other and everything was with a hand shake, now everything is now on paper.
- JH** On all our site assessment reports in the appendixes at the back of the report is where we have all the supporting documents from the lab and we also have summaries in the report.
- AB** What I am saying is for each one of these for example when we did outpost you test the site and you know what is going into the water and all that stuff but we do not know that here. We just hear what you say. It would be easier if you have this information at the end of each mine site presentation.
- RBr** Its one of those things when we have so much information out there and the communities do have the reports the environmental site assessments they do have those findings. What we want to say today is instead of parts per millions but what we say is we have exceedances above our standard. That's the kind information and concerns that are out there we want to show. If there are elevations above standards, that is what we need to talk about.
- AB** Exactly. The main ones like arsenic what levels are they at the lake bottom and the beach stuff like that.
- RBr** Just as an example you might want flash up those intensity maps on Copper Pass. There is some color coding that Charles showed we can have a closer look at that. What those levels actually mean. We do have some of that information here today.
- CG** The information we have from the lab is bunch of papers what might be more beneficial is showing the concentration if that is easier for you. I have this information on my computer we can link up my computer and we can view some of those tables.
- AB** I was not speaking for myself. We just want the information summary, you can break up the data and give us the information.
- CG** Yes,
- TU** While you are supplying us with all data can you give us exceedance levels and thresholds or some of metals you are talking about?
- CG** Just as a general rule Tom, in our assessment report we typically compare our information to the standards for that site.  
--- Explanation of Graphs Used ---
- RBe** What are talking about PHC?
- CG** PHC is a technical term used for oil, gas, diesel fuel, that is what we are talking about.
- RBj** Did you do any sampling for phytoplankton?
- CG** That's part of the program we did back in 2010. The sediment samples were submitted for metal testing. We didn't do Hydrocarbon; we were not concern with hydrocarbon then.
- RBj** I have another question. This is regards to all the work that you guys are doing; you're talking to the Elders around but did you talk to anybody that worked at the mine? Are you guessing what happened, so.
- CG** Unfortunately, in a lot of these operations the people that worked the claims and whatnot aren't really around so we don't often have the luxury of speaking with them. Generally, these are old abandoned explorations or mine operations that went bankrupt and the people just disappeared so we get more information talking with you people. Who often worked on site so when we want to know where the winter road is done we often rely on you guys.
- RBj** I just wanted to know who you talked with.
- CG** Sometimes what we do is have access to data base where records are kept on how much mineral was produced and how much mining they actually did but really that is



what you are left with whatever the mining operator wanted to provide. The rest is what you observe.

**RBr** Just to add to that, Charles. That is a good question, Rosy. I guess when we do have that luxury of speaking with people that are still around like the Rayrock Mine, we do have those discussions. We do rely on historical information like Ryan Silk out of Yellowknife and he does put these reports together. It's based on some of those records, Workers Compensation Board (WCB), those historic are good source of information. You're never going to have the information but we have a pretty good handle on the information just from historic from what Ryan Silk has done alone.

**TU** What Rosy is talking about some of the old people and some of the mine owners and some people that worked at the mines sites are gone. For me, this program does not put enough enfances on traditional knowledge. If you spoke with some of the people that are alive today you may find some answers there. Our traditional knowledge is pretty vast it's came from centuries their observation and spiritual practices, living in harmony with the land and water, so we are part of whole. It is the intellectual properties of first nation's members through stories, experiences, practices, even spiritual feelings and teachings. It was passed on by our parents and ancestors. This knowledge will continue to exist it will be passed on to our children we will teach our children to live off the land. We have some of the rights it is not something you can take off the shelf and use it. That knowledge is for people all of us here have wealth of information. I feel it is not coming out here. We went through this traditional knowledge process I don't think you really thought out what is you are getting. Some of the historical stuff is not there because you didn't really talk to all the people. All of us here have some traditional knowledge so let use it let's not say we are done with it. As long as the people get involve it will involve traditional knowledge. It is our passed it is fact so let's use if properly.

**AB** We are here to help with this process you said something about contract. People talking about the area in regard before they build the mine and made a mess of course we are always stuck with the mess. We had very few people working at the mines. We want to be a part of labour force, could come out of the small community here.

**CG** When it comes to contracting that is something sometimes confusing because it is another department that takes of that. Everything that we do has to fare and transparent so anyone can apply for the job. We have caveat in there that contractors can commit to local employment. So what we do is we have contractors hire 60 % and over in aboriginal hire. Your community can pull together and put in a bid for the contract. The contractor would come into the community to look for skilled labourers like equipment operators and whatever and look for resumes. We do encourage local hire.

**AB** We already have affirmative action up here. When it was first introduced it was not followed and put on back shelf. Look at the mines, how many people from Ft Res work at the mines. More people are working from the south like Newfoundland. It is up to us to go to our Members of Legislative Assembly, MLAs to be included in economic benefits. In the small community like this, there is no work.

**RBr** I just had comment passed on to me I guess one of the Elders made observation that we'd like to move on to other mines site. I think we will have time to answer some other questions later on. I did mention we will talk about economic benefits later. Let's focus on the mine options and we will leave enough time at the end to answer questions.

**CG** ***SENES technical presentation continued – Copper Pass Mine***

**TU** Just a comment on your agenda here, I want to speak to that. Dealing with all the Elders we need to give them the opportunity to question some of your efforts while it is still fresh in their minds some will leave here in the hour or so. We should look at the agenda so the Elders will have some of their questions answered.

**RBr** I appreciate that Tom and we are trying to keep pace and we are also trying to keep focus on mine sites and remedial options and we can keep questions on contracts to another day or at the end of the meeting. But we really want to keep focus on the options so with that Charles can we move onto Copper Pass.



**CG Copper Pass Presentation Con't.**

? What is that stain?

**CG** What is in the rock at that location is when water is, it is reacting with the water it starts to stain and turns to powder.

**TU** How high is that waste rock?

**CG** I would say on the order of 25 feet.

**CB** I took that picture it is a little in the middle see where it says exposed bedrock its hard to see but it is bedrock so the waste rock is not that thick.

**DISCUSSION REGARDING CORES**

**EB TALKS ABOUT STARK LAKE AND REGINA BAY**

- details recording not included here

**RBr** Thank you, Ernest. A quick note on that, we are doing sampling with DFO around that area and sample in GSL and Copper Pass site. I think we just need to get more information back to the community. We will continue to work with Mike and your group and get that information back and just looking at the time, it may be a good time for a break

**BREAK**

**RBr** Ok, we'll start again. 4 or 5 slides on Copper Pass then we'll go to questions.

**CG Copper Pass Presentation Con't.**

**AB** You should take water samples too

**CG** As a general rule, they go hand in hand, with sediment sampling.

**CG Copper Pass Presentation Con't.**

**AB** Just a quick question. How many litres of water is in the trenches, approximately?

**CG** I think we are on the order of I want to say 5000 litres

**AB** Those 5000 litres, we can put that in drum and get it out of there, thank you.

**CG** One of two things we can bring in a treatment plant which will be expensive ... non audible

**RBr** Ok, that was a good discussion on Copper Pass. Are there any other questions, before we move onto Outpost? We'll have a good chance tomorrow before the end of the day when we summarize all the discussions and pick up any questions at the end of the day. If there is nothing else on Copper Pass let's get started with Outpost. This is Options Analysis we want to go through now. We'll do this a couple of different ways Joel's got some colour stickers he will put on posters as we go through our choices. We are going through each component with a review of what the issue is between Charles and Jessie and we will work through each option. On each option we want to meet the objectives of each project as while as the program. If it is technically feasible, cost effective, won't create any health and safety concern or environmental issue so those are all the considerations as we talk about the options. On that, look at slides and work off the posters starting with Mine Opening at the Outpost Mine.

**OPTIONS ANALYSIS PROCESS**

**OUTPOST MINE SITE**

<b>Mine Openings –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Acceptable</b>
	<b>Option 3</b>	<b>Acceptable</b>
	<b>Option 4</b>	<b>Preferred</b>



Discussion (point form) – do nothing is not preferred, CG explains the retrofit with foam cover, AB asks how long the foam would last, CG wanted to get back to them but AB decides the cement would last 200 years (suggesting longer than foam cover) and he prefers the use of cement, CG says foam if left undisturbed would last like the cement but sunlight and forest fires would cause damages, mine inspectors would accept the use of cement for cover, AB suggests the cement would be a good choice, and does not want the waste rock to be moved around. PK says he talked about the mine caps before, 1946 Japanese were at Gro cap, Outpost open 1936 and closed 1946, GBL uranium mine. I want to seal it with cement. EB, arsenic is serious, people in Deline are concern, people die of cancer like Regina Bay, drain the water out or it will drain, we don't know how much water will drain, maybe arsenic there I don't know, someone may fall in, use concrete it don't matter, wants concrete, SB wants concrete, RBj wanted concrete and wanted it back to natural state, told no sign of vegetation growth, the opening cover will be smooth, so safe. SB asks about the foam and after CG explanation it was decides concrete would be better, RBr suggests maybe a combination of the two foam and concrete, we'll bring to WCB, we are good either way, AB agrees, Mine Inspector will be consulted,

<b>Building –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Preferred</b>

Discussion (point form) – JG explains the options, AB burn no painted wood, treat and burn, JH says there are equipment and generators, CG says we can burn no hazard wood, PS, take away or burn, EB says to burn the wood, PK says mine shut down in 46 and was there last is 51, there use to be all kinds of equipment, mine is on rock, worked in con mine in 46 then later giant mine, now diamond mines, AE says burns the materials, TU says my feeling is burn, AB agrees

#### **BREAK**

<b>Non-hazardous Waste –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Preferred</b>
	<b>Option 3</b>	<b>Not Acceptable</b>

Discussion (point form) – RBr explains the options, RB non-audible, AB wants option 2, TU wants it consolidated option 2, PK there in 51, lots of metal, today everything is covered, take to Yellowknife, EB (Chipewyan language), Paul, option 2, SB, CG explains the concrete, to take the concrete and break up and could be used for fill, AB says good idea, want to see safest way used, RBj, wants to remove, safe for walking, RBr some salvage can be done and museum, concrete for break wall on north pond, RBj option 2,

<b>Hazardous Waste Materials –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Preferred</b>

Discussion (point form) – RBr explains the options, legal requirement to remove off site. Everyone agrees for remove off site. Some discussion on where the hazardous would go for disposal.

<b>Mix tailings/Waste rock –</b>	<b>Option 1</b>	<b>Acceptable</b>
	<b>Option 2</b>	<b>Acceptable</b>
	<b>Option 3</b>	<b>Not Acceptable</b>

Discussion (point form) – RBr explains the options, CB waste rock is acid drainage, not clean rock, AB it might make sense to level, JG explains the options, CG explains the options further, no borrow source available, contours will need to reviewed, TU ask about 3<sup>rd</sup> option, no material so why consider it, RBr little borrow material so real challenge, not enough for sloping, CG explains the challenges, TU sitting 60 years dormant, may be



better left alone, we should look at, CG good point, what benefit of moving it around, exposure may be a problem, so good point, RBr we could stabilize, AB slope away from the water, CG set back, RBr is that tailing in waste pile, CB it's compact and very hard, CG rework and bring material back, put larger material along the toe, we need to be clear to contractors, CG option 3, no liner was consider, AE no use in moving it leave as is, do not disturb, AB option 1 and 2 ok, option 2 preferred, TU like to leave it like that, disturb might cause problem, sat there long time, we should look at this, it's kind of out of the way, don't want to really say, if lined than I would say go with it and better drainage, CG explains the north bay is a concern, not stable, over the years the pile has changed or eroded, I would re-grade the north bay, I understand leave as is, but rework some, JH if there is wave action may cause exposure, slowly may cause some problems later, tailing may come out that is one problem, TU I don't see concern, it's been happening for years, JH we did some digging and found some tailings, your right there is wave action, we should try and improve it a bit, TU is it covered in sand, CB it is exposed, we want to re-slope to stop erosion, CG we understand what you are saying, PK been there long time, nothing wrong til today, leave as is for now maybe 50 years, EB been there for so long, like PK leave as is, Paul, like TU says leave as is, CG we are seeing some erosion, not immediate threat, we want to preventive measures in, right now it is not a threat, RBr how can minimize the erosion, question is how do we stabilize, CG we want prevent stuff from happening in the future, both point are valid but there is a potential for erosion both are valid point, AB maybe we could stabilize it for now, we should take a look at the site, CG is that option 2 – yes, this is the main raise we need back fill that, we can see what that looks like, AB we get the north wind the water get higher may cause more erosion, EB we should see the site to provide better solution, RBr we are going to site, maybe we can wait for decision til after the site visit, CG we sometimes leave some design with the contractors to decide what is the best for cleaning the site, there are different types of equipment they use, RBr it's a tough one, we have all options as acceptable, we can take 3 off the table, RBj just want to know, what is the best practices what would you recommend, CG we look at are we going to make the environment better, we look at contractors, we try to find the best solution, we hate to see some failure, we try to look at what is the risk of not doing anything, RBj it's hard to make a choice when everyone suggesting like the Elders wanting to leave as is, I will go with the majority with that one, RBr we can wait til later on this one, we don't have a preferred option right now, Time: 4:50 PM.

<b>Waste Rock –</b>	<b>Option 1</b>	<b>Acceptable</b>
	<b>Option 2</b>	<b>Acceptable</b>
	<b>Option 3</b>	<b>No option written</b>
	<b>Option 4</b>	<b>Preferred</b>

Discussion (point form) – CG we have some waste rock so we have to come with an option, leave as is right now or fill it in, look at this bedrock smooth, not a large deposit could be used for mine cap, ventilation is need on the cap you will see a steel pipe, AB waste rock use it if you need to if not leave as is, Robert, AB leave as is, PK want to say it was there for long time all I worry about is arsenic, we should leave as is, CB we tested the waste and there is some arsenic, but it is not as bad as we first thought, PK that is all I am worried about is the arsenic, CB arsenic is not the main concern there, EB leave as is, Paul if no concern use it or leave as is, SB leave as is, RBr we will finish for today.

Closing Prayer deferred till last day

**DAY ONE MEETING ENDS**





## DAY TWO – JUNE 14, 2013

<b>Metal Impacted Soils –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Preferred</b>
	<b>Option 3</b>	<b>Not Acceptable</b>

**Ron Breadmore** - welcome to day two, I want to welcome Mike Tollis and Patrick Simon, and Kara King who is joining us as while so welcome, quick recap, lots accomplished, good presentation from SENES, so let's pick up from where we left off,

Discussion (point form) – CG explains the options, AB any contaminants that is not hard to take off site that is what we should do, CG provides additional options explanations, JG reads through the options, AB option 2, Robert 2, PK option 2, TU option 2, MT option 2, EB does look good, sometimes moose go around there so it is better to take everything out, it's our main route we go through there depending on weather, better to remove, option 2, Paul option 2, SB bring off site, option 2, PS take it off site, option 2, KK option 2, RBj what will you do with the soil CG explains - option 2,

<b>PHC Impact Soil –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Preferred</b>
	<b>Option 3</b>	<b>Not Acceptable</b>
	<b>Option 4</b>	<b>Not Acceptable</b>

Discussion (point form) – JG explains the options and explains the HC treatment land farm process, AB new thing you are talking about it was tried here at the airport, we don't know what came of it, RBr it's pretty effective for light fuel and gas, here we have small volumes to deal with, it would not be cost effective to build a big facility, AB looking at that you have no soil to work with, it would be better off site disposal, so option 2, Robert option 2, AE option 2, TU option 2, there is not much soil to work with, PK it has to clean, been there long, take it out of there, option 2, MT do we know it is going, RBr maybe Hay River or Zama, CG it will go to license facility, ... option discussed ... EB been there for so long, should take out, we don't know what will happen in the future, option 2, PS option 2, SB option, PS option 2, KK option 2, RBj it's unanimous,

<b>Surface Water and Sediments –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Preferred</b>
	<b>Option 3</b>	<b>Not Acceptable</b>
	<b>Option 4</b>	<b>Not Acceptable</b>

Discussion (point form) – it was consensus for everyone option 2 was preferred. RBr we still need to go through the options, JG explains the options, RBr we will monitor the water quality and sediments, there for a number of years, less materials to work with, Robert option 2, TU are we talking about GSL or the site area, CG monitoring will be done around the site, TU why do that, it's not sitting in pond, it will not be the same but the sediment should be monitored, take the surface water out, what data are you getting, option 2, RBr we want to monitor for long term change, it may not be that long we do need monitoring, TU some need for monitoring, more on sediment, CG minor to monitor water and can be done together it is quick, we can see the water quality trend and find if we are making a difference, it is for the fish and lake health and the data can be passed to others, TU we should do the whole profile, we need it representative, CB we do not want disturb the surface, especially in the windy place, PK (non-audible) water is influence by the lake, option 2, MT option 2, EB same as Pete, option 2, PS option 2, SB option 2, PS option 2, KK option 2, RBj same as Tom and Pete, option 2, I have a question, how this will tie in RAP Review? RAP Review not all complete, more work may be needed, there are different options, Tech may come back with different answer, AB I don't why they would have different option, RBr we had a meeting with the Elders and it



is unfortunate Marc could not be here to meet face to face, we did receive comments already on Outpost, do you know if he will call in today it would be nice if he were part of the discussion, RBj no, he is not going to be calling in because it is too hard to hear, I am heading to the office and he will email me, RBr it would be an idea at some point that you would sit down with Marc and Elders and have that discussion, RBj yes, it's very important that happens, RBr Ok, we are finished Outpost, maybe time now for a break, then we can go onto Blanchet,

## **BREAK**

### **BLANCHET MINE SITE**

<b>Adit –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Not Acceptable</b>
	<b>Option 3</b>	<b>Not Acceptable</b>
	<b>Option 4</b>	<b>Preferred</b>

Discussion (point form) – JG explains the options, CG explains the difficulty to get to the entrance, we can't burn the wood will be take away, tracks will be taken out as while, RB how high is the entrance, CG about as high as me, not very high, JH entrance is horizontal, foam plug would work here, RBr mine safety will in support of this, SEVERAL seem to want option 4, TU what about wiring around the opening, CG discussion with others on what to do with the cart it went in on track, AB with technology, we should be able to take it out, PK fill up foam and cement, MT option 4, but will you using rock to cover after foam, CG shot treat, MT how far into the adit, CG about 4 feet, JH when you walk in 4 meters you would hit wall, foam will get into the underground working, EB (Chipewyan language) option 4, PS option 4, SB option 4, PS option 4,

<b>Building Structures –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Preferred</b>

Discussion (point form) – JG explains the options, RBr we have 3 option 2, TU option 2, PK been there long just burn, option 2, MT option 2 ... it was unanimous everyone wanted option 2,

<b>Refuse –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Preferred</b>
	<b>Option 3</b>	<b>Not Acceptable</b>

Discussion (point form) – JG explains the options, AB Outpost is finished lets not go back there, maybe some of that could be used for fill, option 2, but material could be used, CG when it comes to refuse, we do have drums on site, dead spruce tree with white color need to be managed, option can to place and place a liner, can be manage with waste rock on site, one option is not relocating the waste rock, pull down and build landfill to minimize materials needed for landfill, lots of issue, not a lot of garbage, about 82 drums, JH maybe this is one, we can look at this later, how we look at waste rock, this will give us an idea on what to do, TU you are going to leave the waste rock, we want it off site, it's small amount, RBr are suggesting option 2 Tom, it is a small amount, let's focus on refuse then, so off site disposal, PK option 2, RB is talking option 3, but option, MT better to take off site, option 2, EB option 2, PSm option 2, PSi option 2,

<b>Waste Rock –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Not Acceptable</b>
	<b>Option 3</b>	<b>Preferred</b>

Discussion (point form) – JG explains the options, CG option 2 is re-slope consolidate and cover with waste rock, option 3 cover with liner and waste rock, as long as no water is in contact then it would be safe and this is minimize with a liner, PS we kind of see



what you saying to cover with liner, CG option 3 is with liner, option 2 is soil cover, we are good at this site for cover, JH we want to far enough away from Great Slave Lake, CG we don't contact with humans or animals, CB there is about 20 meters cube, CG long reach boom will be needed to do the work, JH our preference is take down and cover, because of the slope it will be a challenge, RBr it will be a challenge but we think it can be done safely, TU airborne emission, water can be used to keep the dust down, RB option 3, AE option 3, TU option 3 and vegetation on top so it do not wash down maybe grass, CG we were thinking more coarse rock material because we did not have much vegetation material, we are in favour of grass material but little of it here, if we identify more material then we can use that, RBr that is a good idea and it can create some growth, PK maybe use cover and some dirt, option 3, MT option 3, Everyone agree on option 3. CG about the borrow sources, we will try and any soil we find.

## **BREAK**

<b>Ore Concentrate –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Preferred</b>
	<b>Option 3</b>	<b>Not Acceptable</b>

Discussion (point form) – Not Recorded

<b>Metal Impacted Soil –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Not Acceptable</b>
	<b>Option 3</b>	<b>Preferred</b>

Discussion (point form) – JG explains the options ...late recording... AB option 3, TU option 3 also, PK option 3, MT how much soil are we talking, CG impact soil in the woods will be consolidated, were looking at working within that area, CB about 2000 meters cube, TU cubic meters?, MT why were not talking off site disposal, CG from result of risk assessment with measure in place and the volume it was considered on site, AB easier to put on barge, were talking two different things can be confusing, it should be hauled away, not brought back on the hill, RBr remove drainage risk by putting in liner, 7000 cubic meters is large amount for off site removal, AB are you talking beach, CG stuff on overpass will be taken off site, we want to combine with waste rock and cover, below waste rock is soil and we don't want people to touch, on the beach no liner but we'll have clean material, TU there will be back haul empty we should back haul the material, let's clean it up, we can save money by using back haul, Elders says he said that already, MT is all going under the same cover, JH yes, in the same area, consolidate, in one spot, done right, MT option 3 with cover, needs more discussion, RBr away from drainage location, dry area, CG location is important, let's talk location, building on JH point, Location on Map, up from marsh, - showing location on map – open to discussion, RBr good location for cover, CG – talking and viewing map – TU boys wondering, will another mine open? Trevor has land permit, what are the chances of another mine open again, RBr always that possibility, but we want to secure the site, any mine application has to go through the permit process and consultations, EB option 3, PS option 3, PS option 3, KK option 3, RBj yesterday, best practice, permeability if reliable then I would go with option 3, CG liner will be used at this site, RBj option 3,

## **LUNCH**

<b>PHC Impacted Soil –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Preferred</b>
	<b>Option 3</b>	<b>Not Acceptable</b>
	<b>Option 4</b>	<b>Not Acceptable</b>

Discussion (point form) – JG explains the options, included some HC treatment process, CG explain the context of oil, talking about small amount, about 50 cubic meters, RBr we





have small amount to deal with, off site disposal, on site treatment but big effort for small, SEVERAL want option 2 right away, everyone wants option 2 and unanimous,

<b>Surface Water and Sediments –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Preferred</b>
	<b>Option 3</b>	<b>Not Acceptable</b>
	<b>Option 4</b>	<b>Not Acceptable</b>

Discussion (point form) – CG – Slide show explanation - JG explains the options, RB option 2 and monitor, AB option 2, TU option 2 but about option 4, RBr water can't be capped, were talking about the beach, we could cap but it is shoreline disturbance, we are talking low risk sediment impact, TU cap should be looked at, AB been there since 70s, JG you wouldn't want winter road on this shoreline, AB winter road would be further down, west would be the deepest part, we know this from traditional knowledge, PK – TU & PK discuss – leave the way it is, monitor, MT looking at page 27, wetland, will this be monitored, is it a creek, will you be going there, CG it is a monitoring point, MT that was what I was thinking, so option 2, CG interesting point yesterday name of Blanchet crumbling rock and that is what we are seeing, naturally high in arsenic, once cleaned it will get back to natural background, RBj it is actually is named after Blanchet, person who my grandfather worked with, CB I think they mean traditional knowledge name, EB rock in the valley, rain and drains to the lake, same as Regina Bay, any valley like that there is a creek, it runs year round, there is a creek there, there is road there, CG we do agree there is a creek there, west of the adit, CG – slide explanation – EB option, PS, Everyone agree on option 2, unanimous,

## **BREAK**

### **COPPER PASS SITE**

<b>Surface Trenches –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Not Acceptable</b>
	<b>Option 3</b>	<b>Preferred</b>

Discussion (point form) – JG explains the options, CG two large trenches, partly filled with water, two other trenches not physical hazard, east showing not much trench, - slide explanation – water in trench impact is management, RBr mine safety not crazy for fencing not a walk away option, RB backfill, - some discussion – RBr so hybrid, CG trench 1 limited capacity will fill up not much free board, CG if backfill, water is contaminated, clean water first then backfill, to the surface and no water for animals, we will treat the water before release, RBr we need to get the information to the Elders, CG – slide explanation – trench 2 if fill will drain to the lake, AB how deep CG about 25 feet wide, AB how contaminated is the water, CB it is contaminated, AB freeze then take out, CG we agree we take the water out first, AB I can't see how you can't take it out, on winter road, CG we will treat and discharge, we want the same thing, we can come with a cost estimate, RBr we do want to treat the water, AB we don't want to depend on the contractors, RBr sometimes the contractors have some good ideas, CG we have 3<sup>rd</sup> party regulators we have to deal with, TU we got to deal with water first, no short cut, swamp can be used, we don't need process plant when we can use swamp and monitor, use the TK here, JG we do recognize the wetlands ability, we need to treat first it does not to be a fancy plant, use polishing system safe for fish and people, untreated may harm, TU it is small quantity, use the wetlands it can do wonders, CG we still need to look downstream receiver, more testing needs to be done, nature concentration is decreasing, we prefer to treat water before discharge, we could use the combination of things, then we can nature take it's course, at the source we should treat, AB take samples, CG we plan to sample this summer, AB I go with backfill, CG we need to deal with the water in the trench, RBr we don't want to do any harm, we can treat then discharge to the environment, good discussion, AB add to option 3 treat water and backfill, AB option 3, TU option backfill



and treatment of water, PK option 3, MT treat on site, option 3, no threat to wildlife, EB option 3, everyone else wanted option 3,

<b>Ore –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Not Acceptable</b>
	<b>Option 3</b>	<b>Preferred</b>

Discussion (point form) – JG explains the options, AB good idea, option 3, CG for benefit of those not here yesterday, - slide explanation – we want to the ore consolidated and put trench 1 and 2, TU acid generating? CB, no, quantity is not a concern, RB quantity of ore? CB 150 cubic mix with other material, about 100 cubic meters, RBr Elders understand cubic meters, EB option 3, AE option 3, TU option 3, PK option – TU & PK discussion – water treatment, option 3, MT option 3, everyone else want option 3, RBr we have a request for 5 minutes break, translator needs a break,

## **BREAK**

<b>Waste Rock –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Not Acceptable</b>
	<b>Option 3</b>	<b>Preferred</b>

Discussion (point form) – JG explains the options, CG a bit of recap slide 36, waste rock with trench 2, this material for backfill the trenched, no acid drainage issue, AB page 35, water will be treated, backfill with waste rock option 3, AB option 3, TU option 3, PK option 3, MT option 3, EB option 3, PSi option, RBj option, everyone for option 3,

<b>Metal Impact Soil –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Preferred</b>

Discussion (point form) – JG explains the options, CG similar to waste rock issue, pull back into the trenched, AB option 2, TU option 2, PK option 2, MT option 2, EB option, PSi, option 2, KK option 2, everyone wants option 2,

<b>PHC Impacted Soils –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Preferred</b>
	<b>Option 3</b>	<b>Not Acceptable</b>
	<b>Option 4</b>	<b>Not Acceptable</b>

Discussion (point form) – JG explains the options, AB option 2, CG – slide 32 explanation, challenges to moving materials on site, on site treatment will not be easy given the space available, option 3 and 4 difficult to implement, RBr volume, CB 70 meters cube, EB option 2, TU option 2, CG you will end up with expose bedrock, will look different, PK option 2, MT option 2, CG do nothing to trenches 3,4 and 5, MT adit opening? CG less than 3 meters in, not considered as an opening, EB option 2, so many numbers, how many trenches dig CG main showing 2 large and 2 small ones, west trench not deep, over upland pond exploration trenches just knee deep so we are not looking at that, so everyone else want option 2,

<b>Structures –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Preferred</b>

Discussion (point form) – JG explains the options, AB option 2, August option 2, TU option 2, PK option 2, MT option 2, RBj I have a question, CG generally we collect the ash, option 2, JG we use containers so we collect the nails and everything,

<b>Non-Hazardous Materials –</b>	<b>Option 1</b>	<b>Not Acceptable</b>
	<b>Option 2</b>	<b>Not Acceptable</b>
	<b>Option 3</b>	<b>Not Acceptable</b>



## Option 4 Preferred

Discussion (point form) – JG explains the options, CG we have miscellaneous drums, couple location have timbers we can burn, off site or in trenches, AB haul the drum away and burn option 4, CG we will bring scraps off site, get rid of the ashes, RB option 4 and anything with metals, TU option 4, PK option 4, MT option 4, EB option 4, everyone agree with option 4, RBr on that note we will take a five minute break, then we will rap up, can we bring the dinner up to 4:30 pm, CG you're hard on the caterers, Laughter, Applause,

## BREAK

## CLOSING COMMENTS & DINNER

**Ron Breadmore** - start by saying my feelings for the two days, thank you to the Elders, not an easy work, Anne and Tom for translation, very productive day, Applause, Joel did a great job and he will complete the review,

**Joel Gowman** - reviews of the options, Outpost

Discussion (point form) - CG metal structure on site at Outpost, want to know comfort of taking off site, there is heritage value could be left on site, take other scrap off site, think about that and let us know what you want, RBr PK mention this, plaque may be a good idea, we will check with mine heritage and or look at other option, MT it would be a good idea to leave on site, PSi I like the idea, RBr we can look into this, everything is on risk, leave equipment on site may not be a risk, RBr not a bad idea, never been but the young people may go there,

Discussion (point form) - JG review of the options, there is a waste rock, tailings, RBr we had two options, we could leave it the community and the Tech Advisor, with site in two week, we can decide then,

**Joel Gowman** - review of the options, Blanchet

**Joel Gowman** - review of the options, Copper Pass

**Ron Breadmore** – RAP will be finalised, will include any input from the Tech Advisors,

**George Lafferty** – TK Questionnaire, 6 Elders from Lutsel K'e and 6 Elders from Fort Resolution, this is small part of TK for the RAP, this options analysis included TK knowledge you have, READ out the questionnaire items, included burial sites, overnight visit, trapping, hunting and fishing, berry picking, drinking water was taken from anywhere on site, burial sites is identify in Blanchet and Copper Pass and we can try locate them when we visit the site, no muskoxen or grizzly sighting, furbearing animal trapping was identified mostly marten, we asked for other stories but none was received, that is some of the information I have captured on the questionnaire, lastly confidential information used working papers will not be used in the RAP without the consent of the community. That is it. I want to thank the Elders and interpreters, that is not all the TK information we will be using, thank you, Applause

**Ron Breadmore** - right now we are building TK into the RAP like Tom says it is an on-going information, it will continue into monitoring phase, so thank you, Applause,

**Joel Gowman** - I also want to thank the Elders for their help during the mine site visit, thank you for your participation, Applause

**Ron Breadmore** - I want thank Joel for stepping in even when he was sick, thank you, Applause,

**Rosy Bjornson** - I also want to say thank to the Elders land user Dad, Anne Biscaye for interpreter, we hear the Elders how hard it was in the past, after we lose a few of them, we recall some stories and the knowledge behind and we think of those stories, it is



overwhelming, I think of those stories and they get me through the day and the long meeting, Masicho, Applause

**Arthur Beck** - land use and represent the FRMC, this is one meeting where we did not argue. Laughter, sitting on the same side for a change, we seen the changes, now 56, no aboriginal leaders at meeting before mostly done by Federal Government, Science learn their stuff in school but we learn from our Elders, I did some commercial fishing when younger, we are on the same page for a change, thank you,

**Tom Unka** - thank you for the effort and the Elders, the younger people will take over and we will leave something positive for them, thank you from the bottom of my heart, masi, Applause,

**Pete King** - I went to school in 33 only spoke French and Chipewyan, thank you everyone of you and my friends here, 87 today, today all my friends are gone that is all I have to say, thank you, Applause,

**Ernest Boucher** - most know me, been around well know to Beaufort Sea, think about the mine site, I want to Regina Bay, so in the future, closed 54, went to school here in the mission, now young Elder laughter, Applause,

**Patrick Simon** - I hope we treated you well thank you for teaching me some good stuff,

**Kara King** - thank you for being here, thank to Anne, glad for this meeting, we talk about so many site, we see you doing lots of work compared to giant, this is good for us, we see many mine being cleaned, Applause,

**Ron Breadmore** - we enjoy our stay and we will be back. I enjoy these meeting in the community and we will have a site tour and we will visit Lutsel K'e. Ft Res will then be able to visit some friends in Lutsel K'e,

**Ernest Boucher** - before prayer, everyone is happy here, I called PK my friend even when he is older, I know all the Elders. Thank you for the couple days here. Applause,

**Ernest Boucher** Closing Prayer

**Masicho – APPLAUSE.**

**OPTIONS ANALYSIS MEETING COMPLETED.**

**Transcript Summary by:**

**George Lafferty, Consultations Officer, AANDC-CARD**

**July 15, 2013**

## **APPENDIX B**

### **REMEDIAL ACTION PLAN OPTIONS ANALYSIS WORKOUT MINUTES**

## Remedial Action Plan Options Analysis Workout

Date: 13-14 June 2013  
Location: Fort Resolution (Deninu Kue), Northwest Territories  
Participants: Mr. Ron Breadmore (AANDC)  
Mr. Joel Gowman (AANDC)  
Mr. George Lafferty (AANDC)  
Mr. Jessie Hoyt (PWGSC)  
Mr. Charles Gravelle (SENEC Consultants)  
Ms. Claire Brown (SENEC Consultants)  
Ms. Ann Biscaye (Translator)  
Mr. Robert Beaulieu (Fort Resolution)  
Mr. August Enzoe (Lutselk'e)  
Mr. Arthur Beck (Fort Resolution)  
Mr. Tom Unka (Fort Resolution)  
Mr. Pete King (Fort Resolution)  
Mr. Mike Tollis (Lutselk'e, June 14 only)  
Mr. Ernest Boucher (Lutselk'e, June 14 only)  
Mr. Paul Smith (Fort Resolution)  
Mr. Stanley Beck (Fort Resolution)  
Mr. Patrick Simon (Fort Resolution, June 14 only)  
Ms. Kara King (Fort Resolution, June 14 only)  
Ms. Rosy Bjornsen (Fort Resolution)

+ 4-6 Elders and adult observers

**Context:** Community consultations to discuss the remediation of three small abandoned mines within the East Arm of Great Slave Lake, including: Outpost Island Mine, Blanchet Mine and Copper Pass Mine. The meeting was chaired by AANDC and PWGSC; with technical presentations and responses provided by SENEK Consultants. Community representatives from Lutselk'e and Fort Resolution were presented with an overview of the sites, focusing on the components identified for remedial consideration. For the three sites, each remedial component was discussed and community members indicated their preferred remedial option.

### Meeting Minutes - June 13, 2013

Approx. Time	Speaker	Topic/Comment/Discussions Actions
10:30	R. Breadmore	Meeting brought to order and attendees welcomed.
10:35		Opening Prayer
10:40	R. Breadmore	<b>AANDC presentation outlining project objectives and status</b>
	A. Beck	Was not aware of the TK study and would like to opportunity to provide some information.
	R. Breadmore	Anyone that was not able to attend can provide their information on the marked up map that has come back to the communities.
	A. Beck	How are people going to visit the site when the Elder's tour happens?
	R. Breadmore	Most likely using Twin Otters.
	A. Beck	Recommend that a boat is used to access the three sites.
	R. Breadmore	This option will be considered during planning.
10:50	R. Breadmore	<b>AANDC presents the Workout Framework for the meeting.</b>
	T. Unka	Has the length of time required to get a water license been

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
		considered during planning? This may impact the schedule.
	R. Breadmore	The process can be lengthy and we have allowed for extra time to receive our approvals.
	T. Unka	Do you think this project will go to Environmental Assessment (EA)?
	R. Breadmore	Based on what is on site, AANDC does not anticipate that an EA will be required. The same process was used for Colomac (much larger project) and an EA was not required.
	P. King	O'Connor Lake Mine is also in the area, so why aren't we talking about it?
	R. Breadmore	O'Connor Mine is part of the list of AANDC sites to be assessed, but isn't part of today's discussion.
11:00 am	C. Gravelle	<b>SENES technical presentation - Outpost Island Mine</b>
	A. Beck	Who was there during the 1994 remediation?
	C. Gravelle	Do not have the names right now but can get that information after the meeting.
	R. Breadmore	The NWT Metis were involved as part of that work.
	A. Beck	All of that rain from the spring and summer goes into the waste rock and then into the GSL. We use the lake for fishing which is important to the community. Have fish been assessed?
	C. Gravelle	This will be considered as part of our options analysis when considering the tailings and waste rock. Fish have been assessed in the regional context and we'll talk to the community more about it later in the meeting.
	A. Beck	What will happen to the existing equipment on site?
	R. Breadmore	It would go to Yellowknife and the concrete blocks may be broken down.
11:30	BREAK	
11:35	C. Gravelle	<b>SENES technical presentation continued – Blanchet Mine</b>
	A. Beck	Knows the area well; the draw and drainage.
	R. Beaulieu	When was this mined?
	C. Brown	I believe it was the late 1960s, but we can confirm.
	T. Unka	What is meant by population and individual effects?
	C. Gravelle	Population is related to how many animals of a particular species are within its effective range relative to a site. The individual effects are what could impact on an individual animal.
	T. Unka	Have you looked at cumulative effects?
	C. Gravelle	The risk group has reviewed the cumulative effects in the HHERA (ore at beach, As and Co hot spots; As, Cr, Co, Ni in surface water at beach and As in soil). Findings indicate action required for As and Co.
	T. Unka	Do we propose to clean up the soil? Have you considered metals uptake in the vegetation?
	C. Gravelle.	The issue of soil impacts is limited to those related to the presence of ore concentrate at discrete locations on site.
	T. Unka	Will you be taking the ore off-site? Will you be taking soils out of the drainage pathway?
	C Gravelle	The ore will be consolidated and removed from site while soil impacts will be remediated by eliminating the exposure pathway for both humans and ecological receptors.

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
12:20	LUNCH	
1:30	C. Gravelle	<b>SENES technical presentation continued – Blanchet Mine</b>
	A. Beck	Fish is important to the communities, can they be checked?
	R. Breadmore	Fish is difficult to sample because the fish move around to many different sites in Great Slave Lake. This may be possible in Sachowia Lake.
	J. Hoyt	It would be difficult to determine if the concentrations in the fish are due to mine activities at the site. Our Expert Advisors (DFO) confirmed this and recommended we should instead look at cleaning up the source.
	A. Beck	Then sediment should be sampled at depth and we need to see the documentation.
	J. Hoyt	Sediments have been sampled at depth. This is provided in the assessment reports, but we appreciate this is a very large document.
	A. Beck	We would also like one page summaries of chemical concerns.
	J. Hoyt	We can do this in the future.
	T. Unka	Exceedance levels need to be made more clear.
	J. Hoyt	The figures show this, but we can also provide this in a summary table format.
	R. Bjornsen	Have benthics been tested?
	C. Gravelle	Yes.
	R. Bjornsen	It seems like there's some guesswork. Have you spoken with the former mine workers?
	C. Gravelle	They are often unavailable, but if available we do speak with them.
	R. Breadmore	The Ryan Silke report summarizes much of the available information in his historic mine report, but not everything.
	T. Unka	You are not relying enough on Traditional Knowledge (TK). There's a lot of benefit within TK, but it isn't coming out.
	A. Beck	The communities did not benefit from mining, but should benefit from the clean up (perhaps 25% of labor). This would provide on-site TK and work for the community.
	J. Hoyt	The process for the procurement of a remediation contractor needs to be transparent, fair, and must benefit local communities. This is often as high as 60-70% of the workforce. In PWGSC contracting procedures the percentage of local Aboriginals to be retained for a particular remediation contractor cannot be prescribed. The contractor will also be held accountable for meeting any employment targets they have set out for the project.
	R. Beaulieu	How do you ensure this happens?
	J. Hoyt	We can withhold funds if the contractor doesn't meet the requirements.
	R. Breadmore	We need to focus our discussions on the remedial options today
	C. Gravelle	<b>SENES technical presentation continued – Copper Pass Mine</b>
	S. Beck	Is the stain on the wall of the trench the mineral?
	C. Gravelle	Yes, it's the ore in the rock reacting with the environment.
	T. Unka	How tall is the waste rock pile?
	C. Gravelle	Approximately 20 to 25 feet.



## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	C. Brown	It is important to note that it isn't just waste rock. It's a bedrock knoll with waste rock pushed over the side.
	A Beck	There's no equipment left behind at this site.
	S. Beck	They would've had diamond drill program and drill core – where is it?
	C. Gravelle	This is a difficult site to access. There is no mining equipment, but there is some exploration equipment and approximately 600 ft of core in the racks at the Camp Area.
	A Beck	The light green vegetation shows re-growth – this is the old roadway used to access the mine showings.
	A. Beck	Soil samples should be collected at the trench and further down the Main Showing draw. To get good background samples you need to get to high ground and out of the draw.
	C. Gravelle	This is agreed and is planned in the 2013 summer program.
	E. Boucher	They should test the water at Stark Lake. There has been testing in Regina Bay (it flows past Lutsel K'e and into Great Slave Lake) but no report of results and nobody will eat the fish because they feel it's contaminated.
	R. Breadmore	DFO is testing at this location as part of another project. AANDC will look into getting information to the communities.
2:15	BREAK	
2:30	C. Gravelle.	<b><i>SENES technical presentation continued – Copper Pass Mine</i></b>
	A. Beck	You should collect water samples when you sediment sample.
	C. Gravelle	This is typically the approach employed during the assessment of surface water and sediments.
	A. Beck	How much water in the trenches?
	C. Gravelle	Over 1,000,000 Litres.
	A. Beck	That should be pumped out and shipped south.
2:35	R. Breadmore	<b><i>Introduces remedial option discussions for Outpost Island Mine</i></b>
	J. Gowman	<i>Introduces the remedial options for mine openings at Outpost.</i>
	R. Breadmore	It is not appropriate to leave the openings as is
	R. Beaulieu	The site should be cleaned up.
	A. Enzoe	Leave it as is.
	A. Beck	Option 1 is NOT an option – there needs to be some action. Caps should be repaired due to underlying waste rock. Chemicals are a greater concern and it would be best to leave the mill equipment as is.
	J. Hoyt	These are good thoughts and we'll get to these topics too.
	P. King	Spoke in Yellowknife already on this issue - No opinion on this topic.
	E. Boucher	We don't know what will happen in the future. We should open it up.
	P. Smith	Recap so it does not cave in.
	S. Beck	All of this should be cleaned up. Anything that can be done to cleanup runoff from the tailings. Would like to see the shafts resealed (concrete lasts longer) and back to the original condition.
	R. Bjornsen	Clean it up.

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	J. Gowman	<i>Introduces option 2 and 3.</i>
	C. Gravelle	<i>Describes option 2 and option 3.</i>
	A. Beck	What is the lifespan of foam? Concrete is 200 years and we would prefer concrete.
	C Gravelle.	Manufacturer says it should last as long as concrete, however it is important to reduce the exposure of the foam to UV and forest fire. We look at using foam plugs because of the challenges of placing concrete at such a remote site.
	A. Beck	If you use a winter road, you're going to need TK and we would prefer to use concrete.
	A. Enzoe	Prefer concrete.
	P. King	Discussed this in Yellowknife 3 years ago and prefer concrete caps.
	E. Boucher	Arsenic is a problem and many people are dying of cancer. We should drain the workings and ship it out. Or fill it with cement. Concrete or foam – either is OK.
	P. Smith	Concrete cap preferred.
	S. Beck	Concrete cap preferred.
	R. Bjornsen	How can it be revegetated? How can you return the site to a natural state?
	J. Gowman.	It is surrounded by waste rock and isn't a natural environment.
	R. Bjornsen	Is vegetation growing around it now?
	J. Hoyt	It is not vegetated and the concrete (already in place) isn't even lasting 20 years because it hasn't been installed properly. There are ways to tie it into the bedrock to make it more natural, but foam can also last a very long time and withstand heavy equipment.
	S. Beck	Do you tie the cap all the way out to bedrock?
	C. Gravelle	Yes, using steel and a concrete structure.
	S. Beck	What are the specifications of foam, such as design life and strength?
	C. Gravelle	The main advantage of foam is the ease in which it can be used in remote locations while providing the same level of protection as a concrete cap.
	S. Beck	Is concrete best in this case?
	C. Gravelle	We would recommend the use of foam for everything except Shaft #1 where we would recommend a concrete cap.
	R. Breadmore	We should add this as a hybrid option.
	A. Beck	This is a good idea and we can see what techniques work well for the future.
	J. Gowman	<i>Adds Option 4 to Options Table (Hybrid – Concrete cap for Shaft #1, Foam for other shafts/raises). Option 4 Identified as Preferred Remedial Option.</i>
	J. Gowman	<i>Introduces Remedial Options for Buildings at Outpost</i>
	P. Smith	There's no poison in the outhouse. Take it away if painted, burn if clean.
	E. Boucher	It's been there so long, burn it.
	P. King	You could use blasted out areas.
	A. Enzoe	Burn it.
	R. Beaulieu	Burn it and consolidate equipment in Yellowknife to maintain

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
		heritage value.
	P. King	This was the first mine in the Northwest Territories.
	T. Unka	You should dismantle and burn the buildings.
	A. Beck	Burn the buildings.
	J. Gowman	<i>Demolish and Burn is the preferred remedial option.</i>
3:35	BREAK	
3:45	J. Gowman	<i>Introduces Remedial Options for Non-Hazardous Waste at Outpost</i>
	J. Gowman	Is it acceptable to leave it as is?
	R. Beaulieu	Leave as is ok.
	A. Enzoe	Leave as is ok.
	A. Beck	Not an environmental concern, but it does look bad. It is preferred that this is taken off site.
	T. Unka	Prefer it is shipped off site.
	P. King	Everything is covered, but if you find metal when digging then it should go to Yellowknife.
	E. Boucher	The metal has been there a long time as the site has a long history. They don't make that equipment anymore so they should take it to a museum. It was hard work and it was Europeans, Black people and Chinese people all working there.
	P. Smith	Prefer off-site disposal.
	S. Beck	Would like to see it removed so it's not an eyesore.
	C. Gravelle.	Recommend filling the main raise with the broken concrete from the foundations existing on site.
	A. Beck	That's ok, but the water inside will need to be treated.
	G. Gravelle	It will be tested, if not already, before disposal.
	S. Beck	Concrete would be ok for a landfill, but not steel.
	C. Gravelle	Steel would come off site.
	R. Bjornsen	Remove equipment if it's still a hazard. If museum is not interested, could the steel be given to a charity?
	R. Breadmore	Salvaging is encouraged and incorporated into the RAP.
	R. Breadmore	<i>Option 2 (off-site disposal) is the preferred option, with concrete used for backfilling.</i>
	R. Breadmore	<i>Introduces Remedial Options for Hazardous Material at Outpost</i>
	R. Breadmore	There is a legal obligation to remove any hazardous materials. We can't leave it on site. Does everyone agree?
	All	Yes
	R. Bjornsen	Does it go to Swan Hills?
	J. Gowman	The contractor has to provide proof they are using a licensed facility, but it won't necessarily be Swan Hills.
	G. Lafferty	So a landfill is not the best option?
	R. Breadmore	The long-term costs would be very high – more cost effective to take off-site.
	J. Gowman	<i>Introduces remedial options for tailings/waste rock at Outpost.</i>
	A. Beck	Is the material at the top clean?
	C. Brown	It is still rich in metals and is leaching, but may have less metal impacts than the materials below (which has more tailings than

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
		waste rock).
	C. Gravelle	Reshaping and grading has been proposed to minimize erosion. There is limited borrow material to work with.
	T. Unka	There isn't enough borrow, why are you including capping?
	R. Breadmore	Part of the management plan is to look at options.
	T. Unka	Leaving this alone is sometimes the best option. Did you really look at the reshaping option, and the disturbance it would cause before recommending it?
	J. Hoyt	This is an important comment and the net effects of remedial activities should be considered.
	R. Breadmore	What do we do with the tailings that are eroding in the shoreline area?
	A. Beck	Pull back and create setback.
	R. Breadmore	What are we seeing when we look at the sides of the pile where it's eroding?
	C. Brown	That is the tailings.
	R. Beaulieu	Option 2 (consolidate and reslope) is best, don't disturb what's been there for 60 years.
	A. Enzoe	Option 2.
	A. Beck	Option 1 (do nothing) or Option 2 (consolidate and reslope)
	T. Unka	Disturbing sometimes creates more problems. Option 1 or 2.
	C. Gravelle	Concerned with the 20% of the face that's exposed – the slope is changing. We do recommend sloping to stop the potential release of tailings (stabilize slope) to the North Bay.
	T. Unka	Tailings are getting pushed up by storm surges and onto land. Doesn't believe anything else will come out.
	J. Hoyt	There are tailings at depth (3 foot test holes were dug).
	C Brown	And there are exposed tailings.
	P. King	Should be left as is.
	E. Boucher	Leave it as is.
	P. Smith	If you disturb it you will have more effects. Leave it as is.
	S. Beck	Concerned with what's in there, which is north facing and exposed to waves. Erosion continues and it is moving. What is that material made of and does this cause a threat?
	J. Hoyt	We did sample and the risk assessment says it isn't a hazard to the regional environment; however, we should do what we can to stabilize it.
	S. Beck	Then we should do what we can now to stabilize it. Option 2.
	C. Gravelle	We think it's important to stabilize the side of the deposit that is eroding and unstable.
	S. Beck	The eroding is worse due to the north winds creating storm surges into the North Bay area.
	R. Beaulieu	You would get better recommendations if we went out on site.
	R. Bjornsen	What do you recommend based on your experience and best practices?
	J. Hoyt	We look at net benefits and that's why we recommend re-sloping the area that is eroding. You need to assess each situation individually to see that the remedial effects don't outweigh the costs.
	R. Bjornsen	Stabilizing seems like the right idea.
	R. Breadmore	<i>We don't have resolution in this case. "Leave as is" and</i>

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
		<i>"consolidate and reslope" are both acceptable options and we will return to this issue later.</i>
	J. Gowman	<i>Introduces waste rock at Outpost Island</i>
	A. Beck	Use it if you need it, or leave it as is.
	R. Beaulieu	Use it if you need it, or leave it where it is.
	A. Enzoe	Leave it where it is.
	P. King	It's been there for 72 years, but is arsenic a concern?
	C. Brown	There is some arsenic, but copper is more of a concern.
	E. Boucher	Leave as is.
	P. Smith	Leave as is.
	S. Beck	Can you use the waste rock?
	J. Hoyt	We could use it to naturalize as much as possible.
	R. Bjornsen	If you're not concerned with it.
	R. Breadmore	<i>Reached consensus. Leave it as is, and use it as needed (Option 4 - Hybrid)</i>
17:00		<i>Meeting adjourned</i>

### Meeting Minutes - June 14, 2013

Approx. Time	Speaker	Topic/Comment/Discussions Actions
9:35	R. Breadmore	<i>Opens meeting and requests Jessie/Charles discuss metal impacted soil at Outpost.</i>
	J. Hoyt	We are talking about metal impacted soil in discrete locations only, such as at dumps and batteries. We are not proposing to excavate all site soil.
	A. Beck	Remove where possible (Option 2 – Consolidate and transfer off-site)
	C. Gravelle	Just to clarify, that Option 2 relates to the impacted soils associated with can dumps and batteries.
	R. Beaulieu	Option 2
	A. Enzoe	Option 2
	T. Unka	Option 2
	M. Tollis	Option 2
	E. Boucher	Option 2
	P. King	Option 2
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	If you do remove soil, will you add borrow from elsewhere?
	C. Gravelle	No, these are very small areas on bedrock.
	R. Breadmore	<i>We have a preferred option to consolidate and transfer off site.</i>
	C. Gravelle	<i>Introduces concerns and remedial options for PHC impacted soil at north end of island.</i>
	R. Breadmore, J. Hoyt, J. Gowman	Soil treatment is when soils are put in liner and aerated before being tested again. There is minimal PHC impacted material at this site and the level of effort may not make sense.

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	A. Beck	Option 2 (off-site disposal)
	R. Beaulieu	Option 2
	A. Enzoe	Option 2
	T. Unka	Option 2
	P. King	Option 2, but add clean dirt.
	M. Tollis	Do we know where it will go?
	R. Breadmore	To a treatment facility.
	M. Tollis	If it's going to be land farmed, then Option 2.
	J. Hoyt	It has to go to a licensed facility.
	E. Boucher	Option 2
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	Option 2
	R. Breadmore	<i>Only acceptable (and preferred) option is off-site disposal (Option 2).</i>
	R. Breadmore	<i>Introduces surface water and sediment at Outpost.</i>
	A. Beck	I think we all agree with Option 2 (long term monitoring).
	J. Hoyt R. Breadmore	Let's review issue for those that were not present yesterday.
	J. Gowman	<i>Reviews surface water and sediment topic and options.</i>
	J. Hoyt R. Breadmore	Net effects need to be considered when you look at each of the options.
	R. Beaulieu	Option 2 (long term monitoring)
	A. Enzoe	Option 2
	A. Beck	Option 2
	T. Unka	Are we referring to tailings ponds or the lake?
	C. Gravelle	We are referring to the area around the lake.
	T. Unka	Why do you bother when it's constantly in motion? I would focus on sediment, as you won't get much from water. Option 2.
	R. Breadmore	We often do a 3 year plan and a 5 year monitoring plan after remediation to make sure there are no impacts and that the environment is stabilizing.
	T. Unka	Sediments will be of more use.
	J. Hoyt	It takes minimal extra time to water sample, so water samples are collected prior to sediment sampling.
	T. Unka	Water samples should also be at depth to avoid surface interactions.
	C. Brown	Correct and we typically collect at depth for that reason.
	P. King	Option 2
	M. Tollis	Option 2
	E. Boucher	Option 2
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	Option 2
	R. Breadmore	<i>Option 2 (long term monitoring) is preferred, all other not acceptable.</i>

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	R. Bjornsen	How may we incorporate this with the results of the technical reviewers which haven't had time to review yet?
	A. Beck	Could we give this information (i.e. preferred vs. not acceptable options) to the consultants to see what they say?
	R. Breadmore	Since your consultant can't be here, we recommend that he meet with members of your community to provide guidance.
10:20	BREAK	
10:35	R. Breadmore	Before going over the Blanchet remedial options, would Patrick and Kara like a review of yesterday's discussions?
	P. Simon	Not necessary
	K. King	Not necessary
	J. Gowman	<i>Introduces remedial options for the adit at Blanchet.</i>
	C. Gravelle	This is a difficult to access area. Wood in adit would be removed and probably can't be burned because of metal concentrations. The wood and steel rail track would be hauled out.
	R. Beaulieu	Option 4 (Foam plug), depending on the size of the adit.
	C. Gravelle	It's about person height and about as wide as your arm span.
	J. Hoyt	A foam plug would be strong enough here, partially because this is a horizontal opening.
	A. Enzoe	Option 4
	A. Beck	Option 4
	T. Unka	Option 4. Is the ore cart of historical value? Typically, chicken wire can be added to reinforce the shotcrete.
	C. Gravelle	Re-iterated that the use of a foam plug would require waste rock or shotcrete as a cover to mitigate potential issues with exposure to fire.
	A. Beck	We should be able to get the cart out.
	J. Gowman	We just need to do it safely which is difficult as the track isn't working.
	P. King	Option 4 (foam plug)
	M. Tollis	Option 4, but would it be covered with waste rock?
	C. Gravelle	Waste rock or shotcrete would be used as a cover.
	M. Tollis	How far would the foam go into the adit?
	C. Gravelle J. Hoyt	The foam plug would extend to the section of the adit where the headwall starts and extends to a depth equal to the width of the mine opening (approximately 1.5 m).
	E. Boucher	Agree with Option 4, but you're never going to completely repair it.
	P. Smith	Option 4
	S. Beck	Option 4
	K. King	Option 4
	R. Breadmore	<i>Preferred option is Option 4, and all other are not acceptable due to health and safety concerns.</i>
	J. Gowman	<b><i>Introduces remedial options for buildings at Blanchet Mine.</i></b>
	R. Beaulieu	Option 2 (Demolish and Burn)
	A. Enzoe	Option 2
	A. Beck	Option 2
	T. Unka	Option 2
	P. King	Option 2
	M. Tollis	Option 2

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	E. Boucher	Option 2
	P. Smith	Option 2
	P. Simon	Option 2
	S. Beck	Option 2
	K. King	Option 2
	R. Breadmore	<i>Option 2 (demolish and burn) has been selected as the preferred option.</i>
	J. Gowman	<i>Introduces remedial options for refuse at Blanchet.</i>
	A. Beck	We should use what we can, and take off site what we can't use. A hybrid option.
	C. Gravelle	At Blanchet, the refuse is empty drums, timbers, etc. Since we may need to construct a landfill, managing the small volume of refuse on site could be integrated. Pull the impacted material down off slope (including timber and refuse) and put under the cap.
	R. Beaulieu	If there's going to be a landfill then add it to the landfill (Option 3), but if not, then take it off-site (Option 2).
	A. Enzoe	Option 2 (Transport off-site)
	A. Beck	Option 2
	T. Unka	Option 2
	P. King	Option 2
	M. Tollis	Option 2
	E. Boucher	Option 2
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Breadmore	<i>Consolidate and transfer off-site (Option 2) is the preferred option.</i>
	J. Gowman	<i>Introduces waste rock remedial options at Blanchet.</i>
	C. Gravelle	The risk assessment says we should reduce exposure to ore and waste rock and could use a soil cover to provide the necessary protection.
	P. Simon	Would the cover be soil or plastic?
	C. Gravelle	Option 2 is soil only and Option 3 is a liner and then soil. There is enough borrow material at this site to use as capping material.
	R. Beaulieu	Why do you need to reslope?
	J. Hoyt	The slope is steep and could be unstable, and to reduce the amount of metals that would leach out.
	R. Beaulieu	How much ore is mixed in?
	C. Brown	We estimate about 20m <sup>3</sup> .
	R. Beaulieu	How would you reslope?
	C. Gravelle	Using an excavator with a longer or extension boom.
	J. Hoyt	We think it's important to stop exposure to this material and will take measures to reduce dust such as wetting it down.
	A. Beck	You may lose the slope if you disturb it.
	T. Unka	You need to re-vegetate and control the dust.
	J. Gowman	We think this can be done safely and dust management will be part of the health and safety plan.
	R. Beaulieu	Option 3 (Reslope and Cover)
	A. Enzoe	Option 3



## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	A. Beck	Option 3
	T. Unka	Option 3, but with revegetation to minimize wash out.
	C. Gravelle	A coarse cover is proposed because there isn't enough organic material to cover it. If during work activities sufficient organics are generated, then it could be added as a cover.
	J. Gowman	This is bioengineering and it worked well at Colomac.
	P. King	It would be good to cover with soil. Option 3.
	M. Tollis	Option 3.
	E. Boucher	Option 3
	P. Smith	Option 3
	S. Beck	Option 3
	K. King	Option 3
	R. Bjornsen	Option 3
	J. Gowman	Option 3, reslope and cover, selected as the preferred option.
	C. Gravelle	There are requirements to re-grade and cover a borrow area with organic material after the extraction of borrow material have been completed. If there is enough material left over after this, then it can be used at the Mine Area.
	R. Breadmore	<i>Option 3 (re-slope and cover) is preferred option</i>
11:20	BREAK	
11:35	R. Breadmore	<i>Introduces remedial options for ore at Blanchet.</i>
	J. Hoyt	We are referring to the ore in small piles and in the Beach Area that is now in the overpacks and used to be in spilled drums.
	R. Beaulieu	Option 2 (Consolidate and offsite disposal)
	A. Enzoe	Option 2
	A. Beck	Option 2
	T. Unka	Option 2
	P. King	Option 2
	M. Tollis	Option 2
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	Which ore are we proposing to move?
	J. Hoyt	Drummed ore and small isolated pockets (spilled ore at the camp).
	C. Gravelle	Not the ore at the Mine Area which is mixed in with waste rock (can't be removed off-site).
	J. Gowman	<i>So Option 2 (off-site disposal) is the preferred option and all others classified as unacceptable.</i>
	J. Gowman	<i>Introduces metal impacted soil remedial options at Blanchet.</i>
	C. Gravelle	These are the same options as waste rock.
	J. Gowman	Option 3 (excavate and place under low permeability cover) would be the same as the management for waste rock.
	R. Beaulieu	Option 3
	A. Enzoe	Option 3
	A. Beck	Option 3
	T. Unka	Option 3
	P. King	Option 3
	M. Tollis	Option 3, but about how much soil is this? Should keep it together.

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	J. Hoyt	Approximately 7,000 m <sup>3</sup> .
	C. Gravelle	This is primarily the soil under the Beach Area ore spill and at the Mine Area.
	C. Brown	Approximately 1000m <sup>3</sup> in the Beach Area and 1000m <sup>3</sup> in the Mine Area.
	M. Tollis	What about offsite disposal if arsenic is the issue?
	C. Gravelle	The risk assessment said we need to reduce exposure, and placing it under a cover would do this.
	R. Breadmore	The soils would be managed outside of the drainage course with the potential for migration reduced by the cap.
	A. Beck	Could you please clarify how you would construct this?
	J. Hoyt	We would mix the soil with waste rock and incorporate under the same cover.
	T. Unka	We should take it offsite like the ore, and could use the backhauls.
	J. Hoyt	To clarify, the ore at the mine that is mixed with the waste rock would be under the cover.
	M. Tollis	At the Mine Area?
	J. Hoyt	Yes, there would only be one landfill and it would be in the Mine Area.
	M. Tollis	Option 3 (excavate and place under low permeability cover), but we should discuss where.
	J. Hoyt	Yes we should get some TK and some opinions regarding where this could be situated.
	C. Gravelle	We are proposing that the impacted materials be placed at the base of the escarpment at the Mine Area.
	J. Gowman	This is a good location because it's out of the drainage path.
	T. Unka	What is the probability of a mine reopening here and what if the claim is sold?
	R. Breadmore J. Gowman	The potential is always there depending on economics. We need to protect human health and the environment, but there is always the possibility of another mine. However, there is now a regulatory process (Land Use Permit or Water Licence) if anything were proposed.
	E. Boucher	Option 3 (excavate and place under low permeability cover)
	P. Smith	Option 3
	S. Beck	Option 3
	P. Simon	Option 3
	K. King	Option 3
	R. Bjornsen	Has a low permeability cover ever been used in the north? If it's reliable then I agree.
	C. Gravelle	We would recommend the use of a liner to minimize the exposure of capped materials to precipitation and snow melt.
	J. Gowman	We have used a liner system before. Is Option 3 suitable?
	R. Bjornsen	Yes, Option 3.
	R. Breadmore	<i>We have identified Option 3 (excavate and place under a low permeability cover) as the preferred option for metal impacted soil.</i>
12:05	BREAK	
1:10	J. Gowman	<i>Introduces remedial options for PHC impacted soil at Blanchet.</i>
	C. Gravelle	It's a small area that is estimated to be 50m <sup>3</sup> and is probably less. A test pit program will be implemented as part of the remediation

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
		program once there is an excavator on site.
	R. Beaulieu	Option 2 (off-site disposal)
	A. Beck	Option 2
	T. Unka	Option 2
	P. King	Option 2
	A. Enzoe	Option 2
	M. Tollis	Option 2
	E. Boucher	Option 2
	P. Smith	Option 2
	S. Beck	Option 2
	K. King	Option 2
	R. Bjornsen	Option 2
	R. Breadmore	<i>Unanimous decision, Option 2 (off-site disposal) is the preferred option.</i>
	J. Gowman	<i>Introduces surface water and sediment remedial options at Blanchet.</i>
	C. Gravelle	We believe that once the cleanup work at the Beach Area and Mine Area is completed that the water quality will be improved over time. The risk assessment states that the source of the metal contamination needs to be remediated.
	R. Beaulieu	Fifty years ago when the mine was operating we would have more options, but now long-term monitoring (Option 2) is the only good option.
	A. Enzoe	Option 2
	A. Beck	Option 2
	T. Unka	Option 2, but what do you mean by capping the water?
	R. Breadmore	That refers to sediment capping and it could be used but there are challenges (Colomac and Giant examples).
	J. Gowman	We did a cover at Discovery using rock.
	R. Breadmore	These examples were for mine tailings and here we are dealing with only impacted sediments.
	T. Unka	Could it be pulled back?
	A. Beck	There are lots of contaminants in the sediments, but these are probably covered with a layer of cleaner sediments that form with time. It's also very deep offshore here.
	R. Breadmore	The natural silt layer and depth are important points to consider.
	J. Gowman	During the remediation we would have plans to prevent the sediments from being disturbed by barges at the old landing (i.e. Beach Area).
	A. Beck	This is an important use for TK during the remediation. There's deeper water to the west and we can interpret these things.
	P. King	Option 2 (leave it as is and monitor)
	M. Tollis	You also show there's a creek with impacts. Are you monitoring that?
	J. Hoyt	Yes we would do this in the long term monitoring program.
	M. Tollis	This is a good study case to see how mines recover. So Option 2.
	J. Hoyt	This is a mineralized area and we have heard the traditional name is Eroding Rock Island. So we will still see elevated arsenic, but we will look at this with background measurements as well.
	E. Boucher	Water flows down from the mine and to the lake year round from

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
		snow melt and rain.
	J. Hoyt	We agree there is such a creek, and we have also taken measurements from the creek above the mine.
	E. Boucher	Option 2.
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	Option 2
	R. Breadmore	<i>We have reached a consensus and Option 2 (long term monitoring) is the preferred remedial option.</i>
1:35	BREAK	
1:45	J. Gowman	<b><i>Introduces remedial options for Copper Pass Trenches.</i></b>
	C. Gravelle	There are two main trenches at the Main Showing and the water within them would need to be treated. The other trenches there are not a major hazard. The West showing trench is a small hazard and is difficult to access. The other trenches are hard to access and much smaller.
	R. Breadmore	The mine inspector would need to sign off on remedial measures.
	J. Gowman	There is still a fall hazard with these trenches.
	A. Beck	What volume of water is in the trenches?
	C. Gravelle	We will confirm the volume of water within the trenches however we would estimate that there is more than 1,000,000 L in the two main trenches. Even if volume was less (500,000 L) it would still spill as the trench is filled.
	A. Beck	How contaminated is this water?
	C. Brown	This water is reported to contain very elevated concentrations of metals and we need to manage it.
	A. Beck	We could let it freeze and then take it out in the winter. It needs to come out.
	J. Hoyt	We want the same thing, but to a certain extent how to manage it is up to the contractor.
	A. Beck	We don't want the contractor to make the decision. How do you monitor them?
	R. Breadmore	Some flexibility is necessary but there is Crown site presence during all phases of the remediation works.
	J. Hoyt	We will monitor them, with third parties and the Crown representatives.
	T. Unka	Can't you use the wetland to treat it? It could be a better use of resources.
	J. Gowman	Wetland treatment does work, but we don't want to harm the wetland. We could do primary treatment and then polish using the wetland.
	T. Unka	Wetlands are effective and better value.
	J. Hoyt	We see that the wetlands are working to remove metals at the Main Showing. But we don't want to contribute additional impacted water. So we could use a hybrid solution.
	A. Beck	Did you test downstream of the Main Showing drainage?
	J. Hoyt	Not right at the drainage but we are planning to do this in the future.

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	R. Breadmore	Trench water metal parameter concentrations are too high to discharge – could be more than the wetlands could handle.
	A. Beck	The option should really be to backfill and treat.
	J. Gowman	<i>Edits Option 3 to Read "Backfill and water treatment"</i>
	A. Enzoe	Option 3
	R. Beaulieu	Option 3
	A. Beck	Option 3
	P. King	Option 3
	T. Unka	Option 3
	M. Tollis	Would the water treatment be onsite?
	J. Gowman	Yes
	M. Tollis	Option 3
	E. Boucher	Option 3
	P. Smith	Option 3
	S. Beck	Option 3
	K. King	Option 3
	R. Bjornsen	Option 3
	R. Breadmore	<i>Backfill and Treat Water (Option 3) is the preferred option.</i>
	J. Gowman	<i>Introduces remedial options for ore at Copper Pass.</i>
	A. Beck	Option 3 (consolidate in trenches and capping), it came out of the trench.
	C. Gravelle	We have ore in consolidated piles and smaller deposits.
	R. Beaulieu	How much ore is there at the site?
	C. Brown	About 150m <sup>3</sup> , of which 120m <sup>3</sup> is in consolidated piles.
	T. Unka -	Is there any ARD?
		ARD is not the primary concern at the site, but there are select locations where the ore/waste rock is classified as acid generating. However, metal leaching is occurring under neutral conditions, most notably of arsenic.
	R. Beaulieu	Option 3 (consolidate in trenches and capping).
	A. Enzoe	Option 3
	A. Beck	Option 3
	T. Unka	Option 3
	P. King	Option 3
	M. Tollis	Option 3
	E. Boucher	Option 3
	P. Smith	Option 3
	S. Beck	Option 3
	P. Simon	Option 3
	K. King	Option 3
	R. Bjornsen	Option 3
	R. Breadmore	<i>Consolidation in trenches and capping (Option 3) is the preferred option.</i>
2:15	BREAK	
2:25	J. Gowman	<i>Introduces remedial options for waste rock at Copper Pass.</i>
	C. Gravelle	The majority of waste rock is at Trench #2. This could be used as a backfill to reduce the physical hazard, but putting it in the trench would also reduce exposure to the material.
	A. Beck	So the water would be treated?

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	C. Gravelle	Yes.
	R. Beaulieu	Option 3 (consolidate in trenches and capping)
	A. Enzoe	Option 3
	A. Beck	Option 3
	T. Unka	Option 3
	P. King	Option 3
	M. Tollis	Option 3
	E. Boucher	Option 3
	P. Smith	Option 3
	S. Beck	Option 3
	P. Simon	Option 3
	K. King	Option 3
	R. Bjornsen	Option 3
	R. Breadmore	<i>Consolidate in trenches and capping (Option 3) is the preferred remedial option.</i>
	J. Gowman	<i>Introduces remedial options for metal impacted soil at Copper Pass.</i>
	C Gravelle	Issues are similar to waste rock
	R. Beaulieu	Option 2 (consolidate in trenches and capping)
	A. Enzoe	Option 2
	A. Beck	Option 2
	T. Unka	Option 2
	P. King	Option 2
	M. Tollis	Option 2
	P. Smith	Option 2
	E. Boucher	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	Option 2
	R. Breadmore	<i>Option 2 (consolidate in trenches and capping) is the preferred option.</i>
	J. Gowman	<i>Introduces remedial options for PHC impacted soils.</i>
	C Gravelle	As some context, Options 3 and 4 would be difficult. Most of the PHC impacted soil is the Camp Area and it would be hard to get it to the mine showing trenches. It would also be difficult to do a landfarm in this area as there is little stable ground in the area of the camp.
	R. Beaulieu	Option 2 (off-site disposal)
	A. Enzoe	Option 2
	A. Beck	Option 2
	J. Gowman	How much soil is impacted?
	C. Brown	About 70m <sup>3</sup> .
	T. Unka	Option 2 (off-site disposal)
	C. Gravelle	It is important to note that when this soil is excavated it will change the topography of the Camp Area, and there will be exposed bedrock.
	T. Unka	It is a mined area and this is expected.
	P. King	Option 2 (off-site disposal)

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	M. Tollis	Option 2. But what are we proposing to do with Trenches 3, 4, 5 and 6?
	C. Gravelle	We wouldn't do anything as the risk is equivalent to the hazards presented by the local topography.
	M. Tollis	What about the adit?
	C. Gravelle	It's not really an adit, but the start of one. It's only 3m deep and we wouldn't propose to do anything at this location.
	R. Breadmore J. Gowman	The mine inspector would likely not classify this as an opening (it's not connected to any underground mine works).
	E. Boucher	How many trenches are there?
	C. Gravelle	Two big ones and two small ones at the Main Showing. One at the West Showing, two at the East Showing and five very small ones at the Upland Pond.
	E. Boucher	Option 2 (off-site disposal).
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	Option 2
	R. Breadmore	<i>Option 2 (off-site disposal) is the preferred option.</i>
	J. Gowman	<i>Introduces remedial options for buildings at Copper Pass.</i>
	A. Enzoe	Option 2 (demolish and burn)
	A. Beck	Option 2
	T. Unka	Option 2
	P. King	Option 2
	M. Tollis	Option 2
	E. Boucher	Option 2
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	Option 2. What do you do with the footprint?
	C. Gravelle	We would remove the ash.
	J. Gowman	The specs usually call for a container to burn in.
	J. Gowman	<i>Option 2 (demolish and burn) is the preferred option for the buildings.</i>
	C. Gravelle	<i>Introduces non-hazardous material remedial options at Copper Pass.</i>
	A. Beck	Haul the drums away but burn the wood.
	R. Breadmore	Let's add a hybrid option. Option 4 is burn all clean wood, remove the drums and steel, and remove ash.
	R. Beaulieu	Option 4
	A. Beck	Option 4
	T. Unka	Option 4
	P. King	Option 4
	M. Tollis	Option 4
	E. Boucher	Option 4
	S. Beck	Option 4
	P. Simon	Option 4

## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	K. King	Option 4
	R. Bjornsen	Option 4
	R. Breadmore	<i>Option 4 is the preferred option for non-hazardous waste at Copper Pass.</i>
2:50	BREAK	
3:05	R. Breadmore	We presented a lot of material and thank you to everyone. A special thank you to Tom and Anne for their hard work interpreting.
	J. Gowman	<i>Reviews the preferred remedial option selected for each component at the three sites.</i>
	J. Hoyt	Is everyone comfortable with the mill equipment coming off site? Or do you want to leave this for heritage reasons?
	R. Breadmore	Such equipment has been left at other sites. Pete King did mention that this is one of the oldest mines in the territories.
	M. Tollis	If it isn't a hazard or environmental concern, then leave it.
	P. Simon	Mining hasn't always been good to us, but we should still look at the history of it.
	R. Bjornsen	I'm not sure how many young people would be visiting the site.
	J. Gowman	Outpost Preferred Remedial Options: Mine Openings: Option 4 – Hybrid (Foam for small openings, concrete for large) Buildings: Option 2 – Demolish and Burn Non-Hazardous Debris : Option 2-Offsite disposal (equipment TBD) Hazardous Waste: Option 2 – Offsite disposal Tailings/Waste Rock: We have two acceptable options (to do nothing, or to consolidate and reslope) Waste Rock: Option 4 – Hybrid (Leave as is, but use it if needed) Metal Impacted Soil: Option 2 - Off-site disposal PHC Impacted Soil: Option 2 – Off-site disposal Water/Sediments : Option 2 – Long Term Monitoring
	R. Bjornsen	DKFN needs to consult with its Technical Advisor.
	R. Breadmore	Speaking to your consultant on the tailings/waste rock issue is a good idea.
	J. Hoyt	We think stabilizing is a good solution.
	R. Breadmore	Take some time and the site visit may help to determine your preferred option.
	A. Beck	Are you going to stabilize the tailings in North Bay?
	G. Gravelle	We recommend stabilizing the waste rock/tailing stockpile slope on the east side of the North Bay and may install large boulders at the mouth of North Bay to act as energy dissipating structures.
	J. Gowman	Blanchet Preferred Remedial Options: Adit: Option 4 – Foam Plug Buildings : Option 2 – Demolish and Burn Refuse: Option 2 – Off-site Disposal Waste Rock: Option 3 – Reslope and Cover Ore: Option 2 – Off-site disposal Metal Impacted Soil: Option 3-Reslope and Cover (low permeability) PHC Impacted Soil: Option 2 – Off-site disposal Water/Sediments: Option 2 – Long-term monitoring
	J. Gowman	Copper Pass Preferred Remedial Options: Trenches: Option 3 – Backfill and treat water



## Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
		Ore: Option 3 – Consolidate in trenches and cap Waste Rock: Option 3 – Consolidate in trenches and cap Metal Impacted Soil: Option 2 – Consolidate in trenches and cap PHC Impacted Soil: Option 2 – Off-site disposal Structures: Option 2 – Demolish and Burn Non-Hazardous Waste: Option 4 – Drums and metal off site, burn clean wood.
	R. Breadmore J. Gowman	The binder we have given you contains draft RAP summaries and preferred remedial options will be incorporated into the Final RAP.
	G. Lafferty	<i>Provides summary of TK questionnaire and indicated this information will be confidential. More TK, including what has been mentioned during current meetings, will be used to formulate RAP. Thank you to participants.</i>
	R. Breadmore	We will continue to use TK for such things as we move through the remedial planning stage, execution and into closure and monitoring (interpreting seasonal conditions, wildlife monitoring etc).
	J. Gowman	Thanks to the elders who participated in the flight tour.
	R. Bjornsen	Thanks to the land users and especially the Elders. Their stories have importance in these meetings and also in life. Thank you also to Anne, INAC and SENES.
	A. Beck	Thank you to everyone. This is one of the few times we were on the same side and didn't need to fight. Scientists need to understand the TK passed on from thousands of years and the benefits of this.
	T. Unka	Thank you for everyone's efforts. The next generation is going to appreciate this.
	P. King	Appreciative of the work activities.
	E. Boucher	Spent time at these sites in the 1950s and has been thinking about this a lot.
	S. Beck	Thank you and safe trip home.
	P. Simon	Thank you.
	K. King	Thank you, especially to the elders. This was a good start, especially with devolution and the number of sites to come.
	R. Breadmore	Thanks from all of us. We really do enjoy these community meetings. This workshop has been a true collaborative effort and we thank Ft Resolution leadership and community for its hospitality.
	A. Enzoe	Everyone has had a happy two days in a row and thank you.
16:00		<i>Closing Prayer</i>

## **APPENDIX C**

### **REMEDIAL ACTION PLAN OPTIONS ANALYSIS WORKOUT TABLES**



# Outpost Mine – Remedial Options Evaluation

Fort Resolution  
June 13-14, 2013

Mine Component	Option 1	Option 2	Option 3	Option 4	Option 5
<b>Mine Openings</b>	Leave as is	Retrofit Caps and Raise Fill in	Upgrade Existing Concrete Caps and Seal Main Raise	"HYBRID" -> Concrete Cap Shaft #1 -> foam for raise and Shaft #2	
<b>Buildings</b>	Leave as is	Demolish and Burn			
<b>Non-Hazardous Refuse</b>	Leave as is	Consolidate and Transport Off-Site	Consolidate and Place in On-Site Landfill		
<b>Hazardous Waste Materials</b>	Leave as is	Consolidate and Transport Off-Site			
<b>Mixed Tailings/Waste Rock</b>	Leave as is	Consolidate and Re-Slope	Consolidate, Re-Slope and Cover		
<b>Waste Rock</b>	Leave as is	Deposit in Surface Excavations		"HYBRID" -> leave as is -> use if needed	
<b>Metal Impacted Soil</b>	Leave as is	Consolidate and Transport Off-Site	Capping		
<b>PHC Impacted Soil</b>	Leave as is	Off-Site Disposal	On-Site Disposal	On-Site Treatment	
<b>Surface Water and Sediments</b>	Leave as is	Long-Term Monitoring			



# Blanchet Mine – Remedial Options Evaluation

Fort Resolution  
June 13-14, 2013

Mine Component	Option 1	Option 2	Option 3	Option 4	Option 5
<b>Adit</b>	Leave as is	Backfill w borrow	Backfill w waste rock	Foam Plug	
<b>Building Structures</b>	Leave as is	Demolish and Burn			
<b>Refuse</b>	Leave as is	Consolidate and transfer off-site	Consolidate and place in on-site landfill		
<b>Waste Rock</b>	Leave as is	Re-slope	Re-slope and cover		
<b>Ore Concentrate</b>	Leave as is	Consolidate and off-site disposal	Consolidate and on-site disposal		
<b>Metal Impacted Soil</b>	Leave as is	Cap w granular material	Excavate and place under low permeability cover		
<b>PHC Impacted Soil</b>	Leave as is	Off-site disposal	On-site disposal	On-site treatment	
<b>Surface Water and Sediments</b>	Leave as is	Long term monitoring			





## Copper Pass Mine – Remedial Options Evaluation

Fort Resolution

June 13-14, 2013

Mine Component	Option 1	Option 2	Option 3	Option 4	Option 5
<b>Surface Trenches</b>	Leave as is	Fencing and/or Berms	Backfilling (and treat water)		
<b>Ore</b>	Leave as is	Grading and Covering	Consolidation in Trenches and Capping		
<b>Waste Rock</b>	Leave as is	Grading	Consolidation in Trenches and Capping		
<b>Metal Impacted Soils</b>	Leave as is	Consolidation in Trenches and Capping			
<b>PHC Impacted Soils</b>	Leave as is	Off-Site Disposal	On-Site Disposal	On-Site Treatment	
<b>Structures</b>	Leave as is	Demolish and Burn			
<b>Non-Hazardous Materials</b>	Leave as is	Consolidate and Manage Off-Site -> drums/steel off-site -> clean wood burned	Consolidate and Dispose in an On-Site Landfill	"HYBRID" -> drums/steel off-site -> burn clean wood	



## **APPENDIX D**

### **WASTEROCK AND TAILINGS EROSION CONTROL OPTIONS**

# SENES Consultants



121 Granton Drive, Unit 12  
Richmond Hill, Ontario  
Canada L4B 3N4  
Tel: (905) 764-9380  
Fax: (905) 764-9386  
E-mail: [senes@senes.ca](mailto:senes@senes.ca)  
Web Site: <http://www.senes.ca>

## MEMORANDUM

---

TO: Jessie Hoyt - PWGSC 350600-207

FROM: Charles Gravelle 30 September 2013  
(Revised 15 November 2013)

SUBJ: **Technical Memorandum Remedial Options Evaluation for Erosion Control on Tailings and Waste Rock Stockpile Outpost Island Mine Site, NWT**

---

Further to dialogue during the course of the Community Meetings held in Fort Resolution to discuss the remedial options for the respective Great Slave Lake Mine Sites (Outpost Island, Blanchet and Copper Pass Mines) a concern was raised by the elders regarding the erosion of the tailings and waste rock stockpile at the Outpost Island Mine Site. By way of this memorandum the nature of this concern is outlined along with two options available to address this concern.

The tailings and waste rock stockpile for the Outpost Island mine site is located on the east side of the North Bay with some tailings located on the causeway between the North and South Bays (See Figure 1). It is understood that as part of earlier remediation works on the property in the 1990's the tailings and waste rock at the mine site were consolidated into its present location. Post-remediation erosion and material losses are evident along the west side of the waste rock and tailings stockpile immediately adjacent the North Bay. As evident from the aerial and close up photographs provided herein (Photographs Nos. 1 to 8) the tailings and waste rock stockpile at the end of the 1994 remediation program had been originally sloped to the edge of the North Bay primarily in the area of the main raise. As a result of wave action and/or a potential collapse of the original main raise cap the slope of the stockpile post-remediation has eroded releasing fine and coarse grained materials into the North Bay.

In order to address this issue one of two remedial options may be considered 1) the west slope of the waste rock and tailings stockpile can be pulled back past the high water mark, re-graded to a 1 vertical (V) to 3 horizontal (H) slope and the toe of the stockpile protected with a layer of the coarsest available waste rock as shown in the Option 1 detail on Figure 1 or 2) the west side of the tailings and waste rock stockpile can be re-graded in a more stable manner (1V:3H) and a line of energy dissipating concrete blocks or a cast in place barrier used to protect the toe of the stockpile (see Option 2 detail on Figure 1).

A detailed description of each remedial option is provided below:

### ***Remedial Option 1***

The re-grading of the tailings and waste rock stockpile would entail the following:

1. Establish the high water mark for the North Bay;
2. Cut a 3 m setback, from high water mark, into the tailings and waste rock stockpile;
3. Reshape the west face of the stockpile to a 3 horizontal to 1 vertical slope; and
4. Construct a 300 mm thick layer of coarse aggregate using the largest aggregate available as shown in Detail 1.

### ***Remedial Option 2***

The re-grading of the tailings and waste rock stockpile would entail the following:

1. Establish the high water mark for the North Bay;
2. Cut a 3 m setback, from high water mark, into the tailings and waste rock stockpile;
3. Reshape the west face of the stockpile to a 3 horizontal to 1 vertical slope;
4. Construct an energy dissipating barrier comprised of concrete blocks anchored into the bedrock (or a cast-in-place concrete berm) at the high water mark; and
5. Place a 300 mm thick layer of coarse material (50 to 150 mm waste rock) between the backside of the concrete blocks and the toe of the stockpile so as to protect at the toe from surface water run-off and wave action.

The final design and installation of the barrier and the re-grading of the stockpile would be the responsibility of the remediation contractor. As a minimum the work involved in the construction of a barrier would entail the following activities:

- Excavation of up to 1,000 m<sup>3</sup> of material to expose the bedrock along the shoreline to confirm the ground conditions at the base of the barrier (would be cut to 3.4 to 4 m back from the high water mark);
- The design engineer would then need to inspect the ground conditions and potentially perform some rock coring and testing on the bedrock to confirm the adhesion strength for the steel rebar-grout anchors that would be required for the barrier;
- The engineer would then need to design the barrier to withstand lateral soil pressures and potential ice slab pressure;
- The construction of the barrier would involve the placement of over 3000 kg of rebar and 50 to 100 m<sup>3</sup> of concrete into forms which would add weeks to the overall remediation program schedule.



This remedial option would result in the construction of a concrete structure that is not natural and would not blend into the aesthetic of the site at the end of the remediation program.

### ***Remedial Option 3***

The construction of a concrete barrier within the bedrock saddle at the entrance to the North Bay could also be constructed however there are some practical limitations to the placing a structure at the entrance of the bay where the area is most exposed to the ice and wave action. The unknown condition of the bedrock complicates the design of this remedial option. It is highly probable that any structure constructed with the limited knowledge of the bedrock conditions within the bedrock saddle would not survive the repeated impacts from both water and ice. The construction of a barrier in the saddle would also increase the potential for impacted tailings currently within the North Bay would be disturbed and flushed in to the greater lake which is inconsistent with the wishes of the Aboriginal Community.

In addition the aesthetic of a man-made structure at the entrance of the bay would be inconsistent with the attempts to return the site to its pre-mining conditions.

### ***Recommendation***

Though the topic of a barrier to protect the toe of the waste rock and tailings was discussed during the community meetings we recommend that Option 1 be implemented for the following reasons:

- By removing the waste rock and tailings from the potential erosion zone the risk of material eroding into North Bay is mitigated.
- The placement of a coarse aggregate on the toe of the embankment will also mitigate the potential for translational failures of the slope.
- Re-grading the west embankment to a flatter 1V to 3H will also ensure the long term stability of the stockpile.
- This option does not require any design-build engineering to implement.
- This is also the more cost effective approach of the two options presented.

Furthermore, the construction of a man-made barrier would be inconsistent with the natural aesthetic we are attempting to prepare by re-grading the existing waste rock/tailing stockpile.



Photograph No. 1: Aerial Overview of Tailings and Waste Rock Stockpile looking west.



Photograph No. 2: Aerial Overview of Tailings and Waste Rock Stockpile looking north.





Photograph No.3: Close-up of Tailings and Waste Rock Stockpile



Photograph No. 4: Close-up of Tailings and Waste Rock Stockpile.





Photograph No. 5: View of Tailings and Waste Rock from west side of North Bay.



Photograph No. 6: View of Tailings from south side of North Bay.

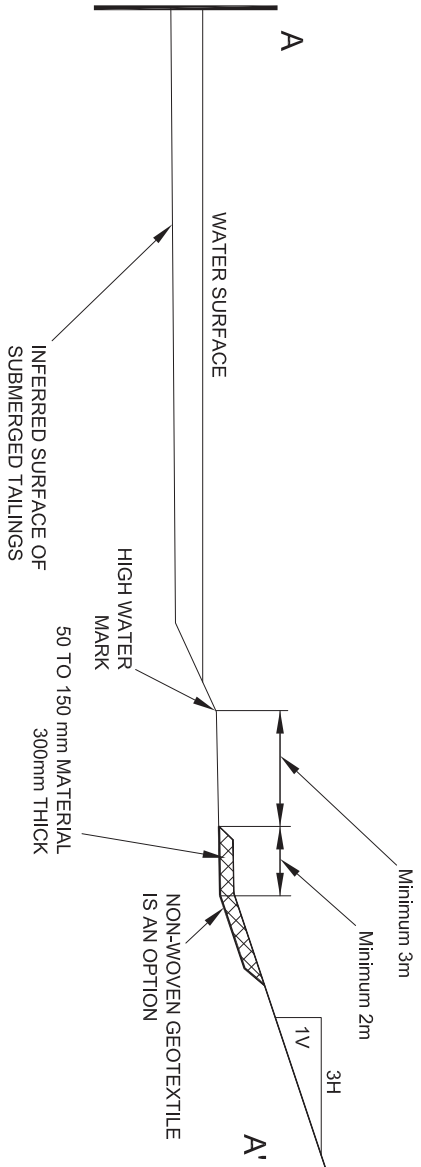
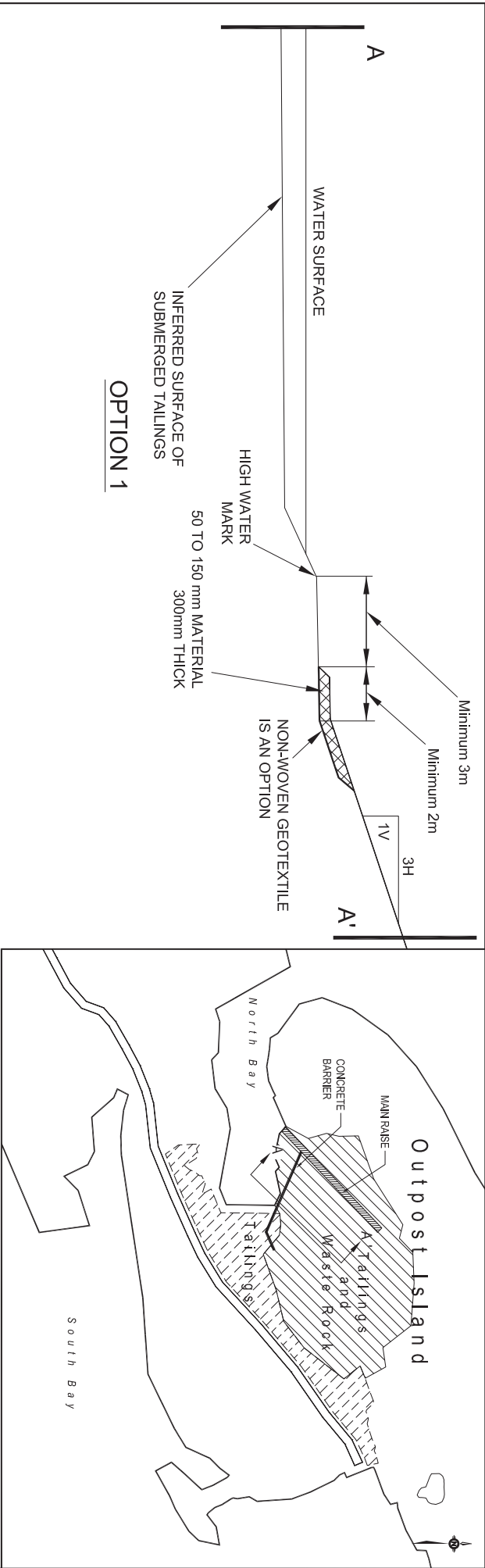




Photograph No. 7: Tailings and Waste Rock Close-up

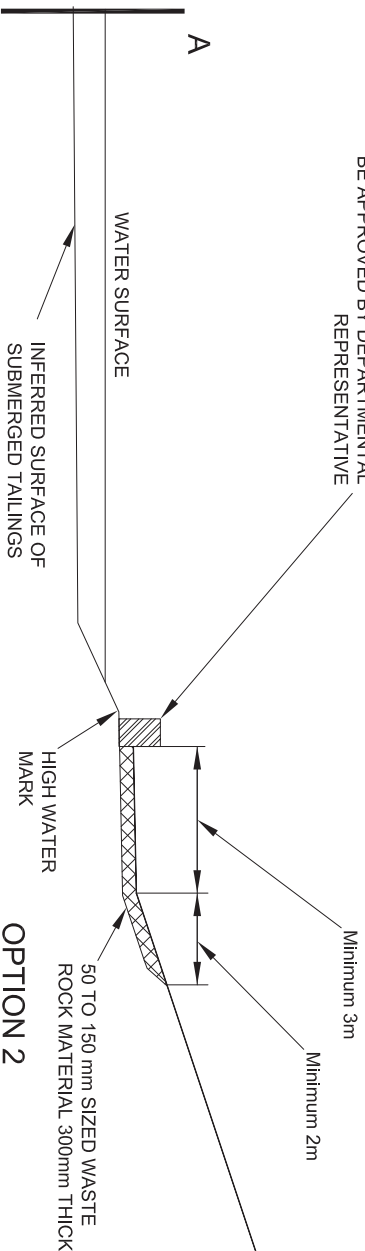


Photograph No. 8: Slope of Tailings and Waste Rock at South end of North Bay



OPTION 1

PRECAST OR CAST-IN-PLACE CONCRETE BLOCK (TYP. 1200x900x600) TO BE ANCHORED INTO UNDERLYING BEDROCK. ANCHORING SYSTEM TO BE APPROVED BY DEPARTMENTAL REPRESENTATIVE



OPTION 2

Legend		NOTES:		REFERENCE:		REVISIONS:		DRAWN BY: P.A.F.		CHECKED BY: C.F.G.		DATE: Sept 2013		FIGURE 1	
TAILINGS and WASTEROCK		All elevations in metres (m) Coordinates displayed as UTM Zone 10													
TAILINGS															
ACCESS ROUTE															
50 to 150mm MATERIAL															
PRECAST OR CAST-IN-PLACE CONCRETE BLOCK															

**Senes Consultants**

**PUBLIC WORKS AND GOVERNMENT SERVICES CANADA**  
**RE-GRADING OF TAILINGS and WASTE ROCK STOCKPILE**  
**OUTPOST ISLAND MINE SITE**  
(UPDATE)  
**CROSS SECTION and PLAN**

Drawn By: P.A.F.  
Date: Sept 2013

Reviewed By: C.F.G.  
Scale: NTS

Project No: 350600-204  
FIGURE 1