

1.7 G.13, Environmental Site Assessment

1.7.1 Executive Summary

Introduction

The Nanisivik Mine, located on the south shore of Strathcona Sound near the community of Arctic Bay in the North Baffin region, produced lead and zinc mineral concentrates from 1976 to 2002. The mine was permanently shut down in 2002 due to depleted ore reserves and poor economic forecasts.

As part of the closure and reclamation planning process, CanZinco Ltd., the mine owner, commissioned an Environmental Site Assessment ("ESA") to identify the nature and distribution of contaminants in soil. A Phase 2 ESA was undertaken in July 2002 by Gartner Lee Limited ("Gartner Lee"). Conditional approval was given by the NWB for the Phase 2 ESA Report based on fulfillment of 15 specified conditions regarding information requests and requests for clarifications. Each of those conditions is addressed herein.

A Phase 3 ESA investigation was conducted in August 2003 that incorporated as many of the comments that were brought forward through the NWB review of the Phase 2 ESA Report as allowed by timelines and practicalities. The Phase 3 ESA investigations are reported on herein.

A total of 267 soil samples were collected from 90 test pits during the Phase 3 ESA. Additionally, 15 water samples were collected from groundwater monitors and surface seeps. Analyses for metals and petroleum hydrocarbon concentrations were conducted at an accredited laboratory for a select subset of the soil samples and all of the water samples.

The work performed for the Phase 3 investigations is considered to complete the needs for preparation of a remedial plan for the Nanisivik site and no further ESA investigations are deemed necessary.

Conclusions

The conclusions drawn from Phase 3 program, as presented herein in Section 5, are provided below

Dock Area

- The downgradient extent of hydrocarbon contaminated soil at the fuel tank farm has been delineated. Testing has shown that it does not extend beyond 40 m from the berm of the tank farm.
- Concentrations of hydrocarbons in the soil within the dock cell containing the ship loader facility exceed the generic PHC CWS IL for the protection of aquatic life, the site soil quality remediation objective.
- Surficial hydrocarbon contamination is present at the AST adjacent the refuge station. The contamination appears to be isolated to the immediate area surrounding the AST.
- Hydrocarbon contamination was detected in a test pit which exposed the fuel line from the dock to the tank farm. Results indicate that contamination is localized and has migrated less than 40 cm from the line.
- Zinc concentrations greater than the SQRO for the dock area have been identified on surface adjacent the door to the concentrate shed on the west side, at the load out dock and adjacent the refuge station. One isolated incidence is documented on the east side of the concentrate shed. Lead concentrations also exceed the SQRO adjacent the door of the concentrate shed on the west side. No lead or zinc contamination greater than the SQROs is indicated in the

reagent storage area. Analytical results indicate that the metal contaminated soil does not extend to 0.4 m below surface.

- Silver exceeds the generic CEQG IL, the site soil quality remediation objective. Elevated silver results were returned in samples with zinc concentrations that were indicative of zinc concentrate and several times greater than the SQRO and therefore silver is contamination would be remediated during the remediation of the zinc contaminated soils.

STOL Airstrip

- Hydrocarbon contaminated soil detected during the Phase 2 ESA at the east end of the airstrip has been delineated. The contaminated soil does not extend 45 m from the point of origin as indicated by surface staining. Hydrocarbon contaminated seepage water was encountered in test pit TP03-373, however soil quality results from this test pit met the PHC CWS RL criteria. Test pit TP03-373 was excavated approximately 45 m from the point of origin.
- Lead concentrations greater than the SQRO detected during the Phase 2 ESA on the apron on the south side of the airstrip were investigated. The lead contamination has been delineated vertically and laterally and it is confined to the soils on surface at the apron.

Town, Carpenter Shop

- The downgradient extent of hydrocarbon contaminated soil at the Carpenter Shop has been delineated. It does not extend 50 m downgradient of the building. No impact of hydrocarbon contamination on the surface water was detected in the water flowing in a ditch adjacent to the Carpenter Shop.

Industrial complex

- Soils beneath the surface water runoff pathway, downgradient of the fuel day tanks, are contaminated with hydrocarbons. Contamination did not extend to 0.95 m beneath surface at test pit TP03-331, but was present at 1.5 m below surface at the upgradient test pit TP02-88.
- Hydrocarbon contaminated soil has been delineated at the waste oil tank, located between Twin Lakes Creek and the industrial complex. Results indicate that it is isolated to the downhill side of the tank and does not extend to the creek.
- Hydrocarbon contaminated soil is present at the oil water separator. Analytical results obtained from test pit TP03-330 indicated that the contaminated soil does not extend 50 m downgradient of the oil water separator.
- Metal contaminated soil is present in the soil surrounding the industrial complex. Analytical results to date indicate that concentrations of cadmium, lead and zinc greater than the SQROs do not generally extend to 0.4 m below surface.

Warehouse Yard

- Hydrocarbon contamination is present in surficial soils with patchy, visible staining. Hydrocarbon contamination at an area of heavy staining (initially identified and sampled during the Phase 2 ESA) extends into the fractured bedrock to at least 0.8 m depth. It does not extend into the weathered, fractured bedrock, encountered 0.4 m, beneath lightly stained surface soils.

Landfarm Cell

- Based on analytical results obtained to date, it is estimated that approximately 25% of the hydrocarbon contaminated soil being remediated in the landfarm cell at the landfill currently meets the generic PHC CWS RL criteria.

Landfill

- No hydrocarbon contamination was detected in soil or water samples down gradient or cross gradient of the landfill and all analyses were less than the method detection limits.
- No elevated metals were encountered in the soils.

K-Baseline

- Hydrocarbon contamination of soil has been detected at the former AST and maintenance shop at K-Baseline. Analytical results from test pits excavated northwest of the former AST and maintenance shop indicated that the contaminated soil does not extent to intermittent tributary of Chris Creek
- Analytical results from the Phase 3 ESA illustrate that the hydrocarbon contaminated soil is isolated to the top of the active layer.

Roads

- Surficial hydrocarbon contamination is present at the ASTs adjacent the refuge stations at the side of the roadways. The contamination appears to be isolated to the immediate area surrounding the ASTs.
- Metal contamination of soil is present adjacent the former Oceanview mine workings.
- Iron contaminated soil is present on the surface of the roadway between the townsite and the industrial complex at the west side of bridge near the sewage treatment plant. The contamination did not extent to 0.4 m below surface.
- Metal contaminated soil is present on the surface of the roadway between the industrial complex and the screening plant, located approximately 1.5 km to the north. The contamination did not extend to 0.4 m below surface and was not detected in soils adjacent to the roadway.

1.8 G.16, Underground Mine Waste Disposal Plan

1.8.1 Executive Summary

The closure of Nanisivik mine, as with any mine, creates a considerable amount of material that requires disposal. The purpose of the waste disposal plan is to identify and classify the waste, which may include derelict equipment, contaminated soil, waste rock, demolition debris, and regulated or hazardous material. The plan will also provide information on how and where the waste will be disposed of.

The objective of the plan is to dispose of all waste in such a manner as to eliminate the pathway by which exposure to humans or the environment is possible. This will be done in two ways:

1. Deposit the material underground in locations where gravity will prohibit migration of contaminants to surface openings and permafrost aggradation will effectively seal the waste in place.
2. Deposit the material into pits, cover with rock fill and contour to allow for positive surface drainage and the prevention of pooling. The natural aggradation of permafrost will then effectively isolate the waste.

After the material is classified, an action plan for that particular material is followed and a storage location is selected. The storage location depends on the associated risk with the particular material as well as the volume required to facilitate the disposal.

Waste handling procedures will be recorded and documentation will be kept on site for review during the reclamation and closure monitoring periods. Records will include a description of the waste, classification, any decontamination required, storage location and estimated storage volume.

A simple classification system is used to differentiate the types of waste as shown below.

Type of Waste	Criteria	Class
Abandoned Equipment	1 – Contains regulated materials (free phase liquids, batteries, etc.)	AE1
	2 – Can be stored directly	AE2
Demolition Debris (Inert solids)	1 – Can be stored directly or burned (wood debris)	DD1
Soil	1 – Contains Metals above the SQRO	S1
	2 – Contains Hydrocarbons above the SQRO	S2

(SQRO – Soil Quality Remediation Objective)

Disposal plans and waste volume estimates for the major component areas of the site are included in the Plan. These include:

1. Dock Area: Total volume of 3,750 m³.
2. Warehouse Yard: Total volume of 1,500 m³.
3. Industrial Complex Area: Total volume of 3,700 m³.
4. Town Site: Total volume of 4,600 m³.
5. WTDA: Total volume of 1,000 m³.
6. Mobile Equipment: Total volume of 4,150 m³.

The total of all waste with a 25% contingency added is 23,500 m³.

Demolition debris and abandoned equipment will be reduced in volume as much as possible prior to being placed in a storage location. This will minimize the number of trips and will better facilitate the loading of haulage trucks and the placement of the waste. The large amount of space available underground will

make it possible to avoid handling the material more than once. In most cases trucks will dump directly into the allotted storage area and no further handling will be required. In areas where the height is limited, the material will be pushed up so that 60 to 75 percent of the space is utilized.

Several areas in the mine have been identified as potential storage areas. The areas selected for storage are in close proximity to the main haulage roads. A total of 315,000 m³ of space is available for the storage of waste underground, which is substantially greater than the volume required for the identified solid waste (23,500 m³).

1.9 G.17, Landfill Closure Plan

1.9.1 Executive Summary

The technical objectives of the landfill closure plan are to provide:

- A closure cover design that satisfies the overall objective of isolating landfill material from the environment;
- A performance monitoring plan that allows the ability to assess the effectiveness of the landfill cover; and
- A contingency plan in the event the landfill cover does not perform in an acceptable manner

A further objective of the Landfill Closure Plan is to address community concerns and perceptions. During the public consultation process for mine closure, the Community of Arctic Bay raised concerns regarding the status and closure of the landfill facility. Specifically, the concerns focus around the potential for environmental contamination from the waste materials contained within the facility. These concerns were considered in the Environmental Site Assessment investigations that were conducted in 2002 and 2003 and are addressed further herein.

The Nanisivik landfill is a conventional landfill facility that has been in operation since the mine and town were constructed in 1975. The facility is located approximately 4 km south of Strathcona Sound on a local topographic high/divide (approximately 350 masl) between two drainage directions, northeast and northwest. This site location was selected to minimize drainage through the facility. The northeast drainage path is intermittent in nature and reports to Strathcona Sound via Twin Lakes Creek. The northwest drainage path reports to Strathcona Sound via a small meadow/marsh area. Drainage from the facility naturally preferentially drains to the northwest and this flowpath is promoted by the presence of a water diversion berms designed to divert water in this direction.

The landfill facility occupies an area of approximately 4 ha and ranges in thickness from about 2 m to approximately 10 m.

During the period of mine operations from 1975 to 2002, the facility received waste from residential, institutional, industrial, and other miscellaneous waste streams. Waste materials were typically end dumped and pushed over the advancing crest after burning and crushing, as appropriate, and were subsequently covered with shale rock to maintain a safe working area and to minimize wind dispersion. An assessment conducted by CanZinco in 1999 estimated the waste stream volume to be 1,150 m³ per year (after burning). The majority (75%) of the waste stream was characterized as institutional and domestic.

In 1990, a substantial amendment to the operating practices of the landfill was instituted that eliminated the disposal of any used oils, glycols or lead-acid batteries as had been common practice at industrial and municipal landfill facilities prior to 1990.

A landfarm cell, internal to the landfill facility was established in 2000 as a means of remediating hydrocarbon contaminated soil that had been excavated from a spill of diesel fuel at the carpenter shop in

the town area. The 2003 Phase 3 Environmental Site Assessment ("ESA") conducted by Gartner Lee for CanZinco indicated that approximately 25% of the soil in the landfarm cell met current federal guidelines for petroleum hydrocarbons in soil.

Gartner Lee Limited conducted a Phase 2 ESA of the mine property for CanZinco in 2002 as part of the closure planning activities. This work was followed up with a Phase 3 ESA in 2003. A total of 14 test pits were excavated in the landfill area. Seepage sampling wells were installed in six of these test pits that encountered water. One seep that emerged at the toe of the landfill in the vicinity of the southwest berm was sampled. The Phase 3 ESA provided the following conclusions regarding the landfill:

1. No hydrocarbon contamination was detected in soil or water samples down gradient or cross gradient of the landfill and all analyses were less than the method detection limits; and
2. No elevated metals were encountered in the soils.

Given that the landfill has been in operation since 1975, these results are considered to provide a positive indication that contaminants have not migrated from the landfill facility.

The selected approach to closure of the Nanisivik landfill is to construct a thermal barrier cover of locally available, natural materials that makes use of the natural thermal regime at the mine site to achieve the reclamation objectives. This design approach has been successfully used for landfill closures at other northern mine sites in the Canadian Arctic. Since the waste will be permanently frozen, there will be no opportunity for contaminants to migrate from the landfill.

The geotechnical issues considered in the design include:

- cover thickness/thermal performance;
- availability of materials;
- infiltration;
- durability;
- gradation/filtration;
- slope stability; and
- erosion.

Based on these considerations, the proposed design of the cover for the landfill facility is as follows:

1. The top slope of the final landfill surface will be about 2 ° and the maximum sideslope of the landfill will be 18 ° (3H:1V);
2. A two-layer thermal cover with a total thickness of 2.20 m will be placed above the landfill waste;
3. The upper erosion-resistant capping layer shall consist of a durable, erosion resistant material with a thickness of 0.25 m. The selected material is the Twin Lakes sand and gravel; and
4. The underlying layer will be shale with a thickness of 1.95 m to provide a minimum total thermal cover thickness (in combination with the surface layer) of 2.20 m. A grain size guideline (grain size distribution ranging from well-graded gravel to fine to medium sand) has been provided. It is recommended that the shale material be durable under freeze-thaw conditions.

Activities to be completed as part of the landfill closure are outlined below.

1. Relocate soil in the landfarm cell that exceeds the remedial objectives for petroleum hydrocarbons to the underground mine according to the Underground Mine Waste Disposal Plan;
2. Develop and implement a construction quality control program, which should include materials testing, survey control, and construction monitoring;

3. Grade the existing surface according to the design drawings to prepare a reclamation surface that does not exceed 3H:1V slope;
4. Construct the lower (shale) layer of the final cover;
5. Construct the upper (Twin Lakes sand and gravel) layer of the cover over the shale and groom the final surface to avoid potential surface channelization of runoff water; and
6. Prepare an as-built report.

Performance monitoring to monitor the effectiveness of the closure design will be conducted throughout the 2- year active reclamation period and the 5-year post-closure period. Components of that monitoring will include surface and ground water sampling and analyses, geothermal monitoring, and physical geotechnical inspections.

In the event that the cover does not perform a number of contingencies have been developed. These include:

- increased frequency of sampling/monitoring and data review by the technical professional;
- repair any erosion of the cover;
- place additional cover material to increase the cover thickness; and
- extend the period of performance monitoring

The risk that contaminated leachate will be observed at the reclaimed landfill facility is considered to be small. Nonetheless, in the unlikely event that contaminated leachate is observed and confirmed by increased sampling and other investigations, the mitigative measures that would be considered would include:

- increasing the cover thickness over all or parts of the facility;
- passive treatment along the seepage flowpath;
- installation of a geosynthetic or GCL liner over all or portions of the facility;
- relocation of portions of the waste materials; and, ultimately,
- installation and operation of a leachate collection system.

Community Summary መጽሐፍት ልማት

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ሙሉ ጋረፊ ለሙሉ ጋረፊ ለራሱ ለራሱ ማሳሰቢያ፡

ሙሉ ጋረፊ ለሙሉ ጋረፊ ለራሱ ለራሱ ማሳሰቢያ፡

Λ%C₂ ԿՃՃԾ-ՎՅ՝ ՎՊՏՖՅՆԴԻ 151,000 ԴԸ ՎԼ₂ 27,500ԴԸ ԴԾԳՊ.

[illegible][illegible]

West Twin Disposal Area Talik Investigation

1.2 G.5 - ၎်အိမ်အိမ် ၎်အိမ်အိမ် ၎်အိမ်အိမ် ၎်အိမ်အိမ် ၎်အိမ်အိမ်

1.2.1 $\mathbb{Q} \Delta^b \subset \Gamma \Delta^c \Gamma \Delta^c \supset \mathbb{Q} \Delta^b \Gamma \Delta^c$

[illegible][illegible]

ፊርማዎን ለሚጠቀሙት ሰነዶች ላይ ፊርማዎን ያቀርቡ፡

[illegible]

- [illegible]

[illegible]

- [illegible]

ጠቅላይ ልማት ሚኒስትር ወ.ሥ. ለጠቅላይ ሚኒስትር ሰብረኃይሉ ልብረት ለሚኒስትሩ 430-ፖሊስ፣ ማህተም ማረጋገጫ ሚኒስትር ለሚኒስትሩ 20-ኃሳብ ለሚኒስትሩ ማረጋገጫ ሚኒስትር -10-ፖሊስ፡

