2.1 Project Team

The team was comprised of members of EBA offices located in Yellowknife, NWT; Edmonton, Alberta; Calgary, Albert and Kelowna, B.C. Mr. Brent Murphy, M.Sc., P.Geol. provided the overall project management and provided technical input into surface contamination and geochemical issues, with assistance provided by Mr. Bill Horne, P.Eng, on the geotechnical issues associated with the mine decommissioning, Dr. Clint Smyth, who provided input on land disturbance and surface contamination issues, and Paula Spencer, B.Sc., who provided technical and administrative support to Mr. Murphy.

Outside expertise was solicited and secured by EBA to provide technical reviews of various aspects of the mine decommissioning program in which EBA did not have a recognized expert in their field. Ms. Shannon Shaw, M.Sc., of Robertson Geoconsultants of Vancouver, B.C, provided technical advice pertaining to Acid Rock Drainage (ARD) and other geochemical issues associated with the mine site. Technical review of rock mechanics and slope stability issues were provided by Dr. Jim Mathis, P.Eng., of URSA Engineering located in Ellensburg, Washington, USA. Dr. Mathis has extensive experience at the EKATI™ Diamond Mine dealing with similar issues and at other mining locations throughout Canada and the USA. Technical review regarding the building demolition and removal was provided by Mr. Court Smith, P.Eng., of Nuna Logistics situated in Vancouver. B.C.

Mr. Don Hayley, P.Eng., Principal Engineer with EBA provided the final technical review of the document.

2.2 Review Documents

The primary documentation provided by the INAC (i.e. the client) was CanZinco Ltd.'s Abandonment and Restoration Plan for the Nanisivik Mine, Water License No: NWB1NAN9702, submitted to the Nunavut Water Board on March 1, 2002. The A & R Plan was prepared by Gartner Lee Limited and was comprised of two volumes:

1. CanZinco Ltd., Nanisivik Mine, Closure and Reclamation Plan, Volume 1 of 2, Closure and Reclamation Plan; and;
2. CanZinco Ltd., Nanisivik Mine, Closure and Reclamation Plan, Volume 2 of 2, Supporting Documents.

During the course of the technical review, additional documents were requested from INAC by the team in order to address questions, or fill in identified data gaps, contained within the A & R Plan. Subsequently, an additional 40 documents were provided to the team and these documents are listed in Appendix A. Team members each reviewed selective documents pertaining to their technical field.

3 SITE DESCRIPTION

The following sections describing the mine site and its associated facilities was extracted from the CanZinco Ltd.'s Abandonment and Restoration Plan for the Nanisivik Mine, Water License No: NWB1NAN9702, as prepared by Gartner Lee Limited in March 2002.

3.1 Overview

The Nanisivik Mine is located on the Borden Peninsula on northern Baffin Island in the Canadian Arctic at a latitude of approximately 73 degrees north. The mine site is situated on the south side of Strathcona Sound approximately 30 kilometres from the inlet of the Sound. The Inuit community of Arctic Bay is located approximately 25 kilometres to the west of Nanisivik, the communities are linked by a 33 kilometre all-weather road. A jet airport that is owned and is operated by the Government of Nunavut is located approximately 9 kilometres south of Nanisivik. Commercial flight service is provided via Ottawa, Iqaluit and Resolute Bay.

Mineral exploration activities were carried our primarily from 1958 to 1968. Construction of the mine commenced in 1974 and operation/processing commenced in 1976, making the site the first operating metal mine in the Canadian Arctic. Mine employees live in the town of Nanisivik, constructed approximately one kilometre from the mine/mill area. The town includes a church, recreation centre, school, housing, post office, store, diesel electric power plant and other amenities to provide comfortable living for employees and their families. Construction of the town was partially funded by the Government of the Northwest Territories. The Government of Nunavut currently owns some of the town facilities. This block of land is referred to as the Block Transfer.

The mill and mine are located approximately three kilometres from Strathcona Sound, with the town situated approximately four kilometres from the Sound and the tailings storage facility located seven kilometres from the Sound. A concentrate storage shed, ship loading facility, dock, fuel, fuel tank farm, and reagent storage are situated along the shore of the Sound. The dock is used by the Canadian Coast Guard as a storage facility for marine environmental emergency response equipment and as a fuelling station.

The mine is primarily an underground operation with smaller contributions of ore from four open pits. Underground mining has been primarily room and pillar method. The underground mine is dry due to permafrost conditions to the extent where specialized dust collection apparatus is installed on drilling equipment. Ground temperatures in the underground mine are constantly below freezing (typically -13^0C) and permafrost conditions are known to extend to at least 600 metres below surface. The underground workings extend in an approximate east-west alignment and daylight on either side of topographic ridge (approximately 3 km long X 100 metres wide X 10 metres thick). Vehicle access into the underground mine is via several adits that allow passage of both heavy and light equipment. There is one ventilation raise to surface from the primary underground workings.

The Nanisivik sulphide deposits are hosted in carbonate rocks within a Proterozoic sedimentary sequence. This sequence developed as a Neohelikian intracratonic basin, the Borden Basin, on a preplaned gneiss complex of Archean-Aphbian age on the geological time scale.

The accepted geological model is that the Nanisivik deposits are Mississippi Valley Type (MVT), which are by definition post depositional, carbonate hosted deposits. The various massive sulphide deposits at the site contain more than 50 million tonnes of which barren massive pyrite bodies occupy most of the area and contain the largest sulphide tonnages. Zones containing sphalerite are present within the massive pyrite bodies, but are confined to a restricted vertical interval.

The processing plant involves dense media separation and conventional grinding, floatation, and dewatering circuits. Zinc and lead metal concentrates are produced that are transported in open gravel trucks from the mill to the concentrate storage shed, which is located at the dock. Mineral concentrates are loaded into ocean going ships during the ice-free season. The ship loading conveyor system was enclosed in the early 1980's. The mine has produced on average 790,000 tonnes/year of ore containing 8 to 14% zinc, producing 110,000 tonnes/year of mineral concentrates.

Process tailings are pumped approximately four kilometres from the mill to the tailings storage facility, West Twin Disposal Area (WTDA), formerly known as West Twin Lake. The WTDA storage capacity was increased in 1990 with construction of an internal dyke across the lake that created upper and lower storage areas. The upper portion of the lake became a surface tailings deposition area and has been the primary storage area since 1990. The lower portion of the lake has remained a subaqueous tailings storage cell and reservoir for water decanted from the upper area via a series of syphon and pipes. A large portion of the water in the WTDA is returned to the mill via an overland pump/piping system for reuse in the concentrator. Surplus water is released seasonally through a polishing/retention system.

A tailings reclamation test area (Test Cell) was constructed in the lower portion of the WTDA. The test cell is separated from the remainder of the lower storage facility by a second internal dyke. Test pads were constructed as a means of testing various reclamation measures. Thermocouples and frost gauges were installed within the tailings and the cover material to allow monitoring of ground freezing. The two WTDA internal dykes were constructed using frozen tailings core construction. The upper storage area dyke has been raised on an incremental basis since 1990 using upstream construction methods with tailings and shale country rock.

3.2 Land and Water Authorizations

CanZinco Ltd. currently holds three land leases that were issued under the Commissioner's Land Act and are subject to the Commissioner's Land Regulations. The lease requires that, upon termination of the lease, the leaseholder shall deliver the land in a restored condition as prescribed by the latest approved plan of restoration.

Water License NWB1NAN9702 was issued by the Nunavut Water Board in 1997 to CanZinco Ltd. The initially stated expiry date was July 2002. This expiry date was extended in December 2001 to correspond to the recently announced date of mine closure (September 2002).

Abandonment and restoration activities planned for the mine site will be regulated under this water license under Part H: Conditions Applying to Abandonment and Restoration. This section of the license contains eight conditions with various clauses that deal with any proposed reclamation activities for the Nanisivik Mine Site. These conditions are presented in Appendix B.

4 DATA REVIEW

The A & R plan is a good report that provides a sound overall blueprint for the proposed site reclamation activities. However, it must be noted that although the report addresses all of the mine site components requiring decommissioning and the components outlined in Part H, Condition 2, it is lacking specific details in regards to particular items of concern. For example, details such as the volume of waste rock; material to be deposited underground; volumes of buildings materials to be transported underground; site specific plans detailing the existing configuration of the pits and the proposed end configuration; plans depicting areas of existing surface hydrocarbon contamination and anticipated volumes of impacted soil. **There is a heavy reliance on use of the abandoned mine workings as a permanent disposal site for a wide variety of waste materials and equipment but no assurances are provided that sufficient storage volume is available or that a plan exists for segregation and systematic placement of the waste.**

The *Closure and Reclamation Plan* (CanZinco Ltd. 2002a) states that CanZinco Ltd. will reclaim the mine "to prevent progressive degradation and to enhance natural recovery in areas affected by mining". This statement implies that there should be an overall plan for the reclamation of the mine. Maps and drawings of specific engineered structures and their geographic location are provided throughout the documentation or have been supplied electronically but an adequate post-mining conceptual reclamation plan does not seem to be in place. A map and supporting text would be valuable reclamation planning tools as well as important visual aids for non-technical stakeholders.

These deficiencies or data gaps are acknowledged in the A & R plan where certain studies and plans are recommended by Gartner Lee Ltd. for implementation this summer. These studies will be required to provide a complete and thorough review of the reclamation program. EBA supports the recommendations contained within the A & R Plan outlining the required additional studies.

The following section deals with each of the work scope items outlined in Section 2.0, and represents a compilation of comments received from each of the team members. Where submissions were obtained from sub consultants their submissions are included in Appendix C.

4.1 Capping Of Tailings Disposal Areas And Associated Long Term Stability Issues

The tailings at Nanisivik have been deposited in the West Twin Lake area. The West Twin Lake area is divided into two areas by an 18 m high dyke. CanZinco proposes to cap the tailings on the upstream side of the dyke with a layer of shale and gravel cover of 1.25 m thickness to permit permafrost agradation and maintain the active layer (depth of season thaw penetration) within the cover. CanZinco proposes to cover the tailings downslope of the dyke with a one metre thick water cover.

The acid base accounting results and water quality results (sample location 159-1, tailings pump sample location) suggest the tailings are currently buffered, however they are considered potentially acid generating with very high sulfur contents. The pH has been maintained alkaline due to process waters and tailings disposal, however concentrations of those parameters reported (Cd, Pb and Zn) are high and consistently above the water quality standards outlined in the Water License which applies to the effluent from the tailings disposal area as marked by sample station 159-4 (see Figures 1 to 3 presented in following pages). While attenuation mechanisms and precipitation along the seepage flowpath may reduce the concentrations, Zn in particular may remain relatively mobile at near neutral pH conditions and pose water quality concerns associated with potential discharge from the tailings disposal facility after closure, regardless of whether or not acidic conditions prevail in the seepage quality. There was no discussion of metal leaching potential at near neutral conditions found in the documents reviewed. However, if the tailing pore waters freeze completely as is predicated by CanZinco and their consultants for the sub-aerial tailings, discharge of metal rich waters will likely be controlled by permafrost stability. Mitigation of the risk of discharge requires a clear understanding of the current and long-term permafrost conditions.

A thermal analysis has been carried out to evaluate the development of permafrost and the active layer in the tailings containment area. There is limited data on existing or initial ground temperatures of the tailings. There may be a talik in the “low” area of the tailings pond where water ponds. There is no discussion of how long this will take to freeze back or the effect of this on the active layer thickness and facility performance.

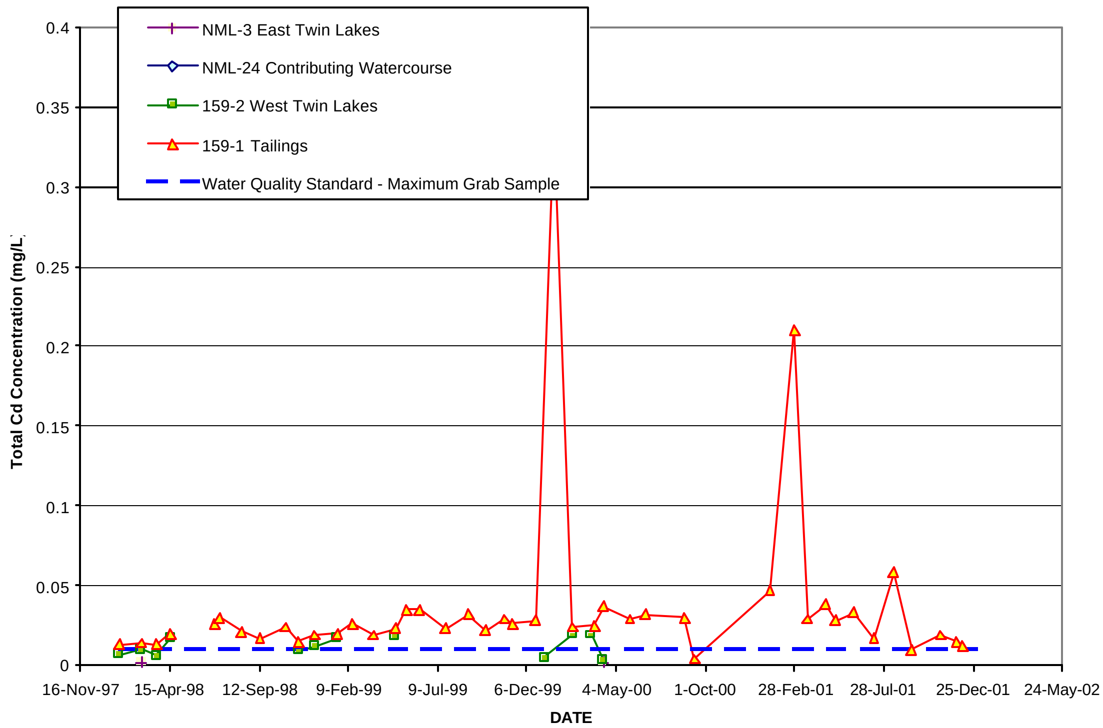

Figure 1: Total Cd Concentrations at Select Monitoring Locations

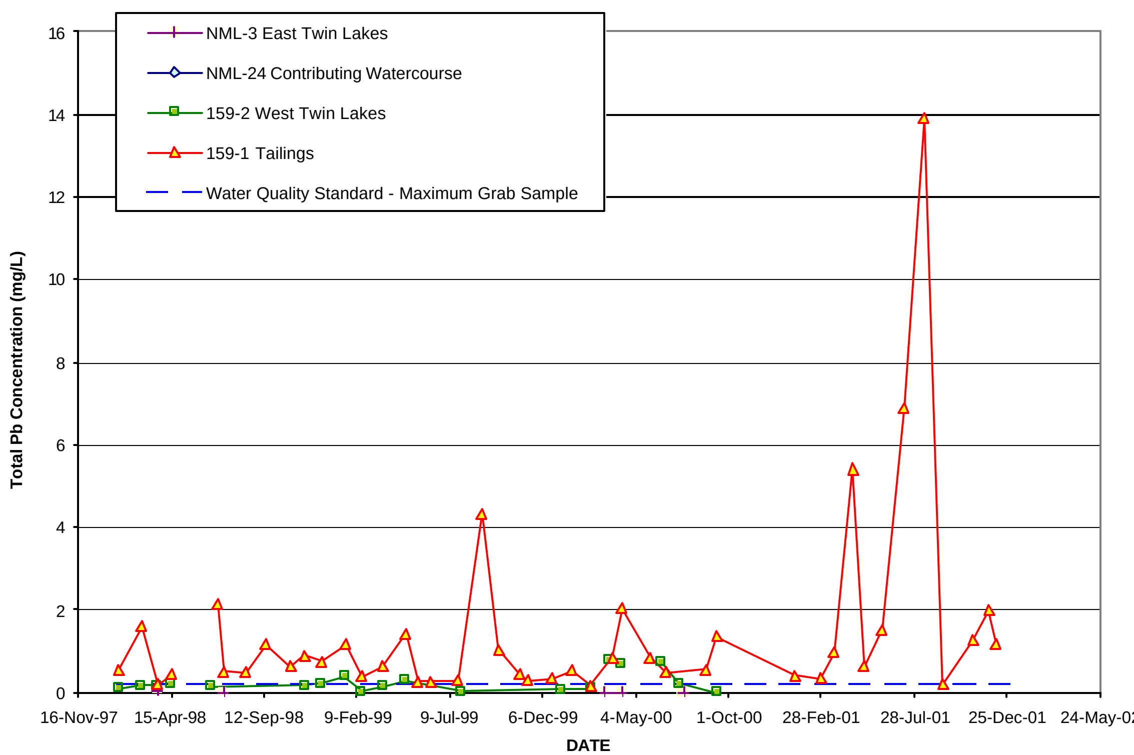

Figure 2: Total Pb Concentrations at Select Monitoring Locations

The thermal analysis has been calibrated to testpads constructed in the tailings facility. The testpads show a variation in active layer between 0.73 m and 1.59 m between 1995 and 1998. Active layers in the shale rock fill dyke in the center of the facility varies from 1.2 to 1.5 m. Deeper active layers are measured in Pads 3, 4 and 5 and closer to the water edge in Pad 1. It is stated that the deeper active layers are due to shoreline influences and due to flooding in the area. It is unknown if there has been any modeling to support this hypothesis, or if the deeper depths could be due to other effects (i.e. variability in the fill materials, annual climate variations). The thermal analysis calibration predicts a depth of 0.90 m in the shale under average climate conditions. This is less than many active layer observations on site. It is recommended that more detailed evaluation of the variations in the observed active layer depths be carried out to confirm the calibration analysis.

The thermal analysis estimates that the active layer is 0.89 m deep under mean conditions and 1.25 m under worst-case global warming conditions. There does not appear to be any safety factor in the design to account for active layer variations due to the probability of particularly warm years, surface properties variations or cover materials or tailings properties. The thermal analysis has been carried for mean climate conditions. It is recommended that an evaluation be carried out to determine the active layer during warm years (1:100 year – 1:1000 year). It also appears that the global warming analysis is based on mean climate conditions. There is no discussion of the active layer during warm years in combination global warming conditions or how the facility is expected to perform under these conditions. **The thermal analyses used, as a basis for the design of the cover thickness, with the objective of sustaining the permafrost, is in our opinion, not conservative and provides little leeway for naturally occurring variations.**

The cover soils proposed for the tailings are a shale with a sand and gravel cover. The shale is expected to be variable. A relatively high moisture content was assumed in the thermal analysis (20%). It is discussed that some of the shale may be blasted for the cover soil. It is expected that this shale will have a lower moisture content that will affect the active layer thickness. Parameters for the assumed unfrozen moisture content of the shale for the thermal analysis are provided. The assumed unfrozen moisture content is approximately 60% at –0.3ºC. The active layer thickness from the thermal analysis has been based on 0°C. It is not stated how deep the active layer would be if the active layer were based on a lower temperature. It is not stated if there have there been any measurements on the salinity or unfrozen moisture content of the shale?

There are two geochemical processes that may affect the development of permafrost in the tailings. The first is the effect of heat from the exothermic reaction of pyrite oxidation on the formation of permafrost. This issue was identified by Gartner Lee and proposed for assessment in the Phase 2 Environmental Site Assessment. It is recommended that this be evaluated relatively soon with the objective of determining the adequacy of cover depth.

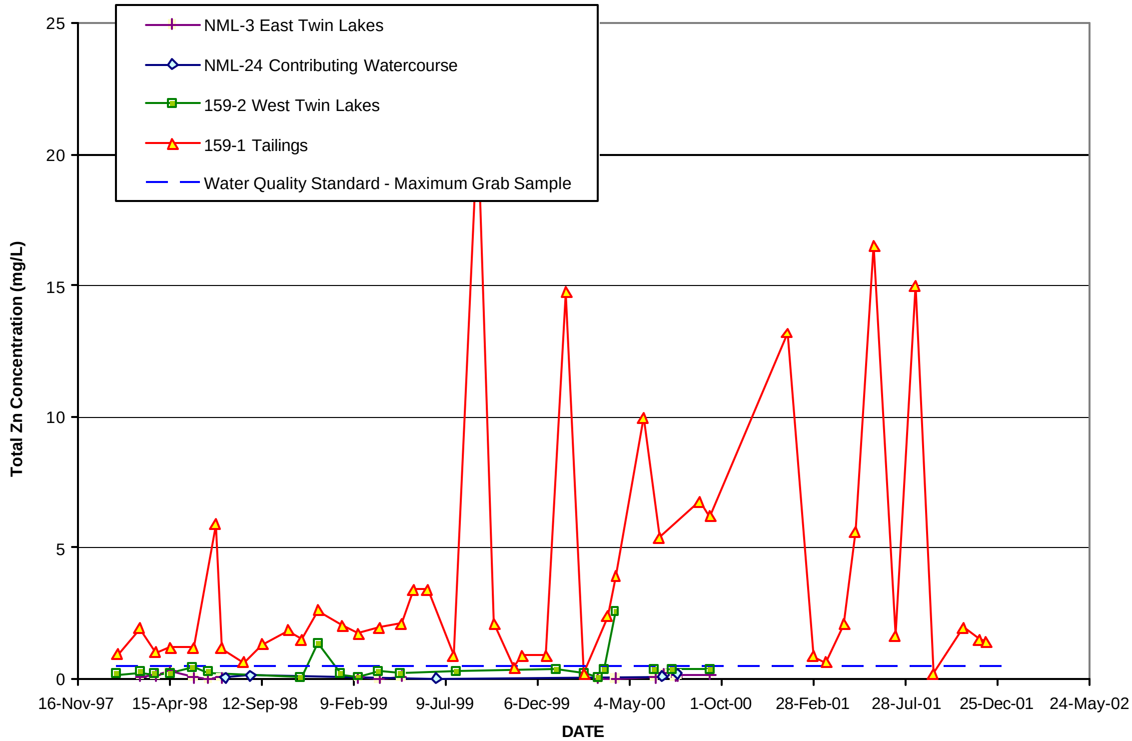

Figure 3. Total Zn Concentrations at Select Monitoring Locations

The second issue relates to the potential of freezing point depression in pore waters with elevated conductivities. The Nanasivik tailings consist of approximately 48% total sulphur, an extremely sulphur-rich material. While there was no information reviewed that related to pore water chemistry (such as kinetic tests, leach extraction tests, pore water sampling etc.), it would be expected that pore waters associated with such high sulphur tailings would have elevated conductivities. The tailings process waters, represented by sampling location 159-1 have electrical conductivities in the range of 5000 to 8000 µS/cm. If localized sulphide oxidation has time to occur within the upper layer of the tailings prior to freezing, these conductivity values could increase. There was reference to humidity cell testing, however there was no report provided for this review, therefore the site specific kinetics of sulphide oxidation, or the potential 'lag' period before sulphide oxidation becomes apparent has not been assessed as part of this review. A relationship is provided in the documents that present the assumed unfrozen moisture content of the tailings for the thermal analysis. It is not clear what data was used to develop this relationship or if any unfrozen moisture content testing of the tailings has been carried out. **This parameter and its relationship to pore water chemistry are critical to a clear understanding of the stability of the permafrost and its effectiveness as a principal component of the containment system.**

The geochemical characteristics of the shale identified as cover material indicate that the shale is acid consuming. It will not generate acid itself and does contain excess buffering capacity, however it should be noted that it will not be an effective buffering source for acid generating material underlying it, but will only provide neutralization for acidic waters in direct contact with the shale (i.e. seepage migrating through it) as the acidic solutions dissolve the carbonate buffering minerals. In this case, it would be anticipated that significant secondary mineral formation, such as gypsum ($CaSO_4.2H_2O$, a white 'salt'), would be evident due to anticipated high SO_4 in acidic waters and Ca from the shale itself. This mineral formation has been noted in the dyke shale during geotechnical inspections in a number of the documents reviewed, suggesting SO_4-rich seepage through the dyke is or has occurred. What effect would this have on the unfrozen moisture content of the shale cover?

The proposed final topography appears to concentrate flow along several north-south linear features. It is not stated whether there will be any special erosion measures along these features or at the outlet of the facility. Portions of the facility are very flat (< than 0.5%). Shallow water ponding should be expected in these areas. It is also not stated whether ponded water will affect the active layer.

The sub-aqueous tailings cell will rely on oxygen limitation for the reduction of sulphide oxidation in the submerged tailings. This type of ARD control is often used for sulphidic and uranium tailings in Canada. The water depth planned for the Nanisivik tailings cell is one metre. There have been significant studies completed and referenced in the literature on the 'appropriate' water cover depth and the potential for water quality degradation as a result of resuspension of tailings due to wind-induced wave action and/or long term drought effects. Resuspension of tailings under water cover could result in impacted water quality of the cover and downstream environment. While the appropriate water cover depth is a site specific parameter, a recent paper by Yanful et al. (2002) references minimum depths of 1.2 to 1.4 m for wind speeds on the order of 10 to 18 m/s, for numerous sites in order to minimize tailings resuspension. Their field measurements at the Heath Steele Mine indicated that resuspension and transportation of tailings within the pond occurred when the water cover was one metre deep or less. There was no reference found in the documents reviewed to studies at Nanisivik looking at either wind-induced wave effects or potential drought effects on the water cover and water quality. It is recommended that the minimum water cover of one metre be reconsidered; addressing issues related to resuspension of the tailings to provide assurance that sulphide oxidation of the underlying tailings will not occur.

4.2 The Disposal Of Sulphide-Bearing Rock And The Restoration Of Waste Rock Disposal Sites

Waste rock piles on the surface, are predominantly from earlier operations. Waste rock that is currently produced is used underground for pillar support and backfill. There are essentially three surface dumps, the West Adit Area, the East Adit Area and Area-14. It has been assumed that any waste rock at the Ocean View and K-Baseline zones are included in the general Area-14 description. It is our understanding that some, but not all of the surface waste rock will be placed underground. That material left on the surface will either be utilized as backfill in the open pits or remain in place with most areas, but not all, being covered.

Gartner Lee Ltd., proposed in the 2002 ESA to estimate the disposal volumes and schedules for waste rock to assess what is going to fit underground and what will stay above ground. We would suggest that the geochemistry of various piles be considered in the scheduling so that a 'mapping' of material characteristics can be created and priority can be given to placing the 'higher risk' material underground with respect to acid generation. It may be likely that additional sampling and testing may be needed to adequately 'map' the waste rock material for these purposes.

In addition, a QA/QC program for material left on surface is recommended. Ideally this program would be significantly conservative as we would expect that even in a net neutralizing waste dump, localized 'hot spots' where massive sulphide rock exists could develop. It is often seen in waste rock dumps that carbonate rocks will 'blind' over time with secondary mineral precipitates such as iron oxy-hydroxides becoming less effective at neutralization over time; whereas massive sulphide rocks will break apart with weathering providing greater surface area thereby increasing the rate of sulphide oxidation over time. The two processes together can result in acid generation in piles that had been characterized as net neutral.

These processes will be mitigated to a large extent if the waste rock is in a cold permafrost condition. It is not clear from the material reviewed however if the hydrologic regime of backfilled pits is such that some seepage, even seasonally, can be anticipated from these areas. Similarly, the waste rock covered in-place or those dumps that will not receive a cover may develop localized seeps. It is a possibility that some of these seeps would be acidic, or may be 'buffered' but still have elevated levels of certain metals, in particular Zn. The metal loading study indicated that these processes and seepage conditions currently exist in the dumps along Twin Lakes Creek. The information reviewed does not confidently indicate that these processes will not continue in some areas, at least on a local scale.

4.3 Filling And Capping Of Open Pits And Associated Long Term Stability Issues.

Little detail is provided in the documents as to how the open pits are to be closed. It is recommended that the following questions be addressed.

- What are the stability conditions of the pits walls?
- Has wall stability been evaluated?

These evaluations should address both the failure in rock and the overlying fill.

There were also no details provided as to how the waste rock and cover will be placed in the pits. The following questions should be addressed:

- What is the design of the waste rock and cover in the pit?
- Are there drainage courses or seeps into the pit?
- Will there be erosion of the cover soils?

It has been assumed that the sulphide-bearing pit walls will be covered with backfilled material so as to minimize the potential sulphide oxidation and acid generation from the exposed, in-situ pit wall rock. It was not clear how this would be performed or monitored. There has been no discussion of an evaluation program to identify sulphidic pit wall material, nor a discussion of the criteria to be utilized to ascertain 'sulphidic' from 'non-sulphidic' wall rock. It is recommended that a 'mapping and sampling program' for design and a QA/QC program during reclamation be completed to ensure that any potentially acid generating pit walls are not left exposed.

4.4 Disposal and Remediation Of The Municipal Infrastructure, Including Solid Waste Disposal Site.

There was little information in the documents about the condition of the landfill. There was reference to a 2001 Environmental Site Assessment Report of the Landfill contained within the A & R Plan. This document included documentation of waste streams, historical and current operating practices, estimation of waste volumes, collection of soil and water samples, and a proposed plan for reclamation of the landfill. Additionally there was a response letter prepared by the Nunavut Water Board regarding the landfill study. The assessment document was reviewed during the course of this technical evaluation, however the response comments to this study prepared by the NWB were not reviewed.

In general the 2001 ESA report provided a good starting point for further evaluation of the landfill. Some questions do remain with regards to the possible presence and location of former landfills. A more detailed breakdown of the waste stream, especially given historical dumping practices in the late 70's and early 80's, should be provided. It is unknown if there were other former locations for the incinerator, and if so has there been downwind sampling of the soil to determine particulate matter dispersion and the identification of potential impacts at the existing location and any other former location.

A 2002 assessment program is proposed which includes a sampling program of 10 testpits at the downslope of the landfill to collect soil samples. It is recommended that surface water samples and leachate samples (if present) also be collected. It is not possible to comment on the adequacy of this proposed program since no details on the size or characteristics of the landfill are provided within the A & R plan. The testing program for the samples is not specifically laid out for the landfill. Will the samples be sampled for hydrocarbons as well as metals? Are PCB's an issue at the site, and are there any samples planned for collection to determine if they are present?

Other landfill-related issues include the following:

- Is the extent of the landfill well defined?
- Is a geophysical program required to determine the landfill extent?
- Has the debris in the landfill been properly consolidated over the years or is further subsidence expected? and
- Are there plans for the sampling of the soil in the "boneyard area" given the historical fact that equipment in need of repair has been stored at that location?

Implementation of a gradiometer geophysical survey is recommended due to the concerns expressed by the Department of Sustainable Development dealing with a rumored volume of 2000 barrels of hydrocarbons buried at the landfill. This geophysical survey technique, which has been used extensively for defining landfill boundaries at the old DEW line sites, will have two objectives. It will improve knowledge of the extent of the landfill and the most probable location of any buried barrels. Following identification of the barrel disposal sites within the landfill, an assessment program utilizing an excavator or backhoe to determine the condition of the barrels and potential soil contamination levels is recommended. The use of a drill rig to assess the landfill is not recommended as the drill stem could potentially puncture the barrels.

CanZinco proposes to cover the landfill with 1.25 m of soil cover such that permafrost agrades into the landfill. It is assumed that this depth of cover is extrapolated from the thermal work of the tailings area; however the thermal behavior of the landfill cover will be different at the landfill than the tailings area. It is recommended that the landfill closure design be re-evalated after the environmental sampling is carried out.

A risk assessment incorporating the results of the thermal modeling and the results obtained from a geophysical and site exploration program at the landfill is suggested. The purpose of this assessment would be to determine the level of risk associated with the long term disposal and burial of hydrocarbon products and other potentially hazardous materials at the landfill. A decision to remove the barrels and other potentially hazardous waste that may be buried at the landfill or to leave all waste within the landfill for long term disposal can only be reasonably achieved after completion of this data collection program.

4.5 The Sealing of Portals.

It is understood that demolition waste, surplus equipment and waste rock will be placed underground along with existing underground infrastructure. It is stated that the portals will be plugged with waste rock. No details are provided to how much waste rock will be used for the plug or how it will be placed. A concrete seal in the massive dolostone along with a waste rock cover would provide a more secure plug. More information on the condition of the underground openings and an evaluation of their stability is needed to assess the merits of this proposed approach.

4.6 The Restoration Of Water Management Structures (Dams, Diversion Channels, Intake, Liming And Dump Ponds) And Associated Long Term Stability Issues.

Spillway

A channel is proposed from the surface impoundment area of the West Twin Disposal Area (WTDA) to the reservoir portion of the WTDA. The channel has a cut of up to 10 m deep and is approximately 600 m long. **This is a major structure to be excavated into permafrost soil and rock. Past experience has indicated that there is a stabilization period up to five years when maintenance is high and potential issues such as response to snow infilling are determined.** Limited geotechnical information is available along the channel alignment. Bruce Geotechnical Consultants (BGC), have recommended that geotechnical information be collected along the channel alignment. Without this information it is not possible to review design details along the channel such as erosion protection requirements or overburden cut slopes. No details on these issues **or recognition of the importance of minimizing maintenance** have been provided in the documents.

Dyke

The West Twin Dyke across the WTDA contains the tailings within the surface impoundment area. The stability of the dyke is presented in BGC 2000. The dyke has been constructed in an upstream manner using shale rockfill overlying tailings. The dyke is founded on tailings sand overlying lakebed sediments. The dyke is 18 m high with local slopes at 1.5H:1V and an overall slope of 3.7H:1V. Thermocouple data from the dyke indicates it is frozen with ground temperatures between –2 and –5 C in October.

BGC state that the moisture content of the tailings ranges from 15 to 20% and limited amounts of ice have been observed in the boreholes through the dyke. They have concluded that the permafrost tailings are sufficiently free of ground ice that creep of the frozen soil beneath the dyke is not an issue. They have carried out a stability analysis of the dyke using unfrozen strength parameters. This appears to be a reasonable assumption given the data presented. It is recommended that the dyke be monitored, using survey monuments, over a period of time to determine and substantiate the conclusion that creep of the dyke is not an issue.

BGC 2000 made recommendations for further work to confirm the assumptions made in the stability analysis. This includes tests to measure the friction angle of the tailings and shale. We concur with the need for this additional test data.

West Twin Reservoir Outlet

Water flow out of the WTDA reservoir is to be lowered to a level that will maintain a water cover on tailings in this area. No details are presented as to how this outlet will be constructed to ensure long term performance.