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Nanisivik Mine Technical Advisory Panel (TAP)

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Stephen Harbicht	Environment Canada, Yellowknife
Anne Wilson	Environment Canada, Yellowknife

February 9, 2004

Please find enclosed the report submitted by Canzinco Ltd. entitled 'Canzinco Limited Nanisivik Mine Metal Mining EEM Study Design'. Please send me your review comments for compilation by April 2, 2004. If this timeline presents a problem, please contact me at (780) 951-8754.

Thank-you,

Jenny Ferone, M.Sc
Regional Environmental Effects Monitoring Coordinator

cc Peter Blackall, Regional Authorization Officer
Sandra Blenkinsopp, Senior Regional EEM Coordinator.

CANZINCO LIMITED
NANISIVIK MINE
METAL MINING
EEM STUDY DESIGN

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PROJECT NO. NBF15058

REPORT TO

CANZINCO LIMITED
TORONTO, ONTARIO

ON

NANISIVIK MINE
METAL MINING ENVIRONMENTAL EFFECTS MONITORING STUDY DESIGN
NANISIVIK, NUNAVUT

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January 27, 2004

EXECUTIVE SUMMARY

Jacques Whitford Environment Limited (JWEL), on behalf of Nanisivik Mine, has prepared this Metal Mining Environmental Effects Monitoring (EEM) Study Design document. In accordance with the *Fisheries Act*, all mines regulated under the *Metal Mining Effluent Regulations* (*MMER*) are required to conduct periodic EEM studies as part of their authority to deposit effluent. The Nanisivik Mine, located near the shore of Strathcona Sound, in the northern part of Baffin Island, Nunavut, operated an underground mine facility and shipped zinc/lead concentrates between 1976 and 2002. The mine ceased production in September, 2002, and Environment Canada received notification of the mine's intent to achieve Recognized Closed Mine status on July 30, 2003. Therefore, the Mine is subject to Part 4 of the *MMER*, which deals specifically with closed mines. As described in Part 4 of the *MMER*, the mine is required to conduct a Final Monitoring study within a three year period following the receipt of that notification by Environment Canada, in accordance with Division 3 of Part 2 of Schedule 5 of the *MMER*.

For Nansivik Mine, there are two potential effluent discharge points that could potentially be subject to the *MMER*. These include: the West Twin Disposal Area (WTDA) from which effluent is discharged into Twin Lakes Creek; and the East Adit Treatment Facility, from which effluent was formerly discharged into an unnamed creek. Due to mine closure and reclamation activities, there was no discharge of mine effluent from the East Adit Treatment Facility during 2002 or 2003, and is it not expected that there will be any effluent discharge from this area in future. As such, the EEM will focus on the effluent discharged from the WTDA, although a contingency plan has been prepared for effluent and water quality monitoring at the East Adit Treatment Facility, in the event that effluent discharge is resumed in 2004, 2005 or 2006.

Site specific and confounding factors that have been taken into account in the development of this EEM study include the following:

- Twin Lakes Creek is a naturally fishless system throughout its length. The creek has a high gradient, with several significant waterfalls and cascades. Being located in the high Arctic, the creek freezes completely in winter, and experiences a major period of spate in the spring.
- The mine effluent is discharged only during the summer months, normally during June, July and August.
- Twin Lakes Creek intersects a natural sulfide outcrop, which leads to high loadings of metals, including zinc, lead and cadmium, to the lower part of the creek.
- Municipal effluent from the townsite enters the creek near the former Mill site, and this introduces nutrients and organic carbon to the creek.

The EEM program required by the *MMER* consists of four major components:

- a fish study;
- a benthic invertebrate community survey;
- effluent and water quality monitoring; and
- sublethal toxicity testing.

A Fish Study is proposed to be carried out in the marine waters of Strathcona Sound, with the Exposure Area at the mouth of Twin Lakes Creek and the Reference Area at the mouth of the Strathcona River. A single fish species, shorthorn sculpin will be collected, with 20 adult male and 20 adult females to be collected at both exposure and reference areas. This study will be carried out during the summer of 2004. The full rationale and study design for this component is provided in Section 3 of this document.

A Benthic Invertebrate Community Survey will be carried out in Twin Lakes Creek, proximal to the point of effluent discharge. The study will have an upstream Reference Area, and three downstream Exposure Areas, with differing levels of exposure to the effluent. Five replicate stations will be sampled within each Area. The sample from each replicate station will be a composite of three field subsamples. Effluent exposure will be determined in the field using specific conductance. Samples will be taken using a U-net with 0.25 mm mesh size. The full rationale and study design for this component is provided in Section 4 of this document.

Effluent Monitoring will be carried out on a monthly basis while effluent is being discharged (normally effluent discharge is limited to the months of June, July and August). Samples will be analyzed for a suite of required and recommended parameters. Water Quality Monitoring will be carried out concurrently with Effluent Monitoring, at upstream and downstream stations in Twin Lakes Creek. Samples will be analyzed for the same suite of required and recommended parameters, with dissolved oxygen and temperature being added. Water sampling for the same suite of parameters will also be performed on a one time basis in the Exposure and Reference Areas for the Fish Study and the Benthic Invertebrate Community Survey, concurrently with those studies, to provide supporting environmental information. The full rationale and study design for Effluent and Water Quality Monitoring components of the EEM Study are provided in Section 5 of this document.

Sublethal toxicity testing will be carried out twice each year (to correspond with the periods of effluent discharge). The testing suite will include rainbow trout survival and early development test, *Ceriodaphnia dubia* reproduction and survival test, macrophyte growth inhibition test using *Lemna minor*, and algal growth inhibition test using *Selenastrum capricornutum*. Sampling dates for sublethal toxicity testing will correspond with Effluent Monitoring dates. The full rationale and study design for this component are provided in Section 6 of this document.

Based upon the mine having notified Environment Canada of their intent to seek Recognized Closed Mine Status effective July 30, 2003, this Study Design is required to be submitted to Environment Canada no later than January 30, 2004. Subject to approval of the Study Design by the Authorizing Officer, it is proposed to conduct the Fish Study and Benthic Invertebrate Community Survey during late July or early August, 2004. Reports on Effluent and Water Quality monitoring, and sublethal toxicity testing, must be submitted to Environment Canada no later than March 31 each year, for the preceding calendar year. The Final Interpretive Report for this EEM study must be submitted to Environment Canada no later than July 30, 2006.

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1.0 INTRODUCTION

In accordance with the Fisheries Act, all mines in Canada regulated under the *Metal Mining Effluent Regulations* (*MMER*) are required to conduct periodic Environmental Effects Monitoring (EEM) studies as part of their authority to deposit effluent.

As a depositor of mine effluent, the Nanisivik Mine requires an EEM study to be conducted. The Nanisivik Mine is located in Nunavut on the Borden Peninsula, part of northern Baffin Island. Specifically, the mine is located on the southern shore of Strathcona Sound, approximately 33 kilometers by road from the nearest settlement, the Hamlet of Arctic Bay. The mine is located 750 kilometres north of the Arctic Circle at an approximate latitude of 73 degrees north (Figure 1.1). The Nanisivik Mine facilities, which are presently undergoing decommissioning, consisted of an underground mine and a 2,200 tonne per day concentrator using conventional crushing, rod and ball mill grinding, differential lead and zinc flotation, and concentrate drying. Ore concentrates were formerly shipped from a concentrate storage shed located adjacent to Strathcona Sound, where a deepwater wharf allows ocean-going vessels to moor. Concentrates were transferred to ships using a ship-loader. Process tailings were transported to and deposited at the West Twin Disposal Area (WTDA), and resulting effluent is discharged into Twin Lakes Creek. The mine was in full operation from its opening in 1976 until closure in September, 2002. Reclamation activities started in 2002. On July 30, 2003, Environment Canada officially received notification of the mine's intent to achieve recognized closed mine status.

The objective of this document is to outline and present a Study Design for EEM at the Nanisivik Mine, as required by the *MMER*. This Introduction includes a brief description of the regulatory basis under which the mine has operated, and under which the EEM study will be carried out, as well as an outline of the further contents of this document. Subsequent sections of the document will be as follows:

- Chapter 2 Site Characterization Information, including descriptions of the mine production processes, effluent mixing zones, and locations of exposure and reference areas.
- Chapter 3 Describes the Fish study (including supporting environmental measurements) proposed for the Nanisivik Mine
- Chapter 4 Describes the Benthic Invertebrate Survey (including supporting environmental measurements) proposed for the Nanisivik Mine
- Chapter 5 Describes the Effluent and Water Quality Monitoring program proposed for the Nanisivik Mine.
- Chapter 6 Describes the program of Sublethal Toxicity Testing proposed for the Nanisivik Mine.

- Chapter 7 Provides a Summary of the document, including a timetable for the implementation of the various studies.
- Chapter 8 Provides References and other cited material.

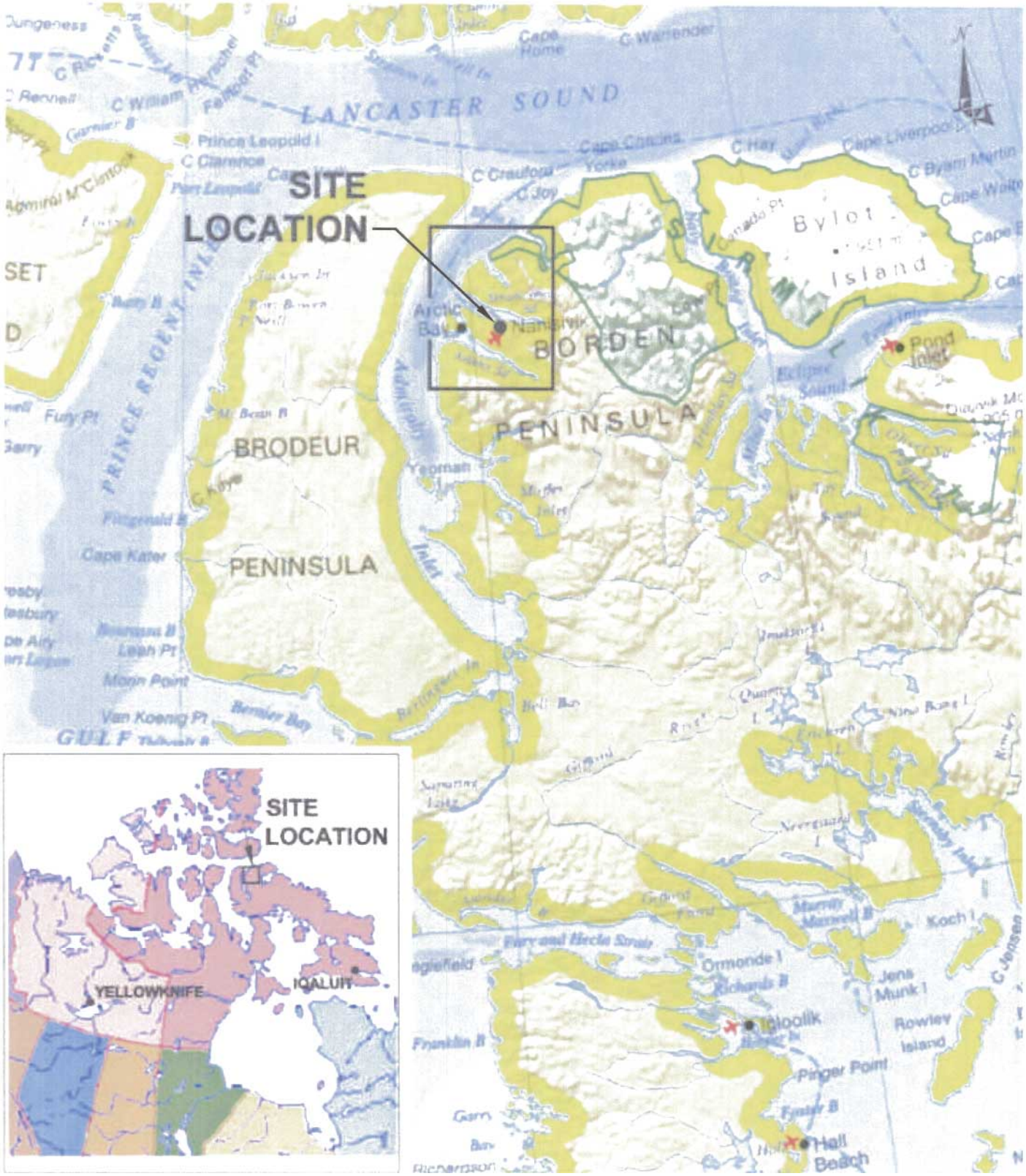
The internal structure of Chapters 3, 4, 5 and 6 has been made as consistent as possible, in order to facilitate the review process and to ensure that all of the required and requested information is presented in an orderly and easily understood manner. This generalized structure is based on the following general Subsections within each Chapter:

- Goals and Objectives of this EEM Component Study;
- Past Monitoring Results and Conclusions;
- Rationale, Hypotheses, Confounding Factors;
- EEM Component Study Design
- EEM Component Study Data Analysis and Interpretation.
- Quality Assurance and Quality Control

As described in the Metal Mining EEM Guidance Document (Environment Canada 2002), and in Schedule 5, Section 10 of the *MMER*, the Study Design is expected to provide certain information. The information requirements, and a guide to where in the present document the information can be found, are summarized in Table 1.1, below.

Prior to the submission of this study design, the Nanisivik Mine and its consultant, Jacques Whitford Environment Limited (JWEL), engaged in discussion with the Technical Advisory Panel (TAP). The purpose of those discussions was to consult with the TAP, to explore, the unique characteristics of the Nanisivik Mine, and to reach a consensus in advance regarding how the requirements of the *MMER* can best be implemented at Nanisivik. This Study Design, prepared by JWEL, reflects those discussions, and the consensus achieved.

FILE: SITE



SITE LOCATION MAP NANISIVIK MINE BAFFIN ISLAND, NUNAVUT	Date: 2003 01 28	Scale: NTS	Jacques Whitford Consulting Engineers Environmental Scientists
	Job No.: 15058	Fig. No.: 1.1	

Table 1.1 Correspondence Between EEM Study Design Information Requirements and the Structure of This Document

Study Design Information Requirement (from Schedule 5, Section 10)	Location of the Information in the Present Document
A detailed timetable for conducting each of the biological monitoring study requirements.	See Chapter 7.
A description of site characterization information.	See Chapter 2.
A description of how the fish study will be conducted in order to determine if there are effects on fish population and fish usability (tissue analysis).	See Chapter 3.
A description of how the benthic invertebrate community survey will be conducted in order to determine if there are effects on fish habitat.	See Chapter 4.
Identification of the quality assurance and quality control measures that will be taken to ensure the validity of the data.	See the relevant sections of Chapters 3 and 4.
A summary of any previous biological monitoring conducted for EEM.	See the relevant sections of Chapters 3 and 4.
Other Recommended Details of the Study Design	
The goals and expectations of the EEM Study.	See Section 1.3 of this introductory Chapter, as well as the relevant sections of Chapters 3, 4, 5 and 6.
The overall approach, including rationale based on site characterization information and previous monitoring results.	See Chapter 2, as well as the relevant sections of Chapters 3 and 4.
Statistical design, development of hypotheses, selection of statistical methods, determination of sample size (statistical significance and power analysis).	See the relevant sections of Chapters 3, 4, 5 and 6.
The design of the monitoring study, taking into account confounding factors (if any), where to sample, what to measure, how frequently to sample.	See Chapter 2, as well as the relevant sections of Chapters 3, 4 and 5.
Operating plans and procedures, sampling procedures, laboratory analysis procedures, quality assurance and quality control procedures, data storage and retrieval, data analysis.	JWEL Standard Operating Procedures for this project are proprietary documents, but will be made available upon request for inspection by Environment Canada.
A plan for data interpretation and evaluation.	See the relevant sections of Chapters 3, 4, 5 and 6.

1.1 Regulatory Basis of Nanisivik Mine

The Nanisivik Mine is subject to all of the laws and statutes of Canada, and Nunavut. However, those that are of special relevance to the operation of the mine are outlined below.

1.1.1 Fisheries Act

The *Fisheries Act* is one of the major federal *Acts* dealing with the environment, and in particular with fish habitat. The *Fisheries Act* enables a number of *Regulations*, and these include the *MMER*. The *MMER* provides the regulatory basis under which mines are permitted to discharge liquid effluent to the environment. Within the *MMER* are specific discharge limits or concentrations that shall not be exceeded in mine effluent waters that are discharged to fish habitat or waters that drain to fish habitat.

All mines regulated under the *MMER*, as part of the federal Fisheries Act, are required to conduct periodic EEM studies as part of their authority to deposit effluent. Section 7 of the *MMER* obliges the mine to conduct EEM studies, submit reports within prescribed timelines, and use standards of good scientific practice to conduct studies and interpret results. Specifically, Section 7 states:

(1) The owner or operator of a mine shall conduct environmental effects monitoring studies of the potential effects of effluent on the fish population, on fish tissue and on the benthic invertebrate community in accordance with the requirements and within the periods set out in Schedule 5.
(2) The owner or operator shall record the results of the studies and submit the reports and required information to the authorization officer as set out in Schedule 5.
(3) The studies shall be performed and their results interpreted and reported on in accordance with generally accepted standards of good scientific practice at the time that the studies are performed

Nanisivik Mine provided notification of their intent to achieve recognized closed mine status to the Regional Director, Prairie and Northern Region, and this was received by Environment Canada, on July 30, 2003. This notification results in the mine becoming subject to Part 4 of the *MMER*, dealing with Recognized Closed Mines. As described in Part 4 of the *MMER*, the mine is required to conduct a biological study during a three year period following the receipt of this notification by Environment Canada, in accordance with Division 3 of Part 2 of Schedule 5 of the *MMER*.

Schedule 5 also describes the required studies that make up an EEM program under the *MMER*. These include:

- Effluent Characterization;
- Sublethal Toxicity Testing;
- Water Quality Monitoring; and
- Biological Studies.

1.1.2 Other Relevant Federal Laws

The Nanisivik Mine occupies land leased from the Government of Canada under the *Territorial Lands Act* and the *Territorial Lands Regulations*.

Mineral title to the Nanisivik Mine is held under mineral leases. Mineral leases were issued for 21-year periods, with rights of renewal. The leases have historically been renewed as required, with the next renewal date being 2009.

In addition to the mineral title requirements, surface title is also required for certain operations. The Federal Government controls all of the surface title in the Nanisivik Mine area. However, at mine start-up, the surface rights to one block, called the Block Transfer, were transferred to the Government of the Northwest Territories (and subsequently to the Government of Nunavut).

Mine operating and other activities at the Nanisivik Mine are subject to an agreement signed June 18, 1974 (the "Master Agreement") between Nanisivik Mines Ltd. (as assignee of Mineral Resources International Limited) and the Department of Indian Affairs and Northern Development ("DIAND"), which provided for the development and operation of the Nanisivik Mine. Based upon the original mineral reserves and initial design capacity of the mine and mill, a mine life of 12 years was contemplated.

A portion of the dock area occupies a surface lease administered by the Department of Fisheries and Oceans ("DFO").

1.1.3 Provincial/Territorial Acts and Statutes

Operations at the Nanisivik Mine are governed by a water license. The Northwest Territories Water Board under the Northwest Territories Waters Act granted the original water license. The Nunavut Water Board assumed the responsibility for current water licenses in 1996 under the mandate of the Nunavut Land Claims Agreement Act.

The final "operating" water license (Water License NWB1NAN9702) came into effect July 1, 1997 and had an initial expiry date of June 30, 2002. The expiry date was extended to September 30, 2002 following CanZinco's announcement that mine closure was scheduled for September 2002. The

extension of the term of the License also stipulated that a Closure and Reclamation Plan be filed with the Nunavut Water Board by February 28, 2002.

The current water license (Water License NWB1NAN0208) came into effect October 1, 2002 and has an expiry date of May 1, 2008. This water license is focussed on mine closure and does not allow any commercial production from the mine.

1.2 Goals and Expectations of the EEM Study

The objective of metal mining EEM is to evaluate the effects of mine effluent on fish, fish habitat, and the use of fisheries resources. This information may be used by Environment Canada to assess the adequacy of the overall *MMER* as it applies more generally to mines in Canada.

The required EEM program will consist of two general components, namely ***biological monitoring studies*** (fish study and benthic invertebrate community survey), and ***effluent and water quality monitoring studies*** (effluent characterization, water quality monitoring, and sublethal toxicity testing).

For the purposes of the EEM program, an ***effect*** is defined as follows:

- an effect on the fish population means a statistical difference between fish population measurements taken in an exposure and a reference area;
- an effect on fish tissue means measurements of total mercury in fish tissue taken from the exposure area that exceed 0.45 µg/g wet weight and that are statistically different from measurements of total mercury taken in a reference area;
- an effect on the benthic invertebrate community means a statistical difference between benthic invertebrate community measurements taken in an exposure area and a reference area.

The guiding principles of the metal mining EEM program are that the program be scientifically defensible, cost effective, and provide flexibility for site-specific requirements, without subjecting field crews to unsafe sampling conditions.

The metal mining EEM program normally follows a tiered approach where results from previous biological monitoring studies are evaluated to trigger the next tier or division of monitoring studies, in accordance with a pre-defined monitoring frequency. Three divisions of biological monitoring studies are identified in Schedule 5 of the *MMER*. These include:

- First Biological Monitoring studies;
- Subsequent Biological Monitoring studies; and
- Final Biological Monitoring study prior to closing mine.

Since the Nanisivik mine has provided to the authorization officer an application for recognized closed mine status under Subsection 32(1) of the *MMER*, the mine is subject only to the Final Biological Monitoring study provisions of Schedule 5 of the *MMER*.

The Final Study Design (*i.e.*, this document) is required to include:

- site characterization information as outlined in Section 11 of Schedule 5;
- a description of how the fish population study will be conducted, if the effluent concentration in the exposure area is greater than 1% in the area located within 250 m of a final discharge point;
- a description of how the fish tissue study will be conducted, if the total mercury concentration in the final effluent is equal to or greater than 0.1 µg/L;
- a description of how the benthic invertebrate community study will be conducted;
- the dates and times that samples will be collected for the biological monitoring;
- a description of the quality assurance and quality control measures that will be implemented to ensure the validity of the data; and
- a summary of the results of any previous biological monitoring studies that were conducted after June 6, 2002 (the date of registration of the *MMER*) respecting the fish population, fish tissue, and the benthic invertebrate community.

2.0 SITE CHARACTERIZATION INFORMATION

Much of the following Site Characterization information is taken directly from a Phase II Environmental Site Assessment document, recently prepared for the Nanisivik Mine in support of the mine decommissioning process, by Gartner Lee Limited (GLL, 2002). JWEL is pleased to acknowledge the generosity of Mr. Eric Denholm of Gartner Lee Limited, in making an electronic copy of that document available for our use.

2.1 General Site Description and Mine Production Processes

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 (Figure 1.1). The mine site is on the south side of Strathcona Sound approximately 30 km from the inlet to the Sound. The community of Arctic Bay is located approximately 25 km to the west of Nanisivik. The two communities are linked by a 33 km all-weather road.

A concentrate storage shed, ship loading facility, dock, fuel tank farm and reagent storage area are located near the mouth of Twin Lakes Creek at Strathcona Sound. The Canadian Coast Guard uses the dock as a storage facility for marine environmental emergency response equipment and also as a fueling station. The land rises steeply away from the sound, and the local height of land is a peak known locally as Mt. Fuji, with an elevation of approximately 650 m, located approximately 6 km south of Strathcona Sound. The mill and mine are located approximately 3 km south of Strathcona Sound. The town is located at an elevation of 325 m, approximately 4 km from the Sound, and the tailings disposal facility is located at an elevation of 375 m, approximately 7 km from the Sound. All of these facilities are located within the general watershed of Twin Lakes Creek.

Most mine employees lived in the town of Nanisivik, built approximately 1 km south of, and uphill from the mine/mill area, specifically to house mine workers. The town included 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 and the Government of Nunavut currently owns some of the town facilities. Some employees commuted from the community of Arctic Bay.

The mine was primarily an underground operation (primary workings plus 3 satellite areas) with smaller contributions of ore from four open pits. The primary underground workings extend in an approximate east-west alignment (approximately 3 km long × 100 metres wide × 10 metres thick) and daylight on either side of a topographic ridge as indicated on Figure 2.1. Vehicle access into the underground mine is via several adits that allow passage of both heavy and light equipment.