Bruce J. Donald
Reclamation Manager

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June 27, 2003

Chief Administrative Officer
Nunavut Water Board
P. O. Box 119
Gjoa Haven, NU X0B 1J0

RE: Polaris Mine Water Licence NWB1POL0311 – Biologic Monitoring Study Plans

As required under Part H, Section 41 of the Water Licence, please find attached two paper copies of the study proposals prepared for Environment Canada titled 'Environmental Effects Monitoring (EEM) Study Design, Teck Cominco Polaris Mine, Nunavut'. We have already submitted copies of this study design to Environment Canada as required under the Metal Mining Effluent Regulations and are also forwarding a copy to the Department of Fisheries and Oceans as agreed in our discussions with them. The report has the word 'draft' on the cover. This is the final report but it has a couple of minor typographical errors due to the rush to issue them.

A separate document containing the information required under Part H, Section 42 will be forwarded early next week. An electronic copy of the documents required under Sections 41 and 42 will be forwarded at the same time.

If you have any questions, please don't hesitate to contact me.

Sincerely;

Bruce Donald
Reclamation Manager

Enclosure

cc: John Knapp, Manager, Polaris Operations
Randy Baker, Azimuth Consultants

Teck Cominco Ltd. / Environment and Corporate Affairs
Bag 2000/Kimberley, British Columbia, Canada V1A 3E1 · Tel: 250-427-8405 · Fax: 250-427-8451 · Email: bruce.donald@teckcominco.com

DRAFT
June 2003
Project No. TC-03-03

teckcominco

Environmental Effects Monitoring (EEM) Study Design
Teck Cominco Polaris Mine, Nunavut

Prepared for:

Environment Canada
Prairie and Northern Region
Rm 200 4999 - 49th Ave.
Edmonton, Alberta T6B 2X3

Prepared by:

AZIMUTH
Azimuth Consulting Group Inc.
218-2902 West Broadway Vancouver,BC V6K 2G8
Tel: 604-730-1220 • Fax: 604-739-8511

teckcominco

June 11, 2003

Environment Canada
Prairie and Northern Region
Rm 200 4999 – 49th Ave.
Edmonton Alta T6B 2X3

Dear Mr. Blackall:

Re: Polaris Mine EEM Study Design

We are pleased to provide your office with 10 copies of the draft document entitled "Environmental Effects Monitoring (EEM) Study Design Teck Cominco Polaris Mine, Nunavut" for your review. This document addresses all of the major study design requirements as per the EEM guidelines.

The unique effluent discharge and receiving environment conditions at Polaris pose a number of challenges regarding logistics, target species, sampling methodology and strategy that have affected the study design for this mine. We have integrated the available historic, empirical data and published literature related to the mine site to design a study that will accomplish the major objectives of the EEM Program, while also recognizing the unique challenges of working at Polaris.

Acknowledging these challenges, the Environment Canada TAP agreed to convene a meeting in Edmonton on April 8, 2003 to attempt to resolve several issues regarding interpretation of the guidelines as they affect the study design. It was agreed that an iterative approach to the study design would be taken, based on the outcome of field reconnaissance studies to be undertaken in August 2003. For this reason, we are submitting a draft design that will be finalized in fall 2003 pending the outcome of reconnaissance study and further discussions with the TAP.

The intent of the reconnaissance study is to answer a number of specific questions regarding receiving effluent characteristics and environment conditions in Garrow Bay. These include, but are not necessarily limited to the following:

- What is the spatial extent of bottom type? (is the bottom hard and ice scoured for several hundred meters offshore of Garrow Creek?)
- What is the theoretical extent of the plume entering Garrow Bay?
- At what distance offshore of Garrow Creek is zinc concentration diluted to 1% or less of effluent zinc concentration?
- Can bottom sediments be acquired with a grab sampler and if so, where is the nearest location this can be accomplished relative to the creek mouth?
- Does this location overlap with the plume?
- Can benthic infauna be collected with a grab sampler?
- Are sculpins present in Garrow Bay and can they be captured?
- What is the distribution of softshell clams in Garrow Bay, relative to Garrow Creek?
- What are the metal and mercury concentrations in effluent?

To develop a scientifically defensible, yet realistic study design for the Polaris Mine, further information on effluent characteristics and the receiving environment in Garrow Bay is needed. For this reason, this draft study design includes a thorough site characterization and targets the required elements of biological monitoring studies under EEM (e.g., sampling areas, sample size, design and analysis), but also proposes alternative methods in the event that primary tools are ineffective, or if target organisms are absent or not in contact with the effluent.

Results of 2003 field studies and plume modeling will be presented to and discussed with Environment Canada to tailor 2004 EEM field studies in order to revise and finalize the study design, prior to December 6, 2003. Field studies will be undertaken at Polaris in 2004 that best recognize the intent of the guiding principles of EEM, that the program be scientifically defensible, cost-effective and provides flexibility for site-specific requirements, without subjecting field crews to unsafe sampling conditions.

Field studies in 2003 are scheduled to take place between August 3 and 13 inclusive. It would be beneficial if one of your staff could join us on site at this time. Note too, that we will be conducting work on behalf of DFO in Garrow Lake and Garrow Bay, that will also satisfy some of the objectives of EEM and we are attempting to harmonize the requirements of both federal departments.

Please do not hesitate to contact Patrick Allard or Randy Baker of Aziumth Consulting Group if you require any further information (phone: 604-730-1220, fax: 604-739-8511).

Sincerely,
Teck Cominco Ltd.

Bruce Donald
Reclamation Manager
Environment & Corporate Affairs

cc John Knapp, Manager, Polaris Operations
Randy Baker, Azimuth Consulting Group

Teck Cominco Ltd. / Environment and Corporate Affairs
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Draft

teckcominco

Environmental Effects Monitoring (EEM) Study Design – Teck Cominco Polaris Mine, Nunavut

Prepared for

Environment Canada
Prairie and Northern Region
Rm 200 4999 – 49th Ave.
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June 2003

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Project No. TC-03-03

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Appendix A – Polaris EEM Exposure Area for Biological Sampling. Email correspondence from Environment Canada to Azimuth Consulting Group Inc. (dated May 24, 2003).

Appendix B – EEM Study Design Meeting Polaris Mine (Teck Cominco Ltd.) and TAP – Meeting Minutes. April 8, 2003. Edmonton, AB.

Appendix C – Effluent and Water Quality Monitoring. Letter from Environment Canada to Teck Cominco Ltd (dated May 23, 2003).

Appendix D – DRAFT DFO Fish Habitat Authorization Permit.

Appendix E – ALS Environmental Quality Management Program.

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1. INTRODUCTION

1.1. Background

Teck Cominco Ltd.'s Polaris Mine is located on Little Cornwallis Island in the Canadian high Arctic, Nunavut. Situated at about latitude 75°N and longitude 97°W, Polaris is approximately 100 km northwest of Resolute Bay and is the world's most northerly metal mine (Figure 1-1). Underground zinc-lead mining operations, which initially began in the early 1980s, permanently ceased on September 3, 2002 with the final shipment of concentrate, via an ocean going bulk carrier, taking place later that same month. The Polaris Mine is currently going through a two-year reclamation and decommissioning phase that is expected to conclude in fall 2004.

Tailings from the Polaris Mine have historically been deposited into nearby Garrow Lake, which is recognized under the Metal Mining Regulations (MMER) as a Tailings Impoundment Area. Garrow Lake is permanently thermally and chemically stratified (i.e., meromictic) and, in the nearly 3,000 years since its separation from adjacent marine waters, the annual freeze-thaw cycle at the lake's surface has transferred and concentrated salt in the deeper parts of the lake. The strong density difference between the bottom and surface layers has generally prevented the upward movement of metals associated with the tailings deposited on the bottom. Discharge from Garrow Lake occurs only during summer/fall (i.e., approximately third week of July to mid September; 1994 - present) when brackish water from the surface layer of the lake is siphoned over the top of a dam (installed in 1990), enters Garrow Creek and, approximately 700 m downstream, drains into the marine foreshore of Garrow Bay (Figure 1-1). During the remainder of the year, the lake and/or the discharge lines are frozen so, no discharge occurs.

Pursuant to the recently enacted MMER, Teck Cominco intends to complete a series of environmental investigations on behalf of Environment Canada aimed at characterizing and monitoring effluent discharge from the Polaris Mine as well as evaluating the spatial extent and magnitude of any effects to fish, fish habitat, and fisheries resources. These studies will be carried out until the mine has received Recognized Closed Mine Status under the MMER, which is 36 months after providing the written notification of closure (dated December 16, 2002).

Azimuth Consulting Group Inc. (Azimuth) was retained by Teck Cominco to assist in implementation of MMER-related investigations at Polaris. Azimuth is also conducting concurrent studies at the site, in Garrow Lake and Garrow Bay, to fulfill obligations under a Department of Fisheries and Oceans (DFO) Habitat Authorization Permit.

1.2. Objectives

In addition to conducting routine chemical analyses and acute toxicity testing of a mine's effluent, one of the key requirements of the MMER is to undertake an environmental effects monitoring (EEM) program comprised of the following two components:

- Biological monitoring studies, including a fish survey (using indicators of fish population health and fish tissue analysis) and a benthic invertebrate community survey.
- Effluent and water quality monitoring studies intended to provide background, supporting information for the assessment and interpretation of biological monitoring. These studies include effluent characterization, water quality monitoring and sublethal effluent testing.

According to Environment Canada (2002), there are four key EEM activities:

- Submission of the study design for biological monitoring.
- Conducting biological monitoring studies in the field.
- Data assessment and interpretation, including submission of the interpretative report.
- Effluent and water quality monitoring and reporting.

The purpose of this document is to address the first EEM activity by developing a study design that focuses on biological monitoring studies and also includes relevant supporting environmental variables (i.e., water and sediment quality data collected concurrently with biological monitoring studies). Specifically, the intent of the document is to meet the objectives of the EEM program while at the same time recognizing the unique features of the mine's discharge as well as the logistical difficulties involved in completing environmental studies in such a challenging environment.

1.3. Approach

The first step in developing a scientifically defensible, yet realistic, study design for the Polaris Mine is to understand characteristics of the effluent discharge and receiving environment and determine how the MMER apply to the mine's unique situation. The following bullets highlight key information that was considered in preparing the study design and incorporate input received from the mine's Technical Advisory Panel (TAP) during a one-day workshop held in April 2003 as well as through follow-up correspondence:

- The mine's effluent is discharged from Garrow Lake to Garrow Creek, approximately 700 upstream of the Garrow Bay marine environment. While the final discharge point is located well within Garrow Creek, the latter does not represent the most ecologically relevant habitat. Therefore, Garrow Bay was identified as the primary exposure area for conducting biological monitoring studies (Appendix A).

- Recognizing the above, the TAP indicated that a fish survey is required on the basis that effluent concentration in Garrow Creek is greater than 1% within 250 m of the final discharge point (Appendix B).

- The high Arctic climate at the Polaris Mine is severe, with short cold summers and long dark winters. During summer, there is limited opportunity for sampling because of the relative lack of ice-free, open water conditions. Ice movements in Crozier Strait and Garrow Bay are unpredictable and in some years, the bay remains ice-covered. Early winters are generally characterized by falling light intensity, increased cold and very unstable ice conditions. These characteristics have several implications:

    - The effluent is discharged over a very short period of time (usually ranging between 8-10 weeks) when the lake and/or discharge lines are not frozen. Consequently, effluent and water quality monitoring studies are only required during flow periods rather than throughout the year as required under MMER (Appendix C).

    - Combined with the influence of ocean currents, tidal movements and winds in Garrow Bay, the short discharge period is anticipated to result in relatively limited effluent exposure in the marine environment. Gross impacts are therefore not expected and biological monitoring studies need to target more subtle effects, if any.

    - There is no road access to nearby embayments that may serve as reference areas (e.g., Tigumiavik Harbour). Consequently, travel to these locations will necessitate boat transport during periods of open water. Due to variable ice conditions and a longer travel time required to reach reference areas, field sampling opportunities may be more limited than in Garrow Bay.

    - Overall, the timing and success of biological monitoring studies is highly dependant on field conditions during the "optimal" summer window for field work.

- The seabed in Garrow Bay is hard and affected by ice scour to depths of about 5 m and up to at least 200 m offshore. At distances greater than 200 – 300 m offshore, the bottom consists of a patchy, heterogeneous mixture of fine sediment (sand, silt) and gravel/cobble. The nearshore substrate is so coarse that it has

never been successfully sampled with a grab sampler. Also, ice scouring has prevented colonization of benthos offshore of the creek area. These features mean that there are no depositional areas where sediment might have accumulated and no benthos in the nearshore environment, where the plume is likely to be detected. Furthermore, given the low discharge volume from the creek relative to the receiving environment, it is unlikely that there will be a detectable plume at the nearest station offshore where we expect to be able to acquire sediment and benthos or fish.

According to Environment Canada (2002), the guiding principles of the 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. Building on these principles, the approach taken for developing a study design for Polaris will involve a tiered process. First, this draft document includes a thorough site characterization exercise and targets the required elements of biological monitoring studies under EEM (i.e., fish survey, fish tissue analysis and benthic invertebrate community survey). For each of these, site-specific conditions that affect monitoring activities are reiterated, a proposed design is presented including targeted sampling areas and sample sizes, and sampling and analysis methods are outlined. In addition, potential alternative methods are reviewed and evaluated in the event that the primary assessment tools are found to be ineffective or that target fish species are absent. Proposed methods for key supporting environmental variables (i.e., water and sediment quality data collected concurrently with biological monitoring studies) are also presented along with a general QA/QC program for all study components.

The second step in the design process will involve EEM field reconnaissance studies in August 2003. These will be conducted in parallel with specific investigations aimed at meeting conditions presented in a DFO Fish Habitat Authorization Permit for work to be carried out during decommissioning of the mine site (Appendix D). Briefly, permit requirements include sampling of fourhorn sculpin (*Myoxocephalus quadricornis*) and sediments in Garrow Lake and fish sampling (note that Appendix D contains the draft authorization; we have recently been informed [B. Donald, Teck Cominco personal communication June 5, 2003] that in the final authorization, "sculpin" has been changed to "fish" in Garrow Bay).

The EEM reconnaissance studies will focus on the following tasks:

- Exploratory sampling (sediment and fish) to evaluate collection methods, species selection, and study locations within the Garrow Bay exposure area (i.e., near-field and far-field) as well as in the proposed Tigumiavik Harbour reference area.
- Theoretical delineation of the spatial and temporal dynamics of the effluent plume discharged and mixed in Garrow Bay, based on available oceanographic

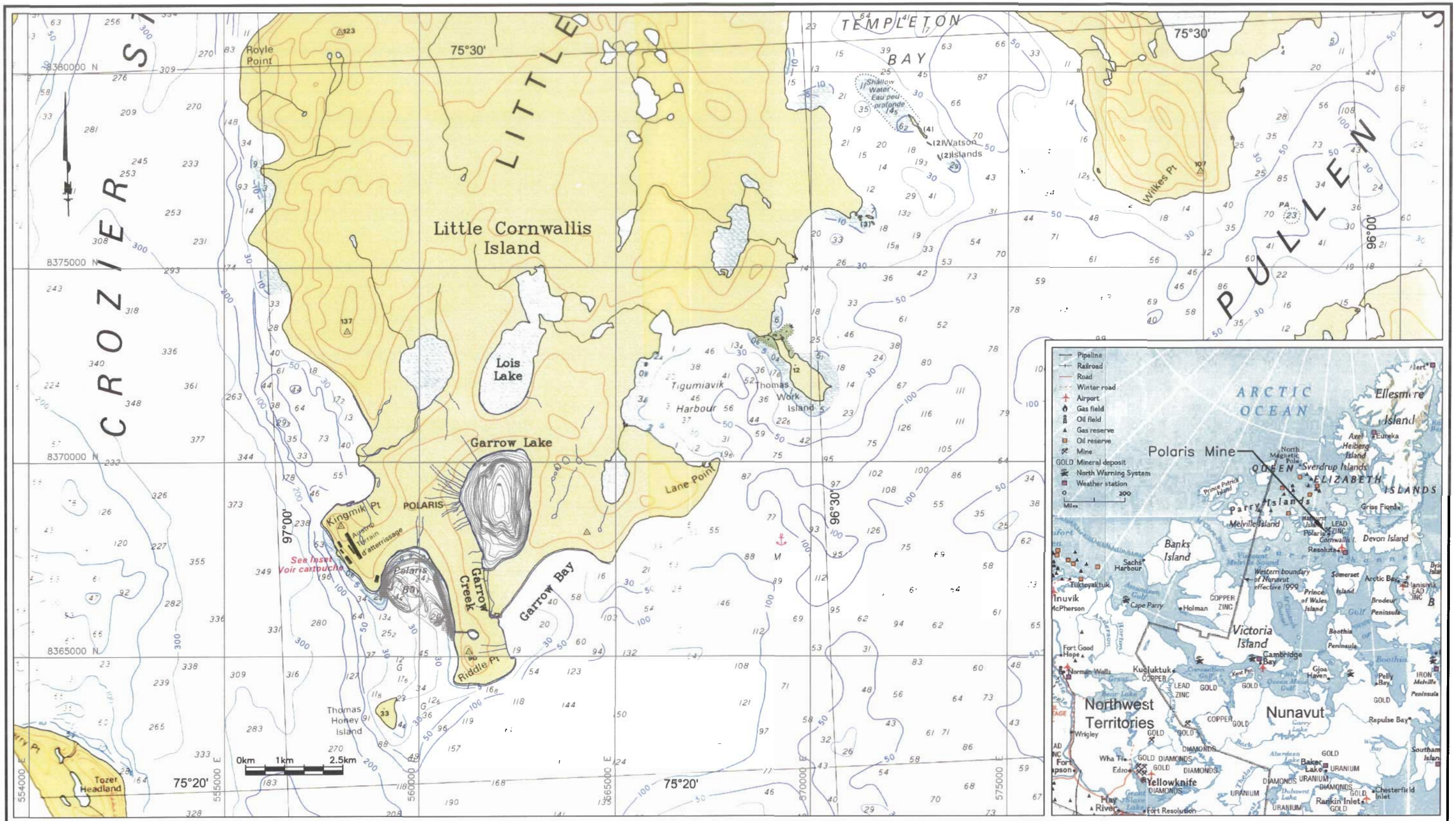
information, creek discharge and chemistry data, tides, wind patterns and ice conditions. Further details are provided in Section 2.3 Hydrology and Effluent Mixing.

The third and final step of the design process will involve preparation of a final study design document based on the findings of the 2003 EEM reconnaissance studies and on the outcome of a meeting with the TAP to arrive at an agreed upon approach/strategy for the 2004 EEM field program. The final study design will then be submitted to the Environment Canada Authorization Officer by December 6, 2003. An interpretative report incorporating the results of all EEM study components (i.e., biological monitoring studies, routine effluent characterization [chemistry and toxicity], and routine water quality monitoring studies) will be prepared and submitted to the Authorization Officer by June 6, 2005.

This document consists of six major sections organized as follows:

- Introduction (Section 1).
- Site characterization (Section 2).
- Fish survey and tissue analysis (Section 3).
- Benthic invertebrate community survey (Section 4).
- Supporting environmental variables (Section 5).
- General quality assurance/quality control (QA/QC) program (Section 6).

Note that at this time, due to uncertainty regarding the final assessment tools that will be selected for the Polaris EEM program (see above), the draft study design outlines proposed field and laboratory methods as well as general QA/QC procedures in a general sense. More detail will be provided as part of the final study design document, once an assessment of results of the 2003 reconnaissance effort is made and reviewed with the TAP. Overall, sampling and analysis procedures will follow guidance presented in Environment Canada (2002).



Carrow Lake, Polaris Bay contour data and surrounding creeks digitized from Map 1 Sampling Sites 1980 *prepared by B.C. Research January 1978*

Other data from Crozier Strait And/Et Pullen Strait 7935 *corrected 2003-03-28 published by the Canadian Hydrographic Service*

Insert Location Map from The Modern North: Roads, Radar Stations, and the End of Isolation, *Produced by National Geographic Maps for National Geographic Magazine, Sept. 1997*

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DRAWN BY:	CHK. BY:	PROJECT No:
BT	RB	TC-03-03
SCALE:	DATE: 6/10/2003 2:52 PM	

PROJECT: Polaris

TITLE: **Polaris Mine Study Area**

CLIENT: Teck Cominco

Figure 1-1