



NORECOL DAMES & MOORE

A DAMES & MOORE SUBSIDIARY

FINAL REPORT

**George Lake Project
Environmental Baseline and
Impact Studies
Terms of Reference**

Arauco NWT Limited

**Job No. 36203-001-310
May 1997**

EXECUTIVE SUMMARY

Arauco NWT Ltd. (Arauco) intends to apply for a production Water Licence to allow mine construction in 1998. As an initial step in the production Water Licence application process, Norecol, Dames & Moore, Inc. (NDM) has developed this Terms of Reference (TOR) document which provides the scope for the environmental, archaeological/heritage and socio-economic baseline and impact assessment studies to be completed. The scope of the study was developed with reference to requirements of the *Canadian Environmental Assessment Act (CEAA)* and through preliminary discussions with Kitikmeot Inuit Association (KIA), Indian and Northern Development Canada (DIAND), Fisheries and Oceans Canada (DFO), and Government of the Northwest Territories (GNWT). The George Lake Project and other related properties were recently acquired by Arauco from Homestake Canada Inc. (Homestake) and Kerr-McGee Corporation. Several years of environmental baseline data collection have already been collected by Homestake and their operator, Trigg, Woollet, Olson Consulting (TWOC). NDM has reviewed these data and the following Scope of Work is designed to confirm previous data and incorporate the collection of new data.

The George Lake deposits are located 70 kilometres south of the community of Bathurst Inlet, and 55 kilometres south of the Arctic Circle, in Nunavut Territory. The Goose Lake deposit is a further 65 kilometres southeast of George Lake. Air access to George Lake will originate from Yellowknife, 500 kilometres southwest of George Lake. At present, a small exploration camp and gravel airstrip exist at George Lake. The existing airstrip is capable of landing Twin Otter and comparable STOL aircraft. Access to the other outlying sites is by float-equipped or wheel-equipped STOL aircraft and helicopter. Historically, an ice runway was built on George Lake to support Hercules aircraft during the annual equipment and supply mobilization. Site specific plans are currently being developed for the George Lake Project. To-date, only conceptual plans for site development have been established.

The ore will be stockpiled at the George and Goose Lake sites, then hauled to Lupin via winter road. Following a favourable feasibility study, a dedicated mill may be constructed at the George Lake project site.

The work program for 1997 will be carried out to support production of a Comprehensive Report, required by the *Canadian Environmental Assessment Act* for projects with potential for significant impacts. The report will also serve to support an application for a production Water Licence through the Nunavut Water Board (NWB). Environmental and socio-economic, archaeological and heritage baseline studies will be conducted during 1997. Some baseline studies (as detailed in the terms of reference) will be continued into 1998. A Comprehensive Report will be submitted to NWB for review during November 1997, together with an application for a Production Water Licence. A subsequent report detailing the results of baseline studies conducted during 1998 will be submitted as an addendum in November 1998.

ATANIIT NAITTOLIOGAIT

Arauco NWT Ltd. (Arauco) apikhiniakhimaliktot atogakhamingnik EmaknikLaisinik ema oyagakhiogotik-hamingnik ovani 1998-mi. Tamna atokkaaktakhaktok emak atogiami EmantLaisianik apihikjutmik, Norecol, Dames & Moore, Inc. (NDM) titiganik atohikhamingnik enikhiot KanogitonikAtutikhanik (TOR) titiganik kanoklikiak nunamikemaniklo atokniagamik oyagakhiokvikmingni, enitoklikonik/otokanik ovalo inuknot kanogilitjutiniaktonik titigakniaktot ovalo honanik kanogilijutiniaktonikehivgiokhiniaktot eniktigilotik. Tamna ehivgiokniagat eliogaklogo ovnai Kanatami Nunanik KanogilijutiniaktonikMaliganik (CEAA) ovalo havaotit okaotigilogit okoalo Kitikmeot Inuit Katimayit (KIA), ItkilinikOkioktantomionik Pivaliayilikiyit Kanatami (DIAND), Ikalulikiot Emakmiotilikiot (DFO), okoalo Nunatiap Kavamaitlo(GNWT). Ona George Lake Oyagakhiokvik okoalo allat oyagakhiokviit piyaoyot nunat okoanit Araucokonanga HomeStake Canada Inc. (Homestake) okoalo Kerr-McGee Corporation. Kaffini okioni nunamikehivgiokhitaaktot emakniklo oyagakhiokvikni Homestake-ni ovalo oyagakhioktinggitnitlo; Trigg, Woollet, Olson Consulting (TWOC). NDM ehivgiokhitaktot nunamik okoalo Kanogitonik Havakniaktoteniktigahoaklogit kangaknitat titigaktatik ovalo eliogakniagait nutaanot titigaktakhanot.

Ona George Lake-mi nalvaak oyagak ovaniitok 70 kilometres hivogaani Kenggaop, ovalo 55 kilometres hivogaani Arctic Circle, Nunavutmi Eloani. Ona Goose Lake nalvaak oyagakongahiloaktoktaok 65 kilometres hivogaani George Lake. Taya, inukokitot oyagakhioktot tupikaktotovalo milvikakhotik ovani George Lake-mi. Tingmiat mitpakniaktot George Lake-mot Yelonaimit, 500kilometres hivoganit George Lake. Taya, tipikaktot ovalo milvikakhoni George Lake. Milvik malgoliittingmiat mikattakvigiyat. Allatlo mitpagat kayalgit tingmiat aoyami naliak allialgit tingmiat ovalohalikaptakkot. Kangali, hikomi mikatakpaktot George Lake-mot tamayanik akyaktot Tingmiakyoakot. Talvanioyakikinahoaliktot nalvaagamiknik Geoge Lake Project-mik. Taya, opalonggaiyakaffoktotoyakikivikhamik.

Tamna nalvaak oyagak kaligiiktiktak Geoge onalo Goose Lake-mi, tamna oyagakakyakniaktat Lupin-mit Tahikyoamot okiokot apkotikot. Tamna ehivgioktakatjuk angikpat nalvaak, talvani nappaktiginiaktot oyakikivikhamik George Lake oyakikivikhamik.

Ona oyagakhiokvik nalvaakhiokhimakniaktot 1997-mi ema angikpatTitigakyoakniaktat Onipkagilogo, pikoyaoyumi Kanatami Nunanik Kanogilijutiniaktonik Maliganik (CEAA) oyagakhiokviknot nunamik kanogili-jutiniaktonik angmakata. Tamna onipkak ekayutaoniaktok apikotmot EmaknikLaisikhanot ovani NunavutmiEmalikiot Katimayit (NWB). Nunamot ovalo Inuknot kanogilitjutiniaktonot, enitoklikakvinik ovalo engilgaknitanik ehivgiokhiniaktot ovani 1997-mi. Elait ehivgiogotikhat(elait titigaktaktot aolajutikhait) aolahimakniaktot Novepami 1997, pikahiotiyaoniaktot omonga Piyukhamik EmaknotLaisinot. Elangat titigakahiotiniaktok ehivgiogotit aolalotik ovani 1998-mi toniyaoyukhatoktotinot Novepa 1998-mi.

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**GEORGE LAKE PROJECT
ENVIRONMENTAL BASELINE AND IMPACT STUDIES
TERMS OF REFERENCE**

1.0 INTRODUCTION

1.1 GENERAL

Arauco NWT Ltd. (Arauco) intends to apply for a production Water Licence to allow mine construction in 1998. As an initial step in the production Water Licence application process, Norecol, Dames & Moore, Inc. (NDM) has developed this Terms of Reference (TOR) document which provides the scope for the environmental, archaeological/heritage and socio-economic baseline and impact assessment studies to be completed. The scope of the study was developed with reference to requirements of the *Canadian Environmental Assessment Act (CEAA)* and through preliminary discussions with Kitikmeot Inuit Association (KIA), Indian and Northern Development Canada (DIAND), Fisheries and Oceans Canada (DFO), and Government of the Northwest Territories (GNWT). The George Lake Project and other related properties were recently acquired by Arauco from Homestake Canada Inc. (Homestake) and Kerr-McGee Corporation. Several years of environmental baseline data collection have already been collected by Homestake and their operator, Trigg, Woollet, Olson Consulting (TWOC). NDM has reviewed these data and the following Scope of Work is designed to confirm previous data and incorporate the collection of new data.

This TOR document discusses the following major topics:

- project description;
- baseline data collection;
- archaeological/heritage assessment;
- socio-economic baseline and impact assessment;
- environmental impact assessment; and
- mitigation and management plans.

1.2 PROJECT DESCRIPTION

1.2.1 Location

The George Lake deposits are located 70 kilometres south of the community of Bathurst Inlet, and 55 kilometres south of the Arctic Circle, in Nunavut Territory (Figure 1). The Goose Lake deposit is a further 65 kilometres southeast of George Lake. The terrain is typical arctic tundra with rolling hills and numerous lakes. Permafrost reaches depths of greater than 500 metres.

1.2.2 Access

Air access to George Lake will originate from Yellowknife, 500 kilometres southwest of George Lake. At present, a small exploration camp and gravel airstrip exist at George Lake. The existing airstrip is capable of landing Twin Otter and comparable STOL aircraft. Access to the other outlying sites is by float-equipped or wheel-equipped STOL aircraft and helicopter. Historically, an ice runway was built on George Lake to support Hercules aircraft during the annual equipment and supply mobilization.

A proposed 1,500 foot airstrip will be constructed at George Lake in 1998 and an identical strip will be constructed at Goose Lake in 1999. Personnel and perishable supplies will be transported to site year-round. It is estimated that two to three F28 flights and two to three Twin Otter flights per week will be required.

At present, there is no road access to any of the George Lake Project areas. Winter road access to the sites is planned (Figure 2) and will originate from Yellowknife, via Echo Bay's Lupin winter road to the southern end of Contwoyto Lake, then to George Lake via a new winter road. The road will head east along an inlet in Contwoyto Lake, pass over Nose Lake, follow the Mara River, cross overland south of the Hackett River into the Western River headwaters to George Lake. This road will consist of 82 kilometres over ice and 63 kilometres over 16 portages. The longest portage will be a 30 kilometre section south of the Hackett River.

After production has commenced at George Lake, a winter road will be constructed to Goose Lake. This winter road will follow the lake system directly south of George Lake to the north end of the Beechey Lake system, and follow these lakes to the north end of Beechey Lake. From the north end of Beechey Lake, the road will cross overland to Goose Lake. The road will consist of 56 kilometres over ice and 36 kilometres over 14 portages. The longest portage will be a 12 kilometre portion east of Beechey Lake.

The ice roads are expected to be operational from early January to late April. All bulk supplies and fuel required for each year will be transported to the sites via winter road. During the mine operation phase, ore will also be transported on the road from the George/Goose sites to Lupin. The winter roads will be designed to handle Super B-train configurations for the bulk supplies and side dump trailers for the ore haulage.

Additional access to the property is also proposed via a 70 kilometre all-weather road from Bathurst Inlet to George Lake from a proposed deep-sea port facility located on the west coast of Bathurst Inlet.

1.2.3 Land Position

All of the properties lie within Tunngavik Federation of Nunavut (TFN) or Nunavut Territory. The Kitikmeot Inuit Association (KIA) administers all surface land use permits. Subsurface

mineral rights for the properties have been 'grandfathered' under the Federal Canadian Mining Regulations. Further information regarding claim status is available if necessary.

1.2.4 Proposed Mine Plan

The conceptual mine plan requires commencement of mining operations in 1998 at George Lake and 1999 at Goose Lake. The mine plan identifies approximately 14% of the mineral resource to be mined by open pit methods, followed by underground mining of the remainder of the resources. The purpose of the open pit mining is to provide cash flow from mining production during the initial stages of underground development.

The 1996 prefeasibility study proposed four long shallow open pits at the Locale 1-2, LCP, Slave and GH deposits at George Lake and one elongated deeper pit at Goose Lake. The pits will have a single lane traffic ramp without switchbacks. The overall strip ratio will be about 13:1. Site specific facilities for stock piling ore at George and Goose Lake have not yet been designed.

Proposed underground mining will utilize narrow vein longhole methods. Access will be by ramp and the main haulage will be on the lower levels. The main haulage fleet will be relatively oversized for the mining rate and sublevel fleet. This will allow improved ramp operating economics. The underground design for Locale 1 and Locale 2 includes provision for the installation of a hoist in the future.

1.2.5 Infrastructure

Site specific plans are currently being developed for the George Lake Project. To-date, only conceptual plans for site development have been established, which include the following infrastructure at both the George and Goose Lake sites:

- Temporary Construction Facilities and Services;
- Fresh Water Collection and Distribution Systems;
- Sewage Treatment Facilities;
- Fuel Storage Facilities;
- Explosives Storage Facilities;
- Power Supply and Distribution Systems;
- Accommodation Facilities;
- Shops, Warehouse, Cold Storage and Assorted Outbuildings;
- Administration Offices; and
- Assay Laboratory.

1.2.6 Mineral Processing

The ore will be stockpiled at the George and Goose Lake sites, then hauled to Lupin via winter road. The ore will be rehandled at Lupin from an outside stockpile through the existing surface jaw crusher and into the coarse ore bin. A gravity circuit consisting of a Knelson concentrator and table will be installed in the Lupin mill. With the exception of the gravity circuit, the

metallurgical process is identical to the process currently utilized by Echo Bay Mines Ltd. to extract gold from the Lupin ore.

The Lupin process consists of secondary and tertiary crushing, milling (rod and ball), preparation and thickening, leaching and thickening, drum filtration, zinc precipitation, and refining. The process is a standard Merrill-Crowe process.

The concept of transportation of the ore to the Lupin mill for custom milling was based on a preliminary economic review. However, if the mineral resource is increased to an appreciable extent as a result of further exploration, the economics may favour the development of a stand-alone mill at George Lake. The transportation and custom milling at Lupin alternative is preferred at this time, because of reduced risk relating to capital cost and environmental permitting.

1.3 SCOPE OF WORK

The work program for 1997 will be carried out to support production of a Comprehensive Report, required by the *Canadian Environmental Assessment Act* for projects with potential for significant impacts. The report will also serve to support an application for a production Water Licence through the Nunavut Water Board (NWB). The environmental studies will be conducted at the George and Goose Lake properties and are detailed in the following sections.

1.4 SCHEDULE

Environmental and socio-economic, archaeological and heritage baseline studies will be conducted during 1997. Some baseline studies (as detailed in the terms of reference) will be continued into 1998. A Comprehensive Report will be submitted to NWB for review during November 1997, together with an application for a Production Water Licence. A subsequent report detailing the results of baseline studies conducted during 1998 will be submitted as an addendum in November 1998.

2.0 BASELINE BIOPHYSICAL STUDIES

2.1 BASELINE STUDIES PROGRAM

2.1.1 Studies Initiation

Baseline studies will be initiated immediately following the initial meeting with RERC/NIRB to finalize the studies terms of reference. NDM will select sites, commence water quality sampling and hydrology measurements, and install the weather station. Designated camp staff will be trained in water quality collection, stream discharge measurement, operation of data loggers for automated equipment and recording of wildlife observations.

2.1.2 Climate

Rationale

A number of parameters of climate are required for the project, either because they may affect the project and are important for environmental design, or because they are required to predict air quality changes that may occur due to operation of the proposed mine. Parameters of interest include:

- temperature;
- precipitation;
- snow accumulation;
- wind velocity and direction;
- relative humidity;
- total radiation.

Previous Work

Background information was collected by Homestake for precipitation, maximum/minimum temperature, wind velocity and direction, and cloud cover at George Lake. The most complete data sets are for temperature and precipitation; limited wind data are also available.

Methodology

To supplement previously collected data, an automated weather station is proposed for George Lake; no data collection is proposed for Goose Lake as it close enough to George Lake that weather at the two locations should be similar. Manual snow accumulation measurement is proposed; a snow gauge will be installed at the George Lake camp and snow accumulation monitored weekly while the camp is in operation. Manual collection of precipitation and maximum/minimum temperature data will be conducted at Goose Lake.

2.1.3 Water Quality/Sediments

Rationale

Background data on water quality and sediments will provide a basis for determining whether mining activities are affecting these components of the aquatic environment in the project areas.

Previous Work

Water quality data were collected at George Lake by TWOC and Homestake over a four-year period and at Goose Lake for two years. Sampling was limited to the open-water season.

Methodology

The same water quality sample sites identified previously are proposed for this program, both at George Lake and at Goose Lake (Figures 3, 4). Proposed parameters to be analyzed are listed in Table 2-1. Frequency of sampling will be monthly during open water, once after freeze up and again before breakup in 1998. (1998 data will be submitted with the Goose Lake addendum.) The same sampling schedule is proposed for both George and Goose Lakes.

The water quality program will include both laboratory and field QA/QC. NDM will ensure that the laboratory analyses blanks and duplicate samples. NDM will review the laboratory data for acceptability of quality control results and for any questionable results such as: unusually high values, dissolved metals higher than total metals, etc. NDM will also ensure that the field program includes the following QC samples with each sampling event:

- two duplicate samples (10% of the total samples; submitted "blind" to the analytical laboratory);
- one field blank (deionized water, treated as the water samples, including preservation; submitted "blind" to the analytical laboratory); and
- one trip blank (sample bottles supplied by the analytical laboratory filled with deionized water; transported to and from the field unopened).

NDM's in-house quality assurance program includes a water quality sampling protocols manual. NDM will provide this manual to the field personnel as part of the training program.

Sediment sampling is proposed for the summer of 1997 on a one-time basis for each sample site. Sediment sampling is proposed for all water quality sites where sediment is present. Five replicates are proposed for each site. Table 2-2 lists parameters which will be analyzed.

2.1.4 Hydrology/Bathymetry

Rationale

Hydrology (stream flow) and bathymetry (lake depth/water volume) data are required for a number of purposes including:

- water balance calculations;
- water management; and
- determination of the assimilative capacity of the aquatic environment.

Previous Work

Homestake collected stream height data from key points at the George Lake property during their exploration activities. Staff gauges were installed at four locations, including George Lake. Discharges were periodically measured (at least annually) by NDM and for the Goose Lake property in 1993 and 1994.

Bathymetry of George, Bob and Goose lakes have been completed and no additional bathymetric data collection is proposed.

Methodology

To augment this database, major streams draining the George and Goose Lake sites are proposed for establishment of hydrographic stations. Automated stations measuring stream height are proposed for Kanosak Creek at the George Lake property and major streams at the Goose Lake property (Figures 3, 4). As well, NDM proposes to install a water level recorder in Bob Lake to measure evaporative loss during the open water season and to re-establish staff gauges at the George Lake property site downstream of Dragon Lake.

Stream discharges will be measured at all hydrometric stations at installation of staff gauges. A designated Arauco staff member will be instructed in stream discharge measurement techniques so that stream discharges can be measured on a weekly or biweekly basis during the open water season. This person will also be instructed in down-loading the automated data loggers, and all other facets of the ongoing data collection.

2.1.5 Hydrogeology

Rationale

Groundwater investigations will be coordinated with the geotechnical program. The key issues are:

- how groundwater levels change with seasons;

- the general quality of groundwater prior to mining;
- the thickness and nature of overburden soils in the vicinity of the proposed open pits; and
- the flow, if any, between lakes, especially Bob and George Lakes, as Bob Lake is proposed for disposal of potentially acid-generating rock.

Previous Work

No previous groundwater studies were conducted at either the George or Goose Lake project areas.

Methodology

NDM will place two piezometers at each pit site. Simple installations will be used and piezometers will be installed by NDM. Exploration staff will be requested to log overburden from the drill holes drilled for the piezometers. The on-site Arauco environmental assistant will be trained to read piezometers on a weekly basis throughout the summer.

2.1.6 Fisheries/Aquatic Resources

2.1.6.1 Fisheries

Rationale

The fisheries program will focus on the completion of baseline information on the fish stocks and aquatic habitat at George Lake and on initiation of studies at Goose Lake for water bodies that could potentially be affected by the development of a mine at both sites.

Previous Work

An overview study of fish populations and habitat was conducted for Homestake in 1990; no studies have been completed for Goose Lake. A more detailed fisheries assessment, including collection of fish tissue samples for metals analyses will be required for the George Lake area and a study of populations, habitat and metals levels will be initiated at the Goose Lake property.

Methodology

The proposed study will:

- inventory the aquatic habitat conditions in the project areas;
- determine the limits of fish distribution in area streams and suitability of area lakes for fish, especially overwintering capability, where not known;

- conduct fish tissue sampling for chemical analysis of metals content. Fish tissues may include muscle, liver, kidney and gonads. Samples will be taken from George Lake and Goose Lake, as well as other lakes that are found to be fish-bearing;
- collect sufficient baseline/background information to allow for the preparation of an environmental impact assessment and potentially a habitat improvement plan to offset any unmitigable adverse impacts to fishery resources, both assuming the project proceeds to development. The plan will need to include measures to ensure no net loss of aquatic biological production (determined in the baseline study), as required by the regulations to the Fisheries Act.

Fish Sampling

Sampling dates, locations and quantities will be finalized through discussions with camp personnel, DFO, NWT and/or Nunavut staff, and in accordance with the requirements of the fish collection permits. Fish will be sampled in July/August during the open water season.

Fish sampling in the summer of 1997 will also be conducted in Goose Lake area streams to determine whether any anadromous fish (e.g. Arctic char) or other species (e.g. sculpins, whitefish) are utilizing the system to spawn. Fishing will be conducted with electrofishing gear and weir traps. Summer sampling will be conducted to provide data on fish distributions and habitat utilization, particularly related to fall-spawning species such as char (lake trout, Arctic char) and whitefish. Fish collection permits and sport fishing licences will be obtained from the regulatory agencies prior to any sampling of fish in the project area.

The electrofishing gear will include Coffelt BP-4 and Smith-Root backpack units. Weir traps will be constructed with ½-inch square steel mesh fencing, including live-box and wings, and installed in the creeks just below the headwater lakes.

All fish captured will be identified, enumerated, measured for fork length and total weight, and released unharmed to the creek or lake systems. Where necessary, fish will be anaesthetized with carbon dioxide (CO₂) from seltzer tablets to allow for the field measurements. Any fish that die in the course of the sampling effort will be fully examined for gonad condition and stomach contents, and sampled for scales and/or otoliths for age determinations.

Habitat Surveys

Aquatic habitat surveys will also be completed for the project area including the creeks and lakes in the vicinity of the deposit and potential waste impoundment sites, as well as the creeks along the proposed winter access road from Contwoyto Lake to George Lake. (Habitat studies for George Lake will focus on in-filling information not collected by Sekerak; the Goose Lake winter road survey is proposed for summer 1998.) Habitat characteristics will be recorded on the standard DFO Stream Survey Forms that include a range of habitat parameters such as: channel widths, wetted widths and bank heights; pool:riffle ratios and depths; substrate/bank composition and stability; cover habitat for fish; flow volumes; *in situ* water quality (temperature, dissolved

oxygen, pH, conductivity and turbidity); cross-sectional sketches and photographs; and fish sampling results. Of particular interest will be the locations of fish spawning and juvenile rearing areas that are generally regarded as critical habitat for fish production. Fish migration barriers, often representing the upstream limits of fish distribution, will also be identified and mapped in all of the streams in the project area. These are important in understanding the locations and timing of fish spawning and egg incubation, and the productive capacity of the drainage system. Hydrological information will also be useful in this regard, and will be provided by the planned streamflow stations.

Fish Tissue

Fish tissue samples will be taken for chemical analysis using ascetic dissection and preservation techniques. Ten (10) fish of each species will be taken from each lake and the mainstem creeks in the project area for tissue analysis. The muscle, liver, kidney and gonads will be used for chemical analysis in each case. Samples will be frozen for shipment to an approved lab.

2.1.6.2 Zooplankton

Rationale

Zooplankters (individual zooplankton) form an important component of the aquatic ecosystem as they harvest the phytoplankton (plant plankton, which is considerably smaller) and provide food for larger invertebrates and fish. Zooplankton species such as the crustacean copepod *Daphnia* sp. can be sensitive to environmental stressors, such as water quality changes, and are sometimes useful as indicator species to monitor aquatic productivity and diversity. Information on the zooplankton community structure in George and Goose Lakes will also aid in the understanding of the productive capacity of the lake/creek system. Early identification of resident zooplankters may also be important if a later environmental effects monitoring (EEM) program is required.

Previous Work

No previous studies were completed.

Methodology

Planktonic invertebrates will be sampled in the lakes of the project area, including George and Goose Lakes to establish the existing range of species in the drainage systems. Creeks do not normally produce zooplankton and will not be sampled, although plankton will drift downstream from the lakes.

Zooplankton sampling will be conducted in mid-to-late summer when phytoplankton and zooplankton communities will likely be at maximum standing crop and life stages will be more advanced than in early summer. Plankton sampling will be conducted using a Wisconsin style plankton net fitted with an 80 micron mesh collecting bag and bucket. The net will be towed from a boat in horizontal hauls through the euphotic zone (epilimnion) where most of the

phytoplankton is produced and the zooplankton feed. Seven (7) replicate samples will be taken on one occasion. Five samples will be sufficient to allow for analysis of variance to identify any significant differences within two standard deviations of the mean at the 90% confidence level; two samples will be archived.

Collected zooplankters will be preserved in 10% buffered formalin for shipment to a taxonomic laboratory for identification and enumeration of species.

Sample Analysis and Quality Control

In the laboratory, invertebrates will be identified at 50x to 600x magnification, and enumerated under the dissecting microscope at 50x magnification. The volume of each sample will be measured, the sample thoroughly agitated, and a subsample placed in a gridded, Sedgwick-Rafter chamber of 1 mL volume. Contents of three to eleven chambers will be enumerated, depending on the plankton density. The densities of zooplankters will be calculated per 1 L.

For taxonomic quality control, 10% of samples will be re-identified by a second reader and results compared to the first identification. If variability is greater than 5%, samples will be re-identified by the first reader.

Phytoplankton will be sampled in the same manner as zooplankton. Prior to identification, samples will be left to settle for two weeks. Following settling, the supernatant will be removed and checked for a possible presence of suspended algae. Densified samples will be stained with Lugol's solution and algae identified using up to 2000x magnification. Identifications will be performed until no new species are encountered in two consecutive slides.

Enumeration of a subsample from a well agitated sample, will be performed in a 0.5 mL Kolkwitz chamber. Perpendicular strips will be examined, at least two in each direction, to complete a count of at least 100 individuals each of the more important species (Schwoerbel, 1972). Results will be tabulated.

2.1.6.3 Benthic Invertebrates

Rationale

In post-mine development monitoring, the health of benthic invertebrate communities is used to determine whether the aquatic habitat has been impacted. Baseline (comparative) data are necessary in order to understand the relation between post-development benthic invertebrate community structure and the effects of a mine. Benthic invertebrate sampling is not specifically required by the general environmental terms of reference for mining projects in NWT, but will be conducted as part of this aquatic studies program to provide important information on stream and lake productivity and food availability to fish. Including benthic sampling in the baseline environmental program will help ensure that good baseline data exists later in the potential development process.

Previous Work

No benthic invertebrate data have been collected for either George or Goose Lake areas.

Methodology

The baseline benthic invertebrate monitoring program will consist of one set of samples at George and Goose Lake project areas, and will be implemented at the end of the fisheries studies.

Sampling Sites

Ideally, a benthic invertebrate monitoring program should include a minimum of two downstream (potentially impacted) sites and two upstream (control) sites on the same stream or in the same drainage basin. Control sites will be established in creeks upstream of the project and in a potentially unaffected lake (if available). There will also be downstream sites in streams draining George and Goose Lakes.

Final site selection will be done in the field. The sites will be matched as closely as possible with respect to substrate size, current velocity, water depth and overhanging vegetation/shading (if any). The sampling will generally be confined to water depths of 30 cm or less.

Sample Collection

The stream benthos samples will be collected with a 30-cm diameter (0.07 m²) X 30 cm deep Waters and Knapp sampler fitted with a 220 µm mesh. Large substrate (>10 cm) will be inspected visually for organisms (which will be shaken or wiped off) and then removed from the sampled area. The remaining substrate will be hand stirred for one to two minutes to dislodge organisms, which are carried by the current into the collection net. Samples will be placed in jars and preserved with buffered 10% formalin.

Seven replicate samples will be collected at each site. Two of the samples will be archived, while the remaining five samples will be processed (invertebrates identified and enumerated). One or both of the archived samples will be processed if power analysis of the data from the initial five replicates indicates that six or seven replicates are required to detect 100% difference either between sites (upstream/downstream of the mine) or between times (before/after the start of mining).

Supplemental data on habitat will be collected. Current velocities and water depths will be measured at each sample location. The substrate composition (particle size and embeddedness) will be determined visually. Other habitat characteristics such as wetted stream width, bank slope and stability, and presence of overhanging vegetation will be recorded.

The lake benthos samples (if collectable; lake bottoms are frequently predominantly cobbles or boulders) will be taken from a boat with an Eckman or Ponar dredge. Seven replicate samples will be taken in each of the lakes. As described for the stream samples, five replicates will be

processed and the remaining two archived. One or both of the additional samples will be processed if data analysis indicates that six or seven replicates are required to detect 100% difference either between sites or between times.

Laboratory Methods

Sorting samples, preservation of sorted animals, identification and enumeration of invertebrates will follow procedures recommended by Environment Canada (1993).

Benthic invertebrates will be removed from accompanying debris using a dissecting microscope at 10x magnification. Rose Bengal stain will be added to the samples first to improve sorting efficiency. Each sample will then be separated into coarse and fine fractions by washing thoroughly through two sieves, with mesh sizes of 1000 µm and 180µm. Each separated fraction of the sample will be examined, portion by portion, on a gridded petri dish under the dissecting microscope, for removal of all benthos. Sorted invertebrates will be stored in vials and preserved in 80% ethanol.

For large samples a fine fraction will be subsampled, following the procedure by Wrona et al. (1982). If required, a coarse fraction will also be subsampled, using the following method. All larger animals will first be removed macroscopically. Then, the entire sample will be thoroughly mixed and evenly spread on a gridded tray containing as little water as possible. The sample will be divided into two halves, and the procedure repeated with one of the halves. The resulting two one-quarters of the sample will then be examined for removal of all remaining animals.

Identification will be performed under dissecting and compound microscopes, and enumeration will be carried out under the dissecting microscope. The results will be tabulated.

Quality control will include resorting the debris for 10% of the samples. If additional organisms found during the resort equal more than 5% of the total organisms in the sample, then an additional 10% of the samples will be resorted. If further sorting shortfalls greater than 5% are discovered, then all of the samples will be resorted.

2.1.6.4 Periphyton

Rationale

Periphyton form a key component of the primary producer trophic level. Mining activities have the potential to affect periphyton communities through alteration of habitat and through increase in nutrients which are typically limiting for periphyton in natural (undisturbed) communities. In the absence of site-specific information, a semi-quantitative survey is suggested.

Previous Work

No periphyton studies have been undertaken at either the George or Goose Lake properties.

Methodology

Sample Sites and Field Methods

A water quality sites with suitable substrate (cobble/boulder) at both the George and Goose Lake properties will be sampled for periphyton during summer months. Five rocks will be sampled from each site, a fixed area of algae scraped off the rocks, e.g. 25 cm². Algae will be filtered onto filter papers in the field, wrapped in foil and shipped to the laboratory for analyses. Habitat data, as previously described, will be collected.

Laboratory Methods

In the laboratory, algae will be dried and weighed. Subsamples will be analyzed for biomass and for chlorophyll *a*. A subsample will be taxonomically identified. A loss on ignition analysis will also be done to determine the amount of mineral material (i.e. sediment) present in the sample.

2.1.7 Terrestrial Resources

2.1.7.1 Soils and Surficial Geology

Rationale

Soils information will be required for reclamation as well as to provide background information on soil metals levels.

Previous Work

No previous soils studies were conducted. Some information on surficial geology will be available from previous bedrock geology studies conducted by Homestake and others.

Methodology

Soils and surficial geology information will be gathered for the George and Goose Lake areas during the summer of 1997. Up to six soil pits will be dug at each site (George and Goose Lake areas). Sample locations will be chosen to be representative of the sites where soils are present and pits will be dug to mineral soil (or bedrock in most areas, since soils are typically very shallow). Pits will be logged and photographed. Both organic and mineral horizons will be sampled for subsequent metals analyses. Soils in areas to be disturbed, as well as control areas will be sampled.

2.1.7.2 Vegetation

Rationale

Vegetation studies will provide information on wildlife habitat and also information on existing plant communities that will be required for developing a reclamation strategy for the Abandonment and Restoration Plan.

Previous Work

General vegetative cover was previously noted, but no detailed studies were conducted.

Methodology

Detailed vegetation studies will be conducted at both the George and Goose Lake areas in conjunction with wildlife studies. The emphasis will be on vegetation as wildlife habitat and vegetation units that may be valuable for reclamation purposes.

2.1.7.3 Wildlife

Rationale

Wildlife issues identified from previous studies include:

- the Goose Lake area is on the migration route of the Bathurst and Beverly caribou herds;
- the region is inhabited by scattered muskoxen herds;
- barren land grizzly bears are known to occur in the region;
- eskers provide valuable wildlife habitat for rodents and for carnivores and raptors which feed on the rodents;
- riparian vegetation provides valuable habitat to waterfowl; and
- raptors (i.e., Peregrine falcons at George Lake) are known to inhabit the region.

Previous Work

Wildlife logs were kept at exploration camps at both George and Goose Lakes; logs have been initiated again in 1997.

Methodology

The extent of required studies will be confirmed with NIRB and GNWT, Renewable Resources. NDM have proposed a spring, summer, and fall survey of wildlife habitat (denning and nesting sites), availability of forage plants for ungulate grazing and qualitative estimates of animal populations will be sufficient. NDM's project team will make use of GNWT telemetry data for caribou if available. As well, a wildlife log has been established at the exploration camps to build on the data base previously collected by this method by Homestake exploration crews.

2.1.8 Acid Rock Drainage/Metals Leaching

Rationale

The potential to create acid and concomitant metals leaching from waste rock and tailings are key issues for mine management and mine closure.

Previous Work

Acid rock drainage studies were completed at the George and Goose Lake project sites. The ore (and possibly some waste rock) was identified as potentially acid generating and conceptual plans were developed to dispose of this rock underwater. Additional work will be required to fill in data gaps.

Methodology

Waste Rock

As part of the baseline studies, samples of waste rock from diamond drill core will be obtained. A detailed geological description and photographic log of all potential waste rocks will be obtained in consultation with Arauco's chief geologist.

NDM will prepare guidelines for the collection of representative samples from site by appropriate site personnel. The samples will be subject to acid-base accounting (including sulphur and carbonate speciation) and metal analysis to define static ARD potential and metal content. A select number will be leach tested (EPA 1312) to determine the probable chemistry of drainage water.

After this initial work is completed NDM will determine whether any further testing is warranted. Arauco's schedule precludes an extensive kinetic test assessment. However, NDM have developed methods to extrapolate long term behaviour from short term test results.

With regard to impact assessment, the assessment of ARD potential will be incorporated into the evaluation of impacts on both surface and groundwater resources and related to the potential hydrochemical buffering capacity of the surrounding country rock.

Characterization of Tailings and Process Water

Tailings characterization studies will be carried out in 1998, since commissioning of a mill is not required until 1999. For these studies, solid samples obtained from bench or pilot-scale testing will be submitted for acid-base accounting (including sulphur and carbonate speciation) and metal analysis. Process water will be analyzed for metal concentrations (low levels) and anions relevant to the process.

Bench and pilot scale metallurgical tests will be conducted during 1997. The mine development plans will be included as an appendix to the EIS report.

3.0 ARCHAEOLOGY/HERITAGE RESOURCES

3.1 RATIONALE

Prior to commencing archaeology/heritage resources studies, NDM will review the proposed program with NWB/NIRB and other interested Inuit groups to assure that studies are carried out in a manner acceptable to the Inuit and adequately address their concerns.

The purpose of an archaeological inventory and assessment is to identify sites of both precontact and historic nature and to evaluate the significance of these sites both scientifically and publicly, relative to perceived impacts from the proposed development. The assessment program will involve in-field investigation for site identification through inspection of exposed surfaces and excavation of shovel tests in areas of vegetation cover for cultural remains.

3.2 PREVIOUS STUDIES

Overview level archaeological investigations were conducted by the Prince of Wales Heritage Museum staff at George Lake in the late 1980s. These studies will have to be expanded to examine all potential sites within the project areas of disturbance at both the George and Goose Lake properties. As well, surveys of the proposed winter road corridors will be required (concentrating on foreshore and esker areas). Studies will be conducted during July through August.

3.3 METHODOLOGY

Providing there are no conditions placed on the archaeology permit with regard to artifact collection, artifacts will be collected from the identified sites if they are:

- temporally or culturally diagnostic;
- consist of formed tools;
- representative of the site content as a whole in terms of lithic material or technology; or
- if they mitigate perceived impact from development at sites.

All archaeological sites identified will be documented in the field as to specific location, conditions, potential size, discernible site type, content, and cultural affiliations. This information will be documented on site inventory forms and assembled for third party review by the Prince of Wales Northern Heritage Centre and Nunavut Impact Review Board. Each site will be photographically documented.

Laboratory analysis and evaluation is required to document the nature of site contents, their relationships, significance and impact implications and to develop appropriate recommendations

regarding final dispensation of sites. An important aspect of laboratory analysis is the establishment of ethnic significance through consultation with local communities and incorporation of ethnic perspective into mitigation schemes.

Pre-field tasks required prior to field study include site file searches and permit application: both of these tasks have been completed. Additional information will be required from Arauco to establish more precise location of facilities, particularly the routing of the proposed roads, location of borrow areas needed for fill and surfacing, and location and size of stockpile sites for waste rock and ore.

The 1997 heritage resources study will consist of the following tasks:

- archaeological inventory, assessment and mitigation of sites associated with the proposed George Lake facilities;
- archaeological inventory of proposed roads;
- archaeological inventory of the proposed Goose Lake facilities;
- analysis and evaluation of field information; and
- preparation of a report suitable for inclusion in the Environmental Impact Statement.

Site mitigation to document, collect and preserve cultural information, will only be completed in the event that a significant archaeological site was identified and could not be avoided through development planning/relocation.

3.3.1 George Lake Field Study

This task will consist of inventory and assessment of the following:

- proposed facilities consisting of plant/camp location, airstrip, and five pit locations,
- other facilities including site roads, water and septic facility locations, borrow areas, and mill site.

3.3.2 Roads Field Study

This task will consist of the following:

- overflight of proposed routes to focus scope of necessary field work,
- inventory and preliminary assessment of general location of the winter road between Contwoyto Lake and George Lake,

- inventory and preliminary assessment of general location of the winter road between George Lake and Goose Lake; and
- inventory and preliminary assessment of general location of all associated identified borrow sources.

Detailed assessment of the roads is not expected to be possible until an exact alignment with surveyed, staked, centreline is present. However, the field program will allow for the inventory of all terrain features of high archaeological potential and the identification of the majority of significant sites. It is recommended at the outset that these sites be avoided, if feasible, by final alignment of the winter and permanent roads and borrow areas.

3.3.3 Goose Lake Facilities Field Study

This task will consist of inventory and assessment of the following:

- the proposed facilities consisting of the plant/camp location, airstrip and pit location;
- other facilities including site roads, water and septic facility locations and borrow pits.

Analysis and Evaluation of Field Results

Analysis of collected artifacts includes cleaning, curation, cataloguing, identification, and description of each individual site for inclusion in the final report and completion of site inventory forms (as per permit requirements). All identified archaeological sites within the development zone will be evaluated on the basis of the observed surficial materials/features and shovel testing program in terms of extent of impact as a consequence of construction/development disturbance. Criteria used in evaluation of the site(s) will consist of amount and nature of cultural material observed and/or recovered and the potential of the site(s) to provide information on past lifestyles relative to extent of intact cultural deposits, the relationship of the site boundaries to the proposed facilities, and the potential of the sites for development of interpretive programs. Ethnic perspectives on the traditional significance of identified sites will also be used in site evaluation. Ethnic significance will be evaluated through consultation with community Elders or appropriate community organizations.

The locations and contents of any newly identified sites associated with the development project and the objectives and strategies for implementing alternate mitigative measures, if necessary, will be fully outlined to the proponent to facilitate decision making by project management. Mitigation is one of the two basic options considered during the impact assessment stage as a means of managing archaeological resources. At significant sites, the preferred option is avoidance as it is cost effective and implies site preservation. Recommendations concerning final dispensation of the identified sites will be formulated on the basis of the evaluation program.

4.0 SOCIO-ECONOMIC BASELINE

4.1 INUIT COMMUNITIES

4.1.1 Rationale

Socio-economic issues revolve around the Inuit Impact and Benefit Agreement (IIBA) that will be negotiated between Arauco and the KIA. Issues will require confirmation with KIA and include: employment, training, contracting, use of the Inuit language on the job, public consultation, sensitivity to cultural heritage and cultural differences between peoples of European and Inuit origins, flexibility in location of temporary camps and a commitment to sound environmental practices, including designing the mine for closure. The study will consider the impact to the communities of Bathurst Inlet, Umingmaktok, Cambridge Bay and Kugluktok.

The objective of the socio-economic program will be to describe the regional and community social and economic setting, to identify the socio-economic impacts that might arise from the proposed development and to recommend ways to mitigate negative impacts. The socio-economic program will concentrate on the communities of the West Kitikmeot Region: the hamlets of Cambridge Bay and Kugluktuk (Coppermine) and the unincorporated settlements of Bathurst Inlet and Umingmaktok.

The negotiating process, including meetings held, issues discussed and the outcome will be documented in the Comprehensive Report.

4.1.2 Previous Studies

No previous formal socio-economic studies were completed in connection with mine development at George Lake.

4.1.3 Methodology

Baseline studies will describe the socio economic environment and will include details such as population and demographics, land use patterns, workforce, employment, income, subsistence economy, housing, infrastructure and services.

This information will be collected by reviewing recent federal, territorial and community government literature and interviews either in person or by telephone with representatives of:

- governments in the communities and in Yellowknife,
- the Kitikmeot Inuit Association,
- the Kitikmeot Corporation, and
- other Inuit organizations such as the Community Land and Resources Committees and Hunters and Trappers Committees in each of Umingmaktok, Bathurst Inlet, Kugluktuk and Cambridge Bay,

- other Inuit organizations such as the Community Land and Resources Committees and Hunters and Trappers Committees in each of Umingmaktok, Bathurst Inlet, Kugluktuk and Cambridge Bay,

Inuit traditional knowledge will be sought throughout the program and integrated into the three reports.

4.2 YELLOWKNIFE

4.2.1 Rationale

Yellowknife is the closest large centre in the western Arctic that would be suitable for servicing a mine at George Lake. Available services will require documentation and this background information will form an important part of the northern purchase policy development of Arauco NWT Ltd.

4.2.2 Previous Studies

Numerous mining projects have gathered the required information.

4.2.3 Methodology

The George and Goose Lake project sites are in remote, generally uninhabited areas of Nunavut and will require fly-in-fly-out operations supported by on-site camp(s). NDM will document all contacts and discussions with local suppliers regarding project development, construction, logistics and operation.

4.3 NAONAYAOTIT TRADITIONAL KNOWLEDGE STUDY

4.3.1 Rationale

Arauco is currently seeking approval from Kugluktuk Angoniatit Association (KAA) for participation in the Naonaiyaotit Traditional Knowledge Study (NTKS). The report is planned for completion in the fall of 1997.

The geographic scope of the study is very large. It encompasses the traditional and modern land use areas on the mainland of the Inuit from Kugluktuk, Bathurst Inlet, Omigmotok, and Cambridge Bay. It extends from the western Nuynavut line east to the Perry River and south from the Arctic coast to the southern boundary of Nunavut.

With this large study area, particular attention will be given to the Hope Bay Belt south of the Kent Peninsula, Lac de Grass, and the area between Tahikyak and Imaokatalok. These areas contain potential mine sites proposed by BHP, Lytton and Kennecott. Traditional knowledge on these areas will greatly assist in planning, monitoring and mitigating the impact of exploration

4.3.2 Previous Studies

Traditional knowledge studies have not previously been carried out for the region.

4.3.3 Methodology

The Kugluktuk Angoniatit Association will carry out the study. BHP, Lytton, Kennecott, Renewable Resources and Parks Canada acknowledge that the KAA will control the interview data. This will provide the people of the Kitikmeot with a valuable tool to help plan and manage their lands.

4.4 ECOTOURISM

4.4.1 Rationale

The George and Goose Lakes areas are not located on major rivers or near centres of ecotourism.

4.4.2 Previous Studies

No previous studies for the George Lake project region have been documented.

4.4.3 Methodology

The objective of the ecotourism study will be to identify the nature and extent of the present ecotourism industry in the West Kitikmeot Region, its potential for expansion, the impacts both positive and negative the Arauco NWT Ltd. project might have on the industry and mitigative measures that can be employed to reduce the negative impacts and enhance the positive impacts.

Any Inuit concerns will be addressed, which may include:

- impact to Inuit-owned and operated Naturalist Lodge at Bathurst Inlet;
- impact to guiding sport hunters through the region; and
- impacts to the limited boating tourism along Back River and Beechey Lake; and within Bathurst Inlet.

The ecotourism industry in the Region and its potential for expansion will be described. In addition to the groups interviewed in Part One the consultants will interview:

- current operators of ecotourism facilities in the Region, and
- territorial and federal tourism officials.

5.0 DATA COMPILATION AND EVALUATION

5.1 INTRODUCTION

A great deal of data will be collected during the baseline studies. Data will be compiled into a database for ease of organizing, analysis, and reporting.

5.2 FISH

The analysis and reporting of fisheries data will include descriptions of the fishery resources (fish stocks and habitat) in the project area. The data will permit an initial assessment of mitigation and habitat improvement potential. Resource inventory information will be derived from several sources: 1997 data; data from past studies; GNWT agencies; and traditional knowledge of the area.

Length:weight frequency histograms will be generated to determine fish condition factors for comparison with other parts of the Arctic drainage area. This comparison will indicate whether the fish stocks in the project area are typical or atypical with respect to stock structure and general condition (robustness).

5.3 ZOOPLANKTON

The number of species and individual zooplankters will be used to calculate summer plankton densities in the lakes sampled. The data will be statistically analyzed to determine whether there are real differences between total densities in the lakes. Power analysis will be used to determine the degree of precision in the detection of differences with different sample sizes. Multivariate statistics such as cluster analysis, principal component analysis and/or correspondence analysis will establish whether community structures are statistically similar or different between the lakes. The results will describe in quantitative terms, the densities and relative numbers of species in the zooplankton communities, and contribute to an understanding of the overall aquatic productivity in the lake and stream system.

5.4 WATER QUALITY AND SEDIMENTS

Water and sediment quality data will be summarized using standard measures of central tendency (mean, standard deviation, variance). Within and between site variation will be evaluated. The QA/QC program will be evaluated with respect to repeatability of sample analyses and the presence or absence of contaminant sources.

5.5 HYDROLOGY

Flow data will be analyzed to produce stage-discharge relationships for streams measured for the study. In this manner, stream height measurements (from automated stations) or manual staff gauge readings can be used to estimate discharges. Special emphasis will be placed on the

freshet analysis, since most of the total annual volume of water discharged by small streams, such as those typical of the project areas, occurs during freshet.

5.6 METEOROLOGY

All data collected at the site including: 1997 data from the automated weather station installed at George Lake, and manual data collected at George and Goose Lakes in 1997 and previous years will be compiled and assessed. Site-specific data will be used to adjust long-term data available from Lupin, Cambridge Bay, Bathurst Inlet, etc. to the project site. Meteorology data will be key in developing a water management plan for the operating mine and mill (if constructed).

5.7 WILDLIFE AND VEGETATION

Four types of wildlife data are available for the project region:

- traditional knowledge;
- GNWT telemetry data for large ungulate herds;
- incidental sightings by exploration crews at George and Goose Lake project areas; and
- (to be collected in 1997/98) seasonal data on wildlife and habitat for the project areas and proposed winter road routes.

All data will be compiled and evaluated to provide a comprehensive understanding of wildlife use and habitats in the project areas. Where appropriate for impact assessment, habitat may be mapped.

Vegetation is important in the project areas principally as wildlife habitat, and secondarily, for reclamation of disturbed areas. Vegetation data will be gathered as part of wildlife studies in 1997 and provide the baseline database for impact assessment and mitigation development.

6.0 ENVIRONMENTAL IMPACT ASSESSMENT

The assessment of potential environmental impacts associated with the proposed development will be based on the findings of the Environmental Baseline Studies and a review of the development proposal.

The significance of each impact will be assigned a level of importance as follows:

- Severe
- Major
- Moderate
- Minor
- Not significant

6.1 MINING CONCEPTS REVIEW

The proposed development may incorporate several components including underground and open pit mines, processing facilities, waste management facilities, and site service facilities. NDM will need to establish the range of options being proposed for each of these components of the project to allow comprehensive impact assessment.

Particular attention will be given to the following issues:

- the nature of the proposed mine development and extent of open pit workings;
- the predicted quality of waste rock leachate and probable waste rock disposal areas;
- the location, construction and operation of tailings facilities; and
- the proposed water management procedures.

As a conclusion of this review, NDM will establish the full range of development options that will have the potential to impact on the environment.

6.2 AQUATIC RESOURCE EFFECTS

6.2.1 Water Resources

The assessment of potential water resources impacts will be a major component of the impact assessment consisting of several phases. Detailed consideration will be given to the potential impact of the development on:

- surface water quality in the surface water systems downstream of mine and mill development, especially with respect to fisheries resources;
- groundwater resources in relation to mine dewatering;

- potential for contamination of surface water and groundwater by ARD from tailings and for waste rock dumps;
- potential for contamination of surface water and groundwater by seepage from tailings facilities;
- local and regional water resources following mine closure.

Impact assessment to water resources will require water balances for the mill and proposed tailings ponds which are normally developed by process and geotechnical engineers, respectively. The hydrology and climate data collected as part of baseline studies will serve as a basis for the data required to perform the analyses. These data will be used in the review of environmental significance. Water quality will be determined from an assessment of effluent and runoff water quality from the site. Development of a water management plan will require both baseline hydrology and climate data, and project information from the engineering feasibility study.

Low-flow assessments will be required if surface water supply is assumed, and for prediction of water quality resulting from planned or possible discharge. Site-specific data can be used to calibrate regional data to produce low and flood flow information on project streams for which data are available.

Mass loadings calculations will be determined by NDM through information supplied by project engineers (e.g. the nature and quantity of explosives to be used; quality of tailings effluent discharge from metallurgical tests), modelling of leaching and data derived from column leach experiments, if conducted. Water contaminants of concern include sediment, nitrogen and phosphorus. Source of sediment will be runoff from exposed soil/bedrock which will be controlled by sediment ponds. With adequate design, sediment should not be discharged from sediment ponds. Information on particle size and settlement rates will be required for pond design and, if indicated, flocculants may be required to enhance settling of fines.

Nitrogen, a concern at open pit mines, is unlikely to be a concern for underground operations, unless the mine makes significant water. The source of nitrogen will be explosives. If warranted by data collected as part of baseline studies, an analysis of impacts of nitrogen release will be undertaken.

6.2.2 Fisheries

NDM will assess the potential for impacts to fish populations and habitats as part of the EIA. Project engineering information from the feasibility study or project engineers will be used together with the baseline information obtained from previous studies (Sekerak 1990) and studies conducted as part of the present proposal. In general, the loss of habitat (in fish-bearing waters) and effluents containing metals, sediments, or low pH, are the major potential impacts that will require assessment.

6.3 TERRESTRIAL RESOURCE EFFECTS

6.3.1 Wildlife

Any wildlife populations or habitat at the proposed mine site could potentially be disturbed by mine development. Our impact assessment will be based on all ground observations available and the habitat assessment. The focus will be on ungulates, large carnivores and rare and endangered species, should they inhabit the region around the proposed mine site. Assessment will be made of the amount and proportion of habitat lost and probable number of animals affected. Appropriate mitigation strategies will be identified to address any significant impacts, and will be key to the reclamation planning. Caribou herd migrations will need to be taken into account during construction and operation to minimize interference with herds.

6.3.2 Vegetation and Soils

Soils and vegetation can be affected by mineral extraction, especially open pit operations, handling (ore stockpiles, infrastructure), waste handling (waste rock dumps, tailings impoundments, roads). Vegetation is an important component of wildlife habitat and if wildlife will be affected by the proposed development then an assessment of potential impacts will be conducted and mitigation strategies developed.

An impact assessment on local soils and vegetation will be developed, as they relate to thermokarst formation, wildlife use and reclamation. The vegetation and soil units identified from baseline surveys will be evaluated as to expected impacts from proposed mine development and their value as reclamation materials, wildlife habitat and food. The evaluation will be based on overlaying the proposed project development on the soils and vegetation map. Units unimportant for erosion control, wildlife habitat or reclamation will be identified, but not dealt with further.

6.4 ATMOSPHERIC RESOURCE EFFECTS

Air emissions from both fugitive and point sources will occur from this project. Point sources can include diesel generators, vehicles, blasting, refuse incinerators, exhaust fans from mills and refineries, and exhaust vents of space heaters (usually propane or natural gas).

Underground operations will not produce significant surface dust, although some emissions will be generated by underground exhaust fans. Vehicular traffic on unpaved roads (especially during winter when watering is not possible), a rock crusher, if located in the mill, will be the principal sources of dust. Open pit blasting, while it generates dust, is generally a minor source because of the extremely short duration of blasts.

An air emission inventory will be developed by NDM as part of the impact assessment based on engineering information and manufacturers specifications. Emission factors derived from the United States Environmental Protection Agency and/or dispersion modelling will be used to

determine anticipated levels of emissions. These will be compared to Canadian criteria for ambient air quality to assess potential impacts.

As part of the air emission assessment, conceptual mitigation measures will be developed in consultation with project engineers to limit, to the extent practicable, both point and fugitive sources of air emissions.

6.5 ARCHAEOLOGICAL/HERITAGE RESOURCE EFFECTS

Upon completion of the archaeological ground reconnaissance, a preliminary report will be produced for client review which details the study results and recommended mitigative measures to ensure that no conflicts with construction scheduling occur. Subsequently, this preliminary report will be submitted to the Prince of Wales Northern Heritage Centre and to the local community(ies) for their input regarding ethnic significance of the specific sites identified.

A final report will be prepared which will include both descriptive and graphic data on the sites identified. Recovered cultural material will be inventoried, described, and discussed with respect to its scientific significance. An evaluation of any potential limitations to development will also be presented.

7.0 ENVIRONMENTAL MANAGEMENT PLANS/MITIGATION

NDM will assist Arauco with development of management plans that will minimize both short- and long-term environmental and financial liabilities.

7.1 CONCEPTUAL CLOSURE AND RESTORATION PLAN

A conceptual reclamation plan is necessary for project approval. A detailed and progressive reclamation plan is a requirement of production Water Licences issued by the Nunavut Water Board.

Requirements for a reclamation plan include:

- Map showing the location and extent of the mine, location of water bodies and inhabited places in the vicinity of the mine;
- Particulars of present land use with respect to ownership, climate, geology, surface and groundwater drainage, water quality, water licences, hydrology and fisheries, soils and surficial geology, vegetation, wildlife and land capability for present uses;
- Project description including nature of the mine, aerial extent, development schedule, waste disposal, acid generation, stockpiles, water use, watercourse protection measures, drainage control, and surface development and disturbance;
- Details of plans to protect and reclaim land and watercourses during all phases of mining, with respect to monitoring and surveillance; and
- A conceptual closure plan.

7.2 ENVIRONMENTAL INPUT TO WATER MANAGEMENT PLAN

A water management plan will address water supply, management and quality for the operation. Water balances for the mill and proposed tailings ponds will be required to confirm water make-up and supply requirements, and are normally developed by process and geotechnical engineers, respectively. These data will be used in the review of environmental significance. Development of a water management plan will require both baseline hydrology and climate data, and project information from the engineering feasibility study.

7.3 ENVIRONMENTAL INPUT TO WASTE MANAGEMENT PLAN

Primary waste materials from mining and milling of ore will be waste rock and tailings solids. Minor sources include sediment from minesite runoff and domestic sewage. Acid generation may be a concern. The purpose of the waste management plan will be to mitigate impacts from solid wastes to the greatest extent practical.

A waste management plan will be required to deal with the following solid and liquid wastes:

- waste rock;
- non stockpiled soils, if any;
- miscellaneous solid wastes generated from mining activities, such as scrap metal, etc.
- waste water streams including process water (whether recycled or discharged), runoff, seepage, and sewage.

Key issues for this project will be determination of acid generation and metals leaching potential.

7.4 HABITAT COMPENSATION

Fisheries and Oceans Canada has a *No Net Loss* Policy which will require compensation for any lost fisheries habitat. Some compensation for lost wildlife habitat may also become an issue, especially if hunting and trapping activities of Inuit are affected by the mine or road developments. Baseline data and project specifications will be used to determine if compensation is required and plans developed and discussed with appropriate agencies.

7.5 ARCHAEOLOGY/HERITAGE RESOURCES

Where practical, heritage resources must be protected from disturbance. If disturbance is unavoidable, any proposed work will be discussed with both GNWT Culture and Communications and the First Nations whose heritage will be affected.

Depending on the nature of any archaeological sites identified and the perceived potential for impact resulting from the proposed project, mitigative excavations may be warranted. Mitigative excavations generally consist of controlled excavation of 1x1 meter units by hand with in situ recording of all artifacts and features encountered and individual bagging and identification of each piece in the field. Because of the limited field time available to complete both assessment and any required mitigation, a meeting will be held with the Prince of Wales Northern Heritage Centre to inform them of the project, project scheduling, and potential conflicts if sites require mitigation so that an appropriate reporting and review procedure can be established.

7.6 CHEMICAL AND HAZARDOUS MATERIALS HANDLING AND STORAGE

A plan will be required for handling hazardous substances and a spill prevention, countermeasures and control (SPCC) plan to address environmental emergencies. The plan will include tailings spills from tailings lines, if not otherwise dealt with (i.e., in the waste or water management plans) in the impact assessment. NDM will use the process chemicals list provided by project engineers to develop a conceptual hazardous materials handling plan and provide a conceptual SPCC plan based on hazardous substances that will be handled. The conceptual SPCC plan will be included in the Comprehensive Report.

7.7 OPERATIONAL MONITORING

The following elements may be required (the monitoring program will be discussed with RERC):

- groundwater wells down gradient of tailings ponds;
- surface water monitoring above and below the mine at both George and Goose Lakes, and tributaries affected by mining;
- hydrographic station monitoring (the need for monitoring and the number of sites to monitor throughout the mine life needs to be clarified with the Water Board); and
- aquatic effects monitoring (the extent of this program will depend on pending amendments to the *Fisheries Act*).

NDM will assist Arauco with negotiations with DIAND, Water Resources and GNWT, Renewable Resources with respect to monitoring program design as well as with design of a construction and operation monitoring program to address the above (or negotiated) requirements.

8.0 SOCIO-ECONOMIC IMPACT ASSESSMENT

The socio-economic impact assessment will be part of the Inuit Impact and Benefit Agreement (IIBA). The assessment from this agreement will be incorporated into the Comprehensive Report by NDM to address requirements for these assessments by CEAA. Details of negotiations (if available and not confidential at the time of submission) and the basis for agreements will be provided in the environmental impact report.

If not confidential, the IIBA will be attached to the Comprehensive Report as an appendix.

The socio-economic impact assessment (SIA) conducted outside the above-referenced context will assess potential positive and negative project effects on employment, local economies, impacts on traditional lifestyles and economic benefits to local communities. The need for job training will be evaluated.

9.0 COMPREHENSIVE REPORT

9.1 CEAA REPORT GUIDELINES

To meet the requirements of the *Canadian Environmental Assessment Act*, the Comprehensive Report must include the following elements as a minimum:

- a description of the project activities;
- project alternatives;
- a discussion of the scope of the environmental assessment;
- a description of the environment;
- environmental effects of the proposed project;
- effects on sustainable use of renewable resources (i.e., fish and wildlife);
- proposed mitigation measures;
- a determination of the significance of residual effects (after application of mitigation);
- an identification of public groups (including Inuit) with an interest in the project and comments received from the public during the course of the environmental assessment, a discussion of how these comments have been incorporated into the comprehensive study report; and
- follow-up program proposed to evaluate the effectiveness of mitigation measures and to determine the accuracy of the environmental assessment (monitoring program).

9.2 GEORGE LAKE PROJECT COMPREHENSIVE REPORT

The report will provide baseline data, impact assessments and environmental management plans. The impacts considered will include those that are beneficial, adverse, direct, indirect, secondary and cumulative, temporary, long term, reversible or irreversible.

The potential impacts of the mine development will be outlined followed by the agreed and suggested mitigation and enhancement measures. In the description of the potential impacts of a proposed development, a critical aspect is the assessment of the significance of the predicted impact. The appraisal of the importance of the impact will take into account the following factors:

- the magnitude and intensity of the impact;

- the context of the effect - local, regional, national or international
- the temporal aspect - short, medium or long-term, whether the impact will occur immediately upon commencement of mining activity or at some point in the future and whether the effect would decrease or increase with time and whether it was continuous or periodic;
- the geographical extent of the impact;
- the probability of occurrence of the impact;
- the topic-specific nature of the impact.

Overlain on these significance levels will be the topic specific criteria which will be clearly defined and assign a level to each topic under consideration. Where possible, reference will be made to published guidelines, but a significant element of 'value judgement' will be required and founded upon NDMs mining experience. The basis upon which the significance has been assessed will be fully documented. The assumptions made and the technical limitations will be clearly stated.

9.3 THE GEORGE LAKE ADDENDUM REPORT

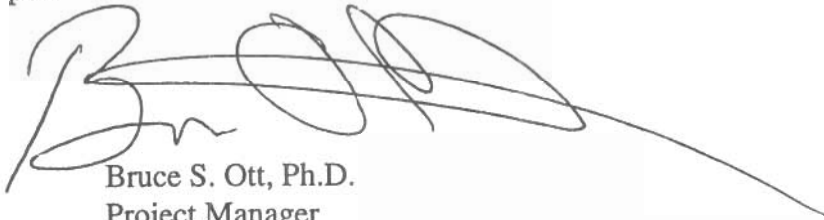
An addendum report containing results and evaluations of data collected during the 1998 season will be submitted as an addendum to the Comprehensive Report in November 1998.

10.0 NWB/NIRB UPDATE MEETINGS

Periodic meetings will be scheduled with NWB/NIRB to ensure the committee remains abreast of studies progress. If it can be arranged, a site visit will be conducted during the summer of 1997 for interested committee members, followed by an update meeting in the fall after most of the Year 1 baseline studies have been completed. NDM's project manager will be available for these meetings.

NORECOL, DAMES & MOORE, INC.

per:



Bruce S. Ott, Ph.D.
Project Manager



for David P. Harpley, M.Sc., P. Geo.
Senior Review

TABLE 2-1
PARAMETERS AND DETECTION LIMITS FOR WATER

Parameter	Units	Detection Limit	Parameter	Units	Detection Limit
WATER			TOTAL AND DISSOLVED METALS		
PHYSICAL			Silver (Ag)	mg/L	0.0001
pH		0.1	Aluminum (Al)	mg/L	0.06
Specific Conductance	uS	1	Arsenic(As)	mg/L	0.0005
TSS	mg/L	4	Boron (B)	mg/L	0.04
TDS	mg/L	4	Barium (Ba)	mg/L	0.001
Hardness Total -D	mg/L	na	Beryllium (Be)	mg/L	0.001
Acidity pH 8.3	mg/L	0.5	Bismuth (Bi)	mg/L	0.02
Acidity pH 4.5	mg/L	0.5	Calcium (Ca)	mg/L	0.05
Alkalinity Phen. 8.3	mg/L	0.5	Cadmium (Cd)	mg/L	0.0001
Alkalinity Total 4.5	mg/L	0.5	Cobalt (Co)	mg/L	0.004
Carbonate (CO ₃)	mg/L	na	Chromium (Cr)	mg/L	0.002
Bicarbonate (HCO ₃)	mg/L	na	Copper (Cu)	mg/L	0.002
Hydroxide (OH)	mg/L	0.5	Iron (Fe)	mg/L	0.05
Chloride Dissolved (Cl)	mg/L	0.1	Mercury (Hg)	mg/L	0.00005
Fluoride Dissolved (F)	mg/L	0.1	Potassium (K)	mg/L	0.4
Ion Balance		na	Magnesium (Mg)	mg/L	0.02
Organic Carbon - Total	mg/L	1.0	Manganese (Mn)	mg/L	0.002
NITROGEN			Molybdenum (Mo)	mg/L	0.004
Organic Nitrogen - Total (N)	mg/L	0.04	Sodium (Na)	mg/L	0.4
Total Kjeldahl Nitrogen (N)	mg/L	0.04	Nickel (Ni)	mg/L	0.01
Total Nitrogen (N)	mg/L	0.02	Phosphorus (P)	mg/L	0.04
Ammonia Nitrogen (N)	mg/L	0.005	Lead (Pb)	mg/L	0.003
Nitrate+Nitrite (N)	mg/L	0.02	Sulphur (S)	mg/L	0.1
Nitrate Nitrogen Dissolved (N)	mg/L	0.02	Antimony (Sb)	mg/L	0.02
Nitrite Nitrogen (N)	mg/L	0.005	Selenium (Se)	mg/L	0.0005
PHOSPHORUS			Silicon (Si)	mg/L	0.8
Ortho-Phosphorus (P)	mg/L	0.003	Tin (Sn)	mg/L	0.02
Phosphorus - Total (P)	mg/L	0.003	Strontium (Sr)	mg/L	0.001
SULFATE			Tellurium (Te)	mg/L	0.02
Sulfate (S)	mg/L	1.0	Titanium (Ti)	mg/L	0.003
CYANIDE			Thallium (Ta)	mg/L	0.03
CN _T (CN)	mg/L	0.001	Vanadium (V)	mg/L	0.003
			Zinc (Zn)	mg/L	0.01
			Zirconium (Zr)	mg/L	0.003

Na Not Available

TABLE 2-2
PARAMETERS AND DETECTION LIMITS
FOR SEDIMENTS

Parameter	Units	Detection Limit
SEDIMENT		
Aluminum (Al)	ug/dry g	1
Antimony (Sb)	ug/dry g	0.05
Arsenic (As)	ug/dry g	0.05
Boron (B)	ug/dry g	1
Barium (Ba)	ug/dry g	0.05
Beryllium (Be)	ug/dry g	0.1
Cadmium (Cd)	ug/dry g	0.05
Calcium (Ca)	ug/dry g	5
Chromium (Cr)	ug/dry g	0.5
Cobalt (Co)	ug/dry g	0.05
Copper (Cu)	ug/dry g	0.5
Iron (Fe)	ug/dry g	1
Lead (Pb)	ug/dry g	0.05
Magnesium (Mg)	ug/dry g	1
Manganese (Mn)	ug/dry g	1
Mercury (Hg)	ug/dry g	0.005
Molybdenum (Mo)	ug/dry g	0.05
Nickel (Ni)	ug/dry g	0.3
Selenium (Se)	ug/dry g	0.3
Silver (Ag)	ug/dry g	0.03
Strontium (Sr)	ug/dry g	0.05
Tellurium (Te)	ug/dry g	0.2
Tin (Sn)	ug/dry g	0.05
Uranium (U)	ug/dry g	0.02
Vanadium (V)	ug/dry g	0.1
Zinc (Zn)	ug/dry g	0.5

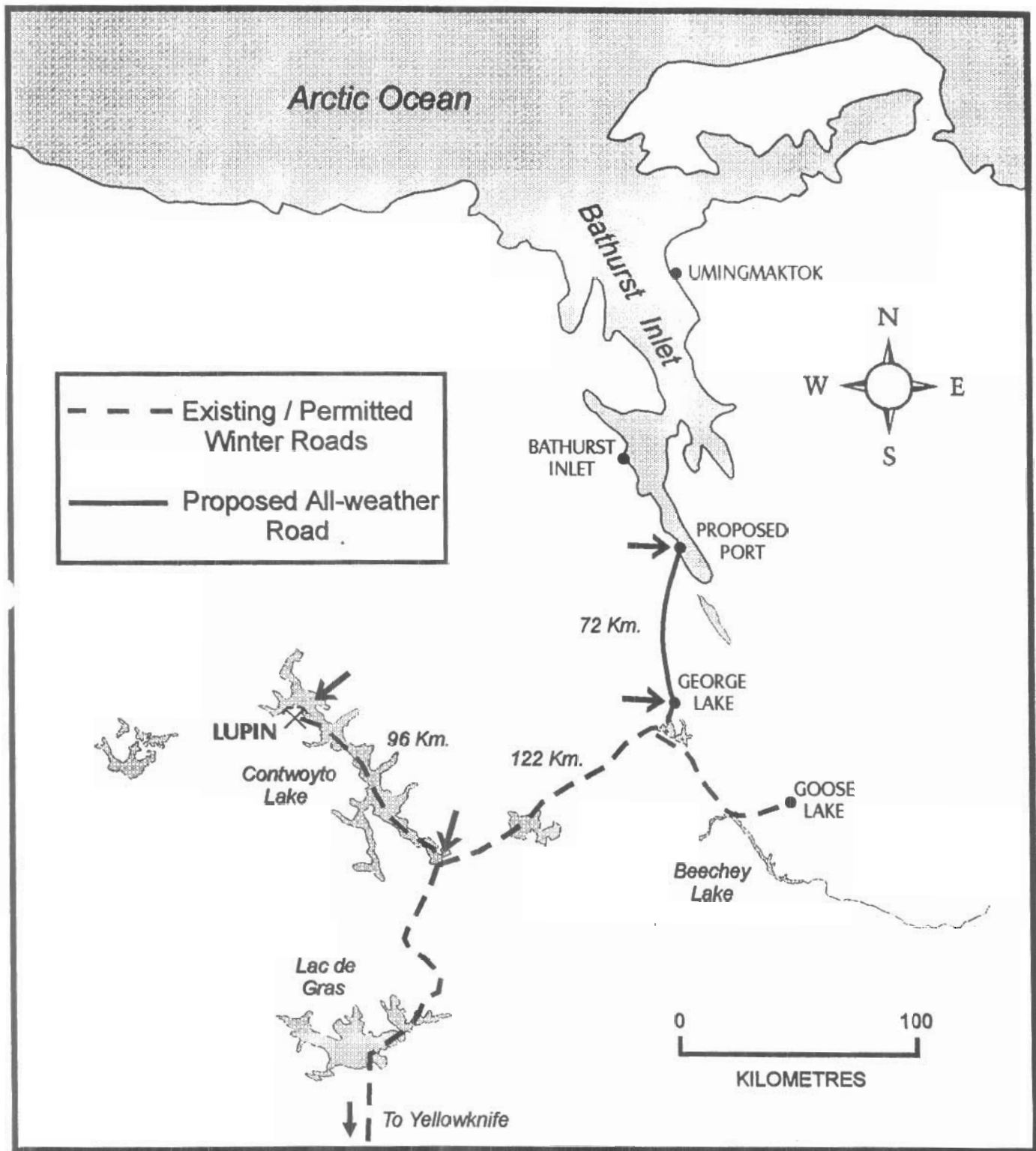
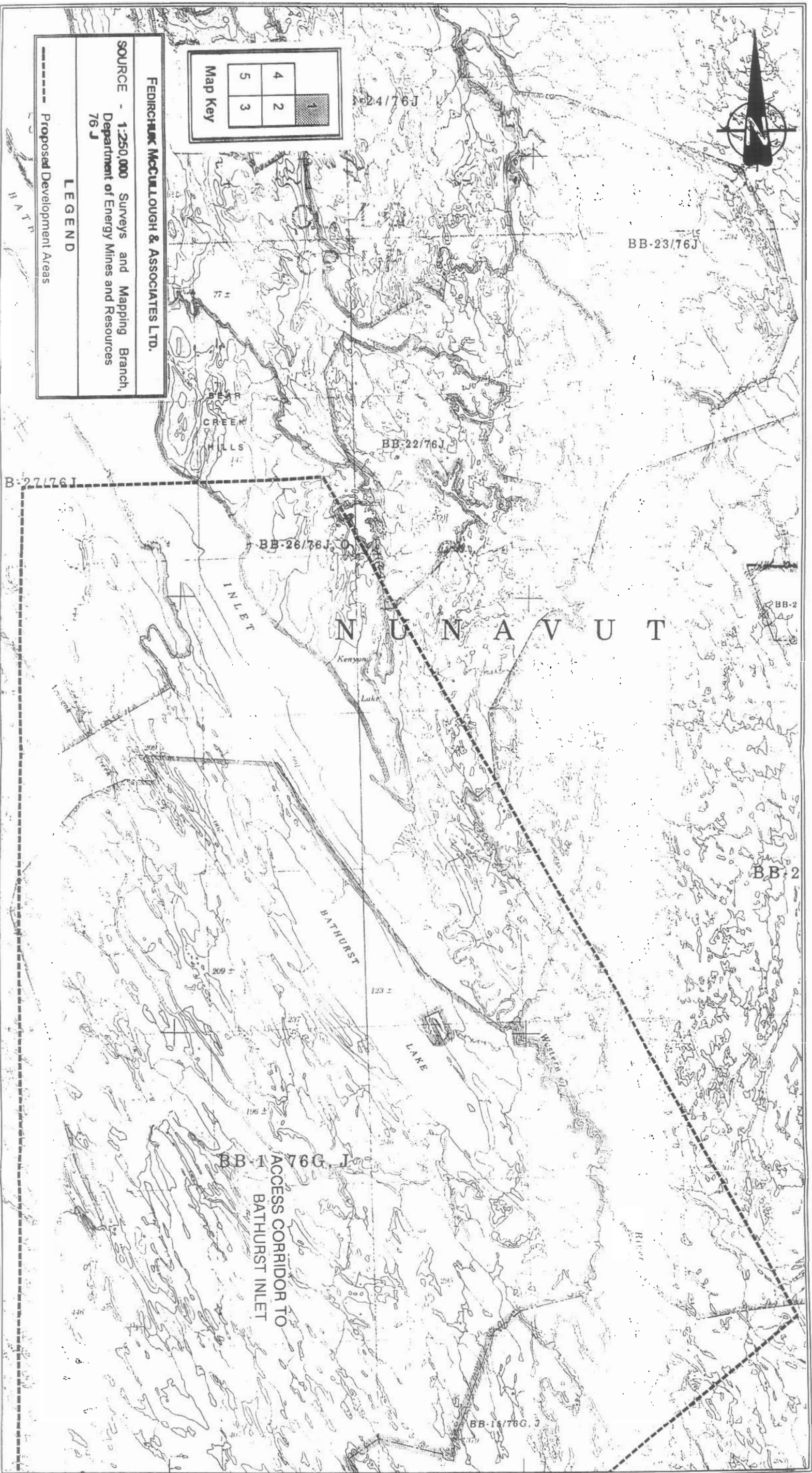
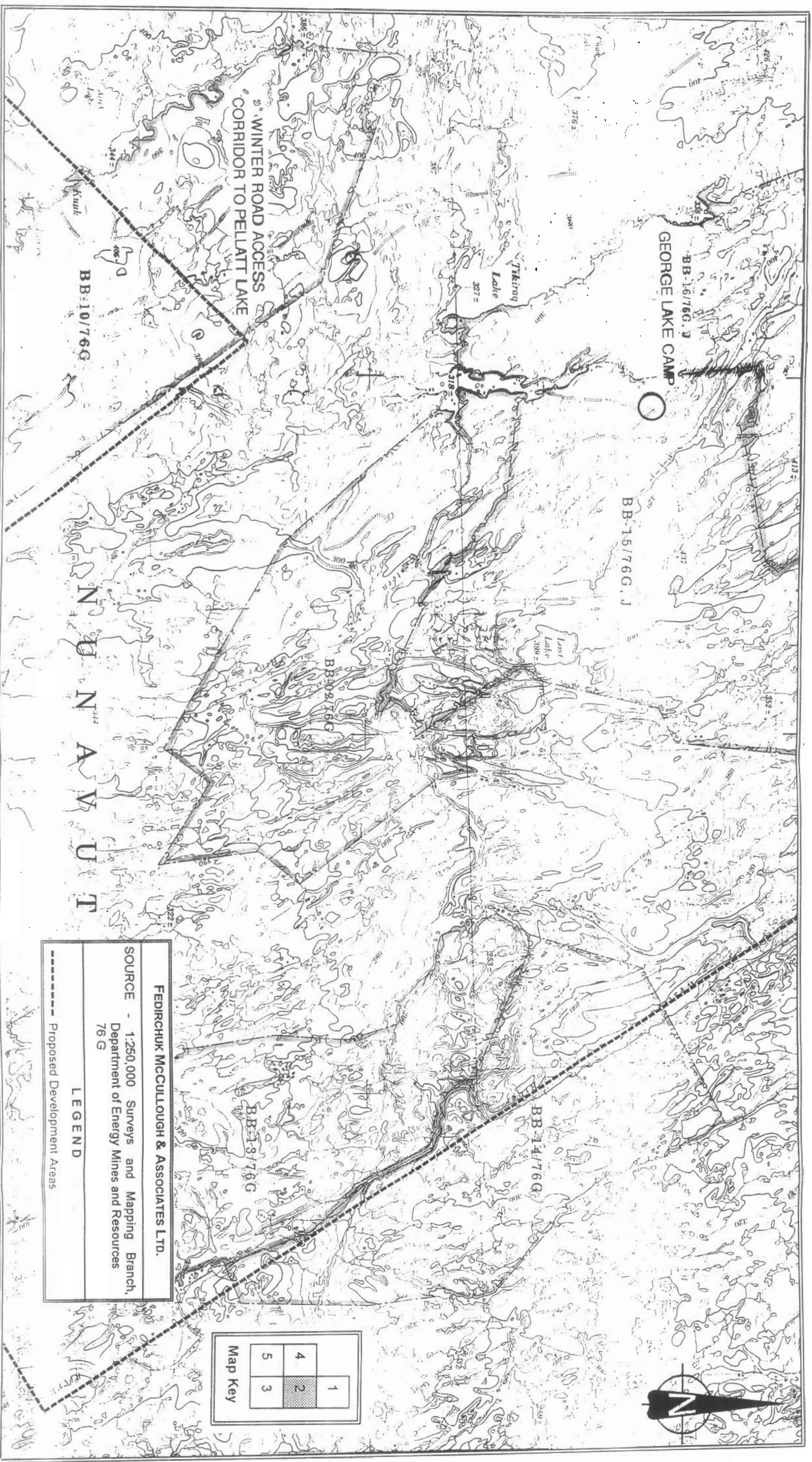


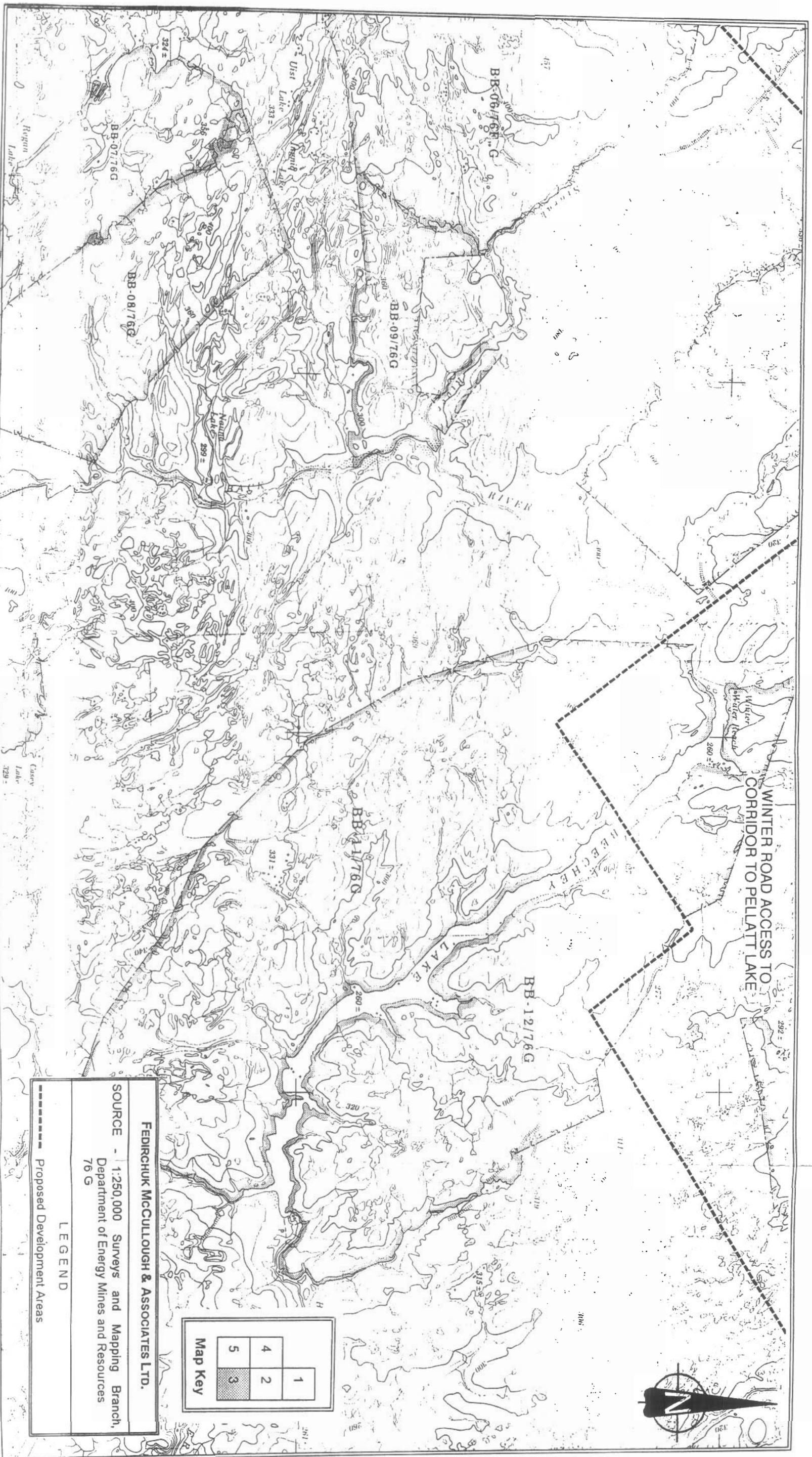
Figure 1 : Location Map

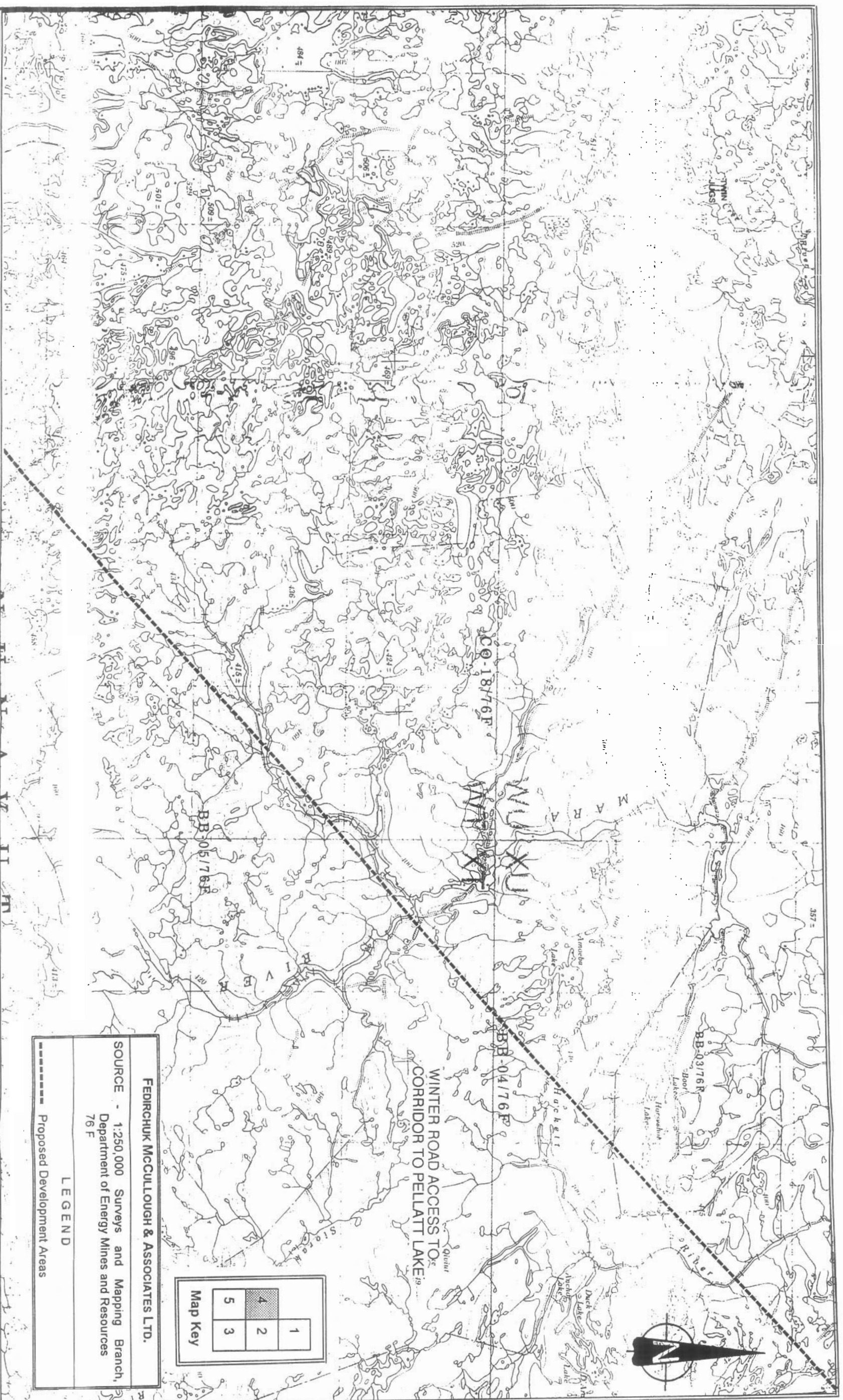
FIGURE 2

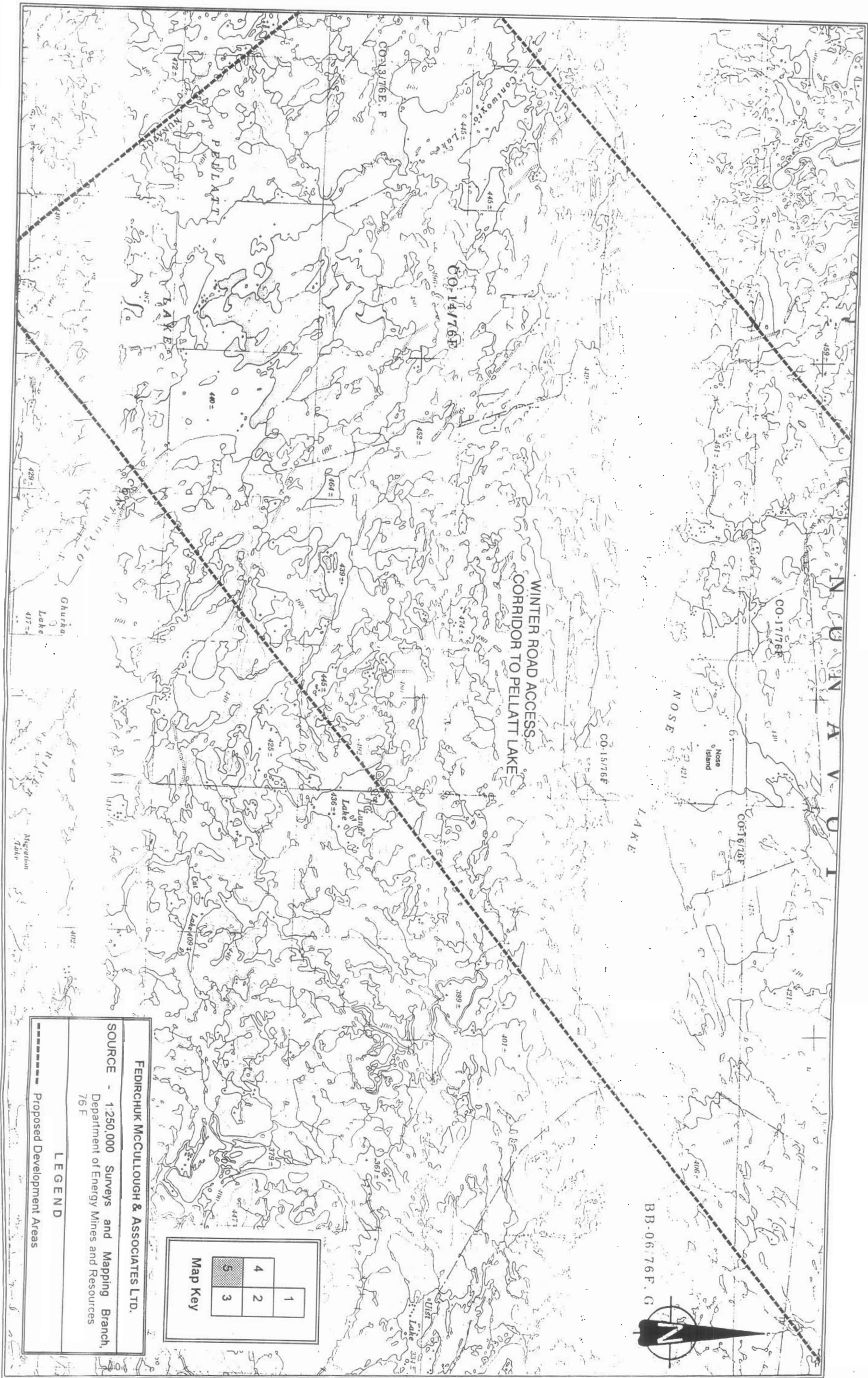
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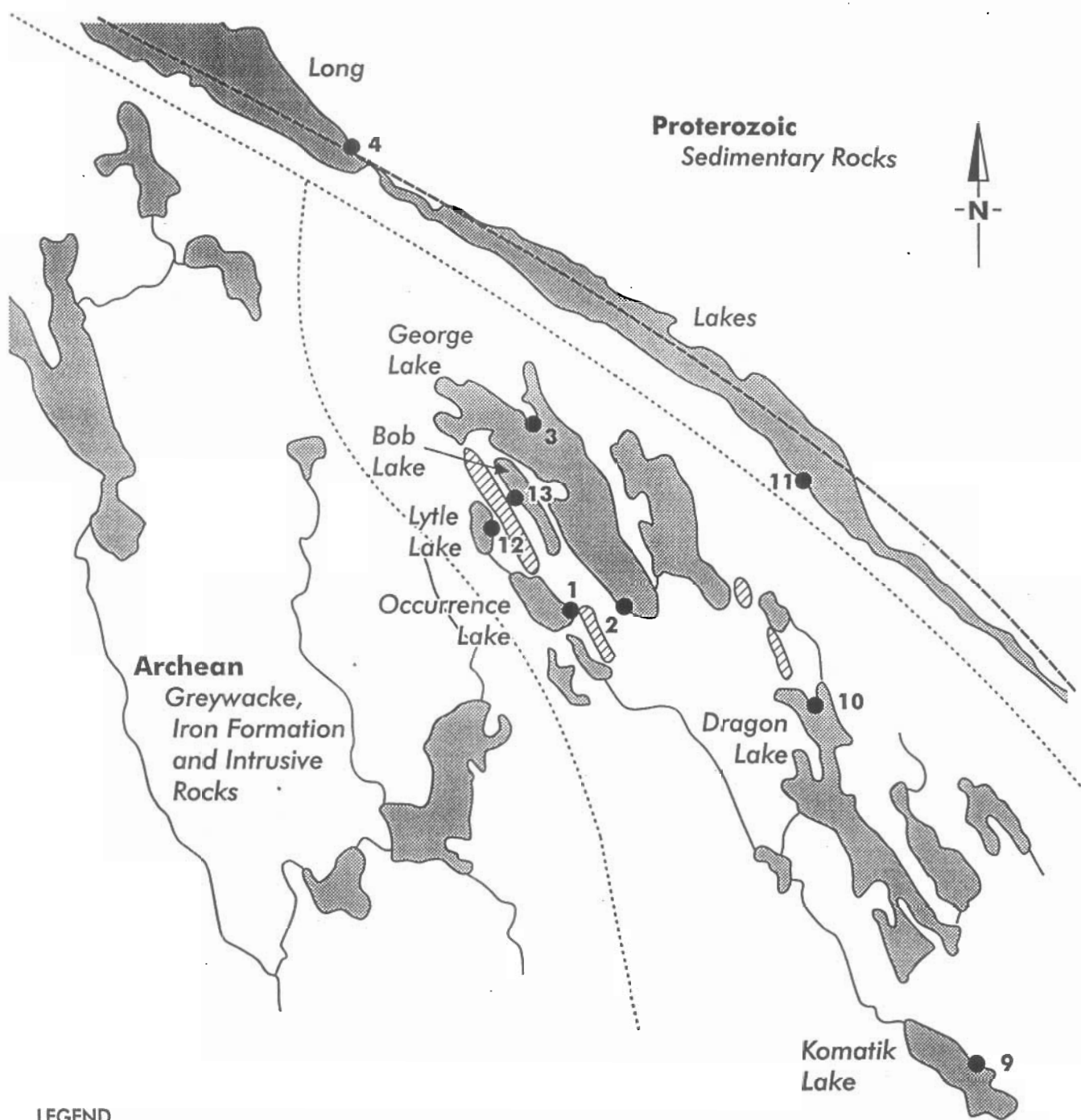












LEGEND

Water Quality Sites (1997)



Drainage Divide



Geological Unconformity



Sulphide Zone where Drilling has been Performed



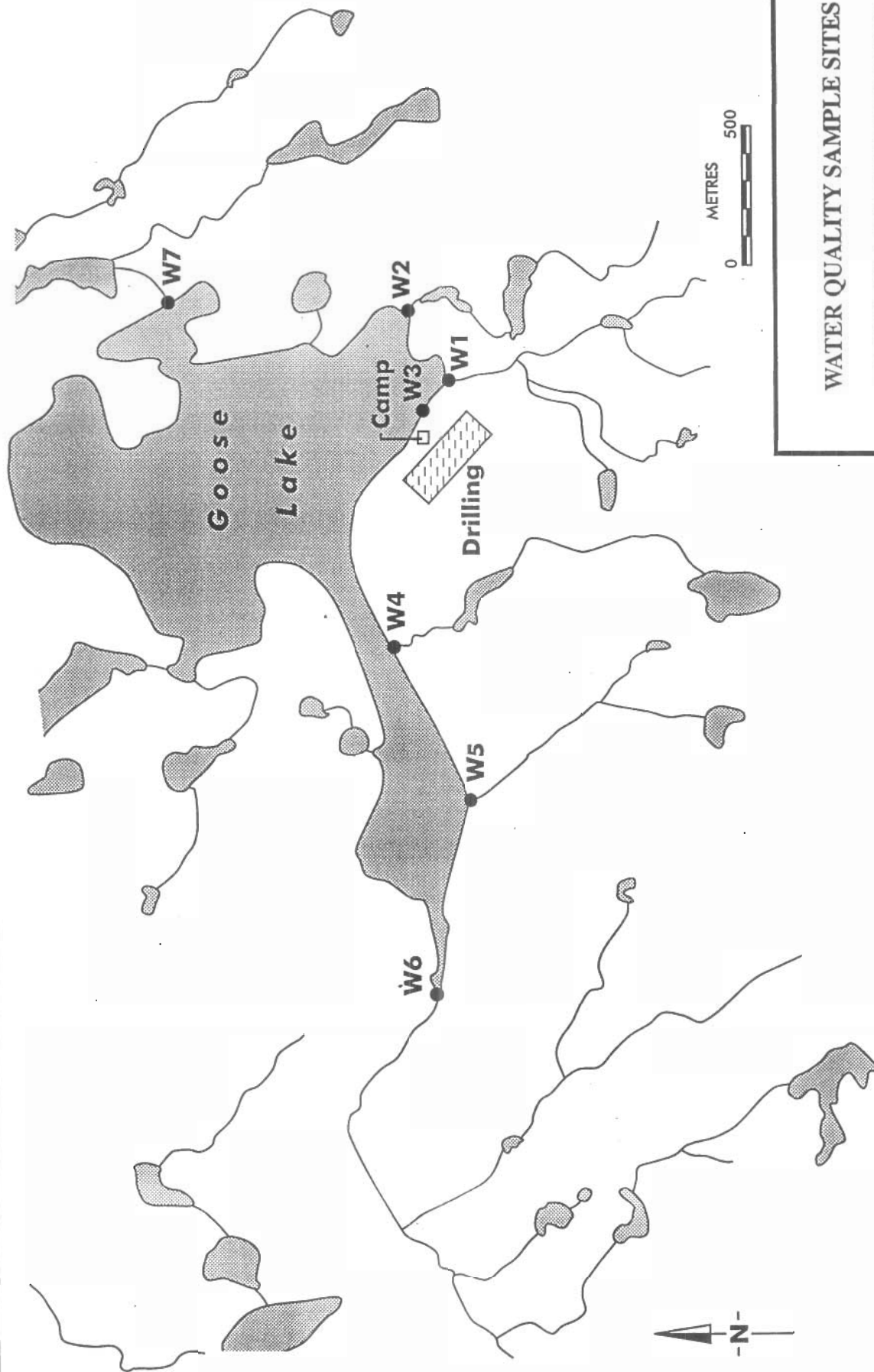
WATER QUALITY SAMPLE SITES

GEORGE LAKE, NORTHWEST TERRITORIES

GEORGE LAKE JOINT VENTURE

MAY 1997

FIGURE 3



WATER QUALITY SAMPLE SITES

GOOSE LAKE, NORTHWEST TERRITORIES

GEORGE LAKE JOINT VENTURE

MAY 1997

FIGURE 4

NDM-36203-001-cdr-goslake

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