

PROJECT SPECIFIC INFORMATION
IZOK/HOOD EXPLORATION
2006/2007
NUNAVUT, CANADA

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July 2006

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1.0 SUBMISSIONS

1.1. INTRODUCTION

This document is submitted to the Nunavut Impact Review Board to meet the requirement for Project Specific Information Requirements (PSIR) for Mineral Exploration to be conducted on Wolfden Resources Inc.'s Izok and Hood properties throughout the fall of 2007 and the full year of 2007.

A completed NIRB Screening Part 1 Form, Project Proposal Summary is provided in Appendix A. A detailed description of the project proposal is provided in Section 2 of this Submittal.

1.2. REPORT ORGANIZATION

This report has been organized and structured to facilitate NIRB's screening of the project according to the sequence of headings provided in their Screening Part 2 Form, Project Specific Information Requirements (PSIR) for Mineral Exploration. Accordingly the headings of this document are arranged according to the following hierarchy.

1.2.1. FIRST LEVEL HEADINGS

The first level headings in this report correspond directly by number to the main headings set out in the PSIR screening form.

These are:

1.0 SUBMISSIONS
2.0 PROJECT DESCRIPTION
3.0 DESCRIPTION OF THE EXISTING ENVIRONMENT
4.0 IDENTIFICATION OF IMPACTS
5.0 MITIGATION OF IMPACTS
6.0 CUMULATIVE EFFECTS
7.0 SUPPORTING DOCUMENTS

1.2.2. SECOND LEVEL HEADINGS

The second level headings are arranged in this report to correspond to the second level headings set out in bold type in the PSIR form.

These are as follows:

TABLE 1 – PSIR/Wolfden Report Headings	
PSIR Form Category Heading	**Wolfden Report Heading Number and Title**
General	2.1 General
Project Information	2.2 Project Information
Geophysical	2.3 Geophysical Surveys
Drilling	2.4 Drilling Programs
Transport	2.5 Transport
Camp Site	2.6 Ham Camp Site
Equipment	2.7 Equipment
Water	2.8 Water Sources
Waste (Grey water, sewage, Other)	2.9 Waste Management
Fuel	2.10 Fuel Management
Chemicals and Hazardous Materials	2.11 Chemicals and Hazardous Materials
Explosives	2.12 Explosives
Public Involvement/Traditional Knowledge	2.13 Public Consultation and Traditional Knowledge

1.2.3. PSIR ORGANIZATION

The following table outlines the correspondence between the numbered PSIR's in NIRB's Screening Part 2 Form and the second and third level headings in Wolfden's Project Description report. For the reader's ease of reference, the NIRB PSIR numbers are also stipulated in the section headings in the main body of the report.

Table 2 – Cross-Reference of PSIR's to Wolfden Report Sections/Titles	
PSIR Number and Description	**Wolfden Report Section**
1. Name and Location of Project	2.1.1 Project Name and Location
2. Contact Information	2.1.2 Contact Information
3. List of acts, regulations and guidelines	2.1.3 Acts, Regulations and Guidelines that Apply to Project Activities
4. List of Approvals	2.1.4 List of Approvals, Permits and Licenses Required Including the Authorizing Agency, Activity to Which the Authorization Applies and Dates.

Table 2 – Cross-Reference of PSIR's to Wolfden Report Sections/Titles	
PSIR Number and Description	**Wolfden Report Section**
5. History of Site	2.2.1 History
6. Map of project site, in regional context	2.2.2 Maps of Project Sites Figure 1
7. Map of project site related to water bodies and wildlife	2.2.2 Maps of Project Sites Figure 2 and 3.
8. Type of Mineral Resource	2.2.3 Type of Mineral Resource Under Exploration
9. Project Need and Purpose	2.2.4 Project Need and Purpose
10. Project Alternatives	2.2.5 Project Alternatives
11. Type of Exploration Activities	2.2.6 Type of Mineral Exploration Activities
12. Description of All Activities	2.2.7 Project Activities
13. DFO Operational Statements	2.2.8 DFO Operational Statements
14. Agreement to Meet DFO Operational Statements	2.2.9 Proponent to Meet Conditions of DFO Operational Statements
15. Schedule of DFO Operational Statement Related Activities	2.2.10 Schedule of Activities in DFO Operational Statements
16. Geophysical Activities	2.3.1 Ground Geophysics
17. Flight Lines below 300 m Altitude	2.3.2 Airborne Geophysics
18. Number of Drill Holes	2.4.1 Number of Holes
19. Drill Additives	2.4.2 Drill Additives
20. Drill Cutting Procedures	2.4.3 Drill Cuttings
21. Drill Water Procedures	2.4.4 Drill Water
22. Drill Equipment Mobilization	2.4.5 Drill Equipment Mobilization and Movements
23. Drill Hole Abandonment	2.4.6 Drilling Areas Restoration
24. Radiation Exposure	2.4.7 Radiation Exposure
25. Site Access and Supply	2.5.1 Site Access and Supply Lines
26. Airstrip Use and Construction	2.5.2 Airstrip Use
27. Existing Camp Structures	2.6.1 Location, Structures and Infrastructure Figure 4
28. Type of Camp	2.6.2 Type of Camp
29. Maximum No. of People on Site	2.6.3 Occupancy
30. Power Source for Camp	2.6.4 Power Source for Camp
31. List of Equipment	2.7.1 List of Equipment
3.2. Photos of Equipment	2.7.2 Photographs of Equipment
33. Methods of Moving Equipment	2.7.3 Methods of Moving Equipment Within the Project Site
34. Location of Water Sources	2.8.1 Water Source Locations

Table 2 – Cross-Reference of PSIR's to Wolfden Report Sections/Titles	
PSIR Number and Description	**Wolfden Report Section**
	Figure 5
35. Rate of Water Consumption	2.8.2 Rate of Water Consumption
36. Water Intakes	2.8.3 Water Intakes
37. Waste Management	2.9 Waste Management
38. Type and Quantities of Fuels	2.10.1 Types and Quantities of Fuel
39. Secondary Containment of Fuel	2.10.2 Secondary Containment
40. Method of Fuel Handling and Transfer	2.10.3 Fuel Transfer and Refueling
41. Type and Quantities of Chemicals	2.11.1 Type and Quantities of Chemicals
42. Chemical Secondary Containment	2.11.2 Secondary Containment of Chemicals
43. Methods of Chemical Transfer	2.11.3 Chemical Transfer
44. Explosive Types	2.12 Explosives
45. Public involvement	2.13 Public Involvement/Traditional Knowledge

1.3. SUPPORTING DOCUMENTS

Maps showing the location of the project site within the regional context of the area as well as specific work areas relating to the diamond drilling activities, camp and water source locations are provided as Figures 1 through 4.

The completed NIRB Screening Forms 1 and 2 are provided in Appendix A and B.

A selection of photographs is provided in Appendix C.

A Spill Contingency Plan is provided in Appendix D.

An Abandonment and Restoration Plan for the Ham Lake Camp and drill sites is provided in Appendix E.

2.0 PROJECT DESCRIPTION

A completed NIRB Screening Part 1 Form, Project Proposal Summary is provided in Appendix A. The following section provides greater details of the project description and operations to supplement the brief summary provided on the form.

2.1. GENERAL

2.1.1. PROJECT NAME AND LOCATION (PSIR 1)

The Izok/Hood project is located in the Izok/Itchin Lakes area approximately 70 km west of the Lupin Mine in the West Kitikmeot region of Nunavut. Boundary UTM coordinates are:

Min Lat (degree/minute)	Izok – 65 / 37' 30"N Hood – 66 / 03' 50" N	Min Long (degree/minute)	Izok – 112 / 45' 25" Hood 112 / 32' 30"
Max Lat (degree/minute)	Izok 66 / 38' 00" N Hood 66 / 07' 16" N	Max Long (degree/minute)	Izok 112 / 46' 30" W Hood 112 / 47' 50" W
NTS Map Sheet No:	IZOK – 86 H / 10 HOOD – 86 I / 2		

Ham Lake Camp location:

Min Lat (degree/minute)	65 40' N	Min Long (degree/minute)	65 41' N
Max Lat (degree/minute)	112 50' W	Max Long (degree/minute)	112 51' W
NTS Map Sheet No:	86H/10		

Drilling to be conducted on Mining lease 3202 and NTI Lands CO-40 Sub-areas A and B (Hood area), West Kitikmeot Region, Nunavut.

Latitude: 66 8" N Longitude: 99 37" W NTS Map No. 82I/2 Scale 1:50:000

The existing camp is located at the southern end of Ham Lake on its southwestern shore. The camp it self is situated on a gravel point adjacent to Ham Lake, Figure 4.

The Wolfden Resources Inc. Izok and Hood Projects are mineral exploration projects focused on base metal exploration in the Point Lake-Itchen Lake volcanic belt and the

Takiyuak greenstone belt. The Izok and Hood Projects are located in the Kitikmeot region of Nunavut, approximately 360km north and 425km north Yellowknife, NWT respectively. The closest population center is Kugluktuk, located 265 km north of the camp on the Izok property.

The Izok and Hood Projects are contained within the Takijua Lake Upland Ecoregion. This ecoregion takes in the eastern half of the Bear–Slave Upland south of Coronation Gulf. Much of the upland surface is composed of unvegetated rock outcrops that are common on the Canadian Shield. The mean annual temperature is approximately -10.5°C with a summer mean of +6°C and a winter mean of –26.5°C. The mean annual precipitation range is 200–300 mm.

2.1.2. CONTACT INFORMATION (PSIR 2)

The principal contact Wolfden Resources for this project will be:

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401-1113 Jade Court
Thunder Bay, Ontario P7B 6M7
Phone: 807-346-1668
Fax: 807-345-0284
e-mail: andrew.mitchell@wolfdenresources.com

Additional Wolfden staff with involvement in the project will include:

Ewan Downie – President and Chief Executive Officer
John Begeman – Chief Operating Officer
Ian Neill, P.Geo. – Exploration Manager
David Stevenson P.Geo. – Exploration Manager
Steven Filipovic – Controller

Subcontractors or contractors include:

Gartner Lee Limited
3015 – 5 Ave. NE, Suite N195
Calgary, AB T2A 6T8
Phone: 403-262-4299 x120
Facsimile: 403-264-8412

Major Drilling
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PO Box 1377
Yellowknife, NT X1A 2P1
Phone 867-873-3358

Wardrop Engineering Inc.
330 Bay Street, Suite 604
Toronto ON, M5H 2S8
Phone: 416.368.9080
Fax: 416.368.1963

Great Slave Helicopters
Bag 7500 1
Yellowknife, NT X1A 2R3
Phone 867 873 208

Discovery Mining Services - expediting services
101 – 487 Range Lake Rd.
PO Box 2248
Yellowknife, NT X1A 3R9
Phone 867 920 4600

2.1.3. ACTS, REGULATIONS AND GUIDELINES THAT APPLY TO PROJECT ACTIVITIES (PSIR 3)

The following is a list of the applicable acts, regulation and guidelines to that apply to the planned activities.

- *Article 13 - Nunavut Land Claims Agreement*
- *NWB - Water Licensing in Nunavut - Interim Procedures and Information Guide*
- *for Applicants*
- *NWTWB - Guidelines for the Discharge of Treated Municipal Wastewater in the*
- *NWTWB - Guidelines for Contingency Planning*
- *DFO - Freshwater Intake End of Pipe Fish Screen Guideline*
- *DFO - Fisheries Act - s.35*
- *RWED - Environment Protection- Spill Contingency Regulations*
- *Canadian Drinking Water Quality Guidelines*
- *Public Health Act Camp Sanitation Regulations*
- *Public Health Act Water Supply Regulations*
- *Territorial Land Use Act and Regulations*
- *Nunavut Research Institute – Field Permits for Environmental Data Collection*
- *Department of Culture, Language, Elders and Youths (CLEY) – Field Permits for Archaeological Data Collection/Mitigation*

2.1.4. LIST OF APPROVALS, PERMITS AND LICENSES REQUIRED INCLUDING THE AUTHORIZING AGENCY, ACTIVITY TO WHICH THE AUTHORIZATION APPLIES, AND DATES. (PSIR 4)

Leases and Mining Claims

IZOK

Mining Lease numbers: ML 3163, ML 4474, ML 4475

Surface leases: 86H/10-1-7, 86H/10-2-7

Mining Claims currently in the process of becoming Mining Leases: F20609 Itch 3, F20610 Itch 4, F23290 Scratch 1

HOOD

Mining Lease numbers: ML 3201,ML 3202,

Surface Lease, 86I/2-1-7

Applications in Processing

Water License application submitted to the Nunavut Water Board June 1, 2006

NIRB screening form completed.

INAC Land Use Permit application, dated June 1, 2006, for Crown land at Izok Lake

KIA Land Use License Application Submitted June 1, 2006

2.2. PROJECT INFORMATION

The information in the following sections is drawn from our experience and our drilling contractor's experience in operating a diamond drill programs in the region as well as background information obtained from a variety of sources. One of the principal sources of environmental background information is a report titled *"Environmental Evaluation, Izok Project – Submission to the Regional Environmental Review Committee"*. The title page and covering letter shows the report as being prepared by Klohn Crippen Consultants Ltd. on behalf of Metall Mining Corporation and submitted to the Regional Environmental Review Committee on December 15, 1993. Selected information taken from the Metall report has been summarized under the in the relevant headings in the following sections of this report. More comprehensive excerpts are contained in Appendix B.

A selection of site photographs is provided in Appendix C.

2.2.1. HISTORY (PSIR 5)

Izok Property

The Izok property was first explored for base metals in 1971 by Texasgulf Inc. and by 1974 massive base metal sulphide mineralization was discovered. Historically, the property was explored through the 70's, 90's and early 2000's. Wolfden obtained the properties in April 2006 from Inmet Mining Corporation and is planning to begin work this summer to further identify and define resources.

Hood Property

The Hood property was first explored by Texasgulf Inc. /Kidd Creek Mines Ltd. for volcanogenic massive sulphide ("VMS") deposits between 1971 and 1983. During this work, six new zones of VMS mineralization were discovered. Exploration was not continued until 1990, when Falconbridge Ltd. conducted a limited program of mapping, re-logging of drill core, pulse EM, and whole rock chemistry over selected parts of the property.

2.2.2. MAPS OF PROJECT SITES (PSIR 6, 7)

A map of the project site within a regional context indicating the distance to the closest communities is provided on Figure 1. Maps of the project sites indicating existing and/or proposed infrastructure, proximity to water bodies and proximity to wildlife is provided as Figures 2 and 3. A map of the camp layout is provided on Figure 4.

2.2.3. TYPE OF MINERAL RESOURCE UNDER EXPLORATION (PSIR 8)

The Izok and Hood properties are base metal properties with resources of zinc, copper, lead and silver and further expansion and delineation of these resources will be the objective of the planned exploration programs. There will be no deliberate exploration for diamonds, uranium, or other commodities.

2.2.4. PROJECT NEED AND PURPOSE (PSIR 9)

Additional exploration is needed at the Izok and Hood properties to increase the scientific and engineering understanding of the ore deposits. This is required to expand the mineral resource both in quantity, by extending beyond known boundaries and in quality by upgrading the resource classification. The purpose of this project is to intersect additional base metal mineralization by diamond drilling beyond the known extent of the mineralized zones as determined by previous workers at the sites.

2.2.5. PROJECT ALTERNATIVES (PSIR 10)

Diamond drilling is required at this stage of a project. Less involved, simpler means of locating base metal mineralization such as prospecting, geological mapping and geophysical surveys have already been conducted extensively throughout the property areas and the project has progressed past the stage where these activities would be valuable exploration tools. Therefore, the only alternative is now to continue the diamond drilling work at the properties from the point at which it was left off by previous workers.

2.2.6. TYPE OF MINERAL EXPLORATION ACTIVITIES (PSIR 11)

Geophysics ***(PSIR 11, First bullet)***

At the time of application, geophysical surveys were not planned in this project, either ground or airborne. If Wolfden's plans change in this regard, formal application will be made for an amendment to the project description and applicable permits and licenses.

Exploration Drilling ***(PSIR 11, Second Bullet)***

We propose to drill up to approximately 30,000 m on the Izok and Hood properties (combined) in 2006. Plans for 2007 have not been determined and will depend on budgetary factors and the results of the 2006 drilling. The majority of the drilling is planned for Inuit Owned Land areas; however the borehole locations have not been finalized and it will be necessary to access crown land for drilling setups. The number of drill holes and number of meters are estimates and will change as the drilling programs progress.

Stripping and/or Trenching ***(PSIR 11, Third Bullet)***

No stripping or trenching is planned.

Deposit Drilling/Preliminary Delineation Drilling ***(PSIR 11, Fourth Bullet)***

See Exploration Drilling above.

*Bulk Extraction (****PSIR 11, Fifth Bullet)***

No bulk sampling or bulk extraction of overburden or ore is contemplated in this project.

2.2.7. PROJECT ACTIVITIES (PSIR 12)

Satellite Remote Sensing ***(PSIR 12, First Bullet)***

Basemaps and photographic underlays will be taken from satellite remote sensing data.

Aircraft Remote Sensing ***(PSIR 12, Second Bullet)***

Aircraft borne remote sensing involving aerial photography may be obtained in 2007. There are no firm plans as of submission of this project description.

*Soil Sampling (****PSIR 12, Third Bullet)***

A program of soil sampling may be conducted be conducted as part of the environmental baseline studies, to be carried out in 2007. Research permits will be applied for in early 2007. As with our High Lake project, field work plans will be distributed to interested parties as they become available.

*Sediment Sampling (****PSIR 12, Fourth Bullet)***

A program of lake sediment sampling may be conducted be conducted as part of the environmental baseline studies, to be carried out in 2007. Research permits will be applied for in early 2007.As with our High Lake project, field work plans will be distributed to interested parties as they become available.

On Land Drilling ***(PSIR 12, Fifth Bullet)***

A Boyles Model 17 or 37 unitized drill rig will be used.

On Ice Drilling ***(PSIR 12, Sixth Bullet)***

A Boyles Model 17 or 37 unitized drill rig will be used.

*Overburden Removal (****PSIR 12, Seventh Bullet)***

There will be no overburden removal in the program. Equipment will be moved by helicopter.

*Road Construction (****PSIR 12, Eighth Bullet)***

There will be no summer road construction. Equipment and personnel will be transported by fixed wing aircraft and helicopter. If a winter drill program is implemented, the existing trails between the Ham Lake Camp, Iznogoudh Lake and Izok Lake may be reused. They traverse mainly over ice.

*Airstrip Use and/or Construction (****PSIR 12, Ninth Bullet)***

The airstrip at the existing Ham Lake Camp will be used for aircraft operations. Some grading and repair will be required prior to placing the strip back in to full operation. This will be done within the existing footprint of the airstrip.

Camp Use and Construction ***(PSIR 12, Tenth Bullet)***

The existing Ham Lake Camp site will be reoccupied for these programs. Because of the condition of the trailers on the site additional living space will be provided by deploying a temporary Weatherhaven tent camp, which will be erected on the existing camp site. No additional site preparation, grading, backfilling or other ground disturbance outside the existing graveled areas of the camp will be required.

Fuel Transport and Storage ***(PSIR 12, Eleventh Bullet)***

The fuel types to be used include diesel fuel, gasoline and propane. In addition to petroleum fuels, motor oil and grease and polymer additives will be utilized in the drilling operations. Diesel fuel will be used in the greatest quantity as motor fuel for the drill rigs and fuel for the camp power generators. Gasoline will be used in engines for small generators, power tools, and all-terrain vehicles used at the camp site and air strip.



Diesel Fuel

There are seven (7) 12,000 gallon (55,000 litre) storage tanks at the camp site, which is located on leased crown land. Secondary containment berms, lined with an impermeable polymeric liner provide secondary containment for the fuel storage area.

Ham Lake Fuel Storage Facility

Diesel fuel will be flown in by aircraft tanker and transferred to the large storage tanks by a fuel tank pulled on a trailer behind a pickup truck from the air strip to the tank farm. The fuel will be transferred from tank to tank using portable electric or gasoline powered fuel transfer pumps. The fuel will then be transferred to 205 litre drums and flown by helicopter to the drill sites. Fuel at the drill sites will be stored in drums placed on spill containment pallets. Typically the drilling contractor will maintain an inventory of 1 to 2 drums at the drill site. Consumption is expected to be in the order of 4-600 litres per day while operating, extending to approximately 80,000 litres for a 3 month work program, with two drills running. Actual consumption will vary depending on the nature of drilling operations.

Gasoline

Gasoline will be handled in 205 litre drums, which will be flown in by aircraft to the air strip and carried in the box of a pickup truck to the tank farm area at the camp. Gasoline will be transferred from drums to portable containers using hand pumps. In the order of 2,050 litres (10 drums) will be kept in inventory at the camp. For a 90 day operating period, consumption is estimated to be 4-600 litres.

Propane

Propane will be flown in to the airstrip in 100 lb or 20 lb bottles. They will be manually unloaded from the aircraft and carried in the box of a pickup truck to the general area of the fuel tank farm for storage. As needed, bottles will be carried to the drill sites by helicopter or to the points beside the camp buildings where the supply hoses protrude from the walls of the structures. Empty bottles will be flow out on a regular basis for refilling. An inventory of fifty (50) one hundred pound bottles will be maintained at the camp. Each drill rig will generally have one or two 20 pound capacity bottles on the drill set up site for torch use and one or two 100 lb. bottles for shack heating.

Jet B

Aviation Fuel (Jet B) will be used for helicopter operations and will be stored at the airstrip site in 205 litre drums. An inventory of approximately100 drums will be kept at the site during operations. Fuel will be transferred from the drums to the aircraft using hand actuated pumps or using battery powered electric pumps. An inventory of approximately 100 drums (20,500 litres will be maintained at the strip. Fuel will be flown in by fixed wing aircraft.

Explosives Transport and Storage ***(PSIR 12, Twelfth Bullet)***

No explosives will be used in the planned exploration programs.

Chemical Transport and Storage ***(PSIR 12, Thirteenth Bullet)***

Chemicals such as drill additives, calcium chloride, detergents and other goods will be transported to the Ham camp site via fixed wing aircraft and unloaded at the camp's airstrip. The packages and containers will be transported by truck to the camp area and placed into storage. Small packages will be placed in the storage sheds at the camp. Larger packages such as the bags of calcium chloride will either be stored in the cam's buildings or placed outdoors on pallets, wrapped in polyethylene sheeting and tarped over. Immediately prior to use, bags or containers of chemicals will be transported to their place of use by carrying by hand or by placing the containers in pick up trucks for movement around the camp site. For the drilling materials, the containers will be slung with a helicopter and deployed at the drill site.

Pit and Quarry Use ***(PSIR 12, Fourteenth Bullet)***

No work involving extraction of aggregate from pits or quarries is contemplated.

Other - Environmental Baseline Surveys ***(PSIR 12, Fifteenth Bullet)***

Environmental baseline studies are expected to be carried out, mainly in the Izok Lake area. The scope of work for the fall of 2006 will be limited to surface water sampling and preliminary terrestrial ecology and archaeological surveys. Fully developed work plans will be provided for work to be conducted in 2007. In a similar manner to the work that Wolfden is undertaking at its other properties, including High Lake, these plans will be fully disclosed to interested parties as the work progresses.

Work within Navigable Waterways ***(PSIR 12, Sixteenth Bullet)***

No work within navigable waters is contemplated.

2.2.8. DFO OPERATIONAL STATEMENTS (PSIR 13)

None of the following Department of Fisheries and Oceans (DFO) Operational Statement (OS) activities apply to the project proposal:

- Bridge Maintenance
- Clear Span Bridge
- Culvert Maintenance
- Ice Bridge
- Routine Maintenance Dredging

2.2.9. PROPONENT TO MEET CONDITIONS IN DFO OPERATIONAL STATEMENTS (PSIR 14)

N/A -No activities planned that are covered by DFO Operational Statements

2.2.10. SCHEDULE OF ACTIVITIES IN DFO OPERATIONAL STATEMENTS (PSIR 15)

N/A -No activities planned that are covered by DFO Operational Statements

2.3. GEOPHYSICAL SURVEYS (PSIR 16, 17)

2.3.1. GROUND GEOPHYSICS (PSIR 16)

No geophysical work is planned at the current time. If the need arises in the future, the information regarding the extent and type of surveys to be conducted will be submitted prior to undertaking the work.

2.3.2. AIRBORNE GEOPHYSICS AND FLIGHT LINES AT ALTITUDES BELOW 300 M (PSIR 17)

No airborne geophysical surveys are planned. Flight operations below 300 m would be restricted to landings and take-offs for fixed wing aircraft at the Ham Lake camp as well as helicopter operations moving drill rigs, equipment and personnel.

2.4. DRILLING PROGRAMS (PSIR 18 - 24)

2.4.1. NUMBER OF HOLES (PSIR 18)

Up to 50 boreholes totaling 30,000 m of drilling is planned for 2006 split between the two properties, time and weather permitting. The number and total footage of drilling for 2007 has not been determined.

2.4.2. DRILL ADDITIVES (PSIR 19)

Table 1 below provides a list of the possible drill additives that may be used are:

Table 3: Possible Drill Additives

Brand Name	Constituent
Poly-Drill O.B.X.	Liquid Polymer
Poly-Drill 133-X	Liquid Anionic Polymer
Poly-Drill 1330	Liquid Anionic Polymer
Linseed Soap	Soap/Detergent

Peladow	Calcium Chloride salt

Polymer Drill Additives are contained in 20 litre pails or in small plastic bags or cardboard box packages. These products will be transported to the drill with general supplies by helicopter. Packaging is disposed of with other refuse by incineration.

2.4.3. DRILL CUTTINGS (PSIR 20)

Water used during drilling is conserved with a closed system of circulation. Drill cuttings will be collected in a sludge recovery system that allows them to settle out. The accompanying water will be returned down the hole. The cuttings are then bagged and transported to natural sumps chosen as to be located more than 50 m from the closest water source and with sufficient opportunity for filtration through local soils.

2.4.4. DRILL WATER (PSIR 21)

Water used in drilling will be re-circulated within a closed system. A small amount of water is actually consumed at the bit face, but the majority returns to surface where it is passed through settling tanks to substantially settle particulate matter (cuttings) and then returned down the hole. When drilling ceases, overflow from the settling tanks will run off and percolate into local soils, providing further filtration before eventually returning naturally to local watercourses as ground water. Surface runoff during or after drilling will be contained or channeled so it will be filtrated and not directly enter watercourses.

2.4.5. DRILL EQUIPMENT MOBILIZATION AND MOVEMENTS (PSIR 22)

Drill equipment will be moved from off-property to the Ham Camp by fixed wing aircraft, landing on the strip at the camp. The drill rigs and equipment will be moved from hole to hole using a helicopter.

2.4.6. DRILLING AREAS RESTORATION (PSIR 23)

After each drill hole is completed any trash and litter is gathered up and transported back to camp for either burning or flying out to Yellowknife. Capped casing pipes are expected to be used to mark hole locations were significant mineralization was intersected. The drill will be dismantled into its main components as per the drilling contractor procedure, packaged and secured along with its ancillary equipment and rods. The drill will be flown out to another project or to a storage site designated by the drilling contractor. Drill sites will be inspected for soil impact. Remaining waste will be taken to camp to be burned if possible or to be flown out to an approved municipal discharge. Greywater and sludge sumps, if excavated will be filled and leveled. A layer of peat moss will be spread on top and slightly fertilized to promote natural

growth. As much as possible, drill sites will be restored immediately after the drill has been moved to the next site and sumps have drained enough to be leveled.

2.4.7. Radiation Exposure (PSIR 24)

The project does not involve uranium exploration drilling. The potential for radiation exposure is therefore considered to be absent or extremely slight. Radiation protection measures are not considered to be required.

2.5. Transport (PSIR 25, 26)

2.5.1. Site Access and Supply Lines (PSIR 25)

The site will be accessed by chartered air service from Yellowknife, NWT. Supplies will be brought to the site by air. Fixed wing aircraft will land on the existing 3000 foot air strip at the Ham camp. Drilling operations will be supported by a dedicated helicopter, which will be used to transport personnel, fuel, drill core, equipment and any other needed items to and from the drill sites. The location of the Ham Camp in the regional setting is shown on Figure 1. Aircraft are expected to fly directly to the Camp from Yellowknife, or fly from the Lupin mine to Ham Camp directly.

2.5.2. Airstrip Use (PSIR 26)

The airstrip to be used is situated approximately 100 m south of the Ham Camp complex as shown on the Camp Layout map, Figure 4. The runway is 1000 m long and 25 m wide and is surfaced with locally sourced sand and gravel materials.

2.6. Ham Camp Site (PSIR 27-30)

2.6.1. Location, Structures and Infrastructure (PSIR 27)

The camp is located on the South and East Shores of Ham Lake. The camp was established by the previous operator of the exploration project, Inmet Mining Corporation (Inmet). The camp includes an accommodation complex, diamond drill core logging and storage facilities, garages, fuel storage facilities and is served by a 2,500 foot long gravel air strip. The layout of the camp is shown on Figure 4.



Ham Camp from the Air Facing North

From an inventory provided by Inmet, following is a list of the major components of the camp

and ancillary facilities.

Major Camp Equipment/Facilities
13 – Travco trailer units
8 – 4' x 44' camp matting
1 – Oil fired incinerator (serial no. 18162)
1 – 10' x 44' Generator Building
2 – Cummins 150 kW diesel generators (serial no's. 44670421 and 4460441)
1 – Steel garage – 20' x 24'
2 – Wood frame, steel clad core storage warehouses
1 – Wood frame, aluminum clad 12' x 36' skidded core shack

Fuel Tanks
7 – 12,000 gal fuel skid mounted fuel tanks

Mobile Equipment
1 – Caterpillar D-6 Bulldozer
1 – Champion Motor Grader
1 – Fuel Trailer
1- 1992 Ford Supercab F-350 trucks (diesel)

A map showing the layout of the camp and airstrip is provided on Figure 4.

The existing facilities have fallen into disrepair and the majority of the PTI Travco trailers at the site would be uninhabitable, therefore a temporary Weatherhaven camp will be established on the existing camp site. This camp will include the following equipment.

2.6.2. TYPE OF CAMP (PSIR 28)

The Ham Camp may be considered permanent in the context of exploration related camp facilities; however, it should not be considered as a permanent accommodation facility as are found at operating mines. A temporary Weatherhaven tent camp will be set up on the site, to house personnel for 2006 and 2007 or until such time as the main camp (Travco trailers) can be rehabilitated for occupancy or removed from the site.



Weatherhaven Camp For Ham Lake

2.6.3. OCCUPANCY (PSIR 29)

A maximum of 40 persons will be in camp at any given moment. It is anticipated that, on average the occupancy will be around 20 people.

2.6.4. POWER SOURCE FOR CAMP (PSIR 30)

The camp is powered by diesel generators listed above (2 Cummins 150 kW diesel generators, serial no's. 44670421 and 4460441).



Diesel Generator Units

2.7. EQUIPMENT (PSIR 31, 32, 33)

2.7.1. LIST OF EQUIPMENT (PSIR 31)

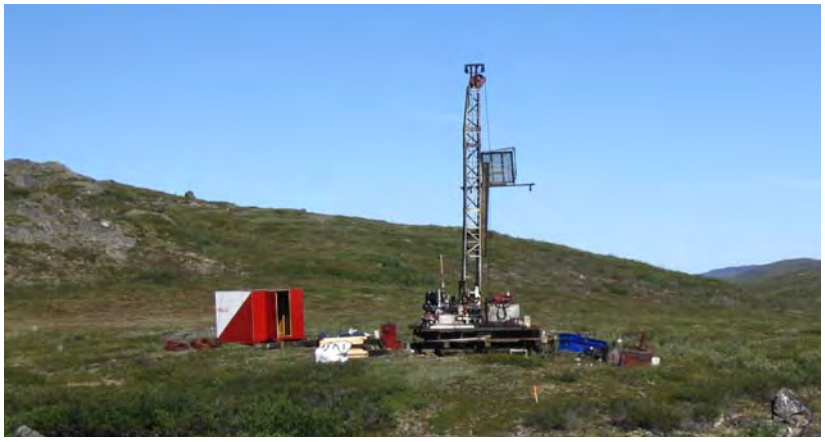
The following table contains the essential drilling equipment used in field operations. There are additional items of equipment that are located at the Ham Lake Camp; however these are not listed because they would only be used in camp operations, which take place on a Crown Land lease area.

Table 4 – Equipment to be Used

Type & Number	Size	Proposed use
Boyles 17 or 37 Unitized, skid mounted Diamond Drill rig (2)	Approx. 5,000 lbs each, 12' x 14'	Drilling boreholes at the Izok Lake and Hood properties
Bean Water Supply Pump (2)	Approx 4' x 6'x 4' high, 1500 lbs	Pumping Water To Drill
Helicopter (1)	A Star or Bell 206 Jet Ranger	Moving drill, transporting personnel
Fixed Wing Aircraft (1)	Twin Otter	Moving personnel and supplies to site

2.7.2. PHOTOGRAPHS OF EQUIPMENT (PSIR 32)

Following are photographs of the equipment listed in Table 2.



Boyles 17 Drill Rig Set up on a Borehole



Bell 206 Jet Ranger Helicopter



Drill Water Supply Pump Enclosure



Twin Otter Aircraft at High Lake

2.7.3. METHODS OF MOVING EQUIPMENT WITHIN THE PROJECT SITE.

Equipment will be moved using helicopters and fixed wing aircraft.



Helicopter Drill Move with Bolyes 17 Drill Rig and A-Star Helicopter

2.8. WATER SOURCES (PSIR 34, 35, 36)

2.8.1. LOCATION (PSIR 34)

A variety of small water bodies will supply the water for the drilling. At Izok, most of the holes will be near Izok Lake itself; therefore most of the volume for drilling there will come from Izok Lake. For Hood, a variety of small lakes may be accessed. In general, it is time consuming to move a supply pump, so lakes will be chosen to be central to the drilling sites. Water supply for the camp will come directly from Ham Lake.

2.8.2. RATE OF WATER CONSUMPTION (L/D). (PSIR 35)

- Camp: 5,000 L/d – maximum
- Drills: 20,000 L/day - maximum

2.8.3. WATER INTAKES (PSIR 36)

The camp water intake uses an electrically powered submersible pump with a fine screen (<1/4" openings) on the intake. The drill pumps use a 1" inside diameter suction hose on the diesel pumps with a fine screen on the foot valve. For drilling, fiberglass window screen with a nominal opening size of less than 1/16" is also generally wrapped around the foot valve to prevent the intake of silt and sand into the pump, which can cause considerable damage to the pump chambers. In addition, it is common practice for the drilling contractor to place the foot valve of the intake hose in a perforated 20 L pail, which further protects against harmful materials and fish from being entrained into water intake hoses.

2.9. WASTE MANAGEMENT (PSIR 37)

2.9.1. SEWAGE

The new Weatherhaven camp is equipped with Pacto type toilets. Sewage waste will be incinerated.



Pacto Toilets

2.9.2. CAMP GREY WATER

Camp greywater will be disposed of into a dry pit located to the southeast of the Travco trailer units. Greywater will be allowed to percolate into the sand gravel soils at a minimum distance of approximately 50 m from Ham Lake.

2.9.3. COMBUSTIBLE SOLID WASTE

Combustible solid waste will be incinerated at the Ham camp incinerator.

2.9.4. NON-COMBUSTIBLE SOLID WASTE

Non combustible solid waste will be stored on site and periodically flown out to a suitable, licensed landfill site off-site.

2.9.5. BULKY ITEMS/SCRAP METAL

Scrap metal and any other non-combustible refuse will be collected and sealed in 205 L drums and then transported to Yellowknife for disposal at an approved site.

2.9.6. WASTE OIL/ HAZARDOUS WASTE

Waste oil will be collected and sealed in clearly marked 205 L drums and transported to Yellowknife for disposal at an approved site... Lead-acid batteries will also be contained in appropriate sealed containers, clearly marked, and transported to Yellowknife for disposal at an approved site.

2.9.7. EMPTY BARRELS/FUEL DRUMS

Empty drums will be collected and transported Yellowknife either for disposal at an approved site or for refilling.

2.10. FUEL MANAGEMENT (PSIR 38, 39, 40)

2.10.1. TYPES AND QUANTITIES (PSIR 38)

The fuel types to be used include diesel fuel, gasoline and propane. In addition to petroleum fuels, motor oil and grease and polymer additives will be utilized in the drilling operations. Diesel fuel will be used in the greatest quantity as motor fuel for the drill rigs. Gasoline will be used in engines for small generators, power tools, all-terrain vehicles and light trucks used at the camp site and air strip.

Diesel Fuel - There are seven (7) 12,000 gallon (55,000 litre) storage tanks at the camp site, which is located on leased crown land. Diesel fuel will be flown in by aircraft tanker and transferred to the large storage tanks by a fuel tank pulled on a trailer behind a pickup truck from the air strip to the tank farm. The fuel will be transferred from tank to tank using portable electric or gasoline powered fuel transfer pumps. The fuel will then be transferred to 205 litre drums and flown by helicopter to the drill sites. Fuel at the drill sites will be stored in drums placed on spill containment pallets. Typically the drilling contractor will maintain an inventory of 1 to 2 drums at the drill site. Consumption is expected to be in the order of 4-600 litres per day while operating, extending to approximately 80,000 litres for a 3 month work program, with two drills running. Actual consumption will vary depending on the nature of drilling operations.

Gasoline will be handled in 205 litre drums, which will be flown in by aircraft to the air strip and carried in the box of a pickup truck to the tank farm area at the camp. Gasoline will be transferred from drums to portable containers using hand pumps. In the order of 2 050 litres (10 drums) will be kept in inventory at the camp. For a 90 day operating period, consumption is estimated to be 4-6,000 litres.

Propane will be flown in to the airstrip in 100 lb or 20 lb bottles. They will be manually unloaded from the aircraft and carried in the box of a pickup truck to the general area of the fuel tank farm for storage. As needed, bottles will be carried to the drill sites by

helicopter or to the points beside the camp buildings where the supply hoses protrude from the walls of the structures. Empty bottles will be flow out on a regular basis for refilling. An inventory of fifty (50) one hundred pound bottles will be maintained at the camp. Each drill rig will generally have one or two 20 pound capacity bottles on the drill set up site for torch use and one or two 100 lb. bottles for shack heating.

Aviation Fuel (Jet B) will be used for helicopter operations and will be stored at the airstrip site in 205 litre drums. An inventory of approximately100 drums will be kept at the site during operations. Fuel will be transferred from the drums to the aircraft using hand actuated pumps or using battery powered electric pumps. An inventory of UP TO 100 drums (20,500) litres will be maintained at the strip. Fuel will be flown in by fixed wing aircraft.

2.10.2. SECONDARY CONTAINMENT (PSIR 39)

The seven 55,000 L tanks are arranged inside a secondary containment berm, which is lined with a polymetric impermeable liner.

2.10.3. FUEL TRANSFER AND REFUELING (PSIR 40)

Diesel Fuel will be flown in by aircraft tanker and transferred to the large storage tanks by a fuel tank pulled on a trailer behind a pickup truck from the air strip to the tank farm. The fuel will be transferred from tank to tank using portable electric or gasoline powered fuel transfer pumps. The fuel will then be transferred to 205 L drums and flown by helicopter to the drill sites. Vehicles operated within the camp will be fueled directly from a dispensing system installed at the tank farm. A day tank on the generators is also fueled directly by pump and hose from the tank farm.

2.11. CHEMICALS AND HAZARDOUS MATERIALS (PSIR 41, 42, 43)

2.11.1. TYPE AND QUANTITIES (PSIR 41)

Motor Oil – An inventory of approximately 1,000 L of motor oils and hydraulic oils will be maintained at the Ham camp for the drill rigs and generators at the camp. The products will be will be supplied in 1L, 4 L or 20 L plastic containers stored in the generator enclosure, or in one of the storage sheds at the camp. For the purpose of this project description submission, the inventory of lubricating oils will be approximately 5 (five) cases of twelve 1 L containers, 10 (ten) cases of four - 4 L containers and 20 (twenty) pails of 20 L capacity. This inventory will be maintained during operations and resupplied as needed by regular air service to the site. These products will be used as crankcase oils in the diesel engines that power the electrical generators, diesel engines on the drill rigs, gasoline engines in small equipment such as portable electrical generators, outboard boat motors and turbine lubricants in

helicopters and fixed wing aircraft. The containers will be stored on spill containment pallets.

Bariod Grease – An inventory of approximately 10 (ten) cases of twelve cartridges each will be maintained at the site, stored in the generator enclosure or storage sheds. Baroid grease is used as a maintenance lubricant for the drill rigs and vehicles on the site, applied to the equipment by grease gun. Due to the small packages and high viscosity of the product, secondary containment will not be provided. Packages will be handled with appropriate care to minimize the risk of spills.

Drill Rod Heavy Grease – An inventory of ten (10) 20 L pails of drill rod heavy grease will be maintained at the camp, stored in either the generator enclosure or storage sheds. The product will be shelved or the pails placed on the shed floor or stacked one upon the other. Drill Rod Heavy grease is highly viscous and would not flow out of a ruptured container, therefore secondary containment measures are not contemplated.

Drill Mud/Additives

Drill muds and polymetric additives will be used in the drilling operations to assist in the recovery of core or to prevent freezing of the drilling fluid. The following table provides an estimate of the expected inventory of these products on-site at the Ham camp.

Table 5: Drill Additive Storage and Containment

Product	No.	Size	Location	Containment
Poly-Drill O.B.X.	10	20 L Pail	Generator/Shed	Spill Containment Pallet
Poly-Drill 133-X	10	20 L Pail	Generator/Shed	Spill Containment Pallet
Poly-Drill 1330	10	20 L Pail	Generator/Shed	Spill Containment Pallet
Linseed Soap	5	20 L Pail	Generator/Shed	None
Peladow	100	40 Kg Bag	Shed/Garage	None

Antifreze – An inventory of approximately 140 L of ethylene glycol based antifreeze will be maintained at the site. The product will be contained in either four L plastic jugs, or 20 L plastic pails. For the purpose of this project description we have assumed that 10 four litre jugs and five 20 L pails may be stored on site. Antifreze will be stored in the generator enclosure or in a storage shed at the camp. Four litre containers will be shelved. 20 L pails will be stored on a manufactured secondary containment pallet.

Calcium Chloride – Will be supplied to the site under the trade name Peladow. The product is supplied in 20 kg plastic and paper bags. An inventory of up to 100 bags

will be maintained on the site. The product will be stored either in a storage shed at the site or placed on pallets and stored in the garage. Peladow is a granulated product; therefore, secondary containment is not contemplated.

Lead Acid Batteries will be present on the drill rigs, in the pickup trucks and heavy equipment and on the diesel engines for the electrical generators. In addition a small number of batteries may be needed for other portable items such as generators. Spares will be maintained on site. For the purpose of this project description, we have assumed that five (5) spare lead acid batteries will be kept in the generator enclosure or storage shed. Secondary containment measures are not contemplated given the small number of batteries in storage.

Cleaners - An inventory of cleaners will be maintained on the site for the general maintenance and cleaning of the camp buildings and equipment. It is difficult to estimate with certainty the number of small containers of items such as soaps and detergents; however, the following table provides an estimate of the quantities of cleaning supplies expected to be inventoried on the project, their storage and containment requirements.

Table 6 – Cleaners and Solvent Storage and Handling

Product	No.	Size	Location	Containment
Varsol	2	100 L Drum	Generator	Drip Pan
Floor Cleaner	10	1 L Bottle	Camp	None
Dish Soap	10	1 L Bottle	Camp	None
Dishwasher Detergent	10	5 kg Box	Camp	None
Window Cleaner	5	750 mL Bottle	Core Shack	None
Laundry Detergent	10	10 kg Box	Camp	None
Misc. Solvents	10	<1 L Bottles	Camp/Generator	None
Spray Cleaners	20	<1 L Can	Camp/Generator	None
Spray Solvents	20	< 1 L Can	Camp/Generator	None

2.11.2. SECONDARY CONTAINMENT (PSIR 42)

Secondary containment measures for chemical products will be provided according tot the nature of the chemical (liquid vs. solid), the quantity stored and the manner of use. For liquid products such as lubricating oils spill containment pallets will be provided underneath the product containers. For solids, tarps and/or polyethylene sheets will be placed under the pallets or the bags/pails of product where significant quantities are stored.

2.11.3. CHEMICAL TRANSFER (PSIR 43)

Chemicals will generally be transferred directly to the end use machinery from the containers that the products were provided in. Considering the nature of the operations, generally less than 20 L of product will be transferred at a time. Spill kits will be kept on hand to clean up any product spilled in the transfer process. For solid products, such as Peladow, the bags will be opened directly over the water tanks into which the product will be placed. Used chemical products will be returned to empty containers and stored for shipment off-site. Used motor oil will be accumulated in sealed, labeled 205 L drums for shipment off-site.

2.12. EXPLOSIVES (PSIR 44)

There will be no explosives storage at the Ham camp or anywhere in the project area.

2.13. PUBLIC INVOLVEMENT/ TRADITIONAL KNOWLEDGE (PSIR 45)

Wolfden actively employs from local communities wherever possible, and have hired employees from Cambridge Bay, Bathurst Inlet and Kugluktuk to work on our High Lake project. Wolfden will endeavor to continue this good relationship with the local communities with continued employment opportunities for field personnel in the 2006 and 2007 seasons.

As the environmental baseline studies are renewed from Inmet's work and continue on the project in 2007, a significant part of the work will involve the gathering of Traditional Knowledge (TK) baseline data. As with our High Lake project, community consultation and outreach will become a key part of the TK program. This will involve community meetings, discussions and elders site tours amongst the more scientific and academic work.

As with our High Lake project, field work plans will be shared with interested parties, a quarterly newsletter will initiated and regular progress meetings with regulators and community leaders will be scheduled. Wolfden representatives will also likely attend trade shows and symposia in the region to communicate the progress of work on the project. The strategic plan used for the company's High Lake project will be updated to include the other projects in our Amaqqut group of projects, which includes the Izok project.

3.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

The majority of the background data for this section has been taken from a report prepared by Inmet Mining Corporation titled 'Metall Mining Corporation, Izok Project Environmental Evaluation" dated December 15, 1993. Wolfden is not aware if the report was published or submitted to regulatory or public scrutiny as a supporting document for a regulatory submission or not. The report is quite comprehensive and several thousand pages in length and was evidently prepared for the full scale industrial development of the Izok Project as a producing open pit base metal mine.

Considering the comparatively slight undertaking proposed in the current project description (diamond drilling and mineral exploration only) only a very small portion of the work presented in Inmet's report is presented in the following discussion. Also considering the limited scope of work in this proposal, we have not gone to the effort of rigorously fact-checking the materials in the Metall report, nor is there extensive cross referencing back to published literature or supporting documents to Inmet's main 1993 report.

3.1. PHYSICAL ENVIRONMENT

The following section describes the physical environment in the Izok/Hood area following the headings provided in Appendix A of NIRB's Screening Part 2 Form, Project Specific Information Requirements.

3.1.1. PROXIMITY TO DESIGNATED ENVIRONMENTAL AREAS

There are no known Designated Environmental Areas in close proximity to, or that would be influenced or impacted by, exploration activities occurring on the Izok and Hood properties. Wolfden's approach to all of its activities ensures that minimal or no disturbance to the environment occurs. Mitigation measures, adaptive management and a policy for active and on-going reclamation are policies, principles and actions that are applied to all project activities to ensure environmental protection.

3.1.2. ESKERS AND OTHER UNIQUE LANDSCAPES

The most significant esker type landform in the project area is the Ham Lake esker located approximately 8.5 km to the northwest of Izok Lake. This is a roughly east-west trending landform that is composed largely of gravelly sand soils. The Ham Camp site, including the air strip is situated on this esker.

3.1.3. EVIDENCE OF GROUND, SLOPE OR ROCK INSTABILITY, SEISMICITY

In general, the terrain in the Izok area does not include the type of landforms that lend themselves to significant geological instabilities. The topography is relatively gentle

with flat or gently sloping gradients. The surficial geology of the area is dominated by areas of thin, discontinuous drift deposits, shallow and exposed bedrock, till and glaciofluvial deposits of sand and gravel. Extensive deposits of organic soils, peat, swamp and marine or lacustrine clay are not found in the area. Because of this, ground, slope and rock instability issues are not large. There is evidence of thermokarst in the glaciofluvial (esker) deposits; however there is no work planned for these areas.

The earthquake history of northern Canada is brief and incomplete. The largest recorded earthquakes to have occurred within the region were in 1985 Nahanni events, which were magnitude 6.6 and 6.9 events, which occurred on December 23 near Fort Simpson. The Izok project site is approximately 750 km distance from the epicenter of these events. The National Building Code of Canada places Yellowknife in Seismic Zone 1, which is the lowest risk zone in the classification scheme. Because of these factors, seismicity is not expected to be of significance for this project.

3.1.4. Evidence of Thermokarsts

The occurrence of massive ground ice within the Ham Lake Esker was found to be consistent with the presence of circular thaw ponds and depressions (thermokarst) along the flanks of the esker. Extensive areas of thermokarst outside of glaciofluvial deposits such as the Ham Lake Esker are not reported in Inmet's reports.

3.1.5. Evidence of Ice Lenses

From investigations conducted by Inmet as part of the overall engineering and environmental studies for the Izok Project published in 1993, ground ice was found to occur in till at between 10% and 50% of the soil volume in till. Massive ice lensing was also found in the core of the Ham Lake esker, with drill hole results indicating massive ice lenses up to 10 m thick.

3.1.6. Topography

Topograpy in the area is characterized by gently rolling hills with relative elevation changes in the order of 20-30 m over several kilometers. The surface topography is largely controlled by the underlying bedrock surface, with the highest points of land largely being promontories of exposed bedrock.

3.1.7. Surface and Bedrock Geology

Turbic and Static Cryosols soil types have formed on thin discontinuous sandy morainal and fluvioglacial materials, and in association with rock outcrops, dominate the uplands. Organic Cryosols are the dominant soils in the lowlands.

Bedrock in the region consists mainly of massive Archean rocks that form broad, sloping uplands, plateaus, and lowlands. The Bathurst Hills form a prong of rugged ridges that reach about 610 m above sea level and stand as much as 185 m above nearby lakes.

3.1.8. TOPOGRAPHY

Topograpy in the area is characterized by gently rolling hills with relative elevation changes in the order of 20-30 m over several kilometers. The surface topography is largely controlled by the underlying bedrock surface, with the highest points of land largely being promontories of exposed bedrock.

3.1.9. PERMAFROST

The Izok Project site lies well within the region of continuous permafrost. Ground temperatures reported by Inmet in 1993 are typically below -5oC below the zone of seasonal variation. The seasonally active layer was also estimated by Inmet to be between 1 m in moist till soils and 4 m in elevated, drained bedrock areas. Typical active layer depth in well drained esker was estimated to be 2 m.

3.1.10. HYDROLOGY/LIMNOLOGY

The hydrological features in the Izok project area that are described in Inmet's report include: the Ham Lake and Iznogoudh Lake Catchments; and the Ham Creek Discharge. The flow of water is from northwest to southeast from Ham Lake to Iznogoudh Lake, from Iznogoudh Lake to Izok Lake and finally from Izok Lake to Itchin Lake. Ham lake has a catchment area of approximately 155 km^2. Iznogoudh Lake has a catchment area of approximately 312km^2, including the Ham catchment of 155 km^2.

Discharge rates in Ham Creek measured by Inmet's consultant ranged from11.3 m^3/s in June to 0.7 m^3/s in September of 1993. Ham Creek is expected to freeze to the bottom in the winter. Discharge from Iznogoudh to Izok Lake through Izok creek were measure at a maximum of 23.9 m^3/s on June 22 and 24th, 1993 and at a low of 3.0 m^3/s on September 10, 1993. Itchin Lake is considerably large that either Ham or Izok Lake and details are not reported in Inmet's report.

The Metall report provides bathymetric information for Ham, Izok and Itchin Lakes. The deepest basin of Ham Lake was found to be the northwest basin at a maximum depth of 11.7 m., with a mean depth of 2.18 m, a surface area of 306.3 ha and a volume of 6.69 x 10^6 m^3. Izok Lake was found to have a maximum depth of 18.7 m, with a mean depth of 4.8 m, a surface area of 141.3 ha and a volume of 6.7 x 10^6 m^3.

Itchen Lake is a considerably larger and more complexly formed lake than Ham or Izok Lakes. Metall reports a maximum depth of 36.5 m, a surface area of 1100 ha, a mean depth of 12.9 m and a volume of 142 x 10^6 m^3 of water.

Extensive data compilation and interpretation of water quality in Ham, Iznogoudh and Itchin Lakes is presented in the Metall report and the level of detail and complexity far exceeds that practical for presentation in this screening response. Given the relatively non-invasive nature of the work proposed and considering the proportionally trivial water takings (less than 100 m^3/d from lakes containing tens to hundreds of millions of m^3/d), detailed water and sediment chemistry is not be provided herein. If more details are required by individual parties, the water chemistry and sediment quality data can be taken from Inmet's report and provided for their information.

3.1.11. TIDAL PROCESSES AND BATHYMETRY

The site is situated several hundred kilometers inland from the Arctic Ocean; therefore, tidal processes do not factor in to the environmental aspects of the Izok project. General bathymetry of the inland lakes in the project area is presented under the Hydrology/Limnology heading above. Additional information on the bathymetry of Ham, Iznogoudh and Itchin Lakes can be made available on request.

3.1.12. WATER QUALITY AND QUANTITY

Water quality data is available from Inmet's work in 1993 and can be made available upon request. Estimates of water quantity both in lake storage and streamflow are provided under the Hydrology/Limnology heading above.

3.1.13. AIR QUALITY

No significant information was available from Inmet's 1993 study. The site is very remotely situated with respect to anthropogenic influences on air quality. Other than global, continent scale or regional impacts on air quality, it is not anticipate that baseline air quality conditions would be other than pristine, naturally occurring conditions.

3.1.14. CLIMACTIC CONDITIONS

The Izok project site is located in the Continental Tundra climactic zone, approximately midway between Yellowknife and Kugluktuk. Average July temperature is approximately 10°C and average January temperature is approximately -31°C. Precipitation averages about 260 mm per year, half of which occurs between October and June. The average length of winter (days below 0°C) is 235 days.

3.1.15. NOISE LEVELS

No significant information was available from Inmet's 1993 study concerning pre-existing noise levels. The site is very remotely situated with respect to anthropogenic influences on ambient noise levels. It is not anticipated that baseline ambient noise levels would represent other than pristine, naturally occurring conditions.

3.1.16. OTHER PHYSICAL VEC'S

None have been identified with respect to the exploration level of operations in this proposal.

3.2. BIOLOGICAL ENVIRONMENT

3.2.1. VEGETATION

The Izok Project is contained within the Takijua Lake Upland Ecoregion. This ecoregion is classified as having a low arctic ecoclimate. Numerous lakes fill its lowlands. Vegetative cover is characterized by shrub tundra, consisting of dwarf birch, willow, northern Labrador tea, Dryas spp., and Vaccinium spp. Depressional sites are dominated by willow, sphagnum moss, and sedge tussocks. Scattered stands of spruce occur along the southern boundary of the ecoregion.

3.2.2. WILDLIFE

Sixteen species of terrestrial mammals occupy the Izok Lake area. These include Wolf, Wolverine, Grizzly Bear, Muskox, Caribou and a variety of small mammal species.

3.2.3. BIRDS

The short arctic summer and abundant daylight is an ideal breeding environment for migratory birds. Only four species can be considered residents of the arctic region for the full year round. These are: the raven, gyrfalcon, and two species of ptarmigan.

From Inmet's report, the following table provides a list of the bird species observed in and around the Izok project area:

Table 7 - Checklist of Birds Observed During 1993 Field Season (Metall report)	
Species	**Location**
Common loon	Iznogoudh Lake
Yellow-billed loon	Iznogoudh Lake
Red-throated loon	Ham Lake
Canada Goose	Ham Lake, Iznogoudh Lake
Pintail	Izok Lake
Lesser scaup	Iznogoudh Lake
Oldsquaw	Izok Lake, Ham Lake
Common merganser	Ham Lake
Semipalmated plover	Ham Lake
Common snipe	Izok Lake
Parasitic jaeger	Ham Lake
Golden eagle	Izok Lake
Rough-legged hawk	Iznogoudh Lake, Izok Lake
Peregrine falcon	Itchen Lake, Ham Lake
Rock ptarmigan	Iznogoudh Lake
Eastern phoebe	Izok Lake
Horned lark	Common throughout area
Cliff swallow	Ham Lake
Raven	Ham Lake
Grey cheeked thrush	Izok Lake
American robin	Izok Lake
Yellow warbler	Itchen Inlet
Harris sparrow	Izok Lake
White crowned sparrow	Izok Lake

3.2.4. SPECIES OF CONCERN

Within Nunavut the main species of concern include mammals (Caribou, Muskox, Grizzly and Polar Bears, Wolves, Fox, Shrew, Marine mammals), birds (Peregrine Falcon, Arctic Tern), fish (Arctic grayling, bull trout), and rare vegetation. Species at risk in Nunavut have been identified and include the following mammals and birds:

Mammals

- Polar Bear (Species of Special Concern on Schedule 3 of SARA)

Birds

- Eskimo Curlew
- Peregrine Falcon
- Ross's Gull

Where these species of concern may be encountered during Wolfden's exploration activities, the Wildlife Management Plan associated with this project will be implemented. The Wildlife Management Plan outlines measures to be taken to avoid these species and if encountered, then how to ensure minimal disturbance.

3.2.5. FISHERIES

Inmet commissioned R.L. & L. Environmental Services Ltd. to conduct fisheries studies in the summer of 1992 and 1993. Fish communities and habitat conditions were assessed in Ham, Iznogoudh, Izok and parts of Itchen Lake. These studies identified the presence of five species of fish. These included, in order of abundance in the catch, lake trout (*Salvelinus namaycush*), round whitefish (*Prospopium cylindraceum)*, longnose sucker (*Catostomus catstomus*) lake cisco (*Coregonus artedii*), and arctic grayling (*Thymallus arcticus*).

3.2.6. VEC'S

The Metall report describes a number of VEC's for the full scale mine development project, which do not translate well to the modest scale of the proposed undertaking , i.e. diamond drilling programs.

3.2.7. SOCIOECONOMIC ENVIRONMENT

Archaeology

The 1993 assessment carried out by Inmet began with an aerial assessment and was followed up with foot surveys over land. The study area encompassed the Ham Lake esker, Izok Lake, Itchen Inlet and the haul road along the shore of Iznogoudh Lake. Coverage included both high and low potential terrain though the emphasis was placed on high potential locales. Three sites are shown on the Inmet maps within the planned area of operations. One near the Ham Camp site, the other two along the south shore of Izok Lake. The find near the camp (Borden N. LkPc 1) is characterized as lithic scatter including retouched siltsone biface fragment, one retouched siltsone flake and one quartz flake. The two sites on the south shore of Izok Lake are designated LjPc 2 and LjPc 3. LjPc 2 includes lithic scatter including 7 quartz flakes and 1 quartz core. LjPc 3 is described as a camp site or lookout site and included one argillite flake, 23 quartz flakes, and 2 quartzite flakes.

The largest concentrations of cultural heritage resources finds are along the north shore of Ham Lake, which is not part of our operating area for this project. All of the proposed drill sites would be situated in areas of rocky ground and not on areas of typically high heritage resources potential such as eskers.

Land Resources Use

Historic Land Use Patterns – Three specific time periods that mark changes in land use patterns were noted in Inmet's reports. These are: pre-1916, 1916 – 1955 and 1955 – 1975. The pre-1916 maps showed the largest extent of use of the area by the Coppermine hunters and trappers encompassing the area bounded by Bluenose Lake, Great Bear Lake, and the north end of Napaktulik Lake. The 1916-1955 period shows Contwoyto Lake as the centre for extensive trapline networks as well as the area south of Contwoyto Lake for hunting activities. In 1955 to 1975 the hunting corridor remains strong for the Coppermine hunters and trappers through Napaktulik Lake to the land east and south of the far end of Contwoyto Lake.

The current land use is consistent with that documented starting in the 1970's Caribou hunting is the most common activity throughout the region of land use. Hunting wolves and wolverine are the activities associated with the hunters reporting to Inmet during their community consultations. The Nunavut Atlas (1982) outlines land use for Kugluktuk harvesters that is very similar to that presented in Inmet's studies.

Local and Regional Traffic Patterns

The project area is located some 185 km inland from the Arctic Ocean. The closest organized community is Kugluktuk, which is 185 km from the site. The closest air strip to the site is at the Lupin mine, 70 km to the west of the site. A winter use only haul road connects the project sites to the Lupin Mine. There are no other transportation routes into or out of the sites other than by air in the summer, overland by snow machine in winter or by boat. Apart from traditional activities such as hunting and trapping, the largest volume of traffic for aircraft, vehicles, goods and people would be following the Yellowknife to Lupin air route or the Tibbit to Contwoyto winter road. Air traffic into and out of Lupin is in the order of several flights per day of small aircraft, mostly Twin Otter and smaller as well as some helicopter travel in the summer. The air traffic diminishes considerably in the winter. The truck traffic on the Tibbit to Contwoyto road would terminate at the Lupin mine at closest point to the Izok site.

For this program, we anticipate several flights from Yellowknife to the Ham Lake camp airstrip per week during mobilization and one to tow flights per week thereafter.

VSEC's

Inmet's report describes a number of VSEC's for the full scale mine development project, which do not scale-down well to the modest scale of the proposed undertaking , i.e. diamond drilling programs.

4.0 IDENTIFICATION OF IMPACTS

A completed Table 1 – Identification of Environmental Impacts taken from the Nunavut Impact Review Board, Screening Part 2 – Forms is attached in Appendix D. The following section provides more in-depth discussion of the potential environmental impacts noted on this table.

A tabular summary of the potential wildlife and resource impacts and proposed mitigation measures in presented in Table 5 as follows:

Table 8 – Environmental Resources and Potential Impacts

Resource/Topic	Potential Impact
Terrain / Permafrost	Overburden drilling will cause minor disturbance to immediate drilling areas. Contamination of terrain/permafrost and, surface and ground water due to fuel spills. Accidental fuel spills.
Hydrology	Water removal required from local water bodies for drilling. Water quality changes to groundwater if artesian well is encountered during drilling.
Surface Water Quality	None – no discharge to receiving water environment, negligible sedimentation.
Fish and Fish Habitat	Entrainment of fish and other aquatic life from water withdrawal for drilling purposes.
Vegetation	Spilled brine during drilling may result in minor damage in immediate vicinity of drill site. Minor compaction of vegetation caused by drill.
Wildlife and Wildlife Habitat	Wildlife: short-term aircraft and drilling noise, human interaction. Habitat: Minor disturbance to vegetation in drilling areas by compaction. Disturbance of wildlife from low-level aircraft activities.
Socio-economics	Positive impacts. Personnel actively employed from local communities. Continued employment opportunities for field personnel from the local communities.
Archaeology / Cultural sites	Disturbance, removal and/or destruction of archaeological specimens or sites.

4.1. SOCIOECONOMIC IMPACTS

The personnel actively employed from local communities will benefit from continued employment opportunities for field personnel from the local communities. This is considered a positive impact on the socioeconomic conditions within the influence of the project.

4.2. POTENTIAL FOR TRANSBOUNDARY EFFECTS

Itchen Lake has been identified as a transboundary lake with the watershed and downstream lakes and rivers fed by Itchen Lake extending into the Northwest Territories. Given the comparatively slight impacts that simple diamond drilling and camp occupancy could have on the water quality in the Itchen Lake watershed, the potential for transboundary effects is considered negligible for the planned activities.

5.0 MITIGATION OF IMPACTS

The following table provides a summary of the Natural Resource, Potential Impact from the project and the proposed Mitigation to be implemented to minimize the environmental effects of the project.

Table 5 – Environmental Resources, Impacts and Mitigation

Resource/Topic	Potential Impact	Mitigation
Terrain / Permafrost	Overburden drilling will cause minor disturbance to immediate drilling areas. Contamination of terrain/permafrost and, surface and ground water due to fuel spills. Accidental fuel spills.	Drill rigs will be heli-portable and will not traverse the ground surface. Site will be left in a stable state. Proper storage of fuel containers and use of drip pans. See Attachment B Spill Contingency Plan.
Hydrology	Water removal required from local water bodies for geotechnical drilling.	Chilled brine will be kept in closed circulation by the drill, minimizing the amount of water used. Additional make-up water will be required if downhole circulation is lost. Amounts are expected to be minimal.
	Water quality changes to groundwater if artesian well is encountered during drilling.	If an artesian well is encountered, drilling will stop, the hole will be plugged, and the location will be recorded and reported to the Inspector.
Surface Water Quality	None – no discharge to receiving water environment, negligible sedimentation.	No mitigation required.
Fish and Fish Habitat	Entrainment of fish and other aquatic life from water withdrawal for drilling purposes.	Use of screens over intake pipe to prevent entrainment.
Vegetation	Spilled brine during drilling may result in minor damage in immediate vicinity of drill site Minor compaction of vegetation caused by drill.	Implementation of field protocols to ensure there is no brine spillage. Drill-rig will be heli-portable and will not traverse the ground surface.

Table 5 – Environmental Resources, Impacts and Mitigation		
Resource/Topic	**Potential Impact**	**Mitigation**
Wildlife and Wildlife Habitat	Wildlife: short-term aircraft and drilling noise, human interaction. Habitat: Minor disturbance to vegetation in drilling areas by compaction.	Personnel training on wildlife-human interaction/encounters. Pre-drilling reconnaissance site visit prior to drilling activities will assist in identifying sensitive wildlife habitat. Site will be left in a stable state, promoting vegetation re-established. Any critical or sensitive wildlife species encountered during the drilling season, such as nesting raptors in the area, will be avoided by a 10 m buffer zone.
	Disturbance of wildlife from low-level aircraft activities.	Low-level aircraft activity will be restricted to flights into and out of the camp for crew changes and supply deliveries.
Socio-economics	Positive impacts. Personnel actively employed from local communities. Continued employment opportunities for field personnel from the local communities.	Local employment provides jobs, employment benefits and income to individuals and families.
Archaeology / Cultural Sites	Minor disturbance to immediate drilling areas.	Pre-drilling terrain mapping and reconnaissance site visit will assist in identifying potential archaeological sites. Personnel training on archaeological resource identification. Standard notification procedures will be followed in the event that archaeological artifacts are encountered.
	Disturbance, removal and/or destruction of archaeological specimens or sites.	Project activities that encounter or disturb an archaeological site or specimen shall be stopped, and the proper regulatory authorities shall be immediately notified. All persons working on site will be made aware of this mitigation procedure and any permit conditions. Archaeological specimens or sites shall not knowingly be removed, disturbed or displaced.

Appendix A
NIRB Screening Part 1 Form, Project Proposal Summary

WOLFDEN Resources Inc.

Appendix B
1993 Metall report Excerpts

WOLFDEN Resources Inc.

APPENDIX C
SITE PHOTOGRAPHS

WOLFDEN Resources Inc.



Generators at Ham Camp



Ham Air Strip Facing SSW from Tanks



Ham Air Strip Facing WNW



Ham Camp Aerial Facing NW



Ham Camp Core Cutting Shack Facing WNW from Tanks



Ham Camp Facing NE Along Shore Line



Ham Camp Facing NNW From top of Fuel Tanks



Ham Camp Facing NW Aerial View



Ham Camp Facing South



Ham Camp Garage and Grader



Ham Camp Generator Building Facing NW



Ham Camp Main Fuel Storage



Ham Camp Northerly Core Storage Bldg Facing West from Tanks



Hm Camp Northerly Core Storage Bldg Facing WNW From Tanks



Ham Camp Portable Double Wall Fuel Tanks



Ham Lake Fuel Storage Facing East



Ham Lake Esker Facing Northeast



Iznogoudh Lake Outlet



Iznogoudh Lake Outlet 2



Izok Inukshuk Deposit Area



Izok Lk Facing NE



Izok Lake Islands



Izok Lake Islands



Izok Lke Inukshuk

Appendix D
NIRB Screening Part 2 Form, Table 1 – Environmental Impacts

3. BIOPHYSICAL AND SOCIAL ENVIRONMENT

3.1 Study Area Definition

3.1.1 Biophysical Study Area

The study area includes land, fresh water bodies and Arctic marine waters that may be affected by project components, during construction, operation and closure. For the purposes of the environmental evaluation, the study area includes a primary zone encompassing the potential area of direct project/environment interactions, and a broader secondary zone encompassing the potential area of indirect, temporary and/or minor effects (Figure 3.3-1).

The primary study area for the Izok Project includes the following:

- all lands occupied by the proposed mine, process plant, waste disposal facilities and mine site ancillary facilities, including airstrip, roads, housing, storage, etc., and by sand and gravel pits and rock quarries for mine area construction;
- all lands within a corridor encompassing potential routes for the winter roads and sand-and-gravel borrow areas for road construction;
- all lands required for port site facilities, including storage areas for concentrate, fuel, and bulk supplies, shiploading facilities, housing, maintenance, airstrip, and sand-and-gravel borrow and rock quarry areas for port site construction;
- freshwater bodies in the vicinity of the mine site that may be affected by water use, diversion, waste discharges and/or erosion from ground disturbance;
- lakes and streams traversed by the winter road and/or affected by construction activities;
- marine and/or freshwater potentially affected by water use, waste discharge and ground disturbance at the port site;
- marine areas potentially affected by construction of port docking facilities; and

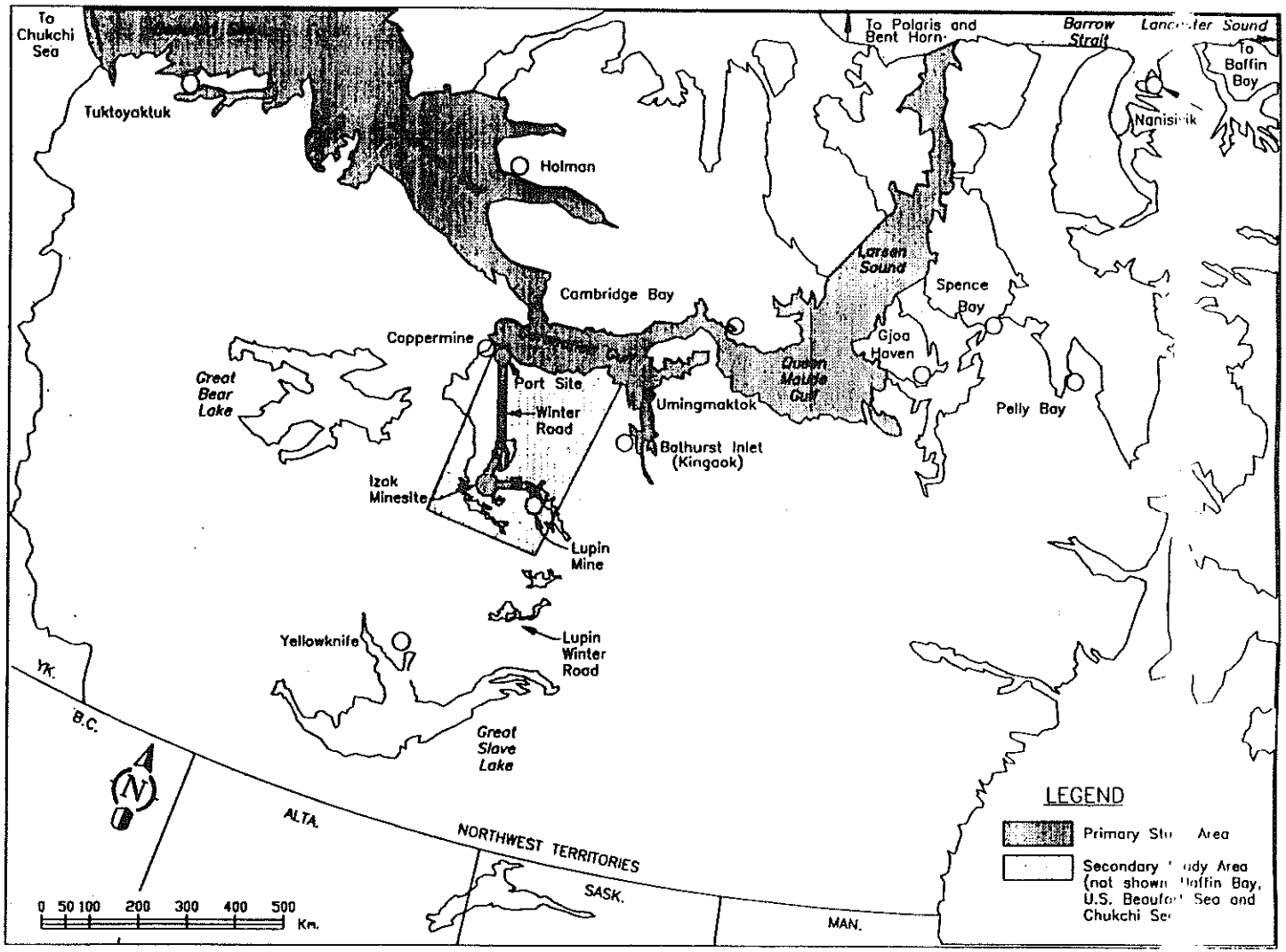


Figure 3.1-1 - Izok Project Study Area - Biophysical Impact Evaluation

- marine waters affected by shipping routes to service the Izok Project.

The larger, secondary study area encompasses the following:

- watersheds in the mine area, upstream and downstream of the primary zone which have been examined in terms of hydrologic interactions and potential for downstream migration of contaminants related to mine area activities;
- a land area of about 90 000 km^2 surrounding the mine area, winter road and port site (bounded by 65° north latitude, 108° and 115° west longitude, and the shore of Coronation Gulf) including seasonal ranges of migratory caribou and annual ranges of muskox and grizzly bear which occupy the primary study area;
- the Lupin winter road corridor where overland transportation for the Izok Project during construction period will contribute a minor increase to existing traffic; and
- marine waters extending from Baffin Bay in the east, through the Beaufort Sea in the west, where shipping related to the Izok Project will be incremental to existing activities.

In addition to these areas, reference is made in the report to other areas, related principally to the study of optional transportation scenarios, which were considered in the prefeasibility studies but are not affected by the current project design and are not included in the study area.

3.1.2 Socio-Economic Study Area

The study area for socio-economic studies has been defined on several levels, reflecting regional and local implications. Accordingly, the study area encompasses the following:

- the Northwest Territories as a whole, to reflect the overall social and economic effects of the project to the region, such as employment effects and financial impacts;

- the Kitikmeot Region, as the area where the bulk of the economic impacts are expected to occur; and

- specific communities both inside and outside of Kitikmeot, potentially influenced socially, economically and/or culturally by the Izok Project, including Coppermine, Cambridge Bay, Umingmaktok, Bathurst Inlet, Gjoa Haven, Pelly Bay, Taloyoak, Rae Lakes, Snare Lake and Yellowknife. (See Figure 3.1-1)

3.1.3 Archaeological Study Area

The assessment of archaeological site potential examined the database for known archaeological sites in a large region encompassing the project area. This area is bounded approximately by 65° to 68° north latitude and 111° to 116° west longitude (refer to Figure 3.4.1, Section 3.4). Field surveys have examined land areas which would be disturbed by project development including:

- mine site lands disturbed in order to develop the open pit mine, process plant, waste disposal facilities and mine site ancillary facilities, including airstrip, roads, housing, storage, etc., and by borrow areas and quarry areas for mine site construction;

- selected areas with archaeological site potential within the corridor for the proposed winter road route and borrow areas for road construction; and

- lands potentially disturbed by development of the port site facilities, including storage areas for concentrate, fuel, and bulk supplies, ship dock and loading facilities, housing, maintenance areas, roads, airstrip, etc., and borrow and quarry areas for port site construction.

Field surveys in 1994 will focus on the winter road between Izok and port site.

3.2 Biophysical Environment

3.2.1 Introduction

This section reviews available information on biophysical aspects of the study area that may be affected by the Izok Project during construction, operation, decommissioning and post abandonment, as requested in the RERC guidelines, Section 3.2. The descriptions focus on "valued ecosystem components" (VECS), those elements of the biophysical environment that are particularly valued by local, regional and national communities (e.g., clean water, fisheries, wildlife, endangered species), and key ecosystem linkages between project actions and effects on valued ecosystem components. These linkages may include, for example, lower trophic levels (i.e., plants and animals which are the food of valued species) where the project could, in turn, affect valued resources; or physical aspects (sediment quality, oceanography, climatology) which could mediate, or provide a suitable medium for measuring project effects.

The purpose of this section is two-fold:

- to provide a basis for discussion of potential project impacts in Section 5.1; and
- to describe baseline environmental conditions against which project effects can be measured in the future.

Where available information is insufficient to serve these purposes, programs are described which are ongoing or proposed by Metall to fill these gaps.

The information presented in the following sections responds to the items identified in the RERC environment evaluation guidelines for the Izok Project. The report sections and corresponding items in the RERC guidelines are as follows:

• Geology and geomorphology (Section 3.2.2)	RERC Item 3.2.1
• Permafrost (Section 3.2.3)	RERC Item 3.2.2
• Seismicity (Section 3.2.4)	N/A
• Ice and Oceanography (Section 3.2.5)	RERC Item 3.2.3
• Climatology (Section 3.2.6)	RERC Item 3.2.4
• Hydrology (Section 3.2.7)	RERC Item 3.2.5
• Water Quality (Section 3.2.8)	RERC Item 3.2.6
• Sediments (Section 3.2.9)	RERC Item 3.2.7
• Fisheries and Aquatic Biota (Section 3.2.10)	RERC Item 3.2.9 (Freshwater and Marine subsections)
• Vegetation (Section 3.2.11)	RERC Item 3.2.8
• Wildlife (Section 3.2.12)	RERC Item 3.2.9 (Terrestrial and marine subsections)

3.2.2 Geomorphology and Geology

3.2.2.1 Introduction

The geology and geomorphology (terrain and processes related to surficial or recent geology) of the study area controls the siting and design of project facilities and can influence the potential effect of project actions (e.g., materials requirements, erosion, slope stability etc.). An assessment of the terrain conditions has been carried out by EBA Engineering Consultants Ltd. as part of their current study on the geotechnical conditions of the entire project area.

The following is a preliminary description of terrain conditions in the area of the mine site, winter road, and port site, with reference to potential sources of construction materials (sand, gravel, rock, etc.). A detailed geologic description of the Izok mine site is given in Section 4.1.

The project area lies within the Archean-age Slave Province of the Canadian Shield, as shown in Figure 3.2-1. The topography of the Izok mine site and the winter route to the port site is largely controlled by outcrops of precambrian rock with thin but variable thickness of till infilling the swales in the rock surface. The port site on the coast of Coronation Gulf consists of a bedrock sill largely covered by marine clay deposits.

3.2.2.2 Mine Site

The mine site landscape is dominated by a massive glaciofluvial deposit 8.5 km to the northwest at Ham Lake. The esker and outwash soils are largely gravelly sand. The sand and silt content vary significantly between the margins, surface and core of the esker. The Ham Lake esker is the only viable source of natural sand and gravel for fill construction within reasonable proximity of the mill complex. An alternative construction material is rock that would be quarried on site. It is anticipated that both sources will be developed and used.

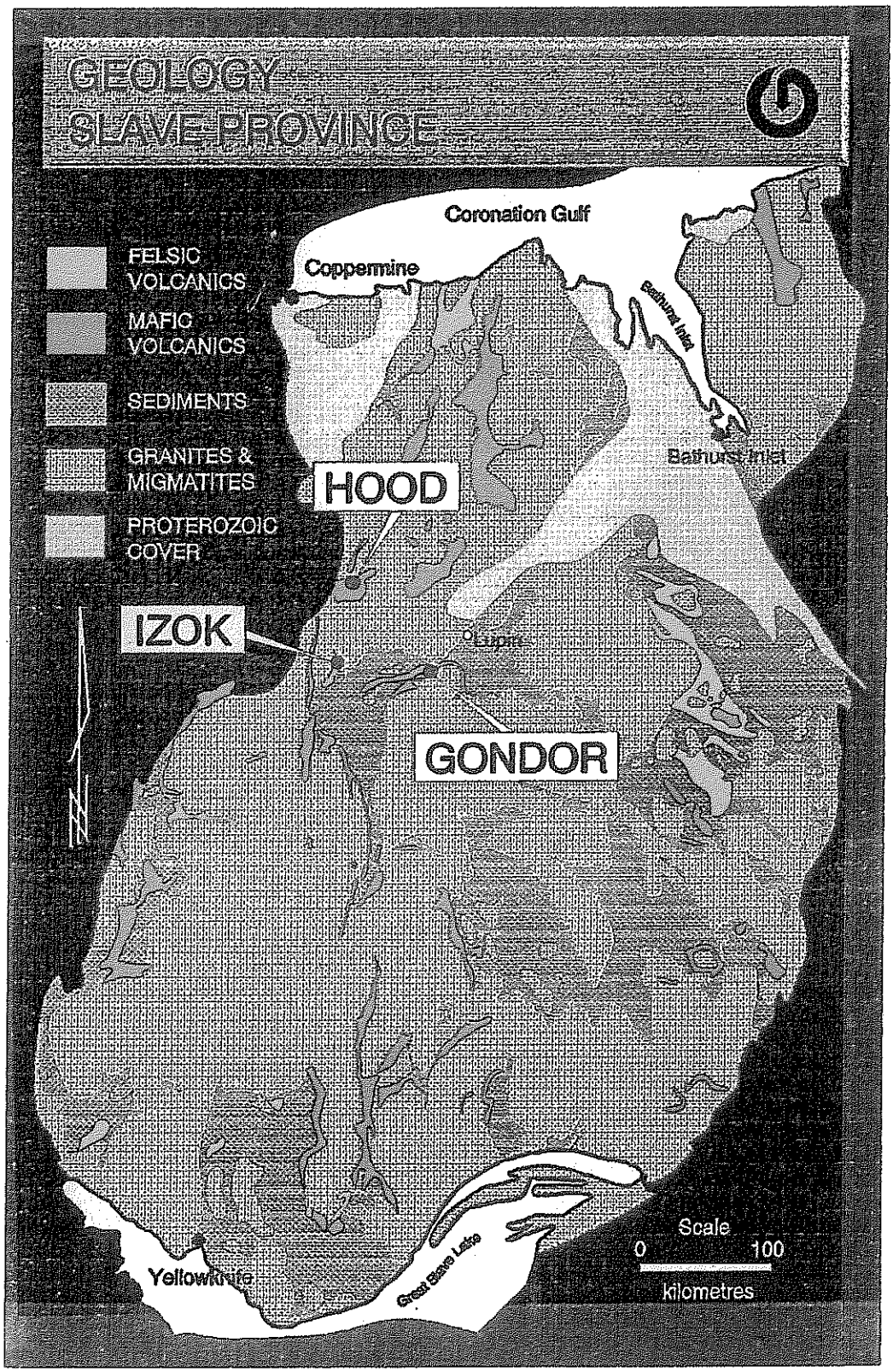


Figure 3.2-1 - Generalized Geology Map of the Slave Province (after Padgham, et al., 1992)

The site chosen for mill construction (Section 4.1) is a relatively level outcrop of rock, predominantly gabbro or andesite. The till varies in thickness at the mill site from 0 m to 5 m. The till can be described as silty sand with cobbles and boulders.

3.2.2.3 Winter Road

Two alternate routes are being studied for the feasibility stage of the project, as shown on Figure 1.1-6. The winter road routes to the port are controlled almost entirely by geology, and by its influence on topography, achievable grades, shape and length of lakes, smoothness of the ground surface, and distribution of granular deposits. Permafrost activity is an important factor influencing local topography: smoothing frozen till slopes, frost-shattering near-surface bedrock, and creating microtopography associated with patterned ground (see also Section 3.2-3, Permafrost).

Both proposed routes follow a well-defined corridor of favourable geologic conditions south and north of Takiyuak Lake (also known as Napaktulik Lake). East of Takiyuak Lake and a few kilometres south of Cowles Lake the Precambrian rocks are largely granitic and gneissic, restricting route location options in this terrain. Unfavourable terrain also exists northwest of Takiyuak Lake and north of Cowles Lake, where a series of high, subparallel hard meta-sedimentary rock ridges control the topography. These bedrock ridges are separated by interweaving deep valleys modified by glacial erosion and deposition. Here a varying thickness of till has been deposited over bedrock, and glacial meltwater erosion has eroded some of the till in valley bottoms, resulting in rough rock micro relief.

Dominant terrain types along the chosen routes consist of relatively smooth ice-abraded low relief bedrock, patches of thin till and boulders over bedrock, smooth till sidehill slopes and elongate ridge crests. Till, scattered boulders on till and waterlaid sediment in some wet depressions compose the valley bottoms. Small and large granular deposits are common adjacent to the southern two-thirds of all selected routes. Granular deposits consist of esker-kame complexes, single discontinuous esker ridges, small outwash and outwash delta deposits.

Esker-kame complexes are characterized by kettleholes, knobs, and long, narrow, sharply crested ridges. Most of these complexes follow valleys. However, a few cross ridges. Small single eskers occur northwest of Takiyuak Lake on the middle and east routes and on the northerly part of the westerly alternative. Small level outwash and outwash delta deposits occur in some valley bottoms, often at the ends of elongate lakes.

Along the north end of the route alignment, below approximately 150 m elevation, Precambrian sedimentary rocks are covered by waterlaid marine plastic clay, silt, and fine sand. Here a few linear dykes and small to large tilted plateaus of sloping steep-walled gabbro sills project through icy fine-grained marine sediments. Talus piles appear along the base of some near-vertical sill cliffs.

3.2.2.4 Port Site

The chosen port site is the surface of a bedrock sill on the coast of Coronation Gulf. Thick marine clay and silt surround the bedrock exposure both onshore and offshore. Most facilities, except access roads and an airstrip, will be situated on rock rather than the marine clays. The marine clay is ice-rich permafrost onshore and is nonfrozen and soft offshore.

3.2.3 Permafrost

The Izok Project mine site, winter road haul routes, and port site all lie well within the region of continuous permafrost. Permafrost characteristics will influence design requirements; for example, special consideration will be given to prevent permafrost degradation and related environmental impacts. Project design can also incorporate permafrost to achieve certain design objectives, for example construction of impermeable dams by creating a frozen core.

Ground temperatures measured in the vicinity of the mine site during the winter in 1993 are typically -5°C (below the depth of seasonal ground temperature variation). Thickness of the active layer is anticipated to vary from less than 1 m in moist till soils supporting vegetation, to about 4 m in regions of exposed rock. Typical active layer depth in well-drained granular (esker) slopes is expected to be about 2 m. Thermistors for measuring ground temperatures were installed in selected boreholes drilled in April 1993. These will be used to collect year-around data from which active layer thicknesses can be verified. Site conditions, based on observations during April 1993, are described below.

Warmer permafrost ground temperatures are present below lakes that freeze to the bottom and below active stream channels. In some cases, the permafrost is at or near 0°C. Permafrost is not present below Izok Lake, nor is it present below Ham Lake, where water depths are sufficient that winter ice does not freeze to the lake bottom.

Ground ice occurs in the till as discrete ice lenses and ice coatings on soil particles. Estimates of excess ice content varies significantly from low (less than 10%) to locally high concentrations (greater than 50%).

The bedrock cored at the mine site is generally sound and free of significant fractures that could be filled with ice. Where bedrock is exposed at the surface, the upper 1 m to 2 m is frost shattered, providing potential for ground ice accumulation. The sound

rock at depth is intact with very low fracture frequency, suggesting that it has no thaw-settlement potential and will be essentially impervious to groundwater flow.

The Ham Lake esker near the plant site has substantial concentrations of ground ice within its core. Ground ice features noted during drilling in April 1993 include ice wedges, lenses and massive ice features in excess of 10 m thick. The presence of abundant ground ice in the eskers is consistent with deep thermokarst depressions (thaw ponds) present on the flank of the esker.

Permafrost conditions along the winter road route are anticipated to be similar to those observed at the mine site. Ground temperatures will decrease toward the north with anticipated ground temperature of -7°C to -8°C on land at the port site. The marine clay, which surrounds the bedrock outcrop at the port and is prevalent along the northern 20 km of winter road route, is anticipated to be ice-rich. Saline permafrost soils are anticipated, with salinity increasing with depth below the permafrost table. These soil types were drilled and sampled at the port site in April 1993.

3.2.4 Seismicity

The earthquake history of northern Canada is brief and incomplete (Stevens and Milne, 1973). Most of the areas have always been sparsely populated and thus no substantial account of felt earthquakes is available for compilation. Yellowknife represents the single largest population centre in the Northwest Territories and has been populated for over 100 years.

The largest recorded earthquakes to have occurred within the region were the 1985 Nahanni events of M_s 6.6 (October 5) and M_s 6.9 (December 23). These events occurred along the intersection between the Western Cordillera and the Interior Platform, which is approximately at the location of the Mackenzie River near Fort Simpson. Fort Simpson was approximately 160 km east of the epicentral area. The mine site is about 750 km from the epicentre of these events.

The latest National Building Code of Canada (NBCC) places the Yellowknife area in Seismic Zone I. The NBCC states the seismic exposure for the Izok Lake area in terms of an event which would have a 10% probability of exceeding the 1-in-475-year event in 50 years. This seismic exposure value yields a predicted peak ground acceleration of up to 0.05 g. This seismic value is considered adequate for buildings that are judged to have a 50-year design life.

From the available evidence for the project area, a design peak ground acceleration of about 0.1 g could represent a return period of up to 1-in-10,000 years. However, because of the short record period upon which this design value is based, any seismic events that occur within the region should be carefully reviewed for their effect on the selected zonation and parameters.

3.2.5 Ice and Oceanography

3.2.5.1 Introduction

This section reviews information on marine ice and oceanographic regimes of the study area, in response to information requested in Section 3.2.3 of the RERC guidelines. This information is relevant to the design of the port and marine shipping routes, and assessing the impact of these project components on local hunting, fishing and travel.

Previous Studies

Available information on marine ice conditions and oceanography, as it pertains to the port area and marine shipping routes for the Izok Project, is contained in the following reports:

(1) "The Development of a Marine Transportation System to Service Coronation Gulf, Northwest Territories" (Canarctic, 1993a) commissioned by a consortium of mine developers, including Minnova, and the Northwest Territorial and Federal governments (also referred to as the consortium report). This report contains:

- a comprehensive review of historical, seasonal ice conditions and dynamics along potential shipping routes spanning the Beaufort Sea, through Coronation Gulf, to Lancaster Sound. This review was conducted in order to determine limiting ice conditions on each route and the predicted shipping season for various classes of vessels; and

- a review of hydrographic data to identify potential shipping channels, determine draft limitations (depth of ship below water line which ensures adequate clearance of the keel over the sea bottom) and identify requirements for channel marking and additional hydrographic measurements.

(2) "A Study of Marine Environmental Issues Associated with a Marine Transportation System Servicing Coronation Gulf, Northwest Territories" (Canarctic, 1992), commissioned by Minnova as part of their project environmental assessment. Information in this report includes:

- determination of fracturing; lead systems and detailed patterns of ice cover break-up in Coronation Gulf to evaluate the potential for impacts by icebreaking shipping on the natural ice cover;

the mouths of the rivers along southern Coronation Gulf. The sediment load and resulting turbidity of the waters in Coronation Gulf are low due to the relatively stable nature of the oceanography.

3.2.6 Climatology

The climate in the project area can be defined from limited information obtained from five meteorological stations located in the Izok region (see below). A meterological station was installed at the mine site by Metall in March 1993. This station will provide continuous data on precipitation, temperature, wind velocity and direction and humidity. The prefeasibility studies relied on preliminary assessments of the local climate using the closest weather station as representative of the local conditions, e.g., Lupin Airport Station for the mine site and Coppermine Station for the port site. For the feasibility studies more detailed assessments of the local conditions for each site are being carried out.

The climatic information is applied to the design and siting of buildings and structures and for evaluation of ground operations (airport usage, open pit working conditions, etc.). Precipitation and evaporation data are incorporated in the hydrologic analysis to define the water balance for waste management facilities, and to specify design parameters for water management structures.

The climatic conditions for the Izok site were extrapolated from the existing data at the meteorological stations in the area as part of the waste and water management study carried out by Klohn-Crippen. This section describes the following components of the climate at Izok Lake:

- precipitation (including storm events);
- evaporation and runoff;
- snow;
- wind; and
- temperature.

Ceiling and visibility conditions will be assessed for the design of the airport facilities at the mine site. The climatic conditions at the port site are currently being reviewed

for the feasibility design of the facilities. This section will be updated as more site specific information becomes available.

3.2.6.1 General

The mine site is located in the Continental Tundra climactic zone, approximately midway between Yellowknife, Northwest Territories and Coppermine, Northwest Territories. Average July temperature is about 10°C and average January temperature is about -31°C. Precipitation averages about 260 mm per year, half of which occurs between October and June. August is typically the wettest month. The area is mixed grassland and arctic tundra. The limited vegetation in combination with a short summer season and long winters limits evapotranspiration. The average length of winter (days below 0°C) is 235 days.

3.2.6.2 Meteorological Stations

There are five Atmospheric Environment Services (AES) meteorological stations in the Project area. A summary of the stations is given in Table 3.2-9 and their location is shown on Figure 3.2-13. The Lupin Airport and Contwoyto Lake stations are the closest to the minesite, located approximately 80 km and 120 km east of Izok Lake at elevations of 498 m and 451 m, respectively. The elevations of the stations are similar to Izok Lake, which is located at an elevation of approximately 417 m. The meteorological data from Lupin Airport and Contwoyto Lake were considered most representative of the minesite because of their proximity and elevation, and the data were used wherever possible.

A continuously recording meteorological station was installed at the Izok Project airstrip between Ham Lake and Iznogoudh Lake in early 1993 by Metall. This station will provide future site specific meteorological data for the project. (See Klohn-Crippen, 1993).

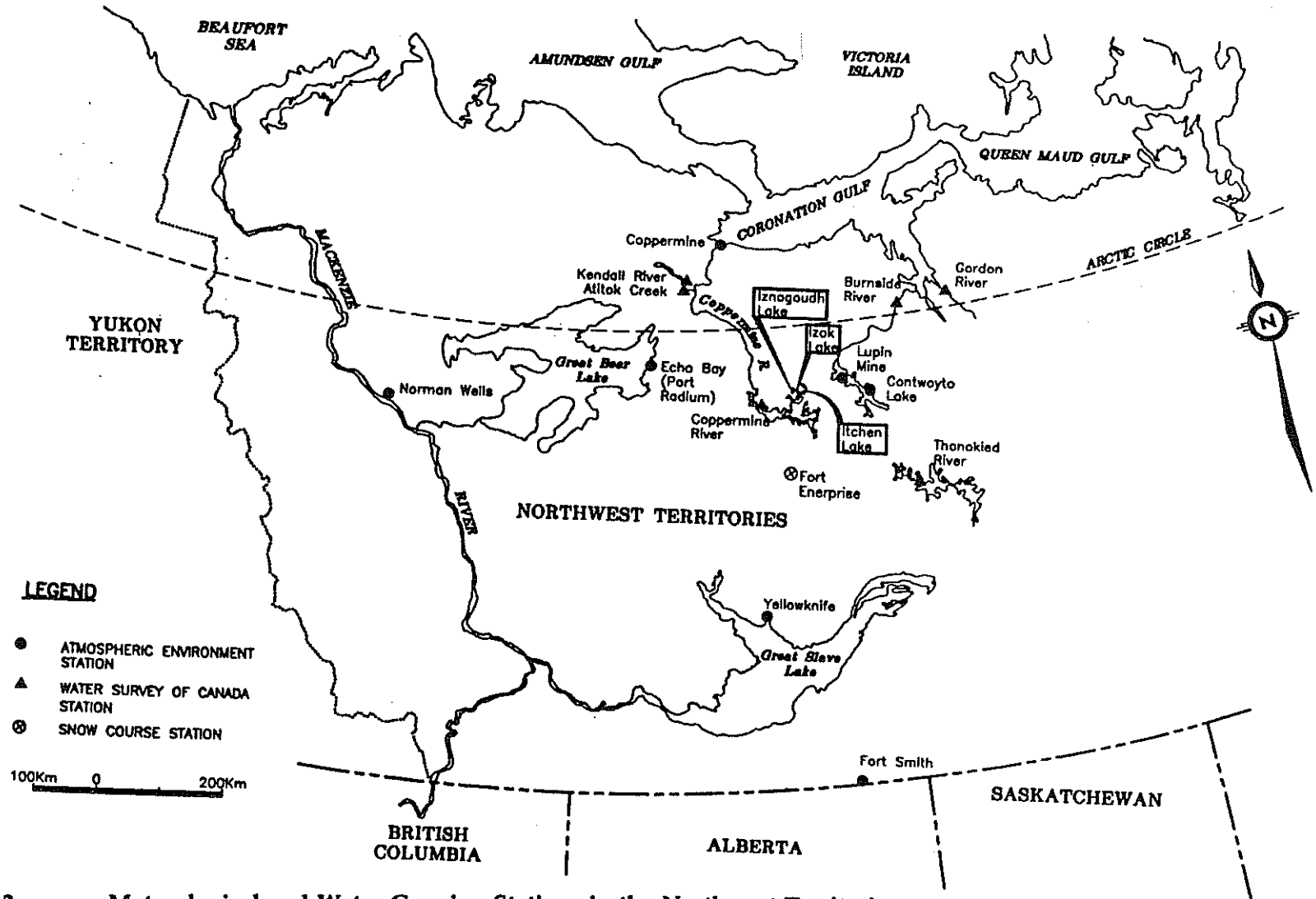


Figure 3.2-13 - Meterological and Water Gauging Stations in the Northwest Territories

Table 3.2-9 - Atmospheric Environment Services (AES) Meteorological Stations

NAME	LATITUDE (Deg Min)	LONGITUDE (Deg Min)	ELEVATION (m)	PERIOD OF RECORD (Years)	DISTANCE TO MINESITE (km)
Contwoyto Lake 2200850	65 29	110 22	451	1959-1981 (23)	120
Coppermine 2200902	67 50	115 07	9	1930-1992 (63)	270
Lupin Airport 22026HN	65 46	111 15	498	1982-1992 (11)	80
Port Radium 2203300	66 05	118 02	191	1937-1974 (29)	240
Yellowknife 2204100	62 28	114 27	205	1942-1992 (51)	360
Izok Project (by Metall)	65 38	112 46	438 (approximately)	1993	0

3.2.6.3 Precipitation

The period of records for Lupin Airport and Contwoyto Lake are not sufficiently long for extrapolation to extreme events. Concurrent data for Lupin Airport and Contwoyto Lake were also not available for comparison to allow merging of the data from these two stations. In order to develop a site specific precipitation record of sufficient length to extrapolate to extreme precipitation events, stations with longer periods of record were correlated with Lupin Airport. Of the four stations available for correlation, Coppermine and Yellowknife overlapped the Lupin period of record. For the period of the Lupin record, the average annual precipitation for Yellowknife was determined to be about 3% greater than Lupin and the Coppermine average annual precipitation was determined to be about 12% less than Lupin. On this basis, Yellowknife was chosen as the long-term station to be used for correlation.

The volume of spring runoff and the volume of summer rain are of interest for this project. Spring runoff is related to the amount of total precipitation occurring as snowfall from October to June inclusive. Summer runoff volume is related to the total precipitation which falls as rainfall from July to September.

Winter and summer data for Lupin and Yellowknife were compared and the results showed that, in winter, total precipitation is approximately 20% less at Lupin than at Yellowknife and in the summer, total precipitation is approximately 25% more at Lupin than at Yellowknife. The Yellowknife data for all years were adjusted by these values to compile a representative long-term data set for the Izok Lake minesite.

3.2.6.4 Frequency Analysis

The representative minesite data set (the adjusted Yellowknife data) was used for frequency analyses to determine total precipitation amounts for a range of return periods. Table 3.2-10 shows the results of annual, winter and summer total precipitation frequency analyses. Rainfall and snowfall have been combined for these analyses.

Table 3.2-10 - Izok Lake Total Precipitation Frequency Analysis Results

RETURN PERIOD (YEARS)	TOTAL PRECIPITATION (mm)			
	ANNUAL	WINTER OCT. TO JUNE	SUMMER JUL. TO SEPT.	ANNUAL (DRY YEAR ANALYSIS)
Average	261	130	128	261
5	317	158	169	205
10	351	178	197	184
20	379	197	222	169
50	410	220	253	150
100	430	236	275	140
200	448	252	295	130

The sum of the winter and summer total precipitation is greater than the annual values, except for the average value, because the frequency analyses for each period were carried out independently. The return period for a combined wet winter and wet summer is greater than the return period of the events separately. For instance, a 10-year return period winter (178 mm) and summer (197 mm) when combined (375 mm) results in approximately a 20-year return period annual event.

For closure planning a dry-year analysis was also carried out based on cumulative precipitation from October 1 to September 30. A frequency analysis was carried out by ordering the cumulative precipitation from driest to wettest. The results are shown in Table 3.2-10. The driest year on record out of 49 years of data had 146 mm of precipitation from October 1, 1946, to September 30, 1947. This event has a return period of approximately 1 in 80 years.

3.2.6.5 Short Duration Precipitation

Short duration Intensity-Duration-Frequency (IDF) data were obtained from AES for Yellowknife Airport. The Yellowknife station is the closest station with short duration IDF data and is considered to be representative of Izok Lake based on a comparison with 24 hour data from Lupin Airport. The IDF data for five-minute to 24-hour storms with return periods of 2 to 200 years are shown in Table 3.2-11. The 200-year IDF data was extrapolated from the AES data. Figure 3.2-14 is a plot of the data in Table 3.2-11, up to 24 hours duration, converted to intensity, i.e., mm/h.

Table 3.2-11 - Intensity-Duration-Frequency Data

DURATION	RETURN PERIOD RAINFALL AMOUNTS (mm)							
	2 Years	5 Years	10 Years	25 Years	50 Years	100 Years	200 Years	PMP
5 minutes	3.7	5.7	7.1	8.8	10.1	11.3	12.9	
10 minutes	5.2	8.1	10	12.4	14.1	15.9	17.9	
15 minutes	6.1	9.5	11.7	14.5	16.6	18.6	20.9	
30 minutes	7.9	12.1	14.9	18.4	21.0	23.6	26.3	
1 hour	9.6	14.5	17.7	21.8	24.8	27.8	30.0	
2 hours	12.3	18.4	22.4	27.5	31.2	34.9	38.3	
6 hours	18.8	28.7	35.3	43.6	49.7	55.8	62.2	
12 hours	22.6	34.6	42.6	52.6	60.1	67.5	75.1	
24 hours	27.4	42.4	52.4	65.0	74.3	83.6	94.0	257
2 days						90	104	276
3 days						93	108	294
4 days						95	110	312
5 days						96.5	111	328
6 days						98	112	345
7 days						98.5	113	360
8 days						99	114	375
9 days						99.5	114.5	387
10 days						100	115	400

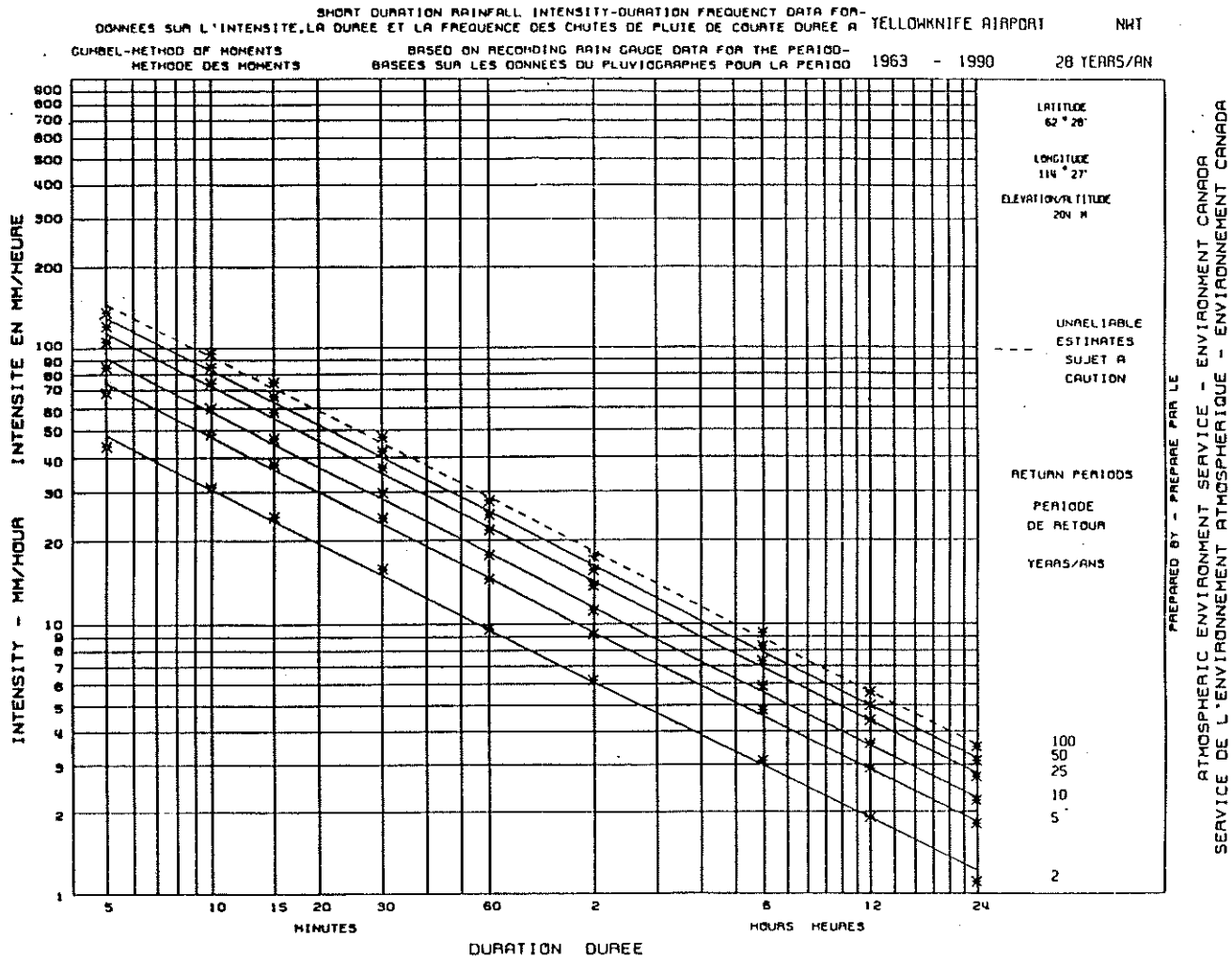


Figure 3.2-14 - Short Duration Precipitation for 24 Hours

3.2.6.6 Long-Duration Precipitation and Probable Maximum Precipitation (PMP)

One- to ten-day precipitation and PMP data were obtained from AES for the following stations and periods of record, Contwoyto Lake (23 years), Coppermine (58 years), Lupin Airport (9 years), Port Radium (26 years), and Yellowknife (48 years). One- to ten-day data were not available for the entire periods of station records for Lupin Airport, Port Radium and Yellowknife. Contwoyto Lake, Lupin Airport and Port Radium data were rejected because of their short periods of record. Long-duration precipitation and PMP values for the Izok Lake minesite were selected by a best fit of Coppermine and Yellowknife data weighted about equally between Coppermine and Yellowknife.

Table 3.2-11 shows the recommended long-term 100-year, 200-year and PMP values for the minesite.

3.2.6.7 Lake Evaporation, Evapotranspiration and Runoff

Evaporation data, available for three AES stations in the Northwest Territories (Fort Smith, Norman Wells and Yellowknife), evaporation studies at Lupin Mine and the Climatological Atlas of Canada, were used to estimate the average annual evaporation from lakes in the region of the minesite. The estimate was made by pro-rating the measured lake evaporations to the number of degree days of thawing (above 0°C) at each AES station. Table 3.2-12 is a summary of the data used to estimate the annual lake evaporation of 330 mm at the minesite. The estimated thawing index of 835°C-days for the minesite was based on the long-term average values available for Contwoyto Lake and Lupin Airport. Below average evaporation could be expected in September due to less solar radiation and lower air temperature. Therefore, the majority of the annual lake evaporation would occur in the months of June through August.

Mean daily pond evaporation estimates carried out in studies at Lupin Mine vary between 3.2 mm/day and 3.7 mm/day (Gibson et al., 1993). These values result in average annual evaporation (assuming 90 days available for evaporation) of 288 mm to

333 mm which confirm the estimate of 330 mm of annual lake evaporation at the minesite. Potential evapotranspiration from the ground surface in the region of the minesite is approximated as 70% of lake evaporation or 230 mm annually. Both evaporation and evapotranspiration values should be reviewed when more site data have been collected such as air temperature, wind speed and relative humidity.

Table 3.2-12 - Lake Evaporation Data

STATION	LATITUDE (Deg Min)		LONGITUDE (Deg Min)		ELEVATION (m)	AVERAGE ANNUAL LAKE EVAPORATION (mm)	AVERAGE ANNUAL DEGREE-DAYS ABOVE 0°C (°C Days)
Fort Smith	60	01	111	57	203	524.2	1951
Norman Wells	65	17	126	48	73	497.0	1745
Yellowknife	62	28	114	27	205	481.5	1771
Contwoyto Lake	65	29	110	22	451	-	827
Lupin Airport	65	46	111	15	498	288 to 333*	845
Izok Lake	65	38	112	46	420	330 (Estimated)	835

* Gibson et al., 1993

A review of discharge records for Atitok Creek (217 km^2 catchment), Thonokied River (1780 km^2 catchment), and Coppermine River at Outlet of Point Lake (19 300 km^2 catchment) was carried out to estimate actual losses. The ratio of runoff to precipitation for 1981 to 1990 data varied from 0.50 to 0.70. The resulting total combined losses due to evaporation from open water and evapotranspiration from ground surfaces in the catchments varied from 80 mm to 140 mm. For the Izok Lake area an average annual runoff coefficient of 0.60 is recommended for water balance studies; i.e., 60% of the annual total precipitation will report as runoff.

3.2.6.8 Snowpack Data

Northwest Territories snowpack data were obtained from the Department of Indian Affairs and Northern Development. The closest snowpack station is at Winter Lake located near Fort Enterprise about 125 km south of Izok Lake (see Figure 3.2-14). The

period of record for this station is 15 years with typically one reading in February and April as shown in Table 3.2-13. The average end of season sno water equivalent is 75.1 mm.

Table 3.2-13 - Winter Lake Snowcourse Data

DATE Y/M/D	SNOW WATER EQUIVALENT (mm)
78/04/22	55.0
79/04/12	98.3
80/04/15	100.0
81/04/23	60.0
82/02/26	31.0
82/04/22	57.7
83/03/02	54.6
83/04/21	73.2
84/02/22	87.1
85/02/28	53.6
85/04/18	56.9
86/02/25	57.7
86/04/22	83.6
87/02/27	75.4
88/03/01	66.5
88/04/18	87.1
89/02/15	63.0
89/04/18	54.6
90/02/06	61.7
90/04/25	106.7
91/01/30	41.4
91/04/22	71.9
92/02/12	61.2
92/04/15	75.4
93/02/10	59.0

3.2.6.9 Wind

Data on wind speed and direction are available for the Contwoyto Lake Station. Typical wind direction from July to February is from the north to northwest. The average wind speed during this period is about 22.5 km/h with the strongest winds occurring in September and January. Wind direction during the months of March to June is predominantly from the east to southeast with an average wind speed of about 17 km/h. Maximum hourly winds range from 56 km/h to 97 km/h with gusts reaching 132 km/h. During the period of open water on lakes in June through September, the maximum gust velocity is 113 km/h.

Maximum average daily wind data were available for the minesite from March 12, 1993, to August 6, 1993. (See Klohn-Crippen, 1993) A review of this data indicated that the direction and magnitudes were consistent with average values from Contwoyto Lake Station and, hence, the wind data described above is considered applicable to the minesite.

3.2.6.10 Temperature

The combined AES temperature data from Contwoyto Lake and Lupin Airport, which were considered to be representative of the Izok Lake area, indicates an average July temperature of 11°C and average January temperature of -31°C. On average, temperature rises above freezing in the beginning of June and drops below freezing in the middle of September. The lowest extreme temperature on the Lupin Airport record is -49°C for January of 1990 and the highest extreme temperature on record is 31°C for July, 1989.

3.2.7 Hydrology

3.2.7.1 Introduction

Limited information is available on hydrologic conditions within the project area. The prefeasibility studies relied on preliminary assessments of the local hydrology based on climate and typical runoff information available for the region (as discussed above). R.L. & L. is currently conducting an environmental baseline data collection program which includes flow measurements on various streams and creeks throughout the project area. More detailed assessments of the local conditions for each site will be carried out during 1993.

The hydrology information is used to define the water balance for waste management facilities, to specify design parameters for water management structures (diversions, stream crossings, etc.), and mitigative measures to protect and enhance fish habitat. Water balance information will also be applied to predictions of water quality.

The hydrology for the Izok site was extrapolated from the existing data on site and from Water Survey of Canada gauging stations as part of the waste and water management study carried out by Klohn-Crippen. This section describes the following components of the hydrology in the Izok Lake area:

- general stream flow regime in the Izok Region;
- Ham Lake and Iznogoudh Lake Catchments;
- Ham Creek discharge;
- Iznogoudh Creek discharge;
- Ham Lake bathymetry;
- Izok Lake bathymetry; and
- Itchen Lake bathymetry.

This section will be updated as more site specific information becomes available, particularly with respect to the Napaaktoktok River and the port site area.

3.2.7.2 General Streamflow Regime in the Izok Region

Water Survey of Canada (WSC) operates several continuous recording gauging stations in the Northwest Territories. A review of the records for the WSC gauges listed in Table 3.2-14 was carried out. The location of these gauges is shown on Figure 3.2-15. The gauges with catchment areas less than 3000 km^2 (Atitiok Creek, Gordan River, Thonokied River and Kendall River) freeze solid and stop flowing during the winter, while the larger catchments (Burnside River and Coppermine River) continue flowing throughout the winter. Typical discharge hydrographs for an average year are plotted on Figure 3.2-16.

Table 3.2-14 - Water Survey of Canada Streamflow Gauges

STATION NUMBER	STATION NAME	LATITUDE (Deg. Min)	LONGITUDE (Deg. Min)	CATCHMENT AREA (km^2)	PERIOD OF RECORD
10PC002	Atitok Creek near Dismal Lake	67 12	116 36	217	1980 - present
10QC002	Gordon River near the mouth	66 48	107 06	1 530	1978 - present
07RC001	Thonokied River near the mouth	64 08	108 55	1 780	1981 - present
10PC001	Kendall River near outlet of Dismal Lakes	67 12	116 34	2 790	1970 - present
10QC001	Burnside River near the mouth	66 44	108 49	16 800	1977 - present
10PB001	Coppermine River at outlet of Point Lake	65 24	114 00	19 300	1966 - Present

Rivers and creeks with catchment areas between 1000 km^2 and 3000 km^2 generally freeze up in December and remain frozen until late May. Creeks with smaller catchment areas freeze up in October and remain frozen until late May. The spring runoff duration also varies with catchment size. Spring runoff occurs in June for a duration of approximately three to four weeks for gauges with catchment areas up to 3000 km^2. The peak flow period is approximately one week long. For larger catchments spring runoff occurs over a two- to three-month period.

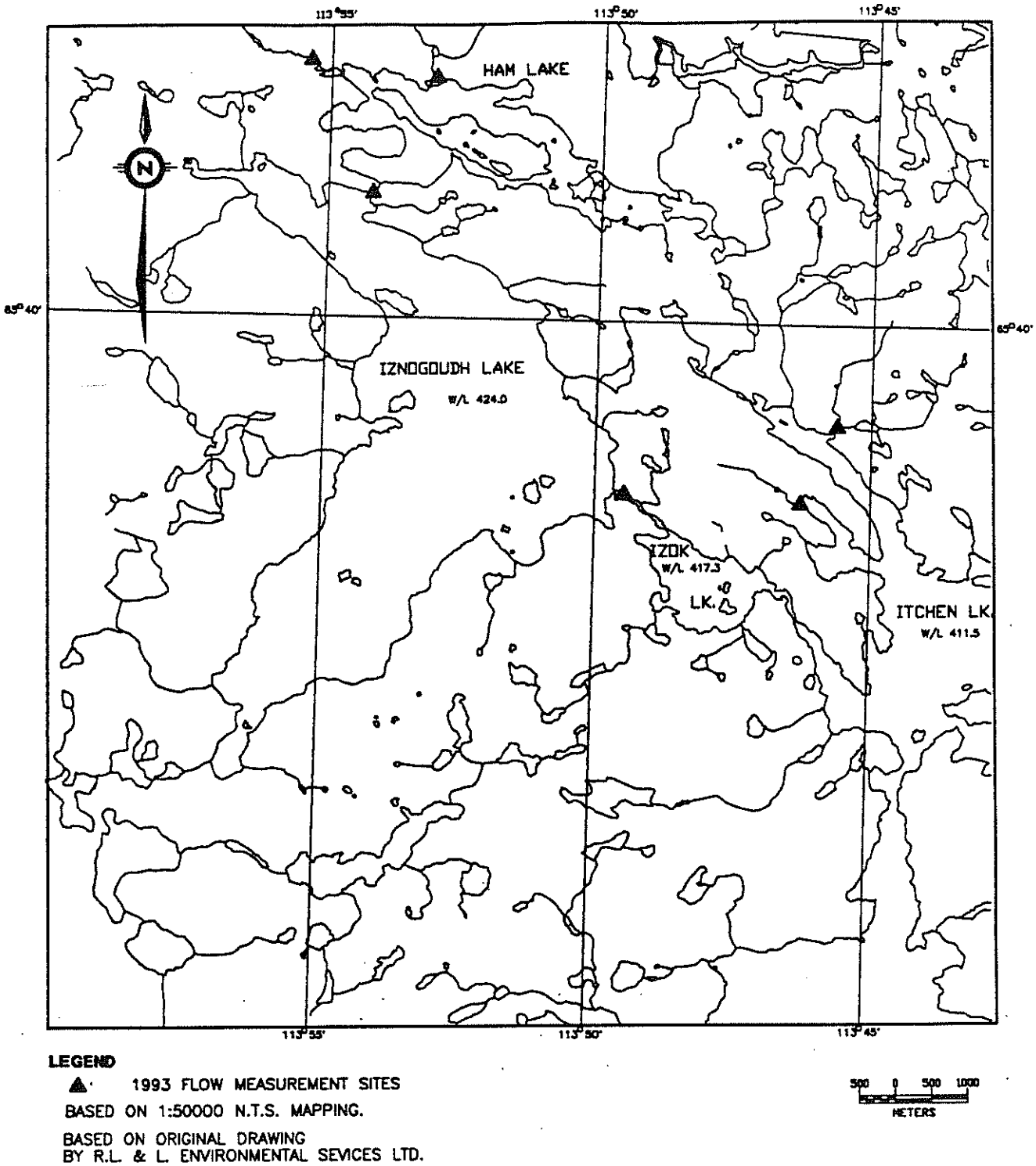


Figure 3.2-15 - Izok Mine Site Area - Streamflow Measurement Sites - 1993 Program

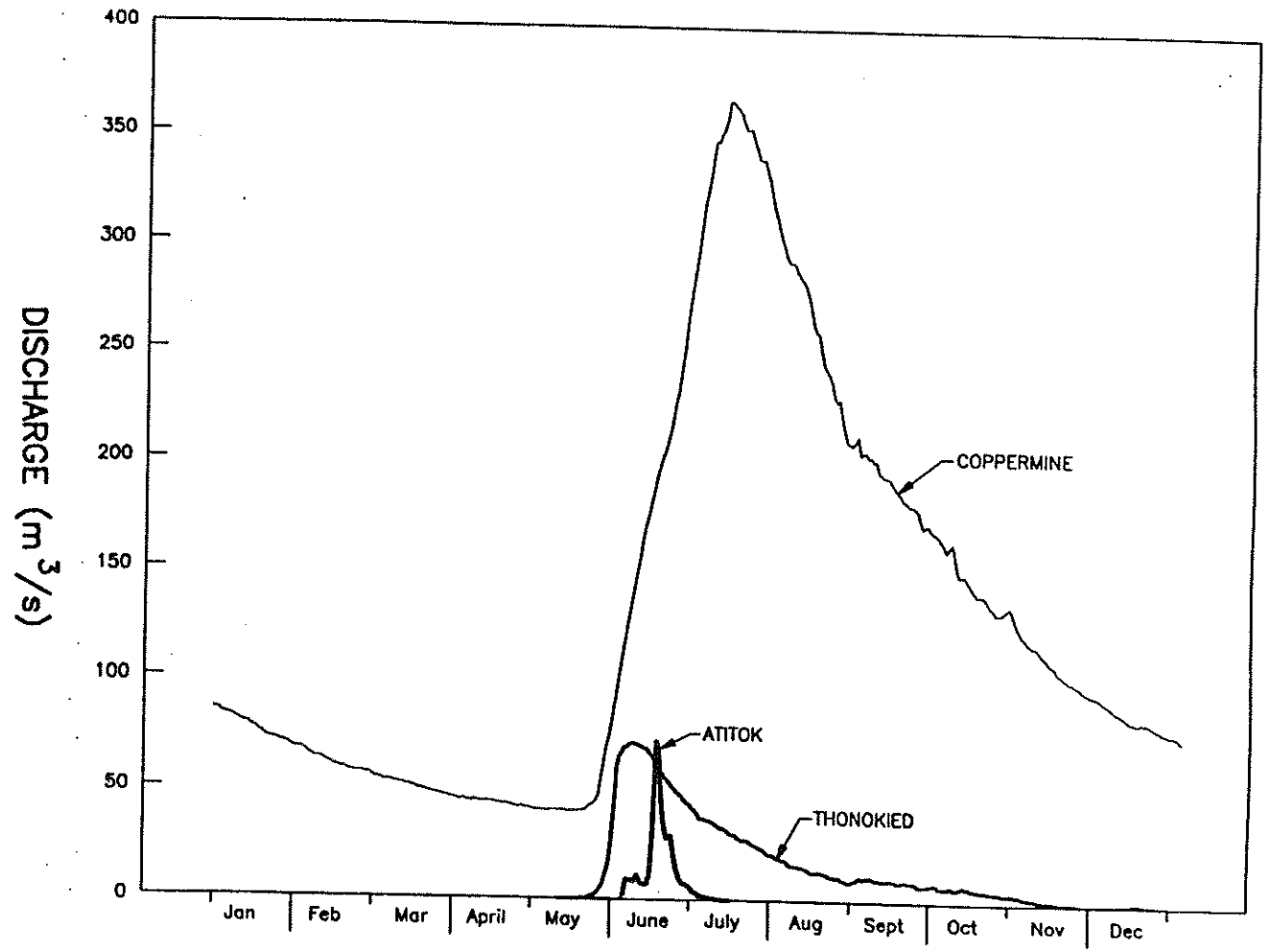


Figure 3.2-16 - Typical Discharge Hydrographs for an Average Year

Figure 3.2-17 shows the main catchments around the Izok Site. In the Izok Lake area, lakes and rivers can develop ice covers in excess of 2 m. Small catchments generally freeze solid with no winter flow from approximately October to May, while larger catchments will tend to have steadily declining flows until late April or May, at which time temperatures start to increase and spring runoff begins.

3.2.7.3 Ham Lake and Iznogoudh Lake Catchments

Ham Lake is drained by Ham Creek at its most southern point. The catchment area of Ham Lake is approximately 155 km^2. The Ham Lake catchment contains an upper plateau area with a large lake at elevation 526 m and several smaller lakes at elevation 540 m. Ham Lake itself is at approximately elevation 430 m. In general the catchment is relatively flat with many lakes and ponds scattered throughout.

Iznogoudh Lake is drained at its eastern end by Iznogoudh Creek, which flows through Izok Lake and then into Itchen Lake. The catchment area for Iznogoudh Lake is approximately 312 km^2 (including the 155 km^2 Ham Lake catchment). The portion of the Iznogoudh Lake catchment which does not include the Ham Lake catchment contain a large number of lakes and ponds. The largest lake in this catchment is at approximately elevation 524 m, while Iznogoudh Lake is at approximately elevation 424 m.

3.2.7.4 Ham Creek Discharge

Five discharge measurements were made at Ham Creek, one by WSC and four by R.L. & L. Environmental Services Ltd. (R.L. & L.). Details of the measurements are given in Table 3.2-15. WSC installed a benchmark on a large boulder on the east bank of the creek, which consisted of an orange paint mark. The assumed elevation datum of the benchmark was 10 m.

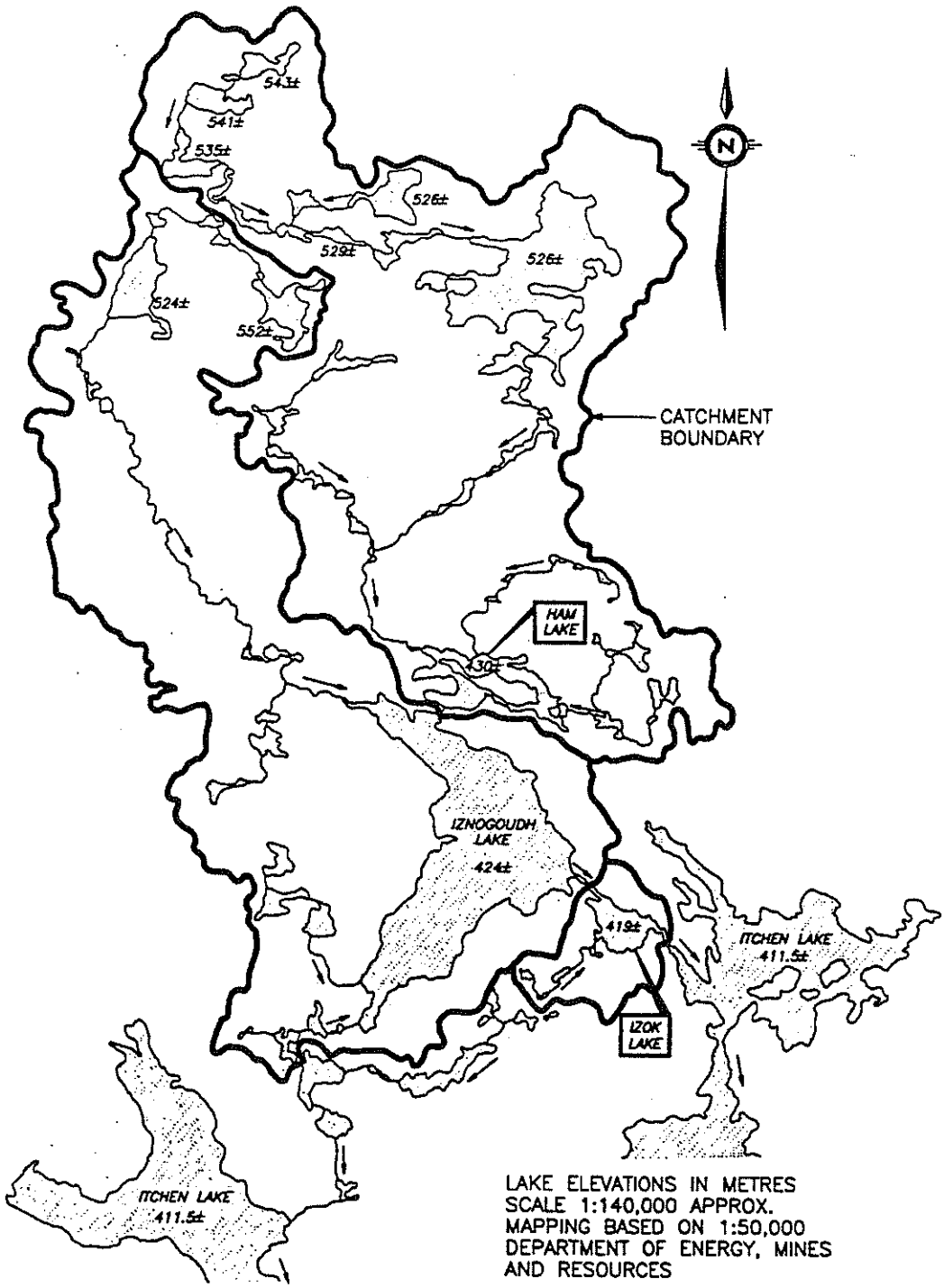
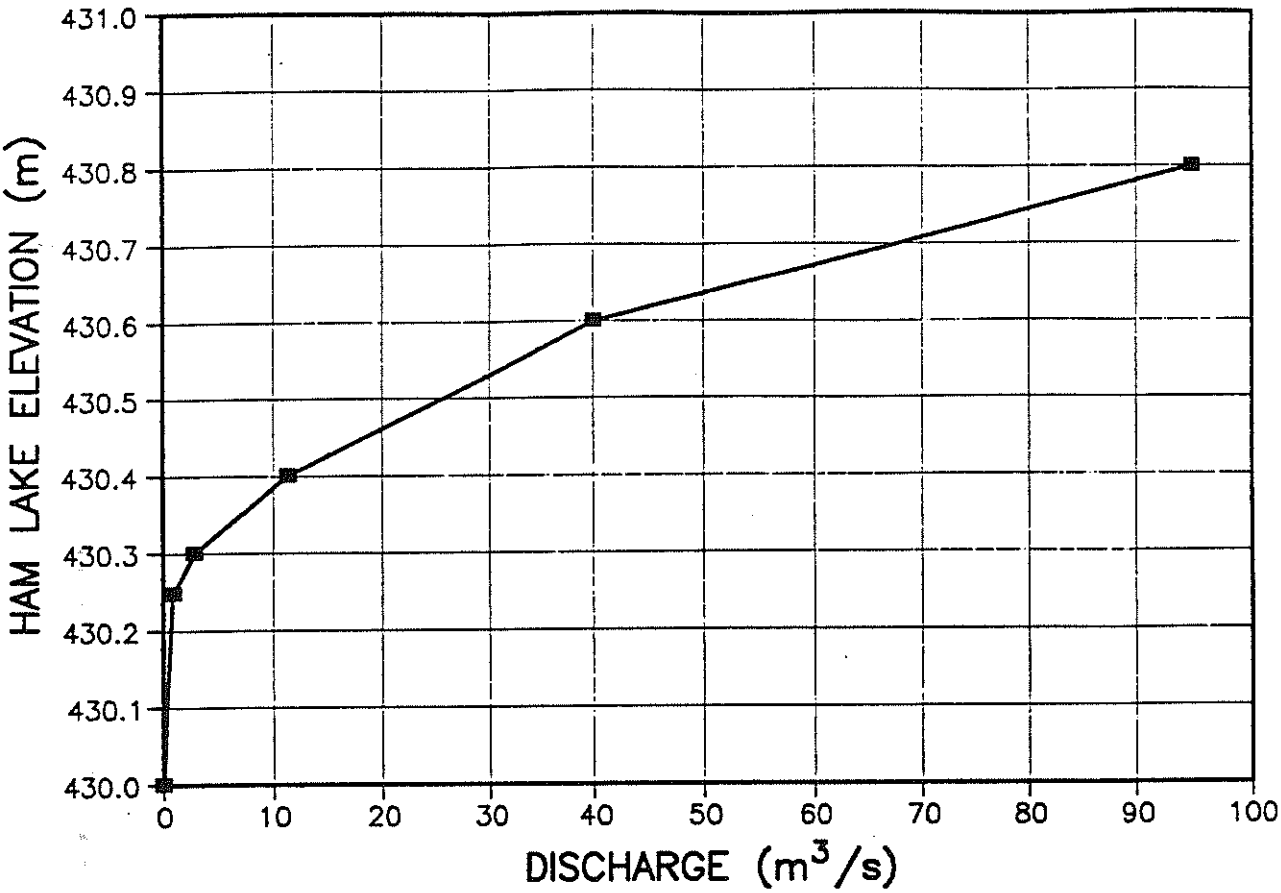


Figure 3.2-17 - Main Catchments in the Izok Mine Site Area

Table 3.2-15 - Izok Mine Site: Creek Discharge Measurements

LOCATION	DATE	MEAN DEPTH (m)	TOP WIDTH (m)	DISCHARGE (m^3/s)	WATER ELEVATION (ASSUMED DATUM) (m)	COMMENTS
Ham Creek	June 17, 1992	0.40	72.5	11.3	9.267	Benchmark established with assumed El. 10 m (WSC)
Ham Creek	July 30, 1992	0.25	16.5	0.76	(not taken)	(RLL)
Ham Creek	June 23, 1993	0.35	87	7.8	(not taken)	(RLL)
Ham Creek	August 5, 1993	0.30	75	2.4	(not taken)	(RLL)
Ham Creek	September 14, 1993	0.25	19	0.7	(not taken)	(RLL)
Iznogoudh Creek	June 17, 1992	-	48 (estimated)	16.8 (estimated)	0.946	Benchmark established with assumed El. 10 m (WSC)
Iznogoudh Creek	July 30, 1992	0.70	35	2.44	0.250	1-m diameter boulders on creek bottom (RLL)
Iznogoudh Creek	June 13, 1993	-	-	11.8	-	6.682 m (Lake Level Recorder)
Iznogoudh Creek	June 16, 1993	-	-	14.4	0.708	6.734 m (Lake Level Recorder)
Iznogoudh Creek	June 18, 1993	-	-	18.8	0.788	6.830 m (Lake Level Recorder)
Iznogoudh Creek	June 22, 1993	-	-	23.9	0.965	6.985 m (Lake Level Recorder)
Iznogoudh Creek	June 23, 1993	-	-	23.0	0.910	6.965 m (Lake Level Recorder)
Iznogoudh Creek	June 24, 1993	-	-	23.9	0.895	6.945 m (Lake Level Recorder)
Iznogoudh Creek	August 1, 1993	-	-	8.0	0.50	6.521 m (Lake Level Recorder)
Iznogoudh Creek	September 6, 1993	-	-	2.7	0.265	
Iznogoudh Creek	September 10, 1993	-	-	3.0	0.274	6.240 m (Lake Level Recorder)

Using the data contained in Table 3.2-15 and inspections of the creek, a rating curve was developed for Ham Creek and is shown in Figure 3.2-18. The large discharge capacity with minimal rise in water level is indicative of the wide channel section.



HAM LAKE ELEVATION (m)	DISCHARGE (m^3/s)	
430.80	94.5	
430.60	40.0	
430.40	11.3	(ESTIMATED JUNE 17, 1992)
430.30	2.8	
430.25	0.8	(MEASURED JULY 30, 1992)
430.00	0.0	(ELEVATION ESTIMATED)

ORIGINAL DRAWING BY KLOHN LEONOFF LTD.

Figure 3.2-18 - Rating Curve for Ham Creek

3.2.7.5 Iznogoudh Creek Discharge

Details of the measurements are given in Table 3.2-15. A staff guage was installed by WSC on the southwest bank of the creek approximately 150 m downstream of the outlet from Iznogoudh Lake along with a brass cap bench mark 7 m upstream of the staff guage. The assumed elevation of the brass cap was 10 m. From Jun3 17, 1992 to August 31, 1992, weekly readings of the staff gauge were made by Minnova Inc. Personnel as shown in Table 3.2-16. Upon request by Metall's Izok Project staff, WSC installed a continuous recording water level gauge on Iznogoudh Creek May of 1993.

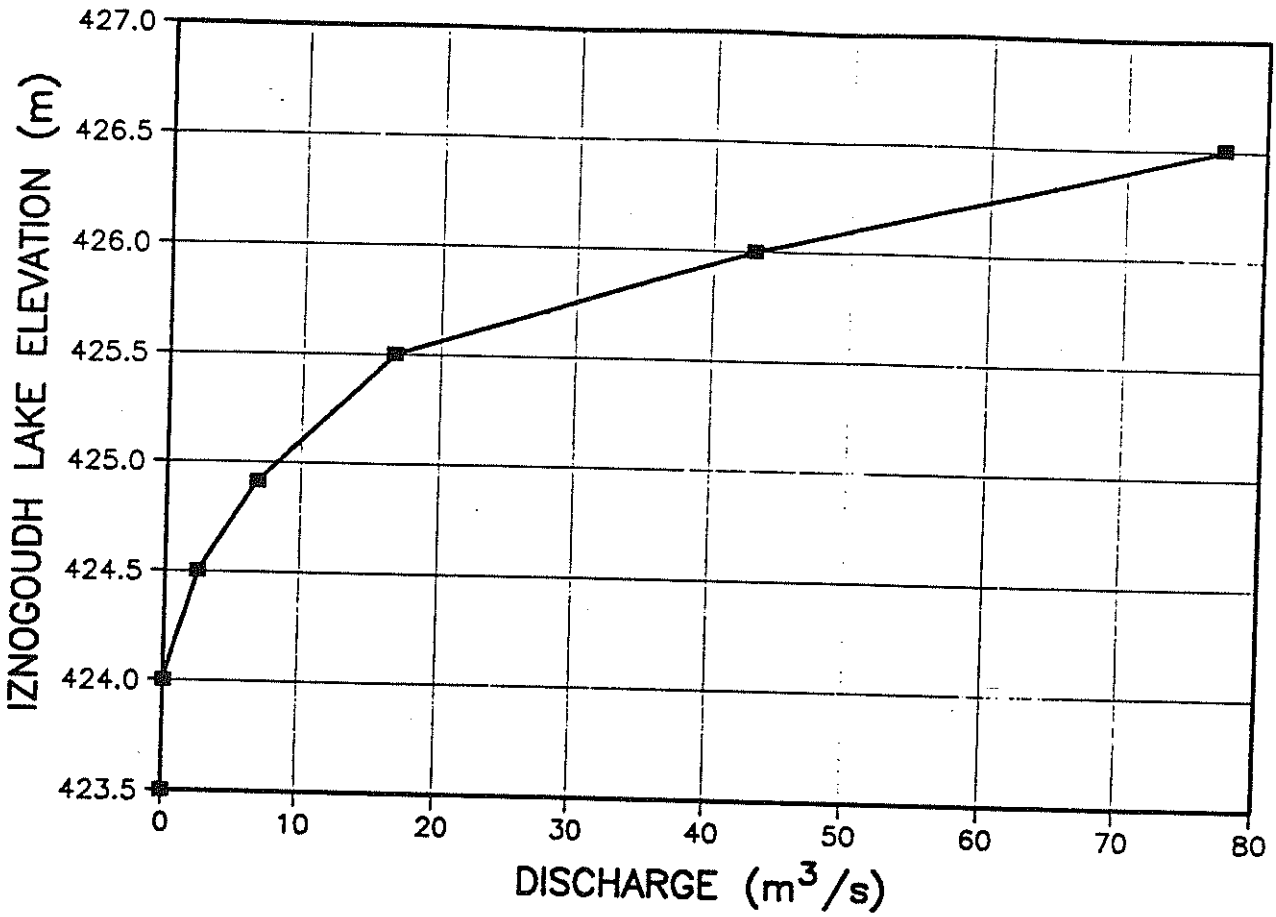
Table 3.2-16 - Iznogoudh Creek Staff Gauge Readings

DATE	STAFF GAUGE READING
June 17, 1992	0.946
July 3, 1992	0.570
July 10, 1992	0.454
July 17, 1992	0.365
July 24, 1992	0.295
July 30, 1992	0.250
August 1, 1992	0.224
August 10, 1992	0.186
August 23, 1992	0.142
August 31, 1992	0.102
June 16, 1993	0.708
June 18, 1993	0.788
June 22, 1993	0.945
June 23, 1993	0.910
June 24, 1993	0.895
July 12, 1993	0.642
July 14, 1993	0.603
July 16, 1993	0.581
July 18, 1993	0.553
July 20, 1993	0.549
July 22, 1993	0.533
July 24, 1993	0.53
July 26, 1993	0.527
July 28, 1993	0.523

Table 3.2-16 - Iznogoudh Creek Staff Gauge Readings (continued)

DATE	STAFF GAUGE READING
July 30, 1993	0.519
August 1, 1993	0.501
August 3, 1993	0.483
August 5, 1993	0.464
August 7, 1993	0.459
August 10, 1993	0.443
August 12, 1993	0.419
August 14, 1993	0.393
August 16, 1993	0.369
August 18, 1993	0.354
August 20, 1993	0.350
August 23, 1993	0.348
September 6, 1993	0.265
September 10, 1993	0.274

Water Survey of Canada have developed a stage discharge curve based on the 1993 data, (see Figure 3.2-19). The banks along Iznogoudh Creek are steeper than those at Ham Creek and, therefore, for a given rise in water level the discharge at Iznogoudh Creek is significantly smaller than the increase in discharge at Ham Creek. The rating curve was developed by WSC to a maximum discharge of 28.6 m^3/s and was extrapolated by Klohn-Crippen to higher discharges based on the geometry of the creek section.



IZNOGOUDH LAKE ELEVATION (m)	DISCHARGE (m^3/s)	
426.5	122.6	
426.0	76.7	
425.5	43.0	
424.9	16.7	(ESTIMATED JUNE 17, 1992)
424.5	6.7	
424.2	2.5	(MEASURED JULY 30, 1992)
424.0	0.9	
423.5	0.0	(ELEVATION ESTIMATED)

ORIGINAL DRAWING BY KLOHN LEONOFF LTD.

Figure 3.2-19 - Rating Curve for Iznogoudh Creek

3.2.7.6 Lake Bathymetry

Ham Lake

A general bathymetric map of Ham Lake is presented in Figure 3.2-20. Ham Lake has an irregular shape, and has a large island (esker) in its centre, and several smaller islands in the southeast end of the lake. The large island separates the lake into three main areas: a shallow west basin, a narrow channel along the south, and a larger northeast basin. The maximum depth recorded in the lake was 11.7 m in the northeast basin of the lake. The west basin has a maximum depth of slightly over 3 m, although the northwestern bay is primarily less than 1 m. The channel between the island and the south shore (i.e., the channel near the present exploration camp) has a maximum depth of over 8 m, although there is a shallow sandbar located at the west and another one about a third of the distance along the channel. The northern end of the northeast basin is also shallow (<2 m).

The approximate area, volume, and mean depth of the main basins and the total lake are given in Table 3.2-17. The total area of the lake is 306.3 ha and the volume is 6.69 million m^3, which results in a mean depth of 2.18 m.

Table 3.2-17 - Approximate Area, Volume, and Mean Depth of the Main Basins of Ham Lake

BASIN	SURFACE AREA (ha)	VOLUME (m^3)	MEAN DEPTH (m)
West Basin	103.6	9.74×10^5	0.94
Channel between Island and South Shore	14.1	3.56×10^5	2.52
Northeast Basin	188.6	5.37×10^6	2.85
Total	**306.3**	**6.69×10^6**	**2.18**

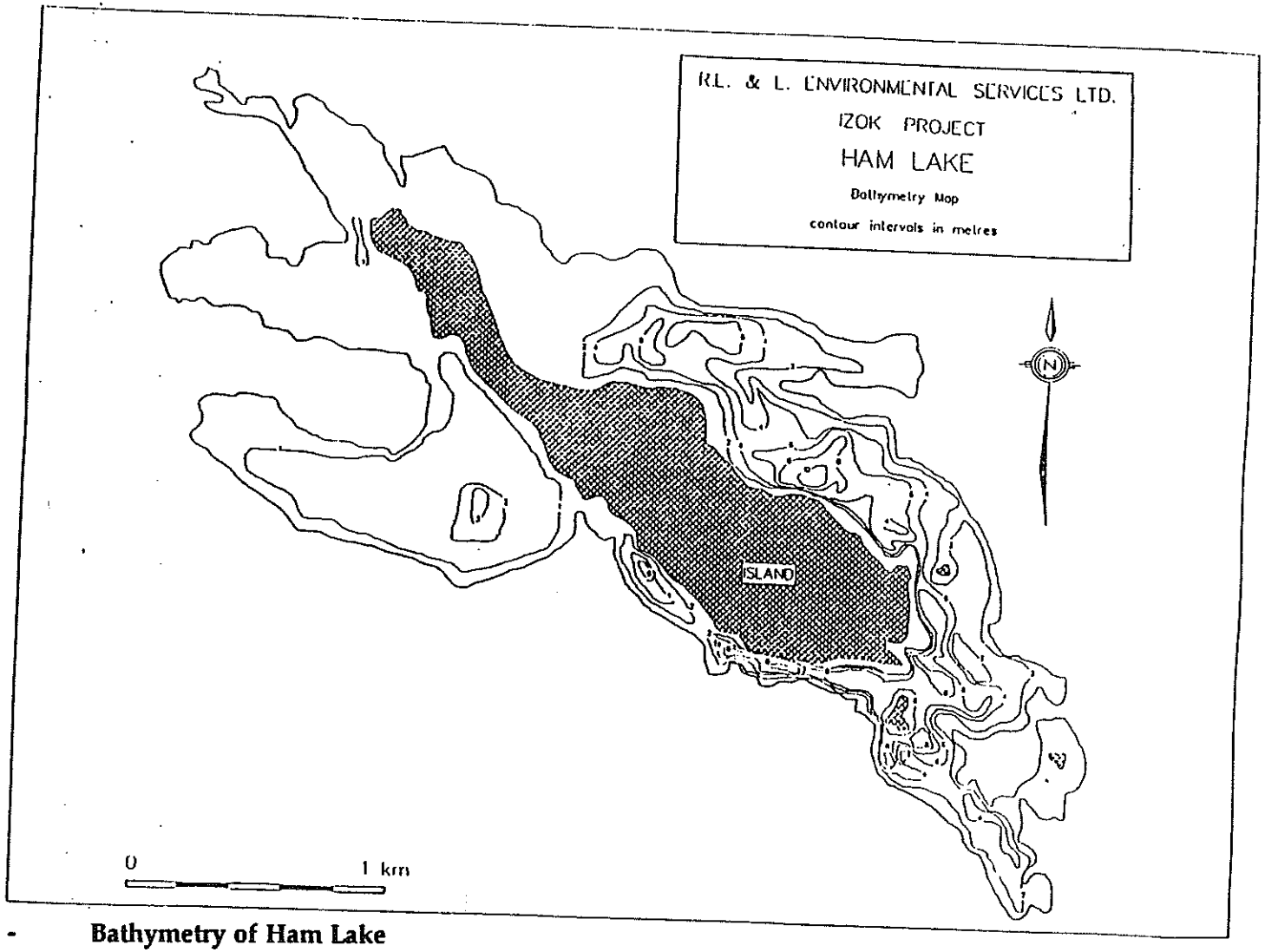


Figure 3.2-20 - Bathymetry of Ham Lake

Izok Lake

A bathymetric map of Izok Lake (Figure 3.2-21) has been prepared by Minnova Inc. based on soundings conducted through the ice during the period 1976-77. Based on this information, Minnova calculated the surface area to be 141.3 ha, and the volume 6.7 million m^3, resulting in a mean depth of 4.8 m. The maximum depth is 18.7 m, which occurs in a depression in the western part of the lake.

Itchen Lake - North Basin

The north basin of Itchen Lake represents a complex array of deep water trenches and submerged islands. This portion of Itchen Lake is comprised of a central basin containing several sub-basins and numerous large islands and deepwater shoals. The north basin of Itchen Lake is connected to the main lake via a shallow (i.e., <2.0 m), narrow waterway located at the southwest corner of the lake. Three arms extend off the main basin. The relatively shallow Izok arm, extends from the southwestern portion of the basin. Itchen inlet is a long trench, approximately 4.0 km in length, located northwest, with another arm located just south. The deepest water depth recorded in the north basin was 36.5 m. The approximate total area of North Itchen Basin is 1100 ha, the volume is estimated at 142 million m^3, resulting in an average mean depth of approximately 12.9 m.

3.2.7.7 Stream Flow - Port Site 1993

Discharge measurements were taken in the Napaaktoktok River along a 64 m transect approximately 3 km upstream from Coronation Gulf. On 15 July, the total discharge was measured at 23.34 m^3/s; a subsequent measurement on 30 August indicated a discharge of 16.09 m^3/s (Table 3.2-18).

In addition to Napaaktoktok River, discharges were measured on 12 July in four small unnamed streams in the Port Site Area (see Figure 3.2-22 for location). Two of these streams were not flowing, and the discharges of the remaining two streams were very low (0.01 and 0.03 m^3/s; Table 3.2-18). The channel depth and width measurements for the four streams and the Napaaktoktok River are presented in Table 3.2-19.

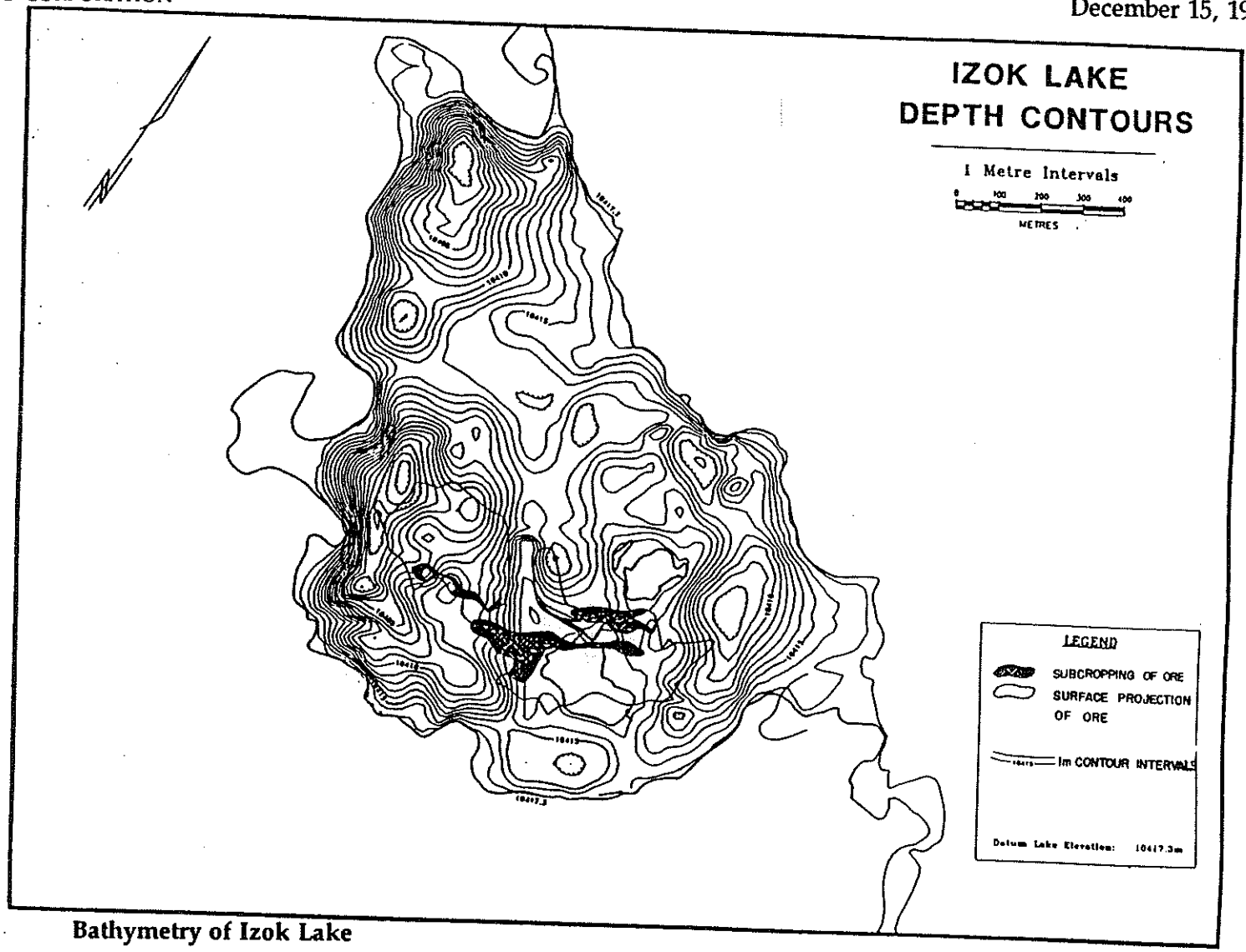


Figure 3.2-21 - Bathymetry of Izok Lake

3.2.8 Water Quality

3.2.8.1 Introduction

This section reviews available water quality data for the study area, in response to RERC guidelines item 3.2.6. The Izok Project area has been of interest for potential mineral development since the early 1970s, and various interests have collected baseline water quality data in the vicinity of Izok Lake since the mid-1970s. In 1992, Minnova initiated a water quality sampling network in the area of their proposed mine and tailings disposal facilities. Existing water quality data reflect primarily summer conditions, but spans the months of June to September. In 1993, Metall's water sampling network incorporated sites in both the mine and port areas and examined seasonal variability during the open water period.

The following sections review water quality data from previous studies (Section 3.2.8.2) and presents the results of the 1992 and 1993 sampling programs to date (Section 3.2.8.3).

Information Sources

Water quality data have been excerpted from the following sources:

1. "Northwest Territories Water Board - Texasgulf Incorporated - Izok Lake Property, Water Quality Analysis Summary," prepared by the Water Resources Division of DIAND (1975). Samples were collected for Izok Lake, Izok Creek and Iznogoudh Creek during July and August.

2. "Environmental Studies of Izok Lake Area - Initial Environmental Evaluation and Pre-Operational Survey in the Area of the Izok Lake Deposit," prepared for Texasgulf Incorporated by Beak Consultants Ltd. (1977). Samples were collected from Izok and Itchen Lakes in June 1976. (Samples were also collected in Amooga Booga and South Camp lakes, upstream of Takiyuak Lake and outside of the Izok primary study area.)

3. "Biological and Water Surveys at Potential Mines in the Northwest Territories, IV. The Texasgulf Copper-Zinc Property, Itchen Lake," prepared by Environment Canada, Environmental Protection Service (Moore, 1978). Data are provided for samples from Iznogoudh, Izok and Itchen lakes, taken in July, August and September 1976.

4. Miscellaneous water quality data collected and provided by **Echo Bay Mines Ltd.**, including samples from Izok and Itchen lakes taken in July of 1987 and 1989.

5. "Izok Lake Project - 1992 Aquatic Investigations," prepared for Minnova by R.L. & L. Environmental Services Ltd. (1992) which presents data for samples collected in Ham Lake, Ham Creek, Iznogoudh Lake, Iznogoudh Creek, Izok Lake, Izok Creek and Itchen Lake, in late July 1992.

6. "R.L. & L. Environmental Services Ltd. Report - in preparation". Data for samples collected during spring and summer from the Mine Site and Port Site study areas during 1993.

3.2.8.2 Previous Studies

DIAND Survey - 1975

In 1975, the Water Resources Division of the DIAND carried out a survey of three stations, including a surface water sample from Izok Lake and samples from Iznogoudh Creek and Izok Creek (DIAND, 1975). The sites were sampled on two occasions, during July and August, respectively. Results are shown in Table 3.2-20.

Texasgulf Investigations - 1976

The results of Texasgulf's June 1976 water quality survey on Izok and Itchen Lake are provided in Table 3.2-21 where they are compared with the earlier DIAND results (Beak, 1977). Data from Amooga Booga and Southcamp lakes, east of Takiyuak Lake, are not presented. A description of water quality conditions in the mine area has been excerpt from the Texasgulf report (Beak, 1977) as follows:

The lakes in the southern area, Izok and Itchen, appeared to be slightly acid having a pH of 6.6 and 6.2, respectively. Conductivity in both lakes is low, with the level of dissolved solids being near 46 mg/ℓ for both lakes. Colour appears in both areas to be higher in smaller headwater lakes, but in an absolute sense these lakes should be classed as quite low in colour. The northern area lakes, Southcamp and Amooga Booga, appear to be slightly less acidic with a pH near neutral. This corresponds with a slightly

Table 3.2-20 - Water Quality Data from DIAND's Survey of the Izok Project Area, 1975

	Sampling Station 1		Sampling Station 2		Sampling Station 3	
	Iznogoudh Creek 50' (15m) Downstream from Outflow of Iznogoudh Lake		Izok Lake at Centre		Izok Creek 50' (15m) Upstream of Mouth	
Date of Sampling	23/07/75	16/08/75	23/07/75	16/08/75	23/07/75	16/08/75
Temp. at Testing °C	16.1	19.4	15.8	19.8	16.4	19.8
Temp. at Sampling °C	12.0	10.0	13.5	11.5	13.0	12.0
pH at Sampling	—	—	—	—	—	—
pH at Testing	6.7	6.8	6.5	6.8	6.5	6.7
Turbidity (Turb. Units)	0.9	0.2	0.8	0.3	1.1	0.2
Colour (Rel. Units)	5.0	5.0	5.0	5.0	5.0	5.0
Sp. Cond. at testing (umho/cm)	9.4	5.0	9.5	4.9	10.5	4.9
Sp. Cond. at Sampling (umho/cm)	—	—	—	—	—	—
Alkalinity: Total, $CaCO_3$	1.6	<1.0	7.4	<1.0	<1.0	<1.0
Hardness: Total, $CaCO_3$	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Calcium (Ca): D	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium (Na): D	0.45	<1.0	0.55	0.2	0.45	—
Potassium (K): D	0.15	0.1	0.20	0.4	0.15	—
Chloride (Cl): D	0.32	0.30	0.32	0.25	0.32	0.25
Sulphate (SO_4): D	2.0	<1.0	2.3	<1.0	2.2	<1.0
Nitrogen: NO_2 - NO_3	—	0.022	—	<0.01	—	0.06
Phosphorus (P): Total	—	0.007	—	0.009	—	0.006
Silica: Reactive SiO_2	0.30	0.30	0.30	0.22	0.20	0.20
Iron (Fe): E	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Manganese (Mn): E	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium (Cd): E	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (Cr): E	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt (Co): E	<0.001	<0.001	<0.001	<0.001	<0.005	<0.001
Copper (Cu): E	0.002	<0.001	0.002	<0.001	0.002	<0.001
Zinc (Zn): E	0.018	0.004	0.023	0.003	0.005	<0.001
Lead (Pb): E	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum (Mo): E	<0.5	<0.05	<0.05	—	<0.05	—
Nickel (Ni): E	<.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic (As): D	<.01	<0.01	<0.01	<0.01	<0.01	<0.01

All units in mg/ℓ unless otherwise stated.

E = Extractable D = Dissolved

Table 3.2-21 - Analytical Results for Surface Water Samples Collected by Beak Consultants for Texasgulf Inc., Izok Project Area, June 1976

	LOCATION	
PARAMETER	IZOK LAKE	ITCHEN LAKE
pH	6.6	6.2
Colour (Co-Pt)	20	10
Suspended Solids (mg/ℓ)	<0.5	<0.5
Dissolved Solids (mg/ℓ)	45.5	46.5
Total Solids (mg/ℓ)	46	47
Alkalinity ($CaCO_3$ mg/ℓ)	3.0	2.0
Hardness ($CaCO_3$ mg/ℓ)	8.0	8.0
Conductivity (umhos/cm^2)	14	11
Nutrients		
Kjeldahl Nitrogen (mg/ℓ)	0.20	0.18
Total Phosphorous (mg/ℓ)	0.023 (0.006)	0.023
Ortho Phosphorous (mg/ℓ)	<0.005	<0.005
Calcium (mg/ℓ)	3.0	2.6
Magnesium (mg/ℓ)	0.45	0.39
Iron (mg/ℓ)	0.074	0.026
Sodium (mg/ℓ)	0.360	0.348
Silica (mg/ℓ)	0.8	0.8
Metals		
Chromium (µg/ℓ)	<1.0	2.0
Copper (µg/ℓ)	1.0 (<1.0-2.0)	<1.0
Lead (µg/ℓ)	<5.0 (<5.0)	<5.0
Mercury (µg/ℓ)	<0.1	1.2
Zinc (µg/ℓ)	16.0 (<1.0-23.0)	14.0
Arsenic (µg/ℓ)	3.0	3.0
Selenium (µg/ℓ)	0.45	0.25

Note: Ranges in brackets obtained from 1975 DIAND reports.

higher level of conductivity, dissolved solids, and hardness. Levels of suspended solids in all four lakes were less than 0.5 mg/ℓ.

In terms of nutrient chemistry, all the lakes in both study areas must be considered as very nutrient poor, with nitrogen levels apparently being limiting at the time of sampling. This limiting relationship may be expected to change with seasonal succession and shifting population uptake and requirements. Levels of heavy metals in all these lakes appear quite low, and levels of Kjeldahl nitrogen and iron suggest the majority of metals present is probably in a bound state.

Environment Canada Surveys - 1976

The Environmental Protection Service of Environment Canada (Environmental Protection Service) carried out a water quality sampling program during July, August and September in 1976 (Moore, 1978). Samples were taken from three sites on Izok Lake and one site on each of Iznogoudh and Itchen lakes. Analytical results for these samples are shown in Table 3.2-22.

Echo Bay Mines - 1987 and 1989

In July of 1987 and 1989, Echo Bay Mines carried out some baseline water quality sampling at three sites: Iznogoudh Creek near the outlet of Iznogoudh Lake, Izok Creek near Itchen Lake, called Izok Lake downstream, and the Itchen Lake discharge to Point Lake. Analytical data for these sites are summarized in Table 3.2-23.

3.2.8.3 Minnova Investigations - 1992

In 1992, Minnova initiated a water quality sampling network in conjunction with the fisheries program, as shown in Figure 3.2-23. Samples were collected by R.L.& L. Environmental Services Ltd. of Edmonton, and analyzed by Norwest Labs. The field studies were initiated on July 23, 1992, and continued through to July 30. Iznogoudh (and Izok) lakes had become ice-free the week prior to the start of the field studies, and Ham Lake had become ice-free several weeks prior to initiation of the study. Ice

Table 3.2-22 - . Water Quality Data for Survey Conducted by Environment Canada, Izok Project Area, 1976

	IZNOGOUDH LAKE			IZOK LAKE			ITCHEN LAKE				INLET TO IZOK LAKE					OUTLET OF IZOK LAKE				
DATE	July 12	Aug. 15	Sept. 7	July 23	Aug. 15	Aug. 16	July 12	Aug. 15	Aug. 15	Sept. 7	July 12	July 23	Aug. 15	Aug. 16	Sept. 7	July 12	July 23	Aug. 15	Aug. 16	Sept. 7
STATION	1	1	1		1		1	1	2	1	1		1		1	1		1		1
DEPTH	7m	7m	8m		2m		5m	5m	10m	5m	0.5m		0.5m		0.5m	0.5m		0.5m		0.5m
Specific conductance (umho/cm)	9.3	9.2	9.2	9.5	9.3	4.9	10.4	10.4	10.4	9.2	9.5	9.4	9.7	5.0	13.8	9.3	10.5	9.4	4.9	13.8
Turbidity (JTU)	1.5	2.9	1.5	0.8	3.0	0.3	2.3	2.9	2.5	1.6	1.9	0.9	3.0	0.2	1.5	2.0	1.1	2.5	0.2	1.5
Colour (relative units)	5	5	5	5.0	5	5.0	5	5	5	5	5	5.0	5	5.0	<5	5	5.0	5	5.0	<5
Total alkalinity	2.3	1.2	1.6	7.4	1.6	1.0	1.6	1.4	1.8	1.8	1.9	1.6	<1.0	1.0	4.3	3.4	1.0	<1.0	1.0	4.3
Total hardness	6.3	5.1	8.4	<5.0	7.1	<5.0	5.3	5.2	4.6	6.7	7.0	<5.0	4.9	<5.0	9.3	6.0	<5.0	4.0	<5.0	9.3
Calcium (dissolved)	2.1	1.7	2.0	<1.0	1.7	<1.0	1.9	1.7	1.6	2.3	2.5	<1.0	1.6	<1.0	2.6	1.9	<1.0	1.3	<1.0	2.6
Potassium (dissolved)	0.3	0.2	0.2	0.20	0.2	0.40	0.3	0.2	0.3	0.2	0.4	0.15	0.2	0.10	0.2	0.3	0.15	0.2	—	0.2
Sodium (dissolved)	0.4	0.5	0.5	0.55	0.5	0.2	0.4	0.5	0.6	0.4	0.4	0.45	0.5	0.50	0.4	0.3	0.45	0.5	—	0.4
Chloride (dissolved)	0.25	0.3	0.3	0.32	0.4	0.25	0.25	0.3	0.3	0.3	0.3	0.32	0.3	0.30	0.2	0.2	0.32	0.3	0.25	0.2
Silica (reactive)	0.4	0.6	0.3	0.30	0.3	0.22	0.3	0.3	0.3	0.3	0.3	0.30	0.4	0.30	0.3	0.4	0.20	0.3	0.20	0.3
Nitrate, nitrite (dissolved)	<0.01	0.01	0.018	—	<0.01	0.01	0.01	<0.01	<0.01	0.01	0.02	—	0.01	0.022	0.018	0.01	—	0.001	0.06	0.018
Total phosphorus (dissolved)	0.010	<0.005	0.007	—	<0.005	0.009	0.020	<0.005	0.010	<0.005	<0.005	—	<0.005	0.007	0.005	0.006	—	<0.005	0.006	0.005
Arsenic (dissolved)	0.0005	0.0009	0.0005	0.01	<0.0005	0.01	0.0031	<0.0005	<0.0005	<0.0005	0.0023	<0.01	0.0005	<0.01	0.0005	0.0014	<0.01	<0.0005	<0.01	0.001
Cadmium (extractable)	<0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.001
Cobalt (extractable)	0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	0.002	0.002	0.002	<0.001	<0.001	0.002	<0.001	0.001	<0.001	<0.005	0.003	<0.001	0.006
Copper (extractable)	0.002	0.002	<0.001	0.002	0.003	0.001	0.001	0.002	0.002	0.002	0.001	0.002	0.002	<0.001	0.006	<0.001	0.002	0.003	<0.001	0.05
Iron (extractable)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.005
Lead (extractable)	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Manganese (extractable)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.005	<0.01	<0.005	<0.01
Nickel (extractable)	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	0.007	0.006	0.009	<0.005	<0.005	0.005	<0.005	0.004	<0.005	<0.005	0.007	<0.005	0.004
Zinc (extractable)	0.008	0.002	0.002	0.23	0.010	0.003	0.017	0.004	0.003	0.023	0.012	0.018	0.005	0.004	0.004	0.068	<0.005	0.014	<0.001	0.004

All parameters expressed as g/m³ unless otherwise indicated.

Physio-Chemical Characteristics of Water Collected by Personnel from the Department of Indian Affairs and Northern Development during 1975.

The symbol '—' means that analyses were not done.

Source: Moore, 1978

still remained on some parts of Itchen Lake; however, the arm of Itchen Lake which was studied was ice-free.

Table 3.2-23 - Miscellaneous Water Quality Data Collected and Provided by Echo Bay Mines Ltd. for the Izok Project Area, 1987 and 1989

	IZNOGOUDH CREEK		IZOK CREEK		ITCHEN LAKE DISCHARGE STREAM TO POINT LAKE	
Date of Sampling	July 27/87	July 24/89	July 27/87	July 24/89	July 27/87	July 24/89
pH	6.85	6.77	6.74	6.76	6.87	6.94
Total Hardness	6.0	3.0	4.0	3.0	6.0	3.5
Conductivity	9	9	9	10	10	10
Total Metal mg/ℓ						
As	0.0005	0.0015	0.0003	0.0008	0.0003	<0.0002
Zn	0.001	0.005	0.004	0.003	0.002	0.004
Pb	<0.001	<0.002	<0.004	<0.002	<0.001	<0.002
Ni	<0.001	<0.002	< >0.001	0.003	0.002	0.002
Fe	0.024	0.032	0.024	0.023	0.028	0.029
Cu	<0.001	<0.002	<0.001	<0.002	<0.001	<0.002

Water samples were collected from surface, mid-depth and bottom locations at one station in each of Iznogoudh, Izok and Itchen lakes. In Ham Lake, three sites were sampled: two in deep water where surface, mid-depth and bottom samples were taken, and one in shallow water where a surface sample only was collected (Figure 3.2-23). Temperature and oxygen profiles were taken at each lake site. Water samples were also collected from Ham Creek, Iznogoudh Creek and Izok Creek (Figure 3.2-23). The following sections, discussing the results of the 1992 program, have been extracted, largely verbatim, from "Izok Lake Project - 1992 Aquatic Investigations" (R.L. & L., 1992).

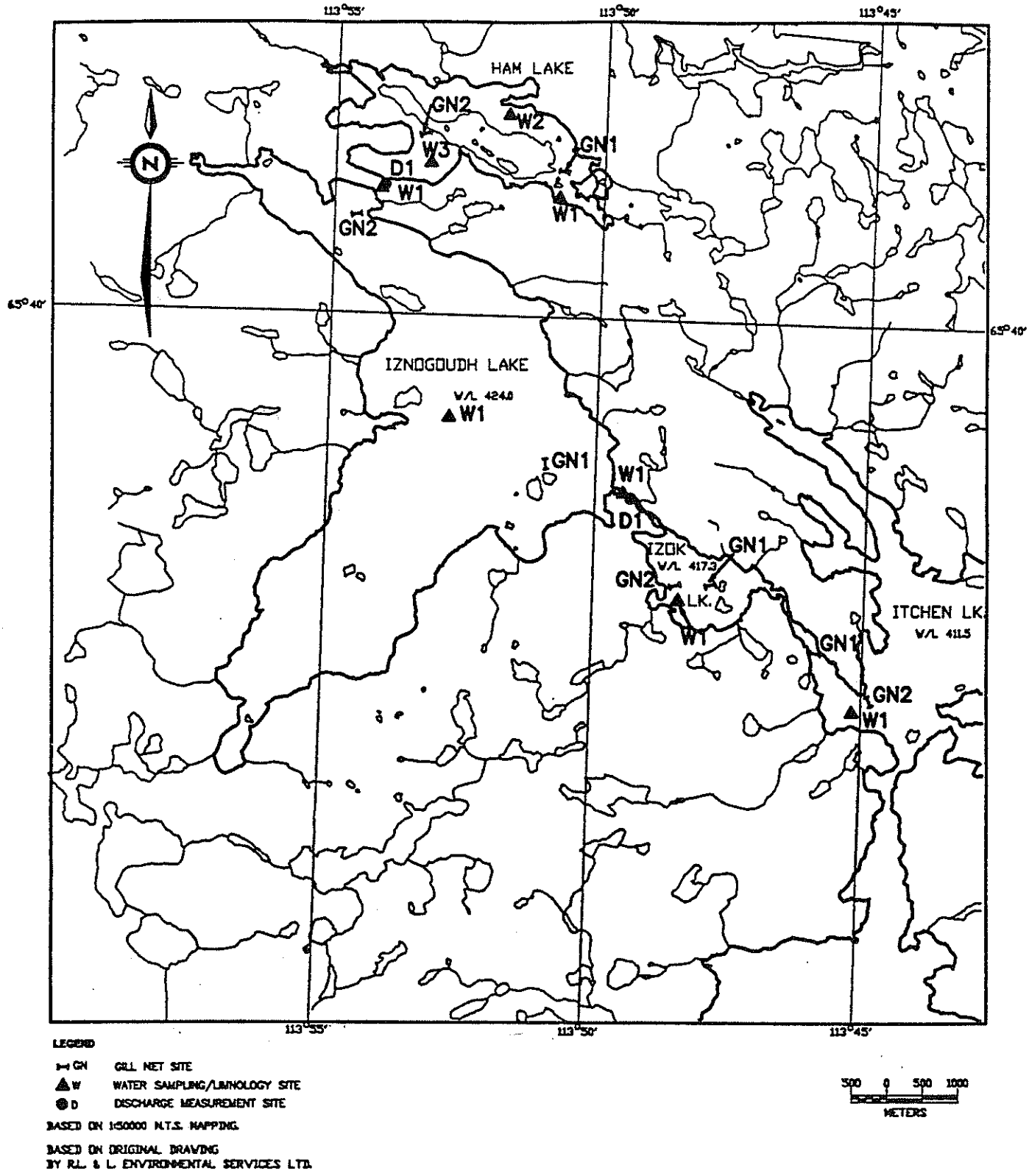


Figure 3.2-23 - Mine Site - 1992 Aquatic Sampling Program

General Characteristics of the Study Lakes

The study lakes are representative of small and medium sized lakes in the sub-Arctic region of the central Northwest Territories. The lakes are on the Canadian Shield and are located near the headwaters of the Coppermine River which flows north into Coronation Gulf of the Arctic Ocean. During the brief summers, surface water inflow to most small and medium sized lakes in central Northwest Territories is minimal due to low rainfall and small catchment areas. Thus, changes in nutrient levels in the surface waters in summer likely are controlled by internal rather than external factors.

Typically, small to medium sized lakes in the area thermally stratify in August, and can be classified as dimictic (i.e., the temperature in the water column equalizes such that lake water can mix completely twice per year — an important factor with respect to the availability of nutrients throughout the water column).

Temperature and Dissolved Oxygen

Data for temperature and dissolved oxygen profiles are plotted on Figures 3.2-24 to 3.2-27. The temperature of Ham Lake during the study period ranged from 18.5°C at the surface in the west basin (Station W3; Figure 3.2-24) to 9.3°C near the bottom (10 m depth) in the east basin (Station W2; Figure 3.2-24). A weak thermocline was observed at the two deeper stations (W1 & W2) between 5 m and 7 m depth. Due to the shallowness of the west basin (Station W3), the water column was isothermal. Dissolved oxygen concentrations in Ham Lake varied from a high of 9.6 mg/ℓ in the upper part of the water column at Station W1 at the south end of the lake, to a low of 7.6 mg/ℓ near the bottom (8 m depth). The dissolved oxygen concentrations in the shallow west basin ranged from 9.2 mg/ℓ at the surface to 9.5 mg/ℓ at 2.8 m depth.

The temperature of Iznogoudh Lake during the study ranged from 11.4°C at the surface to 4.4°C near the bottom (30 m depth) (Figure 3.2-25). A thermocline was noted between 4 m and 12 m depth, with the temperature declining from 10.0°C to 5.4°C. It should be noted that the ice did not completely disappear from Iznogoudh Lake until mid-July (F. Balint, Metall Mining Corp., pers. comm., 1992). Dissolved oxygen concentrations varied from 11.3 mg/ℓ at the surface to 13.3 mg/ℓ near the bottom (30 m

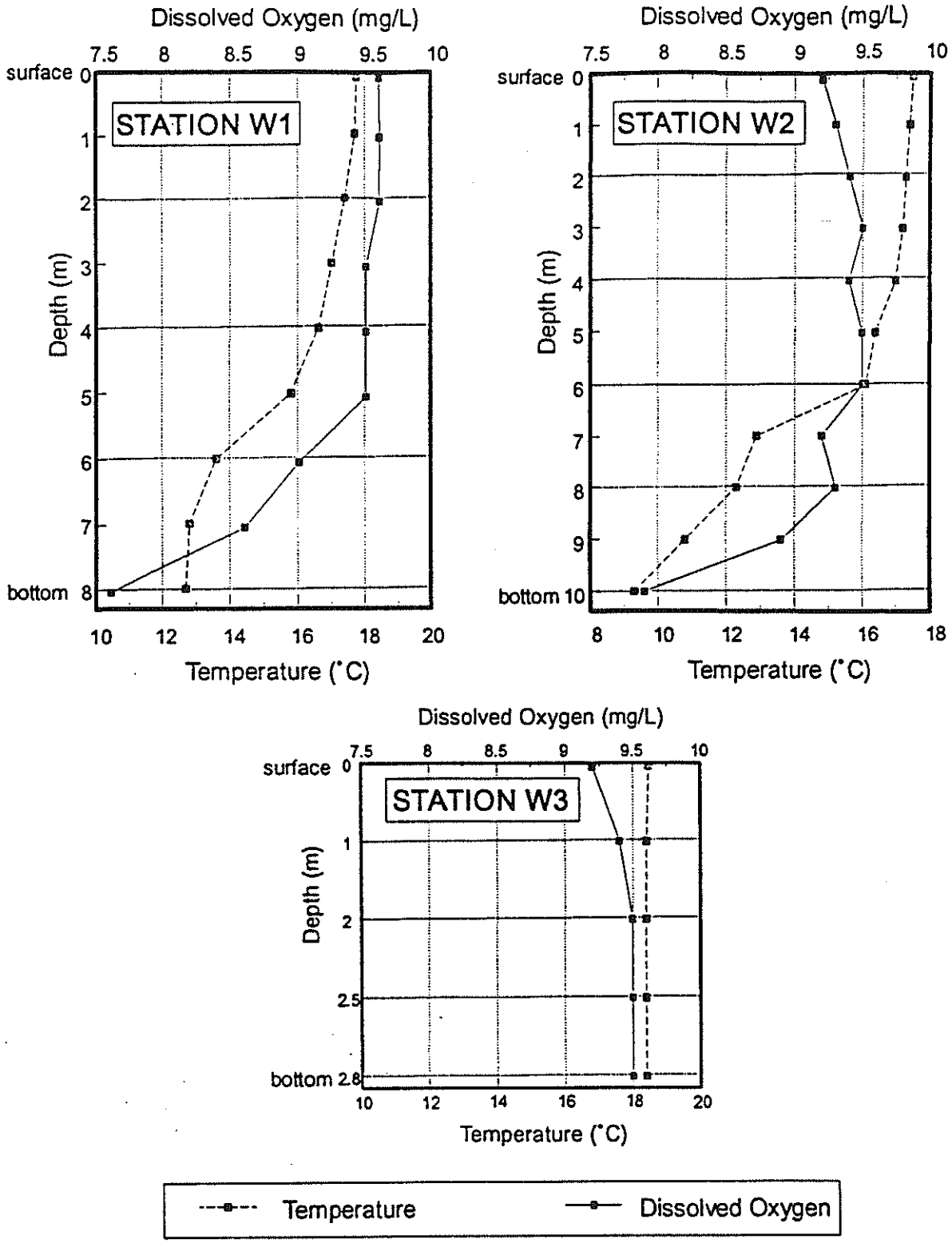


Figure 3.2-24 - Dissolved Oxygen and Temperature Profile of Ham Lake, July 28 and 29, 1992 (R.L. & L., 1992)

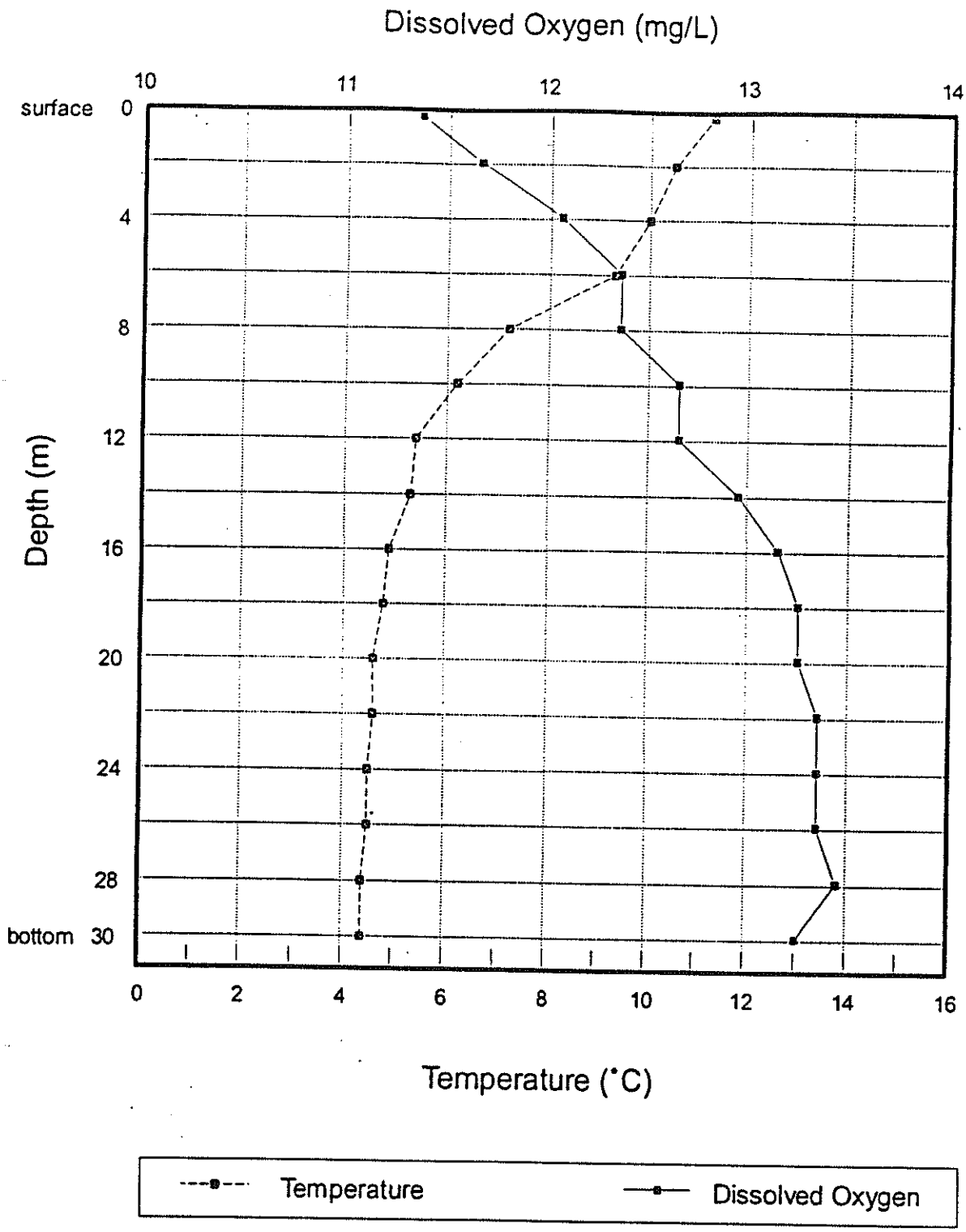


Figure 3.2-25 - Dissolved Oxygen and Temperature Profile of Iznogoudh Lake, July 29, 1992 (R.L. & L., 1992)

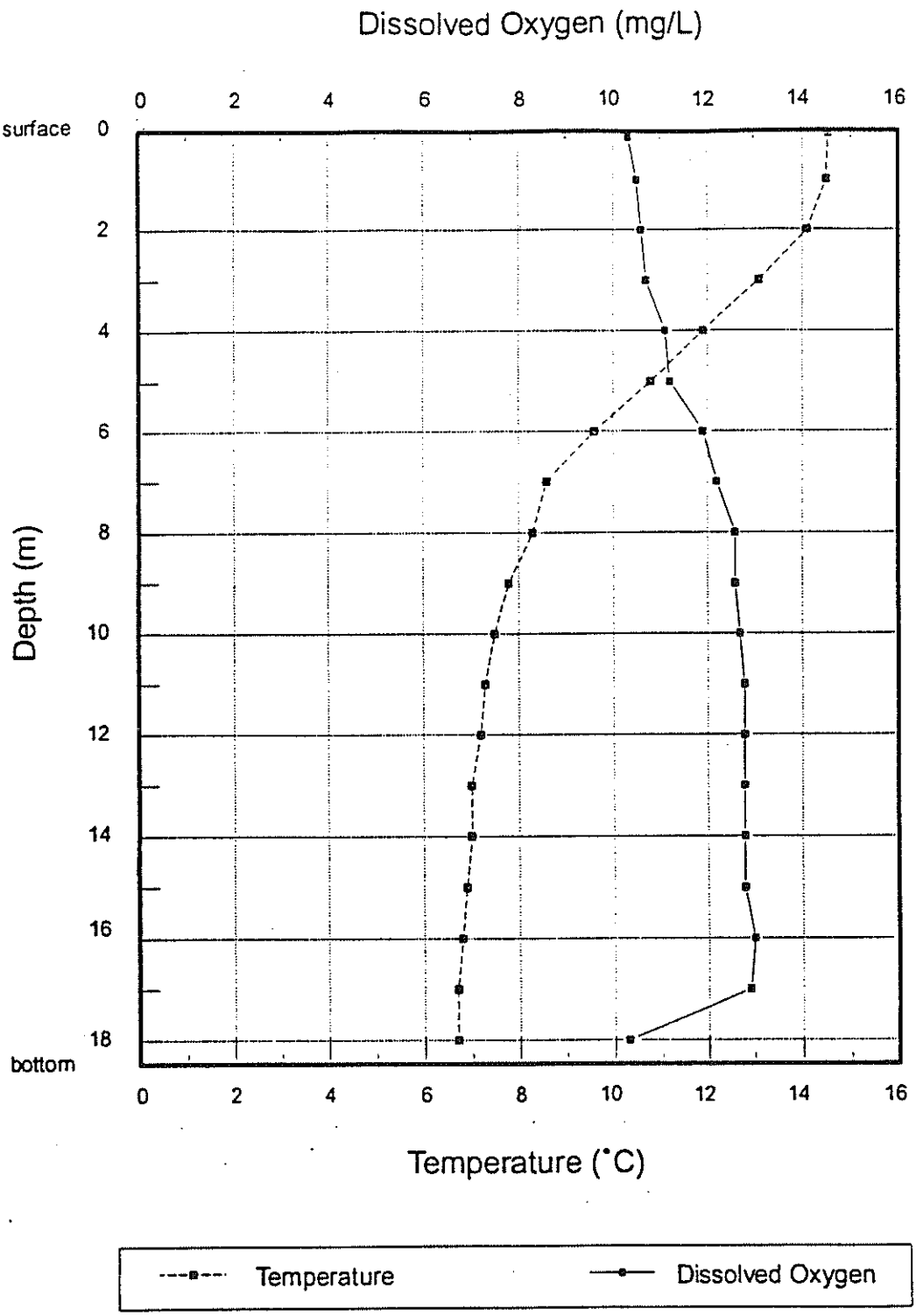


Figure 3.2-26 - Dissolved Oxygen and Temperature Profile of Izok Lake, July 29, 1992 (R.L. & L., 1992)

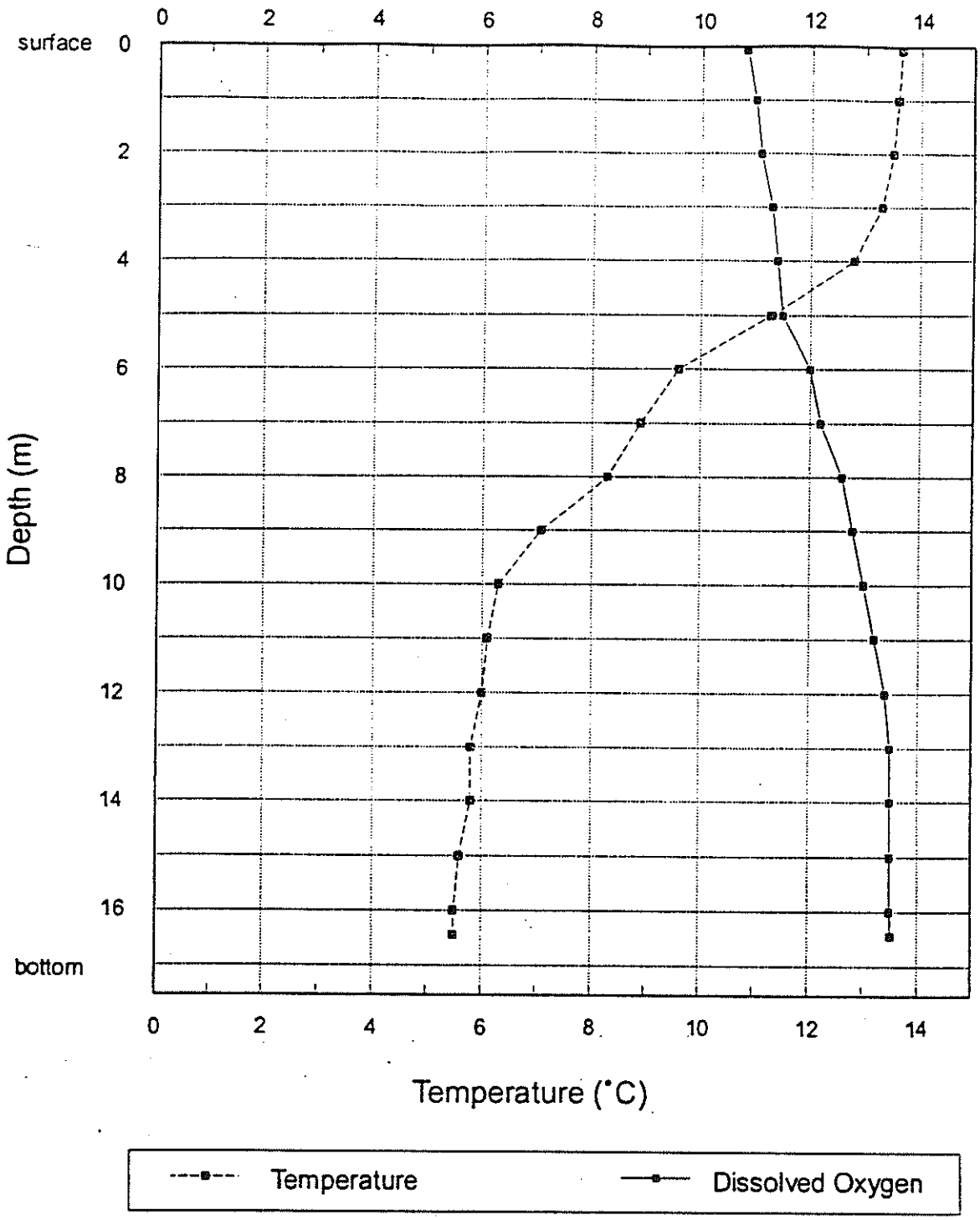


Figure 3.2-27 - Dissolved Oxygen and Temperature Profile of Itchen Lake, July 29, 1992 (R.L. & L., 1992)

depth). The increase in dissolved oxygen concentration with depth reflects the effects of temperature on the solubility of oxygen (i.e., colder water can hold greater concentrations of dissolved gases than can warmer water).

At the time of sampling, the temperature of Izok Lake was 14.5°C at the surface, declining steadily to 6.7°C near the bottom (18 m) (Figure 3.2-26). Dissolved oxygen levels increased from 10.3 mg/ℓ at the surface to 13.0 mg/ℓ at 16 m, then declined again to 10.3 mg/ℓ near the bottom. The decline near the bottom reflects the higher oxygen demand of the flocculent silt/detrital substrate at this site.

The temperature of Itchen Lake ranged from 13.7°C at the surface to 5.5°C near the bottom (16.5 m depth) (Figure 3.2-27). The sharpest decrease in temperature occurred between 4 m and 10 m where the temperature declined from 12.8°C to 6.3°C. During the time of the survey in late July, there were still patches of ice on the main part of Itchen Lake to the southeast of the study area. Dissolved oxygen at the site in Itchen Lake ranged from 10.7 mg/ℓ at the surface to 13.6 mg/ℓ near the bottom. The substrate at the site was large rock (i.e., minimal organic accumulation and low oxygen demand), and as such no decline in dissolved oxygen was noted near the bottom.

Transparency

The water transparency of the study lakes ranged from 8.4 m in Itchen Lake to 6.2 m in the south end of Ham Lake (Table 3.2-24). Based on these data, the euphotic zone (depth of water in which phytoplankton are able to grow and reproduce = 2 x Secchi disk depth) extended over the entire bottom surface area of Ham Lake, and most of the area of Izok Lake.

The high clarity of the water reflects the low biological productivity of the northern lakes (i.e., low biomass of phytoplankton and zooplankton in the water column). The lowest transparency values were recorded from Ham Lake which is the shallowest and warmest of the study lakes; as such, it is also likely the most productive of the study lakes, particulary in the west basin (i.e., mean depth of 0.94 m).

Table 3.2-24 - Water Transparency Measurements, Izok Lake Project Area, July 1992

LAKE		TRANSPARENCY DEPTH (Secchi Depth)
Ham Lake	W1	6.2 m
	W2	6.4 m
	W3	>2.8 m
Iznogoudh Lake		7.2 m
Izok Lake		7.2 m
Itchen Lake		8.4 m

Water Chemistry

A summary of the water quality data collected in July 1992 is presented in Table 3.2-25. The lakes and streams were all slightly acidic (pH of 6.1 - 6.5) and poorly buffered (total alkalinity of 5 mg/ℓ - 8 mg/ℓ as $CaCO_3$), which is characteristic of waters on the Canadian Shield. The hardness of the water (composed of calcium and magnesium expressed as $CaCO_3$) is considered to be very low, with all values being less than 0.7 mg/ℓ.

The nutrient levels also were low, with nitrite/nitrate values of 0.08 mg/ℓ or less, and the phosphorus levels below 0.1 mg/ℓ (below detection limits of ICP scan). Moore (1978) also found low nitrogen and phosphorus concentrations of <0.02 mg/ℓ and <0.005 mg/ℓ, respectively. Based on these data, the lakes can be classified as oligotrophic (nutrient poor) and are probably phosphorus limited (lack of phosphorous limits plant growth) (Wentzel, 1983).

The concentrations of metals in the waters of the study area were all at, or below, water quality objectives to protect aquatic life (CCREM, 1987) with the exception of aluminum. Concentrations of up to 0.20 mg/ℓ aluminum were noted in surface waters at the south end of Ham Lake (Station W1), and near the bottom in the east basin (Station W2). High levels of 0.17 mg/ℓ were also recorded in both Izok Lake and Itchen Lake. These values are above the Canadian Water Quality Guideline of 0.1 mg/ℓ as established by CCREM (1987), and may be related to the higher solubility of aluminum in acidic waters; however, the analytical values for this metal varied considerably throughout the water

Table 3.2-25 - Summary of Water Quality Data, Izok Lake Project Area, July 28 to 30, 1992 (R.L. & L., 1992)

Parameter	Ham Lake							Ham Creek (Outlet)
	Station 1			Station 2			Station 3	
	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	30/07/92
pH (units)	6.2	6.1	6.1	6.1			6.2	6.1
Specific Conductance (µS/cm)	20.0	20.0	20.0	30.0			20.0	30.0
Calcium	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1
Magnesium	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1
Sodium	2.2	1.4	1.4	1.9			1.2	1.1
Potassium	<0.20	<0.20	<0.20	<0.20			<0.20	<0.20
Sulphate	<0.3	<0.3	<0.3	<0.3			<0.3	<0.3
Chloride	0.4	0.4	0.4	0.5			0.3	0.3
Bicarbonate	7.2	8.3	6.2	6.2			7.2	8.3
Nitrite/Nitrate Nitrogen as N	0.05	0.06	<0.05	0.06			0.06	0.06
Total Alkalinity as $CaCO_3$	6	7	5	5			6	7
Hardness as $CaCO_3$	<0.7	<0.7	<0.7	<0.7			<0.7	<0.7
Total Dissolved Solids (calculated)	7	7	6	6			6	6
Arsenic, Total	0.0003	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Aluminum	0.20	<0.06	0.10	<0.06	0.08	0.20	<0.06	<0.06
Barium	0.004	<0.001	0.007	0.004	0.006	0.005	0.003	0.007
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chromium	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Cobalt	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	0.002	0.002	0.002	0.002	0.001	0.002	0.002	0.002
Iron	0.03	<0.02	0.03	<0.02	0.02	0.04	0.03	0.08
Lead	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	0.039	0.009	0.041	0.022	0.047	0.034	0.011	0.078
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium, Total	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0002
Silver	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Silicon	0.32	0.28	0.26	0.27	0.30	0.30	0.18	0.29
Titanium	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Thallium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Zinc	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cyanide, Total	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

*Note - All values expressed in mg/ℓ unless otherwise indicated.
- All metals acid extractable unless otherwise noted.

Table 3.2-25 - Summary of Water Quality Data, Izok Lake Project Area, July 28 to 30, 1992 (R.L. & L., 1992) (continued)

Parameter	Iznogoudh Lake			Iznogoudh Creek (Outlet)	Izok Lake		
	Surface	Middle	Bottom	30/07/92	Surface	Middle	Bottom
pH units	6.5	6.3	6.3	6.4	6.3	6.2	6.2
Specific Conduction (µS/cm)	20.0	20.0	20.0	10.0	20.0	20.0	20.0
Calcium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Magnesium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	7.8	4.5	3.4	2.2	3.9	2.4	2.0
Potassium	<0.20	<0.20	<0.20	0.22	<0.20	<0.20	<0.20
Sulphate	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chloride	0.4	0.4	0.2	0.2	0.3	0.4	0.4
Bicarbonate	9.3	9.3	8.3	8.3	9.3	8.3	8.3
Nitrite/Nitrate Nitrogen as N	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Alkalinity as $CaCO_3$	8	8	7	7	8	7	7
Hardness as $CaCO_3$	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
Total Dissolved Solids (calculated)	14	10	8	7	8	8	7
Arsenic, Total	<0.0001	<0.0002	<0.0002	<0.0002	<0.00022		<0.0002
Aluminum	<0.06	<0.06	<0.06	<0.06	0.17	0.09	0.11
Barium	0.002	0.002	0.003	<0.001	0.006	0.007	0.008
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chromium	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Cobalt	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	0.002	0.002	0.001	<0.001	0.001	0.001	0.001
Iron	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Lead	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	0.006	0.007	0.006	0.008	0.050	0.047	0.070
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.00011		<0.0001
Molybdenum	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium, Total	<0.002	0.0003	0.0002	<0.0002	<0.00022		<0.00020
Silver	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Silicon	<0.17	0.18	0.19	0.16	0.21	0.21	0.24
Titanium	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Thallium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Zinc	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cyanide, Total	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

*Note - All values expressed in mg/ℓ unless otherwise indicated.
- All metals acid extractable unless otherwise noted.

Table 3.2-25 - Summary of Water Quality Data, Izok Lake Project Area, July 28 to 30, 1992 (R.L. & L., 1992) (continued)

Parameter	Izok Creek (outlet) 30/07/92	Itchen Lake		
		Surface 29/07/92	Middle 29/07/92	Bottom 29/07/92
pH (units)	6.2	6.1	6.2	6.1
Specific Conductance (µS/cm)	20.0	20.0	20.0	30.0
Calcium	<0.1	<0.1	<0.1	<0.1
Magnesium	<0.1	<0.1	<0.1	<0.1
Sodium	2.1	1.0	1.1	1.0
Potassium	<0.20	<0.20	<0.20	0.26
Sulphate	<0.3	<0.3	<0.3	<0.3
Chloride	0.4	0.2	0.3	0.3
Bicarbonate	8.3	7.2	8.3	8.3
Nitrite/Nitrate Nitrogen as N	0.06	0.06	0.07	0.08
Total Alkalinity as $CaCO_3$	7	6	7	7
Hardness as $CaCO_3$	<0.7	<0.7	<0.7	<0.7
Total Dissolved Solids (calculated)	7	6	6	6
Arsenic, Total	<0.0002	<0.0002	<0.0002	<0.0002
Aluminum	<0.06	0.06	<0.06	0.17
Barium	0.002	0.004	0.002	0.004
Beryllium	<0.001	<0.001	<0.001	<0.001
Boron	<0.01	<0.01	<0.01	<0.01
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.006	<0.006	<0.006	<0.006
Cobalt	<0.01	<0.01	<0.01	<0.01
Copper	0.001	0.002	0.001	0.003
Iron	<0.02	<0.02	<0.02	<0.02
Lead	<0.001	<0.001	<0.001	<0.001
Manganese	0.015	0.022	<0.003	0.038
Mercury	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	<0.02	<0.02	<0.02	<0.02
Nickel	<0.02	<0.02	<0.02	<0.02
Phosphorus	<0.1	<0.1	<0.1	<0.1
Selenium, Total	0.0003	<0.0002	<0.0002	<0.0002
Silver	<0.05	<0.05	<0.05	<0.05
Silicon	0.16	0.15	0.13	0.20
Titanium	<0.003	<0.003	<0.003	<0.003
Thallium	<0.1	<0.1	<0.1	<0.1
Vanadium	<0.003	<0.003	<0.003	<0.003
Zinc	<0.005	<0.005	<0.005	<0.005
Cyanide, Total	<0.001	<0.001	<0.001	<0.001

*Note - All values expressed in mg/ℓ unless otherwise indicated.
- All metals acid extractable unless otherwise noted.

column at the same station (e.g., 0.20 to <0.06 mg/ℓ at Ham Lake Station 1). Further sampling may be necessary to confirm these concentrations.

3.2.8.4 Metall Investigations - 1993

This section describes the water quality program conducted by R.L. & L. Environmental Services Ltd. during the spring and summer 1993 open water period. A similar limnology and water quality program was conducted in fall (late August to mid-September), and is presented in a separate R.L.& L. Report. The program was designed to generate baseline data adequate for monitoring potential water quality impacts associated with the Izok Project, in the mine and port site areas. Discussions about the program were held with Department of Fisheries and Oceans Canada and Environment Canada in December 1992; the proposed program addresses suggestions which arose at that meeting.

The study area included water bodies potentially affected by mining and waste management activities in the Mine Site area (including Ham Lake, Iznogoudh Lake, Izok Lake, Itchen Lake and the streams connecting these lakes) (Figure 3.2-28). The study area at the Port Site included the area of the Coronation Gulf in the vicinity of the port facility (Figure 3.2-29).

Limnology and water quality sampling at the Mine Site area were undertaken at the same stations that were sampled for water quality in 1992. In addition, an extra station in Iznogoudh Lake (north end), two additional stations in Itchen Lake, a new station at the inlet to Point Lake, and several stations at the Port Site were sampled. The extra station in Iznogoudh Lake was in the shallow northern part of the lake near the inflow from Ham Lake. Sampling during 1992 indicated that this shallow part of the lake provided feeding habitat for round whitefish and lake trout. Furthermore, it is downstream of the proposed tailings disposal area in Ham Lake. The two additional stations in Itchen Lake were in the arm that was being investigated as an option for tailings disposal and at the narrows where the north basin of Itchen Lake enters the main basin. The station at the entrance to Point Lake (which corresponds to the Echo

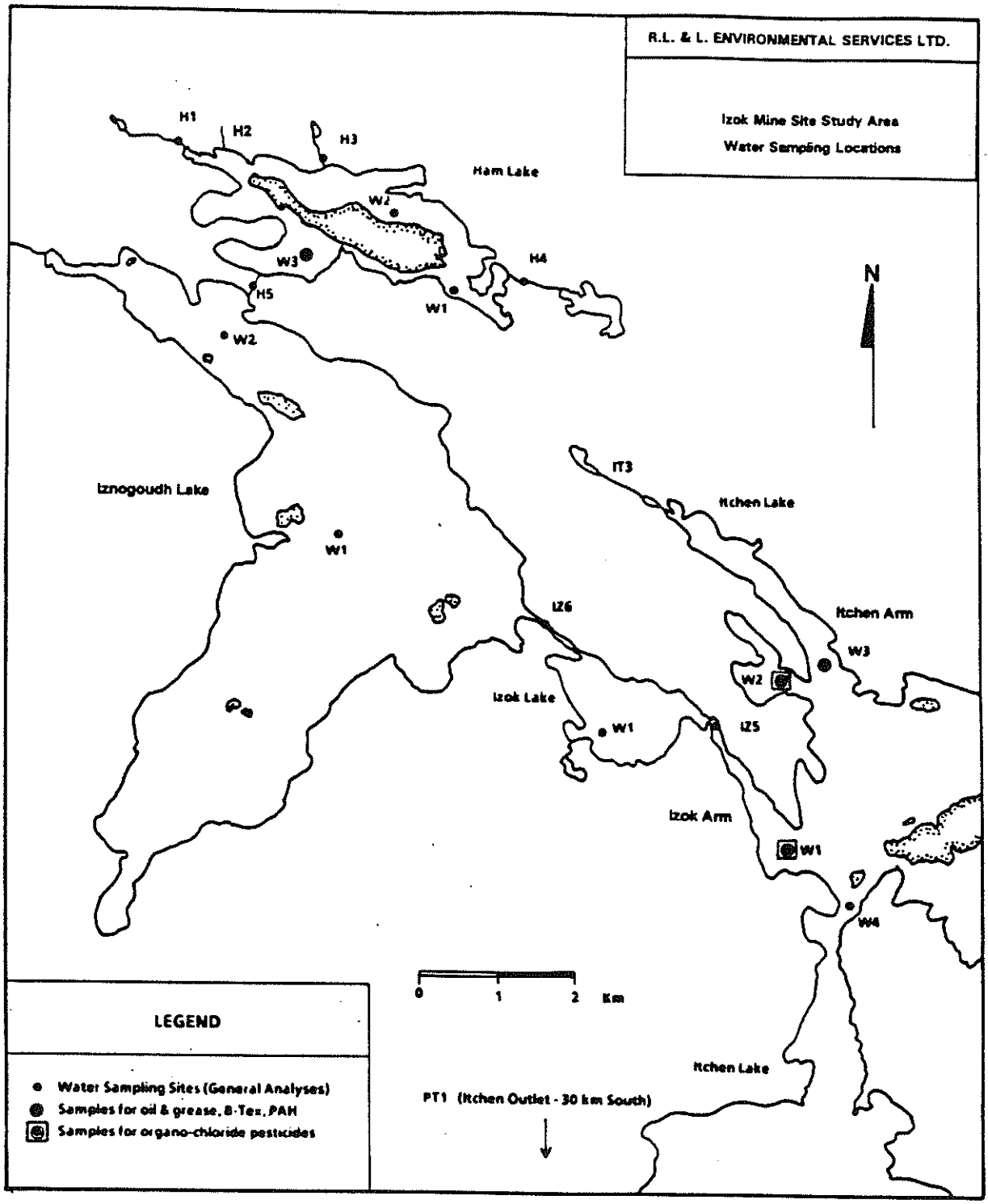


Figure 3.2-28 - Izok Mine Site Study Area - Water Sampling Locations

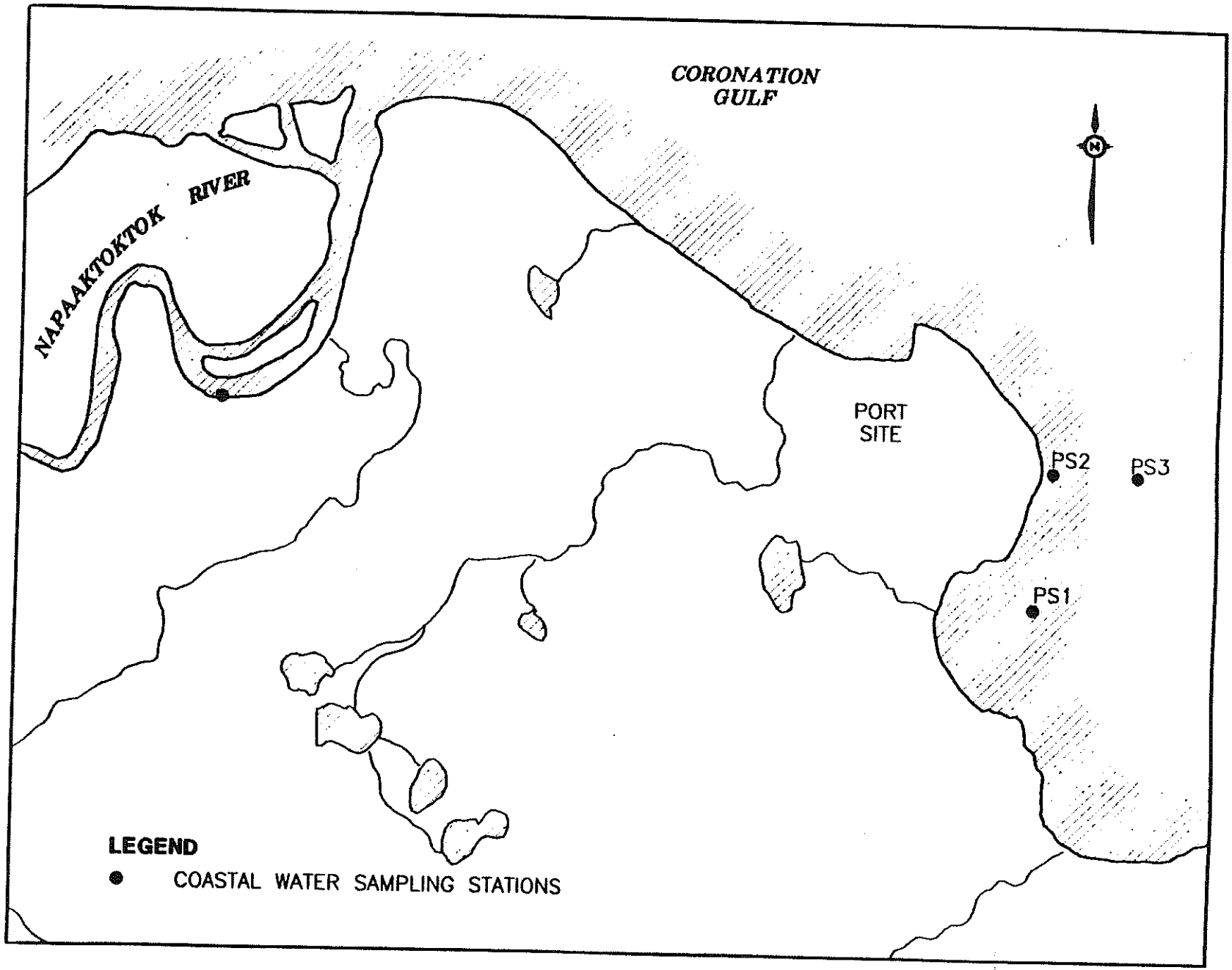


Figure 3.2-29 - Coastal Water Sampling Stations

Bay Station sampled in 1987 and 1989) monitored water quality in the outflow from Itchen Lake. Stations at the Port Site included the lower section of the Napaaktoktok River, and three sites near the dock site in Coronation Gulf.

Limnology and water quality sampling at the Mine Site area lake stations and at the Port Site stations were conducted during both early summer and fall sampling periods. Only results from the summer sampling period is presented below. At the time this report was prepared, the fall sample laboratory analyses were in progress.

Izok Mine Site Area

Temperature and Dissolved Oxygen

Data for temperature and dissolved oxygen profiles are plotted on Figures 3.2-30 to 3.2-33. The temperature of Ham Lake during the study period ranged from 15.0°C at the surface in the west basin (Station W3; Figure 3.2-30) to 12.1°C near the bottom (7.8 m depth) in the east basin (Station W1; Figure 3.2-30). A weak thermocline was observed at the two deeper stations (W1 & W2) between 3 m and 5 m depth. Due to the shallowness of the west basin (Station W3), the water column was isothermal. Dissolved oxygen concentrations in Ham Lake varied from a high of 14.4 mg/ℓ in the upper part of the water column at Station W2 at the north end of the lake, to a low of 9.7 mg/ℓ near the bottom of Station W1 at the east end of the lake (7.8 m depth). The dissolved oxygen concentrations in the shallow west basin ranged from 10.2 mg/ℓ at the surface to 10.7 mg/ℓ at 2.5 m depth.

The temperature of Iznogoudh Lake during the summer ranged from 10.9°C at the surface to 5.6°C near the bottom (30 m depth) in the centre basin, Station W1 (Figure 3.2-31). A thermocline was noted between 4 m and 16 m depth, with the temperature declining from 10.6°C to 6.0°C. Dissolved oxygen concentrations varied from 11.1 mg/ℓ at the surface to 8.3 mg/ℓ near the bottom (30 m depth) of Station W1. The shallow east station (W2) had isothermal temperatures and dissolved oxygen levels that varied little (10.2 to 10.3 mg/ℓ).

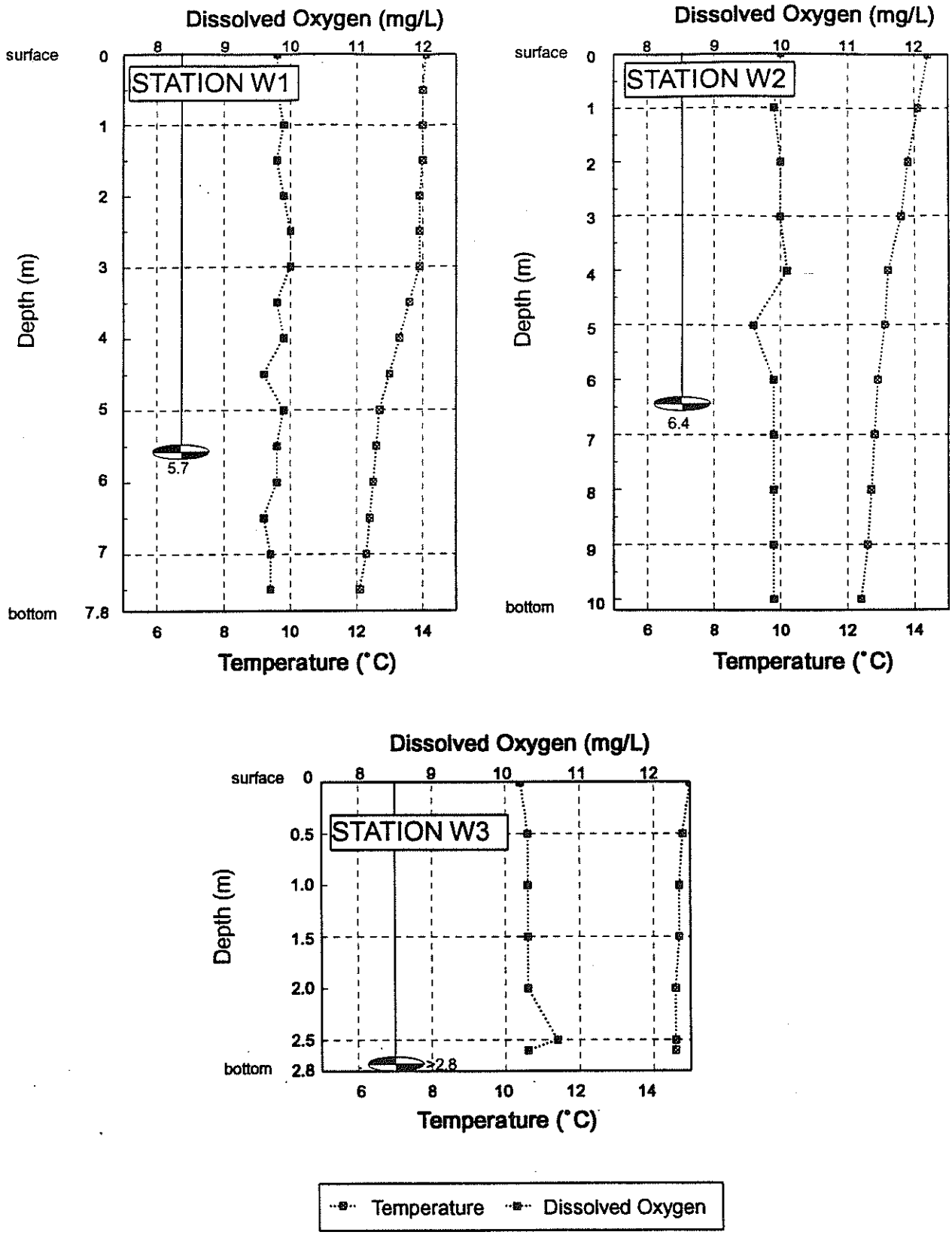


Figure 3.2-30 Dissolved oxygen and temperature profiles of Ham Lake, 4 August 1993.

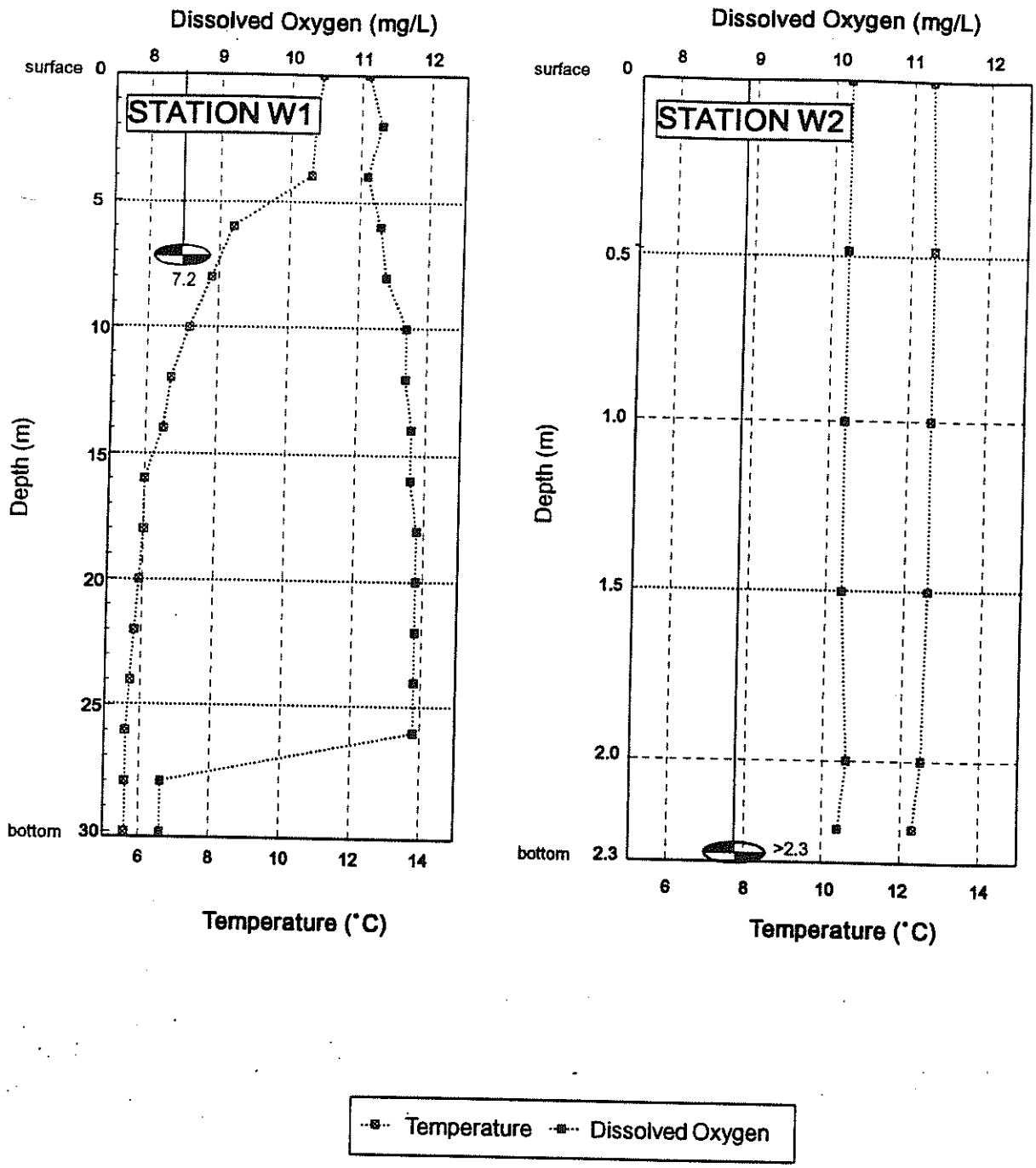


Figure 3.2-31 Dissolved oxygen and temperature profiles of Iznogoudh Lake, 7 August 1993.

At the time of sampling, the temperature of Izok Lake was 11.4°C at the surface, declining steadily to 7.9°C near the bottom (15.2 m) (Figure 3.2-32). Dissolved oxygen levels decreased from 11.0 mg/ℓ at the surface to 10.8 mg/ℓ at 4 m, then increased to 11.3 mg/ℓ at 9 m and declined again to 10.8 mg/ℓ near the bottom. The varying dissolved oxygen levels may reflect the spacial variability of algal densities, which oxygenate the water column.

The temperature of Itchen Lake ranged from 11.1°C at 4 m in Stations W1 and W4 to 5.0°C near the bottom of the north station, W3 (16.5 m depth) (Figure 3.2-33). The sharpest decrease in temperature occurred between 4 m and 26 m, at north station W3, where the temperature declined from 10.1°C to 6.0°C. Dissolved oxygen in Itchen Lake ranged from 11.7 mg/ℓ at 24 m of Station W3 to 10.5 mg/ℓ near the bottom of Stations W2 and W4 (17.5 and 10 m, respectively). The increases in dissolved oxygen concentrations with depth in Stations W1, W2, and W3 may reflect the effects of temperature on the solubility of oxygen (i.e., colder water can hold greater concentrations of dissolved gases than can warmer water). The shallow south station (W4) had isothermal temperatures and dissolved oxygen levels that dropped from 10.9 to 10.5 mg/ℓ over the sediments.

Transparency

Water transparency ranged from a maximum of 7.2 m in Iznogoudh Lake to a minimum of 5.7 m in Ham Lake (Figures 3.2-30 through 3.2-33). These results generally were similar to those recorded in 1992; however, transparency in Itchen Lake dropped from 8.4 m in 1992 to 6.0 m in 1993 at Station W1. The timing of measurements (late July in 1992 and early August in 1993), as well as natural year to year variation, may account for observed differences.

In summary, high transparency levels were measured in 1993 as well as 1992, which reflects the low biological productivity of northern lakes.

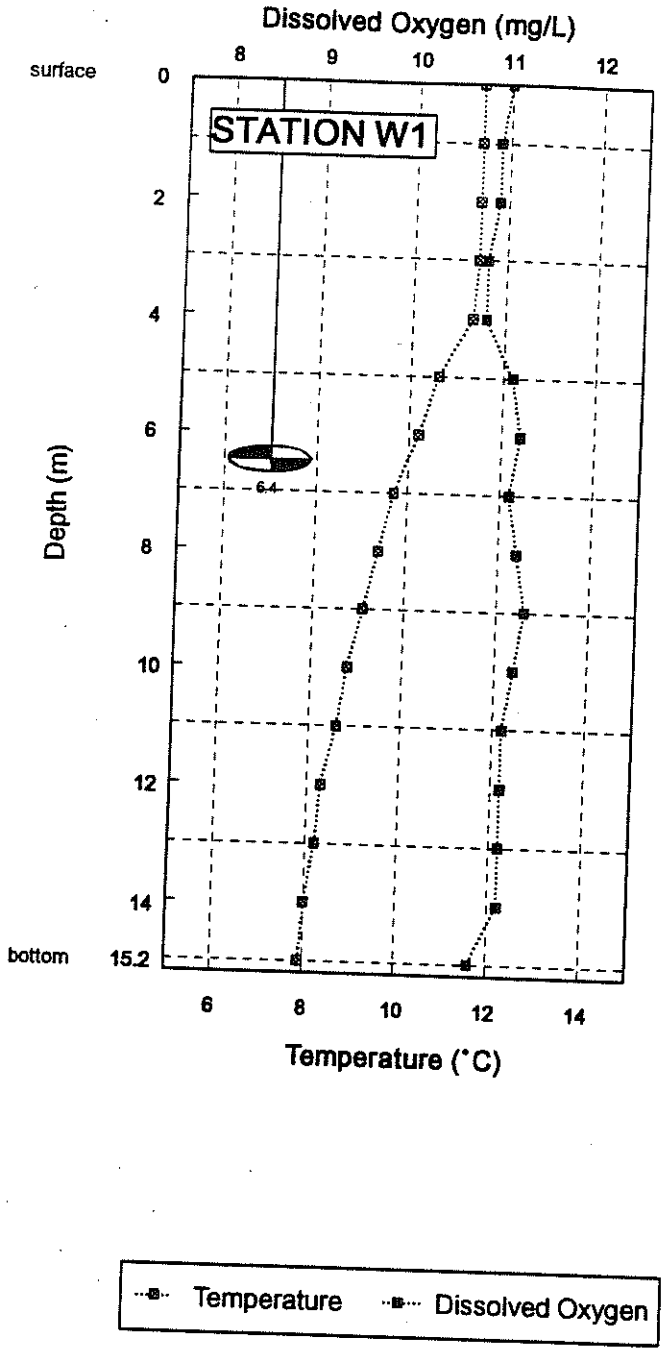


Figure 3.2-32 Dissolved oxygen and temperature profile of Izok Lake, 7 August 1993.

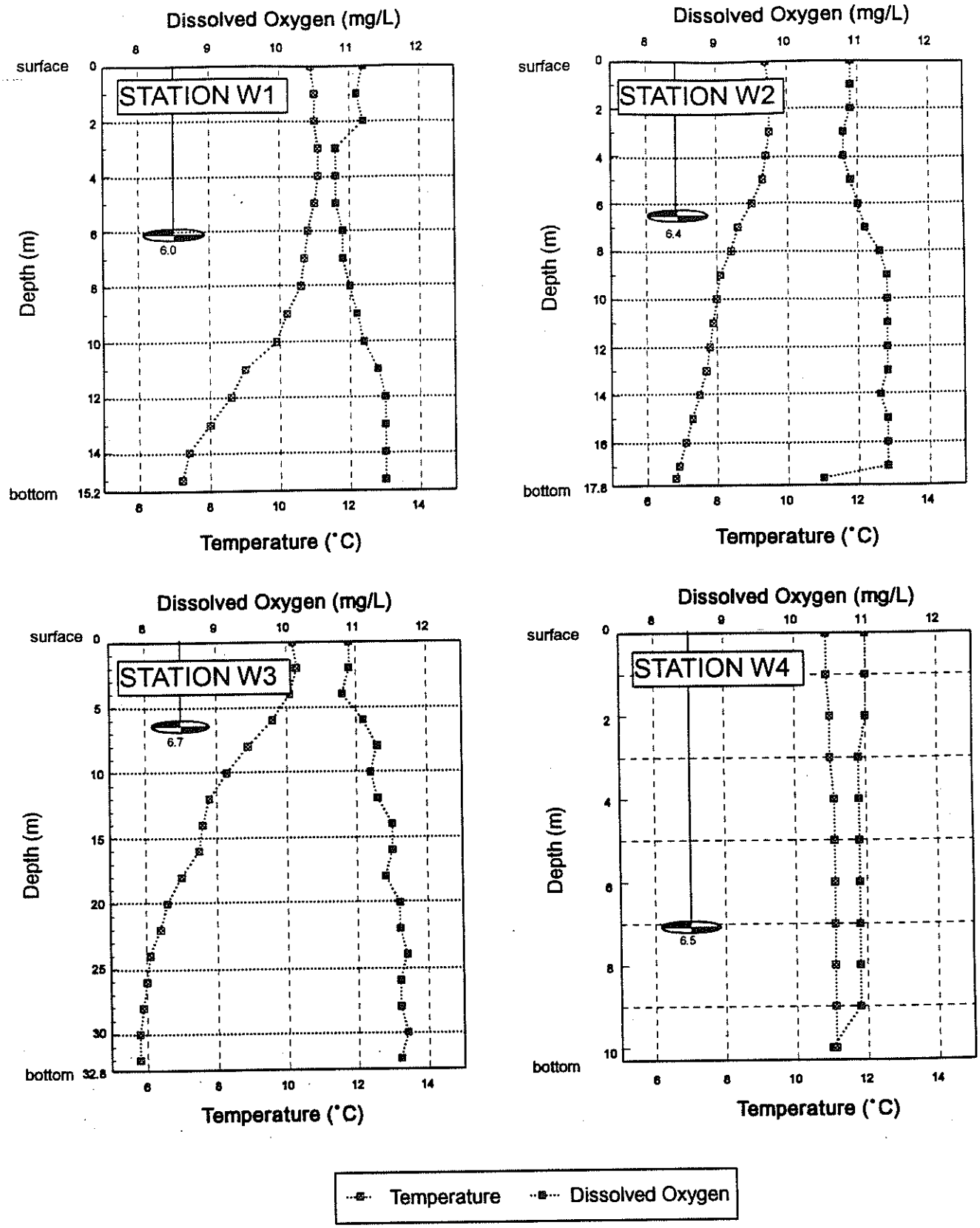


Figure 3.2-33 Dissolved oxygen and temperature profiles of Itchen Lake, 8 and 9 August 1993.

Water Chemistry

A summary of the water quality data collected in August 1993 is presented in Table 3.2-26. The lakes and streams were all slightly acidic (pH of 5.8 to 6.4) and poorly buffered (total alkalinity of 4 to 5 mg/ℓ as $CaCO_3$). The hardness of the water (comprised of calcium and magnesium expressed as $CaCO_3$) was low, with values less than 5.9 mg/ℓ. These results were consistent with those reported in previous studies (DIAND, 1975; Beak, 1977; Moore, 1978; data from Echo Bay Mines, 1987 and 1989, Table 3.2-21) (see Tables 3.2-20 through 3.2-23).

Nutrient levels were low, as is typical of northern Canadian Shield lakes (Table 3.2-26). Nitrite/Nitrate values varied from 0.31 to <0.05 mg/ℓ in the lakes and streams. Ham Lake had the greatest nitrite/nitrate values; however, the blank sample for this lake was high (0.1 mg/ℓ) suggesting that results are elevated for this lake and are actually comparable to the other waterbodies and previous studies (cf., Tables 3.2-20 through 3.2-23). In general, the streams had greater nitrite/nitrate levels than did the lakes. Total Kjeldahl nitrogen ranged from 0.24 mg/ℓ in Itchen Lake (bottom of Station W2) to 0.12 mg/ℓ in various waterbodies. Total phosphorus levels were substantially greater in the middle samples of Stations W1, W2, and W4 (0.192, 0.2 and 0.109 mg/ℓ respectively) of Itchen Lake. All other total phosphorus values were relatively low and comparable to previous studies (see Tables 3.2-20 through 3.2-23).

The elevated total phosphorus levels in Itchen Lake may be due to natural spacial-variability (e.g., algal plume at these sample sites) of this nutrient. In general, the study streams had similar concentrations of total Kjeldahl nitrogen and total phosphorus as the lakes. Overall, the data suggest that the waterbodies are nutrient poor (oligotrophic) and are probably phosphorus limited (Wetzel, 1983).

With the exceptions of aluminum, cadmium, and iron, concentrations of metals in the freshwaters of the study area were all at or below water quality objectives to protect aquatic life (CCREM, 1987). Inlet stream IT3 of Itchen Lake had aluminum and iron concentrations of 0.11 and 0.63 mg/ℓ, respectively. These values were above the

Table 3.2-26 - Summary of Water Quality Data, Izok Mine Site Area, 7-9 August 1993

PARAMETER*	HAM LAKE								TRIBUTARIES OF HAM LAKE					
	STATION W1			STATION W2			STATION W3						Duplicate	
	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Surface Dupl	Inlet H1	Inlet H3	Inlet H4	Outlet H5	Outlet H5	BLANK
pH units	5.9	5.8	5.9	5.9	5.9	5.9	6	6	6.1	6	5.9	6	6	5.4
Specific Conductance (µS/cm)	8	9	8	8	8	8	8	8	9	9	11	9	8	1
Calcium	0.6	0.6	0.6	0.6	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.7	0.6	<0.1
Magnesium	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.3	0.3	<0.1
Sodium	0.8	0.8	0.7	0.7	0.8	0.7	0.8	0.7	<0.6	1.7	1.6	1.3	1.1	<0.6
Potassium	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Sulfate	0.6	0.7	0.6	0.6	0.5	0.6	0.5	0.5	1	1.1	0.9	0.7	0.6	<0.3
Chloride	0.3	0.4	0.4	0.4	0.3	0.3	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.2
Bicarbonate	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Nitrite/Nitrate Nitrogen as N	0.17	0.31	0.18	0.14	0.13	0.13	0.12	0.11	0.12	0.14	0.18	0.18	0.18	0.1
Total Organic Carbon	4.4	4.5	4.6	4.3	4.6	4.1	3.8	3.6	3.2	4.5	4.7	3.7	3	<0.5
Total Kjeldahl Nitrogen	0.15	0.2	0.14	0.14	0.15	0.14	0.19	0.16	0.12	0.12	0.12	0.12	0.12	0 09
Hardness as CaCO3	2.8	2.9	2.8	2.6	2.6	2.5	3	3	<0.7	3	3.5	3.9	3.2	2.9
Total Dissolved Solids (calculated)	5	5	5	5	5	5	5	5	2	6	7	7	6	6
Total Alkalinity as CaCO3	4	3	3	3	3	3	4	4	2	5	4	5	4	4
Total Phosphorus	0.023	0.025	0.03	0.027	0.021	0.02	0.022	0.023	0.02	0.019	0.025	0.012	0.013	0.016
Aluminum	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	0.13
Arsenic	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Barium	0.003	0.002	0.004	0.002	0.003	0.003	0.002	0.004	<0.001	0.002	0.004	0.004	0.002	0.003
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
Cadmium	<0.003	0.052	0.05	<0.003	0.019	0.017	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chromium	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Cobalt	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	0.001	0.001	0.002	<0.001	0.001	0.001	<0.001	<0.001	0.002	0.001	<0.001	<0.001	<0.001	<0.001
Iron	0.03	0.06	0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.07	0.05	0.05	0.03	<0.02
Lead	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Mercury, Total	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium, Total	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Silicon	0.28	0.29	0.29	0.26	0.25	0.25	0.23	0.23	0.25	0.93	0.44	0.23	0.24	<0.05
Silver	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Thallium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Titanium	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Vanadium	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Zinc	<0.002	0.005	0.006	<0.002	0.004	0.002	0.007	0.012	<0.002	<0.002	0.003	0.006	0.007	<0.002
Cyanide, Total	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

*NOTE:
- All values expressed in mg/L unless otherwise indicated.
- All metals acid extractable unless otherwise noted.

Table 3.2-26 - Summary of Water Quality Data, Izok Mine Site Area, 7-9 August 1993 (continued)

PARAMETER*	ITCHEN LAKE												Tributaries of Itchen Lake		
	STATION 1			STATION 2			STATION 3			STATION 4					
	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Outlet PT1	Inlet IT3	BLANK
pH	5.8	5.8	5.9	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.9	6.4	5.8	5.3
Specific Conductance (µS/cm)	13	13	15	14	16	15	14	14	19	16	14	26	12	15	3
Calcium	0.6	0.7	0.7	0.7	1.3	0.7	0.7	0.7	1.1	0.7	0.7	0.7	0.9	1.1	<0.1
Magnesium	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.8	<0.1
Sodium	<0.6	<0.6	<0.6	<0.6	0.8	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	1.1	<0.6
Potassium	<0.20	<0.20	<0.20	0.21	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Sulfate	1	1.1	1.3	1.3	2.3	1.4	1.4	1.4	2.2	1.2	1.1	1.2	1.8	2.2	<0.3
Chloride	0.2	0.3	1	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.4	<0.1
Bicarbonate	5	5.2	5.3	5.2	5.2	5.2	5	5	5	5	5	5.2	6.6	5.3	<5.0
Nitrite/Nitrate Nitrogen as N	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.09	0.17	<0.05
Total Organic Carbon	3.8	3.6	4	4	3.6	3.6	3.9	3.5	3.8	3.9	3.7	3.6	3.7	7.6	0.5
Total Kjeldahl Nitrogen	0.14	0.14	0.18	0.13	0.14	0.24	0.2	0.14	0.17	0.16	0.19	0.16	0.12	0.25	<0.05
Hardness as CaCO3	3.1	3.2	3.3	3.4	5.2	3.4	3.4	3.5	4.8	3.4	3.3	3.3	4	5.9	<0.7
Total Dissolved Solids (calculated)	5	6	7	6	8	6	6	6	7	6	6	6	8	8	2
Total Alkalinity as CaCO3	4	4	4	4	4	4	4	4	4	4	4	4	5	4	2
Total Phosphorus	0.032	0.192	<0.005	0.064	0.2	0.023	<0.005	<0.005	0.063	0.022	0.109	<0.005	0.035	0.027	<0.005
Aluminum	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	0.11	<0.06
Arsenic	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0005	<0.0002
Barium	0.002	0.004	0.003	<0.001	0.003	0.002	<0.001	0.002	0.001	0.002	0.001	0.001	0.003	0.007	<0.001
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	<0.003	<0.003	0.009	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chromium	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Cobalt	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.002	0.001	<0.001
Iron	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.63	<0.02
Lead	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	<0.003	<0.003	0.003	<0.003	0.003	0.004	<0.003	0.003	0.004	<0.003	<0.003	<0.003	<0.003	0.015	<0.003
Mercury, Total	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium, Total	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Silicon	0.13	0.14	0.14	0.14	0.14	0.13	0.12	0.13	0.14	0.13	0.12	0.13	0.1	0.83	<0.05
Silver	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Thallium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Titanium	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Vanadium	<0.003	<0.003	<0.003	<0.003	0.004	<0.003	0.005	0.005	0.006	<0.003	<0.003	<0.003	<0.003	<0.003	0.008
Zinc	0.005	0.009	0.006	0.007	0.003	0.005	0.006	0.004	0.005	0.004	0.006	0.002	0.005	0.006	<0.002
Cyanide, Total	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.001	<0.001	<0.001	0.024	<0.001	<0.001

*NOTE:
- All values expressed in mg/L unless otherwise indicated.
- All metals acid extractable unless otherwise noted.

Table 3.2-26 - Summary of Water Quality Data, Izok Mine Site Area, 7-9 August 1993 (continued)

PARAMETER*	IZOK LAKE STATION W1				Izok Creek	IZNOGOUDH LAKE STATION W1			STATION W2	Iznogoudh Creek
	Surface	Surface Dupl	Middle	Bottom	Station IZ5	Surface	Middle	Bottom	Surface	Station IZ6
pH (units)	5.8	5.8	5.8	5.8	6	5.8	5.8	5.8	5.8	6
Specific Conductance (µS/cm)	13	12	13	12	10	12	17	26	12	10
Calcium	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.7	0.6	0.8
Magnesium	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.4
Sodium	<0.6	<0.6	<0.6	<0.6	1.1	<0.6	<0.6	<0.6	<0.6	1
Potassium	<0.20	0.24	0.24	0.23	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Sulfate	0.8	0.7	0.7	0.7	0.9	0.8	0.8	0.9	0.6	0.9
Chloride	0.2	0.2	0.3	0.2	0.4	0.2	0.2	0.3	0.2	0.4
Bicarbonate	5	5	<5.0	<5.0	5.2	<5.0	<5.0	5	5.2	5.2
Nitrite/Nitrate Nitrogen as N	<0.05	<0.05	<0.05	<0.05	0.18	<0.05	<0.05	<0.05	<0.05	0.18
Total Organic Carbon	3.4	3.3	3.6	3.3	3.8	3.4	3.2	3.3	3.9	3.9
Total Kjeldahl Nitrogen	0.12	0.18	0.14	0.18	0.14	0.15	0.12	0.16	0.14	0.14
Hardness as CaCO3	3	2.8	2.9	2.9	3.5	2.8	2.9	3.1	2.9	3.5
Total Dissolved Solids (calculated)	5	5	5	5	6	5	5	5	5	6
Total Alkalinity as CaCO3	4	4	4	4	4	4	4	4	4	4
Total Phosphorus	<0.005	<0.005	<0.005	<0.005	0.027	<0.005	<0.005	<0.005	<0.005	0.018
Aluminum	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Arsenic	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Barium	<0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	<0.003	<0.003	0.006	0.005	<0.003	<0.003	0.009	0.014	<0.003	<0.003
Chromium	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Cobalt	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Iron	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	0.06	<0.02
Lead	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.004	0.004	<0.003	<0.003
Mercury, Total	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium, Total	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Silicon	0.14	0.15	0.14	0.14	0.14	0.14	0.15	0.16	0.23	0.15
Silver	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Thallium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Titanium	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Vanadium	<0.003	0.007	0.005	0.007	<0.003	0.003	0.004	0.005	<0.003	<0.003
Zinc	0.007	0.005	0.007	0.005	0.009	0.003	0.005	0.008	0.002	0.003
Total Cyanide	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

*NOTE:
- All values expressed in mg/L unless otherwise indicated.
- All metals acid extractable unless otherwise noted.

Canadian Water Quality Guidelines of 0.1 mg/ℓ for aluminum and 0.3 mg/ℓ for iron as established for CCREM (1987). Cadmium was above the Canadian Water Quality Guideline of 0.0002 mg/ℓ in Ham Lake (0.017 to 0.052 mg/ℓ at the middle and bottom of Stations W1 and W2, respectively), Iznogoudh Lake (0.009 and 0.014 mg/ℓ in the middle and bottom of Station W1, respectively), bottom of Station W1 in Itchen Lake (0.009 mg/ℓ), Izok Lake (0.006 and 0.005 mg/ℓ at the middle and bottom of Station W1, respectively).

In 1992, aluminum was the only metal above Canadian Water Quality Guidelines. The variability in results between years may be due to natural variation or contamination during sampling and/or analytical procedures; no blanks were sampled in 1992 and the blank collected in Ham Lake had an aluminum concentration of 0.13 mg/ℓ. No other study program reported cadmium concentrations above Canadian Water Quality Guidelines (see Tables 3.2-20 through 3.2-23). The relatively high acidity of the study lakes may contribute to the increased concentrations of cadmium.

Blank (double distilled water) and split samples (duplicates) were submitted from various sampling locations (Table 3.2-26). In general, the blank samples had results where the parameters analyzed were at or below detection limits, or had very low values as would be expected for double distilled water. Some exceptions were aluminum, barium, boron, nitrite/nitrate, and total Kjeldahl nitrogen in Ham Lake, and vanadium, and total organic carbon in Itchen Lake suggesting that the values for these parameters may in reality be lower than reported. Most parameters of duplicate samples varied little from one another; however, barium at Station W3 at stream outlet H5 of Ham Lake, and vanadium at the surface of Station W1 in Izok Lake had values that differed by a factor of two between the duplicates. These parameters have low concentrations (i.e., just above detection limits) and discrepancies between the duplicates do not have a substantial impact on overall results. Potential sources of contamination include the sample bottles, acid preservatives, or the source of the double-distilled water; however, analyses were not performed to isolate the potential contamination source.

Field measurements of selected water quality parameters were performed in eight tributaries of the Izok Mine Site area (Table 3.2-27). Conductivity ranged from 5.9 μS/cm in June of tributaries H1 and H5, to 15.5 μS/cm in August of tributary IT3, while pH varied from 5.6 in June at PT1 to 7.0 in August at H5 and PT1. All tributaries were well oxygenated, dissolved oxygen ranged from 8.7 to 12.5 mg/L. In general, conductivity, pH, and temperature were greater in August than in June while dissolved oxygen concentrations were greater in June than in August (reflecting the ability of colder waters to hold greater concentrations of gases).

Oil and grease analysis on surface samples from Ham and Itchen lakes were below analytical laboratory limits (Table 3.2-28).

Table 3.2.27 - Field Measurements of Selected Water Quality Parameters in the Tributaries of the Izok Mine Site Area, June and August 1993.

PARAMETER	HAM LAKE TRIBUTARIES								ITCHEN LAKE TRIBUTARIES		IZOK LAKE TRIBUTARIES				ITCHEN LAKE TRIBUTARIES	
	H2		H3		H4		H5		IT3	IT3	IZ5	IZ5	IZ6	IZ6	PT1	PT1
	28/06/93	04/08/93	28/06/93	04/08/93	28/06/93	04/08/93	28/06/93	04/08/93	28/06/93	04/08/93	28/06/93	04/08/93	28/06/93	04/08/93	28/06/93	04/08/93
Conductivity (uS/cm)	5.9	8.5	6.0	9.5	7.6	10.8	5.9	8.4	8.1	15.5	7.6	9.6	7.3	9.5	8.6	12.4
pH (units)	6.4	6.6	6.1	6.7	6.0	6.2	6.0	7.0	5.8	6.2	5.7	6.8	6.1	6.4	5.6	7.0
Temperature (°C)	7.4	14.3	10.8	14.7	9.2	13.1	7.1	14.7	8.7	16.0	4.0	12.6	3.1	11.2	4.7	—
Dissolved Oxygen (mg/L)	11.2	10.0	9.6	9.6	10.0	9.2	11.4	10.5	10.3	8.7	12.1	10.8	12.3	11.2	12.5	—

Table 3.2-28 - Summary of Oil and Grease Analysis on Selected Water Samples, Izok Mine Site Area, August 1993

Parameter	Ham Lake			Itchen Lake			
	Station W1 Surface	Station W2 Surface	Station W3 Surface	Station W1 Surface	Station W1 Dupl.	Station W2 Surface	Station W3 Surface
Oil and Grease (mg/L)	<0.3	<0.3	<0.2	<0.2	<0.2	<0.2	<0.2

All petroleum hydrocarbons and organo-chloride pesticide analyses were below analytical laboratory detection limits (Table 3.2-29 and 3.2-30).

Port Site Area

Temperature and Salinity

Surface temperature and salinity were monitored daily at a nearshore location (approximately 800 m south of the proposed dock) during the summer (16 to 27 July 1993) and fall (23 August to 6 September 1993) sampling periods (Figure 3.2-34). During the summer, surface temperatures ranged between 6.5 and 11°C. Nearshore surface salinity ranged from a minimum of 3.2 ppt on 18 July 1993 to a maximum of 22.3 ppt on 2 September 1993. In general, salinity concentrations were lower in the summer than in the fall; however, large day-to-day fluctuations were recorded during both seasons.

Data for temperature and salinity profiles in the sampling stations of Coronation Gulf are plotted on Figure 3.2-35. Temperatures ranged from -1.1°C at the bottom (23 m) of Station PS2 on 17 July 1993, to 10.9°C at the surface of Station PS1 on 18 July 1993. Strong thermoclines were observed at Stations PS2 and PS3. These thermoclines generally occurred between 5 m and 10 m depth; however, on 27 July 1993, the thermocline was between 2 and 3 m. Station PS1 was relatively shallow and exhibited a strong thermocline on 27 July only (Figure 3.2-35). Salinity ranged form 3.9 ppt at the surface of Station PS1 on 18 July 1993 to 29.1 ppt at the bottom (39 m) of Station PS3 on 27 July 1993. Salinity profiles generally mirrored temperature profiles (Figure 3.2-35). Station PS4 (Napaaktoktok River) had temperatures that ranged from 5.1°C at

Table 3.2-29 - Summary of Petroleum Hydrocarbon Analysis on Selected Samples from the Izok Mine Site Area, August 1993

PARAMETER	HAM LAKE	ITCHEN LAKE			
	STATION W3 BOTTOM	STATION W1 BOTTOM	STATION W1 BOTTOM***	STATION W2 BOTTOM	STATION W3 BOTTOM
Non-halogeneated Aromatics*					
Benzene	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Toulene	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Echylhenzene	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
m- and pO Zylene	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
o-Xylene	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Total Purgables (C3-C12)	<0.001	<0.001	<0.001	<0.001	<0.001
Polynuclear Aromatic Hydrocarbons**					
Acenaphythene	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene	<0.1	<0.1	<0.1	<0.1	<0.1
Naphthalene	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)anthracene	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	<0.5	<0.5	<0.5	<0.5	<0.5
Anthracene	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(ghi)perylene	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	<0.2	<0.2	<0.2	<0.2	<0.2
Dibenzo(a,h)anthracene	<0.1	<0.1	<0.1	<0.1	<0.1
Indeno(1,2,3-cd)pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	<0.2	<0.2	<0.2	<0.2	<0.2

* Results are expressed in ppm (mg/ℓ).
** Results are expressed in ppb (μ/ℓ).
*** Duplicate sample.

Table 3.2-30 - Summary of Organo-Chloride Pesticide Analysis on Selected Samples from the Izok Mine Site Area, August 1993

PARAMETER*	HAM LAKE	ITCHEN LAKE			
	STATION W3 BOTTOM	STATION W1 BOTTOM	STATION W1 BOTTOM**	STATION W2 BOTTOM	STATION W3 BOTTOM
Pesticide					
Lindane	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.01	<0.01	<0.01	<0.01	<0.01
Aldrin	<0.01	<0.01	<0.01	<0.01	<0.01
Endosulfan I	<0.01	<0.01	<0.01	<0.01	<0.01
Dieldrin	<0.01	<0.01	<0.01	<0.01	<0.01
4,4' - DDE	<0.01	<0.01	<0.01	<0.01	<0.01
Endrin	<0.01	<0.01	<0.01	<0.01	<0.01
Endosulfan II	<0.01	<0.01	<0.01	<0.01	<0.01
4,4' - DDD	<0.01	<0.01	<0.01	<0.01	<0.01
4,4' - DDT	<0.02	<0.02	<0.02	<0.02	<0.02
Methoxychlor	<0.03	<0.03	<0.03	<0.03	<0.03
BHC (betea isomer)	<0.01	<0.01	<0.01	<0.01	<0.01
BHC (alpha isomer)	<0.01	<0.01	<0.01	<0.01	<0.01

* Results are expressed in ppb ($\mu g/\ell$).

** Duplicate sample.

3.2.10 Fisheries and Aquatic Biota

3.2.10.1 Introduction

This section reviews available information on freshwater and marine fisheries and lower trophic levels in aquatic ecosystems (aquatic plants and animals which are the food of fish and aquatic birds and mammals) in the study area. This information is provided in response to item 3.2.9 of the RERC guidelines, under the subheadings "Freshwater" and "Marine".

Available information concerning fisheries and aquatic biota potentially affected by the Izok Project activities relates to the mine site area and the marine port and shipping areas. Several studies have examined fisheries in lakes in the mine area, as well as plankton communities (microscopic, free floating or swimming plants and animals in the water column), benthic communities (aquatic plants and animals that dwell on lake and stream bottoms) and aquatic macrophytes (large aquatic plants). These studies include:

- Texasgulf's studies of plankton, benthic, macrophyte and fish communities, and metal levels in fish, in Izok, Iznogoudh and Itchen lakes in June 1976 (Beak, 1977);
- Environment Canada's investigation of plankton and benthic communities in Izok, Iznogoudh and Itchen lakes during July, August and September 1976 (Moore, 1978);
- Minnova's investigation of fisheries in Izok, Iznogoudh, Ham, and Itchen lakes in July 1992 (R.L. & L., 1992); and
- Minnova's investigation of metal levels in fish tissue from mine area lakes (R.L. & L., 1993).
- Metall Mining Corporation investigations of plankton, fish and metal levels in fish tissue in Izok, Iznogoudh, Ham and Itchen lakes, during June to September 1993 (R.L. & L, in prep.).

In addition, Minnova commissioned an assessment of potential effects of shipping on marine aquatic ecosystems which includes a description of marine plankton, benthic animals and fish in the vicinity of the proposed marine port and shipping routes

(Canarctic, 1992c). A more detailed assessment of the marine aquatic ecosystem in the immediate vicinity of the proposed marine port site was completed during July to September 1993 (R.L. & L. in preparation).

The following sections review this information for the mine area and port area respectively.

3.2.10.2 Mine Area

Phytoplankton

Beak (1977) sampled phytoplankton (microscopic, free-floating plants) from Iznogoudh, Izok, and Itchen lakes in late June 1976. They found the phytoplankton communities to be dominated by Chrysophyta in all three lakes, with Chryptophyta being subdominant in Iznogoudh and Izok lakes, while the dinoflagellates (Pyrrophyta) were subdominant in Itchen Lake. Biomass ranged from a high of 102.0 mg/m^3 in Iznogoudh Lake to 67.1 mg/m^3 in Itchen Lake. They noted that the species composition and biomass of phytoplankton were typical of ultra-oligotrophic lakes (lakes with very low nutrient levels and low biological productivity), and were similar to other lakes at or near the treeline in non-permafrost areas of Canada.

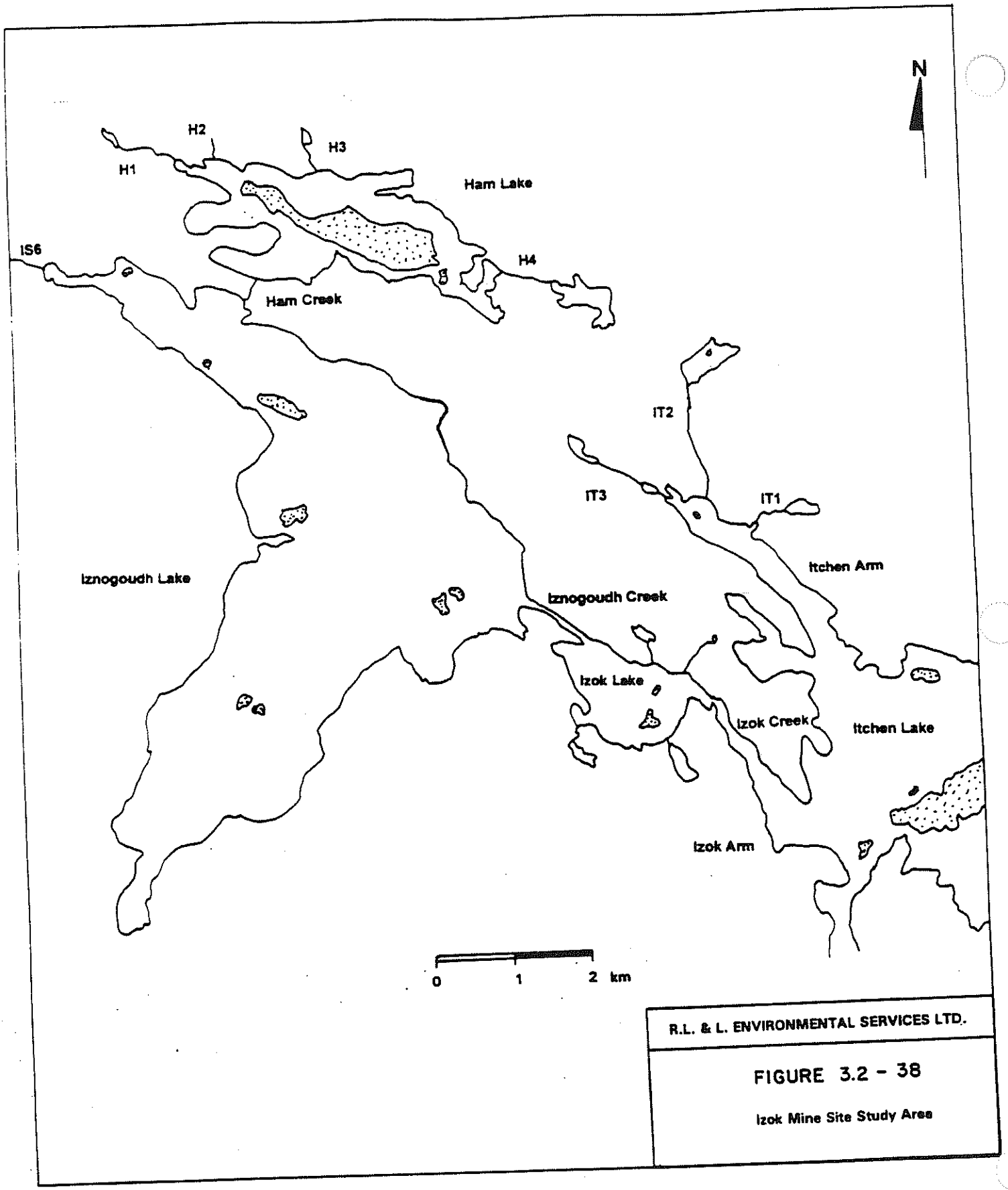
Moore (1978) reported the results of more detailed sampling conduced by Environment Canada during mid-July, mid-August, and early September of the same year (1976). He noted a similar dominance of Chrysophyta (primarily *Dinobryon cylindricum* and *D. bavaricum*) in each of the lakes, although *Ankistrodesmus falcatus* (Chlorophyta) was the numerically dominant species in Itchen Lake during the July sampling. Total phytoplankton densities averaged 8×10^7, 16×10^7, and 10.5×10^7 cells/m^3 in Iznogoudh, Izok, and Itchen lakes, respectively. Moore also observed that the phytoplankton assemblage was characteristic of extremely oligotrophic conditions.

To provide additional baseline information on the lower trophic levels in the mine site area lakes (Figure 3.2-38), a phytoplankton sampling program was undertaken by R.L. & L. Environmental Services Ltd. during 1993. Plankton samples were collected

four times (near the beginning and end of each of the two open water sampling periods) at the stations depicted in Figure 3.2-39. Below are results from the summer 1993 sampling period; the results from the fall sampling program are presented in a separate R.L. & L. Environmental Services Ltd report.

Data for the six most abundant phytoplankton species are plotted on Figures 3.2-40 to 3.2-45. The most common species in all lakes were the blue-green algae *Aphanothece clathrata* and *Aphanocapsa elachista*. These species exist in colonies of very small cells; although they are numerically dominant, they contributed little to the overall biovolume of phytoplankton. *A. clathrata* densities ranged from 59 x 10^7 cells/m^3 in Station W1 of Izok Lake (28 July 1993) to 1105 x 10^7 cells/m^3 in Station W2 of Ham Lake (10 August 1993). *A. elachista* greatest densities were in Stations W1 and W3 of Itchen Lake (116 x 10^7 cells/m^3 at both stations) and was not observed in Station W1 of Izok Lake. Several other species (e.g., *Kephyrion boreale* and *Ochromonas globosa*) were occasionally recorded in large densities (up to 153 x 10^7 cells/m^3).

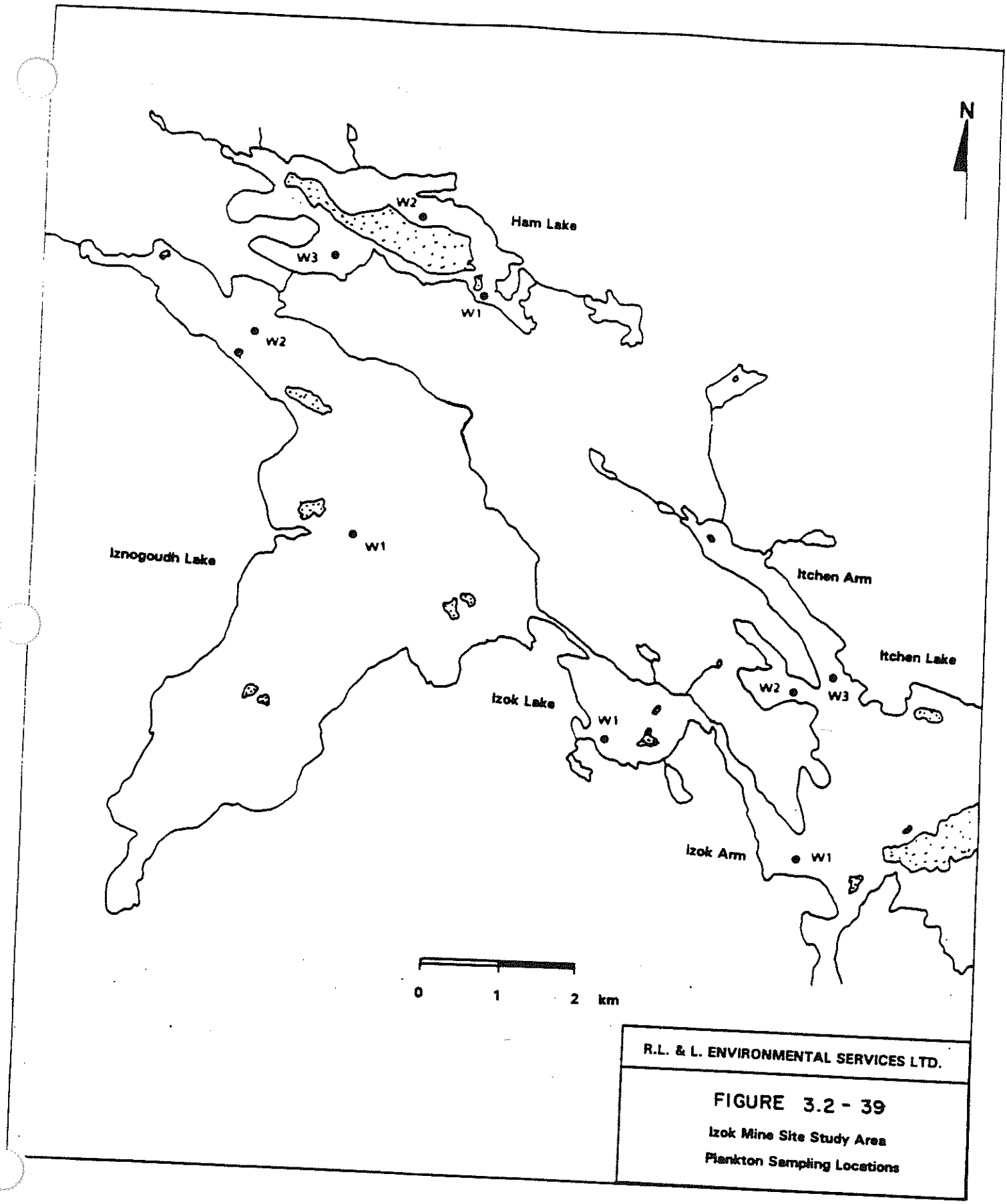
Total phytoplankton densities varied from 170 x 10^7 cells/m^3 (Station W1 of Iznogoudh Lake, 7 August 1993) to 2430 x 10^7 cells/m^3 (Station W2 of Ham Lake, 10 August 1993) which were substantially greater than those reported by Moore (1978) (up to 20 x 10^7 cells/m^2 in Izok Lake). Discrepancies were probably due to laboratory and field collection procedures. Individual cells were counted in this study, whereas colonies were counted by Moore (1978) (J.W. Moore, Alberta Environment, Vegreville, Alberta, pers. comm.). When blue-green (*Cyanophyta*) algae (many species exist in colonies) are omitted from the total density estimate in Station W2 of Ham Lake (10 August 1993), total cell density is 55 x 10^7 cells/m^3 (approaching values reported by Moore, 1978). Moore (1978) collected phytoplankton with a Van-Dorn water bottle, whereas a weighted plastic tube with a foot valve was used in this study. Van-Dorn collection bottles tend to destroy (i.e., lysis) algal cells which results in an underestimate of cell counts (J.W. Moore, pers. comm.).



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FIGURE 3.2 - 38

Izok Mine Site Study Area



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FIGURE 3.2 - 39

Izok Mine Site Study Area

Plankton Sampling Locations

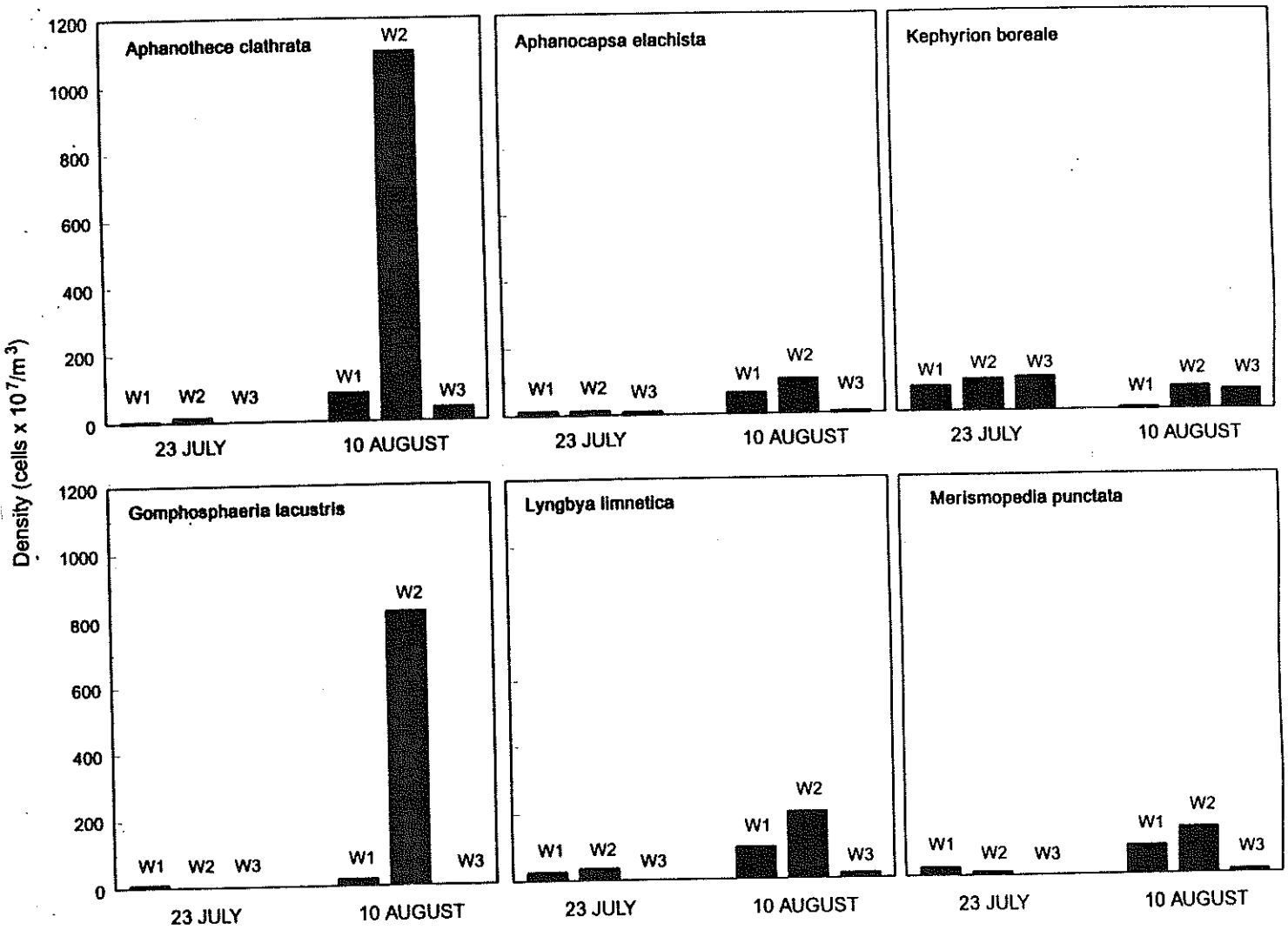


Figure 3.2-40 - Phytoplankton Densities of the Six Most Abundant Taxa in Ham Lake, Summer 1993

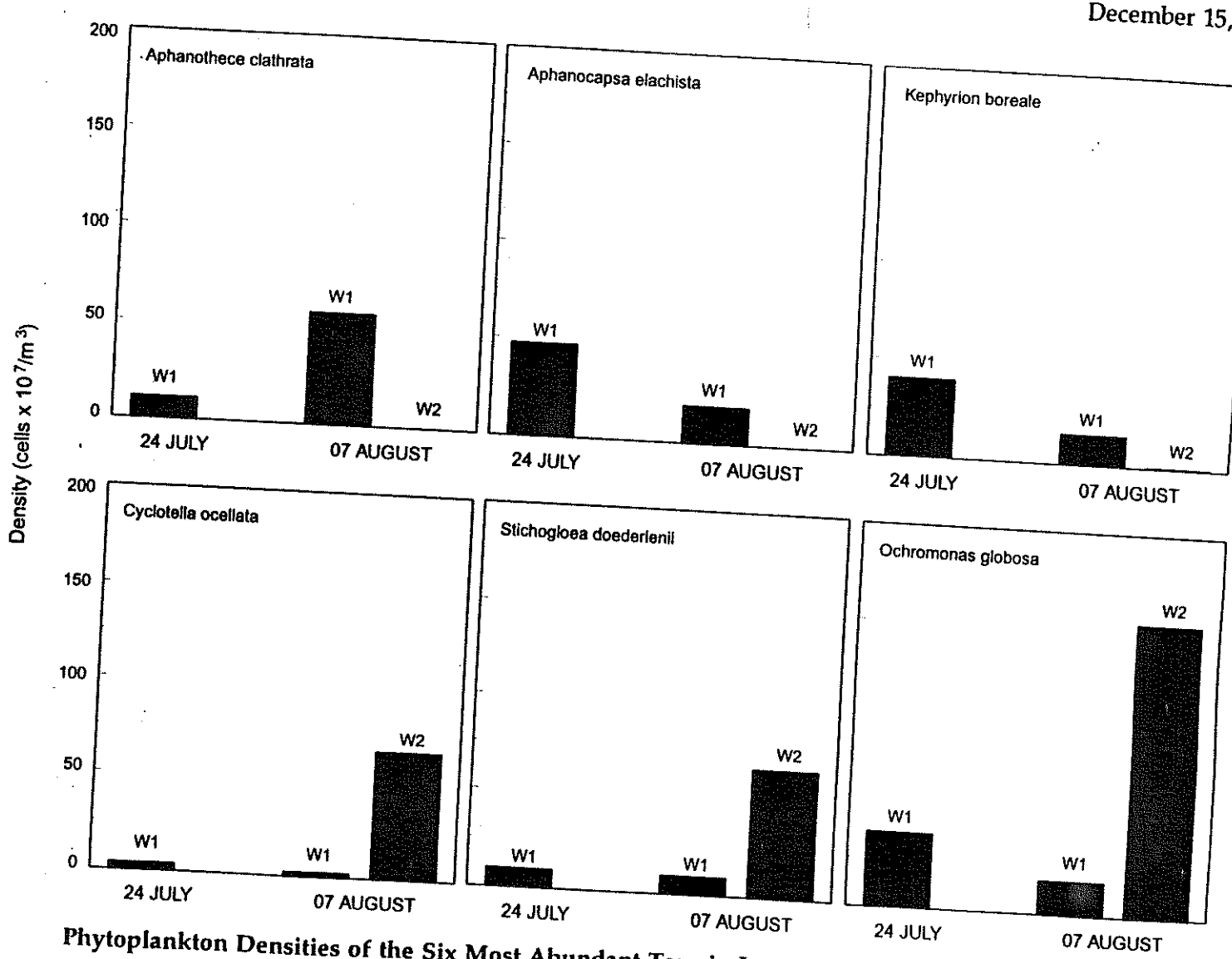


Figure 3.2-41 - Phytoplankton Densities of the Six Most Abundant Taxa in Iznogoudh Lake, Summer 1993

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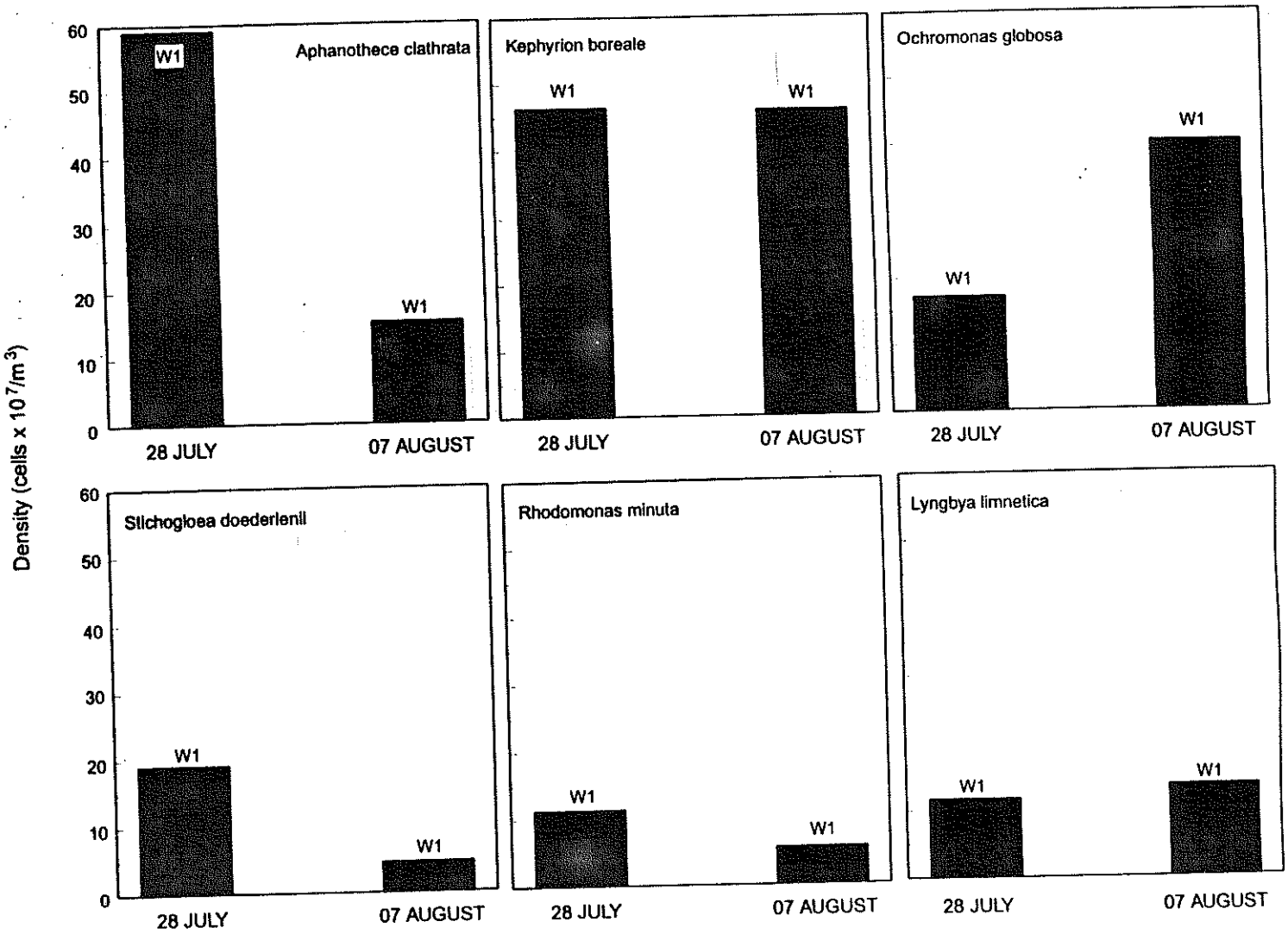


Figure 3.2-42 - Phytoplankton Densities of the Six Most Abundant Taxa in Izok Lake, Summer 1993

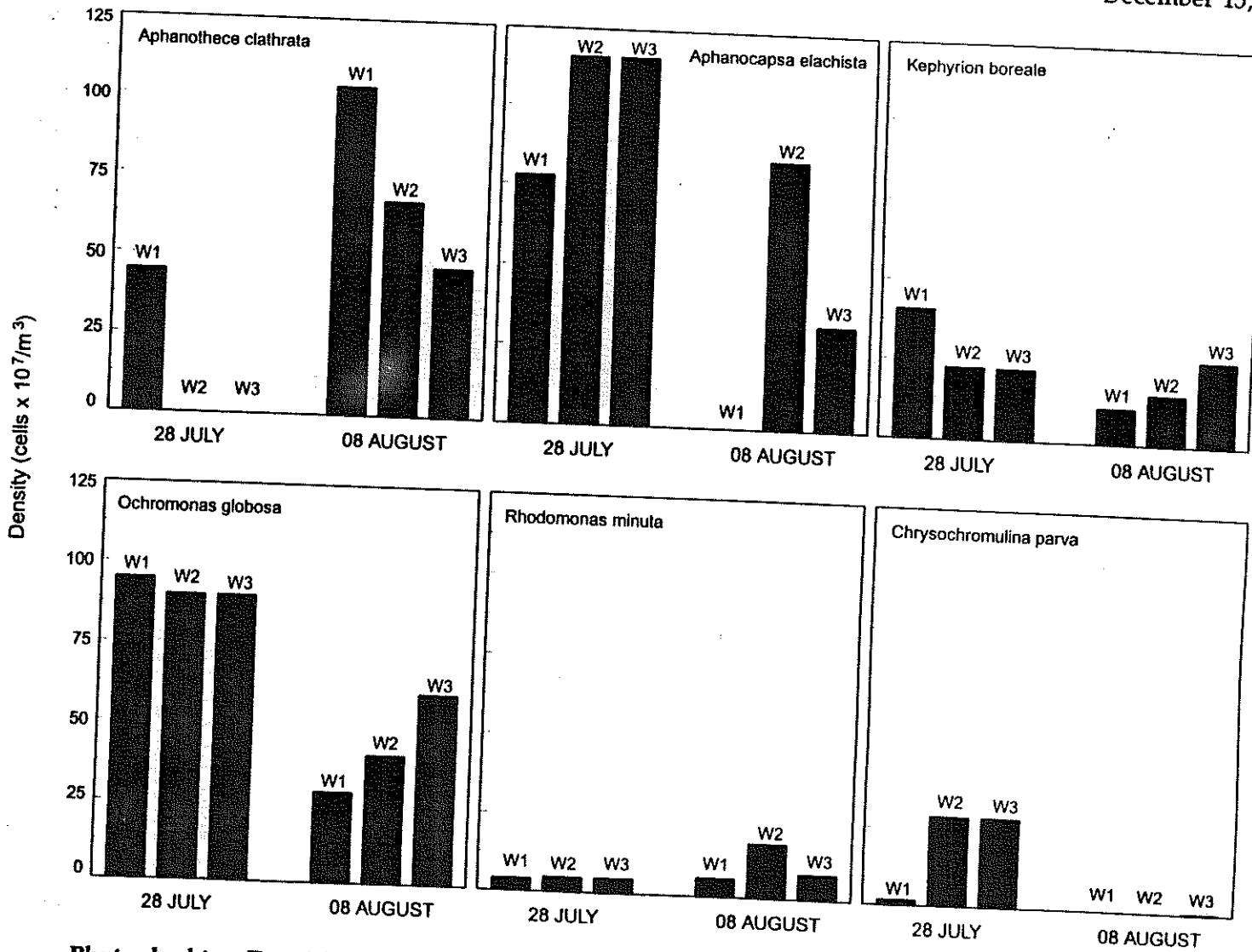


Figure 3.2-43 - **Phytoplankton Densities of the Six Most Abundant Taxa in Itchen Lake, Summer 1993**

Densities of non-colonial species of phytoplankton were similar between Moore (1978) and this study. For example, Moore (1978) reported *Dinobryon cylindricum* densities that varied from approximately 1.0×10^7 to 2.0×10^7 cells/m^3 in Iznogoudh Lake. In this study *D. cylindricum* densities in Iznogoudh Lake ranged from present (small numbers) to 3.4×10^7 cells/m^3.

Zooplankton

Beak (1977) reported that the zooplankton (small or microscopic animals that live in the water column) populations in the three lakes sampled were dominated by copepods (*Cyclops scutifer* and unidentified immature forms, called nauplii), with rotifers (primarily *Keratella cochlearis* and *Kellicottia longispina*) being subdominant. Cladocerans (primarily *Holopedium gibberum*) were in greater abundance in Iznogoudh Lake than in Izok Lake or Itchen Lake at the time of sampling in late June. The early season zooplankton populations were considered to be typical of oligotrophic lakes occurring in the northern parts of Canada.

By July of the same year, the rotifers had become numerically dominant in all of the lakes, with the copepods (including *Diaptomus sicilis* and *Cyclops bicuspidatus thomasi*) being subdominant (Moore, 1978). *Kellicottia longispina* was the most common species, reaching densities of up to $7.5 \times 10^3/m^3$ in Itchen Lake.

Zooplankton communities in the proposed mine area were sampled by R.L. & L. Environmental Services Ltd. during summer and fall 1993 (Figure 3.2-39). This section discusses the results of the summer sampling period (22 July to 10 August). Fall results are summarized in the aquatic studies report prepared by R.L. & L. Environmental Services Ltd.

The zooplankton communities of Ham, Iznogoudh, Izok and Itchen Lakes were dominated by the copepods *Leptodiaptomus sicilis* (Forbes) and *Cyclops scutifer* Sars, and the rotifers *Conochilus hippocrepis* Schrank and *Kellicottia longispina* (Kellicott) during summer 1993 (Figure 3.2-44 through 3.2-47). Overall, *Conochilus hippocrepis* was the most

abundant taxon in the study lakes. *Cyclops scutifer* was the most abundant taxon in all lakes except Ham Lake, where *L. sicilis* was the second dominant taxon (825 individuals/m^3 at Station W2 in July). The rotifer *Conochilus hippocrepis* was very abundant in Ham and Iznogoudh lakes in July 1993 (1930 and 1499 individuals/m^3 at Station W2 in July, respectively); however, it must be noted that in this study *C. hippocrepis* densities were estimated from individual counts, not numbers of colonies; colony size ranged from 4 to >100 individuals and numbers of individuals among sampling sites within lakes varied greatly. By early August, numbers of *C. hippocrepis* had declined considerably in Ham and Iznogoudh lakes to 100.0 and 104.6 individuals/m^3, respectively. Other zooplankton taxa present, listed in order of descending importance, were *Holopedium gibberum* Zaddach, *Keratella cochlearis* Ahlstrom, an unidentified cyclopoid copepod, a large calanoid copepod (*Heterope* or *Epischura* sp.), *Daphnia* spp. (2 species), and *Bosmina* sp.; densities of the last five taxa were all less than 128 animals/m^3, on both sampling dates. In general, densities of *L. sicilis* and *C. scutifer* increased in Itchen and Izok lakes from July to early August, while the reverse was true for the same taxa in Ham and Iznogoudh lakes. Densities of *C. hippocrepis* decreased considerably in all lakes except Izok from July to early August, while densities of *H. gibberum* decreased in all lakes during the same period. Densities of all taxa combined in Station W2 decreased in Ham Lake from July (11 595 animals/m^3 in Station W2) to early August (4040 animals/m^3 in Station W2), whereas densities increased in Iznogoudh, Itchen, and Izok Lakes from July (i.e., 2015, 2238, and 3548 animals/m^3 in Station W1, respectively) to early August (6300, 3540, and 4440 animals/m^3 in Station W1, respectively).

Phytobenthos

Moore (1978) reported the results of phytobenthos (i.e., algae living on the bottom of streams or lakes) sampling conducted in Iznogoudh, Izok, and Itchen lakes, and in the Izok Lake inlet and outlet streams. *Tabellaria flocculosa* was the most abundant epilithic (living on rock surfaces) species at all sites and during each sampling period, accounting for 40% to 65% by numbers of the flora. *Achnanthes minutissima* generally was second

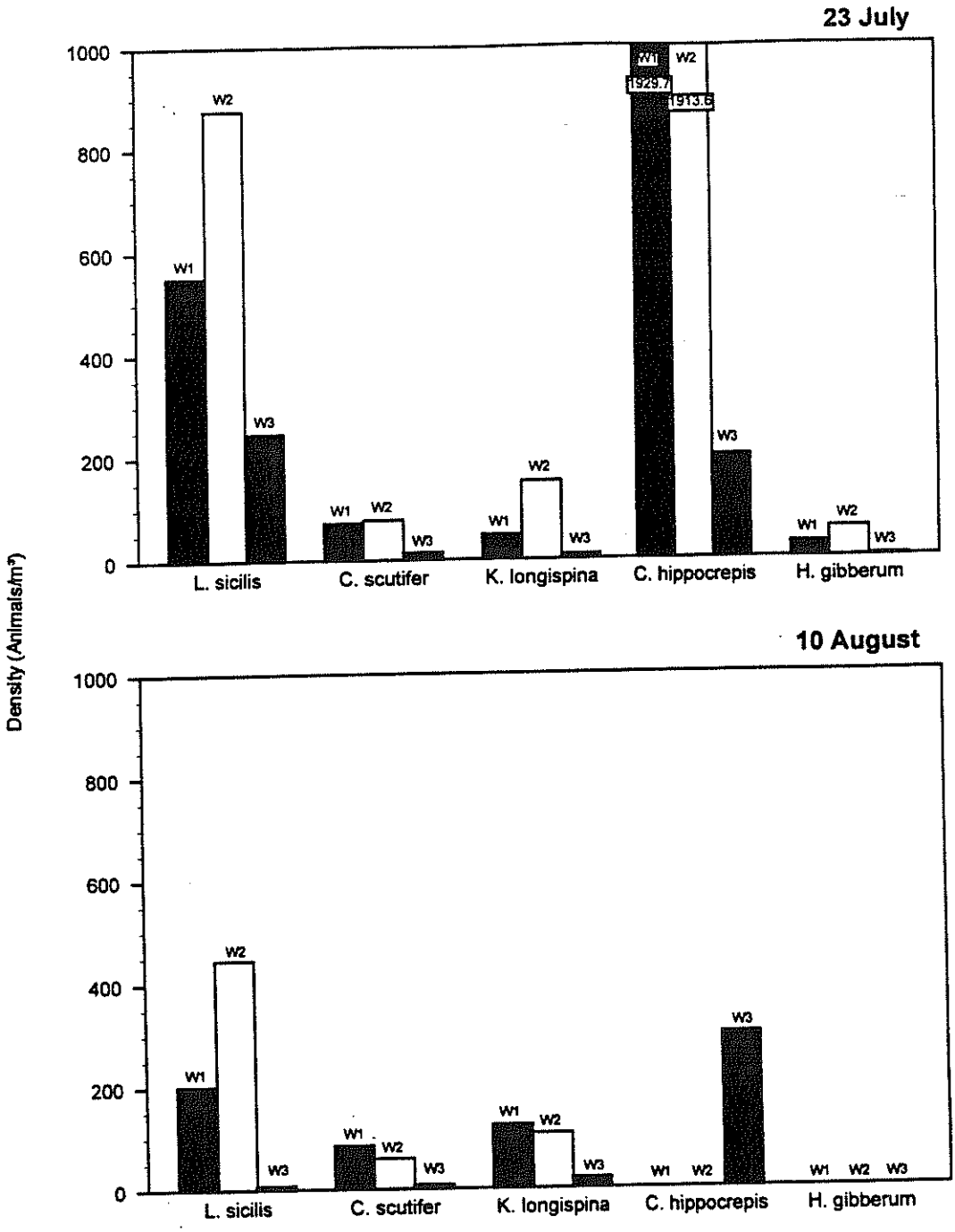


Figure 3.2-44 - Densities of the Five Most Abundant Zooplankton Taxa in Ham Lake, Summer 1993

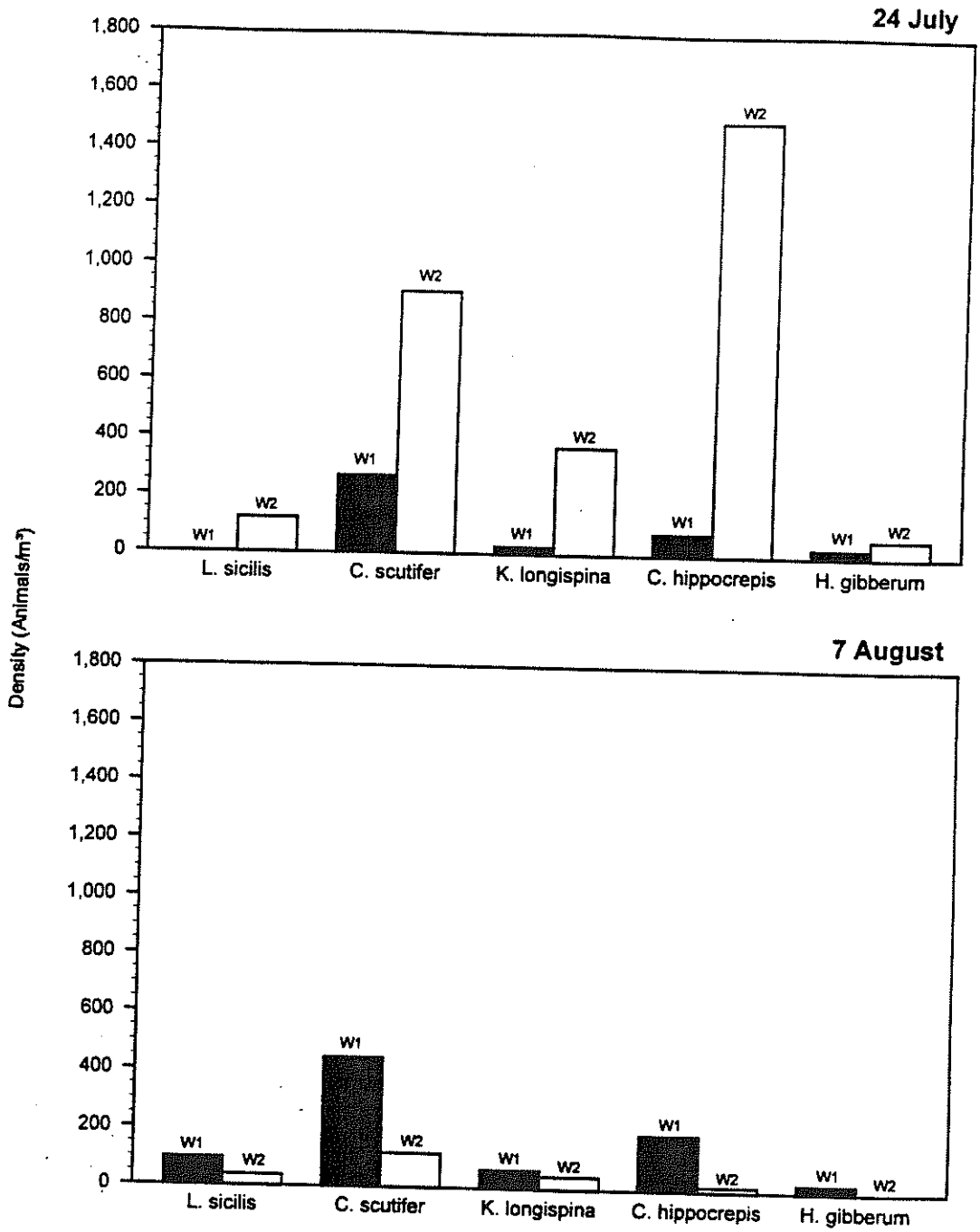


Figure 3.2-45 - Densities of the Five Most Abundant Zooplankton Taxa in Iznogoudh Lake, Summer 1993

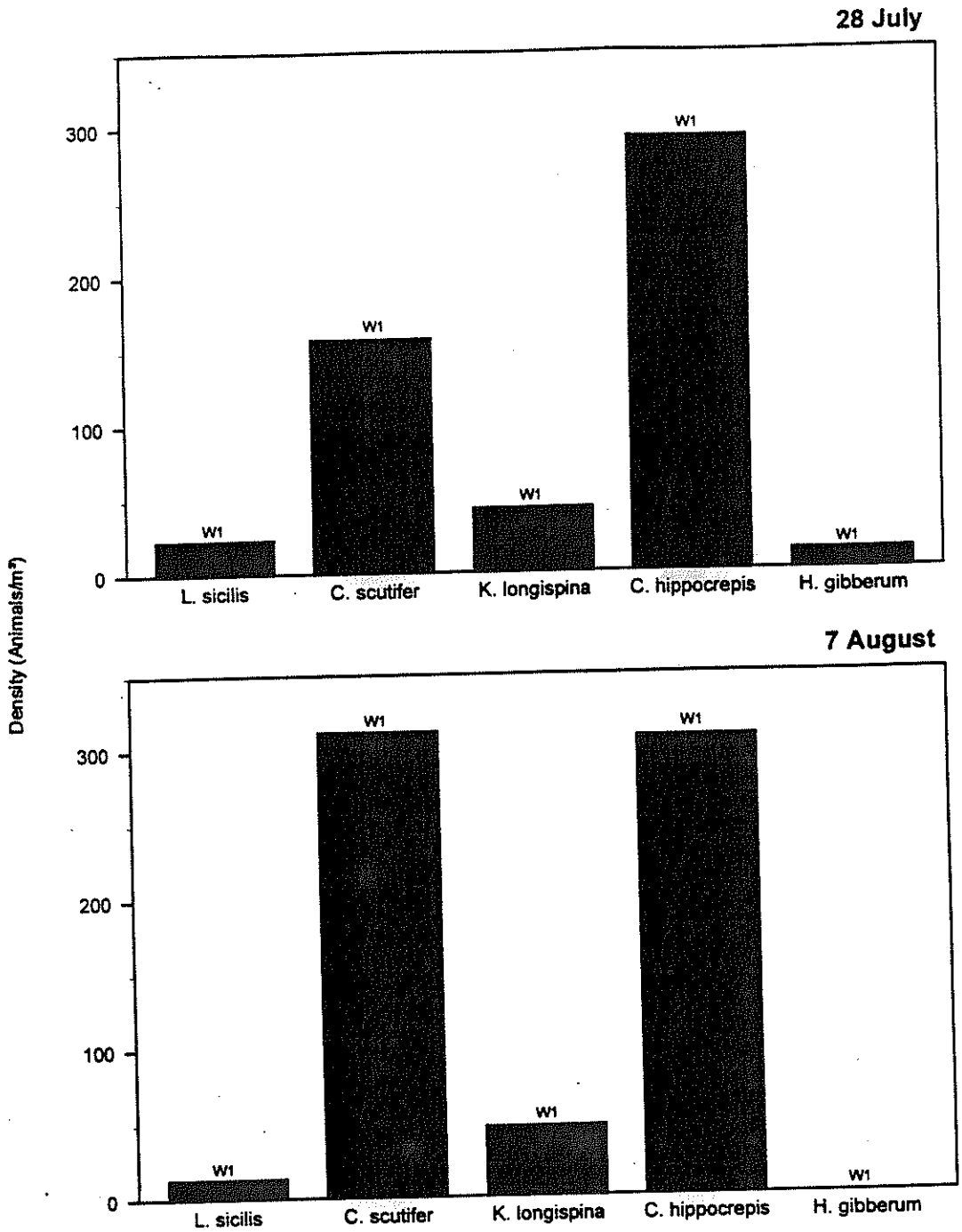


Figure 3.2-46 - Densities of the Five Most Abundant Zooplankton Taxa in Izok Lake, Summer 1993

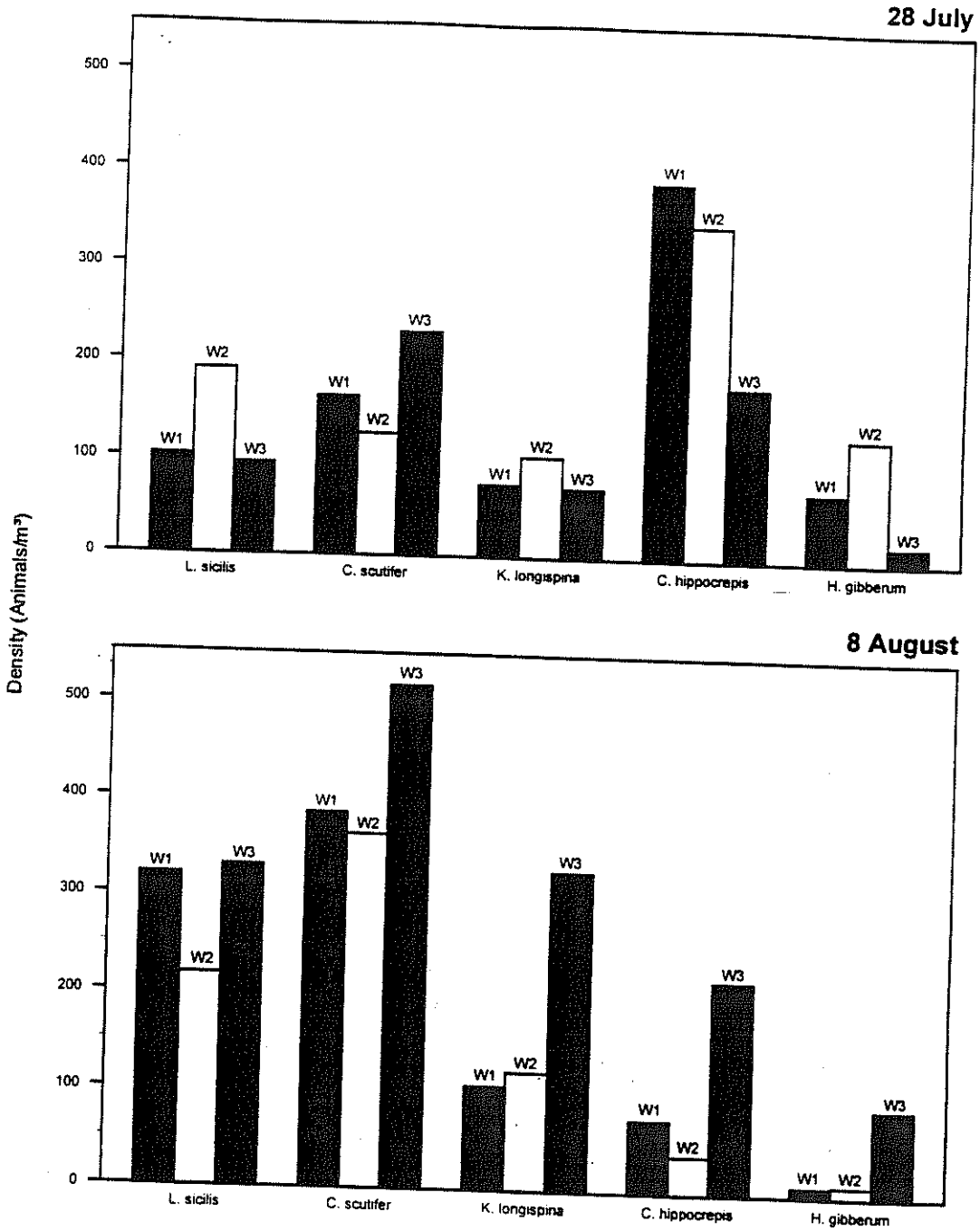


Figure 3.2-47 - Densities of the Five Most Abundant Zooplankton Taxa in Itchen Lake, Summer 1993

in importance, contributing from 2% to 14%. The standing crop of phytobenthos varied widely, depending on collection site, although densities were higher in Izok Lake than in either of Iznogoudh Lake or Itchen Lake. The algal abundance in the inlet and outlet streams of Izok Lake was also noted to be high in comparison to Iznogoudh and Itchen lakes.

Zoobenthos

Beak (1977) sampled the zoobenthic (small animals such as insect larvae, worms and clams that live on the bottom of streams and lakes) communities in the inlet stream to Izok Lake, and both the littoral area (lake bottom in the shallow area along the shoreline) and the main basin profundal (deep) zone of Izok Lake. They concluded that the benthos of the study area waterbodies was indicative of good water quality conditions. The benthic community of the inlet stream was dominated by plecopterans (stoneflies) and chironomids (midges) although smaller numbers of other diptera, cladocerans, nematodes, and oligochaetes also were noted. The shoreline littoral benthos in Izok Lake was numerically dominated by oligochaetes, chironomids, and nematodes, whereas the profundal community was comprised mainly of chironomids and pelecypods.

Moore (1978) noted that the chironomid abundance was lower in Izok and Itchen lakes in comparison to Iznogoudh Lake. During mid-July, *Heterotrissocladius oliveri* was the dominant species in both Iznogoudh and Itchen lakes, whereas *Stictochironomus* sp. was dominant in Izok Lake. As the season progressed, *Procladius denticulatus* became the most abundant chironomid in Iznogoudh and Itchen lakes. Molluscs (primarily *Pisidium* spp.) were collected in all three lakes at densities of 75/m^2 to 100/m^2; oligochaetes were present at densities of 30/m^2 to 60/m^2. Moore noted that the zoobenthic species which are prevalent in the study lakes, are known to occur abundantly throughout the zone of transition between boreal (northern forest) and tundra areas.

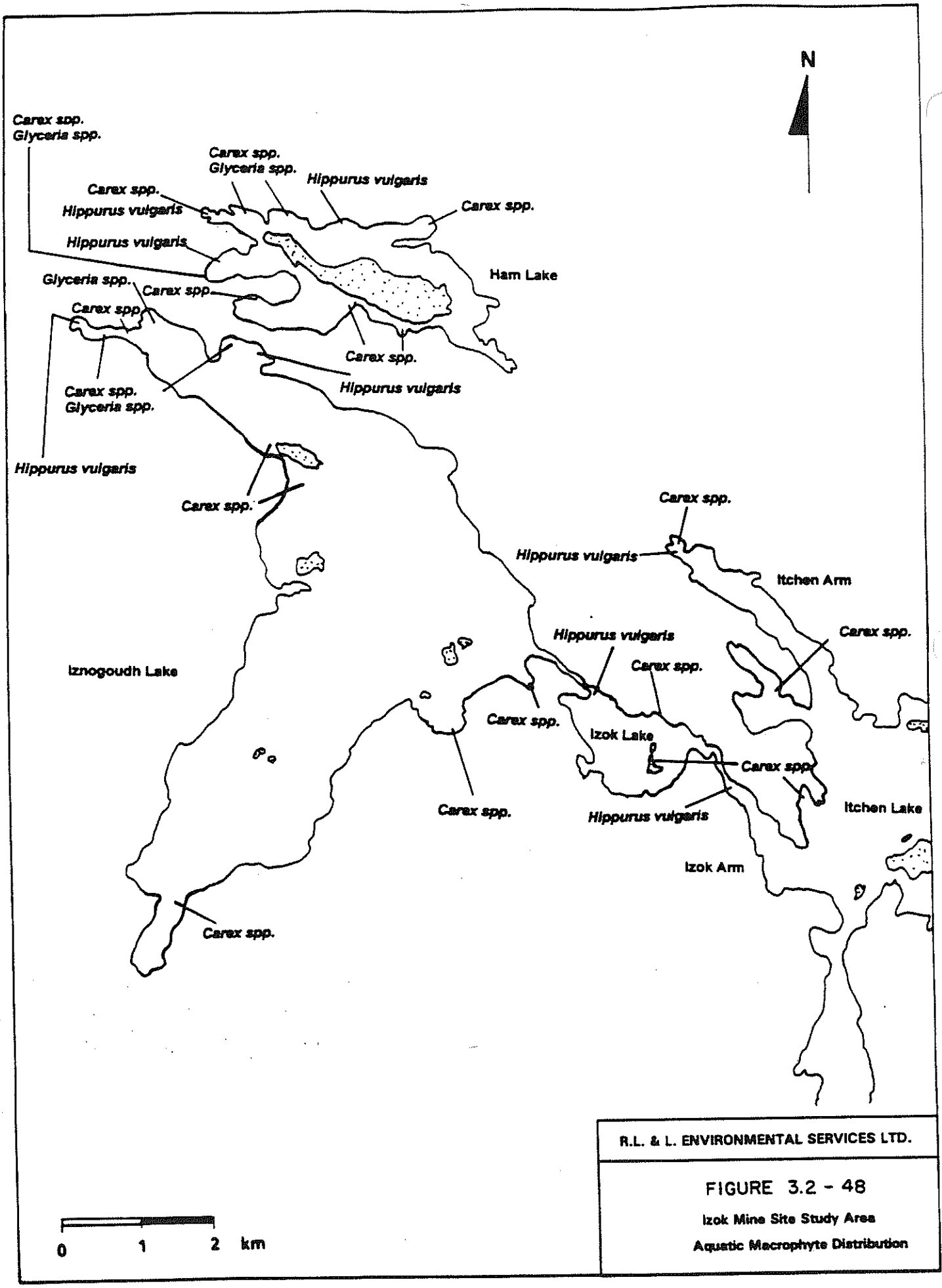
Aquatic Macrophytes

Beak (1977) reported that sedges (grasses) and mosses occurred along the shoreline of the waterbodies in the study area, although the extent of growth was quite variable, depending on the availability of suitable substrate. They also noted that the aquatic grass *Arctophila fulva* was abundant in some of the shallow bays of lakes in the area, but they did not specify which lakes. Water milfoil (*Myriophyllum* sp.) was recorded from silt and silt/clay substrates in all three lakes (i.e., Iznogoudh, Izok, and Itchen lakes) investigated by Beak (1977).

R.L. & L. Environmental Services Ltd. conducted shoreline surveys of four lakes in the study area (i.e., Ham, Iznogoudh, Izok, and Itchen lakes) during summer (22 July to 10 August) and fall (2 September to 14 September) 1993. In general, aquatic macrophytes were not abundant in any of the lakes. This was due to several factors including restricted littoral zones (i.e., limited amounts of shallow water), paucity of plant nutrients, cold water temperatures, and lack of suitable substrates.

Aquatic macrophytes include both emergent and submergent plant communities. Emergent plant communities were sparsely distributed along the shoreline perimeter of surveyed lakes (Figure 3.2-48). The most widespread emergents were sedges (*Carex spp.*) while aquatic grasses (*Gylceria spp.*) were more clumped in distribution. The only extensive growths of emergent vegetation were observed in sheltered bays of Ham and Iznogoudh lakes.

Submergent vegetation which could be observed from the water's surface was limited in abundance. The only species of submergent encountered during the survey was Mare's Tail (*Hippurus vulgaris*). This species was restricted to areas containing sand/silt substrate in sheltered bays of all four lakes. Water milfoil (*Myriophyllum spp.*), a species which was recorded by Beak during 1977, was not encountered during the present study.


N
Carex spp.
Glyceria spp.
Carex spp.
Glyceria spp.
Hippurus vulgaris
Carex spp.
Hippurus vulgaris
Carex spp.
Hippurus vulgaris
Ham Lake
Glyceria spp.
Carex spp.
Carex spp.
Carex spp.
Hippurus vulgaris
Carex spp.
Glyceria spp.
Hippurus vulgaris
Carex spp.
Carex spp.
Hippurus vulgaris
Itchen Arm
Iznogoudh Lake
Hippurus vulgaris
Carex spp.
Carex spp.
Carex spp.
Izok Lake
Carex spp.
Itchen Lake
Hippurus vulgaris
Izok Arm
Carex spp.
0
1
2
km
R.L. & L. ENVIRONMENTAL SERVICES LTD.
FIGURE 3.2 - 48
Izok Mine Site Study Area
Aquatic Macrophyte Distribution

Fisheries

The results of the Texasgulf studies of fisheries and metals levels in fish tissue are referred to in the discussion of more recent fisheries studies, below.

Minnova Investigations

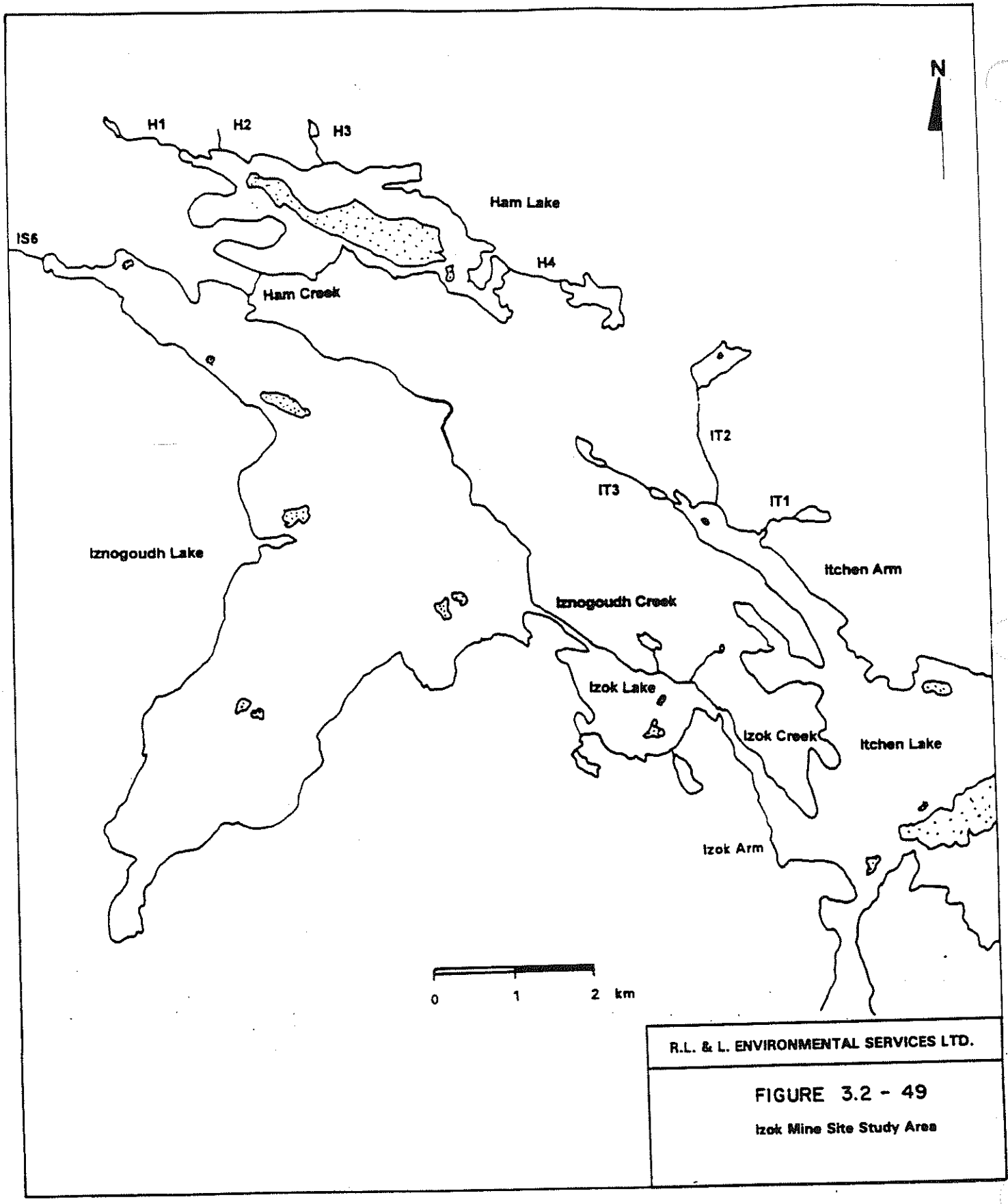
This section presents results of fisheries studies conducted by R.L. & L. Environmental Services Ltd. during summer (23 July to 30 July) 1992 (R.L. & L. 1992; 1993), and during spring (23 June to 3 July), summer (22 July to 10 August 1993), and fall (2 September to 14 September). Information concerning findings during fall sampling, 1993 are partially summarized in this section. These data will be presented in their entirety in the Aquatic Studies report being prepared by R.L. & L. Environmental Services Ltd.

Fisheries Investigations - Lakes

Fish communities in four study lakes were investigated during 1992 and 1993 (Figure 3.2-49). These lakes were Ham, Iznogoudh, and Izok lakes and portions of Itchen Lake (Izok Arm and Itchen Arm). A number of sampling techniques were utilized, including standard gangs of gill nets and angling. Beach seines and backpack electrofishers also were employed in an attempt to capture smaller fish (i.e., sculpin spp. and younger age-classes of other species) along shoreline areas. Fish habitat in the study lakes (i.e., spawning, rearing, and feeding areas) were assessed by a combination of aerial reconnaissance and ground truthing. The distribution of shallow water areas, fine substrates (i.e,. sand and silts), and aquatic macrophyte growth were recorded during these surveys.

Fish Species Composition

During 1992, five species of fish were captured from lakes in the vicinity of the mine site; these included (in order of abundance in the catch) lake trout (*Salvelinus namaycush*),



R.L. & L. ENVIRONMENTAL SERVICES LTD.

FIGURE 3.2 - 49

Izok Mine Site Study Area

round whitefish (*Prosopium cylindraceum*), longnose sucker (*Catostomus catostomus*), lake cisco (*Coregonus artedii*), and Arctic grayling (*Thymallus arcticus*) (Table 3.2-42).

Table 3.2-42 - Fish Species Composition and Percentage in the Gill Net Catch, Izok Mine Site Area, Summer 1992

SPECIES	HAM LAKE		IZNOGOUDH LAKE		IZOK LAKE		ITCHEN LAKE		TOTAL	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
Lake Trout	22	32.8	35	59.3	18	85.7	16	84.2	91	54.8
Round Whitefish	34	50.7	20	33.9	2	9.5	1	5.3	57	34.3
Longnose Sucker	10	14.9	4	6.8	1	4.8		0.0	15	9.0
Lake Cisco		0.0		0.0		0.0	2	10.5	2	1.2
Arctic Grayling	1	1.5		0.0		0.0		0.0	1	0.6
Total	67	100	59	100	21	100	19	100	166	100

Lake trout contributed 54.8% of the total catch from all lakes, followed by round whitefish (34.3%), and longnose sucker (9.0%) (Table 3.2-42). Lake cisco and Arctic grayling contributed only 1.2% and 0.6% to the total catch, respectively. Lake trout and round whitefish were captured in each of the four study lakes; longnose sucker were absent from Itchen Lake samples, lake cisco were collected only from Itchen Lake, and one Arctic grayling was taken from Ham Lake.

Results obtained during summer 1993 sampling were similar to those of the previous year (Table 3.2-43). Lake trout was the predominant species followed by round whitefish, longnose sucker, and Arctic grayling. Burbot were encountered during fall sampling.

Table 3.2-43 - Fish Species Composition and Percentage of the Gill Net Catch From Izok Mine Site Area, Summer 1993

	HAM LAKE		IZNOGOUDH LAKE		IZOK LAKE		ITCHEN LAKE		TOTAL	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
Lake Trout	28	40.0	68	71.6	44	65.6	33	89.2	173	64.3
Round Whitefish	24	34.3	17	17.9	20	29.9	4	10.8	65	24.2
Longnose Sucker	14	20.0	10	10.5	3	4.5		0.0	27	10.0
Lake Cisco		0.0		0.0		0.0		0.0		0.0
Arctic Grayling	1	1.4		0.0		0.0		0.0	1	0.4
Burbot*	3	4.3							3	1.1
TOTAL	70	100	95	100	67	100	37	100	269	100

* Burbot encountered during fall sampling.

Lake trout contributed 64.3% to the total gill net catch, followed by round whitefish (24.2%), and longnose sucker (10.0%). Arctic grayling contributed only 0.4%. No lake cisco were encountered during 1993 sampling. The two predominant species, lake trout and round whitefish, were collected from all four study lakes; longnose sucker were absent from the Itchen Lake sample and a single Arctic grayling was captured from Ham Lake. One additional species, burbot (*Lota lota*), was encountered during fall sampling, 1993; three adult burbot were captured in Ham Lake during gill netting operations to develop population estimates. No burbot were found in the other three study lakes during 1993, nor was this species captured in 1992.

During 1992, the catch rate of lake trout was greatest in Iznogoudh Lake (7.1 fish/100 m^2·12 h), followed by Ham Lake (6.0 fish/100 m^2·12 h), Izok Lake (3.7 fish/100 m^2·12 h), and Itchen Lake (3.5 fish/100 m^2·12 h) (Figure 3.2-50). Round whitefish catch rates were greatest in Ham Lake (9.2 fish/100 m^2·12 h), followed in decreasing order of abundance by catches from Iznogoudh Lake (4.1 fish/100 m^2·12 h), Izok Lake (0.5 fish/100 m^2·12 h), and Itchen Lake (0.22 fish/100 m^2·12 h). All but three of the 34 round whitefish captured in Ham Lake were caught in the gill net set in the shallow west basin. Longnose suckers were present in moderate abundance only in Ham Lake

(2.6 fish/100 m^2·12 h) with lower catch rates for this species occurring in the remaining lakes. Catch rates of all other species were less than 0.1 fish/100m^2·12 h.

Catch rates obtained during the summer session in 1993 generally were similar to those for 1992. Catch rates for lake trout in summer 1993 were higher in Ham (5.5 fish/100 m^2·12 h) and Iznogoudh lakes (2.8 fish/100 m^2·12 h) than in Izok (2.5 fish/100 m^2·12 h), and Itchen lakes (1.2 fish/100 m^2·12 h). Round whitefish catch rates were highest in Ham Lake (4.7 fish/100 m^2·12 h), with much lower catch rates obtained for this species in the other three study lakes (<1.2 fish/100 m^2·12 h). Longnose sucker catch rates followed the same pattern as round whitefish; catch indices for this species was highest in Ham Lake (2.8 fish/100 m^2·12 h) and much lower in all other lakes (>1.0 fish/100 m^2·12 h).

Beak (1977) reported lake trout as being abundant in the lakes in the study area. The other major species collected by Beak was lake whitefish (*Coregonus clupeaformis*), which was not collected during the present study. It may be possible that the previous study mis-identified round whitefish, which was common in the 1992 and 1993 catches, as lake whitefish. Although the two species show some similarities, round whitefish belong to the genus *Prosopium* which can be distinguished from *Coregonus* by the single flap between the nostrils, the presence of a distinct notch below the hind margin of the pupil, and by 61 to 130 pyloric caecae. The round whitefish, as its name implies, generally is more cylindrical in shape, whereas the lake whitefish generally is deeper and often has a "humpback" appearance.

It is possible that lake whitefish also are present in the study lakes but by chance were not collected during the present study; however, the level of effort and range of mesh sizes used in the present study were much greater than in the Beak study.

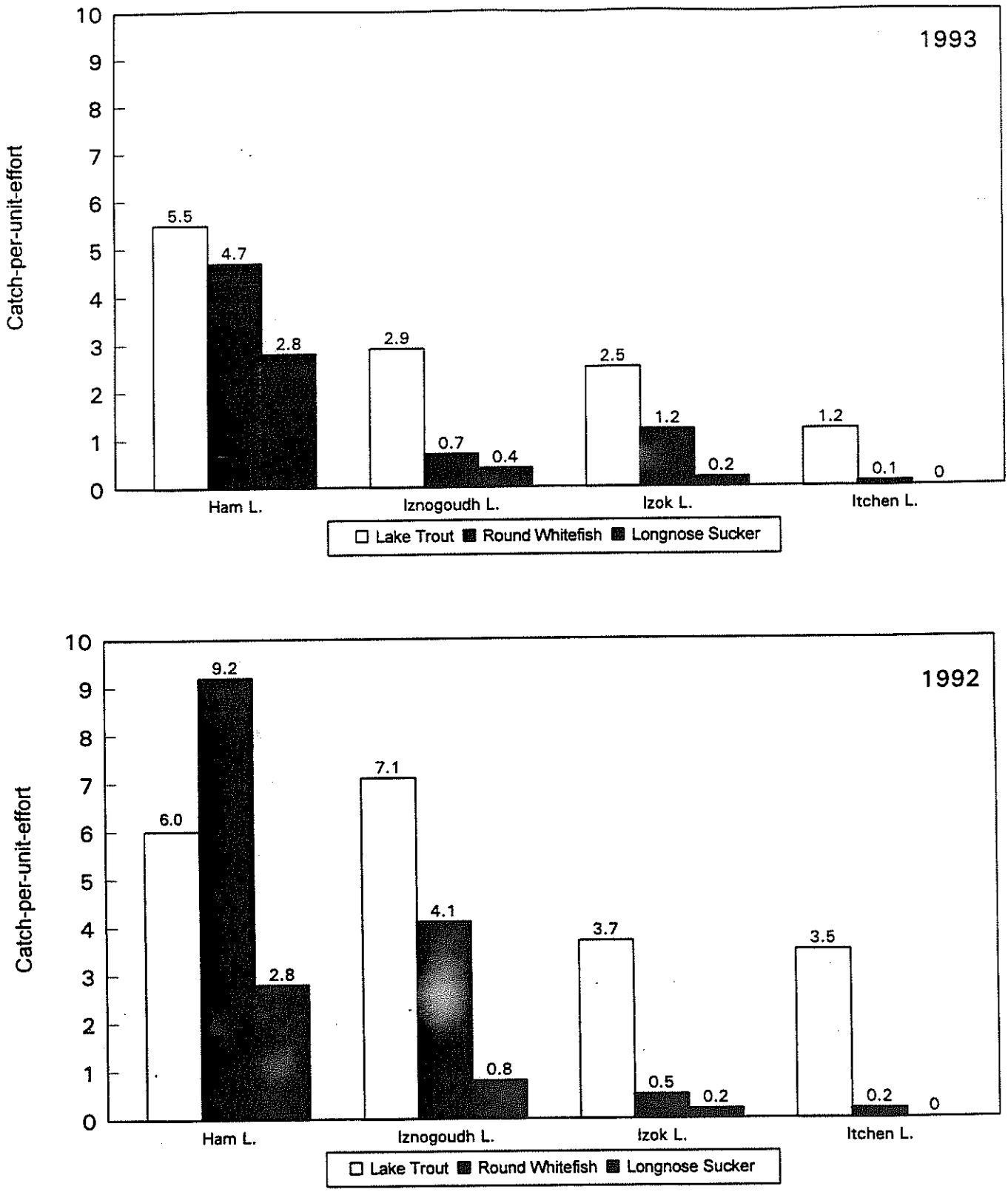


Figure 3.2-50 - Catch-per unit-effort (fish/100m^2·12h) for Lake Trout, Round whitefish and Longnose sucker, Izok Mine Site Area, Summer 1992 and 1993

Beak (1977) also reported the presence of slimy sculpin (*Cottus cognatus*) in benthic samples collected in the study area. During 1992 and 1993, this species was not captured in lakes by the sampling methods employed (gill nets, beach seines electrofishing). Slimy sculpin, however, were observed in tributaries of the study lakes and in the stomachs of captured lake trout, suggesting they are still present in the lakes.

Although only two Arctic grayling were captured while sampling the four study lakes (both caught in Ham Lake), this species was present in several study area creeks (see tributary section). Arctic grayling are better adapted to stream habitats, and usually reside in streams during open water periods. Sampling during spring 1993 indicated that Arctic grayling moved into tributaries to spawn, well before the main lake became ice free (R.L. & L./RCPL, 1985). Because these tributaries freeze to the bottom, Arctic grayling very likely move out of the study area streams and into the lakes to overwinter.

Age-Growth Relationship - Ham Lake

Information in this section represent data obtained from summer 1993. The data set was restricted to this time period to reduce biases associated with differences in length-at-age (i.e., growth between summer and fall) and to reduce problems associated with small sample sizes obtained during other periods (i.e., in accurate estimates). To increase the sample size for Arctic grayling, however, data from spring and summer were combined for the analyses.

Lake Trout

The 54 lake trout captured in Ham Lake by angling or gill netting during summer 1993 ranged in length from 177 mm to 964 mm (Figure 3.2-51), and in weight from 59 g to 11.9 kg. Ages ranged from 3 years to 41 years (Table 3.2-44; Figure 3.2-52). The growth rate of lake trout noted in the present study was considerably lower than that reported by Beak (1977) (e.g., 13-year-old fish averaged 433 mm in the present study versus 570 mm reported by Beak); however, the method of ageing used in the Beak study was not

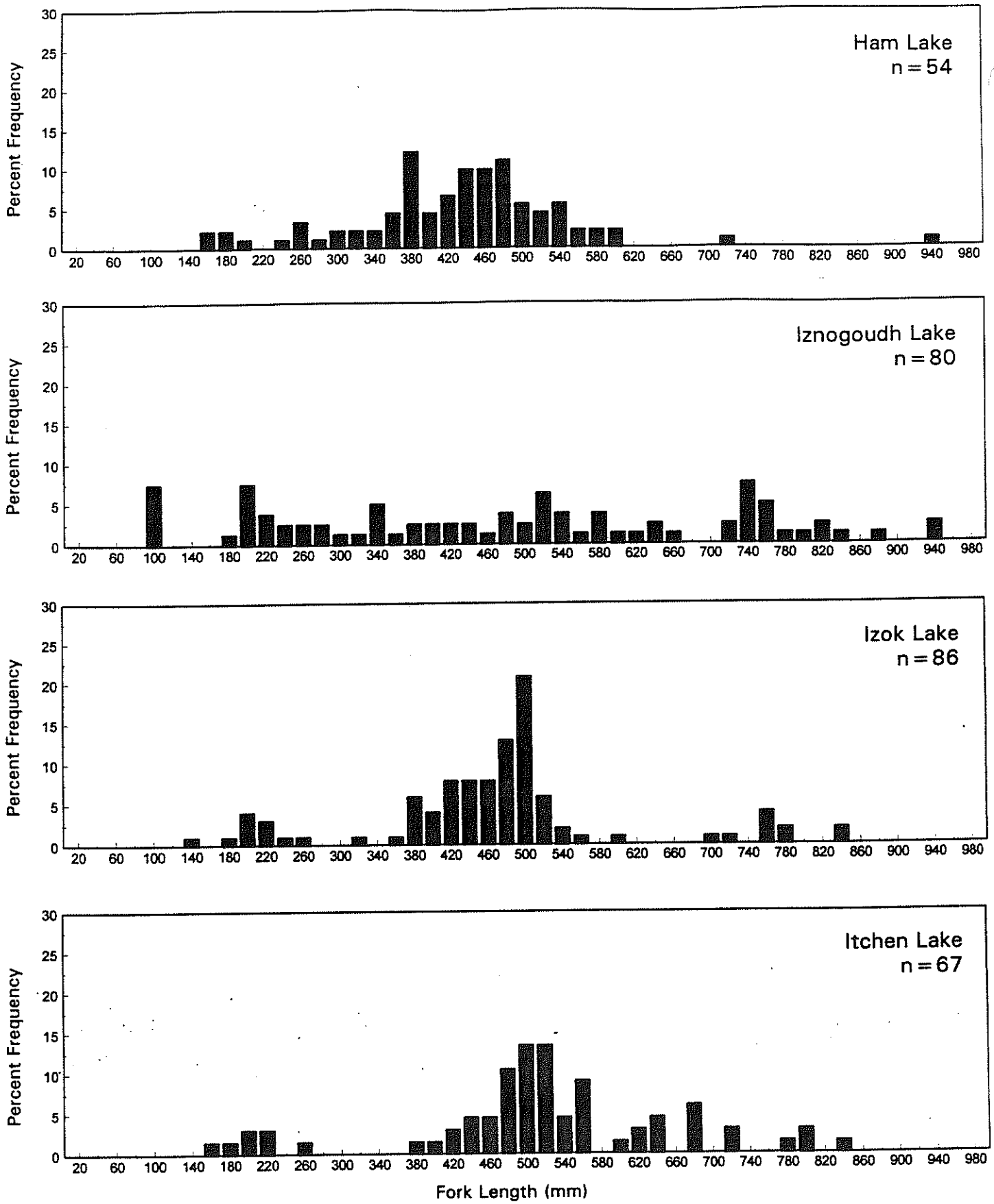


Figure 3.2-51 - Length-frequency Distribution of Lake Trout, Izok Mine Site Area, Summer 1993

Table 3.2-44 - Age-length Relationship for Lake Trout, Izok Mine Site Area

AGE	HAM LAKE		IZNOGOUDH LAKE		ITCHEN LAKE		IZOK LAKE		IZOK AREA (Beak, 1977)	GREAT BEAR LAKE (Miller & Kennedy, 1948)	KAMINURIAK LAKE (Bond, 1975)	
	FORK LENGTH (mm)	SAMPLE SIZE	FORK LENGTH (mm)	SAMPLE SIZE	FORK LENGTH (mm)	SAMPLE SIZE	FORK LENGTH (mm)	SAMPLE SIZE	FORK LENGTH (mm)	FORK LENGTH (mm)	FORK LENGTH (mm)	SAMPLE SIZE
0												
1										63		
2			99	5						98		
3	179	2					144	1		134		
4	205	3	202	9	194	3	202	6		180		
5			226	3	225	1	226	2				
6	253	1	260	2	226	1	247	1			224	1
7	281	2	285	1	268	1	268	1		293	285	2
8			291	2						320	283	3
9	335	2	330	3					456	354	272	1
10	374	1	355	4			376	3	474	372	325	2
11	386	1	399	1	380	1	375	2	490	412	372	1
12			401	4			404	3	600	412	389	2
13	433	2			421	1	429	1	570	420	432	01
14			447	1	448	3	445	3	570	449	478	7
15	492	1	501	1	482	5	452	3	660	487	500	7
16	515	1	503	2	532	5	473	1	660	515		
17	527	1	527	2	529	8	494	3	770	556	539	6

Table 3.2-44 - Age-length Relationship for Lake Trout, Izok Mine Site Area (continued)

AGE	HAM LAKE		IZNOGOUDH LAKE		ITCHEN LAKE		IZOK LAKE		IZOK AREA (Beak, 1977)	GREAT BEAR LAKE (Miller & Kennedy, 1948)	KAMINURIAK LAKE (Bond, 1975)	
	FORK LENGTH (mm)	SAMPLE SIZE	FORK LENGTH (mm)	SAMPLE SIZE	FORK LENGTH (mm)	SAMPLE SIZE	FORK LENGTH (mm)	SAMPLE SIZE	FORK LENGTH (mm)	FORK LENGTH (mm)	FORK LENGTH (mm)	SAMPLE SIZE
18			550	3	523	1	489	1		574	546	9
19			577	2	564	3				607	545	41
20					564	1	528	2		626	557	11
21			591	1						656	556	5
22					560	1	593	1		700	584	41
23	557	1			653	2				698	617	8
24	531	1			633	3					582	9
25											600	01
26											627	31
27											593	5
28			660	1							625	51
29											619	42
30					695	2					610	21
31							755	1			623	92
32							701	1				
33			717	1								
34			744	3								
35					796	1						

Table 3.2-44 - Age-length Relationship for Lake Trout, Izok Mine Site Area (continued)

AGE	HAM LAKE		IZNOGOUDH LAKE		ITCHEN LAKE		IZOK LAKE		IZOK AREA (Beak, 1977)	GREAT BEAR LAKE (Miller & Kennedy, 1948)	KAMINURIAK LAKE (Bond, 1975)	
	FORK LENGTH (mm)	SAMPLE SIZE	FORK LENGTH (mm)	SAMPLE SIZE	FORK LENGTH (mm)	SAMPLE SIZE	FORK LENGTH (mm)	SAMPLE SIZE	FORK LENGTH (mm)	FORK LENGTH (mm)	FORK LENGTH (mm)	SAMPLE SIZE
36			739	1								
37			761	3								
38												
39												
40												
41	964	1										
42												
43												
44												
45												
46												
47												
48												
49			936	1								
50			942	1								

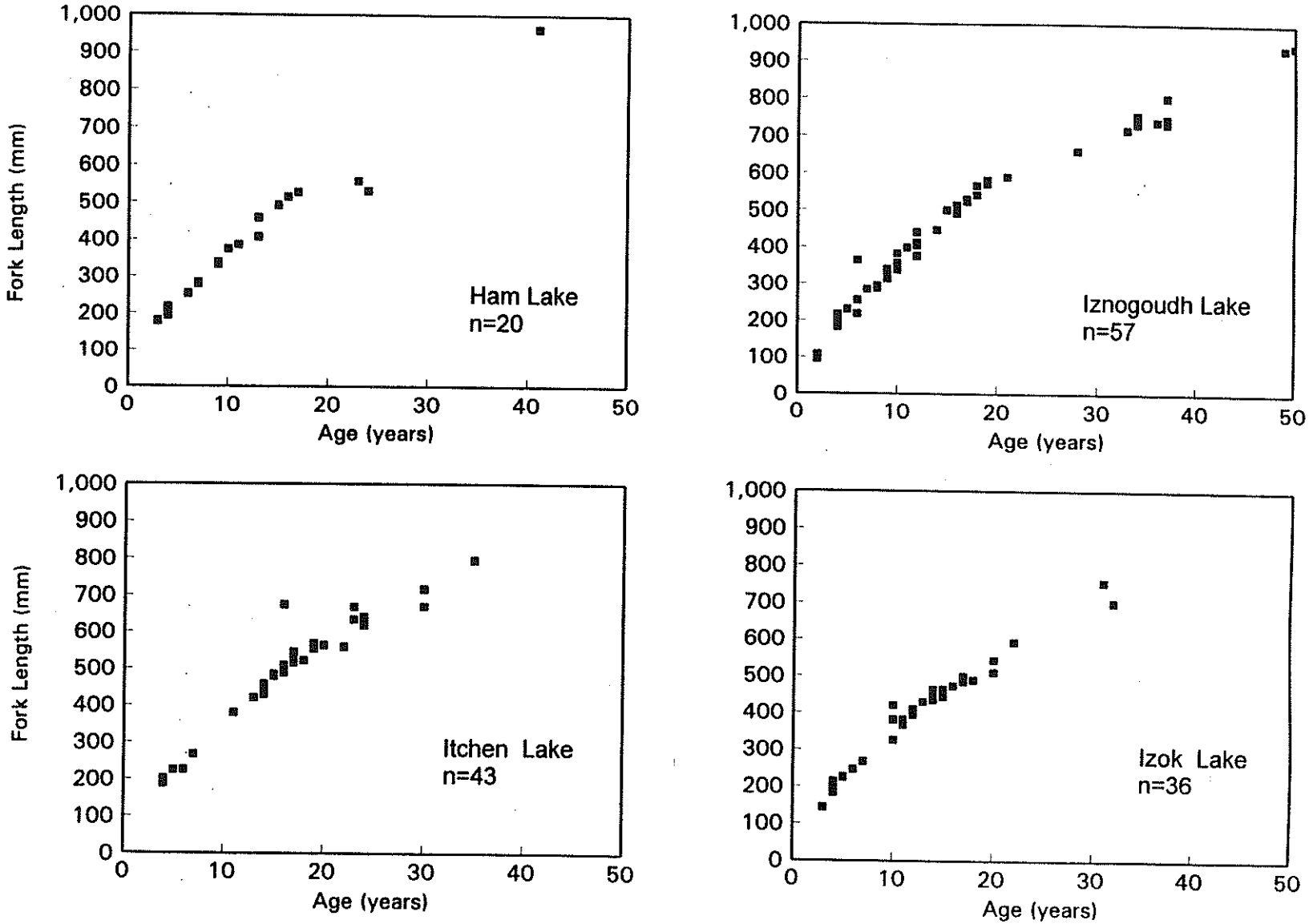


Figure 3.2-52 - Age-length Relationship for Lake Trout, Izok Mine Site Area, Summer 1993

reported. It is now generally accepted that ageing of lake trout using scales usually underestimates the age (particularly in old fish), and therefore might explain the apparent rapid growth rate. Otoliths, which were used in the present study, are the ageing structures more commonly used now for ageing this species. The growth rates of lake trout from Ham Lake are generally similar to Great Bear Lake located to the west of the study area.

Round Whitefish

The 24 round whitefish captured in Ham Lake ranged in length from 207 mm to 442 mm (Figure 3.2-53), and in weight from 83 g to 1034 g. Ages ranged from 3 years to 17 years (Table 3.2-45; Figure 3.2-54).

Longnose Sucker

The 14 longnose sucker caught in Ham Lake ranged in length from 172 to 501 mm (Figure 3.2-55), and in weight from 64 g to 1872 g. Ages ranged from 3 to 20 years (Table 3.2-46, Figure 3.2-56).

Arctic Grayling

Twenty-seven Arctic grayling were captured in Ham Lake and its tributaries (one individual was captured from Ham Lake proper during summer 1993) (Figure 3.2-57). These fish ranged in length from young-of-the-year to 7 years (Table 3.2-47, Figure 3.2-58).

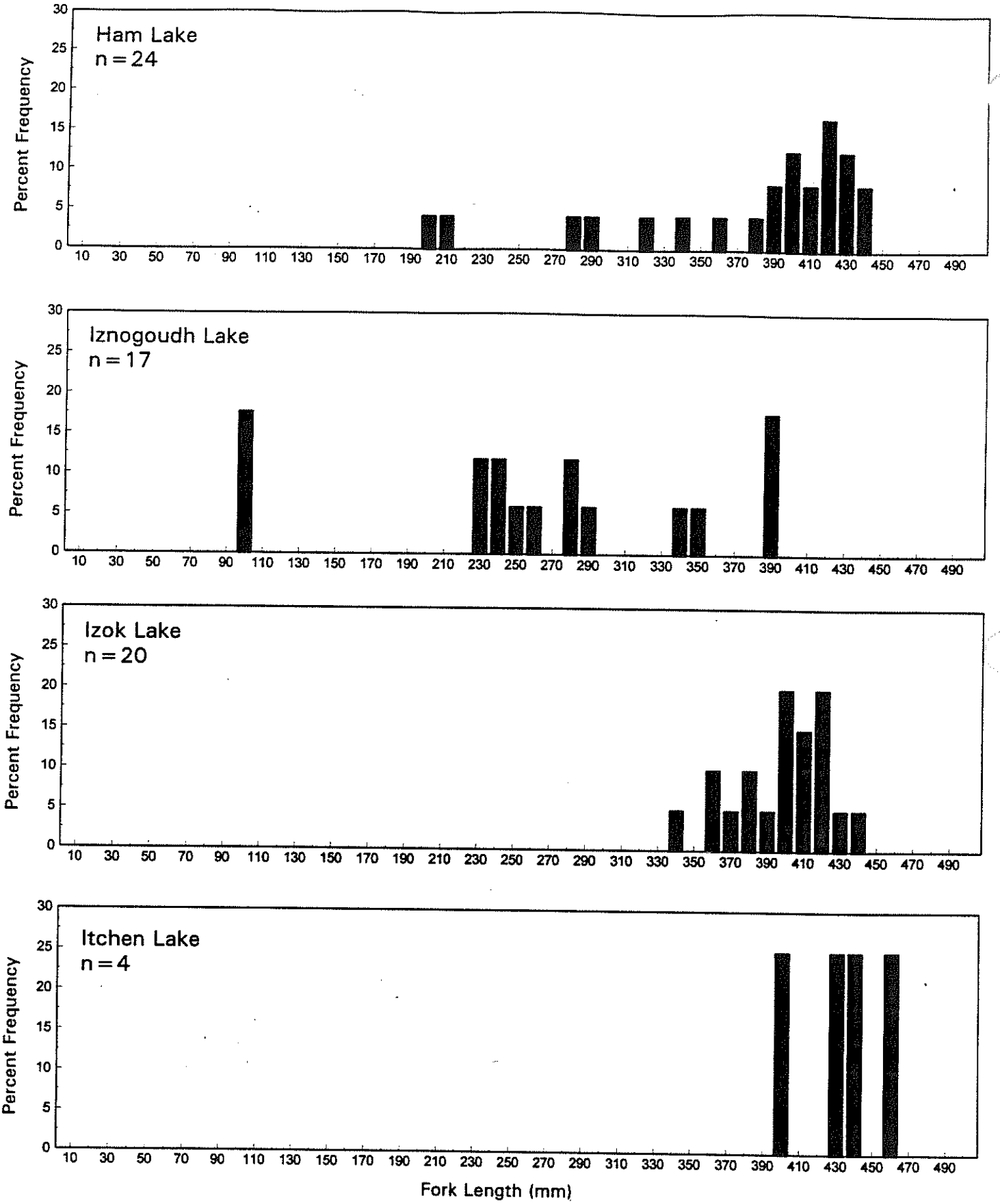


Figure 3.2-53 - Length-frequency Distribution of Round whitefish, Izok Mine Site Area, Summer 1993

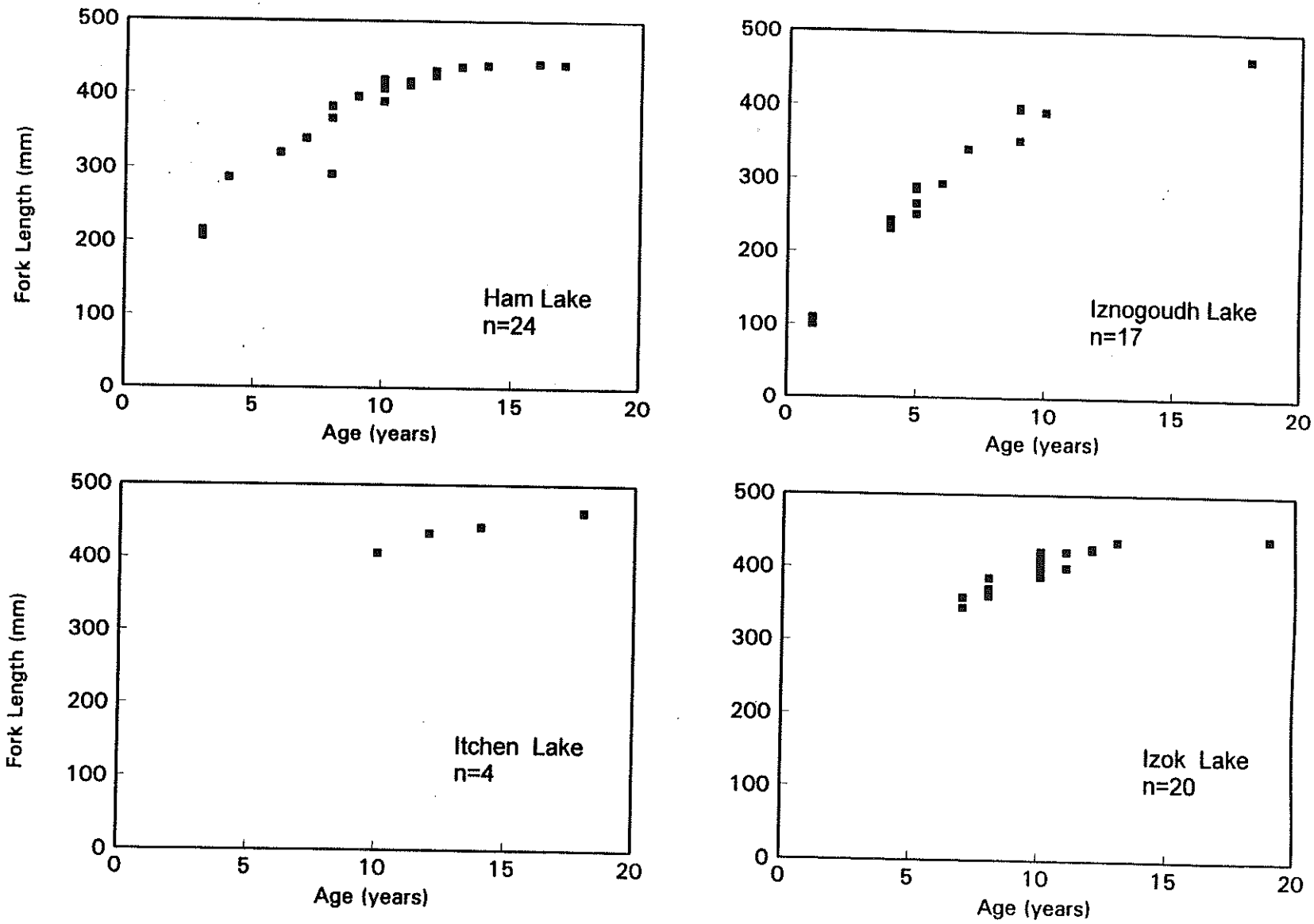


Figure 3.2-54 - Age-length Relationships for Round Whitefish, Izok Mine Site Area, Summer 1993

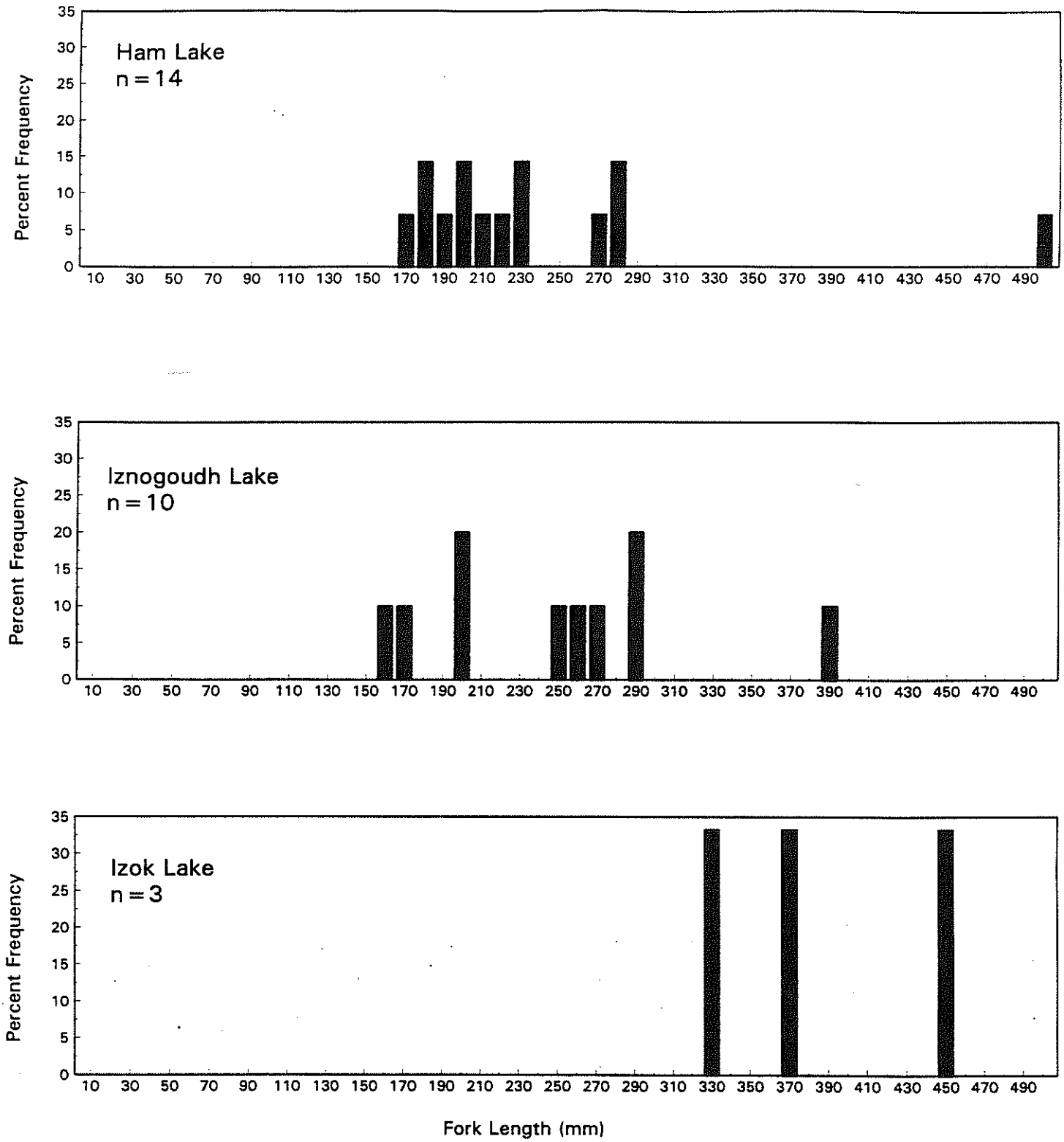


Figure 3.2-55 - Length-frequency Distribution of Longnose Sucker, Izok Mine Site Area, Summer 1993

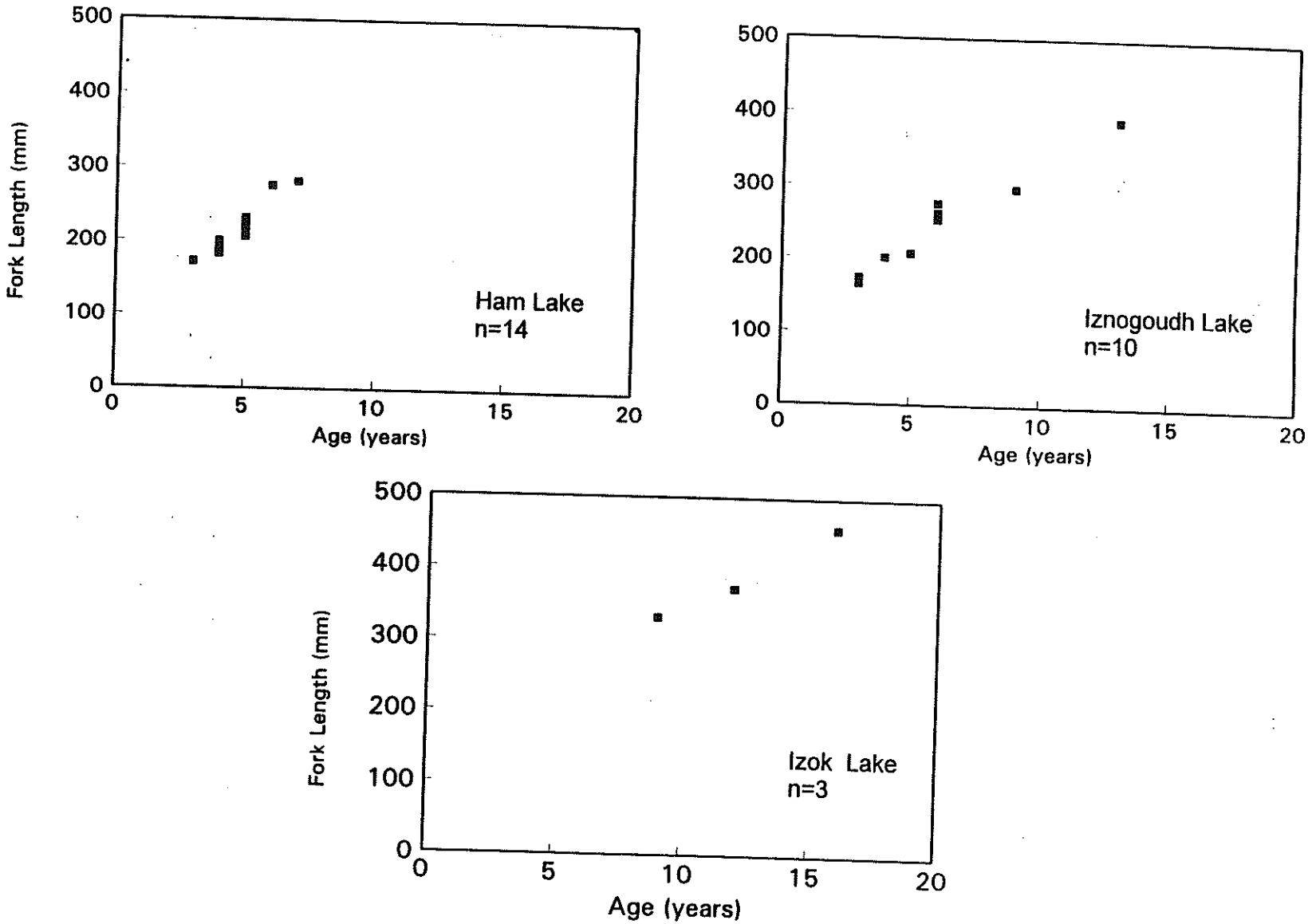


Figure 3.2-56 - Age-length Relationship for Longnose Sucker, Izok Mine Site Area, Summer 1993

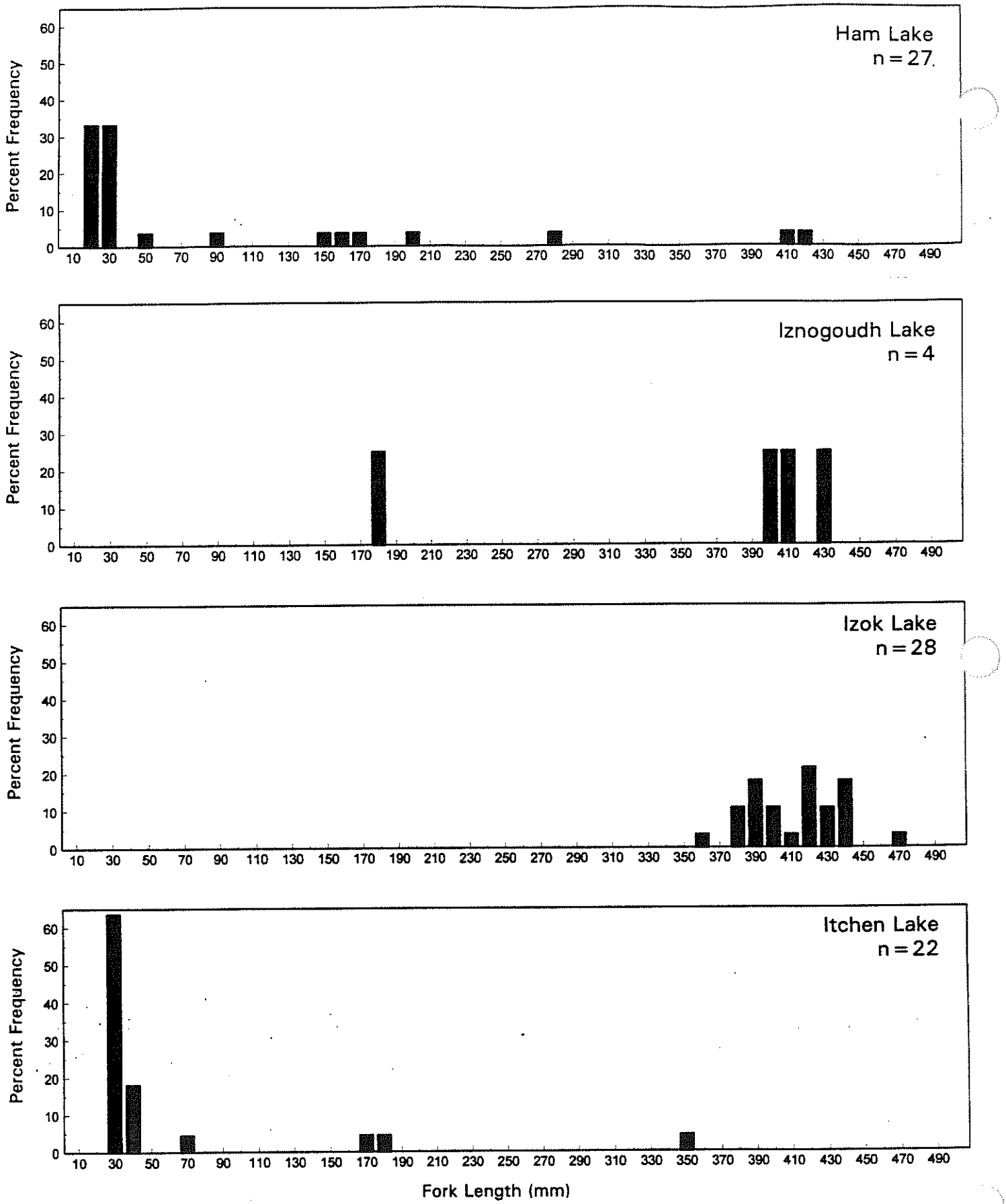


Figure 3.2-57 - Length-frequency Distribution of Arctic Grayling, Izok Mine Site Area, Summer 1993

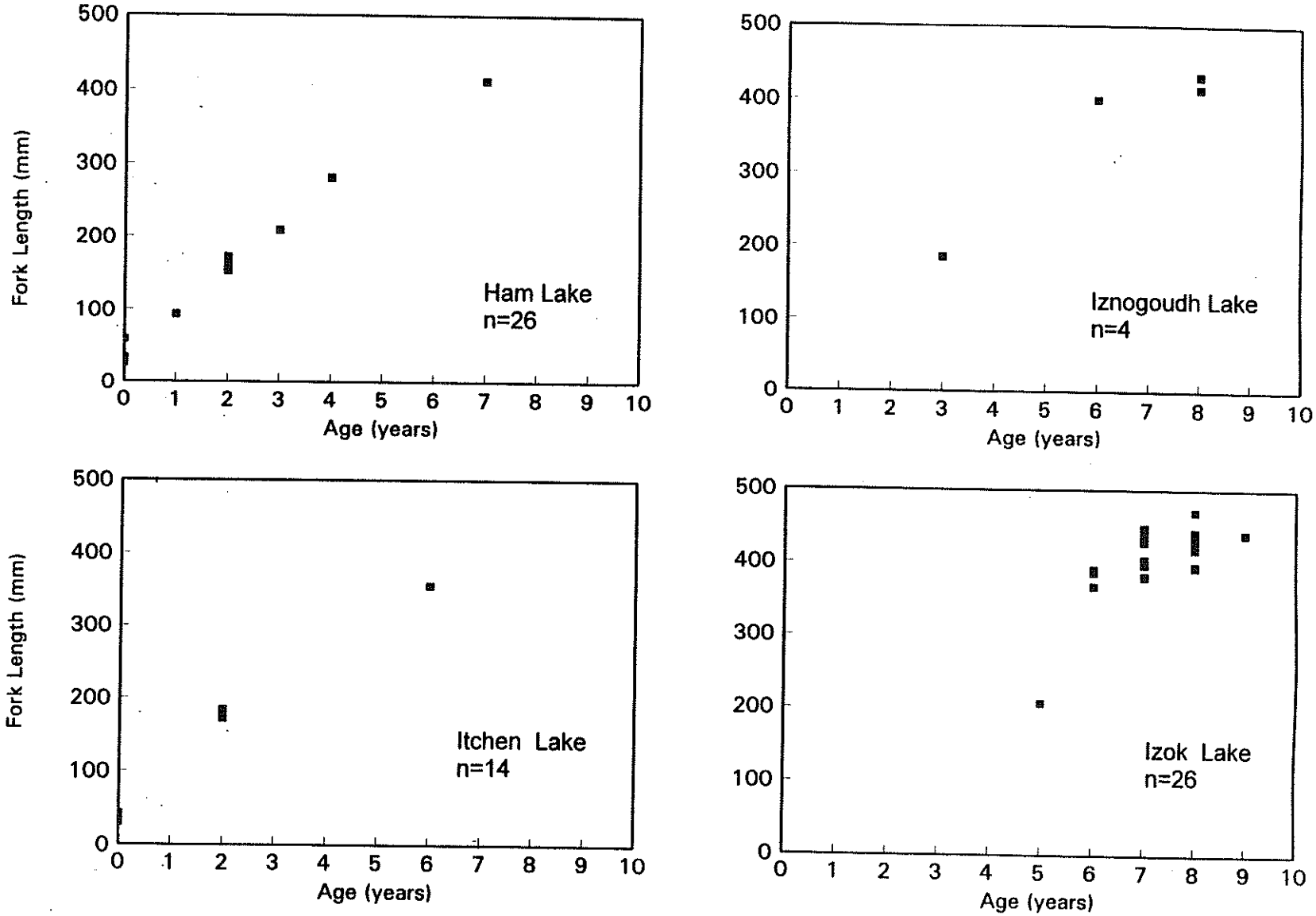


Figure 3.2-58 - Age-length Relationships for Arctic Grayling, Izok Mine Site Area, Summer 1993

Table 3.2-45 - Age-length Relationship for Round Whitefish, Izok Mine Site Area, Summer 1993. Sample size given in italics.

LOCATION	MEAN FORK LENGTH (mm) AT AGE																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ham Lake				211	287		321	340	348	397	407	415	428	437	439		442	441			
				2	*1*		*1*	*1*	*3*	*1*	*5*	*2*	*4*	*1*	*1*		*1*	*1*			
Iznogoudh Lake		108			238	273	293	340		381	391										
		2			*4*	*4*	*1*	*1*		*3*	*1*										
Itchen Lake											407		434		443				463		
											1		*1*		*1*				*1*		
Izok Lake								353	374		407	412	427	437						441	
								2	*3*		*9*	*2*	*2*	*1*						*1*	
Great Bear Lake (Kennedy 1949)						328	338	353	368	421											

Table 3.2-46 - Age-length Relationship for Longnose Sucker, Izok Mine Site Area, Summer 1993. Sample size is given in italics.

LOCATION	MEAN FORK LENGTH (mm) AT AGE																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ham Lake				172	192	222	276	282													501
				1	*4*	*5*	*1*	*2*													*1*
Iznogoudh Lake				170	201	207	264			297				391							
				2	*1*	*1*	*3*			*2*				*1*							
Izok Lake										332			373				458				
										1			*1*				*1*				
Great Slave Lake (Harris 1962)			152	170	253	290	314	330	372	403	433		499			547				642	

Table 3.2-47 - Age-length Relationship for Arctic Grayling, Izok Mine Site Area, Summer 1993. Sample size is given in italics.

LOCATION	MEAN FORK LENGTH (mm) AT AGE									
	0	1	2	3	4	5	6	7	8	9
Ham Lake	31	93	163	209	281			413		
	19	*1*	*3*	*1*	*1*			*1*		
Iznogoudh Lake				185			400		424	
				1			*1*		*2*	
Itchen Lake	37		145				355			
	18		*3*				*1*			
Izok Lake							384	412	426	440
							4	*10*	*11*	*1*
Great Bear Lake (Miller 1946)		93	155	231	285	325	353	378	399	410

Age - Growth Relationship - Iznogoudh Lake

Lake Trout

The 80 lake trout captured in Iznogoudh Lake ranged in length from 96 mm to 942 mm, and in weight from 5 g to 8.9 kg. Ages ranged from 2 years to 50 years.

Round Whitefish

The 17 round whitefish ranged in length from 397 mm to 426 mm, and in weight from 27 g to 754 g. The youngest round whitefish was one year old, and the oldest was 10 years.

Longnose Sucker

The 10 longnose suckers ranged in length from 165 mm to 391 mm, and in weight from 62 g to 941 g. Ages ranged from 3 years to 13 years.

Arctic Grayling

The four Arctic grayling captured from the Iznogoudh system were taken from its principle tributary at the north-west end of the lake. These fish ranged in length from

185 mm to 432 mm and in weight from 700 g to 910 g (the smallest fish was not weighed). These fish were aged from 3 to 8 years.

Age - Growth Relationship - Izok Lake

Lake Trout

The 106 lake trout from Izok Lake ranged in length from 144 mm to 696 mm, and in weight from 56 g to 6.5 kg. Ages ranged from 3 years to 32 years.

Round Whitefish

Twenty round whitefish were captured in Izok Lake. Lengths ranged from 346 mm to 441 mm, and weights from 506 g to 946 g. Ages ranged from 7 to 19 years.

Longnose Sucker

The three longnose suckers collected from Izok Lake ranged in length from 332 mm to 458, and in weight from 510 g to 1441 g. These fish were from 9 to 16 years of age.

Arctic Grayling

Of the 30 Arctic grayling sampled from Izok Lake system, all were captured from Iznogoudh Creek or at this creek's confluence with the lake. These fish ranged in length from 368 mm to 470 mm and weighed from 614 g to 1118 g. Ages ranged from 6 to 9 years.

Age - Growth Relationship - Itchen Lake

Lake Trout

The 67 lake trout captured in the two arms of Itchen Lake ranged in length from 160 mm to 847 mm, and in weight from 39 g to 5.7 kg. Ages ranged from 4 years to 35 years (the smallest fish was not aged).

Round Whitefish

Only four round whitefish were captured in Itchen Lake. These fish ranged in length from 407 mm to 467 mm, and in weight from 804 g to 1307 g. These fish were aged from 10 to 18 years.

Lake Cisco

Although no lake cisco were captured during the 1993 program, two were collected in 1992 from Itchen Lake. These fish were 100 mm and 105 mm in length, and weighed 8 g each. Both were aged as two years old.

Arctic Grayling

Twenty-two Arctic grayling were collected from the Itchen Lake area during the spring and summer of 1993; all were captured in tributaries. These included two adult fish from Izok Creek and the remainder from much smaller tributaries feeding into Itchen Arm. Captured fish ranged in length from 30 mm to 355 mm, and in weight from 47 g to 423 g (the smallest fish were not weighed). Fish were aged 0 to 6 years.

Feeding Habits

The results in the following section are based on analyses of a small number of stomachs of several sportfish species collected during summer 1992 and summer and fall 1993. Data were obtained from fish that succumbed during capture or were sacrificed for tissue samples and represent a range of size-classes taken during the sampling period. The information is illustrated by percent occurrence of food items in stomachs and percentage of food points allotted to food items, a volumetric measure of fullness.

Ham Lake

Lake Trout

A diverse assemblage of food items were consumed by lake trout in Ham Lake (Figure 3.2-59). Items consumed included insects, zooplankton, and fish. Within the insect group, trichopterans (caddisflies) were predominant during 1992; chironomids (midges)

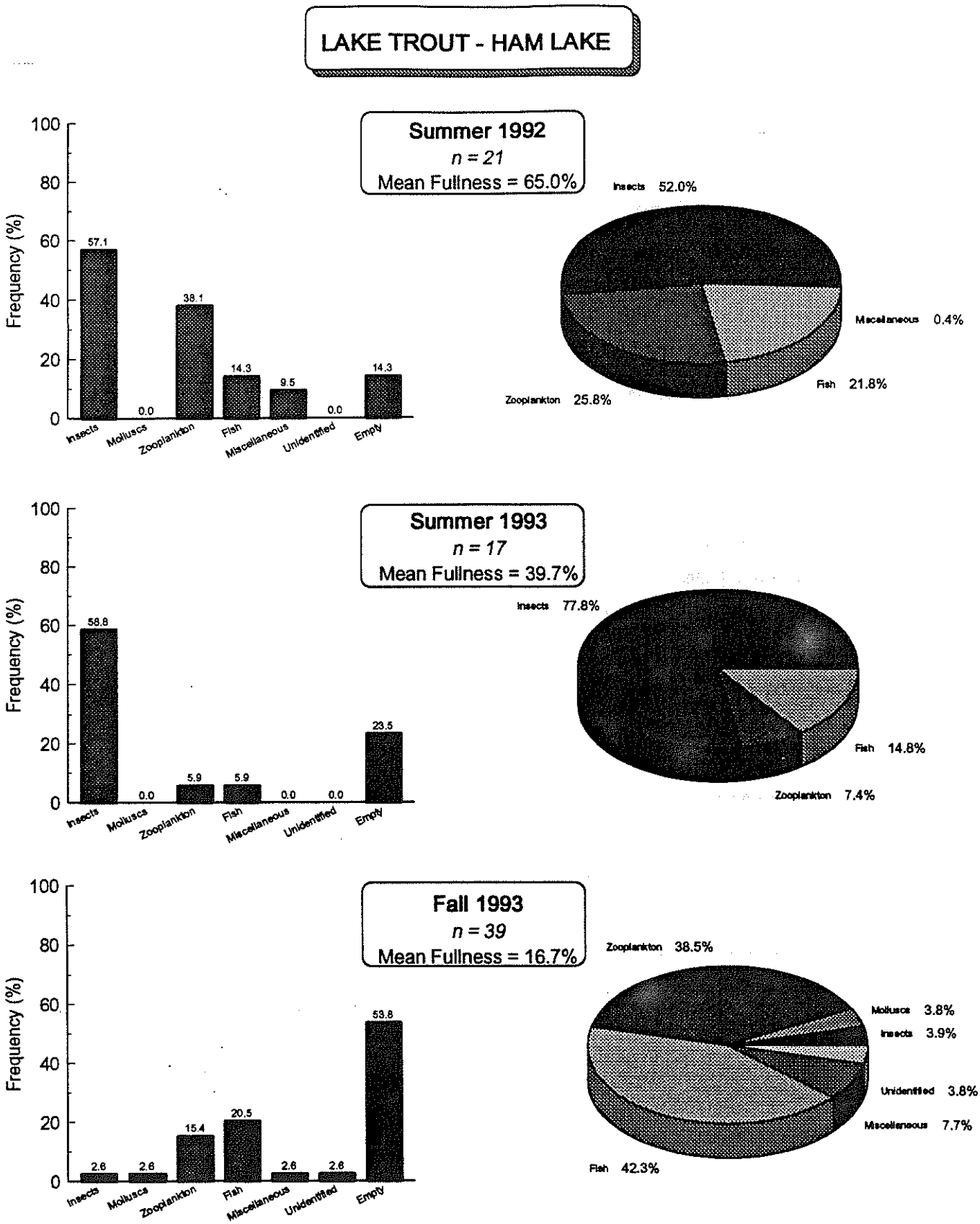


Figure 3.2-59 - Frequency of Occurrence (bar) and Percent Composition (pie) of Food Items in the Stomachs of Lake Trout from Ham Lake during 1992 and 1993

were the major insect group consumed during 1993. Insects were the major food group utilized during summer (>57% occurrence and >77% by volume). During fall, there appeared to be a shift in diet; zooplankton (38% by volume) and fish (42% by volume) replaced insects (4% by volume) as major food items consumed. Mean fullness of lake trout stomachs decreased during the fall and the number of empty stomachs increased.

Round Whitefish

Round whitefish in Ham Lake also consumed a wide variety of food items during 1992 and 1993 (Figure 3.2-60); however, insects and molluscs were the predominant food groups. Within the insect group, chironomids were the major food item consumed during summers of both years (75% occurrence in 1992; 62% occurrence in 1993). Within the mollusc group, both pelecypods (clams) and gastropods (snails) were consumed. Seasonal shifts in diet occurred within the Ham Lake population. Although insects were an important food group during all seasons (>50% by volume during all periods), molluscs increased in importance during fall (0% in summer to 31% in fall by volume). The number of empty stomachs increased, and mean fullness was lower during the fall sampling period.

Arctic Grayling

A limited number of fish (n=3) were available for analyses. These individuals consumed aquatic insects and zooplankton.

Iznogoudh Lake

Lake Trout

The diet of lake trout in Iznogoudh Lake consisted of a number of food items including insects, zooplankton, fish, and branchiopods (tadpole shrimp) (Figure 3.2-61). Insects were an important food group for lake trout in Iznogoudh Lake only during summer 1992 (40% occurrence; 50.3% by volume). Within this group, trichopterans predominated (40% occurrence). Fish also were an important food group during summer 1992 (24% occurrence; 47.4% by volume). In 1993, zooplankton predominated the summer sample (24.4% occurrence; 71% by volume); however, fish were an important food for lake trout during fall of that year (5.3% occurrence; 33% by volume).

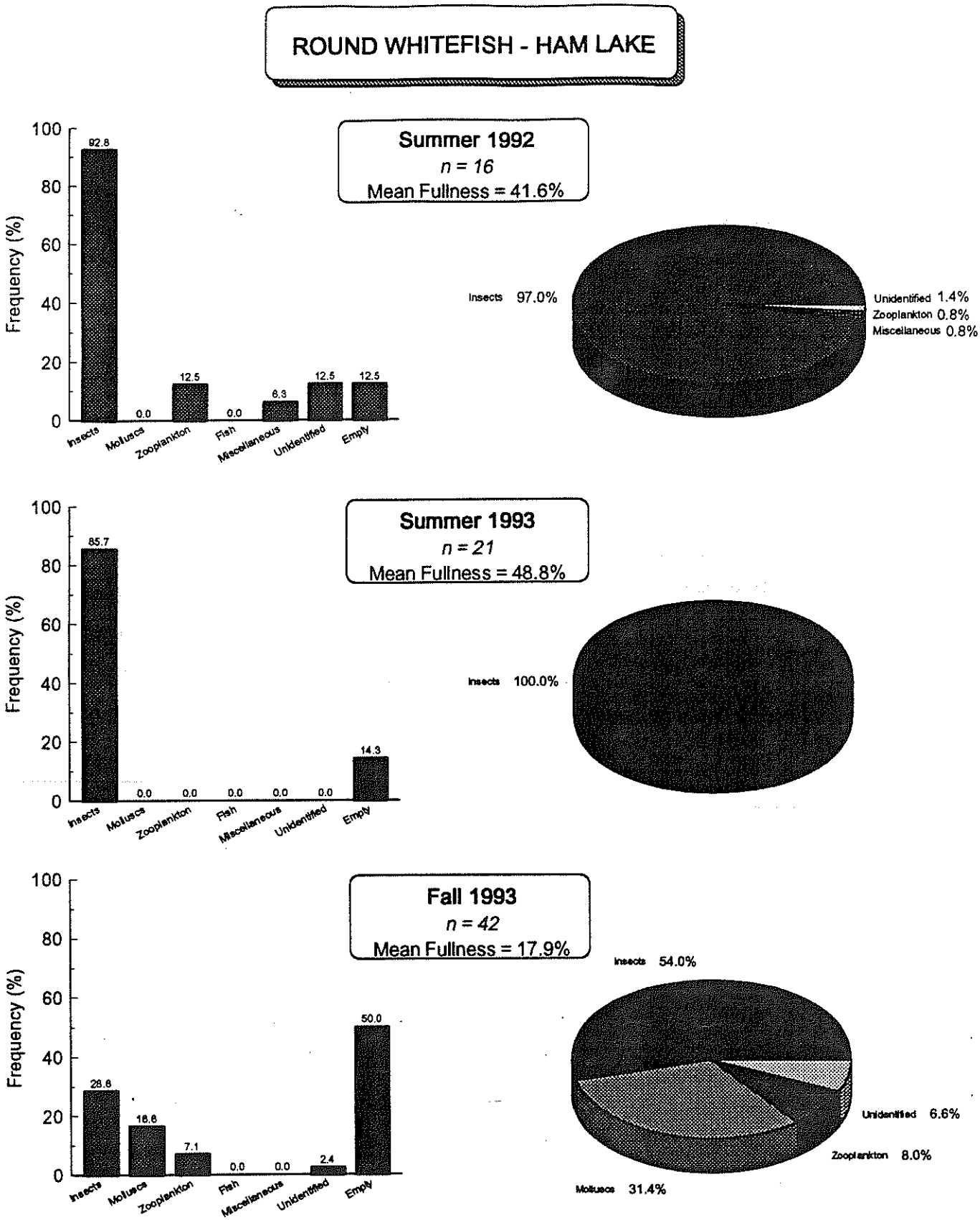


Figure 3.2-60 - Frequency of Occurrence (bar) and Percent Composition (pie) of Food Items in the Stomachs of Round Whitefish from Ham Lake during 1992 and 1993

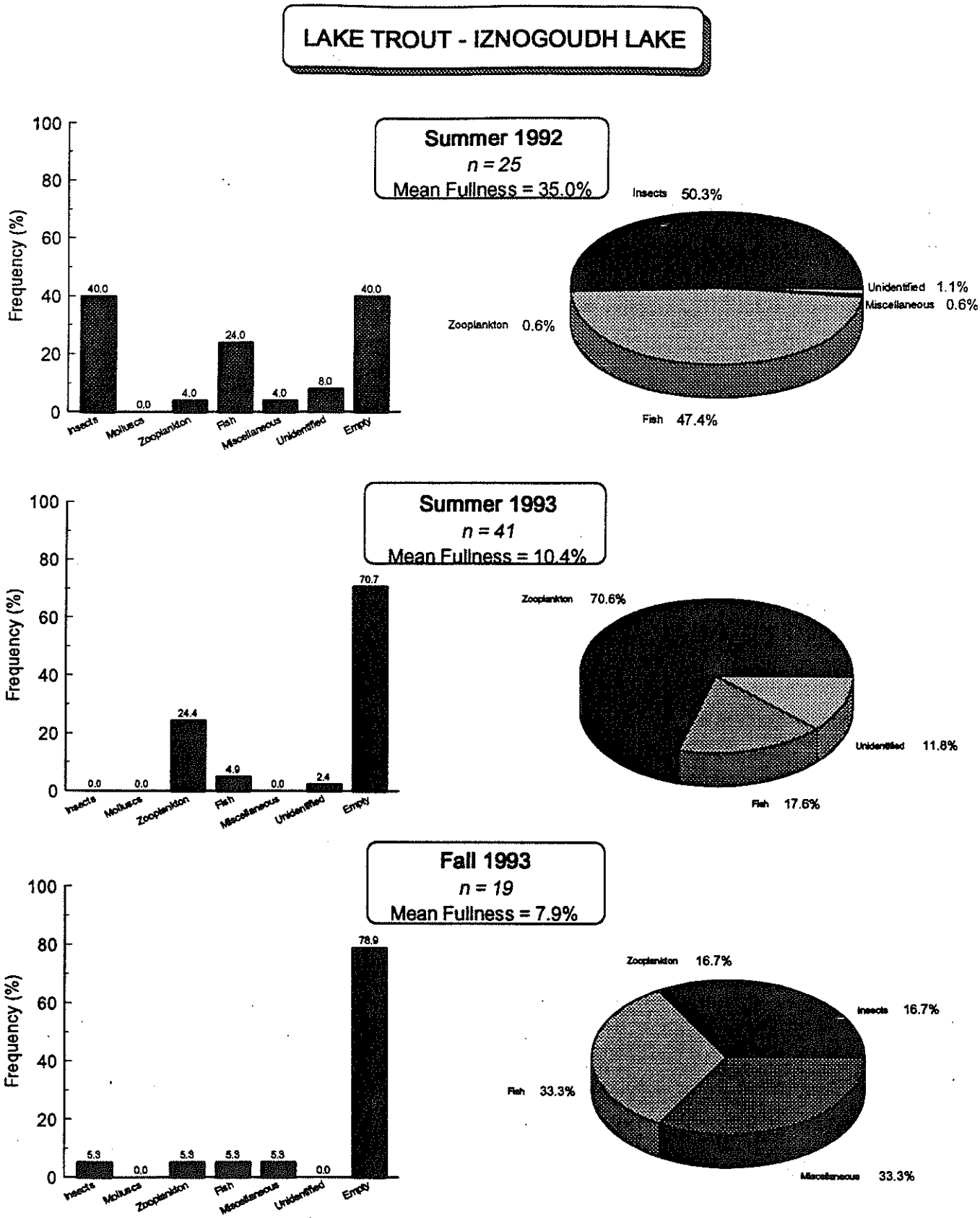


Figure 3.2-61 - Frequency of Occurrence (bar) and Percent Composition (pie) of Food Items in the Stomachs of Lake Trout from Iznogoudh Lake during 1992 and 1993

Round Whitefish

Only low numbers of round whitefish stomachs were available for diet analyses. This species consumed zooplankton, insects, molluscs, and miscellaneous (lake trout eggs and detritus) (Figure 3.2-62). The predominant insect food items were trichopterans during 1992 and chironomids during 1993. In the mollusc food group, pelecypods were consumed. Insects did not occur in round whitefish stomachs during fall 1993; instead, zooplankton (50% by volume) and lake trout eggs (50% by volume) were present in the six round whitefish stomachs examined.

Izok Lake

Lake Trout

Lake trout from Izok Lake consumed zooplankton, fish, insects, and other lake trout eggs (Figure 3.2-63). Unlike other lake trout populations in the study area, insects made up a small proportion (<20% by volume) of food items consumed. Zooplankton was the most important food group, consistently exceeding 55% by volume of items eaten. Fish also were an important food group during all seasons (>15% by volume). During fall, lake trout eggs also were consumed (11% by volume and 7% occurrence).

Round Whitefish

A small sample of round whitefish stomachs were available from Izok Lake. During summer 1992, insects and mulluscs were consumed by two fish (Figure 3.2-64). Insects were present in stomachs during summer 1993, while zooplankton was the only food group encountered during fall 1993.

Itchen Lake

Lake Trout

Lake trout from Itchen Lake consumed fish, insects, zooplankton, and miscellaneous (consisting of branchiopods and detritus) (Figure 3.2-65). Trichopterans and chironomids were predominant items within the insect food group. During summer 1993, fish (54% by volume) and insects (37% by volume) were the major groups

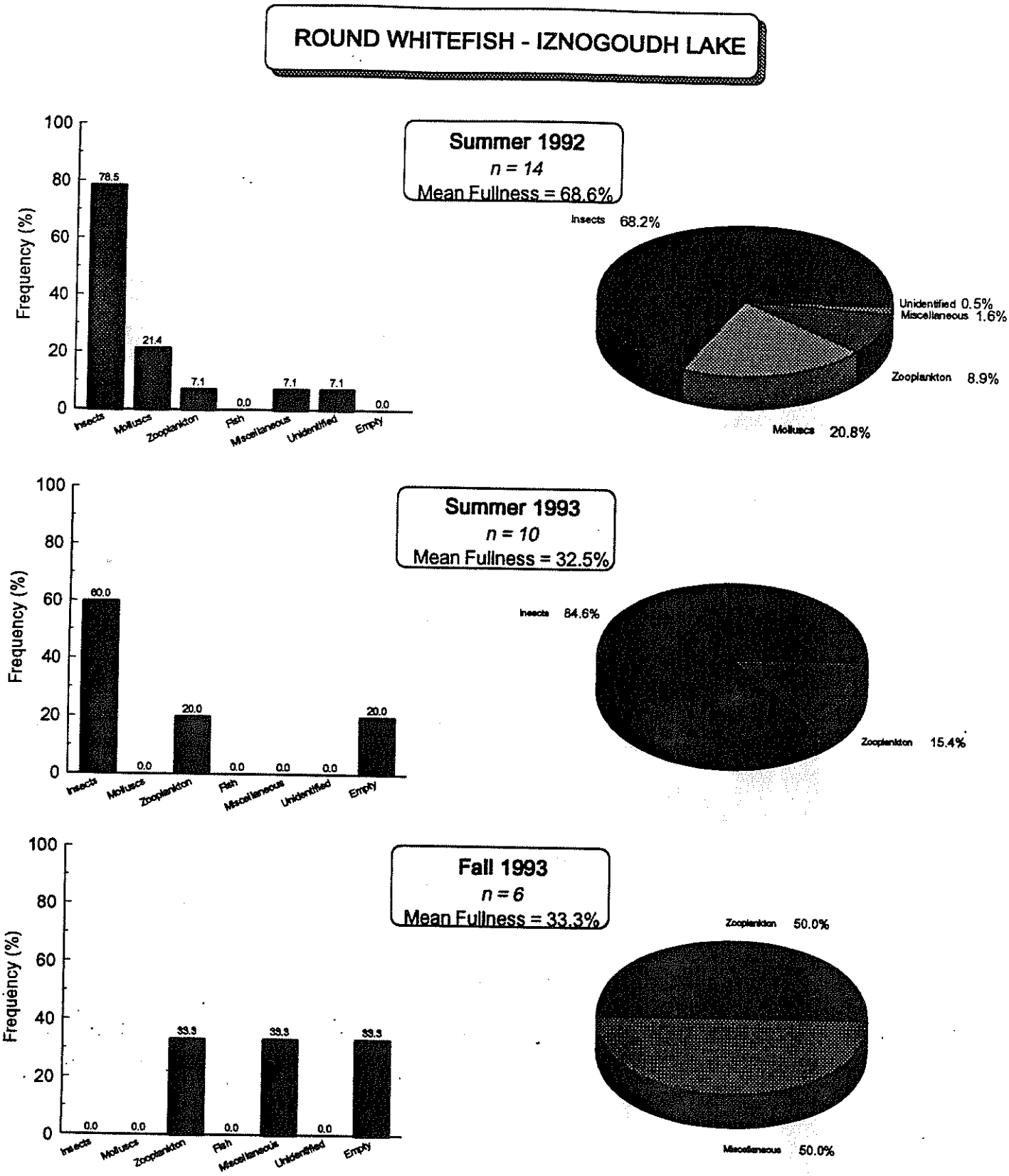


Figure 3.2-62 - Frequency of Occurrence (bar) and Percent Composition (pie) of Food Items in the Stomachs of Round Whitefish from Iznogoudh Lake during 1992 and 1993

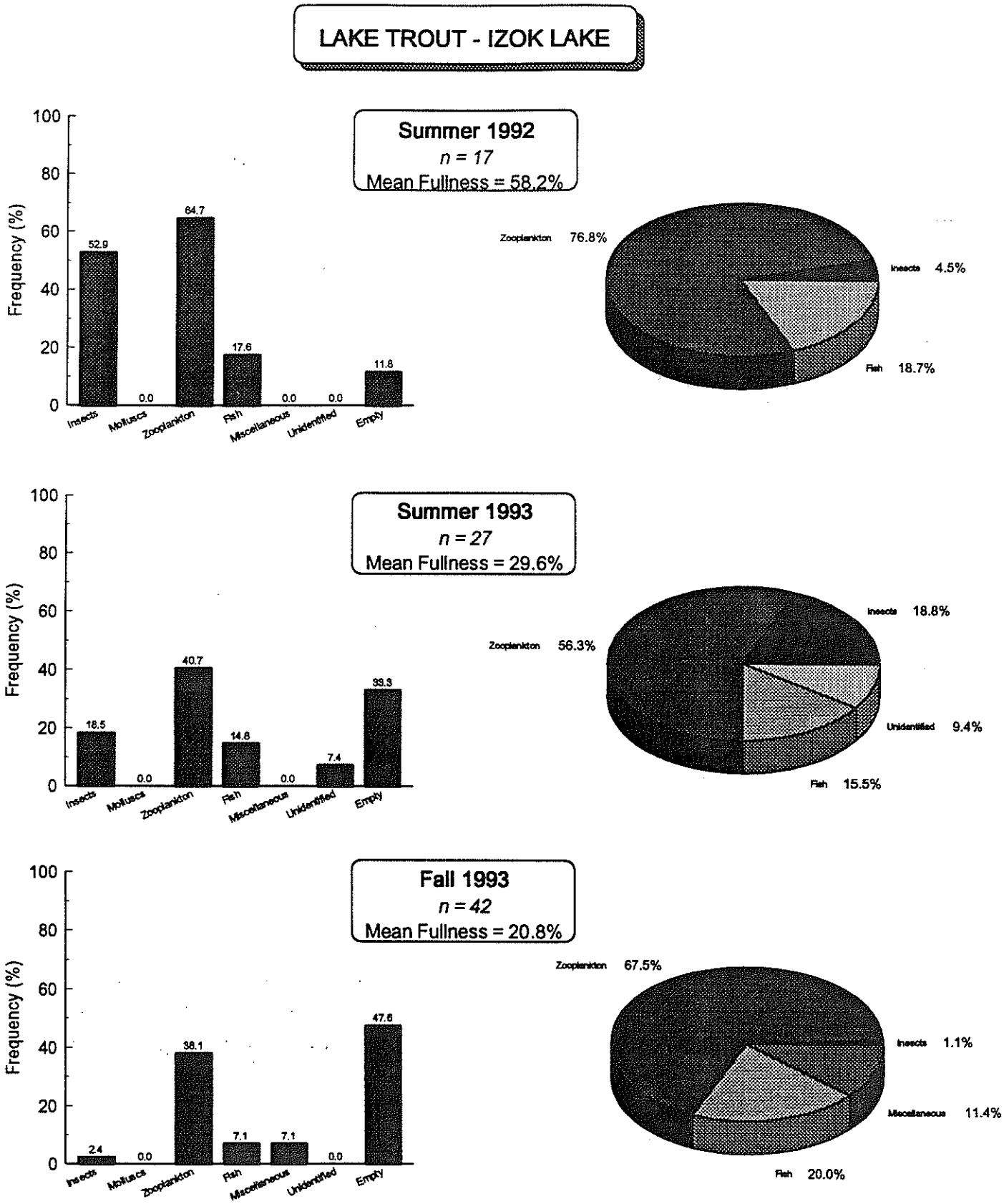


Figure 3.2-63 - Frequency of Occurrence (bar) and Percent Composition (pie) of Food Items in the Stomachs of Lake Trout from Izok Lake during 1992 and 1993

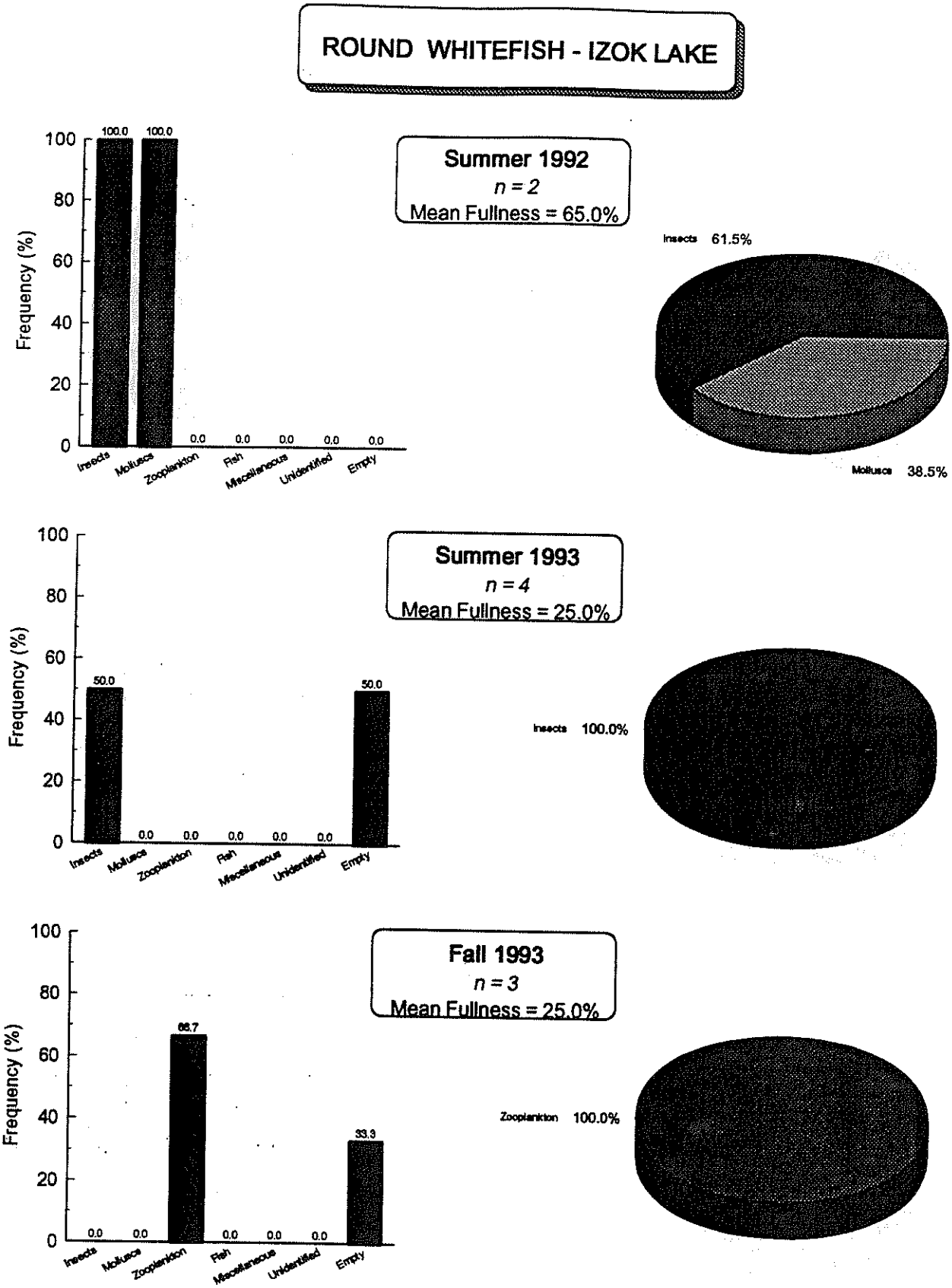


Figure 3.2-64 - Frequency of Occurrence (bar) and Percent Composition (pie) of Food Items in the Stomachs of Round Whitefish from Izok Lake during 1992 and 1993

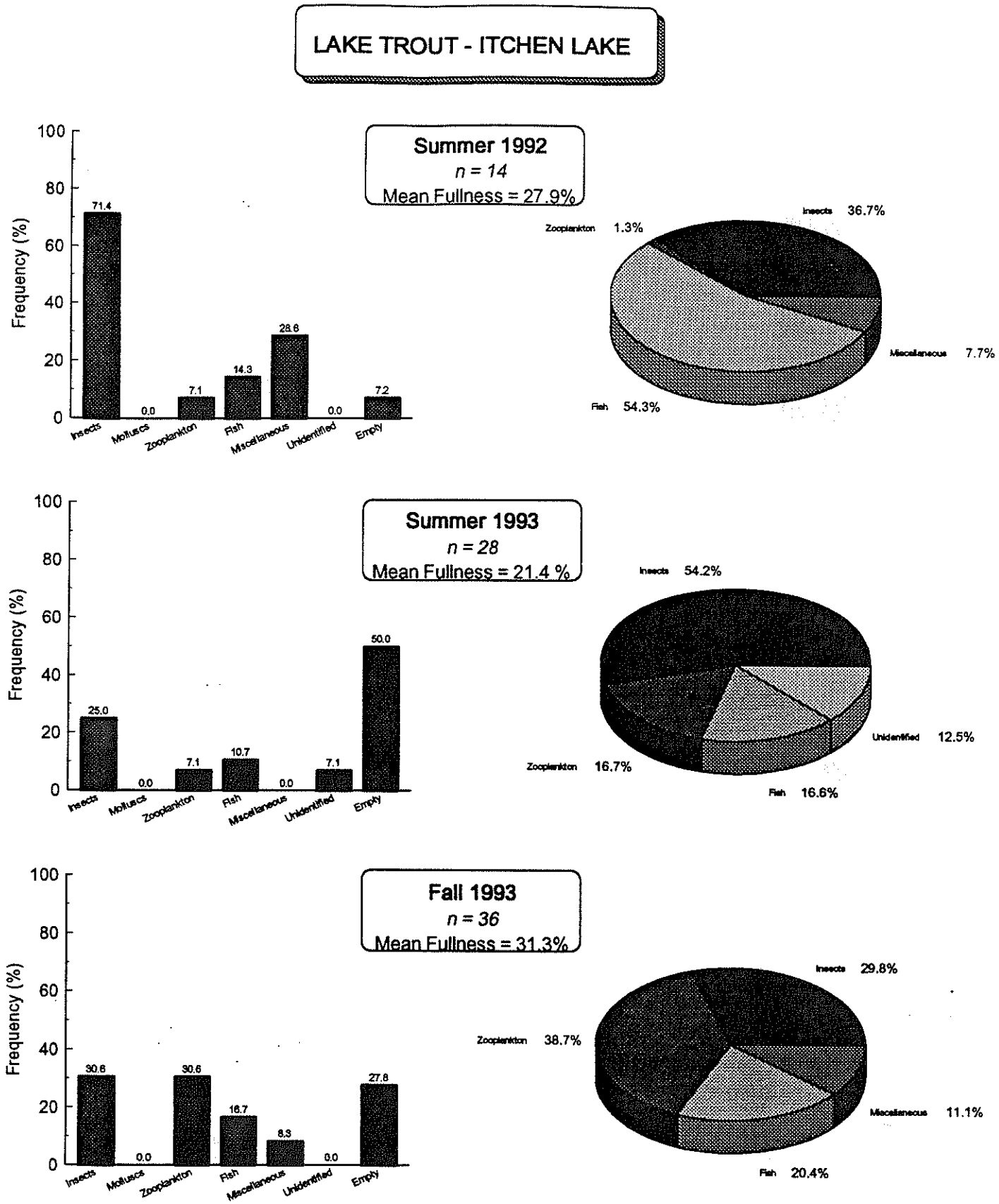


Figure 3.2-65 - Frequency of Occurrence (bar) and Percent Composition (pie) of Food Items in Stomachs of Lake Trout from Itchen Lake during 1992 and 1993

consumed by lake trout in Itchen Lake. Insects predominated in samples from summer 1993 (54% by volume). Lake trout diet shifted slightly in fall with zooplankton and fish becoming major constituents of the diet (39% and 20% by volume, respectively), although insects were still important (30% by volume).

Round Whitefish

Only seven round whitefish stomachs were available from Itchen Lake for diet analyses. Insects, predominantly trichopterans, were the major food item consumed (Figure 3.2-66).

Lake Cisco

Stomach contents of two lake cisco were examined during summer 1992. The diet of these fish consisted of zooplankton (97% by volume) with a minor component consisting of insects.

Feeding Habits - Summary

Feeding habits of several fish species were assessed from the four study lakes using a small number of samples. The most prevalent food group consumed by all species were aquatic insects, of which most were benthic fauna such as trichopterans, and chironomids. In addition to benthic fauna, fish consumed zooplankton, which normally were located in midwater areas. Adequate numbers of stomachs were obtained from lake trout and round whitefish to do a more detailed analysis of feeding habits. In general, these two species consumed primarily benthic invertebrates; however, lake trout also consumed a large amount of fish (primarily smaller lake trout and round whitefish) as well as zooplankton.

The feeding habits described are typical for the species examined (Scott and Crossman, 1973). Fish seemed to be taking advantage of whatever food items were readily available. For example, it was noted that during 1992, the major component of food items were trichopterans (caddisflies). This suggests that fish were probably taking

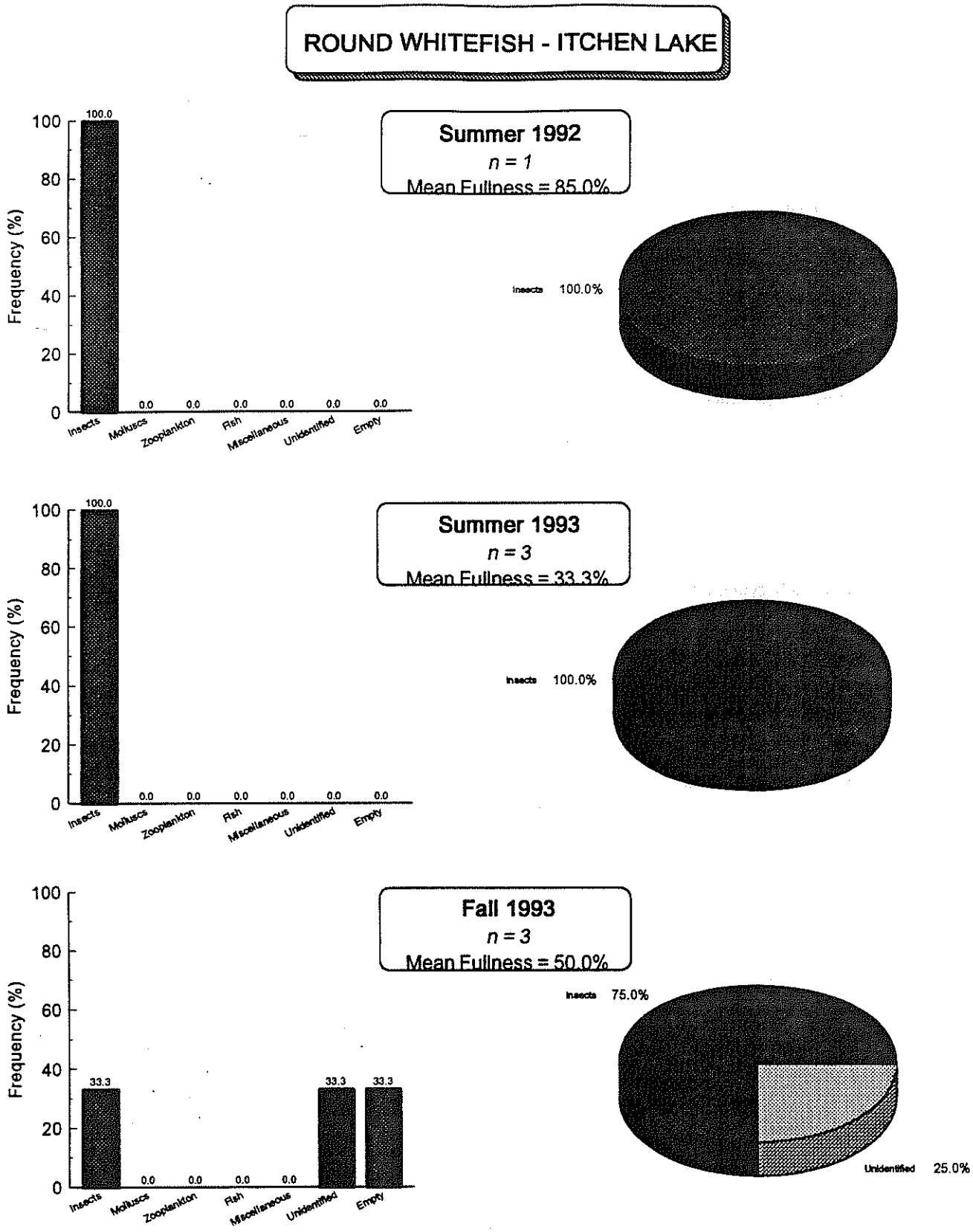


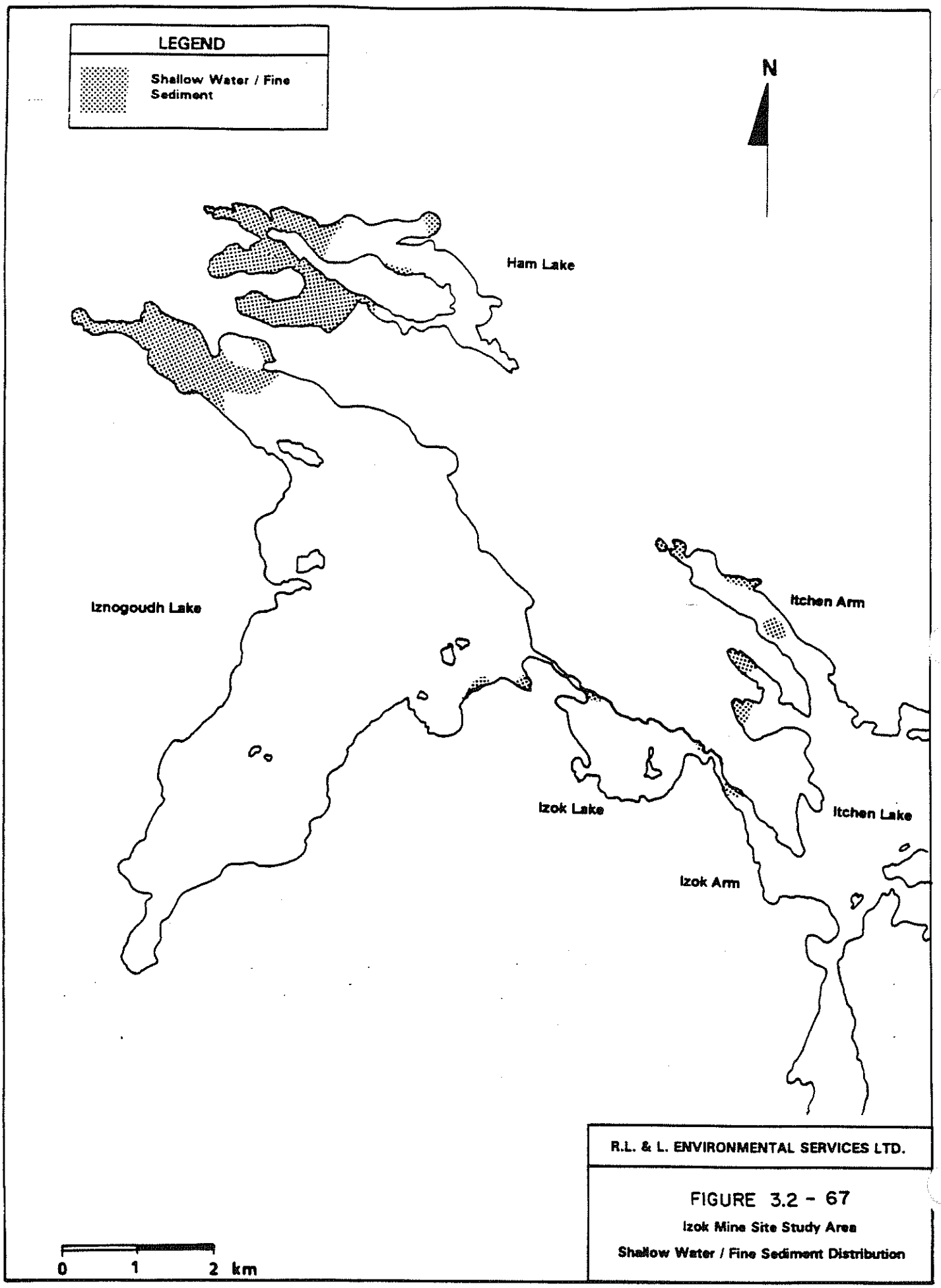
Figure 3.2-66 - Frequency of Occurrence (bar) and Percent Composition (pie) of Food Items in Stomachs of Round Whitefish from Itchen Lake during 1992 and 1993

advantage of a mass emergence of these specimens. During 1993, food items of preference were chironomids, which likely was due to an abundance of this benthic invertebrate during the sampling period in summer 1993.

Fish Habitat - Lakes

The four study lakes located in the vicinity of the mine site are generally characterized as deep, cold, oligotrophic systems which are nutrient poor (see Sections 3.2-7 and 3.2-8). These characteristics limit primary productivity which in turn reduces the growth potential of fish populations residing in these systems. A second limiting factor for certain fish species is the limited availability of critical habitats such as spawning and rearing areas.

For many lake species, including lake trout, round whitefish, and longnose sucker, shallow warm water areas which provide food for younger age-classes and protection from predators, are important for rearing purposes. This habitat was not abundant in any of the four study lakes (Figure 3.2-67). Shallow water areas containing fine sediment substrates which promote aquatic macrophyte growth were largely absent from Itchen and Izok lakes. The only areas exhibiting these characteristics were the northwest arm of Iznogoudh Lake and two areas in Ham Lake — the southwest basin and the west end of Ham Lake. The remainder of each of the study lakes was deep and exhibited a rocky shoreline. Fish distribution patterns reflected these characteristics. Juvenile round whitefish, lake trout, and longnose sucker were encountered in the shallow bay at the northwest end of Iznogoudh Lake near the mouth of its major inlet tributary. Adult round whitefish were encountered in greatest densities in the southwest basin of Ham Lake and numerous adult longnose suckers were observed in the west bay of Ham Lake. Although being limited in area, these shallow water habitats most likely provided critical rearing and feeding areas.



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FIGURE 3.2 - 67

Izok Mine Site Study Area

Shallow Water / Fine Sediment Distribution

Spawning areas for lake dwelling species such as lake trout and round whitefish were not limited in any of the four study lakes. Both species require gravel to boulder sized substrate in areas sufficiently deep enough so as not to freeze to the bottom (Scott and Crossman 1973). These types of habitats were abundant in all of the four study lakes examined. Individuals of both species, in spawning or pre-spawning condition, were distributed over many of the shoal areas sampled, and no distinct areas of fish concentration were noted.

Fisheries Investigations - Tributaries

Investigations of major tributaries associated with the four study lakes were undertaken during spring, summer and fall sampling in 1993. Summary results are provided in this section — a complete assessment will be given in the R.L. & L. Aquatic Studies report.

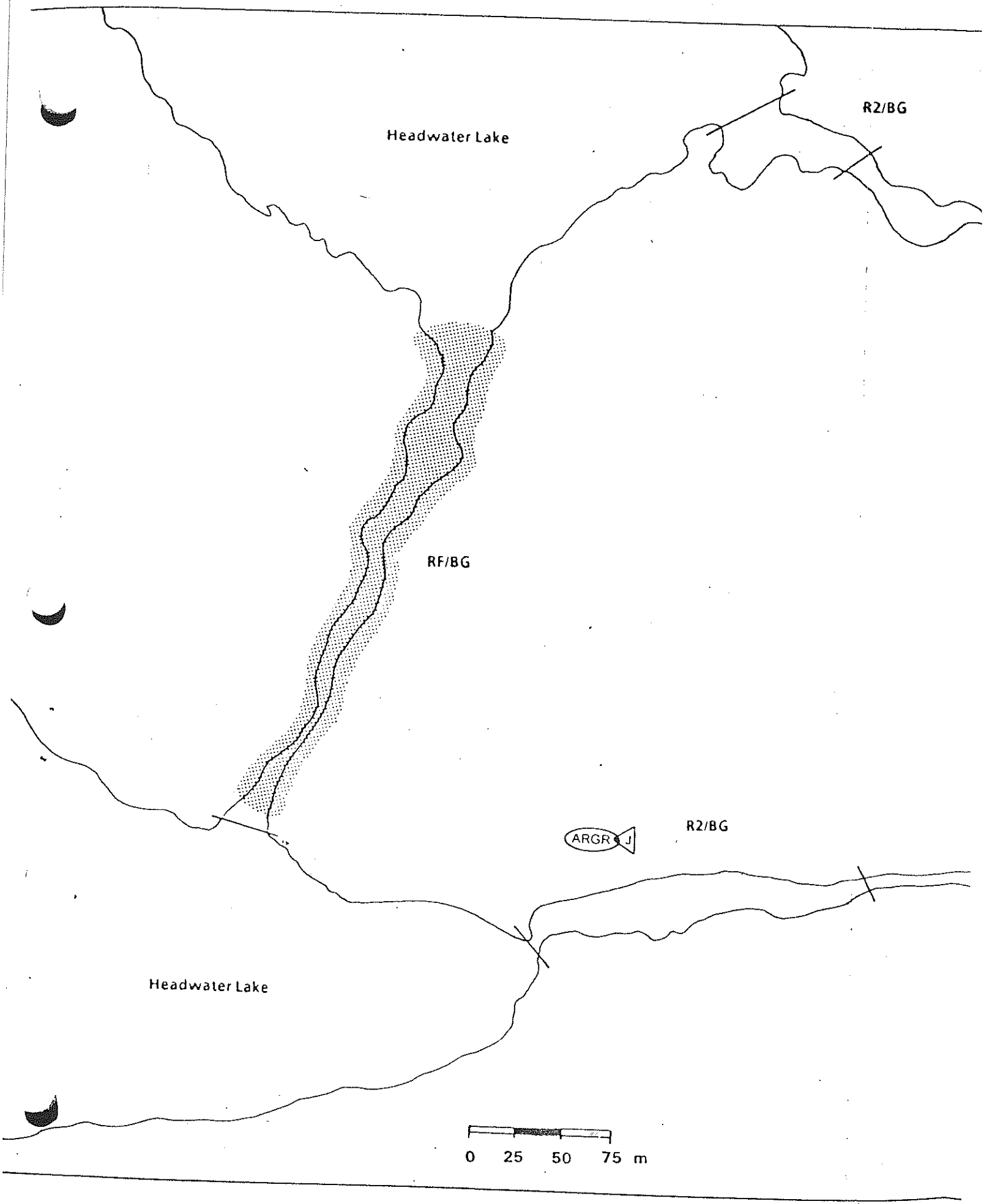
Tributaries were sampled utilizing a variety of techniques which included aerial reconnaissance, ground truthing, angling, and synoptic level backpack electrofishing. Sampling was designed to assess fish distribution patterns (i.e., temporal and spatial) and the availability of critical fish habitat (i.e., spawning and rearing areas) to fish populations in the study area. Physical characteristics of each tributary also were quantified.

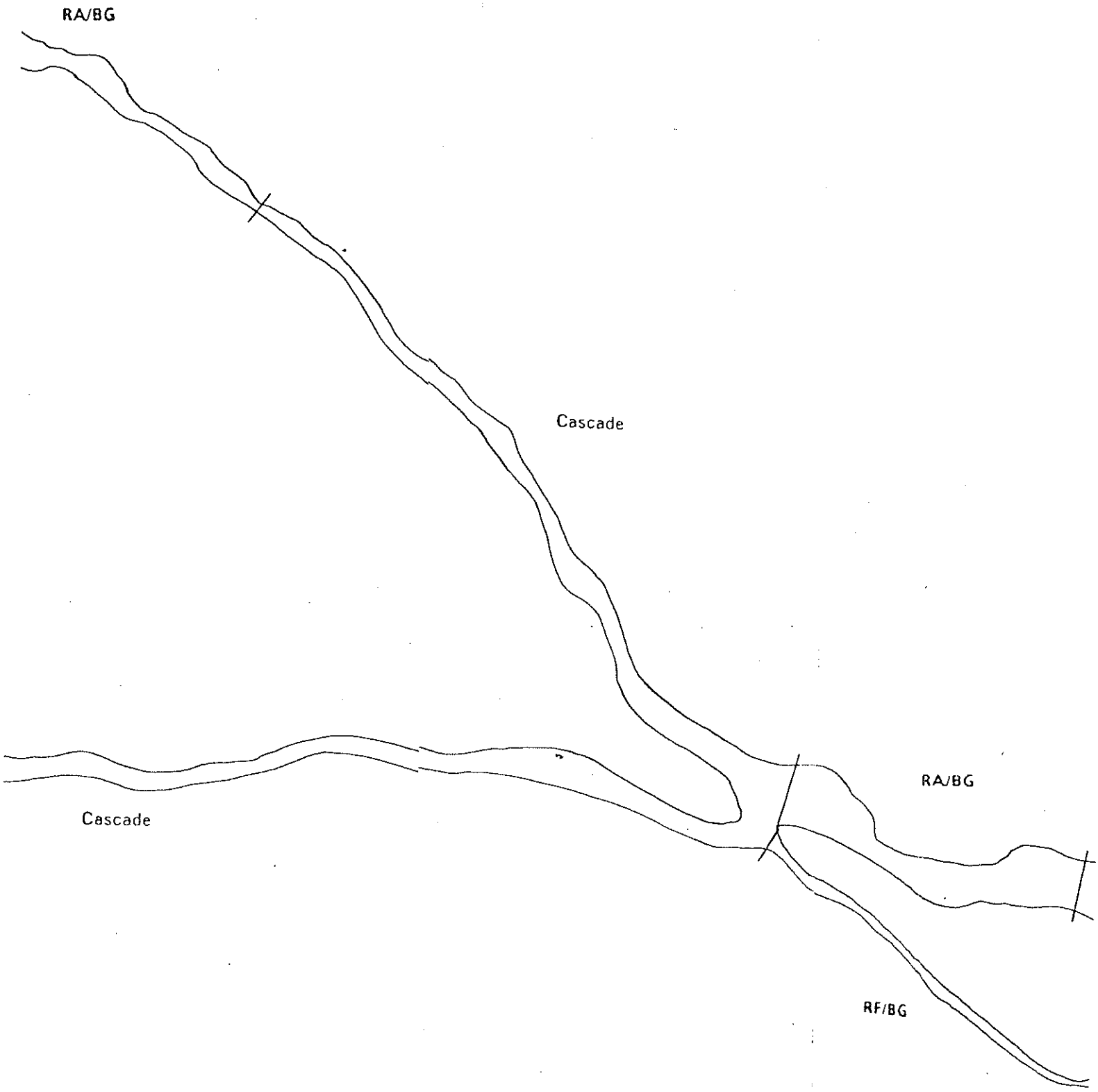
In total, eleven tributaries were surveyed during the 1993 program (Figure 3.2-49). They represented significant water courses in the study area. Not included were intermittent streams which were active only during major runoff periods (i.e., spring snow melt).

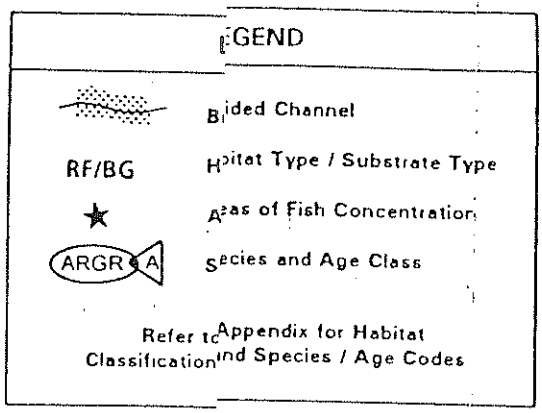
Ham Lake Tributaries

H1

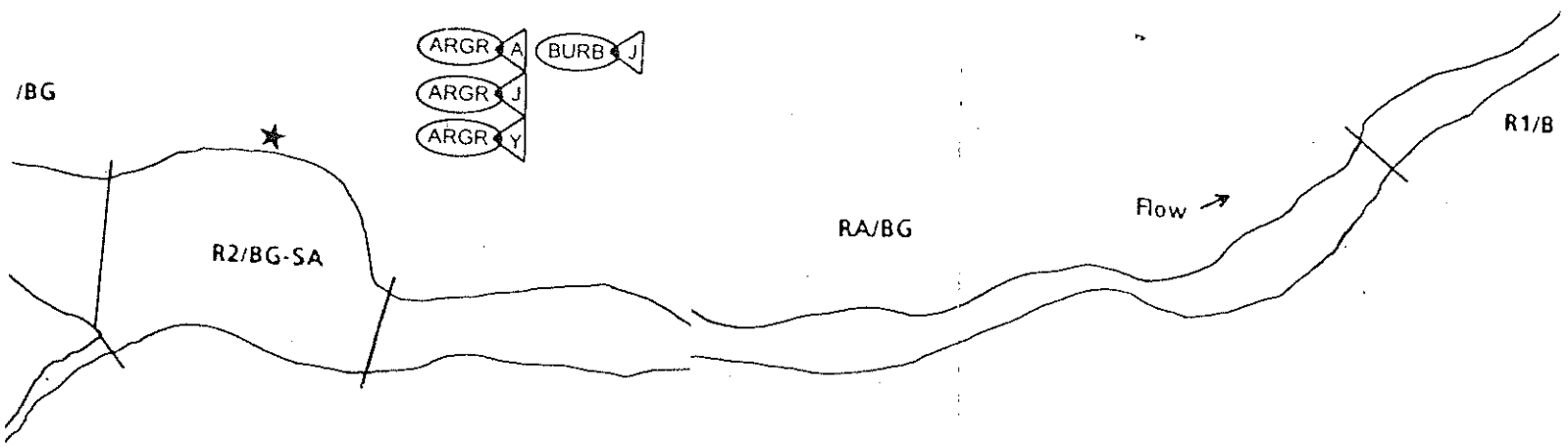
This inlet stream, located at the west end of Ham Lake, was the second largest of the five Ham Lake streams investigated (Figure 3.2-68). The stream originates from two headwater lakes located approximately 2 km upstream of Ham Lake. Discharge during the summer was 2.16 m^3/s (Tables 3.2-48 and 3.2-49). Tributary H1, as were most other

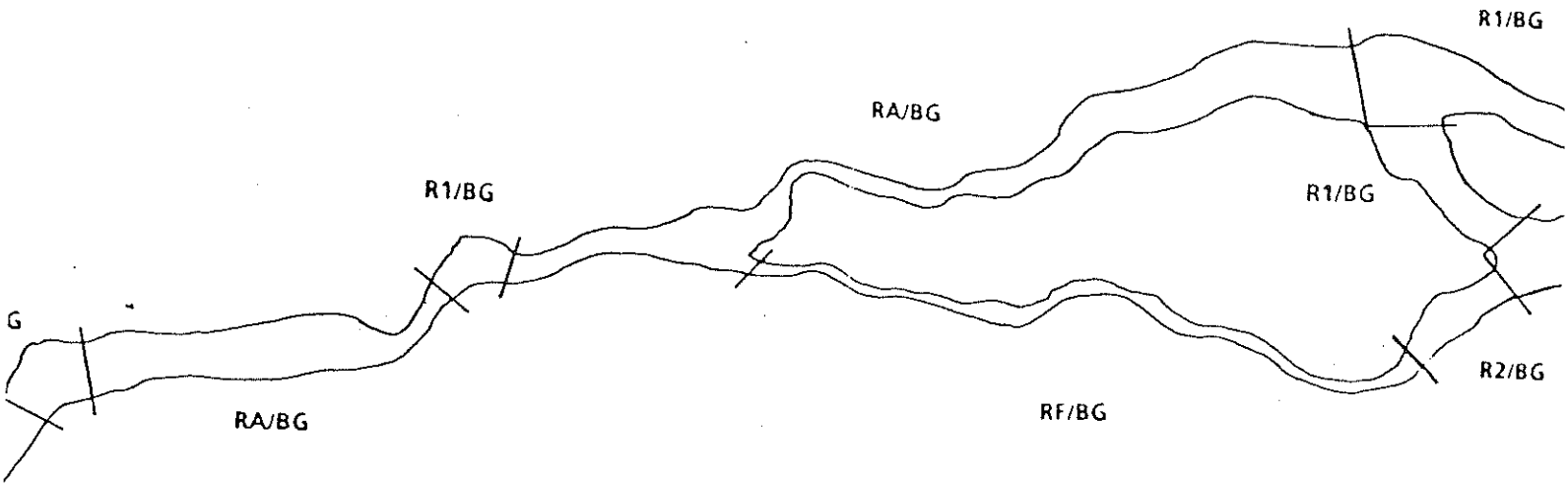

Headwater Lake
R2/BG
RF/BG
ARGR
J
R2/BG
Headwater Lake
0 25 50 75 m

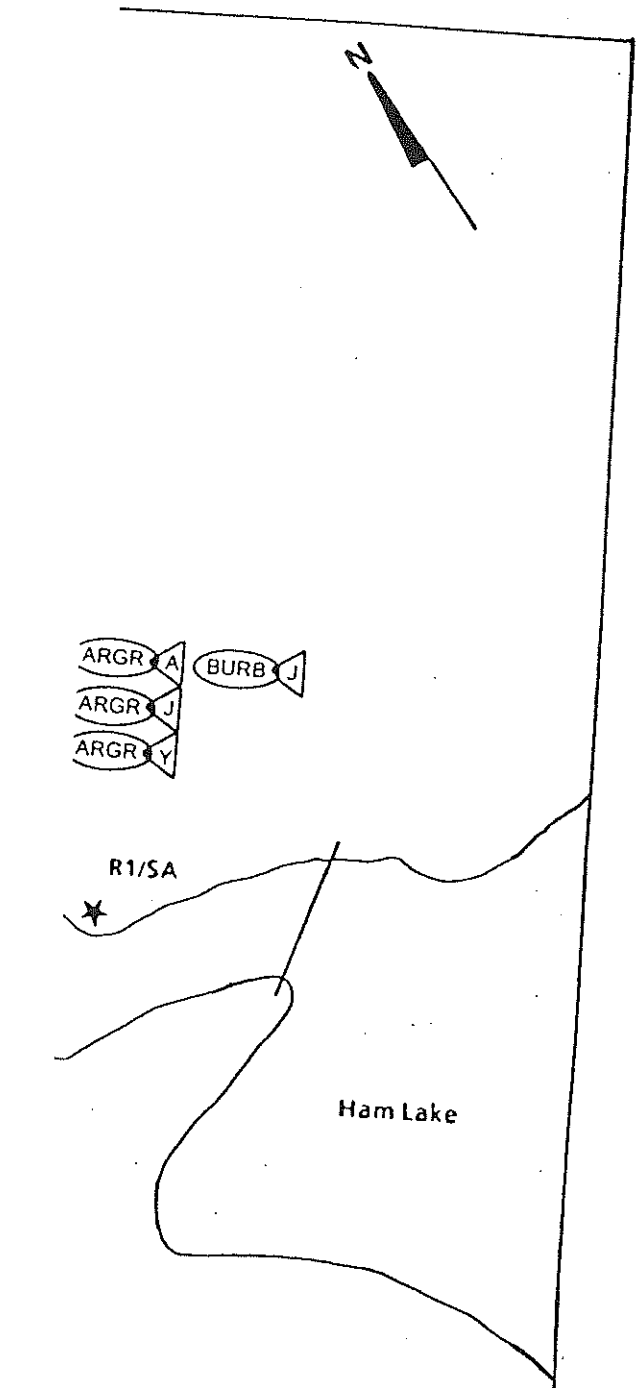

RA/BG
Cascade
Cascade
RA/BG
RF/BG


EGEND
Bi ided Channel
RF/BG
Habitat Type / Substrate Type
Areas of Fish Concentration
ARGR A
Species and Age Class
Refer to Appendix for Habitat
Classification nd Species / Age Codes

P


/BG
ARGR A
BURB J
ARGR J
ARGR Y
R2/BG-SA
RA/BG
Flow
R1/B


R1/BG
RA/BG
R1/BG
R1/BG
G
R2/BG
RA/BG
RF/BG



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FIGURE 3.2-68

Tributary H1

Fish and Habitat Distribution

Table 3.2-48 - Physical Habitat Characteristics of Izok Mine Site Area Tributaries, Summer 1993

Lake	Stream	No. Transects	Mean Width (m)	(SD)	Mean Depth (m)	(SD)	Mean Velocity (m^3/s)	(SD)	Substrate (%)[a]					Shoreline Cover (%)	
									Bo	Co	Gr	Pe	SaSi	Tundra	Willow
Ham L.	H1	20	22.18	(10.08)	0.37	(0.11)	0.24	(0.17)	54	15	29	0	2	50	50
	H2	10	0.91	(0.40)	0.28	(0.09)	0.05	(0.03)	0	0	0	0	100	100	0
	H3	45	6.88	(5.74)	0.24	(0.12)	0.13	(0.15)	70	2	21	0	6	70	30
	H4	20	3.57	(1.47)	0.15	(0.08)	0.45	(0.23)	35	40	26	0	0	40	60
	Ham Creek	10	28.90	(4.48)	0.34	(0.10)	0.50	(0.23)	100	0	0	0	0	50	50
Itchen L.	IT1	15	1.67	(0.64)	0.34	(0.10)	0.05	(0.03)	86	0	12	0	2	33	67
	IT2	15	0.44	(0.16)	0.30	(0.16)	0.16	(0.08)	64	32	4	0	0	33	67
	IT3	15	0.30	(0.10)	0.18	(0.13)	0.21	(0.20)	0	0	19	0	81	100	0

[a] Modified Wentworth's classification.

Table 3.2-49 - Habitat Characteristics of Izok Mine Site Area Tributaries, Summer 1993. Numbers in italics represent number of habitat units.

LAKE	TRIBUTARY	SURVEYED LENGTH (m)	GRADIENT (m/km)	SUMMER DISCHARGE (m^3/s)	PERCENTAGE OF HABITAT TYPE[a] BY WATER DEPTH											
					GREATER THAN 2.0m DEPTH			BETWEEN 1.0 AND 2.0m DEPTH			LESS THAN 1.0m DEPTH			HIGH GRADIENT AREAS		
					Pool	Run	Flat	Pool	Run	Flat	Pool	Run	Flat	Riffle	Rapid	Cascade
Ham Lake	H1 (Lower)	1563	6.4	2.16	0.7	10.4			10.4					23.2	22.2	
					1	*5*			*4*					*4*	*3*	
	H1 (Upper)	625	65.6	—											10.1	22.9
															2	*1*
	H2	610	21.3	0.01								100				
												1				
	H3	825	7.3	0.16				24.9				9.6	13.9	51.6		
								1				*1*	*1*	*3*		
	H4	818	24.5	0.12								85.9		14.1		
												2		*2*		
	Ham Cr.	325	18.5	2.43											100.0	
															1	
Iznogoudh Lake	IS6	1338	6.0	—	12.5	6.6			44.1	32.1					4.7	
					2	*2*			*1*	*1*					*3*	
Itchen Lake	IT1	305	36.1	0.10								11.0	24.0	65.0		
												1	*1*	*1*		
	IT2	463	32.4	0.15					5.4			20.5	4.9	69.2		
									1			*1*	*1*	*1*		
	IT3	473	23.3	0.08								70.2	29.8			
												4	*3*			
Izok Lake	Izok Cr.	675	10.3	3.80		6.2			43.1						47.3	3.3
						2			*2*						*4*	*1*
	Iznogoudh Cr.	940	7.4	—		14.0			67.1						6.8	12.1
						4			*3*						*3*	*2*

[a] For habitat classification system, see R.L. & L. Aquatic Studies report (in preparation)

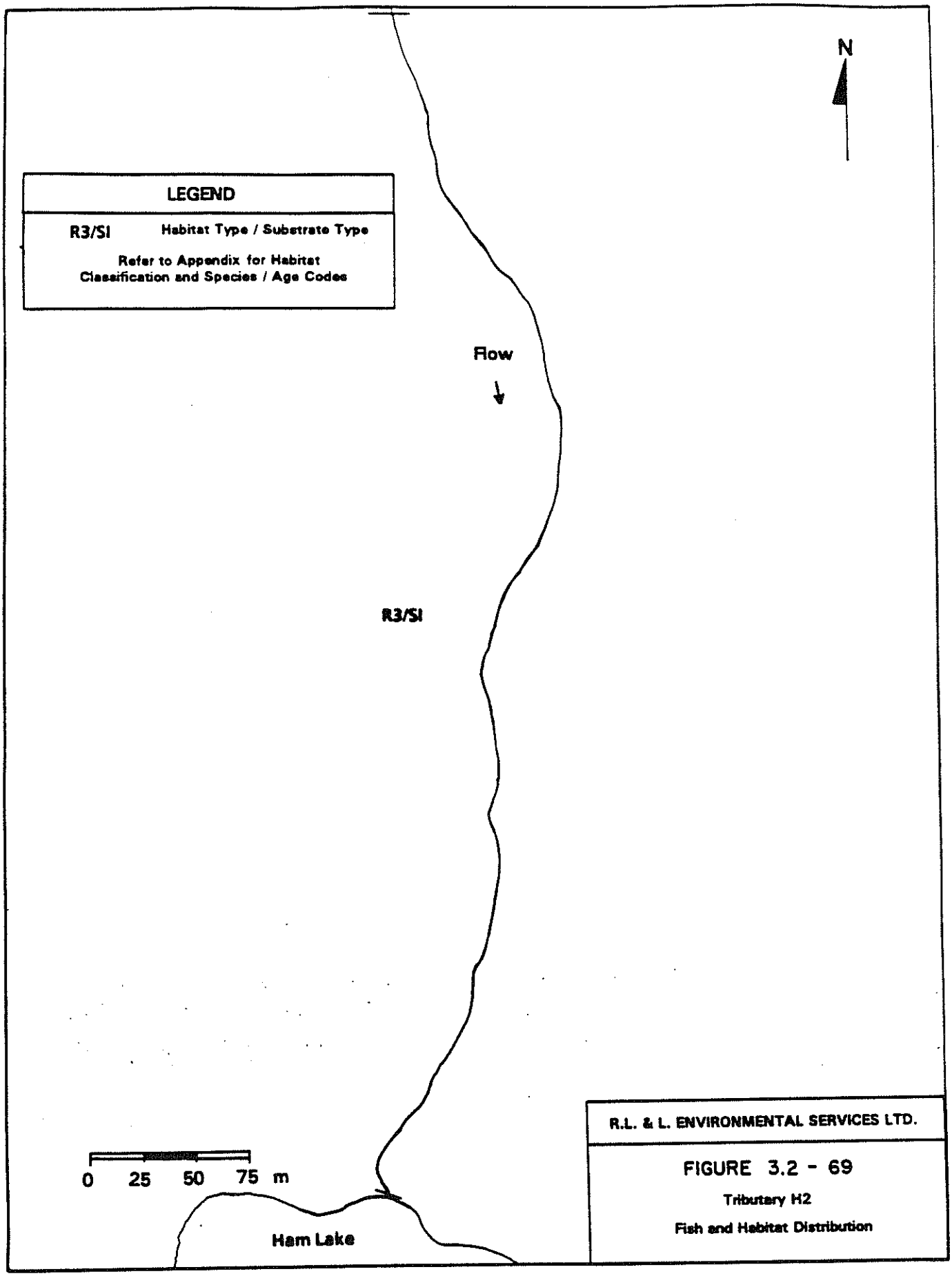
streams in the study area, was characterized by a steep longitudinal profile. A short upstream section of this stream exhibited a steep gradient of 65.6 m/km; the gradient of the lower portion of the tributary was moderate at 6.4 m/km. The gradient influenced the type and distribution of fish habitat available. RIFFLE and RAPID type habitats dominated the stream. The high gradient also influenced substrate size. Boulder substrate was predominant throughout most of the surveyed length. Finer particles, such as gravels and sand, were abundant only in a small area near the confluence of the headwater streams and at the mouth of tributary H1. High gradient and coarse substrate combined to limit the value of this stream as fish habitat.

Two species of fish were encountered in H1 — Arctic grayling and burbot. During spring, small numbers of Arctic grayling in spawning condition were observed. This occurred at two locations: 1) immediately downstream of the confluence of the headwater streams (one ripe male), and 2) at the confluence with Ham Lake (single ripe male). Both capture locations contained significant amounts of gravel/small cobble substrate which is required for spawning. Numerous young-of-the-year and juvenile fish were captured during the summer, confirming that the stream was utilized by Arctic grayling for spawning and rearing. Juveniles also were encountered in the outlet areas of both headwater lakes. It is suspected that these deep waterbodies contain resident populations of Arctic grayling.

Small numbers of juvenile burbot were captured in tributary H1 during the fisheries survey, indicating that the stream was utilized for rearing purposes. It appears that the Ham Lake system is inhabited by a resident population of burbot. Sampling during fall confirmed the presence of adult fish in the lake.

H2

This inlet stream was small (Figure 3.2-69) (Tables 3.2-48 and 3.2-49), and contained limited amounts of fish habitat. During years with limited precipitation, it is likely that


N
LEGEND
R3/SI
Habitat Type / Substrate Type
Refer to Appendix for Habitat Classification and Species / Age Codes
Flow
R3/SI
0 25 50 75 m
Ham Lake
R.L. & L. ENVIRONMENTAL SERVICES LTD.
FIGURE 3.2 - 69
Tributary H2
Fish and Habitat Distribution

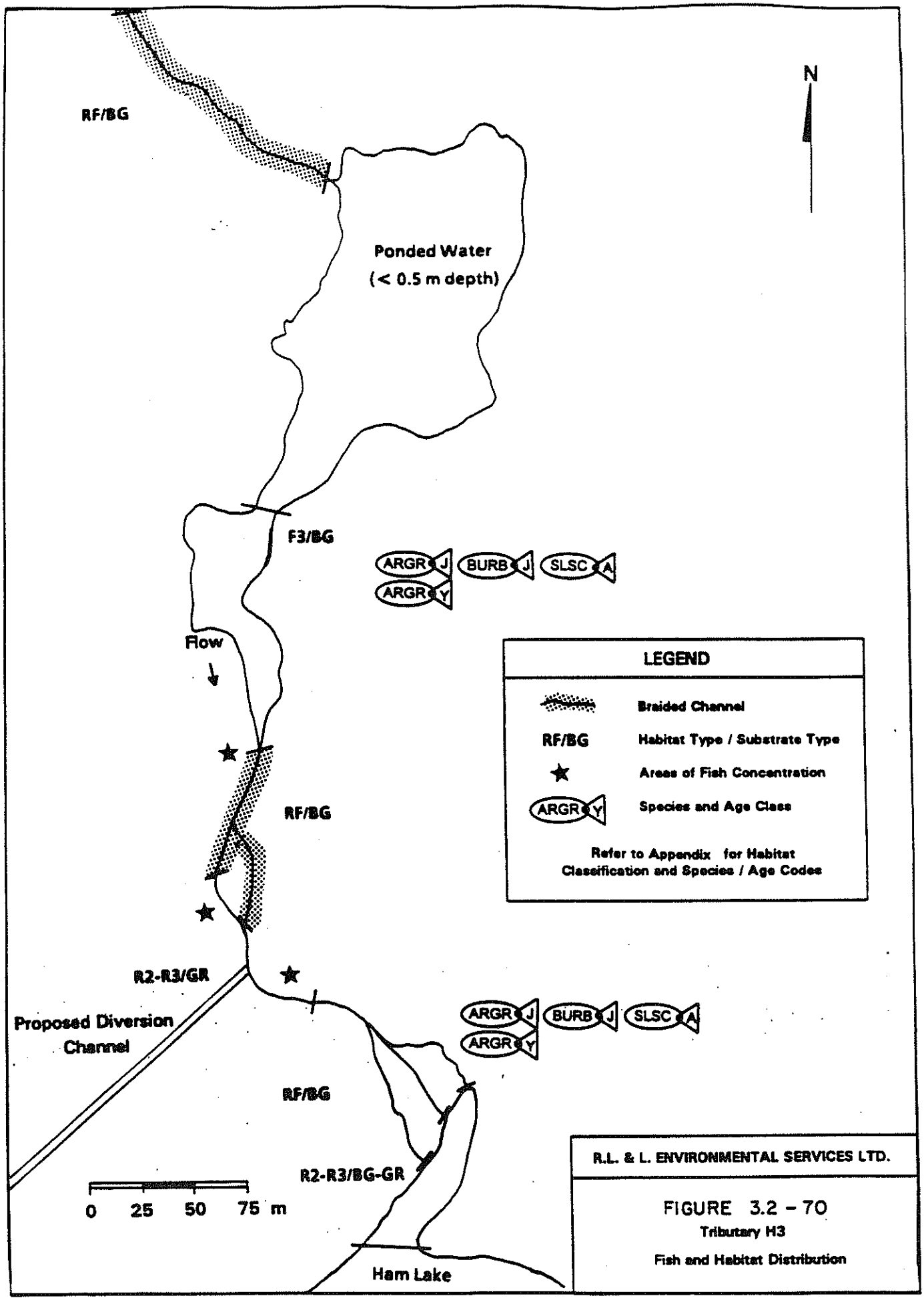
this stream would become completely dry. No fish were encountered during spring, summer, and fall sampling.

H3 (North Dam Diversion Stream)

Tributary H3, which is located on the north side of Ham Lake, was small (Tables 3.2-48 and 3.2-49). Water flow was maintained throughout the open water period by a series of small headwater ponds located approximately 1.0 km upstream from Ham Lake. Over its entire surveyed length (i.e., 825 m), this stream exhibited a moderate gradient (7.3 m/km). Gravels and sand were present throughout much of its length, but predominated only in two areas close to its confluence with the lake (Figure 3.2-70). An area of ponded water located 0.5 km upstream promoted rapid warming of tributary H3 during the spring melt period. Water temperatures were several degrees warmer than all other inlet streams during spring sampling (12°C versus 3°C). The moderate gradient and relatively warm water temperatures provided favourable conditions for fish.

Three species of fish were encountered in tributary H3, including Arctic grayling, burbot, and slimy sculpin. Although adult grayling were not captured during any of the three sampling periods, juveniles and young-of-the-year were observed from Ham Lake to the area of ponded water (Figure 3.2-70). Most of these individuals were collected in areas with gravel substrate, which suggests a spawning and rearing habitat function of these areas. While the small size of this stream precludes its use as a summer feeding area for adult Arctic grayling, it does support spawning fish. Adult fish were not encountered in spring due to warm stream temperatures in this tributary at the initiation of sampling (i.e., 9°C). It is likely that fish had completed spawning and vacated the stream prior to the survey.

Low numbers of juvenile burbot and adult slimy sculpin were captured in H3 during summer sampling. These fish likely entered the tributary to feed during the open water period. It is expected that they re-enter Ham Lake for overwintering (just prior to the onset of winter).


N
RF/BG
Ponded Water
(< 0.5 m depth)
F3/BG
ARGR J
BURB J
SLSC A
ARGR Y
Flow
RF/BG
R2-R3/GR
Proposed Diversion Channel
ARGR J
BURB J
SLSC A
ARGR Y
RF/BG
R2-R3/BG-GR
0 25 50 75 m
Ham Lake
LEGEND
Braided Channel
RF/BG
Habitat Type / Substrate Type
Areas of Fish Concentration
ARGR Y
Species and Age Class
Refer to Appendix for Habitat Classification and Species / Age Codes
R.L. & L. ENVIRONMENTAL SERVICES LTD.
FIGURE 3.2 - 70
Tributary H3
Fish and Habitat Distribution

H4

Tributary H4 is located at the east end of Ham Lake. It originates in a headwater lake located approximately 1 km upstream from the mouth (Figure 3.2-71). Despite having continuous water flow during the open water period, and several areas of gravel substrate, its small size (i.e., 0.12 m^3/s summer discharge), high gradient (i.e., 24.5 m/km), and extensive braided channels, limited its usefulness as fish habitat (Tables 3.2-48 and 3.2-49).

Only one species, slimy sculpin, was captured from this stream. Small numbers of adult slimy sculpin were encountered at its confluence with Ham Lake, as well as in a small area a short distance upstream. The deep headwater lake may contain resident populations of fish, but due to time constraints, this lake was not sampled.

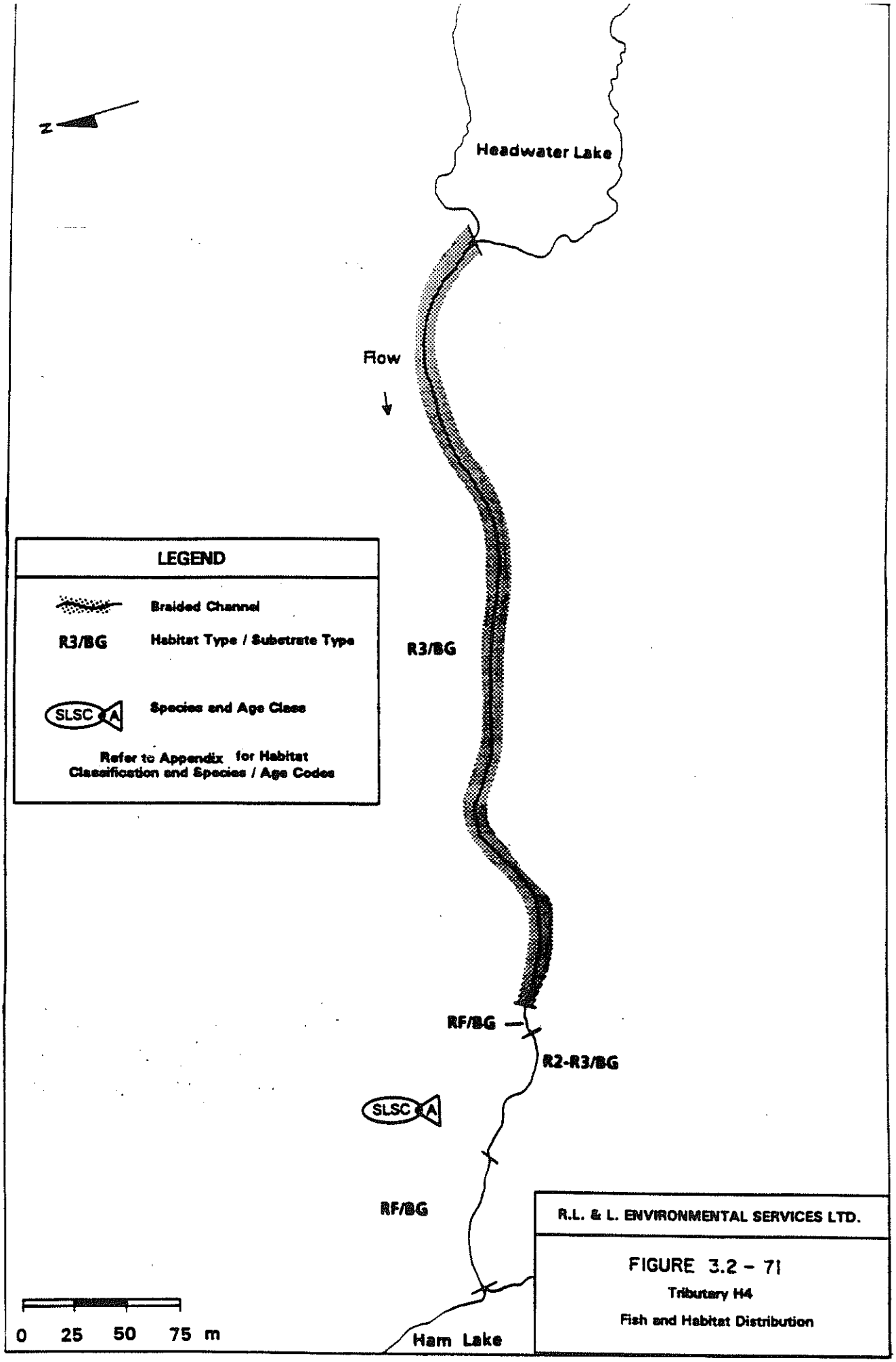
Ham Creek

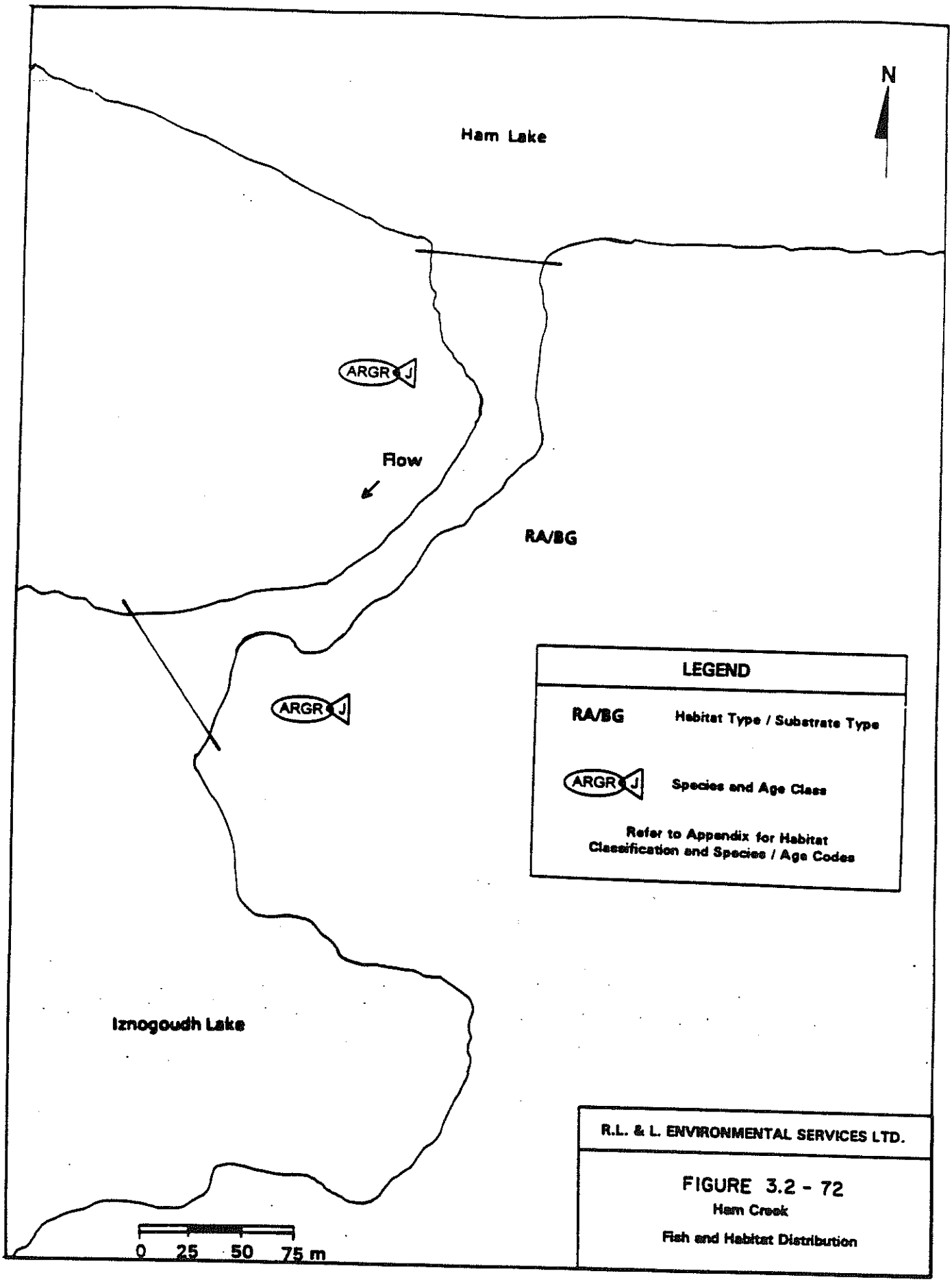
Ham Creek is the outlet stream to Ham Lake and is located at southern end of the southwest basin. It exhibits a high gradient and a very wide, shallow channel (Tables 3.2-48 and 3.2-49); as such, the active channel fluctuates widely depending on discharge (Figure 3.2-72). Because of the large boulder substrate, high gradient, short length, and shallow water depth, this stream does not provide good quality fish habitat.

Very low numbers (i.e., 2 fish) of juvenile Arctic grayling were observed in Ham Creek. Due to its physical characteristics, it is highly unlikely that it is utilized extensively for spawning or rearing purposes by Arctic grayling. Low discharge rates during fall, as well as shallow water and silt covered substrate at its confluence with Iznogoudh Lake, reduces its potential as a spawning area for lake trout populations in either Ham or Iznogoudh lakes.

Itchen Lake Tributaries

Those portions of Itchen Lake (i.e., Izok Creek Arm and Itchen Arm) in the study area contained a paucity of inlet tributaries (Figure 3.2-73). Although numerous intermittent


N
Headwater Lake
Flow
LEGEND
Braided Channel
R3/BG
Habitat Type / Substrate Type
SLSC A
Species and Age Class
Refer to Appendix for Habitat Classification and Species / Age Codes
R3/BG
RF/BG
R2-R3/BG
SLSC A
RF/BG
0 25 50 75 m
Ham Lake
R.L. & L. ENVIRONMENTAL SERVICES LTD.
FIGURE 3.2 - 71
Tributary H4
Fish and Habitat Distribution

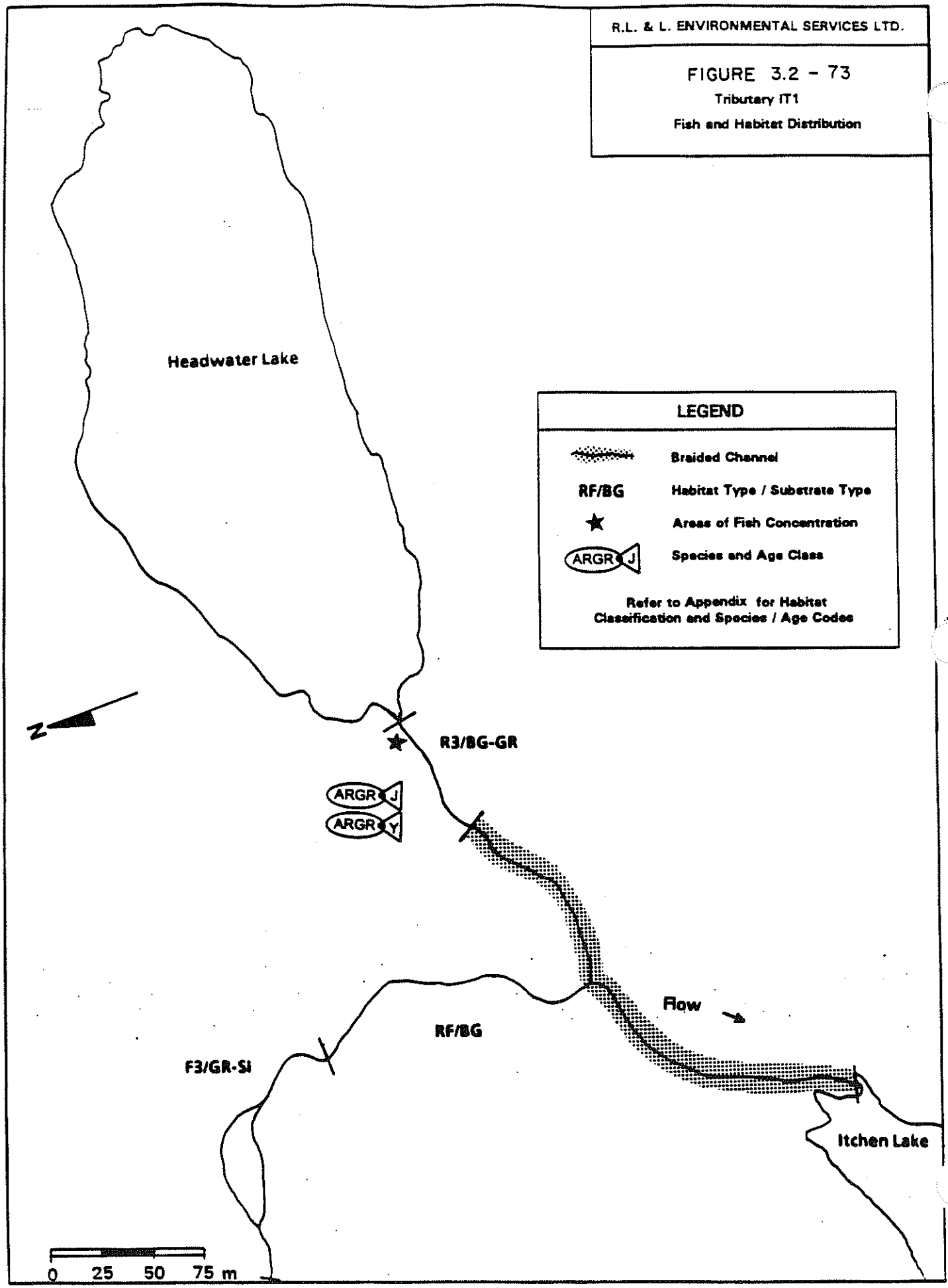

N
Ham Lake
ARGR J
Flow
RA/BG
ARGR J
Iznogoudh Lake
0 25 50 75 m
LEGEND
RA/BG
Habitat Type / Substrate Type
ARGR J
Species and Age Class
Refer to Appendix for Habitat Classification and Species / Age Codes
R.L. & L. ENVIRONMENTAL SERVICES LTD.
FIGURE 3.2 - 72
Ham Creek
Fish and Habitat Distribution

R.L. & L. ENVIRONMENTAL SERVICES LTD.

FIGURE 3.2 - 73

Tributary IT1

Fish and Habitat Distribution



streams were encountered during spring sampling, only three contained defined channels and sufficient flow to warrant further investigation.

IT1

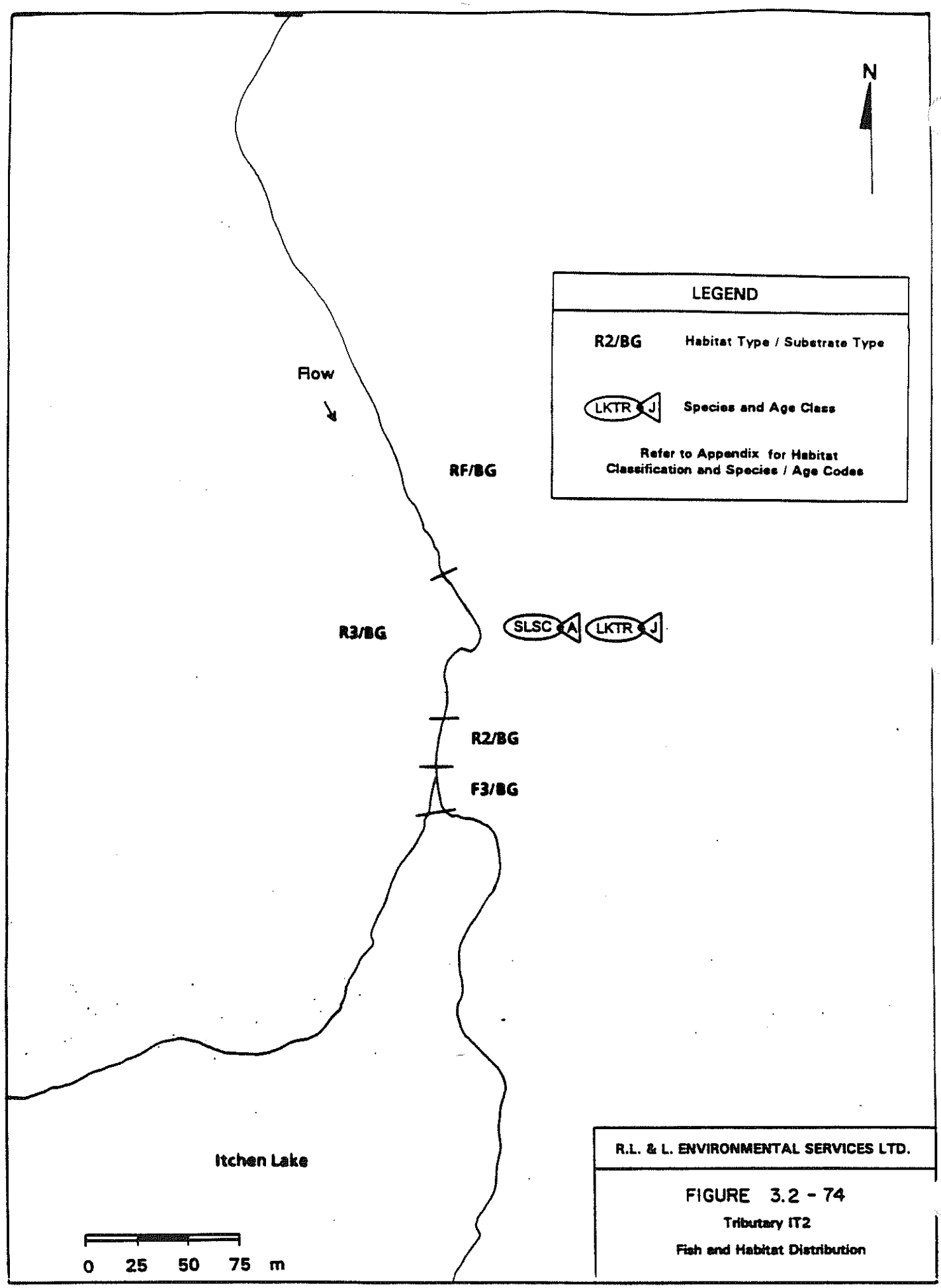
Tributary IT1 is located on the northwest side of Itchen Arm and is fed by a series of small deep headwater lakes. This tributary was small (Tables 3.2-48 and 3.2-49) and much of the surveyed length consisted of highly braided channel through large boulder substrate. Fish habitat was extremely limited in the lower portion of the stream. Suitable spawning and rearing habitat was present only near the outlet of the headwater lake which was located about 300 m upstream from Itchen Lake (Figure 3.2-73).

No fish were encountered in the lower portion of the stream, although high numbers of young-of-the-year and some juvenile Arctic grayling were captured in the outlet area of the headwater lake during summer sampling. It is likely that these fish were produced from a resident Arctic grayling population in the headwater lake and did not originate from fish residing in Itchen Lake. No other species were encountered in this tributary.

IT2

Tributary IT2, which is located just north of IT1, was very similar to IT1 in terms of size and gradient (Tables 3.2-48 and 3.2-49). Unlike the previous tributary, however, it exhibited a well defined channel over much of its surveyed length. The stream's substrate was predominately large boulder (Figure 3.2-74).

Due to its small size and high gradient, fish habitat was severely limited. Small numbers of slimy sculpin and a single juvenile lake trout were captured during sampling. This stream had limited potential as spawning or rearing habitat for Arctic grayling.


N
LEGEND
R2/BG
Habitat Type / Substrate Type
LKTR J
Species and Age Class
Refer to Appendix for Habitat Classification and Species / Age Codes
Flow
RF/BG
R3/BG
SLSC A
LKTR J
R2/BG
F3/BG
Itchen Lake
0 25 50 75 m
R.L. & L. ENVIRONMENTAL SERVICES LTD.
FIGURE 3.2 - 74
Tributary IT2
Fish and Habitat Distribution

IT3

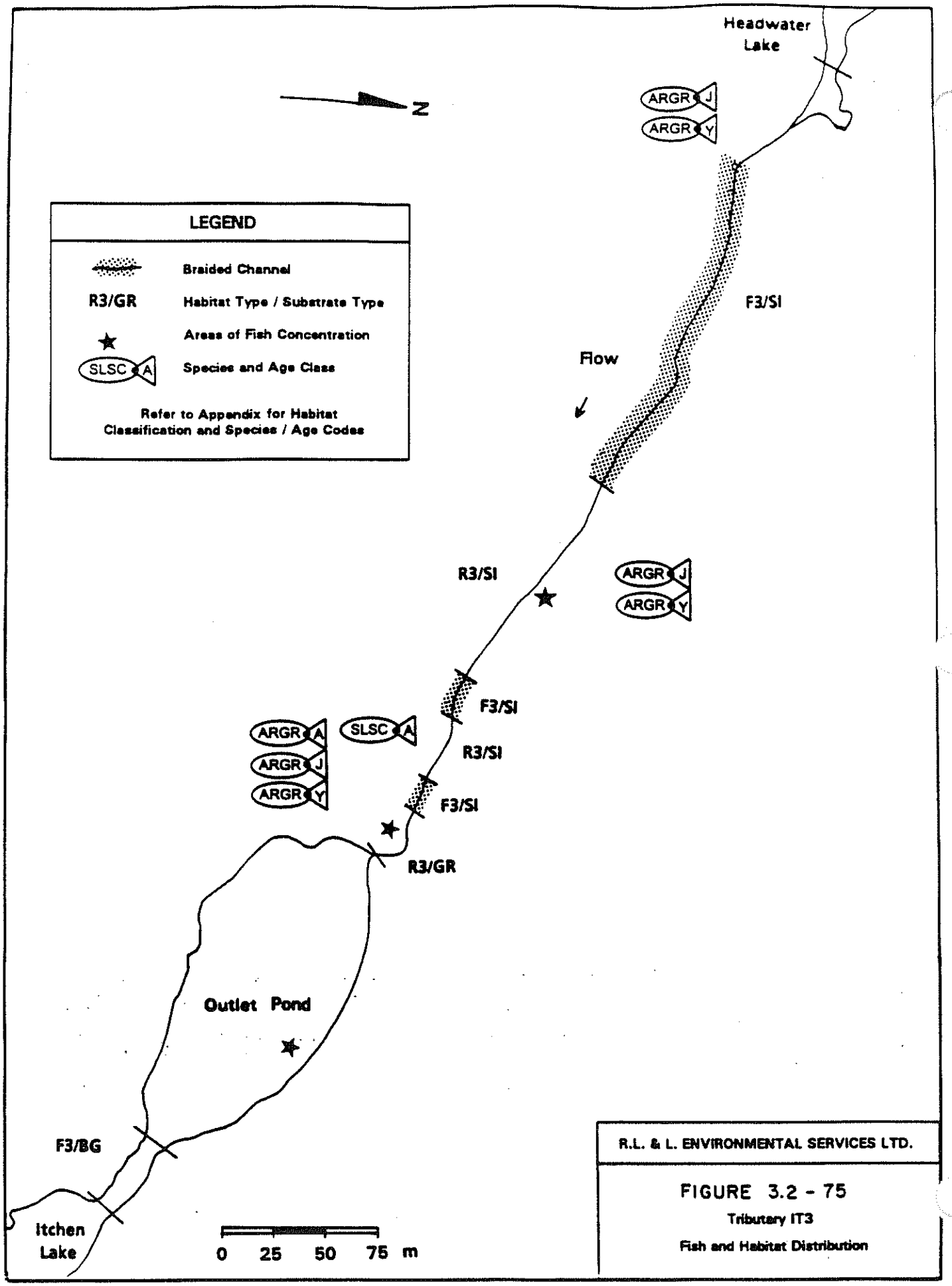
Tributary IT3 is a small inlet stream located at the northeast end of Itchen Arm. This stream was unique among the three tributaries investigated in the area in that it had a lower gradient (i.e., 23.3 m/km) and contained an abundance of fine substrates (i.e., gravels and silts) (Tables 3.2-48 and 3.2-49). This stream did not drain into Itchen Lake directly, but instead, entered a ponded area which was connected to the lake proper by a shallow channel (Figure 3.2-75).

Stream flow of Tributary IT3 was maintained throughout the open water period by input from a series of small deep headwater lakes situated approximately 0.5 km upstream from Itchen Lake. Although the channel of IT3 was extremely braided in several locations, the presence of fine substrates maintained water flow at the surface in these locations. This physical environment provided quality rearing habitat for fish populations.

Two species, Arctic grayling and slimy sculpin, were encountered during fisheries sampling of this tributary. Three adult Arctic grayling were captured in the lower section of IT3 during spring sampling, of which one was a male in spawning condition. Numerous young-of-the-year Arctic grayling (and some juveniles) were captured during summer investigations; they were distributed throughout the length of the stream. This indicated that a large portion of the tributary was utilized by Arctic grayling for rearing purposes. Suitable spawning substrate was abundant only in the lower most sections of the stream. In addition, small pockets of gravel were distributed throughout the tributary. Adult and juvenile fish also were observed in the headwater lakes during summer, suggesting that resident populations exist in these small waterbodies. Small numbers of slimy sculpin were captured in the lower section of this stream.

Izok Lake Tributaries

Izok Lake is situated between two large waterbodies, these being Iznogoudh Lake and Itchen Lake. As a consequence, it receives a large inlet stream (i.e., Iznogoudh Creek) and a large outlet stream (i.e., Izok Creek). Investigations during spring sampling identified no


Headwater Lake
N
ARGR J
ARGR Y
LEGEND
Braided Channel
R3/GR
Habitat Type / Substrate Type
Areas of Fish Concentration
SLSC A
Species and Age Class
Refer to Appendix for Habitat Classification and Species / Age Codes
F3/SI
Flow
R3/SI
ARGR J
ARGR Y
F3/SI
ARGR A
SLSC A
ARGR J
ARGR Y
R3/SI
F3/SI
R3/GR
Outlet Pond
F3/BG
Itchen Lake
0 25 50 75 m
R.L. & L. ENVIRONMENTAL SERVICES LTD.
FIGURE 3.2 - 75
Tributary IT3
Fish and Habitat Distribution

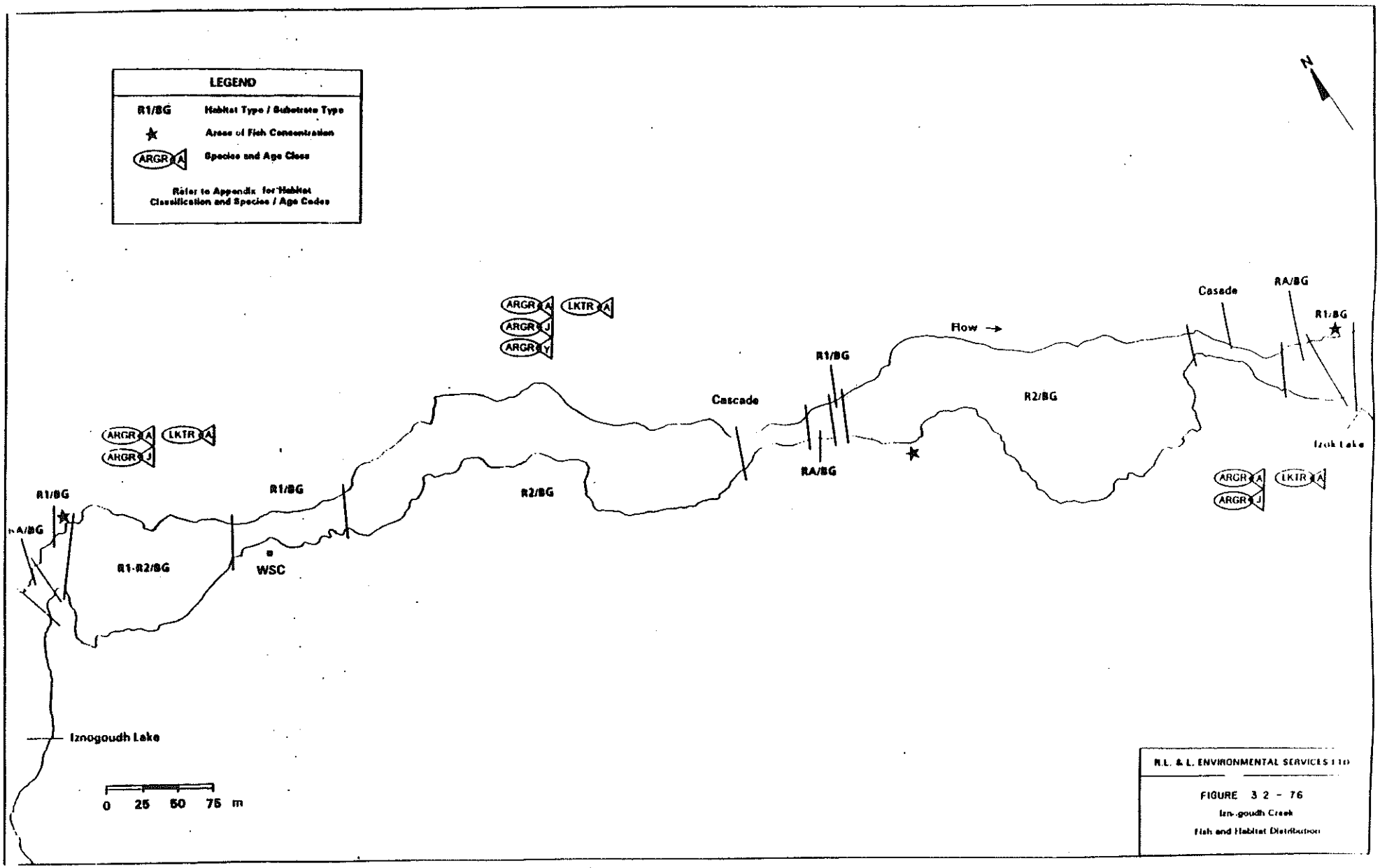
other significant tributaries associated with the lake. Due to the size of the two major tributaries, sampling methodologies were restricted to visual assessment of fish habitat, snorkelling, and angling. Physical habitat parameters were not quantified for these creeks.

Iznogoudh Creek

Iznogoudh Creek is relatively short (i.e., 940 m), has a moderate gradient (i.e., 7.4 m/km) and is predominated by RAPID habitat and boulder substrate (Tables 3.2-48 and 3.2-49) (Figure 3.2-76). Discharge rates recorded during summer were below 5.0 m^3/s; however, spring discharges exceeded 15 m^3/s (see Section 3.2-7). Two high gradient areas (CASCADE habitat) also occur in this stream which probably represent barriers to fish movement during high discharge periods.

Due to its size and channel configuration, a significant portion of this tributary (i.e, 14.0%) contained water depths greater than 2.0 m. A snorkel survey conducted during fall documented particularly deep sections (i.e., >4.0 m) in the vicinity of the Water Survey of Canada metering station. Deep water areas have the potential for use as summer feeding areas and as overwintering sites for stream dwelling species such as Arctic grayling.

Field sampling established the presence of adult Arctic grayling throughout the stream during summer and fall. Concentrations of fish were encountered at three locations (Figure 3.2-76). A snorkel survey conducted during mid September identified a group of approximately five adult fish downstream of the CASCADE habitat in the middle section of the river. The presence of these fish in Iznogoudh Creek just prior to winter, suggests that it may be utilized as overwintering habitat. Small numbers of juvenile and young-of-the-year Arctic grayling also were observed during field programs. Gradient, size, large substrate, and the presence of large predatory fish (i.e., lake trout) precludes this stream from being an important spawning or rearing area for Arctic grayling.


LEGEND
R1/BG
Habitat Type / Substrate Type
Areas of Fish Concentration
ARGR A
Species and Age Class
Refer to Appendix for Habitat Classification and Species / Age Codes
N
ARGR A
LKTR A
ARGR J
ARGR Y
Cascade
R1/BG
Flow
R2/BG
RA/BG
Cascade
RA/BG
R1/BG
Izok Lake
ARGR A
LKTR A
ARGR J
R1/BG
R1/BG
R2/BG
RA/BG
R1-R2/BG
WSC
ARGR A
LKTR A
ARGR J
Iznogoudh Lake
0 25 50 75 m
R.L. & L. ENVIRONMENTAL SERVICES LTD
FIGURE 3 2 - 76
Izn.goudh Creek
Fish and Habitat Distribution

Adult lake trout were present in Iznogoudh Creek throughout the open water period. Lake trout were most often encountered where the creek empties into Izok Lake, although fish were distributed throughout the stream. To assess whether Iznogoudh Creek was an important spawning area for lake trout, a snorkel survey of the creek was conducted during fall. One group of eight adult fish were encountered in the mid-section of the stream. These fish appeared to be in spawning condition (i.e., visual assessment of body colour); however, they may have been feeding individuals after completion of spawning. The limited number of fish encountered suggests that the area was not a major spawning habitat for lake trout. Also, significant numbers of spawning fish were collected from Izok Lake proper during fall sampling which suggests that most of the lake trout utilize shoals in the lake for spawning purposes.

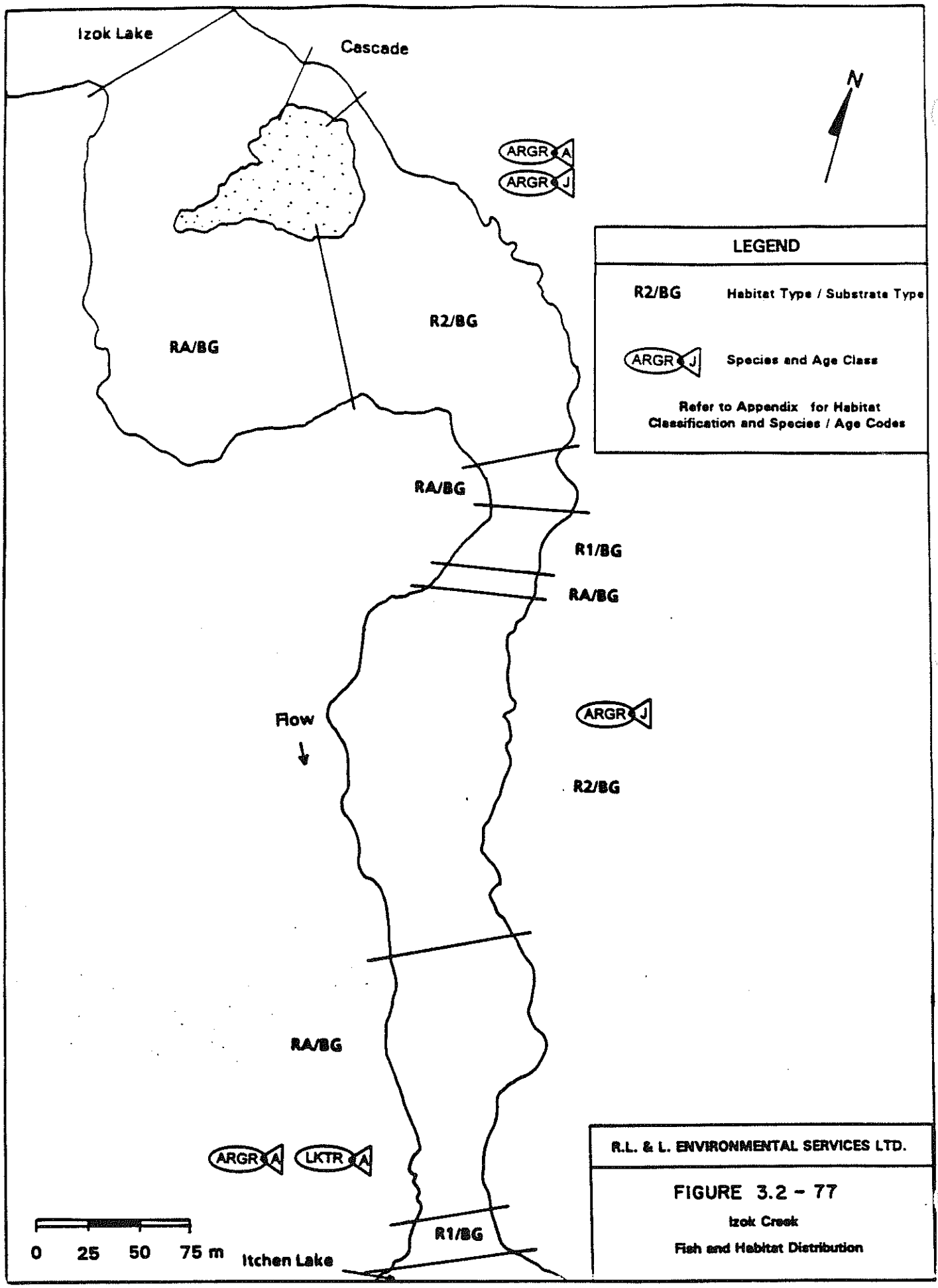
Izok Creek

Izok Creek is the outlet stream of Izok Lake. This major watercourse was characterized as being a relatively short (i.e, 675 m), high gradient (i.e., 10.3 m/km) stream, dominated by RAPID habitat and boulder substrate (Tables 3.2-48 and 3.2-49) (Figure 3.2-77). Limited amounts of suitable habitat were available for adult fish in Izok Creek. Only 6.4% of the stream was classified as deep water, therefore, little overwintering habitat was available for fish. The steep gradient and large boulder substrate limited its potential as spawning or rearing habitat.

Two species of fish were captured in Izok Creek — Arctic grayling and lake trout; neither species was abundant. Greatest numbers of both species were captured where Izok Creek enters Itchen Lake. As well, small numbers of juvenile fish were observed throughout the system during the summer period.

Iznogoudh Lake - Tributaries

An aerial reconnaissance of Iznogoudh Lake's shoreline during spring identified only one large stream entering the lake. All other streams were small with poorly defined channels. Due to the size and physical characteristics of IS6, it was included in the


Izok Lake
Cascade
N
ARGR A
ARGR J
LEGEND
R2/BG
Habitat Type / Substrate Type
ARGR J
Species and Age Class
Refer to Appendix for Habitat Classification and Species / Age Codes
R2/BG
RA/BG
RA/BG
R1/BG
RA/BG
Flow
ARGR J
R2/BG
RA/BG
ARGR A
LKTR A
R1/BG
0 25 50 75 m
Itchen Lake
R.L. & L. ENVIRONMENTAL SERVICES LTD.
FIGURE 3.2 - 77
Izok Creek
Fish and Habitat Distribution

study area, even though it will not be directly affected by the development (Figure 3.2-78).

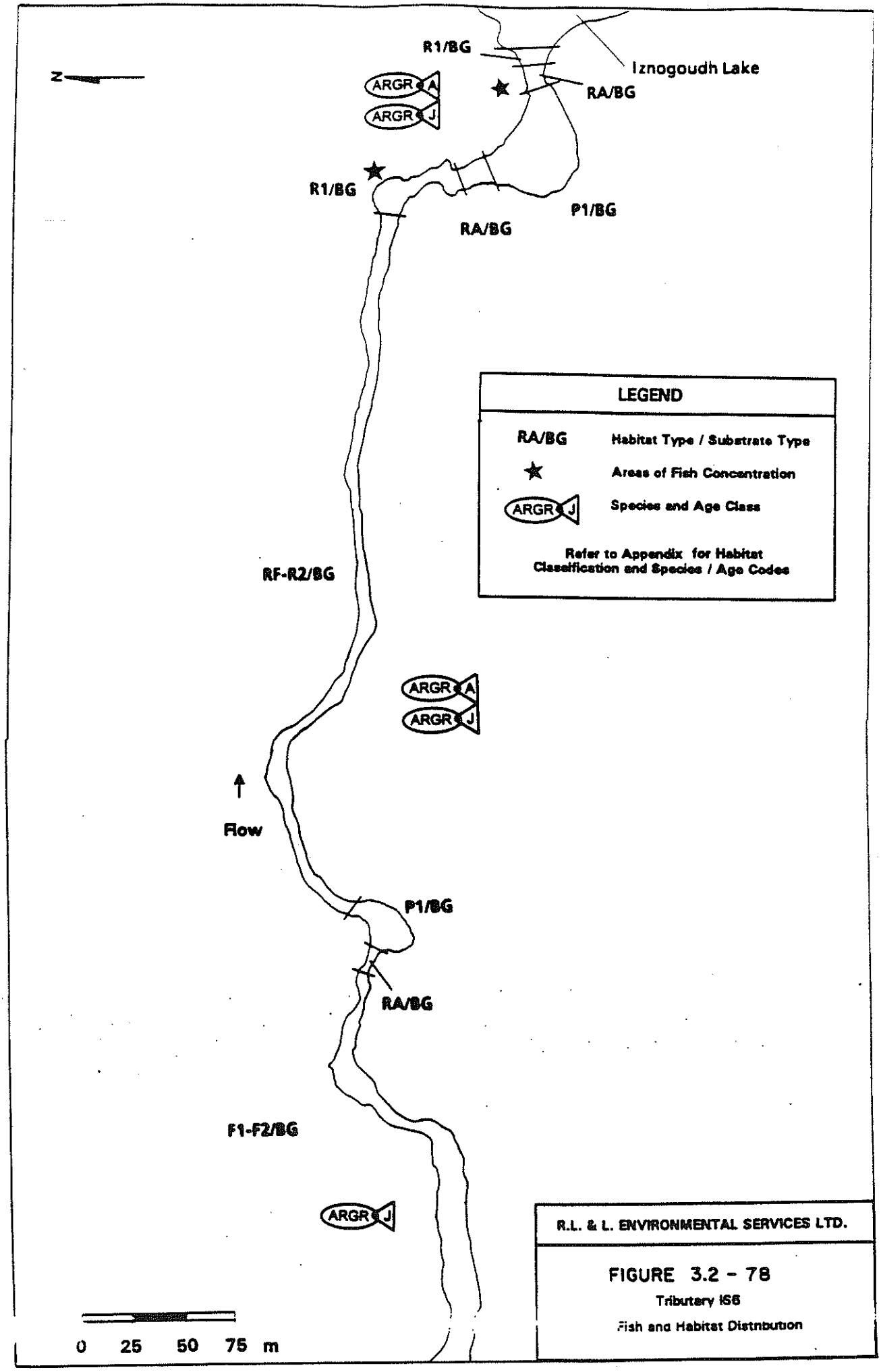
IS6

This stream enters the end of the shallow northwest bay of Iznogoudh Lake. This large stream was characterized as having a moderate gradient (i.e., 6.0 m/km) and a well defined channel (Table 3.2-49). In general, IS6 exhibited extensive sections of low gradient, FLAT and RUN habitats, interspersed with short sections of high gradient RAPID habitats (Figure 3.2-78). It also contained a relatively large amount of water greater than 2.0 m depth (19.1% by length) which may be utilized by fish for overwintering purposes. A continuous supply of water during the ice-free months was provided by a series of deep headwater lakes situated approximately 3 km upstream of Iznogoudh Lake. Small areas of gravel substrate were distributed throughout the 1338 m of surveyed stream.

The moderate gradient, and relatively large size, of IS6 provided good quality habitat for stream dwelling fish species. Synoptic level sampling by angling identified adult and juvenile Arctic grayling in this stream. Adult fish in spawning condition were captured during spring sampling and both adults and juveniles were encountered during summer. Although limited sampling was undertaken in this stream, it is likely that a significant number of Arctic grayling utilize the system. Because it was the only large stream entering Iznogoudh Lake with suitable feeding, spawning and rearing habitat, IS6 is likely critical habitat for the Arctic grayling population residing in Iznogoudh Lake and possibly other systems.

Population Estimates - Mine Site

An attempt was made to estimate the population size of major fish species inhabiting Ham and Izok lakes. Because the primary lake sampling techniques were angling and gillnetting, estimates were generated only for lake trout, a species which was easily captured by angling and which exhibited low mortality rates during gill net sampling. Captured fish in good physical condition were marked with a numbered Floy tag during


N
R1/BG
Iznogoudh Lake
ARGR A
ARGR J
RA/BG
R1/BG
P1/BG
RA/BG
LEGEND
RA/BG
Habitat Type / Substrate Type
Areas of Fish Concentration
ARGR J
Species and Age Class
Refer to Appendix for Habitat Classification and Species / Age Codes
RF-R2/BG
ARGR A
ARGR J
Flow
P1/BG
RA/BG
F1-F2/BG
ARGR J
0 25 50 75 m
R.L. & L. ENVIRONMENTAL SERVICES LTD.
FIGURE 3.2 - 78
Tributary IS6
Fish and Habitat Distribution

spring, summer, and fall sampling periods. In total, 234 lake trout were captured from Ham Lake and 189 were captured from Izok Lake. Of these fish, 143 and 102 were tagged in Ham Lake and Izok Lake, respectively (Table 3.2-50).

Table 3.2-50 - Number of Lake Trout Marked and Re-captured during Spring, Summer, and Fall Sampling in Ham and Izok Lakes, 1993, and Estimated Population Size.

	SPRING	SUMMER	FALL	TOTAL
HAM LAKE				
No. Tagged	29	35	79	143
No. Captured	31	54	149	234
No. Recaptured	9	—	15	24
IZOK LAKE				
No. Tagged	19	42	41	102
No. Captured	20	81	88	189
No. Recaptured	0	5	11	16
Adjust Values for Estimate[a]	Marking Period (Spring and Summer)		Recapture Period (Fall)	
HAM LAKE				
No. Tagged	60		—	
No. Captured	—		129	
No. Recaptured	—		7	
Population Estimate	991 fish ≥350 mm fork length			
Upper 95% C.I.	2087			
Lower 95% C.I.	515			
IZOK LAKE				
No. Tagged	55		—	
No. Captured	—		67	
No. Recaptured	—		6	
Population Estimate	544 fish ≥350 mm fork length			
Upper 95% C.I.	1190			
Lower 95% C.I.	270			

[a] Fish <350 mm fork length excluded from the analyses; marked fish recaptured within one day of being tagged, excluded from analyses.

The Peterson's Single Census Population Estimate requires that there be a single recapture event from which an estimate is generated (Ricker 1975). To meet the assumption of random mixing of marked fish in the population, individuals which were tagged during spring and summer were utilized as the marked cohort. The fall session

was used to sample for these marked fish. During fall a major gillnetting program was undertaken to capture as many marked fish as possible. Tagged fish ranged in length between 250 mm and 964 mm; however, all recaptured fish exceeded 350 mm in length. To remove potential biases caused by the absence of smaller fish in the recapture sample, all fish less than 350 mm in fork length were omitted from the analyses. These individuals represented 6% of Ham Lake and 9% of Izok Lake marked individuals. Also, a significant percentage of fish which were tagged during fall were recaptured within 2 days (i.e., 7 of 8 fish in Ham Lake and 3 of 4 fish in Izok Lake); as such, fish tagged and recaptured during fall were not used in the analyses. Table 3.2-51 summarizes the results. The population of lake trout ≥350 mm was estimated to be 991 fish in Ham Lake and 544 fish in Izok Lake. Due to the small number of recaptured fish, the 95% confidence intervals surrounding each estimate are large; however, the estimates do provide an approximation of the number of lake trout in each waterbody.

Caution should be used when interpreting these estimates. Lake populations in the Arctic region exhibit intraspecific predation (Johnson, 1976) which may influence the validity of these estimates. Indirect evidence suggests that tagged fish may have been predated upon by larger lake trout at a higher rate than untagged fish. On two occasions, recently tagged individuals were observed being pursued by their larger counterparts. Also, the stomach of one fish, a 746 mm long individual, contained the tag of another lake trout. The tagged fish which was consumed was 503 mm in length. Marked fish may have been inherently more vulnerable to predation, either by being in a weakened state after release, or by the presence of an orange floy tag which served as an attractant. If this differential mortality existed, tagged fish were selectively removed from the sample which would bias the estimates upward.

Fish Movements

The Izok Project Area contains several lakes which are interconnected by major tributaries. The potential exists, therefore, for fish to undertake movements between these waterbodies. Also, some species such as Arctic grayling, may undertake small

scale movements into tributaries to complete several of their life prerequisites (i.e., spawning and rearing).

In an attempt to assess movement patterns of fish species in the mine site area, a tagging program was undertaken during the 1993 sampling period. During this time lake trout or Arctic grayling (≥250 mm in length) in good physical condition were tagged and released. Round whitefish were not included in this program because captured individuals generally were in poor physical condition.

During the tagging program, 300 lake trout and 33 Arctic grayling were tagged in the four study lakes and their major tributaries (Table 3.2-51). A limited number of tagged fish were subsequently recaptured. Of the 40 lake trout which were recaptured, 24 and 16 were taken from Ham Lake and Izok Lake systems, respectively. No lake trout were recaptured from Itchen and Iznogoudh lakes, nor were any tagged Arctic grayling recaptured.

Table 3.2-51 - Number of Lake Trout and Arctic Grayling Tagged and Recaptured in the Izok Mine Site Area, 1993

LOCATION	NO. TAGGED (NO. RECAPTURED)							
	SPRING		SUMMER		FALL		TOTAL	
LAKE TROUT								
Ham Lake	29	(9)	35		79	(15)	143	(24)
Izok Lake	19		42	(5)	41	(11)	102	(16)
Iznogoudh Lake	—		16		14		30	
Itchen Lake	4		19		2		25	
TOTAL	52	(9)	112	(5)	136	(26)	300	(40)
ARCTIC GRAYLING								
Ham Lake	1				—		1	
Izok Lake			28		—		28	
Iznogoudh Lake	2		1		—		3	
Itchen Lake	1				—		1	
TOTAL	4		29		—		33	(0)

Most of the recaptured lake trout (i.e., 39 of 40 fish) were located in the lake in which they were tagged. The one exception was an individual which was recaptured in the middle section of Iznogoudh Creek on 28 July. This 485 mm fish had been originally tagged a month previous (i.e., 27 June), in Izok Lake. This fish likely had entered the creek to feed. Based on the results of the 1993 sampling program, it does not appear that there are any large scale inter-lake movements of lake trout within the waterbodies studied.

Arctic grayling are known to exhibit extensive migrations between spawning and feeding areas (McCart et al., 1972; Stein et al., 1973). This species spawned and reared in several small streams in the study area. Adult fish, however, were abundant only in larger water courses such as Iznogoudh Creek. Adult fish likely undertake spring migrations to small tributaries for spawning, and then return to deep protected feeding sites in the larger streams. Iznogoudh Creek did not appear to be an important spawning area for Arctic grayling (see previous section), nor were there any tributaries suitable for spawning draining into Izok Lake. Adult fish originating in Iznogoudh Creek probably move to other tributaries, either in Iznogoudh Lake or Itchen Lake to spawn. Although no direct evidence exists, the creek located at the northwest end of Iznogoudh Lake is the most likely candidate.

Mine Area Fisheries - Summary Discussion

The lakes and streams in the Izok Lake project area are low in nutrients and therefore have low biological productivity, which is typical of waters of the sub-Arctic Canadian Shield. The waters of the project area are slightly acidic, and have a very low buffering capability. The concentrations of most metals in the waters are low, many being below the analytical detection limit. One exception was aluminum, which was present at up to twice the level recommended in the Canadian Water Quality Guidelines (CCREM, 1987).

The lakes in the project area support slow growing populations of lake trout, round whitefish, Arctic grayling, lake cisco, longnose sucker, burbot and slimy sculpin, and

possibly lake whitefish (based on reports of earlier studies). Based on the 1992 and 1993 sampling results, lake trout were the predominant species. Round whitefish was the next most abundant species, although most of the catch was from Ham Lake, Izok Lake and Iznogoudh Lake. Arctic grayling, although not abundant in the lakes, was captured in greater numbers in the tributaries, and in streams connecting the study lakes. Lake cisco were collected only from the arm of Itchen Lake during 1992, although they may be present in some of the other larger study lakes (e.g., Iznogoudh Lake). Burbot were encountered in Ham Lake while younger age-classes occurred in several of its tributaries.

Based on the sampling results from summer 1992 and 1993 (i.e., catch rates using standardized overnight gill net sets), lake trout densities are highest in lakes containing shallow areas (i.e., Ham and Iznogoudh lakes), and least in deeper areas such as the two arms of Itchen Lake and in Izok Lake. The differences in lake trout catch rates probably reflect the more productive shallow water habitats present in Ham Lake and in the northwest section of Iznogoudh Lake.

The lake trout populations in the study lakes are slow growing and are dominated by the older age-classes. To some extent, this may reflect the cannibalistic nature of this species, with the larger individuals preying on the smaller, younger lake trout.

Round whitefish were most abundant in the shallow west bay of Ham Lake and in the northwest end of Iznogoudh Lake, with only low numbers encountered in Izok Lake and the two arms of Itchen Lake. These shallow, more productive areas in Ham and Iznogoudh lakes probably provide better feeding habitats for this species (i.e., greater numbers of benthic invertebrates such as chironomids).

The tributaries to the study lakes support populations of Arctic grayling, and other species such as sculpins and burbot. Although much of the annual discharge results from snow melt in the early part of the season, the sampled creeks maintain flow throughout the open water period. As such, they are utilized for spawning and rearing

by Arctic grayling. Tributaries which were identified as important rearing areas for Arctic grayling included H1, H3 on Ham Lake and IT1 and IT2 on Itchen Lake. Adult Arctic grayling appear to utilize Iznogoudh Creek during the summer period for feeding purposes. Because of the shallow nature of these streams and the low winter flows, they likely freeze to the bottom in winter; as a consequence, the fish must leave the creeks in the fall and overwinter in the adjoining lakes.

Based on the available information, it appears that Ham, Iznogoudh, or Izok lakes are not used as commercial or domestic fisheries. Sport fishing use is probably restricted to anglers associated with the exploration activities being conducted in the area. Because of the relatively small size of these lakes and the low productivity, they would be susceptible to overharvest of the sportfish species. Since Itchen Lake is much larger, it would be able to sustain higher fishing pressure.

3.2.10.3 Winter Road

Very little information is available relating to the fisheries resources along the winter road corridors (A. Wilson, Department of Fisheries and Oceans, Yellowknife, pers. comm.). Based on the studies conducted in the vicinity of the mine site area, and other areas in the region (e.g., Contwoyto Lake), it is likely that most of the larger lakes along the corridor support populations of lake trout, round whitefish, longnose sucker and Arctic grayling. A winter domestic fishery for lake trout occurs on the north end of Napaktulik (Takiyuak) Lake by Inuit from Coppermine (J. Hunter, NWT Department of Renewable Resources, Coppermine, pers. comm.).

3.2.10.4 Port Area and Marine Shipping

This section presents the review of fisheries and lower trophic levels from Minnova's study of the environmental effects of marine shipping (Canarctic, 1992c). The information was compiled from a literature survey and the experience of LGL Limited (fisheries consultants to Canarctic) in Arctic marine ecology, and studies conducted by R.L.& L. Environmental Services Ltd.

The small and shallow freshwater lakes, located on the tundra plain west and south of the Port Site, did not appear to support substantial populations of fish. Based on standard gang gillnet catch in one of these lakes, the catch of only three large adult broad whitefish indicated that these lakes may occasionally be inhabited by some fish. It is assumed that these fish arrived in the lake through a small stream connecting it to the sea; subsequently they remained there to take advantage of a very abundant food supply (amphipods). The size and condition factor of these broad whitefish were considerably greater than that of their counterparts captured in coastal brackish habitats; however, it remains unknown whether the shallow nature of the lake would allow repeated overwintering.

Based on available information, it appears that the immediate area of the Port Site is not used extensively for commercial or sport fisheries; however, it is utilized by some residents of Coppermine as part of their subsistence domestic fishery. Due to the migratory nature of Arctic charr (the target species of these fisheries), fish that are harvested near the Port Site likely form part of the same stock that is harvested by the commercial, sport and domestic fisheries in the Coppermine River. The domestic fishery (estimated at over 20 000 kg of fish per year) accounts for the largest part of the overall Arctic charr harvest in the Coppermine area; in contrast, the commercial (600 kg of fish per year) and sport (approximately 900 kg per year) fisheries harvests appear to be relatively minor contributors to Arctic charr exploitation.

Metal Analysis in Fish

During 1992, Minnova initiated a monitoring program in the Izok Mine Site area to assess background metal concentrations in fish (i.e., muscle and liver tissues). During 1993, this program was expanded to provide additional information. Samples were collected from locations previously sampled in the Mine Site area which included Iznogoudh and Izok lakes, and Izok Arm of Itchen Lake. Fish also were collected at two new locations — Itchen Arm of Itchen Lake and a control lake which was outside the influence of mining activity (i.e., 5 km northeast of Ham Lake). Species of interest at

these locations included lake trout and round whitefish. At the Port Site, Arctic charr and Arctic cisco were collected from coastal waters.

During 1992, 58 lake trout and 13 round whitefish were collected from the Izok Mine Site area (Table 3.2-57). Forty-three percent of lake trout samples were collected from Iznogoudh Lake, while the remainder originated in Izok Lake (17 fish) and the Izok Arm of Itchen Lake (16 fish). Most of the round whitefish samples (77%) were collected from Iznogoudh Lake; the remainder were from Izok Lake (2 fish) and Itchen Lake (1 fish).

Table 3.2-57 - Number, Mean Length (SD), and Size Range of Fish Collected for Muscle and Liver Tissue Analyses, 1992 and 1993

YEAR	LOCATION	SPECIES	SAMPLE SIZE	MEAN FORK LENGTH (mm)	STANDARD DEVIATION	MINIMUM LENGTH (mm)	MAXIMUM LENGTH (mm)
1992	MINE SITE - Iznogoudh L.	Lake trout	25	558.6	163.9	257	776
		Round whitefish	10	377.6	32.1	331	426
	- Izok L.	Lake trout	17	391.4	168.4	180	696
		Round whitefish	2	443.5	61.5	399	486
	- Itchen L. (Izok Arm)	Late trout	16	426.6	189.2	191	738
		Round whitefish	1	470.0			
1993	PORT SITE	Arctic charr	20	705.5	73.5	556	817
		Arctic cisco	20	396.8	30.3	356	481
	MINE SITE - Control L.	Lake trout	20	589.7	163.8	320	893
		Round whitefish	0				
	- Iznogoudh L.	Lake trout	21	661.0	137.7	492	942
		Round whitefish	6	344.7	61.2	252	397
	- Izok L.	Lake trout	20	535.7	112.5	429	761
		Round whitefish	11	404.8	28.8	346	441
	- Itchen Lake (Itchen Arm)	Lake trout	20	540.2	60.6	454	675
		Round whitefish	2	448.5	20.5	434	463
	- Itchen Lake (Izok Arm)	Lake trout	20	576.6	90.0	430	796
		Round whitefish	2	425.0	25.5	407	443

In 1993, 101 lake trout were sampled from the Mine Site study area. These included 20 fish from the unnamed control lake which is situated approximately 5 km northeast of Ham Lake and outside the influence of the proposed mine. Twenty lake trout also were sampled from each of Iznogoudh and Izok lakes, and Itchen and Izok Arms of Itchen

Lake. Lower numbers of round whitefish were captured during 1993 (i.e., 21 fish). The majority of these fish originated from Izok Lake (52%). The remainder were captured from Iznogoudh Lake (29%), and Itchen Lake (19%). No round whitefish were collected from the control lake.

In total, 20 Arctic charr and 20 lake cisco were collected from the Port Site study area.

At the time of report submission, tissue sample analyses were partially complete. As such, the results presented in this section are incomplete and subject to review. Complete summary statistics and discussion will be provided in an R.L. & L. Environmental Services Ltd. report.

The availability of aluminum to aquatic organisms has been correlated with the pH of the aquatic environment (Holtze and Hutchinson, 1989); however, it is unclear at what pH threshold or at what concentration aluminum becomes toxic to fish (Neville, 1985). Aluminum can be acutely toxic at high exposure levels (Seville, 1985), but it does not bioaccumulate in aquatic organisms.

Arsenic is more common in the earth's crust than is mercury or cadmium, and is more toxic to plants than to animals (Demayo, et al., 1979). It does not appear to biomagnify through different trophic levels, and species demersal are more likely to accumulate arsenic than pelagic fish (Demayo, et al., 1979). Arsenic concentrates mainly in the liver and is a cumulative toxin (Falk, et al., 1973).

Cadmium apparently does not bioaccumulate in the food web (Reeder, et al., 1979a). The rate of cadmium uptake is generally faster in hard waters, although cadmium toxicity decreases in hard water (Reeder, et al., 1979a).

Copper is considered one of the elements essential for metabolism, and the main areas of the body where it concentrates are the muscle, liver, and brain tissues (Demayo and Taylor, 1981). Complexing agents, pH, alkalinity, and species of plant or animal can all

influence the toxicity of copper. Copper is not considered to be a cumulative systemic poison since it is excreted from the body, and very little is retained (Falk, et al., 1973).

Lead tends to deposit in bone as a cumulative toxin (Falk, et al., 1973), and is more toxic in soft water than in hard water (Demayo, et al., 1980).

Mercury present in fish tissue is most commonly in the form of methyl mercury, although the number of mercury forms potentially present in the environment means that total mercury is recommended as the form used for setting guidelines (Reeder, et al., 1979b). The maximum allowable level of mercury in muscle tissue of fish sold in Canada for human consumption is 0.5 mg/kg (wet weight) which is comparable to about 2.5 mg/kg when expressed on a "dry weight" basis (assuming 80% moisture content).

Lower water hardness and increasing acidity increase the toxicity of nickel (CCREM, 1987). The toxicity of nickel increases when nickel is present with copper, likely as a result of synergism (Taylor, et al., 1979). Nickel has the greatest effect on the early life stages of fish, including fertilized eggs. Nickel does not biomagnify in the food web (Taylor, et al., 1979). Hutchinson, et al. (1975) reported that nickel concentrations were highest in plants and lowest in top predators.

Zinc primarily affects gill epithelial tissues and can cause outright mortality or induce stress that leads to death at a later time (Falk, et al., 1973). Zinc, however, is essential for plant and animal health. Zinc toxicity increases with increasing pH and decreases with increasing water hardness. Zinc concentrations are usually greater in omnivorous than in piscivorous species, and greater in benthic invertebrates than in fish (CCREM, 1987).

The partial data set available for analyses from the Mine Site area suggests that background metal concentrations in lake trout and round whitefish tissues (both muscle and liver) are at normal levels (Tables 3.2-58 to 3.2-63). A significant percentage of the samples were below the detection limit.

Preliminary results of tissue analysis for Arctic cisco (Table 3.2-64) and Arctic charr (Table 3.2-65) indicated that fish sampled at the Port Site exhibited metal concentrations that were similar to fish from the Mine Site area. The only exception was higher levels of arsenic in fish from the Port Site area. In both Arctic charr and Arctic cisco, liver and muscle tissues showed mean concentrations several times greater than in freshwater fish tissues. Despite the preliminary nature of the data, these differences appear real. It is highly unlikely that these high levels of arsenic resulted from contamination of the samples in the field or in the laboratory because arsenic contamination can only occur from point sources such as tailings ponds (R. Jornitz, CanTest Labs, pers. comm.). High arsenic levels in fish muscle tissues have been identified in other coastal fish communities (Windom, 1973 in Forstner and Wittman, 1979). No definitive conclusions can be made regarding arsenic levels in Arctic charr and Arctic cisco collected from coastal waters of the Port Site until a complete data set is available.

Table 3.2-58 - Summary of Partial Metal Analyses from Tissue Samples Collected from Lake Trout in Iznogoudh Lake, Mine Site, 1992 and 1993[a]

Tissue	Parameter	Al	As	Cd	Cu	Pb	Hg	Ni	Zn
Liver	Sample Size	42	42	42	42	42	42	42	42
	Number below Detection Limit	31	23	0	0	33	0	18	0
	Mean (µg/g)	6.04	0.06	1.29	50.70	0.04	2.298	0.379	140.93
	SD[b]	7.38	0.05	0.96	26.60	0.03	2.518	2.282	32.67
	Minimum (µg/g)	<5.0	<0.05	0.34	4.89				
	Maximum (µg/g)	32.40	0.17	4.35	120.12	0.14	15.463	1.190	200.10
Muscle	Sample Size	46	46	46	46	46	46	46	46
	Number below Detection Limit	44	40	42	0	33	0	42	0
	Mean (µg/g)	2.76	0.03	0.03	1.54	0.06	1.268	0.142	18.43
	SD[b]	1.37	0.02	0.02	0.67	0.07	0.994	0.058	5.21
	Minimum (µg/g)	<5.0	<0.05	<0.05	0.49	<0.05	.300	<0.25	8.09
	Maximum (µg/g)	11.36	0.13	0.09	2.73	0.43	6.077	0.422	38.10

[a] Preliminary results subject to review.
[b] Standard deviation.

Table 3.2-59 - Summary of Partial Metal Analyses from Tissue Samples Collected from Lake Trout in Izok Lake, Mine Site, 1992 and 1993[a]

Tissue	Parameter	Al	As	Cd	Cu	Pb	Hg	Ni	Zn
Muscle	Sample Size	26	26	26	26	26	26	26	26
	Number below Detection Limit	20	20	0	0	2	0	9	0
	Mean (µg/g)	5.67	0.04	3.31	46.29	0.26	1.153	0.364	135.41
	SD[b] (µg/g)	6.83	0.03	2.87	28.31	0.15	1.019	0.262	26.81
	Minimum (µg/g)	<5.0	<0.05	0.67	4.46	<0.05	0.100	<0.25	83.80
	Maximum (µg/g)	28.28	0.18	14.97	147.4	0.60	4.519	1.190	190.50
Liver	Sample Size	32	32	32	32	32	32	32	32
	Number below Detection Limit	32	25	28	0	27	0	26	0
	Mean (µg/g)	<5.0	0.04	0.04	1.711	0.04	0.650	0.184	18.65
	SD[b] (µg/g)	0	0.03	0.04	0.54	0.06	0.533	0.144	5.31
	Minimum (µg/g)	<5.0	<0.05	<0.05	0.90	<0.05	0.170	<0.25	11.01
	Maximum (µg/g)	<5.0	0.15	0.19	3.41	0.31	2.058	0.761	28.90

[a] Preliminary results subject to review.
[b] Standard deviation

Table 3.2-60 - Summary of Partial Metal Analyses from Tissue Samples Collected from Lake Trout in Itchen Lake, Mine Site, 1992 and 1993[a]

Tissue	Parameter	Al	As	Cd	Cu	Pb	Hg	Ni	Zn
Liver	Sample Size	43	43	43	43	43	43	43	43
	Number below Detection Limit	21	27	0	0	34	0	15	0
	Mean (µg/g)	9.71	0.06	2.44	63.46	0.06	1.914	0.459	137.31
	SD[b]	10.36	0.06	1.88	40.72	0.10	1.798	0.352	28.10
	Minimum (µg/g)	<5.0	<0.05	0.46	5.03	<0.05	0.320	<0.25	55.30
	Maximum (µg/g)	50.43	0.35	7.76	159.63	0.60	8.8703	1.580	180.98
Muscle	Sample Size	49	49	49	49	49	49	49	49
	Number below Detection Limit	48	40	49	0	47	0	49	0
	Mean (µg/g)	2.57	0.04	<0.05	1.41	0.03	0.974	<0.25	17.46
	SD[b]	0.51	0.04		0.57	0.01	0.709		5.74
	Minimum (µg/g)	<5.0	<0.05	<0.05	0.63	<0.05	0.045	<0.25	10.31
	Maximum (µg/g)	6.07	0.25	<0.05	2.78	0.07	3.361	<0.25	28.00

[a] Preliminary results subject to review.
[b] Standard deviation

Table 3.2-61 - Summary of Partial Metal Analyses from Tissue Samples Collected from Lake Trout in Iznogoudh Lake, Mine Site, 1993[a]

Tissue	Parameter	Al	As	Cd	Cu	Pb	Hg	Ni	Zn
Liver	Sample Size	13	13	13	13	13	13	13	13
	Number below Detection Limit	13	11	1	0	8	0	6	0
	Mean (µg/g)	<5.0	0.04	0.34	7.41	0.19	0.519	0.288	104.86
	SD[b]	0	0.03	0.21	1.362	0.48	0.133	0.205	9.94
	Minimum (µg/g)	<5.0	<0.05	<0.05	5.99	<0.05	0.340	<0.25	91.90
	Maximum (µg/g)	<5.0	0.13	0.71	10.46	1.78	0.822	0.770	119.97
Muscle	Sample Size	15	15	15	15	15	15	15	15
	Number below Detection Limit	15	12	14	0	14	0	14	0
	Mean (µg/g)	<5.0	0.03	0.03	1.85	0.03	0.334	0.163	15.68
	SD[b]	0	0.02	0.01	0.88	0.01	0.154	0.147	2.17
	Minimum (µg/g)	<5.0	<0.05	<0.05	0.58	<0.05	0.090	<0.25	13.25
	Maximum (µg/g)	<5.0	0.07	0.08	3.22	0.08	0.695	0.695	21.10

[a] Preliminary results subject to review.
[b] Standard deviation

Table 3.2-62 - Summary of Partial Metal Analyses from Tissue Samples Collected from Round Whitefish in Izok Lake, Mine Site, 1992 and 1993[a].

Tissue	Parameter	Al	As	Cd	Cu	Pb	Hg	Ni	Zn
Liver	Sample Size	13	13	13	13	13	13	13	13
	Number below Detection Limit	11	6	0	0	2	0	10	0
	Mean (µg/g)	4.43	0.08	0.92	6.97	0.60	0.492	0.256	97.53
	SD[b]	4.71	0.07	0.70	1.07	1.31	0.165	0.380	11.48
	Minimum (µg/g)	<5.0	<0.05	0.52	4.68	<0.05	0.199	<0.25	83.70
	Maximum (µg/g)	15.48	0.22	2.99	8.40	4.86	0.915	1.503	131.23
Muscle	Sample Size	13	13	13	13	13	13	13	13
	Number below Detection Limit	13	13	13	0	12	0	12	0
	Mean (µg/g)	<5.0	<0.05	<0.05	1.14	0.08	0.264	0.271	15.00
	SD[b]	0			0.18	0.20	0.095	0.525	2.02
	Minimum (µg/g)	<5.0	<0.05	<0.05	0.95	<0.05	0.143	<0.25	12.33
	Maximum (µg/g)	<5.0	<0.05	<0.05	1.53	0.76	0.522	2.018	18.98

[a] Preliminary results subject to review.
[b] Standard deviation

Table 3.2-63 - Summary of Partial Metal Analyses from Tissue Samples Collected from Round Whitefish in Itchen Lake, Mine Site, 1992 and 1993[a]

Tissue	Parameter	Al	As	Cd	Cu	Pb	Hg	Ni	Zn
Liver	Sample Size	5	5	5	5	5	5	5	5
	Number below Detection Limit	4	4	1	0	4	0	3	0
	Mean (µg/g)	3.34	0.04	0.71	4.77	0.11	0.565	0.207	75.36
	SD[b]	1.87	0.04	0.53	2.18	0.20	0.085	0.113	35.81
	Minimum (µg/g)	<5.0	<0.05	<0.05	0.96	<0.05	0.476	<0.25	12.49
	Maximum (µg/g)	6.69	0.11	1.15	6.43	0.47	0.685	0.340	100.56
Muscle	Sample Size	5	5	5	5	5	5	5	5
	Number below Detection Limit	4	5	4	0	5	0	4	0
	Mean (µg/g)	3.46	<0.05	0.10	2.08	<0.05	0.403	0.195	29.42
	SD[b]	2.15		0.17	1.97		0.229	0.156	30.61
	Minimum (µg/g)	<5.0	<0.05	<0.05	0.84	<0.05	0.260	<0.25	14.07
	Maximum (µg/g)	7.30	<0.05	0.41	5.56	<0.05	0.807	0.475	84.08

[a] Preliminary results subject to review.
[b] Standard deviation

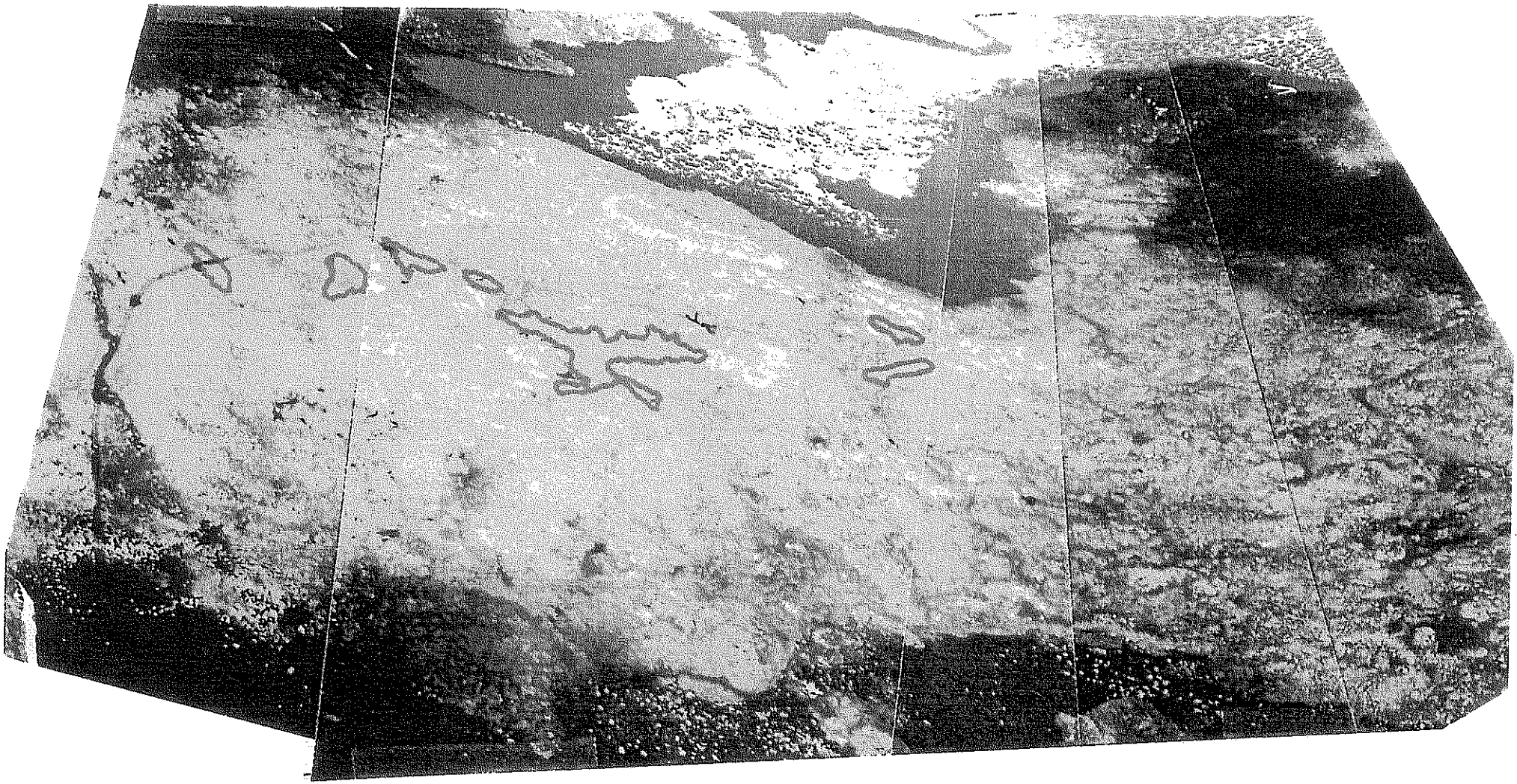


FIGURE 3.2 - 92
Composite photograph showing relative size and proportion of cottongrass / sedge habitat at plant site.

Table 3.2-68 - Percent Frequency for Plant Species Near km 161 of Izok Project Winter Road (n=1000)

SPECIES	PERCENT FREQUENCY [1] (values in brackets denote range per 100 m transect)
Sedge	20.4 (12 - 30)
Lupin	19.9 (10 - 29)
Willow	19.3 (5 - 32)
Mountain avens	12.9 (4 - 20)
Pea	3.4 (0 - 7)
Vetch	1.2 (0 - 6)
Bear root	4.3 (0 - 11)
Alpine bearberry	2.8 (0 - 11)
Bilberry	.3 (0 - 1)
Dwarf birch	.6 (0 - 3)
Arctic white heather	1.7 (0 - 7)
Cotton grass	.8 (0 - 2)
Birdfoot buttercup	.2 (0 - 1)
Draba spp.	.3 (0 - 1)
Bare ground	7.3 (3 - 10)
Rock	4.2 (6 - 10)
Rounded Total[1]	99.6

[1] Total may not add up to 100% due to rounding.

Port Site

Habitat conditions at the port site are more variable than either at the mine site or at km 161 of the winter road. The vegetation on the headland is dominated by mountain avens with willow, bell heather, sedges and dwarf birch making up the species of secondary abundance. The adjacent lowland between the headland of the port site and the outcrops to the west is a mixture of extensive wet meadows with cottongrass and sedge tussocks, small raised bogs (less than 100 m across) with bell heather and mountain avens dominating, and raised beaches dominated by lupine and dryland

sedges. Soils seemed to be of alluvial origins. Table 3.2-69 provides the percent frequency and ranges for plant species in the habitat types in the vicinity of the port site. Habitat alteration for port development will mostly and perhaps exclusively affect habitats dominated by mountain avens.

Table 3.2-69 - Percent Frequency for Plants in the Vicinity of the Izok Project Port Site on Coronation Gulf

SPECIES	PERCENT FREQUENCY (values in brackets denotes range per 100 m transect)			
	PORT HEADLAND n=1000	RAISED BOG n=500	SEDGE MEADOW n=500	WILLOW UPLAND n=500
Mountain avens	27.2 (16-45)	15.6 (6-23)	15.3 (8-22)	22.5 (18-37)
Arctic white heather	13.7 (5-22)	40.7 (32-51)		2.2 (0-3)
Sedges	13.2 (4-23)	6.8 (2-9)	40.5 (32-51)	15.6 (7-21)
Alpine bearberry	3.1 (1-8)	7.8 (2-11)		3.6 (0-4)
Bear root	1.8 (0-6)	6.3 (4-11)		
Willow	2.1 (6-5)	6.0 (0-10)	18.5 (7-29)	37.5 (23-51)
Bilberry	7.3 (1-15)	6.1 (0-14)	2.5 (0-6)	.5 (0-2)
Dwarf birch	10.4 (0-20)	1.6 (0-1)		10.3 (6-17)
Crowberry	.7 (0-3)			
Lupin	8.7 (1-16)	4.5 (0-8)		2.0 (0-4)
Moss-campion	1.9 (0-4)			
Pea	2.5 (0-5)			
Cranberry	.3 (0-3)			
Arctic azalea		4.7 (0-6)	.2 (0-2)	2.0 (0-2)
Labrador tea	.3 (0-3)			
Cotton grass			23.0 (10-33)	
Rock	6.5 (0-13)			
Rounded Total[1]	99.7	100.0	100.0	96.2

[1] Total may not add up to 100% due to rounding.

Sign of wildlife in the vicinity of the port site included light caribou trails and droppings, Arctic ground squirrels and goose droppings. The lowlands west of the port site are used by migrating Canada geese in the spring. Numerous spent shotgun shells are evidence that it is also a site that is used by hunters at that time of year. This was confirmed in conversation with Colin Adjun of Coppermine.

3.2.12 Wildlife

This section reviews the available information on terrestrial birds and mammals for the study area, referred to as Valued Ecosystem Components (VECs) by RERC (guidelines section 3.2.9) This information provides the basis for the impact assessment in Section 5.3.

Previous reports on wildlife as related specifically to the Izok Project include:

1. "An Annotated Inventory of Terrestrial Wildlife in the Area Between Izok Lake and Coronation Gulf, Northwest Territories" (Hubert and Associates Ltd., 1992a);

2. "A Study of Marine Environmental Issues Associated with a Marine Transportation System Servicing Coronation Gulf, N.W.T." (Canarctic, 1992c); and

3. "Location and Occupancy Profiles of Raptor Nest Sites for the Preliminary Alignment of the Winter Road Serving the Izok Project" (Hubert and Associates Ltd., 1992b)

4. "Initial Environmental Evaluation and Pre-operational Survey in the Area of the Izok Lake deposits" (Beak Consultants Ltd., 1977).

Collectively, these studies provide an overview of the wildlife in the study area. The Hubert report covers terrestrial and freshwater bird and mammal species that may interact with the mining, winter road and/or port components of the project. The Canarctic report addresses the marine environment and species associated with the port and shipping components. The land-based wildlife VECs are discussed in the context of the study area as a whole, with specific comments on distribution in relation to the mine site, winter road and port site. This is followed with a discussion of the marine-based wildlife which could interact with the port (berthing facility) and/or shipping component of the project. Certain species, such as waterfowl, shorebirds and caribou are discussed in both subsections, with subsection 3.2.12.1 emphasizing mainland habitat use, and the Canarctic subsection 3.2.12.2 emphasizing marine and island habitat use.

As noted earlier, the information on freshwater and marine fisheries requested in Section 3.2.9 of the Guidelines has been presented separately in Section 3.2.10.

3.2.12.1 Terrestrial Wildlife

These notes on the VECs species ecology are intended to describe the critical elements of the species' natural history that may be relevant to their interactions with the Izok Project. Reference is made to legislation under which each species is managed or protected as well as any designation under domestic or international conventions for wildlife conservation. None of the birds that are known to breed regularly in the region or any of the mammals resident here are designated as "endangered" or "threatened" by The Committee on the Status of Endangered Wildlife in Canada. Status under endangered species designation was taken from *1992 Canadian Endangered Species* published by the World Wildlife Fund. Special mention is made of the eskimo curlew whose historic breeding range may have included the tundra/forest transition habitat west and south of Izok. This bird is designated "endangered" in USA and Canada.

Birds

The short arctic summer with abundant daylight is an ideal breeding environment for migratory birds. The long daylight hours and abundant food resources, be they insect or vegetable, provide the birds summering in the region "longer working hours" for feeding their young at a season when food is most in demand (Welty, 1962).

Only four species can be considered residents for the full year: the raven, gyrfalcon and two species of ptarmigan. All the remaining species migrate to southern latitudes or coastal environments that offer open water.

Tundra environments are generally critical to the breeding success of many North American migratory bird species. The study area stretches through 250 km from south to north within the central mainland tundra of the Northwest Territories. Agencies concerned with migratory birds, especially waterfowl, have conducted numerous surveys to document the summer distribution of nesting and moulting waterfowl here

(Bellrose, 1976). The Canadian Wildlife Service has monitored the results of surveys that describe the summer distribution of nesting waterfowl in the Northwest Territories and has published a compendium of "key" terrestrial habitat sites for waterfowl in the Northwest Territories (Alexander, et al., 1991). It sets a minimum requirement as a guideline for designating "key habitat sites":

> *Sites that are believed to support at least 1% of a national population are considered to be Key Habitat Sites.*

This is the same criterion used for designation of sites in Europe and under the Convention on the Conservation of Wetlands of International Importance (Alexander, et al., 1991). The region under consideration here does not include any sites designated as "key habitat" for migratory birds. A checklist of birds observed during the 1993 field studies is given in Table 3.2-70

VECs Bird Species

RERC Guidelines designated several species in the study area as VECs. These are:

- loons,
- ducks and geese,
- tundra swans,
- shorebirds,
- raptors.

Loons

Three species of loons are present in low densities throughout the tundra: the red-throated loon *(Gavia stellata)*, Pacific loon *(Gavia pacifica)*, and yellow-billed loon *(Gavia Adamsii [Gray])*. All three nest on interior lakes in the summer. The red-throated loon also nests along coastal lakes. A fourth species of loon, the common loon *(Gavia immer)*, is present as an occasional visitor.

Table 3.2-70 - Checklist of Birds Observed During 1993 Field Studies

SPECIES	DATE	LOCATION*
Common loon	August 6	Iznogoudh Lake
Yellow-billed loon	June 30	Izok Lake
	July 15/16	Port site
Red-throated loon	July 13	Port site
	August 9	Ham Lake
Sandhill Crane	May 28	Coppermine
Tundra swan	July 2	Napaktulik Lake
	July 2	km 155
	July 15	Port site
White-fronted goose	July 4	Iznogoudh Lake
Canada goose	May 28	Ham Lake
		Napaktulik Lake
	June 30	Iznogoudh Lake
	July 2	Napaktulik Lake
	July 12	Port site
Pintail	June 30	Izok Lake
Lesser scaup	July 4	Iznogoudh Lake
White winged scoter	July 2	Napaktulik Lake km 75
Oldsquaw	June 29	Izok Lake
	July 2	km 130
	July 3, 6	Ham Lake
Common merganser	July 2	Napaktulik Lake km 60
	July 3/4	Ham Lake
Semipalmated plover	June 30	Ham Lake
	July 12	Port site
Golden plover	July 7	km 161
Red-necked phalarope	July 2, 4	Iznogoudh Lake
Common Snipe**	July 1	Izok Lake
	July 4	Ham Lake
Least sandpiper	June 30	Izok Lake
Pectoral sandpiper	July 14	Port site

Table 3.2-70 - Checklist of Birds Observed During 1993 Field Studies (continued)

SPECIES	DATE	LOCATION*
Parasitic jaeger	June 29, July 6	Ham Lake
Herring gull	numerous	Port site
Golden eagle	June 29, July 3	vicinity of mine site
	July 13	Port site
Rough-legged hawk	May 28	Iznogoudh Lake
	July 2	Izok Lake
	July 2	km 122, km 130, km 220
	July 15	Port site
Peregrine falcon	June 25, July 1	Itchen Lake
	June 29	Ham Lake
	July 2	km 220 (not positively identified as peregrines)
Rock ptarmigan	August 7	Iznogoudh Lake
Eastern phoebe	July 3	Izok Lake
Horned lark	numerous	common
Cliff swallow	July 7	Ham Lake
	July 2	km 220
	July 17	Port site
Raven	numerous	Ham Lake
	numerous	Port site
Grey cheeked thrush	July 3	Izok Lake
American robin**	July 1	Izok Lake
Yellow warbler	June 29	Itchen Inlet
Savannah sparrow	numerous	common
American tree sparrow	numerous	common
Harris sparrow	numerous	Izok Lake
White crowned sparrow	numerous	Izok Lake
Lapland longspur	numerous	common
Common redpoll	numerous	common

* weather conditions at port site were very poor for bird inventories
** heard but not seen

Loons are adept and swift in the water but clumsy on land, so their nests are located at water's edge (Sutton, 1965). Nests, made of heaps of rotting vegetation, are widely spaced, usually only one nest per small lake or pond. Usually two eggs are laid and incubated from 27 to 29 days. A relatively long fledging time means young loons are often in the breeding range very late and may not leave until freeze-up. The diet of the adults and chicks is almost exclusively fish caught by diving and underwater pursuit. The annual moult of the flight feathers, leaving adult loons flightless, occurs before or after breeding and rearing the young, depending on the species (Godfrey, 1986). A study of red-throated loons in the arctic showed that pairs nesting within 11 km of the ocean had greater success in rearing their young than those with more distant nests (Eberle, 1991). From a study in the Canadian Beaufort, Dickson (1992) reported red-throated loons could be a useful bioindicator species.

In the past, loon skins with feathers intact were used for Inuit clothing; today there is little traditional subsistence use of loons. Loons and their characteristic call remain a universal symbol of wilderness and are a significant factor in the experience of southern visitors to the Arctic.

All loons are protected under the Migratory Bird Convention Act (Canada). None are listed as endangered species. The Canadian Wildlife Service is the agency responsible for protecting loons in Canada. All loons observed during the 1993 summer wildlife field studies are enumerated below.

Mine site

Three species of loon were recorded near the mine site in the summer of 1993. A pair of yellow-billed loons was observed on Izok Lake June 30. It is not known if these birds were nesting nor if they produced a brood. A pair of common loons was observed on Iznogoudh Lake while conducting an aerial search for caribou by helicopter on August 6. Red-throated loon calls were heard near Ham Lake June 29 and two adults were observed flying over Ham Lake on August 9, 1993.

Winter road

Loons were not observed during helicopter flights in the vicinity of the proposed winter road alignment on July 2 and 7.

Port site

A single red-throated loon was seen swimming in the bay south of the port site July 13 and again flying over the bay on July 16. A pair of yellow-billed loons was observed on a small lake in the lowland west of the port site on July 15 and 16. A yellow-billed loon was swimming in the bay on July 16.

Waterfowl

The term waterfowl is a misnomer in that it includes only swans, geese, and ducks, not all bird species occupying aquatic or marine environments. Coronation Gulf and the interior lands to the south lie between two very important mainland tundra waterfowl habitats, the coastal plain along Queen Maud Gulf and Rasmussen lowlands to the east, and the coastal lowlands from the Anderson River Delta to the Mackenzie Delta to the west. Several nesting colonies of geese are located in these two areas. The frequency of nesting waterfowl and the diversity of waterfowl species along Coronation Gulf is considerably lower than that of the coastal regions to the east or west (from maps in Bellrose, 1976). The region is not considered to be "good" waterfowl habitat (Robert Bromley, pers. comm.), so is not subjected to regular waterfowl surveys.

A review of waterfowl species of northern Canada presented in Bellrose (1976) shows that 10 species frequent the inland areas south of Coronation Gulf and 14 species frequent coastal environments in the region. Five of the inland species nest there while seven species nest near the coast. Field observations of waterfowl species made during the 1993 summer wildlife studies are described below.

Swans

Tundra swans *(Cygnus columbianus)* can be found in low densities in their breeding range throughout the tundra of continental North America and southern portions of Banks Island, Victoria Island, and Baffin Island, as well as islands in Hudson Bay.

Pairs arrive on the nesting ground of the central Arctic in late May, and prepare a nest by piling a 12- to 18-inch high mound of moss, dead grass and sedge near water. Three to five eggs are laid and incubated 31 days (Bellrose, 1976). Cygnets fly 60 to 70 days later. During the fledging period, breeding and non-breeding adults lose and replace their flight feathers, remaining flightless for 35 to 40 days. Swan diets consist of leaves, stems and tubers of aquatic and marsh vegetation. Most tundra swans leave their nesting ranges with the onset of fall and progress southward, congregating on the Peace-Athabasca Delta in October before dispersing to their respective wintering grounds in Chesapeake Bay, Maryland, inland marshes in the western U.S., and coastal marshes near San Francisco.

The tundra swan is one of the few waterfowl species of the region whose breeding range falls entirely within the North American tundra, most of it in Canada (Bellrose, 1976). The Canadian population of 151,000 birds, which nests entirely within the Northwest Territories (Alexander, 1991), has been increasing in recent years (Bromley and Stenhouse, 1989). Recent surveys of specific waterfowl nesting and moulting areas in the central Arctic revealed a continuous distribution of swans in mainland coastal environments from Coppermine to the Kent Peninsula (Bromley and Stenhouse, 1989).

Although swans may be taken for the pot in the region, swan is not a major item in the diets of northern peoples.

Tundra swans are protected under the Migratory Bird Convention Act (Canada). They are not listed as an endangered species. The Canadian Wildlife Service is the agency responsible for protecting swans in Canada.

Mine site

No swans were observed in the vicinity of the mine site in any of the walking or helicopter surveys conducted for wildlife in June, July and August.

Winter road

On July 2, four pair of tundra swans, widely spaced and presumably nesting, were observed along the shore of Napaktulik Lake in the vicinity of km 90 of the winter road. Two more pair were observed near km 155.

Port site

Two tundra swans were observed flying over the port site in a westerly direction on July 15. No swans were observed to be nesting on the lowland west of, and adjacent to the port site.

Geese

Two species of goose are occasionally found in the region. The white-fronted goose *(Anser albifrons)* nests in colonies and singly in the region. Major nesting colonies are in the Queen Maud Bird Sanctuary, on southern Victoria Island, the Rasmussen Lowlands and in the Anderson and Mackenzie River deltas This goose arrives in its nesting area from mid to late May. Canada geese *(Branta canadensis)* nest in both coastal and inland environments. They are segregated into distinct races and populations. The population in this region breeds from the Mackenzie Delta to eastern Victoria Island. It is distributed thinly but in clumps throughout the region, along the coast and south of Coronation Gulf. This area is considered poor goose habitat.

Canada geese arrive for nesting from mid-May to early June depending on the year. The nest may be a site used in previous years or a new "scrape" near water, usually on an island, will be used. Most clutch sizes range from four to seven eggs (Bellrose, 1976). Incubation takes 24 to 33 days (Godfrey, 1986). The goslings fly in 40 to 46 days (Bellrose, 1976). Pairs mate for life and family groups migrate south as a unit, staying

together until they return to the breeding grounds the following spring (Godfrey, 1986). The Canada goose diet consists of plants including berries.

Geese are hunted in the north in spring and in the south in fall. All geese are listed under the Migratory Bird Convention Act (Canada). None are listed as endangered species. The Canadian Wildlife Service is the agency responsible for managing geese in Canada.

Mine site

Canada geese were seen around the camp on Ham Lake on May 28. The area was still snow covered and these birds congregated in the areas where snow had been removed for the airstrip. Six Canada geese were on Iznogoudh Lake near its outflow to Izok Lake on June 30. These birds were observed in this general area for several days.

A nesting pair of white-fronted geese was found near Iznogoudh Lake close to the outflow of Ham Lake on July 4. The nest contained 4 eggs.

Winter road

Several flights of Canada geese were seen in the vicinity of the winter road alignment on the west side of Napaktulik Lake during aerial surveys on May 28. The flight size was 20 - 30 birds which seemed to be searching for feeding areas as they circled low to the ground. On July 2 a raft of approximately 30 Canada geese was seen on Napaktulik Lake near km 70 of the winter road.

Port site

A single Canada goose was observed swimming in the bay south of the port site on July 12. The wet sedge lowland west and south of the port site showed abundant evidence of goose use. Goose faeces were common indicating recent grazing in the area. According to local hunters this is a location where numerous Canada geese congregate in early June. No nesting by any goose species was noted at or near the port site during field investigations there July 12 - 17.

Ducks

Eleven species of ducks may be found in the study area. Of these; four are common residents (pintails, common eiders, oldsquaws, and red-breasted mergansers) seven are occasional migrants or visitors (green-winged teals, canvasbacks, king eiders, white-winged scoters, black scoters, surf scoters, and common mergansers) and five are occasional species (green-winged teals, canvasbacks, king eiders, black scoters, and surf scoters).

The breeding range for pintails *(Anas acuta)* includes most of continental North America and occasionally some of the Arctic islands (Godfrey, 1986). The study area is on the margins of the range. Pintail ducks arrive on their nesting grounds in late May or early June, depending on the rate of melt for the year. Nests are usually on open ground with sparse vegetation. An average of 7.76 eggs are laid and incubated for 22 to 23 days. It appears that males moult their flight feathers in migration, while females moult while tending their broods on water bodies in nesting areas (Bellrose, 1976). Young pintails fly sooner on northern ranges (36 days in Alaska) than on southern ranges (46 to 57 days in South Dakota).

In Canada, oldsquaws *(Clangula hyemalis)* nest in both coastal and inland environments throughout the north and are the most common ducks in the Arctic (Bellrose, 1976). They arrive on the nesting grounds in early June and select nest sites close to water (the greatest distance recorded is 200 m) (Bellrose, 1976). Clutch sizes vary from 2 to 11 eggs, and incubation takes 24 to 29 days. After a few weeks on freshwater ponds, the broods move to coastal waters and remain there until they fly. The oldsquaw diet is almost entirely invertebrates, with crustaceans, molluscs and insects taken by diving.

Three species of scoters, the white-winged scoter *(Melanitta fusca)*, black scoter *(Melanitta nigra)* and surf scoter *(Melanitta perspicillata)*, were occasionally found in the study area. Although the white-winged scoter has been observed to nest at Bathurst Inlet (Bathurst Inlet Lodge, unpublished), nesting on the tundra is well beyond the breeding range described in Godfrey (1986). Scoters as a group have received very little attention from

ornithologists. All species appear to prefer very dense cover like nettles, gooseberry shrubs, and other forest shrubbery for their nest sites. This may explain why they are not common in tundra environments.

Two species of merganser, the red-breasted merganser *(Mergus serrator)* and common merganser *(Mergus merganser)*, were reported for the study region (Godfrey, 1986). Common mergansers were observed in the vicinity of the mine site and along the winter road. Nesting begins in late June (Bellrose, 1976). Mergansers are predominantly fish eaters.

Pintails, oldsquaws and scoters are hunted in the north in spring and in the south in fall. Scoters bear the distinction of being the only species named in the Migratory Bird Convention Act (Canada) as a group of birds that can be taken by "Indians...at any time for food." Mergansers are not highly sought after by subsistence or recreational hunters. Eiders are sought for their nests, which have been used as a source of down for clothing. This practice is common where eider nest densities are relatively high. It has not been reported for central Arctic communities.

All ducks cited here are listed under the Migratory Bird Convention Act (Canada). No northern species are listed as endangered. The Canadian Wildlife Service is the agency responsible for managing ducks in Canada.

Mine site

Reconnaissance on foot and by helicopter revealed few ducks to be in the area. Two pintail drakes were observed near the outflow of Izok Lake on June 30 and later that day a female pintail was flushed in the same area but no nest was found. Individual oldsquaw were observed on Izok Lake on June 29 and on Ham Lake on July 3 and 6. Two pair of lesser scaup were seen on Iznogoudh Lake on July 4. A common merganser drake was noted swimming in Ham Lake on July 3 and 4.

Winter road

Very few ducks were seen during a helicopter flight over the winter road on July 2. A single oldsquaw was observed near km 130, a flight of white-winged scotters was seen near km 75 and three male common mergansers were seen near km 60.

Port site

No ducks were observed in the area of the proposed port.

Birds of Prey

The study area is within the breeding ranges of four raptor species: the golden eagle, the rough-legged hawk, the peregrine falcon and gyrfalcon. All are open-country raptors that take their prey live, unlike ravens or bald eagles, which scavenge for a significant portion of their food. Each of these raptors is a summit predator; its ecological niche is at the top of a food chain. Their presence is evidence of an ecosystem (or series of ecosystems, in the case of migratory species) that supports a complete food chain and is thus an important indicator of a healthy and productive environment.

In most birds of prey the female of the species is larger than the male (Godfrey, 1986). Most raptors are monogamous and pair for the full life of the adult bird (Brown, 1977). It is therefore important to keep adult mortality on the breeding range to a minimum if local populations are to grow. All birds of prey need a relatively long period for incubation and fledging their young. They occupy their nests early, usually well before the spring melt, and are often found on their summer ranges well into the fall. The gyrfalcon is a permanent resident of the tundra.

The GNWT Department of Renewable Resources is currently conducting field studies on birds of prey in a study area centred on Coppermine. The rugged diabase dykes that are common near the coast of the Coronation Gulf are ideal geological structures for nesting sites for these raptors (Maps 76M, 76N, 86O, 86P, Land Use Information Series, Environment Canada, 1978).

Golden Eagle

The golden eagle *(Aquila chrysaetos)* is a common summer resident nesting throughout the region, but most abundant near the coast (Department of Renewable Resources, unpublished data). In Canada, golden eagles breed in the western mountains, the Yukon, and along the Arctic coast. One author (Mansell, 1980) reports that the breeding range of golden eagles coincides with the presence of ground squirrels, hares or marmots. Of 36 sites monitored by the Department of Renewable Resources along and near the Arctic coast east of Coppermine, five are golden eagle nests. One of these sites has been occupied for four consecutive years (GNWT Renewable Resources, unpublished data).

Nests are made of sticks and other coarse material, usually situated on a cliff, and are often used in successive breeding seasons. Two eggs are incubated for 43 days (Godfrey, 1986). This long incubation period requires the birds to occupy their nests in early April, long before the snowmelt. Golden eagles arrive on their breeding territories near Coppermine in April and stay until late September to mid-October (C. Shank, unpublished data). Egg laying begins in mid-April. Chicks leave the nest 65 to 80 days after hatching (Brown, 1977). Observations of golden eagle nests on the Coppermine study area show fledging 65 to 77 days after hatching (C. Shank, pers. comm.). Young golden eagles stay in the vicinity of the nest for a period of up to 12 weeks (C. Shank, unpublished data) before migrating to temperate latitudes where they winter in open country. The main prey species of golden eagles include ground squirrels, hares, and ptarmigan (Pearson, 1936).

Mine site

A single golden eagle was observed in the vicinity of the mine site on June 29 and again on July 3. A thorough examination of prospective nesting habitat in the area showed no nest sites within the Izok, Ham, Iznogoudh Lake area. The presence of a solitary bird may indicate that the area of the mine site is within an active territory.

Winter road

A survey of the winter road alignment for raptor nest sites by helicopter on July 2 revealed no golden eagle nests along the route from the mine site north to the southern edge of the GNWT Department of Renewable Resources study area south of the port site. Profiles of golden eagle nest sites in that study area within 5 km of the winter road are provided below.

Nest site #: 729	Location	67.44N X 114.46E
History of occupation:	June 1983	golden eagle
	July 1987	golden eagle
	May 1989	golden eagle

Distance from current winter road alignment: 4 km (2.4 mi) west near km 270

Notes: Beyond the 3.2 km distance recommended as the minimum distance by Matthews (1988) with a natural height of land between proposed road location and the nest site.

Nest site #: 1062	Location	67.38N X 114.33W
History of occupation:	July 1989	golden eagle
	July 1991	golden eagle
	June 1992	golden eagle
	July 1993	vacant

Distance from current winter road alignment: 0 km at km 260

Notes: This site seems to have the remnants of numerous nests.

Golden eagles occupy nest sites and initiate egg laying in late April while the winter road is expected to be in use. There is usually more than one nest site in a raptor breeding territory (C. Shank, pers. comm.).

This site was visited by the authors on July 2 and was found to be inactive. GNWT personnel visited the site on July 7 and found the site to be inactive but saw an adult eagle in the area which suggests that the territory was occupied (C. Shank, pers. com.).

Port site

A solitary golden eagle was observed south of the port site on July 13. The general area in which this observation was made could have been in the territory of the bird discussed for site # 1062 mentioned above. No other observations of golden eagles or eagle nesting were made in the vicinity of the port site.

Hawks

The rough-legged hawk *(Buteo lagopus)* is a regular summer resident that nests in both coastal and inland environments (Godfrey, 1986). In Canada this hawk nests throughout the mainland tundra, plus the islands of Hudson Bay, Baffin Island and the western Queen Elizabeth Islands of the Arctic Islands Archipelago (Godfrey, 1986).

Like other raptors in the region, the rough-legged hawk nests on ledges of cliffs. It builds a nest of sticks and grasses and will use the same nest in successive years. Nesting is initiated in May. Two to six (usually three or four) eggs are laid and incubated for 28 to 31 days (Godfrey, 1986). The young hawks fledge about 41 days after hatching (Fleck, 1981). The prey of rough-legged hawks consists almost entirely of small mammals — voles, lemmings and occasionally ground squirrels (Brown, 1977).

Mine site

Rough-legged hawks were observed migrating through this area in late May. Personnel at the camp reported that hawks were abundant in the summer of 1992 when brown lemming were also abundant there. One adult was observed over Izok Lake on July 2, 1993. Also, only one lemming was seen while trekking over the terrain near the mine site in July and August.

Winter road

The helicopter flight along the winter road alignment showed three active rough-legged hawk nests, one east of the road at km 122, another east of the road at km 130, and one west of the winter road near km 220. The road traverses lakes at all these sites.

Port site

An occupied rough-legged hawk nest was observed on the cliffs west of the port site at 67.47.30N X 114.40.40W a straight line distance of more than 2 km from the port site.

Falcons

Two species of falcon breed in the study area — peregrine falcons and gyrfalcons. Peregrine falcons *(Falco peregrinus)* are summer residents, nesting throughout the region. The peregrine falcon is truly a cosmopolitan species, breeding throughout both northern and southern hemispheres. Several subspecies with rather discrete ranges are recognized for peregrine populations in Canada. Birds occupying the tundra regions of the Northwest Territories are of the *tundrius* subspecies (Bromley, 1988). The GNWT Coppermine study area has numerous nest sites. There are also nest site records for peregrine falcons at Point Lake, Contwoyto Lake, and Napaktulik Lake.

Peregrine falcons prefer open country at all seasons. Nests are usually in cliffs (or their urban equivalent, skyscrapers, in cities). Little is done by way of nest preparation for the three to five eggs. Egg laying begins in late May and incubation lasts 33 to 35 days. The young birds will fledge about 35 to 40 days later and stay in the area of the nest for four to six weeks (C. Shank, pers. comm.). Peregrines take prey (almost exclusively other birds) in flight by diving, to deliver a sharp blow with their large taloned feet. A speed of 180 mph during a dive has been recorded (Godfrey, 1986). The GNWT raptor nest site database shows that more than 12 sites are reliable locations for breeding pairs east and south of Coppermine. It is difficult to assess sites more accurately because the same site may be used by ravens or gyrfalcons, even after several successive years of occupation by a peregrine.

The gyrfalcon *(Falco rusticolus)* is a permanent resident on the tundra nesting throughout the region. It is a holarctic species, breeding on all circumpolar continents plus Iceland and Greenland. It often winters on the tundra but may also be found in more southerly latitudes (Godfrey, 1986). The Coppermine study area has at least four sites east of Coppermine which are usually occupied by gyrfalcons.

Gyrfalcons do not build nests but will occupy structures built by ravens. One site (#1070) in the GNWT nest site database was occupied by a raven in 1984, by a peregrine falcon in 1985 and by a gyrfalcon in 1986. In a study south of the Kent Peninsula, Poole and Bromley (1988a) observed that gyrfalcons occupied the abandoned nests of ravens and golden eagles. When not occupying a site prepared by another species, the gyrfalcon uses nothing more than a scrape, which, when used in successive years, will accumulate bones and other debris of prey. The winter ecology of gyrfalcons is poorly documented. Males are known to be in nesting territories in February (Poole and Bromley, 1988a) and may overwinter on the tundra (C. Shank, unpublished). Nests are usually located on inaccessible ledges of cliffs. Incubation starts in mid- to late April. Usually three or four eggs are laid and hatch after 28 or 29 days incubation (Brown, 1977). The young birds observed in the Kilgavik study area fledged seven weeks after hatching (Poole and Bromley, 1988a). Most young birds had fledged by late July or early August. Gyrfalcons are the largest falcon and therefore can take larger prey than other falcons. The diet of gyrfalcon in the central Arctic was predominantly rock ptarmigan (73%) and ground squirrel (14%) (Poole and Boag, 1988).

Mine site

A single peregrine falcon was reported over Itchen Inlet on June 25. A peregrine falcon was observed over Ham Lake on June 29 and again over Itchen Inlet July 1. This may suggest that the area north of Izok is part of an active territory. Chris Shank (GNWT raptor biologist) had a report of an active peregrine falcon nest on an unnamed lake in the area north of Izok. A search in the Izok, Ham, and Iznogoudh area did not turn up any nests.

There were no observations or reports of gyrfalcons or their nests for the mine site and vicinity for 1993. The wildlife siting log kept at the mine site showed an active nest with three chicks "at Itchen Bay east of Izok" on July 12,1992. This site could not be located in July 1993.

Winter road

During the helicopter flight on July 2 two falcons were observed west of the winter road near km 220. A positive identification was not made and the birds were not seen again. It may be that there was no nest in 1993 but that a pair is maintaining a territory in the vicinity.

The GNWT raptor nest site data base includes two peregrine falcon nest sites near the winter road in the study area east and south of Coppermine. The profiles are provided below.

Nest site #:	1028	Location	67.41N X 114.44E
History of occupation:		July 1984	peregrine

Distance from current winter road alignment: 2.4 km (1.4 mi) west near km 270

Notes: If this site were to be re-occupied by peregrine during the life of the project, the birds should not be affected as peregrine nesting is not initiated until early June, after the winter road has been shut down for the season.

Nest site #:	2015	Location	67.37N X 114.27E
History of occupation:		July 1990	peregrine
		July 1991	peregrine

Distance from current winter road alignment: 4.8 km (3 mi) east

Notes: Beyond the 3.2 km distance recommended as the minimum distance by Matthews (1988).

No gyrfalcons nor their nests were observed or reported for the area of the winter road.

Port site

A thorough search was made for falcons and their nests in the cliffs near the port site and those to the west. No falcons nor falcon nests were observed or reported for the vicinity of the port site.

Golden eagles, rough-legged hawks and peregrine falcons are not considered important in an economic sense to nearby communities. However, these large raptors — particularly peregrine falcons, which have attracted worldwide attention — may be important as symbols of wilderness for the growing eco-tourism industry, attracting southern visitors to the region. Gyrfalcons have been prized by falconers for centuries. In the early 1980s several young falcons were taken from the Coppermine area for sale to falconers. This practice has since been stopped in the Northwest Territories.

Golden eagles and rough-legged hawks are not protected by the Migratory Bird Convention Act (Canada), but are a species protected by the Wildlife Act (NWT). They are not named in international conventions and are not listed as endangered species.

All peregrine falcons were placed on the endangered list as a result of a crash in global populations. This was caused by pesticides which had a detrimental effect on breeding success. Following a ban on the indiscriminate use of organochloride pesticides in many countries, the numbers of peregrine falcons have increased significantly. Populations in this region were reported "apparently numerically healthy ... and are reproducing at normal rates" (Bromley, 1988). In 1992 the *tundrius* subspecies was downlisted in Canada from "Endangered" to "Vulnerable."

All falcons are protected by the Wildlife Act (NWT). The gyrfalcon is not listed as an endangered species in Canada, but is included with peregrines on Appendix 1 of the Convention on International Trade in Endangered Species (CITES), which requires that the birds cannot be exported except for exceptional purposes such as research or breeding. Export for commercial purposes, such as for falconry in a foreign country, would not be permitted for any species listed in Appendix I of CITES.

Shorebirds

Thirteen species of shorebird are reported for the region in summer. Four, the semipalmated plover, least sandpiper, Baird's sandpiper, and red-necked phalarope, are common residents. Two, the lesser golden plover and the semipalmated sandpiper, are occasional residents. Seven, the lesser yellowlegs, ruddy turnstone, sanderling, white-rumped sandpiper, pectoral sandpiper, stilt sandpiper, and common snipe, are rare visitors (Godfrey, 1986).

Mine site

Field studies did not reveal many shorebirds. Only three species, the least sandpiper, red-necked phalarope and semipalmated plover were observed in the area of the mine site. None of these species were common in that only isolated individuals were observed. In addition to these observations, a common snipe was heard but not seen in two widely separated locations.

Winter road

While conducting vegetation transects near km 161 on July 7, a golden plover was observed defending a territory.

Port site

Pectoral sandpipers were observed in three widely separated locations on the lowland west of the port site. A semipalmated plover regularly defended a territory near the mouth of the small stream south of the port site headland.

Shorebirds are protected by the Migratory Bird Convention Act (Canada) administered by the Canadian Wildlife Service. All are protected, and only snipe is hunted in southern latitudes.

The study area includes part of the historic nesting range of the eskimo curlew. Records describe nesting habitat as forest/tundra transition. Since 1930 eskimo curlew have been reported twelve times in Canada with eight of these reports from the NWT, all from the "lower Anderson River", with the last report in 1976. The forest/tundra transition nesting habitat described for this endangered species is west of the study area. The closest geographical place name in the COSEWIC status report on eskimo curlew is the Coppermine River (Gollop and Shier, 1978).

Mammals

Sixteen species of terrestrial mammals occupy the study area. Unlike the birds of the region, mammals are not migratory, except for caribou, and even some caribou remain on the tundra over the winter. The mammalian fauna here are a full complement of the natural ecosystem, in that no species has been extirpated from the region. All populations here are healthy, and although the muskox population was hunted to near extirpation 100 years ago, it has made a strong recovery.

The RERC guidelines (3.2.9) identified VECs mammal species that are to be described in relation to the project and related activities: wolves and wolverines, barren-ground grizzly bears, muskox and caribou. Their habitat and geographical distribution in the study area are reviewed.

The description of the VECs species' ecology is not intended to be either exhaustive or definitive, but is intended rather to discuss those aspects that are relevant to the developments under consideration by Metall. Where inadequate information on the presence or seasonal distribution of a VECs species is available, additional work by way of monitoring is described.

Wolf

The welfare of this large carnivore in the Northwest Territories is intimately tied to the distribution and abundance of caribou. The wolf *(Canis lupus)* has a holarctic distribution. Once spread throughout Canada with the exception of the Queen Charlotte Islands, wolves have been exterminated in large areas of southern British Columbia, the Prairie provinces, Ontario, Quebec and the Maritime provinces.

The basic social unit of wolf society is the family pack, which consists of a dominant male, his mate, their offspring and other close family members, usually totalling between four and seven in number. They are the dominant predator of large ungulate species and also take small game such as hare, ground squirrels, and mice. They will occasionally take ground-nesting birds, fish, berries, insects and grass. Wolves will return to a previous kill but are not carrion feeders in general. They are reported to mate for life. All members of the pack, however, take responsibility for the rearing the pups, which are born to the pack's dominant female in early May. The average size of litters is seven (range 5-14). Female pups are sexually mature at two years, males at three. Seasonal movements may occur as wolf packs follow migrating caribou herds (Banfield, 1974).

In a study of wolves at 209 dens (63 on the range of the Bathurst caribou herd) Heard and Williams (1992) projected statistically that most dens will be located at or near treeline. They concluded that wolves den at treeline because that is where the caribou are most likely to be in September when the nutritional demands of the growing pups are the greatest. The study did not locate any dens in the general vicinity of Izok Lake.

The wolf has traditionally been an important furbearing species in the Northwest Territories. Wolves are classed as furbearers and big game animals under the Wildlife Act (NWT) administered by the Department of Renewable Resources. The annual wolf harvest reported by Coppermine hunters/trappers averaged 126 over 6 years between 1986 to 1992 (range 77-200) (GNWT Renewable Resources unpublished). The wolf is not listed as an endangered species in the Northwest Territories.

Numerous observations of wolves have been made by camp personnel. Sightings reported in 1992 and 1993 are summarized in Table 3.2-71.

Table 3.2-71 - Wolf Sightings at Izok Project Camp and Nearby Activity Sites

DATE	NUMBER OF ANIMALS	LOCATION	REMARKS
1992 July 8	1	north of Izok	
July 18	1	east of Izok	greyish white
July 24	4	north of Itchen	full grown
1993 March 27	1	airstrip	running away
May 18	1	Itchen Lake	chasing caribou
May 20	1	Iznogoudh Lake	snoozing
May 21	1	airstrip	
June 12	1	Ham Lake	cruising
August 13	2	Izok	

Wolverine

This large and solitary carnivore *(Gulo luscus)* enjoys the respect of human and beast alike. In Canada wolverine are found primarily on the tundra of the Yukon and the Northwest Territories, where their distribution extends to northern Ellesmere Island.

The wolverine is a solitary species. Sexes associate briefly during mating season; family groups of females and their cubs during the first season are the only social groupings. Wolverines are omnivorous, primarily scavengers cleaning up carcasses left by wolves and bears, and also feeding on a wide variety of roots and berries, small game and fish. One litter of two to five young is born in late April or early May and the young remain with their mother until the following spring (Banfield, 1974). Wolverine are distributed throughout the study area. A study of wolverine ecology in Alaska reported the yearly ranges of adult wolverine. Adult males' ranges covered 488 km^2 to 917 km^2, while adult females with young covered 55 m^2 to 99 km^2 and females without young covered 68 km^2 to 178 km^2 (Magoun, 1985.)

Wolverines can be a costly nuisance to trappers as they sometimes follow traplines and destroy the catch. They also are known to break into and destroy caches of food, furs, and gear. Wolverine pelts are valued as parka trim for their frost-resisting quality. Wolverines are classed as furbearers and big game animals under the Wildlife Act (NWT) administered by the Department of Renewable Resources. The wolverine is not listed as an endangered species in western Canada or the Northwest Territories. Hunters/trappers of Coppermine take wolverine for domestic use and sale. Catches for recent years are reported in Table 3.2-72.

Field Observations

Wolverine have been observed at the Izok Project camp and nearby work sites. Also, on February 25, 1993 a wolverine was observed near the southern end of Napaktulik Lake during an aerial survey.

Table 3.2-72 - Annual Catch[1] and Value of Wolf and Wolverine Pelts Sold by Coppermine Harvesters

YEAR	WOLF		WOLVERINE	
	CATCH	$	CATCH	$
1986/87	200	20,772	42	11,045
1987/88	112	28,300	30	6,355
1988/89	112	28,071	15	4,835
1989/90	119	30,776	20	7,550
1990/91	77	28,434	15	2,730
1991/92	137	47,690	43	14,890

[1] These data show only the value and number of pelts sold. They do not show the number used for domestic purposes which probably exceeds the number sold for both species.

Table 3.2-73 - Observations of Wolverine at the Izok Project Camp on Ham Lake

DATE	NUMBER	LOCATION	REMARKS
1992 July 25	1	East of Izok Lake	charged a geologist
1993 Aug 12	1	Izok Lake	

Grizzly bear

Grizzly bears *(Ursus horribilis)* are the largest carnivore on the tundra and are resident throughout the region. Grizzly bears are found throughout Alaska, the Yukon, in the Rocky Mountains of Alberta and British Columbia, and in the mountain states of the US northwest. In the Northwest Territories, grizzly bears roam throughout the Mackenzie Mountains, much of the Mackenzie Delta, and most of the mainland tundra including the adjacent forest/tundra transition zone (Banfield, 1974). Grizzlies are extinct in most of their historic range, which included all of western North America south to central Mexico.

Adult grizzlies are mostly solitary except during the mating season. They shun human contact but may react fiercely when surprised, cornered, wounded or separated from their cubs. Their eyesight is poor but senses of smell and hearing are excellent. Grizzlies prefer open areas and are most active during evening, night and early morning hours, usually napping during the day. Their diet is omnivorous, including roots, berries, fish, small mammals, and sometimes large mammals. They will also scavenge, cleaning up carcasses of winter-killed big game. Mid-November to April is spent in a den or natural shelter, though male bears may be active for short periods at any time of the winter. They usually emerge from their winter rest earlier than females with cubs, who emerge in late May. Eskers are a common denning habitat on the tundra for grizzles. Sows breed every second year and cubs remain with their mother for their first two winters. Sexual maturity is reached at an age of six to seven years (Banfield, 1974).

Studies on the grizzly bear have not been conducted in the Izok Project area however, the GNWT Department of Renewable Resources has been studying the grizzly population in the area west and south of Coppermine. It determined a density of one bear for every 212 km^2. The age of first breeding for females was 7.33 years. Breeding females have a mean home range size of 1350 km^2. Territories for adult males are larger than for females (Nagy, 1983; Craighead and Mitchell, 1982). Two females were captured near Bloody Falls and monitored for five years. One remained within 10 km to 30 km of Coppermine and the cabins along the west side of the Coppermine River.

In that period these bears have not been reported as a nuisance there (Renewable Resources, unpublished, and Ray Case, pers. comm.).

Statistics on problem grizzly bears killed in the central mainland tundra since 1967 show characteristics of the animals killed. Of the 48 reports only three were identified as adult females. Two were accompanied by two cubs each. (Data on sex and age for five bears was not provided in the kill report.) Of the remaining 41 bears in the statistics, 25 were immature, of which 12 were male and seven were female. Six reports did not identify the sex of the young bear (Renewable Resources, unpublished). On the face of these data, it would appear that killing "problem" bears has little effect on the adult female cohort of the population. The probability is high that a "problem bear" will be an immature male.

Of the 48 bears included in the statistics, there is only one report from Lupin Mine. In that case a female with two cubs had to be destroyed after being been removed from the area twice by helicopter. They returned from the release site 200 km away.

Except as suggested by the data cited for immature bears above, grizzly bears do not normally seek out sites of human occupation unless they are attracted by food. Grizzlies can very quickly become habituated to "a free lunch" (Follmann and Hechtel, 1990). This Alaska study concluded:

- *Conscientious food and waste management, fencing of permanent and semi-permanent facilities, education and prompt action whenever potentially troublesome situations occur all can reduce the types of bear problems that were encountered.*
- *We predict that application of these solutions will result in fewer bears being killed and that economic losses incurred by contractors will be significantly reduced.*

Coppermine hunters have killed an average of 6.2 bears per year since 1981 (range 2-13); of this average annual kill 1.4 bear have been problem bears (range 0-4) and 1.2 have

been female bears (range 0-4) (GNWT Renewable Resources unpublished data). Grizzly bears are included in the Wildlife Act (NWT) administered by the Department of Renewable Resources. While they are not listed as an endangered species in Canada, all grizzly populations in Canada are considered "vulnerable" by COSEWIC. Grizzlies are included in Appendix II of CITES, which means that export and import permits are required for international shipments of grizzly bears or their parts.

Outfitters serving sports hunters in the study area do not have a quota for grizzly at present.

Field Observations

The nearest bear sign to the Izok Camp noted during the April 1993 reconnaissance surveys was in the of the Coppermine River valley approximately 60 miles (96 km) to the west. Several observations of grizzly were made at the Izok Project camp on Ham Lake (see Table 3.2-74 below).

Table 3.2-74 - Grizzly Bear Sightings at Izok Project Field Sites

DATE	NUMBER	LOCATION	REMARKS
1992	No reports		
1993 May 18	1	Ham Lake Camp	Passing through
May 31	2	S. end Napaktulik Lake	Crossing lake
July 26	1	W. side Ham Lake	
July 26	1	E.side Iznogoudh Lake	
Aug 12	2 (female + cub)	Ham Lake esker	
Aug 31	4 (female + 3 cubs)	Iznogoudh Lake, west shore	

It is not possible to determine from this sighting record if the vicinity of the mine site is in one (or more) active territories. It should be assumed that it is within the territory of both an adult male and a reproductively active female. Figure 3.2-94 shows the eskers throughout the study area that were observed during an aerial survey on May 28 and 29, 1993 for signs of recent grizzly activity. Fresh grizzly tracks were observed in two locations — west of Napaktulik Lake and north of the same lake.

Muskox (Ovibos moschatos)

This large tundra ungulate is resident throughout the study area. The historic range of muskox included the entire mainland tundra of NWT and most of the arctic islands. Overhunting in the 1800s reduced numbers to the point where all hunting in Canada was banned in 1917. The most serious reductions in the populations occurred on the mainland, which was accessible to hunting parties and explorers who traded the hides as carriage robes. Muskox have made a strong recovery throughout their range. Recolonization of mainland ranges has progressed slowly but steadily, and now muskox are again hunted, under quota. Ranges to the west and south of Bathurst Inlet have been recolonized more slowly than the range east of Bathurst Inlet (Barr, 1991). Muskox are not migratory like the caribou but relatively sedentary, moving more in response to feeding conditions than to innate seasonal triggers (Hubert, 1974). Their diet includes all classes of tundra vegetation from willow to lichen (personal observations, and Gunn, 1982). Herd size varies from season to season, and is largest in winter (Tenner, 1965; Hubert, 1974), however large herds (> 20 head) may be encountered at any time of year.

After reviewing the current status of muskox, Barr (1991) concludes that the muskox is in "a safer position than it has been at any time since it was first encountered by Europeans". In assessing risks to muskox it is probably safe to say that in the absence of wanton habitat destruction, the animal is largely immune to the hardships of the environment except under weather conditions that result in extremely heavy wet snow under freezing conditions (Barr, 1991). Muskox cannot withstand indiscriminate hunting but have demonstrated that they can accommodate and indeed become habituated to certain activities associated with resource development activities on their ranges without



Esker habitat surveyed for grizzly bear sign, May 28 and 29, 1993.

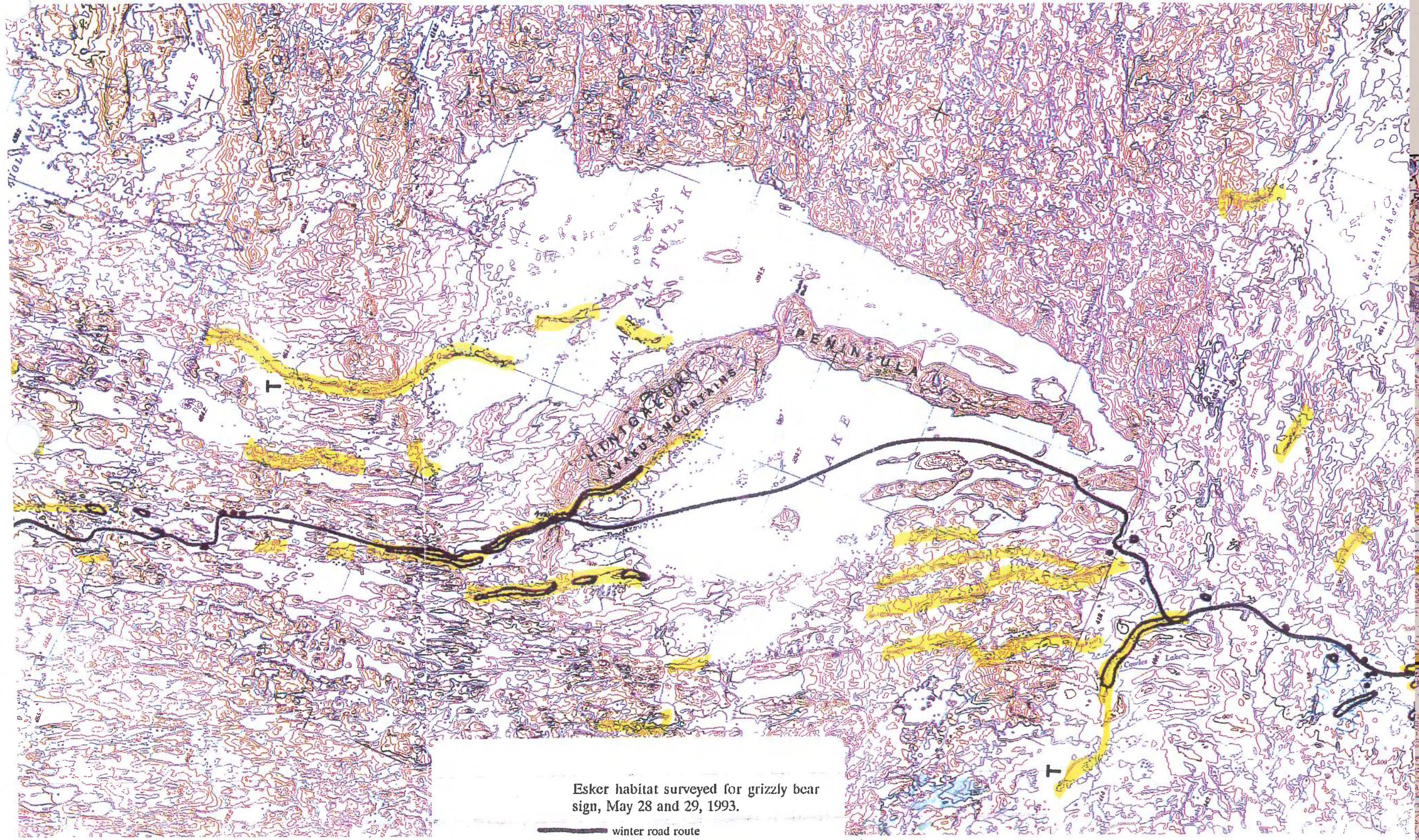
winter road route

esker examined in aerial survey

prospective borrow sources

FIGURE 3.2

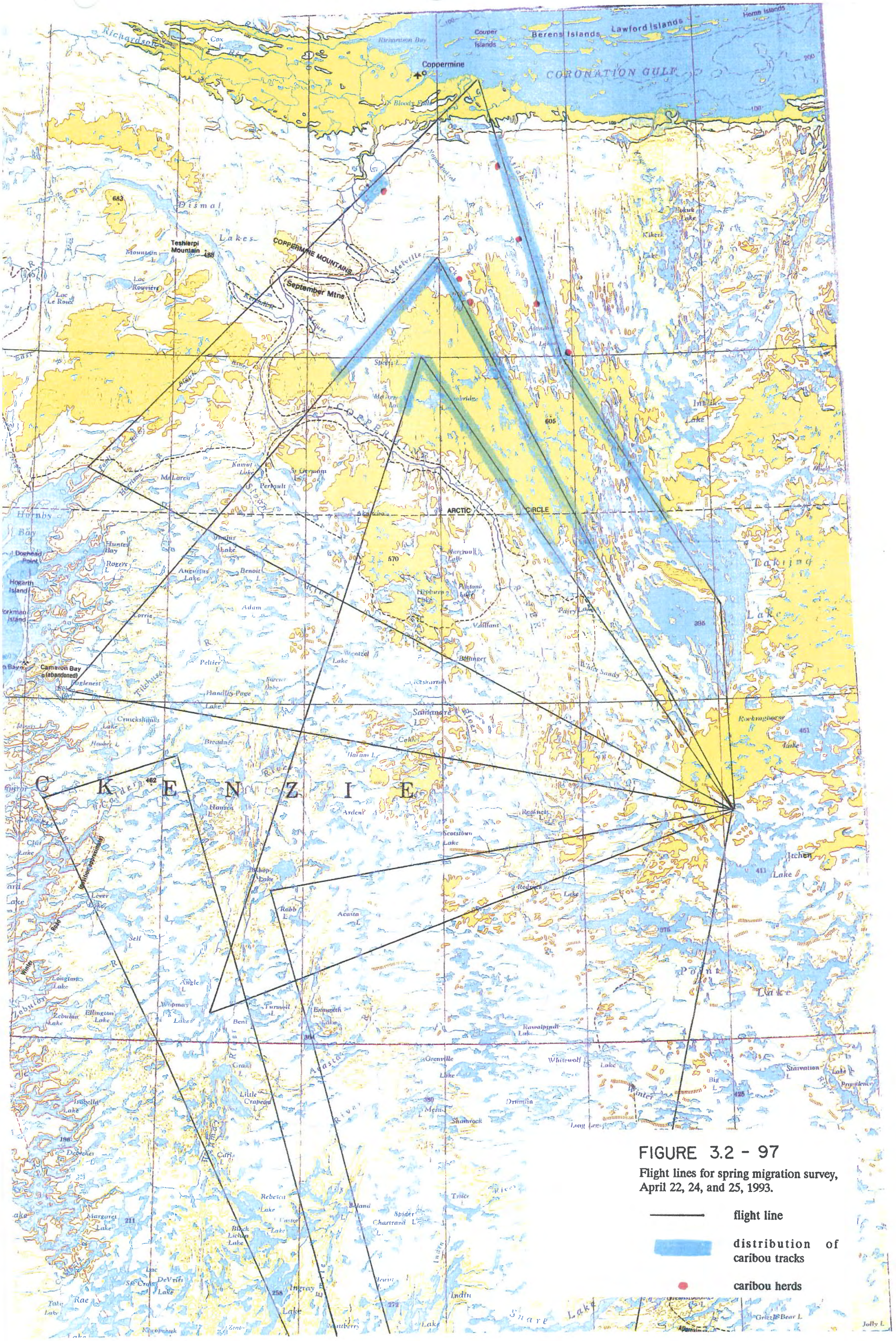
JRE 3.2



Esker habitat surveyed for grizzly bear sign, May 28 and 29, 1993.

- winter road route
- esker examined in aerial survey
- prospective borrow sources
- T grizzly tracks observed during survey

FIGURE 3. - 94
(cont.)


Richardson
Cox
River
Richardson Bay
Couper Islands
Berens Islands
Lawford Islands
Home Islands
Coppermine
CORONATION GULF
Bloody Falls
Dismal Lakes
Teshierpi Mountain
COPPERMINE MOUNTAINS
September Mtns
Loc Rouvière
Loc Le Roux
Kendall R.
Kelsey Lake
Kikerk Lake
Bukut Lake
Inman Lake
Coppermine R.
ARCTIC CIRCLE
Hornby Bay
Dorhead Point
Hogarth Island
Workman Island
Hunter Bay
Rogers L.
Augustus Lake
Benoit L.
Adam
Lorrie L.
Pelitier L.
Cameron Bay (abandoned)
Eaglenest L.
Handley Page Lake
Cruickshanks Lake
Hooker L.
Breadner L.
Kamut Lake
McLaren
Perrault L.
St. Germain
Thaidus Lake
Wentzel Lake
Vaillant
Bellinger
Fairy Lake
Pointed Lake
Horseshoe Lake
Morgan Lake
Whitesand R.
Hornaday R.
Snare Lake
Scotstown Lake
Redrock Lake
Ichen Lake
Point Lake
Rawalpindi Lake
Whitewolf Lake
Grenville Lake
Starvation L.
Big L.
Winter
Drimdin L.
Shamrock
Long Lake
Trice
Spider
Chartrand L.
Rebecca Lake
Margaret Lake
Black Lichen Lake
Isabella Lake
Longtime Lake
Zebulon Lake
Ellington Lake
Angle L.
Wrigley
Turnwell L.
Bent
Crapeau L.
Little Crapeau L.
Carle L.
Decocker L.
Grant L.
Aguascie River
Ingray
Lake
Rae
Lac De Cruz
DeVries Lake
Self L.
Rabb L.
Acasta L.
Redrock L.
Indin
Grizzly Bear L.
Jolly L.
Mattberry
Kuptchuk
Lever Lake
Bishop Lake
Hansen L.
Ardent
Scotstown Lake
Redrock L.
Ichen Lake
Point Lake
Snare Lake
Grizzly Bear L.
Jolly L.
Tsotilon approximate
Road
Winter
Hanna L.
Celia
Saimangaré L.
Rockingwater Lake
Inman Lake
Kikerk Lake
Bukut Lake
Coppermine R.
Kendall R.
Kelsey Lake
Whitesand R.
Hornaday R.
Snare Lake

being displaced (Gunn, 1982). Eureka, Truelove Inlet, and Polar Bear Pass on Bathurst Island are a few locations where camps served by aircraft have co-existed with muskox for many years with no apparent effect on the animals' seasonal activities and distribution.

Muskox are not numerous around the proposed mine site but herds are seen in the area during the summer months. Aerial surveys for muskox conducted over the area from the headwaters of the Hood, James and Mara Rivers west to Coppermine (115° W) and south to Rocking Horse Lake (approximate southern boundary of survey) in the summer of 1991 revealed an estimated population of 1,403 muskox. The frequency of observations was highest north of Contwoyto Lake and lowest in the southwest quadrant of the survey area. Only one herd was noted in the area surveyed (approximately 16 000 km^2) between 113° and 115° W in the transect survey covering 10% of the area (Department of Renewable Resources unpublished report).

Muskox have probably been hunted as long as they have occupied the same range as humans. All muskox hunting in the NWT is managed by the Department of Renewable Resources with quotas for muskox management areas. A quota of 80 animals is in place for muskox in the study area north of 66°. These animals may be taken by local aboriginal hunters for subsistence needs, by non-aboriginal hunters for recreational/domestic needs, and by non-resident trophy hunters. Like caribou, muskox represent considerable economic potential for local hunters and outfitters.

Muskox are protected under the Wildlife Act (GNWT) administered by the Department of Renewable Resources. They are named in an Order-in-Council pursuant to the NWT Act (Canada) to be a species "in danger of becoming extinct." This designation was deemed necessary for government to regulate harvests by native hunters taking muskox for food. Muskox are not listed as endangered in any other national or any international wildlife conservation convention.

Field Observations

No muskox were observed during aerial wildlife surveys in winter or summer. Observations of muskox by camp personnel are provided in Table 3.2-75.

An annual quota of 80 muskox is shared equally among the communities of Coppermine, Bathurst Inlet, Bay Chimo and Cambridge Bay. The area to which this quota applies (F2-2) extends from the Coppermine River easterly to 107° W. The quota area includes the port site and the winter road south to 66° N. (just south of Napaktulik Lake).

Table 3.2-75 - Observations of Muskox at the Ham Lake Camp and Nearby Locations, 1992 and 1993

DATE	NUMBER	LOCATION	REMARKS
1992 July 28	1	south of camp	
July 29	1	airstrip	
Aug. 20	~ 30	airstrip	several calves
1993 April 27	35	Leanne Lake	
June 22	10	Ham Lake north	2 calves
June 29	1 male	east of airstrip	
June 30	1 male	airstrip	
Aug. 6	16	east of Iznogoudh	3 yearlings
Aug. 7	16	north of Iznogoudh	1 male, 3 yearlings, 3 subadults, 8 females
Aug. 9	16	north of Iznogoudh	1 male, 3 yearlings, 3 subadults, 8 females
Aug. 9	1 male	Ham Lake east	
Aug. 10	16	airstrip east	
Aug. 31	31	airstrip	

Caribou (Rangifer tarandus)

Perhaps the most conspicuous and widely distributed of the large game animals on the tundra, caribou occupy the study area in varying numbers throughout the year. The mine site, winter road and port site are all located in the range of the Bathurst caribou herd. Caribou herds in the Northwest Territories are named after a major landmark near to the herd's traditional calving grounds. In this case, the herd that occupies the study area is named after Bathurst Inlet.

Caribou are covered by the Wildlife Act (NWT) which is administered by the Department of Renewable Resources. Caribou were designated to be "in danger of becoming extinct" by Order-in-Council under the NWT Act (Canada). This was deemed necessary to regulate harvesting by "Indians" and "Eskimos". No restrictions have been placed on the harvest of caribou from the Bathurst herd by aboriginal people for food (Renewable Resources, unpublished). Barren-ground caribou are not listed as endangered in any other domestic or international wildlife conservation convention.

For the purposes of this report those caribou that cross from the mainland to Victoria Island will be named Victoria Island caribou. A report prepared for COSEWIC on the status of caribou on the Canadian Arctic Islands recommended that caribou there be differentiated into Peary Caribou (Queen Elizabeth Islands — north of Lancaster Sound/Viscount Melville Sound) and "arctic island caribou" which include the Victoria Island caribou. The Victoria Island caribou display some of the physical and ecological characteristics of the Peary Caribou but are not classed as endangered as are the Peary Caribou of the Queen Elizabeth Islands. COSEWIC has designated the caribou on Victoria Island and island populations to the east (King William Island, Prince of Wales Island, Sommerset Island) as "threatened" (Miller, F. 1991).

Bathurst Caribou Herd

Abundance and Seasonal Distribution

The Bathurst herd increased from 100,000 to 120,000 adults in 1979 to 484,000 in 1986 (Department of Renewable Resources, unpublished). The most recent population

estimate for the herd placed its size at 352,000 in 1990. The growth of the herd between 1979 and 1986 was likely associated with immigration of animals from an adjacent caribou herd, and since there has been high survival of caribou calves in the years since 1986, the apparent decline between 1986 and 1990 is not considered to be as severe as a comparison of the 1986 to 1990 population estimate indicates (Renewable Resources, unpublished).

Most of the animals in this herd spend the winter (October through mid-April) at or within the treeline in a broad band from Hottah Lake south of Great Bear Lake east to the forests north of the East Arm of Great Slave Lake. Kelsall (1968) provided numerous winter range maps that show this herd wintering as far west as the Mackenzie River in the early 1950s. The summer range on the tundra stretches from the Coppermine River east to the Perry River including the lands north of the Back River.

Winter Range

It is well known that not all the caribou of this herd spend their winter in the forests south and west of their summer range (Land Use Information Map, 86O, Environment Canada, 1978). Kelsall (1968) shows that, between 1948 and 1960, caribou spent the winters of 1951/52, 1955/56, 1958/59, and 1959/60 on the tundra between the Coppermine River and Bathurst Inlet in significant numbers. Also, there were caribou in the vicinity of Coppermine throughout the winter of 1974/75.

Information on the distribution and migratory habits of the Bathurst Herd up to 1980, was compiled in an unpublished report for the GNWT Department of Renewable Resources (Urquhart, 1981). In summing up the assembled data on the geographic range of the Bathurst Herd, Urquhart concluded in part:

- "The entire known winter range of the Bathurst Herd is virtually equal to the entire known range of this population."

- "Some winter ranges are used for many years in succession but none are occupied every year without fail."
- "There are no areas within this population's range that are known to have been unoccupied every winter."
- "The most frequently recorded winter ranges of the Bathurst Herd are: Hottah Lake, Gordon Lake, McLeod Bay, Artillery Lake, Caribou Point, Dismal Lake, Coppermine River, Coronation Gulf coast and north Bathurst Inlet."
- "There is probably some winter range overlap between the Bathurst and Bluenose herds and between the Bathurst and Beverly herds."

Migration

Caribou start the spring migration from their winter ranges to a common calving ground in mid-April. By late May the females of the herd are on the calving ground. In early June, 75% of the calving occurs within a space of five days (Calef, 1981). The yearlings of the herd are near the edges of the calving ground at this time, with the bulls en route to the summer range.

Urquhart's conclusions on spring migratory patterns of the Bathurst Herd included:

- "The routes followed by the taiga wintering herds are dependent upon topography, annual snow conditions and where the animals happen to be concentrated in late winter. Thus the specific routes used each year are practically unique although they are composed of parts of routes used for centuries."

After calving, the herd may or may not combine into one mass of animals. It is not uncommon for the bulls to remain segregated from the cow/calf herd for the summer. During the early stages of the post-calving period in June and July, caribou stay in one or several aggregations which may number in the thousands, and remain within the general region of the calving ground. In late July they move away and reach their maximum summer distribution in August (Kelsall, 1968). In late July it is common to see

caribou in large numbers moving south past the northerly and southerly extremities of Contwoyto Lake (Urquhart, 1981).

The herd approaches the treeline along a broad front in early September and will stay in the forest-tundra transition zone until breeding has been completed in late October. Following the rut, the herd breaks into smaller groups and disperses throughout the winter range.

Social and Economic Role of Bathurst Caribou

Caribou have been the main source of food, clothing and shelter for northern cultures for millennia. They remain important today. A rough economic value of the Bathurst herd prepared by the Department of Renewable Resources estimates the overall economic value of the annual harvest from this herd to exceed $13 million. This total includes the result of applying the replacement cost of beef in the smaller communities to the combined harvest in the following categories:

GHL (general hunting licence)	$10,580,000
Resident hunters	649,000
Non-resident hunters	1,100,000
Commercial tags	831,000
	$13,160,000

This estimated value does not include secondary economic benefits such as purchase of supplies and services by resident and non resident hunters. These values show the importance of the Bathurst herd to aboriginal hunters (GHL), non-aboriginal hunters (resident) and the growing number of non-resident hunters who must secure the services of a northern guide or outfitter. The herd also represents a tremendous potential for commercial development of caribou meat.

Table 3.2-76 - Harvest of Caribou (Bathurst Herd) by General Hunting License Holders

COMMUNITY	POPULATION[a]	GHL HOLDERS[b]	MAX. HARVEST SINCE 1980	TYPE, YEAR[c]
NUNAVUT				
Bay Chimo/Bathurst*	80	51	627	E,88/89
Cambridge Bay*	1,027	311	140	E,87/88
Coppermine*	956	322	227	E,88/89
Subtotal:	2,063	684	994	
DENE/METIS				
Fort Rae/Edzo*	1,443	574	5999	E,87/88
Yellowknife/Dettah*	13,142	954	1445	E,80/81
Rae Lakes*	188	103	2289	E,87/88
Lac la Martre*	413	113	877	E,88/89
Snare Lake*	123	44	1255	E,87/88
Fort Smith	2,505	699	828	E,83/84
Hay River	3,008	465	269	E,80/81
Fort Resolution	475	372	132	E,82/83
Snowdrift	263	125	125	R,83/84
Reliance	11	3	8	R,78
Fort Good Hope	586	279	1,129	R,80/81
Fort Franklin	550	292	991	E,83/84
Fort Norman	360	137	72	R,81/82
Fort Providence	577	325	164	R,83/84
Fort Simpson	1,006	424	178	E,83/84
Wrigley	161	99	50	E,77/78
Subtotal:	24,811	5,008	15,811	
TOTAL:	26,874	5,692	16,805	

[a] Data from GNWT Bureau of Statistics, 1989. Population Estimates Northwest Territories June 1988.
[b] All data for up to August 1990. Source: NWT Department of Renewable Resources data summary.
[c] Estimated harvest (E) or reported figures only (R) and year for which data was obtained also included.
* Primary user community.
Source: GNWT Department of Renewable Resources unpublished data.

Table 3.2-77 - Resident Hunter Harvest of Bathurst Caribou 1981/82 - 1990/91

YEAR	NUMBER OF HUNTERS[1]	ESTIMATED HARVEST[2]
1981/82	467	250
1982/83	567	389
1983/84	696	924
1984/85	706	348
1985/86	602	432
1986/87	778	1,065
1987/88	990	1,905
1988/89	1,011	1,437
1989/90	-	1,547
1990/91	1,094	2,004

[1] Number of hunters who purchased tags in the primary user communities (see Table 3.2-76).
[2] From hunter harvest questionnaire forms.

The overall annual range of the Bathurst herd places it within hunting reach of 19 communities. Some are directly on the range while others have access by way of the Lupin winter road. Tables 3.2-76 and 3.2-77 summarize the harvest statistics that are provided by the GNWT Department of Renewable Resources. It is noteworthy that a significant portion of the annual value of the Bathurst herd is the direct result of access provided by the Lupin winter road. The harvest along the winter road was monitored from a hunter check station in winter from 1979/80 through 1984/85. A minimum annual harvest total of 3,700 caribou is reported for this six-year period. It is felt that the winter harvest along the road has increased since these data were assembled (Renewable Resources, unpublished).

Bluenose Caribou Herd

Two different studies have surveyed the overall Bluenose range since 1975. Studies by Hawley in 1974/75/76 and Carruthers and Jakimchuk (1981) for Polar Gas in 1980/81 both conducted extensive surveys in summer and in winter. Both studies found that animals from this herd winter close to Coppermine in the Rae-Richardson valley. Also, both studies showed the Coppermine River as the eastern extremity of the normal range for

this herd. This general distribution of the Bluenose herd was also described in a GNWT Renewable Resources study of wolf dens in relation to caribou ranges (Heard and Williams, 1992).

The wildlife survey conducted for the Izok Project in April, 1993 did not find any caribou west of the Coppermine River and revealed very few caribou tracks there suggesting that the Coppermine River valley and adjacent lands were not used by Bluenose caribou during late winter of 1993.

Hawley (1979) however included April 1976 observations of Bluenose caribou migrating to their calving ground from the vicinity of Hottah Lake, as well as caribou from Caribou Point (Great Bear Lake) heading toward Bathurst Inlet. It appears that there is ample opportunity for mixing in the two herds on their winter ranges.

1993 Field Studies

Bathurst Caribou Herd

Wildlife surveys conducted for the Izok Project in January, February, March and April 1993 showed that caribou occupy the area north of Napaktulik Lake throughout the winter. The distribution of caribou in the area of the winter road (north of Napaktulik Lake) was observed on the surveys to be light but continuous over approximately 75 km of the winter road route. Caribou between the proposed mine site and the north end of Napaktulik Lake were very scarce. Relatively low numbers were observed on each survey with the greatest numbers observed in March (2.9 caribou per km of survey line) which dropped in April (.7 caribou/ km). However in April there was continuous sign that caribou had moved from west to east through the area of the winter road. Tracks were observed west to the highlands bordering the Coppermine River. No caribou tracks were observed crossing the Coppermine River in either direction.

The major migration routes of caribou from the winter range within treeline did not pass near the mine site in the spring of 1993. Figure 3.2-95 shows the range of the Bathurst herd.

FIGURE 3.2 - 95

Ranges of Bathurst and Bluenose caribou herds


Bathurst herd
Bluenose herd
calving ground (after Heard & Williams 1991)
Izok mine site
GULF
Prince Albert Sound
120°
115°
70°
WOLLASTON PENINSULA
HILLS
Read Island
Cambridge Bay
Coppermine
Kent Peninsula
Perry River
Bathurst Inlet
Port Radium
Great Bear Lake
Point Lake
Lac de Gras
Yellowknife
Fort Providence
Fort Reliance
Thompson Landing
Snowdrift
Nonacho Lake
Rennie Lake
Firedrake Lake
Coventry
Manchester Lake
Porter Lake
Hjalmar Lake
Halliday Lake
Doran Lake
Rocher River
Lake Providence
Gros Cap
Gypsum Pt.
Caribou Pt.
Moraine Pt.
Sulphur Pt.
Redrock Pt.
Arm
Dismal Lakes
Kikerk Lake
Contwoyto Lake
Courageous Lake
Artillery Lake
Aylmer Lake
Clinton-Colden Lake
Mary Frances Lake
Walmsley Lake
Beaverhill Lake
Mosquito Lake
Garde Lake
Whitefish Lake
Tyrrell Lake
Eyeberry Lake
Campbell Lake
Lynx Lake
Howard Lake
Gravel Hill Lake
Eileen Lake
Noman Lake
Tent Lake
Penylan Lake
Damiant Lake
Brooks Lake
Gagnon Lake
Thubun Lakes
Lac la Martre
Marian Lake
Weyburn Lake
Russell Lake
Clive Lake
Horn Lake
Fawn Lake
Birch Lake
Mink Lake
Caen Lake
Dieppe Lake
Calais Lake
Falaise Lake
Hottah Lake
Wopmay Lake
Exmouth Lake
Rawalpindi Lake
Whitewolf Lake
Hardisty Lake
Rebecca Lake
Ingray Lake
Indin Lake
Snare Lake
Mayberry Lake
Faber Lake
Sarah Lake
Basler Lake
Kwejinne Lake
Wecho Lake
Jolly Lake
Warburton Bay
Lockhart Lake
Camsell Lake
Wheeler Lake
Slemon Lake
Benjah Lake
Gordon Lake
Duncan Lake
Prosperous Lake
Hearne Lake
Francois Lake
Redrock Lake
Gagnon Lake
Nonacho Lake
Ennadai Lake
Ellice River
Western Arctic
Bathurst
Banks Pen.
Wilberforce Falls
Hood River
Kathawachaga Lake
Contwoyto Lake
Nose Lake
Pelly Lake
Ghurka Lake
Baillie River
Musk-ox Lake
Tourgis Lake
Sifton Lake
Hanbury River
Thelon Game Sanctuary
Mackenzie Mountains
Great Slave Lake
Yellowknife River
Back River
Coppermine River
Richardson Mountains
Horton River
Anderson River
Kendall River
Dease Strait
Queen Maud Gulf
Simpson Bay
Dolphin and Union Strait
Cape Young
Cape Bexley
Cape Barrow
Cape Back
Cape Baring
Cape Ernest Kendall
Lady Richardson Bay
Tinney Pt.
Williams Pt.
Clifton Pt.
Clinton Pt.
Cape Thompson Pt.
Cape Peel
Cape Alexander
Byron Bay
Turnagain Pt.
Melville Peninsula
Hope Bay
Buchan Bay
Lewes Lake
Wilmot Island
Richardson Is.
Murray Is.
Lambert Is.
Cache Pt.
Lady Franklin Pt.
Duke of York Archipelago
Locker Pt.
Basil Pt.
Cape Krusenstern
Cape Hearne
Hepburn Island
Forsyth Bay
Cape Kellett
Cape Parry
Cape Lyon
Cape Barrow
Cape Bexley
Cape Young
Cape Krusenstern
Cape Hearne

Winter Surveys

The literature (Urquhart, 1981) and community caribou harvest data show that caribou frequently overwinter on the tundra within reach of Coppermine hunters. Fixed wing aerial surveys to describe the distribution and relative abundance of caribou in the vicinity of the winter road to Coronation Gulf were flown monthly beginning January 1993. Figure 3.2-96 shows the flight lines for the surveys that were repeated in February, March and April. The winter road alignment was preliminary when these surveys were initiated which explains the flight lines deviating from the present winter road alignment. The results of these surveys show caribou use of habitats in the area described above near km 161. Caribou were observed on the surveys in January, February and March. The geographical distribution for caribou observed on these surveys is summarized in Table 3.2-78.

Table 3.2-78 - Caribou Observed on Winter Aerial Surveys Over Izok Project Study Area

SURVEY DATE	# CARIBOU	# HERDS	AV. HERD SIZE	DISTRIBUTION	RELATIVE ABUNDANCE CARIBOU/KM
Jan. 28	136	11 (3-22)	11.4	89 km[1]	1.3
Feb. 25	67	13 (1-14)	4.6	110 km	.5
Mar. 31	426	29 (2-50)	14.8	148 km	2.9
Apr. 24/25	160	7 (2-100)	22.9	230 km	.7

[1] Flight line distance covering caribou presence.

Spring Migration Surveys

The literature cited by Urquhart (1981, unpublished) provides numerous references to the routes and staggered timing of cow and bull caribou migrations in spring. Extensive fixed wing surveys were flown on April 22, 24 and 25, 1993 to determine if the 1993 spring migration would bring caribou to or through the study area.

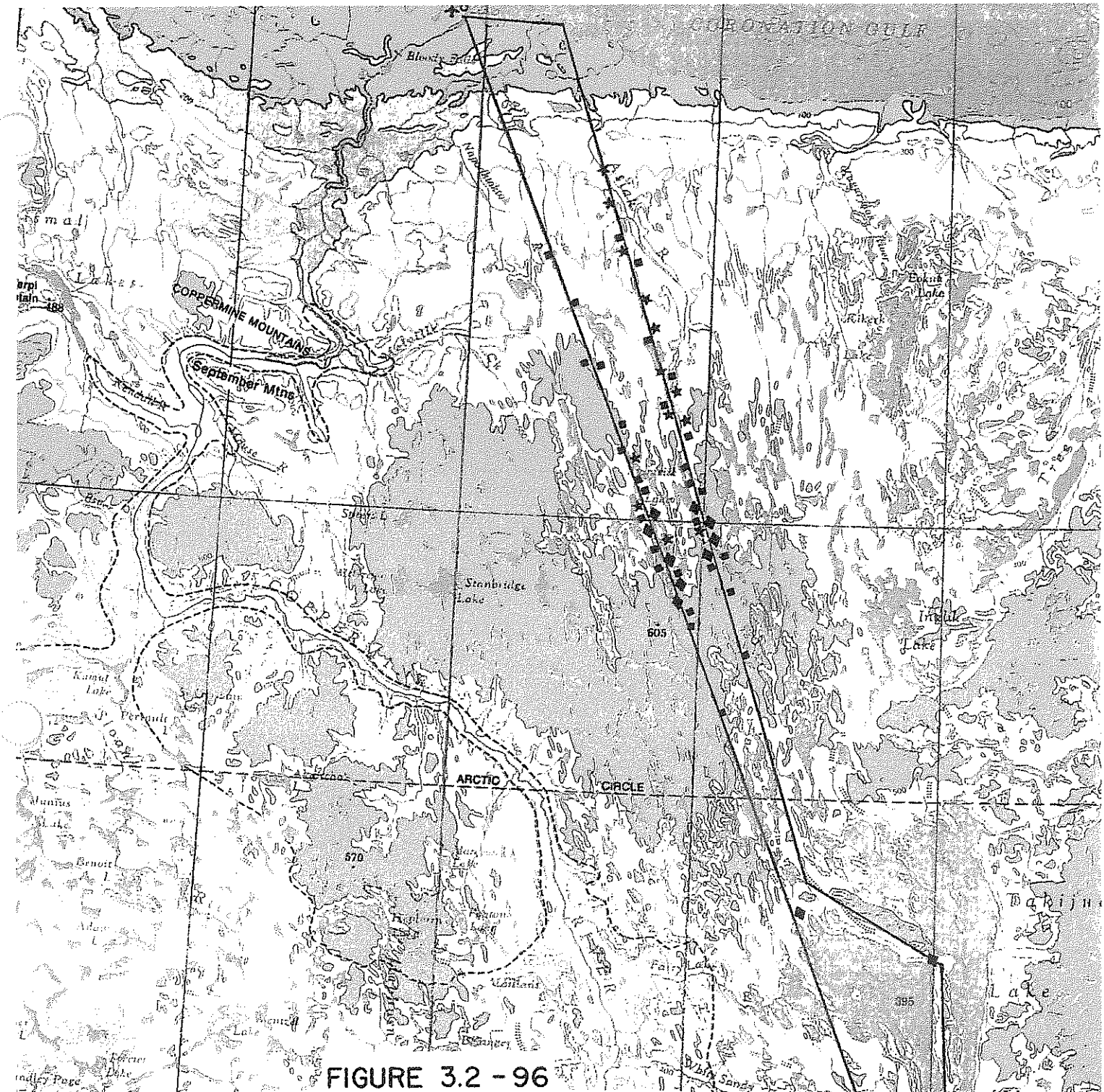


FIGURE 3.2 - 96

Winter wildlife survey flight lines.

- ♦ January 28 observations
- ★ February 25 observations
- ■ March 31 observations
- W wolverine observed Feb.25

The distribution of caribou observed during the April survey showed that caribou had left the study area in the north. In addition to animal presence, feeding sign and tracks were also recorded during all surveys. Distribution of tracks matched distribution of caribou observed for the winter surveys (January, February and March). Fewer herds were observed but feeding sign and tracks in low density were noted for the entire distance from Napaktulik Lake north to the rough terrain near the Coronation Gulf coast (km 266). The caribou tracks and trails were oriented in an easterly and southeasterly direction. The April survey of the winter road alignment was part of a larger regional reconnaissance (Figure 3.2-97) which revealed that almost all of the caribou that had overwintered on the tundra within and in the vicinity of the Izok Project study area had departed for the calving ground. Very few light caribou trails were observed near Izok. These tended in a northerly direction until the latitude of Napaktulik Lake where they changed course for a northeasterly destination. The wildlife sighting records for the Izok camp showed relatively few caribou passing through the mine site and vicinity in April and May 1993. The distribution of caribou observed on the south eastern portions of their forested winter range indicated that movement toward the Bathurst Inlet calving grounds would take migrating animals well east of the study area. Anecdotal information from camps and pilots confirmed this migratory pattern for April and May 1993.

The 1993 spring migration of some Bathurst Herd bulls showed a different pattern and schedule. Izok project drilling personnel in a camp near the south east shore of Napaktulik Lake reported large numbers of male caribou passing the camp throughout the month of June. This was a repeat of similar observations that were made there in June 1992. This pattern may show the bulls migrating to the tundra to be met by the cows after calving rather than migrating to the calving grounds. Numerous bulls were observed resting on snowbanks along the winter road alignment during the July 2 survey for raptor nest sites. This pattern of migration is common in the caribou literature (i.e. Pike, 1892, in Urquhart recorded the description of caribou migration given by the Yellowknife Indians).

Kelsall (1968) provides numerous maps describing the annual spring migration of the Bathurst Herd which were reviewed in Hubert and Associates wildlife inventory filed in November 1992. Thomas (1969) provides details of a specific migration sequence which is noteworthy as it shows the concentrations of animals which are possible and the rate of advance that a large, concentrated herd displays in spring migration.

Several consecutive surveys in the spring of 1967 showed the Bathurst herd mustering east of Great Bear Lake in late March and early April. Table 3.2-79 shows the highlights of the survey observations covering the March 16 to April 16 period as the herd advanced towards and through what is now the Izok Project study area. At the pace this herd was moving when observed on April 25, 1967 it would have crossed the proposed winter road south of Napaktulik Lake around May 1 or 2 and would have taken a full day for the bulk of the herd to pass any given point at this time of the migration. Had they maintained the density of April 18, it would have taken 1.5 to 2 days for the bulk of the herd to pass a given point. Data from similar surveys of the Beverly Herd in 1967 showed that herd to be travelling at rates of 25 km per day between May 5 and 19. It may be that the pace increases as the concentrations increase and the season advances. This may suggest that the rate of 5.8 km/day calculated for the Bathurst Herd in Table 3.2-79 above is a conservative value and that the herd may in fact have crossed the area of the winter road a day or two earlier than estimated.

Such spectacular spring concentrations may be the exception rather than the rule. Between April 17 and 20, 1985, "tens of thousands" of caribou were observed strung out from Camsell River through Rocknest Lake with the vanguard moving from Napaktulik Lake toward Rockinghorse Lake (Mark Williams, GNWT biologist, pers. comm.). This observation was considered to include "a significant portion of the Bathurst Herd". The herd was strung out over a distance of 260 km (Camsell River to Rockinghorse Lake).

Table 3.2-79 - Size, Concentration and Rate of Progress of the Bathurst Herd Spring Migration in 1967 (from Thomas, 1969)

DATE	ESTIMATED HERD SIZE	AREA COVERED (km^2)	DENSITY (km^2)	RATE OF MOVEMENT
March 18		5,220	-	-
April 9	69,500	2,930	23.7	-
April 18	75,000	330	230.3	-
April 25	93,000	105	885.7	5.8 km/day

At the rate of progress observed by Thomas in 1967 for the Beverly Herd, the caribou observed at Camsell River on April 17 would have passed the winter road around April 27. Under these conditions, Williams' observation suggests that there could have been a constant stream of caribou over the winter road for 10 - 11 days beginning April 16.

1993 Summer Observations

Mine site

Field studies at the mine site were conducted in two periods: June 29 to July 8, and again from August 6 - 10. Only two caribou were seen at the mine site on the first visit. On June 30 a lame cow attended by a yearling were observed grazing in the valley immediately south of Izok Lake destined for waste rock disposal.

During the period August 6 to 10 caribou were present at the site but were not numerous. Camp personnel reported the first summer caribou in the area on July 24 when an estimated 1000 animals approached the area from north east of Ham Lake, spent a day feeding in the area south and east of the airstrip and then departed in a southwesterly direction beyond Iznogoudh Lake. In 1992 the first caribou was also reported on July 24 but at no point was more than one caribou reported on the wildlife siting log kept at the camp.

In order to document the abundance of caribou in the area of the mine site in August 1993, timed counts were conducted at several vantage points from where a large area of the proposed mine site could be viewed with binoculars and spotting scope. Table 3.2-80 shows the results of these observation sessions. The caribou in the area seemed relatively sedentary in that the number of animals observed in these sessions did not change more than one or two during a session of two hours or more. When an animal did not show up in the count that had been seen earlier, it was often found later having emerged from behind a ridge or rock. While this technique is not very precise it does show that the area is not key summer habitat for caribou. This is probably due to the dominant plant species being high in unpalatable resins. The pruning effect observed on the willows present show that it is likely preferred to the dominant species which is dwarf birch.

Table 3.2-80 - Caribou Abundance at Izok Project Mine Site

DATE	LOCATION	APPROX. AREA UNDER OBSERVATION**	TIME	MAX. # CARIBOU IN VIEW	DENSITY /KM² (EST.)
Aug. 8	Ham L. esker	6 km²	1200-1500	44	7.3
	Plant site	4 km²	1530-1730	6*	1.5
Aug. 9	Plant site	4 km²	0830-1200	32	8
	Ham L. east	2 km²	1330-1530	3	1.5
	Ham L. esker	6 km²	1600-1800	20	3.3
Aug. 10	Plant site	4 km²	0800-1000	6	1.5
	Ham L. esker	6 km²	1030-1230	39	6.5

* observed a single caribou swimming across mouth of Itchen Inlet
** includes water area

In addition to the timed observation reported above, a local and regional survey by helicopter was done to ascertain the extent of caribou presence in the area. Figures 3.2-98 and 3.2-99 show the flight path and the animals per kilometre of flight line. The distribution survey showed that there were few if any caribou to the

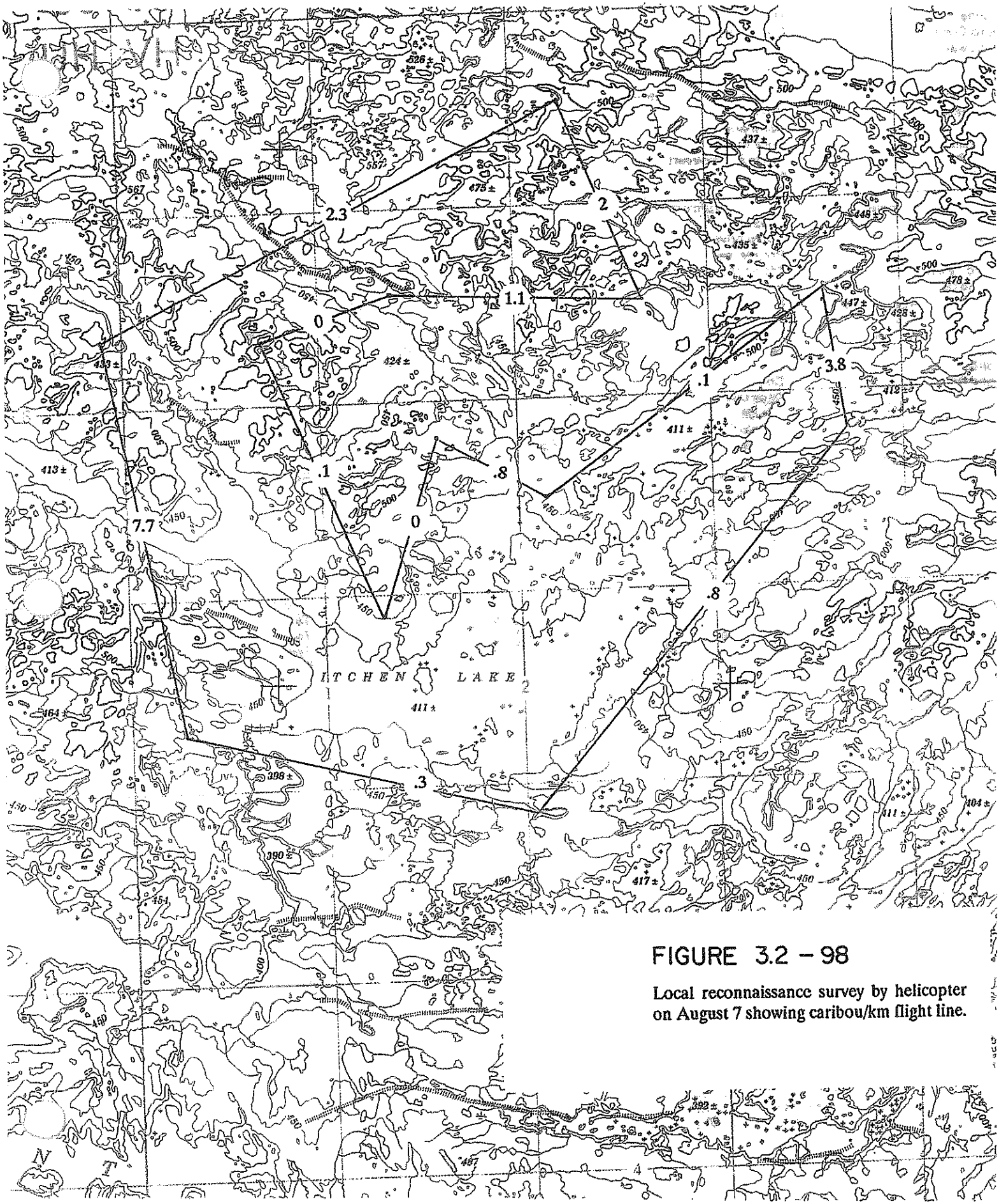


FIGURE 3.2 – 98

Local reconnaissance survey by helicopter on August 7 showing caribou/km flight line.

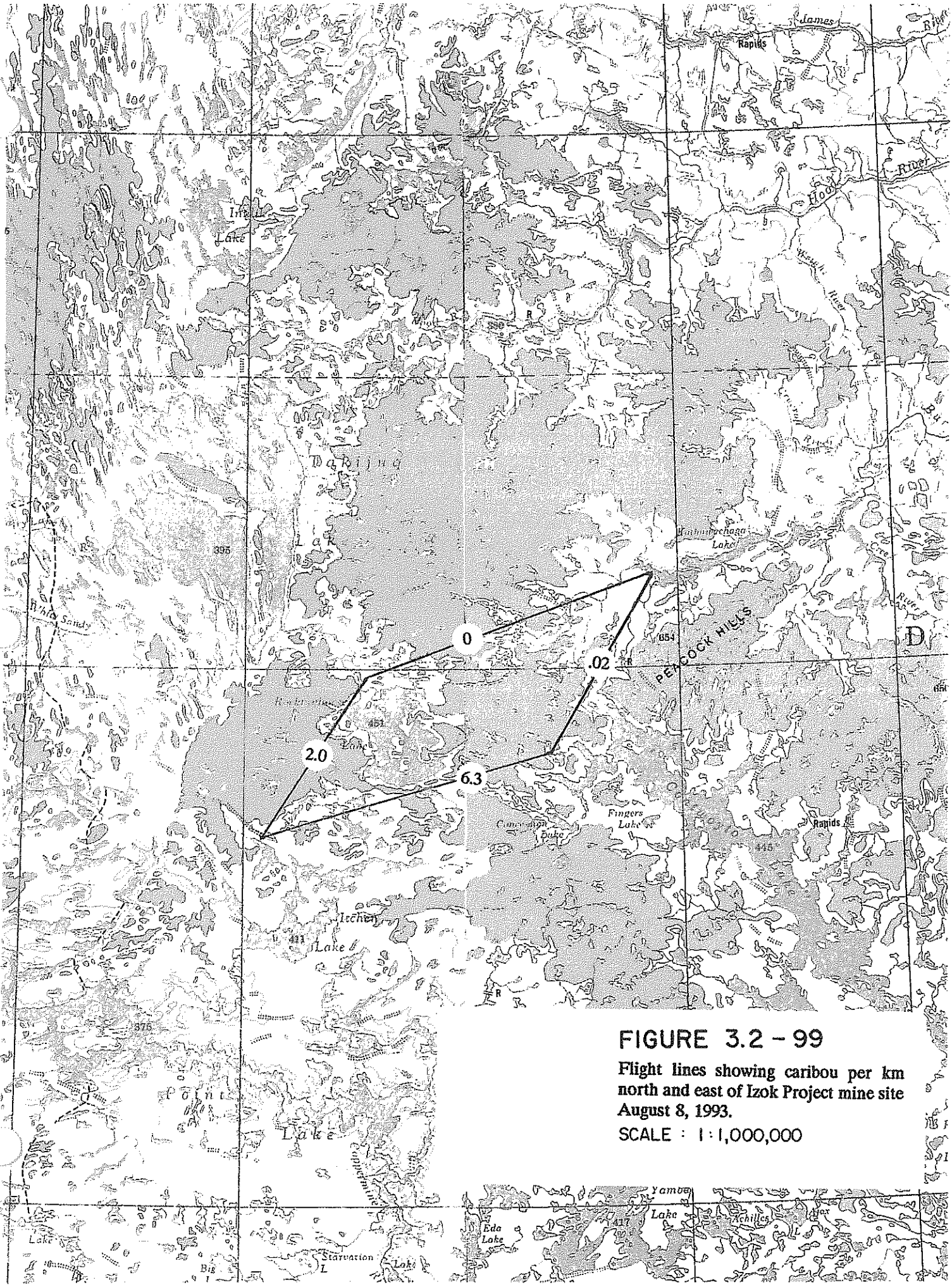


FIGURE 3.2 - 99

Flight lines showing caribou per km north and east of Izok Project mine site August 8, 1993.

SCALE : 1 : 1,000,000

northeast, but that directly east of Izok and west of Iznogoudh there were small pockets with much higher caribou density.

The assessment that the area of the mine site is marginal caribou summer habitat may be supported by the poor trail development in the immediate area of the mine site. The heaviest trails observed in the immediate area are at the eastern end of Ham Lake to the meadows and uplands above the stream that drains Iznogoudh Lake. Whereas many local "game trails" were observed, no heavy "thoroughfare" was seen in the area either during treks overland or from numerous local trips by helicopter.

Victoria Island Caribou

In this report those caribou that spend part of the year on the range of the Bathurst Herd and some part of the year on Victoria Island will be referred to as Victoria Island caribou.

Over the past 100 years there seem to have been two distinct groups of caribou that have crossed the ocean between the central mainland and Victoria Island. Urquhart (1981, unpublished) reviewed all available published and unpublished reports on the subject, some dating back into the early 1850s. Well documented observations describe significant numbers of caribou crossing Dolphin and Union Strait in the vicinity of Lady Franklin Point in spring between mid-March and early June. Similarly, there are documented observations of spring crossings over Coronation Gulf and Dease Strait. The caribou that crossed over to Victoria Island were believed to spread out over the entire Island. In the fall these animals returned as soon as ice conditions over Dease Strait, Coronation Gulf, and Dolphin and Union Strait permitted. This migration (both spring and fall) seemed to decrease drastically in the 1920s. Urquhart's conclusions on the migration and its decline are repeated below.

a. Prior to 1920 a caribou population of substantial size wintered on the Bathurst range and calved on Victoria Island.

b. For reasons that may partly involve hunting pressure, the annual crossings by this herd decreased in the 1920s and have continued at an unknown but probably insignificant magnitude since then.

c. The Victoria - Mainland herd was probably not extirpated completely but became absorbed into the Bathurst and Victoria populations."

The present day movement of caribou across the ice between the mainland and Victoria Island seems to be the reverse of that observed prior to the 1920s. In that migration the caribou involved were definitely barren-ground caribou originating from the mainland. The caribou that make the crossing today more closely resemble Peary caribou which Miller (1991) describes as a "transitional form" between the high arctic Peary caribou and the mainland barren-ground caribou. Miller labelled caribou on Victoria Island "arctic island caribou" and deemed them to be different from both the Peary caribou of the high arctic and the barren-ground caribou of the mainland. The present day movement of caribou between the mainland and Victoria Island seems to be a relatively recent phenomenon for which there are very few direct data. The summer harvest of caribou from the Cape Kruzenstern (north of Coppermine) includes Victoria Island caribou spending the summer there (Colin Adjun, pers. comm.). This is a relatively recent phenomenon of "the last seven years or so."

1993 Field Observations

Surveys done by the GNWT Department of Renewable Resources in April and May of 1993 showed numerous Victoria Island caribou on Kent Peninsula and the islands in Coronation Gulf. The field data of these surveys have not yet been analyzed by the biologists coordinating the surveys and so few, if any, conclusions can be drawn. Field notes of these surveys were made available to this study and the observations are summarised in Table 3.2-81. Not knowing the study design nor the survey methods it is difficult to reconstruct the "situation on the ground". As the most important question with respect to the Izok Project is the dates for caribou movements on the ice of the shipping lane, the examination of the GNWT data focused only on that question.

A single aerial survey of the western portion of the GNWT study area was also flown in a fixed-wing by Hubert and Associates Ltd. on May 29. The last entry on Table 3.2-81 summarizes observations made from the flight lines shown on Figure 3.2-100.

Table 3.2-81 - Observations of Caribou on the Sea Ice Between Mainland and Victoria Island by GNWT Personnel During Aerial Surveys April 30 to May 15, 1993

DATE	AREA SURVEYED	TOTAL # OF OBSERVATIONS	CROSSING EVENTS	CROSSING EVENTS/HOUR
Apr. 30	Coppermine to Bernard Hbr.	4	2	.9
May 3	Coppermine east to Hepburn Isl.	10	3	.9
May 8	Kugaryuk R. to Jameson Isl.	26	5	.9
May 10	Jameson Isl./ Kent Peninsula	29	1	.3
May 11	Kent Peninsula/ Jameson Isl.	34	13	1.7
May 12	Kent Peninsula east	19	0	—
May 13	Kent Peninsula/ Hepburn Isl.	59	31	4.8
May 15	Kent Peninsula/ Jameson Isl.	63	117	28.5
May 29*	Coppermine to Jameson Isl. return	12	9	3.6
	Coppermine NW to Cape Young	0	0	—

* Aerial survey by Izok Project field studies.

These preliminary data suggest that mid-May, 1993, was a period of more caribou crossings to Victoria Island than either late April or late May.

On the basis of available data it is premature to draw any firm conclusions about Victoria Island caribou and their relationship to mainland habitats.

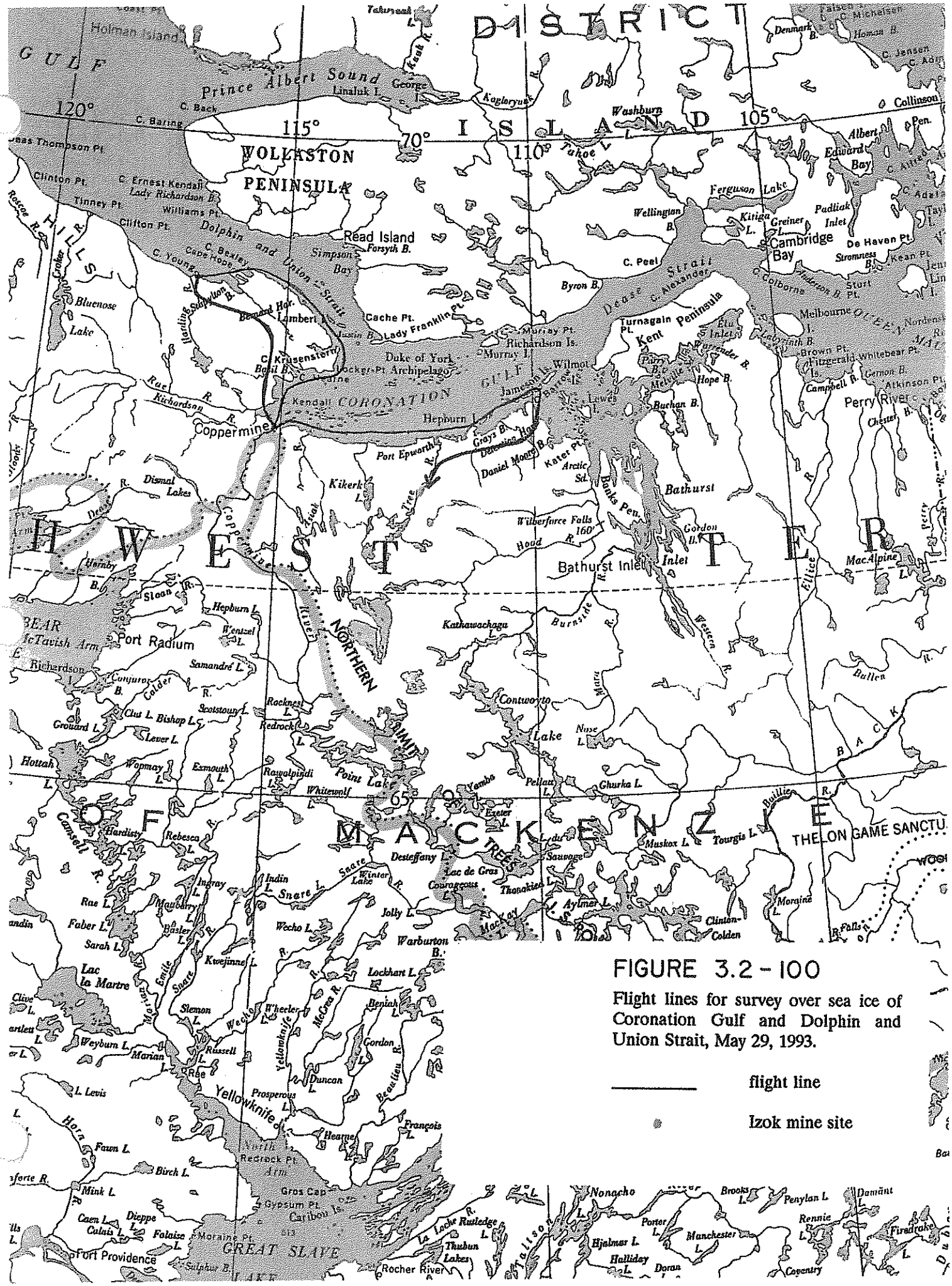


FIGURE 3.2 - 100

Flight lines for survey over sea ice of Coronation Gulf and Dolphin and Union Strait, May 29, 1993.

flight line

Izok mine site

Community Land Use and Harvesting

The RERC Guidelines request that the "past and present land use activities by all users" should be reviewed. Metall addressed this subject by preparing a questionnaire and data form in consultation with the Metall/KIA office in Coppermine. The form incorporated questions on land use, travel routes and harvesting effort.

Data forms and community specific maps were prepared for and sent in bulk to the Metall/KIA office who coordinated the collection of data. A sample data sheet is shown on Figure 3.2-101. The forms were translated for better understanding by Inuktitut speaking harvesters. As a summer project, it was difficult to collect data in that many families were on the land. The work is continuing as of this writing and only the preliminary results from Coppermine are reported here. The current data are reviewed and compared to the data presented in the *Inuit Land Use and Occupancy Study* (Freeman et al., 1976) and the *Nunavut Atlas* (1992).

Historic Land Use Patterns

The *Inuit Land Use and Occupancy Study* reviews land use for three specific periods: pre-1916, 1916 - 1955, and 1955 - 1974). The pre-1916 maps show a very large land base for Coppermine families extending from the Parry Peninsula west of Paulatuk, east to the upper Back River (south of Bathurst Inlet) and north to Prince Albert Sound (Victoria Island). On the mainland the land use extended inland to Bluenose Lake, Great Bear Lake, and the north end of Napaktulik Lake. The maps for this period show a continuous distribution for caribou harvesting and intermittent distribution of grizzly bear, wolves, muskox, wolverine and waterfowl harvesting.

The 1916 - 1955 period shows the distribution of traplines as well as hunting. The geographic distribution of harvesting for this period changes considerably in that the westernmost harvesting extends only to half way to Paulatuk but covers all of southern Victoria Island to Cambridge Bay. The distribution of land use on the mainland for this period shifted as well. Contwoyto Lake is shown as a centre for extensive trapline

DATE: _____ COMMUNITY: _____
CAMP (tent or cabin): _____ LOCATION: (show location on map)
CONTACT PERSON: _____ PHONE #: _____
MAILING ADDRESS: _____ TOWN/CITY: _____
CAMP WAS ESTABLISHED IN 19__

MONTH OF YEAR CAMP IS OCCUPIED:

JAN _____ days	MAY _____ days	SEPT _____ days
FEB _____ days	JUNE _____ days	OCT _____ days
MAR _____ days	JULY _____ days	NOV _____ days
APR _____ days	AUG _____ days	DEC _____ days

CAMP IS OCCUPIED BY:
__ Adults __ Children __ Harvesters

12 MONTH HARVEST DATA FOR 1992/93

HUNTING: Caribou _____ Wolverine _____ Wolf _____ Bear _____ Muskox _____
Polar Bear _____ Seal _____ Ptarmigan ___ Waterfowl _____
Please show hunting areas on map.

TRAPPING: White Fox _____ Coloured Fox _____
Please show trapping areas on map.

FISHING: Please specify number of fish taken and months of the year when they are taken.

INLAND	# / Month	COAST	# / Month	
Char	/_____	Char	/_____	Flounder /_____
Grayling	/_____	Grayling	/_____	Cod /_____
Lake Trout	/_____	Trout	/_____	Capelin /_____
Whitefish	/_____	Whitefish	/_____	Smelt /_____
Pike	/_____	Pike	/_____	Other /_____
Burbot	/_____	Burbot	/_____	
Sucker	/_____	Sucker	/_____	
Other	/_____	Cisco	/_____	

Please show fishing areas on map.

WHICH SPECIES MIGRATE THROUGH YOUR AREA:

Species?		When?	Where?
Caribou	__	__	_____
Fish	__	__	_____
Waterfowl	__	__	_____

Figure 3.2-101 - Land Use Data Sheet: Metall Mining Corporation Izok Project

networks. The importance of Bathurst Inlet seems to diminish in this period. The hunting maps also show that the territory southeast of Contwoyto Lake is used in this period.

In 1955 - 1974 the distribution of hunting and trapping shrinks somewhat in that Bathurst Inlet is not shown as an area used by trappers from Coppermine. There remains a strong corridor for hunting and trapping land use from Coppermine through Napaktulik Lake to the land east and south of the far end of Contwoyto Lake.

Current Land Use

The Metall/KIA office returned 32 completed forms. The data from these show that the distribution of land use of the 1970s is continued today. Figure 3.2-102 shows the areas identified by harvesters. Caribou hunting is the most common activity throughout the region of land use. Hunting wolves and wolverine are the activities associated with the land uses at the extreme south, east and west of the land use maps provided by the hunters reporting to this Metall/KIA project. Wolverine, wolf and muskox harvesting was reported in seven, seven, and eight forms respectively. Table 3.2-82 summarises the frequency of major place names that were given in the forms returned from this survey effort.

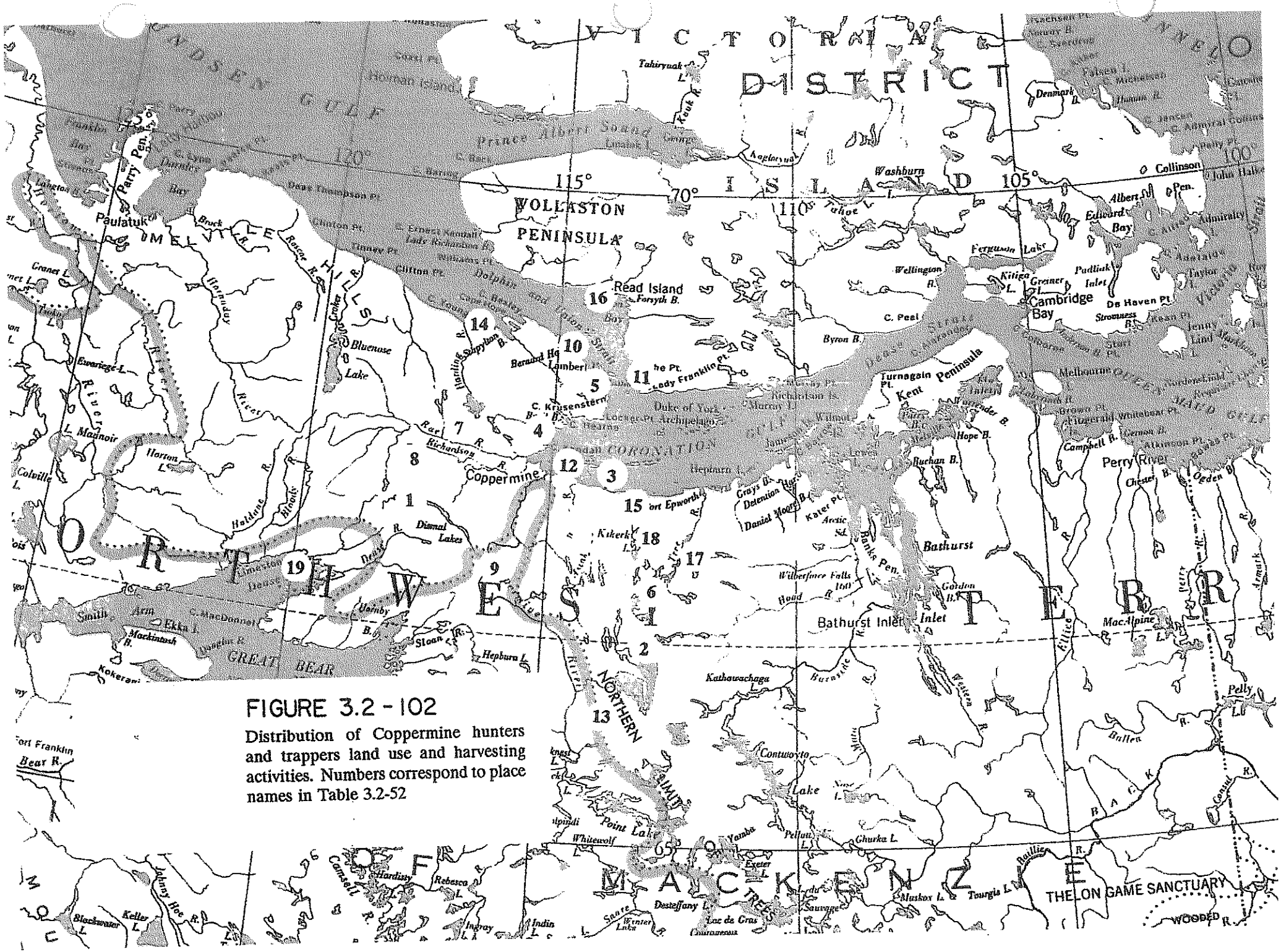
The Nunavut Atlas (1992) outlines land use for Coppermine harvesters that is very similar to that presented.

This cursory summary shows that the geographical extent of local land use and harvesting activities by the Coppermine hunters and trappers ranges throughout the study area in both marine and terrestrial environments.

Table 3.2-82 - Frequency of Geographical Place Names Given in Questionnaires and Maps for Describing Land Use by Coppermine Harvesters, 1993

	PLACE NAME	NUMBER OF REFERENCES
1*	Dismal Lakes	9
2	Napaktulik Lake	9
3	Coronation Gulf Coast - east	8
4	Klengenberg Bay	5
5	Cape Kruzenstern	4
6	Kiglikavik Lake	4
7	Rae River - inland	3
8	Richardson River - inland	2
9	Coppermine River - inland	2
10	Bernard Harbour	2
11	Lady Franklin Point	2
12	Maligut (port site)	2
13	65.50N x 114W	1
14	Cape Young	1
15	Kugaryuak River	1
16	Read Island	1
17	Upper Tree River	1
18	Kiekerk Lake	1
19	Great Bear Lake	1

* The number preceding the place name above corresponds to its map location shown on Figure 3.2-102.


VICTORIA
DISTRICT
ISLAND
WOLLASTON PENINSULA
Read Island
Cambridge Bay
Bathurst Inlet
Coppermine
Bluenose Lake
Paulatuk
Parry Pen.
Washburn
Collinson
Albert Pen.
Edward Bay
Admiralty
Ferguson Lake
Wellington B.
Kitiga L.
Greiner L.
Padluak Inlet
De Haven Pt.
Strowness B.
C. Peel
Byron B.
Turnagain Peninsula
Kent Pen.
Melbourne
Perry River
Bathurst
Bathurst Inlet
Inlet
Kathawachaga
Contwoyto Lake
Point Lake
Whitewolf L.
Yamba L.
Pellatt L.
Ghurka L.
Exeter L.
Musk-ox L.
Tourgis L.
Sauvage
Lac de Gras
Winter Lake
Indin L.
Ingray
Rebecca L.
Hardisty
Camsell R.
Johnny Hoe R.
Keller L.
Blackwater L.
Fort Franklin
Bear R.
Great Bear
Smith Arm
Dismal Lakes
Horton L.
Maunoir L.
Colville L.
Hepburn L.
Hoare Bay
Queen Maud Gulf
Prince Albert Sound
Victoria Island
Takiryuak L.
Kauk R.
Kagleryuak R.
Denmark B.
Hunnam R.
Melville Hills
Parry Pen.
Paulatuk
Brock R.
Rae R.
Horton R.
Granet L.
Ewaniga L.
Anderson R.
Richardson R.
Hanbury R.
Harding R.
Snipetown B.
Bernard Hr.
Lambert I.
Lady Franklin Pt.
Duke of York Archipelago
C. Krusenstern
Richardson Is.
Murray I.
Wilmot I.
Jayne I.
Lowes I.
Hepburn I.
Grays Bay
Detention Harbour
Daniel Hoare B.
Kater Pt.
Arctic Sd.
Hope B.
Buchan B.
Campbell B.
Fitzgerald Whitebear Pt.
Chester B.
Ogden B.
Arnark R.
Ellice R.
Mac.Alpine L.
Pelly L.
Ballen R.
Consul R.
Back R.
Wilberforce Falls
Hood R.
Gordon B.
Banke Pen.
Burnside R.
Western R.
Kokerai
Kokerai R.
Mackintosh B.
Ekka L.
C. MacDonnell
Uarnby B.
Stoan R.
Haldane R.
Hanbury R.
Dease R.
Kikerk L.
Fort Epworth
Richardson R.
Coppermine

Appendix E – Ham Camp Abandonment and Decommissioning Plan

WOLFDEN Resources Inc.

SITE ABANONMENT AND RESTORATION PLAN EXPLORATION OPERATIONS IZOK, HOOD AND GONDOR PROJECTS NUNAVUT, CANADA

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ABANONMENT AND RESTORATION PLAN
EXPLORATION OPERATIONS
IZOK, HOOD AND GONDOR PROJECTS
NUNAVUT, CANADA

June 5, 2006

Prepared By:	Sandra Rickard – Geologist Wolfden Resources Inc.	Date:	June 5, 2006
Reviewed By:	Andrew Mitchell - Project Manager Wolfden Resources Inc.	Date:	June 5, 2006
Authorized By:	John Begeman - Chief Operating Officer Wolfden Resources Inc.	Date:	June 5, 2006

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1.0 PREAMBLE

The Abandonment and Restoration Plan is effective from July 29, 2006 to July 29, 2008 and applies to the Izok/Hood Projects – Ham Lake Camp operated by Wolfden Resources in the Kitikmeot District of Nunavut, north latitude 65° 40' and west longitude 112° 50' . The project is under agreement with Nunavut Tunngavik Incorporated (NTI). Land Use permit's with the Kitimeot Inuit Association (KIA), Indian and Norther Affairs Canada (INAC) and Nunavut Water Board (NWB) have been submitted concurrent with the submission of this document.

The locations of the Izok and Hood drilling program areas are shown on Figures 1 to 3. The Ham Camp layout is shown on Figure 4.

The following formal distribution has been made of this plan: KIA, NWB, Ian Neill (Camp Manager, Wolfden Resources), John Begeman (Chief Operating Officer, Wolfden Resources Inc.) Ewan Downie (President and Chief Executive Officer – Wolfden Resources Inc.).

2.0 INTRODUCTION

This abandonment and restoration plan has been prepared as a document for the Ham Lake Camp, and for the drilling program to be carried within the Point Lake-Itchen Lake volcanic belt and the Takiyuak greenstone belt. The fly-in camp is located 265 km south of Kugluktuk and 360 km north of Yellowknife. The camp will support a population of up to 40 people and is open seasonably between mid February and mid December.

3.0 SCHEDULE

The seasonal shutdown of the camp site should take 5 days to complete and will take place after the drilling activities have ceased. The plan will be applied by the Izok/Hood projects personnel under the supervision of the field supervisor.

4.0 SITE INFRASTRUCTURE

The camp is located on the South and East Shores of Ham Lake. The camp was established by the previous operator of the exploration project, Inmet Mining Corporation (Inmet). The camp includes an accommodation complex, diamond drill core logging and storage facilities, garages, fuel storage facilities and is served by a 2,500 foot long gravel air strip. The layout of the camp is shown on Figure 4.

From an inventory provided by Inmet, following is a list of the major components of the camp and ancillary facilities.

Major Camp Equipment/Facilities

13 – Travco trailer units
8 – 4' x 44' camp matting
1 – Oil fired incinerator (serial no. 18162)
1 – 10' x 44' Generator Building
2 – Cummins 150 kW diesel generators (serial no's. 44670421 and 4460441)
1 – Steel garage – 20' x 24'
2 – Wood frame, steel clad core storage warehouses
1 – Wood frame, aluminum clad 12' x 36' skidded core shack

Fuel Tanks

7 – 12,000 gal fuel skid mounted fuel tanks

Mobile Equipment

1 – Caterpillar D-6 Bulldozer
1 – Champion Motor Grader
1 – Fuel Trailer
1- 1992 Ford Supercab F-350 trucks (diesel)

A map showing the regional setting of the project areas is provided on Figure 1. This Abandonment and Restoration Plan can be extended to drilling operations that will be carried out at some distance from the camp. The outlines of these areas are shown on Figures 2 and 3. A map showing the layout of the camp and airstrip is provided on Figure 4.

5.0 FINAL ABANDONMENT AND RESTORATION PLANS

5.1. BUILDINGS AND CONTENTS

Reusable equipment including tents, tent metal frames, stoves, foam rubber mats, the kitchen stoves, refrigerators and other appliances and equipment, showers, hot water tank, and other portable components will be packaged and flown out from project site to Yellowknife. The Travco trailers will be disposed of by burning and/or removed from site for use elsewhere or disposal. The wood framed buildings will be burned and the non-combustible hardware will be removed from site.

5.2. WATER SYSTEM

Pump, tanks and hoses will be drained, dismantled, packaged and flown out to Yellowknife. The wooden pump shack built to protect the pump will be burned as for the other wood structures.

5.3. ELECTRICAL SYSTEM

The generator shed will be inspected for residual hazardous waste (oil, grease) and will be drained of its fuel. Remaining waste fuel and oil will be collected in the containers labeled for that use and used through the summer. The shed will be dismantled and burned. The soil will be inspected for contamination. Electrical wires, sockets, etc…will be taken down and either returned with camp material to Yellowknife, or flown out to an approved municipal discharge.

5.4. FUEL AND CHEMICAL STORAGE FACILITIES

Fuel inventory will be managed so as to retain only a minimum quantity of fuel on site to permit closure activities to take place. On full abandonment of the site, remaining fuel will be pumped from the large tank(s) in to drums and removed from site. The large fuel tanks and smaller containers such as drums and day tanks will be scrapped and removed from site or removed from site and sold. Propane cylinders will be flown out as well to source.

Chemical stored on site will consist of drill additives, oil, grease and household cleaners. All drill additives will be stored in or by the drill foreman shed. Household cleaners will mainly be stored in the kitchen. Upon camp closure, any unused drilling additive, oil or grease will be returned to the drilling company warehouse. Half empty containers will be taken off site to be properly disposed in an approved discharge. Empty containers will be disposed with regular garbage.

5.5. WASTE FACILITY AND INCINERATOR

Once the camp is entirely dismantled, all remaining combustible waste stored at this site will be burned. The incinerator will be dismantled, reusable parts will be returned to Yellowknife and the barrel will be discarded in an approved municipal discharge.

5.6. GREYWATER SUMP

The kitchen-dry greywater sump will be filled back and leveled.

5.7. BLACKWATER SUMP

Not applicable. The outhouses consist of “pacto” style toilets where waste is collected in a plastic bag lined container and content burned on a daily basis.

5.8. HELICOPTER PAD

The helicopter pad consists of a wooden platform built of a 2x4 base with plywood cover. Soil around the helicopter pad will be inspected for contamination. The wood will be burned as per other wooden structures on site.

5.9. CAMP SITE

The camp site will have a final inspection. Areas showing too much wearing evidences will be covered with a layer of peat moss and lightly fertilized to promote natural growth. Drill core to be left on site will be properly stored and secured.

5.10. DRILLING AREA RESTORATION

The drill will be dismantled into its main components as per the drilling contractor procedure, packaged and secured along with its ancillary equipment and rods. The drill will be flown out to another project or to a storage site designated by the drilling contractor. All drill sites will be inspected for soil contamination. Any remaining waste will be taken to camp to be burned if possible or to be flown out to an approved municipal discharge. Greywater and sludge sumps will be filled and leveled. A layer of peat moss will be spread on top and slightly fertilized to promote natural growth. As much as possible, drill sites will be restored immediately after the drill has been moved to the next site and sumps have drained enough to be leveled.

5.11. DOCUMENTATION AND INSPECTION

Photos of camp and drill sites prior to building of drilling will be taken. Monitoring will be done during occupancy and photos taken. Once the site restored, it will again be documented with photos. Soil contaminated by hydrocarbons and unnoticed before abandonment will be treated as per the spill contingency plan. A final site inspection visit with community representatives, Land Use Inspector and in collaboration with NWB staff will be organized by the permit holder.

6.0 SEASONAL SHUTDOWN AND RESTORATION PLAN

6.1. BUILDINGS AND CONTENT

All equipment will be stored inside the wooden buildings to ensure they will withstand the winter season. Canvas tents will be secured and braced internally to ensure they will withstand snow and wind loads. Wood structures will be secured with nailed plywood over windows and doors to prevent inadvertent opening. Snowmachines, argo's and quads will be stored inside the core shacks and shop building.

6.2. WATER SYSTEM

Pump, tanks and hoses will be drained and dismantled. Rented equipment will be flown out to owner. Hoses will be rolled and stored in the kitchen.

6.3. ELECTRICAL SYSTEM

The generator shed will be inspected for remaining hazardous waste (oil, grease) and will be drained of its fuel. Remaining waste fuel and oil will be collected in the containers labeled for that usage and used through the summer. The generator will be winterized and prepared for startup in spring. The soil surrounding the generator shed will be inspected for impact. Electrical wires, plugs and sockets will be stored in the kitchen.

6.4. FUEL AND CHEMICAL STORAGE FACILITIES

An inventory of remaining fuel will be made and full drums will be inspected and secured for the winter. Empty drums will be flown out to source. Empty propane cylinders will be flown out to source. Chemical stored on site will consists of drill additives, oil, grease and household cleaners. All drill additives will be stored in or by the drill foreman shed and secured for the winter. Empty containers will be disposed with regular garbage. The soil of the areas will be inspected for contamination

6.5. WASTE FACILITY AND INCINERATOR

Once the camp has been dismantled and remaining buildings secured, all remaining combustible waste stored at this site will be burned. The incinerator will be dismantled and stored in the kitchen. The soil will be inspected for contamination.

6.6. GREYWATER SUMP

The greywater sump wood cover will be secured for winter.

6.7. BLACKWATER SUMP

Not applicable. The outhouses consist of “pacto” style toilets where waste is collected in a plastic bag lined container and content burned on a daily basis.

6.8. HELICOPTER PAD

The helicopter pad consists of a wooden platform built of a 2x4 base with plywood cover. Soil around the helicopter pad will be inspected for contamination.

6.9. CAMP SITE

Areas showing too much wearing evidences will be covered with a layer of peat moss and lightly fertilized to promote natural growth. Soil contaminated by hydrocarbons and unnoticed before abandonment will be treated as per the spill contingency plan. Drill core to be left on site will be properly stored and secured in cross stacked piles or wooden cores racks.

6.10. DRILLING AREA RESTORATION

The drill will be dismantled into its main components as per the drilling contractor procedure, packaged and secured along with its ancillary equipment and rods. The drill will be left on solid ground until next season. All drill sites will be inspected for soil contamination. Any remaining waste will be taken to camp to be burned if possible to be flown out to an approved municipal discharge. Greywater and sludge sumps will be filled and leveled. A layer of peat moss will be spread on top and slightly fertilized to promote natural growth. As much as practical, drill sites will be restored immediately after the drill has been moved to the next site and sumps have drained enough to be leveled.

6.11. DOCUMENTATION

Equipment and buildings left on site will be inventoried. Photos of camp and drill sites prior to drilling will be taken. Monitoring will be done during occupancy and photos taken. Once the site secured for the winter, it will again be documented with photos.

Appendix F – Emergency Response and Spill Contingency Plan

WOLFDEN Resources Inc.

SPILL CONTINGENCY PLAN
EXPLORATION OPERATIONS
IZOK, HOOD AND GONDOR PROJECTS
NUNAVUT, CANADA

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SPILL CONTINGENCY PLAN
EXPLORATION OPERATIONS
IZOK, HOOD AND GONDOR PROJECTS
NUNAVUT, CANADA

June 5, 2006

Prepared By: _____ Date: June 5, 2006

Sandra Rickard – Geologist
Wolfden Resources Inc.

Reviewed By: _____ Date: June 5, 2006

Andrew Mitchell - Project Manager
Wolfden Resources Inc.

Authorized By: _____ Date: June 5, 2006

John Begeman - Chief Operating Officer
Wolfden Resources Inc.

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FIGURE 4 – HAM CAMP LAYOUT MAP

1.0 PREAMBLE

The Spill Contingency Plan is effective from June 30, 2006 to December 31, 2007 and applies to the Izok, Hood and Gondor Projects – Ham camp operated by Wolfden Resources in the Kitikmeot District of Nunavut, north latitude 65° 40' and west longitude 112° 50'. The project is under agreement with Nunavut Tunngavik Incorporated (NTI). Land Use permits with the Kitikmeot Inuit Association (KIA) and Nunavut Water Board (NWB) are currently in place.

The locations of the Izok and Hood drilling areas are shown on Figures 1 to 3. The Ham Camp layout is shown on Figure 4.

The following formal distribution has been made of this plan: KIA, NWB, Ian Neill (Camp Manager, Wolfden Resources), John Begeman (Chief Operating Officer, Wolfden Resources Inc.) Ewan Downie (President and Chief Executive Officer – Wolfden Resources Inc.).

2.0 INTRODUCTION

This Spill Contingency Plan is to provides a plan of action for reasonably foreseeable spill events at the Izok, Hood and Gondor Projects – Ham camp considering the nature of the fuels and other hazardous materials that will be handled during the Company's operations The plan defines the responsibilities of key response personnel and outlines the procedures for responding to spill in a way that will act to minimize potential health and safety hazards, environmental damage and remediation costs. The plan has been prepared to provide ready access to all the information needed in dealing with a spill.

It is Wolfden Resources policy to comply with all existing laws and regulations to help ensure the protection of the environment, to provide such protection of the environment as is technically feasible, to cooperate with other groups working on protection of the environment and to keep employees, government officials and the public informed.

Personnel will be instructed on the plan upon arrival in camp. Instruction will also be given on how to properly manipulate and store fuel and other hazardous substances and on the location of emergency equipment. A more graphical representation of this plan will be posted in common camp areas.

3.0 SITE DESCRIPTION

The camp is located on the South and East Shores of Ham Lake. The camp was established by the previous operator of the exploration project, Inmet Mining Corporation (Inmet). The camp includes an accommodation complex, diamond drill core logging and storage facilities, garage, fuel storage facilities. The camp is served by a 2500 foot long gravel air strip. The layout of the camp is shown on Figure 4.

From an inventory provided by Inmet, following is a list of the major components of the camp and ancillary facilities.

Major Camp Equipment/Facilities

13 – Travco trailer units
8 – 4' x 44' camp matting
1 – Oil fired incinerator (serial no. 18162)
1 – 10' x 44' Generator Building
2 – Cummins 150 kW diesel generators (serial no's. 44670421 and 4460441)
1 – Steel garage – 20' x 24'
2 – Wood frame, steel clad core storage warehouses
1 – Wood frame, aluminum clad 12' x 36' skidded core shack

Fuel Tanks

7 – 12,000 gal fuel skid mounted fuel tanks

Mobile Equipment

1 – Caterpillar D-6 Bulldozer
1 – Champion Motor Grader
1 – Fuel Trailer
1- 1992 Ford Supercab F-350 trucks (diesel)

A map showing the regional setting of the project areas is provided on Figure 1. This plan can be extended to drilling operations that will be carried out at some distance from the camp. The outlines of these areas are shown on Figures 2 and 3. A map showing the layout of the camp and airstrip is provided on Figure 4.

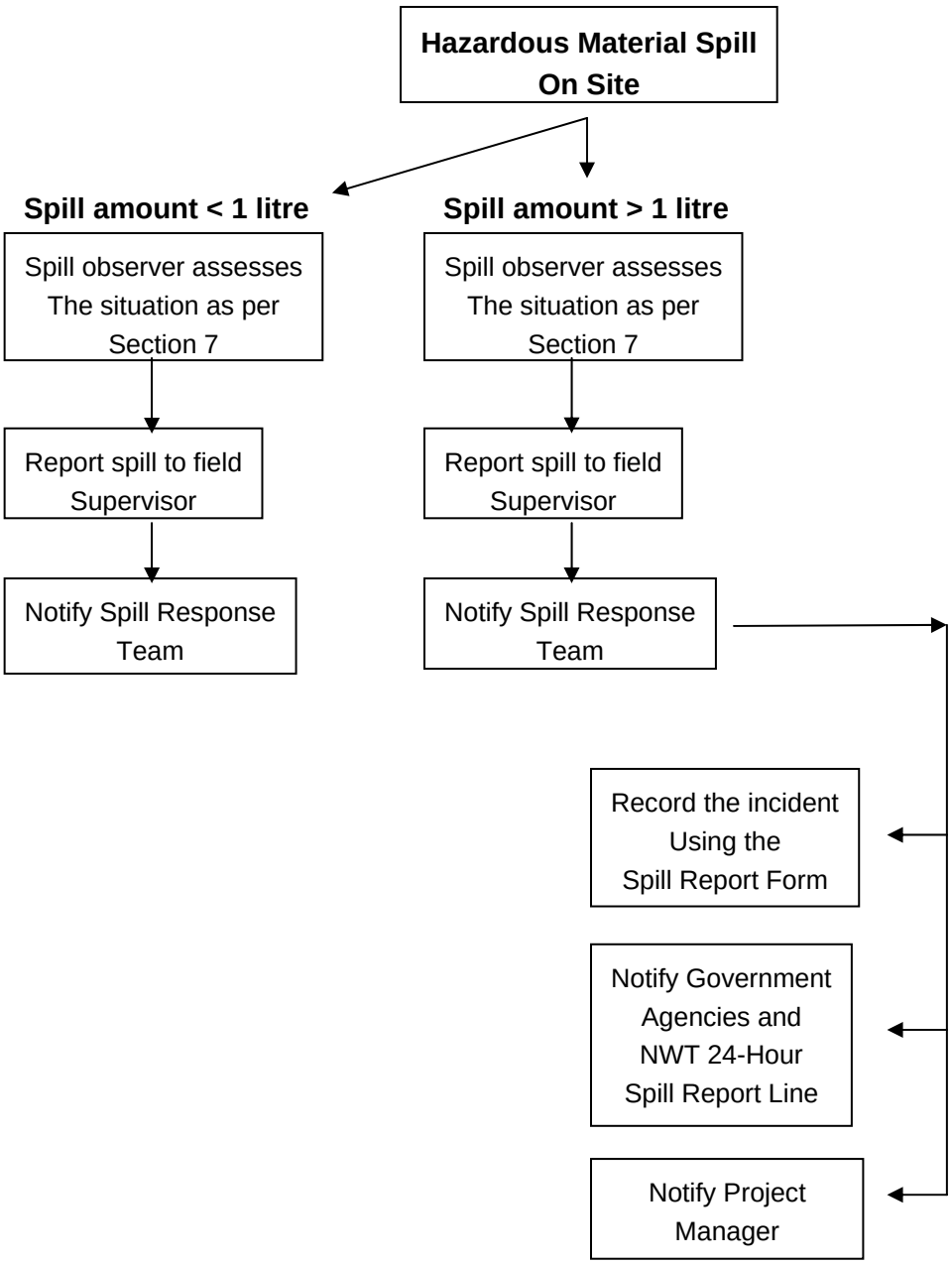
4.0 CONTACTS

People and organizations that can be contacted in the event of a spill:

Camp Manager	Ian Neill	416-987-7167
Field Supervisor	Ian Neill	416-987-7176
Project Manager	Andrew Mitchell	(807)-346-1668
Wolfden Head Office	Ewan Downie	(807)-346-1668
Kitikmeot Inuit Association	Jack Kaniak	(867)-982-3310
Nunavut Water Board	Phyllis Beaulieu	(867)-360-6338 (867)-360-6369 (fax)
Spill Report Line (24 hr)		(867)-873-6924
Environment Canada		(867)-669-4644
WCB 24 Hour Accidents		(867)-873-7468
WCB Inspector	Peter Bengts	(867)-920-3888
Kugluktuk Health Center	Janet Carstairs	(867)-982-4531
Kugluktuk RCMP	Franco Radescho	(867)-982-1111 (867)-920-8130 (fax)

5.0 RESPONSE ORGANIZATION

The following is a flow chart to illustrate the sequence of events if a hazardous material spill occurs at the Izok, Hood or Gondor Projects.



6.0 SPILL RESPONSE TEAM

All personnel will be informed of the contents of the Spill Contingency Plan and trained in the safe use of relevant spill prevention and clean up equipment. The Field Supervisor will appoint and train two persons to be the Spill Response Team. They will also be responsible to carry out the daily inspections of the fuel storage areas and equipment. Personnel on site will be limited, so for any large spill more people will be brought in to help, primarily from Wolfden's Lupin Mine located 75km east of Izok and secondly from Yellowknife.

Spill Response Team Responsibilities

- Perform daily inspections at the Camp fuel and chemical storage areas and fuel hoses.
- Report any spill to Field Supervisor
- Containment of the spill and site remediation.

Field Supervisor Responsibilities

- Assume complete authority over the spill scene and coordinate all personnel involved.
- Evaluate spill situation and develop overall plan of action.
- Activate the spill contingency plan
- Immediately report the spill to the NWT 24-Hour Spill Report Line and regulatory agencies. (For spill greater than 1 litre)
- Fill out the Spill Report Form (for spill greater than 1 litre)
- Report the spill to the Project Manager. (For spill greater than 1 litre)
- If required, obtain additional manpower, equipment, and material if not available on site for spill response.

Project Manager Responsibilities

- Provide regulatory agencies and Wolfden Resources management with information regarding the status of the clean up activities.
- Prepare and submit a report on the spill incident to regulatory agencies within 30 days of the event.

7.0 INITIAL ACTION

These instructions are to be followed by the first person on the spill scene.

1. Always be alert and consider your safety first.
2. Wear personal protective equipment
3. Do not smoke and eliminate all source of ignition
4. Assess the hazard to people in the vicinity of the spill.
5. If possible control danger to human life
6. Do not touch, smell, taste or get close to unknown substance.
7. If substance has been identified and if possible and safe to do so, try to stop the flow of material.
   - If filling is in progress, stop at once
   - If seeping through a small hole, use a patch kit if practical to do so.
   - If necessary and practical, pump the fuel from the leaking container into a refuge container
8. Immediately report the spill to the Field Supervisor and Spill Response Team by radio, satellite phone or in person.
9. Resume any effective action to contain, mitigate, or terminate the flow of the spilled material.
10. If in doubt about cleaning procedures or for a very large spill, regulatory agencies can help.

8.0 REPORTING

The person who notices the spill must immediately notify the Field Supervisor. As soon as possible the Field Supervisor will report the spill to:

- The 24-Hour Spill Report Line Phone (867) 920-8130, Fax (867) 873-6924
- Fill out the NWT Spill Report Form NWT1752/0202
- Notify the Project Manager for a spill greater than 1 litre.
- Notify permitting authorities (Nunavut Water Board, Kitikmeot Inuit Association)

9.0 RESOURCE INVENTORY

A spill kit with a capacity of 240 litres will be located at the fuel tank area and will contain:

1 – 360 litre/79 gallon polyethylene drum
4 – oil absorbent booms (5” X 10’)
100 – oil absorbent sheets (16.5” X 20” X 3/8”)
1 – drain cover (36” X 36” X 1/16”)
1 – Caution tape (3” X 500’)
1 – 1 lb plugging compound
2 – pair Nitrile gloves
2 – pair Safety goggles
2 – pair Tyvek coveralls
1 – instruction booklet
10 – printed disposable bags (24” X 48”)
1- shovel (in remote spill kit only)
1- plastic tarp

Shovels, water pump, plastic pails, garbage bags, extra absorbent pad, drip pans will be placed on the side of the wall at the main office and the kitchen. Fire extinguishers are available throughout the camp facility.

Drill Spill Kits with a capacity of 25 L will contain the following:

10- Pads (17”x19”x2/8”)
3 - Socks (3”x4’)
1 - Pair of Gloves
1 - Disposal Bags
1 - Warning Sign
1 - Literature (Inventory List, MSDS, Instructions)

10.0 HAZARDOUS MATERIAL INVENTORY

This following section lists for each hazardous substance present on the project area, health hazards, spill procedure and disposal procedures. For more detailed information, refer to the MSDS sheets.

10.1. DIESEL FUEL, JET-B, GASOLINE

DIESEL, JET-B AND GASOLINE ARE HIGHLY FLAMMABLE

10.1.1. GENERAL PRECAUTIONS

- Do not smoke
- Will be easily ignited by heat, sparks or flames
- Gasoline and Jet-B are more volatile than diesel
- Explosion hazard indoors, in confined spaces and outdoors
- Vapours may form explosive mixtures with air
- Vapours may travel to source of ignition and flash back
- Most vapours are heavier than air. They will spread along ground and collect in low or confined areas.
- Keep pump or electrical equipment far away, be very careful with metallic tools that could sparks on rocks, wait for vapours to dissipate
- Inhalation may cause central nervous effects
- Aspiration into lungs may cause pneumonitis which can be fatal
- Eye and skin irritation
- Prolonged exposure has caused cancers in laboratory animals

10.1.2. SPILL ON LAND

- Build a containment berm, downslope, using, peat, moss, and soil material, bags filled with sand or rocks and place a plastic tarp at the foot of the berm to pool the spill. Spill can be pumped if in a large amount
- Soak up spilled substance by using absorbent pads
- Excavate the surface soil if necessary. If large excavation is needed, first contact regulatory agencies for approval.
- Remove spill substance splashed on vegetation by applying a thin dusting of Spag-zorb or other ultra-dry absorbent.
- Dispose hydrocarbons, absorbent pad, contaminated soil and cleaning material in an empty drum, seal it and label it.
- On marshy zones, don’t destroy vegetal cover, limit personnel and equipment. Remove pooled oil with absorbent pads and/or skimmer.

10.1.3. SPILL ON WATER

- Contain spill as close to release point as possible
- On small spill, deploy hydrophobic absorbent pads
- On larger spill and weather conditions permitting, use containment boom to limit fuel dispersion. Use a skimmer, pump or hydrophobic absorbent pads to remove fuel inside the boom.
- Dispose hydrocarbons, absorbent pad, contaminated soil and cleaning material in an empty drum, seal it and label it.

10.1.4. SPILL ON RIVERS AND STREAMS

- Prevent entry into water, if possible, by building a berm or trench.
- Intercept moving slicks in quiet areas using (absorbent) booms.
- Do not use absorbent booms/pads in fast currents and turbulent water.

10.1.5. SPILL ON ICE AND SNOW

- Build a containment berm of compacted snow around spill.
- If hydrocarbons are pooling on ice, pump large amount or use hydrophobic absorbent pads.
- Don't delay removing the spill as hydrocarbons could seep through cracks into the water.
- Scrape ice, shovel all contaminated snow in plastic buckets with lids or in drums. Dispose absorbent pads and other contaminated equipment in separated containers. Label and seal the containers.

10.1.6. SPILL DISPOSAL

- Contact Federal and Territorial regulatory agencies to identify appropriate disposal methods before disposing of contaminated material.

10.2. PROPANE

EXTREMELY FLAMMABLE

10.2.1. GENERAL PRECAUTIONS

- Do not smoke
- Cylinders may explode when heated
- Cylinders may rocket if ruptured
- Will be easily ignited by heat, sparks or flames
- Explosion hazard indoors, in confined spaces and outdoors
- Vapours may form explosive mixtures with air
- Vapours may travel to source of ignition and flash back

- Vapours from liquefied gas are initially heavier than air and spread along ground.
- Contact with gas or liquefied gas may cause burns, severe injuries and/or frostbite
- Keep pump or electrical equipment far away, be very careful with metallic tools that could sparks on rocks, wait for vapours to dissipate
- Liquid may cause frostbites and blisters
- Blurred vision if goes in the eyes
- Narcotic aphyxiant
- Dizziness, disorientation, excitation, headache, vomiting, unconsciousness if inhaled

10.2.2. Spill on Land, Water, Ice and Snow

- Eliminate all source of ignition
- Do not attempt to contain the propane release if not absolutely sure on what to do.
- Do not touch or walk through spilled material
- Stop leak if can be done without risk
- If possible, turn container so that gas escapes rather than liquid.
- Water spray can be used to knock down vapours but don't direct water at spill or source of leak
- Prevent spreading of vapours in confined areas
- If or when possible, confine spill with confinement berm. Throw absorbent pads into spill, retrieved them with gaffs or pitchforks.
- Small fire can be extinguished with dry chemical or CO_2.
- Dispose contaminated materials in a labeled drum.

10.2.3. Spill Disposal

- Contact Federal and Territorial regulatory agencies to identify appropriate disposal methods for detective equipment that resulted in the release.

10.3. Motor Oil, Hydraulic Oil, Transmission Fluid

10.3.1. General Precautions

- Avoid breathing mists, may cause lung irritation
- On skin may cause mild irritation

10.3.2. Spill Action

Soak up with absorbent material

- Disposed contaminated soil and material in sealed and labeled container
- Small amount can be incinerated
- Large amount to be disposed as hazardous waste.

10.4. ANTIFREEZE

10.4.1. GENERAL PRECAUTIONS

- Respiratory irritation with prolonged exposure.
- Kidney, liver and bladder problems reported in animals

10.4.2. SPILL ON LAND

- Soak up by using absorbent pads
- Dispose antifreeze, absorbent pad, contaminated soil and cleaning material in an empty drum, seal it and label it.
- On marshy zones, don't destroy vegetal cover, limit personnel and equipment. If possible remove pooled antifreeze with absorbent pads.

10.4.3. SPILL ON RIVERS AND STREAMS

- Prevent entry into water, if possible, by building a berm or trench.

10.4.4. SPILL ON ICE AND SNOW

- Build a containment berm of compacted snow around spill.
- If pooling on ice, pump large amount or use absorbent pads.
- Don't delay removing the spill as it can seep through cracks into the water.
- Scrape ice, shovel all contaminated snow into plastic buckets with lids or in drums.
- Dispose absorbent pads and other contaminated equipment in separated containers. Label and seal the containers.

10.4.5. SPILL DISPOSAL

- Contact Federal and Territorial regulatory agencies to identify appropriate disposal methods before disposing of contaminated material.

10.5. BATTERY ACID

10.5.1. GENERAL PRECAUTIONS

- Fire and explosion hazard
- Can be extinguished with dry chemical fire extinguisher.
- Ventilate area
- Remove combustible materials
- Mist inhalation hazard when being charged or spilled
- Acid burns to skin and eyes irritation

10.5.2. SPILL ACTION

- Neutralize with soda or lime

- Dispose battery and neutralized contaminated material in a sealed and labeled container
- Dispose as an hazardous waste

10.6. POLY-DRILL DR-133

10.6.1. GENERAL PRECAUTIONS

- May cause skin and eye irritation

10.6.2. SPILL ACTION

- Soak up with absorbent pad
- Dispose residue, contaminated soil and material in labeled containers. Solidify with sand.
- Small amount can be incinerated, otherwise dispose as hazardous waste.

10.7. 550-X POLYMER

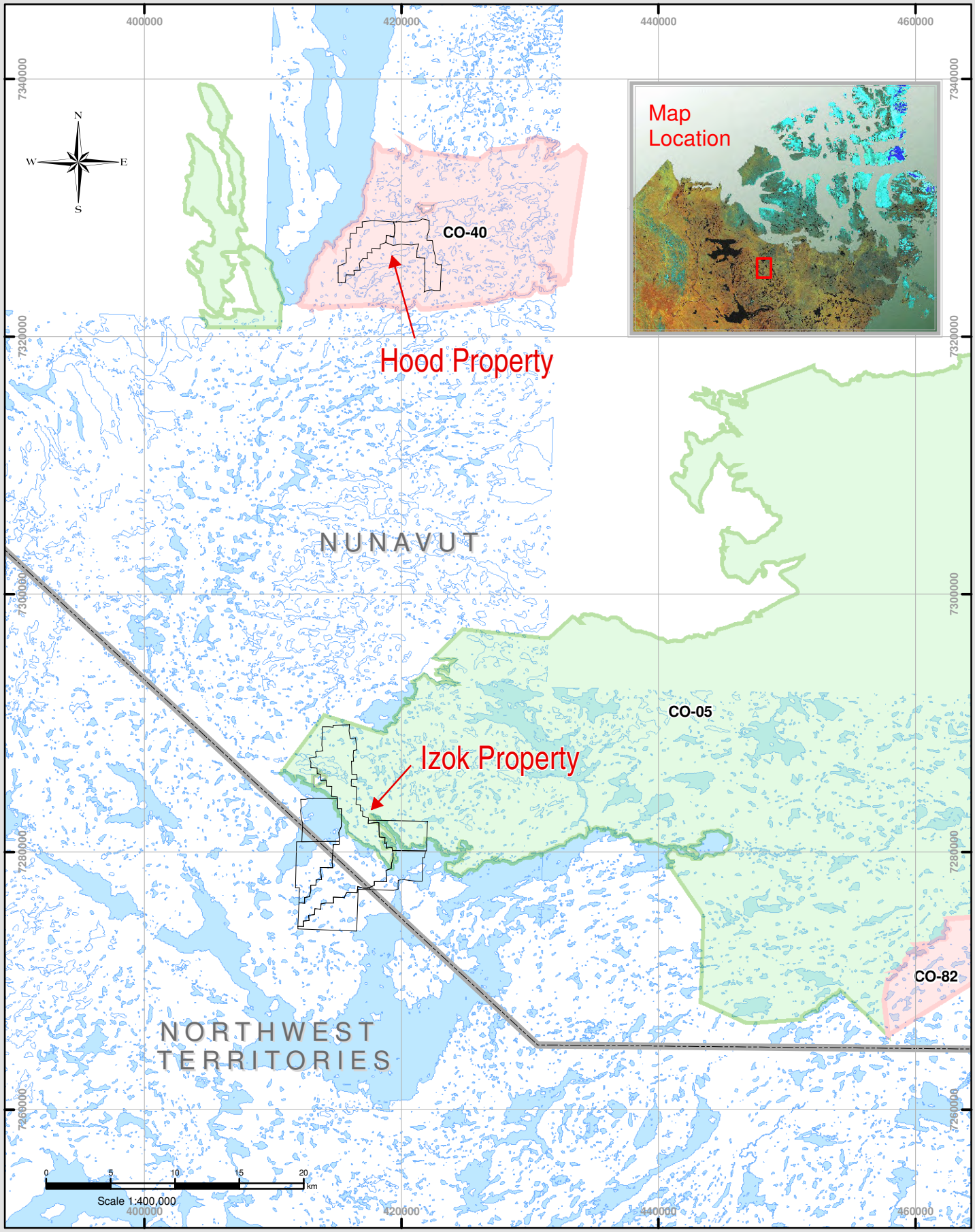
10.7.1. GENERAL PRECAUTIONS

- Prolonged skin contact may cause irritation
- Possible eye irritation
- Ingestion may cause nausea, vomiting, cramps, diarrhea

10.7.2. SPILL ACTION

- Clean up spill with gloves. Scrape soil or surface and disposed in labeled containers
- Dispose as hazardous waste

FIGURES



Legend

- Lease Area
- Inuit Owned Lands
- Surface Rights Only
- Surface and Sub-Surface Rights
- Watercourse
- Waterbody

WOLFDEN Resources Inc.

Regional Overview Map

References:

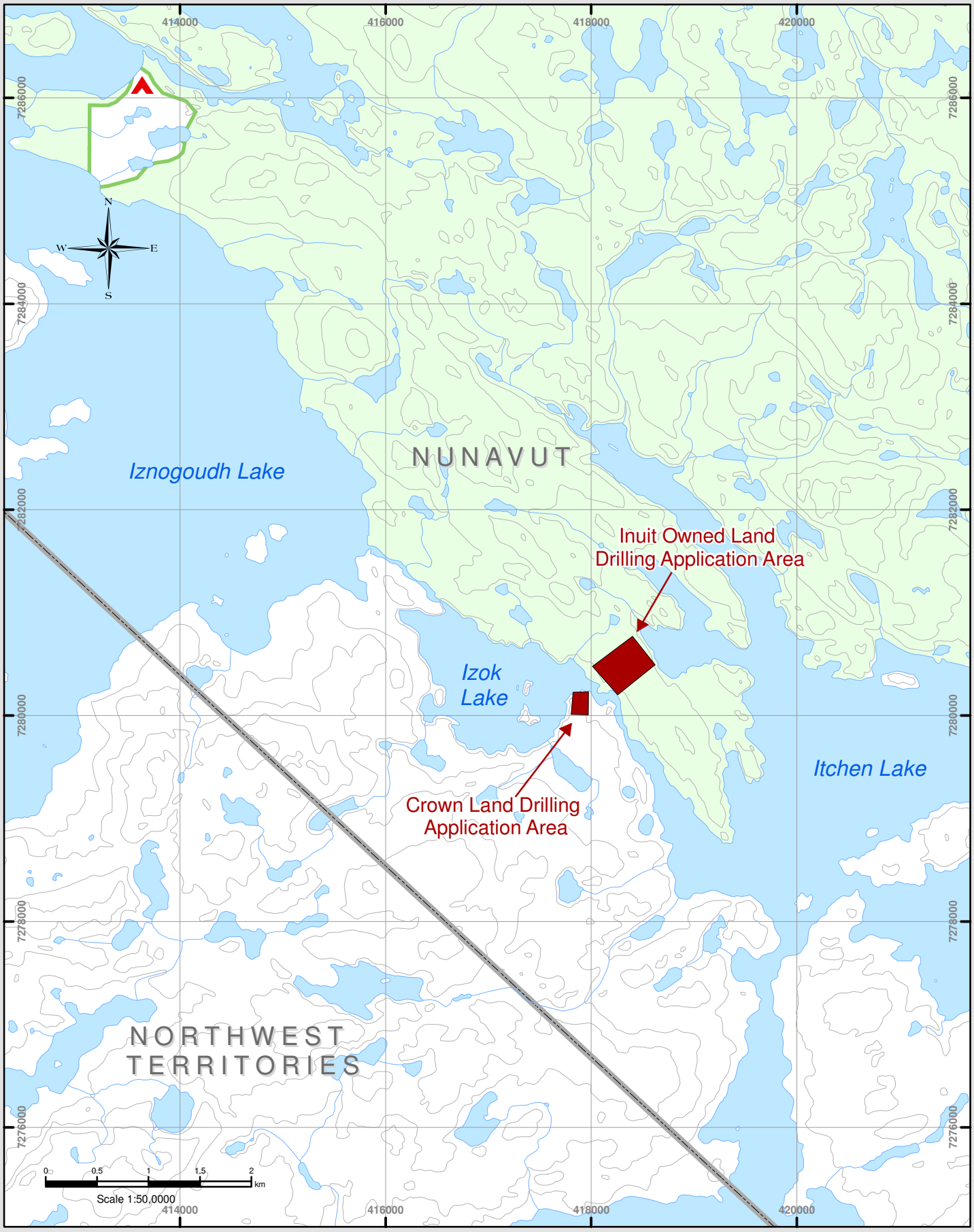
National Topographic Database (NTDB) compiled by the Government of Canada, Natural Resources Canada (NRCan) at 1: 50:000.
Inuit Owned Lands compiled by Nunavut Tunngavik Incorperated.
Lease areas provided by Wolfden Resources Inc.
Government of Canada, Natural Resources Canada, Earth Science Sector, Data Management and Dissemination Branch

Projection: UTM Zone 12 NAD83
Revision: 0
Date: May 31, 2006

Gartner Lee

Map: 1

File: P61013_C1_Fig1RegionalOverview_29eMay2006.mxd



Legend

- Camp
- Planned Drill Areas
- Inuit Owned Lands
- Surface Rights Only
- Contour (20m)
- Watercourse
- Waterbody

WOLFDEN Resources Inc.

Izok Property
Exploration Locations

References:

National Topographic Database (NTDB) compiled by the Government of Canada, Natural Resources Canada (NRCan) at 1: 50:000.

Inuit Owned Lands compiled by Nunavut Tunngavik Incorperated.

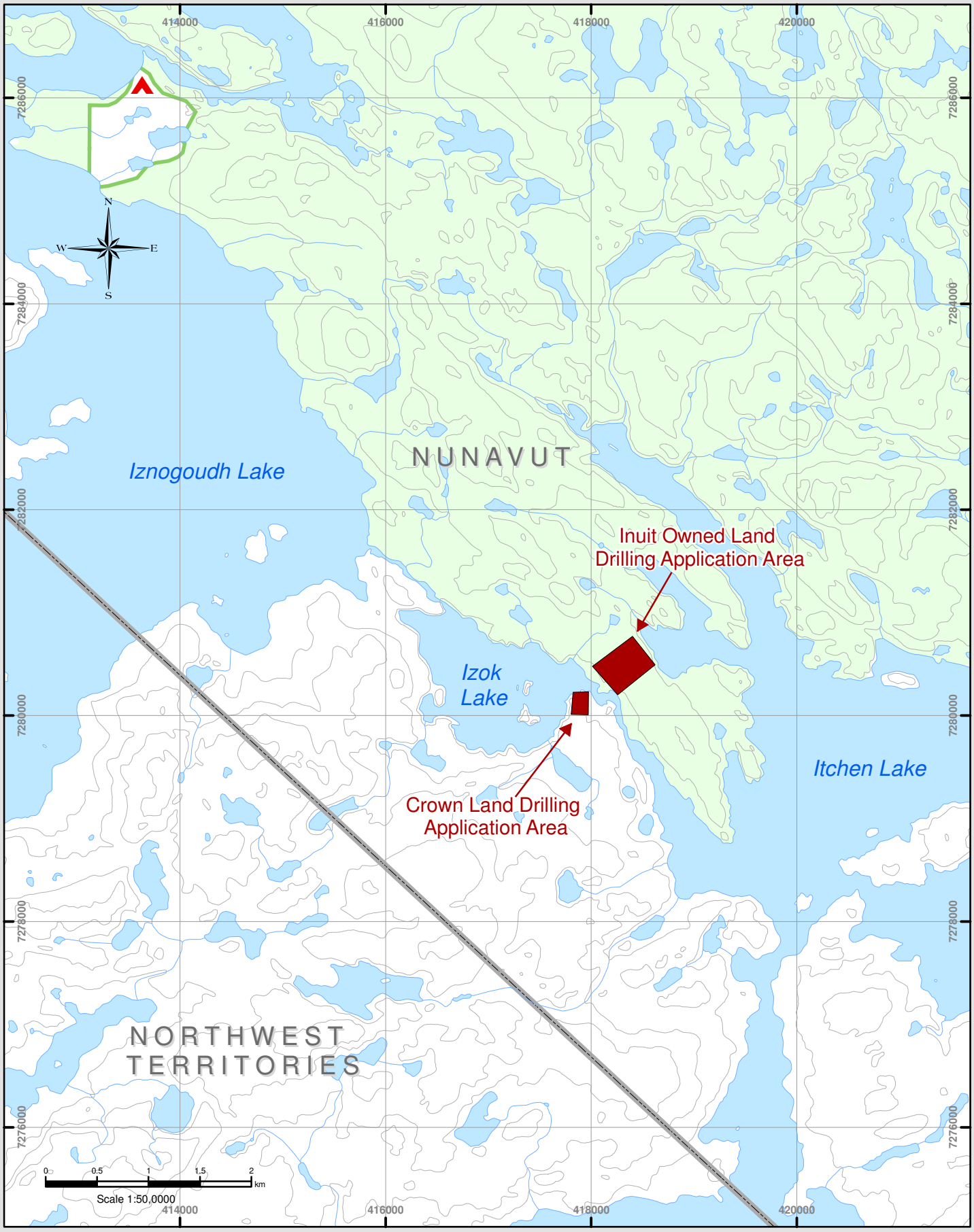
Camp location and planned drill areas provided by Wolfden Resources Inc.

Projection: UTM Zone 12 NAD 83
Revision: 0
Date: May 31, 2006

Gartner Lee

Map: 3

File: P61013_C1_Fig3IzokExplor_29eMay2006.mxd



Legend

- Camp
- Planned Drill Areas
- Inuit Owned Lands
- Surface Rights Only
- Contour (20m)
- Watercourse
- Waterbody

WOLFDEN Resources Inc.

Izok Property
Exploration Locations

References:

National Topographic Database (NTDB) compiled by the Government of Canada, Natural Resources Canada (NRCan) at 1: 50:000.

Inuit Owned Lands compiled by Nunavut Tunngavik Incorperated.

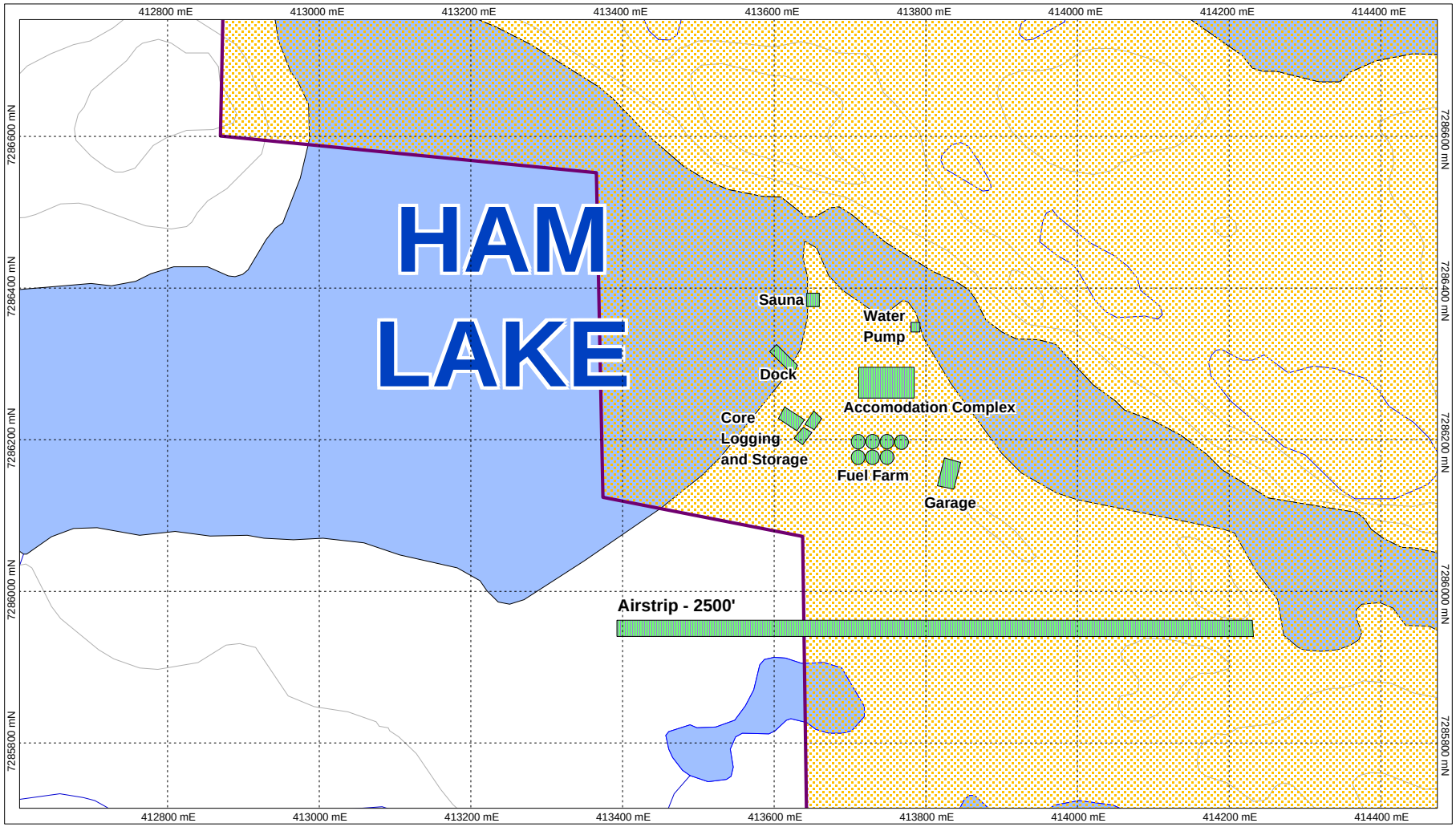
Camp location and planned drill areas provided by Wolfden Resources Inc.

Projection: UTM Zone 12 NAD 83
Revision: 0
Date: May 31, 2006

Gartner Lee

Map: 3

File: P61013_C1_Fig3IzokExplor_29eMay2006.mxd



0 200 400

metres

WOLFDEN RESOURCES INC.

	IZOK/HOOD PROJECTS **Water Licence Application** **Nunavut Water Board** **Camp layout**
Date:25/5/2006	
Author: S.Rickard	
Office: Thunder Bay	
Drawing: IN/SR	
Scale: 1:8,000	Projection: UTM: NAD 83, Zone 12

MSDS SHEETS

WOLFDEN Resources Inc.

PETRO-CANADA

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	**B-3, D-2B**		

Section 1. Chemical Product and Company Identification

Product Name	**STOVE OIL**
Synonym	Stove Oil 55, Switch Heater Fuel, Tobacco Curing Oil, No.1 Diesel, No.1 Furnace Oil, #1 Furnace Oil, ThermaClean.
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3
Material Uses	Stove Oils are light distillate fuels suitable for use in liquid fuel burning equipment without preheating.

Code	W107 SAP: 154
Validated on	**2/24/2004.**
In case of Emergency	Petro-Canada: 403-296-3000 Canutec Transportation: 613-996-6666 Poison Control Centre: Consult local telephone directory for emergency number(s).

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (V/V)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
Complex mixture of petroleum hydrocarbons (C9-C18)	64742-81-0 64742-80-9	>99.9	Not established	Not established	Not established
Trace of functional additives.	Not applicable	<0.1	Not established	Not established	Not established

Manufacturer Recommendation	Not applicable
Other Exposure Limits	Consult local, state, provincial or territory authorities for acceptable exposure limits.

Section 3. Hazards Identification.

Potential Health Effects	Combustible liquid. Exercise caution when handling this material. Contact with this product may cause skin and eye irritation. Prolonged or repeated contact may cause skin irritation, defatting, drying and dermatitis. Inhalation of this product may cause respiratory tract irritation and Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death. Ingestion of this product may cause gastro-intestinal irritation. Aspiration of this product may result in severe irritation or burns to the respiratory tract. For more information refer to Section 11 of this MSDS.

Section 4. First Aid Measures

Eye Contact	IMMEDIATELY flush eyes with running water for at least 15 minutes, keeping eyelids open. Seek medical attention.
Skin Contact	Remove contaminated clothing - launder before reuse. Wash gently and thoroughly the contaminated skin with running water and non-abrasive soap. Seek medical attention.
Inhalation	Evacuate the victim to a safe area as soon as possible. If the victim is not breathing, perform artificial respiration. Allow the victim to rest in a well ventilated area. Seek medical attention.
Ingestion	DO NOT induce vomiting because of danger of aspirating liquid into lungs. Seek medical attention.
Note to Physician	Not available

Section 5. Fire-fighting Measures

Flammability	Class II - combustible liquid (NFPA).	**Flammable Limits**	Lower: 0.7%, Upper: 6%
Flash Points	CLOSED CUP: >40°C (104°F). (Closed Cup)	**Auto-Ignition Temperature**	225°C (437°F)
Fire Hazards in Presence of Various Substances	Flammable in presence of open flames, sparks, and heat. Vapours are heavier than air and may travel considerable distance to sources of ignition and flash back. This product can accumulate static charge and ignite.	**Explosion Hazards in Presence of Various Substances**	Containers may explode in heat of fire. Do not cut, weld, heat, drill or pressurize empty container. Runoff to sewer may create fire or explosion hazard.

Continued on Next Page

Products of Combustion	Carbon oxides (CO, CO2), nitrogen oxides (NOx), sulphur oxides (SOx), sulphur compounds (H2S), smoke and irritating vapours as products of incomplete combustion.
Fire Fighting Media and Instructions	NAERG96, GUIDE 128, Flammable liquids (Non-polar/Water-immiscible). CAUTION: This product has a moderate flash point above 40ºC: Use of water spray when fighting fire may be inefficient. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also consider initial evacuation for 800 meters (1/2 mile) in all directions. SMALL FIRES: Dry chemical, CO2, water spray or regular foam. LARGE FIRES: Water spray, fog or regular foam. Do not use straight streams. Move containers from fire area if you can do it without risk. Fires Involving Tanks or Car/Trailer Loads: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting devices or any discolouration of tank. ALWAYS stay away from the ends of tanks. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible withdraw from area and let fire burn. Wear positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing will only provide limited protection.

Section 6. Accidental Release Measures

Material Release or Spill	Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary. IN THE EVENT OF A LARGE SPILL CONSIDER THE FOLLOWING CONTROL MEASURES: Extinguish all ignition sources. Evacuate non-essential personnel. Ventilate area. Stop leak if safe to do so. Dike spilled material. Use appropriate inert absorbent material to absorb spilled product. Collect used absorbent for later disposal. Ground and bond all equipment used to clean up the spilled material, as it may be a static accumulator. Avoid contact with spilled material. Avoid breathing vapours or mists of material. Avoid contaminating sewers, streams, rivers and other water courses with spilled material. Notify appropriate authorities immediately.

Section 7. Handling and Storage

Handling	COMBUSTIBLE MATERIAL. Handle with care. Avoid contact with any sources of ignition, flames, heat, and sparks. Ensure all equipment is grounded/bonded. Avoid skin contact. Avoid eye contact. Avoid inhalation of product vapours or mists. Wear proper personal protective equipment (See Section 8). Avoid confined spaces and areas with poor ventilation. Empty containers may contain product residue. Do not pressurize, cut, heat, or weld empty containers. Do not reuse containers without commercial cleaning and/or reconditioning. Personnel who handle this material should practice good personal hygiene during and after handling to help prevent accidental ingestion of this product. Properly dispose of contaminated leather articles including shoes that cannot be decontaminated.
Storage	Store away from heat and sources of ignition. Store in dry, cool, well-ventilated area. Store away from incompatible and reactive materials (See section 5 and 10). Ensure the storage containers are grounded/bonded.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.
Personal Protection	***- The selection of personal protective equipment varies, depending upon conditions of use.***
Eyes	Eye protection (i.e., safety glasses, safety goggles and/or face shield) should be determined based on conditions of use. If product is used in an application where splashing may occur, the use of safety goggles and/or a face shield should be considered.
Body	Wear appropriate clothing to prevent skin contact. As a minimum long sleeves and trousers should be worn.
Respiratory	Where concentrations in air may exceed the occupational exposure limits given in Section 2 (and those applicable to your area) and where engineering, work practices or other means of exposure reduction are not adequate, NIOSH approved respirators may be necessary to prevent overexposure by inhalation.
Hands	Wear appropriate chemically protective gloves. When handling hot product ensure gloves are heat resistant and insulated.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Bright oily liquid.	**Viscosity**	1.3 - 4.1 cSt @ 40ºC (104ºF).
Colour	Clear to yellow / brown (may be dyed for taxation purposes).	**Pour Point**	Variable, -50ºC to 0ºC (-58ºF to 32ºF)
Odour	Mild petroleum oil like.	**Softening Point**	Not applicable.
Odour Threshold	Not available	**Dropping Point**	Not applicable.
Boiling Point	150 - 315°C (302 - 599°F)	**Penetration**	Not applicable.
Density	0.80 - 0.85 kg/L @ 15°C (59°F).	**Oil / Water Dist. Coefficient**	Not available
Vapour Density	4.5 (Air = 1)	**Ionicity (in water)**	Not available
Vapour Pressure	1.0 kPa @ 20°C (7.5 mmHg @ 68ºF).	**Dispersion Properties**	Not available
Volatility	<0.1 (Butyl acetate = 1), less than gasoline.	**Solubility**	Insoluble in cold water, soluble in non-polar hydrocarbon solvents.

Section 10. Stability and Reactivity

Corrosivity	Not available		
Stability	The product is stable under normal handling and storage conditions.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Reactive with oxidizing agents.	**Decomposition Products**	May release COx, NOx, SOx, H2S, smoke and irritating vapours when heated to decomposition.

Section 11. Toxicological Information

Routes of Entry Skin contact, eye contact, inhalation and ingestion.

Acute Lethality

Acute toxicity information is not available for the product as a whole, therefore, data for some of the ingredients is provided below:

Kerosine (petroleum), hydrosulfurized (64742-81-0):
Acute Oral toxicity (LD50): >5000 mg/kg (rat)
Acute Dermal toxicity (LD50): >2000 mg/kg (rabbit)
Acute Inhalation toxicity (LC50): >5000 mg/m³/4h (rat)

Distillates (petroleum), hydrodesulfurized middle (64742-80-9):
Acute Inhalation toxicity (LC50): 4600 mg/m³/4h (rat)

Chronic or Other Toxic Effects

Dermal Route:	This product contains a component (at >= 1%) that can cause skin irritation. Therefore, this product is considered to be a skin irritant. Prolonged or repeated contact may defat and dry skin, and cause dermatitis.
Inhalation Route:	Inhalation of this product may cause respiratory tract irritation. Inhalation of this product may cause Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death.
Oral Route:	Ingestion of this product may cause gastro-intestinal irritation. Aspiration of this product may result in severe irritation or burns to the respiratory tract. Ingestion of this product may cause Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death.
Eye Irritation/Inflammation:	This product contains a component (at >= 1%) that can cause eye irritation. Therefore, this product is considered to be an eye irritant.
Immunotoxicity:	Not available
Skin Sensitization:	Contact with this product is not expected to cause skin sensitization, based upon the available data and the known hazards of the components.
Respiratory Tract Sensitization:	Contact with this product is not expected to cause respiratory tract sensitization, based upon the available data and the known hazards of the components.
Mutagenic:	This product is not known to contain any components at >= 0.1% that have been shown to cause mutagenicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a mutagen.

Reproductive Toxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause reproductive toxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a reproductive toxin.
Teratogenicity/Embryotoxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause teratogenicity and/or embryotoxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a teratogen/embryotoxin.
Carcinogenicity (ACGIH):	This product is not known to contain any chemicals at reportable quantities that are listed as Group A1 or A2 carcinogens by ACGIH. (Considered to be A3 by the ACGIH. Kerosine (petroleum), hydrosulfurized, 64742-81-0).
Carcinogenicity (IARC):	This product is not known to contain any chemicals at reportable quantities that are listed as group 1, 2A or 2B carcinogens by IARC.
Carcinogenicity (NTP):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by NTP.
Carcinogenicity (IRIS):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by IRIS.
Carcinogenicity (OSHA):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by OSHA.
Other Considerations	No additional remark.

Section 12. Ecological Information

Environmental Fate	Not available	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available	**Products of Biodegradation**	Not available
Additional Remarks	No additional remark.		

Section 13. Disposal Considerations

Waste Disposal	Spent/ used/ waste product may meet the requirements of a hazardous waste. Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 14. Transport Information

TDG Classification	FUEL OIL, 3, UN1202, PGIII (CL-TDG)	**Special Provisions for Transport**	See Transportation of Dangerous Goods Regulations.

Section 15. Regulatory Information

Other Regulations

This product is acceptable for use under the provisions of WHMIS-CPR. All components of this formulation are listed on the CEPA-DSL (Domestic Substances List).

All components of this formulation are listed on the US EPA-TSCA Inventory.

All components of this product are on the European Inventory of Existing Commercial Chemical Substances (EINECS).

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

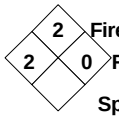
Please contact Product Safety for more information.

DSD/DPD (Europe)	Not evaluated.	**HCS (U.S.A.)**	CLASS: Irritating substance. CLASS: Target organ effects. CLASS: Combustible liquid having a flash point between 37.8°C (100°F) and 93.3°C (200°F).
ADR (Europe) (Pictograms)	NOT EVALUATED FOR EUROPEAN TRANSPORT NON ÉVALUÉ POUR LE TRANSPORT EUROPÉEN.	**DOT (U.S.A) (Pictograms)**	

HMIS (U.S.A.)

Health Hazard	2*
Fire Hazard	2
Reactivity	0
Personal Protection	H

NFPA (U.S.A.)



Rating
0 Insignificant
1 Slight
2 Moderate
3 High
4 Extreme

Section 16. Other Information

References Available upon request.
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Glossary

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CAN/CGA B149.2 Propane Installation Code
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LDLo/LCLo - Lowest Published Lethal Dose/Concentration
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OSHA - Occupational Safety & Health Administration
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RTECS - Registry of Toxic Effects of Chemical Substances
SARA - Superfund Amendments and Reorganization Act
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STEL - Short Term Exposure Limit (15 minutes)
TDG - Transportation Dangerous Goods (Canada)
TDLo/TCLo - Lowest Published Toxic Dose/Concentration
TLm - Median Tolerance Limit
TLV-TWA - Threshold Limit Value-Time Weighted Average
TSCA - Toxic Substances Control Act
USEPA - United States Environmental Protection Agency
USP - United States Pharmacopoeia
WHMIS - Workplace Hazardous Material Information System

For Copy of MSDS
Internet: www.petro-canada.ca/msds

Western Canada, Ontario & Central Canada, telephone: 1-800-668-0220; fax: 1-800-837-1228
Quebec & Eastern Canada, telephone: 514-640-8308; fax: 514-640-8385

For Product Safety Information: (905) 804-4752

Prepared by Product Safety - JDW on 2/24/2004.

Data entry by Product Safety - DSR.

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

PETRO-CANADA

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	**A, B-1**		

Section 1. Chemical Product and Company Identification

Product Name	**PROPANE**
Synonym	Propane HD-5, Propane commercial, Liquified Petroleum Gas (LPG), C3H8, CGSB Propane Grade 1, CGSB Propane Grade 2, odourized propane, stenched propane, automotive propane.
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3
Material Uses	Propane is used as a fuel gas, refrigerant, automotive fuel and as a raw material for organic synthesis. The grade determines the propane content. It is supplied as pressurized liquid in tanks.

Code W222
SAP: 169

Validated on 3/17/2004.

In case of Emergency Petro-Canada: 403-296-3000
Canutec Transportation: 613-996-6666
Poison Control Centre: Consult local telephone directory for emergency number(s).

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (V/V)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
HD-5 Propane					
Propane	74-98-6	>90	1000 ppm	Not established	Not established
Propene	115-07-1	<5	Simple Asphyxiant	Not established	Not established
Commercial Propane					
Propane	74-98-6	>75	1000 ppm	Not established	Not established
Propene	115-07-1	<20	Simple Asphyxiant	Not established	Not established
Both grades may contain:					
Ethane	74-84-0	<6	1000 ppm	Not established	Not established
Butane +	106-97-8	<5	1000 ppm	Not established	Not established

Manufacturer Recommendation Not applicable

Other Exposure Limits Consult local, state, provincial or territory authorities for acceptable exposure limits.

Section 3. Hazards Identification.

Potential Health Effects The product is contained under pressure. Do not puncture, incinerate or heat container as contents may explode. Flammable gas. Exercise caution when handling this material. Propane may displace oxygen and cause asphyxiation. Inhalation of this product may cause respiratory tract irritation and Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death. Contact with gas or liquified gas may cause burns and frostbite to eyes and skin. Ingestion is not an expected route of exposure. For more information, refer to Section 11.

Section 4. First Aid Measures

Eye Contact	IMMEDIATELY flush eyes with running water for at least 15 minutes, keeping eyelids open. Seek medical attention.
Skin Contact	Remove contaminated clothing - launder before reuse. Wash gently and thoroughly the contaminated skin with running water and non-abrasive soap. Seek medical attention.
Inhalation	Evacuate the victim to a safe area as soon as possible. If the victim is not breathing, perform artificial respiration. Allow the victim to rest in a well ventilated area. Seek medical attention.
Ingestion	Ingestion is not an applicable route of exposure for gases.
Note to Physician	Not available

Section 5. Fire-fighting Measures

Flammability	Class I - flammable gas (NFPA).	**Flammable Limits**	Lower: 2.1%; Upper: 9.5%, (NFPA).
Flash Points	CLOSED CUP: -104°C (-155°F).	**Auto-Ignition Temperature**	450°C (842°F), (NFPA).
Fire Hazards in Presence of Various Substances	Extremely flammable in presence of open flames, sparks, and heat. Vapours are heavier than air and may travel considerable distance to sources of ignition and flash back. Rapid escape of vapours may generate static charge causing ignition. May accumulate in confined spaces.	**Explosion Hazards in Presence of Various Substances**	Do not cut, weld, heat, drill or pressurize empty container. Containers may explode in heat of fire. Vapour explosion hazard indoors, outdoors or in sewers. Propane may form explosive mixtures with air.
Products of Combustion	Carbon oxides (CO, CO2), acrid smoke and irritating vapours as products of incomplete combustion.		
Fire Fighting Media and Instructions	NAERG2000, GUIDE 115, Flammable Gas: CAUTION: This product has a low flash point, use of water spray when fighting fire may be inefficient. SMALL FIRE: Use DRY chemicals, CO2, water spray or foam. LARGE FIRE: Use water spray, fog or foam. DO NOT use water jet. If tank, rail car or tank truck is involved in a fire, ISOLATE for 1600 meters (1 mile) in all directions; also, consider initial evacuation for 1600 meters (1 mile) in all directions. DO NOT extinguish a leaking gas flame unless leak can be stopped. Shut off fuel to fire if it is possible to do so without hazard. If this is impossible, withdraw from area and let fire burn out under controlled conditions. Withdraw immediately in case of rising sound from venting safety device or any discolouration of tank due to fire. Cool containing vessels with water spray in order to prevent pressure build-up, autoignition or explosion. Self-contained breathing apparatus (SCBA) will be required if approaching the fire from downwind, or to enter enclosed areas or buildings. Handle damaged cylinders with extreme care.		

Section 6. Accidental Release Measures

Material Release or Spill	IN THE EVENT OF A LARGE SPILL CONSIDER THE FOLLOWING CONTROL MEASURES: Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary. Evacuate non-essential personnel. Extinguish all ignition sources. Stop leak if safe to do so. Ventilate area. Ensure clean-up personnel wear appropriate personal protective equipment. Avoid breathing vapours of material. Notify appropriate authorities immediately.

Section 7. Handling and Storage

Handling	EXTREMELY FLAMMABLE GAS. Handle with care. Avoid contact with any sources of ignition, flames, heat, and sparks. Ensure all equipment is grounded/bonded. Avoid confined spaces and areas with poor ventilation. Avoid skin contact. Avoid eye contact. Avoid inhalation of product vapours. Wear proper personal protective equipment (See Section 8). Rapid escape of vapour may generate static charge causing ignition. Use spark-proof electrical equipment. Do not allow escaping compressed gas or liquid to come in contact with skin or eyes as it can cause frostbite. SPECIAL PRECAUTIONS: Sludges and tank scale from propane storage tanks, trucks and rail cars, and filters/screens may contain naturally occurring radioactive material ('NORM") in the form of lead 210. Similarily, equipment used for the transfer of propane such as product pipelines, pumps and compressors, may have detectable levels of radioactive lead 210 on inner surfaces. Workers involved in cleaning, repair or other maintenance on inner surfaces of such equipment should avoid breathing dust generated from such activities. Suitable codes of practice should be developed for these activities, detailing appropriate occupational hygiene and disposal practices.
Storage	Store away from incompatible and reactive materials (See section 5 and 10). Store away from heat and sources of ignition. Store as flammable material. Compressed gases should be stored in a separate safety storage cabinet or room. Avoid direct sunlight. Keep container tightly closed. Store in dry, cool, well-ventilated area.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.
Personal Protection - ***The selection of personal protective equipment varies, depending upon conditions of use.***	
Eyes	Eye protection (i.e. safety glasses, safety goggles, and/or face shield) should be based on the condition of use. As a minimum, safety glasses with side shields should be worn when handling this material.
Body	Wear appropriate clothing to prevent skin contact. As a minimum long sleeves and trousers should be worn.
Respiratory	Where concentrations in air may exceed the occupational exposure limits given in Section 2 (and those applicable to your area) and where engineering, work practices or other means of exposure reduction are not adequate, NIOSH approved respirators may be necessary to prevent overexposure by inhalation.
Hands	Wear appropriate chemically protective gloves. Wear insulated gloves to prevent from frostbite.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Gas at room temperature; liquid when stored under pressure.	**Viscosity**	Not applicable.
Colour	Colourless.	**Pour Point**	Not applicable.
Odour	Propane is an odourless gas. Odourized propane will contain up to 28 g ethyl mercaptan per 1000 L of propane.	**Softening Point**	Not applicable.
Odour Threshold	Odour is not an adequate warning to prevent overexposure to propane. Prolonged exposure to mercaptans can cause olfactory desensitization.	**Dropping Point**	Not applicable.
Boiling Point	-42°C (-44°F)	**Penetration**	Not applicable.
Density	508 kg/m³ @ 15ºC (59ºF)	**Oil / Water Dist. Coefficient**	Not available
Vapour Density	1.56 (air=1)	**Ionicity (in water)**	Not available
Vapour Pressure	10763 mmHg (1435 kPa) @ 38ºC (100ºF) .	**Dispersion Properties**	Not available
Volatility	Volatile	**Solubility**	Slightly soluble in water.

Section 10. Stability and Reactivity

Corrosivity	Not available		
Stability	The product is stable under normal handling and storage conditions.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Reactive with oxidizing agents.	**Decomposition Products**	May release COx, acrid smoke and irritating vapours when heated to decomposition.

Section 11. Toxicological Information

Routes of Entry Inhalation, skin contact and eye contact.

Acute Lethality

Acute toxicity information is not available for the product as a whole, therefore, data for some of the ingredients is provided below:

Propene (115-07-1):
Acute inhalation toxicity (LC50): >50000 ppm/4h (rat).

Butane (106-97-8):
Acute inhalation toxicity (LC50): 202000 ppm/4h (mouse).

Chronic or Other Toxic Effects

Dermal Route:	Contact with gas or liquefied gas may cause burns and frostbite to the skin.
Inhalation Route:	Propane may displace oxygen and cause asphyxiation. Inhalation of this product may cause respiratory tract irritation. Inhalation of this product may cause Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death.
Oral Route:	Ingestion is not an applicable route of exposure for gases.
Eye Irritation/Inflammation:	Contact with gas or liquefied gas may cause burns and frostbite to the eyes.
Immunotoxicity:	Not available
Skin Sensitization:	Contact with this product is not expected to cause skin sensitization, based upon the available data and the known hazards of the components.
Respiratory Tract Sensitization:	Contact with this product is not expected to cause respiratory tract sensitization, based upon the available data and the known hazards of the components.
Mutagenic:	This product is not known to contain any components at >= 0.1% that have been shown to cause mutagenicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a mutagen.
Reproductive Toxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause reproductive toxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a reproductive toxin.

Teratogenicity/Embryotoxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause teratogenicity and/or embryotoxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a teratogen/embryotoxin.
Carcinogenicity (ACGIH):	This product is not known to contain any chemicals at reportable quantities that are listed as Group A1 or A2 carcinogens by ACGIH.
Carcinogenicity (IARC):	This product is not known to contain any chemicals at reportable quantities that are listed as Group 1, 2A, or 2B carcinogens by IARC.
Carcinogenicity (NTP):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by NTP.
Carcinogenicity (IRIS):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by IRIS.
Carcinogenicity (OSHA):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by OSHA.
Other Considerations	No additional remark.

Section 12. Ecological Information

Environmental Fate	Not available	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available	**Products of Biodegradation**	Not available
Additional Remarks	No additional remark.		

Section 13. Disposal Considerations

Waste Disposal	Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 14. Transport Information

TDG Classification	PROPANE, 2.1, UN1978 (CL-TDG)	**Special Provisions for Transport**	See Transportation of Dangerous Goods Regulations.

Section 15. Regulatory Information

Other Regulations

This product is acceptable for use under the provisions of WHMIS-CPR. All components of this formulation are listed on the CEPA-DSL (Domestic Substances List).

All components of this formulation are listed on the US EPA-TSCA Inventory.

All components of this product are on the European Inventory of Existing Commercial Chemical Substances (EINECS).

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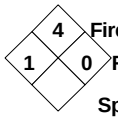
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DSD/DPD (Europe)	Not evaluated.	**HCS (U.S.A.)**	CLASS: Flammable gas. CLASS: Compressed gas. CLASS: Target organ effects.
ADR (Europe) (Pictograms)	**NOT EVALUATED FOR EUROPEAN TRANSPORT** **NON ÉVALUÉ POUR LE TRANSPORT EUROPÉEN.**	**DOT (U.S.A) (Pictograms)**	

HMIS (U.S.A.)

Health Hazard	1*
Fire Hazard	4
Reactivity	0
Personal Protection	H

NFPA (U.S.A.)



Rating

0 Insignificant
1 Slight
2 Moderate
3 High
4 Extreme

Section 16. Other Information

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Internet: www.petro-canada.ca/msds

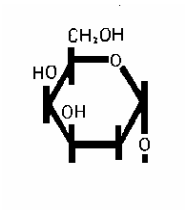
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For Product Safety Information: (905) 804-4752

Prepared by Product Safety - JDW on 3/17/2004.

Data entry by Product Safety - DSR.

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Poly-Drill Drilling Systems
1824 - 104 Avenue, S.W.
Calgary, Alberta, Canada T2W-OA8
(403) 259-5112 FAX (403) 255-7185
email: polydril@telus.net
www.poly-drill.com

poly-drill.com

MATERIAL SAFETY DATA SHEET/FICHE SIGNALETIQUE

1. PRODUCT IDENTIFICATION

PRODUCT TRADE NAME(S): Poly Drill O.B.X.
WHMIS CLASSIFICATION: Non-regulated
TDG Classification: Non dangerous goods
DATE: November 17, 2004

A liquid polymer containing guar gum, mineral oil, vegetable oil, acrylamide copolymer and a surfactant: Evaluation of the ingredient(s) has found no ingredient(s) hazardous as per WHMIS regulations.

2. PHYSICAL DATA

Boiling Point: Not available
Specific Gravity: 0.9 g/cm
Solubility in Water: disperses in water(forms viscous, slippery solution).
pH: 3.8 (1% concentration)
Density (g/ml): Not available
Physical State: Liquid
Appearance and Odor: Brown. Odor slight.

3. FIRE AND EXPLOSION DATA

Flash Point (method used): (PMCC) greater than 100 C.
Conditions of flammability: Very low risk.
Hazardous combustion products: None known.
Upper and Lower flammable limits: Not available.
Extinguishing media: Carbon dioxide, dry chemicals, foam, in preference to water spray

4. REACTIVITY

Chemical stability: Stable under normal conditions.
Hazardous Polymerization: Will not occur.
Incompatible substances: Avoid strong oxidants such as liquid chlorine, concentrated oxygen, sodium or calcium hypo chloride.
Hazardous decomposition products: None known

5. HEALTH HAZARD DATA

TOXICITY RATING: Practically non-harmful.
Routes of Exposure and Effects:

SKIN: Slight irritant: prolonged contact may cause skin irritation or dermatitis in some individuals
EYE: No effects of exposure expected with the exception of possible irritation.
INHALATION: Due to low volatility of mineral distillates a small inhalation hazard exists.

INGESTION: can cause nausea, vomiting, cramps, diarrhea
Chronic exposure limits: None
Sensitization of product: Not suspected to be a sensitizer.
Teratongenicity: Not available.
Mutagenicity: Not available.
Carcinogenicity: None of the components of this product are listed as carcinogens by IARC and ACGIH

6. EMERGENCY AND FIRST AID PROCEDURES

SKIN: Wash exposed area with soap and water. Remove contaminated clothing. Launder contaminated clothing before re-use. If irritation or abnormalities persist, call a physician.

EYE: Immediately flush eyes with water for 15 minutes, lifting upper and lower lids occasionally. Get medical attention.

INHALATION: Remove to fresh air. If breathing becomes difficult, give oxygen and call a physician.

INGESTION: Do not induce vomiting: Call a physician immediately or poison control center. Never give anything by mouth to an unconscious person. Seek medical advice.

8. INDUSTRIAL HYGIENE CONTROL MEASURES

Respiratory Protection: None normally required.
Ventilation: If mist and/or vapors are present, use air purifying respirator of self-contained breathing apparatus, but this is rarely required.
Eye Protection: Safety glasses, if personally preferred
Gloves: Generally not necessary. Personal preference.

7. HANDLING AND USE PRECTIONS

Storage requirements: keep container closed when no in use. Store in a cool dry location away from oxidizing and reducing agents.
Waste Disposal: product should be disposed of in accordance with applicable local, Provincial and Federal regulations.
Steps must be taken if product is released or spilled: clean spill areas thoroughly to avoid hazardous slippery conditions.

8. TOXICOLOGICAL PROPERTIES

G50 Microtox Analysis prepared by HydroQual Laboratories, Calgary, AB--97/6/26 Test#970978:

Test Description	EC20	EC50	Pass/Fail
MTX	>91	>91	PASS

9. DEPARTMENT OF TRANSPORTATION INFORMATION

PROPER SHIPPING NAME/HAZARD CLASS MAY VARY BY PACKAGING, PROPERTIES, AND MODE OF TRANSPORTATION. TYPICAL PROPER SHIPPING NAMES FOR THIS PRODUCT ARE:

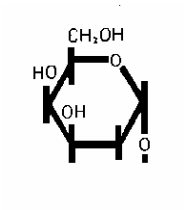
ALL TRANSPORTATION MODES: PRODUCT IS NOT REGULATED DURING TRANSPORATION

Shipping Name: Liquid Drilling Additive
Hazard Class: Not hazardous

Hazardous Substances: None
Cautionary Labeling: None required

10. OTHER INFORMATION

This information contained herein is given in good faith, but no warranty, expressed or implied is made



Poly-Drill Drilling Systems
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poly-drill.com

MATERIAL SAFETY DATA SHEET/FICHE SIGNALETIQUE

1. PRODUCT IDENTIFICATION

PRODUCT TRADE NAME: Poly-Drill 1330-W
PRODUCT DESCRIPTION: LIQUID ANIONIC POLYMER
CHEMICAL DESCRIPTION: Polymer, Surfactant(s), Water, Hydrocarbon solvent
UPDATED: March 15, 2004

NFPA704M/HMIS RATING
HEALTH: 0/1 FLAMMABILITY: 1/1 REACTIVITY: 0/0 OTHER:
0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

2. COMPOSITION

A liquid polymer: Evaluation of the ingredient(s) has found no ingredient(s) hazardous as per WHMIS regulations. None of the substances in this product are hazardous.

3. PHYSICAL DATA

Flash Point: >100°C (PMCC)
Specific Gravity (@ 25°C.): 1.08
Solubility in Water: Emulsifiable
pH: 8.1 (1.0% solution)
Freeze Point: -10 °C (14 Degrees F)
Density (g/ml): 1.08 at 25 °C
Physical State: Liquid
Appearance: Blue liquid
Odor: Hydrocarbon

Note: These physical properties are typical values for this product.

4. FIRE AND EXPLOSION DATA

INCOMPATIBILITY: Avoid contact with strong oxidizers (eg. Chlorine, peroxides, chromates, nitric acid, perchlorates, concentrated oxygen, permanganates) which can generate heat, fires, explosions and the release of toxic fumes.

THERMAL DECOMPOSTION PRODUCTS: In the event of combustion CO, oxides of carbon (COx), oxides of nitrogen (NOx) may be formed. Do not breathe smoke or fumes. Wear suitable protective equipment.

5. FIRE FIGHTING MEASURES

FLASH POINT: >100°C (PMCC)

EXTINGUISHING MEDIA: Based on the NFPA guide, use dry chemical, foam, carbon dioxide or other extinguishing agent suitable for Class B fires. Use water to cool containers exposed to fire. For larger fires, use water spray or fog, thoroughly drenching the burning material.

UNSUITABLE EXTINGUISHING MEDIA:
Do not use water unless flooding amounts are available.

UNUSUAL FIRE AND EXPLOSION HAZARD: May evolve oxides of nitrogen (NOx) under fire conditions.

6. HEALTH HAZARD DATA

EMERGENCY OVERVIEW:
CAUTION: May cause irritation to skin and eyes. Avoid contact with skin, eyes and clothing. Do not take internally.

Empty containers may contain residual product. Do not reuse container unless properly reconditioned.

PRIMARY ROUTE(S) OF EXPOSURE: Eye & Skin

EYE CONTACT: Can cause mild to moderate irritation
SKIN CONTACT: Can cause mild, short-lasting irritation

SYMPTOMS OF EXPOSURE: A review of available data does not identify any symptoms from exposure not previously mentioned.

AGGRAVATION OF EXISTING CONDITIONS: A review of available data does not identify any worsening of existing conditions.

7. EMERGENCY AND FIRST AID PROCEDURES

SKIN: Wash exposed area with soap and water. If irritation or abnormalities persist, call a physician.
EYE: Immediately flush eyes with water for 15 minutes, if irritation or abnormalities persist, call a physician.
INHALATION: Remove to fresh air. If breathing becomes difficult, give oxygen and call a physician.
INGESTION: Do not induce vomiting: Call a physician immediately.

CAUTION: If unconscious, having trouble breathing or in convulsions, do not induce vomiting or give water. Call for medical assistance immediately.

8. HANDLING, ACCIDENTAL RELEASE MEASURES & DISPOSAL CONSIDERATIONS

Storage: Keep container tightly closed when not in use.

DISPOSAL:
In Ontario, the waste class under Regulation 347 is: 233L

SMALL SPILLS:
Soak up spill with absorbent material. Place residues in a suitable, covered, properly labeled container. Wash affected area.

LARGE SPILLS:
Contain liquid using absorbent material, by digging trenches or by dyking. Reclaim into recovery or salvage drums or tank truck for proper disposal. Contact approved waste hauler for disposal of contaminated recovered material. Dispose of material in compliance with regulations indicated.

Dispose of wastes in an approved incinerator or waste treatment/disposal site, in accordance with all applicable regulations. Do not dispose of wastes in local sewer or with normal garbage.

ENVIRONMENTAL PRECAUTIONS
This product should NOT be directly discharged into lakes, ponds, streams, waterways or public water supplies.

As a non-hazardous liquid waste, it should be solidified with stabilizing agents (such as sand, fly ash, or cement) so that no free liquid remains before disposal to an industrial waste landfill. A non-hazardous liquid waste can also be incinerated in accordance with local, state, provincial and federal regulations.

9. INDUSTRIAL HYGIENE CONTROL MEASURES

OCCUPATIONAL EXPOSURE LIMITS:
This product does not contain any substance that has an established exposure limit.

Respiratory Protection: None normally required.

For large spills, entry into large tanks, vessels or enclosed small spaces with inadequate ventilation, a positive pressure, self-contained breathing apparatus is recommended.

Ventilation: General ventilation is recommended.

Eye Protection: Safety glasses, if personally preferred
Gloves: Generally not necessary. Personal preference. Examples of impermeable gloves available on the market are neoprene, nitrile, PVC, natural rubber, viton, and butyl (compatibility studies have not been performed).

If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse.

10. TOXICOLOGICAL PROPERTIES

SENSITIZATION:
This product is not expected to be a sensitizer.

A "LC50-96" Pass/Fail Bioassay test. This test determines the lethality of a fluid on young aquatic organisms . The fluid fails if 50% or more of the animals are dead after 96 hours in the fluid.

96 hour static acute LC50 to Rainbow Trout = Greater than 1,000 mg/L
96 hour no observed effect concentration = 125 mg/L based on no mortality or abnormal effects
96 hour static acute LC50 to Sheepshead Minnow = Greater than 1,000 mg/L
96 hour no observed effect concentration = 1,000 mg/L (highest concentration tested) based on no mortality or abnormal effects.
96 hour static acute LC50 to Mysid Shrimp = 400 mg/L
96 hour no observed effect concentration = 180 mg/L based on no mortality or abnormal effects.
96 hour static acute LC50 to Daphnia Magna - 400 mg/L
96 hour no observed effect concentration = 56 mg/L (lowest concentration tested) based on no mortality or abnormal effects.

Microtoxicity

The Microtox bioassay has been established as the reference test for mud additive toxicity testing.

Test Method: Luminescent Bacteria, IC50@ 15 min
Reference: Appendix 1: Microtox Bioassay Procedure, Drilling Waste Management, Guide G50. 1993. Alberta Energy and Utilities Board, Calgary, AB, Canada.
Sample: Poly Drill 1330, sample #97324-1 for test #970723, 97/05/09 by D. Lintott
Preparation: Sample was diluted to 2 g/L, which formed thick, slightly cloudy liquid. The sample was then centrifuged for 1 hour.

Test Results:

SAMPLE	TREATMENT	%CTL	IC20%	IC50	RESULT
97324-1	None	N/A	14 (9-22)	>91	PASS

The following results are for a 1% aqueous solution of product.

CARCINOGENCITY:
None of the substances in this product are listed as carcinogens by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP) or the American Conference of Government Industrial Hygienists (ACGIH).

HUMAN HAZARD CHARACTERIZATION:
Based on our Hazard Characterization, the potential human hazard is: LOW

ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION:
Based on our Hazard Characterization, the potential environmental hazard is: LOW.

11. DEPARTMENT OF TRANSPORTATION INFORMATION

PROPER SHIPPING NAME/HAZARD CLASS MAY VARY BY PACKAGING, PROPERTIES, AND MODE OF TRANSPORTATION. TYPICAL PROPER SHIPPING NAMES FOR THIS PRODUCT ARE:

ALL TRANSPORTATION MODES: PRODUCT IS NOT REGULATED DURING TRANSPORATION

Shipping Name: Drilling Mud
Hazard Class: Not hazardous
Cautionary Labeling: None required

12. OTHER INFORMATION

This information contained herein is given in good faith, but no warranty, expressed or implied, is made.

Poly-Drill Drilling Systems
1824 - 104 Avenue, S.W.
Calgary, Alberta, Canada T2W-OA8
(403) 259-5112 FAX (403) 255-7185
email: polydril@telus.net
www.poly-drill.com

poly-drill.com

MATERIAL SAFETY DATA SHEET/FICHE SIGNALETIQUE

1. PRODUCT IDENTIFICATION

PRODUCT TRADE NAME: Poly-Drill 133-X
PRODUCT DESCRIPTION: LIQUID ANIONIC POLYMER
CHEMICAL DESCRIPTION: Polymer, Surfactant(s), Water, Hydrocarbon solvent
UPDATED: March 15, 2004

NFPA704M/HMIS RATING
HEALTH: 0/1 FLAMMABILITY: 1/1 REACTIVITY: 0/0 OTHER:
0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

2. COMPOSITION

A liquid polymer: Evaluation of the ingredient(s) has found no ingredient(s) hazardous as per WHMIS regulations. None of the substances in this product are hazardous.

3. PHYSICAL DATA

Flash Point: >100°C (PMCC)
Specific Gravity (@ 25°C.): 1.08
Solubility in Water: Emulsifiable
pH: 8.1 (1.0% solution)
Freeze Point: -10 °C (14 Degrees F)
Density (g/ml): 1.08 at 25 °C
Physical State: Liquid
Appearance: Blue liquid
Odor: Hydrocarbon

Note: These physical properties are typical values for this product.

4. FIRE AND EXPLOSION DATA

INCOMPATIBILITY: Avoid contact with strong oxidizers (eg. Chlorine, peroxides, chromates, nitric acid, perchlorates, concentrated oxygen, permanganates) which can generate heat, fires, explosions and the release of toxic fumes.

THERMAL DECOMPOSTION PRODUCTS: In the event of combustion CO, oxides of carbon (COx), oxides of nitrogen (NOx) may be formed. Do not breathe smoke or fumes. Wear suitable protective equipment.

5. FIRE FIGHTING MEASURES

FLASH POINT: >100°C (PMCC)

EXTINGUISHING MEDIA: Based on the NFPA guide, use dry chemical, foam, carbon dioxide or other extinguishing agent suitable for Class B fires. Use water to cool containers exposed to fire. For larger fires, use water spray or fog, thoroughly drenching the burning material.

UNSUITABLE EXTINGUISHING MEDIA:
Do not use water unless flooding amounts are available.

UNUSUAL FIRE AND EXPLOSION HAZARD: May evolve oxides of nitrogen (NOx) under fire conditions.

6. HEALTH HAZARD DATA

EMERGENCY OVERVIEW:
CAUTION: May cause irritation to skin and eyes. Avoid contact with skin, eyes and clothing. Do not take internally.

Empty containers may contain residual product. Do not reuse container unless properly reconditioned.

PRIMARY ROUTE(S) OF EXPOSURE: Eye & Skin

EYE CONTACT: Can cause mild to moderate irritation
SKIN CONTACT: Can cause mild, short-lasting irritation

SYMPTOMS OF EXPOSURE: A review of available data does not identify any symptoms from exposure not previously mentioned.

AGGRAVATION OF EXISTING CONDITIONS: A review of available data does not identify any worsening of existing conditions.

7. EMERGENCY AND FIRST AID PROCEDURES

SKIN: Wash exposed area with soap and water. If irritation or abnormalities persist, call a physician.
EYE: Immediately flush eyes with water for 15 minutes, if irritation or abnormalities persist, call a physician.
INHALATION: Remove to fresh air. If breathing becomes difficult, give oxygen and call a physician.
INGESTION: Do not induce vomiting: Call a physician immediately.

CAUTION: If unconscious, having trouble breathing or in convulsions, do not induce vomiting or give water. Call for medical assistance immediately.

8. HANDLING, ACCIDENTAL RELEASE MEASURES & DISPOSAL CONSIDERATIONS

Storage: Keep container tightly closed when not in use.

DISPOSAL:
In Ontario, the waste class under Regulation 347 is: 233L

SMALL SPILLS:
Soak up spill with absorbent material. Place residues in a suitable, covered, properly labeled container. Wash affected area.

LARGE SPILLS:
Contain liquid using absorbent material, by digging trenches or by dyking. Reclaim into recovery or salvage drums or tank truck for proper disposal. Contact approved waste hauler for disposal of contaminated recovered material. Dispose of material in compliance with regulations indicated.

Dispose of wastes in an approved incinerator or waste treatment/disposal site, in accordance with all applicable regulations. Do not dispose of wastes in local sewer or with normal garbage.

ENVIRONMENTAL PRECAUTIONS
This product should NOT be directly discharged into lakes, ponds, streams, waterways or public water supplies.

As a non-hazardous liquid waste, it should be solidified with stabilizing agents (such as sand, fly ash, or cement) so that no free liquid remains before disposal to an industrial waste landfill. A non-hazardous liquid waste can also be incinerated in accordance with local, state, provincial and federal regulations.

9. INDUSTRIAL HYGIENE CONTROL MEASURES

OCCUPATIONAL EXPOSURE LIMITS:
This product does not contain any substance that has an established exposure limit.

Respiratory Protection: None normally required.

For large spills, entry into large tanks, vessels or enclosed small spaces with inadequate ventilation, a positive pressure, self-contained breathing apparatus is recommended.

Ventilation: General ventilation is recommended.

Eye Protection: Safety glasses, if personally preferred
Gloves: Generally not necessary. Personal preference. Examples of impermeable gloves available on the market are neoprene, nitrile, PVC, natural rubber, viton, and butyl (compatibility studies have not been performed).

If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse.

10. TOXICOLOGICAL PROPERTIES

SENSITIZATION:
This product is not expected to be a sensitizer.

A "LC50-96" Pass/Fail Bioassay test. This test determines the lethality of a fluid on young aquatic organisms . The fluid fails if 50% or more of the animals are dead after 96 hours in the fluid.

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96 hour static acute LC50 to Sheepshead Minnow = Greater than 1,000 mg/L
96 hour no observed effect concentration = 1,000 mg/L (highest concentration tested) based on no mortality or abnormal effects.
96 hour static acute LC50 to Mysid Shrimp = 400 mg/L
96 hour no observed effect concentration = 180 mg/L based on no mortality or abnormal effects.
96 hour static acute LC50 to Daphnia Magna - 400 mg/L
96 hour no observed effect concentration = 56 mg/L (lowest concentration tested) based on no mortality or abnormal effects.

Microtoxicity

The Microtox bioassay has been established as the reference test for mud additive toxicity testing.

Test Method: Luminescent Bacteria, IC50@ 15 min
Reference: Appendix 1: Microtox Bioassay Procedure, Drilling Waste Management, Guide G50. 1993. Alberta Energy and Utilities Board, Calgary, AB, Canada.
Sample: Poly Drill 1330, sample #97324-1 for test #970723, 97/05/09 by D. Lintott
Preparation: Sample was diluted to 2 g/L, which formed thick, slightly cloudy liquid. The sample was then centrifuged for 1 hour.

Test Results:

SAMPLE	TREATMENT	%CTL	IC20%	IC50	RESULT
97324-1	None	N/A	14 (9-22)	>91	PASS

The following results are for a 1% aqueous solution of product.

CARCINOGENCITY:
None of the substances in this product are listed as carcinogens by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP) or the American Conference of Government Industrial Hygienists (ACGIH).

HUMAN HAZARD CHARACTERIZATION:
Based on our Hazard Characterization, the potential human hazard is: LOW

ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION:
Based on our Hazard Characterization, the potential environmental hazard is: LOW.

11. DEPARTMENT OF TRANSPORTATION INFORMATION

PROPER SHIPPING NAME/HAZARD CLASS MAY VARY BY PACKAGING, PROPERTIES, AND MODE OF TRANSPORTATION. TYPICAL PROPER SHIPPING NAMES FOR THIS PRODUCT ARE:

ALL TRANSPORTATION MODES: PRODUCT IS NOT REGULATED DURING TRANSPORATION

Shipping Name: Liquid Drilling Additive
Hazard Class: Not hazardous
Cautionary Labeling: None required

14. OTHER INFORMATION

This information contained herein is given in good faith, but no warranty, expressed or implied is made

Material Safety Data Sheet

Dow Chemical Canada, Inc

Product Name: PELADOW* DG Calcium Chloride

Issue Date: 2005.09.29
Print Date: 29 Sep 2005

Dow Chemical Canada, Inc encourages and expects you to read and understand the entire (M)SDS, as there is important information throughout the document. We expect you to follow the precautions identified in this document unless your use conditions would necessitate other appropriate methods or actions.

1. Product and Company Identification

Product Name
PELADOW* DG Calcium Chloride

COMPANY IDENTIFICATION
Dow Chemical Canada, Inc
A Subsidiary of The Dow Chemical Company
PO Box 3030
1425 Vidal Street South
Sarnia, ON N7T 8C6
Canada

Prepared By:	Prepared for use in Canada by EH&S, Product Regulatory Management Department. 450-652-1029
Revision	2005.09.29
Print Date:	9/29/2005

Customer Information Number: 800-331-6451

EMERGENCY TELEPHONE NUMBER
24-Hour Emergency Contact: 519-339-3711

2. Hazards Identification

Emergency Overview
Color: White
Physical State: Solid
Odor: Odorless
Hazards of product:

WARNING! Causes eye irritation. May cause skin irritation. May be harmful if swallowed. Isolate area.

Potential Health Effects

Eye Contact: For dust: May cause severe eye irritation. May cause corneal injury. Effects may be slow to heal.
Skin Contact: Brief contact is essentially nonirritating to skin. Prolonged contact may cause skin irritation, even a burn. Not classified as corrosive to the skin according to DOT guidelines. May cause more severe response if skin is damp. May cause more severe response if skin is abraded (scratched or cut). May cause more severe response on covered skin (under clothing, gloves).
Skin Absorption: Prolonged skin contact is unlikely to result in absorption of harmful amounts.
Inhalation: Dust may cause irritation to upper respiratory tract (nose and throat). Vapors are unlikely due to physical properties.
Ingestion: Low toxicity if swallowed. Small amounts swallowed incidentally as a result of normal handling operations are not likely to cause injury; however, swallowing larger amounts may cause injury. Swallowing may result in gastrointestinal irritation or ulceration.
Effects of Repeated Exposure: The data presented are for the following material: Potassium chloride. In animals, effects have been reported on the following organs after ingestion: Gastrointestinal tract. Heart. Kidney. Dose levels producing these effects were many times higher than any dose levels expected from exposure due to use.

3. Composition/information on ingredients

Component	CAS #	Amount W/W
Calcium chloride	10043-52-4	> 91.0 - < 93.0 %
Sodium chloride	7647-14-5	> 1.0 - < 2.0 %
Potassium chloride	7447-40-7	> 2.0 - < 3.0 %
Water	7732-18-5	> 1.0 - < 4.0 %

Amounts are presented as percentages by weight.

4. First-aid measures

Eye Contact: Immediately flush eyes with water; remove contact lenses, if present, after the first 5 minutes, then continue flushing eyes for at least 15 minutes. Obtain medical attention without delay, preferably from an ophthalmologist.
Skin Contact: Wash skin with plenty of water.
Inhalation: Move person to fresh air; if effects occur, consult a physician.
Ingestion: Do not induce vomiting. Give one cup (8 ounces or 240 ml) of water or milk if available and transport to a medical facility. Do not give anything by mouth to an unconscious person.
Notes to Physician: Due to irritant properties, swallowing may result in burns/ulceration of mouth, stomach and lower gastrointestinal tract with subsequent stricture. Aspiration of vomitus may cause lung injury. Suggest endotracheal/esophageal control if lavage is done. If burn is present, treat as any thermal burn, after decontamination. No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient.

5. Fire Fighting Measures

Extinguishing Media: This material does not burn. If exposed to fire from another source, use suitable extinguishing agent for that fire.
Fire Fighting Procedures: Keep people away. Isolate fire and deny unnecessary entry. This material does not burn. Fight fire for other material that is burning. Water should be applied in large quantities as fine spray.
Special Protective Equipment for Firefighters: Wear positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, trousers,

boots, and gloves). Avoid contact with this material during fire fighting operations. If contact is likely, change to full chemical resistant fire fighting clothing with self-contained breathing apparatus. If this is not available, wear full chemical resistant clothing with self-contained breathing apparatus and fight fire from a remote location. For protective equipment in post-fire or non-fire clean-up situations, refer to the relevant sections.
Unusual Fire and Explosion Hazards: Heat is generated when product mixes with water.
Hazardous Combustion Products: Not applicable.

See Section 9 for related Physical Properties

6. Accidental Release Measures

Steps to be Taken if Material is Released or Spilled: Small and large spills: Contain spilled material if possible. Collect in suitable and properly labeled containers. Flush residue with plenty of water. See Section 13, Disposal Considerations, for additional information.
Personal Precautions: Isolate area. Keep unnecessary and unprotected personnel from entering the area. Use appropriate safety equipment. For additional information, refer to Section 8, Exposure Controls and Personal Protection.
Environmental Precautions: Prevent from entering into soil, ditches, sewers, waterways and/or groundwater. See Section 12, Ecological Information.

7. Handling and Storage

Handling
General Handling: Avoid contact with eyes, skin, and clothing. Wash thoroughly after handling. Do not swallow. Heat developed during diluting or dissolving is very high. Use cool water when diluting or dissolving (temperature less than 80°F, 27°C). See Section 8, EXPOSURE CONTROLS AND PERSONAL PROTECTION.

Storage
Keep container closed. Store in a dry place. Protect from atmospheric moisture.

8. Exposure Controls / Personal Protection

Exposure Limits

Component	List	Type	Value
Calcium chloride	DOW IHG	TWA	10 mg/m3
	CAD ON OEL	TWA	5 mg/m3

Consult local authorities for recommended exposure limits.

Personal Protection
Eye/Face Protection: Use safety glasses. For dusty operations or when handling solutions of the material, wear chemical goggles.
Skin Protection: Wear clean, body-covering clothing.

Hand protection: Use gloves chemically resistant to this material. If hands are cut or scratched, use gloves chemically resistant to this material even for brief exposures. Examples of preferred glove barrier materials include: Neoprene. Polyvinyl chloride ("PVC" or "vinyl"). Nitrile/butadiene rubber ("nitrile" or "NBR"). NOTICE: The selection of a specific glove for a particular application and duration of use in a workplace should also take into account all relevant workplace factors such as, but not limited to: Other chemicals which may be handled, physical requirements (cut/puncture protection, dexterity, thermal protection), potential body reactions to glove materials, as well as the instructions/specifications provided by the glove supplier.

Respiratory Protection: Atmospheric levels should be maintained below the exposure guideline. When respiratory protection is required for certain operations, use an approved air-purifying respirator. In dusty or misty atmospheres, use an approved particulate respirator. The following should be effective types of air-purifying respirators: Particulate filter.
Ingestion: Use good personal hygiene. Do not consume or store food in the work area. Wash hands before smoking or eating.

Engineering Controls
Ventilation: Provide general and/or local exhaust ventilation to control airborne levels below the exposure guidelines.

9. Physical and Chemical Properties

Physical State	Solid
Color	White
Odor	Odorless
Flash Point - Closed Cup	Not applicable
Flammable Limits In Air	**Lower**: *Literature* Not applicable **Upper**: *Literature* Not applicable
Autoignition Temperature	Not applicable
Vapor Pressure	0.009 mmHg @ 20 °C *Literature*
Boiling Point (760 mmHg)	>= 204 °C *Literature*
Vapor Density (air = 1)	*Not applicable*
Specific Gravity (H2O = 1)	Not applicable
Freezing Point	Not applicable
Melting Point	772 °C *Literature* (Approx.)
Solubility in Water (by weight)	soluble in water
pH	Not applicable

10. Stability and Reactivity

Stability/Instability
Stable. Hygroscopic.
Conditions to Avoid: None known. Avoid moisture.

Incompatible Materials: Heat is generated when mixed with water. Spattering and boiling can occur. Avoid contact with: Sulfuric acid. Corrosive when wet. Flammable hydrogen may be generated from contact with metals such as: Zinc. Sodium.

Hazardous Polymerization
Will not occur.

Thermal Decomposition
Does not decompose.

11. Toxicological Information

Acute Toxicity
Ingestion
For the major component(s): LD50, Rat 900 - 2,100 mg/kg
Skin Absorption
For the major component(s): LD50, Rabbit > 5,000 mg/kg
Repeated Dose Toxicity

The data presented are for the following material: Potassium chloride. In animals, effects have been reported on the following organs after ingestion: Gastrointestinal tract. Heart. Kidney. Dose levels producing these effects were many times higher than any dose levels expected from exposure due to use.

Developmental Toxicity

For the major component(s): Did not cause birth defects or any other fetal effects in laboratory animals.

Genetic Toxicology

The data presented are for the following material: Calcium chloride or CaCl2. In vitro genetic toxicity studies were negative. The data presented are for the following material Potassium chloride. In vitro genetic toxicity studies were positive. However, the relevance of this to humans is unknown.

12. Ecological Information

CHEMICAL FATE

Data for Component: **Calcium chloride**

Movement & Partitioning

No bioconcentration is expected because of the relatively high water solubility. Partitioning from water to n-octanol is not applicable.

Persistence and Degradability

Biodegradation is not applicable.

Data for Component: **Sodium chloride**

Movement & Partitioning

No bioconcentration is expected because of the relatively high water solubility. Potential for mobility in soil is very high (Koc between 0 and 50). Partitioning from water to n-octanol is not applicable.

Persistence and Degradability

Biodegradation is not applicable.

Data for Component: **Potassium chloride**

Movement & Partitioning

Partitioning from water to n-octanol is not applicable.

Persistence and Degradability

Biodegradation is not applicable.

ECOTOXICITY

Data for Component: **Calcium chloride**

Material is practically non-toxic to aquatic organisms on an acute basis (LC50/EC50 >100 mg/L in the most sensitive species tested).

Fish Acute & Prolonged Toxicity

LC50, bluegill (Lepomis macrochirus): 8,350 - 10,650 mg/l

Aquatic Invertebrate Acute Toxicity

LC50, water flea Daphnia magna: 759 - 3,005 mg/l

Toxicity to Micro-organisms

EC50; activated sludge, respiration inhibition: > 1,000 mg/l

Data for Component: **Sodium chloride**

Material is practically non-toxic to aquatic organisms on an acute basis (LC50/EC50 >100 mg/L in the most sensitive species tested).

Fish Acute & Prolonged Toxicity
LC50, fathead minnow (Pimephales promelas): 10,610 mg/l
Aquatic Invertebrate Acute Toxicity
LC50, water flea Daphnia magna: 4,571 mg/l
Toxicity to Micro-organisms
IC50, OECD 209 Test; activated sludge, respiration inhibition: > 1,000 mg/l

Data for Component: **Potassium chloride**

Material is practically non-toxic to aquatic organisms on an acute basis (LC50/EC50 >100 mg/L in the most sensitive species tested).

Fish Acute & Prolonged Toxicity
LC50, rainbow trout (Oncorhynchus mykiss): 4,236 mg/l
Aquatic Invertebrate Acute Toxicity
EC50, water flea Daphnia magna, 24 h, immobilization: 590 mg/l

13. Disposal Considerations

All disposal practices must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator. DOW HAS NO CONTROL OVER THE MANAGEMENT PRACTICES OR MANUFACTURING PROCESSES OF PARTIES HANDLING OR USING THIS MATERIAL. THE INFORMATION PRESENTED HERE PERTAINS ONLY TO THE PRODUCT AS SHIPPED IN ITS INTENDED CONDITION AS DESCRIBED IN MSDS SECTION: Composition Information. FOR UNUSED & UNCONTAMINATED PRODUCT, the preferred options include sending to a licensed, permitted: Reclaimer. Landfill. Waste water treatment system. As a service to its customers, Dow can provide names of information resources to help identify waste management companies and other facilities which recycle, reprocess or manage chemicals or plastics, and that manage used drums. Telephone Dow's Customer Information Group at 1-800-258-2436 or 1-989-832-1556 (U.S.), or 1-800-331-6451 (Canada) for further details. All disposal practices must be in compliance with all Federal, State/Provincial and local laws and regulations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator. FOR UNUSED & UNCONTAMINATED PRODUCT, the preferred options include sending to a licensed, permitted: Reclaimer. Landfill. Waste water treatment system.
Treatment and disposal methods of used packaging: Offer empty container to licensed reconditioner or crush and dispose of in compliance with all federal, state/provincial and local laws and regulations.

14. Transport Information

TDG Small container
NOT REGULATED

TDG Large container
NOT REGULATED

IMDG
NOT REGULATED

ICAO/IATA
NOT REGULATED

15. Regulatory Information

US. Toxic Substances Control Act
All components of this product are on the TSCA Inventory or are exempt from TSCA Inventory requirements under 40 CFR 720.30
CEPA - Domestic Substances List (DSL)
All substances contained in this product are listed on the Canadian Domestic Substances List (DSL) or are not required to be listed.

Hazardous Products Act Information: CPR Compliance

This product has been classified in accordance with the hazard criteria of the Canadian Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

Hazardous Products Act Information: WHMIS Classification

D2B	Eye or Skin Irritant

Hazardous Products Act Information: Hazardous Ingredients
This product contains the following ingredients which are Controlled Products and/or are on the Ingredient Disclosure List (Canadian HPA Section 13 and 14).

Component	CAS #	Amount W/W
Calcium chloride	10043-52-4	91.0 - 93.0 %

16. Other Information

Recommended Uses and Restrictions

Gas and liquid hydrocarbon dehydrating.

Revision

Identification Number: 50015 / 1002 / Issue Date 2005.09.29 / Version: 2.1
Most recent revision(s) are noted by the bold, double bars in left-hand margin throughout this document.

Legend

N/A	Not available
W/W	Weight/Weight
OEL	Occupational Exposure Limit
STEL	Short Term Exposure Limit
TWA	Time Weighted Average
ACGIH	American Conference of Governmental Industrial Hygienists, Inc.
DOW IHG	Dow Industrial Hygiene Guideline
WEEL	Workplace Environmental Exposure Level
HAZ_DES	Hazard Designation
VOL/VOL	Volume/Volume

Dow Chemical Canada, Inc urges each customer or recipient of this (M)SDS to study it carefully and consult appropriate expertise, as necessary or appropriate, to become aware of and understand the data contained in this (M)SDS and any hazards associated with the product. The information herein is provided in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ between various locations. It is the buyer's/user's responsibility to ensure that its activities comply with all federal, state, provincial or local laws. The information presented here pertains only to the product as shipped. Since conditions for use of the product are not under the control of the manufacturer, it is the buyer's/user's duty to determine the conditions necessary for the safe use of this product. Due to the proliferation of sources for information such as manufacturer-specific (M)SDSs, we are not and cannot be responsible for (M)SDSs obtained from any source other than ourselves. If you have

obtained an (M)SDS from another source or if you are not sure that the (M)SDS you have is current, please contact us for the most current version.

Shell Canada Limited

Material Safety Data Sheet

Effective Date: 2006-04-21
Supersedes: 2003-03-05

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT:	**LINSEED SOAP**
SYNONYMS:	Lubricating Grease
PRODUCT USE:	Lubricating Grease

MANUFACTURER	**TELEPHONE NUMBERS**	
Shell Canada Limited	**Shell Emergency Number**	1-800-661-7378
P.O. Box 100, Station M	**CANUTEC 24 HOUR EMERGENCY NUMBER**	613-996-6666
400-4th Ave. S.W.	For general information:	1-800-661-1600
Calgary, AB Canada	For MSDS information:	403-691-3982
T2P 2H5	(From 7:30 to 4:30 Mountain Time)	403-691-2220

This MSDS was prepared by the Toxicology and Product Stewardship Section of Shell Canada Limited.

*An asterisk in the product name designates a trade-mark(s) of Shell Canada Limited, used under license by Shell Canada Products.

2. COMPOSITION / INFORMATION ON INGREDIENTS

THIS PRODUCT IS NOT A WHMIS CONTROLLED SUBSTANCE.
See Section 8 for Occupational Exposure Guidelines.

3. HAZARDS IDENTIFICATION

Physical Description: Semi-Solid Paste Brown Colour Slight Hydrocarbon Odour

Routes of Exposure: Exposure will most likely occur through skin or eye contact. Inhalation is only possible if the product is heated or mists are generated.

Hazards:

This product is not expected to be irritating and has a low level of toxicity under normal use.
Inhalation of oil mist or vapours from hot oil may cause irritation of the upper respiratory tract.

For further information on health effects, see Section 11.

4. FIRST AID

Eyes: Flush eyes with water for at least 15 minutes while holding eyelids open. If irritation occurs and persists, obtain medical attention.

Skin: Wipe excess from skin. Wash contaminated skin with mild soap and water for 15 minutes. If irritation occurs and persists, obtain medical attention. If material is injected under the skin, get medical attention promptly to prevent serious damage; do not wait for symptoms to develop.

Ingestion:	Not normally required; obtain medical attention if large amounts have been ingested. Do not induce vomiting. If vomiting occurs spontaneously keep head below hips to prevent aspiration of liquid into the lungs.
Inhalation:	Remove victim from further exposure. Additional first aid treatment is not ordinarily required.
Notes to Physician:	In general, lubricating oils have low oral toxicity. High pressure injection under the skin may have serious consequences and may require urgent treatment.

5. FIRE FIGHTING MEASURES

Extinguishing Media:	Dry Chemical Carbon Dioxide Foam Water Fog
Firefighting Instructions:	Material will not burn unless preheated. Caution, spilled material is slippery. Product will float and can be reignited on surface of water. Do not use a direct stream of water as it may spread fire. Use water to cool fire exposed containers. Water may be used to flush spills away from exposure. Do not enter confined fire space without adequate protective clothing and an approved positive pressure self-contained breathing apparatus.
Hazardous Combustion Products:	Carbon monoxide, carbon dioxide and dense smoke are produced on combustion.

6. ACCIDENTAL RELEASE MEASURES

Eliminate all ignition sources. Isolate hazard area and restrict access. Wear appropriate breathing apparatus (if applicable) and protective clothing. Stop leak only if safe to do so. Spilled material is slippery. Dike and contain land spills; contain water spills by booming. For large spills remove by mechanical means and place in containers. Absorb residue or small spills with absorbent material and remove to non-leaking containers for disposal. Clean area with appropriate cleaner. Dispose of recovered material as noted under Disposal Considerations. Notify appropriate environmental agency(ies).

7. HANDLING AND STORAGE

Handling:	Avoid excessive heat, formation of oil mist, breathing of vapours and mist of hot oil and prolonged or repeated contact with skin. Launder contaminated clothing prior to reuse. Wash with soap and water prior to eating, drinking, smoking, applying cosmetics or using toilet facilities. Use good personal hygiene.
Storage:	Store in a cool, dry, well ventilated area, away from heat and ignition sources.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

The following information, while appropriate for this product, is general in nature. The selection of personal protective equipment will vary depending on the conditions of use.

OCCUPATIONAL EXPOSURE LIMITS (Current ACGIH TLV/TWA unless otherwise noted):
Oil mist (mineral): 5 mg/m3 (STEL: 10 mg/m3)

Mechanical Ventilation:	Not normally required. Local ventilation is recommended if oil mist is present or if exposure limit is exceeded. Make up air should always be supplied to balance air exhausted (either generally or locally).

PERSONAL PROTECTIVE EQUIPMENT:

Eye Protection:	No special eye protection is routinely necessary. Wear safety glasses as appropriate.

Skin Protection: Not normally needed. Chemically-resistant gloves should be worn for frequent or prolonged contact with this product.

Respiratory Protection: Not normally required under intended conditions of use. If vaporization of oil component is occurring (i.e. under conditions of high heat), use a NIOSH-approved chemical cartridge respirator with organic vapour cartridges in combination with a P95 particulate filter.

9. PHYSICAL DATA

Physical State:	Semi-Solid Paste	**Odour:**	Slight Hydrocarbon Odour
Appearance:	Brown Colour	**Odour Threshold:**	Not available
Pour Point, ℃ :	0 ℃	**Boiling Point, ℃ :**	100 ℃
Vapour Pressure (absolute):	Not available	**Vapour Density (air = 1):**	Not available
Density:	Not available	**Flash Point, ℃ :**	Not applicable
Specific Gravity (Water = 1):		**Lower Explosion Limit:**	Not applicable
pH:	9.5 - 11	**Upper Explosion Limit:**	Not applicable
Viscosity:	Not available	**Autoignition Temperature, ℃:**	Not applicable
Evaporation Rate (n-BuAc = 1):	Not available	**Partition Coefficient (K_{ow}):**	Not available
Water Solubility:	Soluble	**Molecular Weight:**	
Other Solvents:	None Identified	**Formula:**	

10. STABILITY AND REACTIVITY

Chemically Stable:	Yes	**Hazardous Polymerization:**	No
Sensitive to Mechanical Impact:	No	**Sensitive to Static Discharge:**	No

Incompatible Materials: Avoid strong oxidizing agents.

Conditions of Reactivity: Avoid excessive heat, formation of vapours or mists.

11. TOXICOLOGICAL INFORMATION

Routes of Exposure: Exposure will most likely occur through skin or eye contact. Inhalation is only possible if the product is heated or mists are generated.

Irritancy: This product is not a primary skin irritant after exposure of short duration, is not a skin sensitizer and is not irritating to the eyes.

Acute Toxicity: This product is not expected to be irritating and has a low level of toxicity under normal use.

Chronic Effects: Long term intensive exposure to oil mist may cause benign lung fibrosis. Prolonged and repeated contact with skin can cause defatting and drying of the skin resulting in skin irritation and dermatitis.

12. ECOLOGICAL INFORMATION

Environmental Effects: Do not allow product or runoff from fire control to enter storm or sanitary sewers, lakes, rivers, streams, or public waterways. Block off drains and ditches. Provincial regulations require and federal regulations may require that environmental and/or other agencies be notified of a spill incident. Spill area must be cleaned and restored to original condition or to the satisfaction of authorities.

Biodegradability: Not readily biodegradable.

13. DISPOSAL CONSIDERATIONS

Waste management priorities (depending on volumes and concentration of waste) are: 1. recycle (reprocess), 2. energy recovery (cement kilns, thermal power generation), 3. incineration, 4. disposal at a licenced waste disposal facility. Do not attempt to combust waste on-site.

14. TRANSPORTATION INFORMATION

Canadian Road and Rail Shipping Classification:
This product is not regulated under the Canadian Transportation of Dangerous Goods Regulations for transport by road and rail.

15. REGULATORY INFORMATION

This product has been classified in accordance with the hazard criteria of the *Controlled Products Regulations (*CPR*)* and the MSDS contains all the information required by the CPR.

	THIS PRODUCT IS NOT A WHMIS CONTROLLED SUBSTANCE.
DSL/NDSL Status:	This product, or all components, are listed on the Domestic Substances List, as required under the Canadian Environmental Protection Act. This product and/or all components are listed on the U.S. EPA TSCA Inventory.
Other Regulatory Status:	No Canadian federal standard; however, for general discharge guidance, federal installations limited to 15 mg/L for total oil and grease. Provincial criteria are likely and should be requested when notifying provincial authorities.

16. ADDITIONAL INFORMATION

Revisions:	This MSDS has been reviewed and updated. Changes have been made to: Section 3 Section 4 Section 6

PETRO-CANADA

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	**B-3, D-2B**		

Section 1. Chemical Product and Company Identification

Product Name	**KEROSENE**	**Code**	W106 SAP: 100
Synonym	Kerosene 1-K, Low Sulphur Kerosene, Kerosine	**Validated on**	**7/12/2005.**
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3	**In case of Emergency**	Petro-Canada: 403-296-3000 Canutec Transportation: 613-996-6666 Poison Control Centre: Consult local telephone directory for emergency number(s).
Material Uses	Kerosene is a refined petroleum distillate suitable for burning in wick lamps and non-vented space heaters.		

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (V/V)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
Complex mixture of petroleum hydrocarbons (C9-C16) ** Aromatic content is 10-25% typical (benzene: nil).	8008-20-6	>99.9	200 mg/m³	Not established	Not established

Manufacturer Recommendation	Not applicable
Other Exposure Limits	Consult local, state, provincial or territory authorities for acceptable exposure limits.

Section 3. Hazards Identification.

Potential Health Effects	Combustible liquid. Exercise caution when handling this material. Contact with this product may cause skin irritation. Not expected to cause more than slight eye irritation. Inhalation of this product may cause respiratory tract irritation and Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death. Ingestion of this product may cause gastro-intestinal irritation. Aspiration of this product may result in severe irritation or burns to the respiratory tract. For more information refer to Section 11 of this MSDS.

Section 4. First Aid Measures

Eye Contact	IMMEDIATELY flush eyes with running water for at least 15 minutes, keeping eyelids open. Seek medical attention.
Skin Contact	Remove contaminated clothing - launder before reuse. Wash gently and thoroughly the contaminated skin with running water and non-abrasive soap. Seek medical attention.
Inhalation	Evacuate the victim to a safe area as soon as possible. If the victim is not breathing, perform artificial respiration. Allow the victim to rest in a well ventilated area. Seek medical attention.
Ingestion	DO NOT induce vomiting because of danger of aspirating liquid into lungs. Seek medical attention.
Note to Physician	Not available

Section 5. Fire-fighting Measures

Flammability	Class II - combustible liquid (NFPA).	**Flammable Limits**	LOWER: 0.7% UPPER: 5%
Flash Points	CLOSED CUP: >38°C (100°F) Tag (ASTM D56)	**Auto-Ignition Temperature**	210°C (410°F)
Fire Hazards in Presence of Various Substances	Flammable in presence of open flames, sparks, or heat. May accumulate in confined spaces. This product can accumulate static charge and ignite. Vapours are heavier than air and may travel considerable distance to sources of ignition and flash back.	**Explosion Hazards in Presence of Various Substances**	Do not cut, weld, heat, drill or pressurize empty container. Containers may explode in heat of fire.

Continued on Next Page

Products of Combustion	Carbon oxides (CO, CO2), nitrogen oxides (NOx), sulphur oxides (SOx), smoke and irritating vapours as products of incomplete combustion.
Fire Fighting Media and Instructions	NAERG2000, GUIDE 128, Flammable liquids (Non-polar/Water-immiscible). CAUTION: This product has a very low flash point: Use of water spray when fighting fire may be inefficient. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also consider initial evacuation for 800 meters (1/2 mile) in all directions. SMALL FIRES: Dry chemical, CO2, water spray or regular foam. LARGE FIRES: Water spray, fog or regular foam. Do not use straight streams. Move containers from fire area if you can do it without risk. Fires Involving Tanks or Car/Trailer Loads: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting devices or any discolouration of tank. ALWAYS stay away from the ends of tanks. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible withdraw from area and let fire burn. Wear positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing will only provide limited protection.

Section 6. Accidental Release Measures

Material Release or Spill	IN THE EVENT OF A LARGE SPILL CONSIDER THE FOLLOWING CONTROL MEASURES: Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary. Evacuate non-essential personnel. Extinguish all ignition sources. Stop leak if safe to do so. Ventilate area. Ensure clean-up personnel wear appropriate personal protective equipment. Dike spilled material. Use appropriate inert absorbent material to absorb spilled product. Collect used absorbent for later disposal. If spilled in a confined space, ensure appropriate confined space entry protocols are followed. Avoid breathing vapours or mists of material. Avoid contact with spilled material. Do not allow spilled material to enter sewer systems as vapours may accumulate and may cause an explosion/fire hazard. Do not allow spilled materials to come into to contact with incompatible materials (see Section 10). Ground and bond all equipment used to clean up the spilled material, as it may be a static accumulator. Notify appropriate authorities immediately.

Section 7. Handling and Storage

Handling	COMBUSTIBLE MATERIAL. Handle with care. Avoid contact with any sources of ignition, flames, heat, and sparks. Ensure all equipment is grounded/bonded. Avoid confined spaces and areas with poor ventilation. Avoid skin contact. Avoid eye contact. Avoid inhalation of product vapours or mists. Empty containers may contain product residue. Do not pressurize, cut, heat, or weld empty containers. Do not reuse containers without commercial cleaning and/or reconditioning. Wear proper personal protective equipment (See Section 8). Avoid contact with any incompatible or reactive materials. Personnel who handle this material should practice good personal hygiene during and after handling to help prevent accidental ingestion of this product.
Storage	Store away from incompatible and reactive materials (See section 5 and 10). Store away from heat and sources of ignition. Avoid direct sunlight. Keep container tightly closed. Store in dry, cool, well-ventilated area. Ensure the storage containers are grounded/bonded.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.
Personal Protection - ***The selection of personal protective equipment varies, depending upon conditions of use.***	
Eyes	Eye protection (i.e., safety glasses, safety goggles and/or face shield) should be determined based on conditions of use. If product is used in an application where splashing may occur, the use of safety goggles and/or a face shield should be considered.
Body	Wear appropriate clothing to prevent skin contact. As a minimum long sleeves and trousers should be worn.
Respiratory	Where concentrations in air may exceed the occupational exposure limits given in Section 2 (and those applicable to your area) and where engineering, work practices or other means of exposure reduction are not adequate, NIOSH approved respirators may be necessary to prevent overexposure by inhalation.
Hands	Wear appropriate chemically protective gloves. When handling hot product ensure gloves are heat resistant and insulated.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Clear liquid.	**Viscosity**	1.0-1.9 cSt @ 40ºC (104ºF).
Colour	Clear and bright.	**Pour Point**	<-51ºC (-60ºF)
Odour	Hydrocarbon solvent.	**Softening Point**	Not applicable.
Odour Threshold	Not available	**Dropping Point**	Not applicable.
Boiling Point	150 to 300°C (302 to 572°F)	**Penetration**	Not applicable.
Density	0.8 to 0.82 kg/L @ 15°C (59°F).	**Oil / Water Dist. Coefficient**	Not available
Vapour Density	4.5 (Air = 1)	**Ionicity (in water)**	Not available
Vapour Pressure	0.70 kPa @ 20°C (5.25 mmHg @ 68ºF).	**Dispersion Properties**	Not available
Volatility	<1 (water = 1). Low volatility at ambient temperature and pressure, and much lower than gasoline.	**Solubility**	Insoluble in water. Partially miscible in some alcohols. Miscible with other petroleum solvents.

Section 10. Stability and Reactivity

Corrosivity	Not available		
Stability	The product is stable under normal handling and storage conditions.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Reactive with oxidizing agents.	**Decomposition Products**	May release COx, NOx, SOx, acrid smoke, and irritating vapours when heated to decomposition.

Section 11. Toxicological Information

Routes of Entry Skin contact, eye contact, inhalation, and ingestion.

Acute Lethality Acute toxicity of the product based on actual testing:

Kerosene (8008-20-6):
Acute oral toxicity (LD50): 2835 mg/kg (rabbit).

Chronic or Other Toxic Effects

Dermal Route:	Contact may cause skin irritation based on laboratory test results.
Inhalation Route:	Inhalation of this product may cause respiratory tract irritation. Inhalation of this product may cause Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death.
Oral Route:	Ingestion of this product may cause gastro-intestinal irritation. Aspiration of this product may result in severe irritation or burns to the respiratory tract.
Eye Irritation/Inflammation:	Short-term exposure is expected to cause only slight irritation, if any.
Immunotoxicity:	Not available
Skin Sensitization:	Contact with this product is not expected to cause skin sensitization, based upon the available data and the known hazards of the components.
Respiratory Tract Sensitization:	Contact with this product is not expected to cause respiratory tract sensitization, based upon the available data and the known hazards of the components.
Mutagenic:	This product is not known to contain any components at >= 0.1% that have been shown to cause mutagenicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a mutagen.
Reproductive Toxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause reproductive toxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a reproductive toxin.
Teratogenicity/Embryotoxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause teratogenicity and/or embryotoxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a teratogen/embryotoxin.
Carcinogenicity (ACGIH):	Considered to be A3 by the ACGIH. (Kerosene, 8008-20-6)
Carcinogenicity (IARC):	This product is not known to contain any chemicals at reportable quantities that are listed as Group 1, 2A, or 2B carcinogens by IARC.

Carcinogenicity (NTP):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by NTP.
Carcinogenicity (IRIS):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by IRIS.
Carcinogenicity (OSHA):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by OSHA.
Other Considerations	Chronic exposure to some of the hazardous components of this product may result in damage to the following organs and/or systems: kidney.

Section 12. Ecological Information

Environmental Fate	Not available	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available	**Products of Biodegradation**	Not available
Additional Remarks	No additional remark.		

Section 13. Disposal Considerations

Waste Disposal	Spent/ used/ waste product may meet the requirements of a hazardous waste. Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 14. Transport Information

TDG Classification	KEROSENE, 3, UN1223, PGIII (CL-TDG)	**Special Provisions for Transport**	See Transportation of Dangerous Goods Regulations.

Section 15. Regulatory Information

Other Regulations

This product is acceptable for use under the provisions of WHMIS-CPR. All components of this formulation are listed on the CEPA-DSL (Domestic Substances List).

All components of this formulation are listed on the US EPA-TSCA Inventory.

All components of this product are on the European Inventory of Existing Commercial Chemical Substances (EINECS).

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

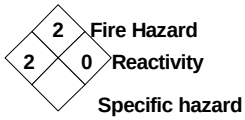
Please contact Product Safety for more information.

DSD/DPD (Europe)	Not evaluated.	**HCS (U.S.A.)**	CLASS: Irritating substance. CLASS: Target organ effects. CLASS: Combustible liquid having a flash point between 37.8°C (100°F) and 93.3°C (200°F).
ADR (Europe) (Pictograms)	**NOT EVALUATED FOR EUROPEAN TRANSPORT** **NON ÉVALUÉ POUR LE TRANSPORT EUROPÉEN.**	**DOT (U.S.A) (Pictograms)**	

HMIS (U.S.A.)

Health Hazard	2*
Fire Hazard	2
Reactivity	0
Personal Protection	H

NFPA (U.S.A.)



Rating
0 Insignificant
1 Slight
2 Moderate
3 High
4 Extreme

Section 16. Other Information

References Available upon request.
* Marque de commerce de Petro-Canada - Trademark

Glossary

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous goods by Road (Europe)
ASTM - American Society for Testing and Materials
BOD5 - Biological Oxygen Demand in 5 days
CAN/CGA B149.2 Propane Installation Code
CAS - Chemical Abstract Services
CEPA - Canadian Environmental Protection Act
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CFR - Code of Federal Regulations
CHIP - Chemicals Hazard Information and Packaging Approved Supply List
CNS - Central Nervous System
COD5 - Chemical Oxygen Demand in 5 days
CPR - Controlled Products Regulations
DOT - Department of Transport
DSCL - Dangerous Substances Classification and Labeling (Europe)
DSD/DPD - Dangerous Substances or Dangerous Preparations Directives (Europe)
DSL - Domestic Substance List
EEC/EU - European Economic Community/European Union
EINECS - European Inventory of Existing Commercial Chemical Substances
EPA - Environmental Protection Agency
EPCRA - Emergency Planning and Community Right to Know Act
FDA - Food and Drug Administration
FIFRA - Federal Insecticide, Fungicide and Rodenticide Act
HCS - Hazard Communication Standard
HMIS - Hazardous Material Information System
IARC - International Agency for Research on Cancer
IRIS - Integrated Risk Information System
LD50/LC50 - Lethal Dose/Concentration kill 50%
LDLo/LCLo - Lowest Published Lethal Dose/Concentration
NAERG'96 - North American Emergency Response Guide Book (1996)
NFPA - National Fire Prevention Association
NIOSH - National Institute for Occupational Safety & Health
NPRI - National Pollutant Release Inventory
NSNR - New Substances Notification Regulations (Canada)
NTP - National Toxicology Program
OSHA - Occupational Safety & Health Administration
PEL - Permissible Exposure Limit
RCRA - Resource Conservation and Recovery Act
RTECS - Registry of Toxic Effects of Chemical Substances
SARA - Superfund Amendments and Reorganization Act
SD - Single Dose
STEL - Short Term Exposure Limit (15 minutes)
TDG - Transportation Dangerous Goods (Canada)
TDLo/TCLo - Lowest Published Toxic Dose/Concentration
TLm - Median Tolerance Limit
TLV-TWA - Threshold Limit Value-Time Weighted Average
TSCA - Toxic Substances Control Act
USEPA - United States Environmental Protection Agency
USP - United States Pharmacopoeia
WHMIS - Workplace Hazardous Material Information System

For Copy of MSDS
Internet: www.petro-canada.ca/msds

Fuels & Solvents:
Western Canada, Ontario & Central Canada, telephone: 1-800-668-0220; fax: 1-800-837-1228
Quebec & Eastern Canada, telephone: 514-640-8308; fax: 514-640-8385

For Product Safety Information: (905) 804-4752

Prepared by Product Safety - JDW on 7/12/2005.

Data entry by Product Safety - DSR.

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

PETRO-CANADA

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	**B-2, D-2A, D-2B**		

Section 1. Chemical Product and Company Identification

Product Name	**JET B AVIATION TURBINE FUEL**	**Code**	W219 SAP: 150, 151, 152
Synonym	Jet B; Jet B DI; JP-4; Jet F-40; NATO F-40; Turbine Fuel, Aviation, Wide Cut Type (CAN/CGSB-3.22).	**Validated on**	**2/8/2005.**
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3	**In case of Emergency**	Petro-Canada: 403-296-3000 Canutec Transportation: 613-996-6666 Poison Control Centre: Consult local telephone directory for emergency number(s).
Material Uses	Used as aviation turbine fuel. May contain a fuel system icing inhibitor.		

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (W/W)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
Complex mixture of petroleum hydrocarbons (C6-C14).	64741-41-9	>99	Not established	Not established	Not established
Benzene	71-43-2	<0.5	0.5 ppm	2.5 ppm	Not established
Fuel System Icing Inhibitor (FSII) (if added*): Diethylene Glycol Monomethyl Ether	111-77-3	≤0.15	Not established	Not established	Not established
Anti-static, antioxidant, corrosion inhibitor and metal deactivator additives. * Please note that Jet B DI, JP-4, Jet F-40 and NATO F-40 all contain Fuel System Icing Inhibitor (FSII).corrosion inhibitor	Not applicable	<0.1	Not applicable	Not applicable	Not applicable

Manufacturer Recommendation	Not applicable
Other Exposure Limits	Consult local, state, provincial or territory authorities for acceptable exposure limits.

Section 3. Hazards Identification.

Potential Health Effects	Flammable liquid. Exercise caution when handling this material. Skin and eye contact can cause irritation. Inhalation of vapours can cause irritation of the respiratory tract and CNS depression with symptoms of nausea, headaches, vomiting, dizziness, fatigue, light-headedness, reduced coordination, unconciousness and possibly death. Aspiration into the lungs may produce potentially fatal chemical pneumonitis (fluid in the lungs), severe lung damage, or respiratory failure. May cause cancer. May cause teratogenicity/embryotoxicity. For more information refer to Section 11 of this MSDS.

Section 4. First Aid Measures

Eye Contact	Quickly and gently blot or brush away chemical. Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for 20 minutes or until the chemical is removed, while holding the eyelid(s) open. Take care not to rinse contaminated water into the unaffected eye or onto the face. Obtain medical attention immediately.
Skin Contact	Quickly and gently, blot or brush away excess chemical. Wash gently and thoroughly with warm water and non-abrasive soap for 5 minutes or until chemical is removed.
Inhalation	Take proper precautions to ensure your own safety before attempting rescue (e.g. wear appropriate protective equipment). Remove source of contamination or move victim to fresh air. If breathing is difficult, oxygen may be beneficial if administered by trained personnel, preferably on a doctor's advice. DO NOT allow victim to move about unnecessarily. Immediately transport victim to an emergency care facility.

Continued on Next Page

Ingestion	NEVER give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing. Have victim rinse mouth thoroughly with water. DO NOT INDUCE VOMITING. Have victim drink 240 to 300 mL (8 to 10 oz) of water to dilute material in stomach. If vomiting occurs naturally, have victim lean forward to reduce risk of aspiration. Repeat administration of water.
Note to Physician	Not available

Section 5. Fire-fighting Measures

Flammability	Flammable liquid (NFPA).	**Flammable Limits**	LOWER: 1.3% UPPER: 8% (NFPA)
Flash Points	CLOSED CUP: -31ºC (-24°F) (NFPA)	**Auto-Ignition Temperature**	240°C (464°F) (NFPA)
Fire Hazards in Presence of Various Substances	Flammable in presence of open flames, sparks, and heat. Vapours are heavier than air and may travel considerable distance to sources of ignition and flash back. This product can accumulate static charge and ignite. May accumulate in confined spaces.	**Explosion Hazards in Presence of Various Substances**	Do not cut, weld, heat, drill or pressurize empty container. Containers may explode in heat of fire.
Products of Combustion	Carbon oxides (CO, CO2), nitrogen oxides (NOx), sulphur oxides (SOx), aldehydes, ketones, smoke and irritating vapours as products of incomplete combustion.		
Fire Fighting Media and Instructions	NAERG96, GUIDE 128, Flammable liquids (Non-polar/Water-immiscible). CAUTION: This product has a very low flash point: Use of water spray when fighting fire may be inefficient. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also consider initial evacuation for 800 meters (1/2 mile) in all directions. SMALL FIRES: Dry chemical, CO2, water spray or regular foam. LARGE FIRES: Water spray, fog or regular foam. Do not use straight streams. Move containers from fire area if you can do it without risk. Fires Involving Tanks or Car/Trailer Loads: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting devices or any discolouration of tank. ALWAYS stay away from the ends of tanks. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible withdraw from area and let fire burn. Wear positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing will only provide limited protection.		

Section 6. Accidental Release Measures

Material Release or Spill	IN THE EVENT OF A LARGE SPILL CONSIDER THE FOLLOWING CONTROL MEASURES: Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary. Evacuate non-essential personnel. Extinguish all ignition sources. Ventilate area. Stop leak if safe to do so. Avoid contact with spilled material. Do not allow spilled material to enter sewer systems as vapours may accumulate and may cause an explosion/fire hazard. If spilled in a confined space, ensure appropriate confined space entry protocols are followed. Ensure clean-up personnel wear appropriate personal protective equipment. Use appropriate inert absorbent material to absorb spilled product. Do not use paper or other flammable materials to absorb product. Collect used absorbent for later disposal. Avoid breathing vapours or mists of material. Notify appropriate authorities immediately.

Section 7. Handling and Storage

Handling	FLAMMABLE MATERIAL. Handle with care. Avoid contact with any sources of ignition, flames, heat, and sparks. Wear proper personal protective equipment (See Section 8). Ensure all equipment is grounded/bonded. Avoid confined spaces and areas with poor ventilation. Avoid inhalation of product vapours or mists. Empty containers may contain product residue. Do not pressurize, cut, heat, or weld empty containers. Do not reuse containers without commercial cleaning and/or reconditioning. Personnel who handle this material should practice good personal hygiene during and after handling to help prevent accidental ingestion of this product.
Storage	Store away from heat and sources of ignition. Store away from incompatible and reactive materials (See section 5 and 10). Ensure the storage containers are grounded/bonded. Keep container tightly closed. Store in dry, cool, well-ventilated area.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.
Personal Protection - ***The selection of personal protective equipment varies, depending upon conditions of use.***	
Eyes	As a minimum, safety glasses with side shields should be worn when handling this material.
Body	If this material may come into contact with the body during handling and use, we recommend wearing appropriate protective clothing to prevent contact with the skin. (Contact your PPE provider for more information).
Respiratory	A NIOSH-approved air-purifying respirator with an organic vapour cartridge or canister with a dust, fume of mist filter (R, or P series) may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air-purifying respirators is limited. Use a positive-pressure, air-supplied respirator if there is any potential for uncontrolled release, exposure levels are unknown, or any other circumstances where air-purifying respirators may not provide adequate protection.
Hands	If this material may come in contact with the hands during handling and use, we recommend wearing gloves of the following material(s): neoprene, polyvinyl alcohol (PVA), and fluoro-elastomer. Consult your PPE provider for breakthrough times and the specific glove that is best for you based on your use patterns.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Clear liquid.	**Viscosity**	Not available (similar to gasoline)
Colour	Clear and colourless.	**Pour Point**	Freezing Point: <-51ºC (<-60ºF) for Jet B/Jet B DI; <-58ºC (<-72ºF) for Jet Fuel F-40.
Odour	Gasoline like.	**Softening Point**	Not applicable.
Odour Threshold	Not available	**Dropping Point**	Not applicable.
Boiling Point	50 to 270°C (122 to 518°F)	**Penetration**	Not applicable.
Density	0.75 to 0.80 kg/L @ 15ºC (59ºF).	**Oil / Water Dist. Coefficient**	Not available
Vapour Density	3.5 (Air = 1)	**Ionicity (in water)**	Not available
Vapour Pressure	21 kPa (158 mmHg) @ 37.8ºC (100ºF).	**Dispersion Properties**	Not available
Volatility	Volatile.	**Solubility**	Insoluble in water. Partially miscible in some alcohols. Miscible in other petroleum solvents.

Section 10. Stability and Reactivity

Corrosivity	Not available		
Stability	The product is stable under normal handling and storage conditions.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Can react with strong oxidizing agents, uranium hexafluoride, diborane. Incompatible with halogens and halogen compounds.	**Decomposition Products**	May release COx, NOx, SOx, aldehydes, ketones, smoke and irritating vapours when heated to decomposition.

Section 11. Toxicological Information

Routes of Entry	Skin contact, eye contact, inhalation and ingestion.
Acute Lethality	Acute toxicity information is not available for the product as a whole, therefore, data for some of the ingredients is provided below:

Based on toxicity of similar product.
Acute oral toxicity (LD50): >5000 mg/kg (rat).
Acute dermal toxicity (LD50): >5000 mg/kg (rabbit).
Acute inhalation toxicity (LC50): >5000 mg/m³/4h (rat).

Benzene
Acute oral toxicity (LD50): 930 mg/kg (rat).
Acute dermal toxicity (LD50): >9400 mg/kg (rabbit).
Acute inhalation toxicity (LC50): 13200 ppm/4h (rat).

Diethylene Glycol Monomethyl Ether
Acute oral toxicity (LD50): 4140-5180 mg/kg (rat).
Acute dermal toxicity (LD50): >2000 mg/kg (rabbit).
Acute inhalation toxicity (LC50): >50000 mg/m³/4h (rat).

Chronic or Other Toxic Effects

Dermal Route:	Skin contact can cause irritation. Prolonged or repeated contact may defat and dry skin, and cause dermatitis.
Inhalation Route:	Ingestion of this product may cause Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death.
Oral Route:	Ingestion of this product may lead to aspiration of the liquid, especially if vomiting occurs. This may result in chemical pneumonitis (inflammation of the lungs) and/or pulmonary edema (an accumulation of fluid in the lungs).
Eye Irritation/Inflammation:	Short-term exposure is expected to cause only slight irritation, if any.
Immunotoxicity:	Not available
Skin Sensitization:	Contact with this product is not expected to cause skin sensitization, based upon the available data and the known hazards of the components.
Respiratory Tract Sensitization:	Contact with this product is not expected to cause respiratory tract sensitization, based upon the available data and the known hazards of the components.
Mutagenic:	Benzene is tumorigenic by RTECS criteria.
Reproductive Toxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause reproductive toxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a reproductive toxin.
Teratogenicity/Embryotoxicity:	This product contains a component(s) at >= 0.1% that has been shown to cause teratogenicity and/or embryotoxicity in laboratory tests. Therefore, this product is considered to be a teratogen/embryotoxin [Diethylene Glycol Monomethyl Ether].
Carcinogenicity (ACGIH):	ACGIH A1: confirmed human carcinogen. [Benzene]
Carcinogenicity (IARC):	IARC Group 1: carcinogenic to Humans. [Benzene]
Carcinogenicity (NTP):	NTP Group 1: known to be a carcinogen. [Benzene]
Carcinogenicity (IRIS):	EPA/IRIS Class A: human carcinogen.
Carcinogenicity (OSHA):	Benzene is an OSHA known carcinogen.
Other Considerations	No additional remark.

Section 12. Ecological Information

Environmental Fate	Not available	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available	**Products of Biodegradation**	Not available
Additional Remarks	No additional remark.		

Section 13. Disposal Considerations

Waste Disposal	Spent/ used/ waste product may meet the requirements of a hazardous waste. Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 14. Transport Information

TDG Classification	FUEL, AVIATION, TURBINE ENGINE, 3, UN1863, PGII (CL-TDG)	**Special Provisions for Transport**	See Transportation of Dangerous Goods Regulations.

Section 15. Regulatory Information

Other Regulations

This product is acceptable for use under the provisions of WHMIS-CPR. All components of this formulation are listed on the CEPA-DSL (Domestic Substances List).

All components of this formulation are listed on the US EPA-TSCA Inventory.

All components of this product are on the European Inventory of Existing Commercial Chemical Substances (EINECS).

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

Please contact Product Safety for more information.

DSD/DPD (Europe) Not evaluated.

HCS (U.S.A.)

CLASS: Contains material which may cause cancer.
CLASS: Flammable liquid having a flash point lower than 37.8°C (100°F).
CLASS: Toxic.
CLASS: Irritating substance.
CLASS: Target organ effects.

ADR (Europe) (Pictograms) **NOT EVALUATED FOR EUROPEAN TRANSPORT**

NON ÉVALUÉ POUR LE TRANSPORT EUROPÉEN.

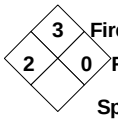
DOT (U.S.A) (Pictograms)



HMIS (U.S.A.)

Health Hazard	2*
Fire Hazard	3
Reactivity	0
Personal Protection	H

NFPA (U.S.A.)



Health **Fire Hazard** **Reactivity** **Specific hazard**

Rating
0 Insignificant
1 Slight
2 Moderate
3 High
4 Extreme

Section 16. Other Information

References Available upon request.

* Marque de commerce de Petro-Canada - Trademark

Glossary

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous goods by Road (Europe)
ASTM - American Society for Testing and Materials
BOD5 - Biological Oxygen Demand in 5 days
CAN/CGA B149.2 Propane Installation Code
CAS - Chemical Abstract Services
CEPA - Canadian Environmental Protection Act
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CFR - Code of Federal Regulations
CHIP - Chemicals Hazard Information and Packaging Approved Supply List
CNS - Central Nervous System
COD5 - Chemical Oxygen Demand in 5 days
CPR - Controlled Products Regulations
DOT - Department of Transport
DSCL - Dangerous Substances Classification and Labeling (Europe)
DSD/DPD - Dangerous Substances or Dangerous Preparations Directives (Europe)
DSL - Domestic Substance List
EEC/EU - European Economic Community/European Union
EINECS - European Inventory of Existing Commercial Chemical Substances
EPA - Environmental Protection Agency
EPCRA - Emergency Planning and Community Right to Know Act
FDA - Food and Drug Administration
FIFRA - Federal Insecticide, Fungicide and Rodenticide Act
HCS - Hazard Communication Standard
HMIS - Hazardous Material Information System
IARC - International Agency for Research on Cancer
IRIS - Integrated Risk Information System
LD50/LC50 - Lethal Dose/Concentration kill 50%
LDLo/LCLo - Lowest Published Lethal Dose/Concentration
NAERG'96 - North American Emergency Response Guide Book (1996)
NFPA - National Fire Prevention Association
NIOSH - National Institute for Occupational Safety & Health
NPRI - National Pollutant Release Inventory
NSNR - New Substances Notification Regulations (Canada)
NTP - National Toxicology Program
OSHA - Occupational Safety & Health Administration
PEL - Permissible Exposure Limit
RCRA - Resource Conservation and Recovery Act
RTECS - Registry of Toxic Effects of Chemical Substances
SARA - Superfund Amendments and Reorganization Act
SD - Single Dose
STEL - Short Term Exposure Limit (15 minutes)
TDG - Transportation Dangerous Goods (Canada)
TDLo/TCLo - Lowest Published Toxic Dose/Concentration
TLm - Median Tolerance Limit
TLV-TWA - Threshold Limit Value-Time Weighted Average
TSCA - Toxic Substances Control Act
USEPA - United States Environmental Protection Agency
USP - United States Pharmacopoeia
WHMIS - Workplace Hazardous Material Information System

For Copy of MSDS

Prepared by Product Safety - JDW on 2/8/2005.

Internet: www.petro-canada.ca/msds **Fuels & Solvents:** **Western Canada, Ontario & Central Canada, telephone: 1-800-668-0220; fax: 1-800-837-1228** **Quebec & Eastern Canada, telephone: 514-640-8308; fax: 514-640-8385** **For Product Safety Information: (905) 804-4752**	**Data entry by Product Safety - JDW.**

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

June 6, 2006

Phyllis Beaulieu
Manager of Licensing
Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU X0E 1J0

Dear: Ms. Beaulieu

RE: Water License Application –
Izok and Hood Property Exploration Drilling Programs

I enclosing a completed Water License Application form for diamond drilling starting this fall in the vicinity of Izok Lake in the West Kitikmeot. The planned drilling program would be part of renewed mineral exploration activity at the site following Wolfden's acquisition of the property from Inmet Mining Corporation earlier this year.

Along with the application package, we also enclose a cheque in the amount of $30.00 payable to the Receiver General for Canada, which corresponds to the stipulated application fee.

We trust that you find the enclosed application documents complete and in good order. If you have any questions or comments, please call me at 807-346-1668.

Yours truly

For: WOLFDEN RESOURCES INC.

Andrew Mitchell, B.Sc., P.Geo.
Project Manager

AM/
Encl.

PETRO-CANADA

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	B-3, D-2B		

Section 1. Chemical Product and Company Identification

Product Name	**FUEL OIL**	**Code**	W105 SAP: 132, 156, 286, 300
Synonym	#1 Furnace Oil, Furnace Oil 50, Seasonal Furnace Oil, Seasonal Furnace Oil Special, Economy Diesel, Stove Oil, ThermaClean.	**Validated on**	**2/5/2004.**
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3	**In case of Emergency**	Petro-Canada: 403-296-3000 Canutec Transportation: 613-996-6666 Poison Control Centre: Consult local telephone directory for emergency number(s).
Material Uses	Fuel Oils are distillate fuels suitable for use in liquid fuel burning equipment without preheating.		

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (V/V)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
1) Mixture of petroleum distillates. Aromatic content is 50% maximum (benzene: nil).	68476-30-2, 64742-81-0	100	100 mg/m³ (as total hydrocarbons) *	Not established	Not established

Manufacturer Recommendation	* Avoid prolonged or repeated skin contact to diesel fuels which can lead to dermal irritation and may be associated with an increased risk of skin cancer.
Other Exposure Limits	Consult local, state, provincial or territory authorities for acceptable exposure limits.

Section 3. Hazards Identification.

Potential Health Effects	Combustible liquid. Exercise caution when handling this material. Contact with this product may cause skin and eye irritation. Prolonged or repeated contact may cause skin irritation, defatting, drying and dermatitis. Inhalation of this product may cause respiratory tract irritation and Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death. Ingestion of this product may cause gastro-intestinal irritation. Aspiration of this product may result in severe irritation or burns to the respiratory tract. For more information refer to Section 11 of this MSDS.

Section 4. First Aid Measures

Eye Contact	IMMEDIATELY flush eyes with running water for at least 15 minutes, keeping eyelids open. Seek medical attention.
Skin Contact	Remove contaminated clothing - launder before reuse. Wash gently and thoroughly the contaminated skin with running water and non-abrasive soap. Seek medical attention.
Inhalation	Evacuate the victim to a safe area as soon as possible. If the victim is not breathing, perform artificial respiration. Allow the victim to rest in a well ventilated area. Seek medical attention.
Ingestion	DO NOT induce vomiting because of danger of aspirating liquid into lungs. Seek medical attention.
Note to Physician	Not available

Section 5. Fire-fighting Measures

Flammability	Class II - combustible liquid (NFPA).	**Flammable Limits**	Lower: 0.7%, Upper: 6%
Flash Points	Open Cup: >40°C (>104°F), Cleveland.	**Auto-Ignition Temperature**	225°C (437°F)
Fire Hazards in Presence of Various Substances	Flammable in presence of open flames, sparks, or heat. Vapours are heavier than air and may travel considerable distance to sources of ignition and flash back. This product can accumulate static charge and ignite.	**Explosion Hazards in Presence of Various Substances**	Containers may explode in heat of fire. Do not cut, weld, heat, drill or pressurize empty container. Runoff to sewer may create fire or explosion hazard.
Products of Combustion	Carbon oxides (CO, CO2), nitrogen oxides (NOx), sulphur oxides (SOx), sulphur compounds (H2S), smoke and irritating vapours as products of incomplete combustion.		

Fire Fighting Media and Instructions	NAERG96, GUIDE 128, Flammable liquids (Non-polar/Water-immiscible). CAUTION: This product has a moderate flash point above 40ºC: Use of water spray when fighting fire may be inefficient. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also consider initial evacuation for 800 meters (1/2 mile) in all directions. SMALL FIRES: Dry chemical, CO2, water spray or regular foam. LARGE FIRES: Water spray, fog or regular foam. Do not use straight streams. Move containers from fire area if you can do it without risk. Fires Involving Tanks or Car/Trailer Loads: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting devices or any discolouration of tank. ALWAYS stay away from the ends of tanks. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible withdraw from area and let fire burn. Wear positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing will only provide limited protection.

Section 6. Accidental Release Measures

Material Release or Spill	Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary. IN THE EVENT OF A LARGE SPILL CONSIDER THE FOLLOWING CONTROL MEASURES: Extinguish all ignition sources. Evacuate non-essential personnel. Ventilate area. Stop leak if safe to do so. Dike spilled material. Use appropriate inert absorbent material to absorb spilled product. Collect used absorbent for later disposal. Ground and bond all equipment used to clean up the spilled material, as it may be a static accumulator. Avoid contact with spilled material. Avoid breathing vapours or mists of material. Avoid contaminating sewers, streams, rivers and other water courses with spilled material. Notify appropriate authorities immediately.

Section 7. Handling and Storage

Handling	COMBUSTIBLE MATERIAL. Handle with care. Avoid contact with any sources of ignition, flames, heat, and sparks. Ensure all equipment is grounded/bonded. Avoid skin contact. Avoid eye contact. Avoid inhalation of product vapours or mists. Wear proper personal protective equipment (See Section 8). Avoid confined spaces and areas with poor ventilation. Empty containers may contain product residue. Do not pressurize, cut, heat, or weld empty containers. Do not reuse containers without commercial cleaning and/or reconditioning. Personnel who handle this material should practice good personal hygiene during and after handling to help prevent accidental ingestion of this product. Properly dispose of contaminated leather articles including shoes that cannot be decontaminated.
Storage	Store away from heat and sources of ignition. Store in dry, cool, well-ventilated area. Store away from incompatible and reactive materials (See section 5 and 10). Ensure the storage containers are grounded/bonded.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.
Personal Protection - ***The selection of personal protective equipment varies, depending upon conditions of use.***	
Eyes	Eye protection (i.e., safety glasses, safety goggles and/or face shield) should be determined based on conditions of use. If product is used in an application where splashing may occur, the use of safety goggles and/or a face shield should be considered.
Body	Wear appropriate clothing to prevent skin contact. As a minimum long sleeves and trousers should be worn.
Respiratory	Where concentrations in air may exceed the occupational exposure limits given in Section 2 (and those applicable to your area) and where engineering, work practices or other means of exposure reduction are not adequate, NIOSH approved respirators may be necessary to prevent overexposure by inhalation.
Hands	Wear appropriate chemically protective gloves. When handling hot product ensure gloves are heat resistant and insulated.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Bright oily liquid.	**Viscosity**	1.2 - 4.1 cSt @ 40ºC (104ºF)
Colour	Clear to yellow / brown (may be dyed for taxation purposes).	**Pour Point**	Not available
Odour	Mild petroleum oil like.	**Softening Point**	Not applicable.
Odour Threshold	Not available	**Dropping Point**	Not applicable.
Boiling Point	150 - 371ºC (302 - 700ºF)	**Penetration**	Not applicable.
Density	0.80 - 0.88 kg/L @ 15°C (59°F).	**Oil / Water Dist. Coefficient**	Not available
Vapour Density	4.5 (Air = 1)	**Ionicity (in water)**	Not available
Vapour Pressure	1.0 kPa @ 20ºC (7.5 mmHg @ 68ºF).	**Dispersion Properties**	Not available
Volatility	<0.1 (Butyl acetate = 1), less than gasoline.	**Solubility**	Insoluble in cold water, soluble in non-polar hydrocarbon solvents.

Section 10. Stability and Reactivity

Corrosivity	Not available		
Stability	The product is stable under normal handling and storage conditions.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Reactive with oxidizing agents and acids.	**Decomposition Products**	May release COx, NOx, SOx, H2S, smoke and irritating vapours when heated to decomposition.

Section 11. Toxicological Information

Routes of Entry	Skin contact, eye contact, inhalation, and ingestion.
Acute Lethality	Acute toxicity information is not available for the product as a whole, therefore, data for some of the ingredients is provided below: **Fuel Oil No. 2 (68476-30-2):** Acute Oral toxicity (LD50): 12000 mg/kg (rat) **Kerosine (petroleum), hydrosulfurized (64742-81-0):** Acute Oral toxicity (LD50): >5000 mg/kg (rat) Acute Dermal toxicity (LD50): >2000 mg/kg (rabbit) Acute Inhalation toxicity (LC50): >5000 mg/m³/4h (rat)
Chronic or Other Toxic Effects	
Dermal Route:	This product contains a component (at >= 1%) that can cause skin irritation. Therefore, this product is considered to be a skin irritant. Prolonged or repeated contact may defat and dry skin, and cause dermatitis.
Inhalation Route:	Inhalation of this product may cause respiratory tract irritation. Inhalation of this product may cause Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death.
Oral Route:	Ingestion of this product may cause gastro-intestinal irritation. Aspiration of this product may result in severe irritation or burns to the respiratory tract. Ingestion of this product may cause Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death.
Eye Irritation/Inflammation:	This product contains a component (at >= 1%) that can cause eye irritation. Therefore, this product is considered to be an eye irritant.
Immunotoxicity:	Not available
Skin Sensitization:	Contact with this product is not expected to cause skin sensitization, based upon the available data and the known hazards of the components.
Respiratory Tract Sensitization:	Contact with this product is not expected to cause respiratory tract sensitization, based upon the available data and the known hazards of the components.
Mutagenic:	This product is not known to contain any components at >= 0.1% that have been shown to cause mutagenicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a mutagen.
Reproductive Toxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause reproductive toxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a reproductive toxin.
Teratogenicity/Embryotoxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause teratogenicity and/or embryotoxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a teratogen/embryotoxin.
Carcinogenicity (ACGIH):	ACGIH A3: animal carcinogen. [Diesel fuel] (See Other Considerations)
Carcinogenicity (IARC):	This product is not known to contain any chemicals at reportable quantities that are listed as group 1, 2A or 2B carcinogens by IARC.
Carcinogenicity (NTP):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by NTP.
Carcinogenicity (IRIS):	Not available
Carcinogenicity (OSHA):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by OSHA.
Other Considerations	* Avoid prolonged or repeated skin contact to diesel fuels which can lead to dermal irritation and may be associated with an increased risk of skin cancer.

Section 12. Ecological Information

Environmental Fate	Not available	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available	**Products of Biodegradation**	Not available
Additional Remarks	No additional remark.		

Section 13. Disposal Considerations

Waste Disposal Spent/ used/ waste product may meet the requirements of a hazardous waste. Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 14. Transport Information

TDG Classification	FUEL OIL, 3, UN1202, PGIII (CL-TDG)	**Special Provisions for Transport**	See Transportation of Dangerous Goods Regulations.

Section 15. Regulatory Information

Other Regulations This product is acceptable for use under the provisions of WHMIS-CPR. All components of this formulation are listed on the CEPA-DSL (Domestic Substances List).

All components of this formulation are listed on the US EPA-TSCA Inventory.

All components of this product are on the European Inventory of Existing Commercial Chemical Substances (EINECS).

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

Please contact Product Safety for more information.

DSD/DPD (Europe)	Not evaluated.	**HCS (U.S.A.)**	CLASS: Irritating substance. CLASS: Target organ effects. CLASS: Combustible liquid having a flash point between 37.8°C (100°F) and 93.3°C (200°F).
ADR (Europe) (Pictograms)	**NOT EVALUATED FOR EUROPEAN TRANSPORT** **NON ÉVALUÉ POUR LE TRANSPORT EUROPÉEN.**	**DOT (U.S.A) (Pictograms)**	

HMIS (U.S.A.)

Health Hazard	2*
Fire Hazard	2
Reactivity	0
Personal Protection	H

NFPA (U.S.A.)



Health — Fire Hazard — Reactivity — Specific hazard

Rating	
0	Insignificant
1	Slight
2	Moderate
3	High
4	Extreme

Section 16. Other Information

References Available upon request.
* Marque de commerce de Petro-Canada - Trademark

Glossary

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous goods by Road (Europe)
ASTM - American Society for Testing and Materials (
BOD5 - Biological Oxygen Demand in 5 days
CAN/CGA B149.2 Propane Installation Code
CAS - Chemical Abstract Services
CEPA - Canadian Environmental Protection Act
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CFR - Code of Federal Regulations
CHIP - Chemicals Hazard Information and Packaging Approved Supply List
COD5 - Chemical Oxygen Demand in 5 days
CPR - Controlled Products Regulations
DOT - Department of Transport
DSCL - Dangerous Substances Classification and Labeling (Europe)
DSD/DPD - Dangerous Substances or Dangerous Preparations Directives (Europe)
DSL - Domestic Substance List
EEC/EU - European Economic Community/European Union
EINECS - European Inventory of Existing Commercial Chemical Substances
EPCRA - Emergency Planning and Community Right to Know Act
FDA - Food and Drug Administration
FIFRA - Federal Insecticide, Fungicide and Rodenticide Act
HCS - Hazardous Communication System
IRIS - Integrated Risk Information System
LD50/LC50 - Lethal Dose/Concentration kill 50%
LDLo/LCLo - Lowest Published Lethal Dose/Concentration
NAERG'96 - North American Emergency Response Guide Book (1996)
NFPA - National Fire Prevention Association
NIOSH - National Institute for Occupational Safety & Health
NPRI - National Pollutant Release Inventory
NSNR - New Substances Notification Regulations (Canada)
NTP - National Toxicology Program
OSHA - Occupational Safety & Health Administration
PEL - Permissible Exposure Limit
RCRA - Resource Conservation and Recovery Act
SARA - Superfund Amendments and Reorganization Act
SD - Single Dose
STEL - Short Term Exposure Limit (15 minutes)
TDG - Transportation Dangerous Goods (Canada)
TDLo/TCLo - Lowest Published Toxic Dose/Concentration
TLm - Median Tolerance Limit
TLV-TWA - Threshold Limit Value-Time Weighted Average
TSCA - Toxic Substances Control Act
USEPA - United States Environmental Protection Agency
USP - United States Pharmacopoeia
WHMIS - Workplace Hazardous Material Information System

HMIS - Hazardous Material Information System
IARC - International Agency for Research on Cancer

For Copy of MSDS
Internet: www.petro-canada.ca/msds

Western Canada, Ontario & Central Canada, telephone: 1-800-668-0220; fax: 1-800-837-1228
Quebec & Eastern Canada, telephone: 514-640-8308; fax: 514-640-8385

For Product Safety Information: (905) 804-4752

Prepared by Product Safety - JDW on 2/5/2004.

Data entry by Product Safety - JDW.

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

PETRO-CANADA

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	**Not controlled**		

Section 1. Chemical Product and Company Identification

Product Name	**DURON* SINGLE GRADE ENGINE OILS SAE VISCOSITY GRADES 10W, 20, 30, 40, 50**	**Code**	420-054, DUR1 420-055, DUR2 420-056, DUR3 420-057, DUR4 420-058, DUR5
Synonym	Not available	**Validated on**	**10/7/2005.**
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3	**In case of Emergency**	Petro-Canada: 403-296-3000 Canutec Transportation: 613-996-6666 Poison Control Centre: Consult local telephone directory for emergency number(s).
Material Uses	DURON* single grade oils are intended for use in diesel and spark ignition engines according to the specific viscosity grade and performance level for each grade of product. They may also be used for wet clutch and gear type transmissions and hydraulic systems in line with equipment builder specifications.		

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (W/W)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
Mixture of severely hydrotreated and hydrocracked and/or solvent-refined base oil (petroleum) and other proprietary, non-hazardous additives.	Mixture	100	5 mg/m³ (oil mist)	10 mg/m³ (oil mist)	Not established

Manufacturer Recommendation	Not applicable
Other Exposure Limits	Consult local, state, provincial or territory authorities for acceptable exposure limits.

Section 3. Hazards Identification.

Potential Health Effects	Prolonged or repeated contact may cause skin irritation, defatting, drying and dermatitis. Not expected to cause more than slight skin or eye irritation. With its relatively low vapour pressure, this product is not expected be inhaled in any appreciable quantity at ambient conditions. If heated to high temperatures or subjected to mechanical actions which produce vapours or mists, inhalation may cause respiratory tract irritation. Ingestion may produce a laxative effect. For more information refer to Section 11 of this MSDS.

Section 4. First Aid Measures

Eye Contact	No effects expected. If irritation does occur, flush contaminated eye(s) with lukewarm, gently flowing water for 5 minutes or until the chemical is removed. If irritation persists, obtain medical advice.
Skin Contact	Quickly and gently, blot or brush away excess chemical. Wash gently and thoroughly with water and non-abrasive soap for 5 minutes or until chemical is removed. Remove contaminated clothing, shoes and leather goods (e.g., watchbands, belts, etc.). If irritation persists, repeat flushing. Obtain medical advice immediately. Completely decontaminate clothing, shoes and leather goods before reuse or discard.
Inhalation	Remove source of contamination or move victim to fresh air. If irritation persists, obtain medical advice.
Ingestion	NEVER give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing. DO NOT induce vomiting because of danger of aspirating liquid into lungs. Have victim drink 240 to 300 mL (8 to 10 oz) of water to dilute material in stomach. If vomiting occurs naturally, rinse mouth and repeat administration of water. Obtain medical attention.
Note to Physician	Not available

Section 5. Fire-fighting Measures

Flammability	May be combustible at high temperature.	**Flammable Limits**	Not available.
Flash Points	CLOSED CUP: ≥194°C (381.2°F) (Pensky-Martens) OPEN CUP: ≥205°C (401°F) (Cleveland)	**Auto-Ignition Temperature**	Fire Point: ≥231°C (447.8°F)
Fire Hazards in Presence of Various Substances	Low fire hazard. This material must be heated before ignition will occur.	**Explosion Hazards in Presence of Various Substances**	Do not cut, weld, heat, drill or pressurize empty container. Containers may explode in heat of fire.
Products of Combustion	Carbon oxides (CO, CO2), nitrogen oxides (NOx), sulphur oxides (SOx), CaOx, ZnOx, POx, smoke and irritating vapours as products of incomplete combustion.		
Fire Fighting Media and Instructions	NAERG2004, GUIDE 171, Substances (low to moderate hazard). If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (0.5 mile) in all directions; also, consider initial evacuation for 800 meters (0.5 mile) in all directions. Shut off fuel to fire if it is possible to do so without hazard. If this is impossible, withdraw from area and let fire burn out under controlled conditions. Withdraw immediately in case of rising sound from venting safety device or any discolouration of tank due to fire. Cool containing vessels with water spray in order to prevent pressure build-up, autoignition or explosion. SMALL FIRE: use DRY chemicals, foam, water spray or CO2. LARGE FIRE: use water spray, fog or foam. For small outdoor fires, portable fire extinguishers may be used, and self contained breathing apparatus (SCBA) may not be required. For all indoor fires and any significant outdoor fires, SCBA is required. Respiratory and eye protection are required for fire fighting personnel.		

Section 6. Accidental Release Measures

Material Release or Spill	Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary. Ensure clean-up personnel wear appropriate personal protective equipment. Extinguish all ignition sources. Stop leak if safe to do so. Dike spilled material. Use appropriate inert absorbent material to absorb spilled product. Collect used absorbent for later disposal. Avoid contact with spilled material. Avoid contaminating sewers, streams, rivers and other water courses with spilled material. Notify appropriate authorities immediately.

Section 7. Handling and Storage

Handling	Avoid contact with any sources of ignition, flames, heat, and sparks. Avoid skin contact. Avoid eye contact. Avoid inhalation of product vapours or mists. Wear proper personal protective equipment (See Section 8). Empty containers may contain product residue. Do not pressurize, cut, heat, or weld empty containers. Do not reuse containers without commercial cleaning and/or reconditioning. Personnel who handle this material should practice good personal hygiene during and after handling to help prevent accidental ingestion of this product. Properly dispose of contaminated leather articles including shoes that cannot be decontaminated.
Storage	Store in dry, cool, well-ventilated area. Keep container tightly closed. Store away from incompatible and reactive materials (See section 5 and 10).

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.
Personal Protection - ***The selection of personal protective equipment varies, depending upon conditions of use.***	
Eyes	As a minimum, safety glasses with side shields should be worn when handling this material.
Body	If this material may come in contact with the body during handling and use, we recommend wearing appropriate protective clothing to prevent contact with the skin. (Contact your PPE provider for more information.)
Respiratory	A NIOSH-approved air-purifying respirator with an organic vapour cartridge or canister with a dust, fume of mist filter (R, or P series) may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air-purifying respirators is limited. A NIOSH-approved positive-pressure, air-supplied respirator or self-contained breathing apparatus may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits.
Hands	If this material may come in contact with the hands during handling and use, we recommend wearing gloves of the following material(s): neoprene, nitrile, polyvinyl alcohol (PVA), fluoro-elastomer. Consult your PPE provider for breakthrough times and the specific glove that is best for you based on your use patterns. It should be realized that eventually any material regardless of their imperviousness, will get permeated by chemicals. Therefore, protective gloves should be regularly checked for wear and tear. At the first signs of hardening and cracks, they should be changed.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Viscous liquid.	**Viscosity**	10W: 41.51 cSt @ 40°C (104°F) 20: 64.9 cSt @ 40°C (104°F) 30: 83.2 cSt @ 40°C (104°F) 40: 133.5 cSt @ 40°C (104°F) 50: 209 cSt @ 40°C (104°F)
Colour	Amber.	**Pour Point**	10W: -42°C (-43.6°F) 20: -39°C (-38.2°F) 30: -36°C (-32.8°F) 40: -30°C (-22°F) 50: -21°C (-5.8°F)
Odour	Mild petroleum oil like.	**Softening Point**	Not applicable.
Odour Threshold	Not available.	**Dropping Point**	Not applicable.
Boiling Point	Not available.	**Penetration**	Not applicable.
Density	0.8667 to 0.8881 kg/L @ 15ºC (59ºF).	**Oil / Water Dist. Coefficient**	Not available
Vapour Density	Not available.	**Ionicity (in water)**	Not available
Vapour Pressure	Negligible at ambient temperature and pressure.	**Dispersion Properties**	Not available
Volatility	Not available	**Solubility**	Insoluble in water.

Section 10. Stability and Reactivity

Corrosivity	10W, 30, 40: Copper corrosion, 3h, 100ºC (ASTM D0130): 1b. 20, 50: Copper corrosion, 3h, 100°C (ASTM D0130): 1a.		
Stability	The product is stable under normal handling and storage conditions.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Reactive with oxidizing agents, acids, halogens and halogen compounds.	**Decomposition Products**	May release COx, NOx, SOx, POx, ZnOx, H2S, alkyl mercaptans, sulfides, aldehydes, methacrylate monomers, smoke and irritating vapours when heated to decomposition.

Section 11. Toxicological Information

Routes of Entry	Skin contact, eye contact, inhalation and ingestion.
Acute Lethality	Acute toxicity information is not available for the product as a whole, therefore, data for the base oils are provided below: Acute Oral toxicity (LD50): >5000 mg/kg (rat) Acute Dermal toxicity (LD50): >2000 mg/kg (rabbit) Acute Inhalation toxicity (LC50): >2500 mg/m³/4h (rat)

Chronic or Other Toxic Effects

Dermal Route:	Prolonged or repeated contact may defat and dry skin, and cause dermatitis. Short-term exposure is expected to cause only slight irritation, if any.
Inhalation Route:	With its relatively low vapour pressure, this product is not expected be inhaled in any appreciable quantity at ambient conditions. If heated to high temperatures or subjected to mechanical actions which produce vapours or mists, inhalation may cause respiratory tract irritation.
Oral Route:	Ingestion of this product may lead to aspiration of the liquid, especially if vomiting occurs. This may result in chemical pneumonitis (inflammation of the lungs) and/or pulmonary edema (an accumulation of fluid in the lungs). May produce a laxative effect.
Eye Irritation/Inflammation:	Short-term exposure is expected to cause only slight irritation, if any.
Immunotoxicity:	Not available.
Skin Sensitization:	Contact with this product is not expected to cause skin sensitization, based upon the available data and the known hazards of the components.
Respiratory Tract Sensitization:	Contact with this product is not expected to cause respiratory tract sensitization, based upon the available data and the known hazards of the components.
Mutagenic:	This product is not known to contain any components at >= 0.1% that have been shown to cause mutagenicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a mutagen.
Reproductive Toxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause reproductive toxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a reproductive toxin.

Teratogenicity/Embryotoxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause teratogenicity and/or embryotoxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a teratogen/embryotoxin.
Carcinogenicity (ACGIH):	This product is not known to contain any chemicals at reportable quantities that are listed as Group A1 or A2 carcinogens by ACGIH.
Carcinogenicity (IARC):	This product is not known to contain any chemicals at reportable quantities that are listed as Group 1, 2A, or 2B carcinogens by IARC.
Carcinogenicity (NTP):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by NTP.
Carcinogenicity (IRIS):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by IRIS.
Carcinogenicity (OSHA):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by OSHA.
Other Considerations	No additional remark.

Section 12. Ecological Information

Environmental Fate	Not available	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available.	**Products of Biodegradation**	Not available
Additional Remarks	No additional remark.		

Section 13. Disposal Considerations

Waste Disposal	Spent/ used/ waste product may meet the requirements of a hazardous waste. Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 14. Transport Information

TDG Classification	Not a hazardous material for transport according to the TDG Regulations. (Canada)	**Special Provisions for Transport**	Not applicable.

Section 15. Regulatory Information

Other Regulations

This product is acceptable for use under the provisions of WHMIS-CPR. All components of this formulation are listed on the CEPA-DSL (Domestic Substances List).

All components of this formulation are listed on the US EPA-TSCA Inventory.

All components of this product are on the European Inventory of Existing Commercial Chemical Substances (EINECS).

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

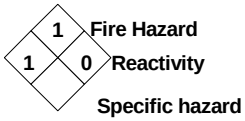
Please contact Product Safety for more information.

DSD/DPD (Europe)	Not classified under the Dangerous Substances or Dangerous Preparations Directives.	**HCS (U.S.A.)**	Does not meet the definitions of a health or physical hazard according to the OSHA - Hazard Communication Standard. (United States)
ADR (Europe) (Pictograms)	NOT EVALUATED FOR EUROPEAN TRANSPORT NON ÉVALUÉ POUR LE TRANSPORT EUROPÉEN.	**DOT (U.S.A) (Pictograms)**	Not evaluated for transport Non évalué pour le transport

HMIS (U.S.A.)

Health Hazard	1
Fire Hazard	1
Reactivity	0
Personal Protection	B

NFPA (U.S.A.)



Rating
0 Insignificant
1 Slight
2 Moderate
3 High
4 Extreme

Section 16. Other Information

References Available upon request.
* Marque de commerce de Petro-Canada - Trademark

Glossary

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous goods by Road (Europe)
ASTM - American Society for Testing and Materials
BOD5 - Biological Oxygen Demand in 5 days
CAN/CGA B149.2 Propane Installation Code
CAS - Chemical Abstract Services
CEPA - Canadian Environmental Protection Act
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CFR - Code of Federal Regulations
CHIP - Chemicals Hazard Information and Packaging Approved Supply List
CNS - Central Nervous System
COD5 - Chemical Oxygen Demand in 5 days
CPR - Controlled Products Regulations
DOT - Department of Transport
DSCL - Dangerous Substances Classification and Labeling (Europe)
DSD/DPD - Dangerous Substances or Dangerous Preparations Directives (Europe)
DSL - Domestic Substance List
EEC/EU - European Economic Community/European Union
EINECS - European Inventory of Existing Commercial Chemical Substances
EPA - Environmental Protection Agency
EPCRA - Emergency Planning and Community Right to Know Act
FDA - Food and Drug Administration
FIFRA - Federal Insecticide, Fungicide and Rodenticide Act
HCS - Hazard Communication Standard
HMIS - Hazardous Material Information System
IARC - International Agency for Research on Cancer
IRIS - Integrated Risk Information System
LD50/LC50 - Lethal Dose/Concentration kill 50%
LDLo/LCLo - Lowest Published Lethal Dose/Concentration
NAERG'96 - North American Emergency Response Guide Book (1996)
NFPA - National Fire Prevention Association
NIOSH - National Institute for Occupational Safety & Health
NPRI - National Pollutant Release Inventory
NSNR - New Substances Notification Regulations (Canada)
NTP - National Toxicology Program
OSHA - Occupational Safety & Health Administration
PEL - Permissible Exposure Limit
RCRA - Resource Conservation and Recovery Act
RTECS - Registry of Toxic Effects of Chemical Substances
SARA - Superfund Amendments and Reorganization Act
SD - Single Dose
STEL - Short Term Exposure Limit (15 minutes)
TDG - Transportation Dangerous Goods (Canada)
TDLo/TCLo - Lowest Published Toxic Dose/Concentration
TLm - Median Tolerance Limit
TLV-TWA - Threshold Limit Value-Time Weighted Average
TSCA - Toxic Substances Control Act
USEPA - United States Environmental Protection Agency
USP - United States Pharmacopoeia
WHMIS - Workplace Hazardous Material Information System

For Copy of MSDS

The Canadian Controlled Products Regulations (CPR) (Under the Hazardous Products Act, part of the WHMIS legislation) only apply to WHMIS Controlled (i.e., hazardous) products. Therefore, the CPR and the 3-year update rule specified therein do not apply to WHMIS Non-Controlled products. Although this is true, customarily Petro-Canada reviews and updates Non-Controlled product MSDS if a customer requests such an update. These Non-Controlled product updates are given a lower priority than Controlled products but are handled as soon as practicable. If you would like to verify if the MSDS you have is the most current, or you require any further information, please contact:

Internet: www.petro-canada.ca/msds

Lubricants:
Western Canada, telephone: 1-800-661-1199; fax: (780) 464-9564
Ontario & Central Canada, telephone: 1-800-268-5850 and (905) 822-4222; fax: 1-800-201-6285
Quebec & Eastern Canada, telephone: 1-800-576-1686; fax: 800-201-6285

For Product Safety Information: (905) 804-4752

Prepared by Product Safety - JDW on 10/7/2005.

Data entry by Product Safety - RS.

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

PETRO-CANADA

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	**Not controlled**		

Section 1. Chemical Product and Company Identification

Product Name	**DURATRAN* XL**	**Code**	DTRANXL, 460-644-0
Synonym	Not available	**Validated on**	**10/23/2003.**
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3	**In case of Emergency**	Petro-Canada: 403-296-3000 Canutec Transportation: 613-996-6666 Poison Control Centre: Consult local telephone directory for emergency number(s).
Material Uses	A synthetic blend, extended season transmission / hydraulic fluid for use in a wide range of ambient conditions with exceptional low temperature performance. Suitable for transmission, hydraulic, wet brake, PTO, final drive and power steering units in mobile equipment.		

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (W/W)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
Mixture of severely hydrotreated and hydrocracked base oil (petroleum), synthetic hydrocarbons and other proprietary, non-hazardous additives.	Mixture	100	5 mg/m³ (oil mist)	10 mg/m³ (oil mist)	Not established

Manufacturer Recommendation	Not applicable
Other Exposure Limits	Consult local, state, provincial or territory authorities for acceptable exposure limits.

Section 3. Hazards Identification.

Potential Health Effects	Prolonged or repeated contact may cause skin irritation, defatting, drying and dermatitis. Not expected to cause more than slight skin or eye irritation. With its relatively low vapour pressure, this product is not expected be inhaled in any appreciable quantity at ambient conditions. If heated to high temperatures or subjected to mechanical actions which produce vapours or mists, inhalation may cause respiratory tract irritation. Ingestion may produce a laxative effect. For more information refer to Section 11 of this MSDS.

Section 4. First Aid Measures

Eye Contact	IMMEDIATELY flush eyes with running water for at least 15 minutes, keeping eyelids open. Seek medical attention.
Skin Contact	Remove contaminated clothing - launder before reuse. Wash gently and thoroughly the contaminated skin with running water and non-abrasive soap. Seek medical attention.
Inhalation	Evacuate the victim to a safe area as soon as possible. If the victim is not breathing, perform artificial respiration. Allow the victim to rest in a well ventilated area. Seek medical attention.
Ingestion	DO NOT induce vomiting because of danger of aspirating liquid into lungs. Seek medical attention.
Note to Physician	Not available

Section 5. Fire-fighting Measures

Flammability	May be combustible at high temperature.	**Flammable Limits**	Not available
Flash Points	OPEN CUP: 219°C (426.2°F) (Cleveland)	**Auto-Ignition Temperature**	Fire Point: 239°C (462.2°F)
Fire Hazards in Presence of Various Substances	Low fire hazard. This material must be heated before ignition will occur.	**Explosion Hazards in Presence of Various Substances**	Do not cut, weld, heat, drill or pressurize empty container. Containers may explode in heat of fire.
Products of Combustion	Carbon oxides (CO, CO2), nitrogen oxides (NOx), sulphur oxides (SOx), CaOx, ZnOx, phosphorus compounds (POx), smoke and irritating vapours as products of incomplete combustion.		

Continued on Next Page

Fire Fighting Media and Instructions	NAERG96, GUIDE 171, Substances (low to moderate hazard). If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (0.5 mile) in all directions; also, consider initial evacuation for 800 meters (0.5 mile) in all directions. Shut off fuel to fire if it is possible to do so without hazard. If this is impossible, withdraw from area and let fire burn out under controlled conditions. Withdraw immediately in case of rising sound from venting safety device or any discolouration of tank due to fire. Cool containing vessels with water spray in order to prevent pressure build-up, autoignition or explosion. SMALL FIRE: use DRY chemicals, foam, water spray or CO2. LARGE FIRE: use water spray, fog or foam. For small outdoor fires, portable fire extinguishers may be used, and self contained breathing apparatus (SCBA) may not be required. For all indoor fires and any significant outdoor fires, SCBA is required. Respiratory and eye protection are required for fire fighting personnel.

Section 6. Accidental Release Measures

Material Release or Spill	Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary. Extinguish all ignition sources. Stop leak if safe to do so. Dike spilled material. Use appropriate inert absorbent material to absorb spilled product. Collect used absorbent for later disposal. Avoid contact with spilled material. Avoid contaminating sewers, streams, rivers and other water courses with spilled material. Notify appropriate authorities immediately.

Section 7. Handling and Storage

Handling	Avoid contact with any sources of ignition, flames, heat, and sparks. Avoid eye contact. Avoid skin contact. Avoid inhalation of product vapours or mists. Empty containers may contain product residue. Do not pressurize, cut, heat, or weld empty containers. Do not reuse containers without commercial cleaning and/or reconditioning. Personnel who handle this material should practice good personal hygiene during and after handling to help prevent accidental ingestion of this product. Properly dispose of contaminated leather articles including shoes that cannot be decontaminated.
Storage	Store away from incompatible and reactive materials (See section 5 and 10). Keep container tightly closed. Store in dry, cool, well-ventilated area.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.
Personal Protection - ***The selection of personal protective equipment varies, depending upon conditions of use.***	
Eyes	Eye protection (i.e., safety glasses, safety goggles and/or face shield) should be determined based on conditions of use. If product is used in an application where splashing may occur, the use of safety goggles and/or a face shield should be considered.
Body	Wear appropriate clothing to prevent skin contact. As a minimum long sleeves and trousers should be worn.
Respiratory	Where concentrations in air may exceed the occupational exposure limits given in Section 2 (and those applicable to your area) and where engineering, work practices or other means of exposure reduction are not adequate, NIOSH approved respirators may be necessary to prevent overexposure by inhalation.
Hands	Wear appropriate chemically protective gloves. When handling hot product ensure gloves are heat resistant and insulated.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Viscous liquid.	**Viscosity**	39.21 cSt @ 40°C (104°F), 8.34 cSt @ 100°C (212°F), VI=196
Colour	Yellow/amber.	**Pour Point**	-49.8º(-57.6ºF)
Odour	No odour or slight petroleum oil like.	**Softening Point**	Not applicable.
Odour Threshold	Not available	**Dropping Point**	Not applicable.
Boiling Point	Not available	**Penetration**	Not applicable.
Density	0.8503 kg/L @ 15°C (59°F).	**Oil / Water Dist. Coefficient**	Not available
Vapour Density	Not available	**Ionicity (in water)**	Not available
Vapour Pressure	Negligible at ambient temperature and pressure.	**Dispersion Properties**	Not available
Volatility	Non-volatile.	**Solubility**	Insoluble in water.

Section 10. Stability and Reactivity

Corrosivity	Copper corrosion, 3h, 149°C (ASTM D0130M): 1b.		
Stability	The product is stable under normal handling and storage conditions.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Reactive with oxidizing agents and acids.	**Decomposition Products**	May release COx, SOx, POx, H2S, CaOx, ZnOx, SiOx, aldehydes, alkyl mercaptans, sulfides, methacrylate monomers, smoke and irritating vapours when heated to decomposition.

Section 11. Toxicological Information

Routes of Entry	Skin contact, eye contact, inhalation and ingestion.
Acute Lethality	Acute toxicity information is not available for the product as a whole, therefore, data for some of the ingredients is provided below: Acute Oral toxicity (LD50): >5000 mg/kg (rat) Acute Dermal toxicity (LD50): >2000 mg/kg (rabbit) Acute Inhalation toxicity (LC50): >2500 mg/m³/4h (rat)
Chronic or Other Toxic Effects	
Dermal Route:	Prolonged or repeated contact may defat and dry skin, and cause dermatitis. Short-term exposure is expected to cause only slight irritation, if any.
Inhalation Route:	With its relatively low vapour pressure, this product is not expected be inhaled in any appreciable quantity at ambient conditions. If heated to high temperatures or subjected to mechanical actions which produce vapours or mists, inhalation may cause respiratory tract irritation.
Oral Route:	Ingestion of this product may lead to aspiration of the liquid, especially if vomiting occurs. This may result in chemical pneumonitis (inflammation of the lungs) and/or pulmonary edema (an accumulation of fluid in the lungs). May produce a laxative effect.
Eye Irritation/Inflammation:	Short-term exposure is expected to cause only slight irritation, if any.
Immunotoxicity:	Not available
Skin Sensitization:	Contact with this product is not expected to cause skin sensitization, based upon the available data and the known hazards of the components.
Respiratory Tract Sensitization:	Contact with this product is not expected to cause respiratory tract sensitization, based upon the available data and the known hazards of the components.
Mutagenic:	This product is not known to contain any components at >= 0.1% that have been shown to cause mutagenicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a mutagen.
Reproductive Toxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause reproductive toxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a reproductive toxin.
Teratogenicity/Embryotoxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause teratogenicity and/or embryotoxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a teratogen/embryotoxin.
Carcinogenicity (ACGIH):	This product is not known to contain any chemicals at reportable quantities that are listed as Group A1 or A2 carcinogens by ACGIH.
Carcinogenicity (IARC):	This product is not known to contain any chemicals at reportable quantities that are listed as Group 1, 2A, or 2B carcinogens by IARC.
Carcinogenicity (NTP):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by NTP.
Carcinogenicity (IRIS):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by IRIS.
Carcinogenicity (OSHA):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by OSHA.
Other Considerations	No additional remark.

Section 12. Ecological Information

Environmental Fate	Not available	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available	**Products of Biodegradation**	Not available
Additional Remarks	No additional remark.		

Section 13. Disposal Considerations

Waste Disposal	Spent/ used/ waste product may meet the requirements of a hazardous waste. Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 14. Transport Information

TDG Classification	Not a hazardous material for transport according to the TDG Regulations. (Canada)	**Special Provisions for Transport**	Not applicable.

Section 15. Regulatory Information

Other Regulations

This product is acceptable for use under the provisions of WHMIS-CPR. All components of this formulation are listed on the CEPA-DSL (Domestic Substances List).

All components of this formulation are listed on the US EPA-TSCA Inventory.

All components of this product are on the European Inventory of Existing Commercial Chemical Substances (EINECS).

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

Please contact Product Safety for more information.

DSD/DPD (Europe)	Not classified under the Dangerous Substances or Dangerous Preparations Directives.	**HCS (U.S.A.)**	Does not meet the definitions of a health or physical hazard according to the OSHA - Hazard Communication Standard. (United States)
ADR (Europe) (Pictograms)	**NOT EVALUATED FOR EUROPEAN TRANSPORT** **NON ÉVALUÉ POUR LE TRANSPORT EUROPÉEN.**	**DOT (U.S.A) (Pictograms)**	

HMIS (U.S.A.)

Health Hazard	1
Fire Hazard	1
Reactivity	0
Personal Protection	B

NFPA (U.S.A.)



Rating
0 Insignificant
1 Slight
2 Moderate
3 High
4 Extreme

Section 16. Other Information

References Available upon request.

* Marque de commerce de Petro-Canada - Trademark

Glossary

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous goods by Road (Europe)
ASTM - American Society for Testing and Materials
BOD5 - Biological Oxygen Demand in 5 days
CAN/CGA B149.2 Propane Installation Code
CAS - Chemical Abstract Services
CEPA - Canadian Environmental Protection Act
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CFR - Code of Federal Regulations
CHIP - Chemicals Hazard Information and Packaging Approved Supply List
CNS - Central Nervous System
COD5 - Chemical Oxygen Demand in 5 days
CPR - Controlled Products Regulations
DOT - Department of Transport
DSCL - Dangerous Substances Classification and Labeling (Europe)
DSD/DPD - Dangerous Substances or Dangerous Preparations
IRIS - Integrated Risk Information System
LD50/LC50 - Lethal Dose/Concentration kill 50%
LDLo/LCLo - Lowest Published Lethal Dose/Concentration
NAERG'96 - North American Emergency Response Guide Book (1996)
NFPA - National Fire Prevention Association
NIOSH - National Institute for Occupational Safety & Health
NPRI - National Pollutant Release Inventory
NSNR - New Substances Notification Regulations (Canada)
NTP - National Toxicology Program
OSHA - Occupational Safety & Health Administration
PEL - Permissible Exposure Limit
RCRA - Resource Conservation and Recovery Act
RTECS - Registry of Toxic Effects of Chemical Substances
SARA - Superfund Amendments and Reorganization Act
SD - Single Dose
STEL - Short Term Exposure Limit (15 minutes)
TDG - Transportation Dangerous Goods (Canada)
TDLo/TCLo - Lowest Published Toxic Dose/Concentration

Directives (Europe)
DSL - Domestic Substance List
EEC/EU - European Economic Community/European Union
EINECS - European Inventory of Existing Commercial Chemical Substances
EPA - Environmental Protection Agency
EPCRA - Emergency Planning and Community Right to Know Act
FDA - Food and Drug Administration
FIFRA - Federal Insecticide, Fungicide and Rodenticide Act
HCS - Hazard Communication Standard
HMIS - Hazardous Material Information System
IARC - International Agency for Research on Cancer
TLm - Median Tolerance Limit
TLV-TWA - Threshold Limit Value-Time Weighted Average
TSCA - Toxic Substances Control Act
USEPA - United States Environmental Protection Agency
USP - United States Pharmacopoeia
WHMIS - Workplace Hazardous Material Information System

For Copy of MSDS

The Canadian Controlled Products Regulations (CPR) (Under the Hazardous Products Act, part of the WHMIS legislation) only apply to WHMIS Controlled (i.e., hazardous) products. Therefore, the CPR and the 3-year update rule specified therein do not apply to WHMIS Non-Controlled products. Although this is true, customarily Petro-Canada reviews and updates Non-Controlled product MSDS if a customer requests such an update. These Non-Controlled product updates are given a lower priority than Controlled products but are handled as soon as practicable. If you would like to verify if the MSDS you have is the most current, or you require any further information, please contact:

Internet: www.petro-canada.ca/msds

Lubricants:
Western Canada, telephone: 1-800-661-1199; fax: (780) 464-9564
Ontario & Central Canada, telephone: 1-800-268-5850 and (905) 822-4222; fax: 1-800-201-6285
Quebec & Eastern Canada, telephone: 1-800-576-1686; fax: 800-201-6285

For Product Safety Information: (905) 804-4752

Prepared by Product Safety - JDW on 10/23/2003.

Data entry by Product Safety - RS.

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	**Not controlled**		

Section 1. Chemical Product and Company Identification

Product Name	**DRILL ROD HEAVY GREASE**	**Code**	650-265, DRODH
		DSL	See Section 15
Synonym	Not available	**TSCA**	See Section 15
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3	**In case of Emergency**	Petro-Canada: 403-296-3000 Canutec Transportation: 613-996-6666 Poison Control Centre: Consult local telephone directory for emergency number(s).
Material Uses	This product is recommended for the lubrication of diamond drill rods.		

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (W/W)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
Mixture of severely hydrotreated and hydrocracked and/or solvent-refined base oil (petroleum) and other proprietary, non-hazardous additives.	Mixture	100	5 mg/m³ (oil mist)	10 mg/m³ (oil mist)	Not established

Section 3. Hazards Identification.

Potential Health Effects	Prolonged or repeated contact may cause skin irritation, defatting, drying and dermatitis. Not expected to cause more than slight skin or eye irritation. With its relatively low vapour pressure, this product is not expected be inhaled in any appreciable quantity at ambient conditions. If heated to high temperatures or subjected to mechanical actions which produce vapours or mists, inhalation may cause respiratory tract irritation. Ingestion may produce a laxative effect. For more information refer to Section 11 of this MSDS.

Section 4. First Aid Measures

Eye Contact	No effects expected. If irritation does occur, flush contaminated eye(s) with lukewarm, gently flowing water for 5 minutes or until the chemical is removed. If irritation persists, obtain medical advice.
Skin Contact	Quickly and gently, blot or brush away excess chemical.Wash gently and thoroughly with water and non-abrasive soap for 5 minutes or until chemical is removed. Remove contaminated clothing, shoes and leather goods (e.g., watchbands, belts, etc.). If irritation persists, repeat flushing. Obtain medical advice immediately. Completely decontaminate clothing, shoes and leather goods before reuse or discard.
Inhalation	Remove source of contamination or move victim to fresh air.If irritation persists, obtain medical advice.
Ingestion	NEVER give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing. DO NOT INDUCE VOMITING. Have victim drink 240 to 300 mL (8 to 10 oz) of water to dilute material in stomach. If vomiting occurs naturally, rinse mouth and repeat administration of water.Obtain medical attention.
Note to Physician	Not available

Section 5. Fire-fighting Measures

Flammability	May be combustible at high temperature.	**Flammable Limits**	Not available
Flash Points	Mineral Oil Blend: OPEN CUP: 252°C (485.6°F). (Cleveland).	**Auto-Ignition Temperature**	Not available
Fire Hazards in Presence of Various Substances	Low fire hazard. This material must be heated before ignition will occur.	**Explosion Hazards in Presence of Various Substances**	Containers may explode in heat of fire. Do not cut, weld, heat, drill or pressurize empty container.
Products of Combustion	Carbon oxides (CO, CO2), smoke and irritating vapours as products of incomplete combustion.		

Continued on Next Page

Fire Fighting Media and Instructions	NAERG2004, GUIDE 171, Substances (low to moderate hazard). If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (0.5 mile) in all directions; also, consider initial evacuation for 800 meters (0.5 mile) in all directions. Shut off fuel to fire if it is possible to do so without hazard. If this is impossible, withdraw from area and let fire burn out under controlled conditions. Withdraw immediately in case of rising sound from venting safety device or any discolouration of tank due to fire. Cool containing vessels with water spray in order to prevent pressure build-up, autoignition or explosion. SMALL FIRE: use DRY chemicals, foam, water spray or CO2. LARGE FIRE: use water spray, fog or foam. For small outdoor fires, portable fire extinguishers may be used, and self contained breathing apparatus (SCBA) may not be required. For all indoor fires and any significant outdoor fires, SCBA is required. Respiratory and eye protection are required for fire fighting personnel.

Section 6. Accidental Release Measures

Material Release or Spill	Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary. Extinguish all ignition sources. Stop leak if safe to do so. Dike spilled material. Use appropriate inert absorbent material to absorb spilled product. Collect used absorbent for later disposal. Avoid contact with spilled material. Avoid contaminating sewers, streams, rivers and other water courses with spilled material. Notify appropriate authorities immediately.

Section 7. Handling and Storage

Handling	Avoid contact with any sources of ignition, flames, heat, and sparks. Avoid skin contact. Avoid eye contact. Avoid inhalation of product vapours or mists. Empty containers may contain product residue. Do not pressurize, cut, heat, or weld empty containers. Do not reuse containers without commercial cleaning and/or reconditioning. Personnel who handle this material should practice good personal hygiene during and after handling to help prevent accidental ingestion of this product. Properly dispose of contaminated leather articles including shoes that cannot be decontaminated.
Storage	Store away from incompatible and reactive materials (See section 5 and 10). Keep container tightly closed. Store in dry, cool, well-ventilated area.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.
Personal Protection -	***The selection of personal protective equipment varies, depending upon conditions of use.***
Eyes	As a minimum, safety glasses with side shields should be worn when handling this material.
Body	If this material may come in contact with the body during handling and use, we recommend wearing appropriate protective clothing to prevent contact with the skin. (Contact your PPE provider for more information.)
Respiratory	A minimum of NIOSH-approved air-purifying respirator with an organic vapour cartridge or canister with a dust, fume of mist filter (R, or P series) may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air-purifying respirators is limited. A NIOSH-approved positive-pressure, air-supplied respirator or self-contained breathing apparatus may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits.
Hands	If this material may come in contact with the hands during handling and use, we recommend wearing gloves of the following material(s): Neoprene, Nitrile, Polyvinyl alcohol (PVA), Fluoro-elastomer. Consult your PPE provider for breakthrough times and the specific glove that is best for you based on your use patterns.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.
Exposure Limits	This product is not expected to form a mist based on its properties and expected use.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Paste of long fibred texture.	**Viscosity**	Mineral Oil Blend: 155.5 cSt @ 40°C (104ºF), 14.42 cSt @ 100°C (212ºF), VI=89
Colour	Dark greenish-brown	**Pour Point**	Mineral Oil Blend: -15ºC (5ºF)
Odour	Mild grease like.	**Softening Point**	Not available
Odour Threshold	Not available	**Dropping Point**	201°C (394ºF)
Boiling Point	Not available	**Penetration**	234 (60 strokes)
Specific Gravity	Mineral Oil Blend: 0.8898 kg/L @ 15°C (59°F).	**Oil / Water Dist. Coeff.**	Not available
Vapor Density	Not available	**Ionicity (in water)**	Not available
Vapor Pressure	Negligible at ambient temperature and pressure.	**Dispersion Properties**	Not available
Volatility	Non-volatile.	**Solubility**	Insoluble in water.

Continued on Next Page

Section 10. Stability and Reactivity

Corrosivity	Not corrosive to copper.		
Stability	The product is stable under normal handling and storage conditions.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Reactive with oxidizing agents, acids and alkalis.	**Decomposition Products**	May release COx, NOx, SOx, diphenylamine, alkenes, smoke and irritating vapours when heated to decomposition.

Section 11. Toxicological Information

Routes of Entry	Skin contact, eye contact, inhalation and ingestion.
Acute Lethality	Acute toxicity information is not available for the product as a whole, therefore, data for the base oils are provided below: Acute Oral toxicity (LD50): >5000 mg/kg (rat) Acute Dermal toxicity (LD50): >2000 mg/kg (rabbit)
Chronic or Other Toxic Effects	
Dermal Route:	Prolonged or repeated contact may defat and dry skin, and cause dermatitis. Short-term exposure is expected to cause only slight irritation, if any.
Inhalation Route:	With its relatively low vapour pressure, this product is not expected be inhaled in any appreciable quantity at ambient conditions. If heated to high temperatures or subjected to mechanical actions which produce vapours or mists, inhalation may cause respiratory tract irritation.
Oral Route:	Ingestion of this product may lead to aspiration of the liquid, especially if vomiting occurs. This may result in chemical pneumonitis (inflammation of the lungs) and/or pulmonary edema (an accumulation of fluid in the lungs). May produce a laxative effect.
Eye Irritation/Inflammation:	Short-term exposure is expected to cause only slight irritation, if any.
Immunotoxicity:	Not available
Skin Sensitization:	Contact with this product is not expected to cause skin sensitization, based upon the available data and the known hazards of the components.
Respiratory Tract Sensitization:	Contact with this product is not expected to cause respiratory tract sensitization, based upon the available data and the known hazards of the components.
Mutagenic:	This product is not known to contain any components at >= 0.1% that have been shown to cause mutagenicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a mutagen.
Reproductive Toxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause reproductive toxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a reproductive toxin.
Teratogenicity/Embryotoxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause teratogenicity and/or embryotoxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a teratogen/embryotoxin.
Carcinogenicity (ACGIH):	This product is not known to contain any chemicals at reportable quantities that are listed as Group A1 or A2 carcinogens by ACGIH.
Carcinogenicity (IARC):	This product is not known to contain any chemicals at reportable quantities that are listed as Group 1, 2A, or 2B carcinogens by IARC.
Carcinogenicity (NTP):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by NTP.
Carcinogenicity (IRIS):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by IRIS.
Carcinogenicity (OSHA):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by OSHA.
Other Considerations	No additional remark.

Section 12. Ecological Information

Environmental Fate	Not available.	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available	**Products of Biodegradation**	Not available
Additional Remarks	No additional remark.		

Section 13. Disposal Considerations

Waste Disposal Spent/ used/ waste product may meet the requirements of a hazardous waste. Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 14. Transport Information

TDG Classification	Not controlled under TDG (Canada).	**Special Provisions for Transport**	Not applicable.

Section 15. Regulatory Information

Other Regulations This product is acceptable for use under the provisions of WHMIS-CPR. All components of this formulation are listed on the CEPA-DSL (Domestic Substances List).

All components of this formulation are listed on the US EPA-TSCA Inventory.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

Please contact Product Safety for more information.

DSD/DPD (Europe) Not evaluated.

DSD/DPD (Europe) (Pictograms) NOT EVALUATED FOR EUROPEAN TRANSPORT

NON ÉVALUÉ POUR LE TRANSPORT EUROPÉEN.

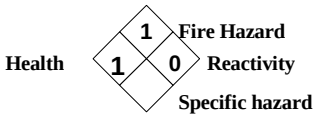
DOT (U.S.A) (Pictograms)



HMIS (U.S.A.)

Health Hazard	1
Fire Hazard	1
Reactivity	0
Personal Protection	B

NFPA (U.S.A.)



Section 16. Other Information

References Available upon request.
* Marque de commerce de Petro-Canada - Trademark

Glossary

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous goods by Road (Europe)
ASTM - American Society for Testing and Materials
BOD5 - Biological Oxygen Demand in 5 days
CAS - Chemical Abstract Services
CEPA - Canadian Environmental Protection Act
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CFR - Code of Federal Regulations
CHIP - Chemical Hazard Information and Packaging Approved Supply List
COD - Chemical Oxygen Demand
CPR - Controlled Products Regulations
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DSD/DPD - Dangerous Substance or Dangerous Preparations Directives (Europe)
DSL - Domestic Substance List (Canada)
EEC/EU - European Economic Community/European Union
EINECS - European Inventory of Existing Commercial Chemical Substances
EPCRA - Emergency Planning And Community Right-To-Know Act
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FIFRA - Federal Insecticide, Fungicide, and Rodenticide Act
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HMIS - Hazardous Material Information System
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LD50/LC50 - Lethal Dose/Concentration kill 50%
LDLo/LCLo - Lowest Published Lethal Dose/Concentration
NFPA - National Fire Prevention Association
NIOSH - National Institute for Occupational Safety & Health
NPRI - National Pollutant Release Inventory
NSNR - New Substances Notification Regulations (Canada)
NTP - National Toxicology Program
OSHA - Occupational Safety & Health Administration
PEL - Permissible Exposure Limit
RCRA - Resource Conservation and Recovery Act
SARA - Superfund Amendments and Reorganization Act
STEL - Short Term Exposure Limit (15 minutes)
TDG - Transportation Dangerous Goods (Canada)
TDLo/TCLo - Lowest Published Toxic Dose/Concentration
TLV-TWA - Threshold Limit Value-Time Weighted Average
TLm - Median Tolerance Limit
TSCA - Toxic Substances Control Act
USEPA - United States Environmental Protection Agency
USP - United States Pharmacopoeia
WHMIS - Workplace Hazardous Material Information System

Information Contact

Lubricants:
Western Canada, telephone: 1-800-661-1199; fax: (780) 464-9564
Ontario & Central Canada, telephone: 1-800-268-5850 and (905) 822-4222; fax: 1-800-201-6285
Quebec & Eastern Canada, telephone: 1-800-576-1686; fax: 1-800-201-6285

Prepared by Product Safety - JDW on 2/26/2005.

Data entry by Product Safety - JDW.

For Product Safety Information: (905) 804-4752	

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

PETRO-CANADA

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	**B-3, D-2B**		

Section 1. Chemical Product and Company Identification

Product Name	**DIESEL FUEL**	**Code**	W104, W293 SAP: 120, 121, 122, 287
		Validated on	**8/17/2005.**
Synonym	Diesel 50, Diesel 50 LS, #1 Diesel , #1 Diesel LS, Diesel LC, Seasonal Diesel, Seasonal Diesel LS, Diesel AA, Domestic Marine Diesel, International marine Diesel, Seasonal Diesel Locomotive, Domestic Marine diesel LS, diesel -20°C (LS), LSD, Low Sulphur Diesel, dyed diesel, marked diesel, coloured diesel, Naval Distillate, Ultra Low Sulphur Diesel, ULS Diesel, Mining Diesel, Mining Diesel Special, Mining Diesel Special LS, High Flash Mining Diesel, Furnace Oil, Stove Oil.		
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3	**In case of Emergency**	Petro-Canada: 403-296-3000 Canutec Transportation: 613-996-6666 Poison Control Centre: Consult local telephone directory for emergency number(s).
Material Uses	Diesel fuels are distillate fuels suitable for use in high and medium speed internal combustion engines of the compression ignition type. Mining Diesel has a higher flash point requirement, for safe use in underground mines.		

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (V/V)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
Diesel oil.	68334-30-5	>99.9	100 mg/m³ (as total hydrocarbons) *	Not established	Not established
Proprietary additives.	Not available	<0.1	Not established	Not established	Not established
Aromatic content is 50% maximum (benzene: nil). Sulphur content is 0-0.50%.					

Manufacturer Recommendation	* Avoid prolonged or repeated skin contact to diesel fuels which can lead to dermal irritation and may be associated with an increased risk of skin cancer.
Other Exposure Limits	Consult local, state, provincial or territory authorities for acceptable exposure limits.

Section 3. Hazards Identification.

Potential Health Effects	Combustible liquid. Exercise caution when handling this material. Contact with this product may cause skin and eye irritation. Prolonged or repeated contact may cause skin irritation, defatting, drying and dermatitis. Inhalation of this product may cause respiratory tract irritation and Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death. Ingestion of this product may cause gastro-intestinal irritation. Aspiration of this product may result in severe irritation or burns to the respiratory tract. For more information refer to Section 11 of this MSDS.

Section 4. First Aid Measures

Eye Contact	Avoid direct contact. Quickly and gently blot or brush away chemical. Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for 15 minutes or until the chemical is removed, while holding the eyelid(s) open. Take care not to rinse contaminated water into the unaffected eye or onto the face. Obtain medical attention immediately.
Skin Contact	Avoid direct contact. Wear chemical resistant protective clothing if necessary. Quickly and gently, blot or brush away excess chemical. Wash gently and thoroughly with warm water and non-abrasive soap for 15 minutes or until chemical is removed. Under running water, remove contaminated clothing, shoes and leather goods (e.g., watch bands, belts, etc.). Obtain medical attention immediately. Completely decontaminate clothing, shoes and leather goods before reuse or discard.
Inhalation	Take proper precautions to ensure your own safety before attempting rescue (e.g. wear appropriate protective equipment). If breathing has stopped, trained personnel should begin artificial respiration (AR) or, if the heart has stopped, cardiopulmonary resuscitation (CPR) immediately. Immediately transport victim to an emergency care facility.

Continued on Next Page

Ingestion	NEVER give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing. Have victim rinse mouth thoroughly with water. DO NOT INDUCE VOMITING. Have victim drink 240 to 300 mL (8 to 10 oz) of water to dilute material in stomach. If vomiting occurs naturally, have victim lean forward to reduce risk of aspiration. Repeat administration of water. If breathing has stopped, trained personnel should begin artificial respiration (AR) or, if the heart has stopped, cardiopulmonary resuscitation (CPR) immediately. Quickly transport victim to an emergency care facility.
Note to Physician	Not available

Section 5. Fire-fighting Measures

Flammability	Class II - combustible liquid (NFPA).	**Flammable Limits**	LOWER: 0.7%, UPPER: 6% (NFPA)
Flash Points	Diesel Fuel: Closed Cup: >40ºC (>104ºF) Marine Diesel Fuel: Closed Cup: >60ºC (>140ºF) Mining Diesel: Closed Cup: 52ºC (126ºF)	**Auto-Ignition Temperature**	225ºC (437ºF)
Fire Hazards in Presence of Various Substances	Flammable in presence of open flames, sparks, or heat. Vapours are heavier than air and may travel considerable distance to sources of ignition and flash back. This product can accumulate static charge and ignite. May accumulate in confined spaces.	**Explosion Hazards in Presence of Various Substances**	Containers may explode in heat of fire. Do not cut, weld, heat, drill or pressurize empty container. Vapour explosion hazard indoors, outdoors or in sewers. Runoff to sewer may create fire or explosion hazard.
Products of Combustion	Carbon oxides (CO, CO2), nitrogen oxides (NOx), sulphur oxides (SOx), sulphur compounds (H2S), water vapour (H2O), smoke and irritating vapours as products of incomplete combustion. See Section 11 (Other Considerations) for information regarding the toxicity of the combustion products.		
Fire Fighting Media and Instructions	NAERG96, GUIDE 128, Flammable liquids (Non-polar/Water-immiscible). CAUTION: This product has a moderate flash point above 40ºC: Use of water spray when fighting fire may be inefficient. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also consider initial evacuation for 800 meters (1/2 mile) in all directions. SMALL FIRES: Dry chemical, CO2, water spray or regular foam. LARGE FIRES: Water spray, fog or regular foam. Do not use straight streams. Move containers from fire area if you can do it without risk. Fires Involving Tanks or Car/Trailer Loads: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting devices or any discolouration of tank. ALWAYS stay away from the ends of tanks. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible withdraw from area and let fire burn. Wear positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing will only provide limited protection.		

Section 6. Accidental Release Measures

Material Release or Spill	Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary. IN THE EVENT OF A LARGE SPILL CONSIDER THE FOLLOWING CONTROL MEASURES: Extinguish all ignition sources. Stop leak if safe to do so. Ventilate area. Dike spilled material. Use appropriate inert absorbent material to absorb spilled product. Collect used absorbent for later disposal. Avoid contact with spilled material. Avoid breathing vapours or mists of material. Avoid contaminating sewers, streams, rivers and other water courses with spilled material. Evacuate non-essential personnel. Ensure clean-up personnel wear appropriate personal protective equipment. Ground and bond all equipment used to clean up the spilled material, as it may be a static accumulator. Notify appropriate authorities immediately.

Section 7. Handling and Storage

Handling	COMBUSTIBLE MATERIAL. Handle with care. Avoid contact with any sources of ignition, flames, heat, and sparks. Avoid skin contact. Avoid eye contact. Avoid inhalation of product vapours or mists. Empty containers may contain product residue. Do not pressurize, cut, heat, or weld empty containers. Do not reuse containers without commercial cleaning and/or reconditioning. Personnel who handle this material should practice good personal hygiene during and after handling to help prevent accidental ingestion of this product. Properly dispose of contaminated leather articles including shoes that cannot be decontaminated. Avoid confined spaces and areas with poor ventilation. Ensure all equipment is grounded/bonded. Wear proper personal protective equipment (See Section 8).
Storage	Store away from heat and sources of ignition. Store in dry, cool, well-ventilated area. Store away from incompatible and reactive materials (See section 5 and 10). Ensure the storage containers are grounded/bonded.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.
Personal Protection - ***The selection of personal protective equipment varies, depending upon conditions of use.***	
Eyes	As a minimum, safety glasses with side shields should be worn when handling this material. If product is used in an application where splashing may occur, the use of safety goggles and/or a face shield should be considered.
Body	If this material may come in contact with the body during handling and use, we recommend wearing appropriate protective clothing to prevent contact with the skin. (Contact your PPE provider for more information.)
Respiratory	A NIOSH-approved air-purifying respirator with an organic vapour cartridge or canister may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air-purifying respirators is limited. Use a positive-pressure, air-supplied respirator if there is any potential for uncontrolled release, exposure levels are unknown, or any other circumstances where air-purifying respirators may not provide adequate protection.
Hands	If this material may come in contact with the hands during handling and use, we recommend wearing gloves of the following material(s): nitrile, neoprene, polyvinyl alcohol (PVA), fluoro-elastomer. Consult your PPE provider for breakthrough times and the specific glove that is best for you based on your use patterns. It should be realized that eventually any material regardless of their imperviousness, will get permeated by chemicals. Therefore, protective gloves should be regularly checked for wear and tear. At the first signs of hardening and cracks, they should be changed.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Bright oily liquid.	**Viscosity**	1.3 - 4.1 cSt @ 40ºC (104ºF)
Colour	Clear to yellow / brown (may be dyed for taxation purposes).	**Pour Point**	Variable, -50ºC to 0ºC (-58ºF to -32ºF)
Odour	Petroleum oil like.	**Softening Point**	Not applicable.
Odour Threshold	Not available	**Dropping Point**	Not applicable.
Boiling Point	150 - 371ºC (302-700ºF)	**Penetration**	Not applicable.
Density	0.80 - 0.85 kg/L @ 15ºC (59ºF)	**Oil / Water Dist. Coefficient**	Not available
Vapour Density	4.5 (Air = 1)	**Ionicity (in water)**	Not applicable.
Vapour Pressure	Not available	**Dispersion Properties**	Not available
Volatility	Semivolatile to volatile.	**Solubility**	Insoluble in cold water, soluble in non-polar hydrocarbon solvents.

Section 10. Stability and Reactivity

Corrosivity	Not available		
Stability	The product is stable under normal handling and storage conditions.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Reactive with oxidizing agents and acids.	**Decomposition Products**	May release COx, NOx, SOx, H2S, H2O, smoke and irritating vapours when heated to decomposition.

Section 11. Toxicological Information

Routes of Entry	Skin contact, eye contact, inhalation, and ingestion.
Acute Lethality	Acute oral toxicity (LD50): 7500 mg/kg (rat).
Chronic or Other Toxic Effects	
Dermal Route:	This product contains a component (at >= 1%) that can cause skin irritation. Therefore, this product is considered to be a skin irritant. Prolonged or repeated contact may defat and dry skin, and cause dermatitis. (See Other Considerations)
Inhalation Route:	Inhalation of this product may cause respiratory tract irritation. Inhalation of this product may cause Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death.

Continued on Next Page

Oral Route:	Ingestion of this product may cause gastro-intestinal irritation. Aspiration of this product may result in severe irritation or burns to the respiratory tract. Ingestion of this product may cause Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death.
Eye Irritation/Inflammation:	This product contains a component (at >= 1%) that can cause eye irritation. Therefore, this product is considered to be an eye irritant.
Immunotoxicity:	Not available
Skin Sensitization:	Contact with this product is not expected to cause skin sensitization, based upon the available data and the known hazards of the components.
Respiratory Tract Sensitization:	Contact with this product is not expected to cause respiratory tract sensitization, based upon the available data and the known hazards of the components.
Mutagenic:	This product is not known to contain any components at >= 0.1% that have been shown to cause mutagenicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a mutagen.
Reproductive Toxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause reproductive toxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a reproductive toxin.
Teratogenicity/Embryotoxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause teratogenicity and/or embryotoxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a teratogen/embryotoxin.
Carcinogenicity (ACGIH):	ACGIH A3: animal carcinogen. [Diesel oil] (See Other Considerations)
Carcinogenicity (IARC):	This product is not known to contain any chemicals at reportable quantities that are listed as Group 1, 2A, or 2B carcinogens by IARC.
Carcinogenicity (NTP):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by NTP.
Carcinogenicity (IRIS):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by IRIS.
Carcinogenicity (OSHA):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by OSHA.
Other Considerations	Avoid prolonged or repeated skin contact to diesel fuels which can lead to dermal irritation and may be associated with an increased risk of skin cancer. Diesel engine exhaust particulate is probably carcinogenic to humans (IARC Group 2A).

Section 12. Ecological Information

Environmental Fate	Not available	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available	**Products of Biodegradation**	Not available
Additional Remarks	No additional remark.		

Section 13. Disposal Considerations

Waste Disposal	Spent/ used/ waste product may meet the requirements of a hazardous waste. Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 14. Transport Information

TDG Classification	DIESEL FUEL, 3, UN1202, PGIII (CL-TDG)	**Special Provisions for Transport**	See Transportation of Dangerous Goods Regulations.

Section 15. Regulatory Information

Other Regulations	This product is acceptable for use under the provisions of WHMIS-CPR. All components of this formulation are listed on the CEPA-DSL (Domestic Substances List). All components of this formulation are listed on the US EPA-TSCA Inventory. All components of this product are on the European Inventory of Existing Commercial Chemical Substances (EINECS). This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

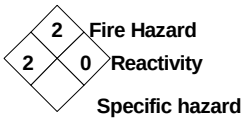
Please contact Product Safety for more information.

DSD/DPD (Europe)	Not evaluated.	**HCS (U.S.A.)**	CLASS: Irritating substance. CLASS: Target organ effects. CLASS: Combustible liquid having a flash point between 37.8°C (100°F) and 93.3°C (200°F).
ADR (Europe) (Pictograms)	**NOT EVALUATED FOR EUROPEAN TRANSPORT** **NON ÉVALUÉ POUR LE TRANSPORT EUROPÉEN.**	**DOT (U.S.A) (Pictograms)**	Not evaluated for transport Non évalué pour le transport

HMIS (U.S.A.)

Health Hazard	2*
Fire Hazard	2
Reactivity	0
Personal Protection	H

NFPA (U.S.A.)



Rating
0 Insignificant
1 Slight
2 Moderate
3 High
4 Extreme

Section 16. Other Information

References Available upon request.
* Marque de commerce de Petro-Canada - Trademark

Glossary

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous goods by Road (Europe)
ASTM - American Society for Testing and Materials
BOD5 - Biological Oxygen Demand in 5 days
CAN/CGA B149.2 Propane Installation Code
CAS - Chemical Abstract Services
CEPA - Canadian Environmental Protection Act
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CFR - Code of Federal Regulations
CHIP - Chemicals Hazard Information and Packaging Approved Supply List
CNS - Central Nervous System
COD5 - Chemical Oxygen Demand in 5 days
CPR - Controlled Products Regulations
DOT - Department of Transport
DSCL - Dangerous Substances Classification and Labeling (Europe)
DSD/DPD - Dangerous Substances or Dangerous Preparations Directives (Europe)
DSL - Domestic Substance List
EEC/EU - European Economic Community/European Union
EINECS - European Inventory of Existing Commercial Chemical Substances
EPA - Environmental Protection Agency
EPCRA - Emergency Planning and Community Right to Know Act
FDA - Food and Drug Administration
FIFRA - Federal Insecticide, Fungicide and Rodenticide Act
HCS - Hazard Communication Standard
HMIS - Hazardous Material Information System
IARC - International Agency for Research on Cancer
IRIS - Integrated Risk Information System
LD50/LC50 - Lethal Dose/Concentration kill 50%
LDLo/LCLo - Lowest Published Lethal Dose/Concentration
NAERG'96 - North American Emergency Response Guide Book (1996)
NFPA - National Fire Prevention Association
NIOSH - National Institute for Occupational Safety & Health
NPRI - National Pollutant Release Inventory
NSNR - New Substances Notification Regulations (Canada)
NTP - National Toxicology Program
OSHA - Occupational Safety & Health Administration
PEL - Permissible Exposure Limit
RCRA - Resource Conservation and Recovery Act
RTECS - Registry of Toxic Effects of Chemical Substances
SARA - Superfund Amendments and Reorganization Act
SD - Single Dose
STEL - Short Term Exposure Limit (15 minutes)
TDG - Transportation Dangerous Goods (Canada)
TDLo/TCLo - Lowest Published Toxic Dose/Concentration
TLm - Median Tolerance Limit
TLV-TWA - Threshold Limit Value-Time Weighted Average
TSCA - Toxic Substances Control Act
USEPA - United States Environmental Protection Agency
USP - United States Pharmacopoeia
WHMIS - Workplace Hazardous Material Information System

For Copy of MSDS
Internet: www.petro-canada.ca/msds

Canada-wide: telephone: 1-800-668-0220; fax: 1-800-837-1228

For Product Safety Information: (905) 804-4752

Prepared by Product Safety - JDW on 8/17/2005.

Data entry by Product Safety - JDW.

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

PETRO-CANADA

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	**Not controlled**		

Section 1. Chemical Product and Company Identification

Product Name	**DEXRON® III/MERCON® AUTOMATIC TRANSMISSION FLUID**	**Code**	460-601, DEXRON
Synonym	Not available	**Validated on**	**11/22/2005.**
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3	**In case of Emergency**	Petro-Canada: 403-296-3000 Canutec Transportation: 613-996-6666 Poison Control Centre: Consult local telephone directory for emergency number(s).
Material Uses	Automatic transmission fluid for most North American automobiles and for off-highway torque converters requiring C-4 type transmission fluid. It is also suitable as a hydraulic fluid and as a top-up in power steering systems. Not to be used in conditions where aerosols could be generated.		

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (V/V)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
Mixture of severely hydrotreated and hydrocracked base oil (petroleum) and other proprietary, non-hazardous additives.	Mixture	100	5 mg/m³ (oil mist)	10 mg/m³ (oil mist)	Not established

Manufacturer Recommendation	Not applicable
Other Exposure Limits	Consult local, state, provincial or territory authorities for acceptable exposure limits.

Section 3. Hazards Identification.

Potential Health Effects	Prolonged or repeated contact may cause skin irritation, defatting, drying and dermatitis. Not expected to cause more than slight skin or eye irritation. With its relatively low vapour pressure, this product is not expected be inhaled in any appreciable quantity at ambient conditions. If heated to high temperatures or subjected to mechanical actions which produce vapours or mists, inhalation may cause respiratory tract irritation. Ingestion may produce a laxative effect. For more information refer to Section 11 of this MSDS.

Section 4. First Aid Measures

Eye Contact	No effects expected. If irritation does occur, flush contaminated eye(s) with lukewarm, gently flowing water for 5 minutes or until the chemical is removed. If irritation persists, obtain medical advice.
Skin Contact	Quickly and gently, blot or brush away excess chemical. Wash gently and thoroughly with water and non-abrasive soap for 5 minutes or until chemical is removed. Remove contaminated clothing, shoes and leather goods (e.g., watchbands, belts, etc.). If irritation persists, repeat flushing. Obtain medical advice immediately. Completely decontaminate clothing, shoes and leather goods before reuse or discard.
Inhalation	Remove source of contamination or move victim to fresh air. If irritation persists, obtain medical advice.
Ingestion	NEVER give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing. DO NOT INDUCE VOMITING. Have victim drink 240 to 300 mL (8 to 10 oz) of water to dilute material in stomach. If vomiting occurs naturally, rinse mouth and repeat administration of water. Obtain medical attention.
Note to Physician	Not available

Section 5. Fire-fighting Measures

Flammability	May be combustible at high temperature.	**Flammable Limits**	Not available
Flash Points	OPEN CUP: ≥180°C (356°F) (Cleveland)	**Auto-Ignition Temperature**	Fire Point: 205°C (401°F)

Fire Hazards in Presence of Various Substances	Low fire hazard. This material must be heated before ignition will occur.	**Explosion Hazards in Presence of Various Substances**	Do not cut, weld, heat, drill or pressurize empty container. Containers may explode in heat of fire.
Products of Combustion	Carbon oxides (CO, CO2), nitrogen oxides (NOx), smoke and irritating vapours as products of incomplete combustion.		
Fire Fighting Media and Instructions	NAERG96, GUIDE 171, Substances (low to moderate hazard). If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (0.5 mile) in all directions; also, consider initial evacuation for 800 meters (0.5 mile) in all directions. Shut off fuel to fire if it is possible to do so without hazard. If this is impossible, withdraw from area and let fire burn out under controlled conditions. Withdraw immediately in case of rising sound from venting safety device or any discolouration of tank due to fire. Cool containing vessels with water spray in order to prevent pressure build-up, autoignition or explosion. SMALL FIRE: use DRY chemicals, foam, water spray or CO2. LARGE FIRE: use water spray, fog or foam. For small outdoor fires, portable fire extinguishers may be used, and self contained breathing apparatus (SCBA) may not be required. For all indoor fires and any significant outdoor fires, SCBA is required. Respiratory and eye protection are required for fire fighting personnel.		

Section 6. Accidental Release Measures

Material Release or Spill	Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary. Extinguish all ignition sources. Stop leak if safe to do so. Dike spilled material. Use appropriate inert absorbent material to absorb spilled product. Collect used absorbent for later disposal. Avoid contact with spilled material. Avoid contaminating sewers, streams, rivers and other water courses with spilled material. Notify appropriate authorities immediately.

Section 7. Handling and Storage

Handling	Avoid contact with any sources of ignition, flames, heat, and sparks. Avoid eye contact. Avoid skin contact. Avoid inhalation of product vapours or mists. Empty containers may contain product residue. Do not pressurize, cut, heat, or weld empty containers. Do not reuse containers without commercial cleaning and/or reconditioning. Personnel who handle this material should practice good personal hygiene during and after handling to help prevent accidental ingestion of this product. Properly dispose of contaminated leather articles including shoes that cannot be decontaminated.
Storage	Store away from incompatible and reactive materials (See section 5 and 10). Keep container tightly closed. Store in dry, cool, well-ventilated area.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.
Personal Protection - ***The selection of personal protective equipment varies, depending upon conditions of use.***	
Eyes	As a minimum, safety glasses with side shields should be worn when handling this material.
Body	If this material may come in contact with the body during handling and use, we recommend wearing appropriate protective clothing to prevent contact with the skin. (Contact your PPE provider for more information.)
Respiratory	A minimum of NIOSH-approved air-purifying respirator with an organic vapour cartridge or canister with a dust, fume of mist filter (R, or P series) may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air-purifying respirators is limited. A NIOSH-approved positive-pressure, air-supplied respirator or self-contained breathing apparatus may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits.
Hands	If this material may come in contact with the hands during handling and use, we recommend wearing gloves of the following material(s): Neoprene, Nitrile, Polyvinyl alcohol (PVA), Fluoro-elastomer. Consult your PPE provider for breakthrough times and the specific glove that is best for you based on your use patterns. It should be realized that eventually any material regardless of their imperviousness, will get permeated by chemicals. Therefore, protective gloves should be regularly checked for wear and tear. At the first signs of hardening and cracks, they should be changed.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Viscous liquid.	**Viscosity**	34.26 cSt @ 40ºC (104ºF), 7.7 cSt @ 100°C (212°F), VI=210.
Colour	Dark red.	**Pour Point**	-51ºC (-59.8ºF).
Odour	Mild petroleum oil like.	**Softening Point**	Not applicable.
Odour Threshold	Not available	**Dropping Point**	Not applicable.
Boiling Point	Not available	**Penetration**	Not applicable.
Density	0.855 kg/L @ 15°C(59ºF) 7.14 lbs/US gal @ 15°C(59ºF)	**Oil / Water Dist. Coefficient**	Not available
Vapour Density	Not available	**Ionicity (in water)**	Not available
Vapour Pressure	Negligible at ambient temperature and pressure.	**Dispersion Properties**	Not available
Volatility	Non-volatile	**Solubility**	Insoluble in water.

Section 10. Stability and Reactivity

Corrosivity	Copper corrosion, 3h, 149°C (ASTM D0130): 1b.		
Stability	The product is stable under normal handling and storage conditions.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Reactive with oxidizing agents, reducing agents and acids.	**Decomposition Products**	May release COx, NOx, metallic oxides, smoke and irritating vapours when heated to decomposition.

Section 11. Toxicological Information

Routes of Entry	Skin contact, eye contact, inhalation, and ingestion.
Acute Lethality	Acute toxicity information is not available for the product as a whole, therefore, data for the base oils are provided below: Acute oral toxicity (LD50): >5000 mg/kg (rat). Acute dermal toxicity (LD50): >2000 mg/kg (rabbit). Acute inhalation toxicity (LC50): >2500 mg/m³/4h (rat).
Chronic or Other Toxic Effects	
Dermal Route:	Prolonged or repeated contact may defat and dry skin, and cause dermatitis. Short-term exposure is expected to cause only slight irritation, if any.
Inhalation Route:	With its relatively low vapour pressure, this product is not expected be inhaled in any appreciable quantity at ambient conditions. If heated to high temperatures or subjected to mechanical actions which produce vapours or mists, inhalation may cause respiratory tract irritation.
Oral Route:	Ingestion of this product may lead to aspiration of the liquid, especially if vomiting occurs. This may result in chemical pneumonitis (inflammation of the lungs) and/or pulmonary edema (an accumulation of fluid in the lungs). May produce a laxative effect.
Eye Irritation/Inflammation:	Short-term exposure is expected to cause only slight irritation, if any.
Immunotoxicity:	Not available
Skin Sensitization:	Contact with this product is not expected to cause skin sensitization, based upon the available data and the known hazards of the components.
Respiratory Tract Sensitization:	Contact with this product is not expected to cause respiratory tract sensitization, based upon the available data and the known hazards of the components.
Mutagenic:	This product is not known to contain any components at >= 0.1% that have been shown to cause mutagenicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a mutagen.
Reproductive Toxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause reproductive toxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a reproductive toxin.
Teratogenicity/Embryotoxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause teratogenicity and/or embryotoxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a teratogen/embryotoxin.
Carcinogenicity (ACGIH):	This product is not known to contain any chemicals at reportable quantities that are listed as Group A1 or A2 carcinogens by ACGIH.
Carcinogenicity (IARC):	This product is not known to contain any chemicals at reportable quantities that are listed as Group 1, 2A, or 2B carcinogens by IARC.

Continued on Next Page

Carcinogenicity (NTP):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by NTP.
Carcinogenicity (IRIS):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by IRIS.
Carcinogenicity (OSHA):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by OSHA.
Other Considerations	No additional remark.

Section 12. Ecological Information

Environmental Fate	Not available	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available	**Products of Biodegradation**	Not available
Additional Remarks	No additional remark.		

Section 13. Disposal Considerations

Waste Disposal	Spent/ used/ waste product may meet the requirements of a hazardous waste. Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 14. Transport Information

TDG Classification	Not a hazardous material for transport according to the TDG Regulations. (Canada)	**Special Provisions for Transport**	Not applicable.

Section 15. Regulatory Information

Other Regulations

This product is acceptable for use under the provisions of WHMIS-CPR. All components of this formulation are listed on the CEPA-DSL (Domestic Substances List).

All components of this formulation are listed on the US EPA-TSCA Inventory.

All components of this product are on the European Inventory of Existing Commercial Chemical Substances (EINECS).

German Water Hazard Classification (Verwaltungsvorschrift wassergefährdende Stoffe - VwVwS) WGK=2

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

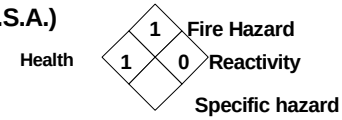
Please contact Product Safety for more information.

DSD/DPD (Europe)	Not classified under the Dangerous Substances or Dangerous Preparations Directives.	**HCS (U.S.A.)**	Does not meet the definitions of a health or physical hazard according to the OSHA - Hazard Communication Standard. (United States)
ADR (Europe) (Pictograms)	NOT EVALUATED FOR EUROPEAN TRANSPORT NON ÉVALUÉ POUR LE TRANSPORT EUROPÉEN.	**DOT (U.S.A) (Pictograms)**	Not evaluated for transport Non évalué pour le transport

HMIS (U.S.A.)

Health Hazard	1
Fire Hazard	1
Reactivity	0
Personal Protection	B

NFPA (U.S.A.)



Rating
0 Insignificant
1 Slight
2 Moderate
3 High
4 Extreme

Section 16. Other Information

References Available upon request.
* Marque de commerce de Petro-Canada - Trademark

Glossary

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous goods by Road (Europe)
ASTM - American Society for Testing and Materials
BOD5 - Biological Oxygen Demand in 5 days
CAN/CGA B149.2 Propane Installation Code
CAS - Chemical Abstract Services
CEPA - Canadian Environmental Protection Act
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CFR - Code of Federal Regulations
CHIP - Chemicals Hazard Information and Packaging Approved Supply List
CNS - Central Nervous System
COD5 - Chemical Oxygen Demand in 5 days
CPR - Controlled Products Regulations
DOT - Department of Transport
DSCL - Dangerous Substances Classification and Labeling (Europe)
DSD/DPD - Dangerous Substances or Dangerous Preparations Directives (Europe)
DSL - Domestic Substance List
EEC/EU - European Economic Community/European Union
EINECS - European Inventory of Existing Commercial Chemical Substances
EPA - Environmental Protection Agency
EPCRA - Emergency Planning and Community Right to Know Act
FDA - Food and Drug Administration
FIFRA - Federal Insecticide, Fungicide and Rodenticide Act
HCS - Hazard Communication Standard
HMIS - Hazardous Material Information System
IARC - International Agency for Research on Cancer
IRIS - Integrated Risk Information System
LD50/LC50 - Lethal Dose/Concentration kill 50%
LDLo/LCLo - Lowest Published Lethal Dose/Concentration
NAERG'96 - North American Emergency Response Guide Book (1996)
NFPA - National Fire Prevention Association
NIOSH - National Institute for Occupational Safety & Health
NPRI - National Pollutant Release Inventory
NSNR - New Substances Notification Regulations (Canada)
NTP - National Toxicology Program
OSHA - Occupational Safety & Health Administration
PEL - Permissible Exposure Limit
RCRA - Resource Conservation and Recovery Act
RTECS - Registry of Toxic Effects of Chemical Substances
SARA - Superfund Amendments and Reorganization Act
SD - Single Dose
STEL - Short Term Exposure Limit (15 minutes)
TDG - Transportation Dangerous Goods (Canada)
TDLo/TCLo - Lowest Published Toxic Dose/Concentration
TLm - Median Tolerance Limit
TLV-TWA - Threshold Limit Value-Time Weighted Average
TSCA - Toxic Substances Control Act
USEPA - United States Environmental Protection Agency
USP - United States Pharmacopoeia
WHMIS - Workplace Hazardous Material Information System

For Copy of MSDS

The Canadian Controlled Products Regulations (CPR) (Under the Hazardous Products Act, part of the WHMIS legislation) only apply to WHMIS Controlled (i.e., hazardous) products. Therefore, the CPR and the 3-year update rule specified therein do not apply to WHMIS Non-Controlled products. Although this is true, customarily Petro-Canada reviews and updates Non-Controlled product MSDS if a customer requests such an update. These Non-Controlled product updates are given a lower priority than Controlled products but are handled as soon as practicable. If you would like to verify if the MSDS you have is the most current, or you require any further information, please contact:

Internet: www.petro-canada.ca/msds

Lubricants:
Western Canada, telephone: 1-800-661-1199; fax: (780) 464-9564
Ontario & Central Canada, telephone: 1-800-268-5850 and (905) 822-4222; fax: 1-800-201-6285
Quebec & Eastern Canada, telephone: 1-800-576-1686; fax: 800-201-6285

For Product Safety Information: (905) 804-4752

Prepared by Product Safety - JDW on 11/22/2005.

Data entry by Product Safety - JDW.

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	Not controlled		

Section 1. Chemical Product and Company Identification

Product Name	**BARIMOL HEAVY GREASE**	**Code**	650-119, BARH
Synonym	Not available.	**DSL**	See Section 15
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3	**TSCA**	See Section 15
Material Uses	This product is a multi-purpose, barium soap based grease with a wide range of automotive and industrial lubricant applications.	**In case of Emergency**	Petro-Canada: 403-296-3000 Canutec Transportation: 613-996-6666 Poison Control Centre: Consult local telephone directory for emergency number(s).

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (W/W)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
1) Mixture of severely hydrotreated and hydrocracked and/or solvent-refined base oil (petroleum) and other proprietary, non-hazardous additives.	Mixture	100	5 mg/m³ (oil mist)	10 mg/m³ (oil mist)	Not established

Section 3. Hazards Identification.

Potential Health Effects	Non irritating to slight transient irritation to skin and eyes, but no permanent damage. Relatively non-toxic via ingestion. This product has a low vapour pressure and is not expected to present an inhalation exposure at ambient conditions. Upon heating to high temperatures, or mechanical actions which may produce vapours or mists, inhalation of product may cause irritation of the breathing passages. For more information, refer to Section 11.

Section 4. First Aid Measures

Eye Contact	IMMEDIATELY flush eyes with running water for at lest 15 minutes, keeping eyelids open. Seek medical attention.
Skin Contact	Remove contaminated clothing - launder before reuse. Wash gently and thoroughly the contaminated skin with running water and non-abrasive soap. High pressure grease gun is capable of injecting grease through the skin. Grease gun injuries require immediate physician assessment. Seek medical attention.
Inhalation	Evacuate the victim to a safe area as soon as possible. If the victim is not breathing, perform artificial respiration. Allow the victim to rest in a well ventilated area. Seek medical attention.
Ingestion	DO NOT induce vomiting because of danger of aspirating liquid into lungs. Seek medical attention.
Note to Physician	Not available

Section 5. Fire-fighting Measures

Flammability	May be combustible at high temperature.	**Flammable Limits**	Not available.
Flash Points	Mineral Oil Blend: OPEN CUP: 230°C (446°F) (Cleveland)	**Auto-Ignition Temperature**	Not available.
Fire Hazards in Presence of Various Substances	Low fire hazard. This material must be heated before ignition will occur.	**Explosion Hazards in Presence of Various Substances**	Do not cut, weld, heat, drill or pressurize empty container. Containers may explode in heat of fire.
Products of Combustion	Carbon oxides (CO, CO2), sulphur oxides (SOx), smoke and irritating vapours as products of incomplete combustion.		
Fire Fighting Media and Instructions	NAERG96, GUIDE 171, Substances (low to moderate hazard). If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (0.5 mile) in all directions; also, consider initial evacuation for 800 meters (0.5 mile) in all directions. DO NOT extinguish a leaking gas flame unless leak can be stopped. Shut off fuel to fire if it is possible to do so without hazard. If this is impossible, withdraw from area and let fire burn out under controlled conditions. Withdraw immediately in case of rising sound from venting safety device or any discolouration of tank due to fire. Cool containing vessels with water spray in order to prevent pressure build-up, autoignition or explosion. SMALL FIRE: use DRY chemicals, foam, or CO2. LARGE FIRE: use water spray, fog or foam. For small outdoor fires, portable fire extinguishers may be used, and self contained breathing apparatus (SCBA) may not be required. For all indoor fires and any significant outdoor fires, SCBA is required. Respiratory and eye protection are required for fire fighting personnel.		

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Section 6. Accidental Release Measures

Material Release or Spill	Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary. Extinguish all ignition sources. Stop leak if safe to do so. Dike spilled material. Use appropriate inert absorbent material to absorb spilled product. Collect used absorbent for later disposal. Avoid contact with spilled material. Avoid contaminating sewers, streams, rivers and other water courses with spilled material. Notify appropriate authorities immediately.

Section 7. Handling and Storage

Handling	Avoid contact with any sources of ignition, flames, heat, and sparks. Avoid skin contact. Avoid eye contact. Avoid inhalation of product vapours or mists. Empty containers may contain product residue. Do not pressurize, cut, heat, or weld empty containers. Do not reuse containers without commercial cleaning and/or reconditioning. Personnel who handle this material should practice good personal hygiene during and after handling to help prevent accidental ingestion of this product. Properly dispose of contaminated leather articles including shoes that cannot be decontaminated.
Storage	Store in dry, cool, well-ventilated area. Keep container tightly closed. Store away from incompatible and reactive materials (See section 5 and 10).

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.
Personal Protection - ***The selection of personal protective equipment varies, depending upon conditions of use.***	
Eyes	Eye protection (i.e., safety glasses, safety goggles and/or face shield) should be determined based on conditions of use. If product is used in an application where splashing may occur, the use of safety goggles and/or a face shield should be considered.
Body	Wear appropriate clothing to prevent skin contact. As a minimum long sleeves and trousers should be worn.
Respiratory	Where concentrations in air may exceed the occupational exposure limits given in Section 2 (and those applicable to your area) and where engineering, work practices or other means of exposure reduction are not adequate, NIOSH approved respirators may be necessary to prevent overexposure by inhalation.
Hands	Wear appropriate chemically protective gloves. When handling hot product ensure gloves are heat resistant and insulated.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.
Exposure Limits	Consult local, state, provincial or territory authorities for acceptable exposure limits. This product is not expected to form a mist based on its properties and expected use.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Paste of long fibred texture.	**Viscosity**	Mineral Oil Blend: 101.36 cSt @ 40°C (104ºF), 10.71 cSt @ 100ºC (212ºF), VI=89
Colour	Dark grey.	**Pour Point**	Mineral Oil Blend: -18°C (0ºF)
Odour	Mild grease like.	**Softening Point**	Not available.
Odour Threshold	Not available.	**Dropping Point**	239ºC (462ºF)
Boiling Point	Not available.	**Penetration**	299 (60 strokes)
Specific Gravity	Mineral Oil Blend: 0.8896 kg/L @ 15°C (59°F)	**Oil / Water Dist. Coeff.**	Not available
Vapor Density	Not available.	**Ionicity (in water)**	Not available
Vapor Pressure	Negligible at ambient temperature and pressure.	**Dispersion Properties**	Not available
Volatility	Non to semivolatile.	**Solubility**	Insoluble in water.

Section 10. Stability and Reactivity

Corrosivity	Not corrosive to copper.		
Stability	The product is stable under normal handling and storage conditions.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Reactive with oxidizing agents, acids, alkalis, metals and peroxides.	**Decomposition Products**	May release COx, NOx, SOx, diphenylamine, alkenes, smoke and irritating vapours when heated to decomposition.

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Section 11. Toxicological Information

Routes of Entry	Skin contact, eye contact, inhalation, ingestion.
Acute Lethality	Based on toxicity of components. Acute oral toxicity (LD50): >5000 mg/kg (rat). Acute dermal toxicity (LD50): >2000 mg/kg (rabbit). Acute inhalation toxicity (LC50): >2500 mg/m³/4h (rat).
Chronic or Other Toxic Effects	
Dermal Route:	Prolonged or repeated contact may cause skin irritation characterized by dermatitis or oil acne.
Inhalation Route:	Negligible breathing hazard at normal temperatures (up to 38°C) or recommended blending temperatures. Elevated temperatures or mechanical action may form vapours, mists or fumes. Inhalation of oil mists or vapours from hot oil may cause irritation of the upper respiratory tract.
Oral Route:	Low toxicity; has laxative effect.
Eye Irritation/Inflammation:	Repeated or prolonged contact may cause transient irritation, but no permanent damage.
Immunotoxicity:	Not available.
Skin Sensitization:	This product is not expected to be a skin sensitizer, based on the available data and the known hazards of the components.
Respiratory Tract Sensitization:	This product is not expected to be a respiratory tract sensitizer, based on the available data and the known hazards of the components.
Mutagenic:	Based on actual test results of base oils and results of similar products, severely hydrotreated base oils give negative results when tested for: (a) Salmonella Typhimurium TA98 using the Modified Ames Assay for Petroleum Product; (b) Salmonella-Escherichia coli/Mammalian-Microsome Reverse Mutation Assay (Ames test) with a Confirmatory Assay; (c) Structural Chromosomal Aberrations in Chinese Hamster Ovary (CHO) Cells.
Reproductive Toxicity:	This product is not expected to be a reproductive hazard, based on the available data and the known hazards of the components.
Teratogenicity/Embryotoxicity:	This product is not expected to be a teratogen or an embryotoxin, based on the available data and the known hazards of the components.
Carcinogenicity (ACGIH):	This product is not known to contain any chemicals at reportable quantities that are listed as A1 or A2 carcinogens by ACGIH.
Carcinogenicity (IARC):	This product is not known to contain any chemicals at reportable quantities that are listed as group 1, 2A or 2B carcinogens by IARC.
Carcinogenicity (NTP):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by NTP.
Carcinogenicity (IRIS):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by IRIS.
Carcinogenicity (OSHA):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by OSHA.
Other Considerations	No additional remark.

Section 12. Ecological Information

Environmental Fate	Not available	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available.	**Products of Biodegradation**	Not available.
Additional Remarks	No additional remark.		

Section 13. Disposal Considerations

Waste Disposal	Spent/ used/ waste product may meet the requirements of a hazardous waste. Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 14. Transport Information

TDG Classification	Not controlled under TDG (Canada).	**Special Provisions for Transport**	Not applicable.

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Section 15. Regulatory Information

Other Regulations

This product is acceptable for use under the provisions of WHMIS-CPR. All components of this formulation are listed on the CEPA-DSL (Domestic Substances List).

All components of this formulation are listed on the US EPA-TSCA Inventory.

All components of this product are on the European Inventory of Existing Commercial Chemical Substances.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

Please contact Product Safety for more information.

DSD/DPD (Europe) Not classified under the Dangerous Substances or Dangerous Preparations Directives.

DSD/DPD (Europe) (Pictograms)



DOT (U.S.A) (Pictograms)



HMIS (U.S.A.)

Health Hazard	1
Fire Hazard	1
Reactivity	0
Personal Protection	B

NFPA (U.S.A.)



Section 16. Other Information

References Available upon request.
* Marque de commerce de Petro-Canada - Trademark

Glossary

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous goods by Road (Europe)
ASTM - American Society for Testing and Materials (
BOD5 - Biological Oxygen Demand in 5 days
CAN/CGA B149.2 Propane Installation Code
CAS - Chemical Abstract Services
CEPA - Canadian Environmental Protection Act
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CFR - Code of Federal Regulations
CHIP - Chemicals Hazard Information and Packaging Approved Supply List
COD5 - Chemical Oxygen Demand in 5 days
CPR - Controlled Products Regulations
DOT - Department of Transport
DSCL - Dangerous Substances Classification and Labeling (Europe)
DSD/DPD - Dangerous Substances or Dangerous Preparations Directives (Europe)
DSL - Domestic Substance List
EEC/EU - European Economic Community/European Union
EINECS - European Inventory of Existing Commercial Chemical Substances
EPCRA - Emergency Planning and Community Right to Know Act
FDA - Food and Drug Administration
FIFRA - Federal Insecticide, Fungicide and Rodenticide Act
HCS - Hazardous Communication System
HMIS - Hazardous Material Information System
IARC - International Agency for Research on Cancer
IRIS - Integrated Risk Information System
LD50/LC50 - Lethal Dose/Concentration kill 50%
LDLo/LCLo - Lowest Published Lethal Dose/Concentration
NAERG'96 - North American Emergency Response Guide Book (1996)
NFPA - National Fire Prevention Association
NIOSH - National Institute for Occupational Safety & Health
NPRI - National Pollutant Release Inventory
NSNR - New Substances Notification Regulations (Canada)
NTP - National Toxicology Program
OSHA - Occupational Safety & Health Administration
PEL - Permissible Exposure Limit
RCRA - Resource Conservation and Recovery Act
SARA - Superfund Amendments and Reorganization Act
SD - Single Dose
STEL - Short Term Exposure Limit (15 minutes)
TDG - Transportation Dangerous Goods (Canada)
TDLo/TCLo - Lowest Published Toxic Dose/Concentration
TLm - Median Tolerance Limit
TLV-TWA - Threshold Limit Value-Time Weighted Average
TSCA - Toxic Substances Control Act
USEPA - United States Environmental Protection Agency
USP - United States Pharmacopoeia
WHMIS - Workplace Hazardous Material Information System

Information Contact **Internet: www.petro-canada.ca**

Lubricants:
Western Canada, telephone: 1-800-661-1199; fax: (780) 464-9564
Ontario & Central Canada, telephone: 1-800-268-5850 and (905) 822-4222; fax: 1-800-201-6285
Quebec & Eastern Canada, telephone: 1-800-576-1686; fax: 800-201-6285

For Product Safety Information: (905) 804-4752

Prepared by Product Safety - JDW on 5/2/2003.

Data entry by Product Safety - JDW.

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

PETRO-CANADA

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	**B-2, D-2B**		

Section 1. Chemical Product and Company Identification

Product Name	**AVIATION GASOLINE 100LL**
Synonym	AVGAS 100LL
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3
Material Uses	This product is used as fuel for internal combustion aircraft engines.

Code 060-100LL, W118

Validated on 5/30/2005.

In case of Emergency Petro-Canada: 403-296-3000
Canutec Transportation: 613-996-6666
Poison Control Centre: Consult local telephone directory for emergency number(s).

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (V/V)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
Complex mixture of aliphatic and aromatic hydrocarbons (C4-C12).	68527-27-5	85-95	Not established	Not established	Not established
Toluene	108-88-3	5-15	50 ppm	Not established	Not established
Contains 0-0.56g/L of lead [from Tetraethyl Lead].					

Manufacturer Recommendation	Not applicable
Other Exposure Limits	Consult local, state, provincial or territory authorities for acceptable exposure limits.

Section 3. Hazards Identification.

Potential Health Effects	Flammable liquid. Exercise caution when handling this material. Contact with this product may cause skin and eye irritation. Inhalation of this product may cause respiratory tract irritation and Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death. Ingestion of this product may cause gastro-intestinal irritation. Aspiration of this product may result in severe irritation or burns to the respiratory tract. For more information refer to Section 11 of this MSDS.

Section 4. First Aid Measures

Eye Contact	Avoid direct contact. Quickly and gently blot or brush away chemical. Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for 20 minutes or until the chemical is removed, while holding the eyelid(s) open. Take care not to rinse contaminated water into the unaffected eye or onto the face. Obtain medical attention immediately.
Skin Contact	Avoid direct contact. Wear chemical resistant protective clothing if necessary. Quickly and gently, blot or brush away excess chemical. Wash gently and thoroughly with warm water and non-abrasive soap for 20 minutes or until chemical is removed. Under running water, remove contaminated clothing, shoes and leather goods (e.g., watch bands, belts, etc.). Obtain medical attention immediately. Completely decontaminate clothing, shoes and leather goods before reuse or discard.
Inhalation	Take proper precautions to ensure your own safety before attempting rescue (e.g. wear appropriate protective equipment). If breathing has stopped, trained personnel should begin artificial respiration (AR) or, if the heart has stopped, cardiopulmonary resuscitation (CPR) immediately. Immediately transport victim to an emergency care facility.
Ingestion	NEVER give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing. Have victim rinse mouth thoroughly with water. DO NOT INDUCE VOMITING. Have victim drink 240 to 300 mL (8 to 10 oz) of water to dilute material in stomach. If vomiting occurs naturally, have victim lean forward to reduce risk of aspiration. Repeat administration of water. If breathing has stopped, trained personnel should begin artificial respiration (AR) or, if the heart has stopped, cardiopulmonary resuscitation (CPR) immediately. Quickly transport victim to an emergency care facility.
Note to Physician	Not available

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Section 5. Fire-fighting Measures

Flammability	Flammable liquid (NFPA).	**Flammable Limits**	LOWER: 1.4%, UPPER: 7.6%
Flash Points	Closed Cup: -50°C (-58°F), Tag, ASTM D56.	**Auto-Ignition Temperature**	257°C (494.6°F)
Fire Hazards in Presence of Various Substances	Easily ignites under almost all normal temperature conditions. Flammable in presence of open flames, sparks, shocks, heat, oxidizing materials. Vapours are heavier than air and may travel considerable distance to sources of ignition and flash back. May accumulate in confined spaces.	**Explosion Hazards in Presence of Various Substances**	Do not cut, weld, heat, drill or pressurize empty container. Containers may explode in heat of fire. Vapours may form explosive mixtures with air. Runoff to sewer may create fire or explosion hazard.
Products of Combustion	Carbon oxides (CO, CO2), reactive hydrocarbons, aldehydes, smoke and irritating vapours as products of incomplete combustion.		
Fire Fighting Media and Instructions	NAERG2004, GUIDE 128, Flammable liquids (Non-polar/Water-immiscible). CAUTION: This product has a very low flash point: Use of water spray when fighting fire may be inefficient. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also consider initial evacuation for 800 meters (1/2 mile) in all directions. SMALL FIRES: Dry chemical, CO2, water spray or regular foam. LARGE FIRES: Water spray, fog or regular foam. Do not use straight streams. Move containers from fire area if you can do it without risk. Fires Involving Tanks or Car/Trailer Loads: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting devices or any discolouration of tank. ALWAYS stay away from the ends of tanks. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible withdraw from area and let fire burn. Wear positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing will only provide limited protection.		

Section 6. Accidental Release Measures

Material Release or Spill	IN THE EVENT OF A LARGE SPILL CONSIDER THE FOLLOWING CONTROL MEASURES: Notify appropriate authorities immediately. Evacuate non-essential personnel. Ensure clean-up personnel wear appropriate personal protective equipment. Extinguish all ignition sources. Ventilate area. Avoid contact with spilled material. Avoid breathing vapours or mists of material. Stop leak if safe to do so. Dike spilled material. Use appropriate inert absorbent material to absorb spilled product. Collect used absorbent for later disposal. Ground and bond all equipment used to clean up the spilled material, as it may be a static accumulator. Do not allow spilled materials to come into to contact with incompatible materials (see Section 10). Avoid contaminating sewers, streams, rivers and other water courses with spilled material. Do not allow spilled material to enter sewer systems as vapours may accumulate and may cause an explosion/fire hazard. Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary.

Section 7. Handling and Storage

Handling	FLAMMABLE MATERIAL. Handle with care. Avoid skin contact. Avoid eye contact. Avoid inhalation of product vapours or mists. Do not ingest this product. Avoid contact with any sources of ignition, flames, heat, and sparks. Avoid contact with any incompatible or reactive materials. Avoid confined spaces and areas with poor ventilation. Ensure all equipment is grounded/bonded. Ensure container is securely closed when not in use. Wear proper personal protective equipment (See Section 8). Exercise caution when washing/drying clothing contaminated with flammable materials. Personnel who handle this material should practice good personal hygiene during and after handling to help prevent accidental ingestion of this product. Empty containers may contain product residue. Do not pressurize, cut, heat, or weld empty containers. Do not reuse containers without commercial cleaning and/or reconditioning.
Storage	Store as flammable material. Store away from heat and sources of ignition. Store away from incompatible and reactive materials (See section 5 and 10). Store in a dry, cool and well-ventilated area.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.
Personal Protection	***- The selection of personal protective equipment varies, depending upon conditions of use.***
Eyes	As a minimum, safety glasses with side shields should be worn when handling this material.
Body	If this material may come in contact with the body during handling and use, we recommend wearing appropriate protective clothing to prevent contact with the skin. (Contact your PPE provider for more information.)
Respiratory	A NIOSH-approved air-purifying respirator with an organic vapour cartridge or canister may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air-purifying respirators is limited. Use a positive-pressure, air-supplied respirator if there is any potential for uncontrolled release, exposure levels are unknown, or any other circumstances where air-purifying respirators may not provide adequate protection.

Hands	If this material may come in contact with the hands during handling and use, we recommend wearing gloves of the following material(s): polyvinyl alcohol (PVA) and fluoro-elastomer. Consult your PPE provider for breakthrough times and the specific glove that is best for you based on your use patterns.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Clear liquid.	**Viscosity**	Not available
Colour	Bright Blue.	**Pour Point**	Not applicable.
Odour	Gasoline.	**Softening Point**	Not applicable.
Odour Threshold	Not available	**Dropping Point**	Not applicable.
Boiling Point	30 to 170°C (86 to 338°F)	**Penetration**	Not applicable.
Density	0.69 kg/L @ 15°C (59°F).	**Oil / Water Dist. Coefficient**	Not measurable. The product is more soluble in oil.
Vapour Density	Heavier than air.	**Ionicity (in water)**	Insoluble in water.
Vapour Pressure	38 kPa @ 20°C (285 mmHg @ 68ºF).	**Dispersion Properties**	Not available
Volatility	Volatile.	**Solubility**	Hydrocarbon components virtually insoluble in water. Soluble in alcohol, ether, chloroform, and benzene. Dissolves fats, oils and natural resins.

Section 10. Stability and Reactivity

Corrosivity	Non corrosive.		
Stability	The product is stable under normal handling and storage conditions.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Can react with strong oxidizing agents, acids, tetranitromethane, uranium hexafluoride and sulfur dichloride.	**Decomposition Products**	May release COx, aldehydes, smoke and irritating vapours when heated to decomposition.

Section 11. Toxicological Information

Routes of Entry	Skin contact, eye contact, inhalation and ingestion.
Acute Lethality	Acute toxicity information is not available for the product as a whole, therefore, data for some of the ingredients is provided below: Toluene (108-88-3): Acute Oral toxicity (LD50): 636 mg/kg (rat) Acute Dermal toxicity (LD50): 12225 mg/kg (rabbit) Acute Inhalation toxicity (LC50): 8800 ppm/4h (rat)

Chronic or Other Toxic Effects

Dermal Route:	This product contains a component (at >= 1%) that can cause skin irritation. Therefore, this product is considered to be a skin irritant. Prolonged or repeated contact may defat and dry skin, and cause dermatitis.
Inhalation Route:	Inhalation of this product may cause respiratory tract irritation. Inhalation of this product may cause Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death.
Oral Route:	Ingestion of this product may cause gastro-intestinal irritation. Aspiration of this product may result in severe irritation or burns to the respiratory tract.
Eye Irritation/Inflammation:	Short-term exposure is expected to cause only slight irritation, if any. This product contains a component (at >= 1%) that can cause eye irritation. Therefore, this product is considered to be an eye irritant.
Immunotoxicity:	Not available
Skin Sensitization:	Contact with this product is not expected to cause skin sensitization, based upon the available data and the known hazards of the components.
Respiratory Tract Sensitization:	Contact with this product is not expected to cause respiratory tract sensitization, based upon the available data and the known hazards of the components.

Mutagenic:	This product is not known to contain any components at >= 0.1% that have been shown to cause mutagenicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a mutagen.
Reproductive Toxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause reproductive toxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a reproductive toxin.
Teratogenicity/Embryotoxicity:	There is a wealth of information about the teratogenic hazards of Toluene in the literature; however, based upon professional judgement regarding the body of evidence, WHMIS classification as a teratogen is not warranted.
Carcinogenicity (ACGIH):	This product is not known to contain any chemicals at reportable quantities that are listed as A1, A2 or A3 carcinogens by ACGIH.
Carcinogenicity (IARC):	This product is not known to contain any chemicals at reportable quantities that are listed as group 1, 2A or 2B carcinogens by IARC.
Carcinogenicity (NTP):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by NTP.
Carcinogenicity (IRIS):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by IRIS.
Carcinogenicity (OSHA):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by OSHA.
Other Considerations	No additional remark.

Section 12. Ecological Information

Environmental Fate	Not available	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available	**Products of Biodegradation**	Not available

Additional Remarks No additional remark.

Section 13. Disposal Considerations

Waste Disposal Spent/ used/ waste product may meet the requirements of a hazardous waste. Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 15. Regulatory Information

Other Regulations This product is acceptable for use under the provisions of WHMIS-CPR. All components of this formulation are listed on the CEPA-DSL (Domestic Substances List).

All components of this formulation are listed on the US EPA-TSCA Inventory.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

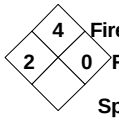
Please contact Product Safety for more information.

DSD/DPD (Europe)	Not evaluated.	**HCS (U.S.A.)**	CLASS: Flammable liquid having a flash point lower than 37.8°C (100°F). CLASS: Irritating substance. CLASS: Target organ effects.
ADR (Europe) (Pictograms)	NOT EVALUATED FOR EUROPEAN TRANSPORT NON ÉVALUÉ POUR LE TRANSPORT EUROPÉEN.	**DOT (U.S.A) (Pictograms)**	Not evaluated for transport Non évalué pour le transport

HMIS (U.S.A.)

Health Hazard	2*
Fire Hazard	4
Reactivity	0
Personal Protection	H

NFPA (U.S.A.)



Rating	
0	Insignificant
1	Slight
2	Moderate
3	High
4	Extreme

Section 16. Other Information

References Available upon request.
* Marque de commerce de Petro-Canada - Trademark

Glossary

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous goods by Road (Europe)
ASTM - American Society for Testing and Materials
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CAN/CGA B149.2 Propane Installation Code
CAS - Chemical Abstract Services
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CNS - Central Nervous System
COD5 - Chemical Oxygen Demand in 5 days
CPR - Controlled Products Regulations
DOT - Department of Transport
DSCL - Dangerous Substances Classification and Labeling (Europe)
DSD/DPD - Dangerous Substances or Dangerous Preparations Directives (Europe)
DSL - Domestic Substance List
EEC/EU - European Economic Community/European Union
EINECS - European Inventory of Existing Commercial Chemical Substances
EPA - Environmental Protection Agency
EPCRA - Emergency Planning and Community Right to Know Act
FDA - Food and Drug Administration
FIFRA - Federal Insecticide, Fungicide and Rodenticide Act
HCS - Hazard Communication Standard
HMIS - Hazardous Material Information System
IARC - International Agency for Research on Cancer
IRIS - Integrated Risk Information System
LD50/LC50 - Lethal Dose/Concentration kill 50%
LDLo/LCLo - Lowest Published Lethal Dose/Concentration
NAERG'96 - North American Emergency Response Guide Book (1996)
NFPA - National Fire Prevention Association
NIOSH - National Institute for Occupational Safety & Health
NPRI - National Pollutant Release Inventory
NSNR - New Substances Notification Regulations (Canada)
NTP - National Toxicology Program
OSHA - Occupational Safety & Health Administration
PEL - Permissible Exposure Limit
RCRA - Resource Conservation and Recovery Act
RTECS - Registry of Toxic Effects of Chemical Substances
SARA - Superfund Amendments and Reorganization Act
SD - Single Dose
STEL - Short Term Exposure Limit (15 minutes)
TDG - Transportation Dangerous Goods (Canada)
TDLo/TCLo - Lowest Published Toxic Dose/Concentration
TLm - Median Tolerance Limit
TLV-TWA - Threshold Limit Value-Time Weighted Average
TSCA - Toxic Substances Control Act
USEPA - United States Environmental Protection Agency
USP - United States Pharmacopoeia
WHMIS - Workplace Hazardous Material Information System

For Copy of MSDS
Internet: www.petro-canada.ca/msds

Canada-wide: telephone: 1-800-668-0220; fax: 1-800-837-1228

For Product Safety Information: (905) 804-4752

Prepared by Product Safety - JDW on 5/30/2005.

Data entry by Product Safety - JDW.

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	**D-2A, D-2B**		

Section 1. Chemical Product and Company Identification

Product Name	**PETRO-CANADA ANTIFREEZE**	**Code**	W269
		Validated on	**5/11/2005.**
Synonym	Universal Antifreeze, Radiator Antifreeze, Diesel Antifreeze, Petro-Canada Antifreeze-Coolant, Petro-Canada Heavy Duty Antifreeze-Coolant, Pre-Mix Antifreeze, Petro-Canada Premium Radiator Antifreeze, Diesel Engine Coolant, Pre-Mixed Radiator Antifreeze/Coolant Petro-Canada.		
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3	**In case of Emergency**	Petro-Canada: 403-296-3000 Canutec Transportation: 613-996-6666 Poison Control Centre: Consult local telephone directory for emergency number(s).
Material Uses	Used as an engine antifreeze coolant.		

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (W/W)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
Ethylene glycol	107-21-1	≥45	Not established	Not established	100 mg/m³ (aerosol)
Sodium tetraborate pentahydrate (Diesel Engine Coolant only)	12179-04-3	≤5	1 mg/m³	Not established	Not established

Manufacturer Recommendation	Not applicable
Other Exposure Limits	Consult local, state, provincial or territory authorities for acceptable exposure limits.

Section 3. Hazards Identification.

Potential Health Effects	Contact with this product may cause eye irritation. Not expected to cause more than slight skin irritation. Inhalation of this product may cause respiratory tract irritation. Ingestion may be extremely hazardous.May cause teratogenicity/embryotoxicity. May cause damage to reproductive organs. For more information refer to Section 11 of this MSDS.

Section 4. First Aid Measures

Eye Contact	IMMEDIATELY flush eyes with running water for at least 15 minutes, keeping eyelids open. Seek medical attention.
Skin Contact	Remove contaminated clothing - launder before reuse. Wash gently and thoroughly the contaminated skin with running water and non-abrasive soap. Seek medical attention.
Inhalation	Evacuate the victim to a safe area as soon as possible. If the victim is not breathing, perform artificial respiration. Allow the victim to rest in a well ventilated area. Seek medical attention.
Ingestion	DO NOT induce vomiting because of danger of aspirating liquid into lungs. Seek medical attention.
Note to Physician	Not available

Section 5. Fire-fighting Measures

Flammability	May be combustible at high temperature.	**Flammable Limits**	Lower: 3.2%, Upper: 15.3%
Flash Points	Closed Cup: 116ºC (241ºF) (Tagliabue) Open Cup: 116ºC (241ºF) (Cleveland)	**Auto-Ignition Temperature**	413ºC (775ºF)
Fire Hazards in Presence of Various Substances	Low fire hazard. This material must be heated before ignition will occur.	**Explosion Hazards in Presence of Various Substances**	Do not cut, weld, heat, drill or pressurize empty container.

Continued on Next Page

Products of Combustion	Carbon oxides (CO, CO2), smoke and irritating vapours as products of incomplete combustion.
Fire Fighting Media and Instructions	NAERG2004, GUIDE 171, Substances (low to moderate hazard). If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (0.5 mile) in all directions; also, consider initial evacuation for 800 meters (0.5 mile) in all directions. Shut off fuel to fire if it is possible to do so without hazard. If this is impossible, withdraw from area and let fire burn out under controlled conditions. Withdraw immediately in case of rising sound from venting safety device or any discolouration of tank due to fire. Cool containing vessels with water spray in order to prevent pressure build-up, autoignition or explosion. SMALL FIRE: use DRY chemicals, foam, water spray or CO2. LARGE FIRE: use water spray, fog or foam. For small outdoor fires, portable fire extinguishers may be used, and self contained breathing apparatus (SCBA) may not be required. For all indoor fires and any significant outdoor fires, SCBA is required. Respiratory and eye protection are required for fire fighting personnel.

Section 6. Accidental Release Measures

Material Release or Spill	IN THE EVENT OF A LARGE SPILL CONSIDER THE FOLLOWING CONTROL MEASURES: Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary. Extinguish all ignition sources. Stop leak if safe to do so. Dike spilled material. Use appropriate inert absorbent material to absorb spilled product. Collect used absorbent for later disposal. Ventilate area. Ensure clean-up personnel wear appropriate personal protective equipment. Avoid breathing vapours or mists of material. Avoid contact with spilled material. Avoid contaminating sewers, streams, rivers and other water courses with spilled material. Notify appropriate authorities immediately.

Section 7. Handling and Storage

Handling	Avoid contact with any sources of ignition, flames, heat, and sparks. Avoid confined spaces and areas with poor ventilation. Avoid skin contact. Avoid eye contact. Avoid inhalation of product vapours or mists. Do not ingest this product. Wear proper personal protective equipment (See Section 8). Empty containers may contain product residue. Do not pressurize, cut, heat, or weld empty containers. Do not reuse containers without commercial cleaning and/or reconditioning. Personnel who handle this material should practice good personal hygiene during and after handling to help prevent accidental ingestion of this product. Properly dispose of contaminated leather articles including shoes that cannot be decontaminated.
Storage	Store in dry, cool, well-ventilated area. Store away from heat and sources of ignition. Keep container tightly closed. Store away from incompatible and reactive materials (See section 5 and 10).

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.
Personal Protection - ***The selection of personal protective equipment varies, depending upon conditions of use.***	
Eyes	Chemical splash goggles should be worn when handling this material.
Body	If this material may come into contact with the body during handling and use, we recommend wearing appropriate protective clothing to prevent contact with the skin. (Contact your PPE provider for more information).
Respiratory	A minimum of NIOSH-approved air-purifying respirator with a organic vapour cartridge or canister may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air-purifying respirators is limited. Use a positive-pressure, air-supplied respirator if there is any potential for uncontrolled release, exposure levels are unknown, or any other circumstances where air-purifying respirators may not provide adequate protection.
Hands	If this material may come in contact with the hands during handling and use, we recommend wearing gloves of the following material(s): Neoprene, Polyvinyl chloride (PVC). Consult your PPE provider for breakthrough times and the specific glove that is best for you based on your use patterns.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Clear viscous liquid.	**Viscosity**	Not available
Colour	Green.	**Pour Point**	Not available
Odour	Odourless.	**Softening Point**	Not applicable.
Odour Threshold	Not available	**Dropping Point**	Not applicable.
Boiling Point	129 to 197°C (264 to 387°F)	**Penetration**	Not applicable.
Density	1.07 to 1.145 (Water = 1)	**Oil / Water Dist. Coefficient**	Not available

Vapour Density	2.1 (Air=1).	**Ionicity (in water)**	Not available
Vapour Pressure	0.06 mmHg @ 20°C (68ºF).	**Dispersion Properties**	Not available
Volatility	0% (w/w)	**Solubility**	Soluble in water, methanol and diethyl ether.

Section 10. Stability and Reactivity

Corrosivity	Not available		
Stability	The product is stable.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Reactive with oxidizing agents, acids, alkalis, perchloric acid, phosphorus and silvered copper wires carrying DC current.	**Decomposition Products**	May release COx, acrid smoke and irritating vapours when heated to decomposition.

Section 11. Toxicological Information

Routes of Entry	Skin contact, eye contact, inhalation and ingestion.
Acute Lethality	Ethylene glycol (107-21-1): LD50: 4700 mg/kg (oral/rat). LD50: 9530 mg/kg (dermal/rabbit). Sodium tetraborate pentahydrate (12179-04-3): LD50: 3200-3500 mg/kg (oral/rat) (Boric acid). [Sodium tetraborate pentahydrate]
Chronic or Other Toxic Effects	
Dermal Route:	Short-term exposure is expected to cause only slight irritation, if any.
Inhalation Route:	Inhalation of this product may cause respiratory tract irritation.
Oral Route:	Extremely dangerous in case of ingestion.
Eye Irritation/Inflammation:	This product contains a component (at >= 1%) that can cause eye irritation. Therefore, this product is considered to be an eye irritant.
Immunotoxicity:	Not available
Skin Sensitization:	Contact with this product is not expected to cause skin sensitization, based upon the available data and the known hazards of the components.
Respiratory Tract Sensitization:	Contact with this product is not expected to cause respiratory tract sensitization, based upon the available data and the known hazards of the components.
Mutagenic:	This product is not known to contain any components at >= 0.1% that have been shown to cause mutagenicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a mutagen.
Reproductive Toxicity:	Borates are possible reproductive toxins based upon available animal ingestion studies in several species. These studies usually involved high doses, over prolonged periods of time. A human study following occupational exposure to borate by inhalation concluded that, no adverse effects to reproduction were found in this population, under the conditions of this study.
Teratogenicity/Embryotoxicity:	This product contains a component(s) at >= 0.1% that has been shown to cause teratogenicity and/or embryotoxicity in laboratory tests. Therefore, this product is considered to be a teratogen/embryotoxin (Ethylene glycol).
Carcinogenicity (ACGIH):	ACGIH A4: not classifiable as a human carcinogen (Ethylene glycol). This product is not known to contain any chemicals at reportable quantities that are listed as Group A1, A2, or A3 carcinogens by ACGIH.
Carcinogenicity (IARC):	This product is not known to contain any chemicals at reportable quantities that are listed as Group 1, 2A, or 2B carcinogens by IARC.
Carcinogenicity (NTP):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by NTP.
Carcinogenicity (IRIS):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by IRIS.
Carcinogenicity (OSHA):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by OSHA.
Other Considerations	The substance may be toxic to kidneys and liver. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 12. Ecological Information

Environmental Fate	Not available	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available	**Products of Biodegradation**	Not available
Additional Remarks	No additional remark.		

Section 13. Disposal Considerations

Waste Disposal Spent/ used/ waste product may meet the requirements of a hazardous waste. Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 14. Transport Information

TDG Classification	Not a hazardous material for transport according to the TDG Regulations. (Canada)	**Special Provisions for Transport**	Not applicable.

Section 15. Regulatory Information

Other Regulations All of the components of this product are on the Domestic Substances List (DSL), are considered to be on the DSL, or are exempt from the New Substance Notification (NSN) requirements.

All components of this formulation are listed on the US EPA-TSCA Inventory.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

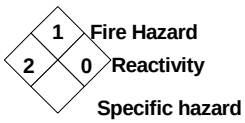
Please contact Product Safety for more information.

DSD/DPD (Europe)	Not evaluated.	**HCS (U.S.A.)**	CLASS: Target organ effects. CLASS: Irritating substance.
ADR (Europe) (Pictograms)	**NOT EVALUATED FOR EUROPEAN TRANSPORT** **NON ÉVALUÉ POUR LE TRANSPORT EUROPÉEN.**	**DOT (U.S.A) (Pictograms)**	

HMIS (U.S.A.)

Health Hazard	2*
Fire Hazard	1
Reactivity	0
Personal Protection	H

NFPA (U.S.A.)



Rating
0 Insignificant
1 Slight
2 Moderate
3 High
4 Extreme

Section 16. Other Information

References Available upon request.
* Marque de commerce de Petro-Canada - Trademark

Glossary

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous goods by Road (Europe)
ASTM - American Society for Testing and Materials
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CAN/CGA B149.2 Propane Installation Code
CAS - Chemical Abstract Services
CEPA - Canadian Environmental Protection Act
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CFR - Code of Federal Regulations
CHIP - Chemicals Hazard Information and Packaging Approved Supply List
CNS - Central Nervous System
COD5 - Chemical Oxygen Demand in 5 days
CPR - Controlled Products Regulations
DOT - Department of Transport
DSCL - Dangerous Substances Classification and Labeling (Europe)
DSD/DPD - Dangerous Substances or Dangerous Preparations Directives (Europe)
DSL - Domestic Substance List
EEC/EU - European Economic Community/European Union
EINECS - European Inventory of Existing Commercial Chemical Substances
IRIS - Integrated Risk Information System
LD50/LC50 - Lethal Dose/Concentration kill 50%
LDLo/LCLo - Lowest Published Lethal Dose/Concentration
NAERG'96 - North American Emergency Response Guide Book (1996)
NFPA - National Fire Prevention Association
NIOSH - National Institute for Occupational Safety & Health
NPRI - National Pollutant Release Inventory
NSNR - New Substances Notification Regulations (Canada)
NTP - National Toxicology Program
OSHA - Occupational Safety & Health Administration
PEL - Permissible Exposure Limit
RCRA - Resource Conservation and Recovery Act
RTECS - Registry of Toxic Effects of Chemical Substances
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For Product Safety Information: (905) 804-4752

Prepared by Product Safety - JDW on 5/11/2005.

Data entry by Product Safety - RS.

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PETRO-CANADA

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	**Not controlled**		

Section 1. Chemical Product and Company Identification

Product Name	**2-CYCLE MOTOR OIL**	**Code**	460-401, TWOCYC
Synonym	Not available	**Validated on**	**4/9/2005.**
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3	**In case of Emergency**	Petro-Canada: 403-296-3000 Canutec Transportation: 613-996-6666 Poison Control Centre: Consult local telephone directory for emergency number(s).
Material Uses	A low ash 2-cycle engine oil designed to lubricate conventional pre-mixed fuel/oil as well as oil injection lubricated engines powering air-cooled two-stroke cycle engines.		

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (W/W)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
Mixture of severely hydrotreated and hydrocracked and/or solvent-refined base oil (petroleum) and other proprietary, non-hazardous additives.	Mixture	100	5 mg/m³ (oil mist)	10 mg/m³ (oil mist)	Not established

Manufacturer Recommendation	Not applicable
Other Exposure Limits	Consult local, state, provincial or territory authorities for acceptable exposure limits.

Section 3. Hazards Identification.

Potential Health Effects	Prolonged or repeated contact may cause skin irritation, defatting, drying and dermatitis. Not expected to cause more than slight skin or eye irritation. With its relatively low vapour pressure, this product is not expected be inhaled in any appreciable quantity at ambient conditions. If heated to high temperatures or subjected to mechanical actions which produce vapours or mists, inhalation may cause respiratory tract irritation. Ingestion may produce a laxative effect. For more information refer to Section 11 of this MSDS.

Section 4. First Aid Measures

Eye Contact	No effects expected. If irritation does occur, flush contaminated eye(s) with lukewarm, gently flowing water for 5 minutes or until the chemical is removed. If irritation persists, obtain medical advice.
Skin Contact	Quickly and gently, blot or brush away excess chemical. Wash gently and thoroughly with water and non-abrasive soap for 5 minutes or until chemical is removed. Remove contaminated clothing, shoes and leather goods (e.g., watchbands, belts, etc.). If irritation persists, repeat flushing. Obtain medical advice immediately. Completely decontaminate clothing, shoes and leather goods before reuse or discard.
Inhalation	Remove source of contamination or move victim to fresh air. If irritation persists, obtain medical advice.
Ingestion	NEVER give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing. DO NOT INDUCE VOMITING. Have victim drink 240 to 300 mL (8 to 10 oz) of water to dilute material in stomach. If vomiting occurs naturally, rinse mouth and repeat administration of water. Obtain medical attention.
Note to Physician	Not available

Section 5. Fire-fighting Measures

Flammability	Combustible at high temperature.	**Flammable Limits**	Not available
Flash Points	OPEN CUP: ≥130°C (266°F) (Cleveland)	**Auto-Ignition Temperature**	Not available
Fire Hazards in Presence of Various Substances	Low fire hazard. This material must be heated before ignition will occur.	**Explosion Hazards in Presence of Various Substances**	Do not cut, weld, heat, drill or pressurize empty container. Containers may explode in heat of fire.

Continued on Next Page

Products of Combustion	Carbon oxides (CO, CO2), nitrogen oxides (NOx), acrid fumes, smoke and irritating vapours as products of incomplete combustion.
Fire Fighting Media and Instructions	NAERG2004, GUIDE 171, Substances (low to moderate hazard). If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (0.5 mile) in all directions; also, consider initial evacuation for 800 meters (0.5 mile) in all directions. Shut off fuel to fire if it is possible to do so without hazard. If this is impossible, withdraw from area and let fire burn out under controlled conditions. Withdraw immediately in case of rising sound from venting safety device or any discolouration of tank due to fire. Cool containing vessels with water spray in order to prevent pressure build-up, autoignition or explosion. SMALL FIRE: use DRY chemicals, foam, water spray or CO2. LARGE FIRE: use water spray, fog or foam. For small outdoor fires, portable fire extinguishers may be used, and self contained breathing apparatus (SCBA) may not be required. For all indoor fires and any significant outdoor fires, SCBA is required. Respiratory and eye protection are required for fire fighting personnel.

Section 6. Accidental Release Measures

Material Release or Spill	Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary. Ensure clean-up personnel wear appropriate personal protective equipment. Extinguish all ignition sources. Stop leak if safe to do so. Dike spilled material. Use appropriate inert absorbent material to absorb spilled product. Collect used absorbent for later disposal. Avoid contact with spilled material. Avoid contaminating sewers, streams, rivers and other water courses with spilled material. Notify appropriate authorities immediately.

Section 7. Handling and Storage

Handling	Avoid contact with any sources of ignition, flames, heat, and sparks. Avoid eye contact. Avoid skin contact. Avoid inhalation of product vapours or mists. Wear proper personal protective equipment (See Section 8). Empty containers may contain product residue. Do not pressurize, cut, heat, or weld empty containers. Do not reuse containers without commercial cleaning and/or reconditioning. Personnel who handle this material should practice good personal hygiene during and after handling to help prevent accidental ingestion of this product. Properly dispose of contaminated leather articles including shoes that cannot be decontaminated.
Storage	Store away from incompatible and reactive materials (See section 5 and 10). Keep container tightly closed. Store in dry, cool, well-ventilated area.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.
Personal Protection - ***The selection of personal protective equipment varies, depending upon conditions of use.***	
Eyes	As a minimum, safety glasses with side shields should be worn when handling this material.
Body	If this material may come in contact with the body during handling and use, we recommend wearing appropriate protective clothing to prevent contact with the skin. (Contact your PPE provider for more information.)
Respiratory	A minimum of NIOSH-approved air-purifying respirator with an organic vapour cartridge or canister with a dust, fume of mist filter (R, or P series) may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air-purifying respirators is limited. A NIOSH-approved positive-pressure, air-supplied respirator or self-contained breathing apparatus may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits.
Hands	If this material may come in contact with the hands during handling and use, we recommend wearing gloves of the following material(s): Neoprene, Nitrile, Polyvinyl alcohol (PVA), Fluoro-elastomer. Consult your PPE provider for breakthrough times and the specific glove that is best for you based on your use patterns.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Viscous liquid.	**Viscosity**	21.1 cSt @ 40°C (104°F), 4.5 cSt @ 100°C (212°F), VI=127
Colour	Blue-green	**Pour Point**	<-54ºC
Odour	Hydrocarbon.	**Softening Point**	Not applicable.
Odour Threshold	Not available	**Dropping Point**	Not applicable.
Boiling Point	Not available	**Penetration**	Not applicable.
Density	0.88 kg/L @ 15°C (59°F).	**Oil / Water Dist. Coefficient**	Not available
Vapour Density	Not available	**Ionicity (in water)**	Not available

Vapour Pressure	Negligible at ambient temperature and pressure.	**Dispersion Properties**	Not available
Volatility	Non-volatile.	**Solubility**	Insoluble in water.

Section 10. Stability and Reactivity

Corrosivity	Not available		
Stability	The product is stable under normal handling and storage conditions.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Reactive with oxidizing agents.	**Decomposition Products**	May release COx, NOx, methacrylate monomers, aldehydes, smoke and irritating vapours when heated to decomposition.

Section 11. Toxicological Information

Routes of Entry	Skin contact, eye contact, inhalation and ingestion.
Acute Lethality	Acute toxicity information is not available for the product as a whole, therefore, data for the base oils are provided below: Acute oral toxicity (LD50): >5000 mg/kg (rat). Acute dermal toxicity (LD50): >2000 mg/kg (rabbit). Acute inhalation toxicity (LC50): >2300 mg/m³/4h (rat).
Chronic or Other Toxic Effects	
Dermal Route:	Prolonged or repeated contact may defat and dry skin, and cause dermatitis. Short-term exposure is expected to cause only slight irritation, if any.
Inhalation Route:	With its relatively low vapour pressure, this product is not expected be inhaled in any appreciable quantity at ambient conditions. If heated to high temperatures or subjected to mechanical actions which produce vapours or mists, inhalation may cause respiratory tract irritation.
Oral Route:	Ingestion of this product may lead to aspiration of the liquid, especially if vomiting occurs. This may result in chemical pneumonitis (inflammation of the lungs) and/or pulmonary edema (an accumulation of fluid in the lungs). May produce a laxative effect.
Eye Irritation/Inflammation:	Short-term exposure is expected to cause only slight irritation, if any.
Immunotoxicity:	Not available
Skin Sensitization:	Contact with this product is not expected to cause skin sensitization, based upon the available data and the known hazards of the components.
Respiratory Tract Sensitization:	Contact with this product is not expected to cause respiratory tract sensitization, based upon the available data and the known hazards of the components.
Mutagenic:	This product is not known to contain any components at >= 0.1% that have been shown to cause mutagenicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a mutagen.
Reproductive Toxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause reproductive toxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a reproductive toxin.
Teratogenicity/Embryotoxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause teratogenicity and/or embryotoxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a teratogen/embryotoxin.
Carcinogenicity (ACGIH):	This product is not known to contain any chemicals at reportable quantities that are listed as Group A1 or A2 carcinogens by ACGIH.
Carcinogenicity (IARC):	This product is not known to contain any chemicals at reportable quantities that are listed as Group 1, 2A, or 2B carcinogens by IARC.
Carcinogenicity (NTP):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by NTP.
Carcinogenicity (IRIS):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by IRIS.
Carcinogenicity (OSHA):	This product is not known to contain any chemicals at reportable quantities that are listed as carcinogens by OSHA.
Other Considerations	No additional remark.

Section 12. Ecological Information

Environmental Fate	Not available	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available	**Products of Biodegradation**	Not available
Additional Remarks	No additional remark.		

Section 13. Disposal Considerations

Waste Disposal Spent/ used/ waste product may meet the requirements of a hazardous waste. Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 14. Transport Information

TDG Classification	Not a hazardous material for transport according to the TDG Regulations. (Canada)	**Special Provisions for Transport**	Not applicable.

Section 15. Regulatory Information

Other Regulations This product is acceptable for use under the provisions of WHMIS-CPR. All components of this formulation are listed on the CEPA-DSL (Domestic Substances List).

All components of this formulation are listed on the US EPA-TSCA Inventory.

All components of this product are on the European Inventory of Existing Commercial Chemical Substances (EINECS).

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

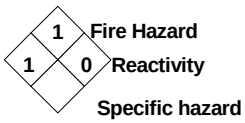
Please contact Product Safety for more information.

DSD/DPD (Europe)	Not classified under the Dangerous Substances or Dangerous Preparations Directives.	**HCS (U.S.A.)**	Does not meet the definitions of a health or physical hazard according to the OSHA - Hazard Communication Standard. (United States)
ADR (Europe) (Pictograms)		**DOT (U.S.A) (Pictograms)**	

HMIS (U.S.A.)

Health Hazard	1
Fire Hazard	1
Reactivity	0
Personal Protection	B

NFPA (U.S.A.)



Rating
0 Insignificant
1 Slight
2 Moderate
3 High
4 Extreme

Section 16. Other Information

References Available upon request.
* Marque de commerce de Petro-Canada - Trademark

Glossary

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous goods by Road (Europe)
ASTM - American Society for Testing and Materials
BOD5 - Biological Oxygen Demand in 5 days
CAN/CGA B149.2 Propane Installation Code
CAS - Chemical Abstract Services
CEPA - Canadian Environmental Protection Act
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CFR - Code of Federal Regulations
CHIP - Chemicals Hazard Information and Packaging Approved Supply List
CNS - Central Nervous System
COD5 - Chemical Oxygen Demand in 5 days
CPR - Controlled Products Regulations
DOT - Department of Transport
DSCL - Dangerous Substances Classification and Labeling (Europe)
DSD/DPD - Dangerous Substances or Dangerous Preparations
IRIS - Integrated Risk Information System
LD50/LC50 - Lethal Dose/Concentration kill 50%
LDLo/LCLo - Lowest Published Lethal Dose/Concentration
NAERG'96 - North American Emergency Response Guide Book (1996)
NFPA - National Fire Prevention Association
NIOSH - National Institute for Occupational Safety & Health
NPRI - National Pollutant Release Inventory
NSNR - New Substances Notification Regulations (Canada)
NTP - National Toxicology Program
OSHA - Occupational Safety & Health Administration
PEL - Permissible Exposure Limit
RCRA - Resource Conservation and Recovery Act
RTECS - Registry of Toxic Effects of Chemical Substances
SARA - Superfund Amendments and Reorganization Act
SD - Single Dose
STEL - Short Term Exposure Limit (15 minutes)
TDG - Transportation Dangerous Goods (Canada)
TDLo/TCLo - Lowest Published Toxic Dose/Concentration

Directives (Europe)
DSL - Domestic Substance List
EEC/EU - European Economic Community/European Union
EINECS - European Inventory of Existing Commercial Chemical Substances
EPA - Environmental Protection Agency
EPCRA - Emergency Planning and Community Right to Know Act
FDA - Food and Drug Administration
FIFRA - Federal Insecticide, Fungicide and Rodenticide Act
HCS - Hazard Communication Standard
HMIS - Hazardous Material Information System
IARC - International Agency for Research on Cancer
TLm - Median Tolerance Limit
TLV-TWA - Threshold Limit Value-Time Weighted Average
TSCA - Toxic Substances Control Act
USEPA - United States Environmental Protection Agency
USP - United States Pharmacopoeia
WHMIS - Workplace Hazardous Material Information System

For Copy of MSDS

The Canadian Controlled Products Regulations (CPR) (Under the Hazardous Products Act, part of the WHMIS legislation) only apply to WHMIS Controlled (i.e., hazardous) products. Therefore, the CPR and the 3-year update rule specified therein do not apply to WHMIS Non-Controlled products. Although this is true, customarily Petro-Canada reviews and updates Non-Controlled product MSDS if a customer requests such an update. These Non-Controlled product updates are given a lower priority than Controlled products but are handled as soon as practicable. If you would like to verify if the MSDS you have is the most current, or you require any further information, please contact:

Internet: www.petro-canada.ca/msds

Lubricants:
Western Canada, telephone: 1-800-661-1199; fax: (780) 464-9564
Ontario & Central Canada, telephone: 1-800-268-5850 and (905) 822-4222; fax: 1-800-201-6285
Quebec & Eastern Canada, telephone: 1-800-576-1686; fax: 800-201-6285

For Product Safety Information: (905) 804-4752

Prepared by Product Safety - RS on 4/9/2005.

Data entry by Product Safety - RS.

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

PETRO-CANADA

Material Safety Data Sheet

WHMIS (Pictograms)	WHMIS (Classification)	Protective Clothing	TDG (pictograms)
	**B-2, D-2A, D-2B**		

Section 1. Chemical Product and Company Identification

Product Name	**GASOLINE, UNLEADED**	**Code**	W102E
		Validated on	**7/4/2005.**
Synonym	Regular, Unleaded Gasoline (US Grade), Mid-Grade, Plus, Super, WinterGas, SummerGas, Supreme, SuperClean WinterGas, RegularClean, PlusClean, Premium, marked or dyed gasoline, Super Premium (94 RO)		
Manufacturer	PETRO-CANADA P.O. Box 2844 Calgary, Alberta T2P 3E3	**In case of Emergency**	Petro-Canada: 403-296-3000 Canutec Transportation: 613-996-6666 Poison Control Centre: Consult local telephone directory for emergency number(s).
Material Uses	Unleaded gasoline is used in spark ignition engines including motor vehicles, inboard and outboard boat engines, small engines such as chain saws and lawn mowers, and recreational vehicles.		

Section 2. Composition and Information on Ingredients

			Exposure Limits (ACGIH)		
Name	**CAS #**	**% (W/W)**	**TLV-TWA(8 h)**	**STEL**	**CEILING**
Gasoline	8006-61-9	85-100	300 ppm	500 ppm	Not established
Methyl tert-butyl ether	1634-04-4	0-15	50 ppm	Not established	Not established
Benzene	71-43-2	<1.5	0.5 ppm	2.5 ppm	Not established
Note: Petro-Canada does not use MTBE in the manufacturing of its gasoline, however MTBE can be introduced from time to time through the use of external gasoline blendstocks.					

Manufacturer Recommendation	Not applicable
Other Exposure Limits	Consult local, state, provincial or territory authorities for acceptable exposure limits.

Section 3. Hazards Identification.

Potential Health Effects	Flammable liquid. Exercise caution when handling this material. May cause cancer. May cause heritable genetic effects (mutagenicity). This product contains an ingredient or ingredients, which have been shown to cause chronic toxic effects. Contact with this product may cause skin and eye irritation. Inhalation of this product may cause respiratory tract irritation and Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death. Ingestion of this product may cause gastro-intestinal irritation. Aspiration of this product may result in severe irritation or burns to the respiratory tract. For more information refer to Section 11 of this MSDS.

Section 4. First Aid Measures

Eye Contact	Avoid direct contact. Quickly and gently blot or brush away chemical. Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for 20 minutes or until the chemical is removed, while holding the eyelid(s) open. Take care not to rinse contaminated water into the unaffected eye or onto the face. Obtain medical attention immediately.
Skin Contact	Avoid direct contact. Wear chemical resistant protective clothing if necessary. Quickly and gently, blot or brush away excess chemical. Wash gently and thoroughly with warm water and non-abrasive soap for 20 minutes or until chemical is removed. Under running water, remove contaminated clothing, shoes and leather goods (e.g., watch bands, belts, etc.). Obtain medical attention immediately. Completely decontaminate clothing, shoes and leather goods before reuse or discard.

Continued on Next Page

Inhalation	Take proper precautions to ensure your own safety before attempting rescue (e.g. wear appropriate protective equipment). If breathing has stopped, trained personnel should begin artificial respiration (AR) or, if the heart has stopped, cardiopulmonary resuscitation (CPR) immediately. Immediately transport victim to an emergency care facility.
Ingestion	NEVER give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing. Have victim rinse mouth thoroughly with water. DO NOT INDUCE VOMITING. Have victim drink 240 to 300 mL (8 to 10 oz) of water to dilute material in stomach. If vomiting occurs naturally, have victim lean forward to reduce risk of aspiration. Repeat administration of water. If breathing has stopped, trained personnel should begin artificial respiration (AR) or, if the heart has stopped, cardiopulmonary resuscitation (CPR) immediately. Quickly transport victim to an emergency care facility.
Note to Physician	Not available

Section 5. Fire-fighting Measures

Flammability	Flammable liquid (NFPA).	**Flammable Limits**	Lower: 1.3%; Upper: 7.6% (NFPA).
Flash Points	Closed Cup: -50 to -38°C (-58 to -36°F), ASTM D56 Standard Test Method for Flash Point by Tag Closed Tester.	**Auto-Ignition Temperature**	257°C (495°F) (NFPA).
Fire Hazards in Presence of Various Substances	Extremely flammable in presence of open flames, sparks, and heat. Vapours are heavier than air and may travel considerable distance to sources of ignition and flash back. Rapid escape of vapour may generate static charge causing ignition. May accumulate in confined spaces.	**Explosion Hazards in Presence of Various Substances**	Do not cut, weld, heat, drill or pressurize empty container. Containers may explode in heat of fire. Vapours may form explosive mixtures with air.
Products of Combustion	Carbon oxides (CO, CO2), nitrogen oxides (NOx), polynuclear aromatic hydrocarbons, phenols, smoke and irritating vapours as products of incomplete combustion. See Section 11 (Other Considerations) for information regarding the toxicity of the combustion products.		
Fire Fighting Media and Instructions	NAERG2004 GUIDE 128, Flammable liquids (Non-polar/Water-immiscible). CAUTION: This product has a very low flash point: Use of water spray when fighting fire may be inefficient. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also consider initial evacuation for 800 meters (1/2 mile) in all directions. SMALL FIRES: Dry chemical, CO2, water spray or regular foam. LARGE FIRES: Water spray, fog or regular foam. Do not use straight streams. Move containers from fire area if you can do it without risk. Fires Involving Tanks or Car/Trailer Loads: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting devices or any discolouration of tank. ALWAYS stay away from the ends of tanks. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible withdraw from area and let fire burn. Wear positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing will only provide limited protection.		

Section 6. Accidental Release Measures

Material Release or Spill	IN THE EVENT OF A LARGE SPILL CONSIDER THE FOLLOWING CONTROL MEASURES: Consult current National Emergency Response Guide Book (NAERG) for appropriate spill measures if necessary. Extinguish all ignition sources. Stop leak if safe to do so. Evacuate non-essential personnel. Ventilate area. Dike spilled material. Use appropriate inert absorbent material to absorb spilled product. Collect used absorbent for later disposal. Ensure clean-up personnel wear appropriate personal protective equipment. Avoid contact with spilled material. Avoid contaminating sewers, streams, rivers and other water courses with spilled material. Avoid breathing vapours or mists of material. Ground and bond all equipment used to clean up the spilled material, as it may be a static accumulator. Notify appropriate authorities immediately.

Section 7. Handling and Storage

Handling	FLAMMABLE MATERIAL. Handle with care. Avoid contact with any sources of ignition, flames, heat, and sparks. Avoid skin contact. Avoid eye contact. Avoid inhalation of product vapours or mists. Wear proper personal protective equipment (See Section 8). Empty containers may contain product residue. Do not pressurize, cut, heat, or weld empty containers. Do not reuse containers without commercial cleaning and/or reconditioning. Personnel who handle this material should practice good personal hygiene during and after handling to help prevent accidental ingestion of this product. Ensure all equipment is grounded/bonded. Avoid confined spaces and areas with poor ventilation. Do not ingest this product.
Storage	Store as flammable material. Store away from incompatible and reactive materials (See section 5 and 10). Store away from heat and sources of ignition. Store in dry, cool, well-ventilated area. Keep container tightly closed. Ensure the storage containers are grounded/bonded. Avoid direct sunlight.

Section 8. Exposure Controls/Personal Protection

Engineering Controls	For normal application, special ventilation is not necessary. If user's operations generate vapours or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.

Personal Protection - *The selection of personal protective equipment varies, depending upon conditions of use.*

Eyes	As a minimum, safety glasses with side shields should be worn when handling this material.
Body	If this material may come in contact with the body during handling and use, we recommend wearing appropriate protective clothing to prevent contact with the skin. (Contact your PPE provider for more information.)
Respiratory	A NIOSH-approved air-purifying respirator with an organic vapour cartridge or canister may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air-purifying respirators is limited. Use a positive-pressure, air-supplied respirator if there is any potential for uncontrolled release, exposure levels are unknown, or any other circumstances where air-purifying respirators may not provide adequate protection.
Hands	If this material may come in contact with the hands during handling and use, we recommend wearing gloves of the following material(s): polyvinyl alcohol (PVA), fluoro-elastomer. Consult your PPE provider for breakthrough times and the specific glove that is best for you based on your use patterns.
Feet	Wear appropriate footwear to prevent product from coming in contact with feet and skin.

Section 9. Physical and Chemical Properties

Physical State and Appearance	Clear liquid.	**Viscosity**	Not available
Colour	Clear to slightly yellow, undyed liquid. May be dyed red for taxation purposes.	**Pour Point**	Not applicable.
Odour	Gasoline. MTBE has a terpene-like odour.	**Softening Point**	Not applicable.
Odour Threshold	Less than 1 ppm.	**Dropping Point**	Not applicable.
Boiling Point	25 to 220°C (77 to 428°F) Initial boiling point by ASTM D86 Standard Test Method.	**Penetration**	Not applicable.
Density	0.685 - 0.80 kg/L @ 15°C (59°F).	**Oil / Water Dist. Coefficient**	Not available
Vapour Density	3 to 4 (Air = 1) (NFPA).	**Ionicity (in water)**	Not available
Vapour Pressure	<107 kPa @ 37.8ºC (100ºF)	**Dispersion Properties**	Not available
Volatility	Volatile.	**Solubility**	Hydrocarbon components virtually insoluble in water. Soluble in alcohol, ether, chloroform, and benzene. Dissolves fats, oils and natural resins.

Section 10. Stability and Reactivity

Corrosivity	Non corrosive.		
Stability	The product is stable under normal handling and storage conditions.	**Hazardous Polymerization**	Will not occur under normal working conditions.
Incompatible Substances / Conditions to Avoid	Reactive with oxidizing agents, acids, interhalogens and uranium hexafluoride.	**Decomposition Products**	May release COx, NOx, phenols, polynuclear aromatic hydrocarbons, acrid smoke and irritating vapours when heated to decomposition.

Section 11. Toxicological Information

Routes of Entry	Skin contact, eye contact, inhalation, and ingestion.
Acute Lethality	Gasoline (8006-61-9): Acute Oral toxicity (LD50): 13600 mg/kg (rat) Acute Dermal toxicity (LD50): >5000 mg/kg (rabbit) MTBE (1634-04-4): Acute Oral toxicity (LD50): 2963 mg/kg (rat) Acute Dermal toxicity (LD50): >6800 mg/kg (rabbit) Acute Inhalation toxicity (LC50): 23576 ppm/4h (rat)

	Benzene (71-43-2): Acute Oral toxicity (LD50): 930 mg/kg (rat) Acute Dermal toxicity (LD50): >9400 mg/kg (rabbit) Acute Inhalation toxicity (LC50): 13229 ppm/4h (rat)
Chronic or Other Toxic Effects	
Dermal Route:	Contact may cause skin irritation. Prolonged or repeated contact may defat and dry skin, and cause dermatitis.
Inhalation Route:	Inhalation of this product may cause respiratory tract irritation. Inhalation of this product may cause Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death.
Oral Route:	Ingestion of this product may cause gastro-intestinal irritation. Aspiration of this product may result in severe irritation or burns to the respiratory tract. Ingestion of this product may cause Central Nervous System (CNS) Depression, symptoms of which may include; weakness, dizziness, slurred speech, drowsiness, unconsciousness and in cases of severe overexposure; coma and death.
Eye Irritation/Inflammation:	Contact may cause eye irritation.
Immunotoxicity:	Not available
Skin Sensitization:	Contact with this product is not expected to cause skin sensitization, based upon the available data and the known hazards of the components.
Respiratory Tract Sensitization:	Contact with this product is not expected to cause respiratory tract sensitization, based upon the available data and the known hazards of the components.
Mutagenic:	This product contains a component(s) at >= 0.1% that has been shown to cause mutagenicity in laboratory tests. Therefore, this product is considered to be a mutagen. (Benzene)
Reproductive Toxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause reproductive toxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a reproductive toxin.
Teratogenicity/Embryotoxicity:	This product is not known to contain any components at >= 0.1% that have been shown to cause teratogenicity and/or embryotoxicity. Therefore, based upon the available data and the known hazards of the components, this product is not expected to be a teratogen/embryotoxin.
Carcinogenicity (ACGIH):	This product contains the following chemical(s) at >=0.1% that are listed as carcinogenic compounds. Therefore this product is considered to be carcinogenic. [Considered to be A1 by the ACGIH. Benzene (71-43-2)] [Considered to be A3 by the ACGIH. Gasoline (8006-61-9), MTBE (1634-04-4)]
Carcinogenicity (IARC):	This product contains the following chemical(s) at >=0.1% that are listed as carcinogenic compounds. Therefore this product is considered to be carcinogenic. [Considered to be carcinogenic to humans (group 1) by IARC. Benzene (71-43-2)] [Considered to be carcinogenic to humans (group 2B) by IARC. Gasoline (8006-61-9)]
Carcinogenicity (NTP):	This product contains the following chemical(s) at >=0.1% that are listed as carcinogenic compounds. Therefore this product is considered to be carcinogenic. [Known to be a human carcinogen according to NTP. Benzene (71-43-2)]
Carcinogenicity (IRIS):	This product contains the following chemical(s) at >=0.1% that are listed as carcinogenic compounds. Therefore this product is considered to be carcinogenic. [Considered to be carcinogenic by IRIS. Benzene (71-43-2)]
Carcinogenicity (OSHA):	This product contains the following chemical(s) at >=0.1% that are listed as carcinogenic compounds. Therefore this product is considered to be carcinogenic. [Considered to be carcinogenic by OSHA. Benzene (71-43-2)]
Other Considerations	Gasoline engine exhaust is possibly carcinogenic to humans (IARC Group 2B).

Section 12. Ecological Information

Environmental Fate	Not available	**Persistance/ Bioaccumulation Potential**	Not available
BOD5 and COD	Not available	**Products of Biodegradation**	Not available
Additional Remarks	No additional remark.		

Section 13. Disposal Considerations

Waste Disposal Spent/ used/ waste product may meet the requirements of a hazardous waste. Consult your local or regional authorities. Ensure that waste management processes are in compliance with government requirements and local disposal regulations.

Section 14. Transport Information

TDG Classification GASOLINE, 3, UN1203, PGII (CL-TDG)

Special Provisions for Transport See Transportation of Dangerous Goods Regulations.

Section 15. Regulatory Information

Other Regulations This product is acceptable for use under the provisions of WHMIS-CPR. All components of this formulation are listed on the CEPA-DSL (Domestic Substances List).

All components of this formulation are listed on the US EPA-TSCA Inventory.

All components of this product are on the European Inventory of Existing Commercial Chemical Substances (EINECS).

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

Please contact Product Safety for more information.

DSD/DPD (Europe) Not evaluated.

HCS (U.S.A.) CLASS: Contains material which may cause cancer.
CLASS: Flammable liquid having a flash point lower than 37.8°C (100°F).
CLASS: Irritating substance.
CLASS: Target organ effects.

ADR (Europe) (Pictograms) NOT EVALUATED FOR EUROPEAN TRANSPORT

NON ÉVALUÉ POUR LE TRANSPORT EUROPÉEN.

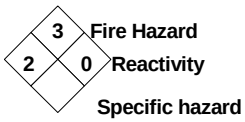
DOT (U.S.A) (Pictograms) Not evaluated for transport

Non évalué pour le transport

HMIS (U.S.A.)

Health Hazard	2*
Fire Hazard	3
Reactivity	0
Personal Protection	H

NFPA (U.S.A.)



Rating
0 Insignificant
1 Slight
2 Moderate
3 High
4 Extreme

Section 16. Other Information

References Available upon request.
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RTECS - Registry of Toxic Effects of Chemical Substances
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TLV-TWA - Threshold Limit Value-Time Weighted Average
TSCA - Toxic Substances Control Act
USEPA - United States Environmental Protection Agency
USP - United States Pharmacopoeia
WHMIS - Workplace Hazardous Material Information System

IARC - International Agency for Research on Cancer

For Copy of MSDS
Internet: www.petro-canada.ca/msds

Canada-wide: telephone: 1-800-668-0220; fax: 1-800-837-1228

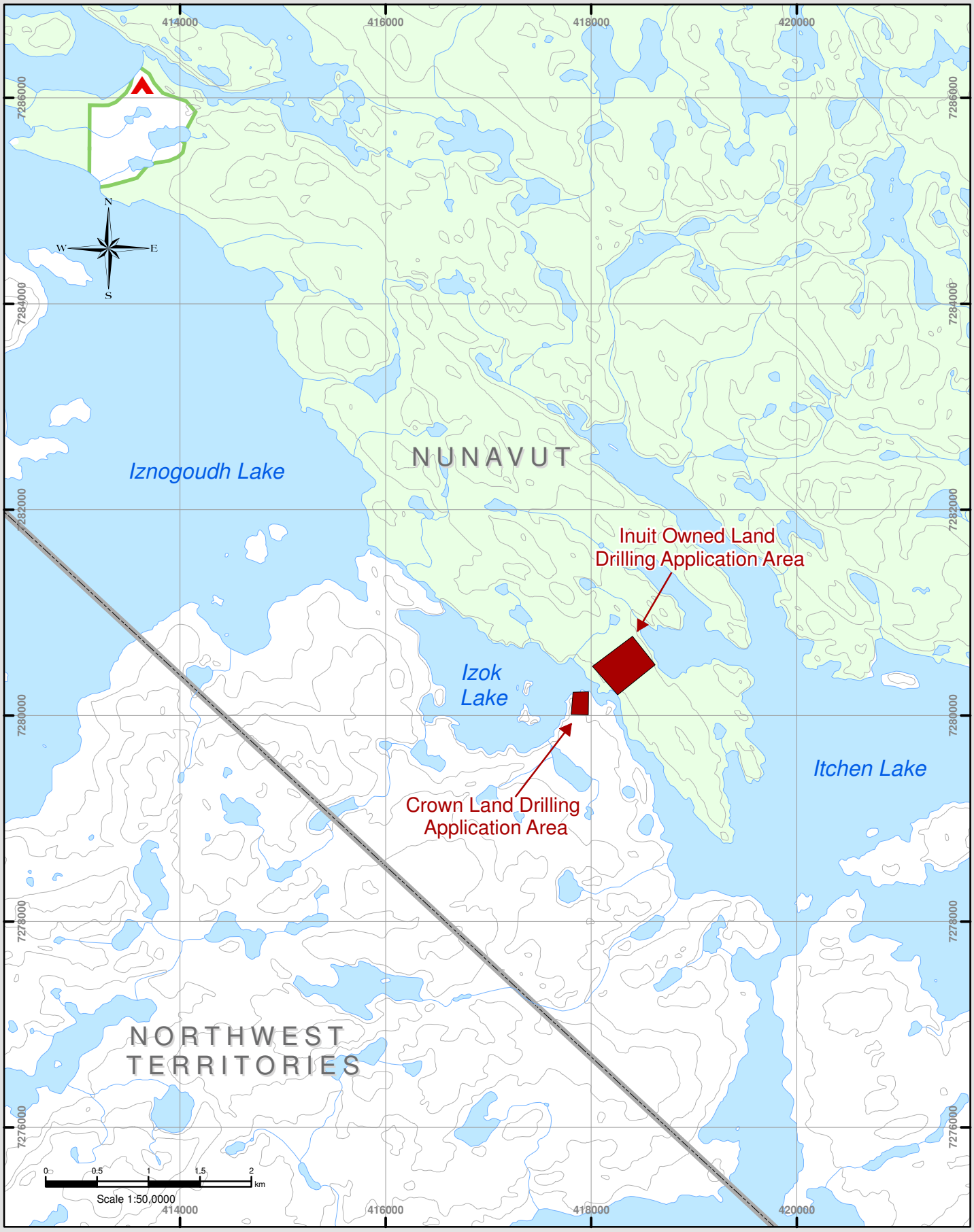
For Product Safety Information: (905) 804-4752

Prepared by Product Safety - JDW on 7/4/2005.

Data entry by Product Safety - JDW.

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FIGURES



Legend

- Camp
- Planned Drill Areas
- Inuit Owned Lands
- Surface Rights Only
- Contour (20m)
- Watercourse
- Waterbody

WOLFDEN Resources Inc.

Izok Property
Exploration Locations

References:

National Topographic Database (NTDB) compiled by the Government of Canada, Natural Resources Canada (NRCan) at 1: 50:000.

Inuit Owned Lands compiled by Nunavut Tunngavik Incorperated.

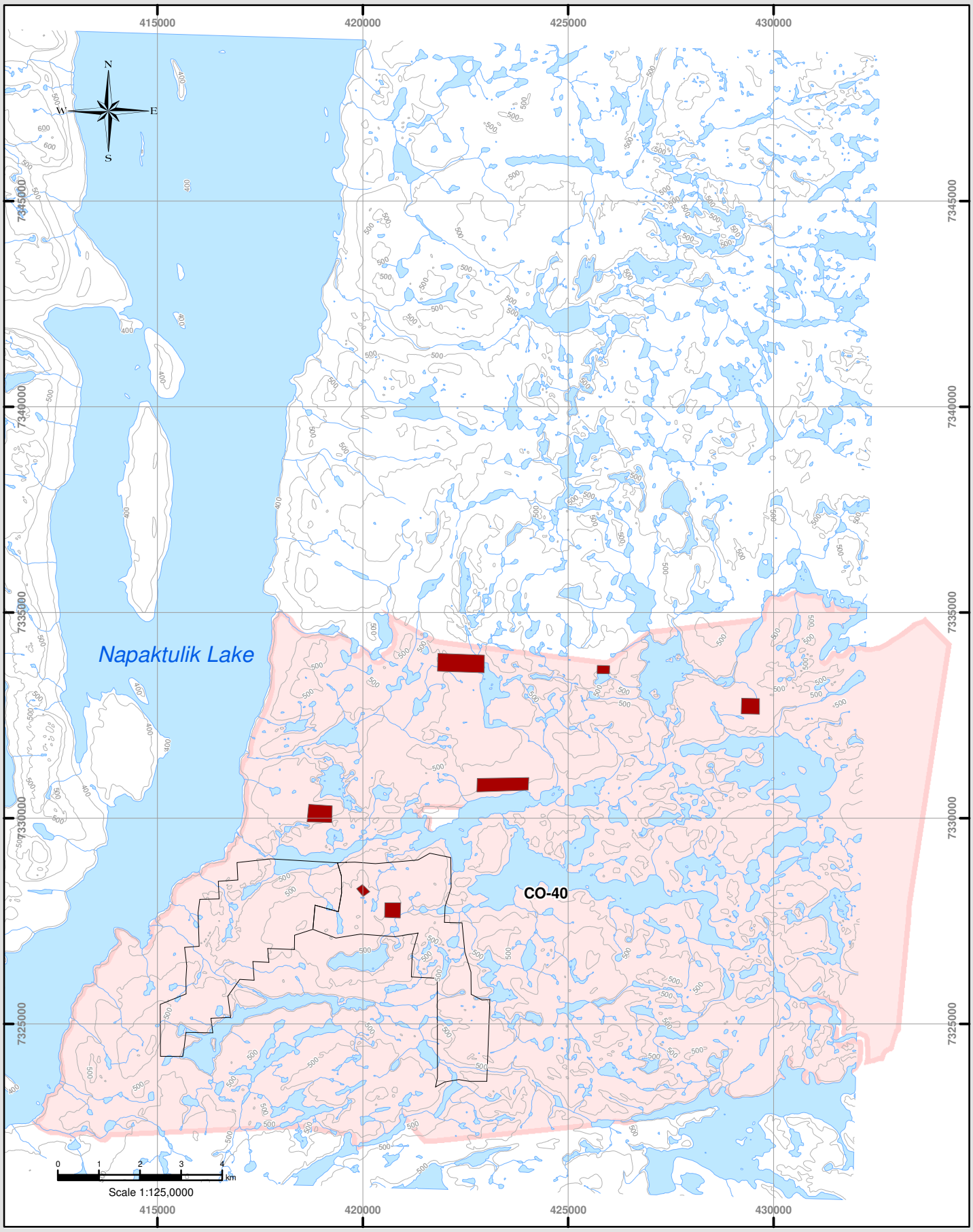
Camp location and planned drill areas provided by Wolfden Resources Inc.

Projection: UTM Zone 12 NAD 83
Revision: 0
Date: May 31, 2006

Gartner Lee

Map: 3

File: P61013_C1_Fig3IzokExplor_29eMay2006.mxd



Legend

- Planned Drill Areas
- Lease Area
- Inuit Owned Lands
- Surface and Sub-Surface Rights
- Contour (50m)
- Watercourse
- Waterbody

WOLFDEN Resources Inc.

Hood Property
Exploration Locations

References:

National Topographic Database (NTDB) compiled by the Government of Canada, Natural Resources Canada (NRCan) at 1: 50:000.

Inuit Owned Lands compiled by Nunavut Tunngavik Incorperated.

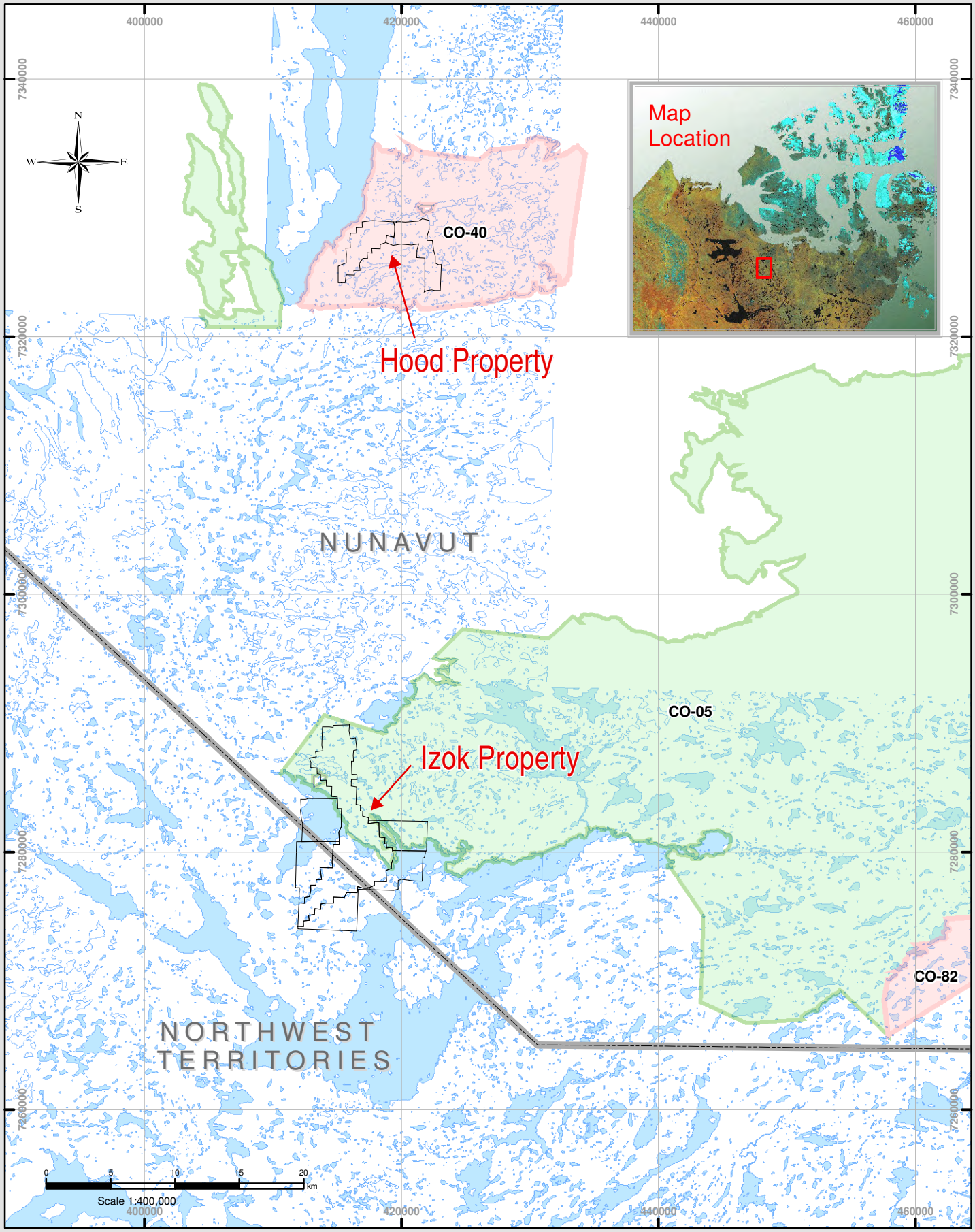
Lease areas and planned drill areasprovided by Wolfden Resources Inc.

Projection: UTM Zone 12 NAD 83
Revision: 0
Date: May 31, 2006

Gartner Lee

Map: 2

File: P61013_C1_Fig2HoodExplor_28eMay2006.mxd



Legend

- Lease Area
- Inuit Owned Lands
- Surface Rights Only
- Surface and Sub-Surface Rights
- Watercourse
- Waterbody

WOLFDEN Resources Inc.

Regional Overview Map

References:

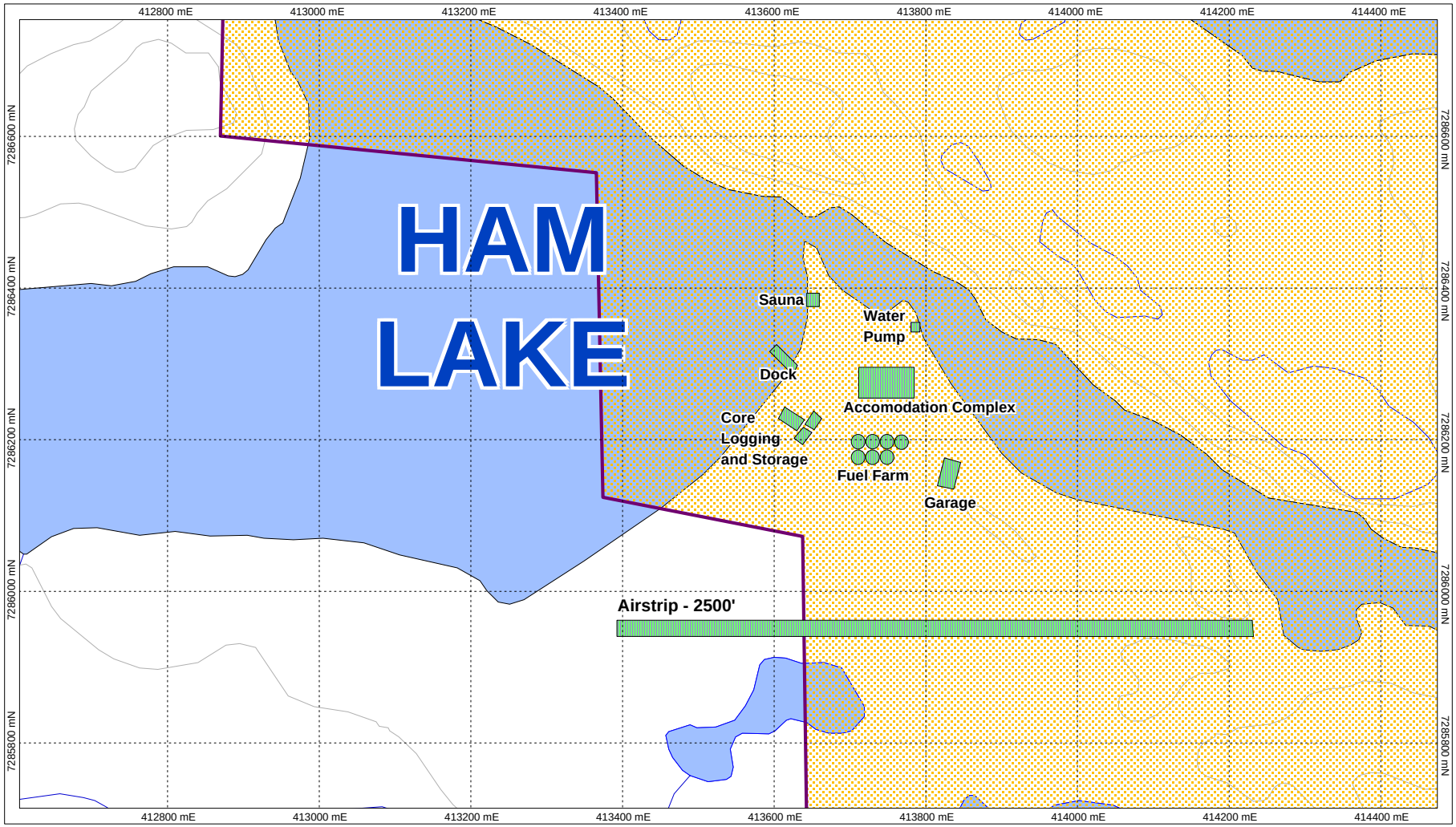
National Topographic Database (NTDB) compiled by the Government of Canada, Natural Resources Canada (NRCan) at 1: 50:000.
Inuit Owned Lands compiled by Nunavut Tunngavik Incorperated.
Lease areas provided by Wolfden Resources Inc.
Government of Canada, Natural Resources Canada, Earth Science Sector, Data Management and Dissemination Branch

Projection: UTM Zone 12 NAD83
Revision: 0
Date: May 31, 2006

Gartner Lee

Map: 1

File: P61013_C1_Fig1RegionalOverview_29eMay2006.mxd

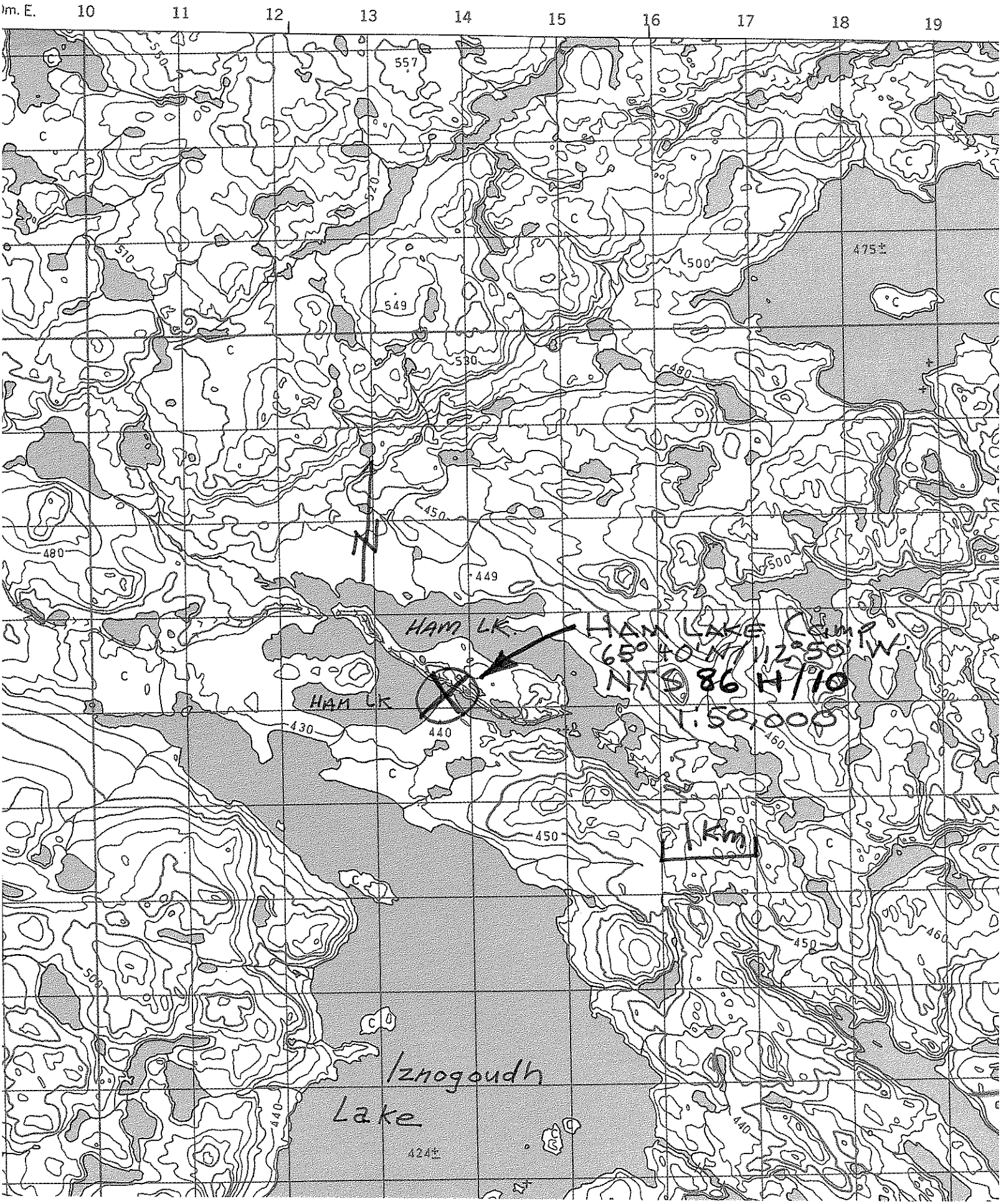


0 200 400

metres

WOLFDEN RESOURCES INC.

	IZOK/HOOD PROJECTS **Water Licence Application** **Nunavut Water Board** **Camp layout**
Date:25/5/2006	
Author: S.Rickard	
Office: Thunder Bay	
Drawing: IN/SR	
Scale: 1:8,000	Projection: UTM: NAD 83, Zone 12


10
11
12
13
14
15
16
17
18
19
HAM LK.
HAM LK
HAM LAKE CAMP
65° 40' N 112° 50' W
NTS 86 H/10
1:50,000
1 km
Iznogoudh
Lake
557
549
530
500
475±
480
450
449
440
430
424±