BASELINE AQUATIC STUDIES PROGRAM IN THE ULU PROJECT AREA, NUNAVUT (1997)

RL&L Environmental Services Ltd.

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Prepared for

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Edmonton, Alberta

by

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The following R.L. & L. Environmental Services Ltd. personnel participated in this project:

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EXECUTIVE SUMMARY

The Ulu Deposit, located approximately 155 km north of the Lupin gold mine is currently being developed by Echo Bay Mines Ltd. The deposit and support facilities are situated in the headwater area of the Ulu Creek (local name) drainage, which contains several lakes that may be influenced by the proposed development. In order to access the site and transport ore for processing, a winter access road extending from Lupin may be required. The proposed road will consist of ice sections on frozen lakes and rivers, and overland sections that may require stream crossings (during the construction phase) during the open water period.

The 1996 study was designed to assess four proposed alternative routes for the winter access road. This entailed evaluation of fish and fish habitat in streams that were to be crossed. Fish communities in several lakes in the immediate vicinity of the Ulu Exploration Site were also inventoried to obtain pre-development baseline information. The 1997 program was a continuation of the 1996 study.

The winter access road route evaluated during the present study included portions of Routes One, Two and Three. The route surveyed traversed a rugged landscape of bedrock, boulders and glacial till. The majority of the watercourses crossed were small, shallow and ill-defined. As such, few contain habitat that was capable of sustaining fish populations.

Availability of overwintering habitat appeared to limit the distribution of fish in the study area. It is likely that most of the surveyed streams freeze completely during winter, therefore, deep-water refugia in the form of lakes must be accessible to fish. If access to critical deep-water habitat is restricted due to physical barriers to fish passage or intermittent water flow during the open water period, then the stream cannot be used by fish.

In total, 13 streams that had the potential to support fish were assessed during the spring (June) and summer (August) surveys, including: 2 streams along Route One, 10 streams along Route Two, and 1 along Route Three. Species encountered included Arctic grayling, burbot, lake trout and slimy sculpin. Good quality fish habitat was documented in only two of the streams: Stream 18.5 along Route One and Stream 41.8 along Route Two. Both were accessible to deep-water lakes. These streams likely were used on an opportunistic basis by some species such as lake trout and burbot that enter the watercourses to feed. However, for species such as Arctic grayling that require streams for spawning and rearing purposes, these watercourses provided critical habitat. As such, care should be taken during road construction and maintenance to avoid or minimize the impacts on these systems.

Surveys of six lakes in the Ulu Exploration Area were conducted in summer (July and August). Most lakes in the area (West Lake, Ulu Lake, Meadow Lake, Reno Lake South and Reno Lake North) were cold, well-oxygenated, nutrient poor systems. The physical characteristics of these lakes also were typical of subarctic systems. Most were dominated by rocky shorelines and contained deep-water areas. Inlet and outlet streams associated with all of these waterbodies were small and several contained physical barriers to fish passage. As such, fish populations in these lakes were residents and could not move between waterbodies.

Water samples collected from seven sites in the Ulu Creek drainage provided baseline information on background concentrations of nutrients, metals and hydrocarbons. The hydrocarbon xylene, which occurred at slightly elevated levels in 1996, was not detectable at any site during the present study. This was also true for all other hydrocarbons analysed. At most sites, concentrations of nutrients and trace metals were near or below detectable limits. Exceptions occurred for several elements in East Lake. Levels of some elements (e.g., chloride and sodium), essential nutrients (e.g., ammonia, nitrogen) and trace metals (nickel, strontium and zinc) were above background concentrations recorded from other sites. These results were due to deposition of the camp's sewage effluent into East Lake and storage of waste rock material in the East Lake basin. The water chemistry results also suggested that concentrations of several elements were elevated in waterbodies immediately downstream of East Lake (Ulu Lake and Ulu Creek) and that these elevated levels were the result of water flow from East Lake into the drainage.

The aquatic biological communities of lakes in the Ulu Exploration Area were typical of subarctic tundra lakes. Plankton and benthic macroinvertebrates exhibited low densities and simple species assemblages. Similar results were found for the fish community. Only a single species, lake trout, was recorded in West Lake, Ulu Lake and Reno Lake South. Reno Lake North was the only waterbody where other species were encountered, which included round whitefish (during the present study) and Arctic char (during 1996). Catch rates recorded during sampling in all four lakes indicated that fish population densities were low. Two waterbodies in the Ulu Exploration Area did not contain fish: East Lake, which was too small and Meadow Lake which was too shallow. It should be noted that the inlet stream to Meadow Lake did contain small numbers of slimy sculpin.

An assessment of the fish community in the Ulu Creek drainage (Ulu Creek and Frayed Knots River) indicated that the system was used by fish. Young-of-the-year Arctic grayling were recorded in Ulu Creek near its confluence with the Frayed Knots River and slimy sculpin were present immediately upstream of Meadow Lake. In the Frayed Knots River, fish were distributed throughout the entire length sampled. All age-groups of Arctic grayling were recorded, as well as adults of round whitefish and lake trout.

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1.0 INTRODUCTION

Echo Bay Mines Ltd. has been operating a gold mine and processing facility at Lupin, N.W.T. since 1982. In 1995, the mineral rights for the Ulu gold deposit were purchased by Echo Bay Mines Ltd. from BHP Minerals Ltd. The development plans for this deposit require extraction of the ore and transportation of the material, via a winter access road, to Lupin for processing.

The Ulu deposit is located approximately 155 km north of the Lupin mine and 510 km northeast of Yellowknife, N.W.T., at 66° 54'30" N, 110° 58' W (Figure 1.1). In order to access the Ulu deposit, a winter access road approximately 180 km in length, extending north from Lupin, which is on the west shore of Contwoyto Lake, may be required.

The winter access road will consist of overland sections and ice sections on rivers and lakes. Due to low snow pack levels in this region and the presence of numerous boulder fields, portions of the overland section will have to be built using gravel deposits extracted from the area (S. Barry Lowe, Land Use Administrator, Echo Bay Mines Ltd., pers. comm.). The overland sections will traverse several streams. As such, there is the potential to impact these systems.

The Ulu gold deposit is situated within the Hood River watershed. The deposit is located in the headwater area of the Ulu Creek drainage (local name), which connects to the Hood River via the Frayed Knots River (local name). Several small lakes are immediately adjacent to the deposit and can potentially be impacted by the development.

In 1996, R.L. & L. Environmental Services was contracted by Echo Bay Mines Ltd. to survey stream crossings along the four proposed winter access road routes. The survey was designed to document the habitat and fish use of each crossed stream. In addition to the road crossing survey, R.L. & L. Environmental Services Ltd. conducted preliminary baseline aquatic surveys of four lakes in the vicinity of the Ulu deposit.

The 1997 work program, which is summarized in this document, was designed to address data gaps identified during the 1996 study. The present study included assessments of stream crossings along sections of the proposed winter access road routes not investigated in 1996 and collection of additional baseline information for the aquatic system in the vicinity of the Ulu deposit.

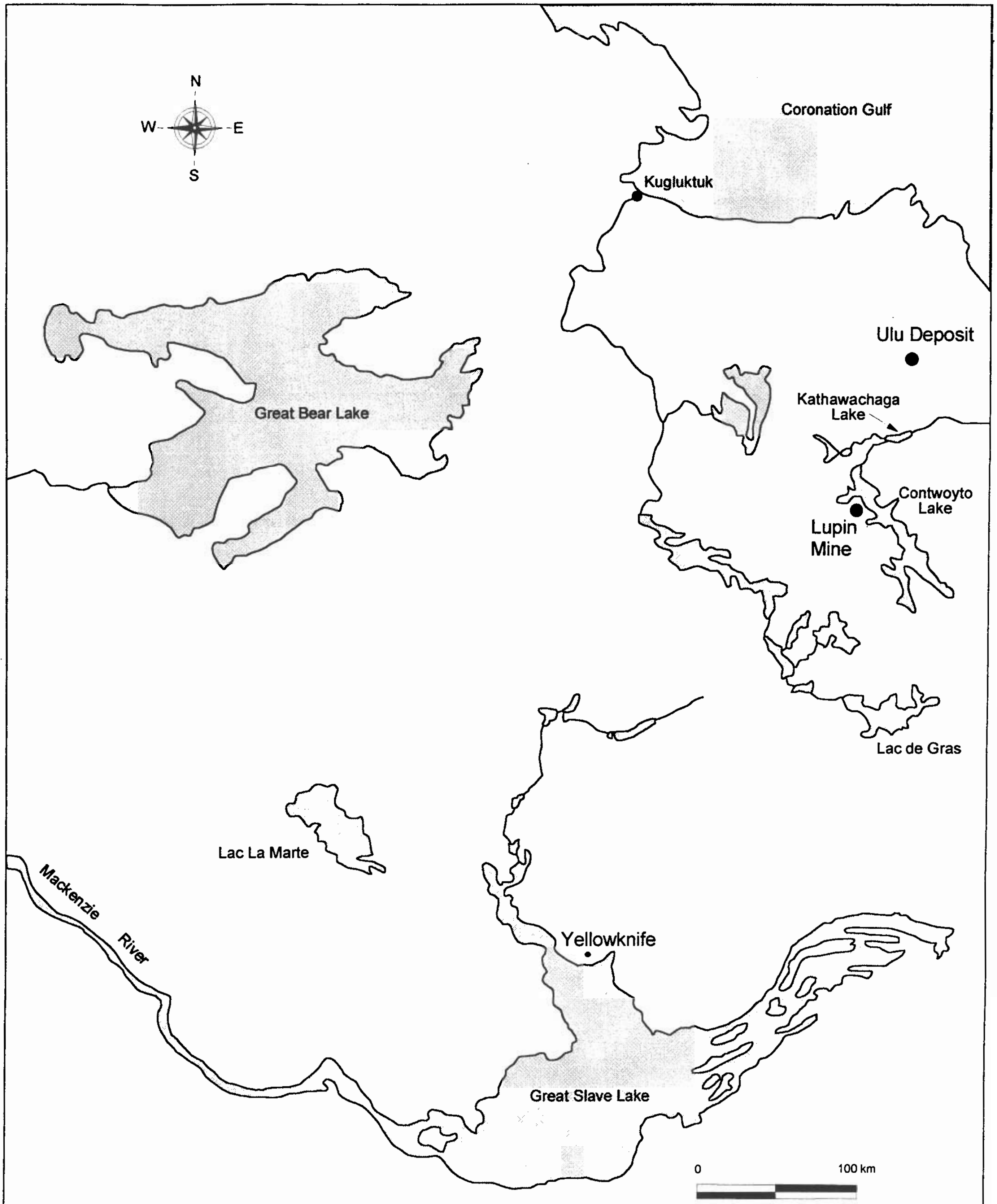

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Figure 1.1

Location of Ulu Deposit

1.1 STUDY AREA

The proposed winter access road routes investigated in 1997 encompassed an area that extends from Contwoyto Lake to the south (66°03' N) and the Ulu deposit to the north (66°59' N). The eastern boundary was approximately 115° 15' W and to the west the approximate boundary was at 111°30' W. The northern portion of the winter access road is located in the Hood River drainage and the central portion is in the Cracroft River drainage. The southern portion of the route lies in the Burnside River drainage (Figure 1.2).

There were three proposed winter access road routes examined during the 1997 program. These included the following:

- Route One from the north end of Kathawachaga Lake Km 0 to Km 86.0;
- Route Two from Km 20.0 to the Hood River (Km 76.0); and,
- Route Three from the Hood River (Km 110.0) to Camp Three at Reno Lake South (Km 124.0).

The Ulu deposit study area (Ulu Exploration Area) is situated in the Hood River drainage (Figure 1.2). The proposed development is located in the headwater region of a small stream locally known as Ulu Creek and is situated on a ridge adjacent to three small waterbodies (Figure 1.3). Ulu Lake is located on the east side of the ridge. East Lake, which is immediately south of the ridge and drains into Ulu Lake, receives discharges of waste water from the development area. West Lake is west of the ridge and also drains into Ulu Lake. This waterbody is the source of potable water for the camp. Ulu Creek is the principal drainage system of the area. Water flows into Meadow Lake, which is situated 1.0 km downstream of Ulu Lake, and then continues on for 4.5 km before entering the Frayed Knots River (local name). The confluence of the Frayed Knots and Hood Rivers is 9.5 km downstream of this point.

The main fuel storage area known as Camp Three (capacity of 3 185 000 L of fuel) is located south of the Ulu deposit. This is a fuel storage area and proposed service depot for vehicles using the winter access road. It is situated on the top of a sand and gravel esker that separates Reno Lake North and Reno Lake South. These waterbodies drain directly into the Hood River, which is located approximately 4.5 km to the south.

1.2 OBJECTIVES

The purpose of the present study was to address data gaps identified by the 1996 program. The 1997 baseline aquatic studies program was designed to collect information for stream crossings not previously surveyed and to collect additional biological information for waterbodies in the vicinity of the proposed Ulu Exploration Site.

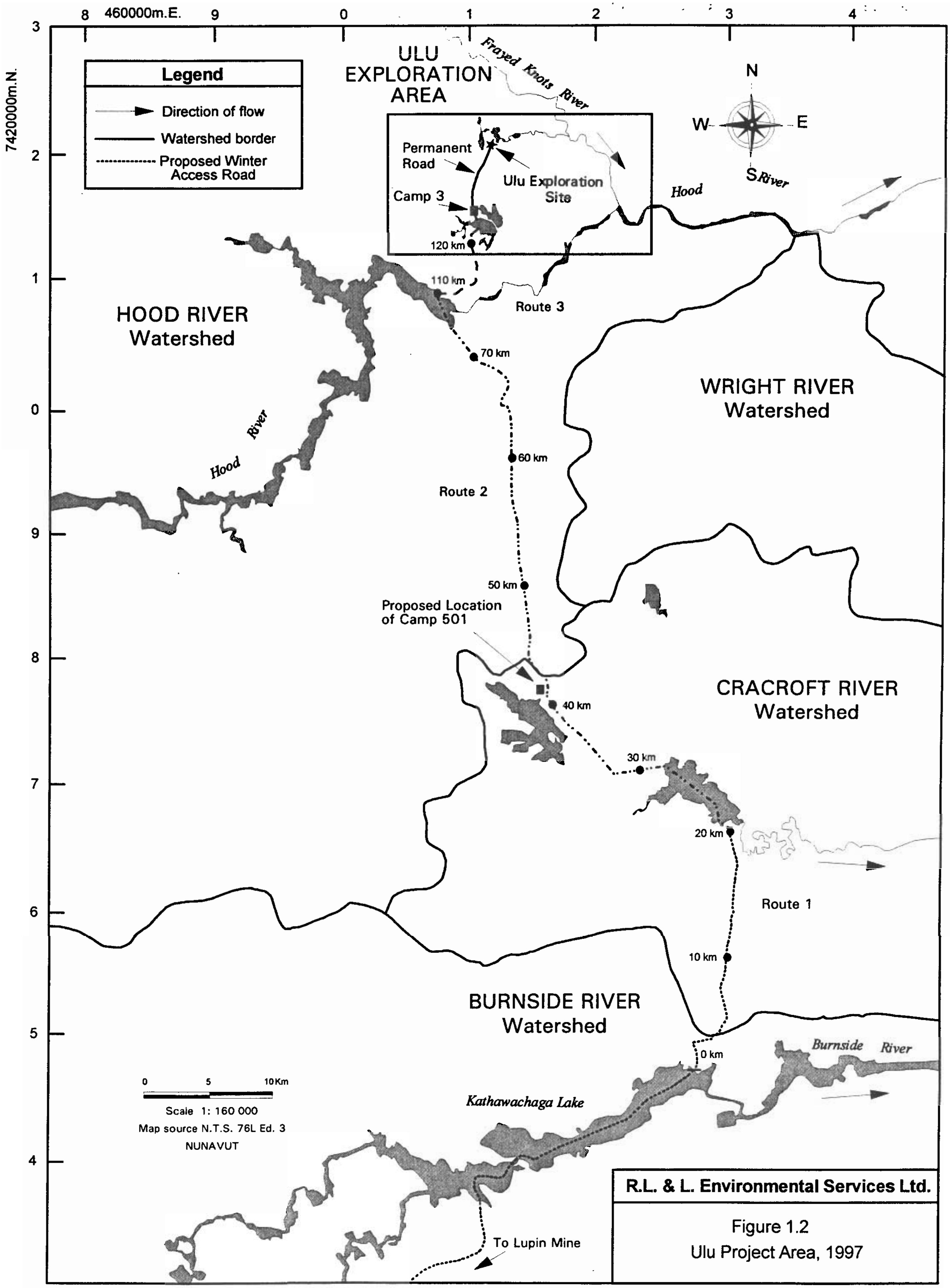

Figure 1.2
Ulu Project Area, 1997

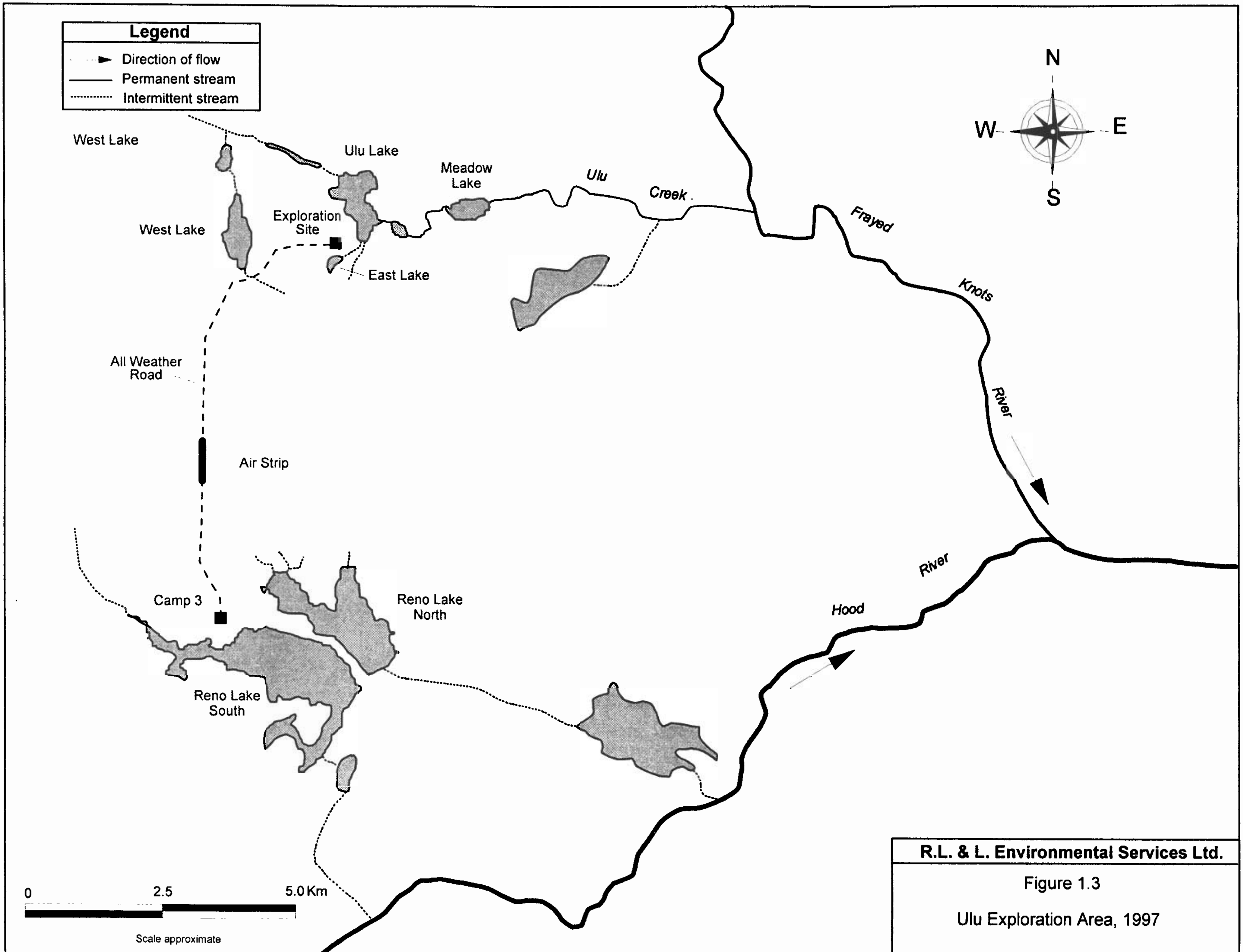

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Figure 1.3

Ulu Exploration Area, 1997

The specific objectives of the proposed 1997 program included the following:

- to assess the fish habitat and fish populations in streams to be crossed by the proposed winter access road that were not inventoried in 1996;
- to determine stream discharges during spring freshet and summer base flow periods at each stream crossing not inventoried in 1996;
- to describe the water chemistry characteristics of waterbodies in the Ulu Exploration Area;
- to describe the phytoplankton, zooplankton and benthic macroinvertebrate communities found in waterbodies in the Ulu Exploration Area;
- to describe the abundance, distribution, and biological characteristics of fish found in waterbodies in the Ulu Exploration Area and the habitat used by the fish; and,
- to assess the importance to fish populations of waterbodies situated within, immediately downstream, and immediately upstream of the development area.

1.3 SITE SELECTION, TIMING, AND LOGISTICS

Site selection was based on two criteria: the characteristics of the site should be representative of the area and where appropriate, sites previously sampled in 1996 were resampled in 1997.

The 1997 field sampling program was conducted during two periods. The spring session was completed between 16 and 20 June. This study component was designed to investigate fish use of streams along the proposed winter access road and to measure the discharge of these streams.

The second field period commenced on 28 July and was completed on 6 August. The sampling program during this period involved several components. Investigations included collection of fish and habitat data from streams previously sampled during the winter access road stream crossing survey. In addition to the stream crossing survey, a sampling program in the Ulu Exploration Area was completed. This required collection of water samples from sites in the Ulu Creek drainage, habitat surveys of lakes and streams, and inventories of biological communities (plankton, benthic macroinvertebrates and fish).

Access to the Ulu Project Area was by fixed-wing aircraft from Edmonton. During spring, accommodations were at the Lupin Mine. In summer, accommodations were at the Ulu Camp. Transportation of personnel and equipment to sampling sites along the winter access road routes and the Ulu Exploration Area was provided by helicopter.

2.0 METHODS

2.1 WINTER ACCESS ROAD STREAM CROSSINGS

There were three proposed winter access road routes examined during the present study. Similar to the 1996 investigation, routes were given a numeric designation (e.g., Route 1, Route 2 and Route 3). Streams that were to be crossed by the proposed route were assigned a unique identification number based on distance (in kilometres) from Kathawachaga Lake. For example, along Route 1, Stream 4.6 was located 4.6 km north of Km 0. It should be noted that no defined stream channels were identified between Kathawachaga Lake and Contwoyto Lake along the proposed route. Km 0 was established on the north shore of Kathawachaga Lake.

2.1.1 Habitat Assessment

Habitat characteristics of the stream were assessed within 100 m upstream and 100 m downstream of each proposed crossing. Habitat type and instream cover were classified according to the R.L. & L. Habitat Classification System outlined in Appendix A1. In addition to documentation of general habitat characteristics of the stream at the crossing, cross section transects were established to assess the water depth, velocity, and substrate type. At each transect, measurements were taken at locations corresponding to ¼, ½ and ¾ of the stream's channel width. Substrate types were classified according to the Modified Wentworth Scale (Appendix A2).

Discharge was determined in all streams that had measurable flow. Water depth and mean velocity measurements were taken at a minimum of 10 intervals along a tag line positioned perpendicular to the flow. Water velocity was measured at 0.4 depth from the stream bottom using a Swoffer Model 2100 digital flow meter ($\pm$0.005 m/s). Water depth was measured using the flow meter wading rod ($\pm$ 0.5 cm). Discharge was calculated according to the methods outlined by Bovee and Cochnauer (1977).

Water conductivity was measured with an Oakton TDS Testr1 conductivity meter (0-1990 $\mu S \cdot cm^{-1}$; $\pm$0.5 μScm) whereas pH was measured with an Oakton Testr 2 meter ($\pm$0.2 pH units). Water temperatures were measured with an alcohol pocket thermometer ($\pm$0.5°C).

Stream bank slopes at the crossing (i.e., between the water's edge and active flood plain) and the slopes of the approach (upslope from the flood plain) were estimated visually and spot checked using a Silva clinometer ($\pm$1°). Bank cover (e.g., vegetation) and bank materials were estimated in the field as a percentage of the total bank area within a 2 m band adjacent to the stream.

A Garmin 45 Global Positioning System (GPS) was used to determine the Universal Transverse Mercator (UTM) coordinates of the sampled stream crossing using the NAD27 datum (Zone 12W). Photographs were taken at each stream crossing site using a Pentax MX 35 mm camera.

2.1.2 Fisheries Assessment

A Smith-Root Model XII Programmable Output Waveform backpack electrofisher was utilized to capture fish at each assessed stream crossing. The electrofisher operator completed synoptic level sampling of areas suspected of containing fish (e.g., undercut banks and boulders). All captured fish were placed in a live-holding bucket.

All captured fish were identified to species and measured (fork length and weight). Non-lethal ageing structures were collected from sportfish species and archived. All fish were released near their collection point.

Fork lengths (to the nearest millimetre) were determined using a measuring board. Weights were determined using a top loading electronic balance (±2 g). Fish identifications were confirmed using keys in Freshwater Fishes of Canada (Scott and Crossman 1973).

Each stream crossing was rated for its potential quality as fish habitat for important species. Ratings were assigned using a scale of 0 (extremely poor) to 3 (excellent). Habitat categories evaluated included spawning, rearing, feeding and movement. Ratings were developed based on a visual assessment by an experienced of the observer.

2.2 ULU EXPLORATION AREA

2.2.1 Water Chemistry

Surface water samples were collected from seven sites in the Ulu Exploration Area. Samples were preserved and shipped to Norwest Labs in Edmonton for analyses. Parameters analysed are presented in Appendix A3 and included the following:

Parameter
Total Metals
Total Mercury
Major Cations (e.g., Ca, Mg, Na, K)
Alkalinity
Nutrients
Ammonia
Nitrate-Nitrogen
Nitrite-Nitrogen
Nitrate + Nitrite--Total Nitrogen
Total Kjeldahl Nitrogen
Total Phosphorous
Total Dissolved Phosphorous
Total Organic Carbon
Total Dissolved Solids
Oil and Grease
Total extractable and purgeable hydrocarbons

2.2.3 Limnology

Temperature and dissolved oxygen were measured in lakes using an Oxyguard Handy Mark II dissolved oxygen-temperature meter. Measurements were taken at 0.5 m intervals to within 0.5 m of the lake bottom (to avoid contamination of the probe with sediment). Water transparency was measured to the nearest 0.1 m using a standard Secchi disk (20 cm diameter).

Other measurements taken from the water surface included conductivity (Oakton TDS Testr1 conductivity meter 0-1990 $\mu S \cdot cm^{-1}$; ± 0.5 μScm) and pH (Oakton pH Testr 2 meter ± 0.2 pH units).

2.2.4 Aquatic Invertebrates

Phytoplankton

Phytoplankton were collected during the summer period from the euphotic zone of selected lakes. This zone is equal to the depth of 1% light penetration (approximately two times the Secchi depth). Vertical collections were made using a weighted plastic tube. A sample consisted of a composite of five discrete vertical collections within this zone. In lakes that were shallower than two times the Secchi depth, phytoplankton hauls encompassed the entire water column to 1 m above the lake bottom (to avoid contamination of the sample with sediment). Samples were placed in labelled 500 mL glass containers, preserved with 5% acid-Lugol's solution, and stored in the dark. Three drops of 100% formalin were added to each sample to prevent growth of bacteria and fungi during storage.

Zooplankton

Zooplankton samples were also collected during the summer period. A sample consisted of a composite of three vertical hauls at a particular site. The depth of each haul was equal to two times the Secchi depth. In lakes that were shallower than two times the Secchi depth, zooplankton hauls encompassed the entire water column to 1 m above the lake bottom (to avoid contamination of the sample with sediment). Zooplankton collections were made with a Wisconsin plankton net constructed with Nitex® mesh (net mouth diameter 13.34 cm). To prevent predation by cyclopoid copepods, each sample was immediately preserved in 5% formalin and stored in labelled 500 mL polyethylene bottles. Equipment was thoroughly rinsed after sampling at each site to prevent contamination.

Benthic Macroinvertebrates

Benthic macroinvertebrates were sampled from sites situated in the littoral zone (i.e., >2 m and <5.0 m depth) of selected lakes during summer. Three replicate samples were collected at each site using an Ekman grab sampler (area equal to 0.023 m^2). Samples were then sieved through a 0.243 mm mesh to remove excess sediments, placed in labelled polyethylene bottles, and preserved in 10% formalin. Water depth and substrate type were recorded for each sample location.

2.2.5 Habitat

Lakes

The physical habitat characteristics of selected lakes in the Ulu Exploration Area were assessed. Shoreline habitat was described visually based on three variables: shoreline slope, shoreline substrate type and presence of important features such as high quality rearing and spawning areas. Basin morphology was assessed using a Lowrance X15 paper recording depth sounder. Where sufficient data were available, a bathymetric map was developed for the lake.

Streams

The physical habitat available to fish in streams in the Ulu Exploration Area was documented during spring and summer. During spring, a reconnaissance level survey was undertaken on the ground to identify streams that provided habitat for fish populations residing in study area lakes. Streams containing barriers to fish passage at their confluence, or those that were ephemeral (water flow only during spring snow melt or high rainfall events), were recorded as having no value to fish and were excluded from more detailed surveys. Detailed surveys followed methods described in Section 2.1.1.

2.2.6 Fish

Lakes

Fish sampling in lakes focussed on determining species composition and relative abundance during summer. The primary fish capture method was standard gang gillnetting. Each gang consisted of six panels (15.2 m x 2.4 m each) of sinking monofilament nylon netting of the following mesh sizes (stretched measure): 1.9 cm, 3.8 cm, 6.4 cm, 8.9 cm, 10.2 cm, and 12.7 cm. A variety of habitats were sampled using bottom and surface sets. Pertinent data recorded at each gill net site included set/pull time, set location/orientation, water depth, and substrate type. Catch rates were assessed by using a net-unit approach (i.e., 100 m^2 surface area of net fished for the equivalent of a 12-hour period constitutes one net-unit of effort). Catch-per-unit-effort (CPUE) was expressed as the number of fish (by species) per net-unit.

Additional capture techniques were employed during lake sampling. For larger size-classes of fish, angling with lures was used. To capture smaller size-classes of fish in habitats not effectively sampled by gillnetting, standard gee traps baited with cheese or meat were used in rocky shoreline areas. Dimensions of the gee traps were 0.4 m length x 0.2 m diameter with an aperture of 0.02 m.

Streams

During both the spring and summer sampling sessions, survey level fish sampling was conducted in representative sections of streams to assess fish species composition, relative abundance, and habitat utilization (spawning, rearing, feeding, and movements). During spring, surveys were undertaken on all streams that were associated with study area lakes. During summer, surveys were limited to streams that were deemed to have usable fish habitat (e.g., flowing water). A variety of sampling methods were used to document the presence of fish in streams; these included visual observations, snorkelling, backpack electrofishing, and angling. The specific methods utilized depended on habitat conditions and stream discharge at the time of sampling. The backpack electrofisher employed during sampling was a Smith-Root Type XII, which is specifically designed for use in low conductivity water.

Fish Biological Characteristics

All captured fish were identified to species. Data recorded for each fish included fork length (to the nearest 2 mm), weight (to the nearest 2 g), sex and maturity. An appropriate ageing structure was also collected (Mackay et al. 1990) from a representative sample of captured fish. Data were recorded on standardized record sheets to facilitate data analyses in the laboratory.

To determine feeding habits, stomach contents of fish that succumbed during sampling were analysed in the field using the method described by Thompson (1959), which is a modification of the numerical method used by Hynes (1950). Each stomach was examined and evaluated for fullness and allotted a designated number of fullness points (i.e., 20 points for a full stomach and 0 points for an empty stomach). After points were allocated for the degree of fullness, the stomach was opened and the points allotted to individual food categories based on their volume. To account for the presence of empty stomachs, values of zero were incorporated into the analysis.

2.4 LABORATORY ANALYSES

2.4.1 Aquatic Invertebrates

Phytoplankton

Prior to enumeration, the phytoplankton samples were inverted gently, and 10 to 100 mL subsamples were dispensed into sedimentation chambers (Lund et al. 1958). After a 24 h sedimentation period, samples were processed. To obtain a comprehensive species list, the entire basal area of the chamber was scanned qualitatively with an inverted microscope (Wild M-40). Taxonomic keys used for identification included Prescott (1970), Taft and Taft (1971), and Webber (1971).

Once a comprehensive species list was formed, cell density was assessed. To calculate cell density (cells/mL), individual cells were enumerated within a specified area of the sedimentation chamber. This was accomplished by counting the number of cells along horizontal transects placed across the specified area. To calculate the cell density of each species in the sample, the number of cells within the specified area was extrapolated to the subsample, and then to the entire sample.

Cell biovolume ($\mu m^3/m^3$) was calculated by first measuring the physical dimensions (length, width, and depth) of between 10 and 30 cells of each species in the sample. Estimates of cell biovolume were then generated by multiplying the mean dimension of cells belonging to a particular species by the number of cells enumerated for that species. The mean cell biovolume estimate for the subsample was then extrapolated to the entire sample. Species that were enumerated during the qualitative assessment, but not encountered (i.e., very low numbers or located outside the enumeration transects), were recorded as present.

For diatom identification and enumeration, a separate subsample was concentrated, dried onto a coverslip, ashed in a muffle furnace to remove organic matter, and mounted in Storax.

Zooplankton

Zooplankton counts were completed using a dissecting stereo-microscope (Wild M-5); identifications were made using a compound microscope equipped with a phase-contrast condenser (Wild M-20). Taxonomic keys used for crustacean plankton were Brooks, Wilson and Yeatman (in Edmondson 1959), supplemented by the keys of Brooks (1957), Smirnov (1971), Brandlova et al. (1972), Flössner (1972), and Kiefer (1978). The taxonomic key used for identification of rotifers was the Voigt revision by Koste (1978), supplemented by keys of Ahlstrom (1943) and Ruttner-Kolisko (1974). Chaoboridae were identified using the keys of Cook (1956) and Saether (1970). Specimens were identified to the lowest taxonomic level possible.

Enumeration of zooplankton in each sample involved different techniques that were dependent on taxonomic group. Cladocerans and copepods (all stages) were enumerated either from three 15 mL subsamples or from the entire sample using a dissecting microscope at magnifications of 12-50×. Subsampling was performed on samples that were subjectively assessed to have large numbers of specimens. Rotifers were enumerated from a subsample: a modified Folsom-style splitter was used to create subsamples. Each 15 mL subsample was allowed to settle for 24 h before processing. An inverted microscope (100 or 200×) was used to enumerate rotifers by counting either 6 fields (1 field = 0.02625 cm^2) or the entire counting chamber (4.907 cm^2). Subsamples were continually removed from the original sample until approximately 200 mature or identifiable rotifer organisms were processed. Species encountered, but not enumerated due to low numbers, were recorded as present.

Once numbers of organisms within each sample were established, these values were converted to densities per cubic metre. This was accomplished by determining the total volume filtered (i.e., net mouth area x depth of haul x number of hauls) and multiplying by the number of organisms enumerated.

Biomass of major taxonomic groups in each sample was also calculated. To calculate biomass, lengths were measured from the first 30 individuals observed in a sample. Lengths of larger zooplankton were measured directly with a microscope equipped with a calibrated Sigma Scan digitizing tablet. Smaller zooplankton, such as rotifers, were measured using an eyepiece graticule and corrected for magnification. Lengths were measured from the first 10-30 individuals of each species observed in each sample. Using length measurements from individual organisms, weights were calculated from published length-weight regression equations as follows:

Organism	Equation	Reference
Copepods (N1-adults)	$\ln W(\mu g) = 1.9526 + 2.399 \cdot \ln L(mm)$	Bottrell et al. (1976)
Daphnia spp.	$\ln W(\mu g) = 1.6 + 2.84 \cdot \ln L(mm)$	Bottrell et al. (1976)
Holopedium spp.	$\ln W(\mu g) = 6.4957 + 3.052 \cdot \ln L(mm)$	Downing (1984)
Rotifers	$\ln W(\mu g) = -10.3815 + 1.574 \cdot \ln L(\mu g)$	Stemberger and Gilbert (1987)

For each sample, a mean individual weight was calculated by averaging the estimated weights generated from the length-weight regression equation (it is important to average weights and not lengths; Bird and Prairie (1985)). Biomass for each taxonomic group was calculated by multiplying the number enumerated for that sample by the mean individual weight.

Zooplankton hauls cannot be considered adequately quantitative for sampling rotifers because coarser mesh sizes, (i.e., >0.065 mm), may allow small forms to escape. Consequently, numbers derived from zooplankton hauls should be considered as a relative comparison of abundance (Green 1977).

Benthic Macroinvertebrates

Samples were first processed to remove all extraneous substrate and organic matter. Individual samples were washed to remove the preservative and repeatedly elutriated to remove silt, sand, and gravel (i.e., inorganic materials). This procedure was continued until invertebrates were no longer observed in the elutriated water. The remaining organic and inorganic material was scanned (without a microscope) in an enamelled tray, and large animals (greater than 0.5 cm) were removed. The sample was then fractionated for ease of sorting (using a series of nested sieves) into: a large fraction containing filamentous algae, macrophyte pieces, and plant material (greater than 4 mm;), a coarse fraction (1 - 4 mm); a medium fraction (0.5 - 1 mm); and, a fine fraction (0.25 - 0.5 mm).

Using a dissecting microscope (6 to 42× magnification), invertebrates were then sorted by major taxonomic group and identified to the lowest practical taxonomic level (genus or species when possible). More difficult groups, such as nematodes, were identified to a higher taxonomic level. Keys used for identification included Wiggins (1977), Merritt and Cummins (1984), Brinkhurst (1986), and Clifford (1991).

2.4.2 Fish

Fish ageing followed the protocol outlined in Mackay et al. (1990). Otoliths were used to age lake trout; scales were used to age Arctic grayling. Otoliths, which had been stored dry in labelled envelopes, were first lightly ground and polished with emery cloth (400 grit) to allow sufficient light transmission. Then a binocular dissecting microscope, equipped with a transmitted light source, was used to obtain an age from each structure. Clean, nonregenerated scales were mounted on a glass slide, and a photocopy was made using a Canon PC Printer 80 microfiche reader/printer. Scales were then aged using this photocopy. Each structure was aged by two independent readers. When discrepancies in the assigned age occurred, the two readers conferred to arrive at a consensus. A third independent reader conducted a random check of selected structures to ensure quality control.

3.0 WINTER ACCESS ROAD STREAM CROSSINGS

The original objective of the 1997 winter access road stream crossing survey was to obtain additional fisheries information for crossings along Routes Two and Three that were not adequately sampled during the 1996 program. During early spring 1997, the preferred alignment of the winter access road was modified to include portions of Routes One, Two and Three. In addition to these changes, sections of these routes were realigned (Barry Lowe Land Use Administrator Echo Bay Mines Ltd., pers. comm.). The primary objective of the winter access road stream crossing survey was modified to address these changes. All stream crossings that had the potential to support fish were evaluated along the new routes.

Surveys were undertaken during spring (16 to 20 June) and summer (28 July to 6 August) to ensure that seasonal use of the streams by fish was documented. All crossings were first assessed visually from the air to document whether they had the potential to support fish (i.e., contained water and were accessible to fish). If the stream at the proposed crossing exhibited some potential to support fish, a ground survey was undertaken. The ground survey included a description of stream habitat characteristics and fisheries resources, as well as a rating of fish habitat quality. If the stream at the proposed crossing contained high quality habitat (e.g., spawning areas for Arctic grayling), a more detailed assessment of the stream was undertaken to quantify these habitat characteristics. The following section provides a description of each stream crossing that had the potential to support fish. All raw data are presented in Appendix B1.

3.1 ROUTE ONE

The new alignment of Route One crossed several watercourses, however, only two had the potential to support fish. These included Streams 3.1 and 18.5 that were situated between Kathawachaga Lake and Lake 501. None of these crossings were inventoried during the 1996 survey.

STREAM 3.1 **UTM: 12W 0517728 7349569** **PLATE 1**

This stream is the outlet system to a small lake situated approximately 250 m upstream of the crossing and this stream drains directly into Kathawachaga Lake. Fish habitat at the crossing consisted of shallow RIFFLE/RUN complexes dominated by large boulder substrates. The wetted width of the stream at the crossing was 5 m during base flow and 15.0 m during the spring freshet. The stream banks were composed of boulders and were stable.

No fish were encountered during the spring survey, however, sixteen Arctic grayling were captured during the summer inventory (CPUE=5.6 fish/min). All individuals were juvenile fish between one and two years of age that likely originated from the headwater lake situated immediately upstream of the crossing. The absence of adult Arctic grayling in spring and young-of-the-year fish during summer suggests that this stream section is used only for rearing purposes by this species. Fish habitat within the study section was rated as high (3) for rearing and low (1) or nil (0) for all other life requisites (i.e., spawning, feeding, movement).

STREAM 18.5 **UTM: 12W 0520950 7363312** **PLATE 2**

This stream is unique among the water courses crossed by the winter access road. The dominant substrate type within the stream and its banks was silt. Habitat at the crossing consisted of deep FLAT habitat interspersed by RIFFLE/RUN complexes dominated by large boulder substrates. The wetted width of the stream at the crossing was 8.0 m during base flow and 15.0 m during the spring freshet. The stream banks were low (0.5 m height), but were unstable due to the preponderance of silt substrates.

No fish were encountered during the spring survey, however, this likely was due to the large size of the stream, which precluded effective sampling. In summer, 40 young-of-the-year Arctic grayling were recorded within the surveyed section (CPUE=9.4 fish/min). These results suggest that either the stream section within the crossing was an important spawning and rearing area for this species, or Arctic grayling spawned at upstream locations and the young-of-the-year fish drifted downstream to rear in this section. The absence of suitable spawning substrates at the proposed crossing indicates that the latter explanation is correct. Fish habitat within the study section was rated as low (1) for spawning, high (3) for rearing, moderate for adult feeding (2) and high for movement (3).

3.2 ROUTE TWO

The modified alignment of Route Two crossed ten watercourses that had the potential to support fish. Only one of these crossings (Stream 45.3), was previously inventoried in 1996.

STREAM 36.7 **UTM: 12W 0508025 73774431** **PLATE 3**

This crossing traverses a wide shallow watercourse that connects a headwater lake to Lake 501. The stream channel was ill-defined and dispersed. The stream substrate was dominated by large boulders and the stream channel was very wide (51.7 m). Flowing water was present during the spring survey, but the channel was dry during summer.

No fish were encountered at this crossing and fish habitat was extremely limited. Fish may move through the section during the spring period to access the headwater lake, however, it has little value for all other life requisites.

STREAM 41.8 **UTM: 12W 0506176 7378165** **PLATE 4**

This stream connects a series of small headwater lakes to Lake 501 and is within the immediate vicinity of the proposed Lake 501 Camp and airstrip (Figure 3.1). Stream 41.8 was small with an average width of 1.0 m during base flow and 1.6 m during the spring freshet. The stream banks were well-defined and were composed of organic substrates underlain by gravels. Fish habitat consisted of extensive RUNS interspersed by RIFFLE and POOL habitats and gravel was the dominant substrate. The stream at the proposed crossing provided high quality habitat for fish.

Fish encountered during the survey included Arctic grayling, lake trout and slimy sculpin. During spring, the catch was dominated by Arctic grayling (7 juveniles and 3 adults). In summer, 40% of the catch consisted of juvenile lake trout (10 fish), while Arctic grayling accounted for 44% of the sample (8 young-of-the-year and 3 juveniles), and slimy sculpin comprised the remainder (16% or 4 fish). The presence of adult Arctic grayling in spring and young-of-the-year Arctic grayling in summer within the proposed crossing indicates that the area is used for spawning and rearing purposes. It is likely that juvenile lake trout moved up to this stream section during summer for rearing. Given the stream characteristics (i.e., well-defined channel, gravel substrates and water flow during summer) fish habitat within the crossing areas was rated as high (3) for spawning, rearing and movement, and moderate (2) for adult feeding.

An alternate crossing location on Stream 41.8 (UTM: 12W 0506536 7378573) was identified several hundred metres upstream of the proposed crossing. This site did not contain high quality fish habitat.

STREAM 43.5 **UTM: 12W 0505153 7379179** **PLATE 5**

This crossing traverses a small ephemeral stream that flows into a small deep lake situated 100 m downstream of the crossing. The stream channel was well-defined, but small (1.0 wide during spring). Habitat at the crossing consisted of shallow RUN; the dominant substrates were gravel and sand. Water was present during spring, but this stream was dry at the time of the summer survey.

Two juvenile burbot were encountered during the spring survey (CPUE=0.4 fish/min). It is likely that these fish entered the stream for rearing purposes, but moved out of the system as flows receded. Fish habitat was limited at the crossing. It was rated as moderate for spawning and rearing, and nil for adult feeding and movement.

STREAM 45.3 **UTM: 12W 0504814 7381306** **PLATE 6**

This crossing traverses a small, ill-defined stream dominated by boulder substrates, which flows into a small deep lake situated 200 m downstream of the crossing. Fish habitat at the crossing was DISPERSED. Water was present during spring, but this stream was dry at the time of the summer survey. No fish were recorded at this site. It is possible that some fish from the lake may move into the stream on an opportunistic basis to rear, but fish habitat was severely limited at the crossing.

STREAM 46.9 **UTM: 12W 0505419 7382972** **PLATE 7**

This crossing traverses a wide shallow watercourse. The stream channel was ill-defined and dispersed. The stream substrate was dominated by large boulders and the stream channel was very wide (66.3 m). Flowing water was present during the spring survey, but the channel was dry during summer.

No fish were encountered at this crossing during the survey. Fish habitat at the stream crossing was extremely limited. Fish may move through the section during the spring period, however, it has little value for all other life requisites.

STREAM 56.1 UTM: 12W 0503839 7391026 PLATE 8

This crossing traverses a small well-defined stream with an average width of 2.5 m during base flow and 3.2 m during the spring freshet. The stream was dominated by cobble and gravel substrates. The stream banks were well-defined and were composed of organic substrates underlain by boulder substrates. Fish habitat consisted of RUNS interspersed by RIFFLE habitats. The stream at the proposed crossing provided good quality habitat for fish.

Despite the existence of good quality spawning and rearing habitat, no fish were encountered at this crossing. It is likely that access to the site is limited by barriers to fish that were situated downstream of the crossing.

STREAM 58.8 UTM: 12W 0503814 7393946 PLATE 9

This crossing traverses a wide shallow watercourse that is ill-defined and dispersed. The stream substrate was dominated by large boulders and the stream channel was very wide (65.0 m). No fish were encountered at this crossing during the survey and fish habitat at the stream crossing was extremely limited. Fish may move through the section during the spring period, however, it has little value for all other life requisites.

STREAM 64.8 UTM: 12W 0502654 7399260 PLATE 10

This crossing traverses a small shallow ill-defined stream that flows into a small deep basin immediately downstream of the crossing. The stream had an average width of 11.0 m during base flow and 11.2 m during the spring freshet and the substrate was dominated by cobbles and boulders. Fish habitat was dominated by DISPERSED areas interspersed by RIFFLE habitats. The stream at the proposed crossing provided good quality habitat for fish.

Two juvenile lake trout were encountered (CPUE=0.6 fish/min) and it is likely that these fish entered the stream for rearing purposes. Fish habitat was rated as nil to moderate for spawning and low to moderate for rearing.

STREAM 66.1 UTM: 12W 0502253 7400217 PLATE 11

This crossing traverses a very wide shallow watercourse that is ill-defined and dispersed. The stream substrate was dominated by large boulders and the stream channel was 80.0 m wide. No fish were encountered at this crossing during the survey and fish habitat was extremely limited. Fish may move through the section during the spring period, however, it has little value for all other life requisites.

STREAM 70.8 **UTM: 12W 0501018 7404130** **PLATE 12**

This crossing traverses a small ephemeral stream that flows into a small deep lake situated immediately downstream of the crossing. The stream channel was well-defined, but small (2.2 m wide during spring). Habitat at the crossing consisted of shallow RUN; the dominant substrates were gravels and cobbles. Water was present during spring, but this stream was dry at the time of the summer survey. No fish were recorded during the survey and fish habitat was limited at the crossing; it was rated as nil to low for all life requisites.

3.3 ROUTE THREE

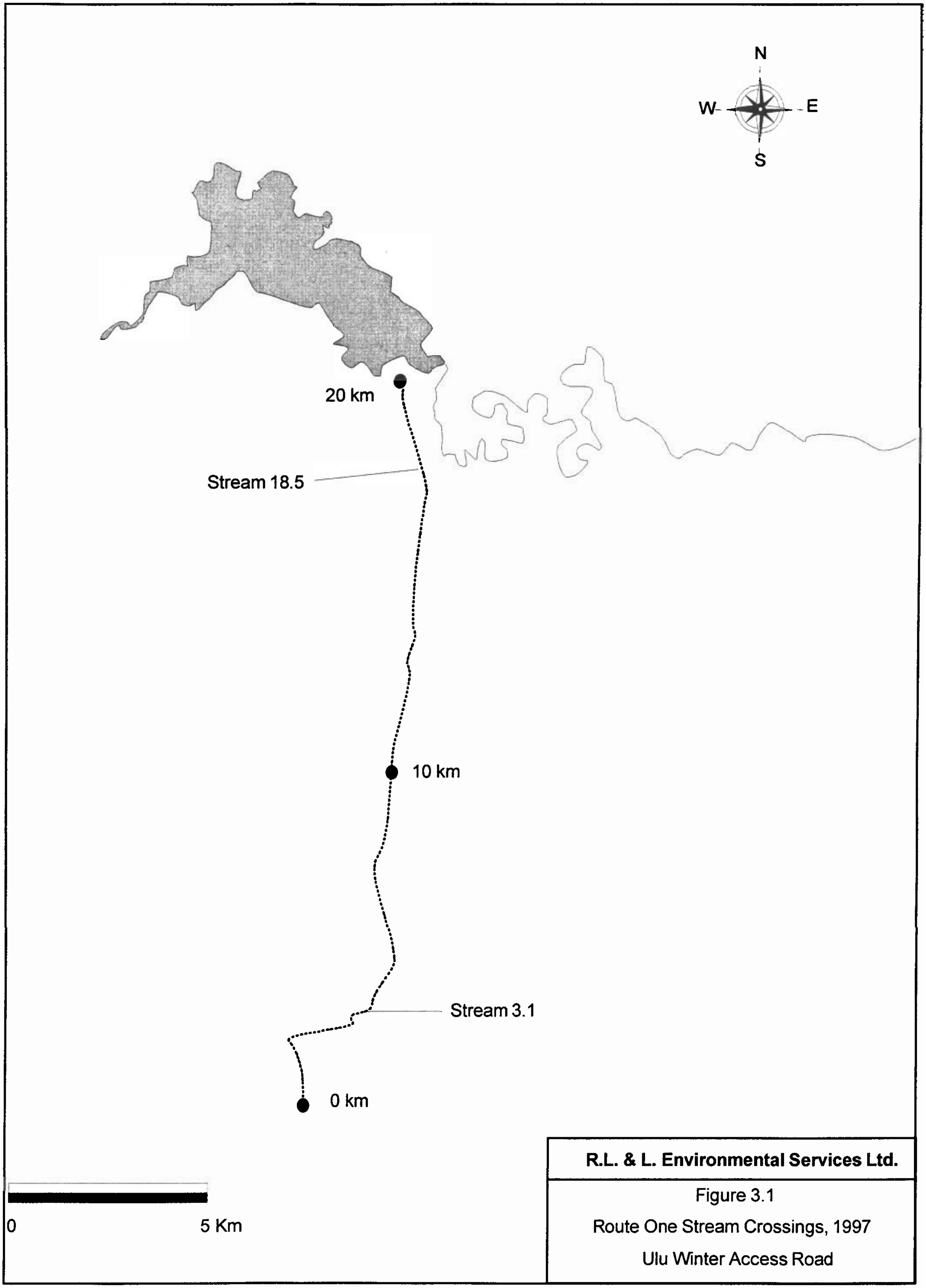
The new alignment of Route Three crossed only one watercourse that had the potential to support fish (Stream 118.2), which was located just south of Camp 3 at Reno Lake. This crossing was not inventoried during the 1996 survey.

STREAM 118.2 **UTM: 12W 0499705 7410668** **PLATE 13**

This small stream is situated north of the Hood River and drains into a small shallow lake situated approximately 1 km downstream of the crossing. Habitat recorded at the crossing consisted of shallow RIFFLE/RUN complexes interspersed by short sections of POOL habitat. The stream substrate was dominated by boulders. The wetted width of the stream at the crossing was 0.8 m during base flow and 1.7 m during the spring freshet. The stream banks were composed of boulder substrates, exhibited low slopes and were very stable.

Despite the presence of good quality spawning and rearing habitats at the crossing, no fish were encountered during the spring or summer surveys. The absence of fish suggests that this stream section is not accessible and therefore, has little value to fish. Consequently, fish habitat at the crossing was given a low or nil rating for all life requisites.

SECTION 3.0 FIGURES

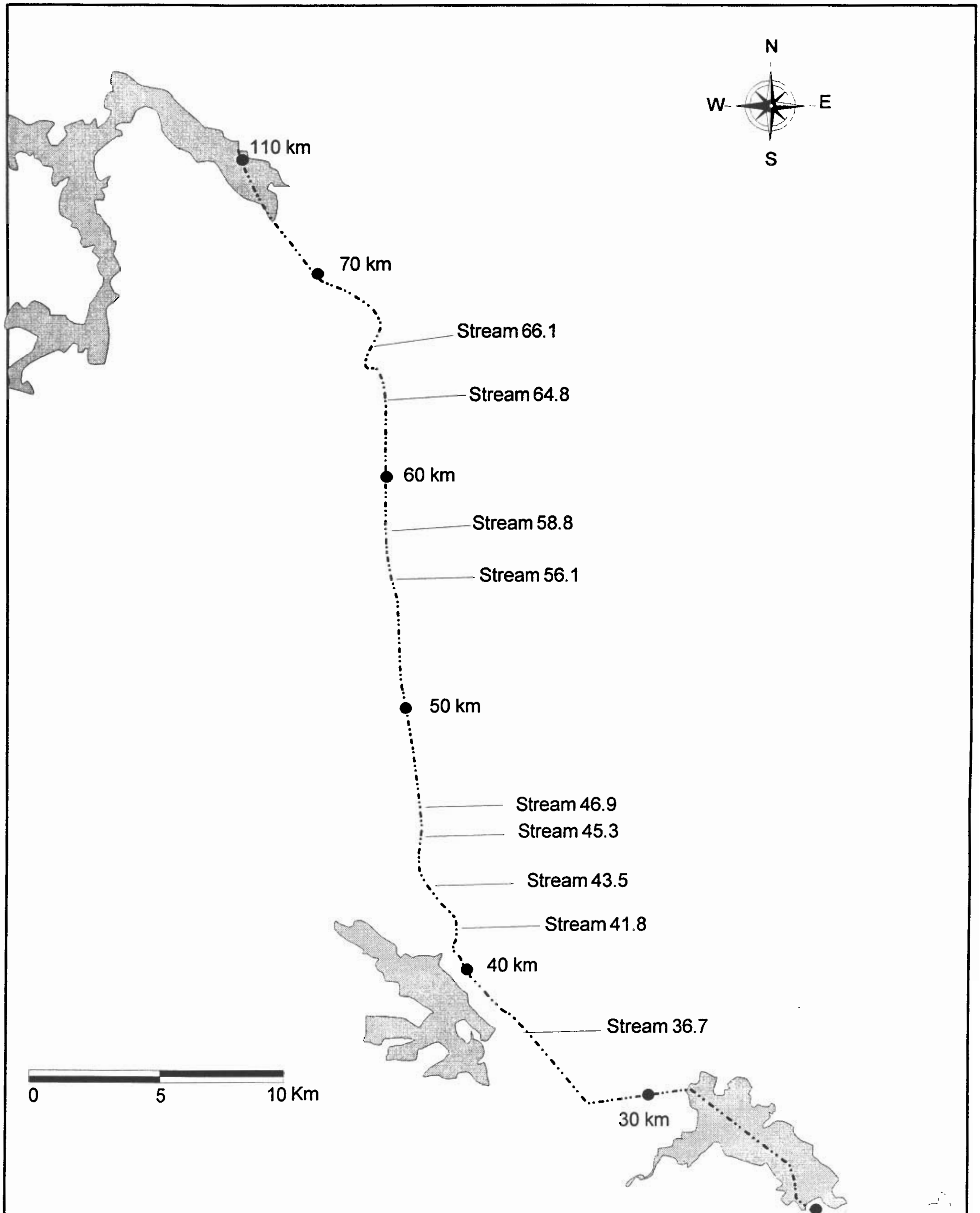


R.L. & L. Environmental Services Ltd.

Figure 3.1

Route One Stream Crossings, 1997

Ulu Winter Access Road

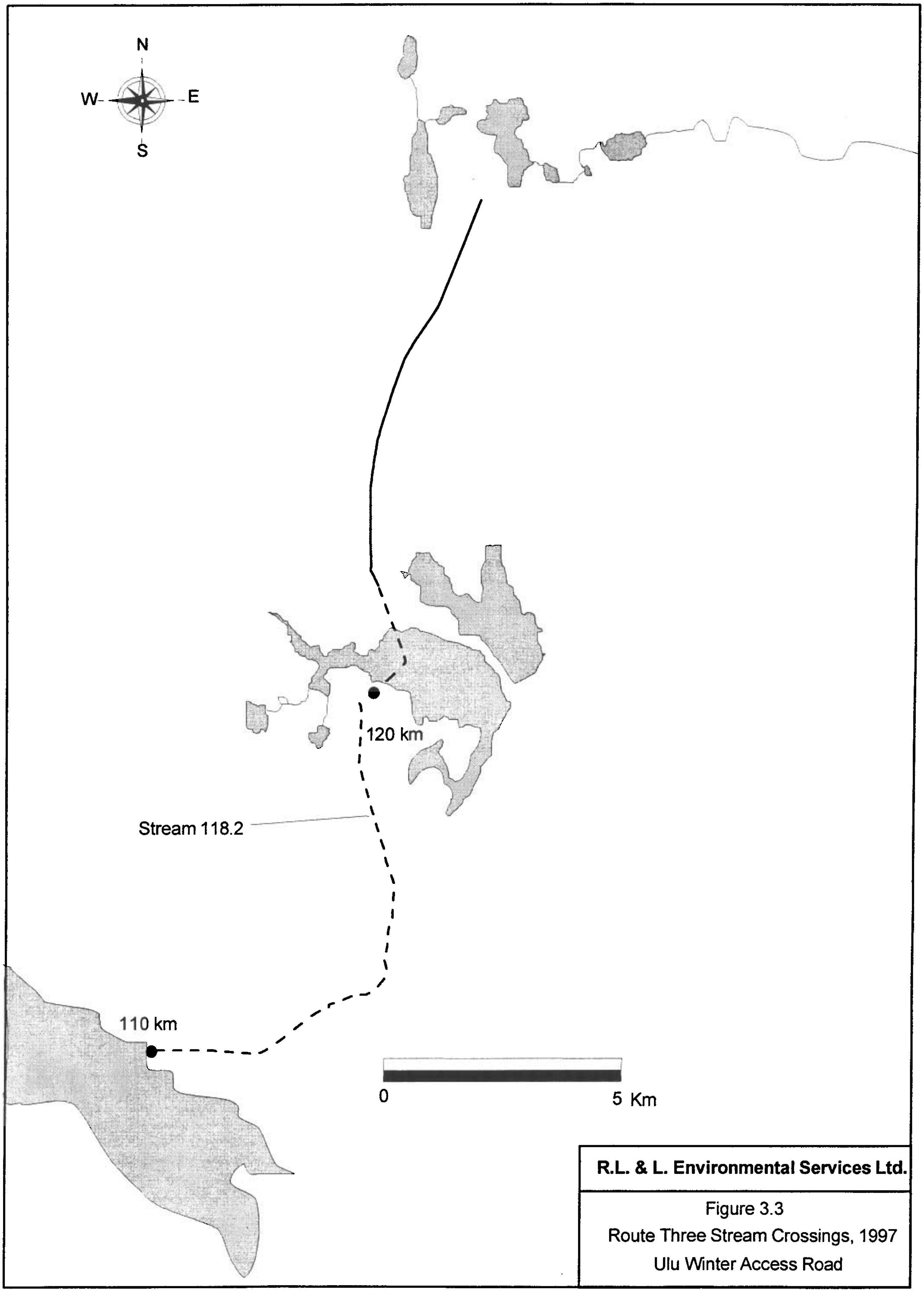


R.L. & L. Environmental Services Ltd.

Figure 3.2

Route Two Stream Crossings, 1997

Ulu Winter Access Road



R.L. & L. Environmental Services Ltd.

Figure 3.3
Route Three Stream Crossings, 1997
Ulu Winter Access Road

4.0 ULU EXPLORATION AREA

Baseline aquatic inventory data were collected from six lakes potentially influenced by the proposed development. West Lake, East Lake, Ulu Lake and Meadow Lake are situated immediately adjacent to or downstream of the Ulu deposit. Reno Lake South and Reno Lake North are located adjacent to the proposed service area and fuel depot at Camp 3. In addition to lake surveys, inventory data were also collected from Ulu Creek and Frayed Knots River, two streams that form the Ulu Creek drainage system between the development area and the Hood River (Figure 4.1.).

The 1997 program was a continuation of the baseline survey initiated in 1996 (R.L. & L. Environmental Services Ltd. 1996). Waterbodies investigated at that time included West Lake, Ulu Lake, Reno Lake South and Reno Lake North. Whenever appropriate, data from the 1996 survey have been incorporated and compared to the information presented for the current study. This section provides summary results for selected lakes and streams in the Ulu Exploration Area.

4.1 EAST LAKE

East Lake is located immediately south of the exploration area at the base of the ridge on which the site is located (Figure 4.1). East Lake receives inputs from surface water run off, from the camp's sewage disposal system and from the potential ore and waste rock stock piles. There are no defined inlet or outlet streams associated with this waterbody, however, excess water exists the basin via a subsurface watercourse that flows into Ulu Lake. The physical characteristics of the outlet channel create a complete barrier to fish passage. The small size and isolated position of East Lake precluded the existence of fish, therefore, no inventories of aquatic biological community were undertaken in this waterbody. Sampling undertaken in East Lake included measurements of lake morphology, lake limnology and water chemistry.

4.1.1 Lake Morphology and Limnology

East Lake is the smallest waterbody inventoried in the Ulu Exploration Area (1.8 ha) and consists of a single basin with a maximum water depth of 6.2 m (Figure 4.2). Based on a bathymetric assessment of the basin it has a maximum water capacity of 40 900 m^3. The shoreline is dominated by large boulder substrates.

Temperature and dissolved oxygen profiles were recorded from the basin on 31 July (Figure 4.3; Appendix C1). The temperature profile indicated that a thermocline existed at 4.0 m depth. Water temperatures above this point were uniform (10.8°C) but dropped to 4.9°C at the bottom. Dissolved oxygen concentrations also differed dramatically (11.2 mg/L at the surface and 4.0 mg/L at the bottom). The existence of a thermocline in this small basin was likely due in part to its sheltered location which protects it from wind. However, the waterbody contained elevated concentrations of anions (see Section 4.1.2), which would have induced stratified conditions.

The decline in oxygen concentrations below the thermocline may have resulted from high oxygen demand and lack of mixing.

Water transparency was low in East Lake. Based on Secchi depth reading, the euphotic zone (depth to 1% light penetration where algae can still subsist = 2 × Secchi depth) was 0.9 m. The low value was due to the high density of the phytoplankton community at the time of sampling. This phytoplankton "bloom" was likely the result of the high nutrient load in this basin (see Section 4.1.2).

4.1.2 Water Chemistry

Routine water chemistry analyses were undertaken using a single grab sample collected from the water surface. Because of the influence from the Ulu Exploration camp sewage disposal system, the water chemistry of East Lake is not typical of an oligotrophic subarctic waterbody. The analyses indicated that levels of several parameters were elevated (Table 4.1; Appendix C2). For example, total dissolved solids was 276 mg/L and water hardness was 76.2 mg/L. Electrical conductivity was high (606 uS/cm), which was an indication of a high ion balance. Concentrations of ions such as chloride, sulphate, sodium and calcium were all elevated. Some nutrients followed a similar pattern; ammonia nitrogen was 3.88 mg/L and total nitrogen exceeded 7.7 mg/L.

Table 4.1 Routine water chemistry analyses results for a surface sample collected on 31 July from East Lake, Ulu Exploration Area 1997.

Parameter (mg/L unless otherwise indicated)	Value
Physical Tests	
Total Dissolved Solids	276
Hardness as CaCO3	76.2
pH @ 20°C	6.70
Dissolved Ions	
Ionic Balance (%)	105
Electrical Conductivity (μS/cm)	606
Alkalinity - Total as CaCO3	19
Alkalinity - Bicarbonate	23
Chloride	139
Sulphate	14.3
Potassium	2.86
Manganese	0.049
Magnesium	6.4
Sodium	82.4
Calcium	20
Iron	<0.04
Nutrients	
Ammonia Nitrogen	3.88
Nitrate Nitrogen	7.79
Nitrite Nitrogen	0.08
Nitrate + Nitrite--Total Nitrogen	7.87
Total Kjeldahl Nitrogen	2.95
Total Dissolved Phosphorous	0.07
Total Phosphorous	0.07

4.2 ULU LAKE

Ulu Lake is located immediately east of the exploration site at the base of the ridge on which the site is located (Figure 4.1). Ulu Lake receives inputs of water from surface runoff and from three inlet streams (Figure 4.4). However, its principal source of water originates from the West Lake drainage (Inlet 1), which enters at the northeast end of Ulu Lake. Although, no water was observed in this inlet stream during 1996 (R.L. & L. Environmental Services 1996), flows were documented in both spring and summer during the present study.

The outlet of Ulu Lake is located at its southeast corner. The outlet stream (Ulu Creek) is a small boulder-filled channel that exhibits largely subsurface water. Ulu Creek flows over a sheer bedrock face (>10 m in height) before it flows into Meadow Lake. The physical characteristics of this stream section created a complete barrier to fish passage, therefore, the fish community in Ulu Lake is resident.

4.2.1 Lake Morphology and Limnology

Ulu Lake is the largest waterbody surveyed in the vicinity of the Ulu deposit, but it has a small surface area (35.0 ha). It is bordered on the west and north sides by steep bedrock ridges, while to the east and south the topography becomes flatter. The entire shoreline is dominated by large rock substrates. Some smaller cobble and gravel substrates are present along the northern shoreline. The east side of the lake is shallow with a large boulder field near the outlet stream.

A bathymetric survey of Ulu Lake indicates that it consists of one large basin with several smaller sub-basins (Figure 4.5). The deepest area of the lake is located near its centre (16.3 m). The maximum water capacity of this waterbody is 1 430 000 m^3.

Temperature and dissolved oxygen profiles were recorded from a single location on Ulu Lake on 30 July (Figure 4.6; Appendix C1). The temperature profile indicated uniform mixing (i.e., isothermal conditions). Water temperatures and oxygen concentrations did not vary between the surface and bottom (13.5°C and 10.4 mg/L). Water transparency in Ulu Lake was relatively high at the time of sampling (6.5 m).

4.2.2 Water Chemistry

Routine water chemistry analyses were undertaken using a single grab sample collected from the water surface. The analyses indicated that levels of several parameters were typical of an oligotrophic subarctic lake (Table 4.2; Appendix C2). For example, total dissolved solids was 21 mg/L and water hardness was 10.9 mg/L. Electrical conductivity was low (42 uS/cm) as were concentrations of ions such as chloride, sulphate, sodium and calcium. Nutrients followed a similar pattern; ammonia nitrogen and total nitrogen were both below detectable levels (<0.05 mg/L).

Table 4.2 Routine water chemistry analyses results for a surface sample collected on 30 July from Ulu Lake, Ulu Exploration Area 1997.

Parameter (mg/L unless otherwise indicated)	Value
Physical Tests	
Total Dissolved Solids	21
Hardness as CaCO3	10.9
pH @ 20°C	6.70
Dissolved Ions	
Ionic Balance (%)	90
Electrical Conductivity (uS/cm)	42
Alkalinity - Total as CaCO3	6
Alkalinity - Bicarbonate	7
Chloride	5.2
Sulphate	5.7
Potassium	<0.60
Manganese	0.004
Magnesium	1.1
Sodium	2.4
Calcium	2.5
Iron	<0.04
Nutrients	
Ammonia Nitrogen	<0.05
Nitrate Nitrogen	<0.05
Nitrite Nitrogen	<0.05
Nitrate + Nitrite--Total Nitrogen	<0.05
Total Kjeldahl Nitrogen	<0.05
Total Dissolved Phosphorous	<0.05
Total Phosphorous	0.24

4.2.3 Aquatic Invertebrates

Phytoplankton, zooplankton and benthic macroinvertebrate samples were collected from Ulu Lake on 30 July. Collections were undertaken to provide a qualitative assessment of the aquatic invertebrate community in Ulu Lake during the open water period. Relevant data are summarized in the following sections; all data are presented in Appendices D1 to D3.

Phytoplankton

Phytoplankton biovolume (microns cubed per metre cubed or $\mu m^3/m^3$) and density (No. cells/mL) are presented in this section because density alone does not provide an accurate assessment of a taxon's importance. Taxa that have large biovolumes due to large individual organism size may not be numerically abundant, but can contribute significantly to lake productivity. As such, an assessment of density alone does not reflect their importance to the system.

In total, 53 species of phytoplankton were identified from the sample collected from Ulu Lake, which represented a biovolume of 892 971 $\mu m^3/m^3$ (Appendix D2). In terms of biovolume, the phytoplankton community was dominated by golden-brown algae (74%) followed by lower percentages of diatoms (15%) and cryptomonads (7%). All other major groups of phytoplankton (green algae, dinoflagellates, euglenoids and cyanobacteria) contributed <2% to the phytoplankton community biovolume.

The relative importance of the most numerous species within each of the six major taxonomic groups varied. The golden-brown algae *Chrysosphaerella rodhei* was the dominant species in the sample (1561 cells/mL). The cyanobacterium *Aphanothece clathrata* was also abundant (932 cells/mL).

Zooplankton

Summary results of zooplankton biomass (micrograms per metre cubed or $\mu g/m^3$) and density (No./m^3) are both presented in this section because, as with phytoplankton, density alone does not provide an accurate assessment of a taxon's importance.

In total, 11 species were identified in the Ulu Lake sample, which represented a biomass of 5 733 491 $\mu g/m^3$ (Appendix D3). Cladocera was the dominant taxonomic group in terms of percent biomass (94%); each of the other groups (calanoid copepods, cyclopoid copepods and rotifers) accounted for <3% of the remaining biomass. Among the cladocera, *Holopedium sp.* was the numerically dominant genus (3321 animals/m^3). Rotifers were dominated by *Kellicottia longispina* (204 074 animals/m^3), while *Leptodiaptomus sicilis* dominated the calanoid copepods (10 009 animals/m^3) and *Cyclops scutifer* was the most numerous cyclopoid copepod (6072 animals/m^3).

Benthic Macroinvertebrates

The sampling program was designed to obtain qualitative information of the benthic macroinvertebrate community. During summer, three replicate samples were collected from a single site located in the littoral zone (water depth <5 m) of Ulu Lake.

In total, 8 taxa were identified in the Ulu Lake sample, which represented a total mean density of 2913 animals/m^2. Summary data are provided in Table 4.3; all relevant data are presented in Appendix D4. Chironomidae larvae as a group were the most abundant taxa present with a mean density of 1196 animals/m^2. Sphaeriid clams also dominated the littoral benthic macroinvertebrate community (1290 animals/m^2). The only other benthic invertebrate that exhibited a high density were ostracods (239 animals/m^2).

Table 4.3 Mean density[a] (± standard error) of benthic macroinvertebrates collected on 30 July from the littoral zone of Ulu Lake, Ulu Exploration Area 1997.

Taxonomic Group	Mean Density (No./m^2)
ANNELIDA	
OLIGOCHAETA	
Lumbriculidae	43
ARTHROPODA	
HYDRACHNIDIA	65 (17.7)
CRUSTACEA	
COPEPODA	
Harpacticoida	174 (35.5)
OSTRACODA	239 (159.7)
INSECTA	
DIPTERA	
Chironomidae[b]	
Chironomini	203 (101.4)
Diamesinae/Orthocladiinae	500 (53.2)
Tanypodinae	449 (297.4)
Tanytarsini	43
Subtotal	**1196 (452.0)**
TRICHOPTERA	
Limnephilidae	87
MOLLUSCA	
PELECYPODA	
Sphaeriidae	1290 (101.4)
MICROTURBELLARIA	196 (88.7)
NEMATODA	130 (71.0)
Total No. Aquatic Taxa/m^2	**8 (1.8)**
Total No. of Aquatic Invertebrates/m^2	**2913 (697.5)**

[a]Mean density (No./m^2) value and standard error generated using three replicate samples.
[b]Sum of all subfamilies and tribes.

4.2.4 Fisheries

Fisheries collections were undertaken to provide a qualitative assessment of the fish community in Ulu Lake during the open water period. Relevant data are summarized in the following section; all data are presented in Appendices E1 and E2.

Two short duration gill net sets (total effort=13.5 h) and four gee traps (total effort= 16.0 h) were deployed in Ulu Lake. Only a single species, lake trout (*Salvelinus namaycush*), was encountered. The 14 fish recorded during one day of sampling represented a catch-per-unit-effort (CPUE) of 5.7 fish/100 $m^2 \cdot 12$ h or 1.0 fish/h of gill net set. The CPUE value recorded during the present study was slightly higher than the catch rate documented in 1996 (0.6 fish/h of gill net set). No fish were recorded in the gee traps.

To properly assess the life history characteristics of fish captured in Ulu Lake, data for 1996 and 1997 were combined for the summary analyses (Table 4.4 and Figure 4.7). The median fork length of lake trout in the sample was 415 mm (n=20), while the median age was 12 (n=7). The largest fish encountered was 740 mm in fork length and weighed 9000 g.

Table 4.4 Summary life history information for fish species captured during gillnetting in Ulu Lake during 1996 and 1997.

Species	Sample Size	Fork Length Range (mm)	Weight Range (g)	Age Range (Sample Size)
Lake trout	20	250-740	156-9000	7-18 (7)

Sexually mature fish were captured from Ulu Lake in 1997. These included three sexually mature females that ranged in fork length from 415 to 455 mm. These fish were aged between 13 and 18 years.

The stomach contents of seven fish that succumbed during sampling indicated that aquatic invertebrates were important food items consumed by lake trout in Ulu Lake. Zooplankton accounted for the highest percentage by volume (58%) followed by chironomid larvae (42%).

4.3 WEST LAKE

West Lake is situated adjacent to the ridge where the gold-bearing deposit is located (Figure 4.1). The lake serves as a source of potable water for the Ulu Exploration camp, which is located approximately 500 m to the east. The lake receives water from surface runoff water and from an intermittent stream that enters at the south end of the lake. The outlet of the lake is located at the north end, where there is a small boulder-filled channel that connects West Lake to the headwater stream of Ulu Lake. Water flow through the stream channel is largely subsurface, which does not permit fish to move between West Lake and Ulu Lake. As such, the fish community in West Lake is resident.

4.3.1 Lake Morphology and Limnology

West Lake is the second largest waterbody in the immediate vicinity of the Ulu deposit (8.6 ha). It is situated in a long narrow valley and its shoreline consists primarily of vertical bedrock faces and large boulder substrates (Figure 4.8). A large boulder reef located in the northern part of the lake partially divides the waterbody into two basins.

A bathymetric survey of West Lake indicates that it consists of two basins (Figure 4.9). The deepest and largest basin of the lake is located near its western side (14.0 m), while the second smaller and shallower basin (10.9 m) is situated to the north. The maximum water capacity of West Lake is 387 000 m^3.

Temperature and dissolved oxygen profiles were recorded from a single location on West Lake on 2 August (Figure 4.10; Appendix C1). The temperature profile identified the existence of a thermocline at approximately 9.5 m. Water temperatures and oxygen concentrations above this thermocline generally did not vary (12.5°C and 10.8 mg/L). Below the thermocline the water temperature fell to 7.8°C, while dissolved oxygen rose to 12.9 mg/L. The water transparency in West Lake was high at the time of the sampling (10.1 m).

4.3.2 Aquatic Invertebrates

Phytoplankton, zooplankton and benthic macroinvertebrate samples were collected from West Lake. Collections were undertaken to provide a qualitative assessment of the aquatic invertebrate community in West Lake during the open water period.

Phytoplankton

In total, 30 species of phytoplankton were identified from the sample collected from West Lake, which represented a biovolume of 1 014 328 $\mu m^3/m^3$ (Appendix D2). In terms of biovolume, the phytoplankton community was dominated by golden-brown algae (93%) followed by a much lower percentage of green algae (3%) and cryptomonads (3%). All other major groups of phytoplankton (diatoms, dinoflagellates, euglenoids and cyanobacteria) contributed <1% to the phytoplankton community biovolume.

The relative importance in terms of density of the most numerous species within each of the six major taxonomic groups varied. Of the two groups with the greatest biovolume, *Chrysochromulina parva* was the dominant golden-brown algae species numerically (992 cells/mL). In the cyanobacterian group, *Anacystis montana* was most abundant species (1784 cells/mL).

Zooplankton

In total, 8 species were identified in the West Lake sample, which represented a biomass of 223 498 $\mu g/m^3$ (Appendix D3). Calanoid copepods was the dominant taxonomic group in terms of percent biomass (62%); cyclopoid copepods and rotifers accounted for 27% and 11% of the remaining biomass. Cladocera were not present in this sample. Among the calaniod copepods, *Leptodiaptomus sicilis* was the numerically dominant species (8284 animals/m^3). *Cyclops scutifer* was the most abundant cyclopoid copepod (313 animals/m^3), while rotifers were dominated by *Kellicottia cochlearis* (189 982 animals/m^3).

Benthic Macroinvertebrates

The sampling program was designed to obtain qualitative information of the benthic macroinvertebrate community. During summer, three replicate samples were collected from a single site located in the littoral zone of West Lake.

In total, 7 taxa were identified in the sample representing a total mean density of 3971 animals/m^2. Summary data are provided Table 4.5; all relevant data are presented in Appendix D4. Chironomidae larvae as a group were the most abundant taxa present with a mean density of 2551 animals/m^2. Sphaeriid clams were the only other taxa to dominate the littoral benthic macroinvertebrate community (1246 animals/m^2). All other benthic macroinvertebrates exhibited densities of < 150 animals/m^2.

4.3.3 Fisheries

Two short duration gill net sets (total effort = 13.3 h) and four gee traps (total effort = 25.7 h) were deployed in West Lake. Only a single species, lake trout, was encountered. The 12 fish recorded during one day of sampling represented a CPUE of 4.1 fish/100 m^2 · 12 h or 0.9 fish/h of gill net set. The CPUE value recorded during the present study was higher than the catch rate documented in 1996 (0.2 fish/h of gill net set). A possible explanation for this discrepancy may be the difference in sampling locations. No fish were recorded in the gee traps.

To properly assess the life history characteristics of fish captured in West Lake, data for 1996 and 1997 were combined for the summary analyses (Table 4.6 and Figure 4.11). The median fork length of lake trout in the sample was 387 mm (n=15), while the median age was 12 (n=3). The largest fish encountered was 422 mm in fork length and weighed 954 g.

Sexually mature fish were captured from West Lake in 1997. These included three sexually mature females that ranged in fork length from 399 to 422 mm. These fish were all aged 12 years.

Table 4.5 Mean density[a] (± standard error) of benthic macroinvertebrates collected on 2 August from the littoral zone of West Lake, Ulu Exploration Area 1997.

Taxonomic Group	Mean Density (No./m^2)
ANNELIDA	
OLIGOCHAETA	
Lumbriculidae	109 (17.7)
CRUSTACEA	
OSTRACODA	109 (53.2)
INSECTA	
DIPTERA	
Chironomidae[b]	
Chironomini	87 (0.0)
Diamesinae/Orthocladiinae	188 (29.0)
Tanypodinae	2000 (87.0)
Tanytarsini	275 (29.0)
Subtotal	**2551 (145.0)**
MOLLUSCA	
PELECYPODA	
Sphaeriidae	1246 (282.1)
NEMATODA	130
Total No. Aquatic Taxa/m^2	**7 (0.9)**
Total No. of Aquatic Invertebrates/m^2	**3971 (226.4)**

[a]Mean density (No./m^2) value and standard error generated using three replicate samples.
[b]Sum of all subfamilies and tribes.

Table 4.6 Summary life history information for fish species captured during gillnetting in West Lake during 1996 and 1997.

Species	Sample Size	Fork Length Range (mm)	Weight Range (g)	Age Range (Sample Size)
Lake trout	15	334-422	432-954	12-12 (3)

The stomach contents of four fish that succumbed during sampling indicated that aquatic invertebrates and fish were equally important food items consumed by lake trout in West Lake. Zooplankton, chironomid larvae and fish each accounted for the 33% of the stomach contents by volume.

4.4 MEADOW LAKE

Meadow Lake is situated immediately downstream of Ulu Lake and forms part of the Ulu Creek drainage system (Figure 4.1). The primary source of water for Meadow Lake is Ulu Creek, which enters at the west end of the lake (Figure 4.4). The outlet of Meadow Lake is situated along the eastern shore, where there is a small boulder field. Both the inlet and outlet streams traverse steep terrain and form complete barriers to fish passage. As such, any fish residing in Meadow Lake would be resident.

4.4.1 Lake Morphology and Limnology

Meadow Lake is the second smallest waterbody in the immediate vicinity of the Ulu deposit; it has a surface area of 14.0 ha. The lake is situated in a broad valley that is surrounded by steep rocky terrain. The parent material dominating the area is glacial till, which is composed of cobbles, gravels and sands. As such, the Meadow Lake basin is dominated by smaller substrates composed principally of sands. The shoreline exhibited a gentle slope and was dominated by tundra vegetation (e.g., sedges and shrubs).

A preliminary bathymetric survey of Meadow Lake indicates that it consists of one simple basin. Meadow Lake is shallow (maximum depth=3.7 m) with the deepest area located adjacent to the eastern shore.

Temperature and dissolved oxygen profiles were recorded from a single location on Meadow Lake on 31 July (Figure 4.12; Appendix C1). The temperature profile indicated uniform mixing (i.e., isothermal conditions). Water temperatures and oxygen concentrations did not vary between the surface and bottom (10.8°C and 10.3 mg/L, respectively). Water transparency in Meadow Lake was to the lake bottom (3.0 m).

4.4.2 Aquatic Invertebrates

Phytoplankton, zooplankton and benthic macroinvertebrate samples were collected from Meadow Lake. Collections were undertaken to provide a qualitative assessment of the aquatic invertebrate community in Meadow Lake during the open water period.

Phytoplankton

In total, 61 species of phytoplankton were identified from the sample collected from Meadow Lake, which represented a biovolume of 263 767 $\mu m^3/m^3$ (Appendix D2). In terms of biovolume, the phytoplankton community was largely composed of cryptomonads (25%), golden-brown algae (24%), green algae (21%) and dinoflagellates (18%). All other major groups of phytoplankton (diatoms, euglenoids and cyanobacteria) contributed <8%.

Individual species of phytoplankton were not abundant. The cyanobacteria *Microcystis flos-aquae* was the dominant species numerically in the sample (157 cells/mL). The green algae *Oocystis pusilla* was the next most numerous species (152 cells/mL).

Zooplankton

In total, 8 species were identified in the Meadow Lake sample, which represented a biomass of 113 292 $\mu g/m^3$ (Appendix D3). Cladocera was the dominant taxonomic group in terms of percent biomass (55%) followed by cyclopoid copepods (25%), rotifers (12%) and calanoid copepods (8%). Among the cladocera, *Daphnia middendorffiana* was the numerically dominant species (1175 animals/m^3). Rotifers were dominated by *Conochilus unicornis* (63 884 animals/m^3), while *Leptodiaptomus sicilis* dominated the calanoid copepods (1205 animals/m^3) and *Ectocyclops phaleratus* was the most numerous cyclopoid copepod (573 animals/m^3).

Benthic Macroinvertebrates

The sampling program was designed to obtain qualitative information of the benthic macroinvertebrate community. During summer, three replicate samples were collected from a single site located in the littoral zone of Meadow Lake.

In total, 11 taxa were identified in the sample representing a total mean density of 22 275 animals/m^2. Summary data are provided Table 4.7; all relevant data are presented in Appendix D3. Chironomidae larvae as a group were the most abundant taxa present with a mean density of 10 889 animals/m^2. Ostracods and nematodes were the only other abundant taxa (8986 animals/m^2 and 1884, respectively). No other benthic macroinvertebrates exceeded a density of 300 animals/m^2).

4.4.3 Fisheries

Two short duration gill net sets (total effort=9.1 h) and four gee traps (total effort= 9.0 h) were deployed in Meadow Lake to sample the fish community. Despite this sampling effort, no fish were captured. These results indicate that a viable fish community does not reside in Meadow Lake. Its small size, shallow water depth and isolated position within the watershed (inlet and outlet streams are barriers to fish passage) severely limits its value as fish habitat. It should be noted, however, that small numbers of slimy sculpin (*Cottus cognatus*) were recorded in the inlet area to Meadow Lake during backpack electrofishing in Ulu Creek. As such, Meadow Lake is used for overwintering purposes by this species.

Table 4.7 Mean density[a] (± standard error) of benthic macroinvertebrates collected on 31 July from the littoral zone of Meadow Lake, Ulu Exploration Area 1997.

Taxonomic Group	Mean Density (No./m^2)
ANNELIDA	
OLIGOCHAETA	
Lumbriculidae	174 (25.1)
Naididae	43
CRUSTACEA	
HYDRACARINA	65 (17.7)
OSTRACODA	8986 (1281.0)
INSECTA	
COLEOPTERA	
Dytiscidae	43 (0.0)
DIPTERA	
Chironomidae[b]	
Chironomini	43
Diamesinae/Orthocladiinae	812 (237.3)
Tanypodinae	4899 (427.7)
Tanytarsini	5145 (415.8)
Subtotal	**10 899 (1081.0)**
MOLLUSCA	
PELECYPODA	
Sphaeriidae	283 (159.7)
MICROTURBELLARIA	109 (17.7)
NEMATODA	1884 (446.5)
Total No. Aquatic Taxa/m^2	**10 (0.3)**
Total No. of Aquatic Invertebrates/m^2	**22 275 (1361.2)**

[a]Mean density (No./m^2) value and standard error generated using three replicate samples.
[b]Sum of all subfamilies and tribes.

4.5 RENO LAKE SOUTH

Reno Lake South is located south of the esker on which Camp 3 is situated (Figure 4.1). This waterbody is isolated from other lakes in the immediate vicinity and drains into the Hood River via a subsurface stream channel that is located at the southwestern end of the lake. There are several small streams draining into Reno Lake South along its northwestern shoreline. One watercourse did contain flowing water during the entire open water period, however, most streams entering Reno Lake South are intermittent. Given these characteristics, the fish community in Reno Lake South is resident.

4.5.1 Lake Morphology and Limnology

Reno Lake South is the larger of the two waterbodies surveyed in the vicinity of Camp 3 (276.4 ha) (Figure 4.13). A preliminary bathymetric survey of this lake indicates that it contains several basins. A long shallow (< 1.0 m) basin dominated by sand substrates is situated west of the narrows that are found directly south of Camp 3, while the largest basin in the lake exists east of these narrows. This large eastern basin is also dominated by sand substrates and is generally shallow (<3.0 m), however, a water depth of 12.3 m was recorded at one location near its western shore. Reno Lake South also contains two smaller basins at its southern end. The first is a narrow deep trench (maximum depth =10.0 m) dominated by rock substrates. The second smaller basin, situated due west of this trench, also contains rock substrates, but is much shallower (maximum depth <6.5 m). The northern shoreline of the lake is composed of sand with isolated boulder outcroppings. The southern shoreline of the lake consists of bedrock outcroppings.

Temperature and dissolved oxygen profiles were recorded at two locations on Reno Lake South on 4 August (Figure 4.14; Appendix C1). The temperature profile indicated uniform mixing (i.e., isothermal conditions) at both sites. Water temperatures and oxygen concentrations generally did not vary between the surface and bottom (12.0°C and 10.3 mg/L). Water transparency in Reno Lake South was high at the time of the sampling (7.5 m).

4.5.2 Fisheries

Two short duration gill net sets (total effort=12.9 h) and four gee traps (total effort= 33.7 h) were deployed in Reno Lake South. Lake trout was the only species encountered. The 26 fish recorded during one day of sampling represented a catch-per-unit-effort (CPUE) of 11.6 fish/100 $m^2 \cdot$ 12 h or 1.4 fish/h of gill net set. The CPUE value recorded during the present study was higher than the catch rate documented in 1996 (0.7 fish/h of gill net set). No fish were captured in the gee traps.

To properly assess the life history characteristics of fish captured in Reno Lake South, data for 1996 and 1997 were combined for the summary analyses (Table 4.8 and Figure 4.15). The median fork length of lake trout in the sample was 310 mm (n=50) and the median age was 4 years (n=3). The largest fish encountered was 466 mm in fork length and weighed 1098 g.

Table 4.8 Summary life history information for fish species captured during gillnetting in Reno Lake South during 1996 and 1997.

Species	Sample Size	Fork Length Range (mm)	Weight Range (g)	Age Range (Sample Size)
Lake trout	50	210-466	84-1098	4-5 (3)

No sexually mature fish were captured from Reno Lake South in 1997.

The stomach contents of eighteen fish that succumbed during sampling indicated that aquatic invertebrates were important food items. Zooplankton accounted for the highest percentage by volume (62%) followed by smaller amounts of chironomid larvae (19%), and sphaeriid clams (19%).

4.6 RENO LAKE NORTH

Reno Lake North is located immediately north of Camp 3 and is separated from Reno Lake South by a narrow esker (Figure 4.1). Similar to Reno Lake South, this waterbody is isolated from other lakes in the immediate vicinity and drains into the Hood River via a subsurface stream channel that is located at the southern end of the lake. There are several small intermittent streams draining into Reno Lake South along its northern shoreline. Given these characteristics, the fish community in Reno Lake North is resident.

4.6.1 Lake Morphology and Limnology

Reno Lake North is the smaller of the two waterbodies surveyed in the vicinity of Camp 3 (133.3 ha) (Figure 4.13). A preliminary bathymetric survey of this lake indicates that it contains one large basin. The western arm of the lake is very shallow (<0.50 m) and is dominated by sand substrates. Sand substrates also dominate in the remainder of the lake, although rock substrates are present along the northern shoreline. The northeastern part of the main basin of the lake is the deepest, with a maximum depth of approximately 18 m near the eastern shore. The shoreline of Reno Lake North is uniform, with sand and gravel found on the southeast, northwest and southern shorelines. Along the northern shoreline the geology changes into a series of boulder areas interspersed with bedrock outcrops.

Temperature and dissolved oxygen profiles were recorded at one location on Reno Lake North on 3 August (Figure 4.16; Appendix C1). The temperature profile indicated uniform mixing (i.e., isothermal conditions). Water temperatures and oxygen concentrations generally did not vary between the surface and bottom (12.0°C and 10.4 mg/L). Water transparency in Reno Lake North was relatively low at the time of the sampling (4.8 m), which likely resulted from high water turbidity. High wind speeds and wave action at the time of sampling had caused suspension of sands.

4.6.2 Fisheries

Two short duration gill net sets (total effort=10.9 h) and four gee traps (total effort= 33.6 h) were deployed in Reno Lake North. In total, 46 fish were captured during one day of sampling (36 lake trout and 10 round whitefish). It should be noted that in 1996, Arctic char (*Salvelinus alpinus*) was also captured in addition to lake trout and round whitefish. The 46 fish recorded represented a catch-per-unit-effort (CPUE) of 14.0 fish/100 $m^2 \cdot 12$ h or 4.2 fish/h of gill net set. The CPUE value recorded during the present study was higher than the catch rate documented in 1996 (1.1 fish/h of gill net set). No fish were captured in the gee traps.

To properly assess the life history characteristics of fish captured in Reno Lake North, data for 1996 and 1997 were combined for the summary analyses (Table 4.9 and Figure 4.17). The median fork length of lake trout in the sample was 384 mm. The largest lake trout encountered was 445 mm in fork length and weighed 1252 g. The median fork length of round whitefish in the sample was 399 mm. The limited sample of five Arctic char indicates that the median size of fish in the population is 380 mm. No fish sampled from Reno Lake North were aged.

Table 4.9 Summary life history information for fish species captured during gillnetting in Reno Lake North during 1996 and 1997.

Species	Sample Size	Fork Length Range (mm)	Weight Range (g)
Lake trout	58	192-445	74-1252
Round whitefish	25	160-427	52-932
Arctic char[a]	5	375-419	606-890

[a] Fish captured during 1996 program.

Several sexually mature fish were captured from Reno Lake North in 1997. Four lake trout ranged in fork length between 386 and 403 mm fork length. The three sexually mature round whitefish encountered during sampling ranged in size from 410 to 419 mm fork length.

The stomach contents of sixteen lake trout that succumbed during sampling indicated that aquatic invertebrates were important food items. Zooplankton accounted for the highest percentage by volume (50%) followed by smaller amounts of chironomid larvae (21%), and gastropods (24%). The stomach contents of three round whitefish also contained aquatic invertebrates, however, the sample was dominated by sphaeriid clams (100% by volume).

4.7 ULU CREEK DRAINAGE

The Ulu Creek drainage is the outlet system for waterbodies in the immediate vicinity of the Ulu Exploration Area (Figure 4.1). Water originating in East and West lakes flows into Ulu Lake. Ulu Creek originates as the outlet stream to Ulu Lake. Water from Ulu Lake drains into Meadow Lake via Ulu Creek and then flows east 4.5 km before entering the Frayed Knots River. From this point, the Frayed Knots River flows in a southerly direction for 9.5 km before entering the Hood River.

4.7.1 Physical Characteristics

Ulu Creek is a small stream that is ill-defined near its origin at Ulu Lake. Further downstream near Meadow Lake it becomes well-defined with an average width of 4.1 m and an average depth of 2.6 m (Appendix B2). The discharge of Ulu Creek on 16 June (spring period) was 1.82 cms near the outlet to Ulu Lake. Later on in summer during the base flow period (29 July) discharge at the same location was only 0.09 cms. At its confluence with the Frayed Knots River, the discharge of Ulu Creek on 29 July was 0.16 cms. For much of its length, Ulu Creek exhibits a low gradient and is dominated by organic and sand substrates. However, it does traverse three high gradient areas that are barriers to fish passage. The first is located only 0.9 km upstream of its confluence with the Frayed Knots River, therefore, Ulu Creek upstream of this barrier is not accessible to fish.

The Frayed Knots River is a much larger system than Ulu Creek; it has an average width of 40 m. Although not measured, the discharge of this river during base water flow in summer was estimated to be 10 cms. The river in the study section is characterized by extensive areas of low to moderate gradients containing sand, gravel, cobble and boulder substrates. These sections are interspersed by high gradient areas containing large boulder substrates. Typically, these high gradient areas terminate in large deep plunge pools. The depth of this river varies depending on location. In moderate gradient areas containing rock substrates, water depth rarely exceeds 1.0 m. However, several of the plunge pools exhibited depths >3.0 m. The Frayed Knots River within the section investigated does not contain any barriers to fish passage, therefore, this river has the potential to be used by fish originating from the Hood River.

4.7.2 Water Chemistry

The water sampling program initiated in 1996, which was designed to describe background water chemistry of lakes and streams in the Ulu Exploration Area, was repeated for selected waterbodies in 1997. An important objective of the 1997 program was to assess whether elevated concentrations of the hydrocarbon xylene, which were documented for some sites in 1996, persisted to the present period. The water sample collection sites used during the present study (Figure 4.18) corresponded closely with locations sampled in 1996. Exceptions included the omission of the West Lake site, the outlet of Ulu Lake (Site 6) and the second downstream site on the Hood River, and the inclusion of East Lake. Collections were made on 1 August 1997 during the base water flow period. Summary data are presented in this section; all raw data are provided in Appendix C2.

In general, concentrations of most water chemistry parameters were at or near the background levels documented in 1996 for most sites. These included parameters for routine water quality, nutrients, organics, total mercury and trace elements. More importantly, the slightly elevated levels of xylene recorded at Ulu Lake, at Station 4 in the Frayed Knots River and in the Hood River in 1996 were not recorded at these sites or any others during the present study. Xylene and all other hydrocarbons were below detectable levels.

The results of the water chemistry analyses did indicate that concentrations of several parameters were elevated in East Lake. For example, levels of the nutrients (Kjeldahl nitrogen, ammonia and total nitrogen) were several magnitudes higher in East Lake than in surrounding waterbodies (Figure 4.19). Despite these high values, only the level of ammonia (3.88 mg/L) was above the Canadian environmental water quality guidelines for the protection of aquatic life (CCME 1993). Levels of selected elements such as calcium, sodium, chloride and sulphur were also elevated as were levels for the trace metals nickel, strontium, and zinc. None of these elements exhibited concentrations above acceptable limits. These results, were expected for East Lake because it is the receiving waterbody for the camp's sewage effluent and the exploration site's waste rock dump .

Elevated levels of some elements were not restricted to East Lake, but were also evident to a lesser degree in the lakes and streams situated immediately downstream: Ulu Lake and Ulu Creek (Figure 4.19). These included elements such as calcium, sodium, chloride and sulphur, as well as the trace metals nickel, strontium and zinc. Levels recorded in these waterbodies were low, and in the case of trace metals, near background levels. However, the results provide a strong indication that East Lake is an integral part of the Ulu Lake drainage. Any chemical inputs into East Lake would reach Ulu Lake and Ulu Creek and possibly other waterbodies situated further downstream.

4.7.3 Fish

The fish community in the Ulu Creek drainage was investigated during the summer field session using a variety of methods including backpack electrofishing, angling and snorkelling. The sampling program was designed to document presence or absence of fish species and life stages (young-of-the-year, juveniles and adults) in the system to assess its importance to fish.

Three species of fish were recorded in Ulu Creek (Table 4.10). These were Arctic grayling (13% of sample), burbot (1%), and slimy sculpin (86%). All the Arctic grayling and burbot, along with the majority of slimy sculpin were recorded in the short section of Ulu Creek immediately upstream of its confluence with the Frayed Knots River. The remainder of the slimy sculpin were captured in the inlet area of Meadow Lake. Although considerable effort was expended to locate fish throughout Ulu Creek (see Appendix E1), no fish were encountered outside of these two small areas. The catch-per-unit-effort was indicative of the low numbers of fish encountered during sampling. CPUE values did not exceed 1.3 fish/min of sampling.

All the Arctic grayling recorded in Ulu Creek were young-of-the-year fish. These results suggested that the stream was used for spawning and rearing purposes by this species. It is most likely that adult fish entered Ulu Creek during early spring to spawn and then migrated out of the system upon completion of spawning.

Table 4.10 Species composition of fish recorded in the Ulu Creek drainage during summer 1997.

Stream	Species	Number	Percent	Average CPUE	Age-Group		
					Y-o-y	Juvenile	Adult
Ulu Creek	Arctic grayling	13	13.0	0.19	√		
	Burbot	1	1.0	0.02		√	
	Slimy sculpin	86	86.0	1.30	√	√	√
Frayed Knots River	Arctic grayling	143	47.8	1.10	√	√	√
	Lake trout	24	8.0	0.18			√
	Round whitefish	82	27.4	0.63			√
	Slimy sculpin	50	16.7	0.38	√	√	√

Four species of fish were recorded from the Frayed Knots River. Arctic grayling accounted for the highest percentage of fish encountered (48%). Round whitefish was second in importance (27%) followed by lower percentages of lake trout (8%) and slimy sculpin (17%). Arctic grayling and slimy sculpin were distributed throughout the river section inventoried, however, lake trout and round whitefish were restricted to the large plunge pools at the base of rapid areas. Although relatively high numbers of fish were recorded the CPUE values were low for all species (<1.0 fish/min). This was due to the large sampling effort expended (Appendix E1).

All age-groups of Arctic grayling were recorded during the survey of the Frayed Knots River. Young-of-the-year and juvenile Arctic grayling were distributed in shallow-water areas along the river margins. In contrast, adult Arctic grayling were located in large pools at the base of rapids. The lake trout and round whitefish age-groups encountered consisted entirely of adults and these fish were restricted to pool areas. The presence of large pools >3.0 m in depth strongly indicates that overwintering habitat is available for fish populations residing in the Frayed Knots River.

A small number of fish were sampled from the Ulu Creek drainage to assess their life history characteristics. The median fork length of the young-of-the-year Arctic grayling recorded in Ulu Creek was 29 mm (n=6). Adult Arctic grayling captured in the Frayed Knots River ranged in fork length from 300 to 417 mm and were 5 to 10 years of age (n=15). The seven lake trout captured in the Frayed Knots River ranged from 336 to 655 mm fork length.

SECTION 4.0 FIGURES

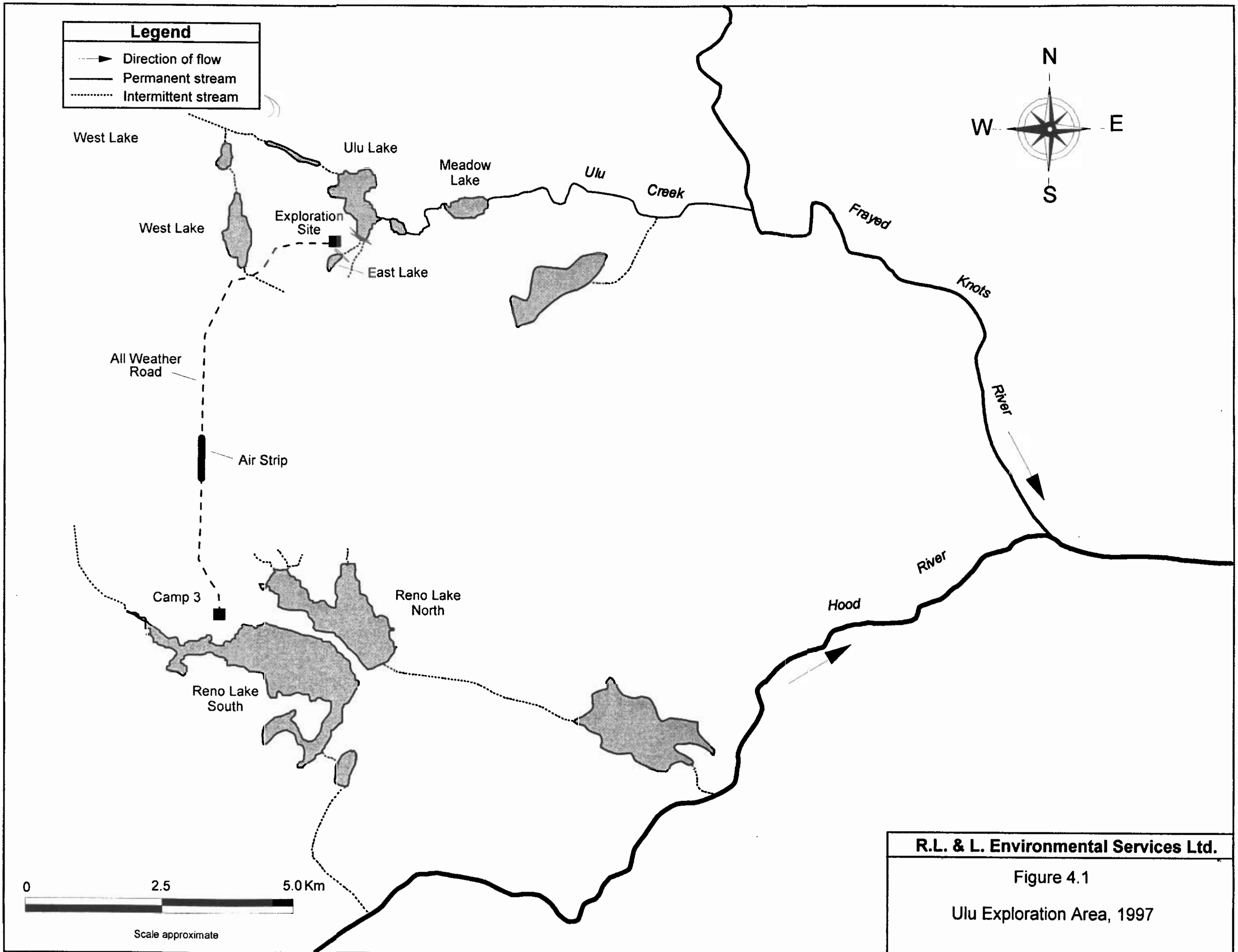


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Figure 4.1

Ulu Exploration Area, 1997

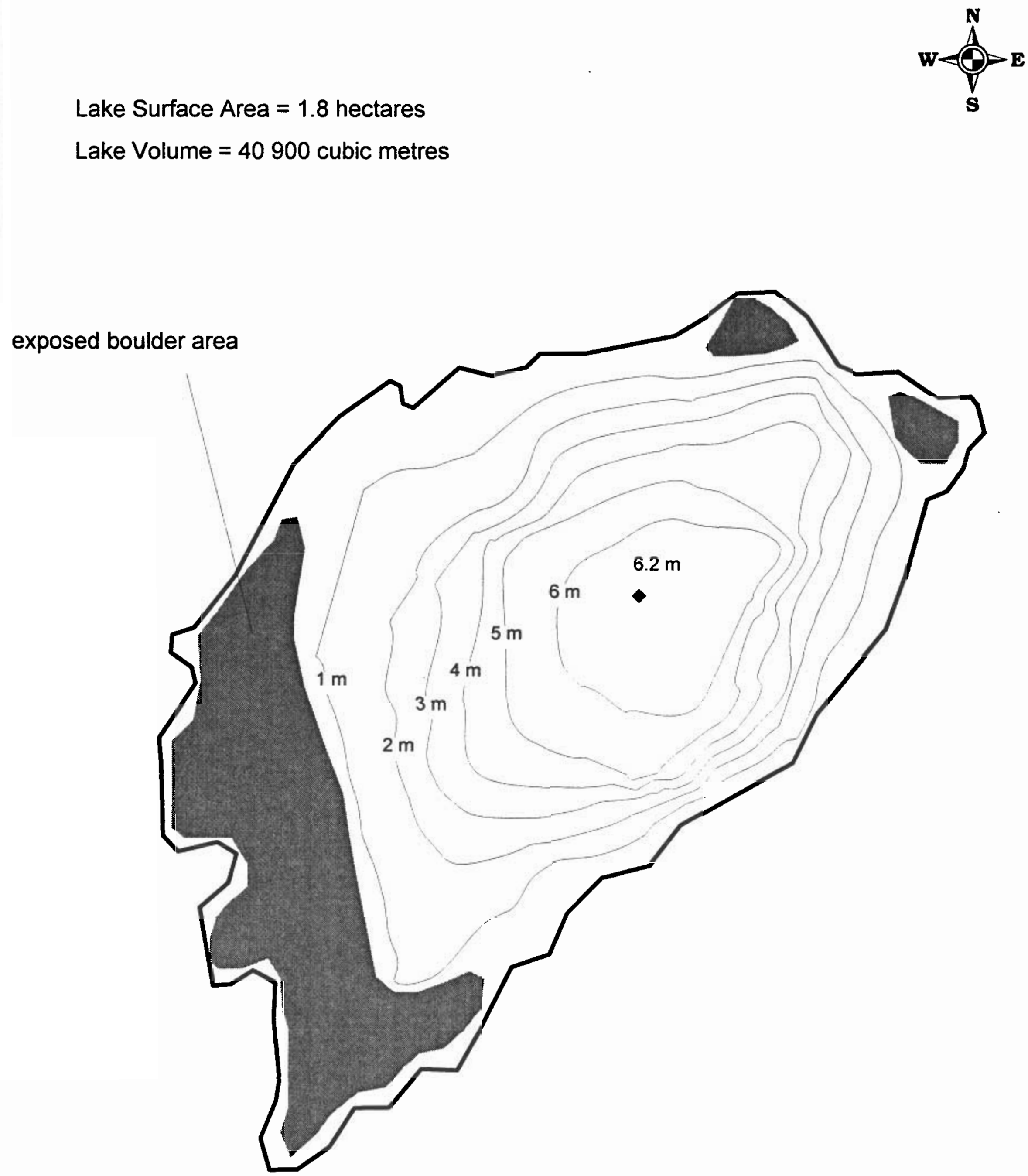

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Figure 4.2

Bathymetry of East Lake
Ulu Exploration Area 1997

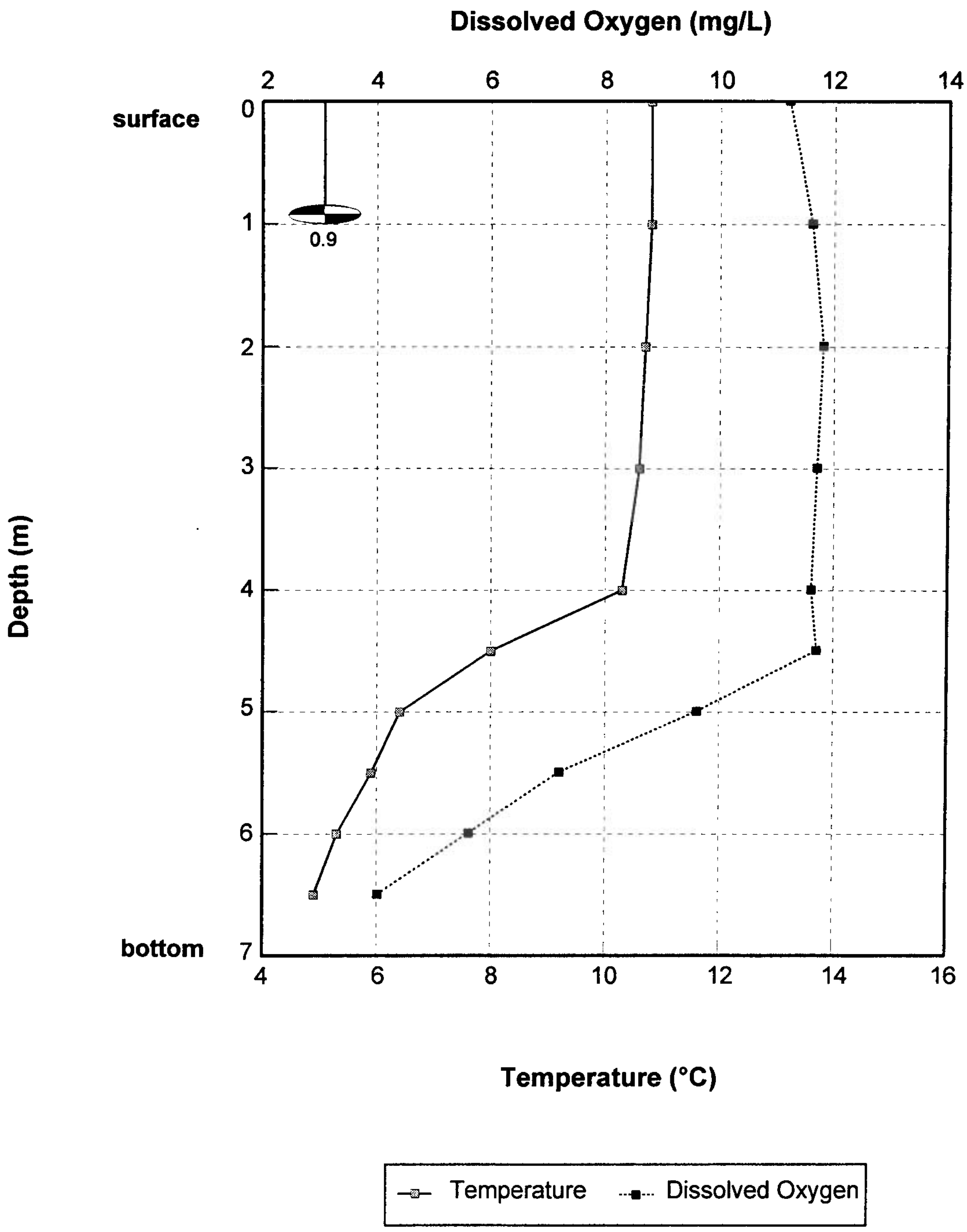

Figure 4.3 Dissolved oxygen and temperature profiles, and Secchi depth reading in East Lake on 31 July 1997, Ulu Exploration Area.

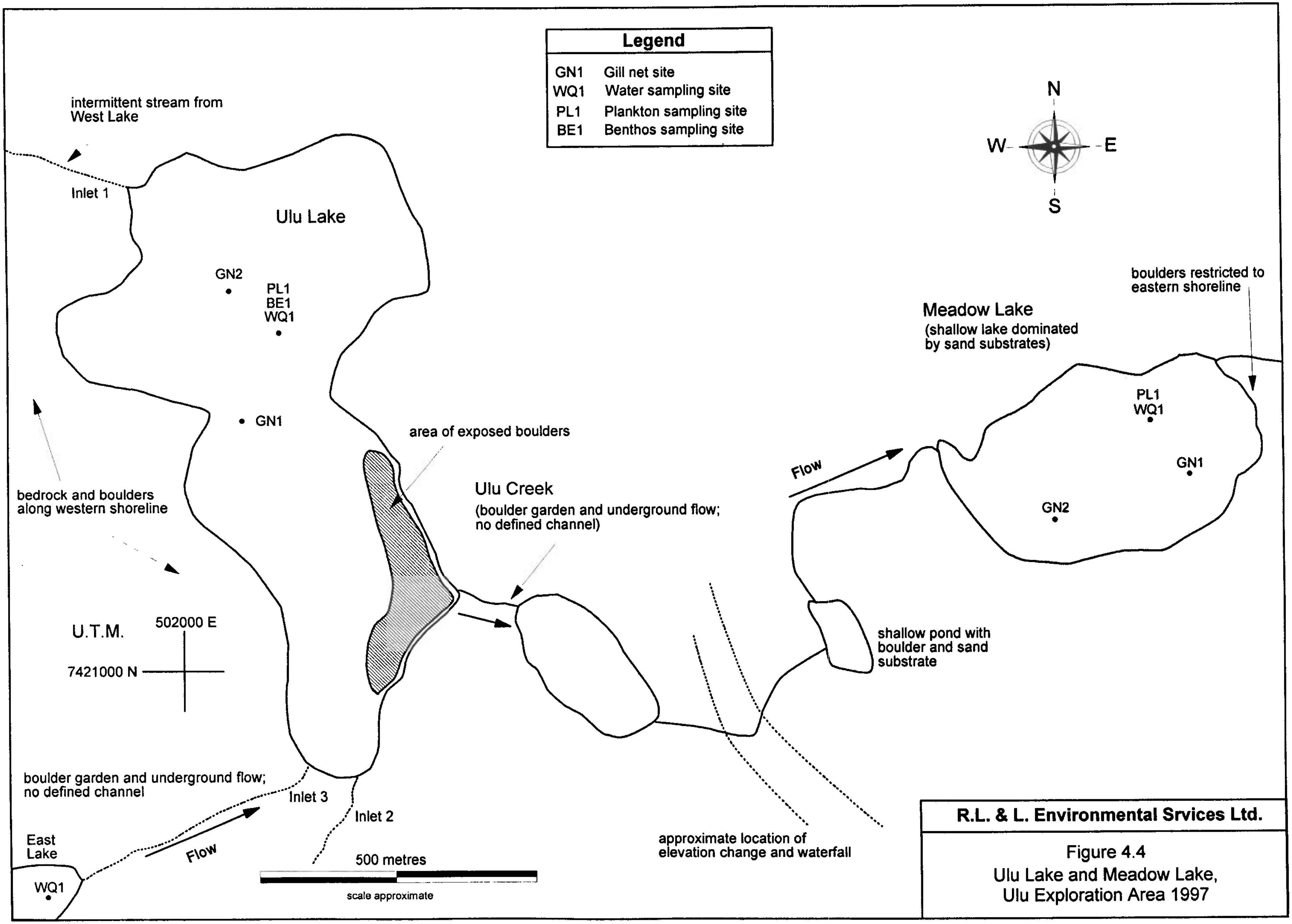

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Figure 4.4
Ulu Lake and Meadow Lake,
Ulu Exploration Area 1997

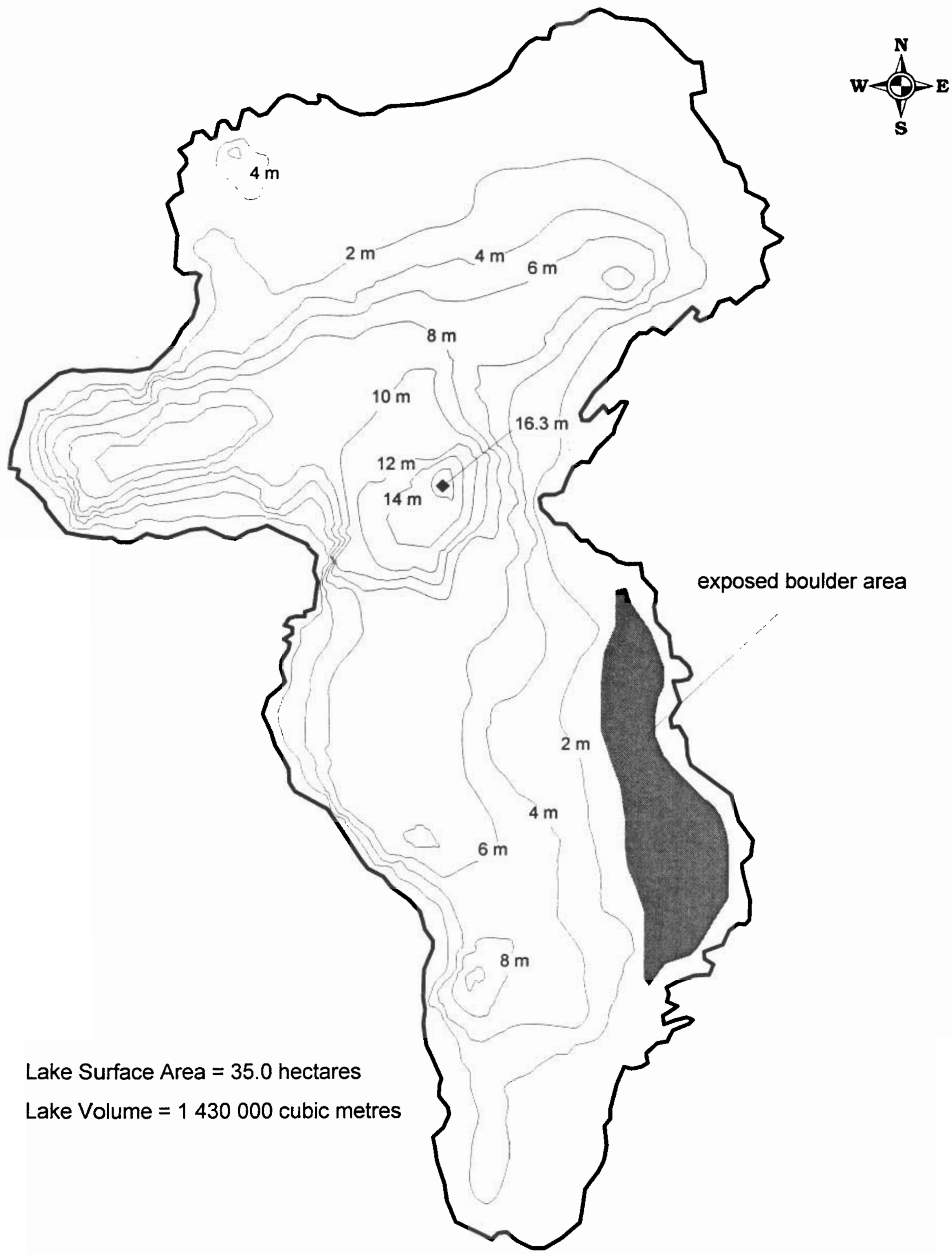

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Figure 4.5
Bathymetry of Ulu Lake
Ulu Exploration Area 1997

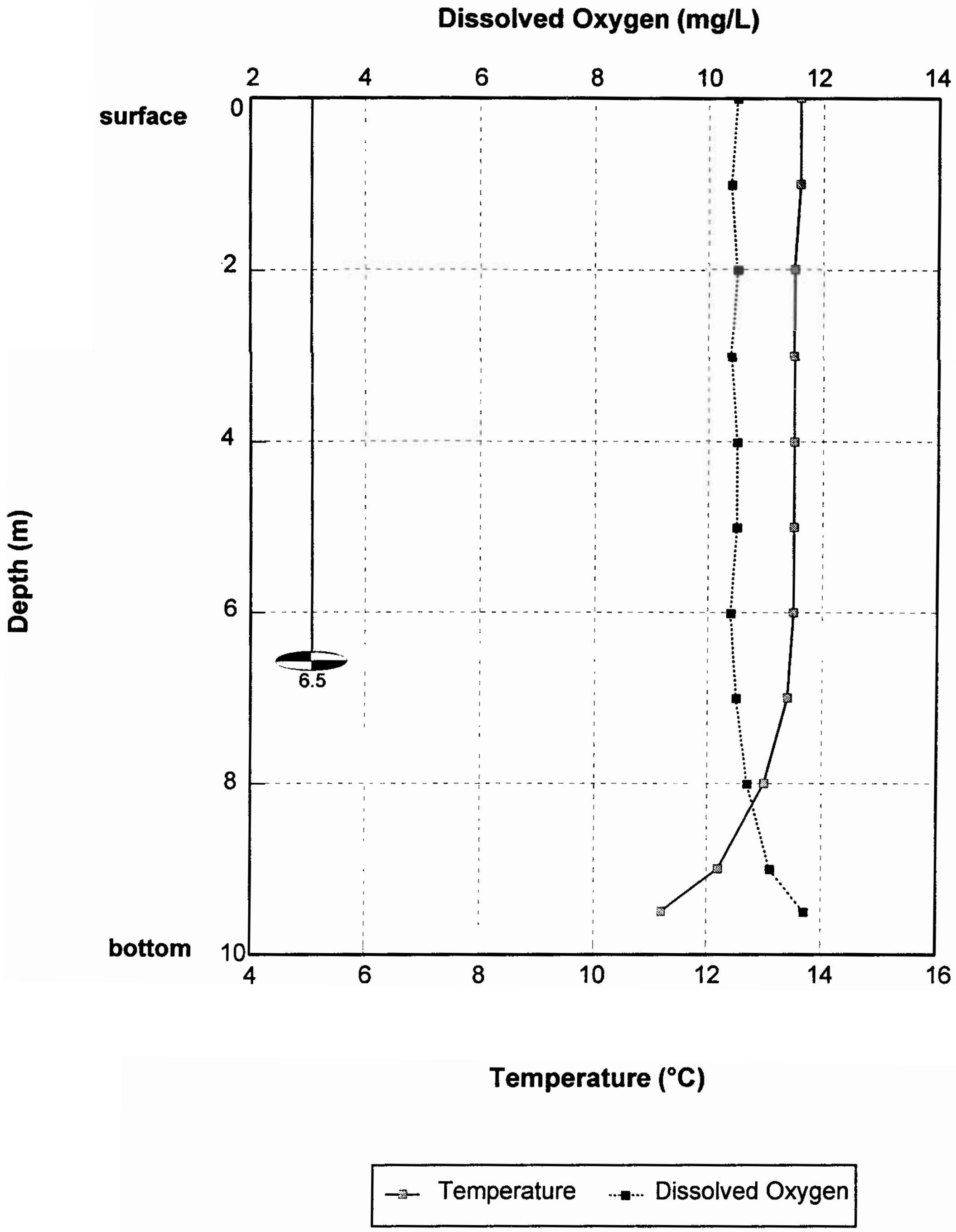

Figure 4.6 Dissolved oxygen and temperature profiles, and Secchi depth reading in Ulu Lake on 30 July 1997, Ulu Exploration Area.

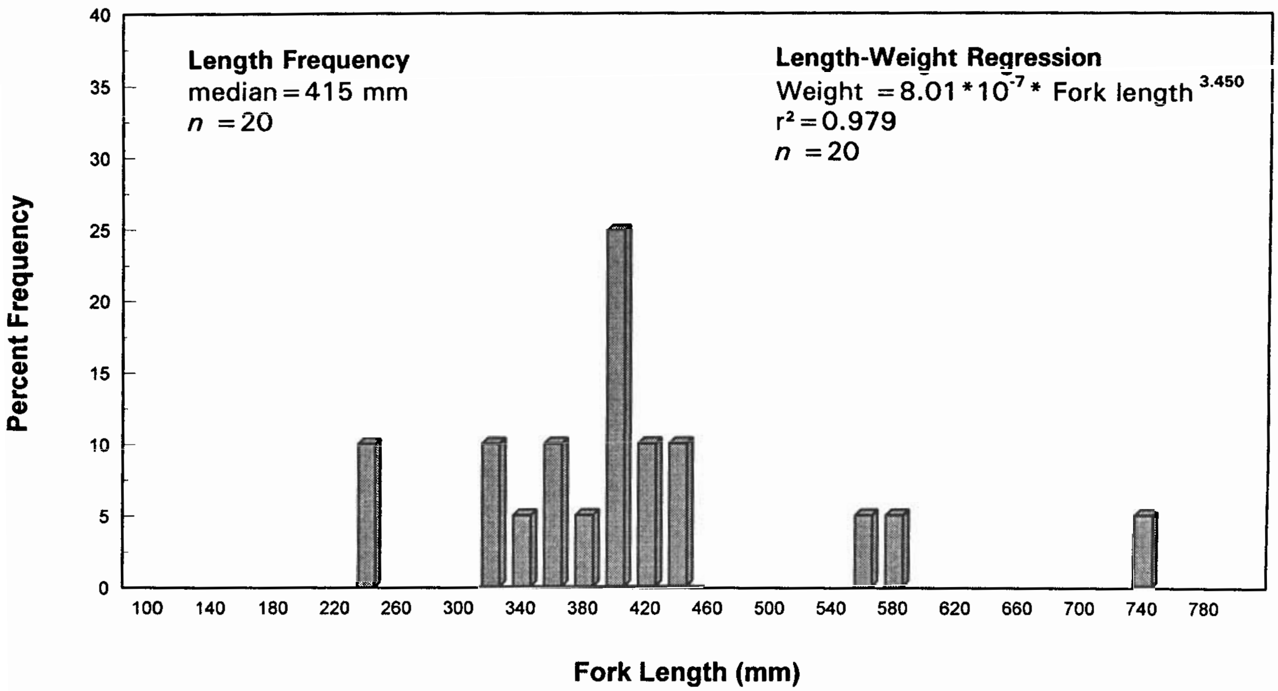

Figure 4.7 Length-frequency distribution and length-weight regression equation for lake trout sampled from Ulu Lake, Ulu Exploration Area (Data for 1996 and 1997 combined).

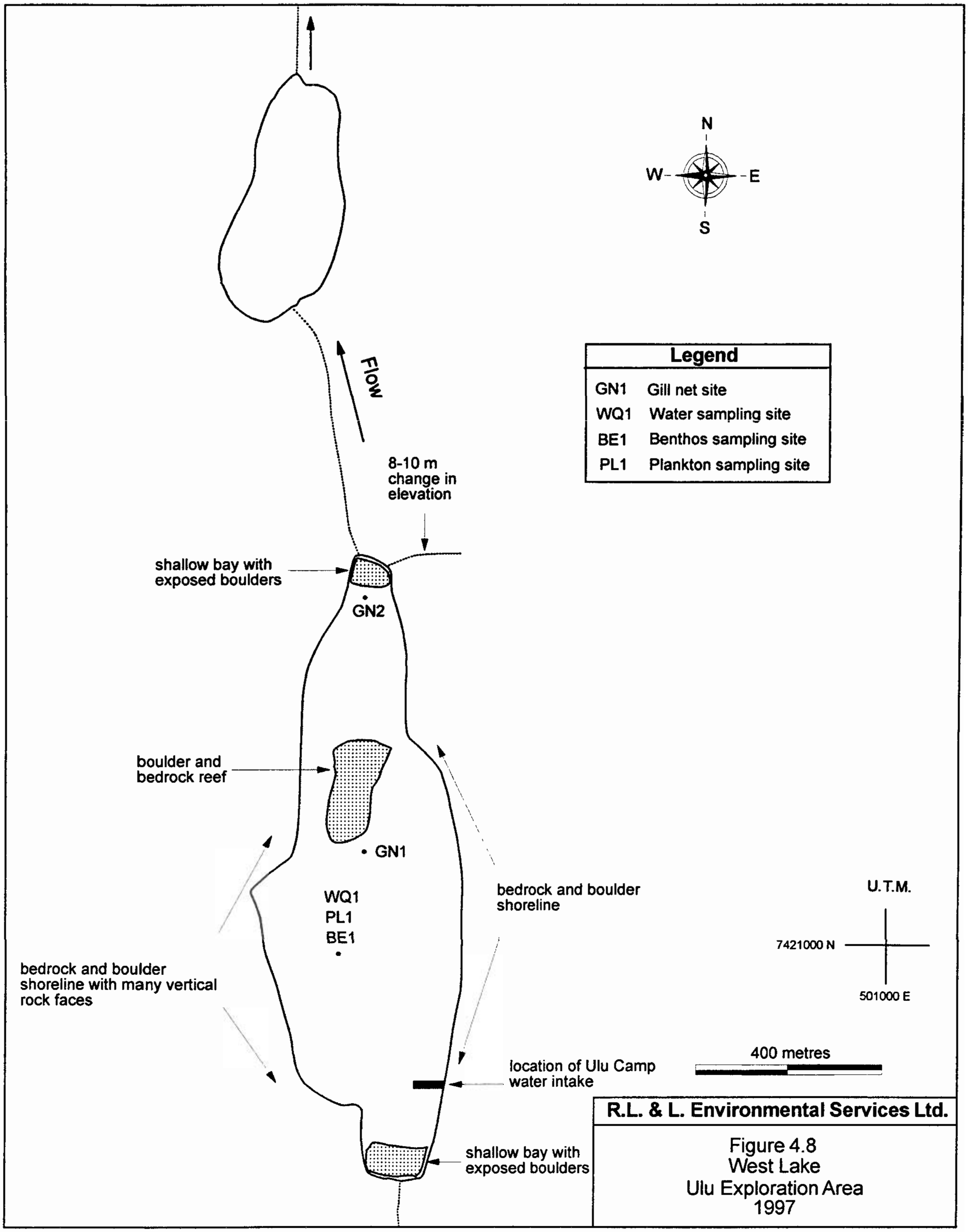

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Figure 4.8
West Lake
Ulu Exploration Area
1997

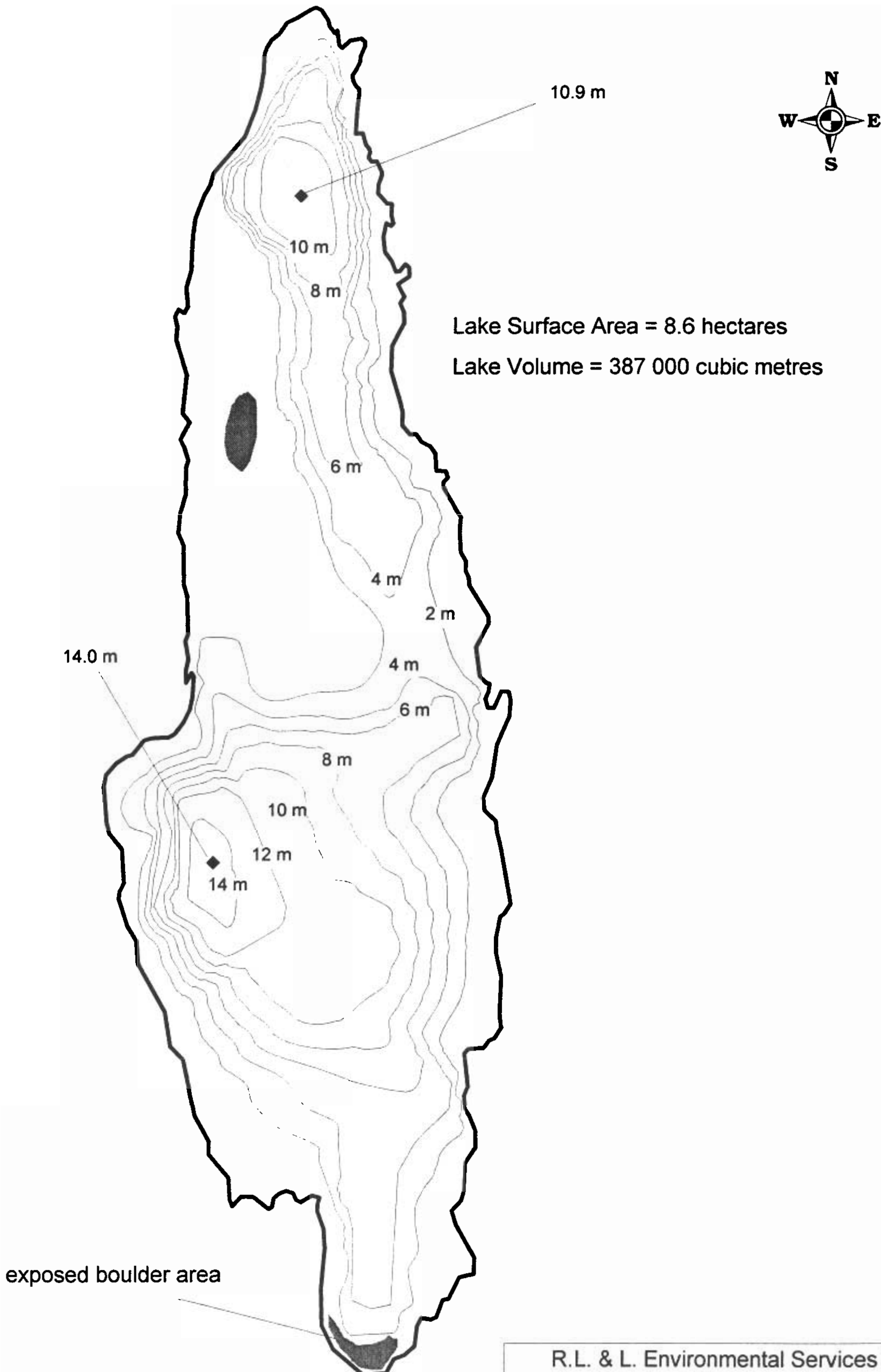

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Figure 4.9
Bathymetry of West Lake
Ulu Exploration Area 1997

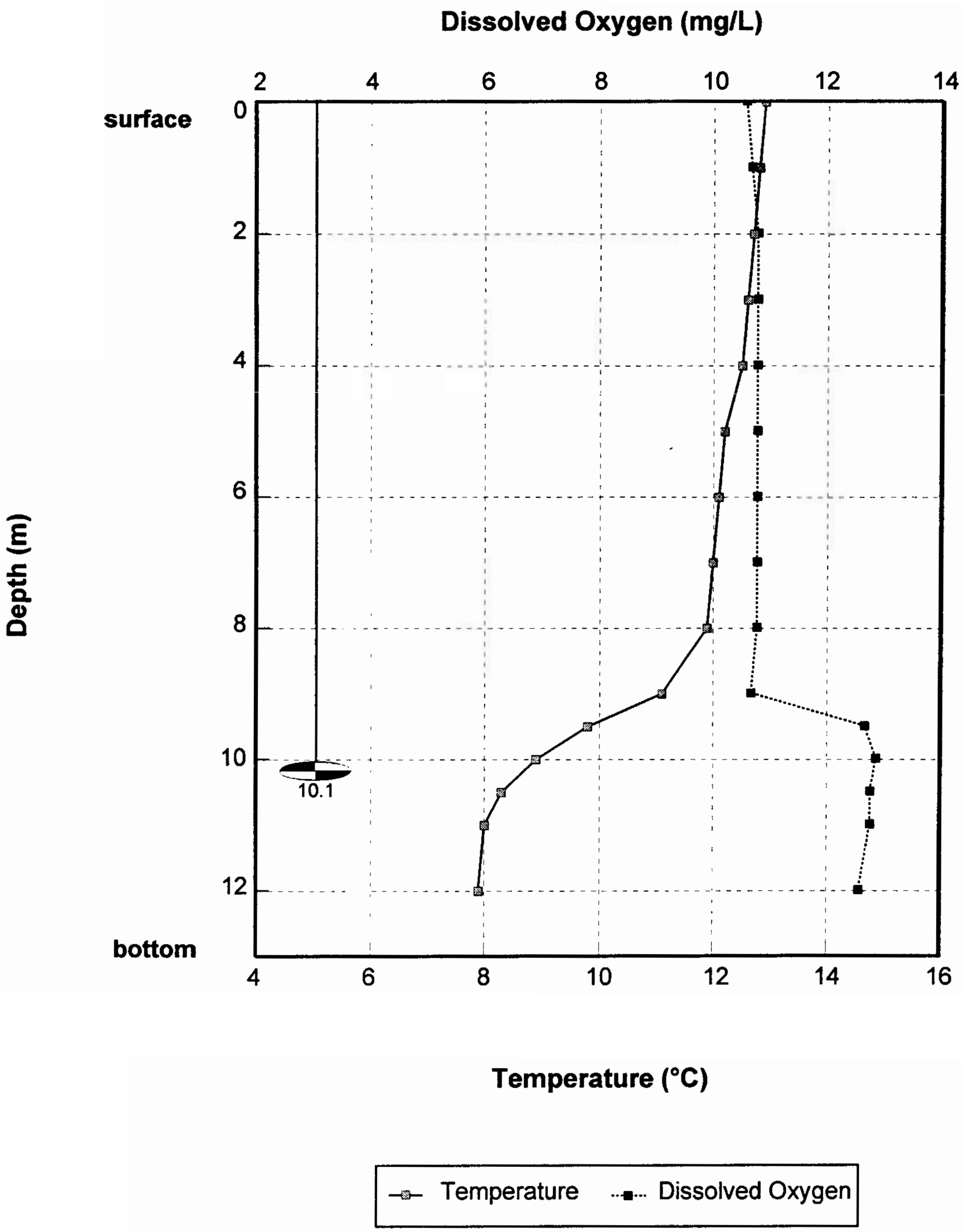

Figure 4.10 Dissolved oxygen and temperature profiles, and Secchi depth reading in West Lake on 2 August 1997, Ulu Exploration Area.

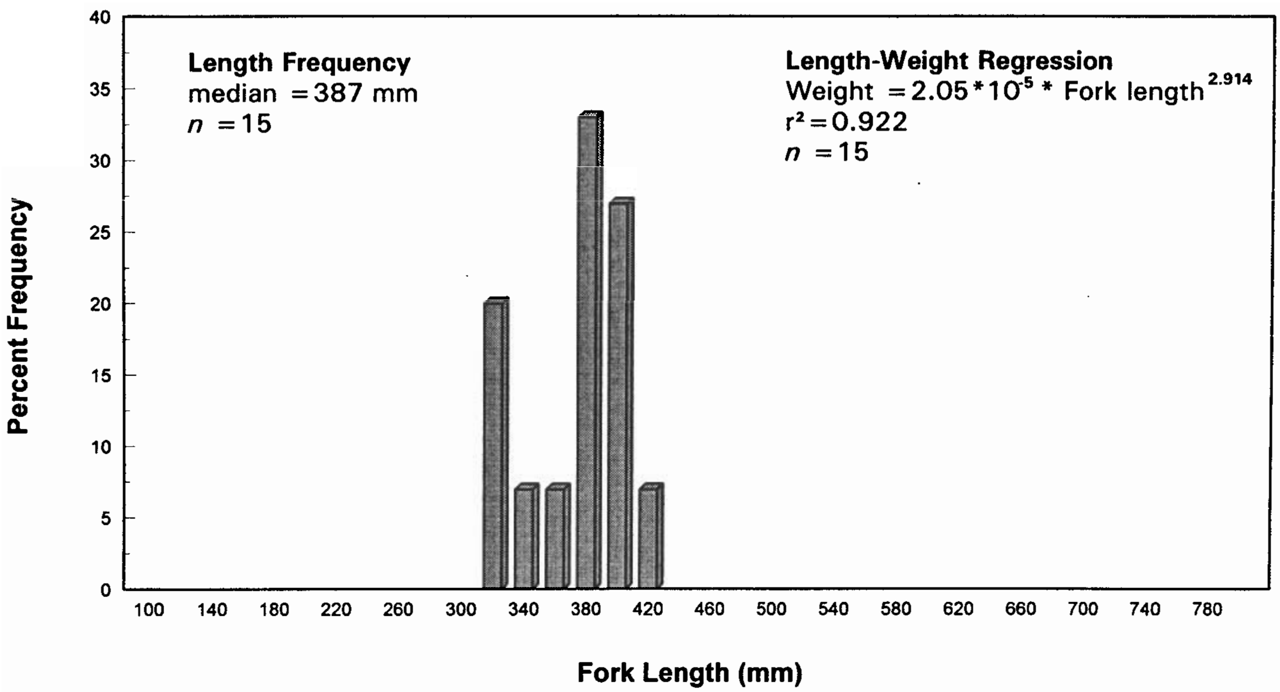

Figure 4.11 Length-frequency distribution and length-weight regression equation for lake trout sampled from West Lake, Ulu Exploration Area (Data for 1996 and 1997 combined).

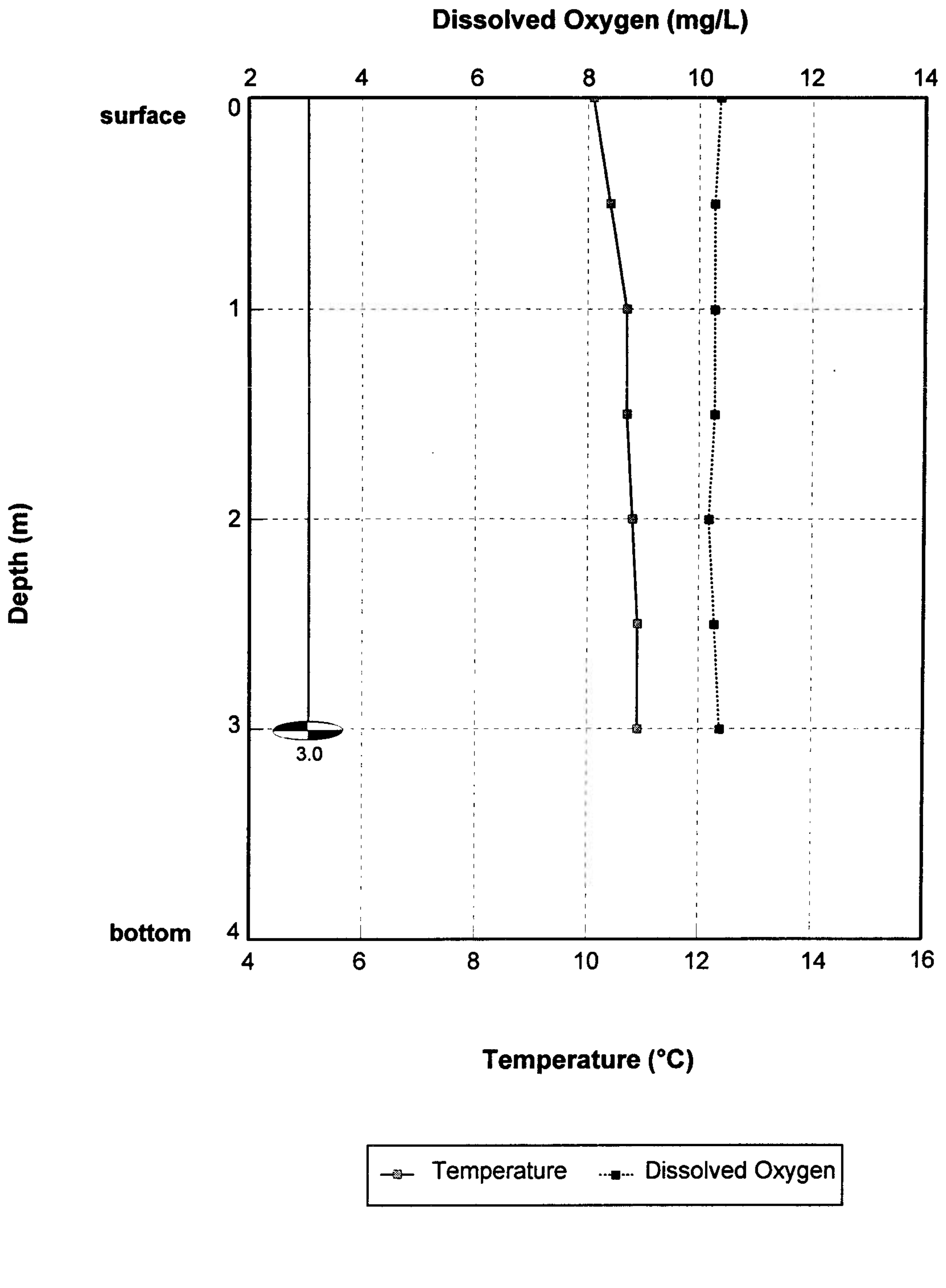

Figure 4.12 Dissolved oxygen and temperature profiles, and Secchi depth reading in Meadow Lake on 31 July 1997, Ulu Exploration Area.

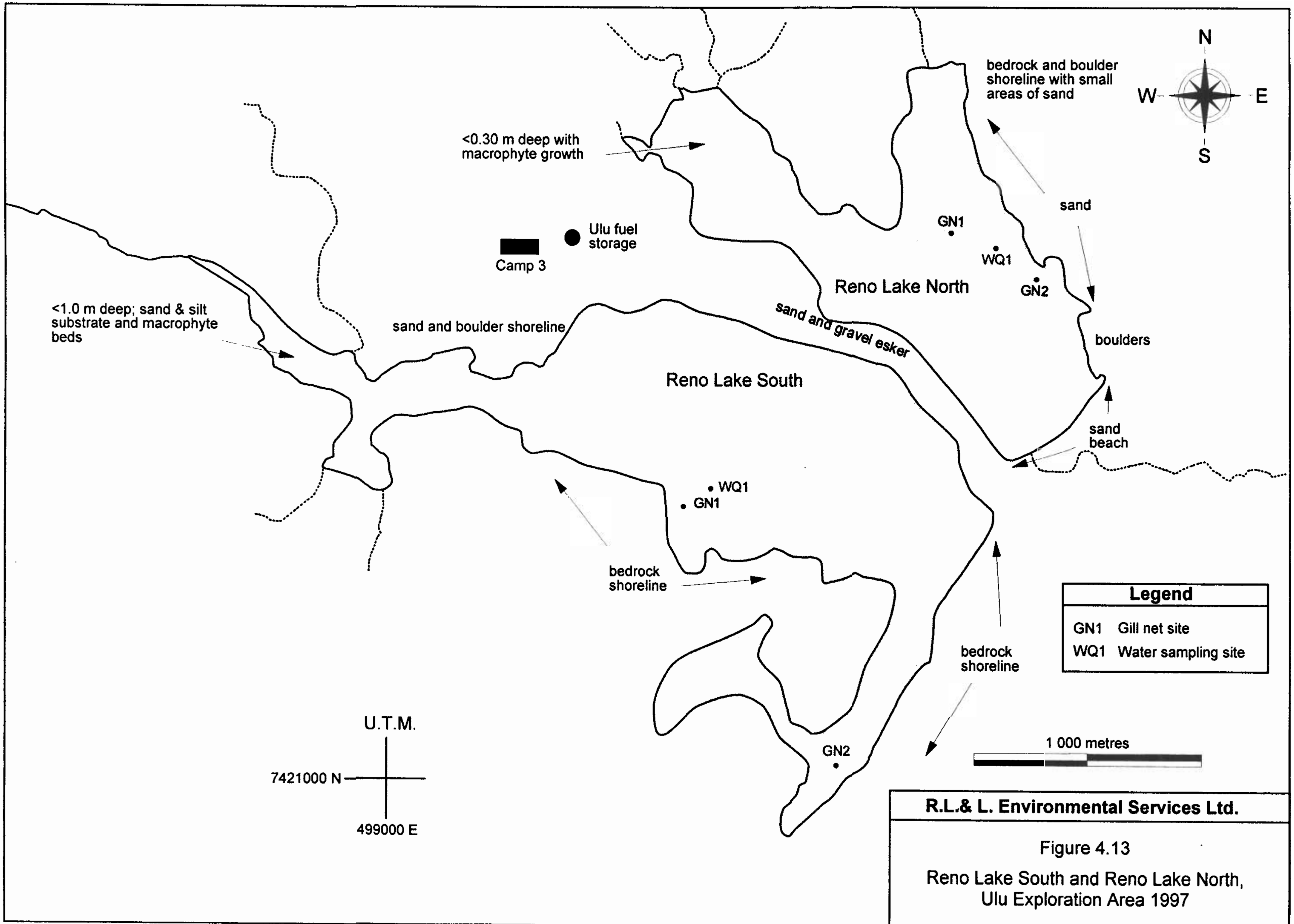

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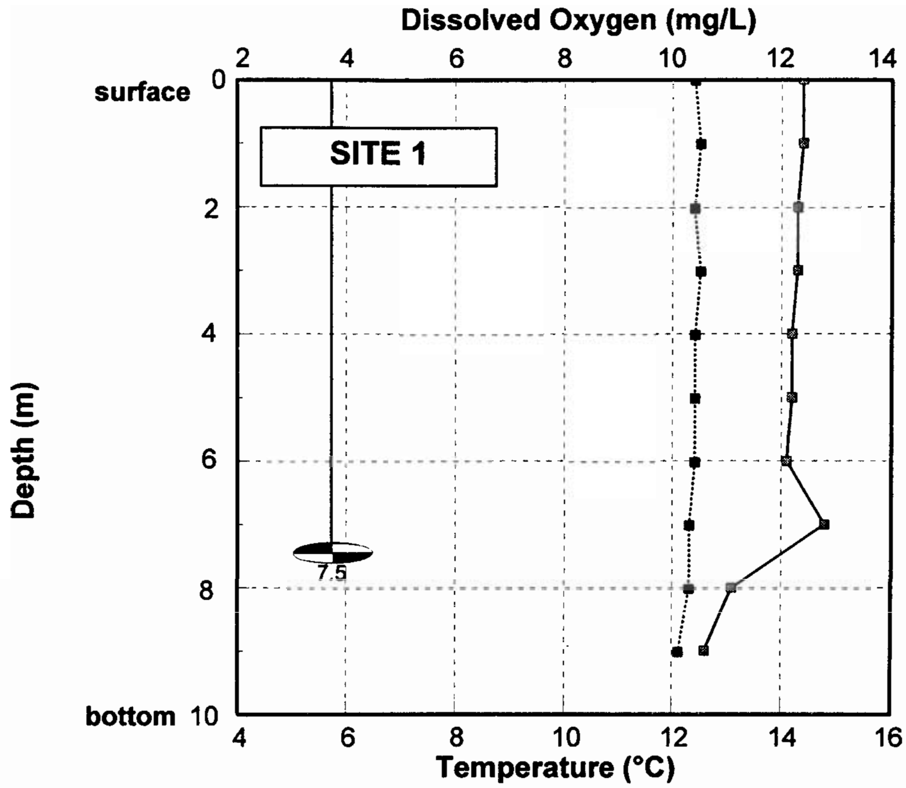
Figure 4.13

Reno Lake South and Reno Lake North, Ulu Exploration Area 1997



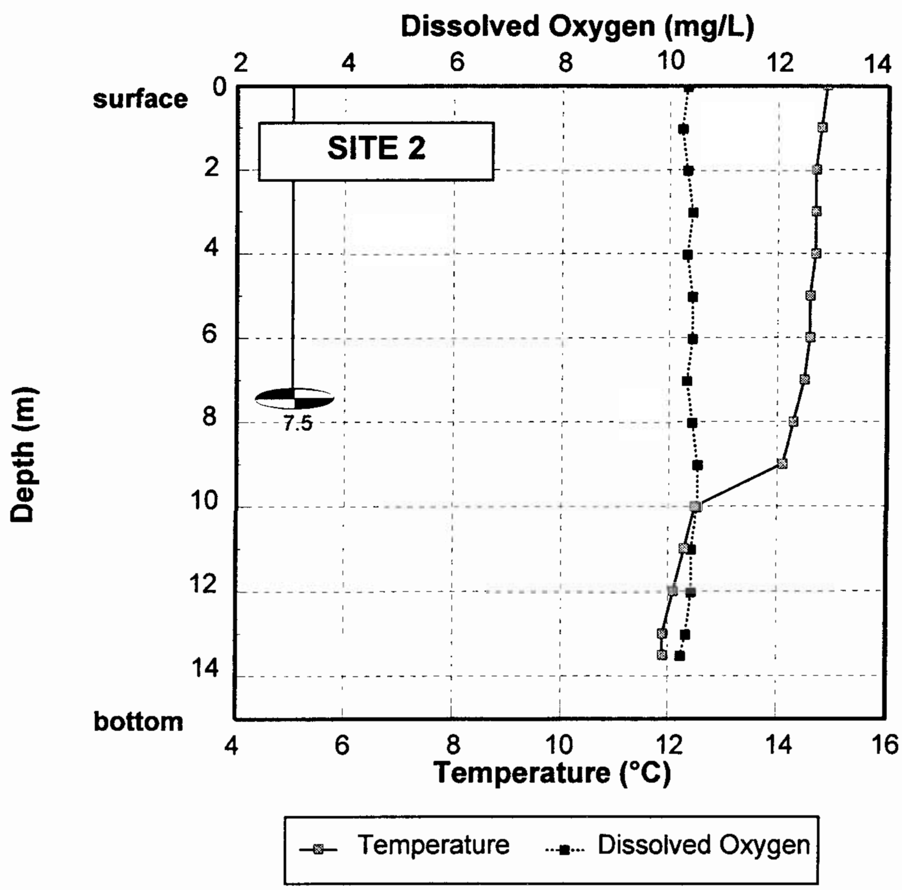


Figure 4.14 Dissolved oxygen and temperature profiles, and Secchi depth reading at Sites 1 and 2 on Reno Lake South on 4 August 1997, Ulu Exploration Area.

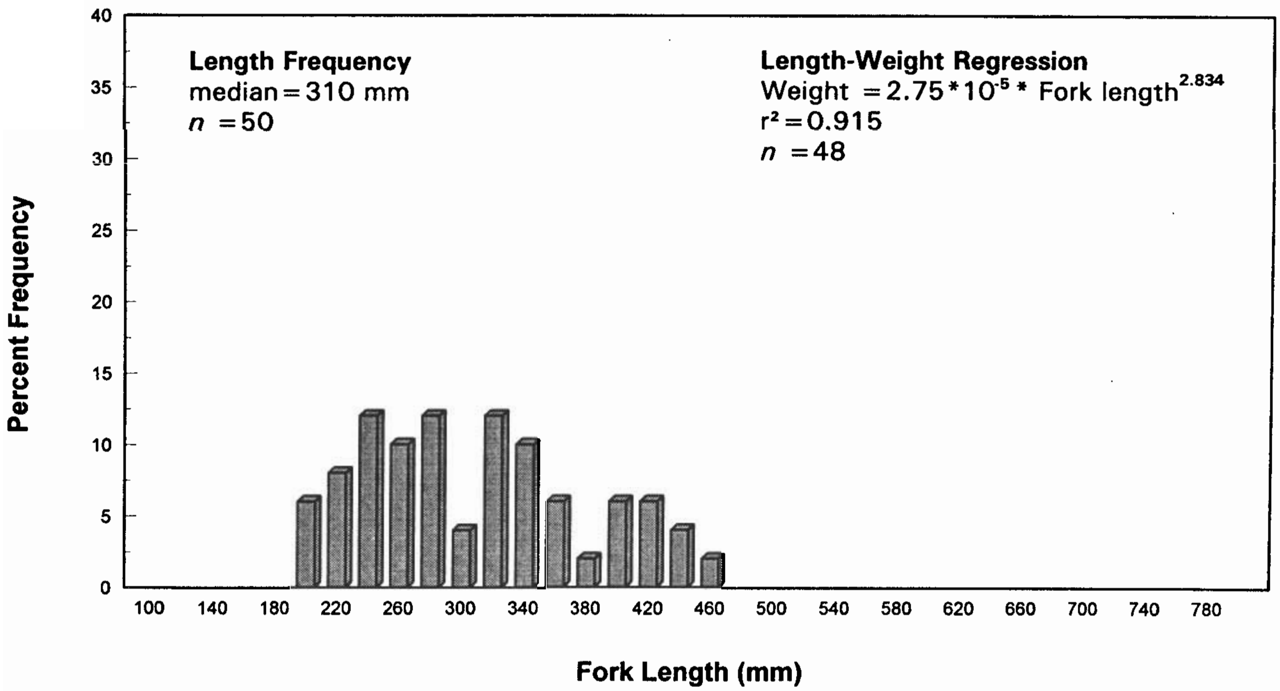


Figure 4.15 Length-frequency distribution and length-weight regression equation for lake trout sampled from Reno Lake South, Ulu Exploration Area (Data for 1996 and 1997 combined).

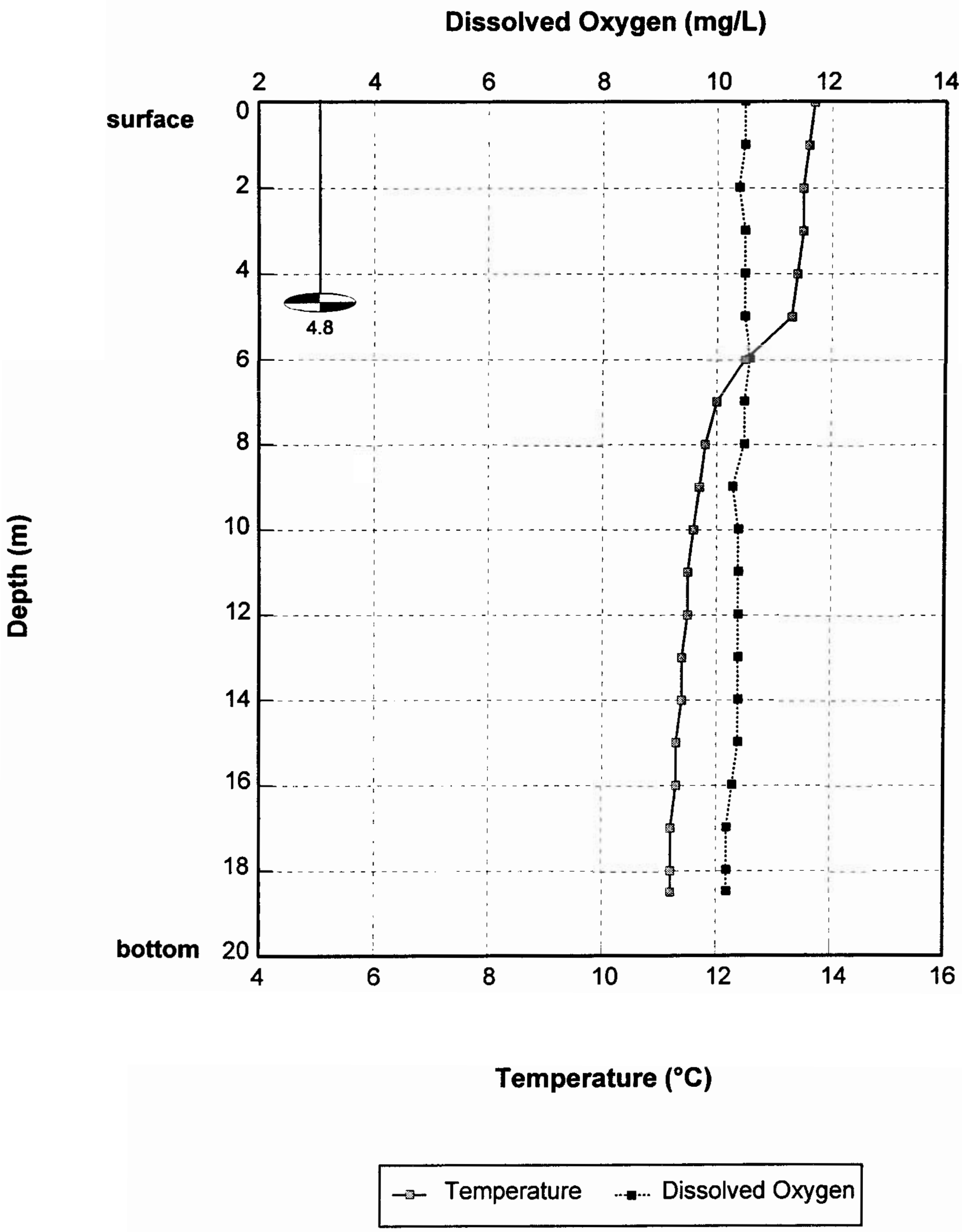
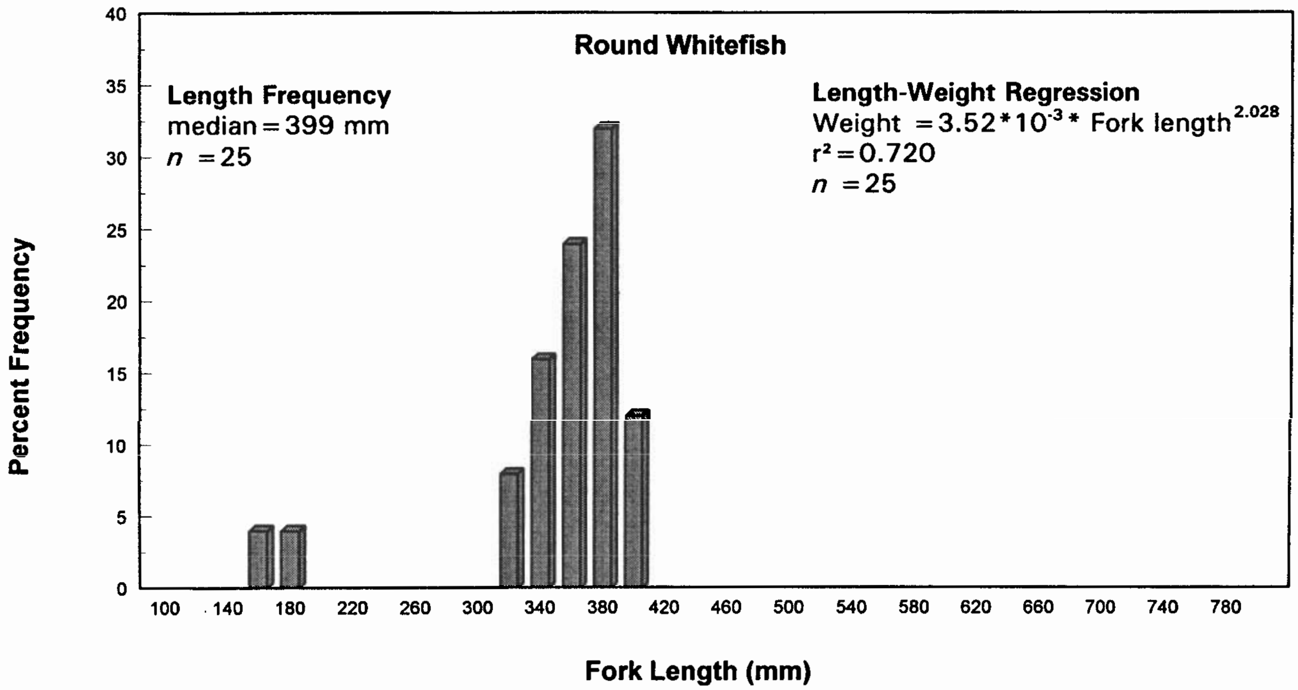


Figure 4.16 Dissolved oxygen and temperature profiles, and Secchi depth reading in Reno Lake North on 3 August 1997, Ulu Exploration Area.



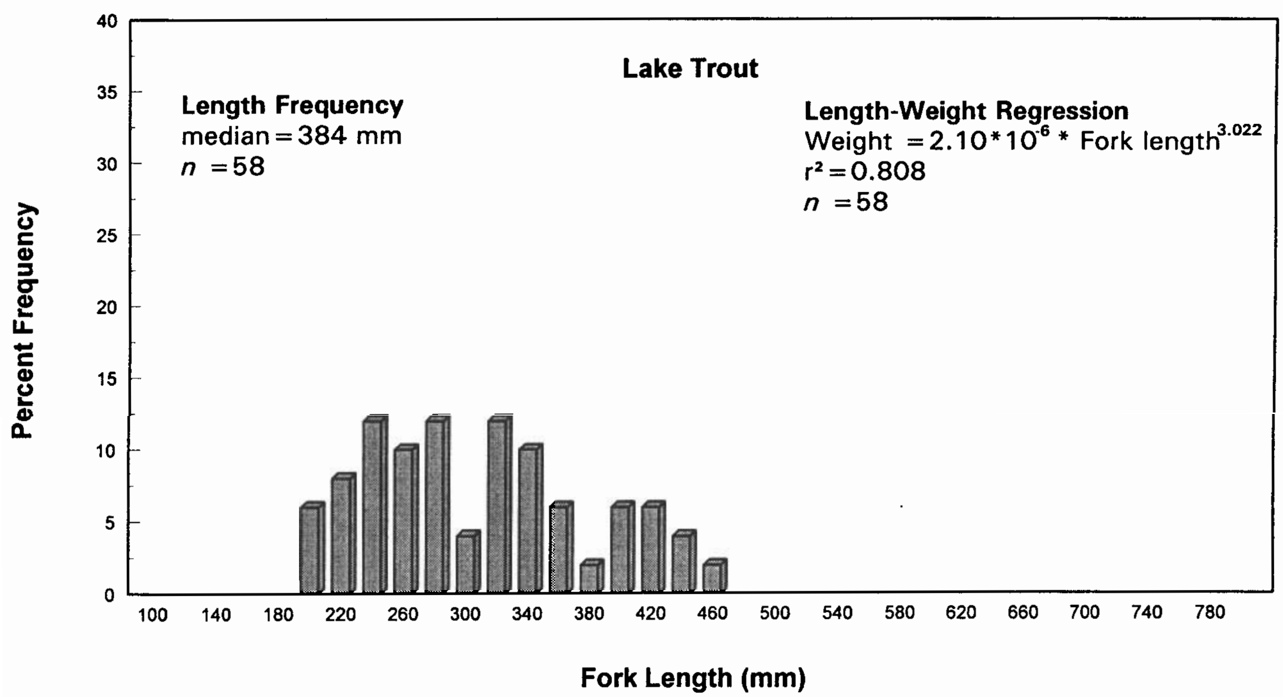


Figure 4.17 Length-frequency distributions and length-weight regression equations for lake trout and round whitefish sampled from Reno Lake North, Ulu Exploration Area (Data for 1996 and 1997 combined).

5.0 SUMMARY AND RECOMMENDATIONS

5.1 WINTER ACCESS ROAD STREAM CROSSING SURVEY

In total, 13 streams that were crossed by the proposed route of the winter access road had the potential to support fish. These included two watercourses along Route One, ten streams along Route Two, and one system along Route Three. With the exception of one stream along Route 2, all surveyed streams had not been previously evaluated during the 1996 investigation.

Surveyed streams ranged in size from 0.8 to 80.0 m in width and exhibited a wide variety of habitat features. In general, streams crossed by the proposed winter access road were small, ill-defined and dominated by boulder substrates. Most streams provided little or no habitat for fish. This was due principally to the small size of most watercourses and the absence of suitable deep-water overwintering habitat. Table 3.1 provides a summary of the winter access road stream crossing survey.

During the 1997 survey, only a limited number of streams provided suitable fish habitat at the proposed crossings. These systems included Streams 3.1 and 18.5 along Route One and Streams 41.8, 43.5 and 64.8 along Route Two. Of these watercourses, only Streams 18.5 and 41.8 contained high quality fish habitat that may be critical to the well-being of fish populations. Both these watercourses provided high quality rearing habitat for Arctic grayling. Stream 41.8 also contained high quality spawning habitat for this species.

Table 5.1 Summary results for winter access road stream crossing survey, Ulu Project Area 1997.

Route	Stream Number	Habitat Type	Fish Captured	Habitat Potential[a]
One	3.1	Well-defined boulder-filled stream.	Arctic grayling	moderate
	18.5	Well-defined stream with banks dominated by silt.	Arctic grayling	high
Two	41.8	Well-defined stream with gravel substrates.	Arctic grayling, lake trout, slimy sculpin	high
	43.5	Intermittent stream.	Burbot	low
	45.3	Intermittent ill-defined stream.	none	negligible
	46.9	Shallow, wide, ill-defined stream.	none	negligible
	56.1	Well-defined stream with downstream barrier.	none	negligible
	58.8	Shallow, wide, ill-defined stream.	none	negligible
	64.8	Small, ill-defined stream.	lake trout	low
	66.1	Shallow, wide, ill-defined stream.	none	negligible
	70.8	Intermittent stream.	none	negligible
Three	118.2	Boulder-filled intermittent stream.	none	negligible

[a] negligible indicates severely limited fish habitat; low indicates a limited amount of suitable fish habitat; medium indicates that fish may use the stream as there is suitable habitat present; and, high indicates that high quality habitat was present at the crossing and that this habitat may be critical to the well-being of fish populations.

5.2 ULU EXPLORATION AREA

Similar to results for 1996, analysis of the water samples obtained from seven sites within the Ulu Creek drainage during the summer program indicated that the system was largely nutrient poor. Concentrations of essential nutrients (i.e., nitrogen, phosphorus, and carbon) were at very low levels at most sites. East Lake did not follow this pattern. In this waterbody, concentrations of essential nutrients were several magnitudes higher than in surrounding lakes.

In general, concentrations of other water chemistry parameters at sampling sites were similar to the background levels documented in 1996. These included total mercury, trace metals and hydrocarbons. The slightly elevated levels of the hydrocarbon xylene recorded at Ulu Lake, at Station 4 in the Frayed Knots River and in the Hood River in 1996, were not recorded at these sites or any others during the present study. Xylene and all other hydrocarbons were below detectable levels.

Similar to the results for nutrients, concentrations of several elements in East Lake were elevated relative to other waterbodies in the Ulu Exploration Area. Levels of calcium, sodium, chloride and sulphur were higher as were levels of the trace metals nickel, strontium, and zinc. None of these elements exhibited concentrations above acceptable limits. These results were expected for East Lake, as it is the receiving waterbody for the exploration site's waste rock dump.

Elevated levels of some elements were not restricted to East Lake; but, were present to a lesser degree at sites situated immediately downstream of the lake: Ulu Lake and Ulu Creek. These included calcium, sodium, chloride and sulphur, as well as the trace metals nickel, strontium and zinc. Levels recorded in these waterbodies were low, and in the case of trace metals, near background levels. However, the results provide a strong indication that East Lake is an integral part of the Ulu Lake drainage. Chemical inputs into East Lake can reach Ulu Lake and Ulu Creek and possibly other waterbodies situated further downstream.

The physical characteristics, limnology and aquatic biological communities recorded in surveyed lakes in the Ulu Exploration Area were typical of oligotrophic subarctic waterbodies. Water temperatures were cool and oxygen levels were generally high. In sampled waterbodies, the plankton and benthic macroinvertebrate communities were made up of low densities of organisms composed of simple species assemblages. Fish were captured in four of the sampled lakes: West Lake, Ulu Lake, Reno Lake South and Reno Lake North. Given its small size and isolated position in the watershed, a viable fish population cannot exist in East Lake. Similarly, the shallow water depth of Meadow Lake, prevents fish populations from becoming established in this waterbody.

The fish communities in sampled lakes were simple; most contained only a single species (lake trout). In fact, the two other species encountered (Arctic char and round whitefish) occurred only in Reno Lake North. Catch-per-

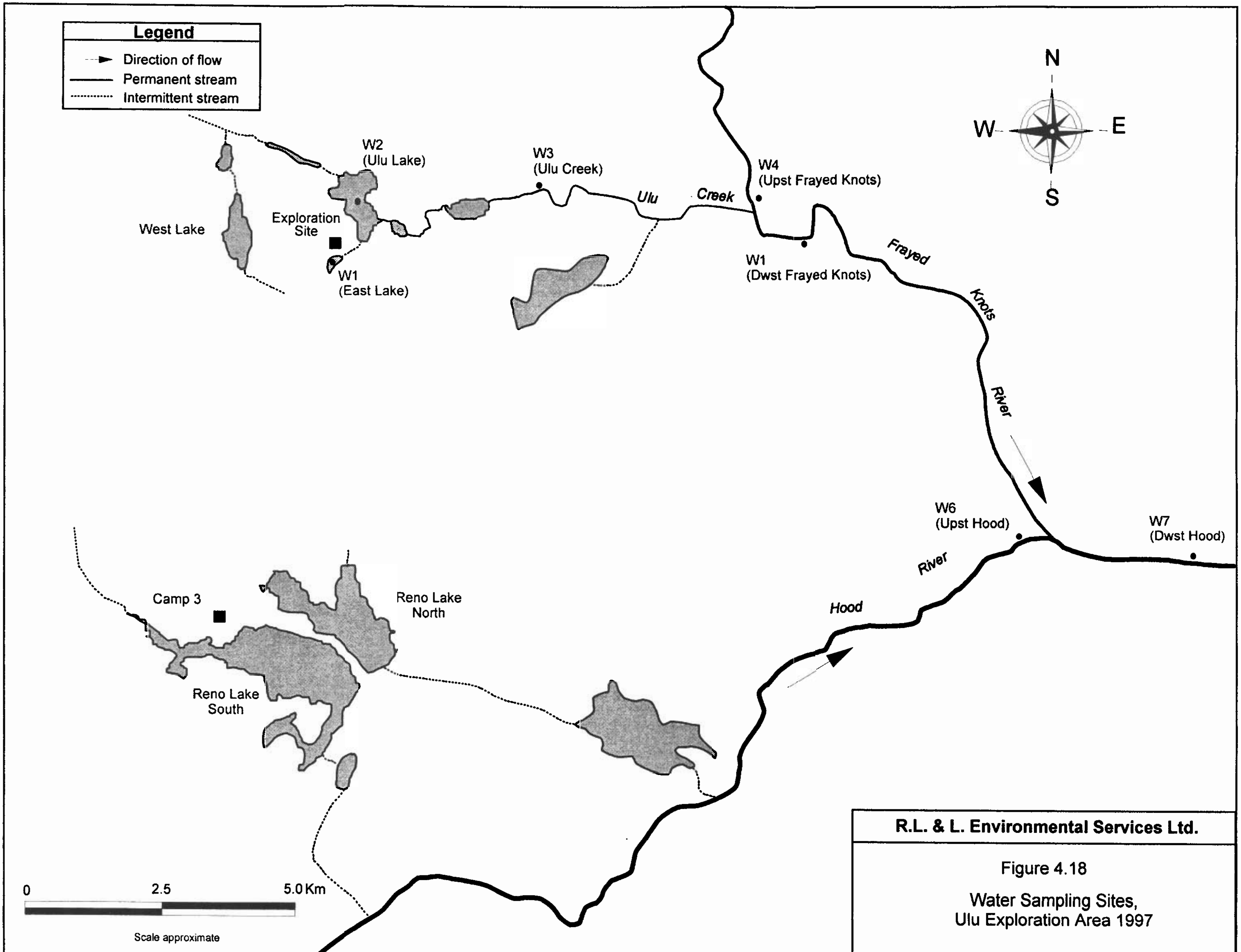


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Figure 4.18

Water Sampling Sites,
Ulu Exploration Area 1997

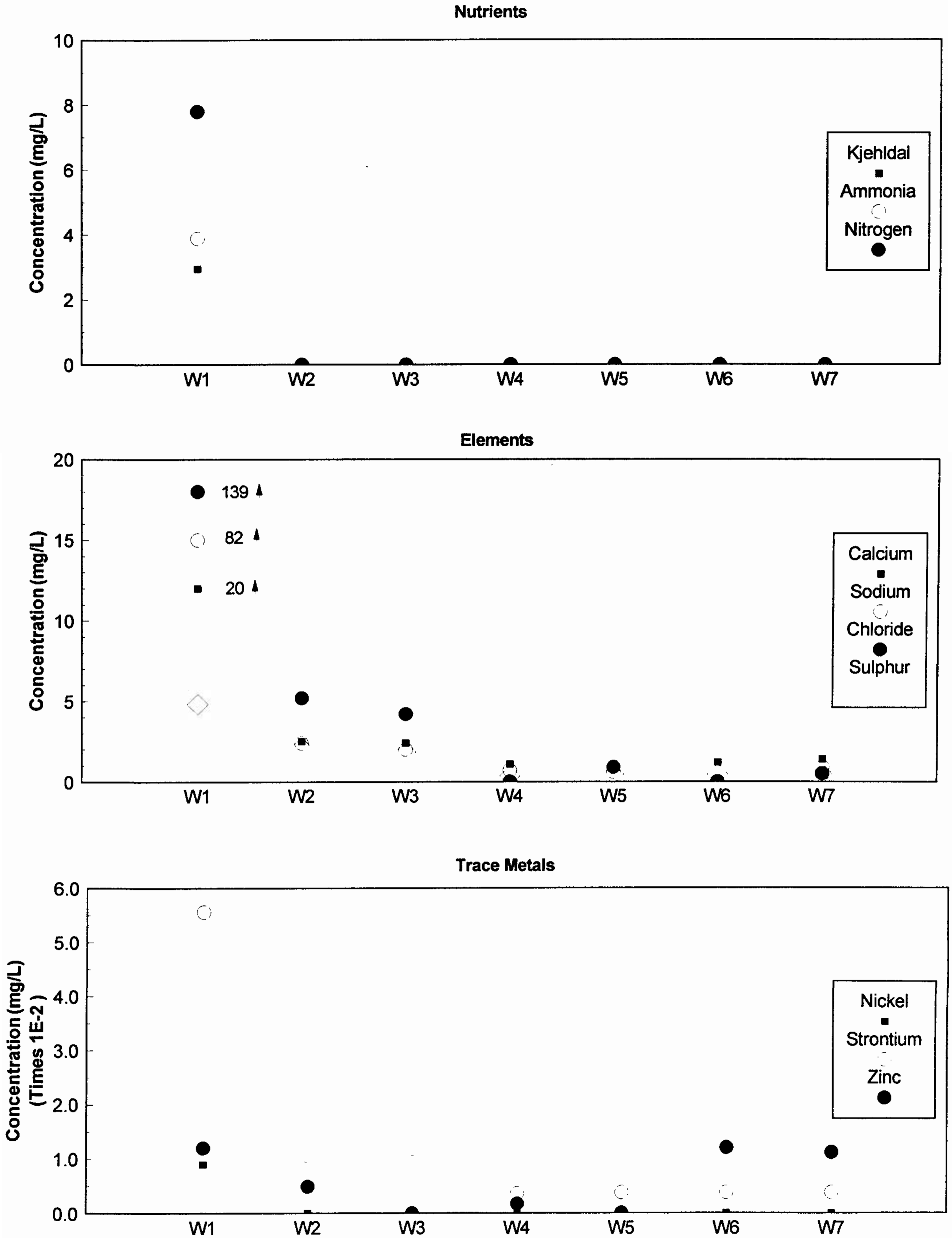

Figure 4.19 Trends in the concentrations of selected water chemistry parameters sampled on 1 August 1997 from waterbodies in the Ulu Exploration Area.

unit-effort values recorded in all four lakes were low. Life history information obtained from captured fish in each of these lakes indicates that they are slow-growing and long-lived.

An assessment of the fish community in the Ulu Creek drainage (Ulu Creek and Frayed Knots River) indicates that the system is used by fish. Young-of-the-year Arctic grayling were recorded in Ulu Creek near its confluence with the Frayed Knots River and slimy sculpin were present immediately upstream of Meadow Lake. In the Frayed Knots River, all age-groups of Arctic grayling, as well as adults of round whitefish and lake trout were recorded.

5.3 RECOMMENDATIONS

5.3.1 Winter Access Road

The proposed route for the winter access road traverses an area that is characterized as having poor quality fish habitat. Of the 13 crossing locations assessed in June and August 1996, good fish habitat was encountered in only two streams. As such, the impact of winter access road construction and maintenance should have minimal impacts on fish and fish habitat at most of the stream crossings. To avoid negatively impacting the limited number of crossings that contain good quality habitat, consideration should be given to selection of alternate crossing sites.

If this is not an appropriate option, it is recommended that biological monitoring of the crossing during road construction be undertaken to ensure that the quality of fish habitat in the stream is not degraded (e.g., introduction of deleterious substances, barriers to fish passage). A mitigative strategy should also be developed and incorporated into the maintenance plan to minimize future impacts. For example, the requirement for, timing of and methods to be used, for culvert and ice-dam removal each spring should be considered.

5.3.2 Ulu Exploration Area

The water quality in most of the Ulu Exploration Area waterbodies is typical of an unperturbed system. East Lake has experienced an introduction of nutrients, trace metals and other elements from the Ulu Camp and exploration site. The water chemistry data suggest that this material has the potential to move to downstream lakes and streams. As such, a water sampling program should be established in order to monitor this potential impact, particularly if the size of the Ulu Camp and associated exploration activity increases.

Since the East Lake and Ulu Lake systems will be receiving effluent from the development area and camp, additional information is needed to fully understand the dynamics and to assess the potential impacts. To accomplish this a water budget for each lake should be developed.

To better assess the potential impacts of development on the aquatic biological community in the Ulu Exploration Area, baseline information should be collected from selected waterbodies in the Ulu Creek drainage where data are lacking. This includes a more complete assessment of fish communities in Ulu Lake, Ulu Creek and the Frayed Knots River systems.

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PHOTOGRAPHIC PLATES

Plate 1 Route 1 - Stream 3.1 looking upstream (1 August 1997).

Plate 2 Route 1 - Stream 18.5 looking upstream (1 August 1997).

Plate 3 Route 2 - Stream 36.7 looking upstream (18 June 1997).

Plate 4 Route 2 - Stream 41.8 looking downstream (1 August 1997).

Plate 5 Route 2 - Stream 43.5 looking upstream (18 June 1997).

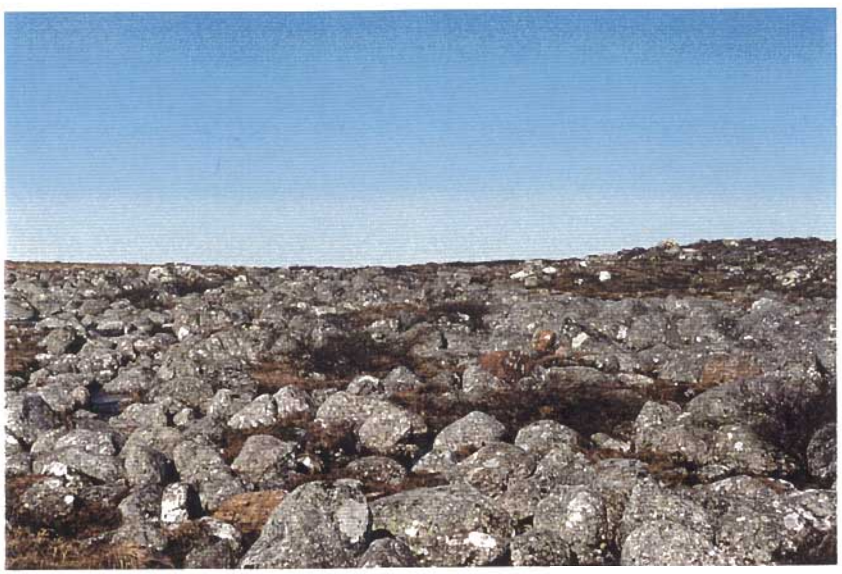

Plate 6 Route 2 - Stream 45.3 looking upstream (18 June 1997).

Plate 7 Route 2 - Stream 46.9 looking downstream (18 June 1997).

Plate 8 Route 2 - Stream 56.1 looking downstream (1 August 1997).

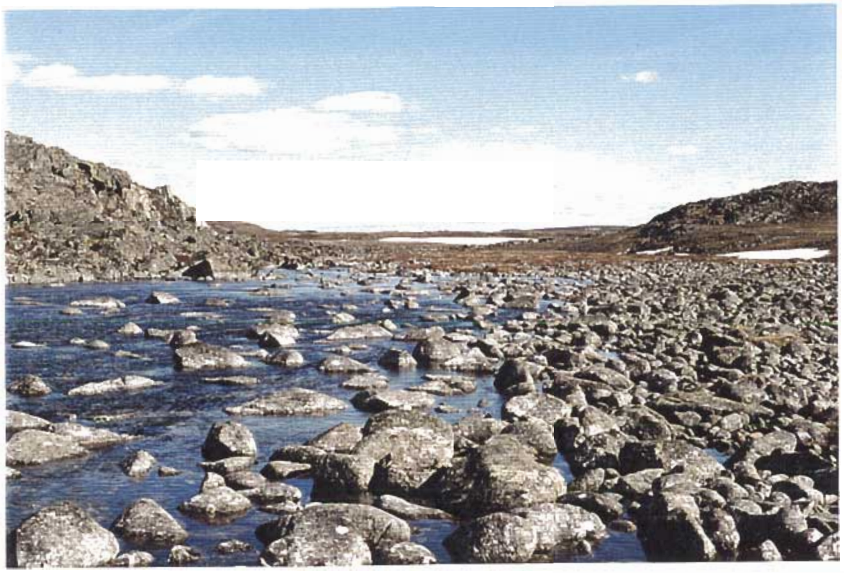

Plate 9 Route 2 - Stream 58.8 looking upstream (17 June 1997).

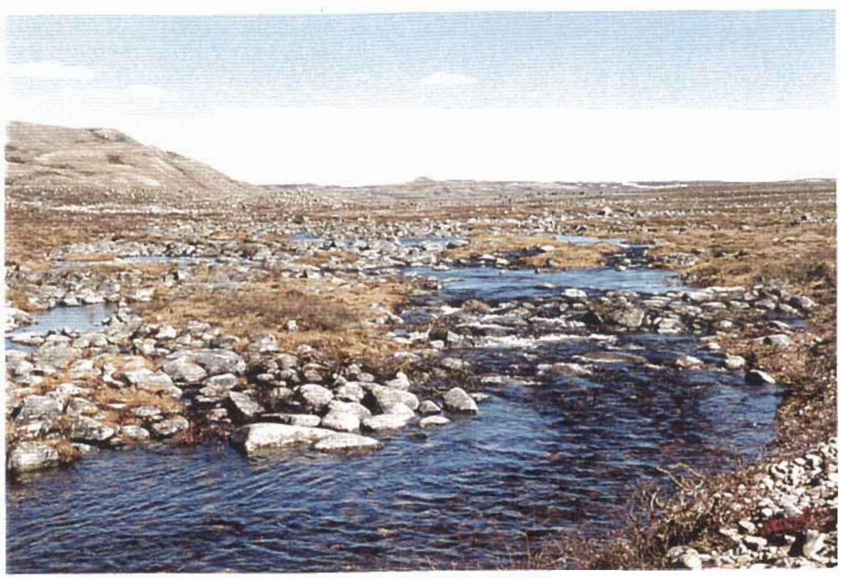

Plate 10 Route 2 - Stream 64.8 looking upstream (17 June 1997).

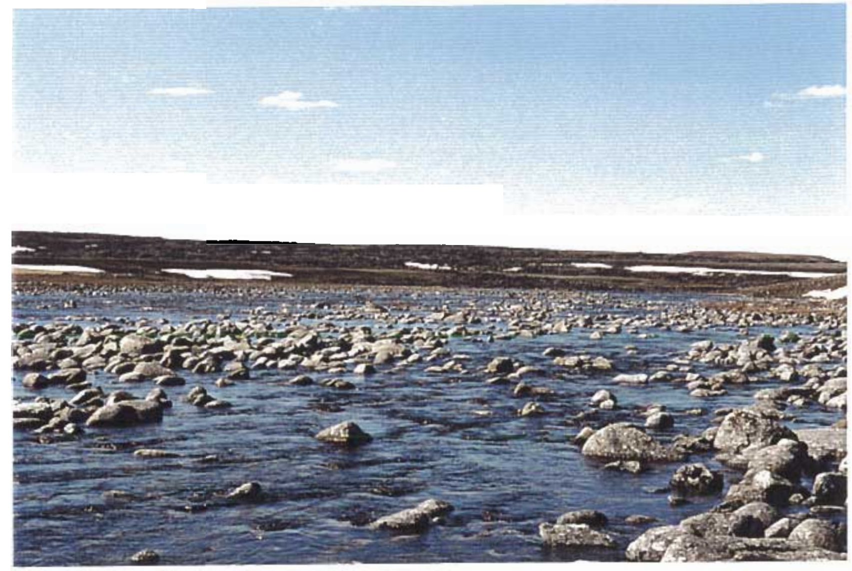

Plate 11 Route 2 - Stream 66.1 looking downstream (17 June 1997).

Plate 12 Route 2 - Stream 70.8 looking downstream (17 June 1997).

Appendix E2 - Fish Life History Data

Sample Number	Project Number	Area	Waterbody	Site ID	Species	Fork Length	Weight	Maturity	Age	Structure	Capture	Code	Comments
163	570	Camp Three	Reno S L	85	LKTR	258	166	99		OT	GN	1	ST5; 5 ZOO
164	570	Camp Three	Reno S L	85	LKTR	217	112	99	4	OT	GN	1	ST5; 5 ZOO
165	570	Camp Three	Reno S L	85	LKTR	424	806	6		OT	GN	1	ST20; 20 PEL
166	570	Camp Three	Reno S L	86	LKTR	295	262	11		OT	GN	1	ST10; 5 ZOO, 5 PEL
167	570	Camp Three	Reno S L	86	LKTR	326	364			OT	GN	1	ST5; 5 ZOO
168	570	Camp Three	Reno S L	86	LKTR	352	454	16		OT	GN	1	ST15; 15 ZOO
169	570	Ulu Exploration Area	Frayed Knot R	92	ARGR	385		10	9	SC	AL	0	
170	570	Ulu Exploration Area	Frayed Knot R	92	ARGR	380		20	7	SC	AL	0	
171	570	Ulu Exploration Area	Frayed Knot R	92	ARGR	399		20	10	SC	AL	0	
172	570	Ulu Exploration Area	Frayed Knot R	92	ARGR	380		10	7	SC	AL	0	
173	570	Ulu Exploration Area	Frayed Knot R	92	ARGR	368		10	5	SC	AL	0	
174	570	Ulu Exploration Area	Frayed Knot R	92	ARGR	348		10	6	SC	AL	0	
175	570	Ulu Exploration Area	Frayed Knot R	92	LKTR	355					AL	0	
176	570	Ulu Exploration Area	Frayed Knot R	92	LKTR	655					AL	0	
177	570	Ulu Exploration Area	Frayed Knot R	92	LKTR	468					AL	0	
178	570	Ulu Exploration Area	Frayed Knot R	92	LKTR	336					AL	0	
179	570	Ulu Exploration Area	Frayed Knot R	92	ARGR	417		10	10	SC	AL	0	
180	570	Ulu Exploration Area	Frayed Knot R	93	ARGR	402		10	10	SC	AL	0	

Appendix E2 - Fish Life History Data

Sample Number	Project Number	Area	Waterbody	Site ID	Species	Fork Length	Weight	Maturity	Age	Structure	Capture	Code	Comments
181	570	Ulu Exploration Area	Frayed Knot R	93	ARGR	332		20	7	SC	AL	0	
182	570	Ulu Exploration Area	Frayed Knot R	93	ARGR	300		20	6	SC	AL	0	
183	570	Ulu Exploration Area	Frayed Knot R	93	ARGR	368		20	9	SC	AL	0	
184	570	Ulu Exploration Area	Frayed Knot R	95	ARGR	395		10		SC	AL	0	
185	570	Ulu Exploration Area	Frayed Knot R	95	ARGR	381		10	9	SC	AL	0	
186	570	Ulu Exploration Area	Frayed Knot R	95	ARGR	375		10	9	SC	AL	0	
187	570	Ulu Exploration Area	Frayed Knot R	95	LKTR	436					AL	0	
188	570	Ulu Exploration Area	Frayed Knot R	95	LKTR	454					AL	0	
189	570	Ulu Exploration Area	Frayed Knot R	95	ARGR	375		20	8	SC	AL	0	
190	570	Ulu Exploration Area	Frayed Knot R	95	LKTR	364					AL	0	
191	570	Camp Three	Reno N L	78	LKTR						GN	0	RND
192	570	Camp Three	Reno N L	78	RNWH						GN	0	RND
193	570	Camp Three	Reno N L	77	LKTR						GN	0	RND
194	570	Camp Three	Reno S L	85	LKTR						GN	0	RND
195	570	Route 2	041.8	34	ARGR	27					EF	0	
196	570	Route 2	041.8	34	ARGR	32					EF	0	
197	570	Route 2	041.8	34	ARGR	34					EF	0	
198	570	Route 2	041.8	34	ARGR	36					EF	0	

Appendix E2 - Fish Life History Data

Sample Number	Project Number	Area	Waterbody	Site ID	Species	Fork Length	Weight	Maturity	Age	Structure	Capture	Code	Comments
127	570	Camp Three	Reno N L	78	RNWH	384	580	16		OT	GN	1	ST10; 10 ZOO
128	570	Camp Three	Reno N L	78	RNWH	400	688	7		OT	GN	1	ST10; 10 ZOO
129	570	Camp Three	Reno N L	78	RNWH	289	278	1		OT	GN	1	ST15; 15 GAS
130	570	Camp Three	Reno N L	78	LKTR	390	664	16		OT	GN	1	ST10; 10 GAS
131	570	Camp Three	Reno N L	78	RNWH	419	742	7		OT	GN	1	ST5; 5 PEL
132	570	Camp Three	Reno N L	84	LKTR	390	508				AL	0	
133	570	Camp Three	Reno N L	84	LKTR	355	456				AL	0	
134	570	Camp Three	Reno N L	78	LKTR	391	602				GN	0	
135	570	Camp Three	Reno N L	78	LKTR	372	592				GN	0	
136	570	Camp Three	Reno N L	78	LKTR	440	345				GN	0	
137	570	Camp Three	Reno N L	78	LKTR	399	702				GN	0	
138	570	Camp Three	Reno N L	78	LKTR	372	466				GN	0	
139	570	Camp Three	Reno N L	78	LKTR	392	756				GN	0	
140	570	Camp Three	Reno N L	78	LKTR	383	642				GN	0	
141	570	Camp Three	Reno N L	78	LKTR	403	608	7		OT	GN	1	ST10; 10 CHI
142	570	Camp Three	Reno N L	78	LKTR	386	688	17		OT	GN	1	ST5; 5 ZOO
143	570	Camp Three	Reno N L	78	LKTR	301	302	1		OT	GN	1	ST10; 10 ZOO; AB PAR
144	570	Camp Three	Reno S L	85	LKTR	326	350				GN	0	

Appendix E2 - Fish Life History Data

Sample Number	Project Number	Area	Waterbody	Site ID	Species	Fork Length	Weight	Maturity	Age	Structure	Capture	Code	Comments
145	570	Camp Three	Reno S L	85	LKTR	308	302				GN	0	
146	570	Camp Three	Reno S L	85	LKTR	466	1098				GN	0	
147	570	Camp Three	Reno S L	85	LKTR	294	242				GN	0	
148	570	Camp Three	Reno S L	86	LKTR	398	644				GN	0	
149	570	Camp Three	Reno S L	86	LKTR	311	344				GN	0	
150	570	Camp Three	Reno S L	86	LKTR	210	84				GN	0	
151	570	Camp Three	Reno S L	86	LKTR	267	198				GN	0	
152	570	Camp Three	Reno S L	86	LKTR	372	432				GN	0	
153	570	Camp Three	Reno S L	86	LKTR	254	156	99		OT	GN	1	ST5; 5 CHI; AB PAR
154	570	Camp Three	Reno S L	86	LKTR	368	474	16		OT	GN	1	ST0
155	570	Camp Three	Reno S L	86	LKTR	218	96	99	5	OT	GN	1	ST10; 10 ZOO
156	570	Camp Three	Reno S L	86	LKTR	356	436	16		OT	GN	1	ST5; 5 ZOO
157	570	Camp Three	Reno S L	86	LKTR	283	242	11		OT	GN	1	ST5; 5 ZOO
158	570	Camp Three	Reno S L	85	LKTR	350	354	16		OT	GN	1	ST10; 5 CHI, 5 ZOO
159	570	Camp Three	Reno S L	85	LKTR	251	166	1		OT	GN	1	ST0
160	570	Camp Three	Reno S L	85	LKTR	247	164	99		OT	GN	1	ST10; 10 ZOO
161	570	Camp Three	Reno S L	85	LKTR	222	116	99	4	OT	GN	1	ST10; 10 ZOO
162	570	Camp Three	Reno S L	85	LKTR	245	154	99		OT	GN	1	ST15; 15 CHI

Appendix E2 - Fish Life History Data

Sample Number	Project Number	Area	Waterbody	Site ID	Species	Fork Length	Weight	Maturity	Age	Structure	Capture	Code	Comments
91	570	Ulu Exploration Area	West L	66	LKTR	422	954	17	12	OT	GN	1	ST10; 5 FISH,5 CHI
92	570	Ulu Exploration Area	West L	67	LKTR	408	856				GN	0	
93	570	Ulu Exploration Area	West L	67	LKTR	395	748				GN	0	
94	570	Ulu Exploration Area	West L	67	LKTR	382	660				GN	0	
95	570	Ulu Exploration Area	West L	67	LKTR	377	632				GN	0	
96	570	Ulu Exploration Area	West L	66	LKTR	334	432				GN	0	
97	570	Ulu Exploration Area	West L	66	LKTR	384	656	17	12	OT	GN	1	ST5; 5 UNID
98	570	Ulu Exploration Area	West L	67	LKTR	411	846				GN	0	
99	570	Ulu Exploration Area	West L	76	LKTR	387	700				AL	0	
100	570	Ulu Exploration Area	West L	76	LKTR	409	748				AL	0	
101	570	Camp Three	Reno N L	78	LKTR	378	502				GN	0	
102	570	Camp Three	Reno N L	78	LKTR	392	586				GN	0	
103	570	Camp Three	Reno N L	78	LKTR	373	456				GN	0	
104	570	Camp Three	Reno N L	78	LKTR	390	512				GN	0	
105	570	Camp Three	Reno N L	78	LKTR	397	712				GN	0	
106	570	Camp Three	Reno N L	78	LKTR	321	322				GN	0	
107	570	Camp Three	Reno N L	78	LKTR	298	300				GN	0	
108	570	Camp Three	Reno N L	78	LKTR	345	520				GN	0	

Appendix E2 - Fish Life History Data

Sample Number	Project Number	Area	Waterbody	Site ID	Species	Fork Length	Weight	Maturity	Age	Structure	Capture	Code	Comments
109	570	Camp Three	Reno N L	78	LKTR	296	254				GN	0	
110	570	Camp Three	Reno N L	78	LKTR	358	318				GN	0	
111	570	Camp Three	Reno N L	78	RNWH	427	932				GN	0	
112	570	Camp Three	Reno N L	78	RNWH	401	748				GN	0	
113	570	Camp Three	Reno N L	78	LKTR	298	188				GN	0	
114	570	Camp Three	Reno N L	78	LKTR	414	850				GN	0	
115	570	Camp Three	Reno N L	78	RNWH	422	812				GN	0	
116	570	Camp Three	Reno N L	77	LKTR	337	218				GN	0	
117	570	Camp Three	Reno N L	77	LKTR	445	1252				GN	0	
118	570	Camp Three	Reno N L	77	LKTR	368	678				GN	0	
119	570	Camp Three	Reno N L	77	LKTR	387	514				GN	0	
120	570	Camp Three	Reno N L	77	LKTR	412	884				GN	0	
121	570	Camp Three	Reno N L	77	LKTR	402	660	16		OT	GN	1	ST10; 5 ZOO, 5 CHI
122	570	Camp Three	Reno N L	77	LKTR	368	604	7		OT	GN	1	ST10; 5 ZOO, 5 UNID
123	570	Camp Three	Reno N L	77	LKTR	333	424	11		OT	GN	1	ST5; 1 PEL, 2 CHI, 2 ZOO
124	570	Camp Three	Reno N L	77	LKTR	192	74	1	2	OT	GN	1	ST10; 5 ZOO, 5 CHI
125	570	Camp Three	Reno N L	77	RNWH	410	726	7		OT	GN	1	ST10; 10 PEL
126	570	Camp Three	Reno N L	77	RNWH	409	714	7		OT	GN	1	ST15; 15 PEL

Appendix E2 - Fish Life History Data

Sample Number	Project Number	Area	Waterbody	Site ID	Species	Fork Length	Weight	Maturity	Age	Structure	Capture	Code	Comments
55	570	Route 2	041.8	34	ARGR	188	70		3	SC	EF	0	
56	570	Route 2	041.8	34	ARGR	184	66		3	SC	EF	0	
57	570	Route 2	041.8	34	LKTR	97	10				EF	0	
58	570	Route 2	041.8	34	LKTR	133	24				EF	0	
59	570	Route 2	041.8	34	ARGR	91	6		1	SC	EF	0	
60	570	Route 2	041.8	34	SLSC	82	6				EF	0	
61	570	Route 2	041.8	34	SLSC	66					EF	0	
62	570	Route 2	041.8	34	LKTR	105					EF	0	
63	570	Route 2	041.8	34	LKTR	79					EF	0	
64	570	Route 2	041.8	34	LKTR	82					EF	0	
65	570	Route 2	041.8	34	LKTR	72					EF	0	
66	570	Route 2	041.8	34	LKTR	76					EF	0	
67	570	Route 2	041.8	34	LKTR	71					EF	0	
68	570	Route 2	041.8	34	LKTR	75					EF	0	
69	570	Route 2	041.8	34	SLSC	96	6				EF	0	
70	570	Route 2	064.8	41	LKTR	174	72				EF	0	
71	570	Route 2	064.8	41	LKTR	169	56				EF	0	
72	570	Ulu Exploration Area	Reno S Cr	45	SLSC	80					EF	0	

Appendix E2 - Fish Life History Data

Sample Number	Project Number	Area	Waterbody	Site ID	Species	Fork Length	Weight	Maturity	Age	Structure	Capture	Code	Comments
73	570	Ulu Exploration Area	Reno S Cr	45	SLSC	110					EF	0	
74	570	Ulu Exploration Area	Reno S Cr	45	SLSC	112					EF	0	
75	570	Ulu Exploration Area	Ulu L	48	LKTR	445	1032	17			GN	0	
76	570	Ulu Exploration Area	Ulu L	48	LKTR	740	9000				GN	0	
77	570	Ulu Exploration Area	Ulu L	48	LKTR	404	820				GN	0	
78	570	Ulu Exploration Area	Ulu L	48	LKTR	340	446	11	8	OT	GN	1	ST5; 5 ZOO
79	570	Ulu Exploration Area	Ulu L	48	LKTR	415	926	17	16	OT	GN	1	ST10; 10 ZOO
80	570	Ulu Exploration Area	Ulu L	48	LKTR	255	156	11	7	OT	GN	1	ST5; 5 ZOO
81	570	Ulu Exploration Area	Ulu L	48	LKTR	378	632	1	12	OT	GN	1	ST15; 15 ZOO
82	570	Ulu Exploration Area	Ulu L	48	LKTR	595	2300	7	18	OT	GN	1	ST0
83	570	Ulu Exploration Area	Ulu L	49	LKTR	439	1176				GN	0	
84	570	Ulu Exploration Area	Ulu L	49	LKTR	574	2104				GN	0	
85	570	Ulu Exploration Area	Ulu L	49	LKTR	431	964				GN	0	
86	570	Ulu Exploration Area	Ulu L	49	LKTR	332	412				GN	0	
87	570	Ulu Exploration Area	Ulu L	49	LKTR	359	508	1	10	OT	GN	1	ST10; 10 CHI
88	570	Ulu Exploration Area	Ulu L	49	LKTR	415	930	17	13	OT	GN	1	ST15; 15 CHI
89	570	Ulu Exploration Area	West L	66	LKTR	412	952				GN	0	
90	570	Ulu Exploration Area	West L	66	LKTR	399	798	17	12	OT	GN	1	ST0

Appendix E2 - Fish Life History Data

Sample Number	Project Number	Area	Waterbody	Site ID	Species	Fork Length	Weight	Maturity	Age Structure	Capture	Code	Comments
19	570	Ulu Exploration Area	Ulu Cr	24	SLSC	49				EF	0	
20	570	Ulu Exploration Area	Ulu Cr	24	SLSC	50				EF	0	
21	570	Ulu Exploration Area	Ulu Cr	24	SLSC	43				EF	0	
22	570	Ulu Exploration Area	Ulu Cr	24	SLSC	98				EF	0	
23	570	Ulu Exploration Area	Ulu Cr	24	SLSC	80				EF	0	
24	570	Ulu Exploration Area	Ulu Cr	24	SLSC	72				EF	0	
25	570	Ulu Exploration Area	Ulu Cr	24	ARGR	28				EF	0	
26	570	Ulu Exploration Area	Ulu Cr	24	ARGR	30				EF	0	
27	570	Ulu Exploration Area	Ulu Cr	24	ARGR	30				EF	0	
28	570	Ulu Exploration Area	Ulu Cr	24	ARGR	30				EF	0	
29	570	Ulu Exploration Area	Ulu Cr	24	ARGR	30				EF	0	
30	570	Ulu Exploration Area	Ulu Cr	24	ARGR	30				EF	0	
31	570	Ulu Exploration Area	Ulu Cr	24	BURB	105				EF	0	
32	570	Ulu Exploration Area	Ulu Cr	30	SLSC	52				EF	0	
33	570	Ulu Exploration Area	Ulu Cr	30	SLSC	84				EF	0	
34	570	Ulu Exploration Area	Ulu Cr	30	SLSC	112				EF	0	
35	570	Ulu Exploration Area	Ulu Cr	30	SLSC	114				EF	0	
36	570	Ulu Exploration Area	Ulu Cr	30	SLSC	75				EF	0	

Appendix E2 - Fish Life History Data

Sample Number	Project Number	Area	Waterbody	Site ID	Species	Fork Length	Weight	Maturity	Age	Structure	Capture	Code	Comments
37	570	Ulu Exploration Area	Ulu Cr	30	SLSC	56					EF	0	
38	570	Ulu Exploration Area	Ulu Cr	30	SLSC	90					EF	0	
39	570	Route 1	003.0	31	ARGR	115	20		1	SC	EF	0	
40	570	Route 1	003.0	31	ARGR	111	18		1	SC	EF	0	
41	570	Route 1	003.0	31	ARGR	112	16		1	SC	EF	0	
42	570	Route 1	003.0	31	ARGR	111	14		1	SC	EF	0	
43	570	Route 1	003.0	31	ARGR	118	22		1	SC	EF	0	
44	570	Route 1	018.5	32	ARGR	41					EF	0	
45	570	Route 1	018.5	32	ARGR	39					EF	0	
46	570	Route 1	018.5	32	ARGR	36					EF	0	
47	570	Route 1	018.5	32	ARGR	36					EF	0	
48	570	Route 1	018.5	32	ARGR	35					EF	0	
49	570	Route 1	018.5	32	ARGR	37					EF	0	
50	570	Route 1	018.5	32	ARGR	36					EF	0	
51	570	Route 1	018.5	32	ARGR	40					EF	0	
52	570	Route 1	018.5	32	ARGR	37					EF	0	
53	570	Route 1	018.5	32	ARGR	41					EF	0	
54	570	Route 1	018.5	32	ARGR	40					EF	0	

Appendix E2 R.L. & L. ENVIRONMENTAL SERVICES LTD. FISH SPECIES ABBREVIATIONS

ABBR.	COMMON NAME	SCIENTIFIC NAME	ABBR.	COMMON NAME	SCIENTIFIC NAME
CTTR	Cutthroat trout	*Oncorhynchus clarki*	BURB	Burbot	*Lota lota*
BLTR	Bull trout	*Salvelinus malma*	SLSC	Slimy sculpin	*Cottus cognatus*
LKTR	Lake trout	*Salvelinus namaycush*	SPSC	Spoonhead sculpin	*Cottus ricei*
ARCH	Arctic char	*Salvelinus alpinus*	PRSC	Prickly sculpin	*Cottus asper*
ARGR	Arctic grayling	*Thymallus arcticus*	SHSC	Shorthead sculpin	*Cottus confusus*
MNWH	Mountain whitefish	*Prosopium williamsoni*	PSSC	Pacific staghorn sculpin	*Leptocottus armatus*
RNWH	Round whitefish	*Prosopium cylindraceum*	MTSC	Mottled sculpin	*Cottus bairdi*
PGWH	Pygmy whitefish	*Prosopium coulteri*	TRSC	Torrent sculpin	*Cottus rhotheus*
LKWH	Lake whitefish	*Coregonus clupeaformis*	BRST	Brook stickleback	*Culaea inconstans*
BRWH	Broad whitefish	*Coregonus nasus*	NNST	Ninespine stickleback	*Pungitius pungitius*
CISC	Ciscoe	*Coregonus artedii*	THST	Threespine stickleback	*Gasterosteus aculeatus*
INCO	Inconnu	*Stenodus leucichthys*	RDSH	Redside shiner	*Richardsonius balteatus*
PINK	Pink salmon	*Oncorhynchus gorbuscha*	NRSQ	Northern squawfish	*Ptychocheilus oregonensis*
CHUM	Chum salmon	*Oncorhynchus keta*	PRDC	Pearl dace	*Semotilus margarita*
COHO	Coho salmon	*Oncorhynchus kisutch*	PEAM	Peamouth	*Mylocheilus caurinus*
SOCK	Sockeye salmon	*Oncorhynchus nerka*	FLCH	Flathead chub	*Platygobid gracilis*
KOKA	Kokanee	*Oncorhynchus nerka*	LKCH	Lake chub	*Couesius plumbeus*
CHIN	Chinook salmon	*Oncorhynchus tshawytscha*	LNDC	Longnose dace	*Rhinichthys cataractae*
LNSC	Longnose sucker	*Catostomus catostomus*	FNDC	Finescale dace	*Pfrille neogaeus*
WHSC	White sucker	*Catostomus commersoni*	NRDC	Northern redbelly dace	*Chrosomus eos*
LRSC	Largescale sucker	*Catostomus macrocheilus*	LPDC	Leopard dace	*Rhinichthys falcatus*
BRSC	Bridgelip sucker	*Catostomus columbianus*	EMSH	Emerald shiner	*Notropis atherinoides*
MNSC	Mountain sucker	*Catostomus platyrhynchus*	SPSH	Spottail shiner	*Notropis hudsonius*
CARP	Carp	*Cyprinus carpio*	FTMN	Fathead minnow	*Pimephales promelas*
CHIS	Chiselmouth	*Acrocheilus alutaceus*	TRPR	Trout-perch	*Percopsis omiscomaycus*
SMBS	Smallmouth bass	*Micropterus dolomievi*	IWDR	Iowa darter	*Etheostoma exile*
LKST	Lake sturgeon	*Acipenser fulvescens*	STFL	Starry flounder	*Platichthys stellatus*
WHST	White sturgeon	*Acipenser transmontanus*	LNSM	Longfin smelt	*Spirinchus thaleichthys*
GOLD	Goldeye	*Hiodon alosdides*	EUAL	Eualchon	*Thaleichthys pacificus*
NRPK	Northern pike	*Esox lucius*	PCLM	Pacific lamprey	*Entosphenus tridentatus*
WBLM	Western brook lamprey	*Lampetra richardsoni*	ARLM	Arctic lamprey	*Lampetra japonica*
LSCS	Least cisco	*Coregonus sardinella*	ARCS	Arctic cisco	*Coregonus autumnalis*

SEX AND MATURITY DESCRIPTIONS

M	F	CLASS	DESCRIPTION
		Immature A	Sex indeterminable due to small gonad size.
01	11	Immature B	Small gonad size; fish has never spawned and will not spawn during the coming spawning season.
02	12	Maturity questionable	Small gonad size; it cannot be determined if fish is immature or if it will spawn during the coming spawning season.
03	13	Developing A	Definite gonad development; fish has never spawned before but will spawn during the coming season.
04	14	Developing B	Definite gonad development; the fish has spawned before and will spawn during the coming season.
05	15	Developing C	Definite gonad development; the fish has spawned before but will not spawn during the coming spawning season, i.e., alternate year spawners.
06	16	Developing D	Used to indicate definite gonad development when the classification into categories "developing A,B, or C cannot be determined, or when such a breakdown is unsuitable or unnecessary.
07	17	Gravid/fully developed	Sexual organs fill ventral cavity testes white, drops of milt fall with pressure; eggs completely round, some already translucent.
08	18	Ripe	Roe or milt are extruded by slight pressure on the belly.
09	19	Spent	Spawning completed; resorption of residual ovarian tissue is not yet complete.
10	20	External	Sex determined by external characteristics; maturity and sex not verified by gonad examination.
99	99	Adult/Juvenile	Based on fish size; sex not determined.

OTHER CODES

CODE	AGEING METHODS	CODE	AGEING METHODS
SC	Scales	CL	Cleithra
OT	Otoliths	CS	Cleithra and scales
SO	Scales and otoliths	VE	Vertebrae
FR	Fin ray	OB	Other bones
SF	Scales and fin rays	LF	Length-frequency

CODE	CAPTURE METHODS
FD	Found dead
SL	Set line
DN	Dip net
GN	Gill net
ES	Electroshocker - Boat shocker
EF	Electrofisher - backpack shocker
BS	Beach seine
OB	Observed - not captured
TU	Trap - fish moving upstream
TD	Trap - fish moving downstream
AL	Angling (Using lures)
AF	Angling (Using flies)
AB	Angling (Using bait)
CR	Creel - sampled from a fisherman's creel
CF	Commercial fisherman's catch
GE	Small Gee trap
GT	Large Gee trap

CODE	TAG CODE
Y, W, R	Color code for tag (i.e., Yellow, White, or Red)
F	Fin clip: 1=Adipose, 2=R. Pectoral, 3=L. Pectoral, 4=R. Pelvic, 5=L. Pelvic, 6=Dorsal, 9=Fin Punch.

CODE	CAPTURE CODE
0	First capture, released
1	First capture, sacrificed
2	Recapture, released
3	Recapture, sacrificed

CODE	STOMACH CONTENT CODE
ZOO	Zooplankton
CHI	Chirnomids
TRI	Trichopterans
FIS	Fish
DIP	Dipterans
COL	Coleopterans
PEL	Pelecypods
BRA	Brachiopods
INS	Insects
ROD	Rodent
GAS	Gastropods
UNI	Unidentified

Appendix E2 - Fish Life History Data

Sample Number	Project Number	Area	Waterbody	Site ID	Species	Fork Length	Weight	Maturity	Age	Structure	Capture	Code	Comments
1	570	Ulu Exploration Area	Ulu Cr	2	SLSC	137	24				EF	0	
2	570	Ulu Exploration Area	Ulu Cr	2	SLSC	129	24				EF	0	
3	570	Ulu Exploration Area	Ulu Cr	2	SLSC	110	16				EF	0	
4	570	Ulu Exploration Area	Ulu Cr	2	SLSC	114	18				EF	0	
5	570	Ulu Exploration Area	Reno S Cr	11	SLSC	99	10				EF	0	
6	570	Route 2	041.8	14	ARGR	154	30		2	SC	EF	0	
7	570	Route 2	041.8	14	ARGR	160	48		2	SC	EF	0	
8	570	Route 2	041.8	14	ARGR	187	80		3	SC	EF	0	
9	570	Route 2	041.8	14	ARGR	239	156			SC	EF	0	
10	570	Route 2	041.8	14	ARGR	172	60		3	SC	EF	0	
11	570	Route 2	041.8	14	ARGR	149	34		2	SC	EF	0	
12	570	Route 2	043.5	15	BURB	105	6				EF	0	
13	570	Route 2	043.5	15	BURB	71					EF	0	
14	570	Route 2	064.8	21	LKTR	289	240				EF	0	
15	570	Ulu Exploration Area	Ulu Cr	23	SLSC	42					EF	0	
16	570	Ulu Exploration Area	Ulu Cr	23	SLSC	42					EF	0	
17	570	Ulu Exploration Area	Ulu Cr	23	SLSC	41					EF	0	
18	570	Ulu Exploration Area	Ulu Cr	23	SLSC	58					EF	0	

APPENDIX E2
FISH LIFE HISTORY DATA

Appendix E1 - Fish Sampling Methods and Effort

Project Number	Region	Waterbody	Site	SiteID	Date	Utm Zone	Easting	Northing	Method	Effort
570	Ulu Exploration Area	Reno N L	2	78	08/03/97	12W	502081	7415002	GN	25020
570	Ulu Exploration Area	Reno N L	1	79	08/03/97	12W	501817	7415495	GT	30600
570	Ulu Exploration Area	Reno N L	2	80	08/03/97	12W	501755	7414973	GT	30300
570	Ulu Exploration Area	Reno N L	3	81	08/03/97	12W	501875	7414571	GT	30060
570	Ulu Exploration Area	Reno N L	4	82	08/03/97	12W	502417	7414932	GT	30060
570	Ulu Exploration Area	Reno N L	1	84	08/03/97	12W			AL	8100
570	Ulu Exploration Area	Reno S L	1	85	08/04/97	12W	500841	7413889	GN	18000
570	Ulu Exploration Area	Reno S L	2	86	08/04/97	12W	501466	7412822	GN	28560
570	Ulu Exploration Area	Reno S L	1	87	08/04/97	12W	500115	7414380	GT	31800
570	Ulu Exploration Area	Reno S L	2	88	08/04/97	12W	500823	7413686	GT	30780
570	Ulu Exploration Area	Reno S L	3	89	08/04/97	12W	499630	7414462	GT	29160
570	Ulu Exploration Area	Reno S L	4	90	08/04/97	12W	499574	7414329	GT	29400
570	Ulu Exploration Area	Frayed Knot R	1	92	08/05/97	12W			AL	1800
570	Ulu Exploration Area	Frayed Knot R	2	93	08/05/97	12W			AL	1800
570	Ulu Exploration Area	Frayed Knot R	3	94	08/01/97	12W			SN	600
570	Ulu Exploration Area	Frayed Knot R	3	95	08/05/97	12W			AL	1800
570	Ulu Exploration Area	Frayed Knot R	4	98	08/05/97	12W			AL	1800

Appendix E1 - Fish Sampling Methods and Effort

Project Number	Region	Waterbody	Site	SiteID	Date	Utm Zone	Easting	Northing	Method	Effort
570	Ulu Exploration Area	Ulu Cr	1	1	06/16/97	12W	503050	7421350	EF	1425
570	Ulu Exploration Area	Ulu Cr	2	2	06/16/97	12W	503127	7421503	EF	378
570	Ulu Exploration Area	Ulu Cr	3	3	06/17/97	12W	502425	7421360	EF	112
570	Ulu Exploration Area	Ulu L Inlet 2	4	4	06/17/97	12W	502138	7420999	EF	158
570	Winter Access Road	118.2	118.2	10	06/17/97	12W	499705	7410668	EF	178
570	Ulu Exploration Area	Reno S Cr	1	11	06/17/97	12W	498530	7415167	EF	230
570	Winter Access Road	003.0	3.1	12	06/18/97	12W	517728	7349569	EF	245
570	Winter Access Road	041.8	41.8	14	06/18/97	12W	506176	7378165	EF	273
570	Winter Access Road	043.5	43.5	15	06/18/97	12W	505153	7379179	EF	295
570	Winter Access Road	045.3	45.3	16	06/18/97	12W	504814	7381306	EF	194
570	Winter Access Road	046.9	46.9	17	06/18/97	12W	505419	7382972	EF	179
570	Winter Access Road	056.0	56.1	18	06/17/97	12W	503839	7391026	EF	212
570	Winter Access Road	064.8	64.8	21	06/17/97	12W	502654	7399260	EF	215
570	Winter Access Road	070.8	70.8	22	06/17/97	12W	501018	7404130	EF	61
570	Ulu Exploration Area	Ulu Cr	1	23	07/29/97	12W	506974	7421319	EF	382
570	Ulu Exploration Area	Ulu Cr	1	24	07/29/97	12W	506814	7421379	EF	544
570	Ulu Exploration Area	Ulu Cr	1	26	07/29/97	12W	506240	7421205	EF	644
570	Ulu Exploration Area	Ulu Cr	1	28	07/29/97	12W	505153	7421425	EF	104
570	Ulu Exploration Area	Ulu Cr	2	30	07/29/97	12W			EF	366
570	Winter Access Road	003.0	3.1	31	08/01/97	12W	517764	7349456	EF	170
570	Winter Access Road	018.5	18.52	32	08/01/97	12W	521012	7363146	EF	255
570	Winter Access Road	041.8	41.8	34	08/01/97	12W	506199	7377974	EF	305

Appendix E1 - Fish Sampling Methods and Effort

Project Number	Region	Waterbody	Site	SiteID	Date	Utm Zone	Easting	Northing	Method	Effort
570	Winter Access Road	056.0	56.1	39	08/01/97	12W	503972	7390775	EF	157
570	Winter Access Road	064.8	64.8	41	08/01/97	12W	502670	7399049	EF	200
570	Winter Access Road	118.2	118.2	44	08/01/97	12W	499717	7410482	EF	79
570	Ulu Exploration Area	Reno S Cr	1	45	08/05/97	12W	498624	7415039	EF	375
570	Ulu Exploration Area	Frayed Knot R	1	46	08/01/97	12W			SN	3600
570	Ulu Exploration Area	Frayed Knot R	2	47	08/01/97	12W			SN	600
570	Ulu Exploration Area	Ulu L	1	48	07/30/97	12W			GN	24300
570	Ulu Exploration Area	Ulu L	2	49	07/30/97	12W	502069	7421575	GN	24300
570	Ulu Exploration Area	Ulu L	1	50	07/30/97	12W			GT	28800
570	Ulu Exploration Area	Ulu L	2	51	07/30/97	12W			GT	28800
570	Ulu Exploration Area	Meadow L	1	56	07/31/97	12W	503542	7421538	GN	17100
570	Ulu Exploration Area	Meadow L	2	57	07/31/97	12W	503396	7421312	GN	15600
570	Ulu Exploration Area	Meadow L	1	58	07/31/97	12W	503256	7421316	GT	16200
570	Ulu Exploration Area	Meadow L	2	59	07/31/97	12W	503636	7421260	GT	16020
570	Ulu Exploration Area	West L	1	66	08/02/97	12W	500681	7421033	GN	23760
570	Ulu Exploration Area	West L	2	67	08/02/97	12W	500629	7421273	GN	24000
570	Ulu Exploration Area	West L	1	68	08/02/97	12W	500727	7420893	GT	23100
570	Ulu Exploration Area	West L	2	69	08/02/97	12W	500664	7421203	GT	23160
570	Ulu Exploration Area	West L	3	70	08/02/97	12W	500581	7420960	GT	23160
570	Ulu Exploration Area	West L	4	71	08/02/97	12W	500655	7420705	GT	23160
570	Ulu Exploration Area	West L	1	76	08/02/97	12W			AL	5400
570	Ulu Exploration Area	Reno N L	1	77	08/03/97	12W	502252	7414862	GN	14160

APPENDIX E1
FISH SAMPLING EFFORT

APPENDIX E
FISHERIES DATA

Appendix D4 Benthic macroinvertebrates (No./m²) collected from sampled lakes during summer, Ulu Exploration Area 1997.

Taxonomic Group	Ulu Lake Replicate			Meadow Lake Replicate			West Lake Replicate		
	1	2	3	1	2	3	1	2	3
ANNELIDA									
OLIGOCHAETA									
Lumbriculidae	1			5	4	3	3	2	
Naididae				1					
ARTHROPODA									
HYDRACARINA									
Lebertia			1		1				
Unidentified		2			1	1			
CRUSTACEA									
CLADOCERA									
Chydoridae									
Unidentified	1								
Daphnidae									
Daphnia					3	1			
Unidentified	24	3	12						
COPEPODA									
Harpacticoida	5	3							2
OSTRACODA	1	10		149	246	225		4	1
INSECTA									
DIPTERA									
Chironomidae									
Orthocladiinae/Diamesinae	10	13		26	8	22	5	3	5
Chironomini	4	9	1			1	2	2	
Tanypodinae	24	4	3	122	93	123	48	42	48
Tanytarsini	1			120	101	134	7	7	5
Chironomidae Pupae	1			5	6	3		1	1
COLEOPTERA									
Dytiscidae									
Agabus					1				
Desmopachria				1		1			
TRICHOPTERA									
Limnephilidae									
Pseudostenophylax		2							
MOLLUSCA									
PELECYPODA									
Sphaeriidae									
Pisidium		3					1		
Unidentified	32	32	25	2	11		26	19	41
MICROTURBELLARIA									
TRICLADIDA									
Dugesia	7	2		2	3				
NEMATODA		1	5	24	59	47		3	
Total Number of Taxa	11	11	8	13	14	11	8	11	9
Total Number of Animals (No./m²)	111	84	47	457	537	561	92	83	103

Appendix D2 Concluded.

Taxonomic Group	Density (No. /mL)			Biovolume (µm³/m³)		
	Ulu Lake 30 July 97	West Lake 2 August 97	Meadow Lake 31July 97	Ulu Lake 30 July 97	West Lake 2 August 97	Meadow Lake 31July 97
PYRROPHYTA (Dinoflagellates)						
Glenodinium sp.	7	7	3	1731	2537	1666
Gumnotinium helveticum	P		1	P		40 204
Gymnodinium uberrimum	P		P	P		P
Peridinium aciculiferum	2		2	6870		4793
Unidentified cyst	P	P	P	P	P	P
Total Pyrrophyta	9	7	6	8601	2537	46 663
EUGELNOPHYTA						
Euglena sp.			P			P
Trachelomonas bacillifera			P			P
Trachelomonas sp.	P			P		
Total Euglenophyta						
CHLOROPHYTA (Green Algae)						
Ankistrodesmus convolutus	2		3	26		66
Ankistrodesmus falcatus		14	P		261	P
Ankistrodesmus gelifactus	16	96	16	234	2500	454
Arthrodesmus angularis	P			P		
Carteria sp.			P			P
Chlamydomonas sp	P	124	5	P	14 927	369
Coelastrum printzii			P			P
Cosmarium sp.			P			P
Cosmarium sp.			P			P
Cosmarium impressulum			P			P
Cosmarium humile			P			P
Crucigenia rectangularis			42			8526
Euastrum bidentatum			P			P
Eudorina elegans			P			P
Monoraphidium sp.	5			28		
Nephrocytium limneticum	P			P		
Oocystis elliptica	13	7	2	7193	5005	918
Oocystis pusilla			152			19 923
Pediastrum tetras	41		P	3308		P
Scenedesmus bijuga	P		3	P		76
Sphaerocystis schroeteri	26	34	31	5423	8671	11 954
Staurastrum sp.			P			P
Teilingia granulata	5	14		815	1527	
Tetraedron minimum	20	P	2	831	P	69
Tetraedron triangulare	P		P	P		P
Westella linearis			31			12 176
Total Chlorophyta	128	289	287	17 859	32 891	54 531
CYANOPHYTA (Cyanobacteria)						
Anacystis montana	252	1784	46	3212	9524	34
Aphanizomenon flos-aquae	P			P		
Aphanothece clathrata	932			3392		
Dactylococcopsis linearis	P			P		
Dicothrix orsiniana	P		26	P		214
Gomphosphaeria lacustris	P			P		
Microcystis flos-aquae			157			19 626
Oscillatoria limnetica	P			P		
Total Cyanophyta	1184	1784	229	6604	9524	20 874
Total Algal Density per Sample (No./mL)	3445	4137	829			
Total Algal Biovolume per Sample (µm³/m³)				892 971	1 014 328	263 767
Total Number of Taxa per Sample	53	30	61			

[1]P=present, but not encountered in routine cell counts.

Appendix D3 Density and biomass of zooplankton collected from sampled lakes during summer, Ulu Exploration Area 1997.

Taxonomic Group	Density (No./m³)			Biomass (µg/m³)		
	Ulu Lake 30 July 97	Meadow Lake 31 July 97	West Lake 2 August 97	Ulu Lake 30 July 97	Meadow Lake 31 July 97	West Lake 2 August 97
CALANOIDA						
Heterocope sp.	95	P[1]	P	8,387	P	P
Leptodiaptomus sicilis	10,009	1,205	8,284	124,031	9,568	137,858
copepodids	142	P	136	541	P	517
nauplii			5,089			1,098
CYCLOPOIDA						
Cryptocyclops bicolor			P			P
Cyclops scutifer	6,072		313	71,730		4,123
Ectocyclops phaleratus		573	109		3,303	612
copepodids	2,562	134,157	136	9,817	24,737	269
nauplii	674,333		308,721	83,035		56,924
CLADOCERA						
Daphnia middendorffiana	95	1,175		5,684	62,412	
Daphnia schoderi				P		
Eubosmina sp.	P			P		
Holopedium sp.	3,321			5,397,449		
ROTIFERA						
Conochilus unicornis	106,474	63,884		9,408	5,645	
Euchlanis diliata	4,436			366		
Keratella cochlearis	22,182	25,554	189,982	1,830	2,109	15,677
Kellicottia longispina	204,074	57,496	71,243	18,184	5,123	6,348
Lecane luna		6,388			396	
Lepadella patella			1,696			74
Polyarthra delichoptera	31,055			2,299		
Syncheata sp.	8,873			732		
Total Density and Biomass	1,073,722	290,432	585,710	5,733,491	113,292	223,498

P=Present, but not encountered in routine cell counts.

Appendix D1 Summary of phytoplankton, zooplankton, and benthic macroinvertebrate collection data from sampled lakes during summer, Ulu Exploration Area 1997.

		Zooplankton						Phytoplankton		Benthos			
Lake	Date	UTM Coordinates	No. of Replicates	Area Sampled (m^2)	Secchi Disk Depth (m)	Haul Depth (m)	Volume Filtered (m^3)	No. Hauls	Haul Depth (m)	UTM Coordinates	Sample Depth (m)	No. of Replicates	Substrate Composition
Ulu	30 Jul 97	12W 052069 7421575	3	0.014	6.5	9.0	0.378	5	9.0	12W 0502263 7420995	4.0	3	silt/clay
Meadow	31 Jul 97	12W 0503571 7421413	3	0.014	3.0	2.5	0.105	5	2.5	12W 0503571 7421413	3.2	3	silt/clay
West	2 Aug 97	12W 0500680 7420896	3	0.014	10.1	12.0	0.504	5	12.0	12W 0500681 7421033	5.5	3	silt/sand/gravel

Appendix D2 Density and biovolume of phytoplankton collected from sampled lakes during summer, Ulu Exploration Area 1997.

Taxonomic Group	Density (No. /mL)			Biovolume (µm³/m³)		
	Ulu Lake 30 July 97	West Lake 2 August 97	Meadow Lake 31July 97	Ulu Lake 30 July 97	West Lake 2 August 97	Meadow Lake 31July 97
BACILLARIOPHYTA (Diatoms)						
Achnanthes flexella		P	2		P	4040
Achnanthes minutissima	9	P	2	3442	P	504
Cyclotella bodanica	22	P		112 273	P	
Cyclotella glomerata	116	7	7	21 960	3543	1291
Eunotia sp.			P			P
Eunotia arcus v.bidens						
Frustulia vulgaris	P		P	P		P
Meridion circular		P			P	
Navicula cryptocephala			P			P
Navicula sp.	P	P	P	P	P	P
Navicula scandinavica			P			P
Nitzschia filiformis	P			P		
Nitzschia sp.			P			P
Pinnularia sudetica			P			P
Pinnularia sp.	P			P		
Synedra sp.	2		3	975		1090
Synedra ulna			P			P
Tabellaria flocculosa	P	P	4	P	P	5026
Total Bacillariophyta	149	7	18	138 650	3543	11 951
CRYPTOPHYTA (Cryptomonads)						
Cryptomonas curvata	7		3	30 155		16 491
Cryptomonas ovata	2		1	4852		627
Cryptomonas reflexa	22	11	44	16 738	10 498	37 309
Katablepharis ovalis	P	62	24	P	6744	3718
Rhodomonas minuta	48	69	52	7812	9005	8011
Total Cryptophyta	79	142	124	59 557	26 247	66 156
CHRYSOPHYTA (Golden-Brown Algae)						
Bitrichia longispina			P			P
Chromulina sp.	P			P		
Chrysochromulina parva	177	992	9	5488	39 289	288
Chrysococcus sp.	P	145		P	66 527	
Chrysoikos skujai		P			P	
Chrysosphaerella rodhei	1561	248	100	51 6931	66 048	32 353
Chrysostephanosphaera globulifera			2			137
Dinobryon sertularia	54		12	45 317		10 457
Dinobryon sertularia v.protuberans	78	441	3	83 036	741 766	5436
Dinobryon sociale	P		1	P		1,825
Dinobryon tabellariae		6			5911	
Kephyrion boreale	P	7	34	P	1055	8378
Mallomonas sp.	2		3	3477		4718
Ochromonas spa	P			P		
Ochromonas spb.	P	55		P	15 932	
Ophiocytium sp.			P			P
Pseudokephyrion sp.	7	P		2485	P	
Stichogloea doederleinii	17	14	P	4965	3058	P
Total Chrysophyta	1896	1908	164	661 700	939 586	63 592

[1]P=present, but not encountered in routine cell counts.

APPENDIX D
AQUATIC INVERTEBRATE DATA

NORWEST LABS

Calgary, AB	**Phone (403) 291-2022**	**Fax (403) 291-2021**
Edmonton, AB	Phone (403) 438-5522	Fax (403) 434-8586
Lethbridge, AB	Phone (403) 329-9266	Fax (403) 327-8527
Langley, B.C.	Phone (604) 530-4344	Fax (604) 534-9996
Winnipeg, MB	Phone (204) 982-8630	Fax (204) 275-6019

TO:	RL&L Environmental Services Ltd.	**DATE SAMPLED:**	1-Aug-97
		DATE RECEIVED:	7-Aug-97
ATTN:	Rick Pattenden	**DATE REPORTED:**	14-Aug-97
		LAB FILE#:	97-08-2769
		Project:	Project 570

HYDROCARBON ASSESSMENT - WATER

EDMONTON WO# 137101	**5**	**6**	**7**	
LAB #	**5**	**6**	**7**	**Detection**
CLIENT #	**W5**	**W6**	**W7**	**Limit**
[1]Non-Halogenated Aromatics:				
Benzene	<0.001	<0.001	<0.001	0.001
Toluene	<0.001	<0.001	<0.001	0.001
Ethylbenzene	<0.001	<0.001	<0.001	0.001
Total Xylenes (o, m & p)	<0.001	<0.001	<0.001	0.001
[1]Total Purgeables (C_5 - C_{10})	<0.01	<0.01	<0.01	0.01
[2]Total Extractables (C_{11} - C_{30}+)	<0.1	<0.1	<0.1	0.1

Results expressed in mg/L (ppm)

[1]Assessment as per US EPA Method 8020

[2]Assessment as per Alta. Env. Method A108.0

NORWEST LABS

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P.O. NO. 3829
W.O. NO. 4 137101
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RL & L ENV. SERVICES
17312-106 AVENUE
EDMONTON, AB
T5S 1H9

RICK PATTENDEN
PROJECT 570
01 08 97

WATER ANALYSIS REPORT

note	pH	pH REPORTED AT ROOM TEMP
note	ELECTRICAL COND	'ELECTRICAL COND' (EC) is in microsiemens/cm and is a measure of solids in solution E.C. CORRECTED TO 25C
note	T ALKALINITY	'ALKALINITY' is CARBONATE/BICARBONATE expressed as CALCIUM CARBONATE
note	HARDNESS	'HARDNESS' is calcium and magnesium expressed as CALCIUM CARBONATE
note	NO2&NO3-N	is expressed as nitrogen

Lab Manager: ______________________

NORWEST LABS

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Winnipeg, MB	Phone (204) 982-8630	Fax (204) 275-6019

TO:	RL&L Environmental Services Ltd.	**DATE SAMPLED:**	1-Aug-97
		DATE RECEIVED:	7-Aug-97
ATTN:	Rick Pattenden	**DATE REPORTED:**	14-Aug-97
		LAB FILE#:	97-08-2769
		Project:	Project 570

HYDROCARBON ASSESSMENT - WATER

EDMONTON WO# 137101	**1**	**2**	**3**	**4**	
LAB #	**1**	**2**	**3**	**4**	**Detection**
CLIENT #	**East L.**	**ULU L.**	**W3**	**W4**	**Limit**
[1]Non-Halogenated Aromatics:					
Benzene	<0.001	<0.001	<0.001	<0.001	0.001
Toluene	<0.001	<0.001	<0.001	<0.001	0.001
Ethylbenzene	<0.001	<0.001	<0.001	<0.001	0.001
Total Xylenes (o, m & p)	<0.001	<0.001	<0.001	<0.001	0.001
[1]Total Purgeables (C_5 - C_{10})	<0.01	<0.01	<0.01	<0.01	0.01
[2]Total Extractables (C_{11} - C_{30}+)	<0.1	<0.1	<0.1	<0.1	0.1

R. Corbet, M.Sc., P. Ag.
Manager - Organics

Results expressed in mg/L (ppm)

[1]Assessment as per US EPA Method 8020

[2]Assessment as per Alta. Env. Method A108.0

NORWEST LABS

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RL & L ENV. SERVICES
17312-106 AVENUE
EDMONTON, AB
T5S 1H9

RICK PATTENDEN
PROJECT 570
01 08 97

WATER ANALYSIS REPORT

SAMPLE		7 W7
ROUTINE WATER		
pH		6.89
ELECTRICAL COND	uS/cm	16.0
CALCIUM	mg/L	1.4
MAGNESIUM	mg/L	0.5
SODIUM	mg/L	0.9
POTASSIUM	mg/L	0.69
IRON	mg/L	<0.04
MANGANESE	mg/L	<0.003
SULPHATE	mg/L	1.4
CHLORIDE	mg/L	0.5
BICARBONATE	mg/L	9
T ALKALINITY	mg/L	7
HARDNESS	mg/L	5.6
T DIS SOLIDS	mg/L	10
IONIC BALANCE	%	~87.1
WATER NUTRIENTS		
TOTAL KJEHL NIT	mg/L	<0.05
AMMONIA-N	mg/L	<0.05
NITRATE-N	mg/L	<0.05
NITRITE-N	mg/L	<0.05
PHOSPHORUS(TOT)	mg/L	0.18
PHOSPHORUS,DISS	mg/L	0.12
NO2&NO3-N	mg/L	<0.05
ORGANICS		
OIL AND GREASE	mg/L	1
TOT ORG CARBON	mg/L	2.2
TOTAL, COLD VAPO		
MERCURY	mg/L	<0.0001
TRACE ICP,TOTAL		
ALUMINUM	mg/L	0.018
ANTIMONY	mg/L	<0.005
ARSENIC	mg/L	<0.01
BARIUM	mg/L	0.0017

Lab Manager:

NORWEST LABS

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RL & L ENV. SERVICES
17312-106 AVENUE
EDMONTON, AB
T5S 1H9

RICK PATTENDEN
PROJECT 570
01 08 97

WATER ANALYSIS REPORT

SAMPLE		7 W7
TRACE ICP,TOTAL		
BERYLLIUM	mg/L	<0.0005
BISMUTH	mg/L	<0.007
BORON	mg/L	<0.002
CADMIUM	mg/L	<0.0005
CALCIUM	mg/L	1.36
CHROMIUM	mg/L	<0.0008
COBALT	mg/L	<0.0007
COPPER	mg/L	0.001
IRON	mg/L	0.045
LEAD	mg/L	<0.002
LITHIUM	mg/L	0.00091
MANGANESE	mg/L	0.0020
MAGNESIUM	mg/L	0.596
MOLYBDENUM	mg/L	0.001
NICKEL	mg/L	<0.001
PHOSPHORUS	mg/L	0.010
POTASSIUM	mg/L	3.04
SELENIUM	mg/L	<0.003
SILICON	mg/L	0.191
SILVER	mg/L	<0.001
SODIUM	mg/L	0.422
STRONTIUM	mg/L	0.0038
SULPHUR	mg/L	0.477
THALLIUM	mg/L	<0.004
TIN	mg/L	<0.003
TITANIUM	mg/L	0.0007
VANADIUM	mg/L	<0.001
ZINC	mg/L	0.0112

Lab Manager:

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RL & L ENV. SERVICES
17312-106 AVENUE
EDMONTON, AB
T5S 1H9

RICK PATTENDEN
PROJECT 570
01 08 97

WATER ANALYSIS REPORT

SAMPLE		4 W4	5 W5	6 W6
ROUTINE WATER				
pH		6.84	6.84	6.90
ELECTRICAL COND	uS/cm	16.0	17.0	16.0
CALCIUM	mg/L	1.1	1.1	1.2
MAGNESIUM	mg/L	0.5	0.5	0.5
SODIUM	mg/L	0.7	0.6	<0.6
POTASSIUM	mg/L	<0.60	<0.60	<0.60
IRON	mg/L	<0.04	<0.04	<0.04
MANGANESE	mg/L	<0.003	<0.003	<0.003
SULPHATE	mg/L	1.1	1.2	1.3
CHLORIDE	mg/L	1.0	0.9	<0.5
BICARBONATE	mg/L	8	8	8
T ALKALINITY	mg/L	7	7	7
HARDNESS	mg/L	4.7	4.9	5.2
T DIS SOLIDS	mg/L	9	9	9
IONIC BALANCE	%	~76.0	~76.2	~81.5
WATER NUTRIENTS				
TOTAL KJEHL NIT	mg/L	<0.05	<0.05	<0.05
AMMONIA-N	mg/L	<0.05	<0.05	<0.05
NITRATE-N	mg/L	<0.05	<0.05	<0.05
NITRITE-N	mg/L	<0.05	<0.05	<0.05
PHOSPHORUS(TOT)	mg/L	0.18	0.19	0.16
PHOSPHORUS,DISS	mg/L	0.05	0.09	0.12
NO2&NO3-N	mg/L	<0.05	<0.05	<0.05
ORGANICS				
OIL AND GREASE	mg/L	2	<1	1
TOT ORG CARBON	mg/L	1.7	1.4	1.7
TOTAL, COLD VAPO				
MERCURY	mg/L	<0.0001	<0.0001	<0.0001
TRACE ICP,TOTAL				
ALUMINUM	mg/L	<0.008	<0.008	0.018
ANTIMONY	mg/L	<0.005	<0.005	<0.005
ARSENIC	mg/L	<0.01	<0.01	<0.01
BARIUM	mg/L	0.0009	0.0012	0.0016

Lab Manager: D. Mathes

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RL & L ENV. SERVICES
17312-106 AVENUE
EDMONTON, AB
T5S 1H9

RICK PATTENDEN
PROJECT 570
01 08 97

WATER ANALYSIS REPORT

SAMPLE		4 W4	5 W5	6 W6
TRACE ICP,TOTAL				
BERYLLIUM	mg/L	<0.0005	<0.0005	<0.0005
BISMUTH	mg/L	<0.007	<0.007	<0.007
BORON	mg/L	0.003	0.002	0.002
CADMIUM	mg/L	<0.0005	<0.0005	<0.0005
CALCIUM	mg/L	1.21	1.25	1.34
CHROMIUM	mg/L	<0.0008	<0.0008	0.0008
COBALT	mg/L	<0.0007	<0.0007	<0.0007
COPPER	mg/L	<0.001	<0.001	0.002
IRON	mg/L	0.063	0.093	0.017
LEAD	mg/L	<0.002	<0.002	<0.002
LITHIUM	mg/L	0.00088	0.00099	0.00097
MANGANESE	mg/L	0.0031	0.0034	0.0016
MAGNESIUM	mg/L	0.549	0.589	0.574
MOLYBDENUM	mg/L	<0.001	0.001	0.001
NICKEL	mg/L	<0.001	<0.001	<0.001
PHOSPHORUS	mg/L	<0.006	<0.006	0.009
POTASSIUM	mg/L	<0.60	0.75	4.88
SELENIUM	mg/L	<0.003	<0.003	<0.003
SILICON	mg/L	0.162	0.179	0.193
SILVER	mg/L	<0.001	<0.001	<0.001
SODIUM	mg/L	0.521	0.556	0.377
STRONTIUM	mg/L	0.0036	0.0038	0.0038
SULPHUR	mg/L	0.364	0.454	0.460
THALLIUM	mg/L	<0.004	<0.004	<0.004
TIN	mg/L	<0.003	<0.003	<0.003
TITANIUM	mg/L	<0.0004	<0.0004	0.0006
VANADIUM	mg/L	<0.001	<0.001	<0.001
ZINC	mg/L	0.0017	0.0005	0.0120

Lab Manager: [signature]

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RL & L ENV. SERVICES
17312-106 AVENUE
EDMONTON, AB
T5S 1H9

RICK PATTENDEN
PROJECT 570
01 08 97

WATER ANALYSIS REPORT

SAMPLE		1 EAST L.	2 ULU L.	3 W3
ROUTINE WATER				
pH		6.70	6.70	6.74
ELECTRICAL COND	uS/cm	606	42.0	39.0
CALCIUM	mg/L	20.0	2.5	2.4
MAGNESIUM	mg/L	6.4	1.1	1.2
SODIUM	mg/L	82.4	2.4	2.0
POTASSIUM	mg/L	2.86	<0.60	0.81
IRON	mg/L	<0.04	<0.04	0.10
MANGANESE	mg/L	0.049	0.004	<0.003
SULPHATE	mg/L	14.3	5.7	4.8
CHLORIDE	mg/L	139	5.2	4.2
BICARBONATE	mg/L	23	7	8
T ALKALINITY	mg/L	19	6	7
HARDNESS	mg/L	76.2	10.9	10.9
T DIS SOLIDS	mg/L	276	21	20
IONIC BALANCE	%	~105	~89.9	~92.2
WATER NUTRIENTS				
TOTAL KJEHL NIT	mg/L	2.95	<0.05	<0.05
AMMONIA-N	mg/L	3.88	<0.05	<0.05
NITRATE-N	mg/L	7.79	<0.05	<0.05
NITRITE-N	mg/L	0.08	<0.05	<0.05
PHOSPHORUS(TOT)	mg/L	0.07	0.24	0.22
PHOSPHORUS,DISS	mg/L	0.07	<0.05	0.05
NO2&NO3-N	mg/L	7.87	<0.05	<0.05
ORGANICS				
OIL AND GREASE	mg/L	<1	1	<1
TOT ORG CARBON	mg/L	6.8	1.5	1.8
TOTAL, COLD VAPO				
MERCURY	mg/L	<0.0001	<0.0001	<0.0001
TRACE ICP,TOTAL				
ALUMINUM	mg/L	0.023	0.023	0.031
ANTIMONY	mg/L	<0.005	<0.005	<0.005
ARSENIC	mg/L	<0.01	<0.01	<0.01
BARIUM	mg/L	0.0582	0.0043	0.0036
BERYLLIUM	mg/L	<0.0005	<0.0005	<0.0005

Lab Manager: D. Mathers

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17312-106 AVENUE
EDMONTON, AB
T5S 1H9

RICK PATTENDEN
PROJECT 570
01 08 97

WATER ANALYSIS REPORT

SAMPLE		1 EAST L.	2 ULU L.	3 W3
TRACE ICP,TOTAL				
BISMUTH	mg/L	<0.007	<0.007	<0.007
BORON	mg/L	0.005	0.005	0.003
CADMIUM	mg/L	<0.0005	<0.0005	<0.0005
CALCIUM	mg/L	19.6	2.60	2.55
CHROMIUM	mg/L	<0.0008	<0.0008	<0.0008
COBALT	mg/L	0.0007	<0.0007	<0.0007
COPPER	mg/L	0.002	0.002	0.002
IRON	mg/L	0.039	0.037	0.123
LEAD	mg/L	<0.002	<0.002	<0.002
LITHIUM	mg/L	0.00130	0.00080	0.00116
MANGANESE	mg/L	0.0423	0.0058	0.0034
MAGNESIUM	mg/L	6.10	1.20	1.24
MOLYBDENUM	mg/L	0.002	<0.001	<0.001
NICKEL	mg/L	0.009	<0.001	<0.001
PHOSPHORUS	mg/L	0.024	<0.006	<0.006
POTASSIUM	mg/L	5.63	<0.60	<0.60
SELENIUM	mg/L	<0.003	<0.003	<0.003
SILICON	mg/L	0.673	0.417	0.286
SILVER	mg/L	<0.001	<0.001	<0.001
SODIUM	mg/L	71.8	2.00	1.66
STRONTIUM	mg/L	0.0556	0.0106	0.0093
SULPHUR	mg/L	4.84	2.13	1.85
THALLIUM	mg/L	<0.004	<0.004	<0.004
TIN	mg/L	<0.003	<0.003	<0.003
TITANIUM	mg/L	0.0018	<0.0004	0.0011
VANADIUM	mg/L	<0.001	0.001	<0.001
ZINC	mg/L	0.0120	0.0049	<0.0005

Lab Manager: D. Smathus

Appendix C2A Summary of physical tests, dissolved anions, nutrients, and organic analyses of water samples collected during summer, Ulu Exploration Area 1997.

Variable and Detection Limits (mg/L unless otherwise stated)		W1 (East Lake) 1 August	W2 (Ulu Lake) 1 August	W3 (Ulu Creek) 1 August	W4 (Upst. Frayed Knots) 1 August	W5 (Dwst. Frayed Knots) 1 August	W6 (Upst. Hood) 1 August	W7 (Dwst. Hood) 1 August
Physical Tests								
Total Dissolved Solids	1	276	21	20	9	9	9	10
Hardness as CaCO3	0.1	76.2	10.9	10.9	4.7	4.9	5.2	5.6
pH	0.1	6.7	6.7	6.74	6.84	6.84	6.9	6.89
Electrical Conductivity (uS/cm)	0.1	606	42	39	16	17	16	16
Ionic Balance (%)	(%)	~105	~89.9	~92.2	~76.0	~76.2	~81.5	~87.1
Dissolved Anions								
Total Alkalinity	1	19	6	7	7	7	7	7
Alkalinity - Bicarbonate	5	23	7	8	8	8	8	9
Chloride	0.5	139	5.2	4.2	1	0.9	<0.5	0.5
Sulphate	0.3	14.3	5.7	4.8	1.1	1.2	1.3	1.4
Nutrients								
Ammonia Nitrogen	0.05	3.88	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrate Nitrogen	0.05	7.79	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrite Nitrogen	0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrite Nitrate Nitrogen	0.05	7.87	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Kjeldahl Nitrogen	0.05	2.95	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Phosphorus	0.05	0.07	0.24	0.22	0.18	0.19	0.16	0.18
Dissolved Phosphorus	0.05	0.07	<0.05	0.05	0.05	0.09	0.12	0.12
Organics								
Oil and Grease	1	<1	1	<1	2	<1	1	1
Total Organic Carbon	0.5	6.8	1.5	1.8	1.7	1.4	1.7	2.2

Appendix C2B Total metals in water samples collected during summer, Ulu Exploration Area 1997.

Variable and Detection Limits (mg/L)		W1 (East Lake) 1 August	W2 (Ulu Lake) 1 August	W3 (Ulu Creek) 1 August	W4 (Upst. Frayed Knots) 1 August	W5 (Dwst. Frayed Knots) 1 August	W6 (Upst. Hood) 1 August	W7 (Dwst. Hood) 1 August
Aluminum	0.008	0.023	0.023	0.031	<0.008	<0.008	0.018	0.018
Antimony	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Barium	0.0002	0.0582	0.0043	0.0036	0.0009	0.0012	0.0016	0.0017
Beryllium	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Bismuth	0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Boron	0.002	0.005	0.005	0.003	0.003	0.002	0.002	<0.002
Cadmium	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Calcium	0.002	19.6	2.6	2.55	1.21	1.25	1.34	1.36
Calcium	0.1	20	2.5	2.4	1.1	1.1	1.2	1.4
Chromium	0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	0.0008	<0.0008
Cobalt	0.0007	0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007
Copper	0.001	0.002	0.002	0.002	<0.001	<0.001	0.002	0.001
Iron	0.003	0.039	0.037	0.123	0.063	0.093	0.017	0.045
Iron	0.04	<0.04	<0.04	0.1	<0.04	<0.04	<0.04	<0.04
Lead	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Lithium	0.00006	0.0013	0.0008	0.00116	0.00088	0.00099	0.00097	0.00091
Magnesium	0.1	6.4	1.1	1.2	0.5	0.5	0.5	0.5
Magnesium	0.005	6.1	1.2	1.24	0.549	0.589	0.574	0.596
Manganese	0.0002	0.0423	0.0058	0.0034	0.0031	0.0034	0.0016	0.002
Manganese	0.003	0.049	0.004	<0.003	<0.003	<0.003	<0.003	<0.003
Mercury	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	0.001	0.002	<0.001	<0.001	<0.001	0.001	0.001	0.001
Nickel	0.001	0.009	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphorus	0.006	0.024	<0.006	<0.006	<0.006	<0.006	0.009	0.01
Potassium	0.6	2.86	<0.60	0.81	<0.60	<0.60	<0.60	0.69
Potassium	0.6	5.63	<0.60	<0.60	<0.60	0.75	4.88	3.04
Selenium	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Silicon	0.004	0.673	0.417	0.286	0.162	0.179	0.193	0.191
Silver	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sodium	0.004	71.8	2	1.66	0.521	0.556	0.377	0.422
Sodium	0.6	82.4	2.4	2	0.7	0.6	<0.6	0.9
Strontium	0.0001	0.0556	0.0106	0.0093	0.0036	0.0038	0.0038	0.0038
Sulphur	0.008	4.84	2.13	1.85	0.364	0.454	0.46	0.477
Thallium	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Tin	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Titanium	0.0004	0.0018	<0.0004	0.0011	<0.0004	<0.0004	0.0006	0.0007
Vanadium	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	0.0005	0.012	0.0049	<0.0005	0.0017	0.0005	0.012	0.0112

APPENDIX C2
WATER CHEMISTRY DATA

Appendix C1 Temperature and dissolved oxygen profile data from sampled lakes, Ulu Exploration Area 1997.

Ulu Lake 30 July 97		
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)
0.0	13.6	10.5
1.0	13.6	10.4
2.0	13.5	10.5
3.0	13.5	10.4
4.0	13.5	10.5
5.0	13.5	10.5
6.0	13.5	10.4
7.0	13.4	10.5
8.0	13.0	10.7
9.0	12.2	11.1
9.5	11.2	11.7

Secchi Disk Reading = 6.5 m
GPS Coordinates = 12W 0502069 7421575
Conductivity = 20 µS/cm

Meadow Lake 31 July 97		
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)
0.0	10.1	10.4
0.5	10.4	10.3
1.0	10.7	10.3
1.5	10.7	10.3
2.0	10.8	10.2
2.5	10.9	10.3
3.0	10.9	10.4

Secchi Disk Reading = 3.0 m
GPS Coordinates = 12W 0503571 7421413
Conductivity = 20 µS/cm

West Lake 2 August 97		
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)
0.0	12.9	10.6
1.0	12.8	10.7
2.0	12.7	10.8
3.0	12.6	10.8
4.0	12.5	10.8
5.0	12.2	10.8
6.0	12.1	10.8
7.0	12.0	10.8
8.0	11.9	10.8
9.0	11.1	10.7
9.5	9.8	12.7
10.0	8.9	12.9
10.5	8.3	12.8
11.0	8.0	12.8
12.0	7.9	12.6
12.5	7.8	12.4

Secchi Disk Reading = 10.1 m
GPS Coordinates = 12W 0500680 7420896
Conductivity = 190 µS/cm

East Lake 31July 97		
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)
0.0	10.8	11.2
1.0	10.8	11.6
2.0	10.7	11.8
3.0	10.6	11.7
4.0	10.3	11.6
4.5	8.0	11.7
5.0	6.4	9.6
5.5	5.9	7.2
6.0	5.3	5.6
6.5	4.9	4.0

Secchi Disk Reading = 0.9 m
GPS Coordinates = 12W 0502600 7421050
Conductivity = 280 µS/cm

Appendix C1 Concluded.

North Reno Lake		
	3 August 97	
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)
0.0	13.7	10.5
1.0	13.6	10.5
2.0	13.5	10.4
3.0	13.5	10.5
4.0	13.4	10.5
5.0	13.3	10.5
6.0	12.5	10.6
7.0	12.0	10.5
8.0	11.8	10.5
9.0	11.7	10.3
10.0	11.6	10.4
11.0	11.5	10.4
12.0	11.5	10.4
13.0	11.4	10.4
14.0	11.4	10.4
15.0	11.3	10.4
16.0	11.3	10.3
17.0	11.2	10.2
18.0	11.2	10.2
18.5	11.2	10.2

Secchi Disk Reading = 4.8 m
GPS Coordinates = 12W 0502252 7414862
Conductivity = 10 μS/cm

South Reno Lake Site 1		
	4 August 97	
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)
0.0	14.4	10.4
1.0	14.4	10.5
2.0	14.3	10.4
3.0	14.3	10.5
4.0	14.2	10.4
5.0	14.2	10.4
6.0	14.1	10.4
7.0	14.8	10.3
8.0	13.1	10.3
9.0	12.6	10.1

Secchi Disk Reading = 7.5 m
GPS Coordinates = 12W 0501575 7412852
Conductivity = 10 μS/cm

South Reno Lake Site 2		
	4 August 97	
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)
0.0	14.9	10.3
1.0	14.8	10.2
2.0	14.7	10.3
3.0	14.7	10.4
4.0	14.7	10.3
5.0	14.6	10.4
6.0	14.6	10.4
7.0	14.5	10.3
8.0	14.3	10.4
9.0	14.1	10.5
10.0	12.5	10.5
11.0	12.3	10.4
12.0	12.1	10.4
13.0	11.9	10.3
13.5	11.9	10.2

Secchi Disk Reading = 6.9 m
GPS Coordinates = 12W 0500962 7414026
Conductivity = 10 μS/cm

APPENDIX C1
OXYGEN AND TEMPERATURE PROFILES

APPENDIX C
LIMNOLOGY AND WATER QUALITY

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	1				
Date	06/17/97	Waterbody	Reno S Cr	Reach			
Nad	27	Zone	12W	East	498530	North	7415167

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	150	Pool	5	Organic	
Temperature (oC)	6.0	Run	95	Silt	
Conductivity (uS)	10.0	Flat		Sand	
pH	7.4	Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	High	Other		Boulder	
Gradient (%)	1.0			Bedrock	
Average Width (m)	4.0				
Average Depth (m)	1.00	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single		Defined	
Discharge (cms)	1.12	Multiple		Illdefined	
Photo Number	2.09	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		1.0	1.0
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs		
	Grass/forbs	100	100
	Rock		
	Exposed Soil		
Substrate (%)	Organic	95	95
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	5	5
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	230

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Slimy sculpin				1	100	0.3

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Slimy sculpin	99.0	99	99	1

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	2	2	2	2
Lake trout	0	1	0	0
Round whitefish	0	1	0	0

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	1				
Date	08/05/97	Waterbody	Reno S Cr	Reach			
Nad	27	Zone	12W	East	498624	North	7415039

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	150	Pool		Organic	
Temperature (oC)	13.0	Run		Silt	
Conductivity (uS)	10.0	Flat		Sand	
pH	8.2	Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Low	Other		Boulder	
Gradient (%)				Bedrock	
Average Width (m)					
Average Depth (m)		**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)					
Discharge (cms)	0.09	Single		Defined	
Photo Number	2.26	Multiple		Illdefined	
		Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	375

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Slimy sculpin				5	100	0.8

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Slimy sculpin	100.7	80	112	3

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	1	3	1	1
Lake trout	0	2	0	1

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	1				
Date	08/05/97	Waterbody	Frayed Knot R	Reach	1		
Nad	27	Zone	12W	East		North	

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)		Pool		Organic	
Temperature (oC)		Run		Silt	50
Conductivity (uS)		Flat	100	Sand	
pH		Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Moderate	Other		Boulder	50
Gradient (%)	1.0			Bedrock	
Average Width (m)	40.0				
Average Depth (m)	1.50	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single	100	Defined	100
Discharge (cms)		Multiple		Illdefined	
Photo Number		Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs	10	10
	Rock	10	10
	Exposed Soil		
Substrate (%)	Organic		
	Silt	40	40
	Sand		
	Gravel		
	Cobble		
	Boulder	60	60
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
AL	1800

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Arctic grayling			9	9	69	0.1
Lake trout			4	4	31	0.0

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Arctic grayling	382.4	348	417	7
Lake trout	453.5	336	655	4

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	0	1	3	3
Lake trout	0	1	3	3

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	2				
Date	08/05/97	Waterbody	Frayed Knot R	Reach	2		
Nad	27	Zone	12W	East		North	

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)		Pool		Organic	
Temperature (oC)		Run	40	Silt	20
Conductivity (uS)		Flat		Sand	
pH		Rf/Ra	60	Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Moderate	Other		Boulder	80
Gradient (%)				Bedrock	
Average Width (m)	40.0				
Average Depth (m)	0.50	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single	100	Defined	100
Discharge (cms)		Multiple		Illdefined	
Photo Number		Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs	10	10
	Rock	15	15
	Exposed Soil		
Substrate (%)	Organic		
	Silt	20	20
	Sand		
	Gravel		
	Cobble		
	Boulder	80	80
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
AL	1800

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Arctic grayling			7	7	78	0.1
Lake trout			2	2	22	0.0

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Arctic grayling	350.5	300	402	4

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	0	1	3	3
Lake trout	0	1	3	3

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	4				
Date	06/17/97	Waterbody	Ulu L Inlet 2	Reach			
Nad	27	Zone	12W	East	502138	North	7420999

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	104	Pool		Organic	1
Temperature (oC)	2.5	Run	11	Silt	7
Conductivity (uS)	10.0	Flat		Sand	0
pH	8.4	Rf/Ra	64	Gravel	0
Colour	Clear	Dispersed	25	Cobble	3
Stage	High	Other		Boulder	89
Gradient (%)	5.0			Bedrock	0
Average Width (m)	3.7				
Average Depth (m)	0.25	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.29	Single	90	Defined	75
Discharge (cms)	0.07	Multiple		Illdefined	25
Photo Number	2.05	Dispersed			
		Subsurface	10		

Stream Banks		LUB	RUB
Slope (%)		0.1	0.1
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs	90	90
	Grass/forbs		
	Rock	10	10
	Exposed Soil		
Substrate (%)	Organic	80	80
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	20	20
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	158

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
Lake trout	0	1	0	0

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	5				
Date	06/17/97	Waterbody	Ulu L Inlet 3	Reach			
Nad	27	Zone	12W	East	502093	North	7421057

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	150	Pool		Organic	20
Temperature (oC)	4.5	Run		Silt	
Conductivity (uS)	240.0	Flat		Sand	
pH	7.1	Rf/Ra		Gravel	
Colour	Clear	Dispersed	100	Cobble	
Stage	Moderate	Other		Boulder	80
Gradient (%)	3.5			Bedrock	
Average Width (m)	30.0				
Average Depth (m)	0.10	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single		Defined	
Discharge (cms)		Multiple	20	Illdefined	100
Photo Number	2.06	Dispersed			
		Subsurface	80		

Stream Banks		LUB	RUB
Slope (%)		0.1	0.1
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs	50	50
	Grass/forbs		
	Rock	50	50
	Exposed Soil		
Substrate (%)	Organic	50	50
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	50	50
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
None Rated				

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	3		
Date	06/17/97	Waterbody	Ulu Cr	Reach	8
Nad	27	Zone	12W	East	502425
North	7421360				

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	89	Pool		Organic	0
Temperature (oC)	4.0	Run		Silt	0
Conductivity (uS)	20.0	Flat		Sand	0
pH	8.2	Rf/Ra		Gravel	0
Colour	Clear	Dispersed	100	Cobble	0
Stage	High	Other		Boulder	100
Gradient (%)	3.0			Bedrock	0
Average Width (m)	35.1				
Average Depth (m)	0.42	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.21	Single	100	Defined	
Discharge (cms)		Multiple		Illdefined	100
Photo Number	2.04	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		1.5	1.5
Height (m)		0.5	0.5
Cover (%)	Trees/shrubs	40	35
	Grass/forbs	10	5
	Rock	50	60
	Exposed Soil		
Substrate (%)	Organic	50	40
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	50	60
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	112

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
Lake trout	0	1	0	0
Round whitefish	0	1	0	0
Arctic grayling	0	1	1	0

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	6		
Date	07/29/97	Waterbody	Ulu L Inlet 1	Reach	
Nad	27	Zone	12W	East	
North					

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	150	Pool		Organic	
Temperature (oC)		Run	20	Silt	
Conductivity (uS)		Flat		Sand	
pH		Rf/Ra	20	Gravel	
Colour	Clear	Dispersed	60	Cobble	
Stage	Low	Other		Boulder	100
Gradient (%)	2.5			Bedrock	
Average Width (m)	3.0				
Average Depth (m)	0.20	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single	50	Defined	100
Discharge (cms)		Multiple		Illdefined	
Photo Number		Dispersed	50		
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
None Rated				

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	2				
Date	06/16/97	Waterbody	Ulu Cr	Reach	8		
Nad	27	Zone	12W	East	503127	North	7421503

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	149	Pool		Organic	0
Temperature (oC)	7.0	Run	41	Silt	0
Conductivity (uS)	10.0	Flat		Sand	1
pH	8.0	Rf/Ra	36	Gravel	8
Colour	Clear	Dispersed		Cobble	36
Stage	High	Other	22	Boulder	38
Gradient (%)	3.5			Bedrock	17
Average Width (m)	21.6				
Average Depth (m)	0.33	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.64	Single	75	Defined	68
Discharge (cms)	1.82	Multiple	25	Illdefined	32
Photo Number	1.25	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		1.0	1.0
Height (m)		0.1	0.1
Cover (%)	Trees/shrubs	20	10
	Grass/forbs	75	80
	Rock	5	10
	Exposed Soil		
Substrate (%)	Organic	70	70
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	30	30
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	378

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Slimy sculpin				4	100	0.6

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Slimy sculpin	122.5	110	137	4

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
Lake trout	0	2	0	0
Round whitefish	0	2	0	0
Arctic grayling	3	3	2	1

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	2				
Date	07/29/97	Waterbody	Ulu Cr	Reach	8		
Nad	27	Zone	12W	East		North	

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)		Pool		Organic	
Temperature (oC)	10.0	Run		Silt	
Conductivity (uS)	20.0	Flat		Sand	
pH	8.2	Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Low	Other		Boulder	
Gradient (%)				Bedrock	
Average Width (m)					
Average Depth (m)		**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single		Defined	
Discharge (cms)	0.09	Multiple		Illdefined	
Photo Number		Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	366

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Slimy sculpin				13	100	2.1

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Slimy sculpin	83.3	52	114	7

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
None Rated				

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	1				
Date	07/29/97	Waterbody	Ulu Cr	Reach	7		
Nad	27	Zone	12W	East	504202	North	7421459

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)		Pool		Organic	
Temperature (oC)		Run		Silt	
Conductivity (uS)		Flat		Sand	
pH		Rf/Ra	40	Gravel	
Colour	Clear	Dispersed	60	Cobble	
Stage	Low	Other		Boulder	100
Gradient (%)	3.0			Bedrock	
Average Width (m)	5.5				
Average Depth (m)	0.25	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single		Defined	60
Discharge (cms)		Multiple	40	Illdefined	40
Photo Number	1.07	Dispersed	60		
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs	60	60
	Grass/forbs		
	Rock	40	40
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	100	100
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
None Rated				

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	1				
Date	06/16/97	Waterbody	Ulu Cr	Reach	8		
Nad	27	Zone	12W	East	503050	North	7421350

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	218	Pool		Organic	0
Temperature (oC)	5.5	Run		Silt	0
Conductivity (uS)	20.0	Flat		Sand	0
pH	8.6	Rf/Ra		Gravel	0
Colour	Clear	Dispersed	100	Cobble	0
Stage	High	Other		Boulder	100
Gradient (%)	3.0			Bedrock	0
Average Width (m)	66.4				
Average Depth (m)	0.37	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.19	Single	100	Defined	
Discharge (cms)		Multiple		Illdefined	100
Photo Number	2.01	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		2.0	2.0
Height (m)		0.3	0.4
Cover (%)	Trees/shrubs	20	10
	Grass/forbs	20	20
	Rock	60	70
	Exposed Soil		
Substrate (%)	Organic	20	30
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	80	70
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	1425

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
Lake trout	0	1	0	0
Round whitefish	0	1	0	0

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	1				
Date	07/29/97	Waterbody	Ulu Cr	Reach	5		
Nad	27	Zone	12W	East	505551	North	7421323

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)		Pool		Organic	
Temperature (oC)		Run		Silt	
Conductivity (uS)		Flat		Sand	
pH		Rf/Ra	60	Gravel	
Colour	Clear	Dispersed	40	Cobble	
Stage	Moderate	Other		Boulder	100
Gradient (%)	4.0			Bedrock	
Average Width (m)	5.0				
Average Depth (m)	0.20	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single		Defined	40
Discharge (cms)		Multiple	60	Illdefined	60
Photo Number	1.05	Dispersed	40		
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs	50	50
	Grass/forbs		
	Rock	50	50
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	100	100
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
None Rated				

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	1				
Date	07/29/97	Waterbody	Ulu Cr	Reach	6		
Nad	27	Zone	12W	East	505153	North	7421425

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)		Pool		Organic	
Temperature (oC)		Run		Silt	
Conductivity (uS)		Flat	100	Sand	
pH		Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Low	Other		Boulder	
Gradient (%)	1.0			Bedrock	
Average Width (m)	25.0	**Channel Type (%)**		**Bank Type (%)**	
Average Depth (m)	0.35	Single	100	Defined	100
Average Velocity (m)		Multiple		Illdefined	
Discharge (cms)		Dispersed			
Photo Number	1.06	Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs	100	100
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt	100	100
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	104

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	0	2	1	2

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	1				
Date	07/29/97	Waterbody	Ulu Cr	Reach	3		
Nad	27	Zone	12W	East	506573	North	7421254

Habitat Characteristics

Stream

Surveyed Length (m)	
Temperature (oC)	
Conductivity (uS)	
pH	
Colour	Clear
Stage	Low
Gradient (%)	9.0
Average Width (m)	10.0
Average Depth (m)	0.20
Average Velocity (m)	
Discharge (cms)	
Photo Number	1.03

Habitat Type (%)		Substrate Type (%)	
Pool		Organic	
Run		Silt	
Flat		Sand	
Rf/Ra	100	Gravel	
Dispersed		Cobble	
Other		Boulder	100
		Bedrock	

Channel Type (%)		Bank Type (%)	
Single	50	Defined	100
Multiple	50	Illdefined	
Dispersed			
Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs	50	50
	Grass/forbs		
	Rock	50	50
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	100	100
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	0	1	0	1

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	1				
Date	07/29/97	Waterbody	Ulu Cr	Reach	4		
Nad	27	Zone	12W	East	506240	North	7421205

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	200	Pool		Organic	0
Temperature (oC)		Run	75	Silt	51
Conductivity (uS)		Flat	25	Sand	0
pH		Rf/Ra		Gravel	31
Colour	Clear	Dispersed		Cobble	0
Stage	Low	Other		Boulder	18
Gradient (%)	1.0			Bedrock	0
Average Width (m)	3.1				
Average Depth (m)	0.32	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.17	Single	100	Defined	100
Discharge (cms)		Multiple		Illdefined	
Photo Number	1.04	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs		
	Grass/forbs	100	100
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt	100	100
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	644

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	3	3	1	1

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	1				
Date	07/29/97	Waterbody	Ulu Cr	Reach	1		
Nad	27	Zone	12W	East	506974	North	7421319

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	500	Pool		Organic	0
Temperature (oC)	9.0	Run		Silt	100
Conductivity (uS)	20.0	Flat	100	Sand	0
pH	8.4	Rf/Ra		Gravel	0
Colour	Clear	Dispersed		Cobble	0
Stage	Moderate	Other		Boulder	0
Gradient (%)	1.0			Bedrock	0
Average Width (m)	4.0				
Average Depth (m)	0.46	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.10	Single	100	Defined	100
Discharge (cms)	0.16	Multiple		Illdefined	
Photo Number	1.01	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		2.0	2.0
Height (m)		0.3	0.3
Cover (%)	Trees/shrubs		
	Grass/forbs	100	100
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt	100	100
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	382

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Slimy sculpin				7	100	1.1

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Slimy sculpin	45.8	41	58	4

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	0	3	2	2

Comments

Echo Bay Mines Ltd. - Ulu Exploration Area Stream Survey

Project 570

Area	Ulu Exploration Area	Site	1				
Date	07/29/97	Waterbody	Ulu Cr	Reach	2		
Nad	27	Zone	12W	East	506814	North	7421379

Habitat Characteristics

Stream		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	150	Pool		Organic	0
Temperature (oC)		Run	100	Silt	35
Conductivity (uS)		Flat		Sand	0
pH		Rf/Ra		Gravel	65
Colour	Clear	Dispersed		Cobble	0
Stage	Moderate	Other		Boulder	0
Gradient (%)	1.5			Bedrock	0
Average Width (m)	1.8				
Average Depth (m)	0.32	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.45	Single	100	Defined	100
Discharge (cms)		Multiple		Illdefined	
Photo Number		Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		35.0	35.0
Height (m)		0.3	0.3
Cover (%)	Trees/shrubs		
	Grass/forbs	100	100
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt	100	100
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	544

Numbers Recorded and Percent Compostion

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Arctic grayling	13			13	17	1.4
Burbot		1		1	1	0.1
Slimy sculpin				62	82	6.8

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Arctic grayling	29.7	28	30	6
Burbot	105.0	105	105	1
Slimy sculpin	65.3	43	98	6

Habitat Quality Rating

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	3	3	2	1

Comments

APPENDIX B2
ULU EXPLORATION AREA STREAM SURVEYS

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 3	Crossing	118.2	Date	06/17/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East	499705		
Detailed Survey Warranted	Yes					North	7410668		

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	131	Pool	6	Organic	7
Temperature (° C)	8.0	Run	84	Silt	14
Conductivity (uS	10.0	Flat		Sand	0
pH	7.5	Rf/Ra	10	Gravel	0
Colour	Clear	Dispersed		Cobble	0
Stage	High	Other		Boulder	72
Gradient (%)	2.5			Bedrock	0
Average Width (m)	1.7				
Average Depth (m)	0.47	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.28	Single	100	Defined	100
Discharge (cms)	0.09	Multiple		Illdefined	
Photo Number	2.07	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		0.1	0.1
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs	80	80
	Grass/forbs	20	20
	Rock		
	Exposed Soil		
Substrate (%)	Organic	95	95
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	5	5
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	178

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Round whitefish	0	1	0	0
Lake trout	0	1	0	0
Arctic grayling	1	2	1	1

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 3	Crossing	118.2	Date	08/01/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East	499717		
Detailed Survey Warranted	No					North	7410482		

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	150	Pool		Organic	
Temperature (° C)	8.0	Run		Silt	
Conductivity (uS	10.0	Flat		Sand	
pH	7.8	Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Low	Other		Boulder	
Gradient (%)				Bedrock	
Average Width (m)	0.8				
Average Depth (m)	0.40	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single		Defined	
Discharge (cms)	0.00	Multiple		Illdefined	
Photo Number	1.21	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	79

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	1	2	0	0

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	70.8	Date	06/17/97	Nad	27
						Zone	12W
Initial Survey Completed in 1996	No					East	501018
Detailed Survey Warranted	Yes					North	7404130

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	150	Pool		Organic	0
Temperature (°C)	9.5	Run		Silt	0
Conductivity (uS	10.0	Flat		Sand	14
pH	7.4	Rf/Ra	100	Gravel	45
Colour	Clear	Dispersed		Cobble	38
Stage	High	Other		Boulder	3
Gradient (%)	5.0			Bedrock	0
Average Width (m)	2.2				
Average Depth (m)	0.09	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.23	Single	100	Defined	100
Discharge (cms)	0.02	Multiple		Illdefined	
Photo Number	2.08	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		40.0	40.0
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs	70	70
	Grass/forbs		
	Rock		
	Exposed Soil	30	30
Substrate (%)	Organic	60	60
	Silt		
	Sand	20	20
	Gravel	10	10
	Cobble	10	10
	Boulder		
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	61

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Lake trout	0	1	0	0
Arctic grayling	1	1	0	0

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	70.8	Date	08/01/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East			
Detailed Survey Warranted	No					North			

Crossing Characteristics

Stream Habitat

Surveyed Length (m)	
Temperature (° C)	
Conductivity (*uS*	
pH	
Colour	Clear
Stage	Low
Gradient (%)	
Average Width (m)	
Average Depth (m)	
Average Velocity (m)	
Discharge (cms)	
Photo Number	

Habitat Type (%)		Substrate Type (%)	
Pool		Organic	
Run		Silt	
Flat		Sand	
Rf/Ra		Gravel	
Dispersed		Cobble	
Other		Boulder	
		Bedrock	

Channel Type (%)		Bank Type (%)	
Single		Defined	
Multiple		Illdefined	
Dispersed			
Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
None Rated				

Comments

DRY

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	66.1	Date	06/17/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East	502253		
Detailed Survey Warranted	No					North	7400217		

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	300	Pool		Organic	
Temperature (°C)	8.0	Run		Silt	
Conductivity (uS	10.0	Flat		Sand	
pH	7.5	Rf/Ra	100	Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Moderate	Other		Boulder	100
Gradient (%)	1.0			Bedrock	
Average Width (m)	80.0				
Average Depth (m)	0.25	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single	100	Defined	
Discharge (cms)		Multiple		Illdefined	100
Photo Number	2.10	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		1.0	1.0
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs	10	10
	Grass/forbs	10	10
	Rock	80	80
	Exposed Soil		
Substrate (%)	Organic	10	10
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	90	90
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Lake trout	0	1	0	0
Round whitefish	0	1	0	0
Arctic grayling	0	1	0	0

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	66.1	Date	08/01/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East			
Detailed Survey Warranted	No					North			

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)		Pool		Organic	
Temperature (° C)		Run		Silt	
Conductivity (uS		Flat		Sand	
pH		Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Low	Other		Boulder	
Gradient (%)				Bedrock	
Average Width (m)					
Average Depth (m)		**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single		Defined	
Discharge (cms)		Multiple		Illdefined	
Photo Number		Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
None Rated				

Comments

DRY

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	64.8	Date	06/17/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East	502654		
Detailed Survey Warranted	Yes					North	7399260		

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	150	Pool		Organic	0
Temperature (° C)	7.5	Run	16	Silt	2
Conductivity (uS	10.0	Flat		Sand	0
pH	7.2	Rf/Ra	33	Gravel	10
Colour	Clear	Dispersed	51	Cobble	49
Stage	High	Other		Boulder	39
Gradient (%)	2.5			Bedrock	0
Average Width (m)	11.2				
Average Depth (m)	0.24	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.32	Single	100	Defined	29
Discharge (cms)	0.28	Multiple		Illdefined	71
Photo Number	2.11	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		1.0	1.0
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs	20	20
	Grass/forbs	20	20
	Rock	60	60
	Exposed Soil		
Substrate (%)	Organic	40	40
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	60	60
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	215

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Lake trout			1	1	100	0.3

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Lake trout	289.0	289	289	1

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Lake trout	0	2	0	0
Round whitefish	0	1	0	0
Arctic grayling	2	1	0	0

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	64.8	Date	08/01/97	Nad	27	Zone	12W

Initial Survey Completed in 1996: No

Detailed Survey Warranted: No

East: 502670

North: 7399049

Crossing Characteristics

Stream Habitat

Stream Habitat	
Surveyed Length (m)	150
Temperature (°C)	9.0
Conductivity (uS	20.0
pH	7.8
Colour	Clear
Stage	Low
Gradient (%)	
Average Width (m)	11.0
Average Depth (m)	0.20
Average Velocity (m)	
Discharge (cms)	0.02
Photo Number	1.20

Habitat Type (%)		Substrate Type (%)	
Pool		Organic	
Run		Silt	
Flat		Sand	
Rf/Ra		Gravel	
Dispersed		Cobble	
Other		Boulder	
		Bedrock	

Channel Type (%)		Bank Type (%)	
Single		Defined	
Multiple		Illdefined	
Dispersed			
Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	200

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Lake trout		2		2	100	0.6

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Lake trout	171.5	169	174	2

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
None Rated				

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project: 570

Area	Route 2	Crossing	58.8	Date	06/17/97	Nad	27
						Zone	12W
Initial Survey Completed in 1996	No					East	503814
Detailed Survey Warranted	No					North	7393946

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	200	Pool		Organic	
Temperature (°C)	8.0	Run		Silt	
Conductivity (uS	20.0	Flat		Sand	
pH	7.6	Rf/Ra		Gravel	
Colour	Clear	Dispersed	100	Cobble	
Stage	Moderate	Other		Boulder	100
Gradient (%)	1.0			Bedrock	
Average Width (m)	65.0				
Average Depth (m)	0.20	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single	100	Defined	
Discharge (cms)		Multiple		Illdefined	100
Photo Number	2.12	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		50.0	1.0
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs	20	
	Grass/forbs	20	
	Rock	30	100
	Exposed Soil	30	
Substrate (%)	Organic		
	Silt		
	Sand		60
	Gravel		10
	Cobble		30
	Boulder	100	
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Lake trout	0	1	0	0
Round whitefish	0	1	0	0

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	58.8	Date	08/01/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East			
Detailed Survey Warranted	No					North			

Crossing Characteristics

Stream Habitat

Surveyed Length (m)	
Temperature (°C)	
Conductivity (*uS*	
pH	
Colour	Clear
Stage	Low
Gradient (%)	
Average Width (m)	
Average Depth (m)	
Average Velocity (m)	
Discharge (cms)	
Photo Number	

Habitat Type (%)

Pool	
Run	
Flat	
Rf/Ra	
Dispersed	
Other	

Substrate Type (%)

Organic	
Silt	
Sand	
Gravel	
Cobble	
Boulder	
Bedrock	

Channel Type (%)

Single	
Multiple	
Dispersed	
Subsurface	

Bank Type (%)

Defined	
Illdefined	

Stream Banks

		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
None Rated				

Comments

DRY

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	56.1	Date	06/17/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East	503839		
Detailed Survey Warranted	Yes					North	7391026		

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	153	Pool		Organic	0
Temperature (° C)	11.0	Run	54	Silt	0
Conductivity (uS	20.0	Flat		Sand	6
pH	7.5	Rf/Ra	46	Gravel	27
Colour	Clear	Dispersed		Cobble	60
Stage	High	Other		Boulder	7
Gradient (%)	1.0			Bedrock	0
Average Width (m)	3.2				
Average Depth (m)	0.28	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.38	Single	100	Defined	100
Discharge (cms)	0.24	Multiple		Illdefined	
Photo Number	2.13	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		1.0	1.0
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs		
	Grass/forbs	95	95
	Rock	5	5
	Exposed Soil		
Substrate (%)	Organic	90	90
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	10	10
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	212

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	0	2	0	0
Round whitefish	0	1	0	0
Lake trout	0	1	0	0

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	56.1	Date	08/01/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East	503972		
Detailed Survey Warranted	No					North	7390775		

Crossing Characteristics

Stream Habitat

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	150	Pool		Organic	
Temperature (°C)	11.0	Run		Silt	
Conductivity (uS	50.0	Flat		Sand	
pH	8.0	Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Low	Other		Boulder	
Gradient (%)				Bedrock	
Average Width (m)	2.5				
Average Depth (m)	0.15	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single		Defined	
Discharge (cms)	0.01	Multiple		Illdefined	
Photo Number	1.19	Dispersed			
		Subsurface			

Stream Banks

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	157

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	1	3	0	0

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	46.9	Date	06/18/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East	505419		
Detailed Survey Warranted	Yes					North	7382972		

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	100	Pool		Organic	0
Temperature (° C)	6.0	Run		Silt	0
Conductivity (uS	20.0	Flat		Sand	0
pH	8.3	Rf/Ra		Gravel	0
Colour	Clear	Dispersed	100	Cobble	0
Stage	Moderate	Other		Boulder	100
Gradient (%)	1.0			Bedrock	0
Average Width (m)	66.3				
Average Depth (m)	0.24	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.09	Single		Defined	
Discharge (cms)		Multiple		Illdefined	100
Photo Number	2.14	Dispersed	100		
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		2.0	1.0
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs		
	Grass/forbs	50	60
	Rock	50	40
	Exposed Soil		
Substrate (%)	Organic	50	60
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	50	40
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	179

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Lake trout	0	1	0	0
Round whitefish	0	1	0	0
Arctic grayling	0	1	0	0

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project: 570

Area	Route 2	Crossing	46.9	Date	08/01/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East			
Detailed Survey Warranted	No					North			

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)		Pool		Organic	
Temperature (° C)		Run		Silt	
Conductivity (uS		Flat		Sand	
pH		Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Low	Other		Boulder	
Gradient (%)				Bedrock	
Average Width (m)					
Average Depth (m)		**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single		Defined	
Discharge (cms)		Multiple		Illdefined	
Photo Number		Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
None Rated				

Comments

DRY

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	45.3	Date	06/18/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	Yes					East	504814		
Detailed Survey Warranted	Yes					North	7381306		

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	150	Pool		Organic	5
Temperature (°C)	5.0	Run		Silt	0
Conductivity (uS	20.0	Flat		Sand	0
pH	7.8	Rf/Ra		Gravel	0
Colour	Clear	Dispersed	100	Cobble	0
Stage	High	Other		Boulder	95
Gradient (%)	2.0			Bedrock	0
Average Width (m)	25.4				
Average Depth (m)	0.17	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.16	Single		Defined	
Discharge (cms)		Multiple		Illdefined	100
Photo Number	2.15	Dispersed	100		
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		1.0	2.0
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs	40	40
	Grass/forbs	20	20
	Rock	40	40
	Exposed Soil		
Substrate (%)	Organic	50	50
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	50	50
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	194

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Lake trout	0	1	0	0
Round whitefish	0	1	0	0

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project: 570

Area	Route 2	Crossing	45.3	Date	08/01/97	Nad	27
						Zone	12W
Initial Survey Completed in 1996	Yes					East	
Detailed Survey Warranted	No					North	

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)		Pool		Organic	
Temperature (° C)		Run		Silt	
Conductivity (uS		Flat		Sand	
pH		Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Low	Other		Boulder	
Gradient (%)				Bedrock	
Average Width (m)					
Average Depth (m)		**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single		Defined	
Discharge (cms)		Multiple		Illdefined	
Photo Number		Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
None Rated				

Comments

DRY

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	43.5	Date	06/18/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East	505153		
Detailed Survey Warranted	Yes					North	7379179		

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	157	Pool	0	Organic	10
Temperature (°C)	12.0	Run	100	Silt	6
Conductivity (uS	20.0	Flat		Sand	28
pH	7.3	Rf/Ra		Gravel	40
Colour	Clear	Dispersed		Cobble	0
Stage	High	Other		Boulder	16
Gradient (%)	1.0			Bedrock	0
Average Width (m)	1.0				
Average Depth (m)	0.15	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.16	Single	100	Defined	100
Discharge (cms)	0.01	Multiple		Illdefined	
Photo Number	2.16	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		1.0	2.0
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs		
	Grass/forbs	100	100
	Rock		
	Exposed Soil		
Substrate (%)	Organic	95	95
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	5	5
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	295

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Burbot		2		2	100	0.4

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Burbot	88.0	71	105	2

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	2	2	0	0
Lake trout	0	1	0	0
Burbot	0	2	0	0

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	43.5	Date	08/01/97	Nad	27	Zone 12W
Initial Survey Completed in 1996	No					East		
Detailed Survey Warranted	No					North		

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)		Pool		Organic	
Temperature (° C)		Run		Silt	
Conductivity (uS		Flat		Sand	
pH		Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Low	Other		Boulder	
Gradient (%)				Bedrock	
Average Width (m)					
Average Depth (m)		**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single		Defined	
Discharge (cms)		Multiple		Illdefined	
Photo Number		Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
None Rated				

Comments

DRY

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	41.81	Date	06/19/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East	506536		
Detailed Survey Warranted	Yes					North	7378573		

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	39	Pool		Organic	0
Temperature (° C)	5.0	Run		Silt	0
Conductivity (uS	30.0	Flat		Sand	0
pH	7.5	Rf/Ra	100	Gravel	0
Colour	Clear	Dispersed		Cobble	0
Stage	Moderate	Other		Boulder	100
Gradient (%)	1.5			Bedrock	0
Average Width (m)	4.4				
Average Depth (m)	0.10	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.08	Single	33	Defined	
Discharge (cms)	0.04	Multiple	67	Illdefined	100
Photo Number	3.18	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		1.0	1.0
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs		
	Grass/forbs	50	50
	Rock	50	50
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	100	100
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	1	1	0	0
Round whitefish	0	1	0	0
Lake trout	0	1	0	0

Comments

Alternate cossing located upstream of proposed crossing.

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	41.81	Date	08/01/97	Nad	27
						Zone	12W

Initial Survey Completed in 1996: No

Detailed Survey Warranted: No

East:

North:

Crossing Characteristics

Stream Habitat

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)		Pool		Organic	
Temperature (° C)		Run		Silt	
Conductivity (uS		Flat		Sand	
pH		Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Low	Other		Boulder	
Gradient (%)				Bedrock	
Average Width (m)					
Average Depth (m)		**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single		Defined	
Discharge (cms)		Multiple		Illdefined	
Photo Number		Dispersed			
		Subsurface			

Stream Banks

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
None Rated				

Comments

DRY - Alternate cossing located upstream of proposed crossing.

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	41.8	Date	06/18/97	Nad	27
Initial Survey Completed in 1996	No					Zone	12W
Detailed Survey Warranted	Yes					East	506176
						North	7378165

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	217	Pool	3	Organic	0
Temperature (°C)	8.0	Run	68	Silt	0
Conductivity (uS	20.0	Flat		Sand	34
pH	7.5	Rf/Ra	29	Gravel	46
Colour	Clear	Dispersed		Cobble	20
Stage	High	Other		Boulder	0
Gradient (%)	2.0			Bedrock	0
Average Width (m)	2.6				
Average Depth (m)	0.27	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.34	Single	100	Defined	100
Discharge (cms)	0.08	Multiple		Illdefined	
Photo Number	2.17	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		3.0	3.0
Height (m)		0.3	0.4
Cover (%)	Trees/shrubs		
	Grass/forbs	100	100
	Rock		
	Exposed Soil		
Substrate (%)	Organic	100	100
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	273

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Arctic grayling		7	3	10	100	2.2

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Arctic grayling	176.8	149	239	6

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	3	3	2	3
Lake trout	0	1	0	2
Round whitefish	0	1	0	2

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	41.8	Date	08/01/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East	506199		
Detailed Survey Warranted	No					North	7377974		

Crossing Characteristics

Stream Habitat

Surveyed Length (m)	150
Temperature (°C)	10.0
Conductivity (uS	40.0
pH	8.2
Colour	Clear
Stage	Low
Gradient (%)	
Average Width (m)	1.0
Average Depth (m)	0.30
Average Velocity (m)	
Discharge (cms)	0.01
Photo Number	1.16

Habitat Type (%)		Substrate Type (%)	
Pool		Organic	
Run		Silt	
Flat		Sand	
Rf/Ra		Gravel	
Dispersed		Cobble	
Other		Boulder	
		Bedrock	

Channel Type (%)		Bank Type (%)	
Single		Defined	
Multiple		Illdefined	
Dispersed			
Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	305

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Lake trout		10		10	40	2.0
Slimy sculpin				4	16	0.8
Arctic grayling	8	3		11	44	2.2

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Arctic grayling	84.6	27	188	7
Lake trout	87.8	71	133	9
Slimy sculpin	81.3	66	96	3

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	3	3	2	3
Lake trout	0	3	1	1

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	36.7	Date	06/18/97	Nad	27
Zone	12W						
Initial Survey Completed in 1996	No					East	508025
Detailed Survey Warranted	Yes					North	7374431

Crossing Characteristics

Stream Habitat

Surveyed Length (m)	150
Temperature (°C)	3.0
Conductivity (*uS*	10.0
pH	7.5
Colour	Clear
Stage	High
Gradient (%)	2.0
Average Width (m)	51.7
Average Depth (m)	0.26
Average Velocity (m)	0.36
Discharge (cms)	
Photo Number	2.18

Habitat Type (%)		Substrate Type (%)	
Pool		Organic	0
Run		Silt	0
Flat		Sand	0
Rf/Ra		Gravel	0
Dispersed	100	Cobble	0
Other		Boulder	100
		Bedrock	0

Channel Type (%)		Bank Type (%)	
Single	100	Defined	
Multiple		Illdefined	100
Dispersed			
Subsurface			

Stream Banks		LUB	RUB
Slope (%)		1.0	1.0
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock	100	100
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	100	100
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Lake trout	0	1	0	1
Round whitefish	0	0	0	1
Arctic grayling	0	0	0	1

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 2	Crossing	36.7	Date	08/01/97	Nad	27
Zone	12W						
Initial Survey Completed in 1996	No					East	
Detailed Survey Warranted	No					North	

Crossing Characteristics

Stream Habitat

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)		Pool		Organic	
Temperature (° C)		Run		Silt	
Conductivity (uS		Flat		Sand	
pH		Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Low	Other		Boulder	
Gradient (%)				Bedrock	
Average Width (m)					
Average Depth (m)		**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single		Defined	
Discharge (cms)		Multiple		Illdefined	
Photo Number		Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
None Rated				

Comments

DRY

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 1	Crossing	18.52	Date	06/19/97	Nad	27
Zone	12W						
Initial Survey Completed in 1996	No					East	520950
Detailed Survey Warranted	No					North	7363312

Crossing Characteristics

Stream Habitat

Surveyed Length (m)	150
Temperature (°C)	
Conductivity (uS	
pH	
Colour	Clear
Stage	High
Gradient (%)	2.5
Average Width (m)	15.0
Average Depth (m)	0.35
Average Velocity (m)	
Discharge (cms)	
Photo Number	3.15

Habitat Type (%)

Pool	
Run	
Flat	40
Rf/Ra	60
Dispersed	
Other	

Substrate Type (%)

Organic	
Silt	
Sand	
Gravel	
Cobble	
Boulder	100
Bedrock	

Channel Type (%)

Single	100
Multiple	
Dispersed	
Subsurface	

Bank Type (%)

Defined	100
Illdefined	

Stream Banks		LUB	RUB
Slope (%)		1.0	7.0
Height (m)		0.5	3.5
Cover (%)	Trees/shrubs		
	Grass/forbs	50	100
	Rock	50	
	Exposed Soil		
Substrate (%)	Organic		
	Silt	40	100
	Sand		
	Gravel		
	Cobble		
	Boulder	60	
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	0	1	3	3

Comments

Crossing location No. 3 (survey stakes present)

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 1	Crossing	18.52	Date	08/01/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East	521012		
Detailed Survey Warranted	No					North	7363146		

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)		Pool		Organic	
Temperature (°C)	10.5	Run		Silt	
Conductivity (uS	20.0	Flat		Sand	
pH	7.9	Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Low	Other		Boulder	
Gradient (%)				Bedrock	
Average Width (m)	8.0				
Average Depth (m)	0.40	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single		Defined	
Discharge (cms)	0.00	Multiple		Illdefined	
Photo Number	1.15	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	255

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Arctic grayling	40			40	100	9.4

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Arctic grayling	38.0	35	41	11

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	1	3	2	2

Comments

Crossing previously sampled on 19 June.

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 1	Crossing	18.5	Date	06/18/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East	520599		
Detailed Survey Warranted	Yes					North	7363097		

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	250	Pool		Organic	
Temperature (° C)	10.1	Run		Silt	
Conductivity (uS	10.0	Flat	80	Sand	100
pH	7.1	Rf/Ra	20	Gravel	
Colour	Brown	Dispersed		Cobble	
Stage	High	Other		Boulder	
Gradient (%)	2.0			Bedrock	
Average Width (m)	25.0				
Average Depth (m)	2.00	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single	100	Defined	100
Discharge (cms)	1.62	Multiple		Illdefined	
Photo Number	2.29	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		2.0	4.0
Height (m)		1.2	1.5
Cover (%)	Trees/shrubs	50	50
	Grass/forbs	50	50
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt	50	100
	Sand		
	Gravel		
	Cobble		
	Boulder	50	
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	0	1	2	3
Round whitefish	0	1	2	3
Lake trout	0	1	2	3

Comments

Crossing location No. 1 (survey stakes present)

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 1	Crossing	18.51	Date	06/19/97	Nad	27
						Zone	12W
Initial Survey Completed in 1996	No					East	521456
Detailed Survey Warranted	No					North	7364267

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	150	Pool		Organic	
Temperature (° C)	12.5	Run		Silt	100
Conductivity (*uS*	20.0	Flat	100	Sand	
pH	7.4	Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	High	Other		Boulder	
Gradient (%)	1.0			Bedrock	
Average Width (m)	19.0				
Average Depth (m)	2.00	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)		Single	100	Defined	100
Discharge (cms)		Multiple		Illdefined	
Photo Number	3.14	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		5.0	5.0
Height (m)		1.5	1.5
Cover (%)	Trees/shrubs	50	50
	Grass/forbs	50	50
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt	100	100
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
Not Sampled	

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Lake trout	0	1	2	3
Arctic grayling	0	1	2	3
Round whitefish	0	1	2	3

Comments

Crossing location No. 2 (survey stakes present)

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 1	Crossing	3.1	Date	06/18/97	Nad	27	Zone	12W
Initial Survey Completed in 1996	No					East	517728		
Detailed Survey Warranted	Yes					North	7349569		

Crossing Characteristics

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	150	Pool		Organic	5
Temperature (° C)	6.0	Run		Silt	0
Conductivity (uS	10.0	Flat		Sand	0
pH	7.0	Rf/Ra	100	Gravel	0
Colour	Clear	Dispersed		Cobble	0
Stage	Flood	Other		Boulder	95
Gradient (%)	3.0			Bedrock	0
Average Width (m)	15.0				
Average Depth (m)	0.38	**Channel Type (%)**		**Bank Type (%)**	
Average Velocity (m)	0.86	Single		Defined	
Discharge (cms)	2.38	Multiple	100	Illdefined	100
Photo Number	2.28	Dispersed			
		Subsurface			

Stream Banks		LUB	RUB
Slope (%)		3.0	1.0
Height (m)		0.2	0.2
Cover (%)	Trees/shrubs	80	80
	Grass/forbs		
	Rock	20	20
	Exposed Soil		
Substrate (%)	Organic	50	50
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder	50	50
	Bedrock		
Unstable Banks (%)		0	0

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	245

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
None Captured						

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
None Measured				

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Lake trout	0	1	0	1
Round whitefish	0	1	0	1
Arctic grayling	0	1	0	1

Comments

Echo Bay Mines Ltd. - Winter Access Road Alignment Survey

Project 570

Area	Route 1	Crossing	3.1	Date	08/01/97	Nad	27
						Zone	12W
Initial Survey Completed in 1996	No					East	517764
Detailed Survey Warranted	No					North	7349456

Crossing Characteristics

Stream Habitat

Stream Habitat		Habitat Type (%)		Substrate Type (%)	
Surveyed Length (m)	150	Pool		Organic	
Temperature (° C)	9.0	Run		Silt	
Conductivity (uS	10.0	Flat		Sand	
pH	7.7	Rf/Ra		Gravel	
Colour	Clear	Dispersed		Cobble	
Stage	Low	Other		Boulder	
Gradient (%)				Bedrock	
Average Width (m)	5.0				

		Channel Type (%)		Bank Type (%)	
Average Depth (m)	0.30				
Average Velocity (m)		Single		Defined	
Discharge (cms)	0.01	Multiple		Illdefined	
Photo Number	1.14	Dispersed			
		Subsurface			

Stream Banks

Stream Banks		LUB	RUB
Slope (%)			
Height (m)			
Cover (%)	Trees/shrubs		
	Grass/forbs		
	Rock		
	Exposed Soil		
Substrate (%)	Organic		
	Silt		
	Sand		
	Gravel		
	Cobble		
	Boulder		
	Bedrock		
Unstable Banks (%)			

Fisheries Resources

Sampling Techniques

Method	Effort (s)
EF	170

Species Compostion and Abundance

Species	YoY	Juvenile	Adult	Total	Percent	CPUE
Arctic grayling		16		16	100	5.6

Summary of Fork Length (mm) Information

Species	Average	Minimum	Maximum	Number
Arctic grayling	113.4	111	118	5

Habitat Quality Rating of Stream Crossing

Species	Spawning	Rearing	Feeding	Movement
Arctic grayling	1	2	0	0

Comments

APPENDIX B1
WINTER ACCESS ROAD STREAM CROSSINGS SURVEY

APPENDIX B
STREAM SURVEY INFORMATION SHEETS

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EDMONTON PH. (403) 438-5522 FAX (403) 438-0396
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RICK PATTENDEN
PROJECT 570
01 08 97

Quality Assurance Analysis

Client Material - Duplicate Analysis

METHOD	ANALYSIS	-UNITS--	--D.L.--	--RUN 1-	--RUN 2-	--RUN 1-	--RUN 2-	--RUN 1-	--RUN 2-	--RUN 1-	--RUN 2-
5021	pH		0.1	6.890	6.890						
5022	E.C.	uS/cm	.1	16.00	16.00						
5031	HCO_3	mg/L	5	9.147	9.390						
4997	T. ALK.	mg/L	1	7.498	7.696						

QC/QA Manager:

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Quality Assurance Analysis

Standard Reference Material Analysis

			----STANDARD----			-----QC WITH----- ---THIS ORDER----			-HISTORICAL-- --PRECISION--		-WARNING LIMITS--	
METHOD	ANALYSIS	-UNITS--	--DESCRIPTION---	--D.L.--	TARGET	#	MEAN	% Y	#	MEAN	LOW	HIGH
5032	NO2 & NO3-N	mg/L	REAGENT BLANK	0.05	0.0	2	0.0		144	0.002521	-0.1	0.1
5041	OIL AND GREASE	mg/L	REAGENT BLANK	1	0.0	1	0.1001		26	0.3346	-0.1	0.8
38000	Al	mg/L	REAGENT BLANK	0.008	0.0	1	0.0		123	0.001262	-0.008	0.008
38002	Sb	mg/L	REAGENT BLANK	0.005	0.0	1	0.0		121	-0.00108	-0.005	0.005
38001	As	mg/L	REAGENT BLANK	.01	0.0	1	0.002044		123	0.000123	-0.004	0.004
38003	Ba	mg/L	REAGENT BLANK	0.0002 0	0.0	1	0.0		121	0.000078	-0.0002	0.0002
38004	Be	mg/L	REAGENT BLANK	0.0005 0	0.0	1	0.0		121	0.00000	-0.0005	0.0005
38041	Bi	mg/L	REAGENT BLANK	0.007	0.0	1	-0.00510		121	-0.00008	-0.007	0.007
38005	B	mg/L	REAGENT BLANK	0.002	0.0	1	0.001422		122	0.000355	-0.002	0.002
38006	Cd	mg/L	REAGENT BLANK	0.0005 0	0.0	1	-0.00029		125	0.000041	-0.0005	0.0005
38007	Ca	mg/L	REAGENT BLANK	0.002	0.0	1	0.0		122	0.0	-0.002	0.002
38008	Cr	mg/L	REAGENT BLANK	0.0008 0	0.0	1	0.000278		128	0.000152	-0.0008	0.0008
38009	Co	mg/L	REAGENT BLANK	0.0007 0	0.0	1	0.0		121	-0.00004	-0.0007	0.0007
38010	Cu	mg/L	REAGENT BLANK	0.001	0.0	1	0.0		130	0.000205	-0.001	0.001
38011	Fe	mg/L	REAGENT BLANK	0.003	0.0	1	0.0		132	0.000277	-0.003	0.003
38012	Pb	mg/L	REAGENT BLANK	0.002	0.0	1	0.0		131	0.000313	-0.002	0.002
38013	Li	mg/L	REAGENT BLANK	0.00006 0.	0.0	1	0.0		121	0.0	-0.00006	0.00006
38015	Mn	mg/L	REAGENT BLANK	0.0002 0	0.0	1	0.0		125	0.000051	-0.0002	0.0002
38014	Mg	mg/L	REAGENT BLANK	0.005	0.0	1	0.0		121	0.000864	-0.005	0.005
38017	Mo	mg/L	REAGENT BLANK	0.001	0.0	1	0.000844		122	0.000016	-0.001	0.001
38018	Ni	mg/L	REAGENT BLANK	0.001	0.0	1	-0.00062		129	0.000196	-0.001	0.001
38019	P	mg/L	REAGENT BLANK	0.006	0.0	1	0.0		121	0.001181	-0.006	0.006
38020	K	mg/L	REAGENT BLANK	0.6	0.0	1	0.0		121	0.001665	-0.040	0.040
38021	Se	mg/L	REAGENT BLANK	0.003	0.0	1	0.0		122	0.000126	-0.003	0.003
38023	Si	mg/L	REAGENT BLANK	0.004	0.0	1	0.0		122	0.000133	-0.004	0.004

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NORWEST LABS

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Quality Assurance Analysis

Standard Reference Material Analysis

			----STANDARD----			-----QC WITH----- ---THIS ORDER----			-HISTORICAL-- --PRECISION--		-WARNING LIMITS--	
METHOD	ANALYSIS	-UNITS--	--DESCRIPTION---	--D.L.--	TARGET	#	MEAN	% Y	#	MEAN	LOW	HIGH
38022	Ag	mg/L	REAGENT BLANK	0.001	0.0	1	0.0		122	0.000053	-0.001	0.00
38024	Na	mg/L	REAGENT BLANK	0.004	0.0	1	0.0		124	0.000138	-0.004	0.00
38025	Sr	mg/L	REAGENT BLANK	0.0001 0	0.0	1	0.0		121	0.000008	-0.0001	0.000
38099	S	mg/L	REAGENT BLANK	0.008	0.0	1	0.0		122	0.001138	-0.008	0.008
38069	Tl	mg/L	REAGENT BLANK	0.004	0.0	1	-0.00150		121	-0.00008	-0.004	0.00
38036	Sn	mg/L	REAGENT BLANK	0.003	0.0	1	0.001911		120	0.000360	-0.003	0.003
38026	Ti	mg/L	REAGENT BLANK	0.0004 0	0.0	1	0.000133		122	0.000077	-0.0004	0.000
38029	V	mg/L	REAGENT BLANK	0.001	0.0	1	0.000744		126	0.000055	-0.001	0.001
38030	Zn	mg/L	REAGENT BLANK	0.0005 0	0.0	1	0.0		130	0.000013	-0.0005	0.000

QC/QA Manager:

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Quality Assurance Analysis

Standard Reference Material Analysis

METHOD	ANALYSIS	-UNITS--	----STANDARD---- --DESCRIPTION---	--D.L.--	TARGET	-----QC WITH----- ---THIS ORDER---- #	MEAN	% Y	-HISTORICAL-- --PRECISION-- #	MEAN	-WARNING LIMITS-- LOW	HIGH
5078	P (DISS)	mg/L	TKN-TP QC Low	.05	4.00	1	3.918	97.9	36	3.975	3.712	4.156
5032	NO2 & NO3-N	mg/L	HIGH CHEMICAL	0.05	3.0	2	3.015	100.5	191	3.009	2.85	3.16
5032	NO2 & NO3-N	mg/L	LOW CHEMICAL	0.05	0.40	2	0.3904	97.6	186	0.3984	0.3577	0.4367
5038	ORGANIC - CARBON	mg/L	HIGH CHEMICAL	0.5	15	1	14.85	99.0	153	14.44	13.5	15.2
5038	ORGANIC - CARBON	mg/L	LOW CHEMICAL	0.5	3.0	1	2.830	94.3	154	2.768	1.96	4.04
38016	Hg	mg/L	MTL STD QC HIGH	0.0001	.003	1	0.003140	104.7	124	0.003001	.0028	.0031
38016	Hg	mg/L	MTL STD QC LOW	0.0001	0.0008	1	0.000820	102.5	128	0.000793	0.00072	0.00088
38000	Al	mg/L	MTL STD QC HIGH	0.008	10.00	1	9.960	99.6	114	10.12	9.96	10.32
38000	Al	mg/L	MTL STD QC LOW	0.008	0.20	1	0.1975	98.7	124	0.1885	0.16	0.24
38002	Sb	mg/L	MTL STD QC LOW	0.005	0.050	1	0.04497	89.9	122	0.05345	0.040	0.060
38001	As	mg/L	MTL STD QC LOW	.01	0.050	1	0.05488	109.8	124	0.05120	0.040	0.060
38003	Ba	mg/L	MTL STD QC LOW	0.0002	0.005	1	0.005010	100.2	121	0.005127	0.004	0.006
38004	Be	mg/L	MTL STD QC LOW	0.0005	0.005	1	0.004960	99.2	121	0.004988	0.004	0.006
38041	Bi	mg/L	MTL STD QC LOW	0.007	0.050	1	0.05048	101.0	122	0.05155	0.040	0.060
38005	B	mg/L	MTL STD QC LOW	0.002	0.20	1	0.2200	110.0	123	0.2063	0.16	0.24
38006	Cd	mg/L	MTL STD QC LOW	0.0005	0.005	1	0.005270	105.4	126	0.005247	0.004	0.006
38007	Ca	mg/L	MTL STD QC HIGH	0.002	20.00	1	20.84	104.2	114	20.69	20.27	20.97
38007	Ca	mg/L	MTL STD QC LOW	0.002	0.100	1	0.1012	101.2	123	0.1079	0.080	0.120
38008	Cr	mg/L	MTL STD QC LOW	0.0008	0.010	1	0.01171	117.1	129	0.01113	0.008	0.012
38009	Co	mg/L	MTL STD QC LOW	0.0007	0.010	1	0.01117	111.7	122	0.01068	0.008	0.012
38010	Cu	mg/L	MTL STD QC LOW	0.001	0.010	1	0.01112	111.2	131	0.01050	0.008	0.012
38011	Fe	mg/L	MTL STD QC HIGH	0.003	5.00	1	5.256	105.1	123	5.112	4.99	5.18
38011	Fe	mg/L	MTL STD QC LOW	0.003	0.050	1	0.04742	94.8	133	0.05175	0.040	0.060
38012	Pb	mg/L	MTL STD QC LOW	0.002	0.020	1	0.01737	86.9	131	0.02072	0.016	0.024
38013	Li	mg/L	MTL STD QC LOW	0.00006	0.005	1	0.005190	103.8	122	0.004901	0.004	0.006

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Quality Assurance Analysis

Standard Reference Material Analysis

METHOD	ANALYSIS	-UNITS--	----STANDARD---- --DESCRIPTION---	--D.L.--	TARGET	-----QC WITH----- ---THIS ORDER---- #	MEAN	% Y	-HISTORICAL-- --PRECISION-- #	MEAN	-WARNING LIMITS-- LOW	HIGH
38015	Mn	mg/L	MTL STD QC HIGH	0.0002	1.00	1	1.045	104.5	116	1.018	0.97	1.04
38015	Mn	mg/L	MTL STD QC LOW	0.0002	0.005	1	0.005520	110.4	126	0.005335	0.004	0.00
38014	Mg	mg/L	MTL STD QC HIGH	0.005	5.00	1	4.803	96.1	111	4.773	4.70	4.8
38014	Mg	mg/L	MTL STD QC LOW	0.005	0.050	1	0.05352	107.0	114	0.05553	0.040	0.060
38017	Mo	mg/L	MTL STD QC LOW	0.001	0.010	1	0.01118	111.8	123	0.01041	0.008	0.01
38018	Ni	mg/L	MTL STD QC LOW	0.001	0.010	1	0.01032	103.2	129	0.01083	0.008	0.012
38019	P	mg/L	MTL STD QC LOW	0.006	0.050	1	0.05727	114.5	123	0.05380	0.040	0.06
38020	K	mg/L	MTL STD QC HIGH	0.6	20.00	1	19.73	98.6	114	19.72	18.79	20.45
38021	Se	mg/L	MTL STD QC LOW	0.003	0.050	1	0.04932	98.6	123	0.05020	0.040	0.06
38023	Si	mg/L	MTL STD QC HIGH	0.004	5.00	1	4.896	97.9	114	4.915	4.84	4.9
38022	Ag	mg/L	MTL STD QC LOW	0.001	0.010	1	0.01175	117.5	121	0.01080	0.008	0.01
38024	Na	mg/L	MTL STD QC HIGH	0.004	20.00	1	20.45	102.3	117	20.17	18.86	20.7
38024	Na	mg/L	MTL STD QC LOW	0.004	0.50	1	0.4617	92.3	119	0.4375	0.40	0.60
38025	Sr	mg/L	MTL STD QC LOW	0.0001	0.005	1	0.005230	104.6	122	0.005269	0.004	0.00
38099	S	mg/L	MTL STD QC HIGH	0.008	20.00	1	21.01	105.0	113	20.39	19.80	20.98
38099	S	mg/L	MTL STD QC LOW	0.008	0.20	1	0.2099	105.0	123	0.2161	0.16	0.2
38069	Tl	mg/L	MTL STD QC LOW	0.004	0.050	1	0.05719	114.4	122	0.05165	0.040	0.060
38036	Sn	mg/L	MTL STD QC LOW	0.003	0.050	1	0.04855	97.1	121	0.04897	0.040	0.06
38026	Ti	mg/L	MTL STD QC LOW	0.0004	0.005	1	0.005140	102.8	122	0.004889	0.004	0.00
38029	V	mg/L	MTL STD QC LOW	0.001	0.010	1	0.01130	113.0	127	0.01074	0.008	0.01
38030	Zn	mg/L	MTL STD QC HIGH	0.0005	1.00	1	1.059	105.9	119	1.038	0.90	1.1
38030	Zn	mg/L	MTL STD QC LOW	0.0005	0.010	1	0.01095	109.5	131	0.01042	0.008	0.012
5029	Cl	mg/L	REAGENT BLANK	0.5	0.0	2	0.01235		158	0.008089	-0.2	0.
5071	NH_3 - N	mg/L	REAGENT BLANK	.05	0.0	2	0.0		151	0.000675	-0.05	0.05
5069	NO_2-N	mg/L	REAGENT BLANK	0.05	0.0	1	0.001000		85	0.000059	-0.1	0.

QC/QA Manager:

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Winnipeg, MB	Phone (204) 982-8630	Fax (204) 275-6019

TO: RL&L Environmental Services Ltd.

ATTN: Rick Pattenden

DATE SAMPLED: 1-Aug-97
DATE RECEIVED: 7-Aug-97
DATE REPORTED: 14-Aug-97
LAB FILE#: 97-08-2769

Project: Project 570

TOTAL EXTRACTABLE HYDROCARBONS
QUALITY ASSURANCE DATA

(This QA/QC data is representative of the lab based quality assurance program and is not to be utilized as field data.)

Calibration Check (CC)

	Actual Amt. (ng)	Detected Amt. (ng)	% Rec.
DIESEL	2650	2553.7	96

Accuracy $= \dfrac{\text{Ave \% Rec. MS + Ave \% Rec. MSD}}{2}$ = 118 % Accuracy

% RSD $= \dfrac{\text{Ave \% Rec. MS - Ave \% Rec. MSD}}{\text{\% Accuracy}}$ = 6.4 % RSD

The calculated values are based on matrix spike and duplicate recovery data performed on your samples at the time of analysis.

Date Acquired: 97-08-13

Analyst: GAVIN JANUARY

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17312-106 AVENUE
EDMONTON, AB
T5S 1H9

RICK PATTENDEN
PROJECT 570
01 08 97

Quality Assurance Analysis

Standard Reference Material Analysis

			----STANDARD----			-----QC WITH----- ---THIS ORDER----			-HISTORICAL-- --PRECISION--		-WARNING LIMITS--	
METHOD	ANALYSIS	-UNITS--	--DESCRIPTION---	--D.L.--	TARGET	#	MEAN	% Y	#	MEAN	LOW	HIGH
5021	pH		HIGH CHEMICAL	0.1	9.18	1	9.220	100.4	231	9.178	9.08	9.2
5021	pH		LOW CHEMICAL	0.1	6.86	1	6.890	100.4	231	6.868	6.83	6.97
5022	E.C.	uS/cm	HIGH CHEMICAL	.1	2767	1	2750	99.4	145	2759	2740	278
5022	E.C.	uS/cm	LOW CHEMICAL	.1	80	1	76.00	95.0	145	82.78	75	80
5023	Ca	mg/L	MTL STD QC HIGH	.1	20.0	1	19.80	99.0	231	20.13	18.0	22.
5024	Mg	mg/L	MTL STD QC HIGH	.1	5.0	1	4.731	94.6	228	4.843	4.5	5.5
5025	Na	mg/L	MTL STD QC HIGH	0.6	20	1	19.60	98.0	222	19.59	18	2
15026	K	mg/L	MTL STD QC HIGH	.6	20.0	1	19.61	98.1	223	19.66	18.0	22.0
5027	Fe	mg/L	MTL STD QC HIGH	.04	5.0	1	5.320	106.4	204	5.329	4.50	5.
5028	SO_4	mg/L	MTL STD QC HIGH	0.3	60.0	1	58.01	96.7	229	58.47	54.0	66.
15016	Mn	mg/L	MTL STD QC HIGH	0.003	1.00	1	1.003	100.3	188	1.027	0.9	1.10
5029	Cl	mg/L	HIGH CHEMICAL	0.5	80	2	80.26	100.3	204	80.05	77.97	81.9
5029	Cl	mg/L	LOW CHEMICAL	0.5	15.0	2	15.05	100.3	199	14.84	14.37	15.39
4997	T. ALK.	mg/L	HIGH CHEMICAL	1	1000	1	992.3	99.2	125	989.8	974	101
4997	T. ALK.	mg/L	LOW CHEMICAL	1	125	1	124.2	99.4	125	124.4	124	129
5074	TKN	mg/L	TKN-TP QC High	0.05	30.0	1	30.45	101.5	130	30.27	27.136	32.28
5074	TKN	mg/L	TKN-TP QC Low	0.05	20.0	1	20.10	100.5	137	20.13	18.521	22.15
5071	NH_3 - N	mg/L	HIGH CHEMICAL	.05	3.00	2	3.068	102.3	196	3.047	2.86	3.2
5071	NH_3 - N	mg/L	LOW CHEMICAL	.05	0.8	2	0.8052	100.7	192	0.8038	0.7330	0.852
5069	NO_2-N	mg/L	LOW CHEMICAL	0.05	0.40	1	0.3980	99.5	86	0.3887	0.38	0.4
5069	NO_2-N	mg/L	TRACE CHEMICAL	0.05	0.09	1	0.08500	94.4	90	0.08999	.078	.10
5076	P(TOTAL)	mg/L	TKN-TP QC High	.05	9.00	1	9.038	100.4	102	8.876	8.475	9.399
5076	P(TOTAL)	mg/L	TKN-TP QC Low	.05	4.00	1	3.918	97.9	104	3.972	3.700	4.16
5078	P (DISS)	mg/L	TKN-TP QC High	.05	9.00	1	9.038	100.4	33	8.896	8.442	9.456

QC/QA Manager:

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17312-106 AVENUE
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RICK PATTENDEN
PROJECT 570
01 08 97

WATER ANALYSIS REPORT

07105L NO2&NO3-N
Automated colorimetry Cadmium reduction
Ref. APHA 4500-NO3-,F
EPA1664 OIL AND GREASE
06005L TOT ORG CARBON
Auto persulphate/UV digest. Colorimetric
Ref. MOE(Ontario Environment)

Method References:
1. APHA Standard Methods for the Examination of Water and Wastewater, American Public Health Assoc., 17th ed.
2. EPA a. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846, 3rd ed., US EPA, 1986
   b. Methods for Chemical Analysis of Water and Wastewater, US EPA, 1983
3. MSS Manual on Soil Sampling and Methods of Analysis, Cdn. Soc. of Soil Science, J. A. McKeague, 2nd ed.

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Lab Manager: ____________________

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TO:	RL&L Environmental Services Ltd.	**DATE SAMPLED:**	1-Aug-97
		DATE RECEIVED:	7-Aug-97
ATTN:	Rick Pattenden	**DATE REPORTED:**	14-Aug-97
		LAB FILE#:	97-08-2769
		Project:	Project 570

BTEX
QUALITY ASSURANCE DATA

(This QA/QC data is representative of the lab based quality assurance program and is not to be utilized as field data.)

Calibration - Check (CC)

	Expected Amt. (ng)	Detected Amt. (ng)	% Rec.	Acceptable Range
Benzene	50.0	49.6	99	80-120
Toluene	50.0	47.4	95	80-120
Ethyl Benzene	50.0	51.5	103	80-120
M & P Xylenes	100.0	97.3	97	80-120
O-Xylene	50.0	50.6	101	80-120

$$\text{Accuracy} = \frac{\text{Ave \% Rec. MS} + \text{Ave \% Rec. MSD}}{2} = \underline{110} \text{ \% Accuracy}$$

$$\text{\% RSD} = \frac{\text{Ave \% Rec. MS} - \text{Ave \% Rec. MSD}}{\text{\% Accuracy}} = \underline{2.9} \text{ \% RSD}$$

The calculated values are based on matrix spike and duplicate recovery data performed on your samples at the time of analysis.

Date Acquired: 97-08-13 Analyst: NANCY HUYNH

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EDMONTON, AB
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RICK PATTENDEN
PROJECT 570
01 08 97

WATER ANALYSIS REPORT

---PARAMETER----	DATE OF-ANALYSIS	------ANALYZED BY-------	---PARAMETER----	DATE OF-ANALYSIS	------ANALYZED BY-------
pH	11Aug97	DARREN CRICHTON	ELECTRICAL COND	11Aug97	DARREN CRICHTON
CALCIUM	08Aug97	LANG QUE TRAN	MAGNESIUM	08Aug97	LANG QUE TRAN
SODIUM	08Aug97	LANG QUE TRAN	POTASSIUM	08Aug97	LANG QUE TRAN
IRON	08Aug97	LANG QUE TRAN	MANGANESE	08Aug97	LANG QUE TRAN
SULPHATE	08Aug97	LANG QUE TRAN	CHLORIDE	08Aug97	THERESA LIEU
BICARBONATE	11Aug97	DARREN CRICHTON	T ALKALINITY	11Aug97	DARREN CRICHTON
HARDNESS	11Aug97	LANG QUE TRAN	T DIS SOLIDS	11Aug97	LANG QUE TRAN
IONIC BALANCE	11Aug97	LANG QUE TRAN	TOTAL KJEHL NIT	11Aug97	THERESA LIEU
AMMONIA-N	08Aug97	THERESA LIEU	NITRATE-N	09Aug97	THERESA LIEU
NITRITE-N	08Aug97	THERESA LIEU	PHOSPHORUS(TOT)	11Aug97	THERESA LIEU
PHOSPHORUS,DISS	11Aug97	THERESA LIEU	NO2&NO3-N	08Aug97	THERESA LIEU
OIL AND GREASE	12Aug97	BARBARA CREPIN	TOT ORG CARBON	08Aug97	THERESA LIEU
MERCURY	13Aug97	LANG QUE TRAN	ALUMINUM	13Aug97	LANG QUE TRAN
ANTIMONY	13Aug97	LANG QUE TRAN	ARSENIC	13Aug97	LANG QUE TRAN
BARIUM	13Aug97	LANG QUE TRAN	BERYLLIUM	13Aug97	LANG QUE TRAN
BISMUTH	13Aug97	LANG QUE TRAN	BORON	13Aug97	LANG QUE TRAN
CADMIUM	13Aug97	LANG QUE TRAN	CALCIUM	13Aug97	LANG QUE TRAN
CHROMIUM	13Aug97	LANG QUE TRAN	COBALT	13Aug97	LANG QUE TRAN
COPPER	13Aug97	LANG QUE TRAN	IRON	13Aug97	LANG QUE TRAN
LEAD	13Aug97	LANG QUE TRAN	LITHIUM	13Aug97	LANG QUE TRAN
MANGANESE	13Aug97	LANG QUE TRAN	MAGNESIUM	13Aug97	LANG QUE TRAN
MOLYBDENUM	13Aug97	LANG QUE TRAN	NICKEL	13Aug97	LANG QUE TRAN
PHOSPHORUS	13Aug97	LANG QUE TRAN	POTASSIUM	13Aug97	LANG QUE TRAN
SELENIUM	13Aug97	LANG QUE TRAN	SILICON	13Aug97	LANG QUE TRAN
SILVER	13Aug97	LANG QUE TRAN	SODIUM	13Aug97	LANG QUE TRAN
STRONTIUM	13Aug97	LANG QUE TRAN	SULPHUR	13Aug97	LANG QUE TRAN
THALLIUM	13Aug97	LANG QUE TRAN	TIN	13Aug97	LANG QUE TRAN
TITANIUM	13Aug97	LANG QUE TRAN	VANADIUM	13Aug97	LANG QUE TRAN
ZINC	13Aug97	LANG QUE TRAN			

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PROJECT 570
01 08 97

WATER ANALYSIS REPORT

The following published METHODS OF ANALYSIS were used:

10301L pH
Electrometric (pH meter)
Ref. APHA 4500-H+

02041L ELECTRICAL COND
Conductance meter
Ref. APHA 2510 B

20103 CALCIUM
ICP spectroscopy @ 317.9 nm
Ref. APHA 3120 B

12102L MAGNESIUM
ICP spectroscopy @ 285.2 nm
Ref. APHA 3120 B

11102L SODIUM

19111 POTASSIUM
Diss.,ICP Spectroscopy, Ref. APHA 3120 B

26304L IRON

16306L SULPHATE
ICP spectroscopy @ 180.7 nm
Ref. APHA 3120 B

17203L CHLORIDE
Automated colorimetry, Thiocyanate
Ref. APHA 4500 Cl-,E

06201L BICARBONATE
Potentiometric titration with standard
acid to pH 8.3 and pH 4.5
Ref. APHA 2320 B

10101 T ALKALINITY
Potentiometric titration with standard
acid to pH 4.5 & pH 8.3. Report as CaCO3
Ref. APHA 2320 B

10602 HARDNESS
Calculation from 2.5*Ca + 4.1*Mg
Reported as CaCO3
Ref. APHA 2340 B

00203 T DIS SOLIDS
SUM OF IONS CALCULATION
Ca + Mg + K + Na + SO4 + Cl + 0.6*T Alk
Ref. APHA 1030 F

NWL4994 IONIC BALANCE

00100 IONIC BALANCE 2
%Diff=(Sum Cations-Sum Anions)/
(Sum Cations+Sum Anions)*100
Ref. APHA 1030 F

07021P TOTAL KJEHL NIT
Total, block digest with K2SO4/HgO
and H2SO4, auto phenate colorimetry.
Ref.US EPA 351.2;Crowther MOE

07557 AMMONIA-N
Automated phenate colorimetry
Ref. APHA 4500 NH3,H

07301 NITRATE-N
Diss., Auto. colorimetry, Cd reduction
Ref. APHA 4500 NO3-E

07205 NITRITE-N
Automated colorimetry
Ref. APHA 4500 NO2,B

15406 PHOSPHORUS(TOT)
Total,Autoclave with persulphate/H2SO4
Auto. colorimetry with ascorbic acid
Ref. APHA 4500 P,B/E

15103 PHOSPHORUS,DISS
Diss.,Autoclave with persulphate/H2SO4
Auto. colorimetry with ascorbic acid
Ref. APHA 4500 P,E

Method References:

1. APHA Standard Methods for the Examination of Water and Wastewater, American Public Health Assoc., 17th ed.
2. EPA a. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846, 3rd ed., US EPA, 1986
   b. Methods for Chemical Analysis of Water and Wastewater, US EPA, 1983
3. MSS Manual on Soil Sampling and Methods of Analysis, Cdn. Soc. of Soil Science, J. A. McKeague, 2nd ed.

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APPENDIX A3
WATER CHEMISTRY PARAMETERS AND METHODS

Channel Type - Includes the following categories:

Single (C1) - Entire water flow of stream through one active channel.
Multiple (C2) - Water flow of stream through more than one active channel.
Dispersed (C3) - No defined channel.

Bank Type - Includes the following categories:

Well-defined (D1) - Well-defined boundary at water-bank interface of active stream channel.
Ill-defined (D2) - Poorly defined boundary at water-bank interface of active stream channel.

Lakes

Provides a qualitative assessment of the physical characteristics of the littoral zone (zone of visible light penetration to bottom) and its potential as critical fish habitat (spawning and rearing).

Slope - The slope of the visible portion of the lake bottom adjacent to the shoreline. The lower the slope, the greater the amount of shallow water (littoral zone) available for use by smaller juveniles and young-of-the-year fish. Visual estimation of slope using three categories.

Low - 0 to 10%
Moderate - 11 to 30%
High - >30%

Substrate - The dominant substrate in the visible portion of the lake bottom adjacent to the shoreline. The presence of rock (cobbles, boulders) indicates potential as a spawning habitat; presence of fines (organics, clay, silt, sand, gravel) indicates the potential as rearing habitat (enhances growth of macrophytes); presence of bedrock indicates limited value as fish habitat. Visual estimation of the percent cover by each substrate size and then grouping into three categories based on the following criteria:

Fines - >40% of bottom consists of organics, clays, silts, or gravel substrates.
Rock - >60% of bottom consists of cobbles or boulders.
Bedrock - > 40% of bottom consists of bedrock.

APPENDIX A2 - SUBSTRATE CLASSIFICATION SYSTEM

Modified Wentworth classification for substrate particle sizes

CLASSIFICATION	PARTICLE SIZE RANGE (mm)
Bedrock	-
Boulder	>256
Cobble	32 - 256
Gravel	1 - 32
Sand	0.0625 - 0.2-1
Silt	0.0039-0.0625
Clay	<0.0039
Organics	-

APPENDIX A1 - HABITAT CLASSIFICATION SYSTEM

Streams

Provides a qualitative assessment of the physical characteristics of a stream and its potential as fish habitat.

Riffle - Portion of channel with increased velocity relative to Run and Pool habitat types; broken water surface due to effects of submerged or exposed bed materials; shallow (less than 25 cm). Limited value as habitat for larger juveniles and adults (i.e., feeding), but may be used extensively by young-of-the-year and small juveniles.

RF - Typical riffle habitat type; provides limited cover for all life stages.

RF/BG - Riffle habitat type with abundance of large cobble and boulder substrates. Limited cover for juveniles and adults; but, may be used extensively by young-of-the-year fish.

Rapids (RA) - Portion of channel with highest velocity relative to other habitat types. Deep (>25 cm); often formed by channel constriction. Substrate extremely coarse; dominated by large cobble and boulder substrates. Habitat provided for juveniles and adults in pocket eddies associated with substrate.

Run - Portion of channel characterized by moderate to high current velocity relative to Pool and Flat habitats; water surface largely unbroken. Potentially high habitat value for all life stages. Can be differentiated into five types based on depth and cover.

R1 - Maximum depth exceeding 1.5 m; average depth 1.0 m. High cover at all flow conditions. Highest quality habitat for larger juveniles and adults; limited value for young-of-the-year-fish.

R2/BG - Maximum depth reaching 1.0 m and generally exceeding 0.75 m; presence of large cobble or boulder substrates in channel. High cover at all flows. Moderate to high quality habitat for larger juveniles and adults.

R2 - Maximum depth reaching 1.0 m and generally exceeding 0.75 m. High cover during most flows, but not during base flows. Moderate quality habitat for juveniles and adults; limited value for young-of-the-year-fish.

R3/BG - Maximum depth of 0.75 m, but averaging <0.50 m; presence of large cobble or boulder substrates in channel. Moderate cover at all flows. Moderate quality habitat for juveniles and adults; but, the value to young-of-the-year-fish is potentially high.

R3 - Maximum depth of 0.75 m, but averaging <0.50 m. Low cover at all flows. Lowest quality habitat for juveniles and adults; but, the value to young-of-the-year-fish is potentially high.

Flat - Area of channel characterized by low current velocities (relative to RF and Run cover types); near-laminar (i.e., non-turbulent) flow. Depositional area dominated sand/silt substrates. Differentiated from Pool habitat type by high channel uniformity and lack of direct association with riffle/run complex. Potential habitat value for all life stages is moderate to high. Can be differentiated into five types based on depth and cover.

F1 - Maximum depth exceeding 1.5 m; average depth 1.0 m or greater. High cover at all flows. Highest quality habitat for larger juveniles and adults; limited value for young-of-the-year-fish.

F2/BG - Maximum depth reaching 1.0 m and generally exceeding 0.75 m; presence of cobble or boulder substrates in channel. High cover at all flows. Moderate to high quality habitat for juveniles and adults.

F2 - Maximum depth exceeding 1.0 m; generally exceeding 0.75 m. High cover during most flows, but not during base flows. Moderate quality habitat for juveniles and adults; limited value for young-of-the-year-fish.

F3/BG - Maximum depth of 0.75 m, but averaging <0.50 m; presence of large cobble or boulder substrates in channel. Moderate cover at all flows. Moderate quality habitat for juveniles and adults; but, the value to young-of-the-year-fish is potentially high.

F3 - Maximum depth of 0.75 m, averaging less than 0.50 m. Low cover at all flows. Lowest quality habitat for juveniles and adults; but, the value to young-of-the-year-fish is potentially high.

Pool - Discrete portion of channel featuring increased depth and reduced velocity (downstream oriented) relative to Riffle and Run habitat types. Normally featuring Riffle/Run associations. Principal habitat value for all life stages is cover. When in close association with Riffle/Run habitats, value can be very high. Can be differentiated into three types based on depth.

P1 - Maximum depth exceeding 1.5 m; average depth 1.0 m or greater; high cover at all flow conditions. Often intergrades with deep-slow type of R1. Highest quality habitat for larger juveniles and adults; limited value for young-of-the-year-fish.

P2 - Maximum depth reaching or exceeding 1.0 m, generally exceeding 0.75 m. High cover at all but base flows. Moderate quality habitat for juveniles and adults; limited value for young-of-the-year-fish.

P3 - Maximum depth of 0.75 m, averaging <0.50 m. Low instream cover; includes small pocket eddies. Lowest quality habitat for all life stages.

Dispersed (DIS) - Portion of stream exhibiting no defined channel. Water depth rarely exceeding 0.25 m and often dispersed over boulder fields. Very limited value as fish habitat.

Habitat Features - Includes the following instream features:

Chutes (CH) - Area of channel constriction; generally resulting in channel deepening and increased velocity. Associated habitat types are Pool, Run, and Rapid.

Ledges (LG) - Areas of bedrock intrusion into the channel; often creates Chutes and Pool habitat.

Falls (FAL) - Area of channel exhibiting rapid vertical decent over boulder and bedrock. Often a barrier to fish passage.

Cascade (CAS) - Area of channel exhibiting rapid decent over boulder and bedrock, but, with no well defined vertical decent (i.e., falls). Often a barrier to fish passage.

Outlet/Inlet (Out) - Confluence of stream and lake; can be the outlet or inlet.

APPENDIX A
CLASSIFICATION SYSTEMS AND METHODS

Plate 13 Route 1 - Stream 118.2 looking upstream (17 June 1997).

Plate 14 Ulu Creek looking downstream (29 July 1997).

Plate 15 Frayed Knots River looking upstream (5 August 1997).

Plate 16 Snorkelling on the Frayed Knots River (3 August 1997).