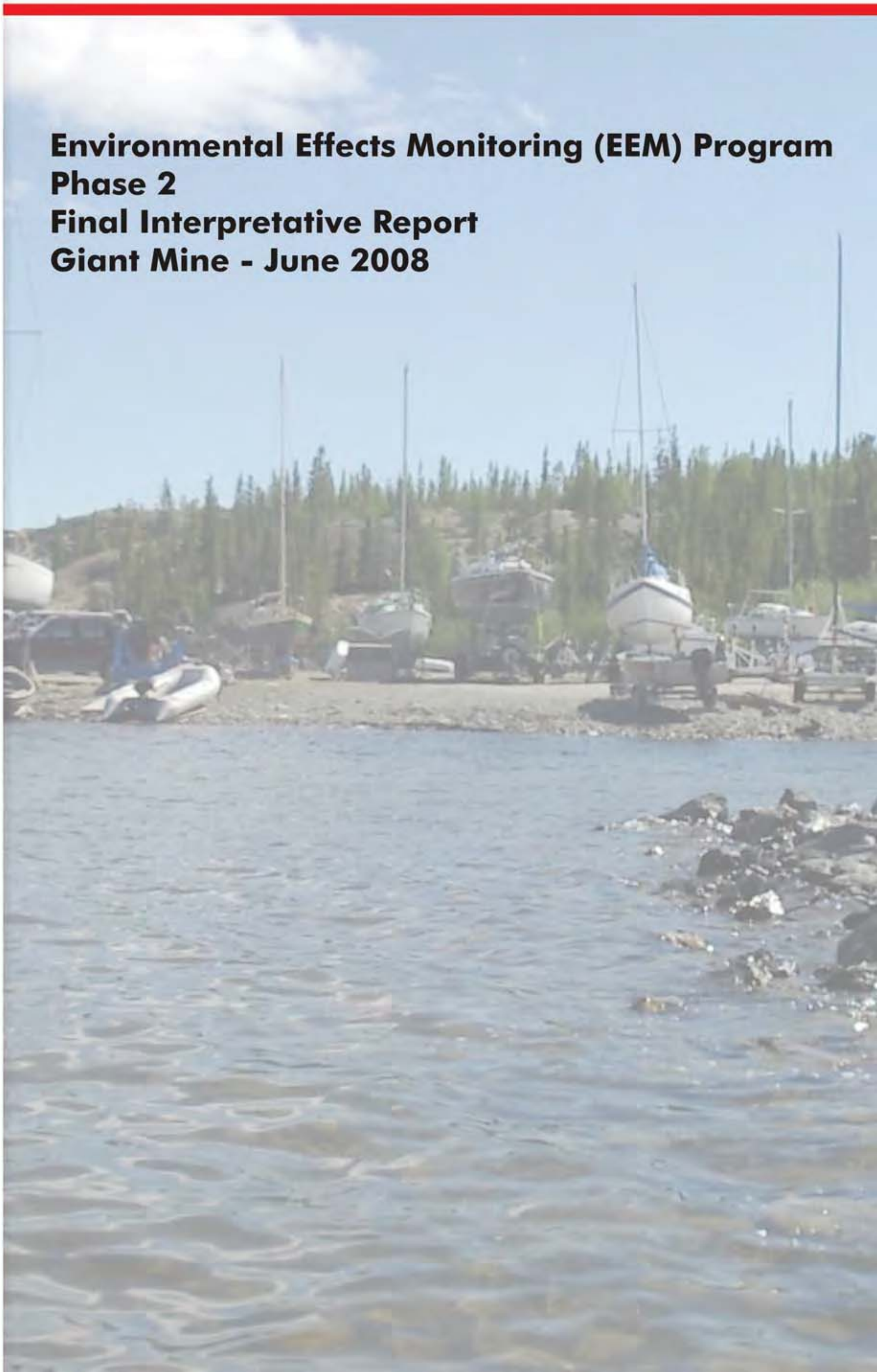
Indian and Northern
Affairs Canada

Environmental Effects Monitoring (EEM) Program
Phase 2
Final Interpretative Report
Giant Mine - June 2008



REPORT ON

INDIAN AND NORTHERN AFFAIRS CANADA
GIANT MINE
ENVIRONMENTAL EFFECTS MONITORING
PHASE 2
FINAL INTERPRETATIVE REPORT

Submitted to:
Environment Canada
by:
Indian and Northern Affairs Canada
Yellowknife, Northwest Territories

Prepared by:
Golder Associates Ltd.
9, 4905-48 Street
Yellowknife, NT
X1A 3S3

DISTRIBUTION:

2	Copies -	Indian and Northern Affairs Canada, Yellowknife, Northwest Territories
1	Copy -	Denton'Cho/Nuna Joint Venture, Yellowknife, Northwest Territories
9	Copies -	Environment Canada, Edmonton, Alberta
2	Copies -	Golder Associates Ltd., Yellowknife, Northwest Territories
1	Copy -	Aurora Research Institute, Northwest Territories

June 2008 08-1328-0023

Acknowledgements

This report was prepared by Katherine Gerein, Travis Shepherd, Chris Fraikin and Hilary Machtans, and reviewed by Zsolt Kovats and Peter Chapman (Golder Associates Ltd.). We would like to thank Brendan Galloway, Sharon Vogel, Allison op der Heijde, Alison Ondrack, Kristy Todd, Brady Balicki and Jill LaPorte (Golder Associates Ltd.), Bill Mitchell, Jamie Lariviere, Gila Somers (Indian and Northern Affairs Canada), Tara Kramers and Ron Connell (Deton'Cho/Nuna Joint Venture) for their assistance with this project and review of this report. Golder Associates and Indian and Northern Affairs Canada also wish to thank the members of the Technical Advisory Panel (TAP) for their valuable suggestions and comments. The study design in this document reflects input and review provided by the TAP during meetings held on May 24, 2006 and the TAP site visit July 20, 2006. The TAP members for the Giant Mine Environmental Effects Monitoring Program are Shelly Boss (Environment Canada, Edmonton), Anne Wilson (Environment Canada, Yellowknife), Chris Baron (Fisheries and Oceans Canada, Winnipeg), Janpeter Lennie-Misgeld (Mackenzie Valley Land and Water Board, Yellowknife), and Mike Palmer (Indian and Northern Affairs Canada, Yellowknife).

Suggested Citation:

Golder Associates. 2008. *Indian and Northern Affairs Canada Giant Mine Environmental Effects Monitoring Phase 2 Final Interpretative Report.* Prepared for Indian and Northern Affairs Canada by Golder Associates Ltd., Yellowknife, NT. 144 p. + appendices and photoplates.

Executive Summary

Giant Mine is a former gold mine located approximately 5 km north of the City of Yellowknife, Northwest Territories, at a latitude of 62°31'N and longitude of 114°21'W. When former owner Royal Oak Mines Ltd. was assigned into receivership in 1999, the Ontario Court ordered the transfer of the Giant Mine property from the interim receiver to INAC. Immediately, the property was sold to Miramar Giant Mine Ltd. in December 1999. To accomplish the sale, Miramar signed a Reclamation Security Arrangement with INAC and the company was indemnified for the existing environmental conditions of the site

Ore mined from 1999 to July 2004 was trucked to Miramar Con Mine Ltd. in Yellowknife, where it was processed. In July 2004, operations ceased at Giant Mine and MGML gave the required notice to INAC that they would terminate their obligations under the Reclamation Security Agreement. Subsequently, Miramar Giant Mine Limited left site. INAC is leading the effort to close and reclaim the property. Final approvals for a closure plan are expected once an environmental assessment has been completed.

According to the Metal Mining Effluent Regulations (MMER), Giant Mine is required to conduct monitoring studies on potential effects of the Giant Mine's treated effluent discharge into Baker Creek. Giant Mine completed its first Environmental Effects Monitoring (EEM) report on June 6, 2005. A study design for Phase 2 of the EEM was submitted in January 2006. Golder Associates Ltd. conducted the Final Biological Monitoring Study for EEM in July 2006. This document is the Final Interpretative Report for Phase 2 and it presents the methods, results, and interpretation of those results for the various components of the EEM program.

The final discharge point for treated effluent from Giant Mine is into a pond that forms part of Baker Creek. Treated effluent flows down Baker Creek for approximately 3 km before entering Yellowknife Bay on Great Slave Lake. A breakwater at the mouth of Baker Creek has resulted in the formation of a marsh behind the breakwater. The water from Baker Creek flows through this marsh before entering Yellowknife Bay. The receiving environment for Giant Mine is defined as Baker Creek from the final discharge point to Yellowknife Bay, up to 785 m from the breakwater.

Fish Survey

A lethal field survey of slimy sculpin and a non-lethal survey of ninespine stickleback were conducted in Baker Creek (exposure area) and three locations on the Yellowknife River (reference areas). An assessment of age distribution, energy use and energy storage was performed on slimy sculpin of the two populations. A non-lethal assessment of survival and energy use was completed on ninespine stickleback.

Slimy sculpin Because fish were in a post-spawning state, the state of maturity and sex and size of slimy sculpin were difficult to determine in the field. Accurate age determinations from otoliths were also difficult for these populations. To accommodate this reality, slimy sculpin were broadly categorized as Age 1 (to represent juveniles) or Age 2+ (to represent adult fish). Age 2+ slimy sculpin males and females were found to be smaller, and females younger, in the exposure area than fish in the reference area. All three groups of slimy sculpin (Age 1 and age 2+ males and females) had greater condition factors than reference fish. There were few Age 2+ male fish in the reference areas (five in reference area A and one in reference area B) and consequently caution is required when interpreting the results. However, the results were nonetheless comparable to those for female fish. The non-lethal analysis of all slimy sculpin captured showed that the condition factor of exposure fish was significantly larger than the reference areas (15%).

Ninespine Stickleback Condition factor, length and weight in ninespine stickleback young-of-the-year fish were significantly higher in the exposure than the reference area. The condition factor of the reference fish matched that of reference fish from the Phase 1 study of ninespine stickleback from Horseshoe Bay Island as well as the condition factor of young ninespine stickleback from the Con Mine EEM study, which was completed within 10 km of this study.

Summary of Fish Study Differences between the exposure area fish and reference area fish were detected. Condition factor was higher in exposure area fish for both sentinel species. There was a marked size difference in young ninespine stickleback between the exposure and reference areas that warrants further study. This Phase 2 FS is the first to have sufficient numbers of fish to determine effects on fish. This is also the first time that slimy sculpin have been used in an EEM study for Giant Mine. Despite some technical issues in sample size parity and age validation, the presence of this fish species and its future use as a study species in the area should allow for better future definition of fish effects in the exposure area. It is presently unclear whether the differences observed are caused by effluent, historical contaminants in the sediment and porewater or habitat differences, or a combination of these potential stressors. Future studies should continue to use slimy sculpin and stickleback together with appropriate refinements to the study areas to reduce habitat variability, to determine significance and causation.

Invertebrate Community Survey

The effects of present day effluent discharge on the invertebrate community in Baker Creek were assessed using artificial substrate samplers (Hester-Dendy multi-plate samplers). Artificial substrate samplers were deployed at stations within the exposure and reference areas, and were left to colonize for a period between 66 and 70 days. Data were summarized using various indices (*e.g.*, Simpson's evenness and diversity indices, Bray-Curtis index) and multivariate analysis, to determine effluent effects on the invertebrate community within Baker Creek. Based on this analysis, the effect of the mine discharge on invertebrates colonizing artificial substrates can be conservatively characterized as low. Analysis of the data collected in 2006 highlights the low level of effects observed on artificial substrates deployed in the water column, in comparison to the severe effects observed in bottom sediments by previous studies. These results suggest that historical sediment contamination likely poses a greater risk to benthic invertebrates in Yellowknife Bay than the periodic discharge of treated mine effluent.

Effluent Toxicity

In 2006, sub-lethal and acute toxicity testing of Giant Mine effluent was conducted. Sub-lethal toxicity responses were observed in *Ceriodaphnia dubia*, *Lemna minor* and *Pseudokirchneriella subcapitata*. Giant Mine effluent was not found to be acutely toxic to rainbow trout or *Daphnia magna*. Sub-lethal toxicity effects are likely to occur throughout Baker Creek and marginally into Great Slave Lake.

Summary

The Phase 2 EEM study showed statistically and ecologically significant differences in fish and benthic invertebrates in the Baker Creek exposure area versus a reference area. Sub-lethal toxicity to aquatic organisms exists in the exposure area. Improvements in water quality and the stream itself (culvert improved) appear to be allowing a recovery of the stream in the exposure area. Because numerous slimy sculpin were found in the exposure area, the next phase of EEM could include refinements to the study design to monitor slimy sculpin upstream and downstream of the Mine. Consideration should be given to finding adult stickleback in the exposure area and a separate reference area (such as Horseshoe Bay Island) in order to conduct an adult lethal survey in addition to using young-of-the-year.

List of Acronyms

ALS	ALS Laboratory Group
ANCOVA	analysis of covariance
ANOSIM	analysis of similarity
ANOVA	analysis of variance
As^{3+}	arsenate species
As^{5+}	arsenite species
BC	British Columbia
BCI	Bray-Curtis Index
CAEAL	Canadian Association for Environmental Analytical Laboratories
CCME	Canadian Council of Ministers for the Environment
COC	chain of custody
CORMIX	Cornell Mixing Model
CPUE	catch-per-unit-effort
CWQG	Canadian Water Quality Guideline for the protection of freshwater aquatic life
DCNJV	Deton'Cho/Nuna Joint Venture
DFO	Fisheries and Oceans Canada
EC	Environment Canada
EEM	environmental effects monitoring
EEM TGD	Metal Mining Technical Guidance Document for Aquatic Environmental Effects Monitoring
EPT	Ephemeroptera, Plecoptera, Trichoptera
ETP	effluent treatment plant
FS	fish survey
F_{stat}	Fisher statistic
GM	geometric mean
GMRP	Giant Mine Remediation Project
GNWT	Government of the Northwest Territories
Golder	Golder Associates Ltd.
GSI	gonadosomatic index
HydroQual	HydroQual Laboratories
IC_{25}	25% inhibition concentration
ICS	invertebrate community survey
INAC	Indian and Northern Affairs Canada
ISQG	Interim Sediment Quality Guideline for the protection of freshwater aquatic life
k	condition factor
K-S	Kolmogorov-Smirnov test
LC_{50}	median lethal concentration
LSI	liversomatic index
Max	maximum
MDL	method detection limit
MGML	Miramar Giant Mine Ltd.

Min	minimum
MMER	Metal Mining Effluent Regulations
MVLWB	Mackenzie Valley Land and Water Board
n	sample size
NMDS	non-metric multidimensional scaling
ns	not significant
NTU	nephelometric turbidity unit
NWT	Northwest Territories
PEL	Probable Effects Level for the protection of freshwater aquatic life
PWGSC	Public Works and Government Services Canada
QA/QC	quality assurance/quality control
RAO	regional authorization officer
RMC	Royal Military College
RPD	relative percent difference
SD	standard deviation
SDI	Simpson's Diversity Index
SE	standard error
SEI	Simpson's Evenness Index
SK	Saskatchewan
SNP	Surveillance Network Program
SOP	standard operating procedure
SR	studentized residuals
TAP	technical advisory panel
TCA	tailings containment area
TOC	total organic carbon
UTM	universal transverse mercator
WTP	water treatment plant
YOY	young-of-the-year
α	Alpha
β	Beta

List of Units

#fish/hr	number of fish per hour
%	percent
‘	minutes
”	seconds
<	less than
>	greater than
≤	less than or equal to
°	degrees
°C	degrees Celsius
µg/g	milligram per gram
µg/L	microgram per litre
µm	micrometer
µS/cm	micro Siemens per centimetre
Bq/L	Becquerels per litre
cm	centimetre
g	gram
inds/m^2	individuals per square metre
km	kilometre
km/hr	kilometre per hour
km^2	square kilometre
m	metre
m/s	metres per second
m^2	square metre
m^3	cubic metre
m^3/s	cubic metre per second
mg/kg	milligram per kilogram
mg/L	milligram per litre
mm	millimetre
t/d	tonnes per day
yrs	years

Table of Contents

List of Tables

List of Figures

PHOTOPLATES

LIST OF APPENDICES

1.0 INTRODUCTION

Indian and Northern Affairs Canada (INAC) conducted an aquatic monitoring program at Giant Mine (the Mine) during the summer of 2006. This program was designed to satisfy the Metal Mining Effluent Regulations (MMER). The MMER (Government of Canada 2002, 2006) were adopted under the federal *Fisheries Act* and are administered by Environment Canada (EC). The regulations apply to all operating metal mines in Canada and impose limits on releases of deleterious substances, which include cyanide, metals, radium-226, suspended solids, and ammonia, as well as prohibits the discharge of effluent that is acutely lethal to fish. Under the MMER, there is a national environmental effects monitoring (EEM) program to assess the effects of metal mining effluent on fish, fish habitat, and the use of fisheries resources. INAC was required to conduct biological monitoring studies in the receiving environment for the Mine. These studies were used to meet the EEM program objectives and include a sentinel fish survey (FS), an invertebrate community survey (ICS), water and sediment quality monitoring, and sub-lethal toxicity testing of the treated effluent.

The final study design for the Mine's Phase 2 EEM program (Golder 2006) was formulated to meet MMER requirements. It was strengthened by guidance and recommendations provided by the Technical Advisory Panel (TAP) for Giant Mine.

1.1 Scope of Environmental Effects Monitoring Program

The specific monitoring requirements for the Phase 2 EEM program for the Mine outlined in the MMER and addressed in this report were:

- effects on the fish population;
- effects on fish habitat; and
- sub-lethal toxicity results.

Supporting environmental variables (*i.e.*, water quality and sediment quality) were also assessed as factors potentially modifying the above primary monitoring requirements.

1.2 Structure of Final Interpretative Report

This is the Final Interpretative Report for the Phase 2 EEM program. It is organized following the requirements of the Final Interpretative Report as identified in the EEM Technical Guidance Document (TGD) (EC 2002). Within this report, there are the following ten sections:

- Section 1 – provides the introduction to the Phase 2 EEM program;

- Section 2 – provides both historical and current information on the Mine operations;
- Section 3 – provides background information regarding the FS and ICS study locations;
- Section 4 – provides a detailed account of the FS including supporting environmental variables;
- Section 5 – provides a detailed account of the ICS including supporting environmental variables;
- Section 6 – provides a summary of the effluent toxicity testing results;
- Section 7 – provides an overall synopsis of the FS, ICS and the toxicity testing results as well as the overall conclusions;
- Section 8 – includes recommendations for future studies;
- Section 9 – contains the *Phase 2 EEM Final Interpretative Report* closure; and
- Section 10 – contains a list of the references cited.

There are two individual appendices (*i.e.*, Appendix I and Appendix II) associated with the FS and ICS. These appendices contain the raw data and additional information related to these specific sections.

2.0 SITE CHARACTERIZATION

A synopsis of the Mine site characterization is provided and includes the following information:

- description of the Mine site;
- current activities and historic operations; and
- modelling of the effluent plume in the receiving environment.

2.1 Site Description

2.1.1 Location and Facilities

Giant Mine is situated approximately five kilometres (km) north of the City of Yellowknife, Northwest Territories (NWT) (Figure 2-1). The final discharge is located at a latitude of 62 degrees (°), 31 minutes ('), 38 seconds (") North and longitude of 114°21'05" West. The area of land within the Mine surface lease boundary is 949 hectares and consists of forty individual leases.

The Mine infrastructure includes the following components (Figure 2-2):

- eight abandoned open pits;
- an underground mine with numerous underground workings, including an area for arsenic trioxide storage;
- several mine waste mine rock stockpiles;
- four original tailings containment areas (TCAs);
- a tailings re-treatment plant (out of service since 1990);
- an effluent treatment plant (ETP);
- a mill site complex with a roaster and several warehouses; and
- a town site.

Baker Creek flows through the Mine site and a portion of the creek (Reach 4) was rerouted in fall 2006 to avoid the mill area and to prevent seepage into the Mine.

2.1.2 Geology and Topography

The Giant Mine gold deposits occur within the Archean-aged Yellowknife Greenstone Belt, located in the southeast corner of the Slave Province and extending north from Great Slave Lake for a distance of over 50 kilometres (km). The Yellowknife Greenstone Belt is bounded to the west by younger granitic rocks of the Western Plutonic Complex and to the east by siliciclastic sedimentary rocks of the Burwash Formation.

LEGEND

- ALL-WEATHER HIGHWAYS
- WINTER ROADS
- RAILWAY
- COMMUNITY

REFERENCE

SELECTED MINERAL DEPOSITS OF THE NORTHWEST TERRITORIES, DEPARTMENT OF ENERGY, MINES AND RESOURCES, MINERAL INITIATIVES 1991 TO 1996

PROJECT

Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada

GIANT MINE ENVIRONMENTAL EFFECTS MONITORING PROGRAM

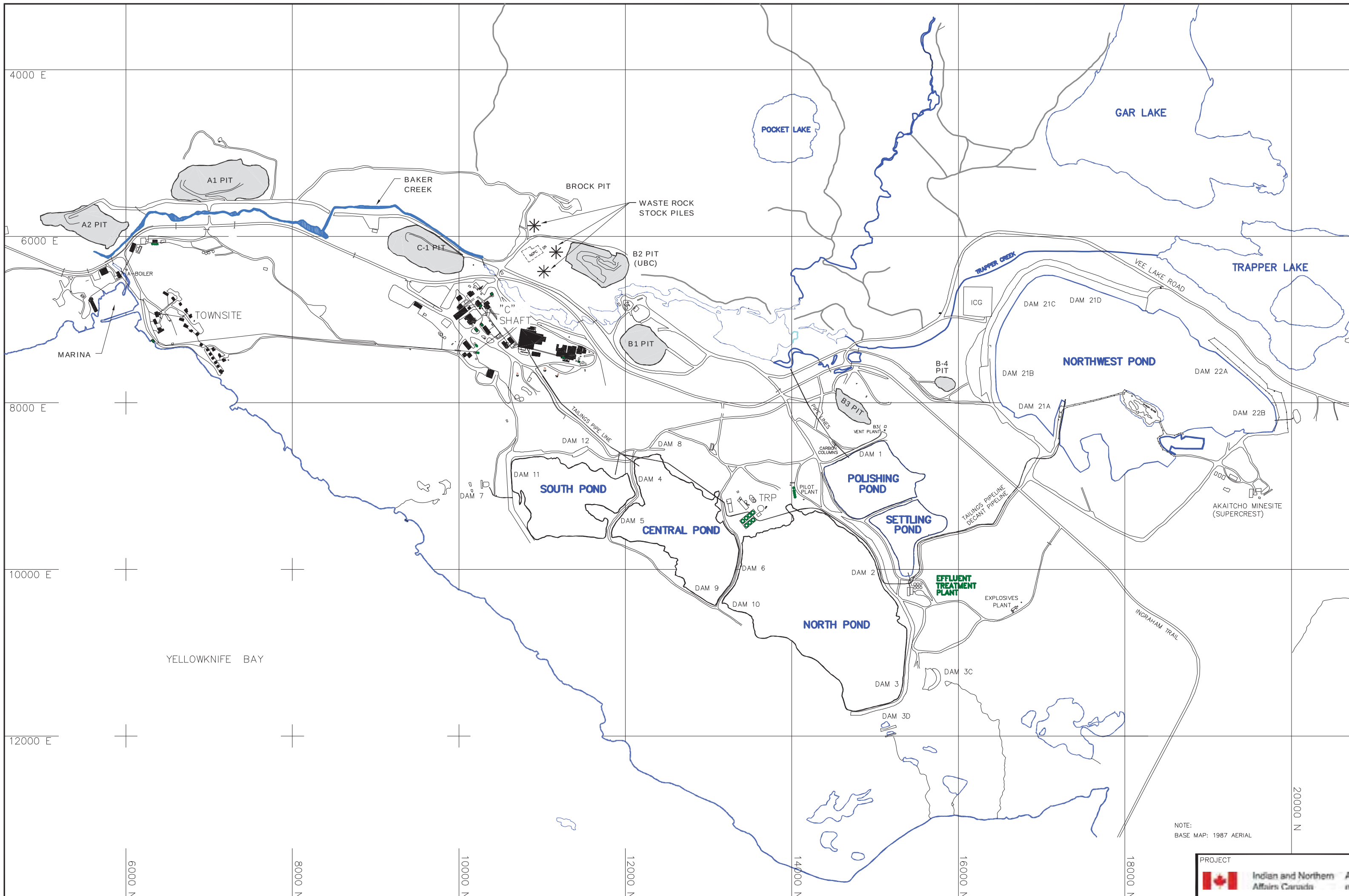
TITLE

REGIONAL LOCATION OF GIANT MINE

Golder Associates, Saskatoon, Saskatchewan

PROJECT	07-1328-0002		FILE No.	Fig 1 Regional Loc
DESIGN	KM	12/12/05	SCALE AS SHOWN	REV. 0
CADD	GNS	23/04/08		
CHECK	KG	30/05/08	**FIGURE: 2-1**	
REVIEW	HM	30/05/08		

G:\2007\1328\07-1328-0002 Giant Mines MME\Fig 2-1 Regional Location of the Giant Mine.dwg May 30, 2008 - 1:41pm



PROJECT

Indian and Northern Affairs Canada | Affaires indiennes et du Nord Canada

GIANT MINE
ENVIRONMENTAL EFFECTS
MONITORING PROGRAM

TITLE

GIANT MINE SITE OVERVIEW

Golder Associates
Saskatoon, Saskatchewan

PROJECT		07-1328-0002	FILE No.	Fig 2-2 Site Layout
DESIGN	KM	12/12/05	SCALE AS SHOWN	REV. 0
CADD	GNS	23/04/08		
CHECK	KG	30/05/08	FIGURE: 2-2	
REVIEW	HM	30/05/08		

G:\2007\1328\07-1328-0002 Giant Mines MME\Fig 2-2 Giant Mine Site Layout.dwg May 30, 2008 - 1:41pm

The Mine site is situated within the central valley containing Baker Creek and Trapper Creek. The ridges on either side of the creek are 10 metres (m) to 20 m high and the slopes are rock controlled. There is limited thickness of soil on the ridge slopes. Mining activity in the Baker Creek Valley has significantly altered the local topography and portions of the creek channel have been relocated at different times.

2.1.3 Climate

Mean climatic data available from 1971 to 2000 for Yellowknife, NWT are summarized below (Canadian Climate Normals; EC 2008):

- mean annual air temperature is -4.6 degrees Celsius (°C);
- mean annual snowfall is 151.8 millimetres (mm);
- mean annual rainfall is 164.5 mm;
- mean annual wind speed 14 kilometres per hour (km/hr); and
- mean annual wind direction is from the east.

Recent changes in climate have been observed in Yellowknife that are not yet summarized in the Climate Normals dataset from Environment Canada because it is only updated at the end of each decade. There has been a general rising trend in the average annual air temperature since temperatures were first recorded in Yellowknife.

2.1.4 Surface Hydrology

In general, surface runoff on the Mine site is controlled by outcropping bedrock on the southwest and southeast sides of the lease boundary (Figure 2-3). Trapper Creek and Baker Creek collect runoff and direct water flow eastward and southward through the property. Creation of the Northwest, South, Central, and North TCAs and the settling and polishing ponds have altered the direction of natural flow. The Northwest TCA has required the relocation of Trapper Creek. Dam 11 at the South TCA has redirected the natural flow from the pond area that was towards Yellowknife Bay to the north through the Central Pond into the North Pond and from there to the effluent treatment plant. The open pits have small individual catchment areas that direct surface water underground; this water is pumped back to the surface and treated at the ETP before being discharged into Baker Creek.

PROJECT

Indian and Northern Affairs Canada | Affaires indiennes et du Nord Canada

GIANT MINE ENVIRONMENTAL EFFECTS MONITORING PROGRAM

TITLE

AERIAL VIEW OF GIANT MINE, 1994

Golder Associates
Saskatoon, Saskatchewan

PROJECT	07–1328–0002		FILE No.	Fig 2–3 Aerial View
DESIGN	KM	12/12/05	SCALE AS SHOWN	REV. 0
CADD	GNS	23/04/08		
CHECK	KG	30/05/08	**FIGURE: 2-3**	
REVIEW	HM	30/05/08		

G:\2007\1328\07–1328–0002 Giant Mines MME\Fig 2–3 Aerial View of Giant Mine.dwg May 30, 2008 – 1:41pm

During summer 2006, 600 m of Baker Creek known as ‘Reach 4’ were realigned to the west side of Ingraham Trail. The primary objectives of the Reach 4 realignment were to isolate the contaminated Mill Pond from Baker Creek. Numerous spills reported to this area during the operating life of the Mine resulted in significant contamination in this area. Realignment of Baker Creek eliminated a source of ongoing contamination as well as prevented seepage loss from Baker Creek into areas of the mine itself (the C1 Pit). Secondary objectives of the realignment were to provide a stable flood conveyance channel, maintain or improve fish passage, and provide spawning and rearing habitat for native fish species. These watershed modifications were constructed for INAC as part of the Giant Mine Remediation Plan (GMRP) (INAC 2007) and a Fisheries Act Habitat Authorization for instream activities.

2.1.5 Subsurface Hydrogeology

A hydrogeological evaluation of the Mine site was completed by Fracflow Consultants Inc. and Dr. John Gibson (Fracflow and Gibson 1998). The inflow to the underground workings generally originates from shallow sources entering seeps along fractures of the mine walls. The greatest inflows are related to precipitation events and spring melt. Seepage into the Mine at deeper elevations is less than seepage at shallow elevations, and is typically associated with the main faults that intersect the Mine. The quality of the inflowing minewater is influenced by mining activities and, in particular, by seepage from the Northwest TCA into the north portion of the Mine. In the area around the C-shaft (Figure 2-2), the stored arsenic trioxide dust influences the underground water quality.

2.2 Operations

2.2.1 Activities at Giant Mine in 2006

The original Mine claims were staked in July of 1935 and exploration in the Baker Creek Valley marked the discovery of the Giant ore deposit in 1943. Giant Mine has changed ownership numerous times over its 56 year history (Golder 2001). In 1999, Royal Oak Resources Ltd., was placed in receivership and abandoned the Mine. In December 1999, Miramar Giant Mine Ltd. (MGML) signed a Reclamation Security Arrangement with INAC and received indemnification from INAC for the pre-existing environmental liabilities. From 1999 to July 2004, ore mined at Giant Mine was trucked to nearby Miramar Con Mine Ltd. in Yellowknife, NWT for processing. In July 2004, operations ceased at Giant Mine.

As per the Reclamation Security Agreement between INAC and MGML, and after providing the required six month notification, the agreement between MGML and INAC was terminated effective June 30, 2005. The company known as MGML was assigned into bankruptcy by the NWT court on July 15, 2005. Deton'Cho/Nuna Joint Venture (DCNJV) now provides care and maintenance for the Mine under a contract administered by Public Works and Government Services Canada (PWGSC) on behalf of INAC's Giant Mine Remediation Project.

DCNJV seasonally operates the ETP to treat contaminated mine water that is stored in the northwest and north ponds. The mine water is pumped form the mine to maintain the water level at an elevation well below the arsenic storage chambers to prevent them from flooding and potentially releasing arsenic into the environment. This practice will continue until a long term management method for the stored arsenic trioxide is implemented. The GMRP (INAC 2007) was submitted by INAC as part of a water licence application to the Mackenzie Valley Land and Water Board (MVLWB) on October 19, 2007. This project will undergo an environmental assessment (anticipated to commence in fall 2008). Once regulatory permitting is complete, it is anticipated that full implementation of the GMRP will take up to eight to nine years and perpetual water treatment is an anticipated requirement.

For 2006, as in 2005, effluent was treated and discharged from July to September into Baker Creek. However, the final GMRP proposes the construction of a new water treatment plant. Effluent will be treated and discharged year-round through a diffuser pipe located at the north end of Yellowknife Bay in Great Slave Lake. For the purposes of the Phase 2 EEM program, it was assumed that the GMRP would not be implemented for at least five years. During this period, minewater would continue to be treated and discharged annually into Baker Creek during the open water season. The contract with DCNJV stipulates that they will operate the ETP and meet the discharge criteria stipulated under MGML's former Water License (N1L2-0043). Accordingly, discharge from the Mine is expected to remain relatively constant in quality for the next few years. In 2007 minor changes in quality were observed (INAC 2008), but this is expected to return to normal in 2008.

2.2.2 Historical Operations

2.2.2.1 Mine Methods

The Giant Mine ore body has a strike length of over 4,500 m. In the past, both underground and open pit mining methods were used at Giant Mine. However, open pit operations ceased in 1990, when the near-surface mineable reserves were exhausted. The Mine continued to operate as an underground mine, at an approximate production rate of 1000 tonnes per day (t/d) until 1999. From 1999 to 2004, the underground mine operated at a rate of 300 t/d.

2.2.2.2 Waste Rock

Waste rock generated during open pit operations and development of underground access drifts or raises has been used at the mine for construction of tailing retention structures, access roads and ramps, lay-down areas, berms, and as mine backfill. There is very little waste rock currently stockpiled on the Mine site. Recent testing indicates that waste rock has a low potential for the generation of acid rock drainage, as the rock is generally acid consuming. Further leach testing demonstrated that the waste rock has a limited ability to act as a source of arsenic to receiving waters.

2.2.2.3 Milling and Processing

As discussed in Sub-section 2.2.1, MGML mined ore from the Giant property and milled ore at the Miramar Con Mine Ltd. property between 1999 and 2004. However, ore was milled on site from the 1940s to the late 1990s. Understanding the historical milling process is relevant to the current Mine site water quality and resulting environmental effects because the by-products of milling were a large source of contamination to air, water and sediment in the local environment.

There are three main ways in which contaminants from the mill entered the environment:

- air-borne emissions from the roaster stack;
- direct disposal of tailings into Yellowknife Bay; and
- discharge of treated effluent from milled tailings and minewater in the TCAs into Baker Creek.

2.2.2.4 Tailings Containment

Mine tailings have been continuously deposited at the Mine site from the time production began in 1948 until 1999. Historical aerial photographs indicate that tailings were initially deposited east of the mill in a small drainage channel that leads to Back Bay of Great Slave Lake. During a period of 34 months, between 1948 and 1951, approximately 375,000 tonnes of tailings were deposited directly into Back Bay (EBA 2001). Between 1951 and 1968, tailings from the mill were re-directed through a new pipeline and deposited into a small lake (Bow Lake) northeast of the Mine (Golder 2001). The liquid portion of the tailings drained into Baker Creek, which discharges into Yellowknife Bay (Golder 2001).

From 1968 to 1987, the bulk of the mill tailings were deposited northeast of the mill, in an area that is known as the original tailings area. This area includes the South, Central, and North TCAs (also known as South Pond, Central Pond and North Pond; Figures 2-2 and 2-3). The natural topography directed surface runoff and mine tailings towards Baker Creek. The bulk of tailings were deposited in the Northwest TCA (or Northwest

Pond) after 1987. No tailings have been produced at the Mine since ore processing operations ceased in 1999.

Water from the South TCA (or South Pond) seeps from the toe of Dam 11 and was collected at Dam 7 (Figure 2-2). This water was pumped back into the South TCA on a continuous basis. The current volume of seepage from the South TCA is low; however, the Central and South TCAs are essentially dry as the Northwest TCA is currently used to manage the majority of the minewater. The TCA is drained each summer and the stored minewater is treated before being discharged into Baker Creek. The Northwest TCA is used to store minewater that is pumped from the mine prior to treatment in the ETP during the summer months. An intermittent seep occurs at Dam 22B, which was pumped back into the Northwest TCA on a daily basis. Approximately 1,000,000 cubic metres (m^3) of water storage is available in the Northwest TCA and the capacity of the North TCA is sufficient for managing surface runoff around the South, Central and North TCAs.

2.2.2.5 Contaminated Soils

There are two main types of contaminated soils on the Mine site, hydrocarbon contaminated soils and arsenic contaminated soils (INAC 2007). While most of the runoff is captured in sumps and routed to the ETP for treatment, these soils constitute a potential contamination source.

The most prevalent potential soil contaminant on the Mine site is arsenic, both from naturally occurring exposed bedrock and from historical mining activities. Most of the other hydrocarbon contaminated soils are associated with the arsenic, either because of common origin (*i.e.*, metal leached from rock) or because of association with common mine facilities (*i.e.*, fuel oils being used near the ore processing facilities).

Elevated arsenic concentrations in soils are defined as being above the background level of 100 to 150 milligram per kilogram (mg/kg), as suggested by the Royal Military College (RMC 2000) and the GNWT Guideline for Contaminated Sites industrial site remediation objective of 340 mg/kg (GNWT 2003). The total volume of arsenic contaminated soils at Giant Mine was estimated to be 235,000 m^3 (Golder 2001). Elevated arsenic concentrations are generally related to one of three sources:

- accidental tailing spills around the site;
- direct discharge of tailing without containment; and
- emissions from the stack.

Water soluble arsenic is the most relevant type of arsenic in respect to potential effects on the aquatic receiving environment. The proportion of water soluble arsenic range from 0.4 percent (%) to 58%, with the highest proportions of soluble arsenic occurring in the mill and roaster areas (INAC 2007). While most of the runoff is captured in sumps and routed to the ETP for treatment, these areas constitute a potential source of arsenic that may be mobilized into the aquatic environment through infiltration and shallow groundwater flow as well as through surface water runoff.

2.2.3 Effluent Treatment Plant

In 1981, an ETP was installed using alkaline chlorination to reduce cyanide levels in effluent from the TCAs. This treatment process was replaced in 1988 by hydrogen peroxide oxidation process for cyanide destruction. Cyanide destruction took place in the first tank, where lime was added to maintain a pH of 9.5. Ferric sulphate was added to the third tank for arsenic precipitation at a 4:1 iron to arsenic molar ratio. Lime was added to maintain a pH of 8.5. In 2001, the process for cyanide destruction ceased. The ETP was used for metal precipitation (in particular arsenic precipitation). Hydrogen peroxide was still used to oxidate arsenate species (As^{3+}) to arsenite species (As^{5+}); however, there was less than 1% As^{3+}, which eliminated the need for oxidation of As^{3+}. After treatment, effluent is released to a settling pond, then flows to a polishing pond, and finally is discharged to Baker Creek through a pipeline (Figure 2-2).

2.2.4 Treated Effluent Quality and Characterization

As part of the water license (N1L2-0043) that was active until July 2005, the effluent discharged from the Mine is monitored under the Surveillance Network Program (SNP) as outlined in Table 2-1. While the water license is no longer active, the care and maintenance contractor is contractually required to meet the former water license discharge criteria (Table 2-2). In addition to the former water license requirements, the effluent must also be monitored for deleterious substances and meet the discharge limits required in the MMER (Table 2-2) (Government of Canada 2002, 2006).

Detailed results for the 2006 treated effluent characterization from the Mine were presented in the 2006 Annual MMER/EEM Report (DCNJV 2007). A summary of the 2006 information, as well as historical data from 1997 to 2005, is provided in Table 2-3. Acute toxicity testing was completed on the 2006 treated effluent and is discussed in Section 6 of this report.

Table 2-1
Water License Sampling Requirements for Effluent Characterization at Giant Mine SNP 43-1

MVLWB Surveillance Network Program Station Descriptions	Frequency of Sampling[a]
SNP 43-1: still wells located above the point of discharge of final treated effluent (*i.e.*, downstream of the Polishing Pond before entering Baker Creek)	1) Twenty-four hour composite samples to be collected daily for pH and concentrations of deleterious substances. 2) Weekly sampling for aluminum, cadmium, iron, mercury, molybdenum, ammonia, nitrate, hardness and alkalinity. 3) Monthly sampling for acute toxicity (rainbow trout) and *Daphnia magna* tests. 4) Twice a year, at spring break-up and before freeze-up in the fall, samples shall be collected and provided to the Environmental Protection Branch of Environment Canada for the purpose of performing a static "pass/fail" bioassay for both rainbow trout and *Daphnia* spp.

Notes: MVLWB = Mackenzie Valley Land and Water Board; SNP = surveillance network program; spp. = species.
a Samples are only collected when Giant Mine is discharging effluent, which is typically July to September.

Table 2-2
Effluent Characterization Requirements at Giant Mine SNP 43-1

Parameter	Units	Water License[a]		Metal Mining Effluent Regulations[b]	
		Maximum Average Concentration[c]	Maximum Concentration of Any Grab Sample	Maximum Authorized Monthly Mean Concentration	Maximum Authorized Concentration in a Grab Sample
pH	n/a	6.0 to 9.5	6.0 to 9.5	6.0 to 9.5	6.0 to 9.5
Total Ammonia	mg/L	12	n/a	n/a	n/a
Total Arsenic	mg/L	0.5	1	0.5	1
Total Copper	mg/L	0.3	0.6	0.3	0.6
Total Cyanide	mg/L	0.8	1.6	1	2
Total Lead	mg/L	0.2	0.4	0.2	0.4
Total Nickel	mg/L	0.5	1	0.5	1
Total Zinc	mg/L	0.2	0.4	0.5	1
Total Suspended Solids	mg/L	15	30	15	30
Oil and Grease	mg/L	n/a	5	n/a	n/a
Radium-226	Bq/L	n/a	n/a	0.37	1.11

Notes: mg/L = milligrams per litre; Bq/L = Becquerels per litre; n/a = not applicable.
a Discharge criteria outlined in the now expired Giant Mine Water License (N1L2-0043).
b Discharge limits outlined in the Metal Mining Effluent Regulations (MMER 2002, 2006).
c Maximum rolling average of four consecutive results.

Table 2-3
Effluent Characterization Results at Giant Mine SNP 43-1, 1997 to 2006

Parameter	Units	2006				1997 to 2005			
		n	Mean[(a)]	Min	Max	n	Mean[(a)]	Min	Max
pH	n/a	45	8.1	7.5	8.4	542	7.9	7.0	9.3
Specific Conductivity	µS/cm	5	2,250	2,170	2,330	14	2,679	1,490	3,380
Total Suspended Solids	mg/L	47	1.6	<1.0	3.6	580	2.196	0.001	85.000
Ammonia (as nitrogen)	mg/L	18	0.02	<0.02	0.06	228	6.71	0.01	15.60
Total Cyanide	mg/L	44	0.004	<0.005	0.014	557	0.092	<0.002	0.680
Arsenic	mg/L	47	0.283	0.027	0.434	755	0.343	0.003	0.980
Copper	mg/L	47	0.015	<0.010	0.167	616	0.039	<0.001	0.340
Lead	mg/L	20	0.0059	<0.00025	0.0150	192	0.0142	<0.00025	0.1900
Nickel	mg/L	47	0.048	0.040	0.060	697	0.142	0.004	0.480
Zinc	mg/L	20	0.008	<0.008	0.014	196	0.015	<0.005	0.100
Oil and Grease	mg/L	10	0.64	<1.0	1.90	31	1.12	<0.02	2.50
Radium-226	Bq/L	13	0.006	<0.005	0.010	51	0.010	<0.005	0.190

Notes: µS/cm = microSiemens per centimetre; n = sample size; min = minimum, max = maximum; < = less than the analytical detection limit.
a = Mean concentrations were calculated using concentrations of half the detection limit where values were below the analytical detection limits.
Sources: Miramar (1997 to 2006 SNP data), reported monthly to the Mackenzie Valley Land and Water Board.
Miramar (2003 to 2005), MMER Water Quality data reported annually to Environment Canada.
Golder Associates Ltd. (2001), Final Abandonment and Restoration Plan.

In 2006, all parameters characterized in the treated effluent were below applicable water license and MMER limits. The 2006 treated effluent from the Mine was slightly alkaline with moderately high specific conductivity (Table 2-3) relative to the reference area (see Table 3-2). This was comparable to historical (1997 to 2005) treated effluent pH and specific conductivity.

Concentrations of ammonia and cyanide as well as oil and grease varied during 2006, but were lower (particularly ammonia) compared to historical (1997 to 2005) concentrations (Table 2-3). Minimum and maximum concentrations of most metals ranged by an order of magnitude; however, mean concentrations in 2006 were lower than historical (1997 to 2005) concentrations (Table 2-3). In addition, there was between a two- to eight-fold decrease in maximum metal concentrations measured in 2006 compared to the maximum concentrations measured between 1997 and 2005. Mean radium-226 concentrations were similar between years, although the range in concentrations was less variable in 2006 compared to historical (1997 to 2005) concentrations (Table 2-3). Further discussion of effluent quality relative to the receiving environment is provided in Section 3 below.

2.2.5 Treated Effluent Volume

The volume and scheduling of effluent discharge varies between years depending on operational requirements and weather conditions. The Mine typically discharges effluent during the open water season between July and September. In some years, additional effluent may have been discharged in early spring (*e.g.*, May 1998) or late fall (*e.g.*, November 1997, November 1998). In 2005, Fisheries and Oceans Canada (DFO) requested that spring discharge of the Mine effluent be delayed until the second week of June to allow spawning fish to move in and out of Baker Creek during spring freshet. In 2006, discharge of effluent commenced on July 5 and ceased on August 31.

On average, approximately 3,975 to 13,859 m^3 of effluent were discharged each day from the ETP between 2000 and 2006 (Table 2-4). Annual discharge volumes ranged from 254,675 to 1,827,855 m^3 between 1997 and 2006. Both average daily and annual discharge volumes were lowest in 2006 compared with other years.

Table 2-4
Effluent Discharge Volumes for Giant Mine SNP 43-1, 2000 to 2006

Year	Average Daily Discharge Volume (m^3/day)	Minimum Daily Discharge Volume (m^3/day)	Maximum Daily Discharge Volume (m^3/day)	Annual Discharge Volume (m^3)	Number of Discharge Days per Year
2000	8,341	2,618	15,450	842,428	101
2001	20,202	262	15,711	1,079,566	105
2002	14,215	4,576	16,038	554,368	39
2003	6,988	339	11,061	545,108	78
2004	7,024	3,445	13,989	337,132	48
2005	6,132	2,313	17,063	374,079	61
2006	5,305	3	8,000	254,675	48

Note: m^3 = cubic metres; m^3/day = cubic metres per day

2.3 Effluent Plume Modelling

Treated effluent from the Mine enters Baker Creek through a pipe into a ponded section of Baker Creek known as Baker Pond (also referred to as Baker Creek Exposure Point). Treated effluent flows downstream in Baker Creek and into an isolated marsh area located behind a breakwater in Yellowknife Bay. The marsh area primarily receives inflow from Baker Creek although there is a second small stream flowing to the marsh from a lake south of the property.

The manner in which the treated Mine effluent mixes in the receiving environment was modelled in 2003:

- the dilution of the treated effluent through Baker Creek was calculated using water conductivity as a conservative tracer; and
- dilution behaviour of the discharge in Yellowknife Bay beyond the breakwater was simulated using a United States Environmental Protection Agency mixing model, the Cornell Mixing Model (CORMIX).

Plume modelling in Yellowknife Bay was performed assuming different treated effluent dilution scenarios at the outlet of the marsh near the breakwater where the treated effluent meets open water. Under the best-case dilution scenario, the treated effluent concentration is estimated to reach 1% within 122 m of the mouth of Baker Creek. Under the worst-case dilution scenario, the treated effluent concentration is estimated to reach 1% at 785 m into the open water area of Yellowknife Bay. The average dilution scenario estimates the treated effluent concentration to reach 1% at 187 m into the open water in Yellowknife Bay.

The 2003 treated effluent plume model was considered valid for the 2006 study because the discharge concentrations fell within the range of concentrations assessed in 2003. The 2004 and 2005 specific conductivity values of the treated effluent at the Baker Creek Exposure Point were lower than those measured in 2003, but fell within the predicted values outlined in the 2003 model. As expected, the 2006 specific conductivity at the Baker Creek Exposure Point was the same or lower than 2005. Given this information, the 'average' scenario used in the 2003 effluent plume model was used to define the concentration of treated effluent in the exposure area for the FS and ICS (Golder 2006).

In 2006, as in the past, treated effluent discharge was intermittent, which is problematic for tracing the effluent plume. There is a lag between when treated effluent discharge begins and when treated effluent can be detected in the lower reaches of the exposure area (Table 2-5). Concentrations of treated effluent at the mouth of Baker Creek are lowest in the spring (estimated at 4% in 2005 and 10% in 2006) and highest in the fall (estimated at 98% in 2005 and 66% in 2006). This is not unexpected as the concentration of treated effluent increases as natural water levels in Baker Creek decrease, resulting in a lower dilution ratio. However, water level changes likely affect the distance at which the treated effluent reaches 1% concentration based on the time of year. This results in uncertainty about the duration of treated effluent exposure in the FS and ICS study areas.

Table 2-5
Specific Conductivity Concentrations of Treated Effluent and the Receiving Environment for Giant Mine 2005 and 2006

Date	Specific Conductivity at Point of Discharge (SNP 43-1) (µS/cm)	Specific Conductivity at Baker Creek Exposure Point (µS/cm)	Estimated Concentration of Effluent at Baker Creek Exposure Point (%)
14-Jul-05	2,970	129	4
17-Aug-05	3,060	1,710	56
14-Sep-05	2,850	2,780	98
10-Jul-06	2,330	230	10
09-Aug-06	2,170	839	39
29-Aug-06[(a)]	2,250	1,517	67

Note: µS/cm = microSiemens per centimetre; % = percent; Jul = July; Aug = August; Sep = September.
a No sample collected in September as effluent discharge ceased on August 31, 2006.

3.0 BACKGROUND INFORMATION ON THE STUDY AREAS AND STUDY DESIGN

There were two study areas for the Phase 2 EEM biological program (Figure 3-1):

- Baker Creek – exposure area for FS and ICS; and
- Yellowknife River – reference area for FS and ICS.

An additional reference area for the MMER water quality is located in Baker Creek, upstream of the effluent discharge. Detailed background information on Baker Creek and the Yellowknife River was provided in the Phase 2 EEM Study Design (Golder 2006). A summary of this information is provided below, along with additional information from 2006 for the following:

- rationale for choice of the study location;
- location of the study area and access;
- hydrology;
- water quality;
- sediment quality;
- aquatic resources (fish and fish habitat, invertebrate community); and
- anthropogenic influences in the area.

3.1 Baker Creek – Exposure Area

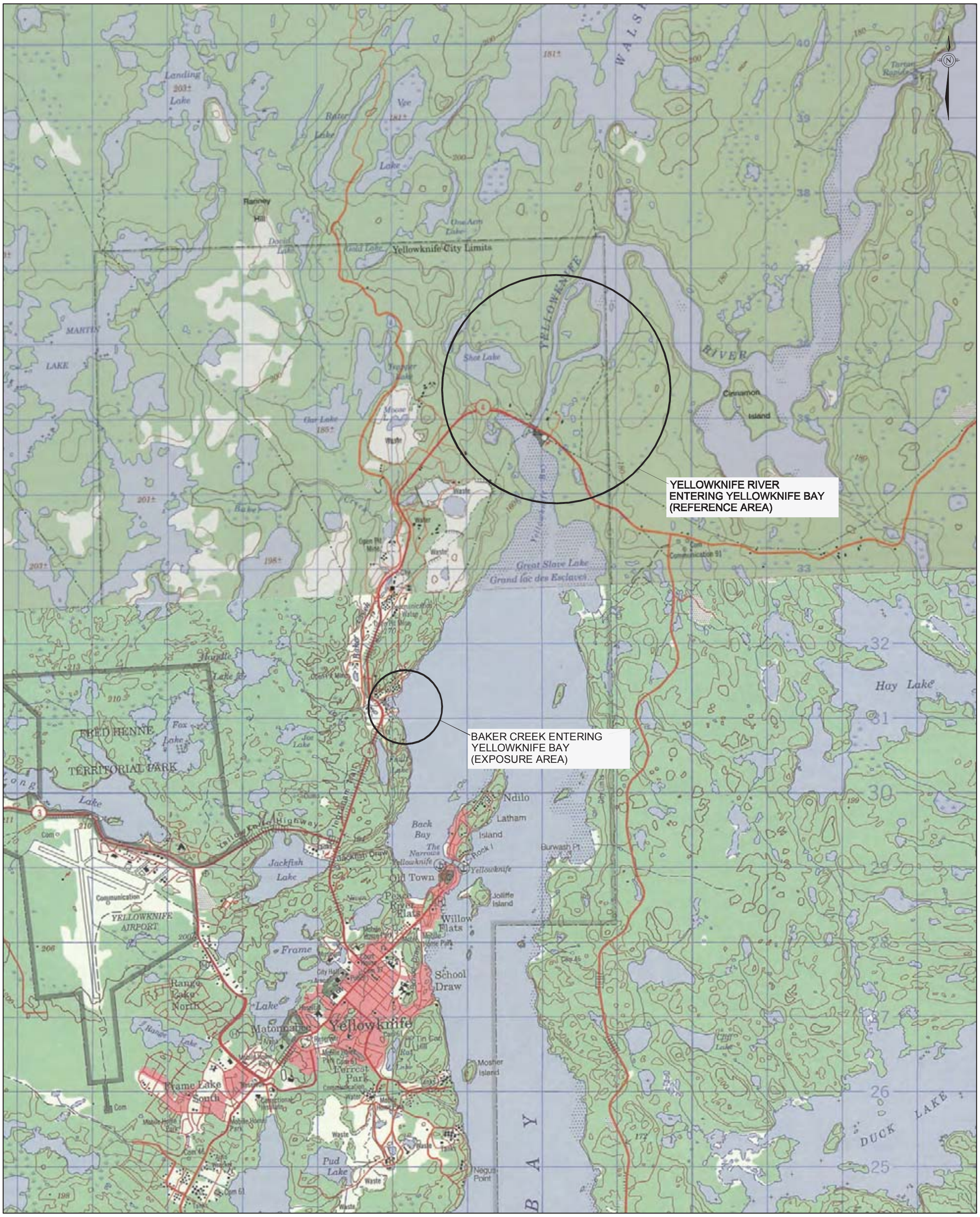
3.1.1 Rationale for Study Location

The MMER defines an exposure area as "…all fish habitat and waters frequented by fish that are exposed to mine effluent." (EC 2002). For the Mine, the exposure area was defined as the area between the final point of treated effluent discharge into Baker Creek up to the point in Yellowknife Bay where the treated effluent concentration reaches approximately 1%. This included the lower reach of Baker Creek (approximately 3 km) and up to 187 m of Yellowknife Bay in Great Slave Lake (Photograph 1). This area was utilized as the exposure area for both the FS (see Section 4) and ICS (see Section 5).

3.1.2 Location and Access

Access to the exposure area in Baker Creek is by the Ingraham Trial highway and from the Mine property (see Figure 2-3 and Figure 3-1). Most reaches of the creek are accessible by vehicle or by foot. Baker Creek is not a navigable waterway with the exception of a few small ponded areas.

G:\2007\1328\07-1328-0002 Giant Mines MME\ Drawing file: Fig 3-1 Exposure-Reference Sampling Areas.dwg May 30, 2008 - 1:42pm



LEGEND

DENOTES APPROXIMATE LOCATION OF SAMPLING AREAS

SCALE 1 0 1 KILOMETRES

REFERENCE

TOPOGRAPHIC MAPS SCANNED BY MAPTOWN. © 1999 HER MAJESTY THE QUEEN IN RIGHT OF CANADA. DEPARTMENT OF ENERGY, MINES AND RESOURCES. 85 J/08 AND 85 J/09 © 2002 NAD 83 TRANSVERSE MERCATOR PROJECTION

PROJECT

Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada

GIANT MINE
ENVIRONMENTAL EFFECTS
MONITORING PROGRAM

TITLE

EXPOSURE AND REFERENCE AREAS

Golder Associates
Saskatoon, Saskatchewan

PROJECT	07-1328-0002		FILE No.	Exposure-Ref Areas
DESIGN	KM	12/12/05	SCALE AS SHOWN	REV. 0
CADD	GNS	23/04/08	FIGURE: 3-1	
CHECK	KG	30/05/08		
REVIEW	HM	30/05/08		

3.1.3 Hydrology

Baker Creek originates at Duckfish Lake, located approximately 25 km northwest of the Mine (Wight 1973). Baker Creek flows south and southeast from Duckfish Lake, through a series of wetland ponds and bedrock outcrops and into a marsh that is separated by a breakwater from Yellowknife Bay. The drainage area of Baker Creek is estimated at 121 km^2 (EC 2008).

Peak discharge occurs during spring freshet, which is typically in May. Between 1983 and 2006, peak discharge volumes ranged from 0.08 m^3/s to 3.93 cubic metres per second (m^3/s) (EC 2008). In 2006, the peak discharge was 3.17 m^3/s, which was higher than the peak discharge in either 2004 or 2005 (EC 2008). Baker Creek flow volumes are variable and the upper reach of the stream can be ephemeral. In contrast, lower Baker Creek (downstream of the Mine discharge) flows continually due to the inputs of effluent (Water Survey of Canada 2003a).

3.1.4 Water Quality

The previous water licence (N1L2-0043) stipulates that the Mine is required to monitor a restricted set of parameters in the receiving environment during the period of effluent discharge (Table 3-1). Water quality in the receiving environment is also sampled as part of the MMER water quality program. Baker Pond, located immediately downstream of the ETP is the exposure area for the MMER water quality characterization program. The corresponding reference area for the MMER water quality program is Upper Baker Creek, which corresponds to SNP 43-11.

This current report is limited to the relevant SNP monitoring data collected during the period of discharge in 2006 (Table 3-2). Historical water quality data are available in the following reports:

- Golder 2001, 2003, 2005 and 2006;
- Jackson *et al*, 1996;
- Jackson 1998;
- Dillon 1998, 2002a and 2002 b; and
- Moore *et al*. 1978.

SNP monitoring data were compared to applicable Canadian Water Quality Guidelines (CWQG) for the protection of aquatic life. The CWQG are conservative concentrations or values that are meant to protect all forms of aquatic life, including the most sensitive species and life stages (CCME 1999, 2007).

Table 3-1
Relevant Giant Mine Surveillance Network Program Water License Stations

Station Number	Description	Frequency of Sampling[a]
SNP 43-11	Baker Creek Upstream of effluent deposition	1) Monthly sampling for pH, total dissolved solids, ammonia, cyanide, arsenic, copper, lead, nickel, zinc, fecal coliforms, and oil and grease. 2) Twice a year, at Spring break-up and before freeze-up in the Fall, samples shall be collected and provided to the Environmental Protection Branch of Environment Canada for the purpose of performing a static "pass/fail" bioassay for both rainbow trout and *Daphnia* spp.
SNP 43-5	Baker Creek at utilidor crossing, prior to discharge into Yellowknife Bay (*i.e.*, mouth of Baker Creek inside the breakwater)	1) Weekly sampling for ammonia, temperature and pH. 2) Twice a month sampling for arsenic, copper, cyanide, lead, nickel, total suspended solids and zinc. 3) Toxicity testing at start and end of effluent discharge.
SNP 43-12	Mouth of Baker Creek, near the causeway prior to entering Yellowknife Bay open water area (*i.e.*, end of the breakwater at the outlet of Baker Creek to Back Bay)	1) Weekly sampling for ammonia, temperature and pH. 2) Monthly sampling for pH, total dissolved solids, ammonia, cyanide, arsenic, copper, lead, nickel, zinc, fecal coliforms, and oil and grease.
Baker Creek Exposure Area	Downstream of SNP 43-1 (effluent discharge) in Baker Pond	1) Monthly sampling for pH, total dissolved solids, ammonia, cyanide, arsenic, copper, lead, nickel, zinc, fecal coliforms, and oil and grease.

a Samples are only collected when Giant Mine is discharging effluent, which is typically July to September.

Table 3-2
Water Quality in Baker Creek, 2006

			Exposure Area											Reference Area					
			Baker Creek Exposure Point			SNP 43-5								Upper Baker Creek (SNP 43-11)					
			62º 30' 23" N 114º 21' 39" W			62º 29' 14.5" N- 114º 21' 45.9 W								62º 30' 41" N 114º 21' 48" W					
Parameter	**Units**	**CWQG[a]**	**5-Jul-06**	**9-Aug-06**	**29-Aug-06**	**10-Jul-06**	**18-Jul-06**	**25-Jul-06**	**1-Aug-06**	**8-Aug-06**	**15-Aug-06**	**22-Aug-06**	**29-Aug-06**	**5-Jul-06**	**1-Aug-06**	**4-Aug-06**	**9-Aug-06**	**15-Aug-06**	**29-Aug-06**
Physical/Chemical																			
Temperature	°C	n/a	21.3	22.0	13.3	17.9	20.5	18.3	18.0	19.7	18.0	18.8	13.2	20.3	17.1	NC	21.1	18.0	12.8
Dissolved oxygen	mg/L	5.5 to 9.5	9.0	8.7	9.9	-	-	-	-	-	-	-	-	9.1	-	-	9.1	-	10.9
Specific conductivity	µS/cm	n/a	235	902	1,517	-	-	-	-	-	-	-	-	92	-	-	107.0	-	115.0
Hardness	mg/L	n/a	94.9	356	703	-	-	-	-	-	-	-	-	44.4	-	-	51.3	-	53.6
pH		6.5 to 9.5	7.9	8.0	7.8	7.4	8.2	8.2	8.0	8.7	8.4	7.8	8.2	7.9	8.4	7.5	8.0	8.4	7.9
Total suspended solids	mg/L	(b)	3.5	2.5	3.7	-	-	-	1.7	-	-	1.0	-	2.5	<1.0	<1.0	1.5	<1.0	1.8
Turbidity	NTU		2.3	1.2	2.8	-	-	-	-	-	-	-	-	1.9	-	-	0.7	-	2.2
Total alkalinity	mg/L	n/a	42	60	67	-	-	-	-	-	-	-	-	37	-	-	44	-	48
Nutrients																			
Ammonia (as nitrogen)	mg/L	0.10 to 2.61[c]	0.02	<0.02	<0.02	0.03	0.03	0.04	0.02	0.02	<0.02	0.02	0.03	<0.02	-	<0.02	<0.02	-	<0.02
Nitrate (as nitrogen)	mg/L	2.90	0.26	0.94	2.39	-	-	-	-	-	-	-	-	0.02	-	-	0.01	-	0.01
Cyanide																			
Total cyanide	mg/L	n/a	0.008	-	<0.005	-	-	-	0.007	-	0.008	0.006	-	0.007	0.007	<0.005	-	0.010	0.008
Total Metals																			
Aluminum	mg/L	0.1	0.033	0.029	0.085	-	-	-	-	-	-	-	-	0.025	-	-	0.026	-	0.086
Arsenic	mg/L	0.005	**0.12**	**0.18**	**0.18**	-	-	-	**0.15**	-	**0.21**	**0.19**	-	**0.04**	**0.04**	<0.0002	**0.04**	**0.04**	**0.04**
Cadmium	mg/L	(d)	*<0.001*	*<0.001*	*<0.001*	-	-	-	-	-	-	-	-	*<0.001*	-	-	*<0.001*	-	*<0.001*
Copper	mg/L	0.002 and 0.004[e]	*<0.010*	*<0.010*	*<0.010*	-	-	-	*<0.010*	-	*<0.010*	*<0.010*	-	*<0.010*	*<0.010*	*<0.010*	*<0.010*	*<0.010*	*<0.010*
Iron	mg/L	0.30	0.20	0.10	0.19	-	-	-	-	-	-	-	-	0.17	-	-	0.13	-	0.26
Lead	mg/L	0.001, 0.002 and 0.007[f]	*<0.030*	*<0.030*	<0.005	-	-	-	0.0002	-	0.0002	<0.0005	-	*<0.030*	<0.00005	*<0.030*	*<0.030*	0.0001	*<0.005*
Mercury	µg/L	0.026	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	<0.05	-	-	<0.05	-	<0.05
Molybdenum	mg/L	0.073	<0.010	0.011	0.017	-	-	-	-	-	-	-	-	<0.010	-	-	<0.010	-	<0.010
Nickel	mg/L	0.025, 0.065 and 0.150[g]	<0.005	0.011	0.022	-	-	-	0.010	-	0.010	0.014	-	<0.005	<0.010	<0.005	<0.005	<0.010	<0.005
Zinc	mg/L	0.03	<0.004	0.004	0.007	-	-	-	<0.004	-	0.005	<0.004	-	<0.004	<0.004	<0.004	<0.004	0.004	<0.004
Radionuclides																			
Radium-226	Bq/L	n/a	<0.005	<0.010	<0.010	-	-	-	-	-	-	-	-	<0.005	-	<0.005	<0.005	-	<0.010

Notes: °C = degrees Celsius; mg/L = milligrams per litre; µS/cm = microSiemens per centimetre; µg/L = micrograms per litre; Bq/L = Becquerel per litre; NTU = nephelometric turbidity units; CWQG = Canadian Water Quality Guidelines; N = north; W = west; Jul = July; Aug = August; - = parameter not analyzed; < = less than; > = greater than; n/a = no applicable guideline.
Bolded values indicated exceedence of applicable CWQG.
Italicized values indicate method detection limit exceeded applicable CWQG.
a = Canadian Water Quality Guidelines for the protection of freshwater aquatic life (CCME 1999, 2007).
b = Total suspended solids can reach 26.5 mg/L for 24 hour period and 6.6 mg/L for 24 hours to 30 day period.
c = Ammonia guideline is dependent on water temperature and pH; ammonia guideline concentration decreases with higher water temperatures and more alkaline pH.
d = Cadmium guideline is dependent on water hardness (as calcium carbonate): Baker Creek Exposure = 0.000032 mg/L to 0.00018 mg/L; Upper Baker Creek = 0.000017 mg/L to 0.000019 mg/L.
e = Copper guideline is dependent on water hardness (as calcium carbonate): 0.002 at water hardness of 0 to 120 mg/L and 0.004 mg/L at water hardness >180 mg/L.
f = Lead guideline is dependent on water hardness (as calcium carbonate): 0.001 at water hardness of 0 to 60 mg/L, 0.002 mg/L at water hardness of 60 to 120 mg/L and 0.007 mg/L at water hardness >180 mg/L.
g = Nickel guideline is dependent on water hardness (as calcium carbonate): 0.025 at water hardness of 0 to 60 mg/L, 0.065 mg/L at water hardness of 60 to 120 mg/L and 0.150 mg/L at water hardness >180 mg/L.

In 2006, *in situ* water temperatures and dissolved oxygen concentrations were similar between the exposure and reference areas within Baker Creek, indicating the treated effluent had little effect on these parameters (Table 3-2). As expected, specific conductivity at the Baker Creek Exposure Point increased during the discharge period, which was reflective of accumulation of effluent within Baker Creek (Table 3-2). This is a result of reduced mixing behind the breakwater as well as a reduction in water levels over this period. Final specific conductivity at the Baker Creek Exposure Point reached a maximum of 1,517 microSiemens per centimetre (µS/cm) on August 29, 2006; however, this value was lower than the final specific conductivity measured in 2005 (2,780 µS/cm). The pH of all waters was within the neutral to slightly alkaline range and showed no variation between reference and exposure areas (Table 3-2).

Arsenic was the only metal to exceed the CWQG and was elevated in both the reference and exposure areas (Table 3-2). Method detection limits (MDLs) for cadmium and lead were variable during 2006 and exceeded the applicable CWQG, preventing comparison of the results (Table 3-2). All other metal concentrations were low and did not exceed applicable CWQG. In addition, metal concentrations exhibited consistent concentrations in both the reference and exposure areas (Table 3-2).

Total cyanide concentrations were similar between the reference and exposure areas (Table 3-2). Concentrations of total cyanide were slightly elevated at SNP 43-11, which is upstream of the point of discharge, but results were within analytical variability. The CWQG for cyanide is applicable to concentration of free cyanide and is, therefore, not directly comparable to these monitoring results.

Ammonia concentrations in 2006 were consistently low, with the majority of concentrations close to or below the method detection limit (MDL) of 0.2 milligrams per litre (mg/L) (Table 3-2). Concentrations of ammonia have decreased over time, reflecting an overall improvement in the quality of discharged effluent.

3.1.5 Sediment Quality

Historical sediment contamination around the Mine site is assumed to be related to past ore processing methods (see Sub-section 2.2.2). Metal concentrations in surficial sediments decreased with distance from the mouth of Baker Creek into Yellowknife Bay, and continued to decrease for more than 1 km along some sampling transects (Moore *et al*. 1978). A detailed comparison of more recent studies (*i.e.*, Dillon 2002a, b; Mace 1998; Jackson *et al*. 1996) was included in the *Phase 1 EEM Final Interpretative Report* (Golder 2005). This comparison indicated that metal concentrations continue to be elevated in sediments of Baker Creek and Yellowknife Bay.

Sediments collected from Baker Creek (exposure area) in 2004 had elevated concentrations of a number of metals (*e.g.*, aluminum, arsenic, chromium copper, iron, nickel and zinc) compared to the reference area in the Yellowknife River. Arsenic concentrations Baker Creek ranged from 59.3 to 1,660 micrograms/gram (µg/g), exceeding the Probable Effects Level (PEL) sediment guideline of 17 µg/g (CCME 1999, 2002). Nine of the ten sediment samples from Baker Creek exceeded the Government of the NWT (GNWT) remediation objective for publicly accessible lands (*e.g.*, boat launch) of 150 µg/g (GNWT 2003). While arsenic concentrations in the Yellowknife River (reference area) were lower, nine of the 11 sediment samples exceeded the Interim Sediment Quality Guideline (ISQG) of 5.9 µg/g (CCME 1999, 2002). Arsenic concentrations in only three of the 11 samples from the reference area exceeded the PEL, and all concentrations were below the GNWT reclamation criteria.

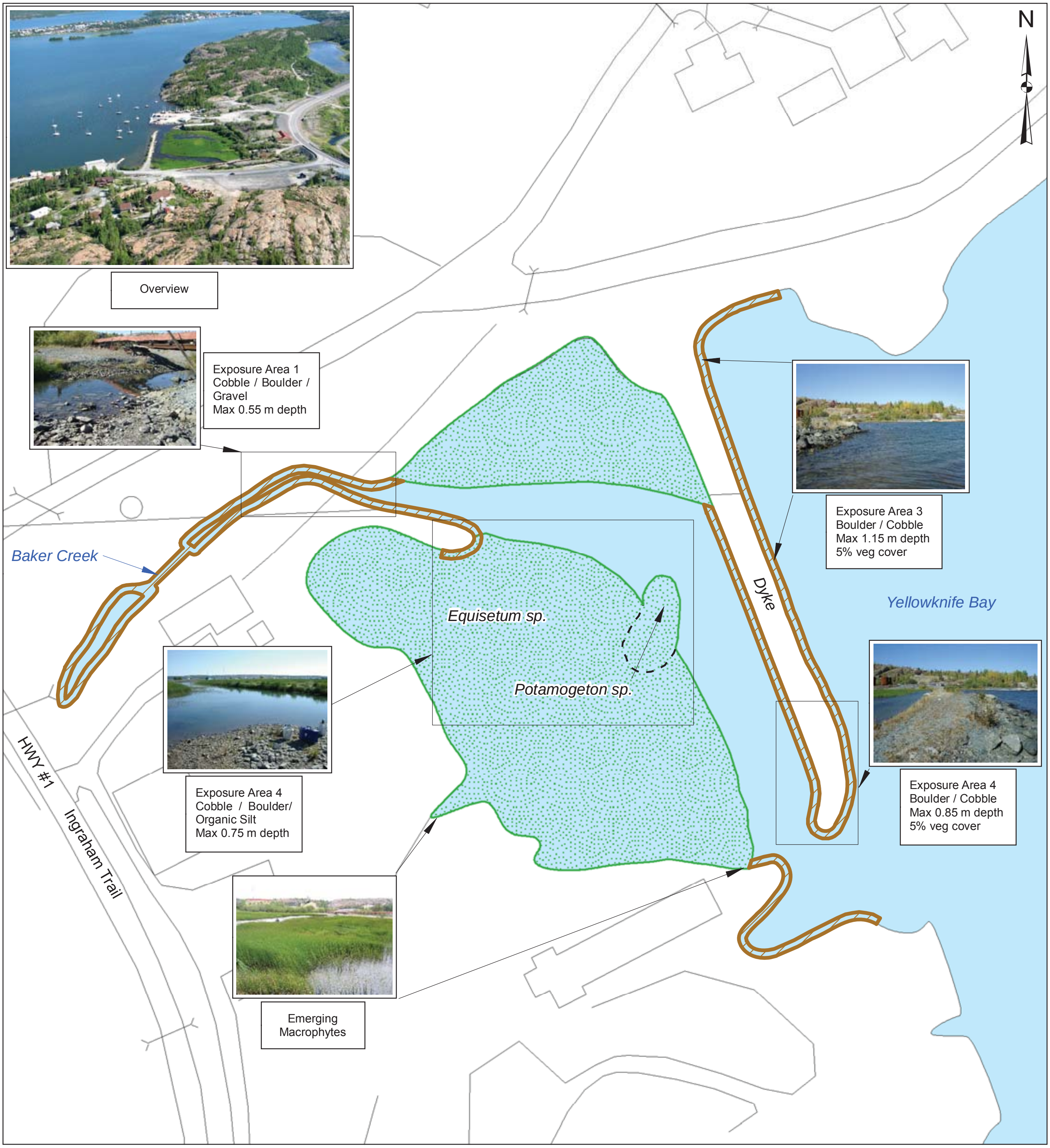
3.1.6 Aquatic Resources

Fish and Fish Habitat

Baker Creek primarily consists of lotic habitat with variable water depths and substrates along its reaches. Depths within the creek vary from a few centimetres (cm) to 2.3 m deep. At the mouth of Baker Creek, where it flows into Yellowknife Bay, a large marsh area is located on the west bank of the bay, which supports predominantly *Equisetum* sp. (horsetail) and a smaller patch of *Potamogeton* sp. (pondweed) (Figure 3-2). To the east of the marsh area, the water from Baker Creek flows along the breakwater and into the main body of Yellowknife Bay. The substrates in this area are dominated by fine material (*i.e.*, silt and sand) and are representative of a depositional area.

After draining from Duckfish Lake, Baker Creek forms the outlet of Martin Lake which is a popular local fishery. Past studies have documented a variety of fish species present in Baker Creek and in Yellowknife Bay (Table 3-3). However, it is unknown whether Baker Creek provides over-wintering habitat, because no formal winter studies have been conducted in this area.

A fish salvage in the mill pond along Baker Creek was conducted in winter 2006 when Baker Creek was being rerouted away from the mill area. A total of 93 fish were removed from the pond; six different species of fish of various ages and sizes were captured (unpublished data collected for INAC by Golder): northern pike (*Esox lucius*); burbot (*Lota lota*); lake whitefish (*Coregonus clupeaformis*); longnose sucker (*Catostomus catostomus*); ninespine stickleback (*Pungitius pungitius*); and lake cisco (*Coregonus artedi*). Lake cisco have not previously been captured in Baker Creek. It is not known if fish were migrants that could not outmigrate or if they are residents of the ponds along the creek.



25 0 25
SCALE 1:1,500 METRES

Legend
- Boulder/Cobble/Sand/Silt
- Emerging Macrophyte

REFERENCE
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 11

PROJECT
Indian and Northern Affairs Canada
GIANT MINE
ENVIRONMENTAL EFFECTS
MONITORING PROGRAM

TITLE
FISH HABITAT IN BAKER CREEK (EXPOSURE AREA), 2006

Golder Associates
Saskatoon, Saskatchewan

PROJECT No.		07-1328-0002
DESIGN	KM/SV	15/01/08
GIS	JRC	13/05/08
CHECK	KG	30/05/08
REVIEW	HM	30/05/08

SCALE AS SHOWN REV. 0

FIGURE: 3-2

Table 3-3
Fish Species Documented in Baker Creek and Yellowknife Bay

Scientific Name	Common Name	Documented Presence in Study Area
Stizostedion vitreum	Walleye	• anglers have observed walleye in the creek and traditional knowledge from the Yellowknives Dene indicated that walleye used to spawn in the creek (Yellowknives Dene First Nation 1997) • field staff of the GMRP team reported seeing walleye near the breakwater in August 2003 • walleye were not captured in late 2006 or spring 2007 sampling in the creek as part of the Baker Creek restoration project
Lota lota	Burbot	• captured in Upper Baker Creek and at the mouth during 2004 Phase 1 EEM program (Golder 2005)
Catostomus catostomus	Longnose sucker	• captured near mouth of creek and in middle of creek (Dillon 1998; DFO unpublished 1996)
Catostomus commersoni	White sucker	• captured near mouth of creek (Dillon 1998; DFO unpublished 1996)
Esox lucius	Northern pike	• captured in mouth and numerous reaches of the creek (Dillon 1998, DFO unpublished 1996) • captured in Baker Creek and Horseshoe Island Bay during 2004 Phase 1 EEM program (Golder 2005)
Coregonus clupeaformis	Lake whitefish	• captured at mouth (Jackson *et al*. 1996) • captured in Baker Creek and Horseshoe Island Bay during 2004 Phase 1 EEM program (Golder 2005)
Coregonus artedi	Lake cisco (Cisco)	• captured in Mill Pond (Golder unpublished data memorandum to INAC)
Thymallus arcticus	Arctic grayling	• captured at mouth (DFO unpublished 1996) • observed in creek by numerous anglers in spring
Couesius plumbeus	Lake chub	• captured at mouth (DFO unpublished 1996)
Cottus cognatus	Slimy sculpin	• captured at mouth (DFO unpublished 1996) • captured in upper reaches of creek (Moore *et al*. 1978) • captured in Baker Creek during 2004 Phase 1 EEM program (Golder 2005)
Pungitius pungitius	Ninespine stickleback	• captured at mouth (DFO unpublished 1996) • captured in upper reaches of creek (Moore *et al*. 1978) • captured in Baker Creek and Horseshoe Island Bay during 2004 Phase 1 EEM program (Golder 2005)
Notropis atherinoides	Emerald shiner	• captured at mouth (DFO unpublished 1996)
Notropis hudsonius	Spottail shiner	• captured at mouth (DFO unpublished 1996) • captured in Baker Creek and Horseshoe Island Bay during 2004 Phase 1 EEM program (Golder 2005a)
Percopsis omiscomaycus	Trout perch	• captured in creek at unknown location (DFO unpublished data 1994, reported in Dillon 1998) • captured in Baker Creek and Horseshoe Island Bay during 2004 Phase 1 EEM program (Golder 2005a)
Perca flavescens	Yellow Perch	• captured at Horseshoe Island Bay during 2004 Phase 1 EEM program (Golder 2005a)

Benthic Invertebrate Community

Prior to the implementation of effluent treatment in the 1980s, benthic invertebrates were virtually absent from Baker Creek due to high contaminant concentrations (Moore *et al*. 1978, Falk *et al*. 1973). Falk *et al*. (1973) documented the absence of invertebrates at four sampling stations within Baker Creek. Moore *et al*. (1978) documented that Baker Creek was largely devoid of fauna downstream of the Mine, although oligochaetes were present in very low numbers (<100 individuals per square metre [ind/m^2]).

Dillon (2002b) documented benthic invertebrate recolonization within Baker Creek. In July 2002, dipteran larvae (*e.g.*, Simuliidae and Chironomidae), Ephemeroptera, Plecoptera, and Trichoptera nymphs and larvae were observed in Baker Creek at locations upstream of the Mine; however, dipteran larvae were the most abundant taxa. Ephemeroptera, Plecoptera, and Trichoptera were absent from locations downstream of the Mine (*i.e.*, areas exposed to effluent) but oligochaetes, ostracods, and dipteran larvae were present. Invertebrate tissue collected at Baker Creek sites downstream of the Mine contained arsenic concentrations that were approximately three times higher than tissues collected at upstream sites (Dillon 2002b).

In 2004, artificial substrates were used to assess the effects of present-day effluent discharge on the invertebrate community (Golder 2005). In general, the invertebrate community colonizing artificial substrates was characterized by low density and richness, but moderate to high diversity and evenness. A relatively high proportion of the total invertebrates was accounted for by sensitive taxa (*i.e.*, mayflies). Results from this study indicated that the effect of the discharged effluent could be conservatively characterized as low. The use of artificial substrates highlighted the low level of effects within the water column compared to the severe effects observed in the bottom sediments during earlier studies. These results suggest that the historical sediment contamination likely poses a greater risk to aquatic life in Yellowknife Bay than the periodic discharge of Mine effluent. It also suggests that the benthic community, at least at the mouth of the creek, may be recovering.

3.1.7 Anthropogenic Influences

Between 1942 and 1999, ore processing at both Giant Mine and Con Mine released arsenic to the atmosphere. Historical emissions of arsenic at Giant Mine contaminated soil on the mine property (Golder 2001, EBA 1998). These emissions likely also contaminated both surficial water and sediments within the exposure area possibly up to a radius of 12 km around the mine.

There are several point sources of contaminants from the Mine (Table 3-4). Water from various locations on the Mine site (*e.g.*, underground, surface runoff, sewage from the

Giant Mine townsite) is treated in the ETP to remove arsenic and released to Baker Creek. Treated effluent is the main point source of contaminants to the receiving environment. In addition to the effluent discharged from the Mine, Baker Creek is subject to several non-point source anthropogenic inputs unrelated to the Mine. These include inputs from the territorial highway (*i.e.*, Ingraham Trail) that runs parallel to the creek and from the privately-owned marina.

Table 3-4
List of Potential Anthropogenic Inputs to the Exposure Area

General Source	Source	Description
Mine Site or Mining Activities	Runoff from Arsenic-Contaminated Soil (> 350 mg/kg) from Mine site	A large volume of runoff from site is collected and treated prior to release. However, some volume of runoff from contaminated soils is assumed to be uncollected and flow directly to Baker Creek.
	Beached Tailing in Yellowknife Bay (Back Bay)	Tailing was historically deposited in Back Bay (see Section 2.2.2.4) and a portion of this tailing is present above the waterline. Arsenic and other metals above the waterline may be leached and transported by infiltration and shallow groundwater to Yellowknife Bay.
	Submerged Tailing in Yellowknife Bay (Back Bay)	In addition to beached tailing in Back Bay, there is also submerged tailing in Back Bay. It was previously assumed that the porewater of the submerged tailing does not provide significant sources of arsenic to the area. Based on recent studies (Mace 1998; Andrade 2006), significant amounts of arsenic may be mobilized from the tailings areas.
	Tailing Pond Seepage on site	Arsenic and other contaminants from tailing in these ponds is transported by infiltration, leaching and subsequent shallow groundwater flow to the underground mine workings, to seepage collection structures and is treated prior to release. However, there is some limited volume of underground seepage that may escape the seepage collection structures and flow to Yellowknife Bay.
	Sediments in the Baker Creek mouth and Back Bay Area	Contaminated sediment at the mouth of the creek and in the bay may be a non-point source of contaminants should contaminants remobilize from these areas. The extent and significance of this is unknown. Based on recent studies (Mace 1998; Andrade 2006), significant amounts of arsenic may be come from the sediment and porewater in this area.
Regional Runoff Including Roads	Surface Runoff in Drainage Basins adjacent to and away from the mine property	Arsenic and other metals may be transported via surface runoff across soils from the region which contain elevated metals concentrations, including loadings from the stack. Receptors are Trapper Creek, Baker Creek and ultimately Yellowknife Bay. This would include surface runoff from the territorial highway.
Private	Surface Runoff from the marina	The marina is not considered a source of arsenic but a source of potential petroleum hydrocarbon contamination due to boat motors and runoff from the parking lot at the marina. The input of the marina to Yellowknife Bay is assumed to be small.

Recent studies in the Yellowknife Bay (Andrade 2006) have shown that the arsenic concentrations in the porewater above the beached tailings are high relative to the surface water (1,010 micrograms per litre [µg/L] at 1.8 cm depth below the sediment water interface [arsenate or pentavalent arsenic]) but are modest at the immediate sediment water interface (15 µg/L). The arsenic may be remobilizing from the sediment into the water.

The porewater concentrations in Baker Creek are elevated about the sediment water interface (117 to 181 µg/L [arsenate, forming the bulk of the total arsenic]). Arsenic trioxide (*i.e.*, As^{3+}), which is a more toxic form of arsenic than As^{5+}, is low at the sediment water interface, but quickly rises to 5,815 µg/L by 18 cm depth. The highest porewater arsenic concentrations were found in the Baker Creek marsh area (Andrade 2006). The effect of this on surface water concentrations and aquatic organisms is not known.

3.2 The Yellowknife River – Reference Area

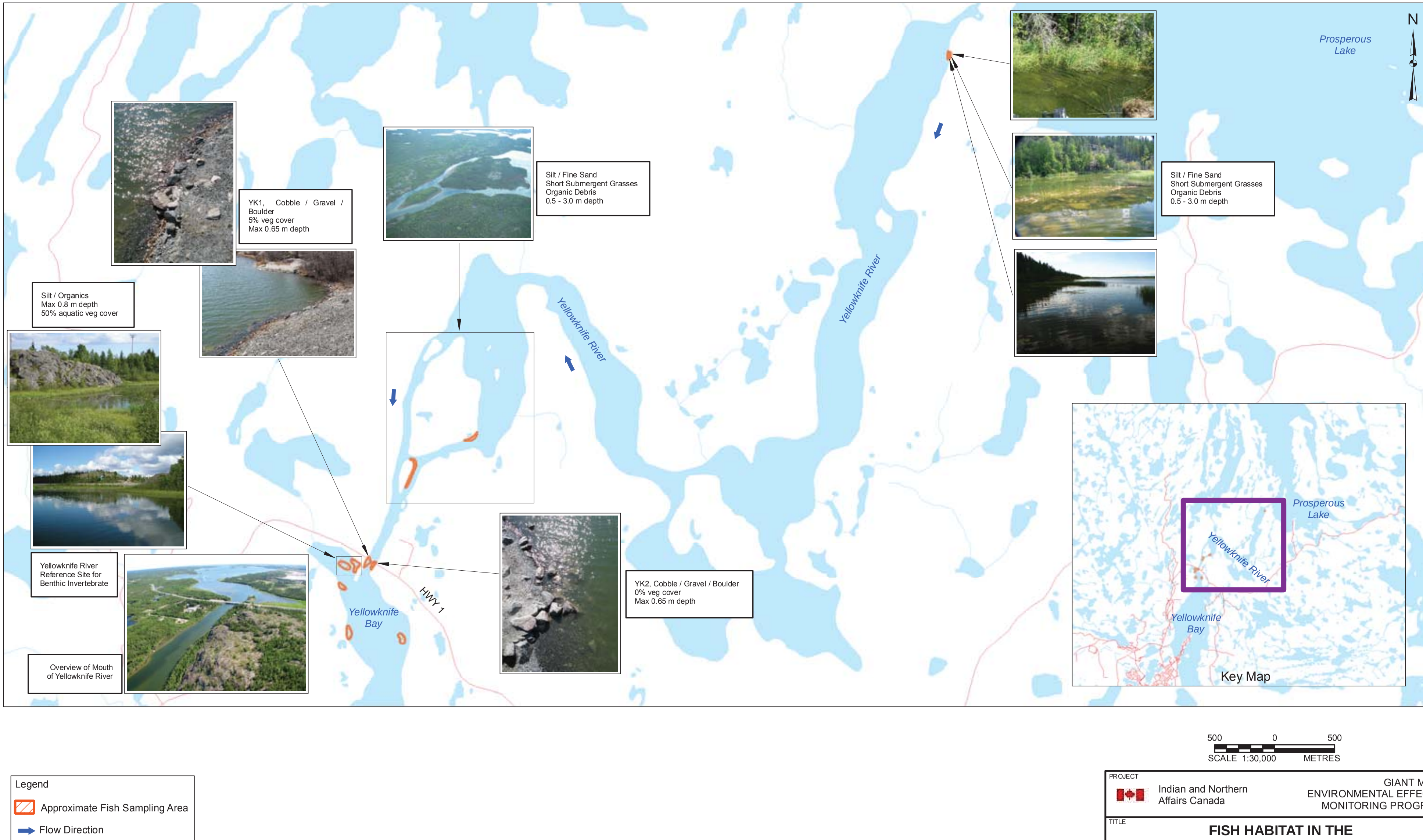
3.2.1 Rationale for Study Location

The MMER defines a reference area as "…waters frequented by fish that is not exposed to effluent and that has fish habitat that, as far as practicable, is most similar to that of the exposure area." (EC 2002). Ideally, the reference area should be located within the same waterbody, but upstream of a potential discharge. Several locations within the Yellowknife River system were utilized as reference areas for the FS and ICS (Figure 3-3).

The mouth of the Yellowknife River resembles the habitat in the Baker Creek exposure area because it has sections with flowing water followed by flat water, marsh habitat, varying water depths, and open areas exposed to wave action (Photographs 2 and 3). This area was identified as being suitable for part of the FS (see Section 4) and was identified as being most suitable for the ICS (see Section 5).

An inlet area located at the northern part of the Yellowknife River, approximately 0.5 km from the outflow of Prosperous Lake, was used as an additional reference location for the FS (see Section 4). The inlet has access to the main river system through a small channel, with water depths ranging from approximately 0.5 to 2.5 m. Submergent and emergent vegetation are also present, similar to vegetation found in both Baker Creek and Yellowknife Bay. The substrate consists of silt, fine sand and organic debris.

Unexpected numbers of slimy sculpin collected along the breakwater in the exposure area required a search for slimy sculpin habitat in the Yellowknife River. With the help of EC, a reconnaissance survey revealed a shallow rocky area along the east portion of the first island north of the Yellowknife River bridge (see Section 4). The rocky areas near the shore resembled the rocky banks of Baker Creek in the area along the breakwater.



REFERENCE
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 11

PROJECT
Indian and Northern Affairs Canada

GIANT MINE
ENVIRONMENTAL EFFECTS
MONITORING PROGRAM

TITLE

FISH HABITAT IN THE YELLOWKNIFE RIVER (REFERENCE AREA), 2006

Golder Associates
Saskatoon, Saskatchewan

PROJECT		07-1328-0002	FILE No.
DESIGN	KM/SV	15/01/08	SCALE AS SHOWN REV. 0
GIS	JRC	14/05/08	
CHECK	KG	30/05/08	FIGURE: 3-3
REVIEW	HM	30/05/08	

G:\2007\1328\07-1328-0002 Giant Mines MME\07-1328-0002 Loc_fish_sampling_YKRivlsl-combined Imagery.mxd

3.2.2 Location and Access

The mouth of the Yellowknife River is located approximately 1 km upstream from the Mine property. The Yellowknife River is accessible at the bridge crossing on the Ingraham Trail where there is a day-use Territorial Park with a boat launch.

3.2.3 Hydrology

The Yellowknife River drains a large watershed (16,300 square kilometres [km^2]) that extends to the north of Great Slave Lake (EC 2008; Water Survey of Canada 2003b). Between 1988 and 2006, mean annual discharge of the Yellowknife River (at the outlet of Prosperous Lake) was 42.1 m^3/s (EC 2008). The Yellowknife River is riverine habitat although lacustrine habitat occurs downstream where the river enters Yellowknife Bay. There are extensive reed beds in an isolated bay located along the north shore immediately downstream of the outlet of Prosperous Lake and Tartan Rapids. Reed beds are also located along the south shore near Yellowknife Bay.

3.2.4 Water Quality

There is extensive information available on the water quality of the Yellowknife River because it is the source of drinking water for the community of Yellowknife and is routinely monitored by the municipal government. The Yellowknife River has also been used as a reference area for background water quality conditions in environmental studies on Yellowknife Bay (*e.g.*, Jackson *et al*. 1996).

The following water quality information is known about the Yellowknife River:

- conductivity values range from 45.0 µS/cm to 149.5 µS/cm and chloride levels range between 1.34 to 2.09 mg/L;
- nutrient concentrations are low:
  - total ammonia concentrations range from 0.003 to 0.043 mg/L;
  - nitrate concentrations are generally below the MDL of 0.005 mg/L; and
  - total phosphorus concentrations range from <0.002 to 0.0123 mg/L;
- TSS levels in the river are typically low although levels can be elevated (*e.g.*, 39 mg/L) during spring freshet; and
- total metals concentrations are near or below the MDLs and the 2004 mean concentration of total arsenic was 0.00046 mg/L.

3.2.5 Sediment Quality

A summary of the two sediment quality studies completed in the Yellowknife River near the mouth into Yellowknife Bay was included in the *Phase 1 EEM Final Interpretative Report* (Golder 2005). Sediment at the mouth of the Yellowknife River is composed predominately of a silt-clay aggregate (Mace 1998, Falk *et al*. 1973). In general, metal concentrations in surficial sediments were low. In particular, total arsenic concentrations were lower in the Yellowknife River than any other location sampled throughout Yellowknife Bay (Mace 1998). Sediment in one focal area of the mouth of the river may be contaminated by historical mining activities (see Station R09 on Figure 5-2); this area was sampled in 2004 and 2006 for the EEM program and is discussed further in Section 6.

3.2.6 Aquatic Resources

Fisheries

The Yellowknife River provides important fish habitat for Arctic grayling (*Thymallus arcticus*) and walleye (*Stizostedion vitreum*), which migrate up the river from Great Slave Lake in spring (Stewart 1997). It also provides important fish habitat for lake cisco and lake whitefish, which migrate up the river from Great Slave Lake in the fall (Stewart 1997; Golder Associates 2008). There are 18 fish species reported to inhabit the Yellowknife River (Table 3-5).

Benthic Invertebrates

Information on the benthic invertebrate community within the Yellowknife River is limited. Falk *et al*. (1973) sampled in 1972 and found 25 genera. The benthic invertebrate community was dominated by chironomids, oligochaetes and nematodes. However, biting midges (Ceratopogonidae), clams, and snails were also relatively abundant in the Yellowknife River. Artificial substrates were used for the 2004 Phase 1 EEM ICS. A total of 32 families were identified, which were dominated by mayflies (Ephemeroptera), dipterans (primarily of the midge family Chironomidae), amphipods (Amphipoda) and occasionally by polycentropodid caddisflies (Trichoptera) (Golder 2005).

Table 3-5
Fish Species Documented in the Yellowknife River

Scientific Name	Common Name
Stizostedion vitreum	Walleye
Lota lota	Burbot
Catostomus catostomus	Longnose sucker
Catostomus commersoni	White sucker
Esox lucius	Northern pike
Prosopium cylindraceum	Round whitefish
Coregonus clupeaformis	Lake whitefish
Coregonus artedi	Lake cisco
Stenodus leucichthys	Inconnu
Thymallus arcticus	Arctic grayling
Salvelinus namaycush	Lake trout
Couesius plumbeus	Lake chub
Cottus cognatus	Slimy sculpin
Pungitius pungitius	Ninespine stickleback
Notropis atherinoides	Emerald shiner
Notropis hudsonius	Spottail shiner
Percopsis omiscomaycus	Trout perch
Perca flavescens	Yellow perch

3.2.7 Anthropogenic Influences

Water and sediment chemistry suggest that the Yellowknife River has not been contaminated by the Mine (see Sub-sections 3.2.4 and 3.2.5) with the exception of one focal area (see R09, see Figure 5-2). Recreational use of the area (*e.g.*, boating, fishing) is high during the summer. The mouth of the Yellowknife River, where it enters into Great Slave Lake, is a traditional site for subsistence fishing by the Yellowknives Dene and is also a common site for recreational fishing (Stewart 1997; Yellowknives Dene First Nation 1997). These activities may have an impact on the fish population, particularly cisco which are heavily harvested recreationally and commercially in fall. The commercial fishery is experimental and based on local news stories, it was temporarily closed in 2007. For the purposes of the EEM, its is assumed that the impact of recreational fishing on benthic organisms is low. In other words, fishing pressure on predators (fish) does not result in great increases in their prey (benthic invertebrates).

3.3 Synopsis of the Study Design

3.3.1 Fish Survey

In January 2006, the study design for the Mine's Phase 2 EEM FS (Golder 2006) was submitted. Initially, a lethal FS was not proposed because few adult small-bodied fish were captured in the exposure area during a reconnaissance survey conducted in 2004. Instead, a non-lethal survey of juvenile spottail shiner (*Notropis hudsonius*) and sucker (Catostomidae) species was proposed as an alternative. This study design was approved June 2006.

Sampling at Giant Mine was approved to proceed in late July. July is an unusual time for sampling fish for EEM programs because fish are either spent or pre-spawning and neither condition is ideal for assessing reproductive condition. Effluent discharge commences in early July and ends in August to September. Historically, fish were not present in Baker Creek in fall and thus sampling for this Phase was done in July to balance the length of time fish are exposed to effluent and their presence in the study area.

3.3.1.1 Deviations from the Study Design

There were significant deviations from the approved 2006 Environmental Effects Monitoring Site Characterization and Study Design. The final study design for the Phase 2 fish survey included elements listed in Table 3-6.

During the Phase 2 EEM FS, spottail shiner were not found in sufficient abundance in either the exposure or reference areas. In addition, it was not possible to identify juvenile suckers to the species level in the field. Despite not being initially targeted, sufficient numbers of slimy sculpin (*Cottus cognatus*) were captured in the exposure and reference areas to act as a sentinel species for the FS. Following approval from the TAP, the study design was adapted to include a lethal survey of slimy sculpin. Based on recommendations of the TAP, two areas within the Yellowknife River were selected as the reference areas for the slimy sculpin survey and one area within Baker Creek was selected as the exposure area. At the time of the slimy sculpin fish survey, juvenile ninespine stickleback were abundant in both the exposure and reference areas so they were selected as a secondary sentinel fish species in a non-lethal FS. As additional refinement to the study was the installation of temperature loggers in both the exposure and reference areas. This was done to better understand the temperatures experienced by fish in both areas throughout the open water season.

Table 3-6
Exposure and Reference Area Sampling and Fish Study Parameters

Study Area	Waterbody	Species	Sample Size	Parameters Measured
Exposure area	Baker Creek	Slimy sculpin and Ninespine stickleback	20 adult males 20 adult females 20 juveniles or 100 juveniles	Length, weight, age, external condition, abundance (CPUE), maturity, sex[2], internal condition[2], gonad weight[2], gonad histology (subset of samples)[2], liver weight[2]
Reference area	Yellowknife River	Slimy sculpin and Ninespine stickleback	20 adult males 20 adult females 20 juveniles or 100 juveniles	Length, weight, age, external condition, abundance (CPUE), maturity, sex[2], internal condition[2], gonad weight[2], gonad histology (subset of samples)[2], liver weight[2]

[1] If adults were not available in sufficient numbers then juveniles were to be captured in a non-lethal survey.
[2] Not all these parameters can be field measured in juvenile fish.

3.4 Invertebrate Community Survey

In January 2006, an ICS was submitted as part of INAC's Giant Mine *Phase 2 EEM Study Design* (Golder 2006). A control/impact design was proposed to examine potential effects of present-day effluent on the invertebrate community in discrete exposure areas within Baker Creek and Yellowknife Bay in comparison to the reference area in the Yellowknife River.

Artificial substrate samplers (multi-plate Hester-Dendy samplers) were selected for the Phase 2 ICS to minimize the effects of confounding factors on the evaluation of present-day effluent effects (see Sections 2 and 3 for details) and to be consistent with the Phase 1 ICS. Use of artificial substrates eliminated the potential effects of historical sediment contamination, as well as variation in sediment particle size distribution and organic content.

3.4.1 Deviations from the Study Design

There were minor deviations from the benthic study design:

1) One exposure station (E06) was not near-field as planned. Based on conductivity, it was considered far-field for the analysis. This resulted in only four stations in the near-field instead of five.
2) Total arsenic in sediments was analyzed on a subset of samples as was planned in Phase 1. In Phase 2, a full metal suite was to be done on all stations. Field samplers mistakenly followed the Phase 1 protocols. Consequently there is a

limited amount of sediment metal data for each station. Data from previous studies including the 2004 Phase 2 EEM are used as a surrogate for interpretation.

3.4.2 Sub-lethal Toxicity Testing

Sub-lethal toxicity tests for the Mine were conducted twice in accordance with requirements outlined in the MMER.

3.4.2.1 Deviations From the Required Testing

There were no deviations from the required testing.

4.0 FISH SURVEY

4.1 Introduction and Objectives

The objective of the EEM FS is to determine if mine effluent discharged into the receiving environment has a significant effect on the growth, reproduction, survival or condition of fish relative to fish populations from a reference area (EC 2002). An effect on a fish population is defined as "a statistical difference between fish population measurements taken in an exposure area and reference area." (EC 2002).

The following effects were determined by statistically comparing life history parameters in fish captured in the exposure and reference areas:

- survival (age distribution);
- energy storage (condition factor); and
- energy use (growth and reproduction).

Two FS were completed for the Phase 2 EEM program:

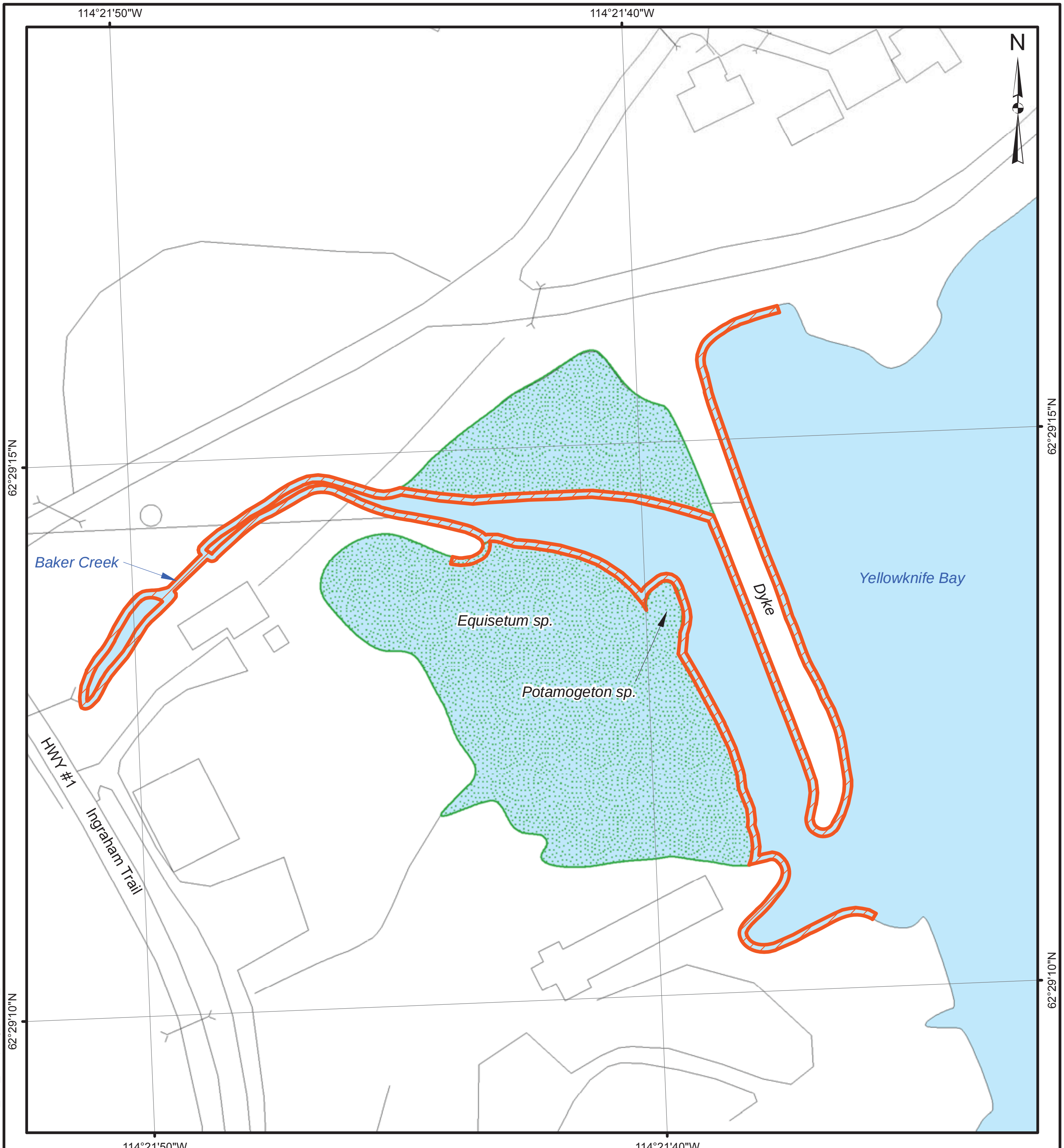
- a lethal FS on slimy sculpin from the exposure area (*i.e.*, Baker Creek) and reference area (*i.e.*, Yellowknife River); and
- a non-lethal FS on ninespine stickleback from the exposure area (*i.e.*, Baker Creek) and reference area (*i.e.*, Yellowknife River).

4.2 Methods

4.2.1 Study Area, Sampling Locations and Timing

The FS took place between July 18 and 27, 2006. The study areas for both the lethal and non-lethal FS were Baker Creek (exposure area; Figure 4-1) and the Yellowknife River (reference areas; Figures 4-2).

Low capture success of slimy sculpin in the original reference area (YK1) resulted in an attempt to increase the sample size by sampling in a second reference area (YK2). There was no statistical difference in any of the measured fish parameters between the slimy sculpin captured from these two areas. Therefore, fish from YK1 and YK2 were pooled for further statistical analyses, and this area is collectively referred to as Yellowknife River – reference area A. Additional slimy sculpin were captured along the rocky shoreline along the east portion of the first island north of the Yellowknife River bridge. This location is referred to as Yellowknife River – reference area B.



25 0 25

SCALE 1:1,500 METRES

Legend

- Approximate Fish Sampling Area
- Emerging Macrophyte

REFERENCE

Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 11

PROJECT

Indian and Northern Affairs Canada

GIANT MINE
ENVIRONMENTAL EFFECTS
MONITORING PROGRAM

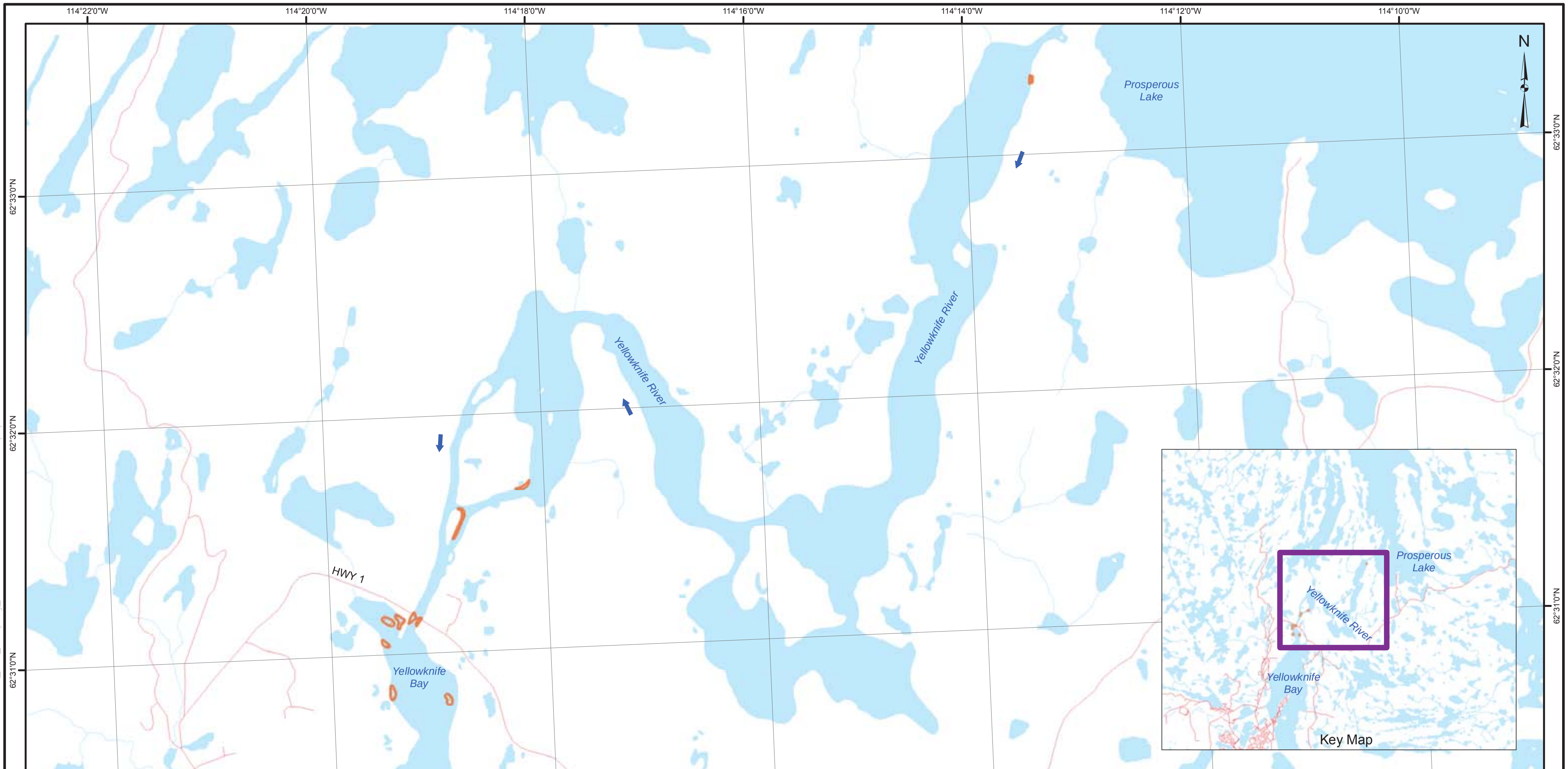
TITLE

LOCATION OF FISH SAMPLING EFFORT IN BAKER CREEK (EXPOSURE AREA), 2006

Golder Associates
Saskatoon, Saskatchewan

PROJECT No.		07-1328-0002	SCALE AS SHOWN	REV. 0
DESIGN	KM/SV	15/01/08	**FIGURE: 4-1**	
GIS	JRC	13/05/08		
CHECK	KG	30/05/08		
REVIEW	HM	30/05/08		

G:\2007\1328\07-1328-0002 Giant Mines MME\07-1328-0002 Loc_fish_sampling_Baker_Creek.mxd



Legend

- Approximate Fish Sampling Area
- Flow Direction

REFERENCE
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 11

PROJECT
Indian and Northern Affairs Canada
GIANT MINE ENVIRONMENTAL EFFECTS MONITORING PROGRAM

TITLE
FISH SURVEY LOCATIONS IN THE YELLOWKNIFE RIVER (REFERENCE AREA), 2006

Golder Associates
Saskatoon, Saskatchewan

PROJECT		07-1328-0002	FILE No.	
DESIGN	KM/SV	15/01/08	SCALE AS SHOWN	REV. 0
GIS	AND	13/05/08		
CHECK	KG	30/05/08		
REVIEW	HM	30/05/08		

FIGURE: 4-2

Low capture success of ninespine stickleback in reference area A resulted in an attempt to increase the sample size by sampling in a ponded area in the Yellowknife River downstream of the Tartan Rapids. This location is referred to as Yellowknife River – reference C.

4.2.2 Fish Capture Methods

Fish were collected according to the detailed methods in Golder's Technical Procedure 8.1-3: *Fish Inventory Methods* (unpublished file information). All captured sentinel fish species (*i.e.*, slimy sculpin and ninespine stickleback) were placed in a bucket with well-aerated, ambient water until processed. Non-target fish species were identified, counted, and released live back into the waterbody from which they were captured.

A variety of gear types were used in an attempt to capture fish during the survey. These gear types included minnow traps, seine net (6 m long by 1.2 m tall with 0.08 cm mesh), backpack electrofishing unit with a 19 inch anode ring as well as dip nets. Backpack electrofishing was the most effective method to capture slimy sculpin, while seining and dip netting were the most effective methods for capturing ninespine stickleback.

The following information was recorded for each minnow trap:

- trap name;
- date and time set and retrieved;
- Universal Transverse Mercator (UTM) coordinates;
- whether the trap was baited or unbaited; and
- the number of fish of each fish species captured.

The following information was recorded for each seine net effort:

- trial number;
- date and time started and ended;
- area sampled; and
- UTM coordinates.

The following information was recorded for each backpack electrofishing effort:

- trial number;
- date and time started and ended;
- fishing effort (seconds);
- backpack electrofisher settings; and
- UTM coordinates at the start and end of sampling area.

The following information was recorded for each dip net effort:

- date and time started and ended; and
- UTM coordinates.

4.2.3 Sample Size

For the lethal FS, the target sample size was 20 adult male, 20 adult female and 20 juvenile slimy sculpin from both the exposure and reference areas. For the non-lethal ninespine stickleback survey, 100 individuals were targeted in each of the exposure and reference areas. Most ninespine stickleback captured were young-of-the-year (YOY) (*i.e.*, <35 mm in length). Although the EEM TGD (EC 2002) recommends that, in the presence of very abundant YOY, fishing continue until a total of 100 non-YOY are captured, the low abundance of non-YOY ninespine stickleback captured at both areas (only 8 non-YOY fish in total) did not allow this target to be achieved.

4.2.4 Field Measurements

4.2.4.1 External Examination

An external health assessment was completed according to methods outlined in Golder's Technical Procedure 8.16-0 *Fish Health Assessment - Metals* (unpublished file information). All slimy sculpin and ninespine stickleback that underwent an external health examination were given a unique biomarker code. Total length (± 1 mm) and total fresh body weight (± 0.001 grams [g]) were recorded for all captured sentinel fish. Fresh body weight was measured on an Acculab® Pocket Pro PP-20600 electronic scale with an accuracy of 0.001 g. Detailed observations were made on any features of the fish that did not appear normal (*i.e.*, wounds, tumours, parasites, fin fraying, gill parasites or lesions), and these were completed following the recommendations outlined in Chapter 4 of the EEM TGD (EC 2002).

4.2.4.2 Internal Examination and Organ Collection

A complete internal health examination was conducted on slimy sculpin according to Golder Associates TP 8.16-0 *Fish Health Assessment - Metals* (unpublished information). All slimy sculpin were rendered unconscious by concussion, followed by spinal severance. Fish were dissected on a cutting board covered with a clean sheet of plastic wrap. All dissecting equipment was cleaned at the end of each day. The internal health examination determined:

- sex (if possible);
- life stage (if possible);
- state-of-maturity (if possible);
- internal pathology;

- liver weight;
- gonad weight; and
- stomach contents.

Slimy sculpin gonads and livers were removed and weighed on an Acculab® Pocket Pro PP-20600 electronic scale with an accuracy of 0.001 g. Gonad tissue was collected from a subset of slimy sculpin, placed into individual labelled histocassettes, and preserved in 10% buffered formalin. Preserved gonad tissues were used to confirm the field assessment of gender. Slimy sculpin were in post-spawning condition, and ovarian development was limited; therefore, fecundity and egg size estimates were not completed. After removal of the liver, the gastrointestinal tract was dissected. Stomach fullness was noted along with a general description of gut contents and parasite load.

Other organ systems (*e.g.*, spleen, gall bladder) were examined for their general appearance and the presence of any abnormalities. If abnormalities, such as tumours, necrosis or parasites, were observed, their appearance was noted and described.

4.2.4.3 Ageing Structures

Slimy sculpin lack scales; therefore, sagittal otoliths were collected as the primary aging structure. Sagittal otoliths were removed from slimy sculpin, placed in numbered-envelopes, sealed, and labelled with catch information. No ageing structures were collected from ninespine stickleback as they were assessed in the field as YOY and juvenile (*i.e.*, <35 mm in length). A subset of spottail shiners were sent for ageing to confirm that they were YOY.

4.2.4.4 Supporting Environmental Variables

As outlined in the EEM TGD (EC 2002), key supporting environmental information must be collected during the field study. Supporting water quality information is required to assist in the interpretation of results from the FS.

Field water quality measurements were taken daily during the FS in both the exposure and reference areas. The following variables were measured with a multi-probe YSI 600QS meter:

- dissolved oxygen;
- water temperature;
- pH; and
- specific conductivity.

Although *in situ* turbidity was included as part of the study design, this parameter was not measured due to an oversight in the field, but was included in the water chemistry analysis. Although not required by the Phase 2 Study Design, periodic measurements of water velocity in Baker Creek and the Yellowknife River were collected.

Water chemistry samples were collected from inside the breakwater area in Baker Creek (exposure area) on July 18, 2006 and from the Yellowknife River near the bridge and boat launch on August 4, 2006.

Water samples were collected according to protocols outlined in the Giant Mine SOP for MMER effluent and water quality monitoring (MGML 2003) and in accordance with the specific handling requirements of ALS Laboratory Group in Vancouver, British Columbia (BC). Sample bottles were triple-rinsed with ambient water prior to sample collection. Surface water samples were collected from approximately 15 cm below the water surface, with the bottle mouth facing upstream. In addition, two travel blanks, two field blanks, and two duplicate samples were submitted as part of the quality assurance/quality control program.

Water samples were shipped on ice in sealed, labelled coolers to ALS for chemical analysis. Water samples were analyzed for the following parameters:

- physical characteristics (conductivity, alkalinity, total hardness, pH);
- total and dissolved metals;
- nutrients; and
- major ions.

Concentrations of water quality analytes in the exposure area were compared to concentrations in the reference area. In addition, concentrations of analytes were compared to the CWQG (CCME 1999, 2007).

Temperature data loggers (Onset HOBO Water Temp Pro, part #H20-001) were deployed in Baker Creek and the Yellowknife River to assess seasonal differences in water temperature between sites. Water temperatures were recorded from June until late October 2006, which is the time encompassing the principal period of growth for fish. For the purpose of temperature data analysis, the June 22 to October 23, 2006 period was examined.

4.2.5 Laboratory

4.2.5.1 Fish Ageing

Slimy sculpin sagittal otoliths were sent to North Shore Environmental Services (Thunder Bay, Ontario) for age determination. For QA/QC purposes, a random set of 60 otoliths (representing 28% of all fish) was re-aged by Gary Carder (formerly of DFO, Salmon Arm, British Columbia).

4.2.5.2 Histology

Histology samples were sent to Prairie Diagnostics Systems in Saskatoon, Saskatchewan (SK) for assessment of sex by a pathologist. Additional effort was made to determine the state of maturity of each sample as well as look for signs of abnormalities. Gonad tissues were sectioned and then mounted on slides. Due to the extremely small size of the gonad tissues, difficulties in sectioning some tissues were encountered.

Histological categories for each stage of gonadal development observed in lethally sampled slimy sculpin were produced based on the categories used for the Miramar Con Mine Phase 1 EEM FS (Golder 2005). These categories were expanded based on the experience and suggestions of the Dr. Cheryl Sangster. Separate histology categories are required for male and female gonad tissues because male and female slimy sculpin exhibit different histological characteristics and potential morphological abnormalities (Table 4-1).

There is some overlap between categories when gonads are identical and are indistinguishable under the microscope. (*e.g.*, female resting and female immature). The correct stage of gonadal development was determined by comparing the gonad histology to the applicable total body length, field assessment of state-of-maturity, gonad weight, and age.

4.2.6 Data Analysis

All data were entered into EC's EEM Metal Mining Data Entry Software (Version 2.1). The data were independently reviewed for data entry errors prior to submitting the data to EC.

4.2.6.1 Abundance

Catch-per-unit-effort (CPUE) was calculated for all fish captured during the health survey. CPUE provides an estimate of relative abundance by standardizing the catch data according to the fishing effort. CPUE was summarized by both area and sampling method to document the effort expended in collecting the required number of fish.

Table 4-1
Gonad Histopathology Categories for Male and Female Ninespine Stickleback

Sex	State-of-Maturity	Histopathology Code	Definition	Histology
Male	Mature	1	Sexually mature with normally developing testes.	Late spermatogenic: Contain primarily spermatozoa (Stage 3 and 4).
	Mature	1B	Sexually mature with normally developing testes, but development retarded compared to 1	Mid-spermatogenic: Contain approximately equal numbers of spermatocytes, spermatids and spermatozoa (Stage 2).
	Immature	2	Immature fish	Pre-spermatogenic: Contain only spermatogonia (Stage 6). Few to no mitotic cells.
	Maturing	3	Male maturing for the first time	Early spermatogenic: Contain predominantly spermatocytes and spermatids. Groups of mitotic spermatocytes are present (Stage 7 and 1).
	Resting	4	Resting	Contain only spermatogonia (Stage 6). Few to no mitotic cells.
	Spent	5	Spent	Fewer spermatozoa in lumen with a prominent ring of spermatogonia lining the tubules (Stage 5).
	Other	6	Testes disorganized	Tubules poorly formed. Pockets of asynchrous cells development. Residual sperm present.
Female	Mature	1	Sexually mature with normally developing ovary	Advanced maturation: Vitellogenic oocytes present (Stages 6 and 7).
	Mature	1B	Sexually mature with oocyte development slightly delayed compared to 1 and some atretic eggs present (>10% but <25%)	Vitellogenesis starts; yolk vesicles present in addition to chromatin nucleolar and perinucleolar oocytes (Stages 3 to 5).
	Immature	2	Immature fish.	Chromatin nucleolar oocytes and perinucleolar oocytes only (Stages 1 and 2).
	Maturing	3	Female maturing for the first time (would not have produced viable eggs)	Vitellogenesis starts; yolk vesicles present in addition to chromatin nucleolar and perinucleolar oocytes (Stages 3 to 5).
	Resting	4	Resting	Chromatin nucleolar oocytes and perinucleolar oocytes only (Stages 1 and 2).
	Spent	5	Spent	Presence of postovulatory follicles and remaining previtellogenic oocytes ± vitellogenic oocytes (Stage 8).
	Other	6	Reabsorbing	Regression: Granulation and disintegration of cytoplasm and surrounding follicular layers of oocytes. Folded and ruptured remains of oocytes. Influx of macrophages and phagocytic follicular cells.

Notes: > = greater than; < = less than.

4.2.6.2 Fish Health Assessment: Slimy Sculpin Lethal Survey

Typically, health data for lethally sampled sentinel species are sub-divided based on sex and state-of-maturity, the rationale being that different energetic requirements are associated with each sex and state-of-maturity (EC 2002). The fish sampling design originally targeted spottail shiners at an appropriate time of year to assess sex and state-of-maturity with confidence if adults were found. Out of necessity, as discussed earlier, the adapted sampling plan targeted slimy sculpin. While sufficient numbers of slimy sculpin were captured, they were in post-spawning condition, making the determination of sex and state-of-maturity exceedingly difficult, especially for younger fish. Histology results for a subset of samples confirmed that the field assessment of the sex was likely correct. Assessment of state-of-maturity in the field was difficult due to the post-spawn condition of the fish. Because of this, an alternative approach using fish age was used to sub-divided the data into adults and juveniles.

Male and female slimy sculpin aged 2 years and older were each used in a set of analyses (representing the adult fish groups), and all age-1 fish were used in another set of analyses (representing the juvenile group). It is doubtful that age 1 fish would be sexually mature; however, it is not known if all age 2 or older fish were sexually mature. Nearly all fish from the reference areas at age 2 were of the size at which slimy sculpin typically become sexually mature (*i.e.*, 55 mm to 60 mm; Table 4-2); however, this group of fish may have included some juveniles. Age 1 fish would be expected to be either juvenile or transitioning between the juvenile and adult stages. Given this, as well because slimy sculpin were in post-spawning condition, all age 1 fish were considered as a single group and analyzed separately. This resulted in three groups of slimy sculpin for the lethal FS analysis:

- age 2+ females (Exposure: $n = 23$; Reference A: $n = 12$; and Reference B: $n = 4$);
- age 2+ males (Exposure: $n = 19$; Reference A: $n = 5$; and Reference B: $n = 1$); and
- all age 1 individuals (Exposure: $n = 20$; Reference A: $n = 45$; and Reference B: $n = 63$).

Although this grouping provided few reference male fish, the benefits of separating the fish into three groups was demonstrated by examining the variability of the data. Analyzing the older groups separately from the age 1 fish reduced the variability in the data. For example, stronger relationships between organ size and body weight was achieved [*i.e.*, > r^2 values] for each of the three groups compared to all age classes combined. Choosing specific age and size-classes has been proposed as a method to reduce the variability of data used in comparative fish health assessments (Galloway *et al*. 2003). Size class was not used to determine maturity (*e.g.*, use fish >55 mm) because this would bias the dataset for the older fish in the Baker Creek population, which had a slower growth rate than the reference area populations (Table 4-2 and Section 4.3.4).

Table 4-2
Number of Slimy Sculpin Shorter than the Approximate Size-at-Maturity of 55 mm in the Exposure Area and the Pooled Reference Areas

Age Category	Exposure Area	Reference Areas
2+ Males	10 of 19	0 of 5
2+ Females	11 of 23	0 of 16
Age 1	14 of 21	41 of 44

Notes: mm = millimetres; 2+ = two years or older.

Summary statistics (*i.e.,* sample size, arithmetic mean, and standard deviation [SD]) were calculated for all fish measurements according to fish group and sampling area. For presentation purposes, common fish indices describing relationships between body metrics were also calculated and included in the summary statistics tables. These indices included:

- Condition factor (k) = $10^5 \times$ (body weight/fork length^3);
- Gonadosomatic Index (GSI) = 100 × (gonad weight/carcass weight); and
- Liversomatic Index (LSI) = 100 × (liver weight/carcass weight).

Carcass weight (calculated by subtracting the liver and gonad weights from the fresh body weight) was used in the calculations of GSI and LSI because of possible differences in organ weight among sampling areas. Using carcass weight instead of body weight eliminated possible confounding effects of altered organ weight (*e.g.*, gonad weight, liver weight) on the interpretation of these variables related to body weight.

Prior to statistical analyses, data were screened for potential outliers by visual examination of box-and-whisker plots and linear regression plots. Studentized residuals (SR) and leverage values from linear regression analyses were used as additional screening tools. Observations that were more than three SR from the mean were considered to be outliers but were only removed if warranted.

Statistical analyses were conducted with the SYSTAT 11 software package (SYSTAT 2004). Sculpin data were $\log_{10}$ transformed to satisfy the requirements of normality and homogeneity of variance for parametric statistics. Outliers detected during statistical testing (*e.g.*, by examining the SR from Analysis of Covariance [ANCOVA]) were removed, and the test was re-run.

Statistical testing of difference among areas was conducted for the following parameters:

- age structure (mean adult age and length frequency distribution);
- size (weight and length);
- growth (size-at-age);
- energy stores (condition, liver weight); and
- reproductive investment (gonad weight).

Differences in parameter endpoints among areas were determined by either analysis of variance (ANOVA) or ANCOVA (Table 4-3). All statistical analyses outlined in Table 4-3 were conducted separately for each group (*i.e.*, age 2+ females, age 2+ males, and age 1). Normally, relative gonad weight is not assessed for juvenile fish as energy investment into reproduction is highly variable depending on the age and state-of-maturity of the fish. Given the possible uncertainties around the juvenile-adult grouping, an analysis of gonad weight was included for all fish.

The probability of a Type I error (α) was set to the same level as a Type II error (β) because the probability of missing important effects (Type II error) was deemed to be as important as the probability of finding an effect when none exist (Type I error). Based on EC (2002) recommendations, α and β were both set to 0.10, thereby giving a power of 90% (1-β) for the statistical analyses.

Table 4-3
Fish Health Response Endpoints, Variables, and Statistical Procedures Used for Identifying Statistical Differences in the Slimy Sculpin Lethal Fish Survey

Parameter	Endpoint	Dependent Variable (Y)	Covariate (X)	Statistical Procedure
Age Structure	Age	n/a	n/a	ANOVA
Size	Total body weight	n/a	n/a	ANOVA
	Carcass weight	n/a	n/a	ANOVA
	Length	n/a	n/a	ANOVA
Growth	Size-at-age	Carcass weight	Age	ANCOVA
		Length	Age	ANCOVA
Energy Storage	Condition	Carcass weight	Length	ANCOVA
	Relative liver size	Liver weight	Carcass weight	ANCOVA
		Liver weight	Length	ANCOVA
Reproductive Investment	Relative gonad size	Gonad weight	Carcass weight	ANCOVA
		Gonad weight	Length	ANCOVA

Notes: n/a = not applicable; ANOVA = Analysis of Variance; ANCOVA = Analysis of Covariance.

An overall ANOVA or ANCOVA was initially performed to test for a significant difference among the three areas. If a significant difference was found, planned, linear orthogonal contrasts were conducted to examine differences between specific areas. These *a priori* comparisons (contrasts) are a method of partitioning the ANOVA treatment sum of squares into a series of uncorrelated (orthogonal) comparisons of sets of treatment means or totals (Hoke *et al*. 1990). The following comparisons were made:

- Exposure versus Reference areas: Baker Creek was compared with the pooled reference areas, Yellowknife River - reference area A and Yellowknife River - reference area B, to detect possible Mine related effects;
- Reference area A versus Reference area B: Yellowknife River - reference area A was compared with Yellowknife River – reference area B in order to investigate natural variation in fish health parameters within the region.

The magnitude of differences between sampling areas was calculated by expressing the difference as a percentage of the pooled reference area mean, as follows:

[(exposure mean – pooled reference mean)/pooled reference mean] * 100

ANCOVA was used to assess site differences in variables that are dependant (or vary) on another (*i.e.*, size-at-age, condition, relative liver size [the relationship of liver weight to carcass weight], and relative gonad size [the relationship between gonad weight and carcass weight]). An assumption of ANCOVA is that the slopes of the regression lines among areas are equal; therefore, a test for homogeneity of slopes (α = 0.10) of regression lines among areas was conducted. If the assumption of homogeneity of slopes was satisfied, then an ANCOVA was performed. If the slopes of the regression lines were found to be different, the relationship between the two variables was considered to differ among areas, and the parameter in question was considered to be different among the areas. *A priori* comparisons among sampling areas were conducted in the same manner as for the ANOVAs.

4.2.6.3 Fish Health Assessment: Non-lethal Surveys

The analyses performed on the non-lethal survey data are outlined in Table 4-4. Differences in the length-frequency distributions between sampling locations were assessed using the non-parametric, two-sample Kolmogorov-Smirnov (K-S) test (Sokal and Rohlf 1995). ANOVA was used to assess differences in size, while ANCOVA was used to assess site differences in condition in the same manner as was done for the lethal survey data. Reproductive performance was also assessed by examining the frequency of younger age classes (Gray *et al*. 2002). This analysis was conducted on slimy sculpin as well as using data from the non-lethal survey on ninespine stickleback. Since most of the ninespine stickleback were YOY, separate analyses were conducted on only YOY fish.

Table 4-4
Statistical Procedure Used to Identify Differences in Slimy Sculpin and Ninespine Stickleback Population Parameters Obtained from the Non-lethal Survey

Parameter	End Point	Dependent Variable (Y)	Covariate (X)	Statistical Procedure
Age and size Structure	Length-frequency distribution	n/a	n/a	Two-sample Kolmogorov-Smirnov test
Size	Length	n/a	n/a	ANOVA
	Total body weight	n/a	n/a	ANOVA
Energy Storage	Condition	Total body weight	Length	ANCOVA

ANCOVA = analysis of covariance, ANOVA = analysis of variance; n/a = not applicable; YOY = young-of-the-year.

4.2.6.4 Power Analysis

Power analysis was conducted to evaluate the adequacy of sample sizes for detecting differences in fish health endpoints. Specifically, power analysis was used to estimate the effect size (or difference in performance measured among treatments) that could be detected given the sample sizes used. Because the study design consisted of four areas, simple power equations comparing two samples could not be used. Cohen (1988) provides methods for power analyses with more than two groups and for a variety of statistical tests (*e.g.*, ANOVA, ANCOVA). Power analyses were conducted using G*Power software (Buchner *et al.* 1997), which performs computations based on methods described by Cohen (1988).

4.2.6.5 Supporting Environmental Variables

Water quality data were summarized in tabular format and compared to CWQG for the protection of freshwater life (CCME 1999, 2007). Concentrations of analytes required under MMER (see Table 6.1 in EEM TGD [EC 2002]) were compared between the reference and exposure areas. Concentrations that differed by more than a factor of two were identified.

Temperature data recorded with the HOBO data loggers were plotted as mean daily and maximum daily water temperatures. Mean daily water temperatures were analyzed using a Mann-Whitney *U*-test, the non-parametric equivalent of a two-sample *t*-test, to assess differences between areas.

4.2.6.6 Quality Assurance/Quality Control Procedures

Quality assurance/quality control (QA/QC) procedures and requirements are an important aspect of any field or laboratory testing program. The objective of having good QA/QC practices is to standardize methods and to ensure that field sampling, data entry, data analysis, and report preparation produce technically sound and scientifically defensible results.

Detailed specific work instructions outlining each field task were provided to the field personnel prior to the field program. Samples were collected by experienced personnel and were labelled, preserved, and shipped according to Golder's Technical Procedures 8.16-0: *Fish Health Assessment - Metals* and 8.1-3: *Fish Inventory Methods* (unpublished file information). Field equipment (*i.e.*, electronic balances) was regularly calibrated according to manufacturer recommendations.

Detailed field notes were recorded in pencil in waterproof field notebooks and on pre-printed waterproof field data sheets. Chain-of-Custody (COC) forms were used to track all sample shipments from the field to the applicable analytical laboratory.

Duplicate water samples were collected in Baker Creek (exposure area) and the Yellowknife River (reference area). Duplicate water samples were collected to assess variability introduced during sample collection and sample handling.

For all calculations, including relative percent difference (RPD), values below the MDL were set to half the MDL value. Differences between analyte concentrations in the duplicate water samples were considered notable if:

- RPD was greater than 20%; and
- concentration was greater than five times the relevant reported MDL.

This threshold takes into account the potential for analytical uncertainty when concentrations approach MDLs (Weiner 2000). These criteria are consistent with those used by ALS for their internal QC procedures. Variability between duplicate samples was rated as follows:

- low if less than 10% of the analytes included in the duplicate sample analysis were notably different from one another;
- moderate if 10 to 30% of the analytes included in the duplicate sample analysis were notably different from one another; and
- high if more than 30% of the analytes included in the duplicate sample analysis were notably different from one another.

Field and trip blanks were included in the water quality QA/QC program. Field blanks were submitted for analysis on July 18, 2006 and August 4, 2006, and were used to detect if any water contamination may have occurred during sample collection. Trip blanks were submitted on these same dates and were used to determine if any water sample contamination may have occurred during transportation, storage, and analysis. Notable results observed in the method blanks were evaluated relative to variable concentrations observed in the water samples to determine if wide-spread contamination may have occurred or if potential contamination was limited to the specific blank(s). If, based on this comparison, it appeared that widespread contamination had occurred, then the affected data were flagged and interpreted with this limitation in mind.

In accordance with Golder's standard QA/QC protocol, a minimum of 10% of the age structures were randomly selected, and the ageing structure was re-analyzed by a second person or separate subcontractor (Section 4.3.4.2).

All field data entered into the electronic database underwent a 100% transcription and validity check by a second person not involved in the initial data entry process. All calculated values, tables, and summary figures generated from the dataset underwent an additional QA/QC verification by a second person. The statistical results were independently reviewed by a senior statistician.

Because the sex and state of maturity of fish were difficult to assess in the field, a subset of samples were sent for histological analysis for confirmation. A total of 32 samples were sent to Prairie Diagnostic Services in Saskatoon, SK.

4.3 Results

4.3.1 Supporting Environmental Variables

Detailed water chemistry data, including QA/QC information, are presented in Appendix Tables I-1 and I-2. A summary of the results follows below.

Mean specific conductivity and water temperature were higher in Baker Creek than the Yellowknife River (Table 4-5). This is reflective of the presence of effluent in Baker Creek. Dissolved oxygen concentrations were similar between Baker Creek and the Yellowknife River and were within the CWQG for the protection of early life stages of aquatic life (CCME 1999, 2007). However, pH was neutral to slightly alkaline in Baker Creek, whereas pH values were slightly acidic in the Yellowknife River. This is likely a reflection of effluent in Baker Creek, as well as the naturally acidic nature of waters in this area. The pH values in the Yellowknife River were below the CWQG for pH on August 4, 2006 at the location near the bridge as well as at the upstream island.

Table 4-5
Mean *in situ* Water Quality Data and Habitat Information from Baker Creek and the Yellowknife River During the Fish Survey, July 2006

Area	Location	Easting	Northing	Date	Time	Velocity (m/s)	Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)[(a)]	pH[(b)]	Specific Conductivity (µS/cm)	Habitat Notes
Exposure	Baker Creek	636020	6931187	18-Jul-06	8:10 AM	NC	1.5	20.4	8.2	8.0	601	Boulder, cobble, sandy substrate; 50% aquatic vegetation cover; no overhanging vegetation
		636006	6931218	19-Jul-06	10:30 AM	0.30	1.8	19.5	9.1	7.7	616	Boulder, cobble, sandy substrate; 50% aquatic vegetation cover; no overhanging vegetation
		NC	NC	27-Jul-06	NC	NC	NC	20.9	10.0	7.7	66	Near marina in Yellowknife Bay
		NC	NC	27-Jul-06	NC	NC	NC	20.2	10.3	7.3	466	Along edge of breakwater near outlet into Yellowknife Bay
Reference	Yellowknife River	638759	6935917	04-Aug-06	NC	0.07	0.6	19.8	9.3	6.5	52	2004 seining locations that were re-seined in 2006; silt substrate with sparse vegetation
	Yellowknife River (near bridge)	NC	NC	20-Jul-06	NC	NC	NC	NC	NC	NC	NC	NC
	Yellowknife River (near bridge)	NC	NC	21-Jul-06	NC	0.60	0.5	NC	NC	NC	NC	NC
	Yellowknife River (near bridge)	637901	6934910	04-Aug-06	NC	NC	0.5	19.4	9.3	5.7	53	Reading collected in back eddy area adjacent to bulrushes downstream left side of bridge
	Yellowknife River (upstream island)	638253	6935584	04-Aug-06	11:15 AM	0.11	0.2	19.4	9.4	6.3	53	cobble area where SLSC were captured
	Yellowknife River (ponded area below Tartan Rapids)	642763	6939111	04-Aug-06	1:28 PM	0.01	0.8	19.6	7.8	6.6	54	Inlet or small bay/ponded area with access to main channel through small opening with submerged grasses; silty substrate with fine sand and areas covered by short submerged grasses (coontail); organic debris (*e.g.*, tree trunk); depth 0.5 m to 3 m at deepest point

Notes: m/s = metres per second; m = metres; °C = degrees Celsius; mg/L = milligrams per litre; µS/cm = microSiemens per centimetre; NC = not collected.
a Canadian Water Quality Guideline for dissolved oxygen for cold-water biota = 9.5 mg/L for early life stages and 6.5 mg/L for other life stages (CCME 1999, 2007).
b Canadian Water Quality Guideline for pH = 6.5 to 9.0 (CCME 1999, 2007); **bolded** values indicate pH was below the CWQG.

Data for analytes required or recommended by EC (2002) are summarized in Table 4-4. Table 4-6 summarizes the analytes with concentrations that were at least a factor of two greater in the exposure areas compared to the reference area, as specified in the EEM TGD (EC 2002).

Waters in Baker Creek and the Yellowknife River are characterized as hard, with low to moderate buffering capacity based on total alkalinity. With the exception of pH and potassium, values for all physical parameters and concentrations of major ions and nutrients were higher in Baker Creek compared to the Yellowknife River. This was expected and confirms the presence of effluent during the FS in Baker Creek.

The majority of total and dissolved metal concentrations were below applicable MDLs in both Baker Creek and the Yellowknife River. Total aluminum, total and dissolved arsenic, total iron, total manganese and total nickel were detected at measurable concentrations in Baker Creek. The concentration of arsenic in Baker Creek exceeded the CWQG concentration of 0.005 mg/L. Iron concentrations in both Baker Creek and the Yellowknife River exceeded the CWQG concentration of 0.003 mg/L.

QA/QC

The majority of analyte concentrations in the field and trip blanks were below the MDL. The few exceedences were within five times the MDL (Appendix Table I-2).

For the majority of analytes, the RPDs for duplicate samples were ≤18% for Baker Creek duplicate samples and ≤16% for Yellowknife River duplicate samples. The RPDs for duplicate samples collected in Baker Creek that were above the assessment criterion of 20% were:

- acidity (25%);
- total suspended solids (85%);
- ammonia (39%);
- total Kjeldahl nitrogen (23%);
- total selenium (86%); and
- dissolved nickel (87%).

The RPDs for duplicate samples collected in Yellowknife River that were above the assessment criterion of 20% were:

- total suspended solids (161%);
- total arsenic (118%);
- total zinc (191%);
- dissolved arsenic (95%); and
- dissolved nickel (87%).

Table 4-6
Summary of Baker Creek and Yellowknife River Water Chemistry, 2006

Parameter	Units	CWQG[(a)]	Exposure Area Baker Creek 18-Jul-06	Reference Area Yellowknife River 4-Aug-06
Physical Tests				
Total Alkalinity (as calcium carbonate)	mg/L	-	48	21
Hardness (as calcium carbonate)	mg/L	-	219	25
Total Suspended Solids	mg/L	-	5.7	<1.0
Major Ions				
Calcium	mg/L	-	62.	6
Chloride	mg/L	-	56	2
Magnesium	mg/L	-	16	2
Potassium	mg/L	-	3	<2
Sodium	mg/L	-	24	<2
Sulphate	mg/L	-	150	3
Nutrients				
Ammonia (as nitrogen)	mg/L	0.4 to 55.76[(c)]	0.049	<0.020
Nitrate (as nitrogen)	mg/L	2.9	0.822	<0.0050
Total Phosphate	mg/L	-	0.0337	0.0073
Total Metals				
Aluminum	mg/L	0.100[)]	0.09	0.06
Arsenic	mg/L	0.005	**0.146**	<0.0002
Cadmium	mg/L	0.00006 and 0.00001[(e)]	*<0.001*	*<0.001*
Copper	mg/L	0.002 and 0.004[(f)]	*<0.01*	*<0.01*
Iron	mg/L	0.003	**0.198**	**0.057**
Lead	mg/L	0.001 and 0.007[(g)]	*<0.020*	*<0.030*
Manganese	mg/L	-	0.027	<0.005
Mercury	µg/L	0.026	*<0.05*	*<0.05*
Molybdenum	mg/L	0.073	<0.01	<0.01
Nickel	mg/L	0.025 and 0.150[(h)]	0.007	<0.005
Selenium	mg/L	0.001	<0.0005	<0.0005
Uranium	mg/L	-	<0.50	<0.50
Zinc			<0.004	<0.004
Dissolved Metals				
Aluminum	mg/L	-	<0.005	0.012
Arsenic	mg/L	-	0.134	<0.0002
Cadmium	mg/L	-	<0.001	<0.001
Copper	mg/L	-	<0.01	<0.01
Iron	mg/L	-	0.01	<0.01
Lead	mg/L	-	<0.02	<0.03
Manganese	mg/L	-	<0.005	<0.005
Mercury	µg/L	-	<0.05	<0.05

Table 4-6
Water Chemistry of Baker Creek and Yellowknife River Water Chemistry, 2006 (continued)

Parameter	Units	CWQG[(a)]	Exposure Area	Reference Area
			Baker Creek	Yellowknife River
			18-Jul-06	4-Aug-06
Molybdenum	mg/L	-	<0.01	<0.01
Nickel	mg/L	-	<0.005	<0.005
Selenium	mg/L	-	<0.0005	<0.20
Uranium	mg/L	-	<0.5	<0.5
Zinc	mg/L	-	<0.004	<0.004
Organics				
Dissolved Organic Carbon	mg/L	-	13	6
Total Organic Carbon	mg/L	-	15	6
Radionuclides				
Radium-226[(b)]	Bq/L	-	<0.005	<0.005
Other				
Total Cyanide	mg/L	-	0.007	<0.005
Fluoride	mg/L	-	0.10	0.06

Notes: CWQG = Canadian Water Quality Guideline for the protection of freshwater aquatic life; Jul = July; Aug = August; mg/L = milligrams per litre; Bq/L = Becquerels per litre; < = less than.
Bolded values indicate the applicable CWQG was exceeded.
Italicized values indicate the method detection limit exceeded the applicable CWQG.
a Source: CCME (1999, 2007).
b Radium-226 analysis was subcontracted to Saskatchewan Research Council Analytical Laboratories, Saskatoon, Saskatchewan.
c Guideline for ammonia (as nitrogen) is temperature and pH dependent; all ammonia guidelines are based on a field temperature of 20°C: 0.40 mg/L at field pH 8.0; 1.23 mg/L at field pH 7.5; 12.2 mg/L at field pH 6.5; 38.4 mg/L at field pH 6.0.
d Guideline for aluminum is 0.005 µg/L at pH <6.5 and 0.100 µg/L at pH >6.5.
e Guideline for cadmium is dependent on water hardness: Baker Creek = 0.00006 mg/L and Yellowknife River = 0.00001 mg/L.
f Guideline for copper is 0.002 mg/L at water hardness of 0 to 180 mg/L and 0.004 at water hardness >180 mg/L.
g Guideline for lead is 0.007 at water hardness of 0 to 60 mg/L and 0.007 at water hardness >180 mg/L.
h Guideline for nickel is 0.025 at water hardness of 0 to 60 mg/L and 0.150 at water hardness >180 mg/L.

Table 4-7
Comparison of Baker Creek and Yellowknife River Water Chemistry, 2006

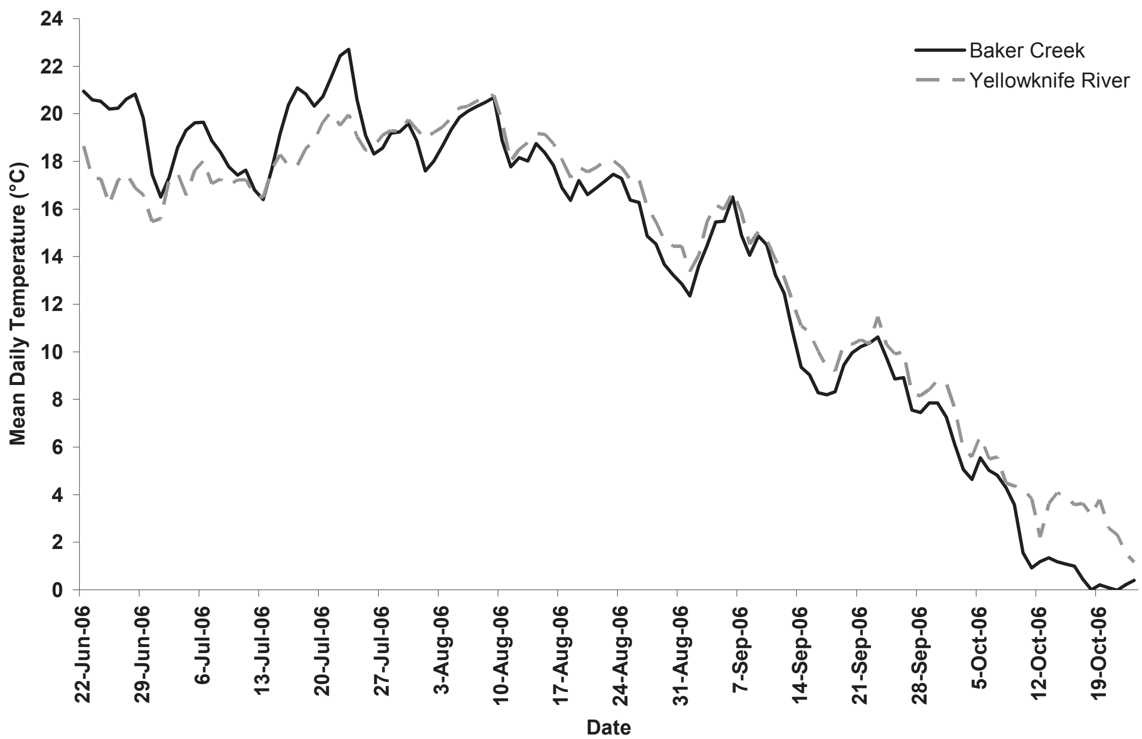
Exposure Area Concentrations at Least Two Times Greater Than Reference Area
• total alkalinity, hardness, total suspended solids
• calcium, chloride, magnesium, sodium, sulphate
• ammonia, nitrate[(a)], total phosphate
• total and dissolved arsenic[(a)], total iron, total manganese, total molybdenum, total nickel, total selenium, total uranium[(a)], total zinc
• total and dissolved organic carbon
Exposure Area Concentrations at Least Two Times Less Than Reference Area
• dissolved aluminum

a = Analytes with concentrations at least 100 times greater than the reference area.

4.3.2 Water Temperature

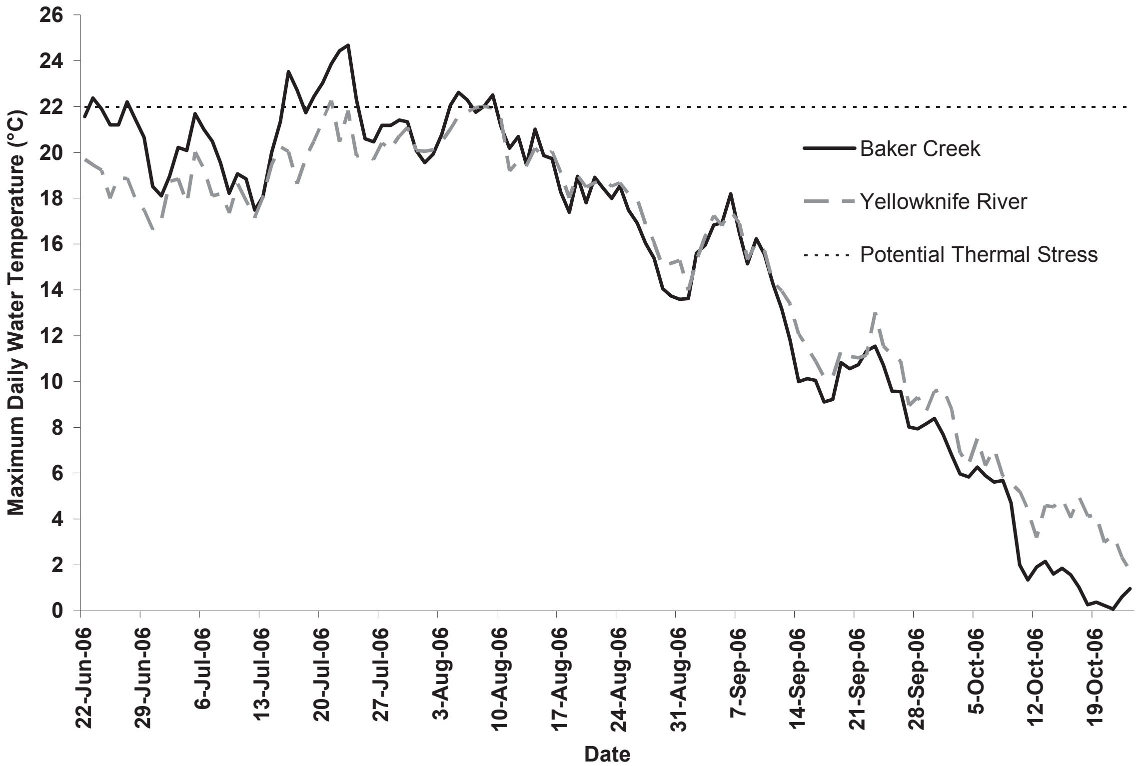
Temperature profiles as recorded by the *in situ* data loggers followed typical seasonal trends in both areas. Mean daily temperatures were similar between the Yellowknife River (reference area) and Baker Creek (exposure area) (U-test: *P*-value = 0.650; Figure 4-3). Between June 22 and July 26, 2006, mean daily temperatures were significantly higher (U-test: *P*-value <0.001) in Baker Creek compared with the Yellowknife River. After this period, the situation reversed and mean daily temperatures were slightly higher in the Yellowknife River; however, this difference was not statistically significant (U-test U*s*: *P*-value = 0.262). In October, mean daily temperatures were significantly lower (U-test: *P*-value = 0.009) in Baker Creek than the Yellowknife River, which likely reflects differences in the size of these watercourses. During effluent discharge in July, daily maximum temperatures exceeded 22°C in Baker Creek (Figure 4-4).

Figure 4-3
Mean Daily Temperatures in Baker Creek and the Yellowknife River, June 22 to October 23, 2006



Notes: Jun = June; Jul = July; Aug = August; Sep = September; Oct = October; °C = degrees Celsius.
Gray line represents the Yellowknife River (n = 124); black line represents Baker Creek (n = 124).

Figure 4-4
Daily Maximum Temperatures in Baker Creek and the Yellowknife River, June 22 to October 23, 2006



Notes: Jun = June; Jul = July; Aug = August; Sep = September; Oct = October; °C = degrees Celsius.
Gray line represents the Yellowknife River (n = 124); black line represents Baker Creek (n = 124).

4.3.3 Fish Catch Data

In both the exposure and reference areas, the majority of sampling was completed in shallow water that could be waded. In Baker Creek, seine netting occurred in water depths of approximately 0.5 to 0.7 m. Habitat typically was silt/gravel substrate, with some aquatic vegetation present. Minnow traps were set in similar habitats as seine netting, with depths ranging between 0.06 to 0.65 m. Backpack electrofishing occurred in habitat consisting of gravel/cobble substrate; aquatic vegetation may or may not have been present. In the Yellowknife River, seine netting and dip netting took place along the shoreline as well as in back-eddies with silt or silt/gravel/cobble substrate and aquatic vegetation cover. Minnow traps were set in water depths of 0.5 to 1.75 m, and included areas with and without aquatic vegetation.

A total of 1,037 fish were captured in Baker Creek (exposure area) and 841 fish were captured in the Yellowknife River (reference area) during the FS (Table 4-8). Five fish species were captured in both Baker Creek and the Yellowknife River: slimy sculpin, spottail shiner, ninespine stickleback, northern pike, and an unidentified sucker species. All of the captured suckers were young-of-the-year (YOY) and because of their small size could not be identified to species. Lake whitefish were only captured in the Yellowknife River. Juvenile burbot were only captured in Baker Creek. Seven unidentified fish fry were captured in Baker Creek, and four unidentified fish fry were captured in the Yellowknife River (two near the bridge and two near Tartan Rapids); field crews had difficulty differentiating between larval lake whitefish, other coregonid species such as cisco, and larval suckers.

Table 4-8
Total Number of Fish Species Captured in Baker Creek and the Yellowknife River, July 2006

Common Name	Latin Name	Baker Creek (Exposure Area)	Yellowknife River (Reference Area)
Burbot	*Lota lota*	15	0
Lake whitefish	*Coregonus clupeaformis*	0	2
Ninespine stickleback	*Pungitius pungitius*	148	388
Northern pike	*Esox lucius*	9	1
Slimy sculpin	*Cottus cognatus*	96	127
Spottail shiner	*Notropis hudsonius*	313	16
Sucker spp.	*Catostomus spp.*	449	303
Unidentified	*unidentified spp.*	7	4
Total		**1,037**	**841**

CPUE was calculated for backpack electrofishing, seine netting and dip netting (Table 4-9). No fish were captured during 148 hours of minnow trapping in Baker Creek and only one juvenile northern pike was captured in 371 hours of minnow trapping in the Yellowknife River.

Spottail shiner young were abundant in Baker Creek, but only 16 individuals were captured in the Yellowknife River. Sucker species were also abundant in both areas; however, identification to species was not possible due to the young life stages that were captured. Slimy sculpin and ninespine stickleback were the most abundant fish species in both the exposure and reference areas. As such, these two fish species were selected as the sentinel fish species for the FS.

Table 4-9
Catch-Per-Unit-Effort in Baker Creek and Yellowknife River, 2006

Area	Location	Species	Backpack Electrofishing			Seine Netting			Dip Netting		
			Time (seconds)	Number of Fish Captured	CPUE (fish/hour)	Area (m^2)	Number of Fish Captured	CPUE (fish/hour)	Time (minutes)	Number of Fish Captured	CPUE (fish/hour)
Exposure	Baker Creek	Burbot	8,667	15	6.23	2,474	0	0	40	0	0
		Ninespine stickleback		1	0.42		141	0.06		6	9.00
		Northern pike		3	1.25		6	0.002		0	0
		Slimy sculpin		96	39.88		0	0		0	0
		Spottail shiner		0	0		310	0.13		3	4.50
		Sucker spp		1	0.42		274	0.11		174	261.00
		Unidentified		0	0		7	0.003		0	0
Reference	Yellowknife River	Burbot	11,999	14	4.20	575	0	0	132	0	0
		Lake whitefish		0	0		0	0		2	0.91
		Ninespine stickleback		0	0		1	0.002		387	175.91
		Northern pike		0	0		1	0.002		0	0
		Slimy sculpin		127	38.10		0	0		0	0
		Spottail shiner		0	0		16	0.03		0	0
		Sucker spp.		0	0		2	0.003		301	136.82
		Unidentified		0	0		2	0.003		2	0.91

Notes: CPUE = catch-per-unit-area; m^2 = square metres.

4.3.4 Fish Health Results: Slimy Sculpin

4.3.4.1 General Health

Very few slimy sculpin from either the exposure or reference areas had noticeable abnormalities (Table 4-10). One hundred and thirty-seven slimy sculpin were assessed in the reference area (Yellowknife River); 120 (or 88%) of these fish had pale livers. Eighty one slimy sculpin were assessed in the exposure area and, similar to the reference area, a large proportion of individuals (48 fish or 59%) had pale livers.

Table 4-10
External and Internal Abnormalities in Slimy Sculpin

Health Assessment Type	Abnormality [(a)]	Baker Creek	Yellowknife River
External	Body deformities	2	9
	Eyes	0	0
	Gills	0	0
	Pseudobranchs	0	0
	Thymus	0	0
	Skin	0	0
	Fins	0	5
	Opercules	0	0
	Hindgut	0	0
Internal	Liver	48	120
	Spleen	2	1
	Gall bladder	0	0
	Gonad	0	0
	Kidney	5	0
Total Number of Fish Assessed		81	137

a See Appendix Table I-4 for detailed health assessment results observed in adult slimy sculpin.

The proportion of parasites in slimy sculpin was higher in Baker Creek (exposure area), with 31 of the 81 fish (38%) having parasites (Table 4-11). However, only 5% of these fish were classified as having "numerous" parasites. The majority of the incidents of parasites were classified as "few".

Table 4-11
Incidents of External and Internal Parasites in Adult Slimy Sculpin

Parasite Load	Baker Creek		Yellowknife River	
	n	Proportion (%)	n	Proportion (%)
Total Fish	81		137	
Parasites absent	50	62	128	93
Parasites observed	31	38	9	7
Severity				
Numerous	4	5	0	0
Moderate	3	4	4	3
Few	24	30	5	4

Notes: n = sample size; % = percent.

4.3.4.2 Age

The mean age of age 2+ female slimy sculpin from the exposure area was lower than in reference areas (Table 4-13). The difference in ages for females (-21.7%) was highly significant (p = 0.0016) (Table 4-14). There was no difference in mean age between reference areas for male age 2+ slimy sculpin since all males classified as age 2+ were two years old.

QA/QC

The QA/QC results of fish ageing identified inconsistencies that exceeded the 10% threshold for reanalysis. Consequently, a full re-aging of otoliths was performed by a second sub-contractor. The re-aging performed on all samples confirmed that aging these small-bodied fish is difficult (Appendix Table I-4). Approximately 75% of the second age estimates were within a year of the initial estimates (with most being re-aged older), though only about a third of the readings were the same (Table 4-12).

The differences in ageing appear to be consistent between the exposure and reference areas; therefore potential biases in the results due to ageing errors may be tempered by this consistency. The tendency for fish to originally be aged younger than they may have been means that our age 2+ groups are still valid as a proxy for mature fish since, on average, they may actually be older. The consistency between the age 2+ male and female fish results (see below) supports this contention. It should be noted, however, that our age 1 group may include adult fish, which would add unwanted variability to this group.

Table 4-12
Difference in Fish Ageing Estimates Between the Initial Reading and the Second Independent Reading

Age	Exposure Area		Reference Areas	
Difference	*n*	%	*n*	%
-1	7	9	4	3
0	21	28	44	34
1	31	41	50	39
2	15	20	18	14
3	2	3	8	6
4	0	0	3	2
5	0	0	2	2

Notes: n = sample size; % = percent.

4.3.4.3 Size

Female and male age 2+ slimy sculpin from the exposure area were significantly smaller than slimy sculpin from the reference areas (Table 4-14). Specifically, Baker Creek exposure area females were 28.8% shorter ($p < 0.0001$), 60.3% lighter in terms of total body weight ($p < 0.0001$) and 60.7% lighter in terms of carcass weight ($p < 0.0001$) than age 2+ females from the Yellowknife River reference areas. Likewise, males were 22.9% shorter ($p = 0.0096$), 49.2% lighter in terms of total body weight ($p = 0.0732$) and 49.1% lighter in terms of carcass weight ($p = 0.0741$) than age 2+ males from the Yellowknife River reference areas (Table 4-14).

In contrast, there was no difference in length between age 1 slimy sculpin from the exposure area and the reference areas, though age 1 slimy sculpin from the exposure area were found to be somewhat heavier in terms of total body weight ($p = 0.06154$) and carcass weight ($p = 0.0624$) (Tables 4-13 and 4-14). There were no differences in sizes between reference areas for age 2+ females; however, age 1 slimy sculpin from reference area A were significantly smaller than those from reference area B. Contrasts between reference areas for age 2+ males could not be conducted because only a single individual in this age group was captured at Reference area B.

Table 4-13
Summary Statistics for Health Parameters for Slimy Sculpin Captured in Baker Creek and the Yellowknife River, 2006

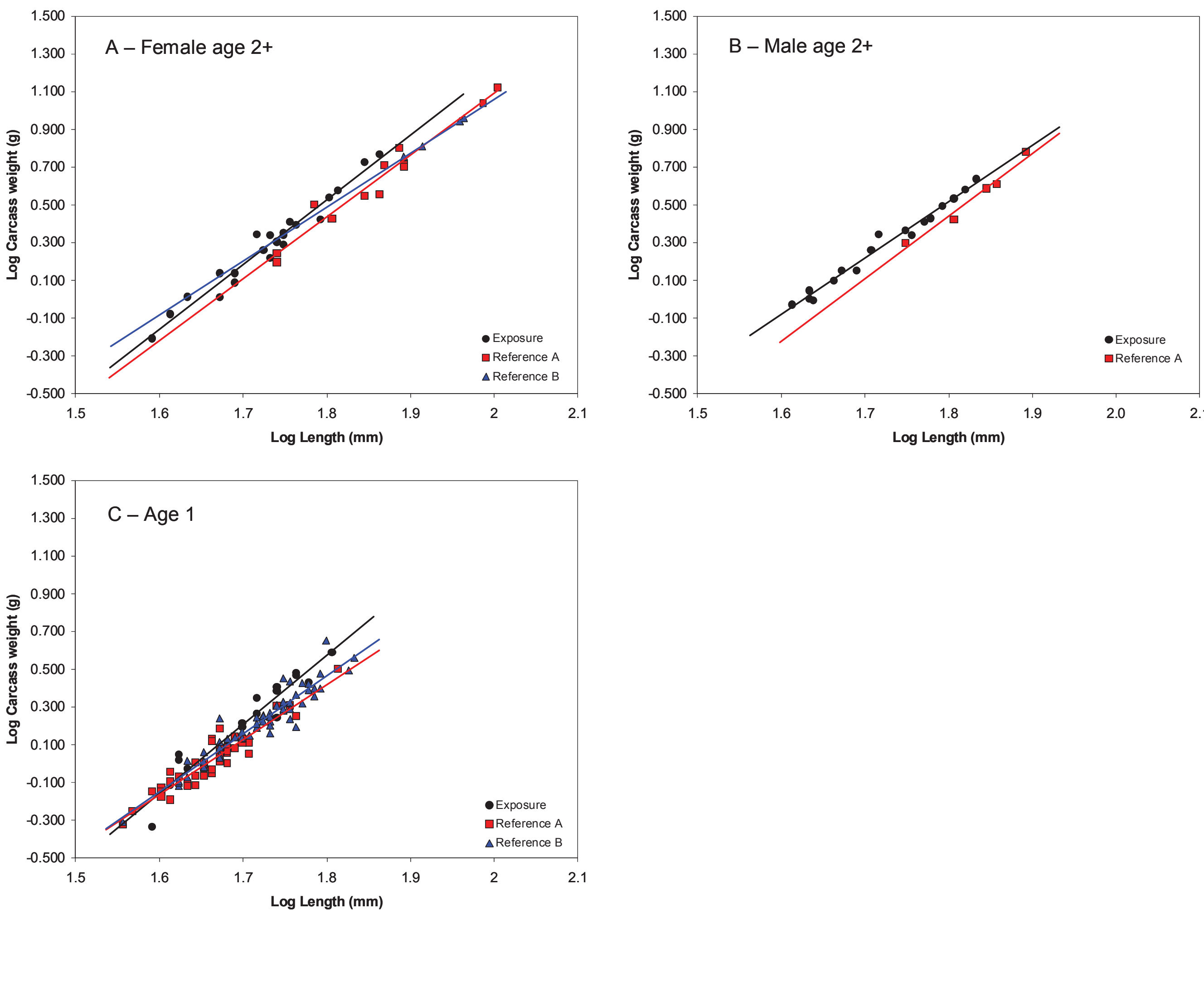
Group	Parameter	Baker Creek – Exposure Area			Yellowknife River – Reference Area A			Yellowknife River – Reference Area B		
		n	Mean	SD	n	Mean	SD	n	Mean	SD
Female Age 2+	Age (yrs)	23	2.3	0.6	12	2.8	0.8	4	3.5	0.6
	Total length (mm)	23	54.6	8.5	12	73.6	14.5	4	85.8	6.8
	Total body weight (g)	23	2.35	1.37	12	5.31	3.63	4	7.71	1.71
	Carcass weight (g)	23	2.27	1.31	12	5.18	3.57	4	7.50	1.69
	Condition (k)	23	1.26	0.16	12	1.14	0.16	4	1.18	0.02
	Liver weight (g)	22	0.064	0.064	12	0.102	0.056	4	0.160	0.083
	LSI (%)	22	2.49	1.56	12	2.20	0.67	4	2.17	1.15
	Gonad weight (g)	23	0.019	0.016	11	0.037	0.024	4	0.048	0.010
	GSI (%)	23	0.84	0.54	11	0.84	0.44	4	0.65	0.14
Male Age 2+	Age (yrs)	19	2	-	5	2	0.00	1	2	-
	Total length (mm)	19	54.1	9.5	5	68.0	8.4	1	81.0	-
	Total body weight (g)	18	2.47	1.52	5	3.82	1.60	1	10.08	-
	Carcass weight (g)	18	2.41	1.50	5	3.71	1.55	1	9.88	-
	Condition (k)	18	1.34	0.15	5	1.12	0.09	1	1.86	-
	Liver weight (g)	17	0.052	0.048	5	0.096	0.051	1	0.159	-
	LSI (%)	16	2.25	1.37	5	2.52	0.61	1	1.61	-
	Gonad weight (g)	18	0.011	0.010	5	0.009	0.007	1	0.037	-
	GSI (%)	18	0.44	0.22	5	0.28	0.20	1	0.37	-
Age 1	Age (yrs)	20	1	-	-	1	-	63	1	-
	Total length (mm)	20	50.5	6.8	45	46.1	5.6	63	52.8	6.6
	Total body weight (g)	19	1.91	0.88	45	1.12	0.48	63	1.84	0.75
	Carcass weight (g)	19	1.86	0.87	45	1.10	0.47	63	1.78	0.73
	Condition (k)	19	1.32	0.18	45	1.08	0.13	63	1.15	0.16
	Liver weight (g)	18	0.039	0.030	45	0.024	0.015	63	0.046	0.027
	LSI (%)	17	2.18	1.19	45	2.08	0.76	63	2.60	0.79
	Gonad weight (g)	15	0.008	0.003	32	0.005	0.003	48	0.008	0.005
	GSI (%)	15	0.41	0.23	32	0.47	0.29	48	0.41	0.19

Notes: n = sample size; SD = standard deviation; SE = standard error; min = minimum; max = maximum; yrs = years; mm = millimetres; g = grams; k = condition factor; GSI = gonad somatic index; LSI = liver somatic index; %=percent.

4.3.4.4 Condition

Condition factor of slimy sculpin, as evaluated by ANCOVA, was found to be higher in the Baker Creek exposure area fish (Tables 4-13 and 4-14): 9.8% higher for age 2+ females (p = 0.0010) (Figure 4-5A); 7.7% higher for age 2+ males (p = 0.0018) (Figure 4-5B); and 18.0% higher for age 1 Baker Creek slimy sculpin (slope interaction $p = 0.0023$) (Figure 4-5C). The assumption of homogeneity of slopes was not met within the ANCOVA for the condition factor of age 1 slimy sculpin (overall slope interaction: $p = 0.0093$); therefore, differences in the regression slopes among areas were tested instead of the area means. The rate of increase in carcass weight with length was 16.9% greater for Baker Creek slimy sculpin than for slimy sculpin from the reference areas ($p = 0.0023$) (Figure 4-5C). The regression slopes did not differ between reference areas (slope interaction $p > 0.1$).

Figure 4-5
Condition Factor of Slimy Sculpin Captured in Baker Creek and the Yellowknife River, 2006



4.3.4.5 Relative Liver Size

The relative liver size (LSI) for all three groups of slimy sculpin did not differ significantly between the exposure area and reference areas (Tables 4-13 and 4-14). The regression slopes for age 1 slimy sculpin were somewhat different among areas when both carcass weight (slope interaction p = 0.0399) and length (slope interaction $p = 0.0650$) were used as body size covariates (Table 4-14); however, the rates of increase in liver size with body size were not found to differ between the exposure area and reference areas (Figure 4-6E, F). Relative liver sizes did not differ between reference areas for age 2+ female slimy sculpin, but they differ between reference areas for age 1 slimy sculpin. The relationship between liver size and body size in age 1 slimy sculpin was significantly different between fish from the two reference areas, and this was likely due to a lack of larger fish in Reference area B (Figure 4-6E, F).

Table 4-14
Summary of Statistical Comparisons for Slimy Sculpin Captured in Baker Creek and the Yellowknife River, July 2006

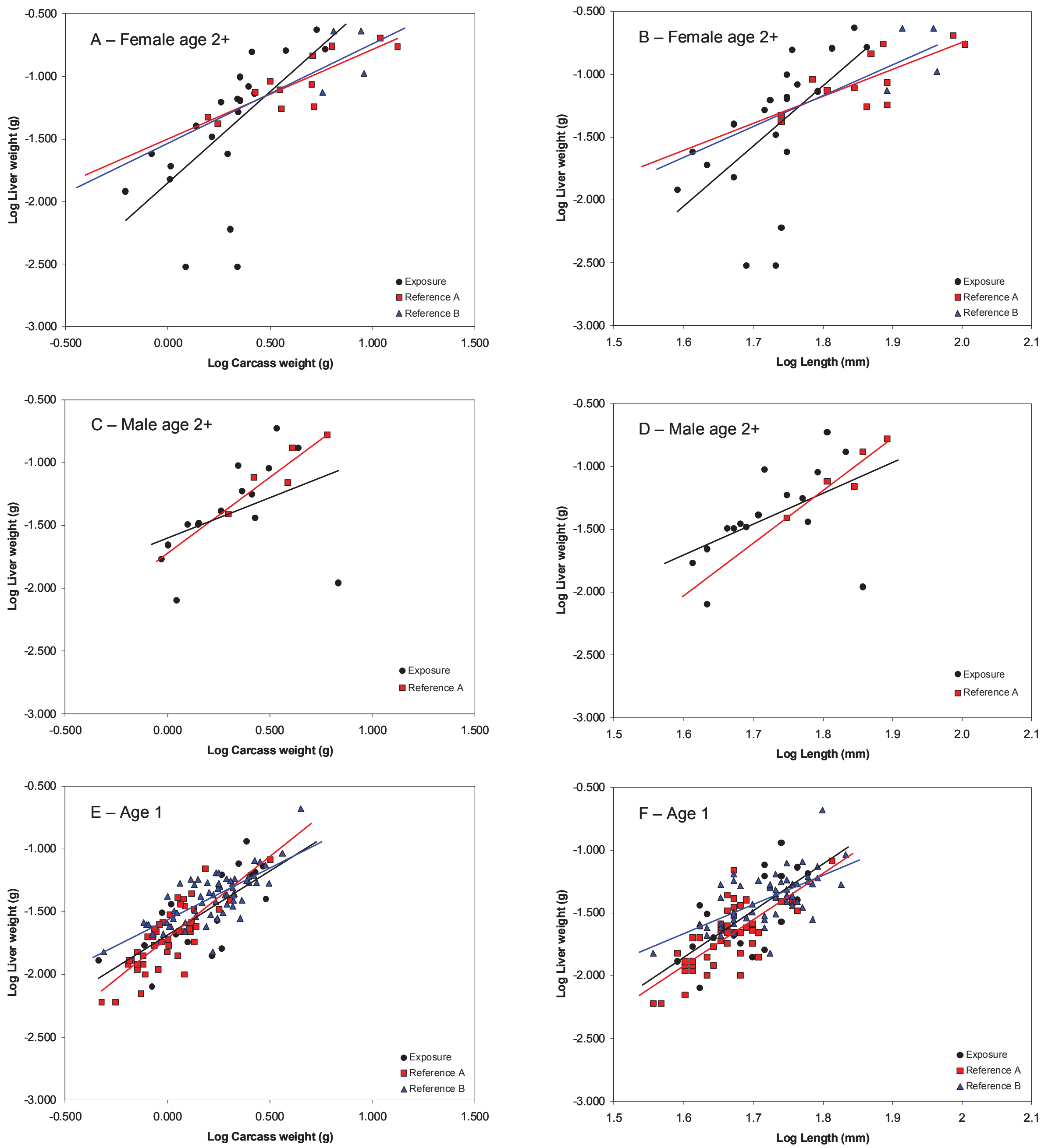
Sex	Type of Endpoint	Parameter	Slope Difference Among All Sampling Areas	Difference in Means Among All Sampling Areas	Exposure vs. Reference Comparison		Reference vs. Reference Comparison	
					NF vs. Ref A and B		Ref A vs. Ref B	
			p	*p*	%[a]	*p*	%[a]	*p*
Female Age 2+	Survival – Effect	Age	n/a	0.0060	-21.7%	**[b]	-19.0%	*
	Energy Use – Support	Length	n/a	< 0.0001	-28.8%	****	-14.2%	*
	Energy Use – Support	Total Body Weight	n/a	< 0.0001	-60.3%	****	-31.1%	ns
	Energy Use – Support	Carcass weight	n/a	< 0.0001	-60.7%	****	-31.0%	ns
	Energy Storage - Effect	Condition Factor	0.7081	0.0016	9.8%	**	-3.2%	ns
	Energy Storage - Effect	LSI[(d] (carcass weight)	0.3397	0.9466	13.6%	ns	1.4%	ns
	Energy Storage - Support	LSI[(d)] (length)	0.3444	0.8463	-	ns	-	ns
	Energy Use - Effect	GSI[(d] (carcass weight)	0.2909	0.9867	6.4%	ns	29.5%	ns
	Energy Use – Support	GSI[(d)] (length)	0.2919	0.5531	-%	ns	-%	ns

Table 4-14
Summary of Statistical Comparisons for Slimy Sculpin Captured in Baker Creek and the Yellowknife River, July 2006 (continued)

Sex	Type of Endpoint	Parameter	Slope Difference Among All Sampling Areas	Difference in Means Among All Sampling Areas	Exposure vs. Reference Comparison		Reference vs. Reference Comparison	
					NF vs. Ref A and B		Ref A vs. Ref B	
			p	p	%[(a)]	p	%[(a)]	p
Male Age 2+	Survival – Effect	Age	-	-	-	-	-	-
	Energy Use – Support	Length	n/a	0.0096	-22.9%	**	-	-
	Energy Use – Support	Total Body Weight	n/a	0.0732	-49.2%	*	-	-
	Energy Use – Support	Carcass weight	n/a	0.0741	-49.1%	*	-	-
	Energy Storage – Effect	Condition Factor	0.3036	0.0018	7.7%	**	-	-
	Energy Storage – Effect	LSI[(d] (carcass weight)	0.5602	0.3759	-5.0%	ns	-	-
	Energy Storage – Support	LSI[(d)] (length)	0.5679	0.7930	-	ns	-	-
		Gonad weight[(e)]	n/a	0.7593	28.2%	ns	-	-
Age 1	Survival – Effect	Age	-	-	-	-	-	-
	Energy Use – Support	Length	n/a	< 0.0001	1.0%	ns	-12.8%	****
	Energy Use – Support	Total Body Weight	n/a	< 0.0001	23.8%	*	-38.8%	****
	Energy Use – Support	Carcass weight	n/a	< 0.0001	24.4%	*	-38.5%	****
	Energy Storage – Effect	Condition Factor	0.0093	n/a	18.0%	**	-6.6%	ns
	Energy Storage – Effect	LSI[(d] (carcass weight)	0.0399	n/a	-8.8%	ns	-20.0%	*
	Energy Storage – Support	LSI[(d)] (length)	0.0650	n/a	-%	ns	-%	*
		Gonad weight[(e)]	n/a	0.0009	14.7%	*	-37.8%	***

Notes: n/a = not applicable; - = insufficient data to complete statistical analyses.
a Percent difference between group means.
b Probability of Type 1 Error: * = <0.10, ** = <0.01, *** <0.001, **** = <0.0001, ns = not significant (p >0.10).
c Limitations of data precluded analysis.
d LSI and GSI differences analyzed as relative liver size and relative gonad size by ANCOVA, respectively. Both carcass weight and length were used as estimates of size. Difference between areas based on index means, as shown in Table 4-12.
e Relationships between gonad weight and body size was not significant for both exposure and reference areas so ANOVA was performed on gonad weight.

Figure 4-6
Relative Liver Size of Slimy Sculpin Captured in Baker Creek and the Yellowknife River, 2006



4.3.4.6 Relative Gonad Size

There were no significant differences among areas in the relative gonad size (GSI) in age 2+ female slimy sculpin (Table 4-14; Figure 4-7A, B). As a likely consequence of the small number of age 2+ male slimy sculpin collected in reference area A, a relationship between gonad weight and size could not be established for this population (Figure 4-7C, D). Likewise, there was no relationship between gonad weight and size in age 1 slimy sculpin (Figure 4-7E, F). Given that the age 1 fish are presumed to be sexually immature, this lack of a relationship is expected. It also provides some evidence that the partitioning of fish according to age was successful at separating juveniles from adults.

As a result of the lack of significant gonad weight-body weight relationships, ANOVAs were used to compare gonad size among sampling areas in age 2+ male slimy sculpin and age 1 slimy sculpin. The ANOVA showed that there was no statistical difference in gonad weight between exposure and reference area age 2+ male fish (Tables 4-10 and 4-13). The slightly greater gonad weight of age 1 exposure area fish compared to that of reference area fish was marginally significant ($p = 0.07$) (Table 4-14; Figure 4-7).

4.3.4.7 Size-at-Age

To assess potential differences in growth rates, a comparison of size-at-age regressions among areas was conducted for age 2+ females. Such a comparison could not be conducted for the other two groups since all fish within those groups were considered to be the same age (*i.e.*, 2 year old males and 1 year old juveniles). There were no significant differences in slopes among areas for age 2+ females (Table 4-15); however, ANCOVA demonstrated clear differences in size-at-age. Female slimy sculpin from the Baker Creek exposure area were significantly shorter and lighter at a given age than slimy sculpin from the reference areas (Table 4-16 and Figure 4-8). Similarly, males from Baker Creek were significantly smaller for the age class represented by these fish (all males were age 2+). Size-at-age of females was not found to differ between reference sites, and, as discussed earlier, there were insufficient numbers of male fish to make a similar comparison.

4.3.4.8 Non-Lethal Estimates of Fish Health

The length frequency distribution of slimy sculpin captured in the exposure area showed that the majority of individuals were between the 45 mm and 60 mm length-class (Figure 4-9A). In the reference areas, slimy sculpin were captured at sizes greater than 80 mm (Figure 4-9B, C). Results of the K-S test showed that the exposure area length-frequency distribution was somewhat different from that of reference area A ($p = 0.0731$) but not different from that of reference area B ($p = 0.7516$). The most significant difference in length frequency distributions was that between the two reference areas ($p = 0.0117$).

Figure 4-7
Relative Gonad Size of Slimy Sculpin Captured in Baker Creek and the Yellowknife River, 2006

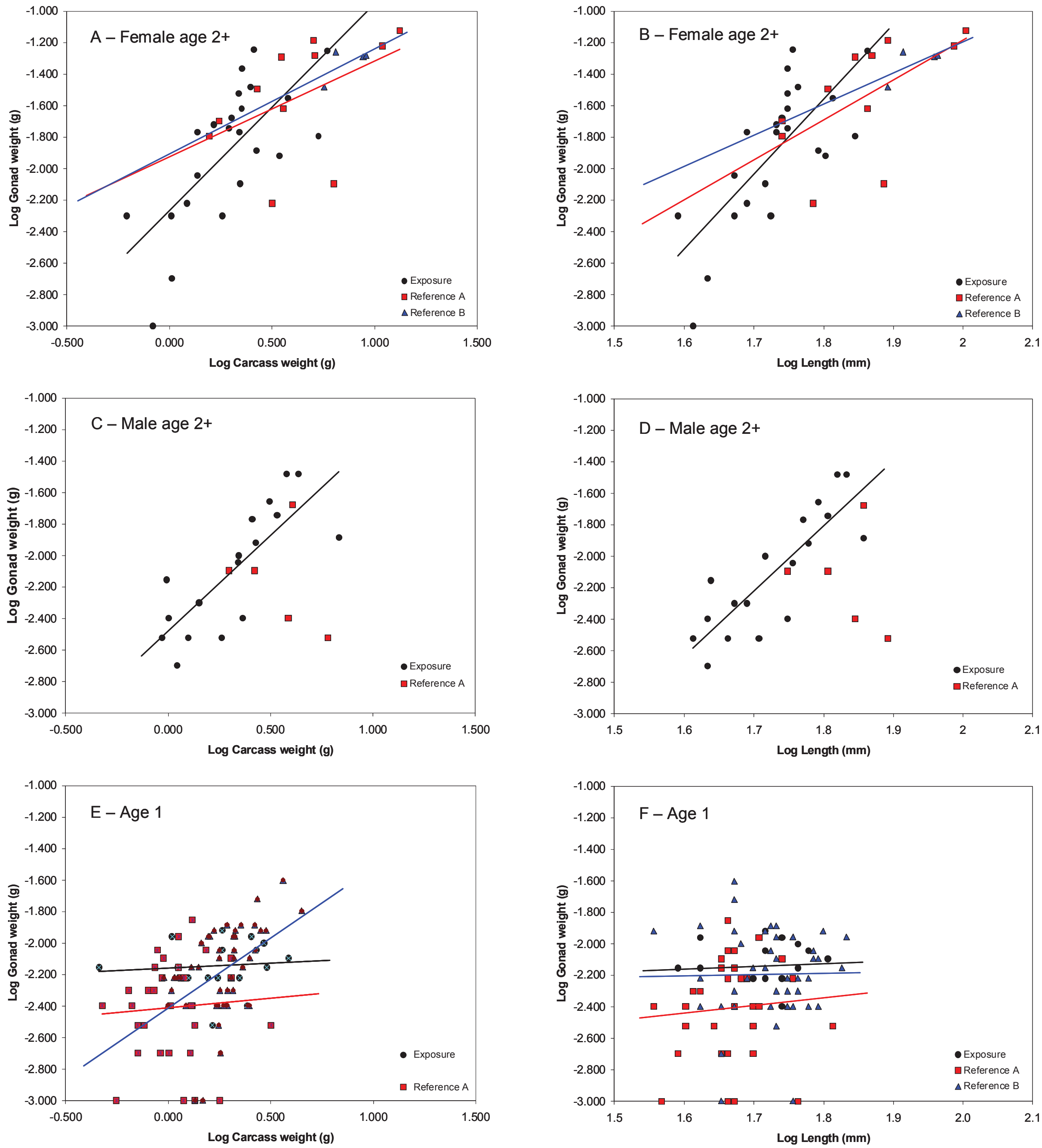


Figure 4-8
Size-at-Age of Age 2+ Female Slimy Sculpin Captured in Baker Creek and the Yellowknife River, 2006

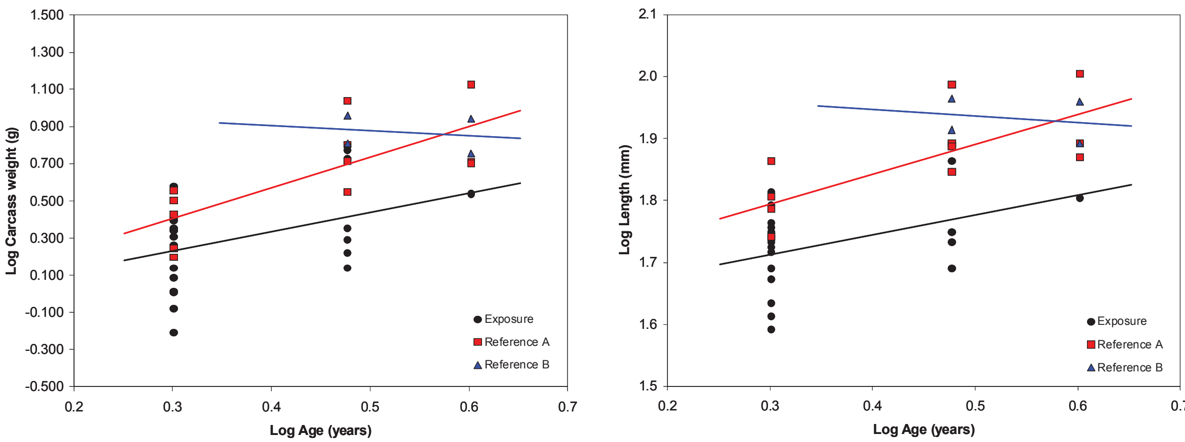


Table 4-15
Results of Statistical Comparisons of Growth Parameters Measured in Slimy Sculpin Captured in the Baker Creek and the Yellowknife River, July 2006

Group	Parameter	Slope Difference Among All Sampling Areas	Slope of Regressions			Significance of Comparisons	
		p	Exp	Ref A	Ref B	Exp vs. Ref A+ Ref B	Ref A + Ref B
Female Age 2+	Length-at-age	0.4346	0.3193	0.4819	-0.1059	ns	ns
	Weight-at-age	0.4420	1.0142	1.6366	-0.2979	ns	ns

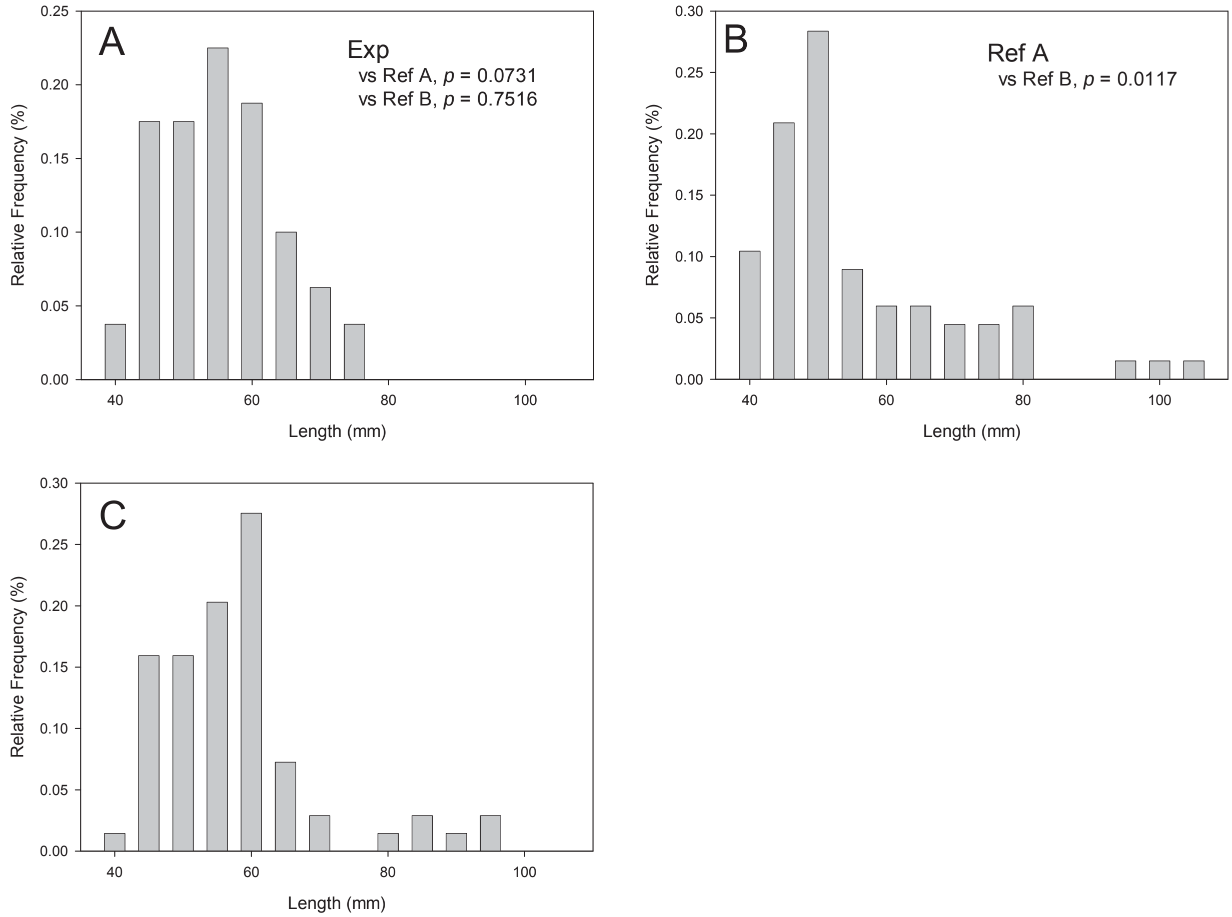
Notes: Exp = exposure area; Ref A = reference area A; Ref B = reference area B; - = minus; ns = not significant.

Table 4-16
Results of Statistical Comparisons of Size-at-Age Parameters Measured in Slimy Sculpin Captured in the Baker Creek and the Yellowknife River, July 2006

Group	Parameter	Difference in Means Among All Sampling Areas	Adjusted Least Squares Means (Log_{10})			Significance of Comparisons	
		p	Exp	Ref A	Ref B	Exp vs. Ref A+ Ref B	Ref A + Ref B
Female Age 2+	Length-at-age	0.0001	1.74764	1.84668	1.88011	****[(a)]	ns
	Weight-at-age	0.0048	0.35815	0.60059	0.70628	**	ns

Notes: Exp = exposure area; Ref A = reference area A; Ref B = reference area B; - = minus; ns = not significant.
a = Probability of Type 1 Error: * = <0.10, ** = <0.01, *** <0.001, **** = <0.0001.

Figure 4-9
Length-frequency Distributions of Slimy Sculpin Captured in Baker Creek and the Yellowknife River, July 2006



With all age classes of fish combined, slimy sculpin from the exposure area were found to be similar in mean length and weight to those from the reference areas (Tables 4-17 and 4-18). Likewise, slimy sculpin were the same size at reference area B and at reference area A. These results indicate that the overall population structure was similar among areas, but they also illustrate the loss of sensitivity in the analysis when all fish are analyzed together. Differences observed with the older, perhaps sexually mature, fish would not be seen if they were not analyzed separately.

The condition factor of slimy sculpin from the exposure area was higher than that for slimy sculpin from the reference areas (Table 4-17). This was the case for each of three groups of fish (Section 4.3.4.4). This difference was highly significant ($p < 0.0001$) and represented an increase in condition at the exposure area of 15.4% (Table 4-18).

Table 4-17
Summary Statistics for Non-Lethal Fish Health Parameters Measured in Slimy Sculpin Captured in Baker Creek and the Yellowknife River, July 2006

Parameter	Exposure		Reference A		Reference B	
	n	Mean ± SD	n	Mean ± SD	n	Mean ± SD
Length (mm)	81	53.3±8.6	67	53.9±14.8	69	55.5±11.3
Total Body Weight (g)	78	2.23±1.26	67	2.25±2.44	69	2.35±1.93
Condition (K)	78	1.30±1.26	67	1.09±2.44	69	1.16±1.93

Notes: mm = millimetre; g = gram; K = Condition factor; SD = standard deviation.

Table 4-18
Statistical Comparisons of Non-Lethal Sampling Statistics Measured in Slimy Sculpin Captured in Baker Creek and the Yellowknife River, July 2006

Parameter	Difference Among All Sampling Areas	Exposure vs. Reference		Reference vs. Reference Comparison	
		Exp vs. Ref A + Ref B		Ref A vs. Ref B	
	p	%[(a)]	*p*[(b)]	%	*p*
Fork Length (mm)	0.4136	-2.6%	ns	-2.9%	ns
Total Body Weight (g)	0.1203	-3.1%	ns	-4.3%	ns
Condition (K)	< 0.0001	15.4%	****	-6.0%	*

Notes: Exp = exposure area; Ref A = reference area A; Ref B = reference area B; mm = millimetre; g = gram; K = Condition factor; - = minus; % = percent.
a Percent difference between group means.
b Probability of Type 1 Error: * = <0.10, ** = <0.01, *** <0.001, **** = <0.0001.

4.3.5 Fish Health Results: Ninespine Stickleback

The length frequency distribution of ninespine stickleback captured in the exposure area showed that the majority of individuals were between the 16 and 30 mm length-class with a few (eight) fish greater than 35 mm (Figure 4-10A). In the reference area, the highest concentration of individuals was within a smaller length-class, and there were no fish greater than 30 mm (Figure 4-10B). Results of K-S tests run on both the complete distribution and that of fish <35 mm (presumed to be YOY) showed the exposure area length-frequency distribution was significantly different from that of reference area fish ($p < 0.0001$).

The YOY fish made up 98.5% of the total catch and the entire catch in the reference area. To reduce the variability in the analysis and to compare similar age groups between areas, only YOY fish were used in the comparison of size and condition factor. Young-of-the-year ninespine stickleback from the exposure area were larger (both in length and weight) compared to those from the reference area, and these differences were highly significant (Table 4-19). The condition factor of young-of-the-year ninespine stickleback from the exposure area was also higher than that of fish from the reference area (Table 4-19). This difference was also highly significant and represented a large increase in condition at the exposure area of 47.1%.

Figure 4-10
Length-frequency Distributions of Ninespine Stickleback Collected from the Exposure Area (Baker Creek) and Reference Area (below Tartan Rapids)

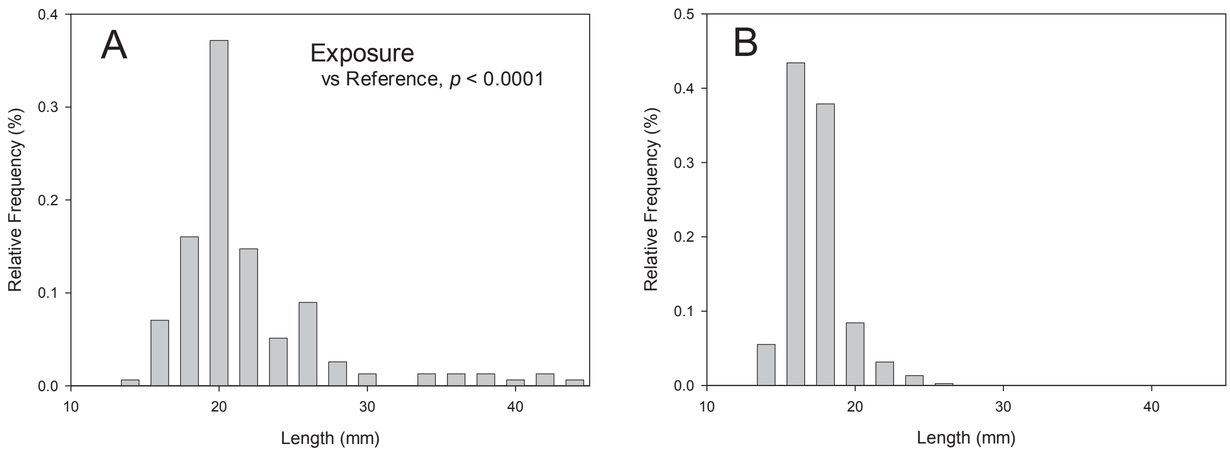


Table 4-19
Summary Statistics and Statistical Comparisons for Non-Lethal Fish Health Parameters Measured in Young-of-the-Year Ninespine Stickleback Captured in Baker Creek and the Yellowknife River

Parameter	Exposure		Reference		Exposure vs. Reference	
	n	Mean ± SD	n	Mean ± SD	%[(a)]	$p^{(b)}$
Length (mm)	148	20.6±3.4	380	16.9±1.9	21.9%	****
Total body weight (g)	16	0.146±0.064	50	0.053±0.016	175.5%	****
Condition (K)	16	1.03±0.31	50	0.70±0.15	47.1%	****

mm = millimetre; g = gram; K = Condition factor; SD = standard deviation % = percent.
a = Percent difference between group means.
b = Probability of Type 1 Error: * = <0.10, ** = <0.01, *** <0.001, **** = <0.0001.

4.4 Power Analyses

The power of statistical comparisons for slimy sculpin fish health parameters was examined in terms of minimum detectable difference. The minimum detectable difference is the minimum difference between the exposure area and reference areas that could be detected given the study sample size, variation in the data, an $\alpha = 0.10$ and a power of 90%. This is especially important to know when statistical differences between areas have not been detected. In other words, power analysis determines if the program had the ability to detect those differences.

In general, the actual power achieved was sufficient to be able to detect differences (Table 4-20). The power to detect area differences was lower for the age 2+ males in general and for both the male and female GSI parameter. The sample size was very low in the age 2+ male group, and since the fish were in post-spawning condition, there was vary little gonadal development and, hence, large relative variability in this parameter.

In a number of cases, the observed difference was slightly less than the minimum detectable difference, even though the observed difference was significant. This is likely due to some assumptions inherent to the calculation of minimum detectable difference, such as equal sample sizes between areas.

For age 2+ female and age 1 comparisons that were not found to be significant, minimum detectable differences were relatively small indicating the sampling program had sufficient power for those groups. For example, age 2+ female LSI, age 1 LSI and age 1 length comparisons had minimum detectable differences that were smaller than 25% of the exposure mean. For age 2+ male parameters that were not significant (such as LSI), minimum detectable differences were high (>200% increase and < 65% decrease) suggesting that the sampling program was not sufficient to detect effects within a reasonable range of responses.

Table 4-20
Observed Percent Differences and Minimum Detectable Differences for Slimy Sculpin Captured in Baker Creek and the Yellowknife River

Sex	Parameter	Observed Difference (%)	Minimum Detectable Difference	
			Increase (%)	Decrease (%)
Female 2+	Age	-21.7	8.3	-7.7
	Length	-28.8	8.0	-7.4
	Total body weight	-60.3	29.4	-22.7
	Carcass weight	-60.7	29.4	-22.7
	Condition factor	9.8	8.0	-7.4
	LSI	13.6	24.8	-19.9
	GSI	6.4	54.6	-35.3
Male 2+	Length	-22.9	24.4	-19.6
	Total body weight	-49.2	108.7	-52.1
	Carcass weight	-49.1	108.2	-52.0
	Condition factor	7.7	12.2	-10.8
	LSI	-5.0	217.6	-68.5
	Gonad weight	28.2	229.6	-69.7
Age 1	Length	1.0	7.5	-7.0
	Total body weight	23.8	27.4	-21.5
	Carcass weight	24.4	27.4	-21.5
	Condition factor	18.0	7.5	-7.0
	LSI	-8.8	23.1	-18.8
	Gonad weight	14.7	14.4	-12.6

Notes: % = percent.

4.5 Discussion

4.5.1 Fishing Success in Baker Creek

In the past, the success of capturing most small-bodied fish species in Baker Creek has been limited. Studies from the 1970s captured almost no fish in the creek. More recent surveys (1998 to 2003) have yielded some fish but few in total (see Golder 2003 and Golder 2005 for details). This is in contrast to the 714 fish that were captured in 2004, the 1,037 in 2006, and the very large schools of adult ninespine stickleback seen consistently in spring 2007 at the mouth of Baker Creek (Golder 2007; Vecsei *et al.* 2008). Fishing effort and gear types can explain part of the difference but the sheer number of fish in the creek seems relatively high compared to the historic data and the local perception of the creek. It is of considerable local interest to see the increase in the number of fish and species of fish in the creek. Dramatic improvements in effluent quality, particularly in ammonia and metals, since closure of the mine in 1999 could partially explain this.

Certainly the capture of large number of slimy sculpin in the exposure area is of interest and was surprising for the Phase 2 EEM FS. Very few slimy sculpin had been captured in the area prior to 2006 (see Golder 2005; Dillon 2002a, b; and Moore 1978). In 2006, the fishing area included rocky habitat in the far-field near the new City dock and this area has not previously been the focal area for fishing. It is also possible the decreasing conductivity in Baker Creek (from 2,600 µS/cm in 1998 to 1100 µS/cm in 2003 to 600 µS/cm in this study) coupled with the use of the larger anode ring (19 inch) likely made the electrofishing more effective than in past years. Slimy sculpin tend to have a lag time from when they are shocked to when they turn over and can be captured with a dip net; field crew experience in capturing slimy sculpin can play a part in success of capture as well. The Yellowknife River has not been extensively sampled by electrofishing methods so comparisons of slimy sculpin catch over time cannot be made.

Given the success of captures in 2006, slimy sculpin and ninespine stickleback were the chosen study species as they were the two most abundant and appropriate species captured in both the exposure area and the reference areas. A combination of a lethal and a non-lethal fish survey was conducted for the Phase 2 EEM FS. As in Phase 1 (Golder 2005), field crews expanded the aerial extent and increased fishing effort in the reference area to improve the study design; three reference areas in Yellowknife River resulted.

4.5.2 Population Structure

The population structure of age 2+ slimy sculpin examined in the Baker Creek exposure area showed a tendency towards younger, smaller fish compared to reference areas, while age 1 slimy sculpin tended to be somewhat heavier in the exposure area. Decreased mean age of a population could be a result of decreased survivorship of the oldest fish (Munkittrick *et al*. 2000); however, the oldest age class (age 4) was found in both the exposure and reference areas. Length-frequency distributions of slimy sculpin did show a lack of larger (>80 mm), and presumably older, individuals at the exposure area, but the size-at-age analysis clearly showed that Baker Creek fish older than age 1 are growing slowly relative to reference area fish. Moreover, the only non-YOY ninespine stickleback were captured in Baker Creek. Therefore, there is little evidence to suggest that survivorship is being affected in Baker Creek.

The tendency towards smaller body sizes in older fish, as seen in age 2+ females and age 2+ males, may be indicative of decreased resource availability. This can be from a lower absolute amount of resources available due to decreased productivity, or may be due to a decrease in the relative amount of resources available due to increased competition. Increased competition at the exposure area does not seem likely given the similar catch per unit effort of slimy sculpin from backpack electrofishing. In addition, there was no evidence of resource limitations for the younger, smaller fish. Age 1 sculpin in Baker Creek were somewhat heavier with greater condition factors, and YOY ninespine stickleback were much larger with much greater condition factors than reference fish. Interestingly, the condition factor of the reference fish (0.7) matches that of reference fish from the Phase 1 study of ninespine stickleback from Horseshoe Bay Island as well as the condition factor of young ninespine stickleback from the Con Mine EEM study, which was completed within 10 km of this study; this suggests the appropriateness of the reference area for YOY ninespine stickleback and highlights the difference in the exposure area.

There were habitat differences between exposure and reference areas (described in Chapter 3; see Photoplates), and these could account for the differences in the population structure that was seen. In addition, predation on slimy sculpin and ninespine stickleback in the exposure area is likely an influential factor given the presence of northern pike, burbot and lake trout.

4.5.3 Fish Health

Based on measurements of gonad size and the population size structure of both species (including the presence of Age 1 slimy sculpin and abundant YOY ninespine stickleback), there was no evidence of reproductive impairment fish in the Baker Creek populations. However, there was evidence of decreased energy expenditure and increased energy storage in exposure area populations. A decrease in energy expenditure, as seen through smaller size-at-age, was observed in age 2+ female slimy sculpin from the exposure area. Statistically significant differences were detected in a number of EEM effect and support endpoints (Table 4-21). However given that many are likely within the range of natural variation (20 to 30%) and that fish from reference areas are often statistically different from each other, the ecological significance of these effects in not hard to determine (Table 4-21). The natural variability in male gonad weight between the two reference areas could not be assessed because of the small sample size in reference area B. Therefore, results for male age 2+ gonad weight cannot be considered conclusive, but are considered as an effect as defined in the EEM TGD (EC 2002).

Table 4-21
Summary of Effects on Lethal Fish Health Parameters of Slimy Sculpin Collected from Baker Creek Relative to Fish from Reference Areas

Sex/ State-of-Maturity	Type of Endpoint	Endpoint	Exposure vs. Reference		Reference vs. Reference	
			Magnitude (%)	Direction	Magnitude (%)	Direction
Effect Endpoints[(a)]						
Female Age 2+	Survival	Age	-21.7	Exp<Ref	-19.0	Ref A<Ref B
	Energy Storage	Condition factor	9.8	Exp>Ref	-3.2	Ref A<Ref B
		Liver weight vs. Carcass weight	13.6	Exp>Ref	1.4	Ref A>Ref B
	Energy Use	Gonad weight vs. Carcass weight	6.4	Exp>Ref	29.5	Ref A>Ref B
Male Age 2+	Energy Storage	Condition factor	7.7	Exp>Ref	-	-
		Liver weight vs. Carcass weight	-5	Exp<Ref	-	-
	Energy Use	Gonad weight	28.2	Exp>Ref	-	-
Age 1	Energy Storage	Condition factor	18	Exp>Ref	-6.6	Ref A<Ref B
		Liver weight vs. Carcass weight	-8.8	Exp<Ref	-20.0	Ref A<Ref B
Support Endpoints[(a)]						
Female Age 2+	Energy Use	Length	-28.8	Exp<Ref	-14.2	Ref A<Ref B
		Body weight	-60.3	Exp<Ref	-31.1	Ref A<Ref B
		Carcass weight	-60.7	Exp<Ref	-31.0	Ref A<Ref B
Male Age 2+	Energy Use	Length	-22.9	Exp<Ref	-	-
		Body weight	-42.9	Exp<Ref	-	-
		Carcass weight	-49.1	Exp<Ref	-	-
Age 1	Energy Use	Length	1.0	Exp<Ref	-12.8	Ref A<Ref B
		Body weight	23.8	Exp>Ref	-38.8	Ref A<Ref B
		Carcass weight	-49.1	Exp>Ref	-38.5	Ref A<Ref B

Notes: Exp = Baker Creek; Ref A = Yellowknife River – reference area A; Ref B = Yellowknife River – reference area B; vs. = versus; > = greater than; < = less than; n/a = not applicable; % = percent; - = insufficient sample size to complete statistical comparison.

a Indicates effect analysis or support analysis as defined in the Metal Mining Environmental Effects Monitoring Technical Guidance Document (EC 2002).

In contrast, energy storage, as evaluated by condition factor, was greater in all age groups of slimy sculpin and in YOY ninespine stickleback from the exposure area (Table 4-22). These differences between the exposure area and reference area populations could be a result of either contaminants (current or historical), habitat differences, fish community differences, or a combination of all three.

Table 4-22
Summary of Effects on Non-lethal Fish Health Parameters of Slimy Sculpin and Ninespine Stickleback Collected from Baker Creek Relative to Fish from the Yellowknife River

Endpoint	Exposure vs. Reference		Reference vs. Reference	
	Magnitude (%)	Direction	Magnitude (%)	Direction
Slimy Sculpin				
Condition	15.4	Exp>Ref	-6.0	Ref A<Ref B
Ninespine Stickleback				
Length	21.9	Exp>Ref	n/a	n/a
Body Weight	175.5	Exp>Ref	n/a	n/a
Condition	47.1	Exp>Ref	n/a	n/a

Notes: Exp = Baker Creek; Ref A = Yellowknife River – reference area A; Ref B = Yellowknife River – reference area B; > = greater than; < = less than; n/a = not applicable; % = percent; vs. = versus.

The main metalloid of concern in the study area, based on historical contamination, is arsenic. Impaired growth could be one of the effects of exposure to elevated levels of arsenic. This then leads to the question of whether the lower growth rate observed in older exposure-area fish is a result of exposure to elevated arsenic concentrations. The arsenic concentration measured during the fish survey in the exposure area (July 18, 2006) was 146 µg/L. This compared to the Reference area measurement of <0.2 µg/L (August 4, 2006). To better estimate the approximate concentrations of this metal to which fish may have been exposed, an average for the areas that were fished using the water quality data collected during the benthic invertebrate survey was calculated. The mean exposure area concentration on August 10, 2006, was 176.5 µg/L (based on water samples from E02 and E03), which was considerably greater than the mean concentration (1.4 µg/L) in the areas fished in the reference areas (water samples from R08 and R10, August 17, 2006).

Toxicity data from several studies indicate that the concentrations of arsenic in the exposure area would not likely cause sub-lethal effects in fish (Jana and Sahana 1989; US EPA [latest quality criteria reference]; State of Idaho [water quality standards doc]; CCME 1999). This conclusion is supported by the presence of higher concentrations of phosphorous in the exposure area. Higher phosphorous concentrations tend to reduce arsenic toxicity (Reuther 1992). This is also supported by the lack of sub-lethal toxicity to the fathead minnow in chronic toxicity tests of the mine effluent (see Chapter 6). Rankin and Dixon (1994) reported a threshold of chronic toxicity of rainbow trout of 490 µg/L of As^{3+}.

Other effluent constituents that could cause sub-lethal effects as detected in this study include aluminum, iron and manganese as they were above CCME guidelines. Sulphate concentrations in the near-field (150 to 350 mg/L) and in the effluent at the end of pipe (950 mg/L) are well above the recommendation in the BC provincial ambient water quality guidelines of 100 mg/L for sulphate (Government of BC 2004).

In addition to the surface water quality constituents above CCME guidelines, metals concentrations in the sediment in the exposure area exceed guidelines and are considerably higher in concentration compared to the reference areas: arsenic and copper, lead and zinc. However, concentrations of these metals are not elevated in the overlying water.

Concentrations of arsenic in bottom sediments in the fish exposure area were elevated compared to the reference area. Mean arsenic concentrations in the exposure area was 718.0 µg/g dry wt in 2004. This concentration is clearly above PEL (17 µg/g) and ISQG (5.9 µg/g) associated with adverse biological effects, principally to benthic-dwelling organisms (CCME 1999, 2002). Recent studies in the Yellowknife Bay (Andrade 2006) have shown that the arsenic concentrations in the porewater in the Baker Creek area are elevated above the surface concentrations and that arsenic may be remobilizing from the sediment into the water similar to the Con Mine receiving environment (*e.g.* Bright *et al.* 1994). The porewater concentrations of arsenate in Baker Creek are elevated above the sediment water interface (117-181 µg/L, arsenate is forming the bulk of the total arsenic)). Arsenic trioxide, which is a more toxic form of arsenic that arsenate ($As5^{+}$), is low at the sediment water interface but quickly rises to 5815 µg/L by 18 cm in depth. The highest porewater arsenic concentrations found in the 2006 study (Andrade 2006) were found in the Baker Creek marsh area.

It is unclear, however, to what degree the elevated concentrations in porewater and sediment could affect slimy sculpin and ninespine stickleback. The long-term dataset on the speciation of arsenic in the creek itself is patchy and the form of arsenic present likely varies with effluent and microhabitat constituents; determination of the exposure to the various forms of arsenic and their risk to fish is difficult to assess. While slimy sculpin are bottom feeders, their primary habitat consists of rocky substrata rather than soft muddy bottoms, from which the sediment and pore water samples were collected. This could suggest that the concentrations measured in the water column could be the relevant measures of arsenic for assessing exposure to slimy sculpin.

Ninespine stickleback on the other hand, are closely associated with soft substrate for most of their life stages including gathering mouthfuls of sediment to build a nest. Interestingly, recent studies the viscera and muscle tissue of fish in Yellowknife Bay demonstrated higher arsenic concentrations in bottom feeders than piscivores (de Rosemond 2008). Stickleback metal uptake was studied in natural populations and they appeared to accumulate metals from food, water and sediment (Bervoets *et al.* 2001). This suggests bottom feeders are at more risk to exposure than other species and this would include both ninespine stickleback and slimy sculpin.

Physical habitat plays an important role in the physiology of slimy sculpin (Craig and Wells 1976; Hershey and McDonald 1985; Hanson *et al.* 1992). The differences observed between the exposure and reference populations of both species, namely growth and condition factor, could well be explained by the considerable difference in habitat types in the two main sampling areas. Although a cobble-size rocky substratum was the principal habitat type targeted in all sampling areas, several habitat characteristics differed between exposure and reference areas. General habitat type also differed between the two areas. The reference areas were near the mouth of a relatively large river, whereas the exposure area was in a marsh area at the mouth of a much smaller creek.

Another habitat characteristic that could explain the growth differences for slimy sculpin and ninespine stickleback is temperature. During effluent discharge in July, daily maximum temperatures exceeded 22°C in Baker Creek. As a cool-water stenotherm, slimy sculpin has a narrow temperature range with an upper lethal limit of approximately 23 to 25°C (Symons *et al*. 1976; Otto and Rice 1977), and would be unable to survive long in waters above 25ºC (Kuehne 1962). Symons *et al.* (1976) suggested that sustained temperatures over 19ºC would lead to a decrease or disappearance of slimy sculpin. Edwards (2001) observed a decrease in slimy sculpin density as water temperature increased, with a dramatic decrease at 22ºC. Gray (2003) also demonstrated slimy sculpin densities decreased with increasing water temperatures and noted an absence of YOY slimy sculpin when water temperatures exceeded 25°C. Therefore, the increased water temperatures in Baker Creek may have contributed to some of the differences observed.

As a result of these habitat differences, it is virtually impossible to distinguish mine-related effects from those due to habitat influences. Should the confounding influence of habitat differences among areas be resolved during the next phase of study, distinguishing historical contamination effects from present-day effluent-related effects could be challenging. Historical contamination, as evidenced by the elevated concentrations of certain metals (known to be toxic) encountered in exposure area sediments, could still be a contributing factor to population differences observed in future studies.

5.0 INVERTEBRATE COMMUNITY SURVEY

5.1 Introduction and Objectives

In January 2006, an ICS was submitted as part of INAC's Giant Mine *Phase 2 EEM Study Design* (Golder 2005). A control/impact design was proposed to examine potential effects of present-day effluent on the invertebrate community in discrete exposure areas within Baker Creek and Yellowknife Bay in comparison to the reference area in the Yellowknife River.

The Phase 1 ICS was initially proposed as a gradient design (Golder 2003); however, effluent concentrations were found to be either concentrated or diluted and did not conform to the expected gradient. As a result, in 2004 a control/impact analysis was used to test for differences between the exposure area near the point of discharge (near-field area), at some distance away from the point of discharge (far-field area), and a reference area that was identified *a priori* (Golder 2005). The proposed Phase 2 ICS study design is a refinement of the Phase 1 ICS study design, converting it to a more balanced control/impact design typical of EEM studies (EC 2002).

Artificial substrate samplers (multi-plate Hester-Dendy samplers) were selected for the Phase 2 ICS to minimize the effects of confounding factors on the evaluation of present-day effluent effects (see Sections 2 and 3 for details) and to be consistent with the Phase 1 ICS. Use of artificial substrates eliminated the potential effects of historical sediment contamination, as well as variation in sediment particle size distribution and organic content on community structure.

5.2 Methods

5.2.1 Study Area and Sampling Locations

Exposure Area

The exposure area for the ICS was restricted to the marsh at the mouth of Baker Creek and adjacent portions of Yellowknife Bay. There are a number of significant historical factors that complicate a study of present-day effects of effluent discharged into Baker Creek:

- historical deposition of tailings in the creek;
- accumulation of metals and metalloids (particularly arsenic) in sediments from atmospheric deposition and run-off;
- extensive alteration of Baker Creek (*i.e.*, channelization, channel diversion, sedimentation, culvert construction); and

- potential groundwater seepage from the underground mine.

While the effects of these confounding factors were reduced by restricting the exposure area, the depositional area of the marsh has been impacted by mining activities. The construction of a breakwater has altered the channel in the marsh and sediment is contaminated with levels of arsenic ranging from 278 to 2,550 µg/g (dry weight) (Mace 1998). Despite these potential confounding factors, this area is a more suitable sampling location than the upper reaches of Baker Creek because the deeper water and slower current in the marsh channel allow for the installation of artificial substrate samplers within the water column. In addition, surface water at the mouth of Baker Creek is estimated to consist of 90% effluent during low flow conditions; therefore, it is reasonable to expect effects in this section of the exposure area.

Specific conductivity measured in the field was used to determine the presence of effluent. The exposure area for the ICS was divided into two areas based on effluent concentration:

- near-field area – defined as the area where effluent concentrations were highest during the period of discharge (*i.e.*, mean specific conductivity values between 1,155 and 1,425 µS/cm at the bottom of the water column), which was at the mouth of Baker Creek; and
- far-field area – defined as the area where effluent concentrations approached background but where some effluent was still evident (*i.e.*, mean specific conductivity values between 62 and 129 µS/cm), which was in Yellowknife Bay.

Five replicate stations were initially established in each of the near-field and far-field areas. Coordinates for each of these sampling locations are provided in Table 5-1. Following field sampling, one near-field station (E06) was reclassified as a far-field station as specific conductivity at this station was more comparable to other far-field stations (Figure 5-1).

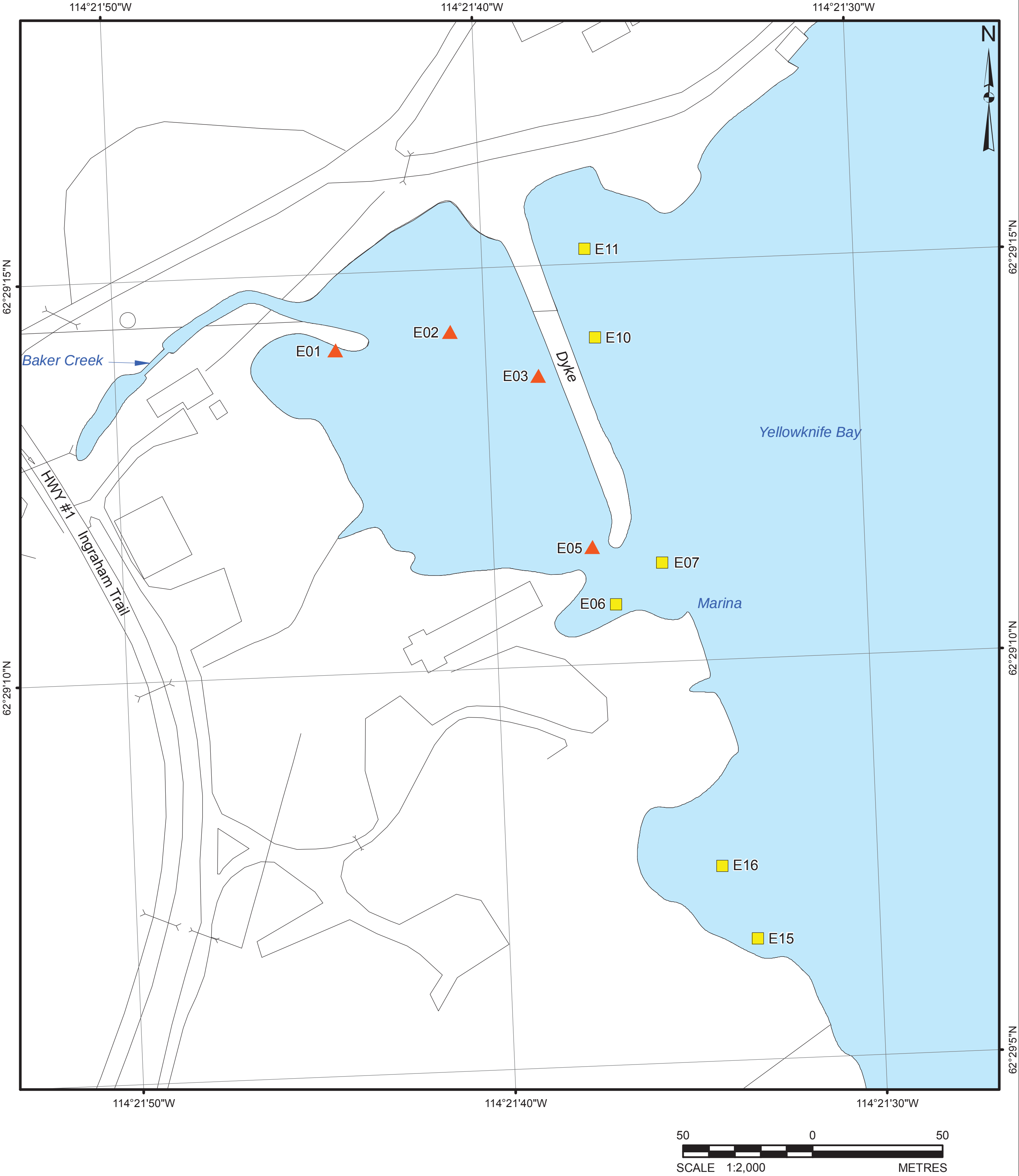
Reference Area

The mouth of the Yellowknife River was selected as the reference area for the ICS because most of it is not affected by mining activities, it is easy to access, and has similar habitat as the exposure area (Golder 2005). A transition from flowing water to lacustrine habitat occurs at the mouth of the Yellowknife River. Sampling stations were restricted to lacustrine habitat to reduce the potential confounding factor of flowing water. Mean specific conductivity values were between 51 to 80 µS/cm.

Table 5-1
Replicate Sampling Station Locations for the Giant Mine Phase 2 Invertebrate Community Survey, 2006

Sampling Area	Replicate Station	Sampling Interval	Length of Sampling	UTM Coordinate[a]		Latitude	Longitude
				Easting	Northing		
Mouth of Baker Creek/ Yellowknife Bay (Near-field Area)	E01	29-Jun-06 to 07-Sep-06	70 days	635917	6931236	62°29'14.0" N	114°21'44.3" W
	E02	29-Jun-06 to 07-Sep-06	70 days	635959	6931242	62°29'14.2" N	114°21'41.3" W
	E03	29-Jun-06 to 07-Sep-06	70 days	635994	6931226	62°29'13.6" N	114°21'38.9" W
	E05	29-Jun-06 to 07-Sep-06	70 days	636014	6931160	62°29'11.5" N	114°21'37.7" W
Baker Creek/ Yellowknife Bay (Far-field Area)	E06	29-Jun-06 to 07-Sep-06	70 days	636023	6931137	62°29'10.7" N	114°21'37.1" W
	E07	30-Jun-06 to 07-Sep-06	69 days	636041	6931153	62°29'11.2" N	114°21'35.79" W
	E10	30-Jun-06 to 07-Sep-06	69 days	636016	6931240	62°29'14.0" N	114°21'37.8" W
	E11	30-Jun-06 to 07-Sep-06	69 days	636011	6931274	62°29'15.1" N	114°21'37.6" W
	E15	30-Jun-06 to 07-Sep-06	69 days	636079	6931008	62°29'6.5" N	114°21'33.6" W
	E16	30-Jun-06 to 07-Sep-06	69 days	636065	6931037	62°29'7.4" N	114°21'34.5" W
Yellowknife River (Reference Area)	R06	30-Jun-06 to 08-Sep-06	70 days	638172	6934065	62°30'42.4" N	114°18'58.7" W
	R07	30-Jun-06 to 08-Sep-06	70 days	638181	6934143	62°30'44.9" N	114°18'57.9" W
	R08	04-Jul-06 to 08-Sep-06	66 Days	637776	6934755	62°31'5.2" N	114°19'24.4" W
	R09[b]	04-Jul-06 to 08-Sep-06	66 Days	637671	6934727	62°31'4.4" N	114°19'31.8" W
	R10	30-Jun-06 to 08-Sep-06	70 days	637922	6934735	62°31'4.3" N	114°19'14.2" W
	R16	30-Jun-06 to 08-Sep-06	70 days	637810	6934864	62°31'8.6" N	114°19'21.7" W

Note: UTM = Universal Transverse Mercator coordinates.
The prefix “E” identifies sampling locations in the exposure area (*i.e.*, Baker Creek and Yellowknife Bay) and “R” identifies sampling locations in the reference area (*i.e.*, Yellowknife River).
a All UTM coordinates are in NAD 83, Zone 11V.
b Station R09 was sampled, but results are provided for informational purposes only and were not included in the statistical analysis or data assessment.
c Station R16 was added in 2006 to replace R09, which has higher arsenic concentrations compared with other reference areas.



Legend

- ▲ Invertebrate Sampling Location - Near-field Area
- ■ Invertebrate Sampling Location - Far-field Area

REFERENCE
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 11

PROJECT
Indian and Northern Affairs Canada

GIANT MINE
ENVIRONMENTAL EFFECTS
MONITORING PROGRAM

TITLE
LOCATION OF BENTHIC INVERTEBRATE COMMUNITY SAMPLING STATIONS IN THE EXPOSURE AREA, 2006

Golder Associates
Saskatoon, Saskatchewan

PROJECT No.		07-1328-0002	SCALE AS SHOWN	REV. 0
DESIGN	KM/SV	15/01/08		
GIS	JRC	13/05/08	**FIGURE: 5-1**	
CHECK	KG	30/05/08		
REVIEW	HM	30/05/08		

G:\2007\1328\07-1328-0002 Giant Mines MME\07-1328-0002 Loc_invertebrate_sampling_Baker_Creek.mxd

Five replicate stations were established in the reference area (Figure 5-2). Coordinates for each of these sampling locations are provided in Table 5-1. One additional location (R09) was sampled. During the Phase 1 EEM ICS, sediment collected at R09 contained arsenic concentrations greater than background concentrations. Additional sampling completed during the Phase 2 EEM program confirmed elevated arsenic concentrations at R09. Thus, station R09 was not considered a reference station and data from this station are provided for informational purposes only; they were not incorporated into the statistical analysis and data assessment.

5.2.2 Timing of Sampling

Artificial substrates were deployed in Baker Creek between June 29 and 30, 2006, and in the Yellowknife River between June 30 and July 4, 2006. All artificial substrates were deployed prior to the start of effluent discharge from the Mine, which began on July 5, 2006.

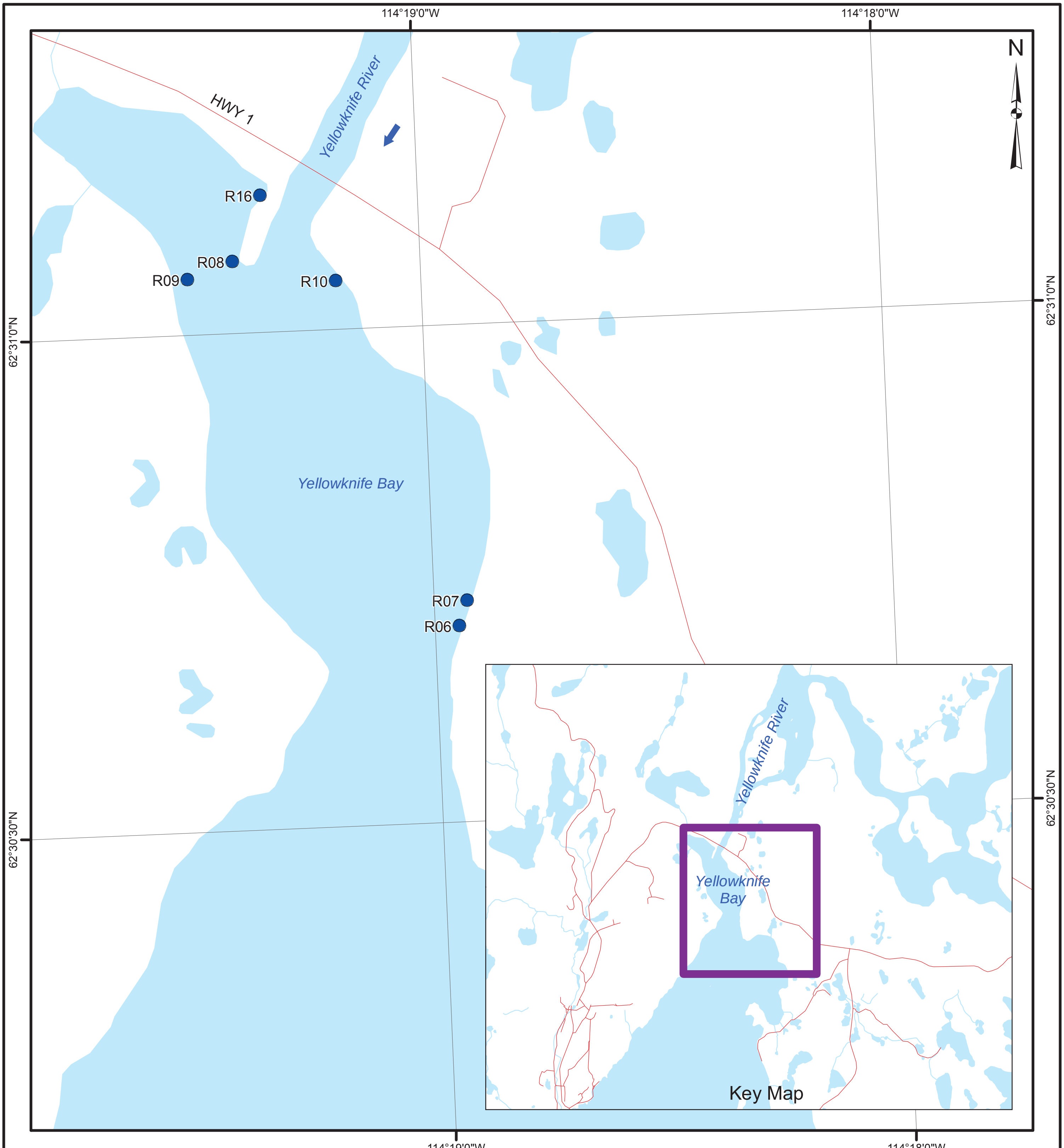
Sampling stations were inspected at mid-program on August 10 and August 17, 2006 to determine if vandalism or wave damage had occurred. One artificial substrate at station E07 (exposure area) was found pulled from the water and sitting on the bank near the breakwater. Supporting environmental information was collected at the time of inspection, but the artificial substrate was not replaced.

The artificial substrates were removed from Baker Creek on September 7, 2006 and from the Yellowknife River on September 8, 2006. Colonization periods of the artificial substrates varied between 66 and 70 days (Table 5-1).

5.2.3 Field Methods

5.2.3.1 Supporting Environmental Variables

As outlined in the EEM TGD (EC 2002), key supporting environmental information must be collected during the ICS. Supporting information may assist in the interpretation of results from the ICS, as well as provide the basis for comparisons of water and sediment quality among study areas. Supporting environmental variables included water and sediment chemistry, along with an assessment of physical habitat characteristics.



200 0 200

SCALE 1:10,000 METRES

Legend

- Invertebrate Sampling Location - Reference Area
- Flow Direction

PROJECT

Indian and Northern Affairs Canada

GIANT MINE
ENVIRONMENTAL EFFECTS
MONITORING PROGRAM

TITLE

LOCATION OF BENTHIC INVERTEGRATE COMMUNITY SAMPLING STATIONS IN THE REFERENCE AREA, 2006

PROJECT No.		07-1328-0002	SCALE AS SHOWN	REV. 0
DESIGN	KM/SV	15/01/08	**FIGURE: 5-2**	
GIS	JRC	21/04/08		
CHECK	KG	30/05/08		
REVIEW	HM	30/05/08		

Golder Associates
Saskatoon, Saskatchewan

REFERENCE
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 11

G:\2007\1328\07-1328-0002 Giant Mines MME\07-1328-0002 Loc_invertebrate_sampling_YKRivIsl.mxd

Water Quality

Water quality parameters were measured *in situ* at each station when the artificial substrate samplers were deployed, at mid-program, and upon retrieval:

- water depth;
- water velocity;
- water temperature;
- dissolved oxygen;
- pH;
- specific conductivity; and
- turbidity.

Water depth, water temperature, dissolved oxygen, specific conductivity, and pH were recorded with a YSI 600QS multi-meter. Turbidity was measured using a Lamotte 2020 turbidity meter. Water velocity was measured using a Marsh-McBirney velocity meter.

During the ICS, water chemistry samples were collected at five replicate stations within both the exposure area (Baker Creek) and the reference area (Yellowknife River). Water chemistry samples were collected on August 10, 2007 (stations E02, E03, and E10) and August 17, 2007 (stations E06, E16, R06, R07, R08, R10, and R16).

Water chemistry samples were collected according to protocols outlined in the Giant Mine SOP for MMER Effluent and Water Quality Monitoring (MGML 2003) and in accordance with the specific handling requirements of ALS Environmental Group (ALS). Sample bottles were triple-rinsed with ambient water prior to sample collection. Surface water samples were collected from approximately 15 cm below the water surface, with the bottle mouth facing upstream. In addition, two travel blanks, two field blanks, and two duplicate samples were submitted as part of the quality assurance/quality control (QA/QC) protocols.

Water samples were shipped on ice packs in sealed, labelled coolers to ALS in Vancouver, British Columbia (BC), for chemical analysis. Water samples were analyzed for the following parameters:

- physical characteristics (*e.g.*, conductivity, alkalinity, total hardness, pH);
- total and dissolved metals;
- nutrients; and
- major ions.

Sediment Quality

Bottom sediment samples were collected at each station when artificial substrate samplers were retrieved over a two day period at the beginning of September. Samples were collected using a standard 6-inch Ekman grab with a bottom area of 0.0232 m^2. Three Ekman grabs were combined into a composite sample with a minimum of 1,000 g (wet weight) for each sampling station.

All sediment samples were frozen and sent to ALS in Vancouver, BC for analysis of particle size, percent moisture and total organic carbon (TOC). The *Phase 2 EEM Study Design* (Golder 2006) indicated that ten samples (five from the exposure and five from the reference area) would be analyzed for total metal concentrations. Due to an error during sample submission, only nine samples were analyzed, and only for total arsenic concentrations.

Particle size was analyzed according to the following classification:

- gravel (>2 mm);
- sand (2 mm to 0.063 mm);
- silt (0.063 mm to 0.004 mm); and
- clay (<0.004 mm).

Habitat Characteristics

Habitat type, substrate characteristics, and percent bottom cover by aquatic vegetation were recorded at each replicate station. Water depth and water velocity were recorded at deployment, mid-program, and upon retrieval of the artificial substrates.

5.2.3.2 Invertebrate Sampling Methods

Artificial Substrate Samplers

The Hester-Dendy sampler is a multi-plate artificial substrate sampler that is approved by the United States Environmental Protection Agency. Specifications of the Hester-Dendy samplers used in the 2006 field program were as follows:

- model # 150-A50;
- constructed of 0.3 cm thick tempered hardboard;
- 7.5 cm round plates and 2.5 cm round spacers with centre-drilled holes;
- the 14 plates are variably separated by 24 spacers on a 14 cm long eyebolt;
- the top nine plates are separated by a single spacer, plate 10 is separated by two spacers, plates 11 and 12 are separated by three spacers, and plates 13 and 14 by four spacers; and
- the total exposed surface area of the sampler is approximately 0.16 m^2.

Sampler Deployment

Six artificial samplers were deployed at each sampling station within the near-field, far-field and reference areas, for a total of 90 artificial substrates. The samplers were attached to a wooden base to minimize contact with the substrate and enhance stability on the bottom. This method was chosen instead of suspending the samplers from floats to minimize vandalism and prevent contact with the bottom if water levels changed. The wooden base consisted of a plywood triangle with T-nuts installed in each corner so that the samplers could be easily attached and removed, but would remain stable in the water. A large rock was tied to the centre of the triangular board to act as a weight and increase stability when deployed (Photographs 9 and 10).

Two sampler mounts (A and B), each with three samplers, were deployed at each station by lowering them to the bottom using rope strung through the eyebolts of the attached Hester-Dendy samplers. Field crews verified that the sampler mounts were placed on the bottom in an up-right position, on relatively flat substrate.

Sampler Retrieval

Eighty-seven of 90 artificial substrates were retrieved at the end of the sampling period. At station E07, only sampler mount B (*i.e.*, three samplers) was retrieved because sampler mount A had been vandalized and removed from the water. The artificial substrates were retrieved by hooking the eyebolts of the Hester-Dendy samplers with two gaff hooks, and then slowly lifting them to the surface to minimize sample disturbance. When the sampling unit was close to the water surface, a crew member lifted it into the boat. Hester-Dendy samplers were removed from the wooden base and placed individually into pre-labelled Ziploc® bags. These samples were then taken to Golder (Yellowknife) where the invertebrates were removed from each sampler.

5.2.3.3 Laboratory Methods

Removal of Invertebrates from the Artificial Samplers

Ziploc® bags with individual Hester-Dendy samplers were refrigerated at 4°C until they could be processed. Hester-Dendy plates were dismantled into a clean plastic washbasin and were gently washed with tap water to remove invertebrates. Invertebrates were rinsed from the washbasin into a 500 micrometer (µm) mesh sieve, and any debris smaller than 500 µm was washed away. Invertebrates retained by the sieve were transferred into a pre-labelled plastic bottle and preserved with 10% buffered formalin.

Sample Sorting and Taxonomic Identification

Six samples from each station (three samples from E07 because of vandalism of one sampler) were submitted for taxonomic identification and enumeration to Dr. J. Zloty, Ph.D., Environmental Research and Consulting. Each sample was sorted according to standard taxonomic methods and recommendations provided in the EEM TGD (EC 2002).

Invertebrates were identified to the lowest practical taxonomic level using current literature and nomenclature. Target levels were as follows:

- phylum – Nematoda;
- order – Ostracoda and Acarina;
- family – Sphaeriidae and Oligochaeta;
- sub-family/tribe – Ceratopogonidae;
- genus – Chaoboridae, Chironomidae, Coelenterata, Coleoptera, Ephemeroptera, Gastropoda, Odonata, and Trichoptera (aside from those taxa identified to the species level); and
- species – Amphipoda and Hirudinea.

Organisms that could not be identified to the desired taxonomic level (*e.g.*, immature or damaged specimens) were reported as a separate category at the lowest level of taxonomic resolution possible. This was typically the family level, which is the level recommended in the EEM TGD (EC 2002). The most common taxa were distinguishable based on gross morphology and required only a few slide mounts (five to ten) for verification. Organisms that required detailed microscopic examination for identification (*e.g.*, Chironomidae and Oligochaeta) were mounted on microscope slides using an appropriate mounting medium (*i.e.*, CMC-9AF). All rare or less commonly occurring taxa were also mounted on slides for identification. A reference collection was prepared, which consisted of several representative specimens from each taxon. The reference collection has been archived by Dr. J. Zloty for possible comparative purposes with BIC data from future studies and quality control of future taxonomic identification.

5.2.4 Data Analysis

Supporting Environmental Variables

Water quality data were summarized in tabular format and compared to CWQG for the protection of freshwater life (CCME 1999, 2007). Concentrations of analytes required under MMER (see Table 6.1 in EEM TGD [EC 2002]) were compared between the reference and exposure areas. Concentrations that differed by more than a factor of two were identified.

Sediment metal concentrations were compared to Canadian Sediment Quality Guidelines (CSQG) for the protection of freshwater aquatic life for arsenic (CCME 1999, 2002). There are two levels of CSQG:

- ISQG – concentrations that are set with the intention to protect all stages of aquatic life for an indefinite period of exposure; and
- PEL – concentration above which adverse biological effects are usually observed (CCME 1999).

In addition, metal concentrations were compared to the remediation criteria of 150 µg/g arsenic (assumed dry weight) in the Yellowknife area sediments within non-residential, publicly-accessible areas (*e.g.*, boat launch) (GNWT 2003). This guideline was derived by the GNWT because the CCME soil guideline is based on an assumed natural background arsenic concentration of 10 µg/g, which is lower than the arsenic that occurs naturally in and around Yellowknife.

Habitat, water quality and sediment quality data were summarized and compared among sampling areas (reference, near-field and far-field). Spearman rank correlations (r_S; Sokal and Rohlf 1995) were calculated to determine if habitat variables were correlated with the invertebrate community variables. The critical value of 0.464 was used to determine significance of the Spearman correlations and was determined from Siegel and Castellan (1988) based on an α value of 0.10 and 14 degrees of freedom. Spearman correlation was performed using the SYSTAT 11 software package (SYSTAT 2004).

Statistical Analysis

Raw invertebrate abundance data were received from the taxonomist in electronic format. During the preparation of the data for analysis, the following non-benthic organisms were removed:

- Crustacea (Cyclopoida, Cladocera) – removed because planktonic organisms;
- Insecta (Isotomidae, Corixidae) – removed because not strictly benthic organisms; and
- Nematoda – removed because samples were sieved through 500 µm mesh sieve, which results in unreliable estimates of nematode numbers (EC 2002).

Raw abundance values were converted to ind/m^2 based on the total surface area of the multi-plate samplers (0.16 m^2). The following standard community variables were calculated for each station:

- total invertebrate abundance (abundance);
- family level richness;

- relative abundance;
- presence/absence;
- Simpson's evenness index (SEI);
- Simpson's diversity index (SDI); and
- Bray-Curtis index (BCI).

Abundance was calculated as ind/m^2. Richness is the total number of taxonomic groups (*i.e.*, family level) present at each replicate station. Richness provides an indication of the diversity of invertebrates in an area; a higher richness value typically indicates a more healthy and balanced community.

Relative abundance quantifies the relative proportion of each family composing the invertebrate community. Presence/absence is quantified through a presence/absence matrix at the family level for each area. These two biotic measures were used as additional descriptors and were not used to indicate an effect.

SEI, or evenness, is a measure of the relative abundances of the different taxa contributing to richness in an area. SEI compares the observed community to a hypothetical community, which consists of the same number of taxa that are equally abundant. A community dominated by one or two species is considered to be less diverse than one in which several different species have similar abundances. SEI values range between 0 and 1, whereby higher values indicate a balanced community consisting of more taxa that are evenly distributed among taxonomic groups. Lower values indicate a community dominated by few taxa. These communities are often referred to as "stressed" and may reflect the influence of natural and/or anthropogenic disturbances.

SDI measures the proportional distribution of organisms in the community, which takes into account the abundance patterns and taxonomic richness of the community. Certain environmental conditions may favour or affect one organism more than another; thus, not all organisms have the same success in a given environment. SDI values range between 0 and 1; higher values indicate a community consisting of more taxa among which abundance is more equitably distributed. Lower values indicate a community dominated by few taxonomic groups, which may reflect natural or anthropogenic stresses. SDI was only used as an additional community descriptor and was not used to indicate an effect, as recommended by EC (2002).

The above indices are measures of total abundance and taxon richness, but they do not take into account any quantitative information on the types of organisms present. Therefore, the BCI, which is a dissimilarity index, was calculated to compare entire invertebrate communities among sampling areas. The BCI summarizes the overall difference in community structure between the reference and exposure replicate stations.

BCI values range between 0 and 1; lower values indicate that the community in the exposure area is more similar to the reference community.

In addition to the standard community descriptors listed above, spatial trends in a number of additional biological variables were also examined to further investigate the differences between the reference and exposure areas. These variables included the abundances of invertebrates in the Ephemeroptera, Plecoptera and Trichoptera (EPT) orders, as well as the family Chironomidae.

Statistical analyses were conducted to evaluate whether there were statistically significant differences in the invertebrate variables among replicate stations, which were grouped as near-field, far-field, and reference. Grouping of stations into near-field, far-field, and reference areas was defined *a priori*. Mean specific conductivity at the bottom of the water column values ranged from 1,155 μS/cm to 1,425 μS/cm in the near-field area, 62 μS/cm to 129 μS/cm in the far-field area, and 51 μS/cm to 80 μS/cm in the reference area. Summary statistics for each community descriptor and biological endpoint (*i.e.,* arithmetic mean, median, minimum, maximum, SD, SE, and sample size) were calculated and summarized by replicate station and area.

Prior to completing the univariate statistical tests, data were screened for outliers and potential data entry errors using both box-and-whisker plots and scatter plots for each variable. Outliers were checked and their validity was confirmed. If warranted, these values were corrected or removed from the data matrix. If data were removed, then screening was re-run (*i.e.*, box-and-whisker plots), outliers were checked, and their validity again confirmed. Outliers that were removed from the analyses were reported and reasons for removal were documented.

Abundance data were transformed to satisfy the requirement of normality for ANOVA. Biological indices (*i.e.*, SEI, SDI, and BCI) were rank ordered prior to analysis by ANOVA. These values are derived variables with unusual statistical properties and, in general, their sampling distributions are unknown (Rosenberg and Resh 1993). For example, BCI represents comparisons back to the same median reference community; consequently, the assumption of independence is violated by using parametric analysis on this variable. However, transformation of these variables to rank order (*i.e.*, all samples are pooled for the purpose of ranking), relaxes the assumption of normality and allows the use of ANOVA. If the ANOVA comparing the reference and exposure areas was statistically significant, an *a posteriori* test (*i.e.*, Dunnett's test) was performed to individually compare each exposure area with the reference area. ANOVA and Dunnett's test were performed using the SYSTAT 11 software package (SYSTAT 2004).

Statistical tests were considered significant at P-value≤0.10, as recommended by EC (2002). The magnitude of the difference between reference and exposure area means was calculated for significantly different pairwise comparisons according to the following formula:

$$\frac{[(\text{exposure area mean}) - (\text{reference area mean}))]}{\text{reference area mean}} * 100$$

Sampling area means were back-transformed (*i.e.*, antilog) where required. The critical effect size was calculated as ±2 SD, expressed as a percentage of the reference area mean. Calculated magnitude differences were considered ecologically significant only if they exceeded the critical effect size.

For a study design with five replicate stations per area, the EEM TGD (EC 2002) recommends that α and β be set equally, at 0.10 to allow a critical effect size equal to ±2 SD from the reference area mean (see Table 9-7 of the EEM TGD [EC 2002]). Using this design, power was set *a priori* at 0.90.

Invertebrate community structure was summarized using a non-parametric ordination method, nonmetric multi-dimensional scaling (NMDS) using Primer 6 (Primer-E 2006). NMDS was used to identify differences existing between sampling areas by reducing the abundance data to three dimensions. Prior to completing the NMDS, the data were log(x+1) transformed and a Bray-Curtis similarity matrix was generated. The NMDS procedure was applied to this similarity matrix and, using rank order information, determined the relative position of samples and sites in terms of taxa abundance. Goodness-of-fit was determined by examining the Shepard diagrams (plots of the reproduced distances versus the original distances similarities) as well as the stress values, which are calculated from the deviations in the Shepard diagrams. Lower stress values (*i.e.*, <0.10) indicate less deviation and a greater goodness-of-fit.

The environmental data (*i.e.*, habitat and sediment characterization) were analyzed separately in NMDS using Primer 6 (Primer-E 2006). Environmental data were normalized prior to analysis by subtracting the mean and dividing by the SD. This was done to convert all environmental variables to the same scale with a similar origin. No further transformation was required prior to generating an Euclidean distance similarity matrix. The NMDS procedure was applied to this similarity matrix, and used rank order to determine the relative position of sites in terms of environmental factors. Goodness-of-fit was determined in the same way as for the community structure NMDS.

For both the community structure and environmental NMDS plots, analysis of similarity (ANOSIM; Primer-E 2006) was used to test if there was a significant difference between all areas (*i.e.*, near-field, far-field and reference) as well as pairwise comparisons to determine differences from the reference area. The null hypothesis for ANOSIM assumes that all sites are equal versus the alternative hypothesis, which assumes that there are differences between sites. ANOSIM calculates the R-statistic, which is the multivariate equivalent of the Fisher (F) statistic. Both the global R-statistic (*i.e.*, differences between all areas) and pairwise R-statistics (*i.e.*, differences between two areas) are generated, which are then examined to determine how well these values relate to the null distribution. If the R-statistic is approximately zero, the null hypothesis is accepted; if the R-statistic is greater than zero, the null hypothesis is rejected. ANOSIM uses permutations to derive a test of significance (*i.e.*, *P*-value), which indicates how unlikely it is that the R-statistic came from the null distribution.

5.2.4.1 Quality Assurance/Quality Control Procedures

QA/QC procedures and requirements are an important aspect of any field or laboratory testing program. The objective of having good QA/QC practices is to standardize methods and to ensure that field sampling, data entry, data analysis, and report preparation produce technically sound and scientifically defensible results.

Detailed specific work instructions outlining each field task were provided to the field personnel prior to the field program. Samples were collected by experienced personnel and were labelled, preserved, and shipped according to Golder's Technical Procedures 8.6-1: *Benthic Invertebrate Sampling* (unpublished file information). Field equipment (*i.e.,* YSI water meter) was regularly calibrated according to manufacturers recommendations.

Detailed field notes were recorded in pencil in waterproof field notebooks and on pre-printed waterproof field data sheets. Field data were checked at the end of each day for completeness and accuracy. COC forms were used to track all sample shipments from the field to the applicable analytical laboratory.

Duplicate water chemistry samples were collected at near-field station E16 and reference area station R16 on August 17, 2006. Duplicate sediment samples were collected at near-field station E05 and reference area station R10 on September 7, 2006. Duplicate water and sediment samples were collected to assess variability introduced during sample collection, sample handling, and during laboratory analytical procedures. In addition, internal laboratory split samples were analyzed to assess variability within analytical methods.

For all calculations, including RPD, values below the MDL were set to half the MDL value. Differences between analyte concentrations in the duplicate water chemistry and sediment samples were considered notable if:

- RPD was greater than 20%; and
- concentration was greater than five times the relevant reported MDL.

This threshold takes into account the potential for analytical uncertainty when concentrations approach MDLs (Weiner 2000). These criteria are consistent with those used by ALS for their internal QC procedures. Variability between duplicate and internal laboratory split samples was rated as follows:

- low if less than 10% of the analytes included in the duplicate or split sample analysis were notably different from one another;
- moderate if 10 to 30% of the analytes included in the duplicate or split sample analysis were notably different from one another; and
- high if more than 30% of the analytes included in the duplicate or split sample analysis were notably different from one another.

Field and trip blanks were included in the water chemistry QA/QC program, but were not applicable for the sediment quality component. Field blanks were submitted for analysis on August 10, 2006 and August 17, 2006, and were used to detect if any water contamination might have occurred during water sample collection. Trip blanks were submitted on these same dates and were used to determine if any water sample contamination might have occurred during transportation, storage, and analysis. Notable results observed in the method blanks were evaluated relative to variable concentrations observed in the water samples to determine if wide-spread contamination might have occurred or if potential contamination was limited to the specific blank(s). If, based on this comparison, it appeared that widespread contamination had occurred, then the affected data would have been flagged and interpreted with this limitation in mind.

Invertebrate sample sorting efficiency was verified by performing spot-checks on left-over debris. Ten percent of the randomly selected samples were re-sorted. The data quality objective was a minimum recovery of 90% of the total organisms. If more than 10% of the total number of organisms removed from the sample were found in the debris, then all samples were re-sorted. In addition, if an entire taxonomic group was omitted by the sorter, then all samples were re-sorted.

5.3 Results

5.3.1 Supporting Environmental Variables

5.3.1.1 Water Quality

In Situ Water Quality

In situ water quality data for the near-field, far-field and reference areas are presented in Table 5-2. Water levels decreased slightly in Baker Creek (≤0.25 m) and the Yellowknife River (≤0.18 m) between July and September 2006.

At replicate stations E01 to E05 (*i.e.*, near-field area), the difference between surface and bottom specific conductivity values increased over the duration of this study. This increase confirmed the presence of effluent, which is more saline and of a higher density than the natural water of Baker Creek. In addition, these four replicate stations were located behind the breakwater, where there is minimal mixing of the water column. Specific conductivity values in both the far-field and reference areas remained relatively consistent throughout the water column and were comparable between these two areas.

Water temperatures recorded at the time of sampler deployment were slightly higher in the near-field area compared to the far-field and reference areas. Water temperatures were more consistent among areas during the mid-program inspection and at the time of sampler retrieval. Dissolved oxygen and pH values remained similar in all sampling areas throughout the study.

Water Quality

Detailed water chemistry results including QA/QC information are presented in Appendix Tables II-1 and II-2. All analyte concentrations in the field and trip blanks were within five times the MDL.

Total suspended solids concentration reported for the E10 internal laboratory split sample was above the assessment criteria outlined in Section 5.2.4.1. This single notable difference represents less than 10% of the variables analyzed by ALS; therefore, analytical precision was rated as high.

For the majority of analytes, RPDs were ≤18% between station E16 duplicate samples and ≤17% for station R16 duplicate samples. The RPDs for duplicate samples collected at station E16 were above the assessment criterion of 20% for aluminum (21%), total phosphate (41%), total suspended solids (92%), and turbidity (51%). The RPDs for duplicate samples collected at station R16 were greater than 20% for turbidity (27%) and aluminum (51%). Notable differences represented less than 10% of the variables analyzed by ALS; therefore, sample variability was rated as low.

Table 5-2
***In Situ* Water Quality at Replicate Stations in the Exposure and Reference Areas, 2006**

Area	Station	Date	Total Depth (m)[a]	Turbidity (NTU)	Water Temperature (°C)		Dissolved Oxygen (mg/L)		pH		Specific Conductivity (µs/cm)	
					Surface[b]	Bottom[b]	Surface[b]	Bottom[b]	Surface[b]	Bottom[b]	Surface[b]	Bottom[b]
Near-field	E1	29-Jun-06	1.0	2.1	19.4	-	8.2	-	7.9	-	101	-
		10-Aug-06	-	1.3	18.9	18.9	9.6	9.9	7.4	7.5	1,153	1,155
		06-Sep-06	0.7	9.6[c]	18.4	16.7	10.4	9.8	6.7	7.0	1,404	1,425
	E2	29-Jun-06	0.9	2.8	20.1	19.9	8.8	8.4	8.0	7.9	103	101
		10-Aug-06	0.7	0.8	18.3	18.0	8.9	6.4	6.4	6.7	1,171	1,189
		07-Sep-06	0.8	2.9	14.8	14.7	10.3	10.1	7.6	7.5	828	1,367[c]
	E3	29-Jun-06	0.9	2.2	20.2	20.0	8.7	8.3	7.9	7.8	101	102
		10-Aug-06	0.7	5.1[c]	18.6	18.5	10.0	9.3	7.6	7.5	1,171	1,175
		07-Sep-06	0.6	3.4	15.3	14.7	10.1	9.3	7.4	7.3	479	1,295
	E5	29-Jun-06	1.0	2.2	20.1	19.9	8.7	7.8	7.9	7.6	102	108
		17-Aug-06	0.9	5.4	17.7	16.9	9.8	7.6	5.6	5.9	126	1,371[c]
		07-Sep-06	0.9	3.6	14.8	15.2	9.3	8.2	7.3	7.0	228	1,233[c]
Far-field	E6	29-Jun-06	1.0	2.6	20.3	17.1	8.9	9.8	7.9	7.9	62	58
		17-Aug-06[d]	0.8	2.1	17.5	-	9.8	-	6.7	-	148	-
		07-Sep-06	0.7	3.5	15.6	15.6	10.4	10.4	7.9	7.8	115	125
	E7	30-Jun-06	1.2	2.6	15.9	16.0	9.6	9.6	7.6	7.6	54	54
		10-Aug-06	1.1	2.1	18.5	18.7	9.4	9.4	7.7	7.7	120	129
		07-Sep-06	1.1	1.95	16.0	16.1	10.3	10.3	7.6	7.7	84	88
	E10	30-Jun-06	1.1	2.49	16.0	16.0	9.6	9.6	7.5	7.5	51	54
		10-Aug-06	1.0	2.0	18.5	18.5	9.6	9.7	7.9	7.9	70	69
		07-Sep-06	1.0	1.8	16.1	16.1	10.4	10.3	7.7	7.7	68	68
	E11	30-Jun-06	0.9	2.5	15.7	15.7	9.3	9.2	7.1	7.2	57	58
		10-Aug-06	0.7	2.4	18.7	18.7	9.6	9.7	8.2	8.1	73	73
		07-Sep-06	0.7	2.0	15.5	15.6	10.2	10.1	7.6	7.6	67	66
	E15	30-Jun-06	1.0	2.3	15.9	16.0	9.5	9.5	7.6	7.6	56	55
		17-Aug-06[d]	1.0	1.5	17.8	-	9.8	-	7.3	-	-	-
		07-Sep-06	0.9	0.2	16.3	16.3	10.6	10.7	7.9	7.9	62	62
	E16	30-Jun-06	1.0	2.2	16.0	16.1	9.4	9.4	7.6	7.6	58	58
		17-Aug-06	1.1	1.3	17.9	-	9.6	-	7.0	-	71	-
		07-Sep-06	0.9	2.3	16.2	16.2	10.6	10.7	7.9	7.9	63	63
Reference	R6	30-Jun-06	1.0	3.1	15.3	15.4	9.9	9.9	7.6	7.6	52	52
		17-Aug-06	0.7	1.5	17.8	-	9.8	-	7.5	-	56	-
		08-Sep-06	0.9	1.7	15.0	15.0	10.6	10.7	7.7	7.8	51	51
	R7	30-Jun-06	1.1	2.4	15.3	15.3	9.9	9.9	7.6	7.6	52	52
		17-Aug-06	1.0	1.6	18.1	18.1	10.0	9.9	7.6	7.7	56	56
		08-Sep-06	0.9	1.8	15.1	15.1	10.7	10.7	7.7	7.7	51	51
	R8	04-Jul-06	0.6	2.8	15.0	15.0	9.7	9.8	7.7	7.6	60	60
		17-Aug-06	0.6	4.0	17.5	-	9.4	-	7.2	-	60	-
		08-Sep-06	0.5	1.7	14.9	14.9	10.4	10.4	7.7	7.6	52	52
	R9	04-Jul-06[e]	0.9	2.9	16.9	16.9	10.0	10.1	6.9	7.0	59	59
		17-Aug-06	0.9	1.6	17.6	17.6	9.9	10.1	7.5	7.5	56	56
		08-Sep-06	0.8	2.6	15.0	14.9	10.8	10.7	7.7	7.7	51	51
	R10	30-Jun-06[e]	1.0	2.7	15.3	15.3	9.7	9.8	7.6	7.6	52	52
		17-Aug-06	1.0	1.6	18.2	-	9.7	-	7.6	-	56	-
		08-Sep-06	1.0	2.0	15.0	15.0	10.4	10.4	7.4	7.4	51	51
	R16	04-Jul-06[e]	0.9	1.9	17.1	16.9	9.3	8.5	6.9	6.8	68	71
		17-Aug-06	0.8	2.0	17.3	17.3	8.2	8.3	7.2	6.9	79	80
		08-Sep-06	0.8	1.2	14.3	13.8	7.7	7.5	7.3	7.1	72	71

Notes:
m = metre; NTU = nephelometric turbidity units; °C = degrees Celsius; mg/L = milligrams per litre; µS/cm = microSiemens per centimetre; SD = standard deviation; - = not recorded.
a = The total depth measured at the time of sampler deployment is the average of the two depths measured during installation; the remaining total depths were collected during velocity measurements at mid-program and upon sampler retrieval.
b = Surface measurements were collected approximately 15 cm below the water surface; bottom measurements were collected approximately 10 cm above the bottom substrate.
c = Elevated turbidity and/or specific conductivity measurement may be related to re-suspension of fine sediments during sampling.
d = Bottom measurements not recorded because of resuspension of fine sediments during sampling.
f = Measurements re-collected on July 11, 2006 because sediments were disturbed on June 30, 2006 during sampler deployment.

Data for analytes required or recommended by EC (2002) are summarized in Table 5-3. Table 5-4 summarizes the analytes with concentrations that were at least a factor of two greater in the exposure areas compared to the reference area, as specified in the EEM TGD (EC 2002). No analyte concentrations in the exposure areas were lower than the reference area.

Waters in Baker Creek and the Yellowknife River are characterized as hard, with low to moderate buffering capacity based on total alkalinity. Values of alkalinity and hardness, and concentrations of calcium, chloride, fluoride, magnesium, potassium, sodium, and sulphate were highest at near-field stations E01 and E03, which are closest to the point of effluent discharge. Concentrations of these analytes at far-field stations E10 and E16 were comparable to concentrations measured in the reference area.

Ammonia and nitrate concentrations were elevated at the two of the near-field stations (E02 and E03) closest to the point of discharge. Ammonia concentrations were below the MDL of 0.02 mg/L at the other stations. Nitrate concentrations were at or below the MDL of 0.005 mg/L at station E10 and at all reference area stations, but only slightly above the MDL (0.007 mg/L) at stations E06 and E16. Concentrations of both of these analytes were below applicable CWQGs. Total phosphate concentrations did not show a definitive pattern between areas, as the highest total phosphate concentration (0.04 mg/L) was measured at station R08.

Concentrations of most metals were below the MDLs in the reference area. Concentrations of cadmium, copper, lead, mercury, molybdenum, nickel, and zinc were also below the MDLs in samples collected at the exposure area water quality stations, with the exception of station E02, which had a nickel concentration of 0.008 mg/L, and station E16, which had a zinc concentration of 0.009 mg/L. Arsenic concentrations were highest at the two exposure stations (E02 and E03) closest to the point of discharge and generally decreased with distance from the discharge. Arsenic concentrations in the reference area exhibited some variability, ranging from 0.0005 mg/L to 0.0075 mg/L. Concentrations of aluminum and iron did not exhibit a clear decline with distance from the point of discharge; in fact, concentrations at station E02 were among the lowest concentrations for these two metals. Concentrations of the majority of metals were below applicable CWQG, with the exception of aluminum at station R08. The MDLs for cadmium, copper, lead, and mercury were higher than applicable CWQGs.

Table 5-3
Water Chemistry Results for the Giant Mine Invertebrate Community Survey, August 2006

Parameter	Units	MDL	CWQG[a]	Stations									
				E02	E03	E06	E10	E16	R06	R07	R08	R10	R16
				10-Aug-06	10-Aug-06	17-Aug-06	10-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06
Physical													
Total Alkalinity (as calcium carbonate)	mg/L	2.0	-	62.1	62.7	20.6	24.2	21.4	20.0	19.0	19.6	19.7	30.2
Hardness (as calcium carbonate)	mg/L	0.5	-	413	410	27.8	27.3	30.6	25.1	24.9	23.8	24.8	38.0
Total Suspended Solids	mg/L	1.0	-	1.6	7.8	1.1	2.0	<1.0	1.7	1.5	17.5	1.1	1.5
Major Ions													
Calcium	mg/L	0.05	-	127	120	7.22	7.46	7.68	6.05	5.90	6.10	5.52	9.30
Chloride	mg/L	0.5	-	98.3	100	2.85	2.31	2.64	1.76	1.74	1.76	1.75	2.62
Magnesium	mg/L	0.1	-	28.7	27.2	2.55	2.48	2.84	2.49	2.41	2.51	2.12	3.90
Potassium	mg/L	2.0	-	3.6	3.4	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Sodium	mg/L	2.0	-	47.7	45.2	2.4	<2.0	2.7	<2.0	<2.0	<2.0	<2.0	2.7
Sulphate	mg/L	0.5	-	339	345	7.11	4.63	6.33	3.00	2.99	3.02	3.00	3.04
Nutrients													
Ammonia (as nitrogen)	mg/L	0.02	0.4 to 55.76[c]	0.066	0.025	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate (as nitrogen)	mg/L	0.005	2.9	1.05	1.05	0.0065	0.0051	0.0065	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Total Phosphate	mg/L	0.002	-	0.0215	0.0289	0.0077	0.0092	0.0082	0.0081	0.0084	0.0400	0.0067	0.0143
Total Metals													
Aluminum	mg/L	0.005	0.1[d]	0.0156	0.150	0.0504	0.0771	0.0528	0.0503	0.0592	0.146	0.0482	0.0167
Arsenic	mg/L	0.01	0.005	0.185	0.168	0.00557	0.00259	0.00365	0.00058	0.00050	0.00233	0.00051	0.00750
Cadmium	mg/L	0.001	0.0001 and 0.00001[e]	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Copper	mg/L	0.01	0.002 and 0.004[f]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	mg/L	0.01	0.003	0.084	0.251	0.051	0.081	0.037	0.065	0.060	0.291	0.061	0.347
Lead	mg/L	0.001	0.001 and 0.007[g]	<0.030	<0.030	<0.0010	<0.030	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Manganese	mg/L	0.005	-	0.0236	0.0294	0.0056	<0.0050	<0.0050	<0.0050	<0.0050	0.0093	<0.0050	0.0142
Mercury	µg/L	0.05	0.026	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum	mg/L	0.01	0.073	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nickel	mg/L	0.005	0.025 and 0.150[h]	0.0079	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Selenium	mg/L	0.00050	0.001	0.00057	0.00103	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00059	<0.00050
Zinc	mg/L	0.004	0.030	<0.0040	0.0065	<0.0040	<0.0040	0.0093	<0.0040	<0.0040	0.0042	<0.0040	<0.0040
Dissolved Metals													
Aluminum	mg/L	0.005	-	<0.0050	<0.0050	0.0066	0.0093	0.0060	0.0067	0.0064	0.0052	0.0079	0.0051
Arsenic	mg/L	0.0002	-	0.165	0.161	0.00492	0.00251	0.00331	0.00052	0.00045	0.00095	0.00046	0.00571
Cadmium	mg/L	0.001	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Copper	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	mg/L	0.01	-	0.013	0.017	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.207
Lead	mg/L	0.001	-	<0.030	<0.030	<0.0010	<0.030	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010

Table 5-3
Water Chemistry Results for the Giant Mine Invertebrate Community Survey, August 2006 (continued)

Parameter	Units	MDL	CWQG[(a)]	Stations									
				E02	E03	E06	E10	E16	R06	R07	R08	R10	R16
				10-Aug-06	10-Aug-06	17-Aug-06	10-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06
Dissolved Metals (continued)													
Manganese	mg/L	0.005	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Mercury	µg/L	0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nickel	mg/L	0.005	-	0.0076	0.0077	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Selenium	mg/L	0.0005	-	0.00062	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zinc	mg/L	0.004	-	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	0.0079	<0.0040
Organics													
Dissolved Organic Carbon	mg/L	0.5	-	11.0	10.8	6.37	6.34	6.26	6.49	6.67	6.30	6.31	8.07
Total Organic Carbon	mg/L	0.5	-	11.9	11.8	7.48	6.53	6.82	7.09	7.11	7.43	9.00	9.18
Radionuclides[(b)]			-										
Radium-226	Bq/L	0.005	-	<0.0050	<0.0050	0.0050	<0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
Other													
Total Cyanide	mg/L	0.005	-	0.0095	0.0095	0.0056	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0094	<0.0050
Fluoride	mg/L	0.02	-	0.102	0.101	0.068	0.064	0.071	0.068	0.067	0.068	0.068	0.078

Notes: mg/L = milligrams per litre; µg/L = micrograms per litre; µS/cm = microSiemens per centimetre; Bq/L = Becquerel per litre; NTU = nephelometric turbidity units; MDL = method detection limit; < = indicates concentration of analyte was less than the MDL.
a Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CCME 1999, 2007).
b Radium-226 analysis was subcontracted to Saskatchewan Research Council Analytical Laboratories, Saskatoon, Saskatchewan.
c Guideline for ammonia (as nitrogen) is temperature and pH dependent; ammonia guideline is 0.40 mg/L at field temperature of 20C and pH 8.0 and 55.76 mg/L at field temperature of 15C and pH 6.0.
d Guideline for aluminum is 0.005 µg/L at pH <6.5 and 0.100 µg/L at pH >6.5; all pH values were >6.5 except one instance of pH 5.6 at E05 on August 17, 2006.
e Guideline for cadmium is dependent on water hardness and was calculated according to the lowest and highest water hardness values.
f Guideline for copper is 0.002 mg/L at water hardness of 0 to 180 mg/L and 0.004 at water hardness >180 mg/L.
g Guideline for lead is 0.007 at water hardness of 0 to 60 mg/L and 0.007 at water hardness >180 mg/L.
h Guideline for nickel is 0.025 at water hardness of 0 to 60 mg/L and 0.150 at water hardness >180 mg/L.
ALS Environmental File Numbers Z1130 and Z1489.

Table 5-4
Comparison of Baker Creek and Yellowknife River Water Chemistry, 2006

Near-field Area Concentrations at Least Two Times Greater Than Reference Area
• total alkalinity, hardness
• calcium, chloride, magnesium, sodium, sulphate
• ammonia, nitrate, total phosphate
• total and dissolved[(a)] arsenic
• total and dissolved organic carbon
Far-field Area Concentrations at Least Two Times Less Than Reference Area
• nitrate

a = Analytes with concentrations at least 100 times greater than the reference area.

5.3.1.2 Sediment Quality

Detailed sediment quality results including QA/QC information are presented in Appendix Table II-3; a summary is provided in Table 5-5. The RPD for all parameters in duplicate samples collected from E05 and R10, except the proportion of sand, was ≤19% between duplicate sediment samples. The RPD values for the proportion of sand were 39% for station E05 and 56% for station R10. This difference indicates that the distribution of sand within these areas was patchy which, because of this habitat variability, could influence the distribution of benthic invertebrates among stations. This single notable difference represented less than 10% of the variables analyzed by ALS; therefore, sample variability was rated as low.

The internal split sample for station R08 had a RPD of 3.5% for arsenic (Appendix II-3). This was the only analyte to be measured in the internal split sample; therefore, it was not possible to rate analytical precision.

Seven of the nine sediment samples had arsenic concentrations above the ISQG of 5.9 µg/g (Table 5-5). Four of the five exposure area stations had arsenic concentrations that exceeded the PEL of 17.0 µg/g. With the exception of station E01, arsenic concentrations exhibited a general decrease with distance from the point of discharge (Table 5-5). The lower arsenic concentration observed at station E01 (49.1 µg/g), compared to other near-field replicate stations, may be related to the location of this stations within the marsh area, which is out of the direct path of the outflow from Baker Creek. Arsenic concentrations were lower in the reference area (<5.0 µg/g to 23.1 µg/g), with only one location (station R16) exceeding the PEL. Only two replicate stations, E03 (near-field area) and E06 (far-field area) exceeded the risk-based remediation sediment quality criteria of 150 mg/kg for total arsenic (GNWT 2003).

Table 5-5
Habitat and Sediment Characteristics at Replicate Stations in the Exposure and Reference Areas, 2006

Station	Mean Water Depth (%)	Mean Velocity (m/s)	Mean Vegetation Cover (%)	Moisture (%)	Arsenic (µg/g)[(a)]	Total Organic Carbon (%)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
Near-field										
E01	0.86	0.01	60	50.9	**<u>49.1</u>**	1.14	<0.10	5.00	15.4	79.6
E02	0.83	0.01	55	50.7	-	3.24	<0.10	23.6	36.6	39.8
E03	0.74	0.01	85	36.9	**<u>224</u>**	2.22	<0.10	23.9	20.8	55.3
E05	0.93	0.01	90	37.6	-	1.87	<0.10	30.3	45.2	24.5
Far-field										
E06	0.84	0.01	68	32.4	**<u>157</u>**	0.45	4.40	67.0	18.1	10.5
E07	1.14	0.02	8	45.0	-	1.96	<0.10	45.1	27.6	27.3
E10	0.99	0.01	0	24.4	**<u>68.0</u>**	1.36	5.50	56.5	25.3	12.7
E11	0.77	0.02	3	62.1	-	1.66	<0.10	55.5	29.1	15.4
E15	0.96	0.02	5	35.6	**14.4**	0.92	<0.10	12.5	57.9	29.6
E16	1.00	0.01	0	32.7	-	1.18	<0.10	23.5	54.6	21.9
Reference										
R06	0.87	0.17	0	27.9	-	0.31	<0.10	46.6	47.6	5.80
R07	1.00	0.21	0	31.0	<5.0	0.45	<0.10	5.70	61.3	33.0
R08	0.55	0.01	3	20.2	5.8	0.47	<0.10	47.1	45.1	7.80
R10	0.99	0.03	50	59.9	**7.0**	1.08	<0.10	10.0	73.8	16.2
R16	0.81	0.01	97	75.6	**<u>23.1</u>**	3.67	<0.10	2.20	59.6	38.2

Note: % = percent; m/s = metres per second; µg/g = microgram per gram; < = less than method detection limit; - = not analyzed.
a = ISQG for arsenic = 5.9 µg/g; PEL for arsenic = 17.0 µg/g. **<u>Bolded and underlined values</u>** exceed the PEL; **bolded values** exceed the ISQG.

The proportion of TOC was low in all three sampling areas, ranging from 1.14% to 3.24% in the near-field area, 0.45% to 1.96% in the far-field area, and 0.31 to 3.67% in the reference area (Table 5-5). In general, sediments consisted of a mixture of sand, silt and clay, but proportions were variable among replicate stations within each sampling area (Table 5-5).

5.3.1.3 Habitat Characteristics

Detailed habitat characteristics are presented in Appendix Table II-4. Replicate stations were primarily located along shorelines in shallow, slow moving water. Bottom cover by aquatic plants was highest in the near-field area, while most stations in the far-field and reference areas had little or no cover. In general, the amount of aquatic plant cover increased over the duration of the invertebrate community survey.

While attempts were made to standardize the habitats in which the artificial substrates were deployed, natural factors that may have influenced the assemblages colonizing the artificial substrates:

- aquatic plant cover, which typically has a strong influence on invertebrate abundance and distribution, and represented a colonization source for the artificial substrates;
- variation in sediment particle size distribution; and
- general habitat type; since the reference area was located in more riverine habitat than the exposure areas, invertebrates colonizing the samplers may reflect a more riverine assemblage, with higher abundances of certain insect orders (*e.g.*, Trichoptera).

5.3.1.4 Effect of Habitat Variation

The following habitat variables were included in the correlation analysis because they either varied over a sufficient range that could affect the benthic community or represented a potential confounding factor:

- aquatic vegetation cover, which represents a potential invertebrate colonization source in the water column;
- proportion of TOC, which is a measure of how much organic material is in the sediment, can affect dissolved oxygen concentrations, as well as complex with metals modify their bioavailability; TOC also provides a qualitative assessment of the nature of the sampling location (*i.e.*, depositional or erosional); and
- proportion of sand, silt, and clay, which represents an indicator of deposition or erosion.

Although there was habitat variability among sampling stations, there were no obvious differences among areas that could readily account for the observed differences in community composition. Accordingly, there were few significant correlations between selected habitat variables and invertebrate community variables (Table 5-6). Mayfly (Ephemeroptera) density was significantly correlated with the proportion of aquatic plant cover, TOC, sand and clay. In general, sites with the lowest proportion of plant cover, TOC and clay, combined with a higher proportion of sand, had the highest abundance of mayflies.

Table 5-6
Correlations Between Invertebrate Community Variables and Selected Habitat Variables

Descriptor	Spearman Rank Correlations (r_s)				
	Mean Aquatic Plant Cover	Total Organic Carbon	Sand	Silt	Clay
Density	-0.206	-0.331	0.318	-0.043	-0.389
Richness	0.074	0.041	-0.018	0.134	0.061
SDI	0.189	0.132	-0.121	0.068	0.029
SEI	0.164	0.034	-0.146	-0.050	0.100
BCI	0.011	0.211	0.268	-0.150	-0.150
Ephemeroptera abundance	**-0.543**	**-0.570**	**0.529**	-0.068	**-0.568**
Plecoptera abundance	-0.107	0.278	0.308	-0.229	-0.079
Trichoptera abundance	-0.010	-0.190	-0.079	-0.175	0.229
Diptera abundance	0.104	-0.168	-0.200	0.207	0.100

Note: **Bolding** indicates significant correlations.
Critical value$_{(\text{alpha} = 0.10;\ 14\ \text{degrees of freedom};\ 2\text{-tailed test})}$ = 0.464. Source: Siegel and Castellan (1988).

Although the reference area was located in a more riverine habitat compared to the near-field and far-field areas, this does not appear to contribute significantly to variability in the invertebrate community composition. While a general habitat effect influencing the invertebrates colonizing the artificial substrates cannot be ruled out, it appears unlikely and should not affect the evaluation of potential effluent-related effects.

Effluent discharge into Baker Creek ceased on August 31, 2006 and the artificial substrates were retrieved on September 7 and 8, 2006. The time elapsed after cessation of the mine discharge is unlikely to have influenced the results of the invertebrate community survey because the specific conductivity remained elevated in the exposure area during this period. This elevated specific conductivity indicates relatively slow dispersion of mine effluent into Yellowknife Bay.

5.3.2 Benthic Invertebrate Community Analysis

5.3.2.1 Data Screening

A detailed list of invertebrate taxa collected during the Phase 2 invertebrate survey and raw abundance data are provided in Appendix Table II-5. Results of taxonomic identification and enumeration are summarized as means and standard deviations in Appendix Table II-7. Data screening identified potential outliers at some of the replicate stations. While data checks confirmed the validity of the data, the strong influence the outliers had on the data necessitated analyzing the dataset with and without the following data:

- abundance and BCI: all samples (except R06-1) from stations R06 and R07 because these samples contained an inordinately high number of Trichoptera (*Neureclipsis* sp.) and Ephemeroptera (Leptophlebiidae);
- abundance and BCI: remaining sample (R06-1) from station R06 sample one (R06-1) because the abundance in this sample was two orders of magnitude lower than in the other replicate samples from this station;
- variation in family composition at R06 and R07 was suspected to be due to slight variation in habitat (*i.e.*, no aquatic plant cover, higher current velocity) and their distance (>0.5 km) from the remaining reference stations; and
- SDI and SEI: station E15 sample two (E15-2) because only one family, Heptageniidae, was present in this sample.

5.3.2.2 Benthic Invertebrate Community Characteristics

Mean abundance of the benthic invertebrate assemblages colonizing the artificial substrates was higher in the reference area (1,252 ind/m^2) compared to both the near-field (259 ind/m^2) and far-field areas (306 ind/m^2) (Table 5-7). However, median abundance values were similar among areas (230 ind/m^2 to 333 ind/m^2).

There was no significant difference in total abundance among areas (ANOVA: P = 0.24) (Table 5-8; Figure 5-3). Two reference stations (R06 and R07) accounted for the majority of the differences in invertebrate abundance. Samples from these two stations had unusually large numbers of the caddisfly *Neureclipsis* sp., which was present in low numbers, or completely absent, at other reference stations. When these two stations were excluded, there was still no significant difference in abundance among sampling areas (ANOVA: P = 0.98) (Table 5-8; Figure 5-4).

Table 5-7
Summary Statistics for Invertebrate Community Variables, 2006

Variable	Area	n	Mean	Standard Deviation	Standard Error	Median	Minimum	Maximum
Abundance	Reference	5	1,252	1,424	260	333	140	3,336
	Near-field	4	259	77	16	230	206	371
	Far-field	6	306	165	29	274	83	497
Richness	Reference	5	8	2	0	9	6	9
	Near-field	4	8	2	0	8	6	10
	Far-field	6	5	2	0	5	1	8
SEI	Reference	5	0.65	0.10	0.02	0.75	0.58	0.77
	Near-field	4	0.71	0.06	0.01	0.73	0.63	0.75
	Far-field	6	0.75	0.14	0.03	0.75	0.40	0.99
SDI	Reference	5	0.76	0.12	0.02	0.70	0.64	0.91
	Near-field	4	0.82	0.07	0.01	0.84	0.73	0.88
	Far-field	6	0.56	0.17	0.03	0.60	0	0.77
BCI	Reference	5	0.65	0.26	0.05	0.79	0.36	0.86
	Near-field	4	0.79	0.04	0.01	0.80	0.73	0.82
	Far-field	6	0.90	0.04	0.01	0.91	0.81	0.98

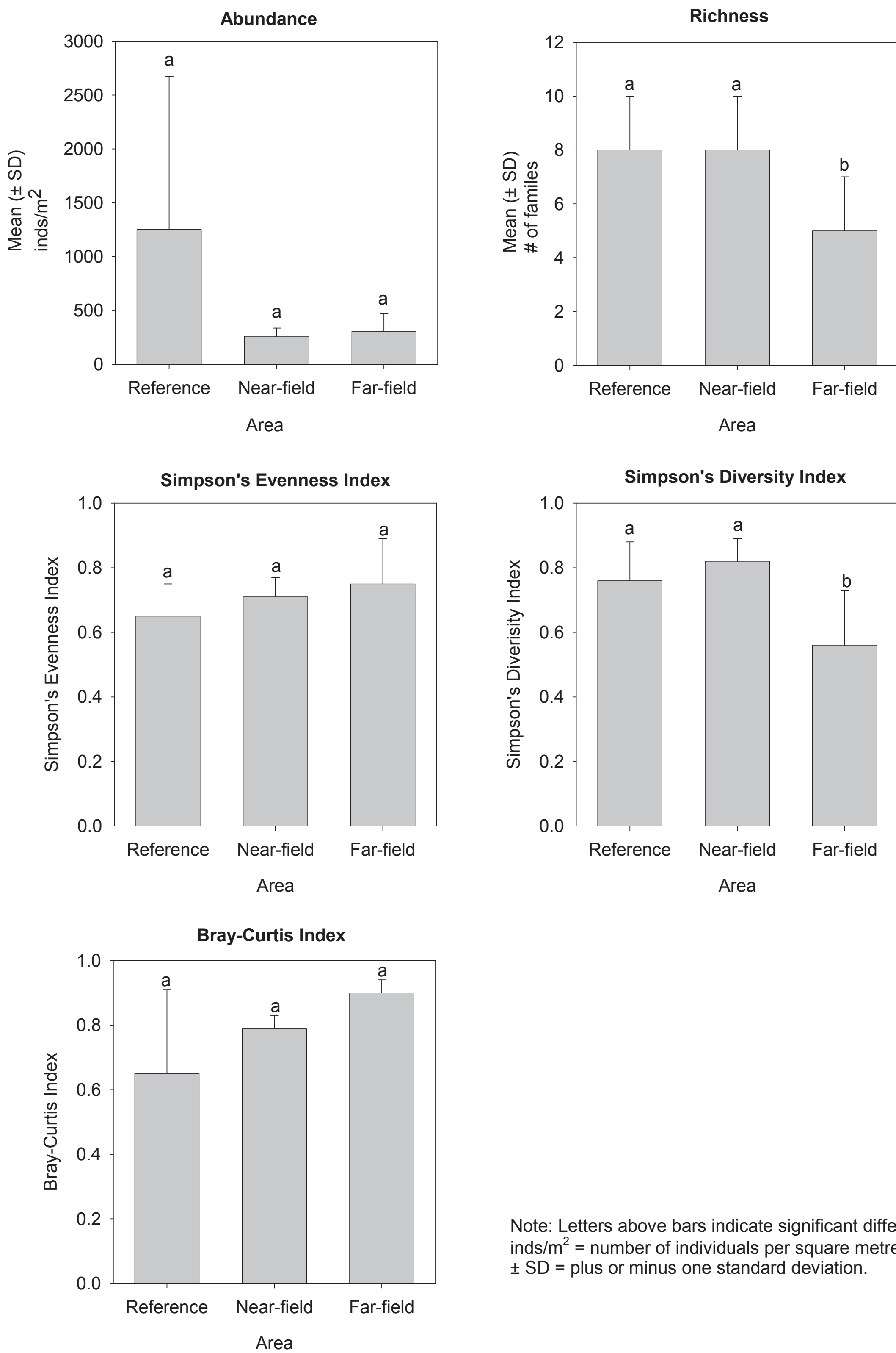
Note: n = sample size.

Table 5-8
Summary of Statistical Tests Comparing Sampling Areas, 2006

Comparison	Benthic Invertebrate Community Variables[a]				
	Abundance (*P*-value)	Richness (*P*-value)	SEI (*P*-value)	SDI (*P*-value)	BCI (*P*-value)
Analysis of Variance	0.24 (0.98)	**<0.03 (0.10)**	0.24	**0.03**	0.13 **(0.01)**
Dunnett's Test					
Reference versus Near-field	n/a	1.00 (0.78)	n/a	0.66	n/a **(<0.01)**
Reference versus Far-field	n/a	**0.03** (0.26)	n/a	**0.09**	n/a **(0.02)**

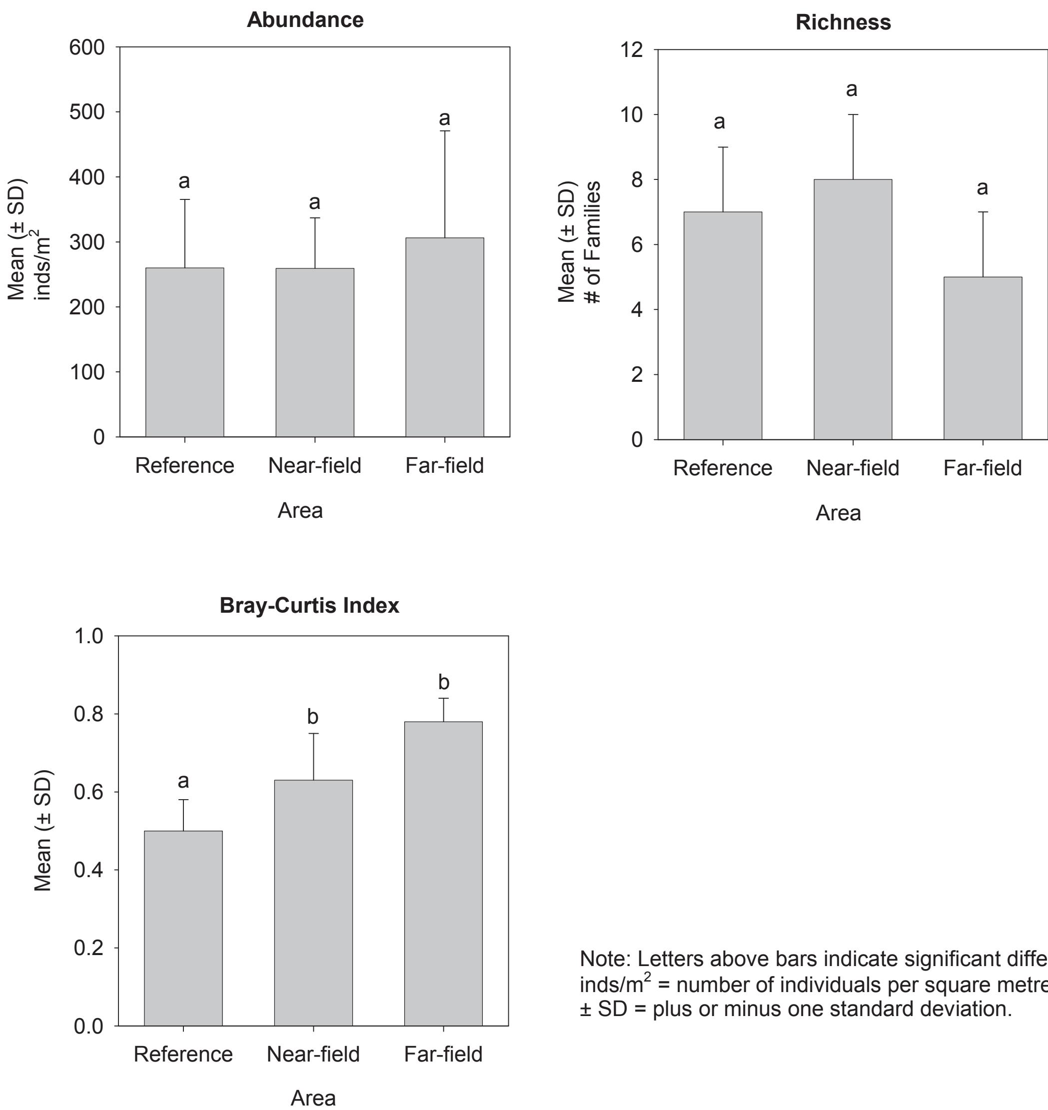
Note: **Bold** values are statistically significant at alpha = 0.10.
n/a = not applicable because there was no significant difference among areas.
(a) Values in parentheses are results of statistical analysis with outliers removed.

Figure 5-3
Effect Summary Plots for Invertebrate Variables (Complete Dataset) for Giant Mine, 2006



Note: Letters above bars indicate significant difference.
inds/m^2 = number of individuals per square metre;
± SD = plus or minus one standard deviation.

Figure 5-4
Effect Summary Plots for Invertebrate Variables (Outliers Removed) for Giant Mine, 2006



Note: Letters above bars indicate significant difference.
inds/m^2 = number of individuals per square metre;
± SD = plus or minus one standard deviation.

There was no significant difference in mean SEI when all three areas were compared (ANOVA: $P = 0.24$; Table 5-8; Figure 5-3). There was a significant difference in SDI among areas (ANOVA: $P = 0.03$; Table 5-8; Figure 5-3). Pair-wise comparisons indicated there was only a significant difference between the reference area and the far-field area (Dunnett's test: $P = 0.09$; Table 5-8; Figure 5-3). SDI in the far-field area was 14% lower than the reference area, which was below the critical effect size of 31% (Table 5-9).

Table 5-9
Critical Effect Sizes and Magnitudes of Differences between the Reference and Exposure Areas

Variable	Critical Effect Size (%)[a]	Reference versus Near-field[a]		Reference versus Far-field[a]	
		Difference (%)	Ecologically Significant?	Difference (%)	Ecologically Significant?
Richness	50 (57)	0 (14)	No (No)	-38 (-29)	No (No)
SDI	31 (31)	n/a (9)	n/a (No)	n/a (-14)	No (No)
BCI	80 (27)	n/a (61)	n/a (Yes)	n/a (55)	n/a (Yes)

Note: n/a = not applicable because analysis of variance among areas was not significantly different.
Critical effect size and magnitudes of differences are expressed as the percentage of the reference area mean.
(a) Numbers in parentheses indicate effect sizes, magnitudes of difference, and determination of significance with outliers (R06 and R07) removed.

There were differences in the number and types of families present between the far-field and both the near-field and reference areas (Table 5-10). A total of 27 families were identified in both the near-field and reference areas. In general, the families present in the reference and near-field areas were similar and most of the differences were a result of variation in the level of taxonomic identification (*e.g.*, some Gastropoda were not identified to family). Three taxa (Plecoptera, Aeshnidae, and Hydropsychidae) were identified in the reference area, but not in the near-field area, which may reflect habitat differences (*i.e.*, riverine in the reference area versus lacustrine in the near-field area). Artificial substrates in the far-field area were colonized by a total of 19 families. One family of Trichoptera (Lepidostomatidae) was unique to the far-field area and one family (Hydropsychidae) was unique to the reference area. Coleoptera, Oligochaeta, and Diptera (other than chironomids) were not present in the far-field area.

While mean richness was similar in the reference, near-field, and far-field areas, there was a statistically significant difference among areas (ANOVA: $P = 0.03$). Results of the pairwise comparison indicated that only the far-field area was significantly different from the reference area when the full dataset was analyzed (ANOVA: $P = 0.03$; Table 5-8; Figures 5-3 and 5-4). The magnitude of the difference for the far-field area was 38% when all the data were included, which was below the critical effect size of 50%. When the outliers were removed from the reference area data, the critical effect size changed to 57%, but the magnitude of the difference for the far-field area (29%) was still below the critical effect size.

Table 5-10
Presence/Absence of Invertebrate Families by Area, 2004 and 2006

Major Taxonomy	Family	2004			2006		
		Reference	Near-field	Far-field	Reference	Near-field	Far-field
Order: Amphipoda	Gammaridae	X	X	X	X	X	X
	Hyalellidae	X	X	X	X	X	X
Class: Bivalvia	Sphaeriidae	X	X	X	X	X	X
Order: Coleoptera	Dytiscidae	X	X		X	X	
	Gyrinidae	X					
	Haliplidae		X		X	X	
Order: Diptera	Ceratopogonidae		X	X	X	X	
	Chironomidae	X	X	X	X	X	X
	Empididae		X			X	
Order: Ephemeroptera	Baetidae	X	X	X	X	X	X
	Caenidae	X	X		X	X	
	Ephemeridae	X					
	Ephemerellidae	X		X	X	X	X
	Heptageniidae	X	X	X	X	X	X
	Leptophlebiidae	X	X	X	X	X	X
Class: Gastropoda	–					X	
	Lymnaeidae	X	X	X	X	X	X
	Physidae	X	X	X	X	X	X
	Planorbidae	X	X	X	X	X	X
	Valvatidae	X	X	X	X	X	
Class: Hirudinea	Erpobdellidae	X	X	X	X		
	Glossiphoniidae	X		X	X	X	X
Order: Hydracarina	–	X	X	X			X
Class: Hydrozoa	–		X			X	
	Hydridae	X		X			
Order: Odonata	Aeshnidae	X	X		X		X
	Coenagrionidae	X			X		
Class: Oligochaeta	Naididae	X	X	X	X	X	
	Tubificidae	X			X	X	
Class: Ostracoda	–		X			X	
Order: Plecoptera	Perlodidae	X		X	X		X
	Pteronarcyidae	X					
Order: Trichoptera	Hydroptilidae	X	X		X	X	X
	Hydropsychidae	X			X		
	Lepidostomatidae						X
	Leptoceridae	X	X		X	X	X
	Limnephilidae			X			
	Phryganeidae				X	X	
	Polycentropodidae	X	X	X	X	X	X
Total number of families per area		31	25	21	27	27	19
Number of samplers per area		15	6	9	36	24	33

Note: X = family present; — = organisms were not classified to the family level.

Mean BCI values were higher in the near-field (0.79) and far-field (0.90) areas compared to the reference area (Table 5-7). This indicates that the near-field and far-field areas were less similar to the reference area than the level of similarity observed within the reference area. The mean BCI value for the reference area was moderate (0.65), which is reflective of the variation among replicate stations in this area. There was no significant difference among areas when the full dataset was analyzed (ANOVA: P = 0.13; Table 5-8; Figure 5-3). Two reference area stations (R06 and R07) had a large effect on BCI values. When these stations were excluded, the mean BCI value for the reference area decreased to 0.51, while the near-field and far-field area BCI values were 0.82 and 0.79, respectively. There was a significant difference (ANOVA: P = 0.01) among areas after removing these two stations (Table 5-8; Figure 5-4). Results of the pair-wise comparison indicated that this difference was statistically significant between both the near-field area (Dunnett's test: P <0.01; Table 5-8) and the far-field area (Dunnett's test: P = 0.02; Table 5-8) relative to the reference area. The magnitude of this difference only exceeded the critical effect size (27%) in both the near-field area (61%) and the far-field area (55%) (Table 5-8).

Differences among replicate stations, as well as among areas, were apparent in the relative abundances of major taxonomic groups (Figure 5-5). Replicate stations in the reference area exhibited the most variability in composition. Two of the reference stations (R06 and R07) had a large proportion of Trichoptera, while one station (R16) had a large proportion of Annelida. Amphipoda, Diptera, and Ephemeroptera contributed the largest proportions to the communities at R08 and R10. The near-field area had relatively large proportions of Diptera (primarily composed of chironomids) and Ephemeroptera. Replicate stations in the far-field area (E06 to E16) consisted predominately of Ephemeroptera. Many mayfly species are known to be highly sensitive to metals (Clements 1991) and their presence in the far-field area suggests that their populations were not affected by the mine discharge.

5.3.2.3 Nonmetric Multi-dimensional Scaling

The three-dimensional NMDS configuration had a stress value of 0.07, indicating a good fit to the original data set. The invertebrate community ordination plots (Figure 5-6) indicate that there was separation among areas in terms of community structure. |ANOSIM indicated that the separation of groups was statistically significant (ANOSIM global R_{stat} = 0.77, P-value <0.01). Pair-wise comparisons between areas indicated that there were significant differences between the reference area and both the near-field (ANOSIM R_{stat} = 0.46, P-value = 0.02) and the far-field area (ANOSIM R_{stat} = 0.75, P-value<0.001).

Figure 5-5
Invertebrate Community Composition by Major Taxonomic Groups, 2006

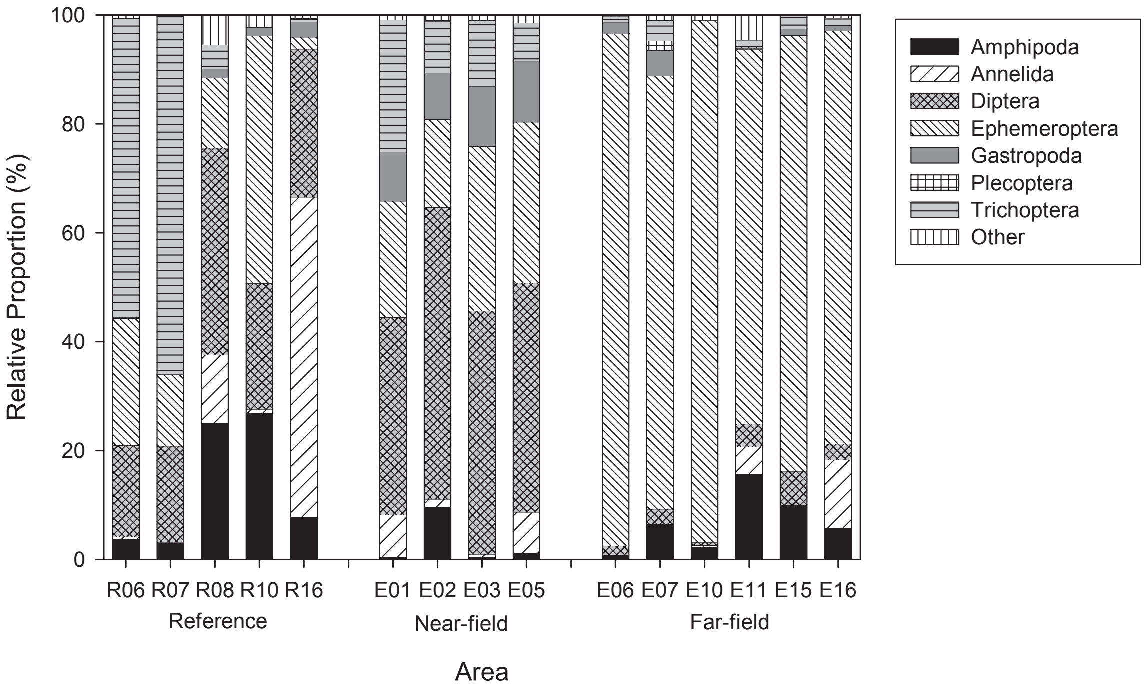
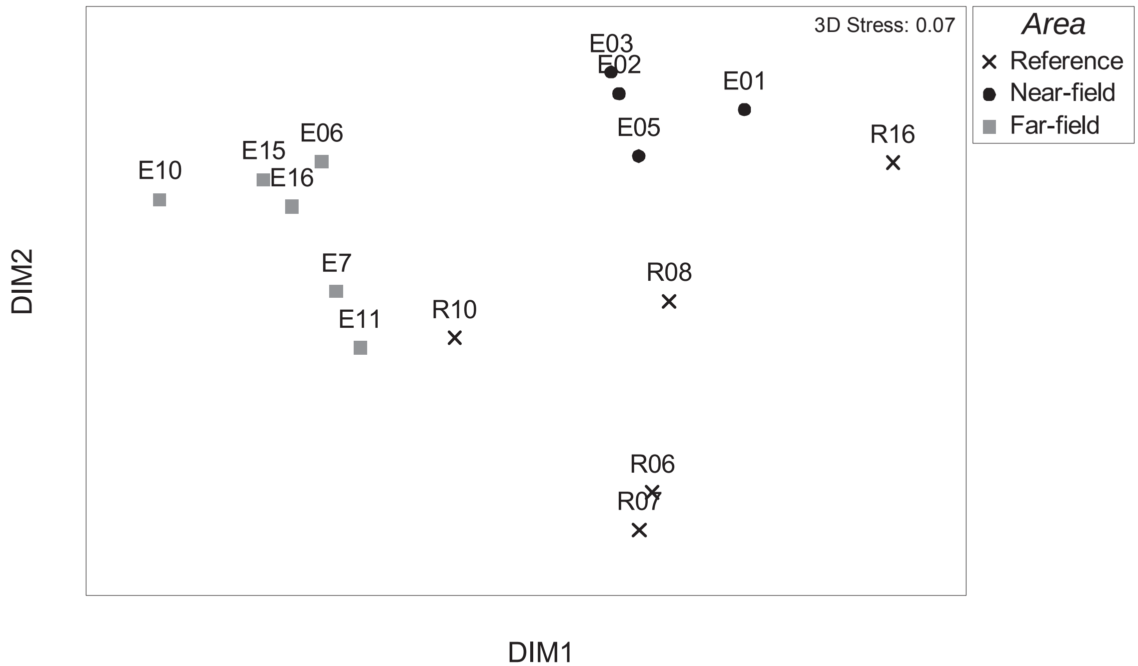
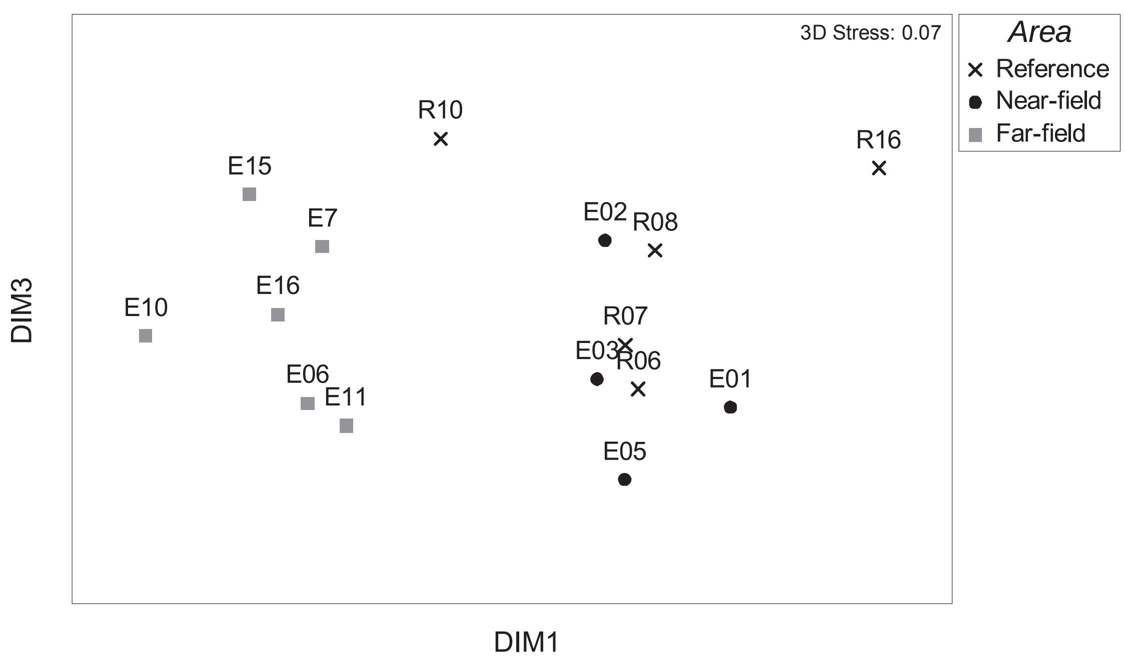


Figure 5-6
Ordination Plots for Benthic Invertebrate Community Abundance, 2006





While separation of sampling areas was evident, the ordering of areas along the ordination axes and the degree of overlap of sampling areas along each axis did not reflect the degree of exposure to the effluent. There was no clear separation of sampling areas, and ordering of areas was inconsistent with an expected greater effect in the near-field area compared to the far-field area. On the DIM1 vs. DIM3 plot, ordering along DIM3 was consistent with a greater effect in the near-field area, but there was a large degree of overlap between the far-field area and each of the reference and the near-field areas, despite widely differing exposure of the two exposure areas to mine effluent.

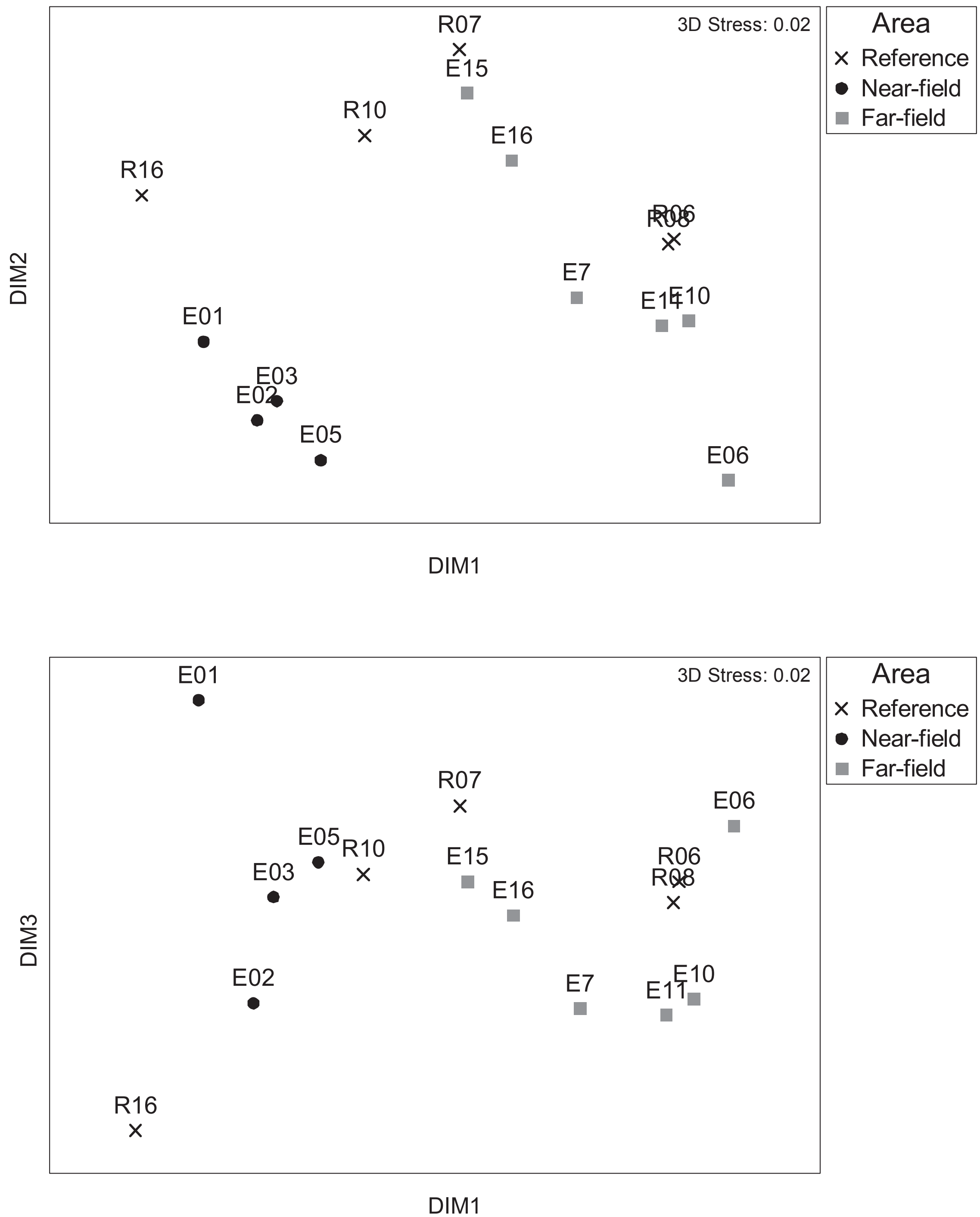
An NMDS plot of the environmental data reflected elevated mean specific conductivity at near-field area stations E01, E02, E03 and E05, which confirms the presence of effluent, and provides an indirect measure of effluent exposure (Figure 5-7). However, pronounced differences in mean specific conductivity values were not identified between the remaining exposure and reference area stations. Even with specific conductivity removed, habitat variables (*i.e.*, TOC, sand and fines [silt+clay]) did not appear to be strongly related to the invertebrate community composition (Figure 5-8). This result provides confirmation that the artificial substrates successfully standardized habitat. The exception was proportion of aquatic plant cover, which appeared to separate the replicate stations along the DIM1 axis. Stations in the near-field and Station R16 in the reference area had a higher proportion of aquatic plant cover than remaining stations. It is possible that the aquatic vegetation provides a different composition of colonizing organisms within these areas compared to areas within Yellowknife Bay (far-field area) and the Yellowknife River (reference area).

5.3.3 Comparison with 2004 Phase 1 Invertebrate Community Results

There were differences in the invertebrate community composition in 2006 compared with the 2004 Phase 1 EEM ICS data (Table 5-11). The total number of families present in the reference and far-field areas decreased by four and two families, respectively. In the near-field area, the total number of families increased by two. The majority of the families present were similar between years, and most of the differences were related to families present in very low numbers in either 2004 or 2006 (*e.g.*, one individual in one replicate sample).

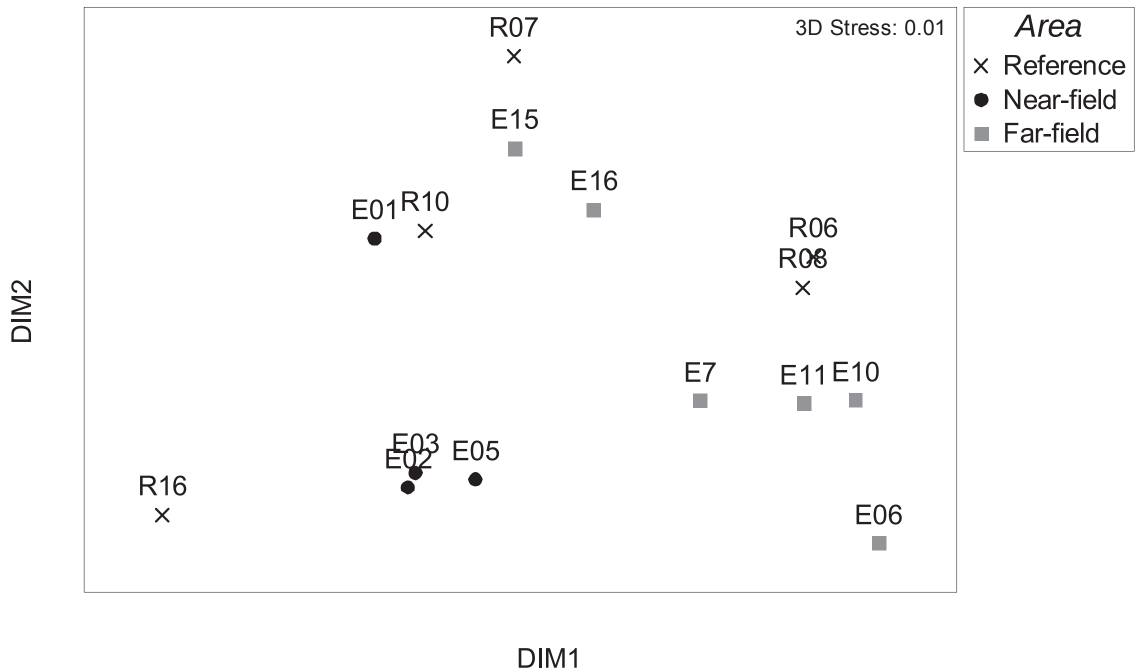
Mean abundance in all areas was higher in 2006 compared to 2004 (Table 5-10). The relatively high abundance in the reference area in 2006 is related to the unusually large numbers of the caddisfly *Neureclipsis* sp. at two stations (R06 and R07). Family richness and SEI values were lower at all stations in 2006. BCI values were similar between 2004 and 2006 for the reference and near-field areas; however, BCI in the far-field area was higher in 2006 compared with 2004.

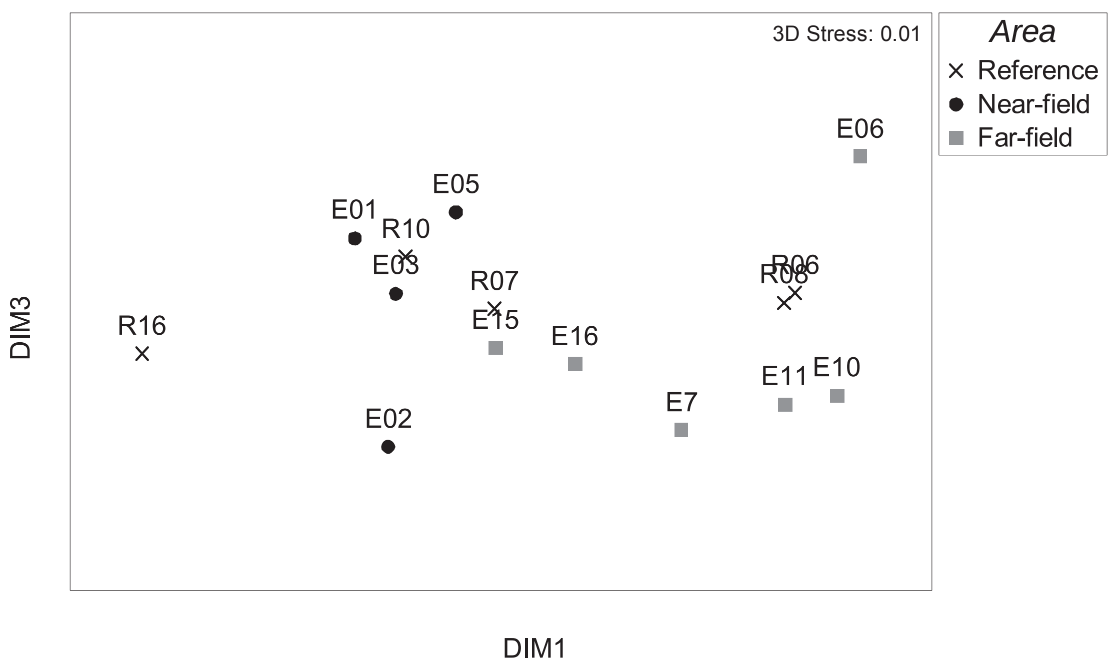
Figure 5-7
Ordination Plots for Environmental Variables, 2006



Notes: Environmental variables included percentage of fines, sands, total organic carbon and vegetation as well as mean bottom specific conductivity.

Figure 5-8
Ordination Plots for Environmental Variables with No Specific Conductivity, 2006





Notes: Environmental variables included percentage of fines, sands, total organic carbon and vegetation, but did not include specific conductivity.

Table 5-11
Summary Statistics for Benthic Invertebrate Community Variables, 2006

Variable	Area	n	2004 Mean	n	2006 Mean
Abundance	Reference	15	343	5	1,252
	Near-field	6	169	4	259
	Far-field	9	170	6	306
Richness	Reference	15	12	5	8
	Near-field	6	11	4	8
	Far-field	9	10	6	5
SEI	Reference	15	0.79	5	0.65
	Near-field	6	0.84	4	0.71
	Far-field	9	0.78	6	0.75
SDI	Reference	15	0.68	5	0.76
	Near-field	6	0.69	4	0.82
	Far-field	9	0.65	6	0.56
BCI	Reference	15	0.63	5	0.65
	Near-field	6	0.74	4	0.79
	Far-field	9	0.76	6	0.90

Note: n = sample size.

5.4 Discussion

Field water quality data collected during the invertebrate community survey provided a reasonable indication of exposure to the mine discharge and confirmed the separation of sampling stations into near-field, far-field and reference areas. Sediment quality results showed elevated concentrations of arsenic within the near-field area relative to both the far-field and reference areas, with the exception of near-field station E01. However, arsenic concentrations were not measured in all sediment samples and other parameters were not analyzed.

Use of artificial substrates provided uniform colonization habitat at each station for evaluating effluent-related effects in Yellowknife Bay. The invertebrate assemblages colonizing artificial substrates were characterized by generally low density and richness, but moderate to high diversity and evenness. A moderate to high percentage of total invertebrates was contributed by mayflies, which as a group are considered metal sensitive (Clements 1991).

Examination of the abundances of EPT taxa and Chironomidae did not indicate any well-defined spatial trends, which suggests there is little effect of the mine discharge on these organisms. In addition, metal sensitive invertebrates (*i.e.*, mayflies) were present in all sampling areas and their relative proportion was similar in the near-field and far-field areas despite a large difference in the degree of effluent exposure. Statistical analysis using standard EEM effect endpoints identified significant differences among the three areas, particularly between the reference and far-field areas (Table 5-12). However, statistically significant differences had magnitudes below the estimated critical effect sizes (based on ±2 SD of the reference area mean), with the exception of the BCI in the far-field area when calculated on the reduced dataset (*i.e.*, outliers removed) (Table 5-12). While habitat-related effects were minimal, they may have partly accounted for these differences. As well the apparent difference in community structure between the reference area and the two exposure areas may also reflect available colonization sources (*i.e.*, riverine in the reference area, lacustrine in the exposure areas) rather than an effect from the Mine discharge.

According to EC (2002), a basic control/impact study design requires five samples per area to attain 90% power. Therefore, reallocating station E06 from the near-field area to the far-field area reduced the power of this study. However, reallocation of this station was necessary to account for the lower specific conductivity and, thus, reduced exposure to effluent. For abundance, SEI and BCI, power was reduced to 82% with four replicate stations in the near-field area, but was 91% and 96% with five and six replicate stations, respectively. Therefore, the average power remained at 90%. Removal of stations R06 and R07 as outliers further reduced the power of statistical tests that were re-run on the reduced data set for abundance. Power ranged from 31% for three replicate stations, 41% for four replicate stations, and 59% for six replicate stations.

While separation of sampling areas was evident in the NMDS ordination plots based on the abundance data, the ordering of areas along ordination axes did not clearly reflect the degree of exposure to the effluent. An NMDS plot of the environmental data reflected that near-field area stations E01, E02, E03 and E05 had elevated mean specific conductivity concentrations, which provides an indirect measure of effluent exposure. However, pronounced differences in mean specific conductivity values were not identified between the remaining exposure and reference area stations. Positions of sampling stations along the DIM1 axis appeared to reflect the amount of aquatic plant cover, which could influence the composition of the invertebrates colonizing the artificial substrates. Particle size of sediments near the artificial substrate samples did not appear to influence the invertebrate assemblages on the samplers.

Table 5-12
Summary of Benthic Invertebrate Community Survey Results

Endpoint	Full Dataset				Outliers Removed			
	Statistically Significant? [(a)]	Direction	Magnitude (%)	Ecologically Significant? [(a)]	Statistically Significant? [(a)]	Direction	Magnitude (%)	Ecologically Significant? [(a)]
Required Effect Endpoints								
Abundance	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Richness	Yes	NF=REF	0	No	Yes	NF=REF	14	No
		FF<Ref	-38	No		FF=Ref	-29	No
SEI	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BCI	No	n/a	n/a	n/a	Yes	NF>Ref	61	Yes
						FF>Ref	55	Yes
Additional Indicators and Relevant Observations								
Family presence/absence	Same number of families in the near-field and reference areas; lower number of families in the far-field area than in the reference area or near-field areas							
EPT proportion	Large proportion of mayflies in the far-field area; moderate proportion of mayflies in the near-field and far-field areas.							
Chironomidae proportion	Higher proportion in the near-field area versus far-field area, but variable proportions in the reference area.							
Community composition	Differences in community composition apparent, but not consistent with differences in degree in effluent exposure among areas.							
SDI	Significantly lower (14%) in the far-field area compared to the reference area.							
Multivariate analysis	Spatial trend in benthic invertebrate community structure may indicate a limited effluent effect.							

Note: n/a = not applicable; Ref = reference area, NF = near-field area; FF = far-field area; SDI = Simpson's Diversity Index.
a = Effect designations are based on statistical significance, as required by the guidance document (Environment Canada 2002); however, as explained in the text, the statistically significant difference among study areas was not necessarily consistent with a discharge-related, ecologically significant effect.

Based on field observations and habitat data collected near the artificial substrate samplers deployed during the study, invertebrate sampling stations were located in similar habitat. Although artificial substrates were successful in minimizing habitat variation and can be expected to minimize the potentially confounding effect of sediment metal contamination in the exposure area, an effect from these potential confounding factors cannot be completely ruled out. While there were no obvious differences among areas in habitat features that could readily account for the observed differences in community structure, there appeared to be some relationship between the proportion of aquatic vegetation and the community composition. In addition, two stations in the reference area (R06 and R07) were identified as outliers and had a large influence on the abundance data, which may be related to their location. However, the removal of these stations had little effect on the statistical results of the remaining EEM endpoints. Overall, the use of artificial substrates was effective in minimizing the influence of potential confounding factors, particularly the potential effects of historical sediment contamination.

During previous studies, taxonomic richness and abundance of benthic invertebrate communities were considerably lower at sites close to the mouth of Baker Creek relative to areas farther away in Yellowknife Bay (Falk *et al*. 1973, Moore *et al*. 1978). Both previous studies found that the zone of influence on benthic invertebrates extended from the mouth of Baker Creek to the south, throughout almost the entire length of Back Bay. In this zone of influence, invertebrate abundance was <400 individuals/m^2; outside of the zone of influence, invertebrate abundance reached up to 2,000 individuals/m^2 (Moore *et al*. 1978). Over 90% of the variability in the invertebrate community variables was related to the concentrations of metals and a metalloid (zinc, arsenic, lead, mercury, copper, nickel, and cadmium) in the sediments of Yellowknife Bay (Moore *et al* 1978). The predominant taxa in the contaminated area were midges (*Procladius denticulatus*, *Heterotrissocladius changi*) and an amphipod (*Pontoporeia affinis*) (Moore *et al*. 1978). Falk *et al*. (1973) found that amphipods, clams, snails and roundworms (nematodes) were abundant in Yellowknife Bay.

Results from the Phase 1 (Golder 2005) and Phase 2 EEM ICS were comparable. However, comparison of these results with previous studies is hindered by differences in sampling methods (artificial substrates in 2004 and 2006; bottom sampling in previous years). Nevertheless, analysis of the invertebrate community data collected in both 2004 (Golder 2005) and 2006 highlights the low level of effects observed on artificial substrates deployed in the water column, in comparison to the severe effects observed in bottom sediments by previous studies. These results suggest that historical sediment contamination likely poses a greater risk to aquatic life in Yellowknife Bay than the periodic discharge of effluent from the Giant Mine.

6.0 TOXICITY TESTING

6.1 Introduction

Sub-lethal toxicity testing of Giant Mine effluent was completed between July 2005 and July 2006 as required by the MMER (MMER 2002, 2006). Sub-lethal toxicity testing of the treated effluent can aid in the interpretation of effluent-related effects on the downstream fish and benthic invertebrate communities. In addition, these tests can provide an indication of the degree of variability in effluent quality and temporal or seasonal trends (EC 2002).

The effluent samples were tested using the following suite of sub-lethal toxicity tests:

- fish early life stage development test (the fathead minnow [*Pimephales promelas*]);
- invertebrate reproduction test (a water flea [*Ceriodaphnia dubia*]);
- algal growth test (a green alga [*Pseudokirchneriella subcapitata*]); and
- a plant toxicity test (a macrophyte [*Lemna minor*]).

Acute lethality testing results, although not required for the biological survey component of the EEM program, are included to demonstrate the overall quality of the effluent. Acute lethality testing (<50% mortality in undiluted effluent) using Mine effluent was completed using *Daphnia magna* and rainbow trout (*Oncorhynchus mykiss*).

6.2 Objectives

The objectives of sub-lethal toxicity testing for the Phase 2 EEM program were as follows:

- to measure changes in effluent quality as a result of effluent treatment and process changes; and
- to contribute to the understanding of the relative contributions of the Mine in multiple discharge situations.

The objective of the acute lethality testing for the Phase 2 period was to identify the presence of acutely lethal effluent being discharged into the receiving environment.

6.3 Methods

6.3.1 Sampling Location and Timing

As per MGML's SOP for MMER/EEM effluent and water quality (MGML 2003), effluent grab samples were collected from the final effluent discharge point (SNP 43-1: Final Discharge to Baker Creek) on the following dates:

- July 14, 2005;
- July 18, 2005;
- August 17, 2005;
- September 14, 2005;
- July 5, 2006;
- August 9, 2006; and
- August 29, 2006.

Two samples were collected in July 2005 because a shipping error was made by the supplier of the fathead minnow.

Acute toxicity testing using undiluted effluent samples from the Mine was completed once per month for *D. magna* and rainbow trout, during the periods of discharge. Acute toxicity testing was completed on the following dates:

- July 14, 2005;
- August 17, 2005;
- September 14, 2005;
- July 5, 2006;
- August 9, 2006; and
- August 29, 2006.

6.3.2 Field

Samples were collected in 20 L plastic carboys, and kept cool (4°C) prior to submission to HydroQual Laboratories (HydroQual) in Calgary, Alberta for biological toxicity testing (acute and chronic tests). All toxicity tests were initiated within three days of sample collection, as required by the MMER.

6.3.3 Laboratory

All sub-lethal and lethal toxicity tests were completed by HydroQual in accordance with accepted methods and minimum reporting requirements outlined in the MMER. HydroQual is accredited by the Canadian Association for Environmental Analytical

Laboratories (CAEAL) and is approved by Environment Canada to conduct toxicity testing according to the Organization of Economic Cooperation and Development principles of Good Laboratory Practice. The sub-lethal toxicity testing methods are described in the following documents, while endpoints and durations are summarized in Table 6-1:

- Test of Growth and Survival Using Fathead Minnow. EPS 1/RM/22 (EC 1992b; amended in November 1997 [EC 1997]);
- Test of Reproduction and Survival Using the Cladoceran *Ceriodaphnia dubia.* EPS 1/RM/21 (EC 1992a; amended in November 1997 [EC 1997]);
- Growth Inhibition Test Using the Freshwater Alga *Selenastrum capricornutum.* EPS/RM/25 (EC 1992c; amended in November 1997 [EC 1997]); and
- Test for Measuring the Inhibition of Growth Using the Freshwater Macrophyte, *Lemna minor*. EPS 1/RM/37 (EC 1999).

Table 6-1
Sub-lethal Toxicity Test Endpoints and Durations

Test Organism	Endpoint	Duration (Days)
Fathead minnow	Growth/Survival	7
Ceriodaphnia dubia	Reproduction/Survival	7
Pseudokirchneriella subcapitata[(a)]	Growth inhibition	3
Lemna minor	Growth inhibition	7

a = The taxonomic name of the chronic toxicity test algal species changed from *Selenastrum capricornutum* to *Raphidocelis subcapitata* in 2005 (Nygaard *et al*. 1986) and to *Pseudokirchneriella subcapitata* as per Hindák (1990) in 2006.

The laboratory reports on the sub-lethal toxicity tests contained the following information:

- test procedures and conditions;
- source of organisms;
- effluent characteristics and sampling details;
- results of the tests;
- results of reference toxicant tests; and
- other aspects of the laboratory QA/QC program.

6.3.4 Data Entry and Analysis

Data from each sub-lethal and acute toxicity test were sent to the Regional Assessment Officer (RAO) within 90 days of the test completion. Sub-lethal toxicity testing results were entered into Environment Canada's Sub-lethal Toxicity Reporting System within the National EEM Database for Metal Mining.

Reporting of statistical results of the sub-lethal test data followed recommendations by the Toxicology Expert Working Group Report (EC 1997d) and the EEM TGD (EC 2002). Endpoint calculations and associated parameters were completed by HydroQual. Reported endpoints included lethal concentration to 50% of the population (LC_{50}) and inhibitory concentration to 25% of the population (IC_{25}) results. The LC_{50} is defined as the concentration of material in water (in this case effluent) that is estimated to be lethal to 50% of the test animals after a defined period of exposure. The IC_{25} refers to the concentration of effluent in water that is estimated to cause a 25% reduction in a qualitative biological measurement, such as growth or reproduction, relative to the control after a defined period of exposure. Estimates of the IC_{25} and their 95% confidence intervals were determined by linear interpolation. This procedure involves a non-parametric monotonic smoothing method and produces a point estimate with a confidence interval based on a specific magnitude of inhibition (*i.e.* 25%).

Reported endpoints for the *C. dubia* and fathead minnow toxicity tests included LC_{50} and IC_{25} results and, where available, associated 95% confidence intervals. Reported endpoints for the *P. subcapitata* and *L. minor* growth inhibition tests included IC_{25} and, where available, associated 95% confidence intervals. Median lethal concentrations (LC_{50}) and their 95% confidence intervals were based on nominal test concentrations and were calculated, where appropriate, using mortality data at the end of the exposure.

6.3.5 Quality Assurance/Quality Control

The quality assurance/quality control (QA/QC) procedures and requirements are an important aspect of any field or laboratory testing program. The objective of having good QA/QC practices is to standardize testing and to ensure that high quality data are generated.

Laboratories contracted to conduct sub-lethal toxicity testing must carry CAEAL, Canadian Association for Environmental Analytical Laboratories, Ministère de l'Environnement et de la Faune, or an equivalent level of accreditation (EC 2002). Sample collection and testing for sub-lethal toxicity must adhere to the following QA/QC requirements (EC 2002):

- sub-lethal toxicity tests that fail to meet test method validity criteria must be repeated on a new effluent sample;
- compliance to effluent sample age limit or re-sampling required (*i.e.*, testing must be completed within three days of sample collection);
- adherence to minimum level of reporting required by the test method;
- reporting of test data within 90 days of test completion for QA check;
- reporting of 'less than' values as a test endpoint is not acceptable;
- all test endpoints must be bracketed by at least one test concentration;

- a reference toxicant test must be conducted within 30 days of the effluent test; and
- reference toxicant tests must be performed under the same experimental conditions as the effluent test.

All necessary QA/QC procedures and requirements were followed by the field staff and HydroQual for all sub-lethal and acute toxicity testing. Technical details and quality assurance/quality control (QA/QC) summaries for the acute and chronic toxicity tests were submitted in the final HydroQual reports (INAC 2007).

6.4 Results

6.4.1 Sub-lethal Toxicity Testing

6.4.1.1 Survival and Growth of Fathead Minnow

Both the LC_{50} and the IC_{25} values for fathead minnow were consistently >100% of the effluent concentration (Table 6-2). This result indicates that the effluent was not acutely toxic to fathead minnow and no growth inhibition was observed.

6.4.1.2 Survival and Reproduction of *Ceriodaphnia dubia*

Undiluted effluent was not acutely toxic to *C. dubia* on September 14, 2005; however, the LC_{50} concentration was 22% on July 14, 2005 and 74% on July 5, 2006 (Table 6-2). Sub-lethal effects on *C. dubia* were observed during all toxicity tests completed during Phase 2, with reproductive impairment (IC_{25}) observed in effluent concentrations ranging from 1.6% to 24%.

6.4.1.3 Growth Inhibition of Pseudokirchneriella subcapitata

Growth inhibition was observed in *P. subcapitata* in effluent concentrations ranging from 14% to 25% (Table 6-2).

6.4.1.4 Growth Inhibition of Lemna minor

In Phase 2, median values from all three sub-lethal toxicity tests displayed an inhibition on the number of fronds produced in effluent concentrations ranging from 8% to 19% (Table 6-2). A reduction in *L. minor* biomass was observed in 33% effluent on July 14, 2005 (Table 6-2).

Table 6-2
Toxicity of Giant Mine Treated Effluent, 2005 and 2006

Test Organism	Test Type	Date Sampled	Acute (% Effluent Concentration)			Chronic (% Effluent Concentration)		
			Response	LC_{25}	LC_{50}	Response	IC_{25}	IC_{50}
Pimephales promelas	7-day Survival and Growth	18-Jul-05	Survival	>100	>100	Growth	>100	>100
(fathead minnow)		14-Sep-05	Survival	>100	>100	Growth	>100	>100
		05-Jul-06	Survival	>100	>100	Growth	>100	>100
Ceriodaphnia dubia	7-day Survival and Reproduction	14-Jul-05	Survival	15	22	Reproduction	5.8	8.6
(water flea)		14-Sep-05	Survival	84	>100	Reproduction	1.6	39
		29-Aug-06	Survival	32	74	Reproduction	24	32
Pseudokirchneriella subcapitata	72-hour Growth Inhibition	14-Jul-05	–	–	–	Growth	16	>100
(green algae)		14-Sep-05	–	–	–	Growth	25	>100
		29-Aug-06	–	–	–	Growth	14	47
Lemna minor	7-day Growth Inhibition	14-Jul-05	–	–	–	Growth	19	62
(lesser duckweed)	(fronds)	14-Sep-05	–	–	–	Growth	15	45
		29-Aug-06	–	–	–	Growth	8.0	29
Lemna minor	7-day Growth Inhibition	14-Jul-05	–	–	–	Growth	33	>97
(lesser duckweed)	(biomass)	14-Sep-05	–	–	–	Growth	>97	>97
		29-Aug-06	–	–	–	Growth	>97	>97

Notes: LC_{50} = concentration estimated to be lethal to 50% of the exposed organisms; IC_{25} = concentration estimated for inhibition of growth in 25% of the organisms; % = percent; > = greater than; Jul = July; Aug = August; Sep = September; n/a = not applicable.

6.4.2 Acute Toxicity Testing

Acute lethality testing results, although not required for the biological survey component of EEM, are included to demonstrate the overall quality of the effluent. No mortality was observed for rainbow trout in 2005 or 2006. Therefore, Mine effluent was consistently non-lethal as defined by MMER (Government of Canada 2002, 2006) during this period (Table 6-3).

Table 6-3
Acute Toxicity of the Giant Mine Treated Effluent, 2005 and 2006

Test Organism	Test Type	Date Sampled	Mortality (%)
Oncorhynchus mykiss (rainbow trout)	96-hour Static Acute Test (undiluted effluent plus control)	14-Jul-05	0
		17-Aug-05	0
		14-Sep-05	0
		05-Jul-06	0
		09-Aug-06	0
		29-Aug-06	0
Daphnia magna (water flea)	48-hour Static Acute Test (undiluted effluent plus control)	14-Jul-05	0
		17-Aug-05	0
		14-Sep-05	0
		05-Jul-06	0
		09-Aug-06	0
		29-Aug-06	0

Notes: % = percent; Jul = July; Aug = August; Sep = September.

6.4.3 Comparison of Environmental Effects Monitoring Phases 1 and 2

The geometric mean of the effluent concentration estimated to cause inhibition of growth or reproduction in 25% of the test organisms (GM-IC_{25}) for each sub-lethal test species can be used to assess changes in effluent toxicity over time (EC 2005). Similarly, the geometric mean of the effluent concentration estimated to reduce survival in 50% of the test organisms (GM-LC_{50}) can also be used to assess effluent quality over time. A summary of the GM-IC_{25} and GM-LC_{50} concentrations for the sub-lethal toxicity testing organisms are presented in Table 6-4.

Toxicity testing during the two EEM phases indicated that effluent from the Mine was not acutely toxic to fathead minnows and resulted in no growth inhibition of fathead minnows (Table 6-4). However, effluent concentrations of <30% elicited sub-lethal toxicity effects *C. dubia*, *P. subcapitata*, and *L. minor*. These results are similar to the Phase 1 results, with the exception of *L. minor*, which did not exhibit sub-lethal effects in Phase 1.

Table 6-4
Geometric Mean of the Concentrations of Giant Mine Effluent Causing Sub-lethal Effects in Toxicity Tests Completed During Phase 1 and Phase 2

Endpoint	Phase	Test Organism				
		Fathead Minnow (% Effluent)	*Ceriodaphnia dubia* (% Effluent)	*Pseudokirchneriella subcapitata* (% Effluent)	*Lemna minor* Fronds (% Effluent)	*Lemna minor* Biomass (% Effluent)
GM-LC_{50}	1	>100	38.1	n/a	n/a	n/a
	2	>100	54.6	n/a	n/a	n/a
GM-IC_{25}	1	>100	5.3	21.4	26.5	>97.0
	2	>100	4.9	17.8	13.2	67.7

Note: GM = geometric mean; n/a = not applicable; % = percent; LC_{50} = concentration estimated to be lethal to 50% of the exposed organisms; IC_{25} = concentration estimated to cause inhibition of growth or reproduction in 25% of the test organisms; > = greater than.

6.4.3.1 Potential Effects in Baker Creek

The EEM TGD (EC 2002) recommends that, if the IC_{25} results are <30%, then the geographic extent of the response in the exposure area should be determined. IC_{25} values of <30% were observed for *C. dubia*, *P. subcapitata*, and *L. minor* during the Phase 2 period.

The 2003 effluent plume model (Golder 2003) was considered valid for the Phase 2 EEM program because it remained within an acceptable range of uncertainty for the following reasons:

- volume of effluent discharged has decreased since 2003, thus the model is conservative;
- concentrations of ammonia and major ions have decreased thus again the model is conservative; and
- toxicity results were generally similar to results from 2004.

Based on the results of the 2003 effluent plume modelling (Golder 2003), effluent concentrations were estimated to be diluted to approximately 90% at the outlet of Baker Creek and 10% at the breakwater. The Phase 2 GM-IC_{25} values indicate that the zone for potential sub-lethal effects in Baker Creek would require the following effluent concentrations to elicit sub-lethal effects:

- >100% for fathead minnows;
- 4.9% for *C. dubia*;
- 17.8% for *P. subcapitata*;
- 13.2% for *L. minor* fronds; and
- 67.7% for *L. minor* biomass.

Based on these results, effluent-related effects may occur between the final point of discharge of treated effluent and past the breakwater at the mouth of Baker Creek into Yellowknife Bay. However, intermittent discharge and mixing in Yellowknife Bay complicate the delineation of the effluent plume and, thus, of the extent of potential effluent-related effects.

7.0 SYNOPSIS AND CONCLUSIONS OF THE FISH SURVEY, INVERTEBRATE SURVEY, AND SUB-LETHAL TOXICITY TESTING

7.1 Fish Survey

Fish Study

A lethal field survey of slimy sculpin and a non-lethal survey of ninespine stickleback were conducted in Baker Creek (exposure area) and three locations on the Yellowknife River (reference areas). An assessment of age distribution, energy use and energy storage was performed on slimy sculpin of the two populations.

Slimy sculpin Because fish were in a post-spawning state, the state-of-maturity and sex and size of slimy sculpin were difficult to determine in the field. Age determination from otoliths was also difficult for these populations. To accommodate this, slimy sculpin were broadly categorized based on size as Age 1 (to represent juveniles) or Age 2+ (to represent adult fish). Age 2+ slimy sculpin females were found to be smaller and younger and had larger livers than fish in the exposure area than in the reference area; exposure females also had increased condition factors compared to reference females. However, difference in females between reference areas existed and often the magnitude of difference between females in exposure versus reference females was less than that of natural variation (20-30%). Statistical difference in male 2+ fish from the exposure area were also found: males were shorter and lighter but had heavier gonads than reference fish. There were few Age 2+ male fish (five) in the reference area A so results for the males should be interpreted with caution. Age 1 slimy sculpin had higher condition factors in the exposure area than the reference area. The non-lethal analysis of all slimy sculpin captured showed that the condition factor of exposure fish was significantly larger than the reference areas.

A comparison of fish from the two reference areas (where possible) provided a measure of natural variability. Only two effect endpoints are deemed ecologically significant once the natural variability it taken into account: female age; and Age 1 condition. There is insufficient data in the reference area B to assess natural variability for male gonad weight; therefore, this endpoint is interpreted as an effect as defined by the EEM TGD (EC 2002).

Ninespine stickleback Condition factor, length and weight in ninespine stickleback young-of-the-year fish were significantly higher in the exposure area than the reference area.

Summary of fish study Differences in the exposure fish versus reference fish were detected. Condition factor was higher in exposure fish for both sentinel species. There was a marked size difference in young ninespine stickleback between the exposure and reference area that warrants further study. This Phase 2 study is the first to have sufficient numbers of fish derive conclusions about effects on fish. It is unclear if the differences are caused by one or a combination of effluent, historical contaminants in the sediment and porewater, or habitat differences. Future studies should continue to use slimy sculpin and ninespine stickleback and make refinements to the study areas to reduce habitat variability.

7.2 Invertebrate Community Survey

Artificial substrates samples (Hester-Dendy multi-plate samplers) were deployed at five stations in Baker Creek (near-field area), Yellowknife Bay (far-field area) and the Yellowknife River (reference area). Six artificial substrates were deployed and retrieved at each of the replicate stations, with the exception of station E07 in the far-field area, which had only one set of three samplers because one set was lost to vandalism. Artificial substrates were left to colonize for over 2 months. Supporting environmental data (water quality, sediment quality and habitat) were collected during the study.

Invertebrate community data were summarized as four effect endpoints (total invertebrate abundance, family level richness, SEI, and BCI), and tested for statistically significant differences. SDI, family presence/absence, invertebrate community composition of major taxa were included as supporting information but were not used to determine effluent-related effects. Multivariate analyses (*i.e.*, NMDS) were also conducted to further evaluate invertebrate community structure and variation related to habitat.

Based on the analyses, the effect of the mine discharge on the invertebrate community can be conservatively characterized as low. Two effect endpoints (richness and BCI) were significantly different between areas; however, only BCI exceeded the critical effect size and was considered to be ecologically significant. While artificial substrates minimized potential confounding factors related to habitat and historical contamination of the sediments, examination of supporting environmental data and results of the multivariate analyses suggested that vegetative cover may affect the composition of the colonizing invertebrates.

7.3 Toxicity Testing

Sub-lethal toxicity testing of Giant Mine effluent was conducted twice in 2005 and once in 2006. Sub-lethal toxicity responses were observed in *Ceriodaphnia dubia, Pseudokirchneriella subcapitata,* and *Lemna minor*. The reason for the sub-lethal toxicity effects are not known; investigative studies would be needed to determine causation. Acute toxicity testing was also conducted at Giant Mine in 2006. The effluent was not acutely toxic to rainbow trout or *Daphnia magna*.

The Phase 2 GM-IC_{25} values indicate that the zone for potential sub-lethal effects in Baker Creek would require the following effluent concentrations to elicit sub-lethal effects:

- >100% for fathead minnows;
- 4.9% for *C. dubia*;
- 17.8% for *P. subcapitata*;
- 13.2% for *L. minor* fronds; and
- 67.7% for *L. minor* biomass.

Based on these results, effluent-related effects may occur between the final point of discharge of treated effluent and past the breakwater at the mouth of Baker Creek into Yellowknife Bay. Intermittent discharge and mixing in Yellowknife Bay complicate the delineation of the effluent plume and thus of the extent of potential effluent-related effects. Results from the FS indicate sub-lethal effects to fish in the exposure area at concentrations less than 100%, which either suggests that sediment or porewater contaminants are a source of further effects or that fathead minnows are not as sensitive to effects as slimy sculpin or ninespine stickleback. In the benthic survey, only the BCI, which summarizes the overall difference in community structure between the reference and exposure replicate stations, was different between the exposure and reference areas.

8.0 RECOMMENDATIONS FOR PHASE 3

The following recommendations are proposed for the Phase 3 EEM field program, which is scheduled for completion in 2010:

- Because effluent quality and quantity is changing from 2008 onward (only 3 months of discharge and metal and ion concentrations are decreasing), the 2003 effluent plume model should be updated prior to the Phase 3 EEM program (*i.e.*, plume characterization work should be completed in August 2009). Radial transects of specific conductivity measurements should be collected in Yellowknife Bay around the mouth of Baker Creek to aid in defining the zone of influence of the Mine effluent.
- The Phase 1 BIC study worked well. Consequently, use of artificial substrates should be continued for the Phase 3 ICS and the study design should be continued as a control/impact design. Locations of ICS stations should be based on the updated plume characterization work and five replicate stations should be established within each of the near-field and the far-field areas.
- Limited sediment metal data was collected at BIC stations in Phase 2. Sediment samples from each of the ICS replicate stations should be analyzed for total metal concentrations as well as particle size, TOC and moisture content to assess the status of historical contamination.
- Due to limited gonad development, fecundity and egg size estimates were not available for slimy sculpin during Phase 2. Future work should collect slimy sculpin in the late fall/early winter or immediately following ice-off when ovarian development has progressed and reproductive development can be better estimated. Effluent is not present in the area until July so fall sampling should be attempted. Previously the concern was that fish moved out of the bay by late fall; however for a sedentary species like slimy sculpin this may not be a concern.
- Additional reference sites should be added that have physical habitat characteristics that are more similar to Baker Creek than was the case in the Phase 2 EEM FS. Selection of additional reference site will need to consider the new water treatment plant that will be constructed as part of the closure and reclamation plan as well as the discharge of treated effluent directly into Great Slave Lake instead of Baker Creek.
- Baker Creek is heavily contaminated from historical mining activity. In 2006, a portion of the creek was rerouted and clean sediment and substrate were installed. If suitable fish species could be found to reside in the new portion of the creek (know as 'Reach 4') then this area could be used as an exposure area where historical contamination is not present. A fall 2008 reconnaissance survey could be initiated to determine if suitable species are present in Reach 4 prior to completion of a 2009 study design for Phase 3. Arctic grayling currently spawn and rear in Reach 4 but they out-migrate prior to effluent release (Golder 2007; Vecsei *et al.* 2008). One trout perch was observed in Reach 4 in summer 2007. It could possibly be used as a study species if appropriate number and life stages were found.

- Few adult ninespine stickleback were found in Baker Creek or in Yellowknife River and the addition of a lethal study on a second sentinel species would be advantageous. An alternate study area for ninespine stickleback could be considered. If enough adult ninespine stickleback are found in Baker Creek, Horseshoe Island Bay could be re-examined as a reference area for adult fish. It was used for the Phase 1 EEM for Giant Mine and for both Phase 1 and 2 for the Con Mine EEM.
- Given that effects on liver, gonad and size were seen in Phase 2, further studies should include gonad histology, liver histology and metallothionein analysis and whole-body or viscera arsenic analysis. This would allow a comparison to the near-by Con Mine EEM and allow for a clearer understanding of the effects on fish. Recent advances in analytical techniques may allow arsenic speciation analysis in small tissues and in sediment and water. This would be advantageous because it would allow comparison to recent Yellowknife Bay studies which found significant amounts of organic arsenic in fish in the area (de Rosemond 2008). The use of total arsenic may be too coarse a measure to understand the mechanism of effects in future studies (Investigation of Cause).

9.0 CLOSURE

We trust this report presents the information required by INAC for the Giant Mine to fulfill the requirements of the Phase 2 EEM program for metal mines. Should any portion of this report require clarification, please contact the undersigned.

GOLDER ASSOCIATES LTD.

Report Prepared by:

Katherine Gerein, M.Sc.
Aquatic Ecologist

Travis Shepherd, Ph.D.
Fisheries Biologist

Report Reviewed by:

Hilary Machtans, M.Sc.
Fisheries Biologist

Chris Fraikin, M.Sc.
Aquatic Biologist

Peter M. Chapman, Ph.D., R.P.Bio.
Principal/Senior Environmental Scientist

.

10.0 REFERENCES

Andrade, Claudio. 2006. Arsenic cycling and speciation in mining-impacted sediments and pore-waters from Yellowknife Bay, Great Slave Lake, NWT. Queen's University M.Sc. Thesis Submission. January 2006.

Bervoets, L, R. Blust, and R. Verheyen. 2001. Accumulation of metals in tissues of three-spine stickleback (*Gasterosteus aculeatus*) from natural fresh waters. Ecotoxicology and Environmental Safety 48:117-127.

Bright, D.A., B. Coedy, W.T. Dushenko, and K.J. Reimer. 1994. Arsenic transport in a watershed receiving gold mine effluent near Yellowknife, Northwest Territories, Canada. Science of the Total Environment 155: 237-252.

Buchner, A., E. Erdfelder and F. Faul. 1997. How to Use G*Power. Available at: http://www.psychologie.uni-trier.de:8000/projects/gpower/how_to_use_gpower.html

Canadian Council of Ministers of the Environment (CCME). 1999. Canadian Environmental Quality Guidelines.

Canadian Council of Ministers of the Environment (CCME). 2002. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life – Summary Table Update 2002.

Canadian Council of Ministers of the Environment (CCME). 2007. Canadian Water Quality Guidelines for the Protection of Aquatic Life – Summary Table Update 7.1.

Clements, W.H. 1991. Community responses of stream organisms to heavy metals: a review of observational and experimental approaches. In Metal Ecotoxicology: Concepts and Applications. M.C. Newman and A.W. McIntosh eds. Lewis Publishers, Chelsea, pp. 363-391.

Cohen, J. 1988. Statistical Power Analysis for the Behavioural Sciences. 2nd Edition. Lawrence Erlbaum Associates, Inc., Hillsdale, New Jersey.

Craig, P.C. and J. Wells. 1976. Life history notes for a population of slimy sculpin (*Cottus cognatus*) in an Alaskan arctic stream. Journal of the Fisheries Research Board of Canada. 33(7):1639-1642.

De Rosemond, S., X. Qianli, and K. Liber. 2008. Arsenic concentration and speciation in five freshwater fish from Back Bay near Yellowknife, NT, Canada. Environmental Monitoring and Assessment, on-line pre-print publication: s10661-007-0112-6.

Deton'Cho/Nuna Joint Venture (DCNJV). 2007. Giant Mine – 2006 Annual MMER/EEM Report. Prepared by Golder Associates Ltd.

Dillon Consulting Limited (Dillon). 2002a. Biological Sampling at Baker Creek 2002. Technical Report – Final. November 2002. Prepared for Indian and Northern Affairs Canada.

Dillon Consulting Limited (Dillon). 2002b. Biological Sampling at Baker Creek – Summary Report for Indian Affairs and Northern Development Canada. April 2002.

Dillon Consulting Limited (Dillon). 1998. Baker Creek Fish Habitat and Rehabilitation Study for Abandonment and Restoration Planning. Prepared for Royal Oak Mines Inc.

EBA Engineering Consultants (EBA). 2001. Assessment of Back Bay Tailings Deposit, Giant Mine, Yellowknife, NT. Submitted to the Royal Oak Project Team, Yellowknife, NT.

EBA Engineering Consultants (EBA). 1998. Evaluation of Surface Contamination Data, Giant Mine Site, Yellowknife, N.W.T. Prepared for Royal Oak Mines.

Edwards, P.A. 2001. An investigation of the potential effects of natural and anthropogenic disturbance on the density and distribution of the slimy sculpin (*Cottus cognatus*) in Catamaran Brook, New Brunswick. Ph.D. thesis, University of New Brunswick, Fredericton, N.B., Canada.

Environment Canada. 2008. Canadian climate normals or averages 1971 – 2000. Available at: http://climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html.

Environment Canada (EC). 2002. Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring. June 2002.

Environment Canada (EC). 1999. Test for measuring the inhibition of growth using the freshwater macrophyte, *Lemna minor*. Environment Canada, Ottawa, Ontario. Report EPS 1/RM/25.

Environment Canada (EC). 1992a. Test of reproduction and survival using fathead minnow. Environment Canada, Ottawa, Ontario. Report EPS 1/RM/22.

Environment Canada (EC). 1992b. Test of reproduction and survival using the cladoceran *Ceriodaphnia dubia*. Environment Canada, Ottawa, Ontario. Report EPS 1/RM/21.

Environment Canada (EC). 1992c. Test of reproduction and survival using freshwater alga *Selenastrum capricornutum*. Environment Canada, Ottawa, Ontario. Report EPS 1/RM/25.

Environment Canada (EC). 1997. Toxicology Expert Working Group Report. EEM Technical Management Committee. EEM/1997/5.

Falk, M.R., M.D. Miller, and S.J.M. Kostiuk. 1973. Data Supplement to: Biological Effects of Mining Wastes in the Northwest Territories. Prepared by Environment Canada.

Fracflow Consultants Inc. and J.J. Gibson (Fracflow and Gibson). 1998. Preliminary Hydrogeological, Geochemical, and Isotopic Investigations at Giant Mine. Prepared for Indian and Northern Affairs Canada.

Galloway B.J., K.R. Munkittrick, S. Currie, M.A. Gray, R.A. Curry, and C.S. Wood. 2003. Examination of the response of slimy sculpin (*Cottus cognatus*) and white sucker (*Catostomus commersoni*) collected on the Saint John River (Canada) downstream of pulp mill, paper mill, and sewage discharges. Environmental Toxicology and Chemistry. 22:2898-2907.

Golder Associates Ltd. (Golder). 2008. River-run lake cisco in the Great Slave Basin: 2007 Data Summary Prepared for Department of Fisheries and Oceans by Golder Associates Ltd., Yellowknife, NT. 47p.

Golder Associates Ltd. (Golder). 2007. Baker Creek, Results of Fish Monitoring in Reach 4, Spring 2007. Draft report submitted to INAC and DFO as part of a Compensation Plan for Baker Creek.

Golder Associates Ltd. (Golder). 2006. Environmental Effects Monitoring Cycle 2 Study Design. Prepared for Giant Mine Remediation Project by Golder Associates Ltd., Yellowknife, NT. 84p.

Golder Associates Ltd. (Golder). 2005. Environmental Effects Monitoring, Cycle 1, Final Interpretative Report. Prepared for Miramar Giant Mine Ltd., by Golder Associates Ltd., Yellowknife, NT. 136p.+ appendices.

Golder Associates Ltd. (Golder). 2003. Environmental Effects Monitoring Site Characterization and Study Design. Prepared for Miramar Giant Mine Ltd. by Golder Associates Ltd., Yellowknife, NT. 71 p. + appendices.

Golder Associates Ltd. (Golder). 2001. Final Abandonment and Restoration Plan Prepared for Indian and Northern Affairs Canada by Miramar Giant Mine Ltd., Yellowknife, NT. Submitted to Miramar Giant Mine, September 2001.

Government of British Columbia. 2006. Approved Ambient Water Quality Guidelines. Ministry of Environment, Science and Information Branch. Update to the 1998 and 2001 Guidelines.

Government of Canada. 2002. Metal Mining Effluent Regulations. SOR/2002-222.

Government of Canada. 2006. Regulations Amending the Metal Mining Effluent Regulations. SOR/2006-239.

Government of Northwest Territories (GNWT). 2003. Environmental Guideline for Contaminated Site Remediation. November 2003.

Gray, M.A. 2003. Assessing non-point source pollution in agricultural regions of the upper St. John River basin using the slimy sculpin (*Cottus cognatus*). Ph.D. thesis, University of New Brunswick, Fredericton, N.B., Canada.

Gray, M.A., A.R. Curry and K.R. Munkittrick. 2002. Non-lethal sampling methods for assessing environmental impacts using a small-bodied sentinel fish species. Water Qual. Res. J. Canada 37: 195-211.

Hanson, K.L., A.E. Hershey & M.E. McDonald. 1992. A comparison of slimy sculpin (*Cottus cognatus*) populations in arctic lakes with and without piscivorous predators. Hydrobiologia 240:189–201.

Hershey, A.E., and McDonald, M.E. 1985. Diet and digestion rates of slimy sculpins, *Cottus cognatus*, in an Alaskan arctic lake. Canadian Journal of Fisheries and Aquatic Sciences. 42:483-487.

Hindák, F. 1990. Studies on the chlorococcal algae (Chlorophyceae), V. *Biologické Práce* 36:1–225. Veda, Publishing House of the Slovak Academy of Sciences (Slovenskej Akadémie Vied), Bratislava, Slovak Republic.

Hoke, R.A., Giesy, J.P and Adams, J.R. 1990. Use of Linear Orthogonal Contrasts in Analysis of Environmental Data. Environmental Toxicology and Chemistry. 9: 815-819.

Indian and Northern Affairs Canada (INAC). 2008. Giant Mine – 2007 Annual MMER/EEM Report.

Indian and Northern Affairs Canada (INAC). 2007. Giant Mine – 2006 Annual MMER/EEM Report.

Indian and Northern Affairs Canada (INAC). 2007. Giant Mine Remediation Plan. Prepared for INAC by SRK Consulting and SENES Consultants Ltd.

Jackson, F.J. 1998. Yellowknife-Back Bay Summer Water Quality Monitoring Program (September 1992 to June 1995). Prepared by the Water Resources Division, Indian and Northern Affairs Canada, Yellowknife, NT.

Jackson, F.J., C.N. Lafontaine, and J. Klaverkamp. 1996. Yellowknife-Back Bay Study on Metal and Trace Element Contamination of Water, Sediment and Fish. Prepared by the Department of Indian Affairs and Northern Development, Department of Fisheries and Oceans, and the Freshwater Institute.

Jana, S. and S. Sahana. 1989. Sensitivity of the freshwater fishes *Clarias batrachus* and *Anabastestudineus* to heavy metals. Environmental Ecology. 7(2):265-270.

Kuehne, R.A. 1962. A classification of streams, illustrated by fish distribution in an Eastern Kentucky creek. Ecology 43:608-14.

Mace, I.S. 1998. A Study of Arsenic Contamination from the Royal Oak Giant Mine, Yellowknife, Northwest Territories. M.Eng. Thesis, Department of Chemistry and Chemical Engineering. Royal Military College of Canada, Kingston, ON.

Miramar Giant Mine Ltd. (MGML). 2003. Standard Operation Procedures: Effluent and Water Quality Monitoring in Accordance with the Metal Mining Effluent Regulations (MMER). Prepared by Golder Associates Ltd. for Miramar Giant Mine Ltd., Yellowknife, NT.

Moore, J. W., D. Sutherland, and S.J. Wheeler. 1978. The Effects of Metal Mines on Aquatic Ecosystems in the Northwest Territories II. Giant Yellowknife Mines Limited. Prepared by the Northwest Region Environmental Protection Service, Fisheries and Environment, Canada.

Munkittrick, K.R., McMaster, M.E., Van Der Kraak, G., Portt, C., Gibbons, W.N., Farwell, A. & Gray, M. 2000. Development of Methods for Effects-driven Cumulative Effects Assessment Using Fish Populations: Moose River Project. Pensacola, FL: Society of Environmental Toxicology and Chemistry.

Nygaard, G., J. Komárek, J. Kristiansen, and O. Skulberg. 1986. Taxonomic designations of the bioassay alga NIVA-CHL 1 ("*Selenastrum capricornutum*") and some related strains. *Opera Botanica* 90:5-46.

Otto, R., and J. Rice. 1977. Responses of a freshwater sculpin (*Cottus cognatus gracilis*) to temperature. Transactions of the American Fisheries Society. 106:89-94.

Primer-E Ltd. 2006. Primer 6 Version 6.1.6. Plymouth, United Kingdom.

Rankin, M. and D. Dixon. 1994. Acute and Chronic toxicity of water borne arsenite to rainbow trout. Canadian Journal of Fisheries and Aquatics Sciences 2:372-380.

Reuther, R. 1992. Arsenic Introduced into a Littoral Fresh-Water Ecosystem. Science of the Total Environment. 115:219-237.

Rosenberg, D.M. and V.H. Resh. 1993. Introduction to freshwater biomonitoring and benthic macroinvertebrates, p. 1-9. *In*: D.M. Rosenberg and V.H. Resh (eds.) Freshwater biomonitoring and benthic macroinvertebrates. Chapman and Hall, New York.

Royal Military College (RMC). 2000. Environmental Study of Arsenic Contamination from the Giant Mine, Yellowknife, NWT – Part 1. Report prepared by the Environmental Sciences Group, Royal Military College, Kingston, ON. Report prepared for Indian and Northern Affairs Canada, November 2000.

Siegel, S., and N. J. Castellan. 1988. Nonparametric statistics for the behavioural sciences. Second edition. McGraw-Hill, New York, New York, USA.

Sokal, R.R., and F.J. Rohlf. 1995. Biometry, 3rd ed. W.H. Freeman and Co., New York.

Stewart, D.B. 1997. A Review of the Status and Harvests of Fish Stocks in the North Slave Area, Northwest Territories. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2393.

Symons, P., J. Metcalfe, and G. Harding. 1976. Upper lethal and preferred temperatures of the slimy sculpin, *Cottus cognatus*. Journal of the Fisheries Research Board of Canada. 33:180-183.

SYSTAT. 2004. Version 11. Systat Software, Inc., Richmond, CA.

Vecsei, P., P. Smith, J. O'Neil and H. Machtans. 2008. Baker Creek, Results of Fish Monitoring in Reach 4, Spring 2007. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2508

Water Survey of Canada. 2003a. Discharge data for Baker Creek from the years 1983-2001. Gauging Station 07SB013 – Baker Creek at Outlet of Martin Lake. Data obtained from the Water Survey of Canada, Environment Canada, Yellowknife, NT.

Water Survey of Canada. 2003b. Discharge data for Yellowknife River from the years 1941-2002. Gauging Station 07SB003 – Yellowknife River at Inlet to Prosperous Lake. Data obtained on-line from the Water Survey of Canada at http://www.msc-smc.ec.gc.ca/wsc/.

Weiner, E.R. 2000. Applications of Environmental Chemistry – A Practical Guide for Environmental Professionals. Lewis Publishers, New York, USA., pp. 195-199.

Wight, J.B. 1973. Aspects of Evaporation and Evapotranspiration in the Water Balance of Baker Creek Basin, Near Yellowknife, Northwest Territories. M.Sc. Thesis, Department of Geography, University of Alberta, Edmonton, AB.

Yellowknives Dene First Nation. 1997. The Weledeh: Principal River of Weledeh Yellowknife Dene. Prepared by the Yellowknives Dene First Nation.

PHOTOPLATES

PHOTOGRAPHS

PLATE: 1

Photograph 1: Aerial view of Baker Creek, Giant Mine, and Back Bay.

Photograph 2: Breakwater at Baker Creek (exposure area), note depth differences on east side (deeper water and no emergent macrophytes) and west side (mouth of creek with emergent macrophytes).

PHOTOGRAPHS

PLATE: 2

Photograph 3: (A) West side of breakwater at Baker Creek; (B) East side of breakwater at Baker Creek.

Photograph 4: West side of breakwater at Baker Creek (exposure area); note depositional material on boulder/gravel substrate.

PHOTOGRAPHS

PLATE: 3

Photograph 5: East side of breakwater at Baker Creek (exposure area); note lack of depostional material on boulder/gravel substrate.

Photograph 6: Aerial view of Yellowknife River and Yellowknife Bay (foreground).

Golder Associates

PHOTOGRAPHS

PLATE: 4

Photograph 7: Emergent macrophytes in small bay of Yellowknife River at bridge (reference area for sediment and invertebrate community survey).

Photograph 8: Substrate/shoreline at Yellowknife River at bridge (fish survey - reference area A).

Golder Associates

PHOTOGRAPHS

PLATE: 5

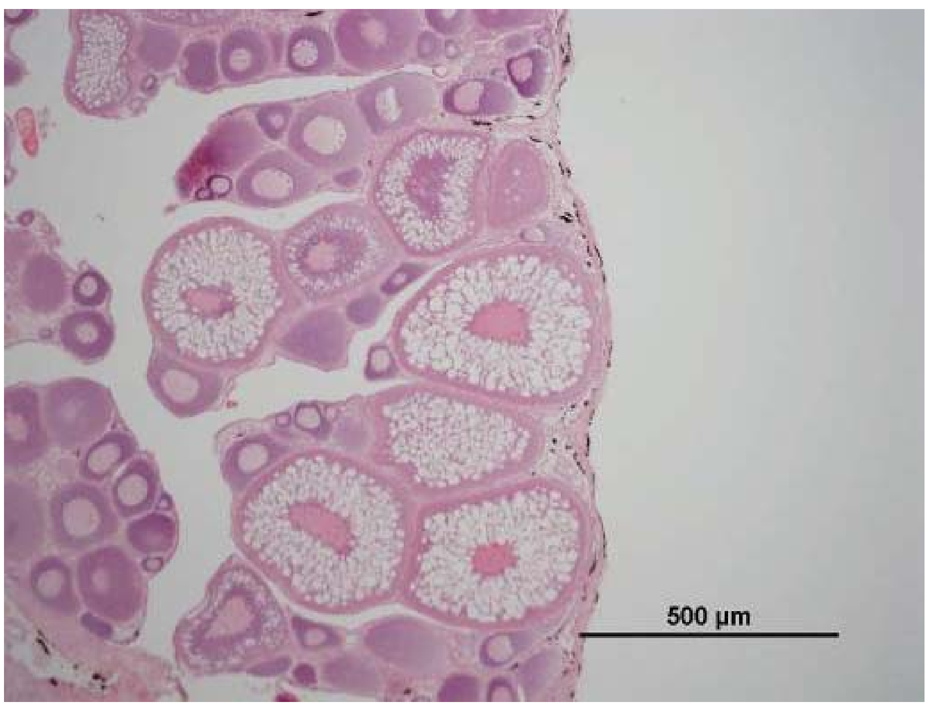
Photograph 9: Ponded area below Tartan Rapids, Yellowknife River (fish survey - reference area C).

Photograph 10: Electrofishing, Yellowknife River below Tartan Rapids (fish survey - reference area C).

PHOTOGRAPHS

PLATE: 6

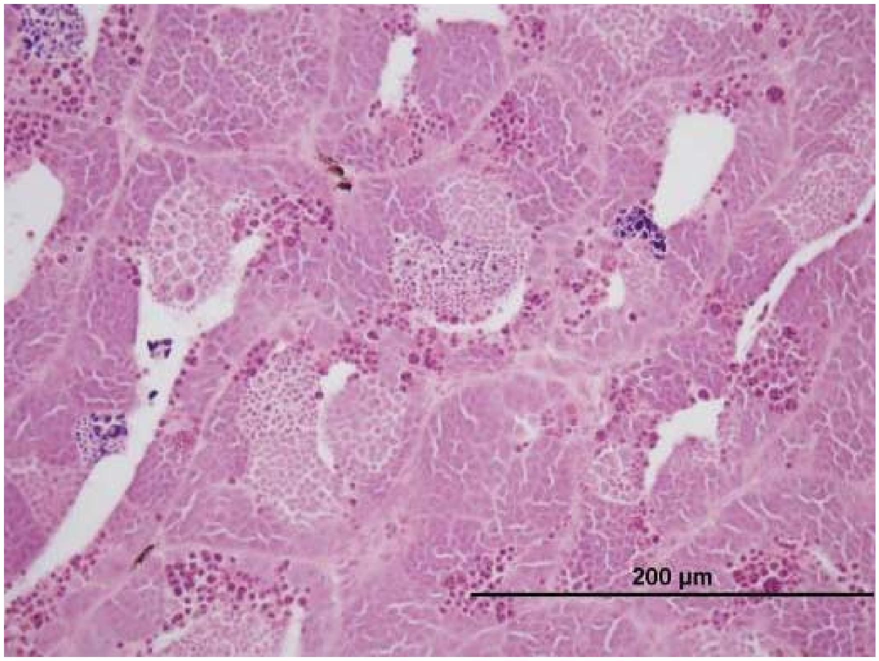
Photograph 11: Seine netting at mouth of Baker Creek (exposure area).



Photograph 12: Histology slide of reproductive female (1B).

PHOTOGRAPHS

PLATE: 7



Photograph 13: Histology slide of reproductive male (1B).

Photograph 14: Slimy sculpin, Baker Creek (exposure area).

Golder Associates

PHOTOGRAPHS

PLATE: 8

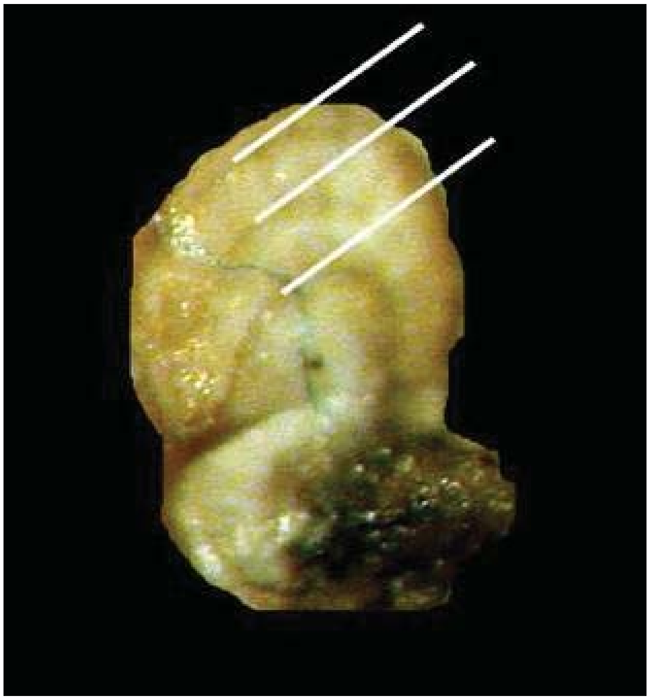
Photograph 15: Spottail shiner, Baker Creek (exposure area).

Photograph 16: Representative ninespine stickleback.

PHOTOGRAPHS

PLATE: 9

Photograph 17: Juvenile northern pike, Baker Creek (exposure area).

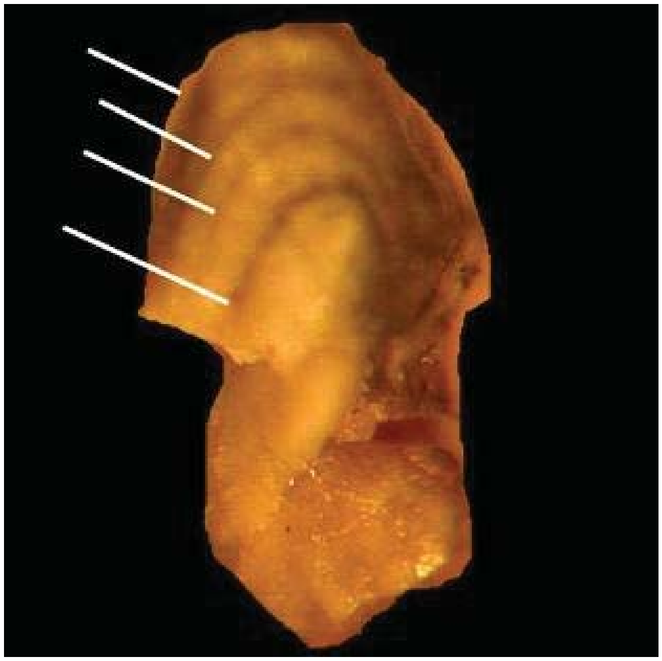


Photograph 18: Otolith, age 3 slimy sculpin.

Golder Associates

PHOTOGRAPHS

PLATE: 10

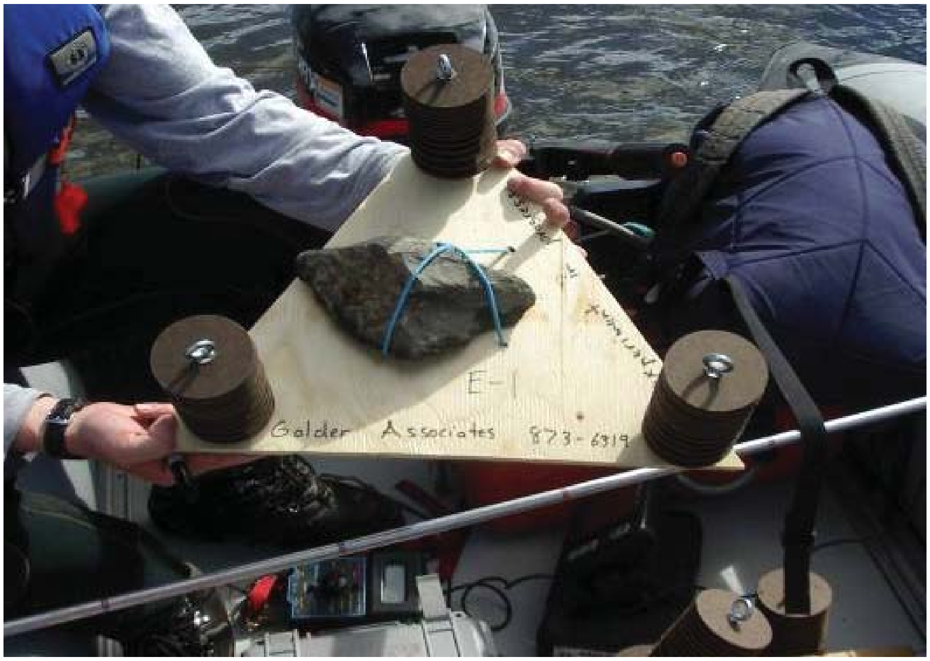


Photograph 19: Otolith, age 4 slimy sculpin.

Photograph 20: Ekman grab of surficial sediment (exposure area).

PHOTOGRAPHS

PLATE: 11



Photograph 21: Hester-Dendy plates with base.

Photograph 22: Installed Hester-Dendy plates (benthic invertebrate collection, exposure area.

APPENDIX I

FISH SURVEY

Table I-1
Water Chemistry Results for the Fish Survey at Giant Mine, August 2006

				Exposure Area	Reference Area	QA/QC					
				Baker Creek	Yellowknife River	Baker Creek - Duplicate	Field Blank	Travel Blank	Yellowknife River - Duplicate	Field Blank	Travel Blank
Parameter	Units	MDL	CWQG[a]	18-Jul-06	4-Aug-06	18-Jul-06	18-Jul-06	18-Jul-06	4-Aug-06	4-Aug-06	4-Aug-06
Physical Tests											
Acidity (to pH 8.3; as calcium carbonate)	mg/L	1.0	-	4	2	3	2	-	2	2	2
Total Alkalinity (as calcium carbonate)	mg/L	2.0	-	48	21	48	<1	-	21	<1.0	2
Conductivity (laboratory)	µS/cm	2.0	-	573	52	578	<2	-	53	<2.0	<2.0
Total Dissolved Solids	mg/L	3	-	424	35	437	3	-	31	<3.0	<3.0
Hardness (as calcium carbonate)	mg/L	0.5	-	219	25	217	<0.5	-	25	<0.54	<0.54
pH (laboratory)		0.0	6.5 to 9.0	7.3	7.5	7.7	6.1	-	7.6	6.1	5.9
Total Suspended Solids	mg/L	1.0	-	5.7	<1	2.3	1.0	-	4.6	<1	<1
Turbidity	NTU	0.1	-	3.7	1.5	3.2	<0.1	-	1.6	<0.1	<0.1
Major Ions											
Calcium	mg/L	0.05	-	62	06	62	<0.05	<0.05	6.02	<0.001	<0.001
Chloride	mg/L	0.5	-	56	2	55	<0.5	-	1.94	<0.5	<0.5
Magnesium	mg/L	0.1	-	16	2	16	<0.1	<0.1	2.29	<0.01	<0.01
Potassium	mg/L	2.0	-	03	<2	03	<2	<2	<2	<2	<2
Sodium	mg/L	2.0	-	24	<2	24	<2	<2	<2	<2	<2
Sulphate	mg/L	0.5	-	150	03	149	<0.50	-	3.39	<0.50	<0.50
Nutrients											
Ammonia (as nitrogen)	mg/L	0.02	0.4 to 55.76[c]	0.049	<0.020	0.033	<0.020	<0.020	<0.020	<0.020	<0.020
Total Kjeldahl Nitrogen	mg/L	0.05	-	0.732	0.251	0.926	<0.050	<0.050	0.213	<0.050	<0.050
Nitrate (as nitrogen)	mg/L	0.005	2.9	0.822	<0.0050	0.817	<0.0050	-	<0.0050	<0.0050	<0.0050
Nitrite (as nitrogen)	mg/L	0.001	0.060	0.0042	<0.0010	0.0042	<0.0010	-	<0.0010	<0.0010	<0.0010
Total Phosphate	mg/L	0.002	-	0.0337	0.0073	0.0353	<0.0020	-	0.0072	<0.0020	<0.0020
Total Metals											
Aluminum	mg/L	0.005	0.1[d]	0.0863	0.0565	0.0852	<0.0050	<0.0050	0.0664	<0.0050	<0.0050
Antimony	mg/L	0.2	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic	mg/L	0.01	0.005	0.146	<0.00020	0.146	<0.00020	<0.00020	0.00039	<0.00020	<0.00020
Barium	mg/L	0.01	-	0.016	<0.010	0.016	<0.010	<0.010	<0.010	<0.010	<0.010
Beryllium	mg/L	0.005	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bismuth	mg/L	0.2	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Boron	mg/L	0.1	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium	mg/L	0.001	0.00006 and 0.00001[e]	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.050	<0.050
Chromium	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Cobalt	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Copper	mg/L	0.01	0.002 and 0.004[f]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	mg/L	0.01	0.003	0.198	0.057	0.166	<0.010	<0.010	0.065	<0.010	<0.010
Lead	mg/L	0.001	0.001 and 0.007[g]	<0.020	<0.030	<0.020	<0.020	<0.020	<0.030	<0.030	<0.030
Lithium	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.10	<0.10
Manganese	mg/L	0.005	-	0.0270	<0.0050	0.0243	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Mercury	µg/L	0.05	0.026	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Molybdenum	mg/L	0.01	0.073	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nickel	mg/L	0.005	0.025 and 0.150[h]	0.0074	<0.0050	0.0064	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Selenium	mg/L	0.0005	0.001	<0.0005	<0.0005	0.00063	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Table I-1
Water Chemistry Results for the Fish Survey at Giant Mine, August 2006 (continued)

Parameter	Units	MDL	CWQG[(a)]	Exposure Area	Reference Area	QA/QC					
				Baker Creek	Yellowknife River	Baker Creek - Duplicate	Field Blank	Travel Blank	Yellowknife River - Duplicate	Field Blank	Travel Blank
				18-Jul-06	4-Aug-06	18-Jul-06	18-Jul-06	18-Jul-06	4-Aug-06	4-Aug-06	4-Aug-06
Silver	mg/L	0.01	0.0001	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Strontium	mg/L	0.005	-	0.503	0.0255	0.500	<0.0050	<0.0050	0.0249	<0.0050	<0.0050
Thallium	mg/L	0.2	0.0008	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Tin	mg/L	0.03	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Titanium	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium	mg/L	0.03	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Vanadium	mg/L	0.004	0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc				<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	0.0853	<0.0040	<0.0040
Dissolved Metals											
Aluminum	mg/L	0.005	-	<0.0050	0.0119	<0.0050	-	-	0.0158	<0.0050	<0.0050
Antimony	mg/L	0.2	-	<0.20	<0.20	<0.20	-	-	<0.20	<0.20	<0.20
Arsenic	mg/L	0.0002	-	0.134	<0.00020	0.132	-	-	0.00028	<0.00020	<0.00020
Barium	mg/L	0.01	-	0.015	<0.010	0.015	-	-	<0.010	<0.010	<0.010
Beryllium	mg/L	0.005	-	<0.0050	<0.0050	<0.0050	-	-	<0.0050	<0.0050	<0.0050
Bismuth	mg/L	0.2	-	<0.20	<0.20	<0.20	-	-	<0.20	<0.20	<0.20
Boron	mg/L	0.1	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10
Cadmium	mg/L	0.001	-	<0.0010	<0.0010	<0.0010	-	-	<0.0010	<0.0010	<0.0010
Chromium	mg/L	0.01	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010
Cobalt	mg/L	0.01	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010
Copper	mg/L	0.01	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010
Iron	mg/L	0.01	-	0.011	<0.010	0.011	-	-	<0.010	<0.010	<0.010
Lead	mg/L	0.001	-	<0.020	<0.030	<0.020	-	-	<0.030	<0.030	<0.030
Lithium	mg/L	0.01	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010
Manganese	mg/L	0.005	-	<0.0050	<0.0050	<0.0050	-	-	<0.0050	<0.0050	<0.0050
Mercury	µg/L	0.05	-	<0.000050	<0.000050	<0.000050	-	-	<0.000050	<0.000050	<0.000050
Molybdenum	mg/L	0.01	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010
Nickel	mg/L	0.005	-	<0.0050	<0.0050	0.0061	-	-	<0.0050	<0.0050	<0.0050
Selenium	mg/L	0.0005	-	<0.00050	<0.20	<0.00050	-	-	<0.20	<0.20	<0.20
Silver	mg/L	0.01	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010
Strontium	mg/L	0.005	-	0.492	0.0258	0.489	-	-	0.0250	<0.0050	<0.0050
Thallium	mg/L	0.2	-	<0.20	<0.20	<0.20	-	-	<0.20	<0.20	<0.20
Tin	mg/L	0.03	-	<0.030	<0.030	<0.030	-	-	<0.030	<0.030	<0.030
Titanium	mg/L	0.01	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010
Uranium	mg/L	0.5	-	<0.50	<0.50	<0.50	-	-	<0.50	<0.50	<0.50
Vanadium	mg/L	0.03		<0.030	<0.030	<0.030	-	-	<0.030	<0.030	<0.030
Zinc	mg/L	0.004	-	<0.0040	<0.0040	<0.0040	-	-	<0.0040	<0.0040	<0.0040
Organics											
Dissolved Organic Carbon	mg/L	0.5	-	13.2	5.50	13.3	0.90	12.8	6.71	<0.20	0.20
Total Organic Carbon	mg/L	0.5	-	14.8	5.60	14.7	1.07	13.2	5.60	0.20	0.30
Radionuclides[(b)]											
Radium-226	Bq/L	0.005	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Table I-1
Water Chemistry Results for the Fish Survey at Giant Mine, August 2006 (continued)

				Exposure Area	Reference Area	QA/QC					
				Baker Creek	Yellowknife River	Baker Creek - Duplicate	Field Blank	Travel Blank	Yellowknife River - Duplicate	Field Blank	Travel Blank
Parameter	Units	MDL	CWQG[(a)]	18-Jul-06	4-Aug-06	18-Jul-06	18-Jul-06	18-Jul-06	4-Aug-06	4-Aug-06	4-Aug-06
Other											
Total Cyanide	mg/L	0.005	-	0.0070	<0.0050	0.0069	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Total Silicon	mg/L	0.05	-	0.696	<0.00050	0.652	<0.050	<0.050	<0.00050	<0.00050	<0.00050
Dissolved Silicon	mg/L	0.05	-	0.351	0.230	0.355	-	-	0.229	<0.050	<0.050
Fluoride	mg/L	0.02	-	0.100	0.063	0.098	<0.020	-	0.062	<0.020	<0.020

Notes:
mg/L = milligrams per litre; µg/L = micrograms per litre; µS/cm = microSiemens per centimetre; Bq/L = Becquerel per litre; NTU = nephelometric turbidity units; MDL = method detection limit; < = indicates concentration of analyte was less than the MDL.
(a) Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CCME 1999, 2007).
(b) Radium-226 analysis was subcontracted to Saskatchewan Research Council Analytical Laboratories, Saskatoon, Saskatchewan.
(c) Guideline for ammonia (as nitrogen) is temperature and pH dependent; all ammonia guidelines are based on a field temperature of 20ºC: 0.40 mg/L at field ph 8.0; 1.23 mg/L at field pH 7.5; 12.2 mg/L at field pH 6.5; 38.4 mg/L at field pH 6.0.
(d) Guideline for aluminum is 0.005 ug/L at pH <6.5 and 0.100 ug/L at pH >6.5.
(e) Guideline for cadmium is dependent on water hardness and was calculated according to the lowest and highest water hardness values.
(f) Guideline for copper is 0.002 mg/L at water hardness of 0 to 180 mg/L and 0.004 at water hardness >180 mg/L.
(g) Guideline for lead is 0.007 at water hardness of 0 to 60 mg/L and 0.007 at water hardness >180 mg/L.
(h) Guideline for nickel is 0.025 at water hardness of 0 to 60 mg/L and 0.150 at water hardness >180 mg/L.
ALS Environmental File Numbers X8952 and X9802.

Table I-2
Duplicate Water Samples Collected for Quality Assurance/Quality Control during the Giant Mine Fish Survey, July 2006

Parameter	Units	Baker Creek	Baker Creek Duplicate	RPD %	Yellowknife River	Yellowknife River Duplicate	RPD %
		18-Jul-06	18-Jul-06		4-Aug-06	4-Aug-06	
Physical Tests							
Acidity (to pH 8.3; as calcium carbonate)	mg/L	4	3	25	2	2	6
Total Alkalinity (as calcium carbonate)	mg/L	48	48	0	21	21	0
Conductivity (laboratory)	µS/cm	573	578	1	52	53	2
Total Dissolved Solids	mg/L	424	437	3	35	31	14
Hardness (as calcium carbonate)	mg/L	219	217	1	25	25	3
pH (laboratory)		7.3	7.7	4	7.5	7.6	1
Total Suspended Solids	mg/L	5.7	2.3	85	<1.0	4.6	161
Turbidity	NTU	3.7	3.2	15	1.5	1.6	6
Major Ions							
Calcium	mg/L	62	62	0	6	6	2
Chloride	mg/L	56	55	1	2	2	0
Magnesium	mg/L	16	16	1	2	2	2
Potassium	mg/L	03	03	0	<2	<2	0
Sodium	mg/L	24	24	0	<2	<2	0
Sulphate	mg/L	150	149	1	3	3	1
Nutrients							
Ammonia (as nitrogen)	mg/L	0.049	0.033	39	<0.020	<0.020	0
Total Kjeldahl Nitrogen	mg/L	0.732	0.926	23	0.251	0.213	16
Nitrate (as nitrogen)	mg/L	0.822	0.817	1	<0.0050	<0.0050	0
Nitrite (as nitrogen)	mg/L	0.0042	0.0042	0	<0.0010	<0.0010	0
Total Phosphate	mg/L	0.0337	0.0353	5	0.0073	0.0072	1
Total Metals							
Aluminum	mg/L	0.0863	0.0852	1	0.0565	0.0664	16
Antimony	mg/L	<0.20	<0.20	0	<0.20	<0.20	0
Arsenic	mg/L	0.146	0.146	0	<0.0002	0.0004	118
Barium	mg/L	0.016	0.016	0	<0.010	<0.010	0
Beryllium	mg/L	<0.0050	<0.0050	0	<0.0050	<0.0050	0
Bismuth	mg/L	<0.20	<0.20	0	<0.20	<0.20	0
Boron	mg/L	<0.10	<0.10	0	<0.10	<0.10	0
Cadmium	mg/L	<0.0010	<0.0010	0	<0.0010	<0.0010	0
Chromium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0
Cobalt	mg/L	<0.010	<0.010	0	<0.010	<0.010	0
Copper	mg/L	<0.010	<0.010	0	<0.010	<0.010	0
Iron	mg/L	0.198	0.166	18	0.057	0.065	13
Lead	mg/L	<0.020	<0.020	0	<0.030	<0.030	0
Lithium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0
Manganese	mg/L	0.0270	0.0243	11	<0.0050	<0.0050	0
Mercury	µg/L	<0.000050	<0.000050	0	<0.000050	<0.000050	0
Molybdenum	mg/L	<0.010	<0.010	0	<0.010	<0.010	0
Nickel	mg/L	0.0074	0.0064	14	<0.0050	<0.0050	0
Selenium	mg/L	<0.0005	0.0006	86	<0.00050	<0.00050	0
Silver	mg/L	<0.010	<0.010	0	<0.010	<0.010	0
Strontium	mg/L	0.503	0.500	1	0.0255	0.0249	2
Thallium	mg/L	<0.20	<0.20	0	<0.20	<0.20	0
Tin	mg/L	<0.030	<0.030	0	<0.030	<0.030	0
Titanium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0
Uranium		<0.50	<0.50	0	<0.50	<0.50	0
Vanadium	mg/L	<0.030	<0.030	0	<0.030	<0.030	0
Zinc	mg/L	<0.0040	<0.0040	0	<0.004	0.0853	191
Dissolved Metals							
Aluminum	mg/L	<0.0050	<0.0050	0	0.0119	0.0158	28
Antimony	mg/L	<0.20	<0.20	0	<0.20	<0.20	0
Arsenic	mg/L	0.134	0.132	2	<0.0002	0.00028	95
Barium	mg/L	0.015	0.015	0	<0.010	<0.010	0
Beryllium	mg/L	<0.0050	<0.0050	0	<0.0050	<0.0050	0
Bismuth	mg/L	<0.20	<0.20	0	<0.20	<0.20	0
Boron	mg/L	<0.10	<0.10	0	<0.10	<0.10	0
Cadmium	mg/L	<0.0010	<0.0010	0	<0.0010	<0.0010	0
Chromium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0
Cobalt	mg/L	<0.010	<0.010	0	<0.010	<0.010	0
Copper	mg/L	<0.010	<0.010	0	<0.010	<0.010	0
Iron	mg/L	0.011	0.011	0	<0.010	<0.010	0
Lead	mg/L	<0.020	<0.020	0	<0.030	<0.030	0
Lithium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0
Manganese	mg/L	<0.0050	<0.0050	0	<0.0050	<0.0050	0
Mercury	µg/L	<0.000050	<0.000050	0	<0.000050	<0.000050	0
Molybdenum	mg/L	<0.010	<0.010	0	<0.010	<0.010	0
Nickel	mg/L	<0.0050	0.0061	87	<0.0050	<0.0050	0
Selenium	mg/L	<0.00050	<0.00050	0	<0.20	<0.20	0
Silver	mg/L	<0.010	<0.010	0	<0.010	<0.010	0
Strontium	mg/L	0.492	0.489	1	0.0258	0.0250	3
Thallium	mg/L	<0.20	<0.20	0	<0.20	<0.20	0
Tin	mg/L	<0.030	<0.030	0	<0.030	<0.030	0
Titanium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0

Table I-2
Duplicate Water Samples Collected for Quality Assurance/Quality Control during the Giant Mine Fish Survey, July 2006 (continued)

Parameter	Units	Baker Creek	Baker Creek Duplicate	RPD %	Yellowknife River	Yellowknife River Duplicate	RPD %
		18-Jul-06	18-Jul-06		4-Aug-06	4-Aug-06	
Uranium	mg/L	<0.50	<0.50	0	<0.50	<0.50	0
Vanadium	mg/L	<0.030	<0.030	0	<0.030	<0.030	0
Zinc	mg/L	<0.0040	<0.0040	0	<0.0040	<0.0040	0
Organics							
Dissolved Organic Carbon	mg/L	13.2	13.3	1	5.50	6.71	20
Total Organic Carbon	mg/L	14.8	14.7	1	5.60	5.60	0
Radionuclides[(b)]							
Radium-226	Bq/L	<0.0050	<0.0050	0	<0.0050	<0.0050	0
Other							
Total Cyanide	mg/L	0.0070	0.0069	1	<0.0050	<0.0050	0
Total Silicon	mg/L	0.696	0.652	7	<0.00050	<0.00050	0
Dissolved Silicon	mg/L	0.351	0.355	1	0.230	0.229	0
Fluoride	mg/L	0.100	0.098	2	0.063	0.062	2

RPD = relative percent difference; % = percent; mg/L = milligrams per litre; µg/L = micrograms per litre; µS/cm = microSiemens per centimetre; Bq/L = Becquerel per litre; NTU = nephelometric turbidity units.

Table I-3
Fish Survey Sampling Locations, July 2006

Area	Waterbody	Date	Gear Type	Effort Number	Coordinates - Start[a]				Coordinates - Middle[a]				Coordinates - End[a]			
					Easting	Northing	Latitude	Longitude	Easting	Northing	Latitude	Longitude	Easting	Northing	Latitude	Longitude
Exposure	Baker Creek	18-Jul-06	Backpack Electrofishing	EXP-BP1	636028	6931165	114° 21' 36.72" W	62° 29' 11.61" N	n/a	n/a	n/a	n/a	636018	6931185	114° 21' 37.36" W	62° 29' 12.27" N
		19-Jul-06	Backpack Electrofishing	EXP-BP2	636025	6931160	114° 21' 36.94" W	62° 29' 11.45" N	n/a	n/a	n/a	n/a	635993	6931256	114° 21' 38.90" W	62° 29' 14.59" N
		19-Jul-06	Backpack Electrofishing	EXP-BP3	635907	6931248	114° 21' 44.92" W	62° 29' 14.45" N	n/a	n/a	n/a	n/a	635822	6931199	114° 21' 50.99" W	62° 29' 12.98" N
		18-Jul-06	Seine Net	EXP-SN1	n/a	n/a	n/a	n/a	636020	6931187	114° 21' 37.21" W	62° 29' 12.33" N		n/a	n/a	n/a
		18-Jul-06	Seine Net	EXP-SN2	n/a	n/a	n/a	n/a	636006	6931218	114° 21' 38.10" W	62° 29' 13.35" N	n/a	n/a	n/a	n/a
		18-Jul-06	Seine Net	EXP-SN3	n/a	n/a	n/a	n/a	635996	6931248	114° 21' 38.71" W	62° 29' 14.33" N	n/a	n/a	n/a	n/a
		18-Jul-06	Seine Net	EXP-SN4	n/a	n/a	n/a	n/a	635956	6931250	114° 21' 41.50" W	62° 29' 14.45" N	n/a	n/a	n/a	n/a
		19-Jul-06	Seine Net	EXP-SN5	n/a	n/a	n/a	n/a	636018	6931186	114° 21' 37.35" W	62° 29' 12.30" N	n/a	n/a	n/a	n/a
		26-Jul-06	Seine Net	EXP-SN8	n/a	n/a	n/a	n/a	635903	6931248	114° 21' 45.20" W	62° 29' 14.45" N	n/a	n/a	n/a	n/a
		26-Jul-06	Seine Net	EXP-SN9	n/a	n/a	n/a	n/a	635998	6931273	114° 21' 38.50" W	62° 29' 15.13" N	n/a	n/a	n/a	n/a
		26-Jul-06	Seine Net	EXP-SN10	n/a	n/a	n/a	n/a	635992	6931249	114° 21' 38.99" W	62° 29' 14.37" N	n/a	n/a	n/a	n/a
		26-Jul-06	Seine Net	EXP-SN11	n/a	n/a	n/a	n/a	636055	6931049	114° 21' 35.16" W	62° 29' 7.83" N	n/a	n/a	n/a	n/a
		27-Jul-06	Seine Net	EXP-SN12	n/a	n/a	n/a	n/a	635998	6931273	114° 21' 38.50" W	62° 29' 15.13" N	n/a	n/a	n/a	n/a
		27-Jul-06	Seine Net	EXP-SN13	n/a	n/a	n/a	n/a	635992	6931249	114° 21' 38.99" W	62° 29' 14.37" N	n/a	n/a	n/a	n/a
		27-Jul-06	Seine Net	EXP-SN14	n/a	n/a	n/a	n/a	636055	6931049	114° 21' 35.16" W	62° 29' 7.83" N	n/a	n/a	n/a	n/a
		26-Jul-06	Dip Net	EXP-DN5	n/a	n/a	n/a	n/a	636032	6931154	114° 21' 36.47" W	62° 29' 11.25" N	n/a	n/a	n/a	n/a
		26-Jul-06	Dip Net	EXP-DN6	n/a	n/a	n/a	n/a	636041	6931023	114° 21' 36.21" W	62° 29' 07.01" N	n/a	n/a	n/a	n/a
		25-Jul-06	Seine Net	EXP-SN7	n/a	n/a	n/a	n/a	635917	6931236	114° 21' 44.26" W	62° 29' 14.05" N	n/a	n/a	n/a	n/a
Reference	Yellowknife River - around boat launch and at both banks under bridge	21-Jul-06	Backpack Electrofishing	REF A-BP2	637938	6934823	114° 19' 12.86" W	62° 31' 7.14" N	n/a	n/a	n/a	n/a	637854	6934873	114° 19' 18.58" W	62° 31' 8.87" N
		21-Jul-06	Backpack Electrofishing	REF A-BP3	637869	6934865	114° 19' 17.55" W	62° 31' 8.59" N	n/a	n/a	n/a	n/a	637914	6934891	114° 19' 14.33" W	62° 31' 9.37" N
		20-Jul-06	Backpack Electrofishing	REF A-BP1	637943	6934836	114° 19' 12.47" W	62° 31' 7.55" N	n/a	n/a	n/a	n/a	637959	6934877	114° 19' 11.23" W	62° 31' 8.86" N
		24-Jul-06	Seine Net	EXP-SN6	n/a	n/a	n/a	n/a	638759	6935917	114° 18' 12.32" W	62° 31' 41.35" N	n/a	n/a	n/a	n/a
	Yellowknife River - cobble area along island	22-Jul-06	Backpack Electrofishing	REF B-BP5	638277	6935675	114° 18' 46.70" W	62° 31' 34.19" N	n/a	n/a	n/a	n/a	638269	6935737	114° 18' 47.08" W	62° 31' 36.20" N
	Yellowknife River - ponded area below Tartan Rapids	21-Jul-06	Backpack Electrofishing	REF C-BP4	642730	6939090	114° 13' 25.35" W	62° 33' 18.33" N	n/a	n/a	n/a	n/a	642732	6939139	114° 13' 25.06" W	62° 33' 19.91" N
		22-Jul-06	Dip Net	EXP-DN1	n/a	n/a	n/a	n/a	642747	6939111	114° 13' 24.10" W	62° 33' 18.98" N	n/a	n/a	n/a	n/a
		22-Jul-06	Dip Net	EXP-DN2	n/a	n/a	n/a	n/a	642730	6939090	114° 13' 25.35" W	62° 33' 18.33" N	n/a	n/a	n/a	n/a
		25-Jul-06	Dip Net	EXP-DN3	n/a	n/a	n/a	n/a	642730	6939090	114° 13' 25.35" W	62° 33' 18.33" N	n/a	n/a	n/a	n/a
		25-Jul-06	Dip Net	EXP-DN4	n/a	n/a	n/a	n/a	642730	6939090	114° 13' 25.35" W	62° 33' 18.33" N	n/a	n/a	n/a	n/a

Table I-4
Slimy Sculpin Captured for the Giant Mine Lethal Fish Survey, July 2006

Area	Waterbody	Date	Gear Type	Effort Number	Biomarker Number	Sex	Maturation Stage	Aging Structure	Age (yrs)	Age QA/QC (yrs)	Total Length (mm)	Body Weight (g)	Eyes	Gills	Pseudobranchs	Thymus	Skin	Body Deformities	Fins	Opercles
Exposure	Baker Creek	19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC001	Unknown	Unknown	Otoliths	4	3	61	2.503	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC002	Unknown	Unknown	Otoliths	4	3	69	3.977	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC003	Unknown	Unknown	Otoliths	3	2	71	5.154	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC004	Female	Unknown	Otoliths	2	4	49	1.230	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC005	Female	Unknown	Otoliths	2	2	55	2.037	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC006	Male	Unknown	Otoliths	3	3	43	1.201	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC007	Female	Unknown	Otoliths	4	4	64	3.459	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC008	Male	Unknown	Otoliths	3	2	61	3.258	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC009	Male	Unknown	Otoliths	2	2	66	3.827	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC010	Male	Unknown	Otoliths	2	1	44	0.992	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC011	Male	Unknown	Otoliths	4	3	55	1.783	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC012	Female	Unknown	Otoliths	2	2	54	2.208	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC013	Unknown	Unknown	Otoliths	1	1	42	1.122	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC014	Unknown	Unknown	Otoliths	2	cannot age	52	1.881	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC015	Male	Unknown	Otoliths	2	3	68	4.500	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC016	Unknown	Unknown	Otoliths	2	4	51	1.673	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC017	Male	Unknown	Otoliths	2	3	72	6.853	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC018	Male	Unknown	Otoliths	2	3	57	2.200	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC019	Male	Unknown	Otoliths	1	2	64	3.873	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC020	Unknown	Unknown	Otoliths	1	3	50	1.572	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC021	Unknown	Unknown	NC	-	No otolith - fin ray cut incorrectly for ageing	57	2.293	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC022	Unknown	Unknown	Otoliths	2	3	47	1.373	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC023	Female	Unknown	Otoliths	3	cannot age	70	5.580	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC024	Female	Unknown	NC	-	-	55	2.423	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC025	Male	Unknown	Otoliths	1	3	42	1.090	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC026	Female	Unknown	Otoliths	2	3	56	2.399	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC027	Unknown	Immature	Otoliths	2	2	40	0.841	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC028	Male	Unknown	Otoliths	1	2	60	2.762	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC029	Female	Unknown	Otoliths	3	3	54	1.698	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC030	Unknown	Immature	Otoliths	1	2	41	0.789	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC031	Female	Unknown	Otoliths	3	3	73	6.095	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC032	Female	Unknown	Otoliths	1	1	58	3.016	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC033	Unknown	Immature	Otoliths	1	1	42	0.849	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC034	Unknown	Immature	Otoliths	2	3	50	1.672	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC035	Female	Unknown	Otoliths	3	5	56	1.994	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC036	Male	Unknown	Otoliths	2	3	56	2.375	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC037	Female	Spent	Otoliths	1	2	55	1.780	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC038	Female	Unknown	Otoliths	2	4	39	0.636	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC039	Male	Unknown	Otoliths	2	3	64	3.610	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC040	Male	Unknown	Otoliths	1	2	55	2.620	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC041	Male	Unknown	Otoliths	2	2	52	2.310	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC042	Female	Unknown	Otoliths	2	2	58	2.600	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal

Table I-4
Slimy Sculpin Captured for the Giant Mine Lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Gear Type	Effort Number	Biomarker Number	Sex	Maturation Stage	Aging Structure	Age (yrs)	Age QA/QC (yrs)	Total Length (mm)	Body Weight (g)	Eyes	Gills	Pseudobranchs	Thymus	Skin	Body Deformities	Fins	Opercles
Exposure	Baker Creek	19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC043	Unknown	Unknown	Otoliths	1	1	52	2.310	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
(cont)	(cont)	19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC044	Female	Unknown	Otoliths	1	4	50	1.660	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC045	Male	Unknown	Otoliths	2	3	43	1.120	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC046	Female	Unknown	Otoliths	2	2	43	1.050	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC047	Male	Unknown	Otoliths	3	6	55	1.940	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC048	Female	Unknown	Otoliths	2	2	56	2.280	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC049	Male	Unknown	Otoliths	1	3	48	1.280	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC050	Female	Unknown	Otoliths	2	2	41	0.856	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC051	Male	Unknown	Otoliths	2	3	47	1.449	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC052	Male	Unknown	Otoliths	1	2	58	3.069	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC053	Unknown	Unknown	Otoliths	3	4	49	1.388	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC054	Female	Unknown	Otoliths	2	3	47	1.421	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC055	Female	Unknown	Otoliths	2	2	57	2.793	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC056	Male	Unknown	Otoliths	2	3	62	3.230	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC057	Female	Unknown	Otoliths	3	4	56	2.339	-	-	-	-	-	No deformities	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC058	Unknown	Immature	Otoliths	0	1	25	0.167	-	-	-	-	-	-	-	-
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC061	Male	Unknown	Otoliths	2	3	46	1.290	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC062	Male	Unknown	Otoliths	1	3	52	1.860	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC063	Female	Unknown	Otoliths	2	3	65	3.970	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC064	Female	Unknown	Otoliths	2	4	52	2.270	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC065	Male	Unknown	Otoliths	2	3	59	2.650	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC066	Male	Unknown	Otoliths	2	3	49	1.460	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC067	Male	Unknown	Otoliths	2	3	51	1.870	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC068	Male	Unknown	Otoliths	2	3	41	0.955	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC069	Male	Unknown	Otoliths	2	2	60	2.730	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC070	Male	Unknown	Otoliths	1	3	55	2.550	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC071	Male	Unknown	Otoliths	1	3	52	1.910	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC072	Male	Unknown	Otoliths	2	2	43	1.030	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		18-Jul-06	Backpack Electrofishing	EXP-BP1	GM06UBCSLSC130	Unknown	Immature	Otoliths	1	3	43	0.970	Normal	Normal	Normal	Normal	Normal	-	Normal	Normal
		18-Jul-06	Backpack Electrofishing	EXP-BP1	GM06UBCSLSC131	Male	Spent	Otoliths	3	2	42	1.300	Normal	Normal	Normal	Normal	Normal	-	Normal	Normal
		18-Jul-06	Backpack Electrofishing	EXP-BP1	GM06UBCSLSC132	Female	Spent	Otoliths	2	4	47	1.040	Normal	Normal	Normal	Normal	Normal	-	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC172	Unknown	Unknown	Otoliths	1		44	-	Normal	Normal	Normal	Normal	Normal	Deformities observed	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC173	Male	Unknown	Otoliths	4	5	60	-	Normal	Normal	Normal	Normal	Normal	Deformities observed	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP2	GM06UBCSLSC178	Male	Unknown	Otoliths	2	2	48	-	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP3	GM06UBCSLSC200	Male	Unknown	Otoliths	3	4	67	3.550	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP3	GM06UBCSLSC201	Female	Unknown	Otoliths	2	3	53	1.880	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP3	GM06UBCSLSC202	Male	Unknown	Otoliths	1	3	47	1.120	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP3	GM06UBCSLSC203	Female	Unknown	Otoliths	2	3	62	2.740	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		19-Jul-06	Backpack Electrofishing	EXP-BP3	GM06UBCSLSC234	Female	Unknown	Otoliths	1	3	39	0.480	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
Reference	Yellowknife River - around boat launch south of bridge and boat launch	20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC001	Female	Unknown	Otoliths	4	5	101	13.510	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC002	Female	Unknown	Otoliths	2	3	61	3.260	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC003	Female	Unknown	Otoliths	3	4	78	5.230	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC004	Female	Unknown	Otoliths	3	4	77	6.520	Normal	Normal	Normal	Normal	Normal	Deformities observed	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC005	Female	Unknown	Otoliths	4	3	74	5.320	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal

Table I-4
Slimy Sculpin Captured for the Giant Mine Lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Gear Type	Effort Number	Biomarker Number	Sex	Maturation Stage	Aging Structure	Age (yrs)	Age QA/QC (yrs)	Total Length (mm)	Body Weight (g)	Eyes	Gills	Pseudobranchs	Thymus	Skin	Body Deformities	Fins	Opercles
Reference (cont)	Yellowknife River - around boat launch south of bridge and boat launch (cont)	20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC006	Unknown	Immature	Otoliths	1	2	48	1.220	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC007	Female	Unknown	Otoliths	2	3	64	2.780	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC008	Female	Unknown	Otoliths	1	2	65	3.260	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC009	Female	Immature	Otoliths	1	2	40	0.725	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC010	Female	Unknown	Otoliths	3	3	70	3.650	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC011	Female	Unknown	Otoliths	1	1	47	1.610	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC012	Female	Unknown	Otoliths	1	2	55	2.070	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC013	Female	Unknown	Otoliths	1	3	50	1.340	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC014	Female	Unknown	Otoliths	1	1	41	0.826	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC015	Unknown	Immature	Otoliths	1	1	43	0.789	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC016	Unknown	Immature	Otoliths	1	1	40	0.749	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC017	Unknown	Immature	Otoliths	1	1	44	1.030	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		20-Jul-06	Backpack Electrofishing	REF A-BP1	GM06UYRSLSC018	Unknown	Immature	Otoliths	1	1	41	0.914	Normal	Normal	Normal	Normal	Normal	Deformities observed	Normal	Normal
	Yellowknife River - around boat launch and at both banks under bridge	21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC019	Female	Unknown	Otoliths	1	1	58	1.818	Normal	Normal	Normal	Normal	Normal	Deformities observed	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC020	Female	Unknown	Otoliths	2	2	55	1.630	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC021	Female	Unknown	Otoliths	3	3	97	11.200	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC022	Female	Unknown	Otoliths	1	1	45	0.984	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC023	Female	Unknown	Otoliths	1	1	49	1.245	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC024	Male	Unknown	Otoliths	2	2	70	3.928	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC025	Female	Unknown	Otoliths	1	1	36	0.487	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC026	Male	Unknown	Otoliths	4	4	94	8.339	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC027	Male	Unknown	Otoliths	1	1	51	1.320	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC028	Female	Unknown	Otoliths	1	1	39	0.730	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC029	Female	Unknown	Otoliths	1	2	47	1.170	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC030	Unknown	Immature	Otoliths	1	1	48	1.016	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC031	Unknown	Immature	Otoliths	1	1	44	0.879	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC032	Male	Unknown	Otoliths	2	2	72	4.216	-	-	-	-	-	Deformities observed	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC033	Male	Unknown	Otoliths	1	3	57	2.073	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC034	Unknown	Immature	Otoliths	1	1	43	0.772	Normal	Normal	Normal	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC035	Female	Unknown	Otoliths	2	3	73	3.668	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC036	Male	Unknown	Otoliths	1	4	50	1.310	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC037	Female	Unknown	Otoliths	4	5	78	5.199	Normal	Normal	Normal	Normal	Normal	Deformities observed	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC038	Male	Unknown	Otoliths	2	3	56	2.030	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC039	Female	Unknown	Otoliths	1	3	46	0.943	Normal	Normal	Normal	Normal	Normal	Deformities observed	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC040	Male	Unknown	Otoliths	1	3	47	1.210	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC041	Female	Unknown	Otoliths	1	5	46	0.916	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC042	Male	Unknown	Otoliths	1	1	44	0.779	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC043	Unknown	Immature	Otoliths	1	3	50	1.370	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC044	Unknown	Immature	Otoliths	1	2	47	1.250	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC045	Female	Unknown	Otoliths	1	1	45	0.891	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC046	Unknown	Immature	Otoliths	1	2	49	1.410	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC047	Unknown	Immature	Otoliths	1	1	48	1.159	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC048	Female	Unknown	Otoliths	1	1	42	0.877	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC049	Male	Unknown	Otoliths	2	2	64	2.722	-	-	-	-	-	-	-	-

Table I-4
Slimy Sculpin Captured for the Giant Mine Lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Gear Type	Effort Number	Biomarker Number	Sex	Maturation Stage	Aging Structure	Age (yrs)	Age QA/QC (yrs)	Total Length (mm)	Body Weight (g)	Eyes	Gills	Pseudobranchs	Thymus	Skin	Body Deformities	Fins	Opercles
Reference (cont)	Yellowknife River - around boat launch and at both banks under bridge (cont)	21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC050	Female	Unknown	Otoliths	1	3	47	1.060	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC051	Male	Immature	Otoliths	1	1	37	0.566	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC052	Female	Unknown	Otoliths	1	1	40	0.726	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC053	Female	Unknown	Otoliths	1	1	51	1.150	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC054	Female	Unknown	Otoliths	0	1	42	0.875	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC055	Unknown	Unknown	Otoliths	2	2	57	2.001	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC056	Male	Unknown	Otoliths	1	1	46	1.380	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC057	Male	Unknown	Otoliths	1	1	45	1.029	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC058	Female	Unknown	Otoliths	1	1	40	0.684	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC059	Female	Unknown	Otoliths	1	1	46	1.370	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP2	GM06UYRSLSC060	Female	Unknown	Otoliths	1	2	41	0.660	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP3	GM06URSSLSC001	Male	Unknown	Otoliths	2	3	78	6.190	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP3	GM06URSSLSC002	Unknown	Immature	Otoliths	2	2	53	1.610	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP3	GM06URSSLSC003	Male	Unknown	Otoliths	1	2	48	1.200	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP3	GM06URSSLSC004	Female	Unknown	Otoliths	2	2	55	1.810	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP3	GM06URSSLSC005	Unknown	Unknown	Otoliths	2	2	70	4.460	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP3	GM06URSSLSC006	Female	Unknown	Otoliths	1	cannot age	46	0.957	-	-	-	-	-	-	-	-
		21-Jul-06	Backpack Electrofishing	REF A-BP3	GM06URSSLSC007	Unknown	Immature	Otoliths	1	2	41	0.666	-	-	-	-	-	-	-	-
	Yellowknife River - cobble area along shoreline of island upstream from bridge	22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC001	Male	Unknown	Otoliths	1	2	63	4.707	-	-	-	-	-	-	-	-
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC002	Male	Unknown	Otoliths	2	2	81	10.076	-	-	-	-	-	-	-	-
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC003	Male	Unknown	Otoliths	1	2	56	2.916	-	-	-	-	-	-	-	-
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC004	Male	Unknown	Otoliths	1		47	1.787	-	-	-	-	-	-	-	-
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC005	Male	Unknown	Otoliths	1		57	2.799	-	-	-	-	-	-	-	-
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC006	Unknown	Unknown	Otoliths	1		47	1.239	-	-	-	-	-	-	-	-
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC007	Female	Unknown	Otoliths	4		91	9.064	-	-	-	-	-	-	-	-
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC008	Female	Unknown	Otoliths	3		92	9.241	-	-	-	-	-	-	-	-
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC009	Unknown	Immature	Otoliths	1		36	0.502	-	-	-	-	-	-	-	-
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC010	Female	Unknown	Otoliths	4		78	5.790	-	-	-	-	-	Deformities observed	-	-
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC011	Female	Unknown	Otoliths	1	3	54	1.730	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC012	Female	Unknown	Otoliths	1	2	56	2.139	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC013	Male	Unknown	Otoliths	1	5	57	2.128	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC014	Unknown	Immature	Otoliths	1	2	52	1.566	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC015	Male	Unknown	Otoliths	1	4	62	3.093	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC016	Male	Unknown	Otoliths	4	3	86	6.437	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC017	Female	Unknown	Otoliths	1	3	45	1.046	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC018	Male	Unknown	Otoliths	1	2	50	1.511	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC019	Unknown	Immature	Otoliths	1	2	50	1.392	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC020	Male	Unknown	Otoliths	1	2	58	2.355	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC021	Female	Unknown	Otoliths	1	3	47	1.115	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC022	Female	Unknown	Otoliths	1	2	47	1.249	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC023	Male	Unknown	Otoliths	1	1	68	3.748	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC024	Female	Unknown	Otoliths	1	2	56	2.170	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC025	Female	Unknown	Otoliths	3	2	82	6.741	Normal	Normal	Normal	Normal	Normal	Deformities observed	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC026	Female	Unknown	Otoliths	1	3	45	1.211	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal

Table I-4
Slimy Sculpin Captured for the Giant Mine Lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Gear Type	Effort Number	Biomarker Number	Sex	Maturation Stage	Aging Structure	Age (yrs)	Age QA/QC (yrs)	Total Length (mm)	Body Weight (g)	Eyes	Gills	Pseudobranchs	Thymus	Skin	Body Deformities	Fins	Opercles
Reference (cont)	Yellowknife River - cobble area along shoreline of island upstream from bridge (cont)	22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC027	Male	Unknown	Otoliths	1	3	53	1.850	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC028	Female	Unknown	Otoliths	1	2	62	2.551	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC029	Male	Unknown	Otoliths	1	2	61	2.559	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC030	Male	Unknown	Otoliths	1	1	54	1.848	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC031	Female	Unknown	Otoliths	1	5	54	1.651	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC032	Female	Unknown	Otoliths	1	2	53	1.845	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC033	Male	Unknown	Otoliths	1	2	61	2.306	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC034	Female	Unknown	Otoliths	1	2	53	1.837	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC035	Female	Unknown	Otoliths	1	cannot age	57	2.151	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC036	Female	Unknown	Otoliths	1	3	58	1.630	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC037	Female	Unknown	Otoliths	1	3	43	1.065	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC038	Unknown	Immature	Otoliths	1	2	42	0.789	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC039	Male	Unknown	Otoliths	1	4	56	1.959	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC040	Female	Unknown	Otoliths	1	2	45	1.022	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC041	Male	Unknown	Otoliths	1	3	52	1.777	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC042	Female	Unknown	Otoliths	1	2	47	1.362	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC043	Male	Unknown	Otoliths	1	2	57	1.760	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC044	Male	Unknown	Otoliths	1	2	59	2.126	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC045	Unknown	Immature	Otoliths	1	2	56	2.127	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC046	Female	Unknown	Otoliths	1	2	47	1.148	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC047	Male	Unknown	Otoliths	1	4	57	1.991	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC048	Male	Unknown	Otoliths	1	2	48	1.403	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC049	Female	Unknown	Otoliths	1	2	54	1.502	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC050	Male	Immature	Otoliths	1	1	53	1.676	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC051	Male	Unknown	Otoliths	1	1	59	2.754	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC052	Unknown	Immature	Otoliths	1	2	42	0.814	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC053	Female	Unknown	Otoliths	1	3	47	1.101	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC054	Male	Unknown	Otoliths	1	3	56	2.194	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC055	Male	Unknown	Otoliths	1	2	67	3.178	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC056	Female	Unknown	Otoliths	1	2	51	1.472	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC057	Male	Unknown	Otoliths	1	2	52	1.653	Normal	Normal	Normal	Normal	Normal	Deformities observed	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC058	Unknown	Immature	Otoliths	1	4	43	0.867	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC059	Unknown	Immature	Otoliths	1	4	42	0.833	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC060	Female	Unknown	Otoliths	1	6	56	2.008	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC061	Unknown	Immature	Otoliths	1	1	57	1.990	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC062	Male	Unknown	Otoliths	1	6	60	2.497	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC063	Male	Unknown	Otoliths	1	1	54	1.895	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC064	Female	Unknown	Otoliths	1	3	54	1.815	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC065	Male	Unknown	Otoliths	1	2	60	2.720	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC066	Female	Unknown	Otoliths	0	3	43	0.921	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC067	Female	Unknown	Otoliths	1	2	45	0.980	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC068	Unknown	Unknown	Otoliths	1	3	45	1.043	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC069	Unknown	Unknown	Otoliths	1	2	49	1.402	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal
		22-Jul-06	Backpack Electrofishing	REF B-BP5	GM06URUSLSC070	Male	Unknown	Otoliths	1	4	55	2.091	Normal	Normal	Normal	Normal	Normal	No deformities	Normal	Normal

Table I-4
Slimy Sculpin Captured for the Giant Mine Lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Hindgut	Mesenteric Fat	Liver	Spleen	Gall Bladder	Kidney	Parasites	Liver Weight (g)	Gonad Weight (g)	Stomach Contents	Histology Sex	Histology Code	Comments
Exposure	Baker Creek	19-Jul-06	-	50 percent	Normal	Normal	Normal	Normal	Few observed parasites	0.005	-	40% full	-	-	Could not do entire health assessment, specimen deteriorated; white nodule parasites; chironomids observed in stomach contents.
		19-Jul-06	Normal	None	Normal	Normal	Normal	Normal	No observed parasites	0.006	-	Empty	-	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Normal	Normal	Normal	Normal	No observed parasites	0.003	0.024	-	-	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	Less than 50 percent	-	-	-	Normal	Few observed parasites	0.003	0.006	-	Kidney	-	-
		19-Jul-06	-	None	Normal	Normal	Normal	Normal	No observed parasites	0.006	0.021	Empty	Kidney	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	Normal	Less than 50 percent	Normal	Normal	Normal	Normal	-	0.003	0.016	Empty	Kidney	-	-
		19-Jul-06	-	None	Normal	Normal	Normal	Normal	Few observed parasites	0.001	0.012	Empty	Kidney	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	Less than 50 percent	Normal	Normal	Normal	Normal	Few observed parasites	0.006	0.033	10% full	Kidney	-	Could not do entire health assessment, specimen deteriorated; one mayfly observed in stomach contents.
		19-Jul-06	-	Less than 50 percent	Normal	Normal	Normal	Normal	No observed parasites	0.001	0.033	Empty	Kidney	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	Less than 50 percent	Normal	Normal	Normal	Normal	No observed parasites	-	0.007	Empty	Kidney	-	Could not do entire health assessment, specimen deteriorated; liver too small to weigh.
		19-Jul-06	-	Less than 50 percent	Normal	-	Normal	Normal	Severe observed parasites	0.003	0.008	Empty	Kidney	-	Could not do entire health assessment, specimen deteriorated; cyst-like globs (parasites).
		19-Jul-06	-	Less than 50 percent	Normal	Normal	Normal	Normal	Severe observed parasites	0.003	0.017	-	Kidney	-	Could not do entire health assessment, specimen deteriorated; cyst-like globs (parasites).
		19-Jul-06	-	Less than 50 percent	Normal	Normal	Normal	Normal	Moderate observed parasites	-	0.007	Empty	Female	4	Could not do entire health assessment, specimen deteriorated; liver too small to weigh; large tapeworm present.
		19-Jul-06	-	Less than 50 percent	Normal	Normal	Normal	Normal	-	-	0.17	20% full	Kidney	-	Could not do entire health assessment, specimen deteriorated; liver too small to weigh; mayflies observed in stomach contents.
		19-Jul-06	-	Less than 50 percent	Normal	Normal	Normal	Normal	Moderate observed parasites	0.130	0.033	empty	Kidney	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	-	-	-	-	-	-	0.001	-	-	-	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	Less than 50 percent	Normal	Normal	Normal	Normal	No observed parasites	0.011	0.013	50% full	Male	3	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	Less than 50 percent	Normal	Normal	Normal	Normal	No observed parasites	-	0.009	-	Male	3	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	Less than 50 percent	Normal	Normal	Normal	Normal	Few observed parasites	-	0.008	50% full	Male	3	Could not do entire health assessment, specimen deteriorated; stomach contents consisted of 50% Chironomids.
		19-Jul-06	-	None	Normal	Normal	Normal	Normal	No observed parasites	0.005	0.006	Empty	Male	3	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Normal	Normal	Normal	Normal	No observed parasites	0.03	0.029	Empty	Female	1B	Could not do entire health assessment, specimen deteriorated; pale liver; no otolith; fin ray cut incorrectly for ageing.
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.024	-	Empty	-	-	Could not do entire health assessment, specimen deteriorated; gonads too small to measure
		19-Jul-06	-	None	Fatty liver	Granular	Normal	Normal	Severe observed parasites	0.236	0.016	-	-	-	Small white cysts, parasite on stomach exterior; could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.068	0.021	Empty	-	-	Could not do entire health assessment, specimen deteriorated; otoliths crushed - no aging structure collected.
		19-Jul-06	-	-	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.036	0.011	Empty	-	-	White cysts; could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Fatty liver	Granular	Normal	Normal	Few observed parasites	0.099	0.043	Full	-	-	Small white cysts; could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.009	-	Empty	-	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.065	0.009	Empty	-	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.033	0.019	Empty	-	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.017	-	-	-	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.164	0.056	Full	-	-	Could not do entire health assessment, specimen deteriorated.

Table I-4
Slimy Sculpin Captured for the Giant Mine Lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Hindgut	Mesenteric Fat	Liver	Spleen	Gall Bladder	Kidney	Parasites	Liver Weight (g)	Gonad Weight (g)	Stomach Contents	Histology Sex	Histology Code	Comments
Exposure	Baker Creek	19-Jul-06	-	None	Normal	Normal	Normal	Normal	No observed parasites	0.073	0.01	Full	-	-	Could not do entire health assessment, specimen deteriorated.
(cont)	(cont)	19-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.008	-	Empty	-	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Normal	Normal	Normal	Normal	No observed parasites	0.033	-	Empty	-	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.024	0.018	Full	-	-	Could not do entire health assessment, specimen deteriorated; white cysts (parasites)
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.059	0.004	Empty	-	-	Could not do entire health assessment, specimen deteriorated; white cysts (parasites)
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.027	0.006	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.012	0.005	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.186	0.018	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.062	0.011	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.094	0.01	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	-	No observed parasites	0.083	0.033	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.076	0.006	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.014	0.003	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.008	0.002	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.019	0.002	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.062	0.006	-	-	-	A few white cysts located near stomach.
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.066	0.03	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.018	0.006	-	Male	4	Small white cysts.
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.024	0.001	-	-	-	White cysts; could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.032	0.005	Full	-	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Swollen	-	0.04	0.007	-	-	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	-	-	-	-	-	-	-	0.017	-	-	-	White cysts on ovary; could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Swollen	Few observed parasites	0.04	0.009	-	Female	1B	White cysts; could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	-	-	-	-	-	Moderate observed parasites	0.157	0.057	-	Male	3	White parasite attached to peritoneal lining, white cysts present; could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.090	0.022	-	-	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	None	Fatty liver	Normal	Normal	Swollen	Few observed parasites	0.064	0.024	-	-	-	Could not do entire health assessment, specimen deteriorated.
		19-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-	Young-of-Year too small for fish health assessment.
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.032	0.003	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.016	0.009	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.161	0.028	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.052	0.008	-	-	-	Tapeworm = 0.246g.
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.056	0.017	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.033	0.005	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.041	0.003	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.017	0.003	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.036	0.012	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.114	0.004	-	-	-	-
		19-Jul-06	Normal	-	Normal	Normal	Normal	Normal	No observed parasites	0.062	0.012	-	-	-	-
		19-Jul-06	Normal	None	Normal	Normal	Normal	Normal	No observed parasites	0.022	0.004	-	-	-	-
		18-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.031	-	Full	-	-	-
		18-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.021	-	Full	-	-	Miscellaneous invertebrates observed in stomach contents.

Table I-4
Slimy Sculpin Captured for the Giant Mine Lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Hindgut	Mesenteric Fat	Liver	Spleen	Gall Bladder	Kidney	Parasites	Liver Weight (g)	Gonad Weight (g)	Stomach Contents	Histology Sex	Histology Code	Comments
Exposure (cont)	Baker Creek (cont)	18-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.015	0.005	Full,	-	-	Small white parasite near liver; Miscellaneous invertebrates observed in stomach contents.
		19-Jul-06	Normal	None	Normal	Normal	Normal	Normal	Severe observed parasites	0.020	immature	Full	-	-	Approximately 20 small white cysts observed within body cavity (exterior of all organs), potentially cestodes; body deformed due to electrofishing; stomach contents consisted of miscellaneous invertebrates.
		19-Jul-06	Normal	None	Normal	Normal	Normal	Normal	Few observed parasites	-	-	-	-	-	Body deformed due to electrofishing.
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.035	-	Full	-	-	Parasite on gonad.
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Swollen	Few observed parasites	0.085	-	-	-	-	Encysted cestode beside stomach and beside vertebral column.
		19-Jul-06	Normal	None	Normal	Normal	Normal	Swollen	Few observed parasites	0.062	0.005	-	-	-	-
		19-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.021	-	-	-	-	-
		19-Jul-06	Normal	None	Normal	Normal	Normal	Normal	-	0.073	0.013	-	-	-	-
		19-Jul-06	Normal	None	Normal	Normal	Normal	Normal	Few observed parasites	0.013	0.007	-	-	-	-
Reference	Yellowknife River - around boat launch south of bridge and boat launch	20-Jul-06	Normal	None	Fatty liver/Nodules or cysts on liver	Normal	Normal	Swollen	Few observed parasites	0.173	0.075	-	-	-	Encysted nematode in liver (white/cream coloured)
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.091	0.006	-	-	-	-
		20-Jul-06	Normal	None	Normal	Normal	Normal	Normal	No observed parasites	0.057	-	Full	-	-	Stomach full of invertebrates.
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.174	0.008	-	-	-	Pelvic fin deformed.
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.146	0.052	-	-	-	-
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.01	-	-	-	-	-
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.074	0.032	-	-	-	-
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.082	0.003	-	-	-	-
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.011	-	-	-	-	Gonads not measurable.
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.078	0.051	-	-	-	-
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.069	0.009	-	-	-	-
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.039	0.008	-	-	-	-
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.026	0.004	-	-	-	-
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.020	0.005	-	-	-	-
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.01	-	-	-	-	-
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.007	-	-	-	-	-
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.017	-	-	-	-	-
		20-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.011	-	-	-	-	Swollen belly; 0.210g tapeworm.
	Yellowknife River - around boat launch and at both banks under bridge	21-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.033	0.001	-	-	-	Skinny belly.
		21-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.047	0.016	-	-	-	-
		21-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.203	0.06	-	-	-	-
		21-Jul-06	-	None	Normal	-	-	-	-	0.026	0.008	-	-	-	-
		21-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.400	0.006	-	-	-	-
		21-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.069	0.004	-	-	-	-
		21-Jul-06	-	-	-	-	-	-	-	0.006	0.004	-	-	-	-
		21-Jul-06	Normal	-	Fatty liver	-	-	-	Moderate observed parasites	0.129	0.055	-	-	-	Surface of liver not smooth in appearance, nematode parasites present in liver; white cysts (parasites).
		21-Jul-06	Normal	None	Normal	Normal	Normal	Normal	No observed parasites	0.022	0.004	-	-	-	-
		21-Jul-06	Normal	None	-	Normal	Normal	Normal	No observed parasites	0.015	0.002	-	-	-	-
		21-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.041	0.007	-	-	-	-
		21-Jul-06	Normal	None	Fatty liver	-	-	-	-	0.015	-	-	-	-	-
		21-Jul-06	Normal	None	-	Normal	Normal	Normal	No observed parasites	0.017	-	-	-	-	-

Table I-4
Slimy Sculpin Captured for the Giant Mine Lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Hindgut	Mesenteric Fat	Liver	Spleen	Gall Bladder	Kidney	Parasites	Liver Weight (g)	Gonad Weight (g)	Stomach Contents	Histology Sex	Histology Code	Comments
Reference (cont)	Yellowknife River - around boat launch and at both banks under bridge (cont)	21-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.13	0.021	-	-	-	Fins slightly deformed; liver not smooth.
		21-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.039	0.006	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.014	-	-	-	-	-
		21-Jul-06	Normal	None	Normal	Normal	Normal	Normal	Moderate observed parasites	0.055	0.024	-	-	-	Small white cysts observed in stomach.
		21-Jul-06	Normal	None	-	Normal	Normal	Normal	No observed parasites	0.023	0.002	-	-	-	-
		21-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	-	0.086	0.065	-	-	-	Pelvic fins deformed.
		21-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.039	0.008	-	-	-	-
		21-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.025	0.002	-	-	-	Missing piece of caudal fin.
		21-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.022	0.001	-	-	-	-
		21-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	-	0.022	0.009	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.012	0.003	-	-	-	-
		21-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.018	0.003	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.035	-	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.023	0.007	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.024	-	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.022	-	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.020	0.005	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.076	0.008	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.03	0.004	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.006	0.001	-	-	-	White worm along peritoneal lining.
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.012	0.003	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.014	0.011	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.014	0.005	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.062	0.022	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.033	0.001	-	Female	1B	-
		21-Jul-06	-	-	Normal	-	-	-	-	0.019	0.002	-	Male	3	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.013	0.004	-	Male	3	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.044	0.014	-	Male	4	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.012	0.005	-	Female	1B	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.166	0.003	-	-	-	Liver not smooth, nematode in liver.
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.052	-	-	-	-	Nematodes in liver.
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.036	0.006	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.042	0.02	-	-	-	Nematode in liver.
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.11	0.011	-	-	-	-
		21-Jul-06	-	-	Fatty liver	-	-	-	-	0.018	0.006	-	-	-	-
		21-Jul-06	-	-	Normal	-	-	-	-	0.013	-	-	-	-	-
	Yellowknife River - cobble area along shoreline of island upstream from bridge	22-Jul-06	-	-	Normal	-	-	-	-	0.208	0.016	-	-	-	Too deteriorated to assess.
		22-Jul-06	-	-	Fatty liver	-	-	-	-	0.159	0.037	-	-	-	Too deteriorated to assess.
		22-Jul-06	-	-	Fatty liver	-	-	-	-	0.079	0.012	-	Male	3	Too deteriorated to assess.
		22-Jul-06	-	-	Fatty liver	-	-	-	-	0.064	n/a	-	-	-	Too deteriorated to assess.
		22-Jul-06	-	-	-	-	-	-	-	0.054	0.019	-	-	-	Too deteriorated to assess.
		22-Jul-06	-	-	Fatty liver	-	-	-	-	0.022	-	-	-	-	-
		22-Jul-06	-	-	Fatty liver	-	-	-	-	0.231	0.051	-	-	-	-
		22-Jul-06	-	-	Fatty liver	-	-	-	-	0.105	0.052	-	-	-	-

Table I-4
Slimy Sculpin Captured for the Giant Mine Lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Hindgut	Mesenteric Fat	Liver	Spleen	Gall Bladder	Kidney	Parasites	Liver Weight (g)	Gonad Weight (g)	Stomach Contents	Histology Sex	Histology Code	Comments
Reference (cont)	Yellowknife River - cobble area along shoreline of island upstream from bridge (cont)	22-Jul-06	-	-	Fatty liver	-	-	-	Moderate observed parasites	0.015	-	-	-	-	Two nematodes outside of intestine.
		22-Jul-06	-	None	Fatty liver	Normal	Normal	Normal	Moderate observed parasites	0.74	0.033	-	-	-	Pelvic fins deformed; 0.364g tapeworm, small white cysts.
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.043	0.012	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.039	0.008	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.053	0.005	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.024	-	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.074	0.012	-	-	-	-
		22-Jul-06	Normal	None	General discoloration; color change in whole liver	Normal	Normal	Normal	Few observed parasites	0.100	0.045	-	-	-	Dead (old) nematode in liver.
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.042	0.004	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.037	0.001	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.032	-	-	-	-	-
		22-Jul-06	Normal	-	Fatty liver	Normal	Normal	Normal	No observed parasites	0.039	0.007	-	-	-	-
		22-Jul-06	Normal	None	Normal	Normal	Normal	Normal	No observed parasites	0.032	0.006	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.026	0.004	-	-	-	-
		22-Jul-06	Normal	-	Fatty liver	Normal	Normal	Normal	No observed parasites	0.092	0.025	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.044	0.011	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.231	0.055	-	-	-	Deformed pelvic fin.
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.053	0.006	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.050	0.002	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.06	0.004	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.054	0.008	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.064	0.008	-	-	-	-
		22-Jul-06	Normal	None	-	Normal	Normal	Normal	No observed parasites	0.045	0.011	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.052	0.005	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.028	0.013	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.053	0.009	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.043	0.009	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.054	0.011	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.024	0.005	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.026	-	-	-	-	Nematode adjacent to liver.
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.043	0.004	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.026	0.004	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.028	0.004	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.057	0.007	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.038	0.004	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.035	0.011	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.049	-	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.031	0.006	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.036	0.005	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.052	0.001	-	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.042	0.01	-	-	-	-

Table I-4
Slimy Sculpin Captured for the Giant Mine Lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Hindgut	Mesenteric Fat	Liver	Spleen	Gall Bladder	Kidney	Parasites	Liver Weight (g)	Gonad Weight (g)	Stomach Contents	Histology Sex	Histology Code	Comments
Reference (cont)	Yellowknife River - cobble area along shoreline of island upstream from bridge (cont)	22-Jul-06	Normal	None	Normal	Normal	Normal	Normal	No observed parasites	0.015	-	-	-	-	Gonads too small for weight.
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.081	0.009	-	-	-	-
		22-Jul-06	Normal	None	Normal	Normal	Normal	Normal	No observed parasites	0.025	-	-	-	-	No visible gonads.
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.028	0.006	Empty	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.058	0.012	Empty	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.053	-	Empty	-	-	No gonad weight available.
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.057	0.007	Empty	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	Few observed parasites	0.030	-	Empty	-	-	Gonads too small for weight; white cyst (parasite) under skin on abdomen.
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.021	-	Empty	-	-	Gonads too small for weight.
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.025	-	Empty	-	-	Gonads too small for weight.
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.058	0.013	Empty	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.043	0.004	Empty	Male	3	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.056	0.004	Empty	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.031	0.004	Empty	-	-	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.048	0.003	Empty	Male	3	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.061	0.013	Empty	Male	1B	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.037	0.006	Empty	Female	1B	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.021	0.006	Empty	Female	1B	-
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.024	-	Empty	Male	4	Gonads too small for weight.
		22-Jul-06	Normal	None	Normal	Normal	Normal	Normal	No observed parasites	0.029	-	Empty	-	-	Gonads too small for weight.
		22-Jul-06	Normal	None	Fatty liver	Normal	Normal	Normal	No observed parasites	0.056	0.006	Empty	Male	3	-

Notes: NC = not collected; yrs = years; mm = millimetres; g = grams. Some slimy sculpin died during holding time and started to decompose, preventing a full health assessment from being completed.

Table I-5
Ninespine Stickleback Captured for the Giant Mine Non-lethal Fish Survey, July 2006

Area	Waterbody	Date	Gear Type	Effort Number	Species	Fish Number	Length (mm)	Body Weight (g)	Live Released	Comments
Exposure	Baker Creek	18-Jul-06	Seine Net	EXP-SN3	Ninespine stickleback	1	24	0.090	Yes	-
		18-Jul-06	Seine Net	EXP-SN3	Ninespine stickleback	2	42	0.410	Yes	-
		18-Jul-06	Seine Net	EXP-SN3	Ninespine stickleback	3	33	0.210	Yes	-
		19-Jul-06	Backpack Electrofishing	EXP-BP3	Ninespine stickleback	4	35	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN8	Ninespine stickleback	5	35	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN8	Ninespine stickleback	6	25	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN8	Ninespine stickleback	7	38	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN8	Ninespine stickleback	8	39	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN8	Ninespine stickleback	9	23	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	10	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	11	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	12	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	13	22	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	14	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	15	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	16	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	17	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	18	21	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	19	28	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	20	25	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	21	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	22	28	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	23	25	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	24	28	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	25	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	26	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	27	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	28	25	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	29	28	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	30	15	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	31	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	32	22	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	33	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	34	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	35	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	36	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	37	25	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	38	25	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	39	21	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	40	21	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	41	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	42	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	43	19	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	44	15	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	45	17	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	46	21	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	47	21	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	48	25	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	49	21	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	50	23	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	51	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	52	19	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	53	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	54	15	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	55	19	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	56	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	57	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	58	14	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	59	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	60	15	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	61	15	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	62	19	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	63	16	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	64	15	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	65	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	66	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	67	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	68	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	69	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	70	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	71	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	72	25	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	73	22	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	74	22	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	75	23	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	76	25	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	77	15	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	78	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	79	20	-	Yes	-

Table I-5
Ninespine Stickleback Captured for the Giant Mine Non-lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Gear Type	Effort Number	Species	Fish Number	Length (mm)	Body Weight (g)	Live Released	Comments
Exposure (cont)	Baker Creek (cont)	26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	80	22	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	81	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	82	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	83	15	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	84	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	85	19	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	86	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	87	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN9	Ninespine stickleback	88	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN10	Ninespine stickleback	89	41	-	Yes	-
		26 Jul 06	Dip Net	EXP-DN-5	Ninespine stickleback	90	22	-	No	Mortality
		26 Jul 06	Dip Net	EXP-DN-5	Ninespine stickleback	91	38	-	Yes	-
		26 Jul 06	Dip Net	EXP-DN-5	Ninespine stickleback	92	19	-	Yes	-
		26 Jul 06	Dip Net	EXP-DN-5	Ninespine stickleback	93	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	96	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	97	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	98	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	99	19	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	100	19	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	101	25	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	102	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	103	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	104	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	105	21	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	106	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	107	19	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	108	19	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	109	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	110	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	111	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	112	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	113	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	114	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	115	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	116	24	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	117	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	118	19	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	119	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	120	16	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	121	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	122	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	123	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	124	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	125	17	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	126	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	127	21	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	128	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	129	19	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	130	19	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	131	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	132	20	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	133	17	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	134	18	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	135	19	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	136	19	-	Yes	-
		26 Jul 06	Seine Net	EXP-SN11	Ninespine stickleback	137	19	-	Yes	-
		26 Jul 06	Dip Net	EXP-DN5	Ninespine stickleback	138	18	-	Yes	-
		26 Jul 06	Dip Net	EXP-DN5	Ninespine stickleback	139	18	-	Yes	-
		27 Jul 06	Seine Net	EXP-SN12	Ninespine stickleback	140	24	-	Yes	-
		27 Jul 06	Seine Net	EXP-SN12	Ninespine stickleback	141	22	-	No	Mortality
		27 Jul 06	Seine Net	EXP-SN12	Ninespine stickleback	142	21	-	No	Mortality
		27 Jul 06	Seine Net	EXP-SN12	Ninespine stickleback	143	21	-	Yes	-
		27 Jul 06	Seine Net	EXP-SN12	Ninespine stickleback	144	29	-	Yes	-
		27 Jul 06	Seine Net	EXP-SN12	Ninespine stickleback	145	29	-	Yes	-
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	146	23	0.22	Yes	-
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	147	22	0.083	Yes	-
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	148	44	0.559	Yes	Mortality
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	149	23	0.101	Yes	-
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	150	25	0.192	Yes	-
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	151	19	0.083	Yes	-
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	152	33	0.312	Yes	-
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	153	22	0.13	Yes	-
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	154	25	0.138	Yes	-
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	155	22	0.121	Yes	-
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	156	26	0.17	Yes	-
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	157	22	0.081	Yes	-
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	158	26	0.168	Yes	-
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	159	21	0.098	Yes	-
		27 Jul 06	Seine Net	EXP-SN14	Ninespine stickleback	160	21	0.135	Yes	-

Table I-5
Ninespine Stickleback Captured for the Giant Mine Non-lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Gear Type	Effort Number	Species	Fish Number	Length (mm)	Body Weight (g)	Live Released	Comments
Reference	Yellowknife River - ponded area below Tartan Rapids	21-Jul-06	Dip Net	EXP-DN1	Ninespine stickleback	1	20	0.070	Yes	-
		21-Jul-06	Dip Net	EXP-DN1	Ninespine stickleback	2	18	0.051	Yes	-
		21-Jul-06	Dip Net	EXP-DN1	Ninespine stickleback	3	17	0.057	Yes	-
		21-Jul-06	Dip Net	EXP-DN1	Ninespine stickleback	4	15	0.037	Yes	-
		21-Jul-06	Dip Net	EXP-DN1	Ninespine stickleback	5	19	0.064	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	6	18	0.048	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	7	15	0.032	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	8	20	0.055	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	9	21	0.081	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	10	15	0.028	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	11	21	0.050	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	12	20	0.044	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	13	16	0.027	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	14	17	0.037	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	15	20	0.061	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	16	22	0.057	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	17	23	0.064	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	18	20	0.046	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	19	23	0.062	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	20	23	0.070	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	21	19	0.038	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	22	20	0.048	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	23	20	0.043	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	24	18	0.036	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	25	17	0.037	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	26	18	0.049	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	27	17	0.038	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	28	20	0.051	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	29	19	0.046	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	30	23	0.074	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	31	21	0.055	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	32	21	0.052	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	33	21	0.061	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	34	18	0.037	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	35	22	0.065	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	36	20	0.043	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	37	21	0.066	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	38	22	0.070	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	39	22	0.068	Yes	Deformed spine/body
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	40	18	0.040	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	41	25	0.093	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	42	20	0.052	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	43	18	0.035	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	44	16	0.028	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	45	18	0.033	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	46	18	0.040	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	47	23	0.080	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	48	22	0.071	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	49	22	0.078	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	50	21	0.068	Yes	-
		22-Jul-06	Dip Net	EXP-DN2	Ninespine stickleback	51	19	0.058	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	52	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	53	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	54	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	55	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	56	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	57	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	58	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	59	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	60	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	61	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	62	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	63	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	64	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	65	20	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	66	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	67	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	68	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	69	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	70	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	71	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	72	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	73	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	74	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	75	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	76	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	77	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	78	15	-	Yes	-

Table I-5
Ninespine Stickleback Captured for the Giant Mine Non-lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Gear Type	Effort Number	Species	Fish Number	Length (mm)	Body Weight (g)	Live Released	Comments
Reference (cont)	Yellowknife River - ponded area below Tartan Rapids (cont)	25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	79	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	80	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	81	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	82	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	83	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	84	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	85	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	86	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	87	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	88	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	89	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	90	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	91	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	92	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	93	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	94	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	95	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	96	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	97	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	98	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	99	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	100	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	101	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	102	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	103	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	104	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	105	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	106	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	107	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	108	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	109	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	110	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	111	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	112	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	113	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	114	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	115	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	116	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	117	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	118	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	119	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	120	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	121	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	122	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	123	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	124	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	125	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	126	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	127	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	128	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	129	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	130	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	131	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	132	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	133	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	134	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	135	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	136	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	137	16	-	No	Mortality
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	138	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	139	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	140	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	141	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	142	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	143	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	144	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	145	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	146	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	147	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	148	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	149	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	150	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	151	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	152	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	153	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	154	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	155	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	156	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	157	16	-	Yes	-

Table I-5
Ninespine Stickleback Captured for the Giant Mine Non-lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Gear Type	Effort Number	Species	Fish Number	Length (mm)	Body Weight (g)	Live Released	Comments
Reference (cont)	Yellowknife River - ponded area below Tartan Rapids (cont)	25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	158	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	159	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	160	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	161	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	162	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	163	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	164	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	165	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	166	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	167	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	168	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	169	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	170	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	171	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	172	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	173	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	174	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	175	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	176	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	177	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	178	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	179	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	180	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	181	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	182	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	183	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	184	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	185	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	186	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	187	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	188	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	189	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	190	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	191	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	192	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	193	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	194	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	195	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	196	15	-	Yes	Fungal growth on tail.
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	197	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	198	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	199	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	200	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	201	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	202	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	203	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	204	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	205	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	206	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	207	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	208	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	209	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	210	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	211	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	212	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	213	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	214	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	215	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	216	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	217	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	218	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	219	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	220	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	221	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	222	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	223	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	224	18	-	Yes	Deformed spine/body.
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	225	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	226	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	227	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	228	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	229	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	230	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	231	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	232	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	233	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	234	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	235	15	-	Yes	-

Table I-5
Ninespine Stickleback Captured for the Giant Mine Non-lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Gear Type	Effort Number	Species	Fish Number	Length (mm)	Body Weight (g)	Live Released	Comments
Reference (cont)	Yellowknife River - ponded area below Tartan Rapids (cont)	25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	236	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	237	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	238	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	239	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	240	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	241	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	242	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	243	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	244	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	245	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	246	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	247	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	248	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	249	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	250	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	251	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	252	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	253	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	254	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	255	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	256	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	257	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	258	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	259	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	260	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	261	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	262	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	263	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	264	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	265	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	266	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	267	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	268	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	269	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	270	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	271	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	272	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	273	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	274	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	275	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	276	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	277	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	278	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	279	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	280	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	281	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	282	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	283	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	284	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	285	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	286	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	287	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	288	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	289	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	290	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	291	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	292	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	293	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	294	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	295	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	296	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	297	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	298	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	299	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	300	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	301	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	302	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	303	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	304	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	305	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	306	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	307	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	308	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	309	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	310	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	311	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	312	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	313	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	314	18	-	Yes	-

Table I-5
Ninespine Stickleback Captured for the Giant Mine Non-lethal Fish Survey, July 2006 (continued)

Area	Waterbody	Date	Gear Type	Effort Number	Species	Fish Number	Length (mm)	Body Weight (g)	Live Released	Comments
Reference (cont)	Yellowknife River - ponded area below Tartan Rapids (cont)	25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	315	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	316	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	317	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	318	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	319	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	320	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	321	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	322	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	323	19	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	324	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	325	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	326	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	327	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	328	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	329	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	330	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	331	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	332	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	333	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	334	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	335	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	336	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	337	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	338	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	339	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	340	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	341	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	342	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	343	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	344	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	345	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	346	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	347	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	348	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	349	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	350	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	351	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	352	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	353	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	354	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	355	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	356	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	357	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	358	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	359	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	360	18	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	361	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	362	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	363	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	364	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	365	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	366	14	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	367	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	368	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	369	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	370	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	371	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	372	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	373	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	374	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	375	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	376	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	377	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	378	15	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	379	16	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	380	17	-	Yes	-
		25-Jul-06	Dip Net	EXP-DN3	Ninespine stickleback	381		-	Yes	-
		25-Jul-06	Dip Net	EXP-DN4	Ninespine stickleback	382	15	-	Yes	-

APPENDIX II

INVERTEBRATE COMMUNITY SURVEY

Table II-1
Water Chemistry Results for the Invertebrate Community Survey at Giant Mine, August 2006

Parameter	Units	MDL	CWQG[a]	Stations										QA/QC					
				E02	E03	E06	E10	E16	R06	R07	R08	R10	R16	E16 Duplicate	R16 Duplicate	Field Blank	Travel Blank	Field Blank	Travel Blank
				10-Aug-06	10-Aug-06	17-Aug-06	10-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	10-Aug-06	10-Aug-06	17-Aug-06	17-Aug-06
Physical																			
Acidity (to pH 8.3; as calcium carbonate)	mg/L	1.0	-	2.0	2.2	2.8	1.0	2.5	2.3	2.2	2.3	2.2	2.8	2.2	2.8	2.5	2.5	1.9	-
Total Alkalinity (as calcium carbonate)	mg/L	2.0	-	62.1	62.7	20.6	24.2	21.4	20.0	19.0	19.6	19.7	30.2	20.3	30.5	4.7	2.7	<1.0	-
Conductivity (laboratory)	µS/cm	2.0	-	1,020	1,040	67	63	66	52	53	53	54	75	67	75	<2	<2	<2	-
Total Dissolved Solids	mg/L	10	-	772	765	43	40	43	36	37	36	34	52	44	49	<10	<10	<3.0	-
Hardness (as calcium carbonate)	mg/L	0.5	-	413	410	27.8	27.3	30.6	25.1	24.9	23.8	24.8	38.0	30.4	38.7	<0.54	<0.54	<0.54	<0.54
pH (laboratory)		0.0	-	8.0	8.0	7.2	7.8	7.5	7.6	7.6	7.6	7.6	7.6	7.6	7.5	5.6	5.6	5.7	-
Total Suspended Solids	mg/L	1.0	-	1.6	7.8	1.1	2.0	<1.0	1.7	1.5	17.5	1.1	1.5	6.3	1.5	<1.0	<1.0	<1.0	-
Turbidity	NTU	0.1	-	1.58	6.30	1.63	2.16	0.91	1.37	1.12	3.26	1.32	0.86	1.54	0.68	<0.10	0.14	0.11	-
Major Ions																			
Calcium	mg/L	0.05	-	127	120	7.22	7.46	7.68	6.05	5.90	6.10	5.52	9.30	8.32	9.25	<0.050	<0.050	<0.050	<0.050
Chloride	mg/L	0.5	-	98.3	100	2.85	2.31	2.64	1.76	1.74	1.76	1.75	2.62	2.66	2.63	<0.50	<0.50	<0.50	-
Magnesium	mg/L	0.1	-	28.7	27.2	2.55	2.48	2.84	2.49	2.41	2.51	2.12	3.90	2.77	3.88	<0.10	<0.10	<0.10	<0.10
Potassium	mg/L	2.0	-	3.6	3.4	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Sodium	mg/L	2.0	-	47.7	45.2	2.4	<2.0	2.7	<2.0	<2.0	<2.0	<2.0	2.7	2.3	2.7	<2.0	<2.0	<2.0	<2.0
Sulphate	mg/L	0.5	-	339	345	7.11	4.63	6.33	3.00	2.99	3.02	3.00	3.04	6.47	3.06	<0.50	<0.50	<0.50	-
Nutrients																			
Ammonia (as nitrogen)	mg/L	0.02	0.4 to 55.76[c]	0.066	0.025	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Total Kjeldahl Nitrogen	mg/L	0.05	-	0.689	0.688	0.244	0.299	0.227	0.180	0.186	0.302	0.183	0.457	0.212	0.386	<0.050	<0.050	<0.050	<0.050
Nitrate (as nitrogen)	mg/L	0.005	2.9	1.05	1.05	0.0065	0.0051	0.0065	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0066	<0.0050	<0.0050	<0.0050	<0.0050	-
Nitrite (as nitrogen)	mg/L	0.001	0.060	0.0037	0.0040	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-
Total Phosphate	mg/L	0.002	-	0.0215	0.0289	0.0077	0.0092	0.0082	0.0081	0.0084	0.0400	0.0067	0.0143	0.0124	0.0136	<0.0020	<0.0020	<0.0020	-
Total Metals																			
Aluminum	mg/L	0.005	0.1[d]	0.0156	0.150	0.0504	0.0771	0.0528	0.0503	0.0592	0.146	0.0482	0.0167	0.0425	0.0162	<0.0050	<0.0050	<0.0050	<0.0050
Antimony	mg/L	0.2	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic	mg/L	0.01	0.005	0.185	0.168	0.00557	0.00259	0.00365	0.00058	0.00050	0.00233	0.00051	0.00750	0.00350	0.00746	<0.00020	<0.00020	<0.00020	<0.00020
Barium	mg/L	0.01	-	0.025	0.026	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Beryllium	mg/L	0.005	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bismuth	mg/L	0.2	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Boron	mg/L	0.1	-	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium	mg/L	0.001	0.0001 and 0.00001[e]	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Chromium	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Cobalt	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Copper	mg/L	0.01	0.002 and 0.004[f]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	mg/L	0.01	0.003	0.084	0.251	0.051	0.081	0.037	0.065	0.060	0.291	0.061	0.347	0.039	0.350	<0.010	<0.010	<0.010	<0.010
Lead	mg/L	0.001	0.001 and 0.007[g]	<0.030	<0.030	<0.0010	<0.030	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.030	<0.030	<0.0010	<0.0010
Lithium	mg/L	0.01	-	0.013	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Manganese	mg/L	0.005	-	0.0236	0.0294	0.0056	<0.0050	<0.0050	<0.0050	<0.0050	0.0093	<0.0050	0.0142	<0.0050	0.0125	<0.0050	<0.0050	<0.0050	<0.0050
Mercury	µg/L	0.05	0.026	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum	mg/L	0.01	0.073	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nickel	mg/L	0.005	0.025 and 0.150[h]	0.0079	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Selenium	mg/L	0.00050	0.001	0.00057	0.00103	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00059	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silver	mg/L	0.01	0.0001	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Strontium	mg/L	0.005	-	0.948	0.888	0.0365	0.0339	0.0366	0.0252	0.0243	0.0253	0.0248	0.0429	0.0365	0.0428	<0.0050	<0.0050	<0.0050	<0.0050
Thallium	mg/L	0.2	0.0008	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Tin	mg/L	0.03	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Titanium	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium	mg/L	0.03	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc	mg/L	0.004	0.030	<0.0040	0.0065	<0.0040	<0.0040	0.0093	<0.0040	<0.0040	0.0042	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040

Table II-1
Water Chemistry Results for the Invertebrate Community Survey at Giant Mine, August 2006 (continued)

Parameter	Units	MDL	CWQG[a]	Stations										QA/QC					
				E02	E03	E06	E10	E16	R06	R07	R08	R10	R16	E16 Duplicate	R16 Duplicate	Field Blank	Travel Blank	Field Blank	Travel Blank
				10-Aug-06	10-Aug-06	17-Aug-06	10-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	17-Aug-06	10-Aug-06	10-Aug-06	17-Aug-06	17-Aug-06
Dissolved Metals																			
Aluminum	mg/L	0.005	-	<0.0050	<0.0050	0.0066	0.0093	0.0060	0.0067	0.0064	0.0052	0.0079	0.0051	0.0062	<0.0050	<0.0050	<0.0050	-	-
Antimony	mg/L	0.2	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-	-
Arsenic	mg/L	0.0002	-	0.165	0.161	0.00492	0.00251	0.00331	0.00052	0.00045	0.00095	0.00046	0.00571	0.00326	0.00559	<0.00020	<0.00020	-	-
Barium	mg/L	0.01	-	0.023	0.025	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	-
Beryllium	mg/L	0.005	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-	-
Bismuth	mg/L	0.2	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-	-
Boron	mg/L	0.1	-	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-	-
Cadmium	mg/L	0.001	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-
Chromium	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	-
Cobalt	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	-
Copper	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	-
Iron	mg/L	0.01	-	0.013	0.017	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.207	<0.010	0.181	<0.010	<0.010	-	-
Lead	mg/L	0.001	-	<0.030	<0.030	<0.0010	<0.030	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.030	<0.030	-	-
Lithium	mg/L	0.01	-	<0.010	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	-
Manganese	mg/L	0.005	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-	-
Mercury	µg/L	0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-
Molybdenum	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	-
Nickel	mg/L	0.005	-	0.0076	0.0077	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-	-
Selenium	mg/L	0.0005	-	0.00062	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-
Silver	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	-
Strontium	mg/L	0.005	-	0.885	0.897	0.0360	0.0320	0.0367	0.0248	0.0247	0.0238	0.0244	0.0413	0.0359	0.0422	<0.0050	<0.0050	-	-
Thallium	mg/L	0.2	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-	-
Tin	mg/L	0.03	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	-	-
Titanium	mg/L	0.01	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	-
Vanadium	mg/L	0.03	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	-	-
Zinc	mg/L	0.004	-	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	0.0079	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	-	-
Organics																			
Dissolved Organic Carbon	mg/L	0.5	-	11.0	10.8	6.37	6.34	6.26	6.49	6.67	6.30	6.31	8.07	6.42	7.93	<0.50	1.05	1.16	0.95
Total Organic Carbon	mg/L	0.5	-	11.9	11.8	7.48	6.53	6.82	7.09	7.11	7.43	9.00	9.18	7.92	9.14	<0.50	1.11	1.18	<0.50
Radionuclides[b]			-																
Radium-226	Bq/L	0.005	-	<0.0050	<0.0050	0.0050	<0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	<0.0050	<0.0050	0.0050	0.0050
Other																			
Total Cyanide	mg/L	0.005	-	0.0095	0.0095	0.0056	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0094	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Total Silicon	mg/L	0.05	-	0.388	0.646	0.351	0.456	0.325	0.363	0.382	0.423	0.293	0.693	0.345	0.675	<0.050	<0.050	<0.050	<0.050
Dissolved Silicon	mg/L	0.05	-	0.319	0.375	0.196	0.239	0.195	0.215	0.187	0.196	0.210	0.630	0.234	0.628	<0.050	<0.050	-	-
Fluoride	mg/L	0.02	-	0.102	0.101	0.068	0.064	0.071	0.068	0.067	0.068	0.068	0.078	0.068	0.077	<0.020	<0.020	<0.020	-

Notes:
mg/L = milligrams per litre; µg/L = micrograms per litre; µS/cm = microSiemens per centimetre; Bq/L = Becquerel per litre; NTU = nephelometric turbidity units; MDL = method detection limit; < = indicates concentration of analyte was less than the MDL.
< = Indicates concentration of analyte was less than the method detection limit; MDL = method detection limit.
[a] Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CCME 1999, 2007).
[b] Radium-226 analysis was subcontracted to Saskatchewan Research Council Analytical Laboratories, Saskatoon, Saskatchewan.
[c] Guideline for ammonia (as nitrogen) is temperature and pH dependent; ammonia guideline is 0.40 mg/L at field temperature of 20C and pH 8.0 and 55.76 mg/L at field temperature of 15C and pH 6.0.
[d] Guideline for aluminum is 0.005 ug/L at pH <6.5 and 0.100 ug/L at pH >6.5; all pH values were >6.5 except one instance of pH 5.6 at E05 on August 17, 2006.
[e] Guideline for cadmium is dependent on water hardness and was calculated according to the lowest and highest water hardness values.
[f] Guideline for copper is 0.002 mg/L at water hardness of 0 to 180 mg/L and 0.004 at water hardness >180 mg/L.
[g] Guideline for lead is 0.007 at water hardness of 0 to 60 mg/L and 0.007 at water hardness >180 mg/L.
[h] Guideline for nickel is 0.025 at water hardness of 0 to 60 mg/L and 0.150 at water hardness >180 mg/L.
ALS Environmental File Numbers Z1130 and Z1489.

Table II-2
Internal Laboratory Split and Duplicate Water Samples Collected for Quality Assurance/Quality Control during the Giant Mine Invertebrate Community Survey, August 2006

Analyte	Units	E10 10-Aug-06	E10 QC# 516659	RPD %	R06 17-Aug-06	R06 QC# 518246	RPD %	E16 17-Aug-06	E16 Duplicate 17-Aug-06	RPD %	R16 17-Aug-06	R16 Duplicate 17-Aug-06	RPD %
Physical Tests													
Acidity (to pH 8.3; as calcium carbonate)	mg/L	1.0	1.1	10	2.3	2.3	0	2.5	2.2	13	2.8	2.8	0
Total Alkalinity (as calcium carbonate)	mg/L	24.2	22.5	7	20.0	19.0	5	21.4	20.3	5	30.2	30.5	1
Conductivity	µS/cm	62.8	62.8	0	52.4	52.4	0	66	67	2	75	75	0
Total Dissolved Solids	mg/L	40	32	22	-	-	-	43	44	3	52	49	6
Hardness (as calcium carbonate)	mg/L	27.3	27.0	1	25.1	24.7	2	30.6	30.4	1	38.0	38.7	2
pH		7.82	7.80	0	7.56	7.56	0	7.5	7.6	1	7.6	7.5	0
Total Suspended Solids	mg/L	2.0	1.5	29	-	-	-	<1.0	6.3	171	1.5	1.5	0
Turbidity	NTU	2.16	2.35	8	1.37	1.24	10	0.91	1.54	51	0.86	0.68	23
Major Ions													
Calcium	mg/L	7.46	7.25	3	6.05	6.09	1	7.68	8.32	8	9.30	9.25	1
Chloride	mg/L	2.31	2.32	0	1.76	1.75	1	2.64	2.66	1	2.62	2.63	0
Magnesium	mg/L	2.48	2.41	3	2.49	2.50	0	2.84	2.77	2	3.90	3.88	1
Potassium	mg/L	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0	<2.0	<2.0	0
Sodium	mg/L	<2.0	<2.0	0	<2.0	<2.0	0	2.7	2.3	16	2.7	2.7	0
Sulphate	mg/L	4.63	4.61	0	3.00	2.99	0	6.33	6.47	2	3.04	3.06	1
Nutrients													
Ammonia Nitrogen	mg/L	<0.020	<0.020	0	<0.020	<0.020	0	<0.020	<0.020	0	<0.020	<0.020	0
Total Kjeldahl Nitrogen	mg/L	0.299	0.298	0	0.180	0.195	8	0.227	0.212	7	0.457	0.386	17
Nitrate Nitrogen	mg/L	0.0051	<0.0050	2	<0.0050	<0.0050	0	0.0065	0.0066	2	<0.0050	<0.0050	0
Nitrite Nitrogen	mg/L	<0.0010	<0.0010	0	<0.0010	<0.0010	0	<0.0010	<0.0010	0	<0.0010	<0.0010	0
Total Phosphate	mg/L	0.0092	0.0093	1	0.0081	0.0085	5	0.0082	0.0124	41	0.0143	0.0136	5
Total Metals													
Aluminum	mg/L	0.0771	0.0746	3	0.0503	0.0465	8	0.0528	0.0425	22	0.0167	0.0162	3
Antimony	mg/L	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
Arsenic	mg/L	0.00259	0.00237	9	0.00058	0.00055	5	0.00365	0.00350	4	0.00750	0.00746	1
Barium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Beryllium	mg/L	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0
Bismuth	mg/L	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
Boron	mg/L	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
Cadmium	mg/L	<0.0010	<0.0010	0	<0.0010	<0.0010	0	<0.0010	<0.0010	0	<0.0010	<0.0010	0
Chromium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Cobalt	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Copper	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Iron	mg/L	0.081	0.076	6	0.065	0.073	12	0.037	0.039	5	0.347	0.350	1
Lead	mg/L	<0.030	<0.030	0	<0.0010	<0.0010	0	<0.0010	<0.0010	0	<0.0010	<0.0010	0
Lithium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Manganese	mg/L	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0	0.0142	0.0125	13
Mercury	µg/L	<0.05	<0.05	0	<0.05	<0.05	0	<0.05	<0.05	0	<0.05	<0.05	0
Molybdenum	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Nickel	mg/L	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0
Selenium	mg/L	<0.00050	<0.00050	0	<0.00050	<0.00050	0	<0.00050	<0.00050	0	<0.00050	<0.00050	0
Silver	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Strontium	mg/L	0.0339	0.0326	4	0.0252	0.0254	1	0.0366	0.0365	0	0.0429	0.0428	0
Thallium	mg/L	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
Tin	mg/L	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0
Titanium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Vanadium	mg/L	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0
Zinc	mg/L	<0.0040	<0.0040	0	<0.0040	<0.0040	0	0.0093	<0.0040	129	<0.0040	<0.0040	0
Dissolved Metals													
Aluminum	mg/L	0.0093	0.0093	0	0.0067	0.0060	11	0.0060	0.0062	3	0.0051	<0.0050	68
Antimony	mg/L	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
Arsenic	mg/L	0.00251	0.00241	4	0.00052	0.00049	6	0.00331	0.00326	2	0.00571	0.00559	2
Barium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Beryllium	mg/L	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0
Bismuth	mg/L	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
Boron	mg/L	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0	<0.10	<0.10	0
Cadmium	mg/L	<0.0010	<0.0010	0	<0.0010	<0.0010	0	<0.0010	<0.0010	0	<0.0010	<0.0010	0
Chromium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Cobalt	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Copper	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Iron	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	0.207	0.181	13
Lead	mg/L	<0.030	<0.030	0	<0.0010	<0.0010	0	<0.0010	<0.0010	0	<0.0010	<0.0010	0
Lithium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Manganese	mg/L	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0
Mercury	µg/L	<0.05	<0.05	0	<0.05	<0.05	0	<0.05	<0.05	0	<0.05	<0.05	0
Molybdenum	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Nickel	mg/L	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050	<0.0050	0
Selenium	mg/L	<0.00050	<0.00050	0	<0.00050	<0.00050	0	<0.00050	<0.00050	0	<0.00050	<0.00050	0
Silver	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Strontium	mg/L	0.0320	0.0314	2	0.0248	0.0241	3	0.0367	0.0359	2	0.0413	0.0422	2
Thallium	mg/L	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0	<0.20	<0.20	0
Tin	mg/L	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0
Titanium	mg/L	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0	<0.010	<0.010	0
Vanadium	mg/L	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0	<0.030	<0.030	0
Zinc	mg/L	<0.0040	<0.0040	0	<0.0040	<0.0040	0	<0.0040	<0.0040	0	<0.0040	<0.0040	0
Organic Parameters													
Dissolved Organic Carbon	mg/L	6.34	6.28	1	6.49	5.99	8	6.26	6.42	3	8.07	7.93	2
Total Organic Carbon	mg/L	6.53	6.80	4	7.09	7.05	1	6.82	7.92	15	9.18	9.14	0
Other													
Fluoride	mg/L	0.064	0.063	2	0.068	0.069	1	0.071	0.068	4	0.078	0.077	1
Total Silicon	mg/L	0.456	0.470	3	0.363	0.379	4	0.195	0.234	18	0.693	0.675	3
Dissolved Silicon	mg/L	0.239	0.230	4	0.215	0.195	10	0.325	0.345	6	0.630	0.628	0

RPD = relative percent difference; % = percent; mg/L = milligrams per litre; µg/L = micrograms per litre; µS/cm = microSiemens per centimetre; Bq/L = Becquerel per litre; NTU = nephelometric turbidity units.

Table II-3
Sediment Quality Results for the Invertebrate Community Survey at Giant Mine, August 2006

		Date Sampled	Moisture (%)	Arsenic (µg/g)	Total Organic Carbon (%)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
Stations	E01	7-Sep-06	50.9	49.1	1.1	<0.1	5.0	15.4	79.6
	E02	7-Sep-06	50.7	-	3.2	<0.1	23.6	36.6	39.8
	E03	7-Sep-06	36.9	224	2.2	<0.1	23.9	20.8	55.3
	E05	7-Sep-06	37.6	-	1.9	<0.1	30.3	45.2	24.5
	E06	7-Sep-06	32.4	157	0.5	4.4	67.0	18.1	10.5
	E07	7-Sep-06	45.0	-	2.0	<0.1	45.1	27.6	27.3
	E10	7-Sep-06	24.4	68.0	1.4	5.5	56.5	25.3	12.7
	E11	7-Sep-06	62.1	-	1.7	<0.1	55.5	29.1	15.4
	E15	7-Sep-06	35.6	14.4	0.9	<0.1	12.5	57.9	29.6
	E16	7-Sep-06	32.7	-	1.2	<0.1	23.5	54.6	21.9
	R06	7-Sep-06	27.9	-	0.3	<0.1	46.6	47.6	5.80
	R07	7-Sep-06	31.0	<5.0	0.5	<0.1	5.7	61.3	33.0
	R08	7-Sep-06	20.2	5.8	0.5	<0.1	47.1	45.1	7.80
	R09	7-Sep-06	63.2	59.1	1.9	<0.1	1.4	44.7	53.9
	R10	7-Sep-06	59.9	7.0	1.1	<0.1	10.0	73.8	16.2
	R16	7-Sep-06	75.6	23.1	3.7	<0.1	2.2	59.6	38.2
QA/QC	E05 Duplicate	7-Sep-06	36.6	-	1.8	<0.1	20.4	54.7	24.9
	R10 Duplicate	7-Sep-06	53.0	-	1.0	<0.1	5.6	77.6	16.8
MDL			0.1	5.0	0.1	0.1	0.1	0.1	0.1

Notes:
< = indicates value is less than the method detection limit; MDL = method detection limit.
Gravel > 2.00 mm; sand = 2.00 mm to >0.063; silt = 0.063 to > 4 µm; clay <4 µm).
Results are expressed on a dry weight basis.
ALS Environmental File Number Z2765.

Internal Split Sediment Samples for Quality Assurance/Quality Control

Analyte	R08	R08	RPD %
	7-Sep-06	QC# 523192	
Arsenic (mg/L)	5.8	5.6	3.51

Notes:
RPD = relative percent difference; % = percent.

Table II-4
Habitat Characteristics for the Invertebrate Community Survey at Giant Mine, August 2006

Area	Station	Date	Velocity (m/s)				Channel Width	Habitat Notes
			20% of Water Column	80% of Water Column	60% of Water Column	0.10 m above bottom		
Near-field	**E1**	29-Jun-06	0.01	0.01	-	0.01	-	Plates located next to shore in slow-water area; 60% veg cover; 40% horsetail; 20% submergent veg; substrate - 90% clay, 10% organic fines
		10-Aug-06	-	-	0	0	-	No information
		6-Sep-06	-	-	0.01	0.02	-	No information
	E2	29-Jun-06	0.01	0.01	-	0.01	10.5	40% veg cover; 30% submergent veg; 10% horsetail; substrate - 90% silt, 10% organic fines
		10-Aug-06	-	-	0.01	0.01	-	50% emergent aquatic veg
		7-Sep-06	0	0	-	0	-	70% veg cover
	E3	29-Jun-06	0.04	0.03	-	0.01	10.5	Substrate - 60% silt, 40% organic fine; 70% veg cover; 40% horsetail; 30% submergent
		10-Aug-06	-	-	0	0	-	85% veg cover
		7-Sep-06	-	-	0.01	0.02	-	100% veg cover
	E5	29-Jun-06	0.02	0.01	-	0.02	14	80% veg cover (potamageton?); substrate - 85% silt, 15% organic fines
		17-Aug-06	0	0	-	0.02	-	100% veg cover
		7-Sep-06	0.02	0.01	0.01	0.01	0.01	100% veg cover
Far Field	**E6**	29-Jun-06	0.01	0.01	-	0.01	-	Substrate - 95% silt on top of clay with 5% organic fines; 50% veg cover (40% potamageton, 10% aquatic grasses)
		17-Aug-06	0	0	-	0	-	50% veg cover
		7-Sep-06	-	-	0.01	0.02	-	75% veg cover
	E7	30-Jun-06	0.02	0.02	-	0.01	-	Substrate - 80% silt, 20% riprap; 0% aquatic veg cover
		10-Aug-06	0.01	0.01	-	0.03	-	0% veg cover; could only visually locate one set of plates during mid-Aug visit
		7-Sep-06	0.01	0.03	-	0.02	-	0% veg cover
	E10	30-Jun-06	0.01	0.01	-	0.02	-	0% veg cover; potamageton present; Substrate - 95% silt, 5% gravel
		10-Aug-06	0.01	0.01	-	0.01	-	0% veg cover
		7-Sep-06	0.03	0.01	-	0.01	-	15% veg cover
	E11	30-Jun-06	-	-	0.01	0.01	-	0% veg cover; some aquatic grasses present; substrate - 95% silt, 5% gravel
		10-Aug-06	-	-	0.02	0	-	0% veg cover
		7-Sep-06	-	-	0.01	0.05	-	0% veg cover
	E15	30-Jun-06	0.03	0.01	-	0	-	Substrate - 80% silt, 20% sand; 0% aquatic veg cover; some aquatic grasses present
		17-Aug-06	0.01	0	-	0	-	No information
		7-Sep-06	0.05	0.03	-	0.03	-	5% veg cover
	E16	30-Jun-06	0.04	0.01	-	0.01	-	0% cover; substrate - 90% silt, 10% boulder; submerged potamageton/organic debris
		17-Aug-06	0.01	0	-	0	-	No information

Table II-4
Habitat Characteristics for the Invertebrate Community Survey at Giant Mine, August 2006 (continued)

Area	Station	Date	Velocity (m/s)				Channel Width	Habitat Notes
			20% of Water Column	80% of Water Column	60% of Water Column	0.10 m above bottom		
		7-Sep-06	0.03	0.01	-	0.01	-	10% veg cover; one plate upside down
Reference	**R6**	30-Jun-06	0.28	0.25		0.13		0% cover; substrate - 100% silt over bedrock
		17-Aug-06	-	-	-	-	-	0% veg cover
		8-Sep-06	0.16	0.1	-	0.08	-	0% veg cover
	R7	30-Jun-06	0.3	0.22	-	0.18	-	0% veg cover; substrate - silt over bedrock
		17-Aug-06	0.24	0.18	-	0.21	-	0% veg cover
		8-Sep-06	0.29	0.2	-	0.05	-	0% veg cover
	R8	4-Jul-06	-	-	0.01	0.01	-	Substrate - 50% boulder, 50% fine silt; some horsetail and aquatic plants present; 0% cover
		17-Aug-06	-	-	0	0	-	5% veg cover
		8-Sep-06	-	-	0.03	0.03	-	0% veg cover
	R9	4-Jul-06	0.02	0.03	-	0.02	-	>5% veg cover; emergent grasses; substrate - organic silt
		17-Aug-06	0	0	-	0	-	80% emergent aquatic vegetation
		8-Sep-06	0.05	0.03	-	0.02	-	50% veg cover
	R10	30-Jun-06	0.02	0	-	0.01	-	0% veg cover; some rooted aquatic vegetation; substrate - 100% silt
		17-Aug-06	0.06	0.06	-	0.03	-	70% veg cover with aquatic grasses
		8-Sep-06	0.04	0.02	-	0.02	-	100% veg cover
	R16	4-Jul-06	-	-	0.01	0.02	-	Potamageton, emergent grasses, adjacent to cattails; substrate - organic silt
		17-Aug-06	-	-	0.01	0	-	95% aquatic grass cover
		8-Sep-06	0.02	0.02	-	0.01	-	100% veg cover

Table II-5
Benthic Invertebrate Taxonomy for the Giant Mine Invertebrate Community Survey, August 2006

Major Taxon	Yellowknife River (Reference Area)																																			
	R06-1	R06-2	R06-3	R06-4	R06-5	R06-6	R07-1	R07-2	R07-3	R07-4	R07-5	R07-6	R08-1	R08-2	R08-3	R08-4	R08-5	R08-6	R09-1	R09-2	R09-3	R09-4	R09-5	R09-6	R10-1	R10-2	R10-3	R10-4	R10-5	R10-6	R16-1	R16-2	R16-3	R16-4	R16-5	R16-6
Phylum: Annelida (segmented worms)																																				
Class: Hirudinea (leeches)																																				
Order: Pharyngobdellida																																				
Family: Erpobdellidae																																				
Nephelopsis obscura																															6		6			
Order: Rhynchobdellida																																				
Family: Glossiphoniidae																																				
Glossiphonia complanata																																				
Helobdella fusca																																				
Helobdella sp																																				
Helobdella stagnalis																																				6
Class: Oligochaeta (aquatic earthworms)																																				
Family: Naididae		19	6	6	6	13	13		13	19			6	13	38	69	44	63	13	13	25	6			6						431	131	175	138	188	94
Family: Tubificidae					6																															
Phylum: Arthropoda																																				
Class: Arachnida																																				
Order: Hydracarina (water mites)																																				
Class: Crustacea																																				
Subclass: Branchiopoda																																				
Order: Cladocera (water fleas) [A]													19	25			6																			
Family: Chydoridae [A]																		6													6					
Family: Macrothricidae [A]															6	6	6	25																		
Subclass: Copepoda																																				
Order: Cyclopoida [A]													75	69	75	81	94	100		6		50	13	25	13		6			6		13			13	
Subclass: Malacostraca																																				
Order: Amphipoda (scuds)																																				
Family: Gammaridae																																				
Gammarus lacustris		6	6		19		6	13	13	6	6	13											6					6	6							
Family: Hyalellidae																																				
Hyalella azteca		50	31	100	106	163	69	175	113	50	63	75	13	13	50	175	119	94	106	81	119	100	75	106	6	44	56	38	44	25	6	25	13	106	6	
Subclass: Ostracoda (seed shrimp)																																				
Class: Insecta																																				
Order: Coleoptera (beetles)																																				
Family: Dytiscidae																																				
Agabus sp						13																								6						
Family: Haliplidae																																				
Brychius sp																																				
Haliplus sp															6			6								6										
Order: Collembola (springtails)																																				
Family: Isotomidae																																				
Isotomus sp [A]																																				
Order: Diptera (flies)																																				
Family: Ceratopogonidae																																				
Bezzia sp																13	13		6												13	19	13			
Probezzia sp															6																					6
Family: Chironomidae																	6																			
Subfamily: Chironominae/Tribe: Chironomini																															6	6				
Chironomus sp																									6						6	44		19	13	
Cladopelma sp																																		6		
Cryptochironomus sp																	6	19																		
Dicrotendipes sp		6					6			6		6	6								13										13	6				6
Endochironomus sp		25	13	6	6	25	19		25	13	25	25	13	50	25	119	69	119	19	6	13	13		25						6	31	6	6	19	13	
Glyptotendipes sp																																				
Microtendipes sp		25	100	56	38	75	63	138	138	88	94	119						6	13						6		6	13			19	6				
Nilothauma sp								13		6	6	6																								
Parachironomus sp																																				
Paratendipes sp																																				
Phaenopsectra sp		6	6			13																											6			
Polypedilum sp	19	238	181	144	125	325	269	288	313	294	156	119	13	19	6	19	13	13	19	6	19	6	6	13		13	6		19			13				
Xenochironomus sp											6																									
Subfamily: Chironominae/Tribe: Tanytarsini																																				
Cladotanytarsus sp														6																						
Micropsectra sp													6		6		6	6																		
Paratanytarsus sp					6	13					6									6			6								6					
Tanytarsus sp		50	19	19	13	25	38	38	13	25	69	38														6				6	25	44	13	31	6	
Tribelos sp																																			19	
Subfamily: Diamesinae																																				
Potthastia longimanus			6					13																												
Subfamily: Orthocladiinae																6																				
Corynoneura sp																																				
Cricotopus/Orthocladius Group		6	6				6	13			19																									
Heterotrissocladius sp														6																						
Metriocnemus sp																																				
Psectrocladius sp							6					6					6																			
Subfamily: Tanypodinae		88	56	44	31	100	94	113	175	69	88	50	6		6	13	13	13	13	13	13	13		6	6	31	25	6	19		25	13		6	6	
Ablabesmyia sp		25	19		6		19							13	6						6				6	6				6						
Labrundinia sp					6		13				6																									

Table II-5
Benthic Invertebrate Taxonomy for the Giant Mine Invertebrate Community Survey, August 2006 (continued)

Major Taxon	Yellowknife River (Reference Area)																																			
	R06-1	R06-2	R06-3	R06-4	R06-5	R06-6	R07-1	R07-2	R07-3	R07-4	R07-5	R07-6	R08-1	R08-2	R08-3	R08-4	R08-5	R08-6	R09-1	R09-2	R09-3	R09-4	R09-5	R09-6	R10-1	R10-2	R10-3	R10-4	R10-5	R10-6	R16-1	R16-2	R16-3	R16-4	R16-5	R16-6
Procladius sp																	6				6											6	13		13	25
Thienemannimyia sp		38	56	25	19	50	69	113	50	69	31	50			13	6	6																			
Family: Empididae																																				
Hemerodromia sp																																				
Order: Ephemeroptera (mayflies)																																				
Family: Baetidae																																				
Acentrella sp		31	13	19		25	6	25		6		6																								
Baetis sp																																				
Callibaetis sp																																				
Family: Caenidae																																				
Caenis sp																															6	19	6			6
Family: Ephemerellidae																																				
Eurylophella sp										31	6	19	6	31		13	6					6		6	19	19		13		13						
Family: Heptageniidae																																				
Heptagenia sp																																				
Maccaffertium sp		6		19						6	6		6	25	13	25	19	19	6	6			31	13	6	6	13	13	13				6			
Family: Leptophlebiidae																																				
Leptophlebia sp		394	325	306	294	1,563	338	550	525	306	363	431	13	31			6	25	44	44	38	25	31	44	31	75	56	31	25	50						
Order: Hemiptera (true bugs)																																				
Family: Corixidae																																				
Callicorixa alaskensis [A]																																				
Sigara trilineata [A]			6																																	
Order: Odonata (dragon & damselflies)																																				
Family: Aeshnidae																																				
Aeshna sp				6	13	13	6						13	31	13		13	6	6		6	6						6				6			6	
Family: Coenagrionidae																																				
Enallagma sp																			13				13													
Order: Plecoptera (stoneflies)																																				
Family: Perlodidae																																				
Isoperla sp			6				6																													
Skwala sp																																				
Order: Trichoptera (caddisflies)																																				
Family: Hydropsychidae																																				
Cheumatopsyche sp		19	75		106	63	50	163	150	38	119	150																								
Family: Hydroptilidae																																				
Agraylea sp																																				
Hydroptila sp																																				
Oxyethira sp																	6																			
Family: Lepidostomatidae																																				
Lepidostoma sp																																				
Family: Leptoceridae																																				
Ceraclea sp								13				6																								
Mystacides sp																			6	6																
Oecetis sp																																				
Family: Phryganeidae																																				
Agrypnia sp						13					6										6															
Family: Polycentropodidae																																				
Neureclipsis sp		975	1,150	1,038	1,338	2,288	1,556	3,513	3,238	838	1,281	2,056	13		19				13					6												
Polycentropus sp														6	6	19	6	6	6					19										6	6	
Phylum: Cnidaria																																				
Class: Hydrozoa																																				
Hydra sp																																				
Phylum: Mollusca																																				
Class: Bivalvia (clams)																																				
Family: Sphaeriidae		6				13								6		6				6																
Sphaerium sp												13																								
Class: Gastropoda (snails)																																				
Subclass: Prosobranchia																																				
Family: Valvatidae																																				
Valvata sincera																																			13	13
Subclass: Pulmonata																																				
Family: Lymnaeidae																																				
Lymnaea sp			13																										6							
Family: Physidae																																				
Physa sp	6			13					13		6			13							6			13						6			6			
Family: Planorbidae																																				
Armiger crista																																				
Gyraulus sp																	6															6			6	
Helisoma sp																	6	6															13			
Promenetus sp																																				
Phylum: Nematoda (roundworms) [A]										6	13	6		13																						
Terrestrial [A]																																				
Total	**25**	**2,013**	**2,094**	**1,800**	**2,138**	**4,788**	**2,650**	**5,175**	**4,775**	**1,875**	**2,375**	**3,194**	**206**	**369**	**294**	**569**	**481**	**531**	**281**	**194**	**269**	**225**	**181**	**275**	**106**	**206**	**169**	**125**	**131**	**125**	**600**	**363**	**275**	**331**	**306**	**156**

Table II-5
Benthic Invertebrate Taxonomy for the Giant Mine Invertebrate Community Survey, August 2006 (continued)

Major Taxon	Baker Creek (Near-field Exposure Area)																							
	E01-1	E01-2	E01-3	E01-4	E01-5	E01-6	E02-1	E02-2	E02-3	E02-4	E02-5	E02-6	E03-1	E03-2	E03-3	E03-4	E03-5	E03-6	E05-1	E05-2	E05-3	E05-4	E05-5	E05-6
Phylum: Annelida (segmented worms)																								
Class: Hirudinea (leeches)																								
Order: Pharyngobdellida																								
Family: Erpobdellidae																								
Nephelopsis obscura																								
Order: Rhynchobdellida																								
Family: Glossiphoniidae																								
Glossiphonia complanata																					6	6		
Helobdella fusca	6						13									6			50	13	6	6	25	6
Helobdella sp									6															
Helobdella stagnalis																								
Class: Oligochaeta (aquatic earthworms)																								
Family: Naididae		56		56																25		13		
Family: Tubificidae																			6		6			
Phylum: Arthropoda																								
Class: Arachnida																								
Order: Hydracarina (water mites)																								
Class: Crustacea																								
Subclass: Branchiopoda																								
Order: Cladocera (water fleas) [A]																								
Family: Chydoridae [A]													6											
Family: Macrothricidae [A]																								
Subclass: Copepoda																								
Order: Cyclopoida [A]	6																						6	
Subclass: Malacostraca																								
Order: Amphipoda (scuds)																								
Family: Gammaridae																								
Gammarus lacustris						6																		
Family: Hyalellidae																								
Hyalella azteca								6	6	63	19	25	6							6	6		6	6
Subclass: Ostracoda (seed shrimp)				13																				
Class: Insecta																								
Order: Coleoptera (beetles)																								
Family: Dytiscidae																								
Agabus sp																				6				
Family: Haliplidae																								
Brychius sp																6				13			6	
Haliplus sp																					6			
Order: Collembola (springtails)																								
Family: Isotomidae																								
Isotomus sp [A]						6																		
Order: Diptera (flies)																								
Family: Ceratopogonidae																					6	6		
Bezzia sp	6		19	19	6								6	13			31	6	13	6	6	25	6	
Probezzia sp																					6			
Family: Chironomidae																								
Subfamily: Chironominae/Tribe: Chironomini																								
Chironomus sp																								
Cladopelma sp		6	6																					
Cryptochironomus sp																					13			
Dicrotendipes sp		6		6			19				6	6	56	6	13	13	13	25	25	44	31	44	6	25
Endochironomus sp										6						6								
Glyptotendipes sp																						6		
Microtendipes sp																								
Nilothauma sp																								
Parachironomus sp										6														
Paratendipes sp			6																					
Phaenopsectra sp		6						6								6								
Polypedilum sp	6	6	13	19	6		13	25	6			6						13		13	13		6	19
Xenochironomus sp																								
Subfamily: Chironominae/Tribe: Tanytarsini	6					6																		
Cladotanytarsus sp				6																				
Micropsectra sp	25	13	31	6		13		19	13	13	44	81	50	31		13	19		13	31	25	56	69	125
Paratanytarsus sp		6	6	6	6						13	6					6							
Tanytarsus sp																								
Tribelos sp																								
Subfamily: Diamesinae																								
Potthastia longimanus																								
Subfamily: Orthocladiinae			6				13																	
Corynoneura sp	6																							
Cricotopus/Orthocladius Group	6			19			6			13						13	31		6		6			
Heterotrissocladius sp																					6	6		
Metriocnemus sp		6																						
Psectrocladius sp																					6			
Subfamily: Tanypodinae	19		88	6	13	31	25	31	19	50	75	75		13	50	19	31	13	6	50	13	19		44
Ablabesmyia sp	25		6			6	6	6	13	6		6	13	13	6		6		6	38	19	6		25
Labrundinia sp	6					6			6			6												

Table II-5
Benthic Invertebrate Taxonomy for the Giant Mine Invertebrate Community Survey, August 2006 (continued)

Major Taxon	Baker Creek (Near-field Exposure Area)																							
	E01-1	E01-2	E01-3	E01-4	E01-5	E01-6	E02-1	E02-2	E02-3	E02-4	E02-5	E02-6	E03-1	E03-2	E03-3	E03-4	E03-5	E03-6	E05-1	E05-2	E05-3	E05-4	E05-5	E05-6
Procladius sp		13		13		6	6		6				25						13	13				
Thienemannimyia sp																					13			
Family: Empididae																								
Hemerodromia sp												6								6				
Order: Ephemeroptera (mayflies)																								
Family: Baetidae																								
Acentrella sp										6					6									
Baetis sp																								
Callibaetis sp													6					6						
Family: Caenidae																								
Caenis sp							6			13		13						6						
Family: Ephemerellidae																								
Eurylophella sp									6															
Family: Heptageniidae																								
Heptagenia sp																								
Maccaffertium sp			13			6				6	6	6	31	13	50		13	31		6		19	19	19
Family: Leptophlebiidae																								
Leptophlebia sp	44	75	50	31	56	50	6	6	56	25	38	6	25	19	13	38	56	63	81	125	75	38	131	144
Order: Hemiptera (true bugs)																								
Family: Corixidae																								
Callicorixa alaskensis [A]																								
Sigara trilineata [A]																								
Order: Odonata (dragon & damselflies)																								
Family: Aeshnidae																								
Aeshna sp																								
Family: Coenagrionidae																								
Enallagma sp																								
Order: Plecoptera (stoneflies)																								
Family: Perlodidae																								
Isoperla sp																								
Skwala sp																								
Order: Trichoptera (caddisflies)																								
Family: Hydropsychidae																								
Cheumatopsyche sp																								
Family: Hydroptilidae																								
Agraylea sp																						6		
Hydroptila sp																								
Oxyethira sp																								
Family: Lepidostomatidae																								
Lepidostoma sp																								
Family: Leptoceridae																								
Ceraclea sp																								
Mystacides sp																								
Oecetis sp																				6				
Family: Phryganeidae																								
Agrypnia sp																				6		6		
Family: Polycentropodidae																								
Neureclipsis sp																								
Polycentropus sp	94	31	56	38	69	81	31	6	25	19	13	25	25	25	25	25	25	25	19	38	19	13	19	25
Phylum: Cnidaria																								
Class: Hydrozoa																								
Hydra sp								6			6		6											
Phylum: Mollusca																								
Class: Bivalvia (clams)																								
Family: Sphaeriidae																								
Sphaerium sp																								
Class: Gastropoda (snails)						6												6						
Subclass: Prosobranchia																								
Family: Valvatidae																								
Valvata sincera	56	13							13		6			6	38		6							
Subclass: Pulmonata																								
Family: Lymnaeidae																								
Lymnaea sp	6						13		6		25	19	6		13	6			6	38	6	13	6	
Family: Physidae																								
Physa sp							6			6		6			6		6							
Family: Planorbidae												6	6				6		6	6		13		
Armiger crista													6					6						
Gyraulus sp	44			6	6													13	6	25	13		6	19
Helisoma sp																								
Promenetus sp													6						6	13	13		31	25
Phylum: Nematoda (roundworms) [A]																	6		6		6	6		
Terrestrial [A]							6																	
Total	**363**	**238**	**300**	**244**	**163**	**225**	**169**	**113**	**181**	**231**	**250**	**300**	**281**	**138**	**219**	**150**	**256**	**213**	**269**	**525**	**325**	**306**	**344**	**481**

Table II-5
Benthic Invertebrate Taxonomy for the Giant Mine Invertebrate Community Survey, August 2006 (continued)

Major Taxon	Baker Creek/Yellowknife Bay (Far-field Exposure Area)																																
	E06-1	E06-2	E06-3	E06-4	E06-5	E06-6	E07-1	E07-2	E07-3	E10-1	E10-2	E10-3	E10-4	E10-5	E10-6	E11-1	E11-2	E11-3	E11-4	E11-5	E11-6	E15-1	E15-2	E15-3	E15-4	E15-5	E15-6	E16-1	E16-2	E16-3	E16-4	E16-5	E16-6
Phylum: Annelida (segmented worms)																																	
Class: Hirudinea (leeches)																																	
Order: Pharyngobdellida																																	
Family: Erpobdellidae																																	
Nephelopsis obscura																																	
Order: Rhynchobdellida																																	
Family: Glossiphoniidae																																	
Glossiphonia complanata										6																		6	6	6			
Helobdella fusca																				144													
Helobdella sp																				6													
Helobdella stagnalis																												13	69	63			
Class: Oligochaeta (aquatic earthworms)																																	
Family: Naididae																																	
Family: Tubificidae																																	
Phylum: Arthropoda																																	
Class: Arachnida																																	
Order: Hydracarina (water mites)														19		6	13	31	6	19	25							6					
Class: Crustacea																																	
Subclass: Branchiopoda																																	
Order: Cladocera (water fleas) [A]																																	
Family: Chydoridae [A]																																	
Family: Macrothricidae [A]																																	
Subclass: Copepoda																																	
Order: Cyclopoida [A]																																	
Subclass: Malacostraca																																	
Order: Amphipoda (scuds)																																	
Family: Gammaridae																																	
Gammarus lacustris				6					6	6	19															13			6	6			
Family: Hyalellidae																																	
Hyalella azteca					13	6	13	13	13		6	13				6	13	169	63	69	150	13		19			6	19	6	13	6	13	6
Subclass: Ostracoda (seed shrimp)																																	
Class: Insecta																																	
Order: Coleoptera (beetles)																																	
Family: Dytiscidae																																	
Agabus sp																																	
Family: Haliplidae																																	
Brychius sp																																	
Haliplus sp																																	
Order: Collembola (springtails)																																	
Family: Isotomidae																																	
Isotomus sp [A]																																	
Order: Diptera (flies)																																	
Family: Ceratopogonidae																																	
Bezzia sp																																	
Probezzia sp																																	
Family: Chironomidae																																	
Subfamily: Chironominae/Tribe: Chironomini																																	
Chironomus sp																																	
Cladopelma sp																																	
Cryptochironomus sp																																	
Dicrotendipes sp					6																						6						
Endochironomus sp					6			6																									
Glyptotendipes sp																38	13	19	31			6											6
Microtendipes sp																																	
Nilothauma sp																																	
Parachironomus sp																														6			
Paratendipes sp																																	
Phaenopsectra sp									6																							6	
Polypedilum sp											6																						6
Xenochironomus sp																																	
Subfamily: Chironominae/Tribe: Tanytarsini																																	
Cladotanytarsus sp																																	
Micropsectra sp		6	6		13	13												6				6											
Paratanytarsus sp																																	
Tanytarsus sp																																	
Tribelos sp																																	
Subfamily: Diamesinae																																	
Potthastia longimanus																																	
Subfamily: Orthocladiinae													6											6									
Corynoneura sp																																	
Cricotopus/Orthocladius Group																																	
Heterotrissocladius sp																																	
Metriocnemus sp																																	
Psectrocladius sp																																	
Subfamily: Tanypodinae								6								6	6	6							6			6				6	
Ablabesmyia sp																																	
Labrundinia sp																																	

Table II-5
Benthic Invertebrate Taxonomy for the Giant Mine Invertebrate Community Survey, August 2006 (continued)

Major Taxon	Baker Creek/Yellowknife Bay (Far-field Exposure Area)																																
	E06-1	E06-2	E06-3	E06-4	E06-5	E06-6	E07-1	E07-2	E07-3	E10-1	E10-2	E10-3	E10-4	E10-5	E10-6	E11-1	E11-2	E11-3	E11-4	E11-5	E11-6	E15-1	E15-2	E15-3	E15-4	E15-5	E15-6	E16-1	E16-2	E16-3	E16-4	E16-5	E16-6
Procladius sp																																	
Thienemannimyia sp																																	
Family: Empididae																																	
Hemerodromia sp																																	
Order: Ephemeroptera (mayflies)																																	
Family: Baetidae																																	
Acentrella sp																																	
Baetis sp	6																																
Callibaetis sp																				13													
Family: Caenidae																																	
Caenis sp																																	
Family: Ephemerellidae																																	
Eurylophella sp				6				13						6		6	6																
Family: Heptageniidae																																	
Heptagenia sp																		6															
Maccaffertium sp	294	263	213	413	331	406	144	150	150	163	206	169	163	181	175	169	181	163	113	119	138	6	38	6	106	50	100	113	69	75	88	169	106
Family: Leptophlebiidae																																	
Leptophlebia sp	119	156	231	144	106	88		25	56	156	119	81	138	163	144	150	200	194	250	175	169			6	31	25	31	113	81	69	44	50	6
Order: Hemiptera (true bugs)																																	
Family: Corixidae																																	
Callicorixa alaskensis [A]																								6									
Sigara trilineata [A]																																	
Order: Odonata (dragon & damselflies)																																	
Family: Aeshnidae																																	
Aeshna sp																					6												
Family: Coenagrionidae																																	
Enallagma sp																																	
Order: Plecoptera (stoneflies)																																	
Family: Perlodidae																																	
Isoperla sp																																	
Skwala sp							6	6								6																	
Order: Trichoptera (caddisflies)																																	
Family: Hydropsychidae																																	
Cheumatopsyche sp																																	
Family: Hydroptilidae																																	
Agraylea sp				6																													
Hydroptila sp																																6	
Oxyethira sp				6																													
Family: Lepidostomatidae																																	
Lepidostoma sp									6																								
Family: Leptoceridae																																	
Ceraclea sp																																	
Mystacides sp		6					6																										
Oecetis sp																																	
Family: Phryganeidae																																	
Agrypnia sp																																	
Family: Polycentropodidae																																	
Neureclipsis sp																																	
Polycentropus sp					6	6		6	6								13	6	13	6				6		6				6	6		
Phylum: Cnidaria																																	
Class: Hydrozoa																																	
Hydra sp																																	
Phylum: Mollusca																																	
Class: Bivalvia (clams)																																	
Family: Sphaeriidae				6			6									6				6	19												
Sphaerium sp																																	
Class: Gastropoda (snails)																																	
Subclass: Prosobranchia																																	
Family: Valvatidae																																	
Valvata sincera																																	
Subclass: Pulmonata																																	
Family: Lymnaeidae																																	
Lymnaea sp				6		6															6												
Family: Physidae																																	
Physa sp									13																	6		6					
Family: Planorbidae								13																									
Armiger crista																																	
Gyraulus sp				6				6																						6			
Helisoma sp																																	
Promenetus sp	6	19		13	6																												
Phylum: Nematoda (roundworms) [A]																																	
Terrestrial [A]											6																						
Total	**425**	**450**	**450**	**613**	**488**	**525**	**175**	**244**	**256**	**331**	**363**	**263**	**306**	**369**	**319**	**394**	**444**	**600**	**475**	**556**	**513**	**31**	**38**	**50**	**144**	**100**	**144**	**281**	**238**	**250**	**144**	**250**	**131**

Footnote: A These organisms were removed from the dataset before the indices were calculated because they are non-benthic organisms and are a sample artifact.
R = reference area; E = exposure area.
Results are reported as number per metre squared.

Table II-6
Quality Control Data for Re-sorted Samples

Site	% Sorting Efficiency
E02-A #3	[1-(0/(29+0))]*100 = 100
E03-B #1	[1-(0/(24+0))]*100 = 100
E05-B #3	[1-(0/(77+0))]*100 = 100
E10-B #1	[1-(0/(49+0))]*100 = 100
E15-A #1	[1-(0/(5+0))]*100 = 100
R06-B #2	[1-(2/(342+2))]*100 = 99.4
R08-A #3	[1-(0/(47+0))]*100 = 100
R09-B #2	[1-(0/(29+0))]*100 = 100
R16-B #1	[1-(0/(53+0))]*100 = 100

Average efficiency – 99.9%.
Note: % sorting efficiency = [1-(# in QA/AC re-sort / (# sorted originally + # QA/QC resort))]* 100

Table II-7
Biotic Indices for the Baker Creek Far-field Area Benthic Invertebrate Communities for the Indian and Northern Affairs Giant Mine, 2006

Area	Date	Replicate Station	Total Invertebrate Abundance[(a)]	Richness (Family Level)[(a)]	Simpson's Evenness Index [(a)]	Simpson's Diversity Index	Bray-Curtis Index[(a)]
Reference	30-Jun-06	R06	2142	9	0.58	0.70	0.37
		R07	3336	9	0.58	0.64	0.36
	4-Jul-06	R08	307	9	0.77	0.87	0.79
	30-Jun-06	R10	140	6	0.75	0.91	0.86
	4-Jul-06	R16	333	7	0.58	0.69	0.86
	Total		6,258	-	-	-	-
	Mean		1,252	8	0.65	0.76	0.65
	Median		333	9	0.58	0.70	0.79
	Standard Deviation		1,424	1.6	0.10	0.12	0.26
	Standard Error		260	0.3	0.02	0.02	0.05
	Minimum		140	6	0.58	0.64	0.36
	Maximum		3,336	9	0.77	0.91	0.86
Near-field	29-Jun-06	E01	253	6	0.73	0.88	0.78
		E02	206	8	0.63	0.73	0.81
		E03	207	8	0.74	0.86	0.82
		E05	371	10	0.75	0.83	0.73
	Total		1,038	-	-	-	-
	Mean		259	8	0.71	0.82	0.79
	Median		230	8	0.73	0.84	0.80
	Standard Deviation		77	2	0.06	0.07	0.04
	Standard Error		16	0	0.01	0.01	0.01
	Minimum		206	6	0.63	0.73	0.73
	Maximum		371	10	0.75	0.88	0.82
Far-field	29-Jun-06	E06	492	5	0.47	0.60	0.84
	30-Jun-06	E07	225	7	0.50	0.59	0.92
		E10	324	4	0.52	0.77	0.85
		E11	497	7	0.69	0.81	0.75
		E15	83	4	0.58	0.79	0.95
		E16	216	6	0.58	0.72	0.90
	Total		1,836	-	-	-	-
	Mean		306	5	0.75	0.56	0.90
	Median		274	5	0.75	0.60	0.91
	Standard Deviation		165	2.0	0.14	0.17	0.04
	Standard Error		29	0.4	0.03	0.03	0.01
	Minimum		83	1	0.40	0.00	0.81
	Maximum		497	8	0.99	0.77	0.98

Note: Indices were calculated on a per m2 basis; - = not applicable.
a = Key Descriptors to detect an effect; additional indices are considered for interpretation of any effect and its possible cause(s) (EC 2006).