



WOLVERINE PROJECT

MONITORING AND SURVEILLANCE PLAN

VERSION 2011-03

Prepared for:
Yukon Energy, Mines and Resources

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Table of Contents

1	Introduction	1
2	Water Monitoring.....	1
2.1	Surface Water Monitoring	1
2.1.1	Surface Water Quality Monitoring	2
2.1.2	Acute Lethality	7
2.1.3	Surface Water Flow Measurement.....	7
2.2	Groundwater Monitoring.....	8
2.2.1	Groundwater Quality Monitoring.....	9
2.2.2	Groundwater Level Monitoring	10
2.2.3	Piezometer Monitoring.....	10
3	Weather Monitoring Program.....	12
4	Tailings Storage Facility Monitoring	12
5	Engineering Inspections	13
6	Progressive Reclamation Effectiveness Monitoring Program	14
7	Bio-pass System.....	14
7.1	Proposed Location.....	14
7.2	Future Work	15
8	Other Monitoring Programs.....	15
8.1	Environmental Effects Monitoring	15
8.2	Sediment and Aquatic Life	16
8.3	Geochemical Testwork.....	17
8.4	Underground Mine Monitoring.....	17
8.4.1	Underground Water Quality Sampling	17
8.4.2	Paste Leachate Monitoring.....	18
8.4.3	Wash Stations	18
8.4.4	In-situ Geochemical Test Pads	18
9	Data Evaluation and Reporting	19
10	Summary	21
11	Works Cited	23

List of Tables

Table 2-1:	Surface Water Monitoring Sampling Sites, Frequency and Parameters during the Operations Phase	2
Table 2-2:	Water Quality Sampling Parameters	4
Table 2-3:	Monitoring Parameter Detection Limits	5
Table 2-4:	Surface Water Flow Monitoring Sites and Frequency.....	7
Table 2-5:	Groundwater Monitoring and Surveillance Program	9
Table 2-6:	Summary of Piezometer Installations	10
Table 4-1:	Surveillance Requirements for the Tailings Facility.....	13
Table 8-1:	Humidity Cells in Operation: Composition and Duration of Operation as of October 31, 2011	17
Table 10-1:	Summary of Monitoring and Surveillance Requirements for the Wolverine Project	21

List of Figures

Figure 2-1:	Monitoring Stations – Surface Water	6
Figure 2-2:	Flow Monitoring Level Logger Installation	8
Figure 2-3:	Groundwater Well Monitoring Station Locations	11
Figure 7-1:	Proposed Location of the Bio-Pass System in Wolverine Creek.....	15

List of Pictures

Picture 8-1:	Wolverine Project Geochemical Test Pads.....	19
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List of Appendices

Appendix A:	Environmental Effects Monitoring First Study Design – Revision 1
Appendix B:	Lorax Environmental Services: Baseline Characterization Summary Report

1 Introduction

This Monitoring and Surveillance Plan (Plan) summarizes the monitoring and reporting for Yukon Zinc Corporation's (YZC) Wolverine Project, as per *Quartz Mining License QML-0006* (QML) (YTG Energy, Mines and Resources, 2006). For a general description of the Wolverine Project, refer to the *General Site Plan V2011-05* (GSP). This Plan supersedes and updates the plan submitted in October 2011, as approved by the Yukon Government Department of Energy, Mines and Resources (EMR) in June 2010. This Plan describes monitoring requirements as per the QML during the operation and closure phases of the Wolverine Project, including:

- Surface water including water quality sampling, hydrology and acute lethality testing;
- Groundwater including water quality sampling, water levels and water table (piezometers);
- Weather including temperature, precipitation, snowpack, and evaporation;
- Sediment, benthos and periphyton;
- Tailings storage facility monitoring;
- Engineering inspections for physical stability;
- Environmental effects monitoring (as per *Metal Mining Effluent Regulations* (MMER, 2006));
- Geochemical testwork;
- Underground mine monitoring; and
- Reclamation program effectiveness monitoring and Bio-pass system design.

2 Water Monitoring

Surface and groundwater quality monitoring requirements for the Wolverine Project are dictated by *Type A Water Licence QZ04-065 (A-Licence)* (Yukon Water Board, 2007) and *Type B Water Licence QZ01-051 (B-Licence)* (Yukon Water Board, 2005). Monitoring under the B-Licence has been superseded by A-Licence monitoring requirements for surface water quality monitoring and infrastructure components, except for the waste rock storage pad. B-Licence monitoring will be discontinued once the waste rock storage pad is decommissioned. Monitoring under the A-Licence will continue for the mine operation phase, through any temporary closure phases, and into the permanent closure phase.

Water monitoring programs for surface and groundwater components, and their respective sampling station locations and monitoring frequencies, are outlined below.

2.1 Surface Water Monitoring

The surface water monitoring program for the Wolverine Project includes the monitoring of hydrology and water quality at eighteen locations in the Wolverine Lake, Go Creek and Money Creek watersheds, as well as from three water storage infrastructure locations. The program has been designed to meet the following objectives:

- Continue to provide stream flow data specific to the mine site operations focusing on Go Creek and Wolverine Creek watersheds;

- Document water quality in the receiving environment and verify compliance during discharge periods from the water treatment facility; and
- Provide data to update predictions of water quality impacts, and to support ongoing review of mine water and waste management strategies during operations and at closure.

2.1.1 Surface Water Quality Monitoring

Surface water quality monitoring locations, water quality frequency and sampling parameters are provided in Table 2-1 for monitoring during operations. Table 2-2 describes the sampling parameters required, Table 2-3 provides the monitoring parameter detection limits and Figure 2-1 shows the monitoring locations. During closure, water quality sampling stations and parameters remain the same as outlined in Table 2-1; however, the sampling frequency is reduced to annually for all stations. Monitoring station R1 represents the water treatment plant retention pond, and as the water treatment plant and corresponding retention pond have not yet been constructed, they are not shown on Figure 2-1, and the UTM co-ordinates are not provided in Table 2-1. Monitoring station WRSS is also not shown in Figure 2-1; however, it is at the approximate location of the “Wolverine Mine” star indicated on the figure.

Surface water quality sample collection will be conducted in accordance with the Environment Canada *Guidance Document for the Sampling and Analysis of Metal Mining Effluents* (Environment Canada, 2001). Data management will consist of incorporating field and laboratory results into a database, which will then be used for subsequent evaluation and reporting requirements (see Section 9).

Table 2-1: Surface Water Monitoring Sampling Sites, Frequency and Parameters during the Operations Phase

Station Name	Description	UTM Northing	UTM Easting	Water Quality Sampling Frequency	Water Quality Sampling Parameters ¹
Site Infrastructure:					
WRSS	Waste rock storage pad collection sump	440169	6808915	Weekly	LP, TM, DM
T1	Tailings Pond	442375	6808500	Monthly	FP, LP, TSS, CN, MA, NP, TM, DM
R1	Retention Pond			Daily when discharging	FP, LP, TSS, CN, MA, NP, TM, DM, DOC, Ra226
Wolverine Creek Watershed:					
W82	Upper Wolverine Creek	439402	6811087	Monthly	FP, LP, TSS, MA, NP, TM, DM, DOC
W9	Wolverine Creek at Little Wolverine	437950	6811140	Monthly	FP, LP, TSS, MA, NP, TM, DM, DOC
W1	Wolverine Lake outlet	429841	6819264	Monthly	FP, LP, TSS, MA, NP, TM, DM, DOC
L1	Little Wolverine Lake	437169	6812098	Monthly	FP, LP, TSS, MA, NP, TM, DM, DOC
W21	Nougha Creek at	439060	6829315	Monthly	FP, LP, TSS, MA, NP,

Station Name	Description	UTM Northing	UTM Easting	Water Quality Sampling Frequency	Water Quality Sampling Parameters ¹
	Campbell Highway				TM, DM
W8	Campbell Creek	437762	6811397	Monthly	FP, LP, TSS, MA, NP, TM, DM
Go Creek Watershed:					
W31	Go Creek above tailings facility	441219	6809593	Monthly	FP, LP, TSS, CN, MA, NP, TM, DM, DOC
W16	Go Creek below tailings facility	442534	6807974	Monthly	FP, LP, TSS, CN, MA, NP, TM, DM, DOC
W15	Hawkowl Creek above Go Creek	442711	6807705	Monthly	FP, LP, TSS, MA, NP, TM, DM
W81	Go Creek below Hawkowl Creek	442684	6807551	Monthly	FP, LP, TSS, MA, NP, TM, DM
W80	Go Creek	443547	6804142	M/Daily during discharging to Go Creek	FP, LP, TSS, MA, NP, TM, DM
W12	Go Creek above Money Creek	443152	6802216	Monthly	FP, LP, TSS, MA, NP, TM, DM
Money Creek Watershed:					
W14	Upper Money Creek	443433	6801983	Monthly	FP, LP, TSS, MA, NP, TM, DM
W22	Money Creek above Campbell Highway	465542	6807941	Monthly	FP, LP, TSS, MA, NP, TM, DM
W40	Money Creek below Campbell Highway	465540	6807931	Monthly	FP, LP, TSS, MA, NP, TM, DM
Road Route:					
W71	Pitch Creek below road crossing	452343	6810246	Monthly	FP, LP, TSS, MA, NP, TM, DM
W72	Light Creek	452185	6816625	Monthly	FP, LP, TSS, MA, NP, TM, DM
W73	Bunker Creek at road crossing	450430	6810105	Monthly	FP, LP, TSS, MA, NP, TM, DM

1. Sampling parameter acronyms are provided in Table 2-2.

Table 2-2: Water Quality Sampling Parameters

Acronym	Description	Required for Surface Water Monitoring	Required for Groundwater Monitoring
FP	Field physical parameters (temperature, conductivity, specific conductivity, pH)	✓	✓
LP	Laboratory physical parameters (temperature, conductivity ¹ , specific conductivity, pH)	✓	✓
TSS	Total Suspended Solids	✓	
CN	Total cyanide and WAD cyanide	✓	
MA	Major anions (Total Alkalinity, Total Acidity, Bromide, Chloride, Fluoride, Sulphate)	✓	✓
NP	Nutrient parameters (Ammonia-N, Nitrate-N, Nitrite-N, Dissolved ortho-phosphate)	✓	✓
TM	ICP Trace Metals Scan (Total Metals) plus Hardness. Metals include Al, Sb, As, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Mo, Ni, P, K, Se, Si, Ag, Na, Sr, Tl, V, Zn	✓	
DM	ICP Trace Metals Scan (Dissolved Metals). Metals include Al, Sb, As, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Mo, Ni, P, K, Se, Si, Ag, Na, Sr, Tl, V, Zn	✓	✓
DOC	Dissolved Organic Carbon	✓	
Ra 226	Radium 226	✓	

1. Accredited laboratories are only able to analyze for specific conductivity (conductivity standardized to a specific temperature), and as such, conductivity will not be measured in the laboratory.

Table 2-3: Monitoring Parameter Detection Limits

Physical Parameters	Detection Limit (mg/L)	Nutrient Parameters	Detection Limit (mg/L)	Total and Dissolved Metals (cont'd)	Detection Limit (mg/L)
Temperature	1	Ammonia Nitrogen	0.005	Iron (Fe)	0.001
Conductivity	1	Nitrate Nitrogen	0.002	Lead (Pb)	0.000005
Hardness	0.5	Nitrite Nitrogen	0.002	Magnesium (Mg)	0.05
Total Suspended Solids	4	Total Phosphate	0.005	Manganese (Mn)	0.00005
Total Dissolved Solids	10	Dissolved Ortho-Phosphate	0.001	Mercury (Hg)	0.00001
pH	0	Total and Dissolved Metals		Molybdenum (Mo)	0.00005
Turbidity	0.1	Aluminum (Al)	0.0002	Nickel (Ni)	0.00002
DOC	0.5	Antimony (Sb)	0.00002	Phosphorus (P)	0.002
Major Anions		Arsenic (As)	0.00002	Potassium (K)	0.05
Alkalinity-Total	0.5	Cadmium (Cd)	0.000005	Selenium (Se)	0.00004
Acidity-Total	0.5	Calcium (Ca)	0.05	Silicon (Si)	0.1
Bromide	0.1	Chromium (Cr)	0.0001	Silver (Ag)	0.000005
Chloride	0.5	Cobalt (Co)	0.000005	Sodium (Na)	0.05
Fluoride	0.01	Copper (Cu)	0.00005	Strontium (Sr)	0.00005
Sulphate	0.5	Iron (Fe)	0.001	Thallium (Tl)	0.000002
		Cobalt (Co)	0.000005	Vanadium (V)	0.0002
		Copper (Cu)	0.00005	Zinc (Zn)	0.0001

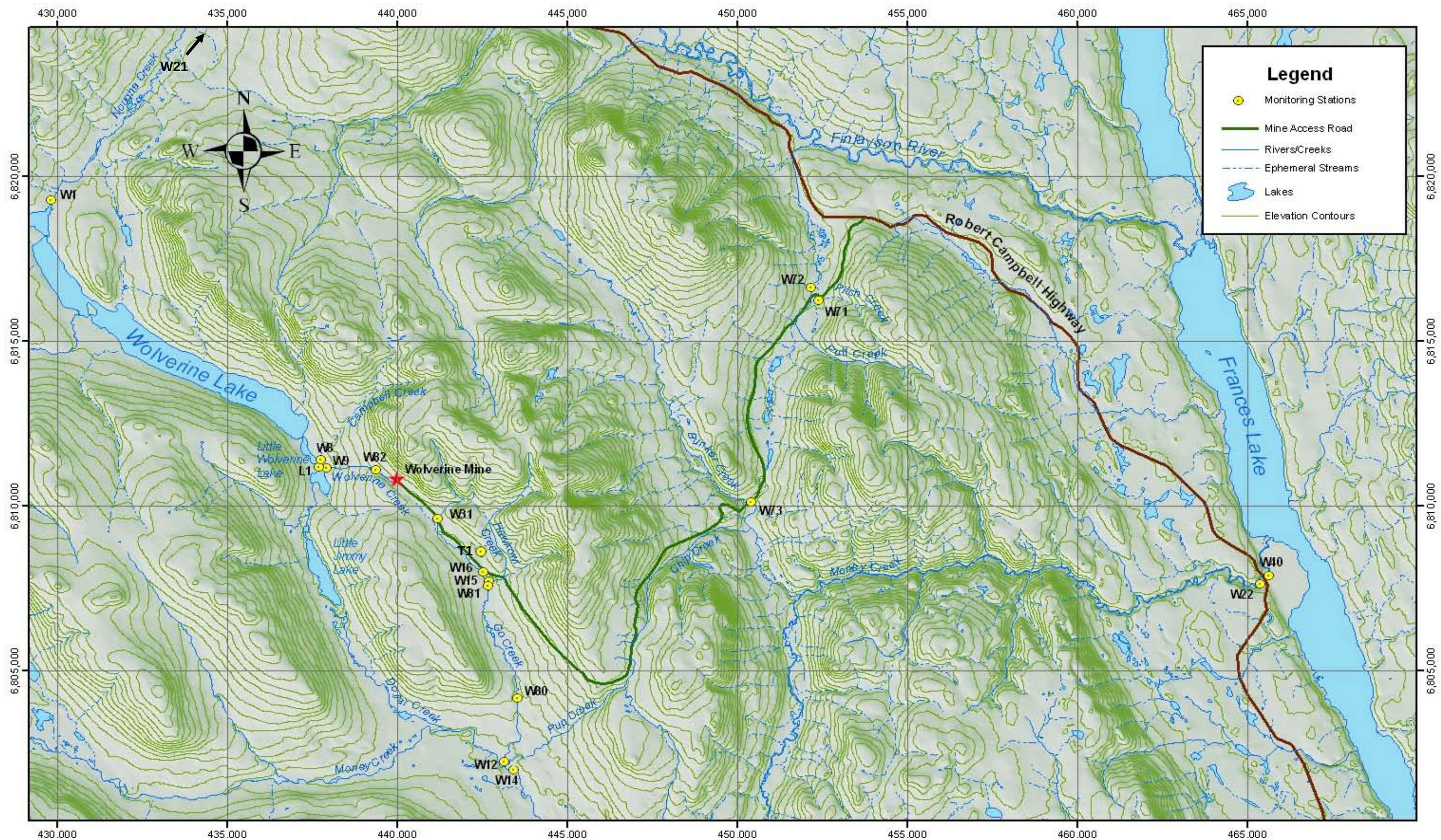


Figure 2-1: Monitoring Stations – Surface Water

2.1.2 Acute Lethality

A-Licence Condition 29 requires that *any discharge to a watercourse must meet a bioassay standard of a 96-hr LC50 bioassay using Rainbow Trout* (YWB, 2007). Also, *Metal Mining Effluent Regulations* require that acute lethality testing on Rainbow Trout and *Daphnia magna* is conducted at least once per month during effluent discharges, with samples taken greater than 15 days apart (MMER, 2006). Acute lethality testing is also required immediately if a deposit occurs outside the normal course of events, and twice per month if a sample of effluent is determined to be acutely lethal. Conversely, if 12 acute lethality tests conducted on effluent are determined to be not acutely lethal, the testing frequency can be reduced to once per quarter (MMER, 2006). To meet both A-Licence and MMER requirements, acute lethality for Rainbow Trout and *Daphnia magna* will be conducted monthly during months where discharge occurs.

2.1.3 Surface Water Flow Measurement

Surface water flow monitoring will be conducted at 14 locations monthly or continuously, as summarized in Table 2-4 and shown on Figure 2-1. Measurements will be taken in accordance with the Environment Canada *Guidance Document for the Flow Measurement of Metal Mining Effluents* (Environment Canada, 2001) for the flow monitoring outlined in Table 2-4. Continuous flow monitoring at the six creek locations is conducted via a water level logger, and a flow meter will be installed at station R2 to record the volume of discharge from the retention pond (not yet constructed).

Table 2-4: Surface Water Flow Monitoring Sites and Frequency

Station Name	Description	UTM Northing	UTM Easting	Water Flow Frequency
Site Infrastructure:				
T1	Tailings Pond	442375	6808500	Monthly (for water level)
R1	Retention Pond			Continuous (for water level)
R2	Discharge from Retention Pond			Continuous
Wolverine Creek Watershed:				
W82	Upper Wolverine Creek	439402	6811087	Continuous
W9	Wolverine Creek at Little Wolverine Wolverine	437950	6811140	Continuous
W21	Nougha Creek at Campbell Highway Highway	439060	6829315	Continuous
W8	Campbell Creek	437762	6811397	Monthly
Go Creek Watershed:				
W31	Go Creek above tailings facility facility	441219	6809593	Monthly
W16	Go Creek below tailings facility facility	442534	6807974	Monthly
W15	Hawkowl Creek above Go Creek Creek	442711	6807705	Monthly
W81	Go Creek below Hawkowl Creek Creek	442684	6807551	Monthly
W80	Go Creek	443547	6804142	Continuous

Station Name	Description	UTM Northing	UTM Easting	Water Flow Frequency
W12	Go Creek above Money Creek Creek	443152	6802216	Continuous
Money Creek Watershed:				
W22	Money Creek above Campbell Highway Highway	465542	6807941	Continuous

A Global Water WL16 Water Level Logger, installed at creek locations, is a submersible pressure transducer/datalogger combination housed in a weather-resistant cylindrical enclosure (Global Water, 2010). The loggers are installed in 2" PVC pipe buried in the creek bank, and fastened to the creek bed with reinforcing steel. Large holes are drilled in the PVC near the sensor location to eliminate velocity effects on the sensor, Figure 2-2 illustrates a surface water installation. At monitoring site W9, a Parshall flume is installed in the creek channel, to encourage the best possible flow measurements by the logger.

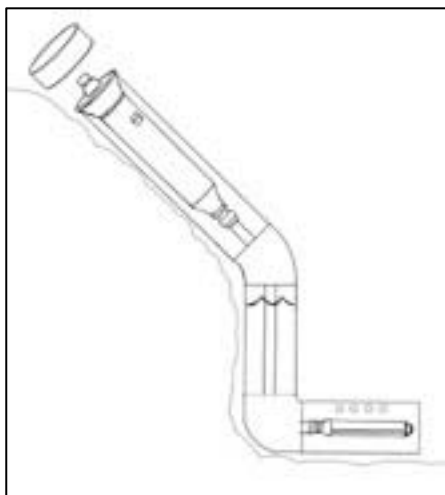


Figure 2-2: Flow Monitoring Level Logger Installation

Continuous data loggers are calibrated by manual hydrology measurements taken at the site at the same time as the data loggers are downloaded by site personnel.

2.2 Groundwater Monitoring

Monitoring of groundwater conditions around the Wolverine Mine focuses on groundwater conditions in the upper Wolverine Creek and Go Creek basins. More specifically, monitoring of groundwater occurs in those areas down gradient of the underground and process plant operations, immediately adjacent to Wolverine Creek, and down gradient of the tailings facility in the Go Creek watershed. Wells are used to monitor groundwater quality at various depths and in different geological units including the shallow alluvial/colluvial aquifer and the shallow, medium and deep bedrock units.

2.2.1 Groundwater Quality Monitoring

Groundwater quality monitoring is conducted at 24 nested wells, as per requirements outlined in the A-Licence Schedule A summarized in Table 2-5, and at locations shown on Figure 2-3. All groundwater sites are sampled quarterly during construction, monthly during operations, quarterly during temporary closure and annually during permanent closure. However, there is an opportunity to reduce groundwater monitoring frequency during operations once consistent groundwater quality results are proven.

Groundwater wells are sampled for field parameters, lab parameters, major anions, nutrient parameters and dissolved metals as outlined in Table 2-2 and analyzed at the detection limits shown in Table 2-3 above. Although total metals are required to be sampled for by the A-Licence, all groundwater is filtered prior to sampling due to sediment being a relic of well installation, and not representative of actual groundwater quality; hence total metals are not analyzed for.

Table 2-5: Groundwater Monitoring and Surveillance Program

Station Name	Description	Depth	UTM Northing	UTM Easting	Water Quality Sampling Frequency ¹	Water Quality Sampling Parameters ²
MW05-1A	Monitor upper reaches of Go Creek groundwater basin	22.9	440643	6810020	G	FP, LP, MA, NP, DM
MW05-1B		5	440642	6810021	G	FP, LP, MA, NP, DM
MW05-2A	To monitor potential impact of tailings facility	22.9	442285	6808037	G	FP, LP, MA, NP, DM
MW05-2B		5	442285	6808037	G	FP, LP, MA, NP, DM
MW05-3A	To monitor potential impact of underground and industrial complex	20	439837	6810758	G	FP, LP, MA, NP, DM
MW05-3B		4.5	439836	6810758	G	FP, LP, MA, NP, DM
MW05-4A		17.6	440076	6810553	G	FP, LP, MA, NP, DM
MW05-4B		3.9	440076	6810553	G	FP, LP, MA, NP, DM
MW05-5A		26.5	439617	6810926	G	FP, LP, MA, NP, DM
MW05-5B		4.4	439618	6810926	G	FP, LP, MA, NP, DM
MW05-6	To monitor upstream of tailings facility	12	441561	6809507	G	FP, LP, MA, NP, DM
MW05-7B	To monitor potential impact of tailings facility	4.6	442540	6808128	G	FP, LP, MA, NP, DM
MW06-8S	To monitor potential impact of underground mine	21.9	439349	6811193	G	FP, LP, MA, NP, DM
MW06-8M		82.3	439373	6811172	G	FP, LP, MA, NP, DM
MW06-8D		184.7	439338	6811201	G	FP, LP, MA, NP, DM
MW06-09S	To monitor groundwater quality on west side of Wolverine Creek (not affected by operations)	21.3	439967	6810547	G	FP, LP, MA, NP, DM
MW06-09M		80.4	439967	6810547	G	FP, LP, MA, NP, DM
MW06-10S	To monitor potential impact of	21.3	439975	6810678	G	FP, LP, MA, NP, DM
MW06-10M		104.3	439980	6810674	G	FP, LP, MA, NP, DM

Station Name	Description	Depth	UTM Northing	UTM Easting	Water Quality Sampling Frequency ¹	Water Quality Sampling Parameters ²
MW06-10D	underground mine	185	439980	6810674	G	FP, LP, MA, NP, DM
MW06-11S	and industrial	21.3	439733	6810827	G	FP, LP, MA, NP, DM
MW06-12S	complex	21.7	440200	6810468	G	FP, LP, MA, NP, DM
MW08-13	To monitor potential impact of tailings facility downstream of seepage dam	2.4	442545	6808068	G	FP, LP, MA, NP, DM
MW08-14	To monitor upstream of tailings facility	10.4	442071	6809030	G	FP, LP, MA, NP, DM

1. G = quarterly during construction, monthly during operations, quarterly during temporary closure and annually during permanent closure.
2. Total metals are required by the A-Licence; however, as groundwater is filtered prior to sampling to eliminate impurities associated with well installation, total metals are not analyzed for by this program.

2.2.2 Groundwater Level Monitoring

Static water levels are measured manually prior to water quality samples being taken. Continuous water level measurements are collected by loggers installed in each of the groundwater wells. The loggers are self contained water level dataloggers that include a pressure transducer, temperature sensor, lithium battery and internal datalogger that can hold up to 40,000 data points (Solinst, 2010). Similarly to the surface water loggers, the groundwater loggers are calibrated via the manual measurements, and downloaded prior to sample collection.

2.2.3 Piezometer Monitoring

Four vibrating wire (VW) piezometers capable of measuring porewater pressure and temperature were installed at two locations (PZA and PZB) in April 2005. Both locations have one shallow and one deep piezometer; details of the four VW piezometer installations are summarized in Table 2-6. The piezometers measure the water table above the underground mine and results reveal the effect of underground mining on the water table.

Table 2-6: Summary of Piezometer Installations

Borehole	UTM Northing	UTM Easting	Ground Surface Elevation (m asl)	Borehole length (m)	VW Piezometer Installation Elevation (m asl)	
					Shallow	Deep
PZA	439759	6811293	1393	194.2	1362.5	1243
PZB	439993	6811020	1389	198.4	1329.2	1280.7

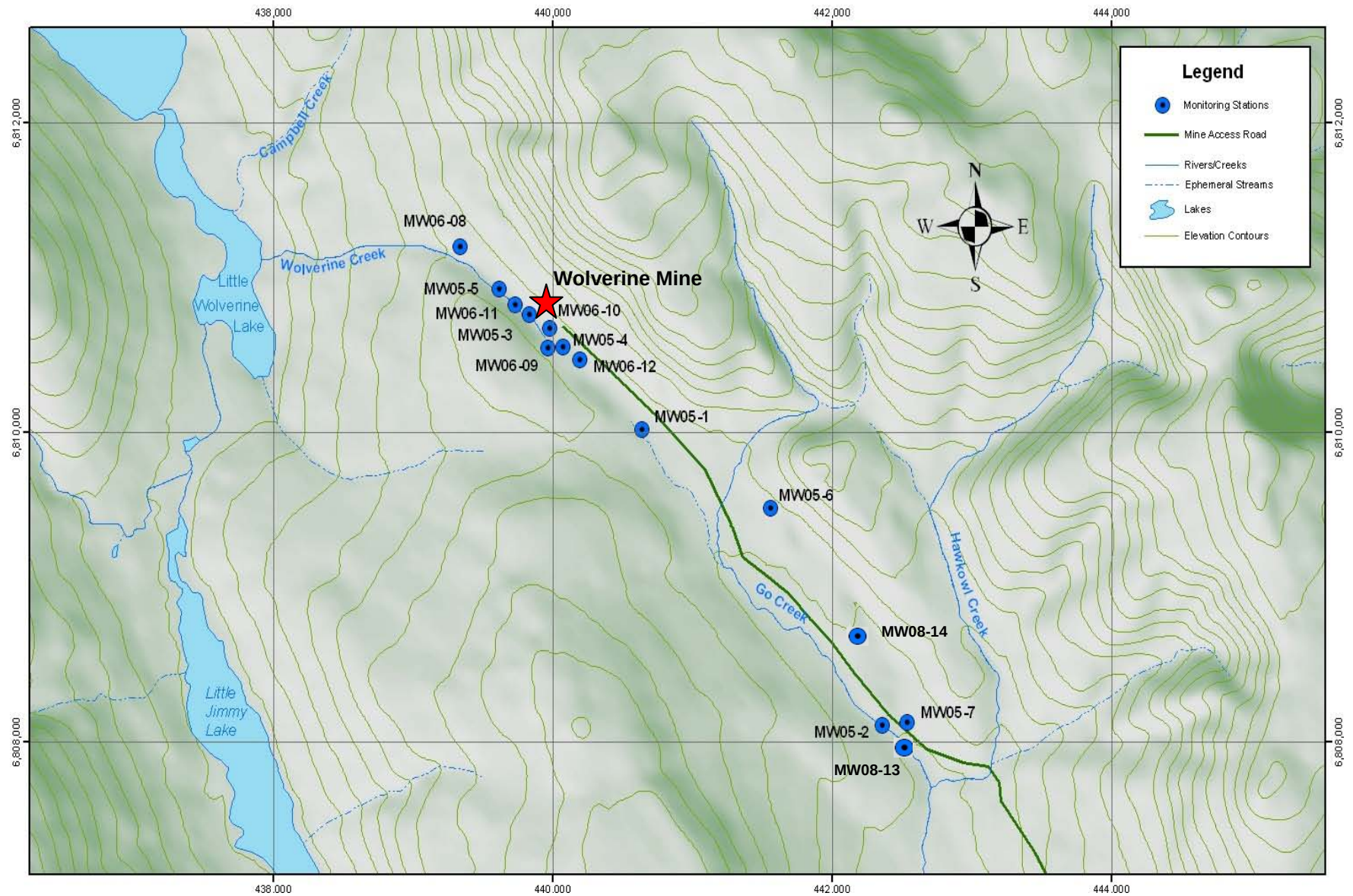


Figure 2-3: Groundwater Well Monitoring Station Locations

3 Weather Monitoring Program

In May 2006, an automated HOBO® Onset Weather Station was installed on the southwest side of the airstrip. The weather station is on a 3 m tripod tower and has the following data collection features:

- Temperature;
- Relative humidity;
- Rain gauge;
- Solar radiation in and out;
- Wind speed and direction; and
- Barometric pressure.

Climate station data has been logged continuously from this station every 10 minutes since May 20th, 2006, and will continue to be the primary weather monitoring location throughout the life of mine. Data is downloaded monthly, and the data is examined at that time to ensure the station is working properly.

Snowpack measurements will be taken in late winter (end of March) to determine the snowpack at maximum depth and again in spring (end of April) to determine the maximum density values.

4 Tailings Storage Facility Monitoring

Monitoring of the tailings facility will be carried out during operations and closure periods (temporary and permanent and post-closure). An operations, maintenance and surveillance (OM&S) manual was submitted to EMR July 2010, and approved in August 2010. The OM&S manual details the facility components, regulatory requirements, operation parameters, maintenance and surveillance programs, as well as an emergency response plan for the facility. The requirements for surveillance and monitoring at the tailings storage facility are summarized in Table 4-1, and details of the monitoring are provided in the OM&S.

The instrumentation installed at the tailings facility starter dam consists of:

- Two inclinometers located in the dam downstream shell to monitor deformation in the embankment and foundation, for confirming dam stability. They will be protected from damage during construction and maintained for monitoring periodically and after a seismic event or for a comprehensive dam safety review.
- Four piezometers located in the dam downstream shell to monitor dam fill and foundation phreatic levels.
- Two survey monuments located on the crest/downstream slope to monitor potential deformation.

Table 4-1: Surveillance Requirements for the Tailings Facility

Surveillance	Frequency
<i>Routine Inspection</i>	
Dam and Liner	Min. Weekly
Diversion ditches	Min. Weekly
Seepage collection system	Min. Weekly
Spillways	Min. Weekly
Pipelines	Min. Weekly
<i>Annual Inspection</i>	Annually
<i>Event Driven Inspection</i>	Following unusual event
<i>Comprehensive Review</i>	Every 7 years & prior to decommissioning
<i>Tailings Pond Monitoring</i>	
Inflows, Outflows, Condition	Monthly
Topography	Annually
Bathymetry	Annually
<i>Instrumentation</i>	Monthly

5 Engineering Inspections

Engineering inspections are required under the QML and under the A-Licence.

Section 10.1 of the QML (EMR, 2006) states that:

The Licensee must ensure that an annual physical inspection is conducted by an engineer by July 1st of each year of all of the structures, works and installations located at the site, including:

- a) Seepage collections dams, tailings impoundment structures;*
- b) Waste rock dumps, including any temporary waste rock dumps;*
- c) Ore stockpiles;*
- d) Temporary ore stockpiles;*
- e) Diversion structures (channels and dams);*
- f) Mill;*
- g) Mine;*
- h) Camp infrastructure; and*
- i) Any other engineered structures, works or installations associated with the Undertaking.*

Section 41 of the A-Licence (YWB, 2007) states that:

Monitoring and inspection of all water retaining structures shall be carried out by a Professional Engineer licenced to practice in Yukon and in accordance with the monitoring plan submitted as part of the Application. A report on the monitoring and inspection, prepared by the Professional Engineer, shall be submitted as a part of each annual report. The report shall document the inspection locations and methodologies, the results of the inspection, all problems identified, and remedial measures recommended. The status of any remedial measures recommended in the previous year's report shall

be appended to the report together with an explanation regarding any recommendation not implemented.

The QML requires that the inspection report is submitted to EMR within 45 days of the inspection (paragraph 10.2). Both licenses require that immediate action is taken on any recommendations made by the engineers report. The actions taken based on the inspections will also be summarized in both annual reports.

Detailed requirements for the engineering inspections for the tailings storage facility and associated infrastructure (seepage dam and diversion ditches) will be contained in the tailings storage facility OMS manual (Section 4 above).

6 Progressive Reclamation Effectiveness Monitoring Program

Reclamation and closure activities for the Wolverine Project are outlined in *Reclamation and Closure Plan V2009-03* (April 2010). This plan will be updated every two years to reflect activities required for successful passive closure of the mine. A brief outline of the Reclamation Research Program is provided within the *Reclamation and Closure Plan V2009-03* and specific details of the program are currently in development, and once finalized will be submitted as an addendum to this Plan.

7 Bio-pass System

The purpose of the bio-pass system is to ensure that discharge from backfilled mine workings does not affect the environmental integrity of Wolverine Creek and Little Wolverine Lake during the closure phase of the Wolverine Project. The bio-pass is a passive biological reactor system where dissolved selenium is reduced to solid phase elemental selenium and metals are precipitated as metal sulphides via microbial processes. The bio-pass will collect groundwater that naturally discharges to Wolverine Creek and that is potentially high in selenium and other metal concentrations derived from mine contact.

7.1 Proposed Location

In 2006, 2009 and 2010, water quality and sediment (2009/2010 only) sampling was conducted along a transect of Wolverine Creek to determine where groundwater intercepting the ore body (assumed to be elevated in metals) was appearing in the creek, and if the sediment in the creek bed was also elevated in metal concentrations. The analytical results were used in determining the proposed location of the bio-pass system in the creek channel, shown in Figure 7-1. The system will be installed at the headwaters of Wolverine Creek, and the original creek channel will be diverted along the system, also shown in Figure 7-1.

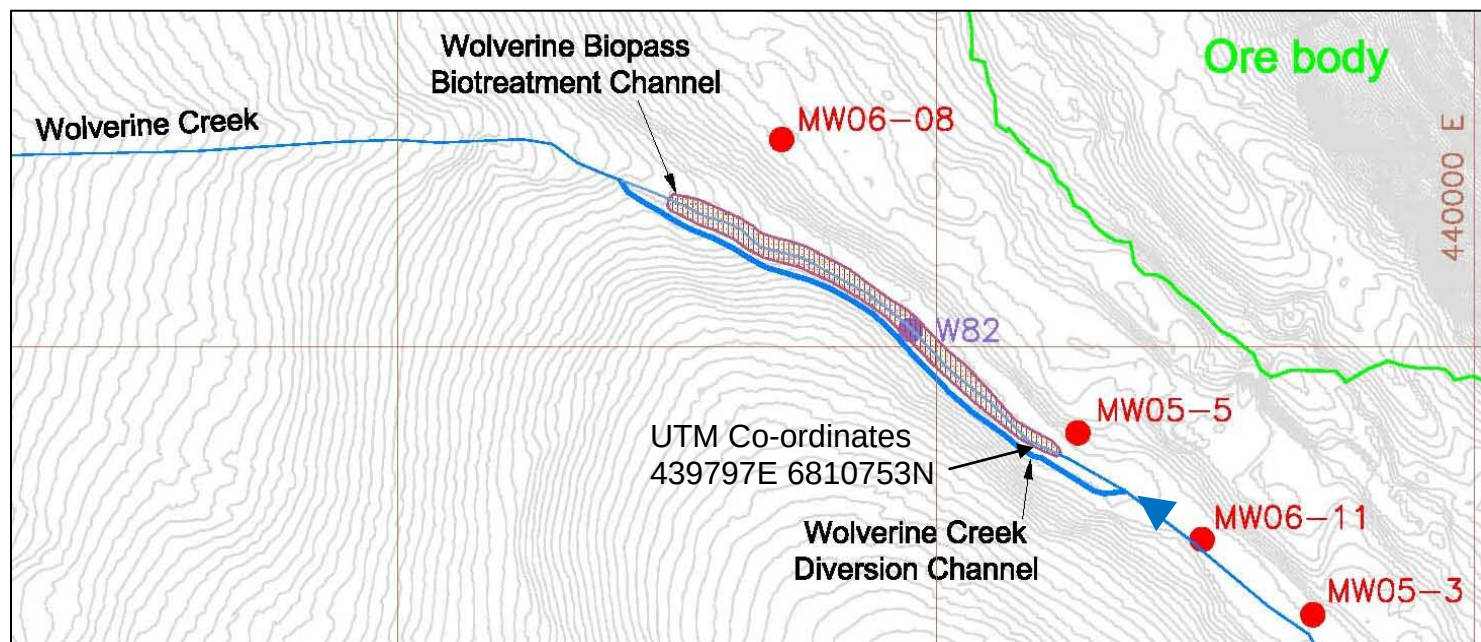


Figure 7-1: Proposed Location of the Bio-Pass System in Wolverine Creek

7.2 Future Work

Preliminary testwork to establish the location of the bio-pass within the Wolverine Creek channel, quantify the desired water quality criteria for the treated groundwater discharge, quantify sediment and water quality metal concentrations in the bio-pass channel, and establish a source of substrate and contaminated water to perform the bench scale testwork was completed in 2010.

The bench scale testwork for the bio-pass project has been conducted, and a summary report of the test work will be presented as an addendum to this plan in 2012.

Design of the bio-pass system, maintenance, a long term monitoring and management plan and an implementation schedule for the bio-pass construction and creek diversion will be finalized in 2012. Construction of the bio-pass is projected to be in 2015.

8 Other Monitoring Programs

Although not required by EMR under the QML, there are other ongoing monitoring programs that are pertinent to this Plan, including: Environmental Effects Monitoring (under the *Metal Mining Effluent Regulations*), sediment and aquatic life monitoring, geochemical testwork and underground mine monitoring studies. Details of these programs are provided below.

8.1 Environmental Effects Monitoring

On June 3, 2009, the Wolverine Project was designated as a “mine under development” as defined in sections 1 and 2 of the *Metal Mining Effluent Regulations* (MMER, 2006). Consequently, YZC was required to submit the Environmental Effects Monitoring (EEM) first study design by June 3, 2010.

The *First Study Design* was submitted to the Director of the Environmental Programs Branch, the Department of the Environment - Environment Canada and the Government of the Yukon, as per Schedule 6.1 of the MMER (MMER, 2006) on July 3, 2010. The *First Study Design* is provided in Appendix A and outlines the site characterization and the biological monitoring study details. As effluent discharge is not predicted to occur until 2013, effluent and water quality monitoring requirements, including sublethal toxicity testing, has not been outlined in the *First Study Design*, but will be included in an update to this report, once discharge commences.

Humidity Cell	Composition	Date Started	Total operating weeks (as of October 31, 2011)
HC4	Rhyolite/rhyolite fragmental	22-Dec-05	307
HC6	Calcite-pyrite exhalite	22-Dec-05	307
HC7	Carbonaceous argillite	22-Dec-05	307
HC10	Non-carbonaceous argillite	12-Jan-06	304
HC21	NP depleted ore	23-May-06	285
T1	Paste backfill	23-May-06	285
T2	Paste backfill	23-May-06	285
OC	Tailings - Overall ore composite	6-Jun-05	335 – to be decommissioned
OD	Tailings - Overall diluted ore composite	22-Jul-05	328 – to be decommissioned

8.2 Sediment and Aquatic Life

There are no monitoring requirements for sediment quality and aquatic life under the A-Licence; however, as previously discussed, effluent quality and receiving environment quality will be subject to EEM under MMER. The EEM program (Section 8.1) will monitor trends in metals levels in waters and stream sediments.

In conjunction with stream sediment quality sampling, monitoring of stream benthic invertebrates will be performed at the stations outlined in the *EEM First Study Design* (Appendix A) – W12, W13, W16 and W76. Sediment and benthos will be sampled in September 2011 and September 2013, to meet the requirements of the *First Study Design*.

For benthic invertebrates, samples will be collected from riffle habitat using a Hess sampler following standard methods described in the *First Study Design*. Five samples will be collected at each site, with each sample being a composite of three Hess settings. Samples will be preserved in formalin.

A fish population study is also required as part of the *EEM Study Design*, and will be conducted in July and August 2013.

Periphyton sampling is not required as part of the *Environmental Effects Monitoring*; however, periphyton sampling will continue to be collected every third year during operations, in opposition to small mammals and vegetation sampling (for details see the *Wolverine Project Wildlife Protection Plan V2009-01*). Samples will be collected from natural substrates in riffle habitat using standard methods (RISC, 1997). Samples will be collected by scraping a known surface area of substrate. Samples will be collected in triplicate and analyzed for biomass (chlorophyll *a* and phaeopigment)

and taxonomy. Biomass samples will be filtered through a 0.45 µm filter and taxonomy samples will be preserved in Lugol's solution.

8.3 Geochemical Testwork

Humidity cell testwork is the recommended kinetic test for predicting primary reaction rates under aerobic weathering conditions, and measured rates can be used to estimate the time to mineral exhaustion (Price, 1997). The testwork consists of a material sample contained in a PVC column being exposed to three days of dry air, three days of humid air, and one day of water washing (Mills, 1998). The leachate from the water washing is then analyzed for the parameters outlined in Table 2-3.

A total of 28 humidity cells containing various mine rock, waste rock and milling products (paste backfill and tailings) were initiated in 2005 and 2006. There are currently nine cells in operation as shown in Table 8-1 – for information on the majority of the decommissioned cells (i.e., the 19 decommissioned cells), refer to the *QML 2009 Annual Report*. Tailings humidity cells OC and OD are to be decommissioned in winter 2011, with the results presented in the *QML 2011 Annual Report*.

Table 8-1: Humidity Cells in Operation: Composition and Duration of Operation as of October 31, 2011

Humidity Cell	Composition	Date Started	Total operating weeks (as of October 31, 2011)
HC4	Rhyolite/rhyolite fragmental	22-Dec-05	307
HC6	Calcite-pyrite exhalite	22-Dec-05	307
HC7	Carbonaceous argillite	22-Dec-05	307
HC10	Non-carbonaceous argillite	12-Jan-06	304
HC21	NP depleted ore	23-May-06	285
T1	Paste backfill	23-May-06	285
T2	Paste backfill	23-May-06	285
OC	Tailings - Overall ore composite	6-Jun-05	335 – to be decommissioned
OD	Tailings - Overall diluted ore composite	22-Jul-05	328 – to be decommissioned

8.4 Underground Mine Monitoring

This section outlines monitoring programs that will be conducted in the underground mine for the purposes of refining the geochemical rates and estimates of mine water quality at closure as required by QML Section 8.6 (h) (EMR, 2006). These programs include sampling of the contact water and groundwater discharge into the mine workings, collection of the leachate from paste backfilled mine stopes, washing of select exposed rock or paste backfilled faces and operation of in-situ geochemical test pads.

8.4.1 Underground Water Quality Sampling

Water quality samples from the underground test mine were a requirement of the B-Licence (YWB, 2005). As the majority of water storage and treatment infrastructure is now permitted

under the A-Licence (YWB, 2007), with the exception of the temporary waste rock and ore storage facility, sampling under the B-Licence has been discontinued. Hence, underground mine sampling will continue monthly, to provide updated water chemistry associated with the underground mining activities. Samples are taken from underground collection sumps, or from mine effluent pumped to a surface sump and analyzed for the parameters outlined in Table 2-3.

8.4.2 Paste Leachate Monitoring

The purpose of the paste leachate monitoring program is to verify the assumptions made in the mine water quality model at closure concerning paste backfilling. Once paste backfilling of mined-out stopes has commenced, monitoring of the leachate quality and volume of leachate emanating from these stopes will commence. The leachate will be analyzed for all of the parameters outlined in Table 2-3.

The paste backfill monitoring program consists of four tasks:

1. Continued operation of two paste backfill humidity cells to provide estimates of contaminant loadings ($\text{mg}/\text{m}^2/\text{wk}$) (see Section 8.3);
2. Construction and operation of an on-site test pad to expose a 50-100 kg block of paste to the natural weathering (see Section 8.4.4 for existing test pad details);
3. Collection of seepage (if available) from selected paste backfilled stopes in the underground mine; and
4. Operation of wall wash stations on paste backfilled stope faces (see Section 8.4.3).

8.4.3 Wash Stations

As outlined in the AMEC Earth and Environmental report *Wolverine Project Predicted Water Quality of Underground Workings at Closure*, provided in the Appendix D of the *Revised Documentation in Support of Water Use Application QZ04-065* (YZC, 2007), laboratory determined leaching rates can significantly overestimate the degree of metal release from materials in the field. To account for this, future measurements of field kinetic rates will be carried out using wall washing stations and in-situ geochemical test pads (see Section 8.4.4).

The wall washing technique can be used to measure unit-area geochemical reaction rates ($\text{mg}/\text{m}^2/\text{week}$) and concentrations (mg/L) from tabular surfaces (Morin & Hutt, 2006). The rates can then be applied to the total amount of reactive surface. The methodology for performing wall washing is outlined by Price (1997), and wall washing will be performed quarterly on selected walls within the mine that represent dominant rock types (e.g., waste and ore) and paste backfilled stopes.

8.4.4 In-situ Geochemical Test Pads

On-site field test pads are a recommended tool for monitoring the drainage chemistry resulting from mine waste and geological materials (Price, 1997). Test pads assembled at the Wolverine Project, as shown in Picture 8-1, consist of plastic 220 L barrels cut in half and open to the natural environment. The barrels drain into sealed 20 L buckets that collect runoff from the barrel. Two of the test pads contain 100% ore, two contain 50% ore and 50% waste, and one is empty, thereby functioning as a control and collecting only rainwater.

In 2012, four new test pads will be added to monitor the leachate of the paste backfill (as described in Section 8.4.2), and the leachate from the mill tailings, following the decommissioning of the tailings humidity cells (see Section 8.3). Each paste and tailings test pad will be constructed in duplicate, similarly to the already existing ore and waste test pads.

Initial ABA analysis on the waste rock and ore samples was conducted prior to commencement of the test pad operation. The test pads are monitored weekly during the snow free period to ensure the water collection buckets have adequate capacity. Water quality samples are taken from the collection buckets when there is enough runoff to fulfill analytical requirements for the parameters outlined in Table 2-3. The volume of water collected in the buckets is recorded prior to sampling, and the buckets emptied following sampling to allow for further collection of runoff. The metal loadings are calculated based on amount of material, amount of collected water, collection time and weather conditions.



Picture 8-1: Wolverine Project Geochemical Test Pads

9 Data Evaluation and Reporting

Section 10.4 of the QML requires that *the Licensee must evaluate data gathered as a result of implementation of the Monitoring and Surveillance Plan referred to in paragraph 12.2 on a semi-annual basis, and take immediate steps to address any results from the monitoring and surveillance activities that indicate any change in environmental performance of the Undertaking or non-compliance with the Act, the Regulations, this License, or any of the plans listed in Schedule C (EMR, 2006).*

Also, section 10.5 of the QML requires that *annually, on or before March 31st of each year commencing in 2008, the Licensee must submit a written report covering the period of January 1st to December 31st of the prior year to the Chief (EMR, 2006).*

Therefore, the results obtained from the monitoring programs outlined above will be evaluated bi-annually, and reported annually. Data analysis will consist of a comparison of results to the baseline results for samples collected at the Wolverine Project 1996-2008 inclusively. The 1996-2008 results were compiled into a document entitled “Baseline Characterization Summary Report” prepared by Lorax Environmental Services, which is provided in Appendix B, and the data contained therein is referred to as baseline data.

Surface water monitoring reports will include water quality summaries for the reporting period and comparisons to baseline data, in tabular and/or graphical formats. Compiled water quality data will be compared to the baseline average and 95th percentile. Hydrology monitoring for the period will include manual measurements, stage discharge curves for the calibration of installed data loggers, continuous hydrographs representing the recorded data, and monthly average hydrographs, including historical data for hydrological comparisons.

Groundwater data reports will include a comparison of water quality to baseline water quality (average and 95th percentile values) and water level elevation versus time graphs. The piezometer (water table measurements above the underground mine) water level data will be compiled into summary water level graphs that plot water table height by date, to establish if there is a correlation between mine activities and water table height.

Sediment quality data and benthic invertebrate data will be presented in *Interpretative Reports*, required to be submitted to Environment Canada following collection of the data outlined in the *First Study Design*. Periphyton results will be presented in the QML Annual reports, and will be compared to the periphyton data presented in Appendix B and that collected in 2010.

Weather data reported in the QML Annual Report will consist of the following:

- The minimum and maximum recorded temperatures, as well as seasonal trends and the data for the year;
- Precipitation data as monthly precipitation totals, and plotted against the date;
- Maximum snow water equivalent (SWE), which occurs at some point between maximum depth and maximum density. Mean annual SWE at Wolverine is calculated by subtracting sublimation from the net SWE.
- Evaporation figures are estimated from the Penman Combination Equation (Penman, 1963) using on-site temperature, relative humidity, wind speed and solar radiation:

Where,

E = evaporation rate in units of depth per time

Δ = slope of the saturation vapor pressure vs. temperature relationship at T_a

K = short wave radiation net input

L = longwave radiation net input

γ = psychrometric constant $\approx 0.066 \text{ kPa } ^\circ\text{C}^{-1}$

λ_v = latent heat of vaporization = 2.45 MJ kg^{-1}

ρ_w = density of water = 1000 kg m^{-3}

K_E = mass transfer coefficient

v_a = velocity of air

e_a^* = saturation vapor pressure at atm temp

e_a = water vapor pressure in atm

Tailings storage facility data evaluation and reporting will summarize the results of the monitoring program provided in Section 4; including an annual update of the site water balance, results of the routine, intermediate, and comprehensive surveillance reviews, and data acquired from instrumentation installed in the dam and vicinity.

Recommendations made in the report summarizing the engineering inspections of the tailings storage dam, seepage dam and all other on-site structures, including the mill, mine and associated infrastructure will be acted on immediately following the inspection. The results of the inspections and subsequent actions taken will be summarized in the QML annual report.

Reclamation activities to be undertaken in the operations phase of the Wolverine Project include a reclamation effectiveness monitoring program and bio-pass system design, field test trial and full scale implementation program. The on-going activities relating to these two programs will be summarized in the annual report.

The results of other monitoring programs conducted at the Wolverine Project, but not required under the QML, including the Environmental Effects Monitoring program, geochemical testwork program, and underground mine monitoring program, will also be summarized in the annual report. Humidity cell results are reviewed by-annually and summarized annually by Marsland Environmental Associates for the tailings cells and by Amec Earth and Environmental for all other humidity cells. The annual reports provided by these consultants are provided in the QML annual report. Amec Earth and Environmental will also incorporate the results of the underground mine monitoring program to update the underground mine water quality model.

10 Summary

This Plan summarizes the requirements for monitoring and surveillance required during the operations and closure phases of the Wolverine Project as per Quartz Mining License QML-0006, Type A Water Licence QZ04-065 and Type B Water Licence QZ01-051 (limited to the waste rock pad infrastructure only). The Plan outlines monitoring programs to be conducted for surface water, groundwater, weather, and the tailings storage facility, plus engineering inspections and reclamation research programs as per QML-0006. Other programs including Environmental Effects Monitoring, sediment and aquatic life, and underground mine monitoring are also described.

Table 10-1 summarizes the monitoring requirements for the Wolverine Project through the operation and closure periods. Data acquired from the above programs will be compiled bi-annually, and reported annually in the QML Annual Report (due March 31 of the subsequent year).

Table 10-1: Summary of Monitoring and Surveillance Requirements for the Wolverine Project

Requirement	Data Logger	Monitoring Frequency	
	Recording Frequency	Operations	Closure
Water Monitoring			
Surface WQ	-	Monthly	Annually ¹ .
Surface flow	Hourly	Monthly	Annually ¹ .
Acute lethality	-	Monthly during discharge	-
Groundwater WQ	-	Monthly	Annually ¹ .
Groundwater level	Hourly	Monthly	Annually ¹ .
Piezometer	Hourly	Monthly	Annually ¹ .
Weather Station			
Snowpack	Every 10 minutes	Monthly	Annually ¹ .
	-	End of March & April	End of March & April
Tailings Storage Facility			
<i>Routine Inspection</i>			
Dam and Liner	-	Weekly	
Diversion ditches	-	Weekly	
Seepage collection system and spillways	-	Weekly	

Requirement	Data Logger	Monitoring Frequency	
	Recording Frequency	Operations	Closure
Pipelines	-	Weekly	
<i>Event Driven Inspection</i>	-	Following unusual event	
<i>Comprehensive Review</i>	-	Every 7 years & prior to decommissioning	
<i>Tailings Pond Monitoring</i>			
Inflows, Outflows, Condition	-	Monthly	
Topography	-	Annually	
Bathymetry	-	Annually	
<i>Instrumentation</i>	-	Monthly	
Engineering Inspection	-	Annually	Annually
Reclamation Effectiveness	To be defined by Reclamation Research Program		
Biopass			
Bench-scale testwork	-	2010	-
Testwork under site conditions	-	2012	-
Long-term plan design	-	2013	-
Construction of bio-pass	-	2015	-
Effluent Monitoring	To be defined by EEM subsequent study design		
Sediment & Aquatic life			
Sediment and Benthos	-	September 2011 & 2013	Not required
Periphyton	-	September 2011 then once every 3 years	Not required
Fish Population Study	-	July/August 2013	Not required
Geochemical testwork	-	Weekly flushing and laboratory analysis every 4 weeks	Not required
Underground mine monitoring			
Underground water quality sampling	-	Monthly	Not required
Paste leachate monitoring	-	Quarterly	Not required
Wash stations	-	Quarterly	Not required
Test pads	-	Weekly during ice-free period	Not required
Construct paste and mill tailings test pads		2012	Not required

1. Monthly monitoring for Closure years 1-3, then annually thereafter.

11 Works Cited

- Environment Canada. (2001). *Guidance Document for Flow Measurement of Metal Mining Effluents*. Environment Canada, Minerals and Metals Division. Ottawa: Minister of Public Works and Government Services Canada.
- Environment Canada. (2001). *Guidance Document for the Sampling and Analysis of Metal Mining Effluents*. Environment Canada, Minerals and Metals Division. Ottawa: Minister of Public Works and Government Services Canada.
- Global Water. (2010). *WL16 Water Level Loggers*. Retrieved April 8, 2010, from Global Water Instrumentation, Inc.: <http://globalw.com/products/wl16.html>
- Hamon, W. (1963). Computation of Direct Runoff Amounts From Storm Rainfall. *International Association of Scientific Hydrology*, 63, 52-62.
- Hamon, W. (1961). Estimating potential evapotranspiration. *Proceedings of the American Society of Civil Engineers, Journal of the Hydraulics Division*, 87 (HY3, Pt. 1), 107-120.
- Metal Mining Effluent Regulations, SOR/2202-222 (2006).
- Mills, C. (1998, September 18). *Kinetic Testwork Procedures*. Retrieved April 4, 2010, from Acid Rock Drainage at Enviromine: [http://technology.infomine.com/enviromine/ard/Kinetic%20Tests/kinetic%20procedures.htm#ASTM 1996](http://technology.infomine.com/enviromine/ard/Kinetic%20Tests/kinetic%20procedures.htm#ASTM%201996)
- Morin, K. A., & Hutt, N. M. (2006). The MEND Minewall Technique: Overview and Details. *13th Annual BC MEND Workshop, Open Pits and Underground Mine Workings*. Vancouver: MEND.
- Penman, H. (1963). Vegetation and hydrology. *Technical Communication No. 53, Commonwealth Bureau of Soils*. England: Farnham Royal.
- Price, D. W. (1997). *Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia*. Smithers: Reclamation Section, Energy and Minerals Division, Ministry of Employment and Investment.
- Resources Information Standards Committee. (1997). *Ambient fresh water and effluent sampling manual*. Retrieved January 21, 2010, from Aquatic Ecosystem: <http://www.ilmb.gov.bc.ca/risc/pubs/aquatic/ambient/index.htm>
- Solinst. (2010). *Levellogger Series: Model 3001 Levellogger Gold*. Retrieved April 9, 2010, from Solinst: <http://www.solinst.com/Prod/3001/3001.html>
- YTG Energy, Mines and Resources. (2006, December 5). Mining Licence No. QML-0006. Whitehorse, YT, Canada.
- Yukon Government Department of Energy, Mines and Resources. (2006, December 5). Mining Licence No. QML-0006. Whitehorse, YT, Canada.
- Yukon Water Board. (2007, October 4). Type A Water Use Licence QZ04-065. Whitehorse, YT, Canada.
- Yukon Water Board. (2005, April 4). Type B Water Use Licence QZ01-051. Whitehorse, YT, Canada.
- Yukon Zinc Corporation. (2007). *Revised Documentation in Support of Water Use Application QZ04-065*. Vancouver: YZC.

Appendix A: Environmental Effects Monitoring First Study Design – Revision 1

Wolverine Project
Environmental Effects Monitoring
First Study Design

Revision 1

Prepared for:
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October 28, 2010

Table of Contents

TABLE OF CONTENTS.....	i
1. INTRODUCTION.....	1-1
1.1 BACKGROUND.....	1-1
1.2 FIRST BIOLOGICAL MONITORING STUDIES SCHEDULE	1-3
2. SITE CHARACTERIZATION.....	2-1
2.1 PROJECT DESCRIPTION	2-1
2.1.1 OVERVIEW OF MINE OPERATION.....	2-1
2.1.2 ORE PROCESSING.....	2-5
2.1.2.1 CRUSHING AND GRINDING.....	2-5
2.1.2.2 FLOTATION AND CONCENTRATE PRODUCTION	2-6
2.1.3 ENVIRONMENTAL MANAGEMENT.....	2-7
2.1.3.1 WASTE ROCK MANAGEMENT AND STORAGE	2-7
2.1.3.2 TAILINGS STORAGE AND MANAGEMENT	2-8
2.1.3.3 TAILINGS WATER TREATMENT SYSTEM	2-8
2.2 APPLICABLE EFFLUENT AND ENVIRONMENTAL MONITORING REGULATIONS.....	2-9
2.2.1 TERRITORIAL MONITORING REGULATIONS AND REQUIREMENTS	2-9
2.2.1.1 SURFACE WATER MONITORING.....	2-10
2.2.1.2 EFFLUENT REGULATIONS AND MONITORING.....	2-15
2.2.2 FEDERAL MONITORING REGULATIONS AND REQUIREMENTS	2-16
2.3 PHYSICAL, CHEMICAL AND BIOLOGICAL DESCRIPTIONS OF REFERENCE AND EXPOSURE AREAS	2-17
2.3.1 PROJECT ENVIRONMENTAL SETTING	2-17
2.3.2 EXPOSURE AND REFERENCE AREAS	2-18
2.3.2.1 PHYSICAL CHARACTERISTICS	2-18
2.3.2.2 HYDROLOGY.....	2-21
2.3.2.3 WATER QUALITY CHARACTERISTICS	2-24
2.3.2.4 BIOLOGICAL CHARACTERISTICS	2-29
2.4 EFFLUENT MIXING AND DILUTION PREDICTIONS	2-29
2.4.1 MIXING AND DILUTION ESTIMATES OF FINAL EFFLUENT	2-29
2.4.2 WATER QUALITY PREDICTIONS DURING EFFLUENT DISCHARGE	2-31
2.5 EXISTING FACTORS AFFECTING FISH HABITAT	2-35
3. FISH MONITORING.....	3-1
3.1 STUDY AREAS.....	3-1
3.2 HISTORICAL FISH DATA	3-1
3.3 EEM SURVEY METHODS.....	3-6
4. BENTHIC INVERTEBRATE MONITORING.....	4-1
4.1 STUDY AREA.....	4-1
4.2 HISTORICAL BENTHIC INVERTEBRATE MONITORING	4-3
4.2.1 ECOLOGICALLY RELEVANT SEASON.....	4-3
4.2.2 BENTHIC INVERTEBRATE MONITORING IN 2005 AND 2007.....	4-3
4.3 EEM SURVEY METHODS.....	4-6
4.3.1 STATISTICAL CONSIDERATIONS.....	4-6
4.3.2 BENTHIC INVERTEBRATE SURVEY METHODS	4-6
4.3.3 SUPPORTING ENVIRONMENTAL VARIABLES	4-7
4.3.4 TAXONOMY AND DATA SUMMARY	4-7
5. INTERPRETIVE REPORT.....	5-1
5.1 EFFECTS ON FISH.....	5-1
5.2 EFFECT ON BENTHIC INVERTEBRATES.....	5-2
5.3 SUBSEQUENT EEM DESIGN.....	5-3

REFERENCES.....	R-1
-----------------	-----

APPENDIX A: BASELINE CHARACTERIZATION SUMMARY REPORT

LIST OF FIGURES

FIGURE 1-1: TIMELINE OF PROJECT ACTIVITIES AND ENVIRONMENTAL EFFECTS MONITORING FOR THE WOLVERINE PROJECT.	1-5
FIGURE 2-1: WOLVERINE PROJECT GENERAL LOCATION	2-2
FIGURE 2-2: WOLVERINE MINE PROJECT REGIONAL LOCATION MAP	2-3
FIGURE 2-3: WOLVERINE MINE PROJECT GENERAL SITE PLAN.....	2-4
FIGURE 2-4: SURFACE WATER QUALITY MONITORING STATIONS AS PER QZ04-065.....	2-11
FIGURE 2-5: EXPOSURE AREA AND REFERENCE AREA STREAMS.....	2-20
FIGURE 2-6 : MEAN MONTHLY FLOWS WITHIN EXPOSURE AREA AND REFERENCE AREA STREAMS.....	2-22
FIGURE 2-7: MEASURED DISCHARGE IN GO CREEK AT STATION W80 FROM 2006 TO 2010	2-23
FIGURE 2-8: SEASONAL TIME SERIES (1995 - 2008) OF TOTAL HARDNESS AND CONDUCTIVITY AT STATIONS IN THE GO CREEK EXPOSURE AREA.....	2-25
FIGURE 2-9: SEASONAL TIME SERIES (1995 - 2008) OF TURBIDITY AND TOTAL SUSPENDED SOLIDS AT STATIONS IN THE GO CREEK EXPOSURE AREA.....	2-26
FIGURE 3-1: EEM FISH SURVEY SITES	3-3
FIGURE 3-2: FISH SURVEY RESULTS FROM HISTORICAL SAMPLING.....	3-5
FIGURE 4-1: EEM BENTHIC INVERTEBRATE SAMPLE SITES	4-2
FIGURE 4-2: TOTAL BENTHIC INVERTEBRATE DENSITY (± 1 STANDARD DEVIATION) FROM ALL BASELINE STREAM MONITORING IN THE WOLVERINE PROJECT AREA	4-5

LIST OF TABLES

TABLE 2-1: REAGENTS EMPLOYED IN WOLVERINE ORE PROCESSING.....	2-7
TABLE 2-2: SURFACE WATER MONITORING SAMPLING SITES, FREQUENCY AND PARAMETERS DURING THE OPERATIONS PHASE AS PER QZ04-065.....	2-12
TABLE 2-3: SURFACE WATER QUALITY SAMPLING PARAMETERS AS PER QZ04-065	2-13
TABLE 2-4: SURFACE WATER QUALITY MONITORING PARAMETERS AND DETECTION LIMITS	2-14
TABLE 2-5: QZ04-065 EFFLUENT LIMITS FOR DISCHARGE TO GO CREEK	2-15
TABLE 2-6: AVERAGE CLIMATE CONDITIONS FOR THE WOLVERINE PROJECT AREA	2-17
TABLE 2-7: PHYSICAL HABITAT DATA FOR EXPOSURE AND REFERENCE STREAMS	2-21
TABLE 2-8: MEAN MONTHLY FLOWS FOR EXPOSURE AND REFERENCE AREA STREAMS	2-23
TABLE 2-9: SURFACE WATER QUALITY SUMMARY FOR GO CREEK EXPOSURE AREA STATIONS.....	2-27
TABLE 2-10: SURFACE WATER QUALITY SUMMARY FOR REFERENCE AREA STREAMS	2-28
TABLE 2-11: DILUTION DOWNSTREAM OF DISCHARGE POINT IN JUNE AND OCTOBER	2-31
TABLE 2-12: EXAMPLE CALCULATION OF WATER CHEMISTRY (MG/L) AT STATION W12 IN EXPOSURE AREA DURING EFFLUENT DISCHARGE FOR THE MONTH OF MAY	2-32

TABLE 2-13: MONTHLY WATER QUALITY PREDICTIONS WITHIN THE GO CREEK EXPOSURE AREA DURING EFFLUENT DISCHARGE.....	2-33
TABLE 3-1: FISH SPECIES PREVIOUSLY CAPTURED IN WOLVERINE PROJECT AREA STREAMS	3-2
TABLE 3-2: RESULTS FROM HISTORIC ELECTROFISHING SURVEYS	3-4
TABLE 4-1: SUMMARY OF TIME SERIES DATA FROM SAMPLES COLLECTED IN 1997 AT STATION W9.....	4-3
TABLE 4-2: COMMUNITY CHARACTERISTIC STATISTICS (AVERAGES) FROM STREAM BENTHIC INVERTEBRATE TAXONOMY DATA	4-4

1. Introduction

1.1 Background

Yukon Zinc Corporation's (YZC) Wolverine Project is an underground mining project that will produce copper, lead and zinc concentrates. The Wolverine Project is currently in the mine commissioning phase with the majority of site infrastructure having been constructed. Mill commissioning has begun to initiate milling and processing optimization and the eventual ramping up of the mill throughput to the project design rate of 1,700 tonnes per day (tpd) by the first Quarter of 2011.

Waste rock and ore from the mine will be stored temporarily on a lined pad during the first two years of mine development. The ore will be processed in the mill and the waste material will be hauled back underground to the mined-out stopes and encapsulated with paste backfill (a mixture of cement and mill tailings). Once adequate space is mined, waste will remain underground and will not be brought to surface.

Water from the underground workings is pumped to the tailings facility and tailings slurry from the milling process will be either pumped to the tailings facility for subsequent reuse in the mill or used in paste backfill operations.

The Wolverine Project will operate with a positive water balance. A water treatment plant is being designed to treat the excess water accumulating in the tailings impoundment. Excess water will consist predominantly of tailings process water, with lesser quantities of mine contact surface runoff, underground water, treated sewage effluent and direct precipitation. The tailings impoundment has sufficient capacity to store approximately three years of excess water discharged to the impoundment. As such, water treatment operations and effluent discharge will not be required until the second Quarter 2013. Presently, water treatment and effluent discharge is only planned to occur during the ice-free period of May to October. All treated effluent from the Wolverine Project will be discharged to Go Creek and no effluent discharges will occur to Wolverine Creek.

In October 2009, YZC completed the construction of the tailings impoundment. Since that time, all contact water capable of containing deleterious substances - including underground water and runoff originating from the industrial complex area undergoing construction - has been directed to the tailings impoundment in order to provide an adequate freshwater supply for mill start-up. As such, no effluent discharges have occurred at the Wolverine Project since late October 2009. Previously, contact water entering the underground mine was treated and periodically released according to the requirements specified in Water Use License QZ01-051 (B Licence) which stipulated discharge quality limits for water releases to

Go Creek. Discharge under QZ01-051 was discontinued in October 2009 upon completion of the tailings facility.

On June 3, 2009 the Wolverine Project became subject to *section 7* of the Metal Mining Effluent Regulations (MMER (2006)). The MMER were developed under section 36 of the *Fisheries Act* to regulate the deposit of mine tailings and other waste material produced during mining operations within natural fish bearing watersheds. The MMER were annexed on June 6, 2002 and are administered by Environment Canada. Specifically, section 7(1) requires that:

The owner or operator of a mine shall conduct environmental effects monitoring studies of the potential effects of effluent on the fish population, on fish tissue and on the benthic invertebrate community in accordance with the requirements and within the periods set out in Schedule 5.

The MMER stipulates limits for the discharge of deleterious substances in mine related effluent(s), including pH, total suspended solids (TSS), arsenic, copper, lead, nickel, total cyanide and radium-226. In addition, the MMER requires the effluent to be non-acutely lethal to rainbow trout. These MMER discharge limits in effluent were established as minimum national standards. *Effluent*, as defined under the MMER (*Part 1, s.1*), includes:

- Milling processing effluent;
- Mine water effluent;
- Tailings impoundment area effluent;
- Treatment pond or treatment facility effluent (not including sewage treatment plant effluent); and/or
- Seepage and surface runoff that contains a deleterious substance as defined above.

Recognizing that metal mining operations within Canada vary widely with respect to environmental setting and mining and milling processes, the application of standard effluent limits may not always be adequately protective of fish and fish habitat. To address and circumvent these potential limitations, the MMER requires the completion of site specific Environmental Effects Monitoring (EEM) studies. These studies are designed to characterize the mine effluent, discharge conditions and the potential effects on the aquatic environment as well as to ensure that environmental protection measures employed by mining operations are achieving desired objectives. More specifically, the EEM program requires all mines regulated under the MMER to conduct:

Effluent and Water Quality Monitoring Studies (*Schedule 5, Part 1*) including effluent characterization, water quality monitoring and sublethal toxicity testing; and

Biological Monitoring Studies (*Schedule 5, Part 2*) - including a fish survey (when effluent in the exposure area is greater than 1% within 250 m of the final discharge point) and a benthic invertebrate community survey.

An integral component of the biological monitoring study is the completion and submission of a detailed study design (First Study Design). This report specifically addresses the requirements of the first biological monitoring studies that will be part of the EEM program for YZC's Wolverine Project, as outlined in *Schedule 5, Part 2, s.10 through s.18* of the MMER. This report has been prepared by Yukon Zinc Corporation and Lorax Environmental Services Ltd.

1.2 First Biological Monitoring Studies Schedule

The MMER prescribe a schedule for completion of the first biological monitoring study that can be summarized as follows (from *Schedule 5, Part 2*):

1. Submission of first study design within 12 months after the day the mine becomes subject to *section 7* of the MMER (*section 14a*);
2. Conduct the first biological monitoring study not sooner than six months after the day on which a study design is submitted (*section 15(1)*);
3. Data assessment of information collected during study (*section 16*);
4. Preparation of the first interpretative report of the results from the biological monitoring study (*section 17*); and
5. Submission of first interpretative report not later than 30 months after the date the mine becomes subject *section 7* of the MMER, if the study design was submitted under paragraph 14(a) (*section 18a*).

In accordance with *Schedule 5, section 14*, the Wolverine Project EEM first study design program has been submitted within 12 months after the day the mine became subject *section 7* (Wolverine Mine subject on June 3, 2009). According to the above schedule an interpretive report from the first EEM cycle shall be submitted not later than December 3, 2011.

Recognizing that the Wolverine Project will not produce mine effluent, as defined in *Part 1, s.1*, for discharge until – at the earliest – May 2013, the first interpretive report will not include monitoring components that require the presence of effluent discharge (*e.g.* effluent characterization) or are exempt from monitoring requirements when effluent concentration is less than 1% at 250 m from the final discharge point (*i.e.* fish population study). Even though fish monitoring will not be part of the first EEM cycle, the fish study design is presented herein for completeness since a fish study will be required subsequent to commencement of effluent discharge.

Section 9(d) does not include the same exemption for benthic invertebrate community study that s 9(b) includes for fish, therefore benthic invertebrate monitoring is required as part of the first interpretive report. While the intent of benthic invertebrate studies is to determine if there has been an effect on the benthic invertebrate community from effluent discharge, it will not be possible to assess this when no effluent will have been discharged. Instead, the benthic invertebrate analyses will be a test of the study design (*i.e.* that a Type I error does not occur), will be useful in refining subsequent study designs, and will provide data that could be used for before/after analyses when monitoring occurs during periods with effluent discharge.

Figure 1-1 provides a Gantt chart of the key submissions and milestones with respect to the biological monitoring studies for the Wolverine Project EEM program. It should be noted that in the First Study Design submitted in June 2010 it was assumed that no biological monitoring would be necessary until after effluent discharge commenced. Environment Canada's review of the First Study Design noted that a benthic invertebrate study will be required for the first EEM cycle. This will have to take place in September 2011, which will provide approximately 3 months to conduct taxonomic analyses and interpret and report the results. Figure 1-1 also shows the expected schedule for the second EEM cycle in order to illustrate when effluent will be discharged and when fish studies will commence. This second cycle schedule is based on the assumption that no effect will be detected during the first cycle therefore the second interpretive report shall be provided no later than 36 months after submission of the first interpretive report.

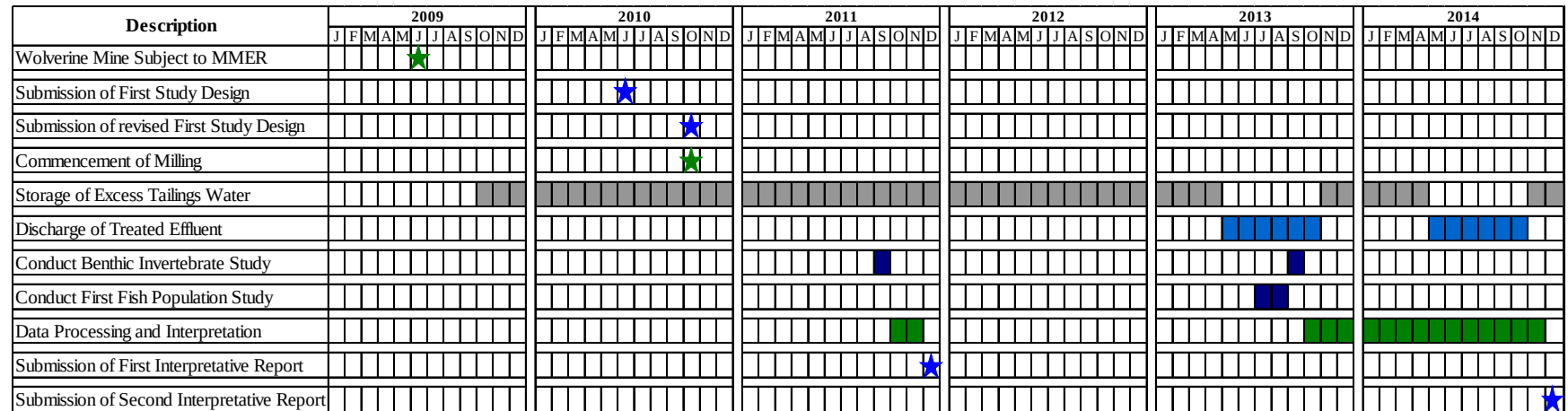


Figure 1-1: Timeline of Project Activities and Environmental Effects Monitoring for the Wolverine Project.

2. Site Characterization

This chapter addresses the site characterization requirements of the First Study Design as outlined in *Schedule 5, s.11* of the MMER. Descriptions of the Wolverine Mine Project, ore processing and environmental management programs relevant to effluent discharge are provided in Section 2.1. A summary of the applicable effluent and environmental monitoring regulations relevant to the Wolverine Mine is presented in Section 2.2. The physical, chemical and biological characteristics of the exposure and reference area receiving environment are described in Section 2.3. The predicted effluent mixing and dilution characteristics, as well as water quality predictions throughout the exposure area, are outlined in Section 2.4. Section 2.5 discusses the naturally existing conditions within the exposure area that may affect fish and/or fish habitat.

2.1 Project Description

The Wolverine Project is an underground mining project that will produce copper, lead and zinc concentrates. It is located in the south-eastern Yukon, near the headwaters of the Wolverine Lake watershed within the Kaska Nation traditional territory (Figure 2-1). Site access is via air or a 26 km long all season access road that connects with the Robert Campbell Highway at km 190 (Figure 2-2).

2.1.1 Overview of Mine Operation

The project includes operation of an underground mine with surface ramp access to produce 1700 tpd of mill feed ore. Operations are scheduled to commence in June 2010. The underground mine will ultimately extend from approximately 1345 masl, at the portal entrance, to 1090 masl at the bottom stope, with a main access ramp, evacuation shafts and a ventilation raise. The Wolverine Mine has a current reserve of 5.15 Mt and a projected mine life of approximately 10 years.

The main industrial complex area currently includes a process plant, crusher building, concentrate load-out building, office buildings, maintenance and fuelling facilities, sewage treatment plant, 246 man camp, laboratory, and water diversion and collection infrastructure. The camp consists of a kitchen and mess hall building, a recreation facility, and six bunk houses with laundry facilities. Power is supplied by diesel gensets and potable water is supplied from a local well. In 2012 a water treatment plant and retention pond will be constructed to treat tailings effluent. Figure 2-3 provides a general site plan for the Wolverine Project mine area operations.



Figure 2-1: Wolverine Project General Location

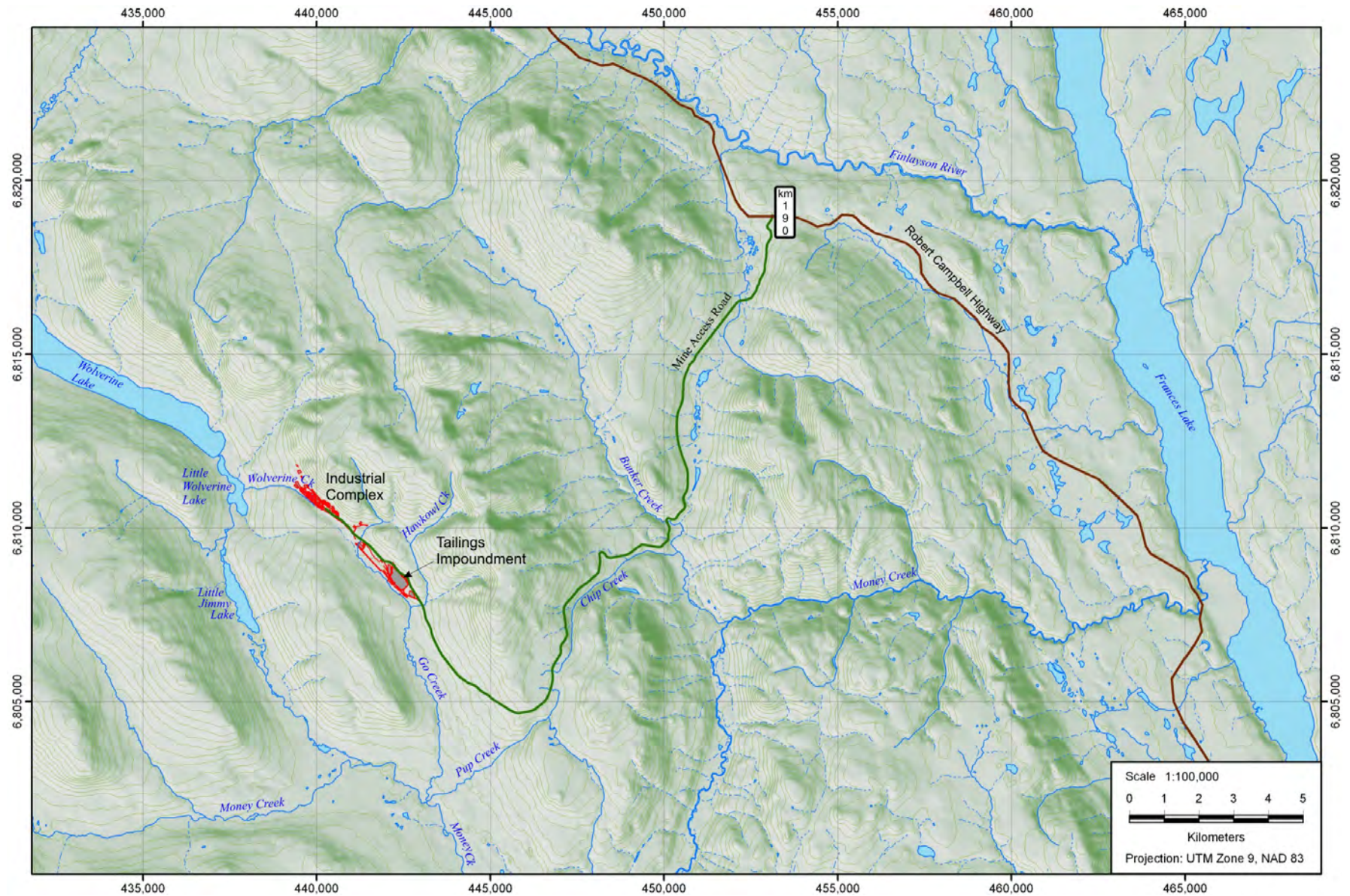
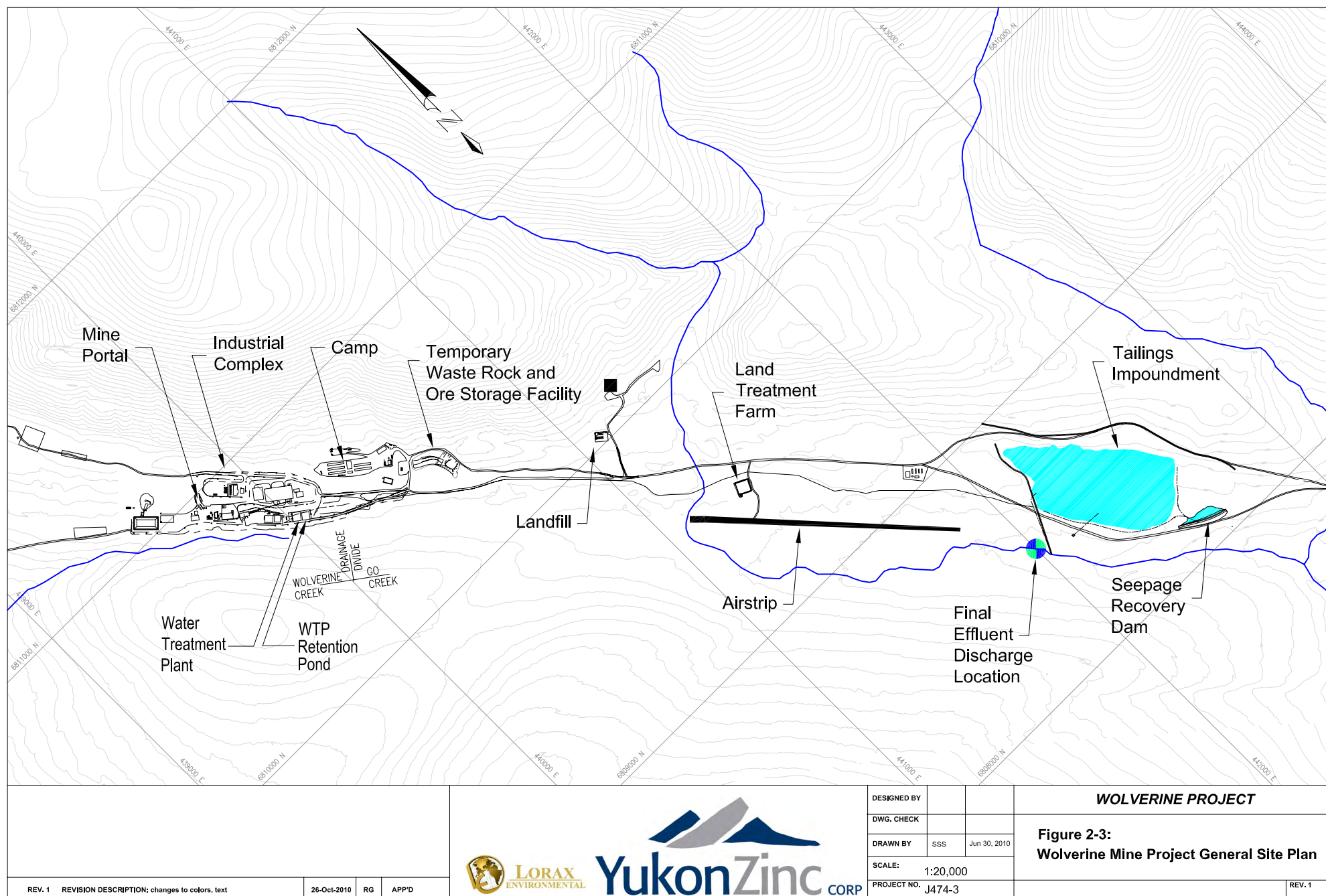


Figure 2-2: Wolverine Mine Project Regional Location Map



2.1.2 Ore Processing

The Wolverine Project is designed to process an annual mill feed treatment rate of 620,500 tonnes or 1,700 tpd. During Year 1 of operations commencing in September 2010, the initial average daily milling rate will be on the order of 1,400 tpd, with production increasing to 1,700 tpd by first Quarter 2011.

The metallurgical processing procedures have been designed to produce saleable high grade copper, lead, and zinc concentrates. The concentrates also contain associated precious metal content of gold and silver. The unit processes selected for the recovery of the metals involve conventional size reduction and mineral beneficiation methods.

The unit operations for the processing of ore include:

- run-of-mine (ROM) ore feed hopper;
- primary crushing and screening;
- secondary crushing and screening;
- two stage rod and ball mill grinding;
- classification;
- pre-flotation, rougher and cleaning stages;
- copper rougher flotation, regrinding and cleaner flotation stages;
- copper concentrate thickening, filtration and dispatch;
- lead rougher flotation, regrinding and cleaner flotation stages;
- lead concentrate thickening, filtration and dispatch;
- zinc rougher flotation, regrinding and cleaner flotation stages;
- zinc concentrate thickening, filtration, and dispatch;
- tailings filtration and disposal by paste backfill underground or to the tailings facility;
- water reclamation from tailings pond; and
- fresh water circuit.

Only the ore processing components relative to evaluating the characteristics of the Wolverine Project process solutions and effluent as well as general environmental management features are described in detail below.

2.1.2.1 Crushing and Grinding

Primary and secondary crushing and grinding is performed on a dry basis and therefore does not utilize any milling reagents or chemical additions. Dust generated from the crushing of ore is removed in a dust collection system. The collected dust is discharged onto the conveyor feeding the rod mill feed bin for subsequent processing.

The grinding circuit reduces the crushed ore to the size required for the flotation process and is a wet process. Lime may be added to the rod mill for the adjustment of the pH of the slurry. In addition, sodium metabisulphite (SMBS), a conditioning reagent for the flotation process, will be added to the mill discharge pumpbox.

2.1.2.2 Flotation and Concentrate Production

The milled ore progresses through a pre-flotation process and three stages of sequential flotation to recover copper, lead, and zinc minerals into high-grade metal concentrates.

The pre-flotation circuit consists of rougher cells and cleaner cells to float non-sulphide minerals from sulphide minerals. Methyl-isobutyl-carbinol (MIBC) reagent is used as a frother. The rougher concentrate is cleaned into a bank of two cleaner cells and pre-flotation cleaner concentrate is pumped into the tailings pumpbox. The rougher and cleaner pre-flotation tailings are pumped into the copper conditioning tank.

The feed to the copper flotation circuit is the pre-flotation tailings or the cyclone overflow from the grinding circuit if the pre-flotation circuit is by-passed. The slurry is conditioned in the copper conditioning tank. Lime is added for slurry pH adjustment, if required. The collector reagent TNC312, a proprietary mixture of dialkyl thionocarbamate and MIBC frother, and supplementary amounts of MIBC are added to the conditioning tank. The conditioned slurry overflows into the copper rougher-scavenger flotation bank of cells. Reagents TNC312, MIBC and SMBS-sodium metabisulphate are also added at the feed-end of the copper rougher cell. Copper minerals are selectively floated into a rougher concentrate away from the other minerals and the waste present in the ore slurry.

The copper rougher-scavenger concentrates are pumped into the copper cleaner column feed tanks, which is discharged by gravity into the copper cleaner column cells. The concentrate from the copper cleaner column cells is the final copper concentrate, which is pumped to the copper concentrate thickener.

The collector reagents used in the copper cleaner flotation circuit are Aero 3477, an isobutyl dithiophosphate, and sodium isopropyl xanthate (SIPX). Lime, as a pH regulator, and SMBS and zinc sulphate, as depressant conditioning reagents, are added at the required dosage rates, with MIBC frother as required. Provision has also been made for the use of copper circuit dilution water from the copper concentrate thickener overflow to be re-used in the copper flotation circuit.

The lead and zinc processing is similar to the copper flotation circuits, but has different numbers and volumes of flotation cells in the various floatation stages. The lead conditioning tank is fed from the copper scavenger tailings, and sodium cyanide is added as a depressant reagent for the zinc minerals. The zinc flotation circuit is fed from the lead tailings stream.

A listing of the chemical reagents added to the process stream to facilitate the separation and flotation processes, as discussed above, is provided in Table 2-1.

**Table 2-1:
Reagents Employed in Wolverine Ore Processing**

Substance	Expected Quantity Stored
Lime	50 t in silo storage - made into 20% solution
SMBS (sodium metabisulphide)	Solid (made into ~ 10% solution)
TNC312	bulk container
MIBC (methyl isobutyl carbinol)	bulk container
Aero 3477 (isobutyl dithiophosphate)	bulk container
SIPX (sodium isopropyl xanthate)	200 kg drums or kg bags
Sodium cyanide	Solid (made into ~ 10% solution)
Zn sulphate and Cu sulphate	Solid (made into ~ 10% solution)
Flocculant	Drums
Ferro – silicon	bulk container

2.1.3 Environmental Management

2.1.3.1 Waste Rock Management and Storage

As milling rates (1,700 tpd) correspond to the rate at which ore is extracted from the underground mine, there is little ore and waste storage required at the Wolverine Project.

Temporary storage was required for the ore and waste produced during the test mining program and pre-production development program, and will be required for mined rock prior to milling. The main locations of ore and waste rock storage at the Wolverine Project are at the temporary waste rock and ore storage facility (Figure 2-3), located east of the camp, the dynamic operating stockpile, located at the west side of the crusher building, and the temporary dynamic ore stockpile at the west end of the industrial complex area.

The temporary waste rock and ore storage facility was constructed in 2005 and extended in fall 2007 to accommodate test mine and pre-production development rock generated in 2005 and 2009 – mid 2010, respectively. The pad was lined with an HDPE liner and clay prior to the deposition of ore and waste. The ore and some waste material contained on the pad will be used to commission the mill during start-up in 2010, and the remaining waste material will be transported underground and used as fill in the first two years of operations.

Water collected within the storage pad drains towards a sump at the south end. Water is pumped from this sump as required and trucked to the tailings facility. Clean runoff emanating from the hillside up slope of the storage pad is directed via ditches around the pad to minimize contamination.

The dynamic operating stockpile is a lined area used to temporarily store the ore as it is brought up from the underground mine preceding throughput through the crusher. This area will be used for life of mine. The temporary dynamic stockpile was developed during pre-production development to meet minimum design through-put in the mill for the early production phase. Runoff from the dynamic stockpiles, and from the entire industrial complex, is intercepted via collection ditches 2, 3 and 4. These are lined ditches that ultimately discharge into the underground mine water settling pond no. 2 located east of the crusher building. Diversion ditch 1 diverts clean surface runoff upslope of the industrial complex, and into the headwaters of Wolverine Creek.

2.1.3.2 Tailings Storage and Management

The milling process produces tailings that will either be utilized in the underground mine as paste backfill, or deposited in the tailings facility. The tailings have high sulphide content and have the potential to become acid generating if allowed to oxidize. Process effluent from the grinding and flotation circuits is also stored in the tailings impoundment where a significant portion (>90%) of it is recycled back to the process plant. To prevent oxidation of the tailings solids and subsequent acid generation, the tailings impoundment has been designed to be a water retaining structure underlain with an impermeable liner. This design permits the tailings to remain completely saturated, both during operations and at closure, and will eliminate the potential for acid drainage from the facility. Moreover, the liner construction also greatly reduces the potential for seepage of tailings water and the concomitant potential for groundwater contamination occurring during operations, closure and at post-closure. The design of the tailings facility was based on field and laboratory investigations of the foundation conditions and considerations of geochemical characteristics of the tailings and supernatant water. The design incorporated the availability of local dam borrow materials, storage capacity requirements, site water balance, dam failure consequence rating, and earthquake and flood potential.

Water from the underground workings and contact water runoff from the industrial complex also reports to the tailings facility along with water discharging from the sewage treatment plant.

2.1.3.3 Tailings Water Treatment System

As previously introduced, the tailings facility will operate with a positive water balance. A water treatment plant is being designed to treat the excess water accumulating in the tailings impoundment. Excess water will consist predominantly of tailings process water, with lesser quantities of mine contact surface runoff, underground water, treated sewage effluent and direct precipitation. A biological reduction treatment system (bioreactor) will be used to produce effluent of acceptable water quality for discharge.

The bioreactor tanks will contain a granular carbon substrate or comparable alternative. Water movement through the bioreactor system will occur in a modified plug up-flow configuration. The water from the tailings pond (influent) will be heated during certain periods of the year to ensure appropriate microbial growth. The water will also receive a nutrient amendment designed to facilitate the growth of the microbial community inoculated on the carbon substrate. The water discharged from the bioreactor will be fed through a sand filter to remove suspended solids.

The bioreactor system will be located at the industrial complex area and water exiting the water treatment plant will be directed to a retention pond. If water in the retention pond does not meet discharge limits (see Section 2.2 for discussion of effluent discharge limits), the water will be recycled back to the tailings impoundment or the water treatment plant. Water meeting permitted discharge limits will be released to Go Creek at the final discharge location adjacent to the tailings impoundment (Figure 2-3). The UTM coordinates of the final effluent discharge location for the Wolverine Project are 442000E and 6808500N (NAD83 9 V).

All treated water from the Wolverine Project will be discharged to Go Creek via the final discharge location and no effluent discharges will occur to Wolverine Creek and no other effluents will be produced at Wolverine. Water treatment and discharge will occur during the ice-free period of May to October.

The ultimate design of the bioreactor system, the required nutrient amendments and optimal flow capacities need to be determined through a field-scale pilot study in which operating characteristics are optimized. This work is currently underway, with pilot plant studies at site commencing in June 2011.

As described previously, the tailings impoundment has sufficient capacity to store approximately three years of water discharged to the impoundment. Accordingly, water treatment operations, and effluent discharge, will not be required until May-June 2013.

2.2 Applicable Effluent and Environmental Monitoring Regulations

2.2.1 Territorial Monitoring Regulations and Requirements

Water quality and effluent monitoring requirements for the Wolverine Project are dictated by Type A Water Licence QZ04-065 (Yukon Water Board, 2007) and Type B Water Licence QZ01-051 (Yukon Water Board, 2005). Monitoring under B-Licence QZ01-051 has been superseded by A-Licence QZ04-065 monitoring requirements for surface water quality monitoring, except for the waste rock storage pad. Monitoring under QZ01-051 will be discontinued once the waste rock storage pad is decommissioned. Monitoring under QZ04-065 will continue for the approximately nine year mine operation phase and into the

permanent closure phase. Should the Wolverine Project enter into a temporary shutdown or closure phase, the monitoring requirements set forth in QZ04-065 will also apply.

Surface water and effluent monitoring components and their respective sampling station locations and monitoring frequencies, are summarized below.

2.2.1.1 Surface Water Monitoring

An extensive surface water monitoring program for the Wolverine Project exists and includes the monitoring of hydrology and water quality at eighteen (18) locations in the Wolverine Lake, Go Creek and Money Creek watersheds. Samples are also collected from the waste rock storage sump and, when excess tailings water discharge is required, samples will also be routinely collected from the tailings impoundment and water treatment retention pond.

Receiving environment surface water quality sampling locations are illustrated in Figure 2-4. Table 2-2 summarizes the sampling frequency and analytical parameters for monitoring during operations. Table 2-3 provides a description of the analytical parameters required and Table 2-4 lists the analytical detection limits for each parameter.

Surface water quality sample collection is conducted in accordance with the Environment Canada Guidance Document for the Sampling and Analysis of Metal Mining Effluents (Environment Canada, 2001).

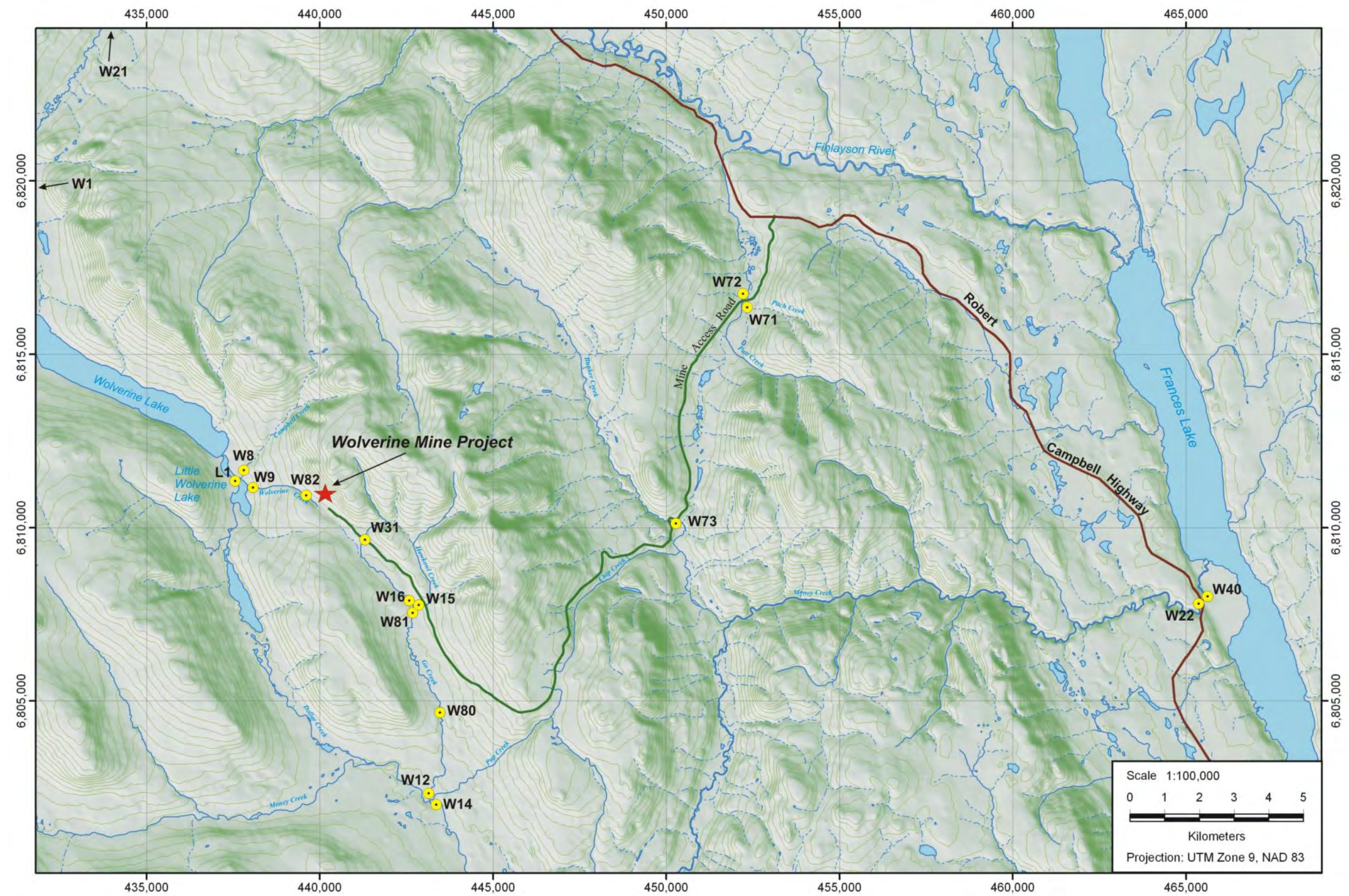


Figure 2-4: Surface Water Quality Monitoring Stations as Per QZ04-065

**Table 2-2:
Surface Water Monitoring Sampling Sites, Frequency and Parameters during the
Operations Phase as Per QZ04-065**

Station Name	Description	UTM Northing	UTM Easting	Sampling Frequency	Water Quality Sampling Parameters ¹
Site Infrastructure:					
WRSS	Waste rock storage pad collection sump	440169	6808915	Weekly	LP, TM, DM
T1	Tailings Pond	442375	6808500	Monthly	FP, LP, TSS, CN, MA, NP, TM, DM
R1	Retention Pond			Daily when discharging	FP, LP, TSS, CN, MA, NP, TM, DM, DOC, Ra226
Wolverine Creek Watershed:					
W82	Upper Wolverine Creek	439402	6811087	Monthly	FP, LP, TSS, MA, NP, TM, DM, DOC
W9	Wolverine Creek at Little Wolverine	437950	6811140	Monthly	FP, LP, TSS, MA, NP, TM, DM, DOC
W1	Wolverine Lake outlet	429841	6819264	Monthly	FP, LP, TSS, MA, NP, TM, DM, DOC
L1	Little Wolverine Lake	437169	6812098	Monthly	FP, LP, TSS, MA, NP, TM, DM, DOC
W21	Nougha Creek at Campbell Highway	439060	6829315	Monthly	FP, LP, TSS, MA, NP, TM, DM
W8	Campbell Creek	437762	6811397	Monthly	FP, LP, TSS, MA, NP, TM, DM
Go Creek Watershed:					
W31	Go Creek above tailings facility	441219	6809593	Monthly	FP, LP, TSS, CN, MA, NP, TM, DM, DOC
W16	Go Creek below tailings facility	442534	6807974	Monthly	FP, LP, TSS, CN, MA, NP, TM, DM, DOC
W15	Hawkowl Creek above Go Creek	442711	6807705	Monthly	FP, LP, TSS, MA, NP, TM, DM
W81	Go Creek below Hawkowl Creek	442684	6807551	Monthly	FP, LP, TSS, MA, NP, TM, DM
W80	Go Creek	443547	6804142	Monthly Daily during discharge	FP, LP, TSS, MA, NP, TM, DM
W12	Go Creek above Money Creek	443152	6802216	Monthly	FP, LP, TSS, MA, NP, TM, DM
Money Creek Watershed:					
W14	Upper Money Creek	443433	6801983	Monthly	FP, LP, TSS, MA, NP, TM, DM
W22	Money Creek above Campbell Highway	465542	6807941	Monthly	FP, LP, TSS, MA, NP, TM, DM
W40	Money Creek below Campbell Highway	465540	6807931	Monthly	FP, LP, TSS, MA, NP, TM, DM
Road Route:					
W71	Pitch Creek below road crossing	452343	6810246	Monthly	FP, LP, TSS, MA, NP, TM, DM
W72	Putt Creek	452185	6816625	Monthly	FP, LP, TSS, MA, NP, TM, DM
W73	Bunker Creek at road crossing	450430	6810105	Monthly	FP, LP, TSS, MA, NP, TM, DM

1: Sampling parameter acronyms are provided in Table 2-3

**Table 2-3:
Surface Water Quality Sampling Parameters as Per QZ04-065**

Acronym	Description
FP	Field physical parameters (temperature, conductivity, specific conductance, pH)
LP	Laboratory physical parameters (conductivity, specific conductance, pH)
TSS	Total Suspended Solids
CN	Total cyanide and WAD cyanide
MA	Major anions (Total Alkalinity, Total Acidity, Bromide, Chloride, Fluoride, Sulphate)
NP	Nutrient parameters (Ammonia, Nitrate, Nitrite, Dissolved ortho-phosphate)
TM	Total metals by ICP Trace Metals Scan. Metals include Al, Sb, As, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Mo, Ni, P, K, Se, Si, Ag, Na, Sr, Tl, V, Zn
DM	Dissolved metals by ICP Trace Metals Scan. Metals include Al, Sb, As, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Mo, Ni, P, K, Se, Si, Ag, Na, Sr, Tl, V, Zn
DOC	Dissolved Organic Carbon
Ra 226	Radium 226

Table 2-4:
Surface Water Quality Monitoring Parameters and Detection Limits

Parameter	Symbol	Detection Limit	Units
Physical Parameters			
Temperature		1	°C
Conductivity		1	µS/cm
Hardness		0.5	mg/L
Total Suspended Solids	TSS	4	mg/L
Total Dissolved Solids	TDS	10	mg/L
pH	pH	0.1	pH
Turbidity		0.1	NTU
Dissolved Organic Carbon	DOC	0.5	mg/L
Major Anions			
Alkalinity-Total		0.5	mg/L as CaCO ₃
Acidity-Total		0.5	mg/L as CaCO ₃
Bromide	Br	0.1	mg/L
Chloride	Cl	0.5	mg/L
Fluoride	F	0.02	mg/L
Sulphate	SO ₄	0.5	mg/L
Nutrient Parameters			
Ammonia-Nitrogen	NH ₃	0.005	mg/L
Nitrate-Nitrogen	NO ₃	0.002	mg/L
Nitrite Nitrogen	NO ₂	0.002	mg/L
Dissolved Ortho-Phosphate	o-P	0.001	mg/L
Total and Dissolved Trace Metals			
Aluminum	Al	0.0002	mg/L
Antimony	Sb	0.00002	mg/L
Arsenic	As	0.00002	mg/L
Cadmium	Cd	0.000005	mg/L
Calcium	Ca	0.05	mg/L
Chromium	Cr	0.0001	mg/L
Cobalt	Co	0.000005	mg/L
Copper	Cu	0.00005	mg/L
Iron	Fe	0.001	mg/L
Lead	Pb	0.000005	mg/L
Magnesium	Mg	0.05	mg/L
Manganese	Mn	0.00005	mg/L
Mercury	Hg	0.00001	mg/L
Molybdenum	Mo	0.00005	mg/L
Nickel	Ni	0.00002	mg/L
Phosphorus	P	0.002	mg/L
Potassium	K	0.05	mg/L
Selenium	Se	0.00004	mg/L
Silicon	Si	0.1	mg/L
Silver	Ag	0.000005	mg/L
Sodium	Na	0.05	mg/L
Strontium	Sr	0.00005	mg/L
Thallium	Tl	0.000002	mg/L
Vanadium	V	0.0002	mg/L
Zinc	Zn	0.0001	mg/L

2.2.1.2 Effluent Regulations and Monitoring

In addition to surface water quality monitoring, QZ04-065 also prescribes effluent discharge limits for a suite of parameters that cannot be exceeded in a grab sample of mine effluent prior to discharge to Go Creek. The licence limits and parameters under strict regulation are summarized in Table 2-5.

**Table 2-5:
QZ04-065 Effluent Limits for Discharge to Go Creek**

Parameter	Units	Limit
Aluminum – total	µg/L	800
Antimony – total	µg/L	80
Arsenic – total	µg/L	50
Cadmium – total	µg/L	2
Copper – total	µg/L	15
Iron – total	µg/L	500
Lead – total	µg/L	20
Mercury – total	µg/L	0.1
Molybdenum – total	µg/L	730
Nickel – total	µg/L	500
Selenium – total	µg/L	20
Silver – total	µg/L	1
Zinc – total	µg/L	500
Radium 226– total	Bq/L	0.37
Cyanide – total	µg/L	50
Cyanide –WAD	µg/L	20
Ammonia – N	mg/L	5
Nitrate – N	mg/L	10
Nitrite – N	mg/L	0.6
Sulphate	mg/L	1800
Total suspended solids	mg/L	15
pH	pH	6.5 - 9
Biological Oxygen Demand	mg/L	25
Faecal coliforms	Counts/100 mL	20000

In addition to meeting specific discharge limits, QZ04-065 licence Condition 29 also requires that any discharge to a watercourse must meet a bioassay standard of a 96-hr LC50 bioassay using Rainbow Trout.

2.2.2 Federal Monitoring Regulations and Requirements

As introduced in Section 1.1, water quality monitoring and effluent characterization are part of the Effluent and Water Quality Monitoring Studies required for EEM under Schedule 5, s.7 of the MMER.

Details of the EEM water quality monitoring program will be finalized prior the commencement of effluent discharge. However, the existing water quality monitoring stations and program required under QZ04-065 is sufficiently robust that the majority of EEM water quality monitoring requirements will be met via the completion of A-Licence monitoring. More specifically, stations within the exposure area, including W16, W81, W80 and W12 will serve as suitable sampling locations for EEM water quality monitoring purposes. In addition, station W73 on Bunker Creek will also be suitable as a water quality monitoring station within the reference area. Water quality monitoring at W13 in lower Pup Creek will need to be added in order to address EEM water quality monitoring requirements in this reference stream. Definitions of exposure area and reference area streams are discussed in more detail in Section 2.3.2.

The QZ04-065 required parameter list also covers all of the EEM water quality parameters with the exception of dissolved oxygen (field measurement), total cyanide and radium 226 (for stations W81, W80, and W12). The latter will be added to the parameter list when the above stations are monitored dually for QZ04-065 and EEM requirements during discharge periods.

As with the water quality monitoring program, the effluent discharge limits and monitoring requirements prescribed by QZ04-065 (Tables 2-2 and 2-5) cover all of the required EEM effluent monitoring and effluent characterization requirements. As such, this component of the EEM is fully addressed within the licence requirements of QZ04-065.

Also, the MMER require that acute lethality testing on rainbow trout and *Daphnia magna* is conducted at least once per month during effluent discharges, with samples taken greater than 15 days apart (MMER, 2006). Acute lethality testing is also required immediately if a deposit/discharge occurs outside the normal course of events, and twice per month if a sample of effluent is determined to be acutely lethal. Conversely, if 12 acute lethality tests conducted on effluent are determined to be not acutely lethal, the testing frequency can be reduced to once per quarter (MMER, 2006). To meet both A-Licence QZ04-065 and MMER requirements, acute lethality for rainbow trout and *Daphnia magna* will be conducted monthly during months where discharge occurs.

2.3 Physical, Chemical and Biological Descriptions of Reference and Exposure Areas

2.3.1 Project Environmental Setting

The project location is in the Campbell Range, at the easternmost limit of the Pelly Mountains and abuts the broad Yukon Plateau to the north and east. The area consists of rolling, glacially scoured mountains with no significant peaks. Elevations on the property range approximately between 1200 and 1400 m. The main valleys are wide and U-shaped. Glacial till covers the majority of the lower lying valleys and there is significant infilling by post-glacial sediments.

The climate at the project site is typical of its location in southeastern Yukon. In general, summers are characterized by unstable air, thunderstorms, and frequent rainfall. Winters are cold and dry. Winter conditions begin in October and last through April. Late April and May are the driest months of the year and constitute spring. Summer lasts from June to August and is the wettest season of the year. The short fall period consists of late August through September. Mean annual precipitation for the project area is estimated at 570 mm. Table 2-6 provides a summary of the key climate parameters for the Wolverine Project area for an average year.

**Table 2-6:
Average Climate Conditions for the Wolverine Project Area**

	AVERAGE YEAR												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean Monthly Temperature (°C)	-15	-16	-12	-8	2	9	11	8	2	-7	-10	-18	
Monthly Total Precipitation (mm)	42.8	33.2	26.5	20.0	42.3	65.3	77.7	62.3	57.1	48.8	46.7	47.4	570
Monthly Rainfall (mm)	0.0	0.0	2.0	3.0	42.3	65.3	77.7	62.3	57.1	7.3	0.0	0.0	317
Monthly Snowfall (SWE in mm)	42.8	33.2	24.5	17.0	0.0	0.0	0.0	0.0	0.0	41.5	46.7	47.4	253
Snow Accumulation (mm)	178.3	211.4	236.0	197.2	49.3	0.0	0.0	0.0	0.0	41.5	88.1	135.5	
Monthly Evaporation (mm)	5.0	4.5	9.5	21.0	72.0	86.5	90.0	61.5	32.0	14.5	6.0	2.0	405
Net Precipitation (mm)	37.8	28.7	17.0	-1.0	-29.7	-21.3	-12.3	0.8	25.1	34.3	40.7	45.4	165

Vegetation in the project area ranges from open forest on lower elevation areas to dwarf shrub, herb, grass and lichen ecosystems at high elevations in the alpine. The majority of the mine site is within the subalpine zone, and the mine access road route is mainly in the boreal highland zone with some subalpine zone incursions. These zones are dominated by open

forests of sub-alpine fir, black and white spruce, and lodgepole pine. Willow and scrub birch are common in riparian areas, areas with recent fire history, and steeper upland areas.

The project area and surroundings are rich in wildlife habitat. A variety of wildlife species live in or pass through the project area. The project area lies at the outer edge of the Finlayson Caribou herd range. Moose abound, as do small furbearers, in the project area. Grizzly bears are occasionally seen in the project area.

The aquatic ecosystems in the project area are generally typified by cold, clear and clean water. Wetlands abound and many small ephemeral streams occur in the area. Waters in the upper drainage areas affected by the project, with the exception of Little Wolverine and Wolverine Lakes, do not appear to support substantial fisheries. Wolverine Lake and Little Wolverine Lake have been designated Conservation Waters and are regulated as a barbless hook fishery (Yukon Territory Fishery Regulations C.R.C, c. 854. CANLii). Go Creek, Money Creek, Bunker Creek, Chip Creek and Putt Creek all have limited to no fisheries potential (see Figure 2-4 for stream locations).

2.3.2 Exposure and Reference Areas

The exposure area is defined as an approximately 7 km length of Go Creek, beginning at the final effluent discharge point and extending to the confluence with Money Creek (Figure 2-5). The exposure area was determined by calculating final effluent concentrations (as % of flow) downstream of the discharge point and determining the location at which effluent constitutes less than 1% of stream flow during average low flow conditions (see Section 2.4).

Suitable reference areas for comparison with the exposure area have been defined as lower Pup Creek (a tributary to lower Go Creek) and Bunker Creek (Figure 2-5). In the following sections, the physical, hydrological, chemical and biological characteristics of the exposure and reference areas are described.

2.3.2.1 Physical Characteristics

All streams in the Wolverine project area including Go Creek (exposure) and Pup Creek and Bunker Creek (reference areas), are classified (after Cowardin *et al.* 1979) as

- System: **riverine**
- Subsystem: **upper perennial**
- Class: **unconsolidated bottom**
- Subclass: **cobble-gravel**

Go Creek has a moderate gradient (~3%) for most of its length. The drainage area for Go Creek at the final effluent discharge location is approximately 9 km². Stream width throughout the exposure area is generally narrow, typically ranging from 2 m to 4 m wide. Pup Creek (reference) is a relatively small tributary to Go Creek with a moderate gradient

(~2%), narrow channel width and a small catchment area of approximately 7 km² (Table 2-7). The other reference area in Bunker Creek is has a moderate gradient (~2%) and is larger than Go Creek, with a catchment area of approximately 53 km² and a mean channel width of 5 m.

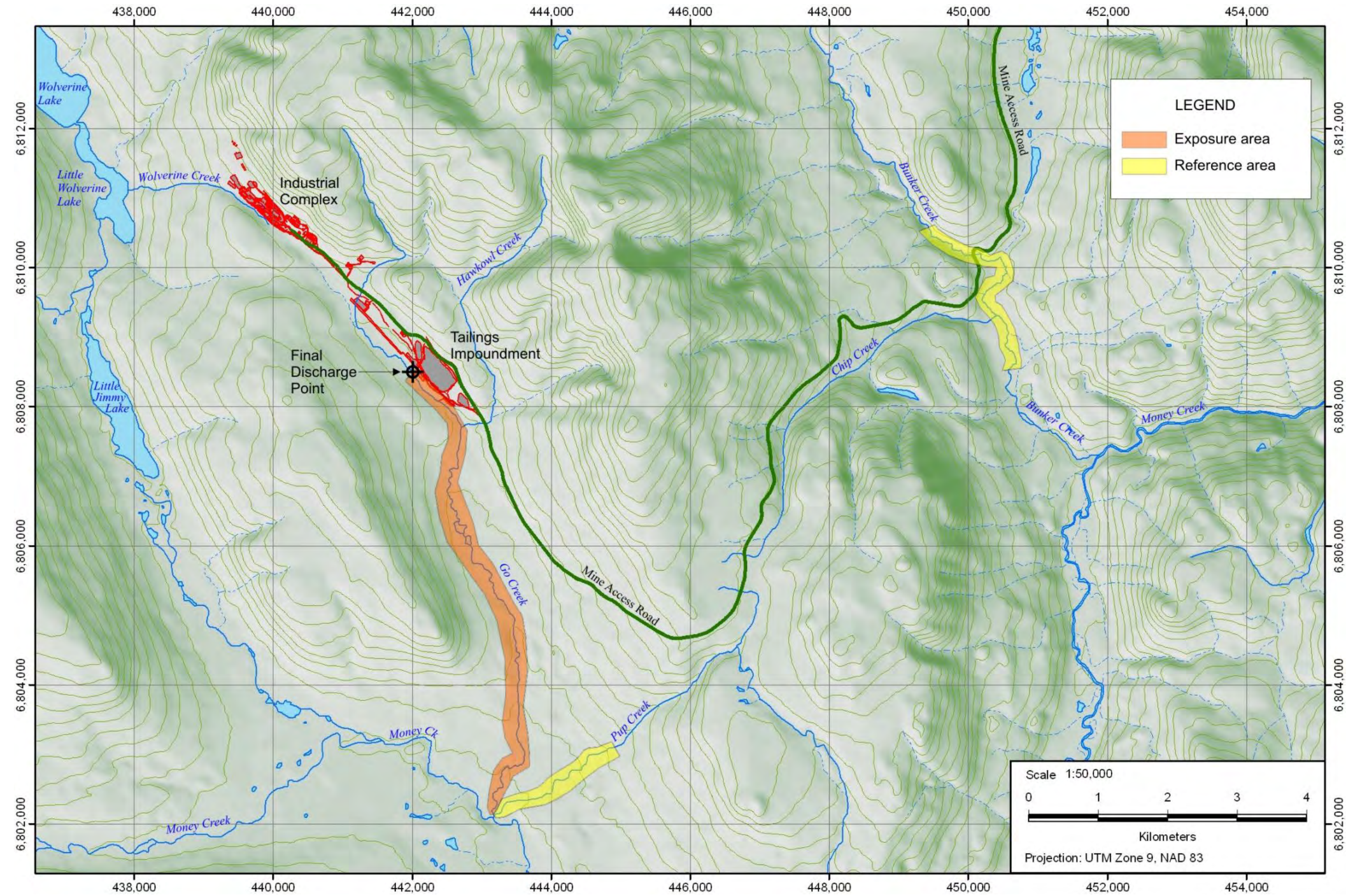


Figure 2-5: Exposure Area and Reference Area Streams

**Table 2-7:
Physical Habitat Data for Exposure and Reference Streams**

Site	Stream	Catchment area (km ²)	Distance downstream of Discharge	Mean Channel Width (m)	Gradient (%)	Dominant Substrate	Sub-dominant Substrate
Discharge point (W85)	Go Ck	9	0 m	ND	ND	ND	ND
W16	Go Ck	10	0.78 km	3.4	3.5	Cobble	Gravel
W81	Go Ck	20	1.2 km	3.2	ND	ND	ND
W80	Go Ck	31	5.0 km	3.0	ND	ND	ND
W12	Go Ck	36	7.0 km	4.2	3	Cobble	Fines
W13	Pup Ck	7	upstream	1.8	2	Gravel	Cobble
W73	Bunker Ck	53	upstream	5.0	2	Gravel	Fines

ND = Not determined

2.3.2.2 Hydrology

The hydrological characteristics of the exposure area in Go Creek have been determined through a regional watershed analysis. Estimates of mean monthly flow for exposure area and reference area streams have been calculated utilizing long-term data from six, Water Survey of Canada (WSC) gauged hydrometric stations. The stations utilized were King Creek, Big Creek, Liard River, Tom Creek, Frances River and Rancheria River.

Mean monthly flow estimates for several stations within the exposure area of Go Creek (*i.e.*, W16, W81, W80 and W12), as well as flow data for the reference areas in Pup Creek (W13) and Bunker Creek (W73), are illustrated in Figure 2-6. Data for station W14 on Money Creek, immediately below the confluence of Go Creek and Money Creek is included for comparative purposes and is not considered an exposure or reference area. Data used to generate the individual unit hydrographs for each station is presented in Table 2-8.

As can be seen in all the unit hydrographs for all stations, surface water flows have an annual cycle with winter low flows from December through April, high flows during freshet beginning in late April and peaking in June, followed by a generally rapid post freshet drop in flows and a gradual decrease to winter low flow conditions.

Flows in Money Creek (W14) are upwards of an order of magnitude greater than in Go Creek (see W80 and W12 in Figure 2-6).

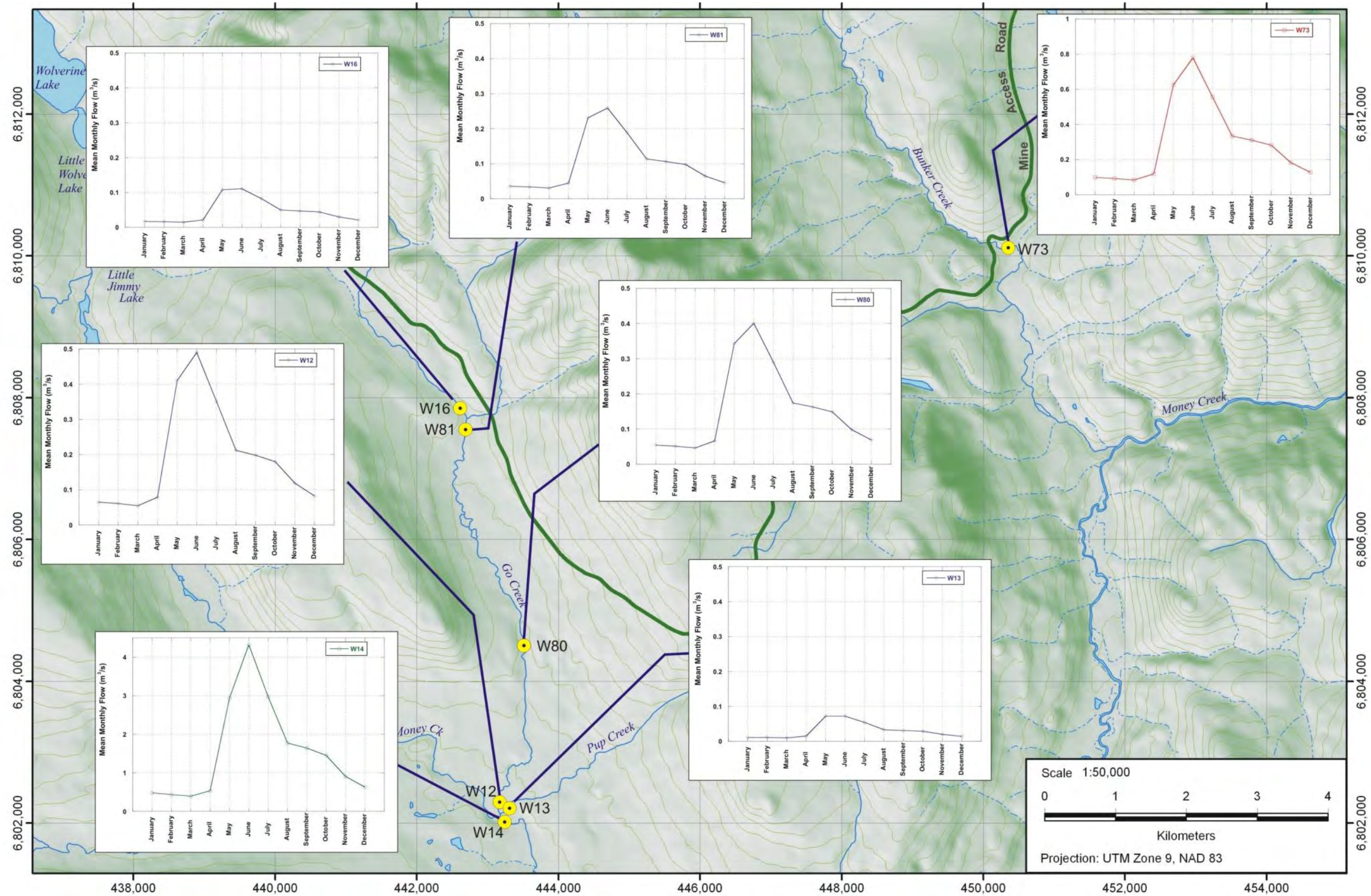


Figure 2-6 : Mean Monthly Flows within Exposure Area and Reference Area Streams

**Table 2-8:
Mean Monthly Flows for Exposure and Reference Area Streams**

Month	Exposure Area				Reference Area		Comparison
	Go Creek W16	Go Creek W81	Go Creek W80	Go Creek W12	Pup Creek W13	Bunker Creek W73	
January	0.017	0.036	0.054	0.065	0.011	0.099	0.479
February	0.016	0.034	0.051	0.061	0.011	0.093	0.435
March	0.015	0.031	0.046	0.055	0.01	0.084	0.392
April	0.021	0.045	0.066	0.079	0.015	0.119	0.537
May	0.108	0.231	0.343	0.410	0.072	0.625	2.938
June	0.111	0.259	0.401	0.490	0.072	0.780	4.324
July	0.083	0.189	0.290	0.352	0.054	0.556	2.970
August	0.050	0.114	0.174	0.212	0.033	0.334	1.772
September	0.047	0.106	0.163	0.198	0.031	0.311	1.642
October	0.044	0.098	0.149	0.180	0.029	0.282	1.450
November	0.030	0.065	0.098	0.119	0.020	0.183	0.906
December	0.021	0.046	0.069	0.083	0.014	0.128	0.631

The above estimates of flow are based on a long-term regional assessment. Hydrological monitoring by YZC has taken place since 2006. These flow measurements indicate that recent freshet flows (May - July) have been higher than predicted from average regional analysis, while fall and winter flows have been slightly higher than average regional estimates (Figure 2-7).

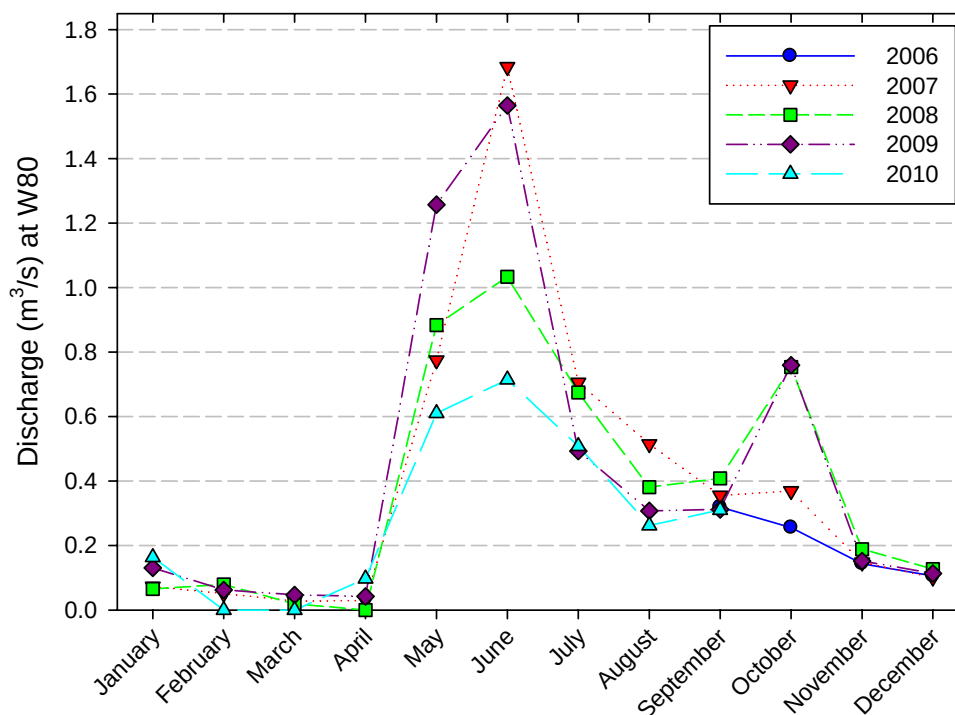


Figure 2-7: Measured Discharge in Go Creek at Station W80 from 2006 to 2010

The generally poor agreement for the peak flow periods of May to July is not surprising when comparing long-term data to yearly measurements as peak flow is strongly governed by snowpack depth at the onset of freshet. Winter snowpack is expected to vary widely from year-to-year and as a result, peak runoff will also be highly variable.

2.3.2.3 Water Quality Characteristics

Baseline water quality for the exposure area in Go Creek is described using data collected from stations W16, W81, W80 and W12 (Figure 2-4) for the period of 1995 to 2008. A complete discussion of baseline water quality throughout the project area is provided in Appendix A.

Mirroring the hydrograph of Go Creek, there is a strong seasonal signature in water chemistry. This is particularly evident for the physical water quality parameters conductivity and hardness where significant decreases are observed for both parameters during the spring freshet in late May/early June (Figure 2-8) owing to the large influx of pristine snowmelt water. As expected, the reverse is true for total suspended solids (TSS) in Go Creek. Values of TSS are typically below the detection limit for most of the year, except for periodically elevated levels that are typically observed during the freshet period (Figure 2-9).

Table 2-9 provides a summary of the average concentrations and 95th percentile values for parameters of key interest in Go Creek. There is little difference throughout Go Creek stations for most water quality parameters; although there is a slight trend towards increasing concentration with distance downstream for some parameters. For example, mean sulphate concentrations in upper Go Creek (W16) is approximately 8 mg/L and generally increases to values of approximately 15 mg/L in the lower reaches (Table 2-9) although these concentrations are considered to be low.

Metals are also similar among stations and generally low throughout the exposure area. The 95th percentile value for total chromium is equal to or slightly higher than the CCME guideline for Cr(VI) of 1.0 µg/L. The 95th percentile value for copper is also slightly elevated above the CCME guideline at 3 of the 4 stations. The 95th percentile value for selenium is exactly 1.0 µg/L at all 4 stations in Table 2-9. In fact, most measurements of selenium in Go Creek were below its detection limit (usually 1.0 µg/L) but when statistics were calculated for a data set, any value less than detection limit was set equal to the detection limit.

It should be noted that at station W80, aluminum, chromium, and iron 95th percentile values have been observed to be greater than their water quality guideline (Table 2-9). Copper 95th percentile is just below the CCME guideline of 2 µg/L. Concentrations of these metals are elevated when TSS levels are elevated during the freshet and are therefore associated with a solid-phase.

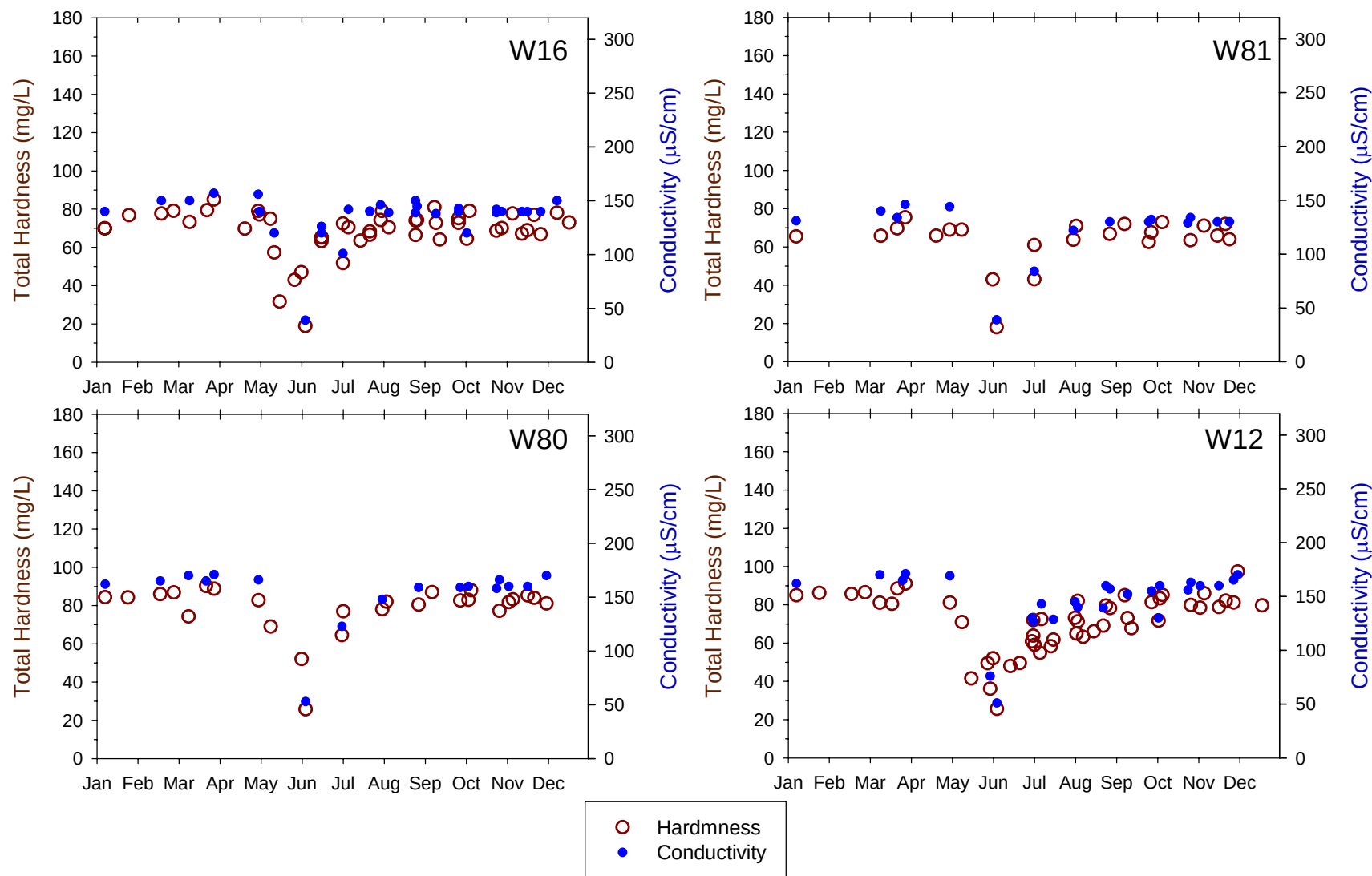


Figure 2-8: Seasonal Time Series (1995 - 2008) of Total Hardness and Conductivity at Stations in the Go Creek Exposure Area

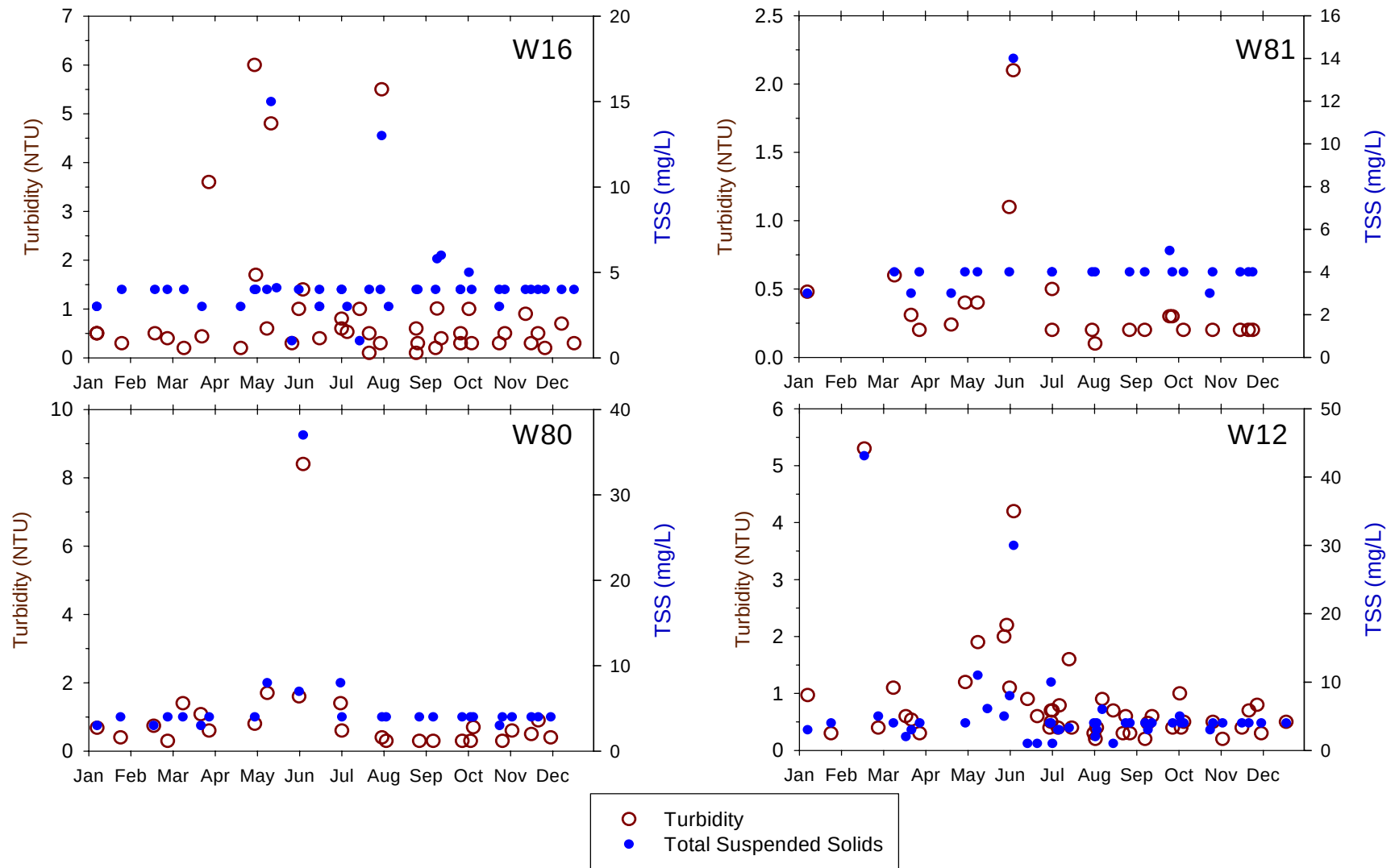


Figure 2-9: Seasonal Time Series (1995 - 2008) of Turbidity and Total Suspended Solids at Stations in the Go Creek Exposure Area

**Table 2-9:
Surface Water Quality Summary for Go Creek Exposure Area Stations**

Parameter	Units	W16		W81		W80		W12		Guideline ¹
		Average	95 th %	Average	95 th %	Average	95 th %	Average	95 th %	
Physical Tests										
pH	pH	7.8	8.1	7.8	8.0	7.9	8.1	7.8	8.1	6.5 - 9
Conductivity	uS/cm	135	153	124	145	154	170	146	170	
TSS ²	mg/L	7	15	4	5	6	8	5	11	
Hardness	mg/L	69	79	64	73	79	89	72	88	
DOC ³	mg/L	2.2	5.2	1.8	5.0	4.8	6.2	2.1	4.3	
Dissolved Anions										
Fluoride	µg/L	40	63	31	40	51	62	56	72	120
Sulphate	mg/L	8	11	9	12	15	19	13	18	100
Nutrients										
Ammonia-N	µg/L	16	49	8	20	10	20	14	53	914
Nitrate-N	µg/L	56	126	64	130	68	279	35	123	2900
Nitrite-N	µg/L	2	5	2	3	6	4	6	5	60
Total Phosphate-P	µg/L	11	28	8	21	7	14	7	14	
Total Metals										
Aluminum-Total	µg/L	35	88	26	60	57	153	32	79	100
Aluminum-Dissolved	µg/L	8	23	7	16	7	13	9	31	50 ^B
Antimony – Total	µg/L	0.12	0.50	0.22	0.10	0.06	0.12	0.12	0.50	6
Arsenic - Total	µg/L	0.25	0.50	0.17	0.30	0.30	0.58	0.30	0.50	5
Cadmium - Total	µg/L	0.08	0.12	0.02	0.04	0.06	0.08	0.03	0.06	0.15 ^A
Chromium - Total	µg/L	0.65	1.40	0.54	1.00	0.57	1.35	0.55	1.17	1
Copper - Total	µg/L	1.01	2.82	0.72	1.68	0.87	1.90	1.08	2.71	2
Iron - Total	µg/L	89	332	45	83	176	617	90	229	300
Iron -Dissolved	µg/L	22	45	14	30	37	109	31	82	350 ^B
Lead - Total	µg/L	0.14	0.50	0.05	0.10	0.12	0.54	0.17	0.62	2
Mercury - Total	µg/L	0.013	0.020	0.010	0.010	0.010	0.010	0.013	0.020	0.026
Molybdenum - Total	µg/L	0.48	1.00	0.32	0.40	0.44	0.47	0.51	1.00	73
Nickel - Total	µg/L	0.54	1.00	0.44	0.59	0.75	1.75	0.60	1.63	65
Selenium - Total	µg/L	0.62	1.00	0.55	1.00	0.86	1.09	0.91	1.26	2 ^B
Silver - Total	µg/L	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.1
Zinc - Total	µg/L	6.5	16.1	2.6	5.1	2.4	4.9	3.1	5.5	30

Bold values are greater than water quality guidelines.

1. Guidelines shown are CCME values unless otherwise noted. 2. Total Suspended Solids; 3. Dissolved Organic Carbon

A. USEPA hardness dependent chronic guideline for cadmium assuming a hardness of 50 mg/L; B. BC 30 day average guideline for protection of aquatic life.

Water quality characteristics of the reference area streams, namely Pup Creek (W13) and Bunker Creek (W73) are summarized in Table 2-10. As illustrated, water quality conditions in the reference streams are very similar to conditions throughout Go Creek.

**Table 2-10:
Surface Water Quality Summary for Reference Area Streams**

		W13 (Pup Ck)		W73 (Bunker Ck)		Guideline ¹
Parameter	Units	Average	95 th %	Average	95 th %	
Physical Tests						
pH	pH	7.7	8.1	8.1	8.2	6.5 – 9
Conductivity	uS/cm	126	158	227	294	
TSS ²	mg/L	4	5	5	5	
Hardness	mg/L	59	76	117	161	
DOC ³	mg/L	2.5	5.4	2.6	7.0	
Dissolved Anions						
Fluoride	µg/L	68	103	64	93	120
Sulphate	mg/L	12	16	19	30	100
Nutrients						
Ammonia-N	µg/L	13	34	8	20	914
Nitrate-N	µg/L	54	177	59	130	2900
Nitrite-N	µg/L	3	4	3	6	60
Total Phosphate-P	µg/L	7	19	7	12	
Total Metals						
Aluminum-Total	µg/L	34	114	17	52	100
Aluminum-Dissolved	µg/L	14	42	5	12	50 ^B
Antimony – Total	µg/L	0.09	0.50	0.13	0.20	6
Arsenic - Total	µg/L	0.24	0.50	0.27	0.50	5
Cadmium - Total	µg/L	0.04	0.11	0.02	0.04	0.22 ^A
Chromium - Total	µg/L	0.55	1.09	0.76	1.40	1
Copper - Total	µg/L	1.09	3.50	1.31	2.80	2
Iron - Total	µg/L	105	265	54	142	300
Iron -Dissolved	µg/L	42	107	18	41	350 ^B
Lead - Total	µg/L	0.15	0.50	0.07	0.11	2
Mercury - Total	µg/L	0.012	0.020	0.011	0.020	0.026
Molybdenum - Total	µg/L	0.44	1.00	0.51	0.66	73
Nickel - Total	µg/L	0.78	1.65	0.95	1.89	65
Selenium - Total	µg/L	0.68	1.00	0.81	1.30	2 ^B
Silver - Total	µg/L	0.01	0.02	0.01	0.02	0.1
Zinc - Total	µg/L	3.3	7.6	3.0	12.6	30

Bold values are greater than water quality guidelines.

1. Guidelines shown are CCME values unless otherwise noted.

2. Total Suspended Solids;

3. Dissolved Organic Carbon

A. USEPA hardness dependent chronic guideline for cadmium assuming a hardness of 50 mg/L;

B. BC 30 day average guideline for protection of aquatic life

Bunker Creek is characterized by higher conductivity and hardness values. Nutrients and major ion concentrations (e.g. ammonia and sulphate) are similar between reference streams and Go Creek. Metal concentrations in reference streams are generally low, with slightly elevated 95th percentile values for Al, Cr and Cu observed similar to that measured throughout Go Creek (Table 2-9 and Table 2-10).

2.3.2.4 Biological Characteristics

No commercial or sport fisheries occur in the project area or reference streams. Extensive fish community surveys conducted in the project area streams have identified the presence of 7 species of fish. None of the fish present are listed under Species at Risk Act (Environment Canada, 2005). Bull trout have been collected from exposure and reference areas. Bull trout have been designated as a “sensitive” species in the Yukon by the General Status of Species in Canada (National General Status Working Group 2004). This designation indicates that a species is not believed to be at risk of immediate extirpation or extinction but may require special attention or protection to prevent them from becoming at risk.

Only slimy sculpin in Money Creek has been shown to be present in sufficient numbers to be considered a species appropriate for EEM. In other streams surveyed, including Go Creek, a maximum of 21 individuals of this species have been captured. Two other species (bull trout and arctic grayling) have been found to be present in Go Creek, with a maximum of 5 individuals of these species captured. Fish habitat surveys of Go Creek and potential reference streams in the project area have concluded that these streams provide poor spawning habitat due to limited spawning substrates and poor overwintering habitat due to infrequent deep pools. Swift flows limit habitat capabilities for fish at all life stages.

More detailed biological information with respect to fish and benthic invertebrates in exposure and reference streams is provided in Chapter 3 and Chapter 4, respectively.

2.4 Effluent Mixing and Dilution Predictions

2.4.1 Mixing and Dilution Estimates of Final Effluent

As discussed, the Wolverine Project will only discharge treated tailings impoundment water through one final discharge location in the upper reaches of Go Creek. Discharge from the water treatment plant into the headwaters of Go Creek will rapidly become fully mixed in Go Creek. The upper reaches of Go Creek are narrow (mean channel width of 1.3 at station W16, with numerous riffles that create turbulence that will rapidly mix the effluent in the stream. For the purposes of this evaluation, effluent was assumed to be discharged between May and October at a rate of $0.012 \text{ m}^3/\text{s}$ or a nominal $45 \text{ m}^3/\text{h}$.

Schedule 5, s.11(a) of the MMER requires that a site characterization shall include “a description of the manner in which the effluent mixes within the exposure area, including an

estimate of the concentration of effluent in water at 250 m from the final discharge point.” Baseline studies of stream discharge included four stations on Go Creek. The closest baseline station to the final discharge point was W16, approximately 780 m downstream. Station W85 was recently established at a location 250 m downstream of the final discharge point (UTM NAD83 coordinates 442000E, 6808500N). Stream discharge measured at W85 on September 4th 2010 was 0.074 m³/s which would produce a dilution of 6:1 (i.e. 14% effluent) at an effluent discharge rate of 0.012 m³/s.

Seasonal data for Go Creek discharge rates are available from baseline measurements at the stations shown in Table 2-11 and Figure 2-6. Discharge rate at these locations has been estimated from regional analysis as well as specific flow measurements collected as part of ongoing monitoring. It is expected that discharge rate at station W16 will closely approximate discharge rate at W85 as there is approximately a 12% increase in catchment area between W85 and W16 and no tributaries to Go Creek in the stretch between these stations. Therefore seasonal changes in discharge rate at W16 can be used to illustrate seasonal changes expected at W85. Average flow rate at W16 during the discharge period varies from a high of 0.11 m³/s in June to a low of 0.044 m³/s in October.

Effluent mixing and dilution was estimated using the average discharge rates at baseline stations in Go Creek and Money Creek in order to determine the expected exposure area (Table 2-11). 780 m downstream of the discharge point (at station W16) dilution will vary between 4:1 (during average low flow in October) and 9:1 (during average high flow in June). Further dilution occurs from Hawkowl Creek which flows into Go Creek between Stations W16 and W81. There is moderate dilution that occurs between Hawkowl Creek and the lower reaches of Go Creek before the confluence with Money Creek as there are no significant tributaries in this section of Go Creek. Near the mouth of Go Creek (Station W12) effluent concentration will be approximately 2% to 6% depending on flow conditions.

Significant dilution occurs immediately as Go Creek enters Money Creek. At station W14 (Money Creek just downstream of Go Creek), the predicted concentration of effluent will be less than 1%. As such, the extent of the exposure area is defined as Go Creek between the effluent discharge point and the confluence with Money Creek.

The above dilution estimates are based on average flow in Go Creek and Money Creek estimated from analysis of regional hydrology. Baseline measurements of stream discharge rate since 2006 have found that measured discharge was much higher than the calculated average during freshet months, was slightly higher in the fall, and had close agreement during winter low flow (Figure 2-7). Considering that measured discharge during months when effluent will be discharged is typically higher than the average discharge used in dilution calculations, the exposure area defined from these calculations can be considered conservative, since effluent concentration will likely be less than 1% in the lower reaches of Go Creek for much of the effluent discharge period.

**Table 2-11:
Dilution Downstream of Discharge Point in June and October**

Site	Distance downstream	Dilution (as % effluent)		Dilution (ratio Creek:Effluent)	
		June	October	June	October
Discharge point	0 m	100 %	100 %	0:1	0:1
W16	780 m	10 %	21 %	9:1	4:1
W81	1.2 km	4 %	11 %	23:1	8:1
W80	5.0 km	3 %	7 %	33:1	13:1
W12	7.0 km	2 %	6 %	41:1	16:1
W14	7.5 km	0.3 %	0.8 %	367:1	125:1

2.4.2 Water Quality Predictions During Effluent Discharge

Estimates of monthly water quality at the various stations throughout the exposure area during effluent discharge (May to October) were developed. The key assumptions used in this assessment were:

- Mean baseline water quality and guideline values in the exposure area are defined in Table 2-9;
- Mean monthly flow conditions for the discharge months of May to October are defined in Table 2-8;
- Since actual effluent chemistry is unavailable, effluent concentrations are assumed equal to the maximum allowable concentrations as defined by Type A Water Licence QZ04-065 (Table 2-5);
- Effluent is discharged at constant rate of 0.012 m³/s for the discharge period of May to October; and
- All parameters behave conservatively within the water column and no allowance for geochemical processes (e.g., adsorption and/or precipitation) to affect downstream concentrations other than dilution.

A mass loading approach was employed using the above assumptions to predict, on a mean monthly basis, water quality in the exposure area of Go Creek. An example calculation of water chemistry at station W12 for the month of May is provided for illustrative purposes in Table 2-12. As shown, the predicted concentrations for key monitoring parameters is a function of hydrologic conditions, effluent flow, effluent chemistry and existing chemistry within Go Creek.

Table 2-12:
Example Calculation of Water Chemistry (mg/L) at Station W12 in Exposure Area During Effluent Discharge for the Month of May

Parameter	Concentration (mg/L)		Discharge rate (L/s)		Predicted Concentration (mg/L)	Guideline (mg/L)
	Baseline	Effluent	W12	Effluent		
Ammonia	0.014	5	410	12	0.16	0.914
Nitrate	0.035	10	410	12	0.32	2.9
Sulphate	13	1800	410	12	64	100
TSS	5	15	410	12	5	
CN-WAD ¹	0.00001	0.02	410	12	0.0006	0.005
CN-total ¹	0.00001	0.05	410	12	0.0014	
Metals						
Aluminum	0.032	0.8	410	12	0.054	0.1
Antimony	0.00012	0.08	410	12	0.0024	0.006
Arsenic	0.0003	0.05	410	12	0.0017	0.005
Cadmium	0.00003	0.002	410	12	0.000086	0.00022
Copper	0.00108	0.015	410	12	0.0015	0.002
Iron	0.09	0.5	410	12	0.102	0.3
Lead	0.00017	0.02	410	12	0.0007	0.002
Mercury	0.000013	0.0001	410	12	0.000015	0.000026
Molybdenum	0.00051	0.73	410	12	0.021	0.073
Nickel	0.0006	0.5	410	12	0.015	0.065
Selenium	0.00091	0.02	410	12	0.0015	0.002
Zinc	0.0031	0.5	410	12	0.017	0.03

1. Cyanide was not measured in baseline, therefore background concentration was estimated as equal to the analytical detection limit.

Summaries of the water quality predictions for each of the four (4) stations in the exposure area (*i.e.* W16, W81, W80 and W12), for all months of the discharge period (May to October), are provided in Table 2-13. It should be noted that the predicted concentrations are an upper bound of expected concentrations in the exposure area as a key assumption in the assessment is that effluent concentrations are discharged at the maximum allowable level. Treatment of the effluent, for example is expected to lower Ni and Zn concentrations in the treated discharge to concentrations below the respective permitted limit. As well, recent measurements of discharge rate in Go Creek have been higher than the monthly average discharge rates used in the mass balance calculations which are based on analysis of regional data. Higher Go Creek discharge rates will produce greater dilution and lower predicted concentrations for parameters with higher concentrations in effluent than background concentration.

Table 2-13:
Monthly Water Quality Predictions within the Go Creek Exposure Area
During Effluent Discharge

Station W16

Parameter	May	June	July	August	September	October	Guideline
Ammonia	0.51	0.50	0.65	0.98	1.03	1.08	0.914
Nitrate	1.05	1.03	1.31	1.98	2.08	2.19	2.9
Sulphate	187	183	234	355	372	392	100
TSS	8	8	8	9	9	9	
CN-WAD	0.0020	0.0020	0.0025	0.0039	0.0041	0.0043	0.005
CN-total	0.0050	0.0049	0.0063	0.0097	0.0102	0.0107	
Metals							
Aluminum	0.112	0.110	0.132	0.183	0.191	0.199	0.1
Antimony	0.0081	0.0079	0.0102	0.0156	0.0164	0.0172	0.006
Arsenic	0.0052	0.0051	0.0065	0.0099	0.0104	0.0109	0.005
Cadmium	0.00027	0.00027	0.00032	0.00045	0.00047	0.00049	0.00022
Copper	0.0024	0.0024	0.0028	0.0037	0.0038	0.0040	0.002
Iron	0.130	0.129	0.141	0.169	0.173	0.177	0.3
Lead	0.0021	0.0021	0.0026	0.0040	0.0042	0.0044	0.002
Mercury	0.00002	0.00002	0.00002	0.00003	0.00003	0.00003	0.000026
Molybdenum	0.073	0.072	0.093	0.142	0.149	0.157	0.073
Nickel	0.050	0.049	0.064	0.097	0.102	0.108	0.065
Selenium	0.0026	0.0025	0.0031	0.0044	0.0046	0.0048	0.002
Zinc	0.056	0.055	0.069	0.102	0.107	0.112	0.03

Concentrations shown as **Bold Red** are in excess of their guideline value.

Station W81

Parameter	May	June	July	August	September	October	Guideline
Ammonia	0.25	0.23	0.31	0.48	0.52	0.55	0.914
Nitrate	0.55	0.50	0.66	1.01	1.07	1.15	2.9
Sulphate	97	88	116	180	191	204	100
TSS	5	4	5	5	5	5	
CN-WAD	0.0010	0.0009	0.0012	0.0019	0.0020	0.0022	0.005
CN-total	0.0025	0.0022	0.0030	0.0048	0.0051	0.0055	
Metals							
Aluminum	0.064	0.060	0.072	0.100	0.105	0.110	0.1
Antimony	0.0042	0.0038	0.0050	0.0078	0.0083	0.0089	0.006
Arsenic	0.0026	0.0024	0.0031	0.0049	0.0052	0.0056	0.005
Cadmium	0.00012	0.00011	0.00014	0.00021	0.00022	0.00024	0.00022
Copper	0.0014	0.0014	0.0016	0.0021	0.0022	0.0023	0.002
Iron	0.067	0.065	0.072	0.088	0.091	0.095	0.3
Lead	0.0010	0.0009	0.0012	0.0020	0.0021	0.0022	0.002
Mercury	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	0.000026
Molybdenum	0.036	0.033	0.044	0.070	0.075	0.080	0.073
Nickel	0.025	0.023	0.030	0.048	0.051	0.055	0.065
Selenium	0.0015	0.0014	0.0017	0.0024	0.0025	0.0027	0.002
Zinc	0.027	0.025	0.032	0.050	0.053	0.057	0.03

Table 2-13 (continued):

Station W80

Parameter	May	June	July	August	September	October	Guideline
Ammonia	0.18	0.15	0.21	0.33	0.35	0.38	0.914
Nitrate	0.40	0.36	0.46	0.71	0.75	0.81	2.9
Sulphate	75	67	86	130	137	148	100
TSS	6	6	6	7	7	7	
CN-WAD	0.0007	0.0006	0.0008	0.0013	0.0014	0.0015	0.005
CN-total	0.0017	0.0015	0.0020	0.0032	0.0034	0.0037	
Metals							
Aluminum	0.082	0.079	0.087	0.105	0.108	0.112	0.1
Antimony	0.0028	0.0024	0.0032	0.0052	0.0055	0.0060	0.006
Arsenic	0.0020	0.0017	0.0023	0.0035	0.0037	0.0040	0.005
Cadmium	0.00013	0.00012	0.00014	0.00019	0.00019	0.00020	0.00022
Copper	0.0013	0.0013	0.0014	0.0018	0.0018	0.0019	0.002
Iron	0.187	0.185	0.189	0.197	0.198	0.200	0.3
Lead	0.0008	0.0007	0.0009	0.0014	0.0015	0.0016	0.002
Mercury	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.000026
Molybdenum	0.025	0.022	0.029	0.048	0.050	0.055	0.073
Nickel	0.018	0.015	0.021	0.033	0.035	0.038	0.065
Selenium	0.0015	0.0014	0.0016	0.0021	0.0022	0.0023	0.002
Zinc	0.019	0.017	0.022	0.035	0.037	0.039	0.03

Concentrations shown as **Bold Red** are in excess of their guideline value.

Station W12

Parameter	May	June	July	August	September	October	Guideline
Ammonia	0.16	0.13	0.18	0.28	0.30	0.33	0.914
Nitrate	0.32	0.27	0.36	0.57	0.60	0.66	2.9
Sulphate	64	56	72	109	115	125	100
TSS	5	5	5	6	6	6	
CN-WAD	0.0006	0.0005	0.0007	0.0011	0.0012	0.0013	0.005
CN-total	0.0014	0.0012	0.0017	0.0027	0.0029	0.0031	
Metals							
Aluminum	0.054	0.050	0.057	0.073	0.076	0.080	0.1
Antimony	0.0024	0.0020	0.0028	0.0044	0.0047	0.0051	0.006
Arsenic	0.0017	0.0015	0.0019	0.0030	0.0031	0.0034	0.005
Cadmium	0.00009	0.00008	0.00009	0.00014	0.00014	0.00015	0.00022
Copper	0.0015	0.0014	0.0015	0.0018	0.0019	0.0020	0.002
Iron	0.102	0.100	0.104	0.112	0.113	0.116	0.3
Lead	0.0007	0.0006	0.0008	0.0012	0.0013	0.0014	0.002
Mercury	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.000026
Molybdenum	0.021	0.018	0.025	0.040	0.042	0.046	0.073
Nickel	0.015	0.013	0.017	0.027	0.029	0.032	0.065
Selenium	0.0015	0.0014	0.0015	0.0019	0.0020	0.0021	0.002
Zinc	0.017	0.015	0.019	0.030	0.031	0.034	0.03

As illustrated in Table 2-13, predicted concentrations for all parameters decrease markedly throughout the exposure area from peak concentrations occurring near the effluent discharge point (W16). At station W12 near the mouth of Go Creek, only minor elevated concentrations of sulphate are predicted for the months of September and October, based on the assumption that effluent will contain parameters at the maximum allowable limit.

2.5 Existing Factors Affecting Fish Habitat

There are no existing anthropogenic factors affecting fish habitat in the exposure and reference areas. The mine access road crosses Bunker Creek and Hawkowl Creek but no disturbance to fish habitat from these crossings has been observed.

The primary factors affecting fish productivity in Go Creek, Pup Creek, and Bunker Creek are swift flows and extremely limited overwintering pool habitat availability. Shallow residual pool depths in most of the watercourses indicate a lack of overwintering habitat. Most pools observed during the August 2005 survey likely freeze solid during winter. Despite low to moderate gradients, rearing bull trout and/or arctic grayling habitat is extremely limited by swift, unimpeded flows, most often with negligible boulders and functioning large woody debris to create low velocity pools. Potential fish migration barriers include beaver dams and steep gradients.

3. Fish Monitoring

As described in the Site Characterization (Chapter 2), the effluent concentration 250 m downstream of the final effluent discharge point is predicted to be greater than 1% during average flow conditions, therefore a fish population survey is required by the MMER (*Schedule 5, Section 9(b)*). Effluent discharge is not expected until 2013, therefore during the first EEM cycle effluent concentration will be less than 1% in the exposure area and a fish survey will not be included. Total mercury concentration in effluent is predicted to be <0.10 µg/L, therefore fish tissue analyses are not included in the study design (*Schedule 5, Section 9(c)*). The mercury concentration in effluent will be verified according to the MMER *Schedule 5, Section 4(1)*.

The objectives of fish monitoring will be to 1) document fish community characteristics in the exposure area (Go Creek), and 2) to evaluate the effect of effluent to fish in Go Creek. Fish community surveys will be conducted in Go Creek and reference streams and the data generated will be analyzed to determine if effluent has had an effect on fish.

3.1 Study Areas

The exposure area is the approximately 7 km length of Go Creek between the effluent discharge point and the confluence with Money Creek (Figure 3-1), as described in Chapter 2. Reference areas are lower Pup Creek and Bunker Creek below the mine access road. It is expected that the number of fish present at each area will be naturally low (see Section 3.2) and having two reference areas will strengthen the interpretation of results. In addition to these exposure and reference areas, Money Creek upstream and downstream of Go Creek will be sampled as supporting data for the survey. Money Creek has different physical characteristics than Go Creek, and supports much higher fish abundance; therefore it is not suitable as a reference area for detecting an effect on fish communities. Nevertheless, data from Money Creek will be used to interpret conditions during the EEM survey relative to historical data from the same locations.

3.2 Historical Fish Data

The following fish habitat and fish community surveys have been carried out in the Wolverine Project area:

- July and September 1996 (Westmin Resources Ltd, 1996)
- September 1997 (White Mountain Environmental Consulting, 1997)
- October 2004 (Gartner Lee Ltd, 2005)
- August 2005 (Jacques Whitford Ltd., 2005)

These surveys have documented the presence of seven species of fish (Table 3-1). Of these seven species, lake trout, burbot, and longnose sucker were only found in the lakes and tributaries to the lakes. No commercial or sport fishery takes place in the exposure or reference area streams.

Table 3-1:
Fish Species Previously Captured in Wolverine Project Area Streams

Family	Species	Common Name	Species Code
Salmonidae	<i>Thymallus arcticus</i>	arctic grayling	GR
Salmonidae	<i>Salvelinus confluentus</i>	bull trout	BT
Salmonidae	<i>Salvelinus namaycush</i>	lake trout	LT
Gadidae	<i>Lota lota</i>	burbot	BB
Catostomidae	<i>Catostomus catostomus</i>	longnose sucker	LSU
Esocidae	<i>Esox lucius</i>	northern pike	NP
Cottidae	<i>Cottus cognatus</i>	slimy sculpin	CCG

General stream characteristics are provided in Chapter 2. The 4 fish habitat surveys that have taken place at the Wolverine Project have generated the same conclusion that fish habitat in Money Creek is generally good, with varied in-stream features providing suitable habitat for most life stages of fish species expected to inhabit the area. Many of the first order tributaries to Money Creek (including Go, Pup, and Bunker Creeks) have fast flows and limited habitat diversity that likely limit spawning, rearing, and overwintering potential of these streams.

Results of fish community surveys in the project area are summarized in Table 3-2 and Figure 3-2. The number of fish captured in each survey was low in all streams. Slimy sculpin was the most abundant species at all sites. Money Creek near Go Creek had the highest abundance of fish. Fish were captured in lower Go Creek in July 1996 and August 2005, but none were captured during the September 1996 survey. No fish were captured in upper Go Creek or Hawkowl Creek. The abundance of fish in the reference areas is also very low. Slimy sculpin were captured in Pup Creek in July 1996 but no fish were captured there during subsequent surveys. An extensive survey of Bunker Creek in August 2005 did not capture any fish there.

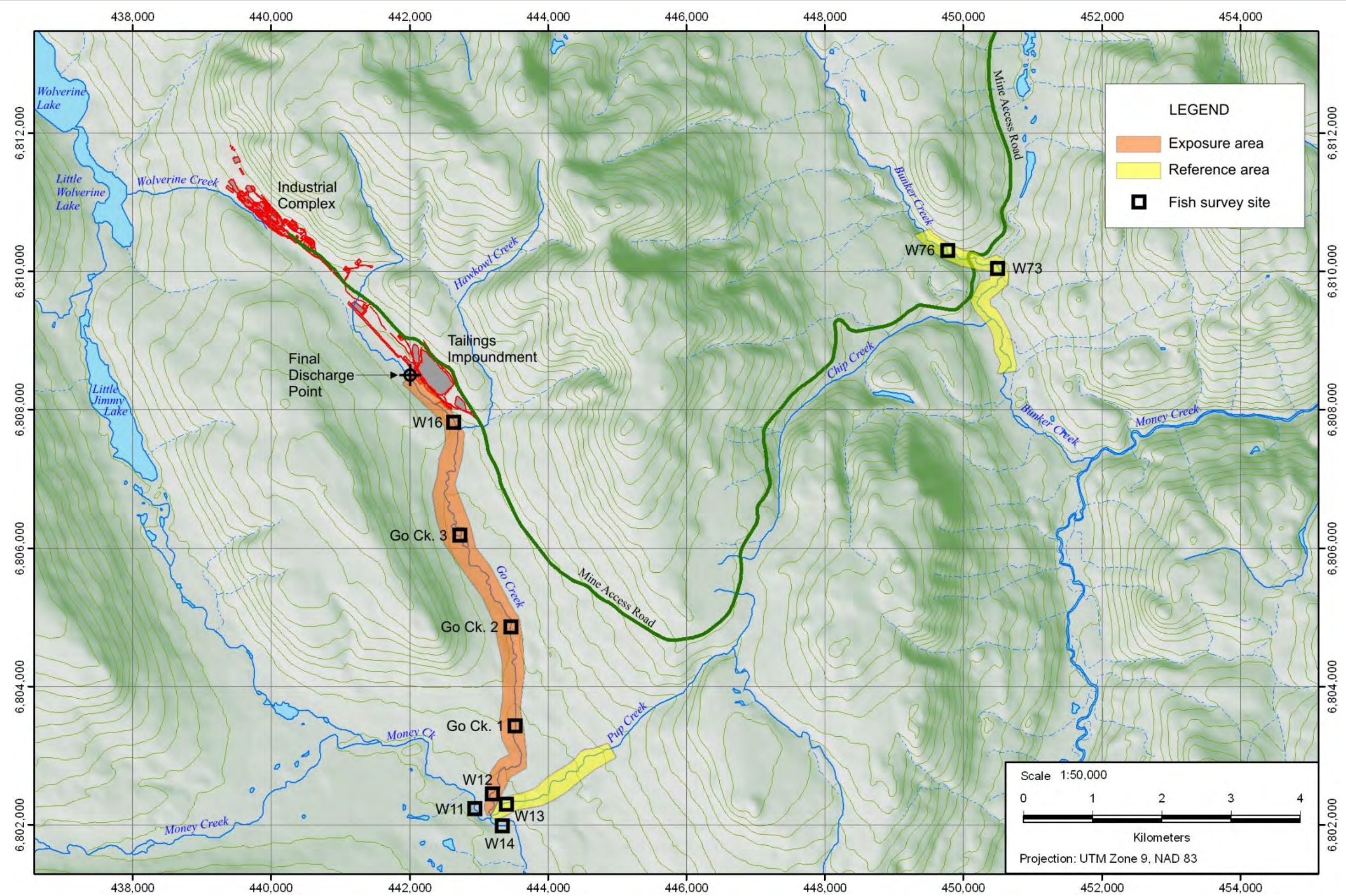


Figure 3-1: EEM Fish Survey Sites

Table 3-2:
Results from Historic Electrofishing Surveys

Creek	Location	July 1996					September 1996					September 1997					October 2004					August 2005												
		Station ID	Species	EF Time (s) ¹	# Caught	CPUE ² (#/min)	Station ID	Species	EF Time (s)	# Caught	CPUE (#/min)	Station ID	Species	EF Time (s)	# Caught	CPUE (#/min)	Station ID	Species	EF Time (s)	# Caught	CPUE (#/min)	Station ID	Species	EF Time (s)	# Caught	CPUE (#/min)								
Go	Upper (u/s of W16)	G4 + G5	-	299	0	0															W24	-	300	0	0									
	Mid (W16 to W80)	G3	-	232	0	0															W16+Go Ck 3+Go Ck 2	-	1070	0	0									
	Lower (W80 to Money Ck)	G2	GR	447	3	0.40															Go Ck 1	GR	1800	1	0.03									
		G1	GR	919	1	0.07																BT	1800	4	0.13									
			CCG	919	21	1.37	G1		89	0	0											W12	GR	840	3	0.21								
			BT	919	5	0.33																	CCG	840	1	0.07								
Hawkowl	Above road	HO	-	244	0	0										R18 + R19	-	1321	0	0	W22 + W23	-	440	0	0									
	Below road															M18	-	1365	0	0	W15	-	780	0	0									
Pup	Lower reach	P1	CCG	175	6	2.06															W13	-	300	0	0									
	Mid reach															M17	-	487	0	0														
Money	U/s Go Ck																				W11	GR	600	2	0.20									
	At Go Ck	M7G	GR	685	6	0.53	M7G	CCG	342	30	5.26																							
			CCG	685	77	6.74																				W14	GR	660	1	0.09				
			BT	685	3	0.26																									CCG	660	14	1.00
	D/s Go Ck	M6	GR	971	11	0.68																												
			CCG	971	156	9.64																				M4 + M4(trib)	GR	823	1	0.07				
			BT	971	6	0.37																									BT	823	13	0.95
	At Bunker Ck	M4 + M4(trib)	GR	823	1	0.07						M4 + Money	CCG	468	3	0.38																		
BT			823	13	0.95	BT																					468	2	0.26					
CCG			823	36	2.62																													
Bunker	U/s of Road															R9 + R10	-	858	0	0	BC2-BC5 + 5	-	1770	0	0									
	Below Road btw beaver dams															M1 u/s	BT	972	2	0.12	BC1	-	840	0	0									
	Below Road d/s of lower beaver dam															M1 d/s	-	1267	0	0														
	Chip Creek -1 trib d/s of Bunker															M3	BT	820	1	0.07														

1. Electrofishing time
2. Catch per Unit Effort
Fish species codes are: BT = bull trout, GR = arctic grayling, CCG = slimy sculpin

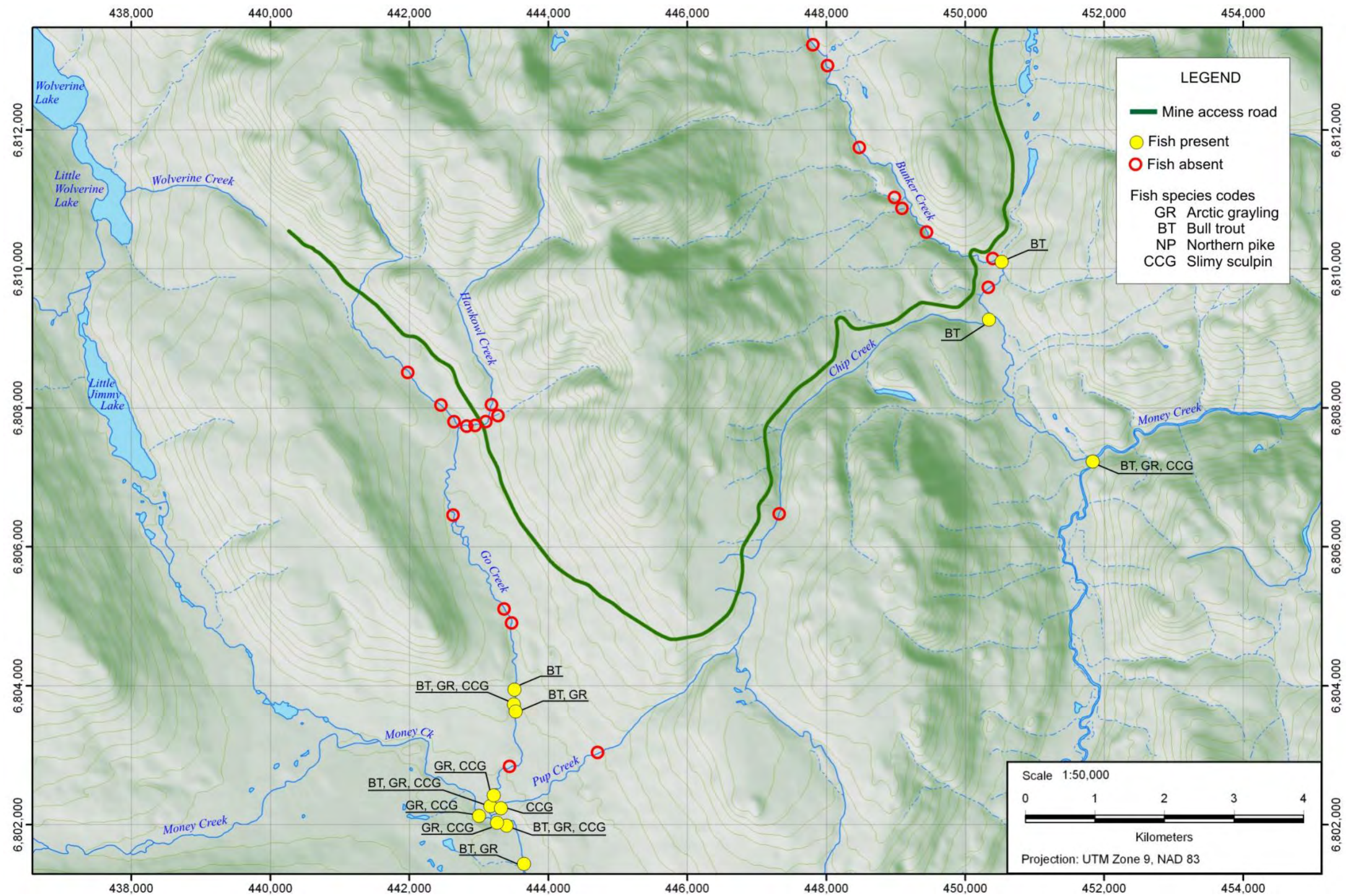


Figure 3-2: Fish Survey Results from Historical Sampling

3.3 EEM Survey Methods

Historical data shows that fish are not abundant in the project area and therefore non-lethal fishing methods will be used. The 1996 and 1997 surveys of Go Creek and Money Creek used several fish collection methods including minnow trapping, seine netting, angling, and electrofishing. Electrofishing was the most effective method for capturing the species present in these creeks and will be used for EEM monitoring.

Fish sampling and fish habitat assessments will be conducted in July or August. Summer months have historically had more fish present than during fall (Table 3-2), therefore, sampling at this time of year will provide the best opportunity to capture enough fish for statistical analyses. The early October 2004 survey captured a total of 8 fish in the 11 reaches sampled (Gartner Lee, 2005). The report for that survey stated “Water temperatures were low, between 0.9 and 2 °C, suggesting fish would be less active and harder to catch, and in the case of Arctic grayling, the fish may have moved to different areas to overwinter.”

Electrofishing will be conducted in five reaches in Go Creek (near Stations W12, Go Creek 1, Go Creek 2, Go Creek 3, and W16), duplicating the 2005 baseline survey (Figure 3-1). Reference areas will be surveyed in lower Pup Creek (W13) and Bunker Creek. Money Creek upstream of Go Creek (W11) and downstream of Go Creek (W14) will also be sampled to gather supporting data, but these data will not be used for comparisons of exposure to reference areas.

The Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring (EEM Guidance Document) (Environment Canada, 2002) states that a minimum of 100 individuals of the target species should be collected if non-lethal sampling is used. However historic results indicate it is unlikely that this many individuals will be captured. Instead of targeting one species, all fish that are encountered during the survey will be captured and length and weight recorded. The area sampled will be maximized in order to capture as many fish as possible. At a minimum, the length of reach surveyed will be a distance ten times the mean channel width. As habitat features of most watercourses are typically repeated approximately every six channel widths, this distance ensures that all representative habitat types are sampled. In streams with narrow channel width (e.g. Go Creek which has a wetted channel width of approximately 1.5 - 3m) at least 400 m length of stream will be sampled if physical conditions permit.

Electrofishing effort will be timed, and the area sampled will be estimated. Electrofishing will take place in all habitats with sufficient depth, with increased effort expended in areas that typically provide refuge for fish (e.g. undercut banks, submerged logs, boulder cover, and overhanging vegetation). Captured fish will be measured for length (± 1 mm) and weight (± 1 %) and released. If the caudal fin is forked, then fork length will be measured;

otherwise total length will be measured. If possible, age and sex of individuals will also be determined in the field. Any physical abnormalities on fish will be recorded.

As part of stream surveys, any special habitat features will be identified and recorded, such as fish migration barriers or factors that potentially limit fish production. Significant habitat quality components (rearing, spawning, overwintering and cover) will be noted for fish species known or suspected to occur in a particular reach or watershed. Habitat data will include the following physical attributes: site length, residual pool depth, bank-full width, stream stage, percentage cover (woody debris, boulder, cutbank, deep pool, overstream vegetation and in-stream vegetation), crown closure, bank shape, bank texture, turbidity, dominant and sub-dominant bed materials, and disturbance indicators.

If the initial fish survey determines that fish populations in the reference and exposure streams are too small to collect the minimum number of fish required for a non-lethal survey then alternative methods for biological monitoring will be considered. Examples of alternative methods are described in Chapter 12 of the EEM Guidance Document. These include mesocosm studies, caged bivalves, and expanded sublethal toxicity testing.

4. Benthic Invertebrate Monitoring

Benthic invertebrates are recommended in the EEM Guidance Document as the primary indicator organisms for monitoring effects on fish habitat. This chapter describes the study design for the initial benthic invertebrate community monitoring. The objective of the first monitoring program is to determine if mine effluent discharged to Go Creek has had an effect on the benthic invertebrate community in the exposure area. An effect on the benthic invertebrate community means a statistical difference between community descriptors (*i.e.* total benthic invertebrate density, evenness index, taxa richness, and similarity index) between an exposure area and a reference area (*MMER Schedule 5, section 1*). The survey will be carried out as described below.

4.1 Study Area

The exposure area is the approximately 7 km length of Go Creek between the effluent discharge point and the confluence with Money Creek, as described in Chapter 2. Benthic invertebrate sampling will take place at two locations in Go Creek: Station W16 (high exposure) and Station W12 at the mouth of Go Creek (moderate exposure) (Figure 4-1). Both these sites have been monitored in 2005 and 2007, as described in Section 4.2, which may permit before-and-after data comparisons during interpretation of EEM program results.

Reference sites for benthic invertebrate monitoring will be in Pup Creek (Station W13) and Bunker Creek (Station W76) (Figure 4-1). These locations are in streams with similar physical characteristics to Go Creek and which will have no exposure to effluent. These sites are preferable to Go Creek upstream of the discharge point because they have physical characteristics that are more similar to the exposure area. Reaches sampled in these reference streams will be selected in the field to be as similar as possible to the Go Creek sites, which will be surveyed first.

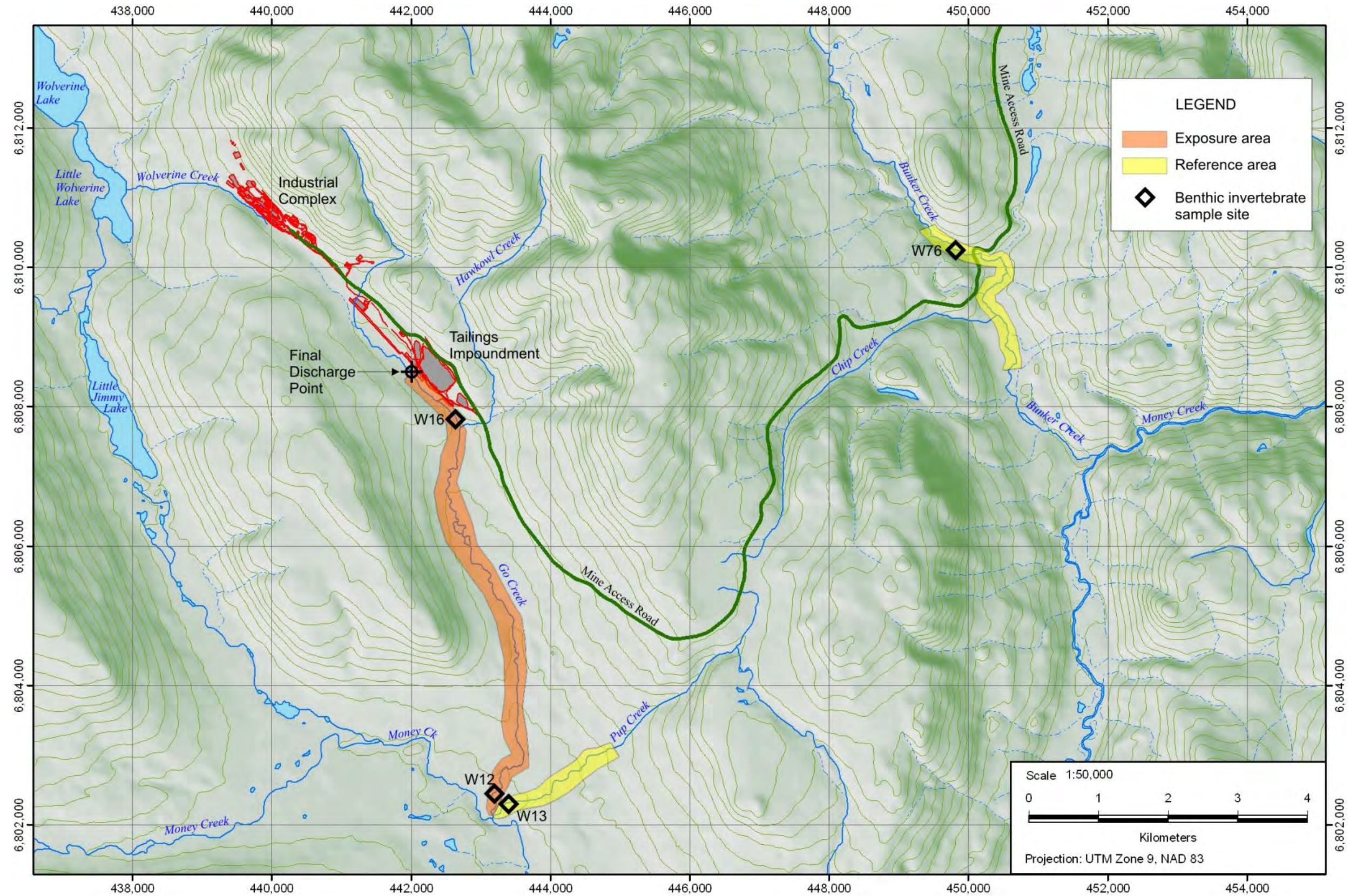


Figure 4-1: EEM Benthic Invertebrate Sample Sites

4.2 Historical Benthic Invertebrate Monitoring

Benthic invertebrate community monitoring in the project area was conducted in 1997, 2005 and 2007. These baseline monitoring programs have been summarized in Appendix A. The sections of that report that are directly relevant to this EEM First Study Design are presented below.

4.2.1 Ecologically Relevant Season

The 1997 benthic invertebrate monitoring program investigated changes in benthic communities over the course of the growing season in May, June, and September by sampling one site (Station W9, at the mouth of Wolverine Creek). Results of these surveys are summarized in Table 4-1. Over the course of the summer there was an increase in total invertebrate density, the number of taxa, and the number of sensitive taxa (*i.e.* taxa in the orders Ephemeroptera, Plecoptera, and Tricoptera (EPT taxa)). Diversity was similar in May and September, while evenness decreased over the same period. Overall these data indicate that the benthic invertebrate community in late summer/early fall is mature, hosting a large number of taxa and sensitive taxa, and density is relatively high. Subsequent monitoring (in 2005 and 2007) was carried out in September. Similarly, EEM monitoring will take place in September, when effects to the benthic invertebrate community from effluent exposure are most likely to be detected, and to allow EEM results to be compared to historic sampling.

Table 4-1:
Summary of time series data from samples collected in 1997 at Station W9

Date	Density (#/m ²)	Richness (# Taxa)	# EPT Taxa ¹	Simpson's Diversity Index	Simpson's Evenness Index
May	280	18	4	0.73	0.20
July	1367	20	6	0.61	0.13
Sept.	4103	39	8	0.77	0.11

1. Number of taxa in the orders Ephemeroptera, Plecoptera, and Tricoptera.

4.2.2 Benthic Invertebrate Monitoring in 2005 and 2007

Baseline sampling in Go Creek and Money Creek as well as potential reference sites took place in September 2005 and 2007 (JWL., 2005 & 2008). Riffle zones were sampled using a Hess sampler (0.093 m² area, 210 µm mesh size). Three replicate stations were sampled per area. Between one and five Hess sampler sets (*field sub-samples*) were composited to make up one sample. Benthic invertebrates were enumerated and identified to lowest practical taxonomic level (genus for most insects, family for oligochaetes) by taxonomist Charles Low (Victoria, B.C.). The total sample was sorted into coarse and fine subsamples. The fine sub-

sample was split, if necessary, to reduce the number of organisms in the predominant taxon to approximately 100 individuals. No splitting of the coarse subsample was necessary.

In general, stations with relatively high density of invertebrates also hosted communities with relatively high total number of taxa and EPT taxa (Table 4-2). An exception to this generalization is Station W12 at the downstream extent of Go Creek which had relatively low density in both 2005 and 2007 (Figure 4-2) but had moderate to high number of taxa and number of EPT taxa (Table 4-2). This characteristic at Station W12 can largely be explained by relatively low abundance of diptera (true flies) at this station.

Table 4-2:
Community Characteristic Statistics (Averages) from
Stream Benthic Invertebrate Taxonomy Data

Stream	Year	Station	Density (#/m ²)	Richness ¹	# EPT Taxa ²	Simpson's Diversity Index	Simpson's Evenness Index
Nougha	2005	W1	278,000	56	13	0.79	0.08
Wolverine	2005	W9	9,000	40	10	0.67	0.08
Wolverine	2007	W9	1,391	40	7	0.82	0.14
Money	2005	W11	8,100	49	17	0.81	0.11
Money	2005	W14	41,000	53	27	0.86	0.14
Go	2007	W17	30,387	48	8	0.78	0.10
Go	2007	W18	2,595	41	10	0.86	0.17
Go	2005	W16	43,200	42	16	0.81	0.13
Go	2007	W16	15,238	41	11	0.68	0.08
Go	2005	W12	2,300	44	17	0.73	0.09
Go	2007	W12	3,047	55	15	0.86	0.13
Putt	2005	W72	23,000	34	14	0.82	0.17
Bunker	2005	W73	31,000	45	22	0.84	0.14
Tributary to Little Jimmy Lake	2005	W75	4,000	35	11	0.67	0.09

1. Total number of taxa from the 3 replicates at each station.
 2. Total number of taxa of the orders Ephemeroptera, Plecoptera, and Tricoptera at each station.
- 2007 data is shaded gray to facilitate comparison within years.

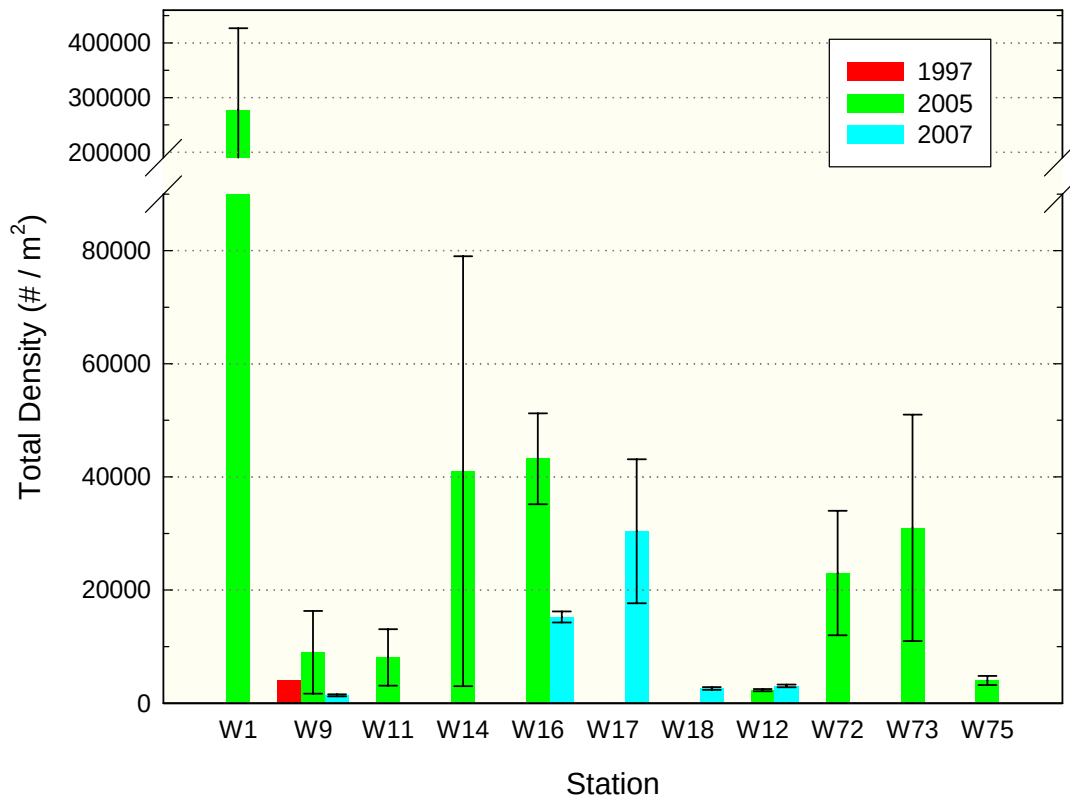


Figure 4-2: Total Benthic Invertebrate Density (± 1 Standard Deviation) from All Baseline Stream Monitoring in the Wolverine Project Area

Potential reference sites that were sampled during baseline monitoring included Nougha Creek at the outlet of Wolverine Lake (station W1) which showed a large influence from the lake that made it unsuitable as a reference site for Go Creek. Sites W17 and W18 in the headwaters of Go Creek were sampled in 2007. These locations have a steeper gradient and narrow channel width which was dissimilar to W16. Sites W72, W73 and W75 were surveyed along the mine access road route. Sites W72 and W75 have distinctly different water and sediment quality than Go Creek, therefore are not suitable reference sites. W73 in Bunker Creek had similar water and sediment quality to Go Creek, as well as similar benthic invertebrate community characteristics (Table 4-2) and is therefore deemed suitable as a reference area. Although extensive monitoring of stream condition below the road crossing has shown no disturbance from the road, a new station (W76) will be established upstream of the road in order to remove the road as a possible contributing factor during data analysis. No historical benthic invertebrate information is available for Station W13 in lower Pup Creek. There is site characterization for this site (Chapter 2) that indicates it is similar to the exposure site and will be suitable as a reference site.

4.3 EEM Survey Methods

4.3.1 Statistical Considerations

The baseline data generated from sampling in 2005 and 2007 and regional information from other benthic invertebrate studies is insufficient for *a priori* setting of effect size based on Option 1 or Option 2 described in the EEM Guidance Document (Section 5.11.1), therefore Option 3 will be adopted and the effect size set to ± 2 times the standard deviation (SD) of the reference mean value. That is, an effect is defined as a change in a benthic invertebrate descriptor that is more than 2 SD from the descriptor for the reference area.

The power of the statistical tests that will be used to compare endpoints at exposure and reference areas will follow the recommendations of the EEM Guidance Document, *i.e.* that $\alpha = \beta = 0.1$. The sampling design (described below) will be a multiple control/impact design suitable for analysis using ANOVA, therefore the power analysis example presented in the EEM Guidance Document (Section 5.11.3) for this type of sample design is applicable, and the recommended sampling effort of five replicates per station for ANOVA designs will be used. Three sub-samples per replicate will be collected, as baseline results from 2007 found that 3 Hess sampler sets captured 75 – 2725 individuals in the family Chironomidae, the most abundant family identified in baseline samples.

4.3.2 Benthic Invertebrate Survey Methods

Survey methods will follow the methods those recommended in the EEM Guidance Document. Riffle zones will be sampled using a Hess sampler (0.1 m² area, 500 μ m mesh size). Sampling will occur along a longitudinal stretch of the stream that includes one pool/riffle sequence. Five replicates will be collected in each area with a minimum separation of three times the bank-full width (measured at the top of the bank) between stations. Three subsamples (*i.e.* Hess sampler sets) will be composited to make up a replicate.

Samples will be collected in September. September has been shown to be ecologically relevant (see Section 4.2.1) and may allow comparison of EEM results to historical data to aid in the interpretation of results, although it must be noted that a smaller mesh size (210 μ m) was used in 2005 and 2007 surveys. It will also allow maximum exposure to effluent, which will be discharged between May and October.

Field notes will contain the following information, at a minimum:

- Coordinates of each of the five replicates
- Date and time of sample collection
- Field crew members
- Habitat descriptions including supporting environmental variables (see Section 4.3.3)
- Type of sampler used including area and mesh size
- Sample IDs, # of jars per sample, preservation
- Any other observations that will help in the interpretation of results

4.3.3 Supporting Environmental Variables

Receiving water quality monitoring samples will be collected at the same time and location as benthic invertebrate sampling. Field measurements of water temperature, dissolved oxygen, pH, and conductivity will be made. Morphometric measurements of each sampling area will include bank-full width, wetted width, depth, and gradient. Canopy cover will also be estimated at each sampling area.

MMER *Schedule 5, section 16(a)(iii)* requires that total organic carbon (TOC) and particle size distribution of sediment be reported along with benthic invertebrate metrics if invertebrate sampling is carried out in an area where sediment can be sampled. The benthic invertebrate sampling for the Wolverine project will take place in riffle zones with mainly cobble and gravel substrate; therefore sediment samples will not be collected as supporting variables. Embeddedness of cobbles will be measured as a supporting variable.

4.3.4 Taxonomy and Data Summary

Benthic invertebrates collected as part of the EEM program will be enumerated and identified to a minimum taxonomic level of family, and statistical summaries and descriptive metrics will be done on family level data. Taxonomy on baseline (historic) samples was done to the lowest practical level, usually genus. If comparison of EEM data to historic data is made in the interpretive report, historic data will be grouped into family before summary statistics are calculated. Taxonomic analysis will be carried out by a qualified taxonomic laboratory experienced with identification of invertebrates from northern streams.

Unidentified juveniles will be listed under their own category. Benthic invertebrate taxonomy carried out during the baseline program was typically able to identify juveniles to the family level. A small proportion of juveniles may only be identifiable to Order. These individuals will be listed in their own category (*e.g.* unidentified Ephemeroptera juvenile).

Data from the taxonomic laboratory will be in the form of bench sheets and an electronic form (*e.g.* Excel workbook). Taxonomic references used for identification will be listed in the taxonomy laboratory report. Data for each replicate sample will include the number of organisms identified from each taxonomic category (minimum of family). The method and level of sub-sampling that was carried out during sorting and identification will be clearly identified. Reporting will include the number of individuals counted as well as the conversion to number per sample. The number per sample will be standardized to number per square meter by dividing by the area sampled (*e.g.* 0.1 m^2 per Hess set x 3 Hess sets per replicate = 0.3 m^2 per replicate). These data will be used to calculate indices of community characteristics described in Chapter 5, which will be used to determine if there is an effect on benthic communities in Go Creek.

5. Interpretive Report

The objective of the Wolverine Project EEM program is to evaluate the effects of mine effluent on the aquatic environment, related to protecting fish and fish habitat. For the control/impact sampling design that will be used for the first EEM program, an effect is defined generally as a statistically significant difference in fish or benthic invertebrate community endpoints measured between an area exposed to effluent and a reference area. The interpretive report will include all data generated from fish habitat, fish community, and benthic invertebrate surveys as well as other EEM requirements that are used to help interpret results of biological surveys (*e.g.*, effluent characterization and water quality monitoring). The data will be prepared and double checked for errors, summarized, and statistically tested to determine if an effect is detected. The results of these analyses will be used to refine or design the subsequent EEM monitoring program.

It is anticipated that effluent discharge from the project will begin in May 2013, as described in Chapter 1. Therefore cycle 1 monitoring will take place before any effluent has been discharged, which means that effluent characterization is not possible, and fish population surveys are not required since there is not effluent in the receiving environment. Although fish studies will not be required as part of cycle 1, the reporting of fish survey results are presented below as required under MMER *Schedule 5, section 17*, which includes details of field surveys, results of field measurements, results of data assessments and statistical analyses, and any supporting information and data used for interpretation of the results.

Similarly, reporting of benthic invertebrate data is described in this section. This includes statistical analysis to determine if an effect of effluent on benthic invertebrates has been detected. While an effluent effect is not possible when no effluent has been discharged, the analyses described below will be useful in evaluating the monitoring program for cycle 2.

5.1 Effects on Fish

Field surveys of fish communities will yield data on the length, and weight of individuals of each species captured at each sample site, and possibly age and sex of individuals. Details of the field work will be tabulated including coordinates and descriptions of reaches sampled, time and date of sampling, electrofishing time at each area, estimate of area sampled, and any observations such as barriers to fish movement, and difficulties or confounding factors encountered during the field work. The abundance, length, and weight will be summarized (mean, median, minimum, maximum, standard deviation, standard error and sample size) for each species at each sample area and presented in tables and figures. The fishing effort at each site (time fished and area fished) will be used to calculate relative abundance as catch per unit effort (CPUE) in terms of time and area.

For statistical analyses of fish population data from non-lethal surveys, it is recommended that the minimum sample size is 100 fish for each of the two sentinel species for each reference and exposure area (Environment Canada, 2005). Based on historical sampling (Table 3-2) it may not be possible to capture 100 fish in exposure and reference creeks. Assuming that a sufficient number of fish are captured and their size measured, then length, weight, and abundance data will be used to calculate endpoints of growth, condition, and survival. Growth will be determined as size (length and weight) fish. Ideally size of young of year is used as an indicator of growth, and this will be done if it is possible to determine relative age of the fish captured. Condition will be measured as body weight relative to length. Reproductive performance/success will be assessed, if possible, as the relative abundance of young-of-year in the population. Survival will be assessed from length frequency distribution.

Data analysis will include statistical comparison of the above endpoints at exposure and reference areas. Differences between sites will be considered significant if the test gives a $p\text{-value} < 0.05$ (*i.e.* $\alpha=0.05$). If sufficient data exist, site differences in length, weight and condition will be tested using an Analysis of Variance (ANOVA) or using a non-parametric statistic (*e.g.* Kruskal-Wallis test or Kolmogorov-Smirnov test) if the assumptions of ANOVA cannot be adequately met. If these tests find a significant difference, then a multiple comparison test will be used determine which sites are different than the others (*e.g.* Tukey test for ANOVA or Dunn test for non-parametric comparisons).

Using non-lethal sampling methods, it may not be possible to age the fish captured. If this is the case then length frequency distribution will be used as a surrogate for size at age distribution as a means of investigating differences in growth rate between exposure and reference areas. Length frequency distribution will be compared using a 2-sample Kolmogorov-Smirnov test to assess differences in growth rate. This is a non-parametric test to determine if two data sets differ significantly.

If low numbers of fish are present in Go Creek, as has been found in previous fish surveys, the statistical power of the above tests will be weak. As an alternative to the statistical analyses described above, presence/absence of fish in Go Creek and reference areas will be compared. If fish are found in the reference areas and none are found in lower Go Creek the absence of fish in the exposure area will be considered an effect.

The fish survey results and statistical analyses will be interpreted relative to stream conditions at the time of sampling, any fish barriers observed, historic data, effluent characterization and water quality results.

5.2 Effect on Benthic Invertebrates

Benthic invertebrates will be surveyed using a multiple control/impact design. Five replicates will be collected at each area. Data from the taxonomy laboratory will be used to

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calculate abundance ($\#/m^2$) of each family as described in Section 4.3.4. The abundance data will be used to calculate the following endpoints for each area:

- Total invertebrate density for each replicate as well as arithmetic mean, standard deviation, median, minimum and maximum;
- Family density for each replicate as well as arithmetic mean, standard deviation, median, minimum and maximum;
- Family richness
- Simpson's diversity index
- Simpson's evenness index
- Bray Curtis index
- Taxon (*i.e.*, family) proportion
- Taxon (*i.e.*, family) presence/absence

Calculation of total invertebrate density will include unidentified individuals. Individuals that cannot be identified to family level will not be included in calculations of family density or community descriptors (*e.g.* richness, evenness, diversity, or Bray Curtis index). Richness for an area will be all taxa observed from all five replicates from an area. These data will be presented in tables and figures, and the taxonomic laboratory data included as an appendix.

Total invertebrate density, family richness, Simpson's evenness index, and Bray-Curtis index will be statistically analyzed using ANOVA (power of 0.1). If the ANOVA determines that a metric has a significant difference among stations, a multiple comparison test (*e.g.* Tukey test) will be used to determine if the exposure sites are significantly different from reference sites, which will be defined as an effect. The results of these analyses will be interpreted relative to the other endpoints listed above (*e.g.* diversity and family density, proportion, and presence/absence) as well as supporting environmental variables measured at the time of sampling, results of fish surveys, and relative to historical sampling. Also, the effect of outliers or extreme values, if any, on results will be evaluated.

5.3 Subsequent EEM Design

The interpretive report will summarize the effects analyses for fish and benthic invertebrates. Observations and data from the first study will be used to refine methods used in subsequent EEM designs. This will include power analysis to determine if the sampling effort and power used in the first design are appropriate for subsequent surveys. Results from the first monitoring program will be used to determine whether periodic monitoring (and level of monitoring) or focussed monitoring is required for subsequent EEM programs.

References

- Cowardin LM, Carter V, Golet FC and LaRoe ET. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service. FWS/OBS-79/31.
- Environment Canada. (2002). Metal mining guidance document for aquatic environmental effects monitoring. Gatineau, Quebec: Environment Canada.
- Environment Canada. 2005. Additional Technical Guidance for Non-lethal Sampling. <http://www.ec.gc.ca/esee-eem/default.asp?lang=En&n=3DB90019-1>
- Gartner Lee Ltd. 2005. Fisheries Study of Proposed Road Access Alignments, Wolverine Property. 2005. (Reproduced in Appendix 7.8 of the 2005 Yukon Zinc Corporation Wolverine Project Environmental Assessment Report)
- Jacques Whitford Ltd., 2005. Aquatic Resources Addendum to Yukon Zinc Corporation Environmental Assessment Report. March 2005.
- Jacques Whitford Ltd., 2008. Results of the 2007 Benthic Sampling Program. Prepared for Yukon Zinc Corp. by Jacques Whitford AXYS. April, 2008.
- Jacques Whitford Ltd., 2005. Aquatic Resources Addendum to Yukon Zinc Corporation Environmental Assessment Report. March 2005.
- Madrone Environmental Services Ltd., 2006. Wolverine Project EAR Response to Public and Regulatory Reviews; Section 5: Hydrology and Aquatic Resources. February 2006.
- Metal Mining Effluent Regulations, SOR/2202-222 (2006). CanLII.
- Westmin Resources Ltd. 1996. Fisheries resource investigations, Wolverine Lake Property, Westmin Resources Ltd. (Spring, Summer and Fall Surveys) December 1996. (Reproduced in Appendix 7.8 of the 2005 Yukon Zinc Corporation Wolverine Project Environmental Assessment Report)
- White Mountain Environmental Consulting. 1997. Money Creek – Bull Trout Utilization Assessment, 1997. (Reproduced in Appendix 7.8 of the 2005 Yukon Zinc Corporation Wolverine Project Environmental Assessment Report).
- Yukon Territory Fishery Regulations, C.R.C., c. 854. Schedule VI Subsection 7(14) Part I. available at <http://www.canlii.org/en/ca/laws/regu/crc-c-854/latest/crc-c-854.html> .
- Yukon Water Board. 2007. Water Use Licence QZ04-065. Type A Water Use Licence issued to Yukon Zinc Corporation. October 4, 2007.
- Yukon Zinc Corporation. 2005., Wolverine Project, Environmental Assessment Report. October, 2005.

Appendix B: Lorax Environmental Services: Baseline Characterization Summary Report

Wolverine Project

Baseline Characterization Summary Report

**February 2010
(updated May 2011)**



LORAX
ENVIRONMENTAL

Wolverine Project

Baseline Characterization Summary Report

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Table of Contents

TABLE OF CONTENTS.....	ii
1. INTRODUCTION.....	1-1
1.1 PURPOSE OF REPORT	1-1
1.2 REPORT STRUCTURE	1-1
2. SURFACE WATER QUALITY.....	2-1
2.1 OVERVIEW AND DATA QUALITY	2-1
2.2 WOLVERINE LAKE WATERSHED	2-3
2.2.1 SEASONALITY	2-4
2.2.2 WOLVERINE CREEK AND CAMPBELL CREEK	2-4
2.2.3 WOLVERINE LAKE.....	2-11
2.3 GO CREEK WATERSHED.....	2-13
2.3.1 SEASONALITY	2-13
2.3.2 UPPER GO CREEK	2-16
2.3.3 LOWER GO CREEK AND COMPLIANCE POINT.....	2-18
2.4 MONEY CREEK WATERSHED.....	2-21
2.5 MINE ACCESS ROUTE.....	2-23
3. GROUNDWATER QUALITY	3-1
3.1 OVERVIEW AND DATA QUALITY	3-1
3.2 WOLVERINE CREEK BASIN – MINE SITE AREA	3-4
3.2.1 BASELINE ALLUVIAL GROUNDWATER QUALITY	3-4
3.2.2 BASELINE SHALLOW BEDROCK GROUNDWATER QUALITY	3-6
3.2.3 BASELINE DEEP BEDROCK GROUNDWATER QUALITY	3-8
3.3 GO CREEK BASIN.....	3-10
3.3.1 BASELINE ALLUVIAL AND SHALLOW BEDROCK GROUNDWATER QUALITY – UPPER GO CREEK BASIN	3-10
3.3.2 BASELINE ALLUVIAL AND SHALLOW BEDROCK GROUNDWATER QUALITY – TAILINGS IMPOUNDMENT AREA	3-12
4. SEDIMENT QUALITY.....	4-1
4.1 OVERVIEW	4-1
4.2 WOLVERINE CREEK	4-3
4.3 GO CREEK.....	4-4
4.4 MINE ACCESS ROUTE.....	4-6
5. BENTHIC INVERTEBRATES AND PERIPHYTON.....	5-1
5.1 BENTHIC INVERTEBRATES.....	5-1
5.1.1 METHODOLOGY.....	5-2
5.1.2 RESULTS	5-4
5.2 PERIPHYTON.....	5-9
5.2.1 METHODOLOGY.....	5-9
5.2.2 RESULTS	5-9
REFERENCES.....	R-1

APPENDIX A-1:	SURFACE WATER QUALITY DATA (ON CD)
APPENDIX A-2:	SURFACE WATER QUALITY STATISTICAL SUMMARY
APPENDIX B:	GROUNDWATER QUALITY DATA
APPENDIX C:	STREAM SEDIMENT QUALITY DATA
APPENDIX D:	2005 AND 2007 BENTHIC INVERTEBRATE TAXONOMY DATA
APPENDIX E:	2005 AND 2007 PERIPHYTON TAXONOMY DATA

LIST OF FIGURES

FIGURE 2-1:	SURFACE WATER QUALITY MONITORING STATION LOCATIONS.	2-2
FIGURE 2-2:	SEASONAL TIME SERIES (1995 - 2008) OF TOTAL HARDNESS AND CONDUCTIVITY AT STATIONS IN THE WOLVERINE LAKE WATERSHED	2-5
FIGURE 2-3:	SEASONAL TIME SERIES (1995 - 2008) OF TURBIDITY AND TOTAL SUSPENDED SOLIDS AT STATIONS IN THE WOLVERINE LAKE WATERSHED	2-6
FIGURE 2-4:	FLUORIDE IN WOLVERINE CREEK, 1995 - 2008	2-8
FIGURE 2-5:	TOTAL ALUMINUM AND TOTAL IRON IN WOLVERINE CREEK, 1995 - 2008	2-9
FIGURE 2-6:	TOTAL CHROMIUM AND COPPER IN WOLVERINE CREEK, 1995 - 2008	2-10
FIGURE 2-7:	TOTAL CADMIUM, ZINC, AND SELENIUM IN WOLVERINE CREEK, 1995 - 2008.....	2-11
FIGURE 2-8:	SEASONAL TIME SERIES (1995 - 2008) OF TOTAL HARDNESS AND CONDUCTIVITY AT STATIONS IN THE GO CREEK WATERSHED.....	2-14
FIGURE 2-9:	SEASONAL TIME SERIES (1995 - 2008) OF TURBIDITY AND TOTAL SUSPENDED SOLIDS AT STATIONS IN THE GO CREEK WATERSHED.....	2-15
FIGURE 2-10:	TOTAL SUSPENDED SOLIDS AND TOTAL ALUMINUM, IRON, CHROMIUM AND COPPER AT STATION W80 IN GO CREEK, 1995 - 2008	2-20
FIGURE 3-1:	GROUNDWATER MONITORING WELLS.....	3-2
FIGURE 3-2:	GROUNDWATER MONITORING WELLS – MINE SITE AREA.	3-3
FIGURE 3-3:	DETAIL OF BASELINE GROUNDWATER QUALITY IN ALLUVIAL AQUIFER – WOLVERINE CREEK BASIN	3-6
FIGURE 4-1:	SEDIMENT QUALITY MONITORING STATIONS.....	4-2
FIGURE 5-1:	BENTHIC INVERTEBRATE AND PERIPHYTON MONITORING STATIONS.....	5-3
FIGURE 5-2:	TOTAL BENTHIC INVERTEBRATE DENSITY (± 1 STANDARD DEVIATION) FROM ALL BASELINE STREAM MONITORING.	5-5
FIGURE 5-3:	INTERANNUAL TOTAL BENTHIC INVERTEBRATE DENSITY (± 1 STANDARD DEVIATION).....	5-6
FIGURE 5-4:	PERIPHYTON BIOMASS (± 1 STANDARD DEVIATION) AT STATIONS SAMPLED IN 2005 AND 2007.....	5-11

LIST OF TABLES

TABLE 2-1: SURFACE WATER QUALITY SUMMARY FOR WOLVERINE CREEK STATIONS.....	2-7
TABLE 2-2: SURFACE WATER QUALITY SUMMARY FOR WOLVERINE LAKE STATIONS.....	2-12
TABLE 2-3: SURFACE WATER QUALITY SUMMARY FOR UPPER GO CREEK STATIONS.....	2-17
TABLE 2-4: SURFACE WATER QUALITY SUMMARY FOR LOWER GO CREEK STATIONS.....	2-19
TABLE 2-5: SURFACE WATER QUALITY SUMMARY FOR MONEY CREEK STATIONS	2-22
TABLE 2-6: SURFACE WATER QUALITY SUMMARY FOR STATIONS ADJACENT TO THE MINE ACCESS ROUTE ..	2-24
TABLE 3-1: WOLVERINE CREEK BASIN GROUNDWATER MONITORING WELLS.....	3-4
TABLE 3-2: SUMMARY OF ALLUVIAL GROUNDWATER QUALITY IN WOLVERINE CREEK BASIN	3-5
TABLE 3-3: SUMMARY OF SHALLOW BEDROCK GROUNDWATER QUALITY IN WOLVERINE CREEK BASIN	3-7
TABLE 3-4: SUMMARY OF DEEP BEDROCK GROUNDWATER QUALITY IN WOLVERINE CREEK BASIN.....	3-9
TABLE 3-5: GO CREEK BASIN GROUNDWATER MONITORING WELLS	3-10
TABLE 3-6: SUMMARY OF ALLUVIAL AND SHALLOW BEDROCK GROUNDWATER QUALITY IN UPPER GO CREEK BASIN.....	3-11
TABLE 3-7: SUMMARY OF ALLUVIAL AND SHALLOW BEDROCK GROUNDWATER QUALITY IN UPPER GO CREEK BASIN.....	3-13
TABLE 4-1: SEDIMENT SAMPLING LOCATIONS AND ASSOCIATED MONITORING PERIODS.....	4-1
TABLE 4-2: BASELINE MEAN AND 95 TH PERCENTILE CONCENTRATIONS OF TOTAL METALS IN WOLVERINE CREEK SEDIMENTS	4-3
TABLE 4-3: BASELINE MEAN AND 95 TH PERCENTILE CONCENTRATIONS OF TOTAL METALS FOR GO CREEK DRAINAGE SEDIMENTS	4-5
TABLE 4-4: BASELINE MEAN AND 95 TH PERCENTILE CONCENTRATIONS OF TOTAL METALS FOR MINE ACCESS ROUTE STREAM SEDIMENTS.....	4-6
TABLE 5-1. SUMMARY OF TIME SERIES DATA FROM SAMPLES COLLECTED IN 1997 AT STATION W09.....	5-4
TABLE 5-2. COMMUNITY CHARACTERISTIC STATISTICS (AVERAGES) FROM STREAM BENTHIC INVERTEBRATE TAXONOMY DATA	5-8
TABLE 5-3. AVERAGE DENSITY, NUMBER OF TAXA, AND DIVERSITY FROM LAKE BENTHIC INVERTEBRATE TAXONOMY DATA.....	5-9
TABLE 5-4. PERIPHYTON AVERAGE BIOMASS AND TOTAL NUMBER OF TAXA	5-11

1. Introduction

1.1 Purpose of Report

The Wolverine Project has advanced into detailed engineering and construction of key project components are nearing completion with a view to commission the mine processing plant in June 2010. A number of regulatory environmental monitoring requirements are triggered as construction advances and the assessment and adaptive management of potential environmental impacts will be determined, in large part, on a comparison of future monitoring results with project baseline conditions. Yukon Zinc Corporation (YZC) requested Lorax Environmental Services Ltd. (Lorax) compile the existing environmental baseline data available for the period 1995 to 2008 for the following components:

- Surface water quality (1995 – 2008);
- Groundwater quality (2006 – 2008);
- Sediment quality (2005 – 2008); and
- Benthos and periphyton (2005 – 2007)

The objective of the work is to provide concise, quantitative and scientifically defensible summations of the baseline conditions for each of the above environmental components that can be used as reference comparisons for future regulatory monitoring reporting during construction, operations and closure.

1.2 Report Structure

Following this introduction, baseline water quality for surface water quality stations in the Wolverine Lake, Go Creek, and Money Creek watersheds, as well as along the road route is described in Chapter 2. While a number of summary tables and graphs are utilized to present the data, a full surface water quality database is provided on the enclosed CD as Appendix A-1. Within the database are descriptions of which data were used in the statistical assessment and rationale for removal of certain data points. Baseline conditions are defined statistically. Mean, standard deviation and 95th percentile values have been calculated for each station for the suite of parameters, which are included in Water Licence QZ04-065, Schedule A Part III – Monitoring Schedule.

Baseline groundwater quality conditions for groundwater monitoring wells established in the upper Wolverine Lake and Go Creek watersheds are described in Chapter 3. As per the surface water quality data, baseline groundwater quality conditions are defined statistically. Summary tables for the monitoring wells are provided in the text of the report and the complete groundwater quality data is provided in Appendix B.

Baseline stream sediment chemistry for Wolverine Creek, Go Creek, Money Creek and stream crossings along the mine access route is presented in Chapter 4. Finally, Chapter 5 discusses the baseline stream benthos and periphyton characteristics of the project streams. For the purposes of this baseline characterization report, and to be consistent with Environmental Effects Monitoring (EEM) requirements, total abundance, taxon richness, diversity (Simpson's diversity index), evenness (similar to equitability) and dominance are described. Additional ecological indicators are discussed in terms of family and genus abundance, tolerance categories and indicator species, as appropriate. Periphyton baseline characterization is more qualitative, describing general assemblages and presence or absence of important indicator species.

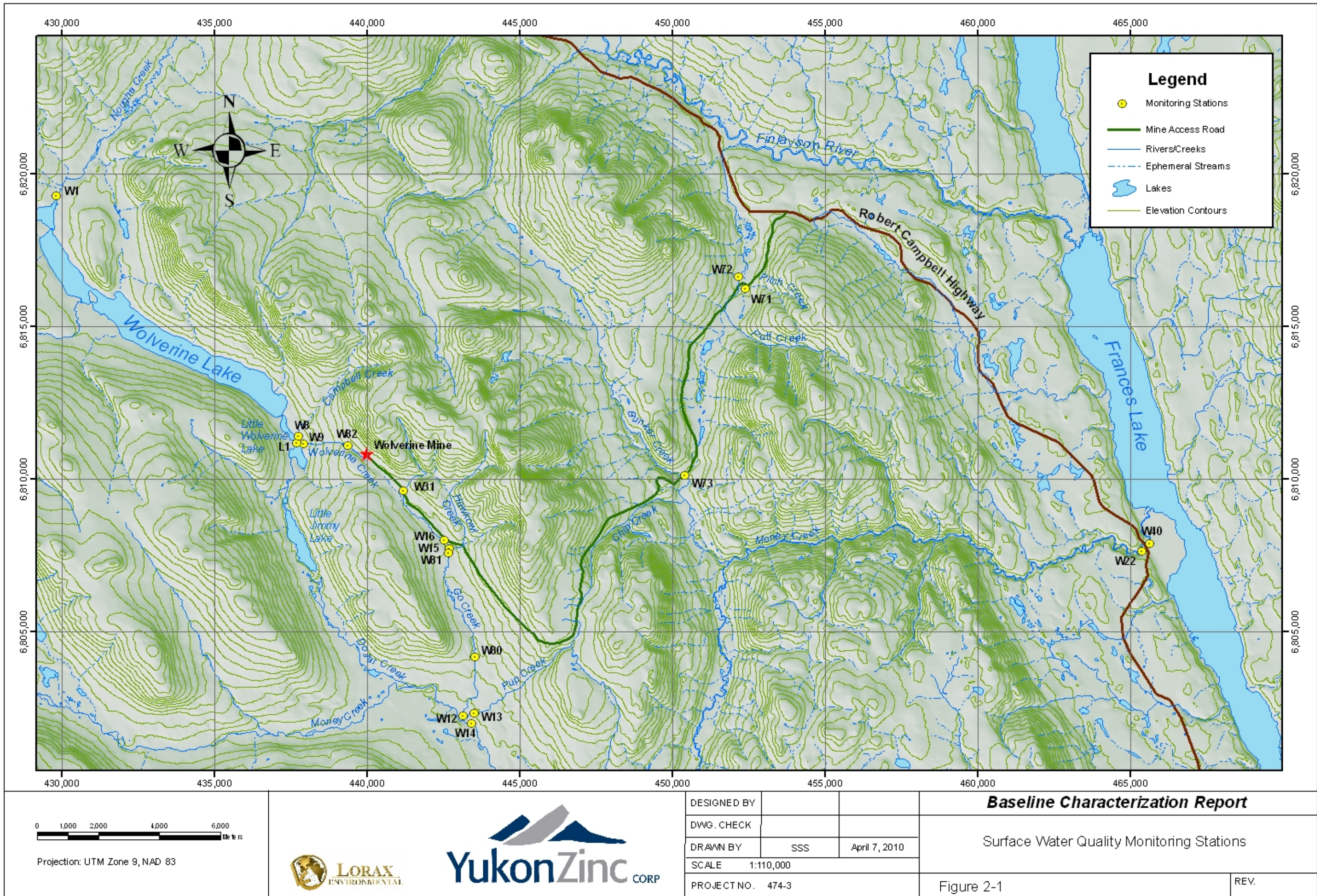
2. Surface Water Quality

2.1 Overview and Data Quality

Water quality samples have been collected from streams and lakes in the project area and reference locations in order to document baseline surface water quality. Forty four (44) stream sites and three (3) lake sites have been periodically sampled since 1995. Reported in this chapter are baseline data for streams and lakes that will continue to be monitored during construction, operations and closure phases of the project (Figure 2-1). These include stations in Wolverine Creek, Go Creek, Money Creek, Campbell Creek (reference site), Pup Creek (reference site) , and the outflows of Wolverine Lake and Little Wolverine Lake. Treated water from the tailings facility will be discharged to Go Creek. Station W80 in Go Creek will serve as the water quality compliance point for the project. Baseline data for these, as well as other surface water quality monitoring sites, are presented in Appendix A.

Water quality samples were first collected in 1995. Detection limits for metals analyzed in 1995 and 1996 samples were often higher than required to characterize baseline conditions. These data have not been used in defining baseline conditions. Data that were not used in calculating baseline conditions are detailed in Appendix A. Data from these early monitoring programs that accurately characterize physical properties and major ions have been retained and used to define baseline conditions. Spuriously high concentrations were identified by graphing the complete data set. These values were then examined relative to other parameters (*e.g.* total suspended solids) and if contamination was the most plausible explanation for the extreme value, the data was not included in the baseline data set. Suspect data that were eliminated are detailed in Appendix A.

Field blanks and travel blanks were also used to assess contamination. These data show that sample contamination was rare and that the data set is robust. There are indications that occasional contamination of dissolved zinc occurred, but only total zinc is reported in this baseline document as A Licence QZ04-065 only includes monitoring requirements for total metals.



Baseline conditions are reported as the average and 95th percentile of all data at a station. Results that were below their analytical detection limit were set equal to the detection limit when calculating averages. Statistical methods for defining the upper limit of background concentrations include using a standard deviation (*e.g.* 2 standard deviations above the mean) or a percentile (*e.g.* 90th or 95th) (BCMOE, 1997). Both of these methods were investigated for the Wolverine Mine Project. Using 2 standard deviations above the mean incorporates large variability introduced by a few unusually high values (*e.g.* for metals associated with high turbidity events) and the resulting upper limit for some parameters was greater than the upper range of values. Defining the upper limit as the 95th percentile (*i.e.* the value below which 95% of measurements fall) avoids incorporating values from extreme events. The 95th percentile was consistently lower than the upper limit defined by 2 standard deviations and provides a robust upper limit of values that can be expected at a water quality monitoring location.

The discussions in this chapter have been organized according to the drainage basins being monitored (*e.g.* Wolverine Lake and Go Creek watersheds). Section 2.3 describes the baseline surface water conditions in Wolverine Creek and Wolverine Lake, as well as a reference station on Campbell Creek. Sections 2.4 and 2.5 describe the baseline surface water quality in Go Creek (including reference station on Pup Creek) and in Money Creek, respectively. Section 2.6 discusses water quality along the mine access route. Summary data tables listing the mean and the 95th percentile for each station are provided to characterize the baseline condition at each station. Time series plots are presented for parameters of key interest.

Also presented in tables and figures are guideline values in order to provide context to the baseline value relative to a level that is protective of aquatic life. The guidelines presented are the most recently updated from Canadian Council of Ministers of the Environment, British Columbia Ministry of Environment, and United States Environmental Protection Agency. For most metals the CCME guideline is shown. Exceptions are cadmium which has more recently been reviewed and updated by USEPA. British Columbia aquatic life guidelines are presented for aluminum, iron, and selenium.

2.2 Wolverine Lake Watershed

Baseline surface water quality is presented for Wolverine Creek, Campbell Creek, and the outlets of Wolverine Lake and Little Wolverine Lake. Campbell Creek is generally outside of Project disturbances and may serve as a regional reference station for creeks potentially affected by Project activities within the Wolverine Lake watershed.

2.2.1 Seasonality

Physical properties of surface waters show a seasonal signal due to spring freshet in late May/early June, when an increase in the proportion water from snow melt is associated with a decrease in conductivity and hardness (Figure 2-2). Higher flow during freshet is also associated with increased turbidity and total suspended solids (Figure 2-1). At other times of the year suspended solids were generally below detection limit, with periodic elevated levels likely associated with high rainfall events.

2.2.2 Wolverine Creek and Campbell Creek

Wolverine Creek naturally receives drainage from the mineralized area of the Wolverine deposit. Baseline water quality has been monitored at station W82 in upper Wolverine Creek and at station W9 in lower Wolverine Creek, upstream of Little Wolverine Lake (Figure 2-1). A summary of surface water quality for key parameters is listed in Table 2-1. Guidelines are listed as a reference value in order to evaluate which parameters are naturally elevated. Also listed in Table 2-1 are summary data for Station W8 on Campbell Creek. Station W8 serves as a regional reference station for Wolverine Creek as it is outside the influence of the mine and all Project facilities with the exception of a road crossing.

Conductivity and hardness in Wolverine Creek are elevated in comparison to other stations in the Wolverine Lake watershed (Figure 2-2), and significantly elevated compared to Go Creek (see Section 2.3). Sulphate and nitrate are also elevated in Wolverine Creek in comparison to Campbell Creek (Station W8) and Go Creek.

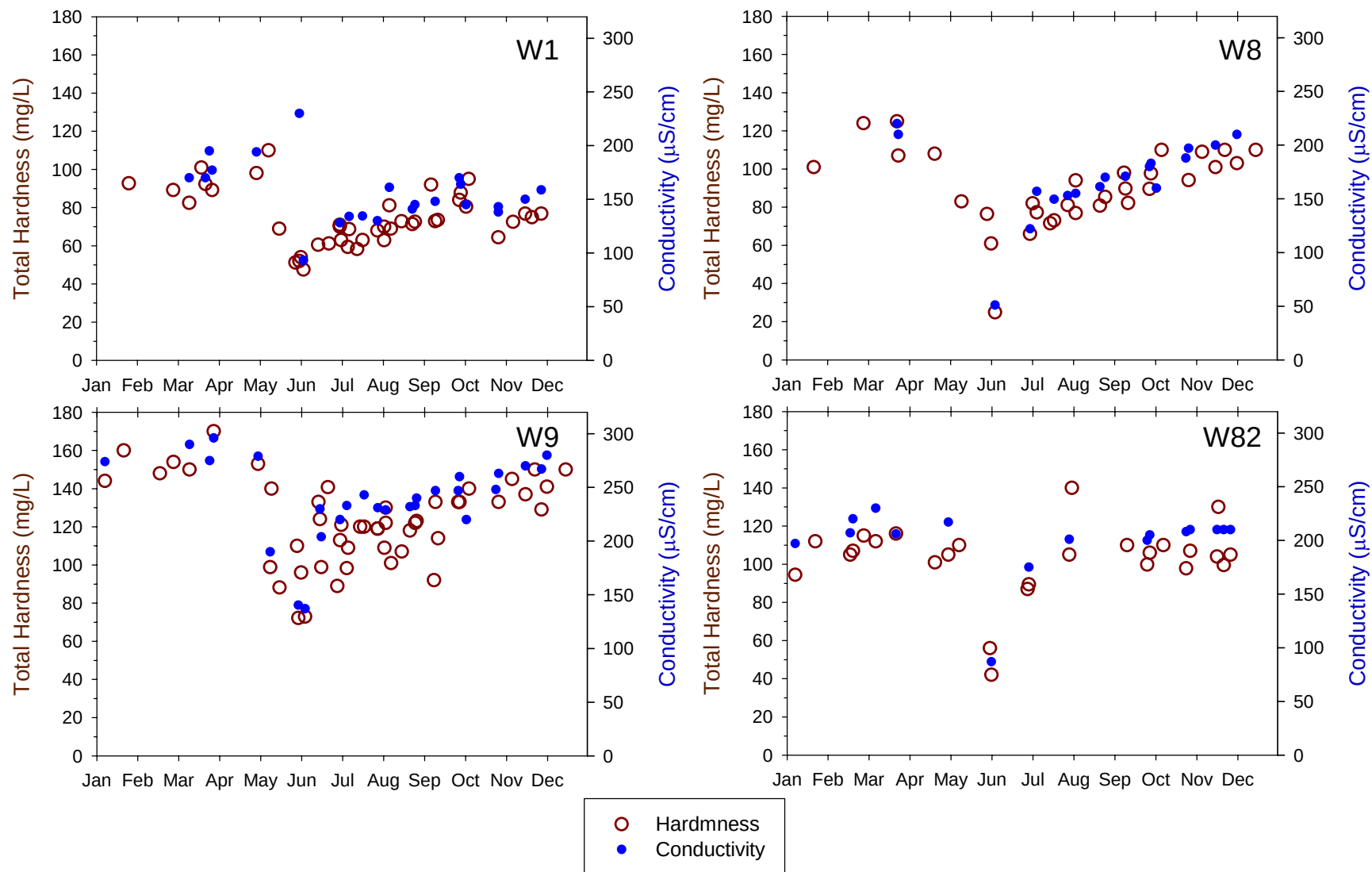


Figure 2-2: Seasonal Time Series (1995 - 2008) of Total Hardness and Conductivity at Stations in the Wolverine Lake Watershed

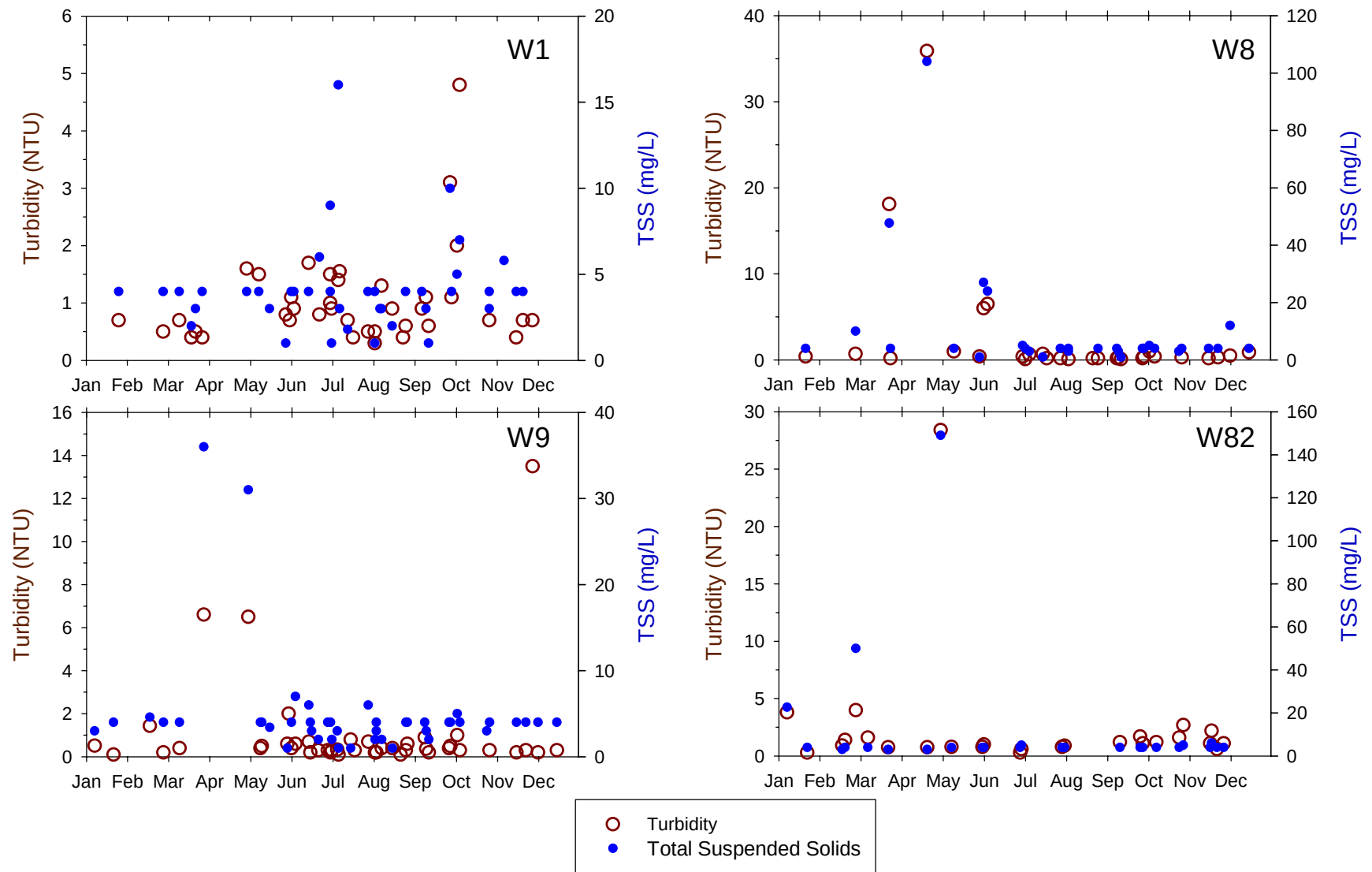


Figure 2-3: Seasonal Time Series (1995 - 2008) of Turbidity and Total Suspended Solids at Stations in the Wolverine Lake Watershed

**Table 2-1:
Surface Water Quality Summary for Wolverine Creek Stations**

Parameter	Units	W82		W9		W8		Guideline ¹
		Average	95 th %	Average	95 th %	Average	95 th %	
Physical Tests								
pH	pH	7.9	8.1	7.9	8.2	7.9	8.1	6.5 - 9
Conductivity	uS/cm	200	223	240	287	169	212	
TSS ²	mg/L	12	43	5	7	7	26	
Hardness	mg/L	103	127	121	154	91	116	
DOC ³	mg/L	2.3	5.8	3.1	8.0	2.9	7.3	
Dissolved Anions								
Fluoride	µg/L	119	172	109	132	45	60	120
Sulphate	mg/L	25	37	29	39	15	20	100
Nutrients								
Ammonia-N	µg/L	19	30	10	20	21	86	914
Nitrate-N	µg/L	299	378	186	425	83	212	2900
Nitrite-N	µg/L	3	6	3	5	2	4	60
Total Phosphate-P	µg/L	17	36	10	25	15	70	
Total Metals								
Aluminum-Total	µg/L	42	103	30	80	63	335	100
Aluminum-Dissolved	µg/L	10	23	7	20	10	25	50 ^B
Antimony – Total	µg/L	0.14	0.25	0.22	0.50	0.13	0.50	6
Arsenic - Total	µg/L	0.24	0.63	0.35	0.60	0.27	0.50	5
Cadmium - Total	µg/L	2.13	4.37	1.39	1.94	0.07	0.11	0.25 ^A
Chromium - Total	µg/L	0.56	1.18	0.59	1.25	0.67	1.20	1
Copper - Total	µg/L	3.50	8.00	1.70	4.52	1.61	3.81	2
Iron - Total	µg/L	403	1083	90	349	132	613	300
Iron -Dissolved	µg/L	47	122	22	62	26	59	350 ^B
Lead - Total	µg/L	0.14	0.35	0.23	0.84	0.24	0.77	2
Mercury - Total	µg/L	0.010	0.010	0.014	0.020	0.012	0.020	0.026
Molybdenum - Total	µg/L	0.34	0.44	0.84	1.12	0.57	1.00	73
Nickel - Total	µg/L	12.26	29.08	3.91	6.37	1.28	2.37	65
Selenium - Total	µg/L	1.94	3.16	3.18	4.47	0.76	1.00	2 ^B
Silver - Total	µg/L	0.01	0.02	0.01	0.02	0.01	0.02	0.1
Zinc - Total	µg/L	173.6	328.3	134.5	195.8	7.8	13.7	30

Bold values are greater than water quality guideline.

1. Guideline value is CCME unless otherwise noted.

2. Total Suspended Solids.

3. Dissolved Organic Carbon.

A. US EPA hardness dependent chronic guideline for cadmium assuming a hardness of 100 mg/L.

B. British Columbia 30 day average guideline for protection of aquatic life.

Fluoride concentration in Wolverine Creek is approximately double the concentration in Campbell Creek (Table 2-1), with the average approximately equal to the CCME interim guideline for inorganic fluoride (Figure 2-4). While the average fluoride concentration is similar at W82 and W9 the 95th percentile at W9 is lower than at W82, likely due to the large data set at W9 (n=37) than at W82 (n=17).

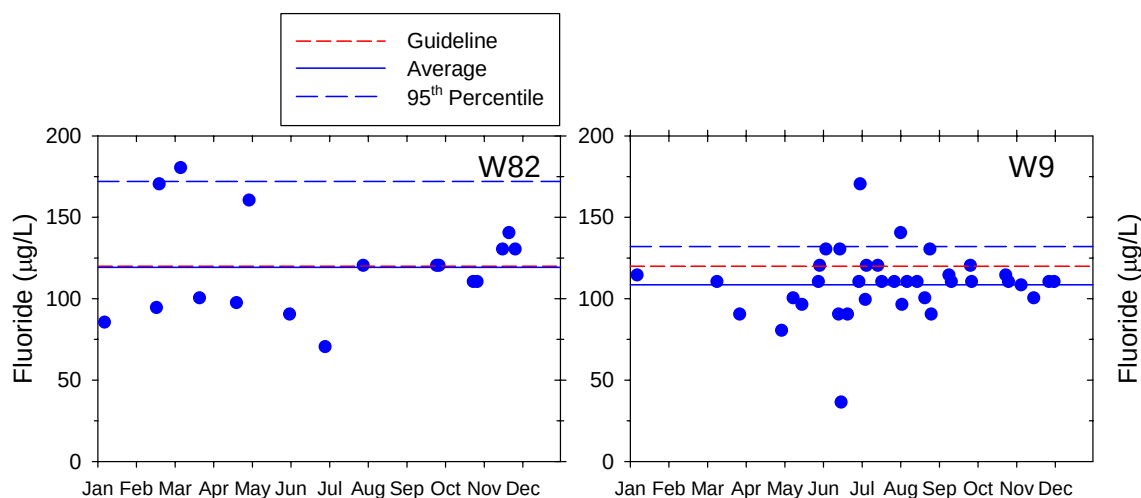


Figure 2-4: Fluoride in Wolverine Creek, 1995 - 2008

Total aluminum and total iron have several data points that exceed CCME guidelines for these metals (Figure 2-5). These instances are associated with elevated turbidity (Figure 2-3) and the particulate fraction, which is less biologically available than the dissolved fraction, makes up large portion of the total. BCMOE guidelines apply to dissolved aluminum, and BCMOE has recently set guidelines for dissolved iron (BCMOE, 2008). In comparison to these dissolved guidelines, the dissolved Al and dissolved Fe concentrations in Wolverine Creek are not considered elevated (Table 2-1). Aluminum and iron are also not elevated in comparison to Station W8 on Campbell Creek (Table 2-1). Similarly, total chromium and copper measurements were often above their guideline value (Figure 2-6) but not markedly elevated above the levels in Campbell Creek.

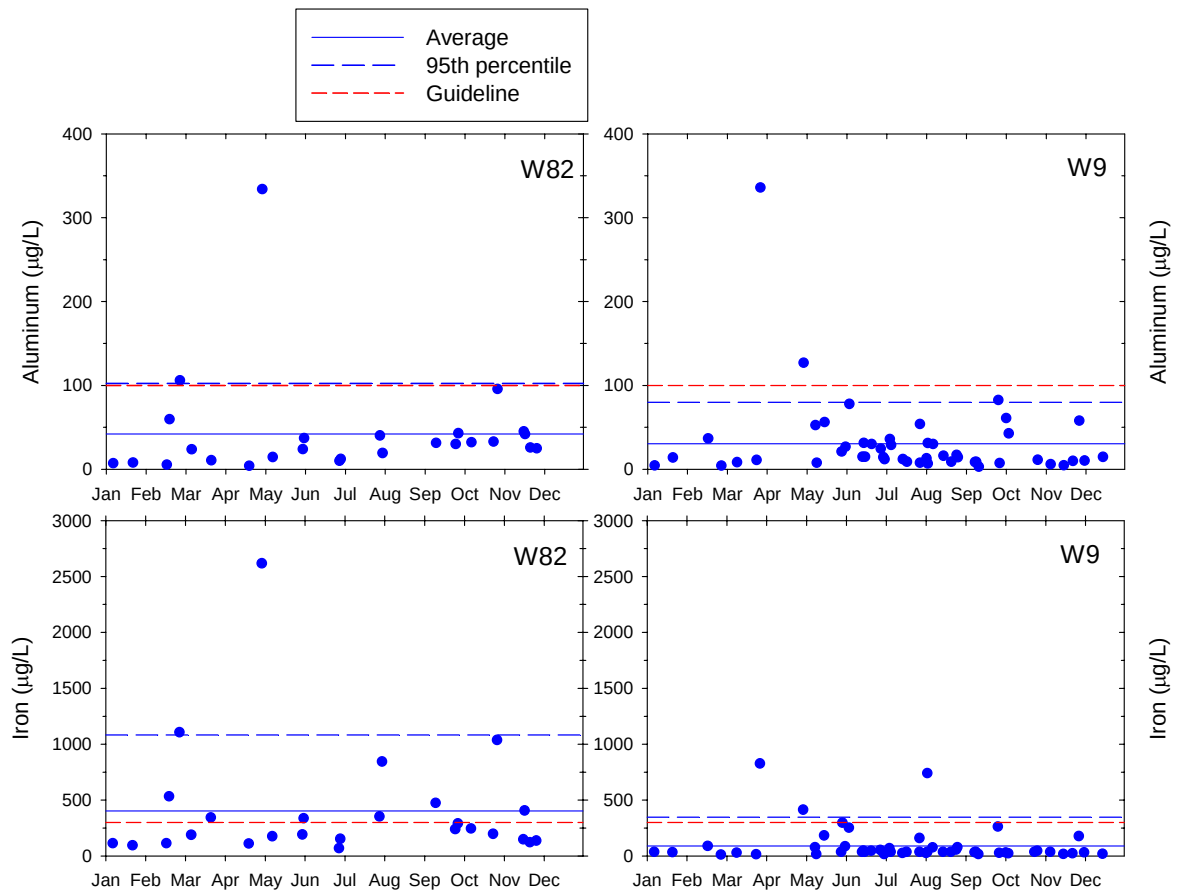


Figure 2-5 Total Aluminum and Total Iron in Wolverine Creek, 1995 - 2008

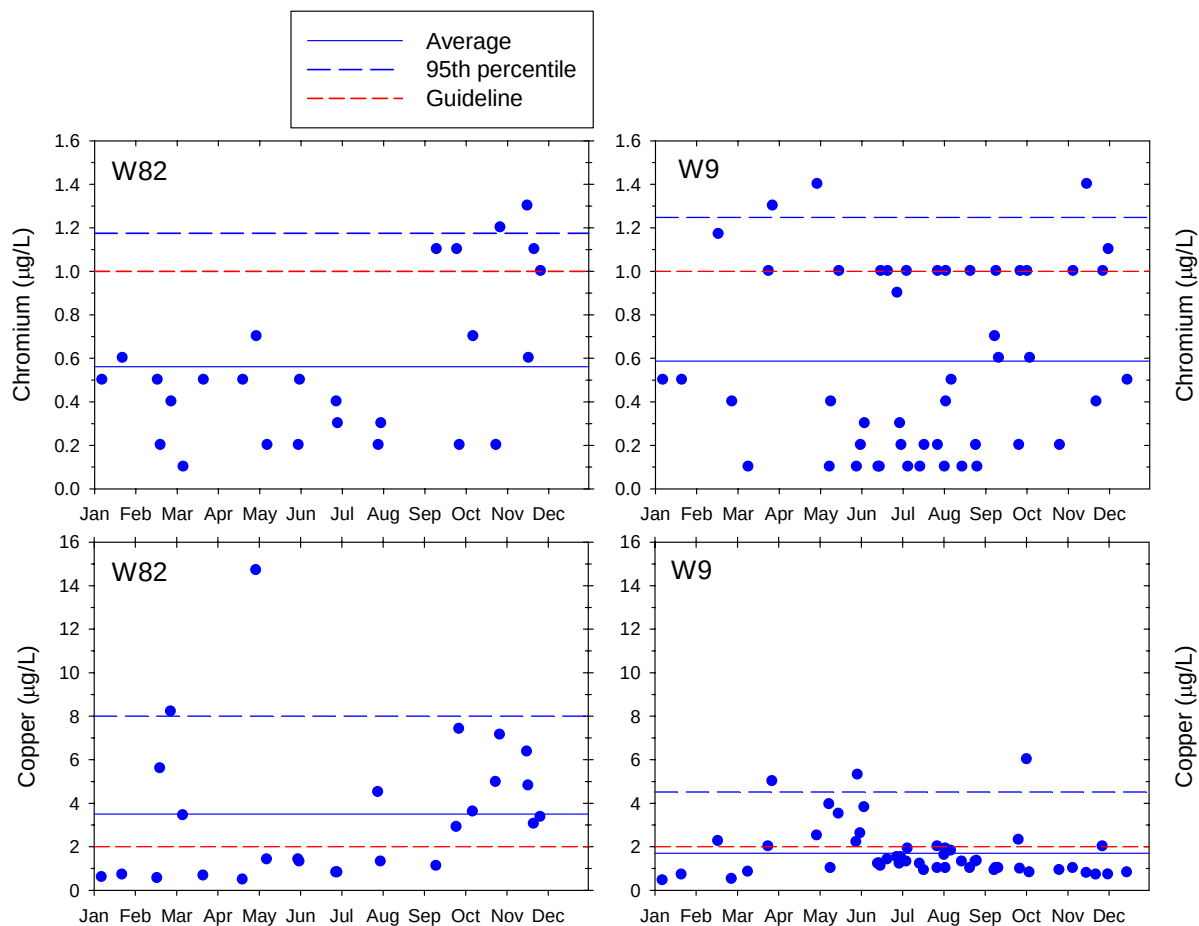


Figure 2-6 Total Chromium and Copper in Wolverine Creek, 1995 - 2008

Nearly all measurements of cadmium and zinc in Wolverine Creek are greater than their respective water quality guidelines (Table 2-1 and Figure 2-7) and reflect the mineralization within the Wolverine Creek drainage. Selenium is also naturally elevated in Wolverine Creek. Average Se concentration at Station W82 is approximately equal to the BCMOE water quality guideline of 2 µg/L whereas nearly all measured Se values from Station W9 are greater than 2 µg/L (Table 2-1 and Figure 2-8). Nickel is elevated at Station W82 in upper Wolverine Creek in comparison to W8 on Campbell Creek (Table 2-1) and in comparison to Go Creek and Money Creek (Sections 2.3 and 2.4).

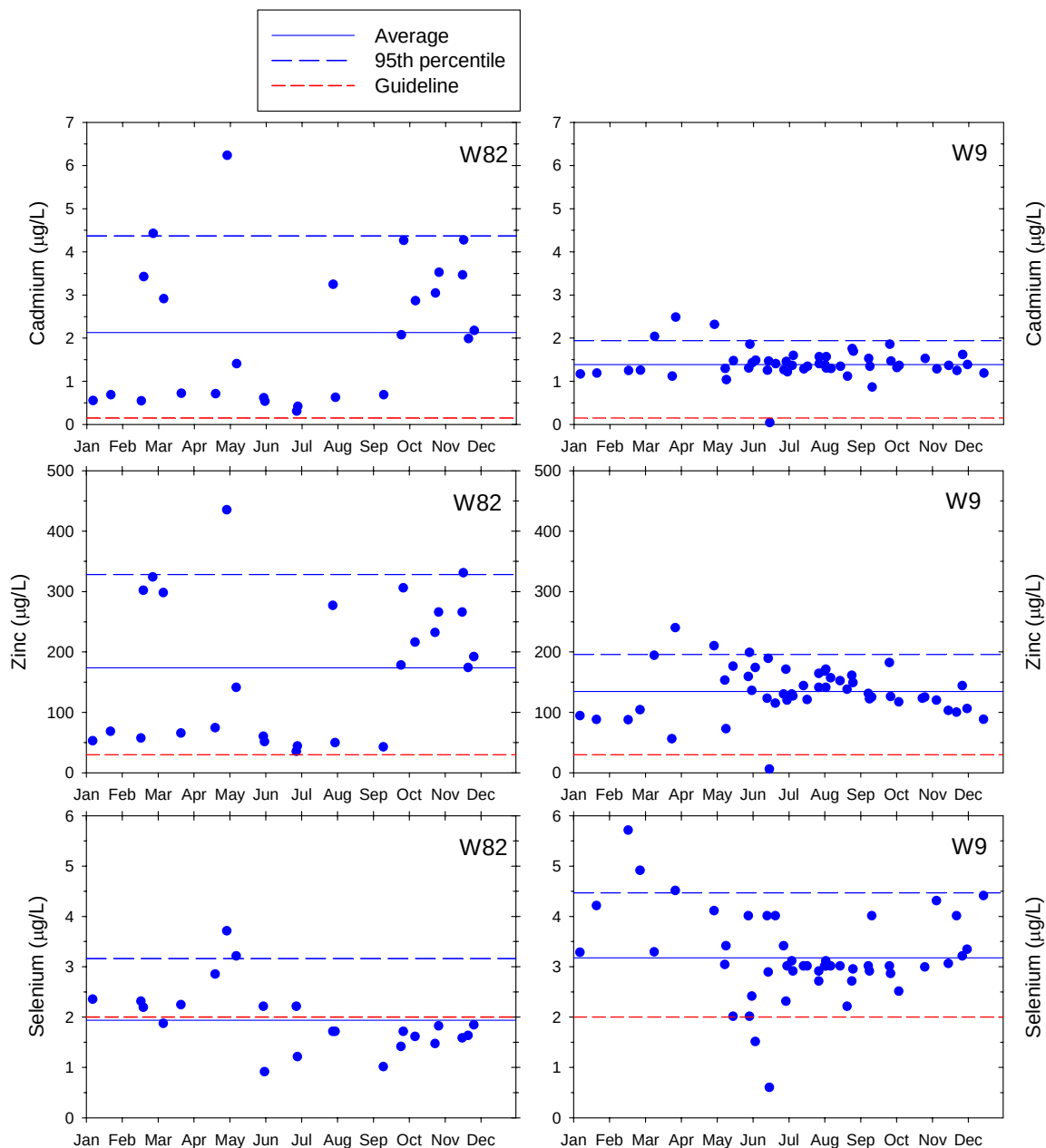


Figure 2-7 Total Cadmium, Zinc, and Selenium in Wolverine Creek, 1995 - 2008

2.2.3 Wolverine Lake

Baseline surface water quality data has been monitored at the outlet of Wolverine Lake (Station W1) and at the confluence of Little Wolverine Lake and Wolverine Lake (Station L1). Baseline concentrations of most parameters are below published water quality guidelines (Table 2-2). The 95th percentile values for fluoride and several metals that are associated with suspended sediments (Al, Fe, and Cr) are slightly greater than guidelines.

**Table 2-2:
Surface Water Quality Summary for Wolverine Lake Stations**

		L1		W01		Guideline ¹
Parameter	Units	Average	95th %	Average	95th %	
Physical Tests						
pH	pH	7.9	8.0	7.8	8.1	6.5 - 9
Conductivity	uS/cm	120	144	155	195	
TSS ²	mg/L	4	6	4	9	
Hardness	mg/L	62	71	75	98	
DOC ³	mg/L	3.3	5.3	5.3	7.3	
Dissolved Anions						
Fluoride	µg/L	79	90	113	134	120
Sulphate	mg/L	9	13	12	18	100
Nutrients						
Ammonia-N	µg/L	14	38	20	68	914
Nitrate-N	µg/L	31	89	16	58	2900
Nitrite-N	µg/L	2	4	2	4	60
Total Phosphate-P	µg/L	22	31	15	22	
Total Metals						
Aluminum-Total	µg/L	32	114	24	52	100
Aluminum-Dissolved	µg/L	7	21	11	32	50 ^B
Antimony – Total	µg/L	0.05	0.06	0.11	0.50	6
Arsenic - Total	µg/L	1.54	2.12	1.87	2.92	5
Cadmium - Total	µg/L	0.04	0.09	0.02	0.05	0.15 ^A
Chromium - Total	µg/L	0.59	1.16	0.55	1.20	1
Copper - Total	µg/L	0.59	1.04	1.01	1.30	2
Iron - Total	µg/L	196	416	128	247	300
Iron -Dissolved	µg/L	42	98	47	79	350 ^B
Lead - Total	µg/L	0.17	0.64	0.14	0.52	2
Mercury - Total	µg/L	0.010	0.010	0.012	0.020	0.026
Molybdenum - Total	µg/L	1.02	1.15	1.13	1.41	73
Nickel - Total	µg/L	0.88	1.96	1.39	2.00	65
Selenium - Total	µg/L	0.49	0.70	0.69	1.00	2 ^B
Silver - Total	µg/L	0.01	0.01	0.01	0.02	0.1
Zinc - Total	µg/L	6.3	10.3	3.3	5.0	30

Bold values are greater than water quality guideline.

1. Guideline value is CCME unless otherwise noted.

2. Total Suspended Solids.

3. Dissolved Organic Carbon.

A. US EPA hardness dependent guideline for cadmium assuming a hardness of 50 mg/L.

B. British Columbia 30 day average guideline for protection of aquatic life.

2.3 Go Creek Watershed

Baseline water quality samples from Go Creek have been collected at 6 stations. Go Creek water quality data are presented first for stations in the upper portion of Go Creek including Station W15 on Hawkowl Creek (Section 2.3.1) and then the lower portion of Go Creek including Station W13 on Pup Creek (Section 2.3.2). Station W80 in lower Go Creek will serve as the compliance point for the Project.

2.3.1 Seasonality

The decrease in conductivity and hardness due to spring freshet in late May/early June that was observed for Wolverine Creek is more pronounced for stations in Go Creek (Figure 2-8), likely due to the larger catchment at Go Creek. Conductivity and hardness were markedly lower in Go Creek than in Wolverine Creek at all times of the year. Similar to Wolverine Creek, total suspended solids was typically below detection limit except for periodically elevated level during freshet or other high flow events (Figure 2-9).

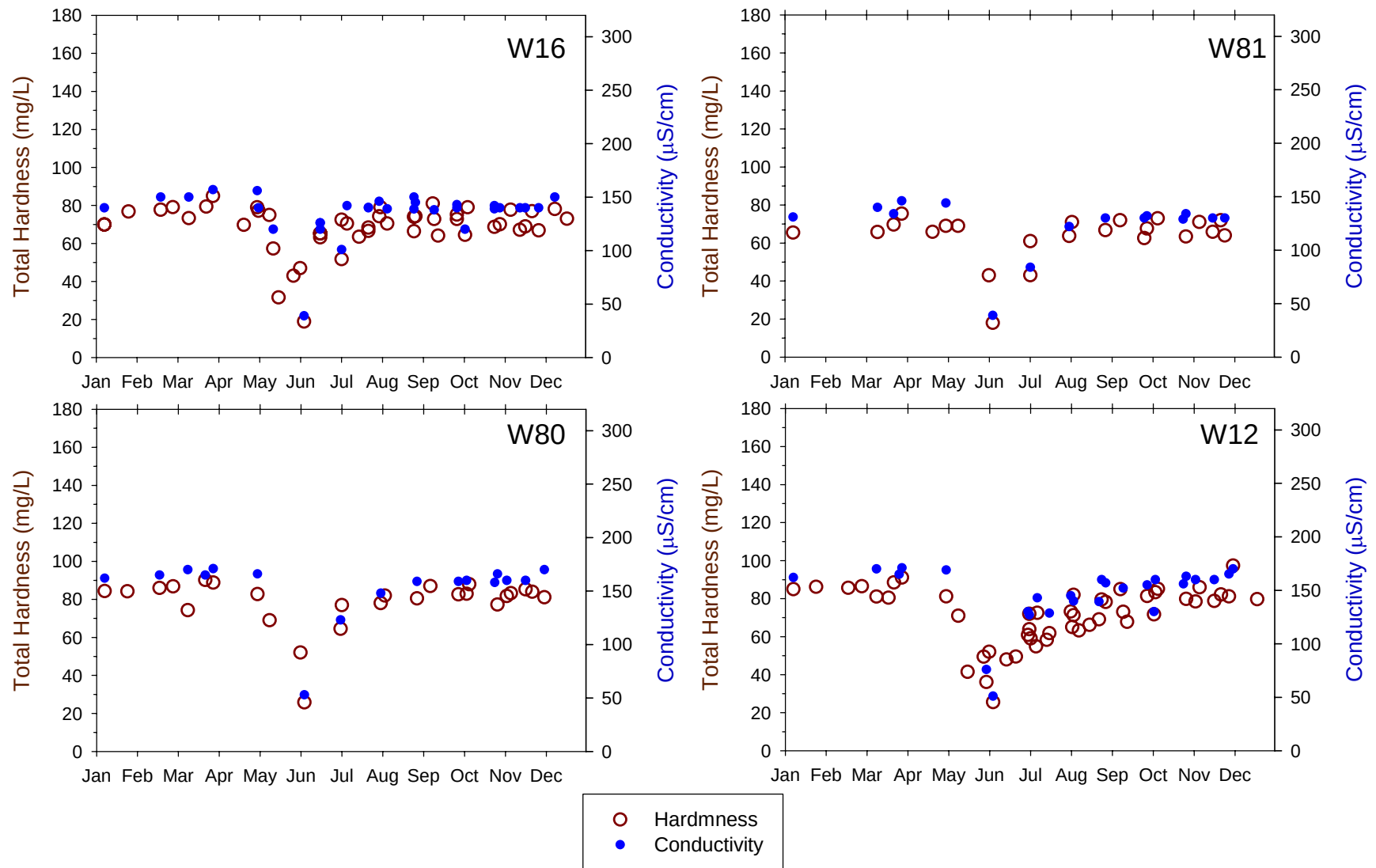


Figure 2-8 Seasonal Time Series (1995 - 2008) of Total Hardness and Conductivity at Stations in the Go Creek Watershed

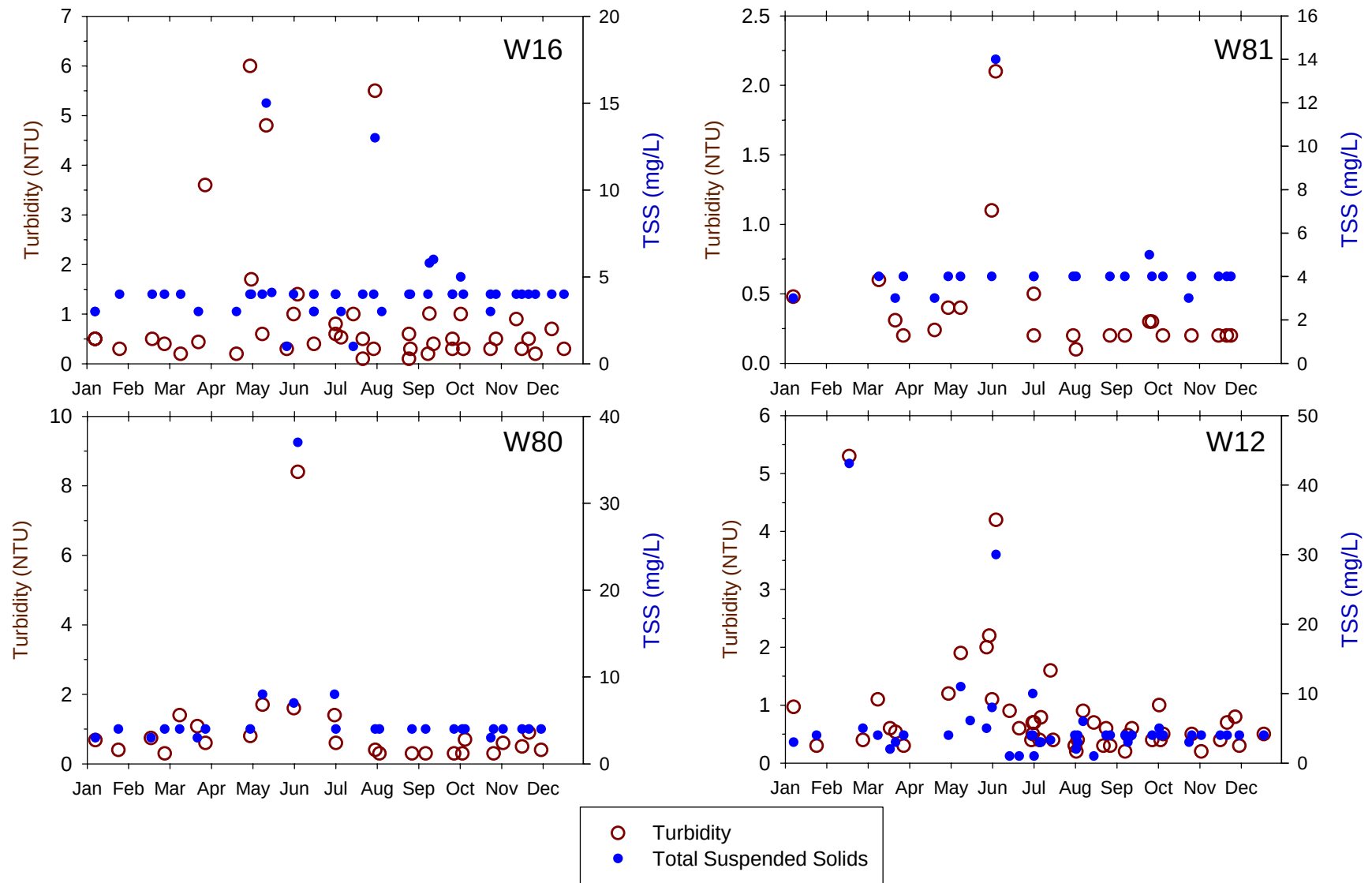


Figure 2-9 Seasonal Time Series (1995 - 2008) of Turbidity and Total Suspended Solids at Stations in the Go Creek Watershed

2.3.2 Upper Go Creek

Upper Go Creek has been sampled at Stations W31, W16, W81, and W15 (Hawkowl Creek above Go Creek). Average concentrations and 95th percentile values for parameters of key interest are listed in Table 2-3. Complete baseline data set is presented in Appendix A.

There is little difference among upper Go Creek stations for most water quality parameters. Average pH is approximately 7.8, average conductivity 125 µS/cm, and average hardness 65 mg/L (54 mg/L at Station W15). Metals are also similar among stations. The 95th percentile value for total chromium is equal to or slightly higher than the CCME guideline for Cr(VI) of 1.0 µg/L. The 95th percentile value for copper is also slightly elevated above the CCME guideline at 3 of the 4 stations. The 95th percentile value for selenium is exactly 1.0 µg/L at all 4 stations in Table 2-3. In fact, most measurements of selenium in Go Creek were below its detection limit (usually 1.0 µg/L) but when statistics were calculated for a data set any value less than detection limit was set equal to the detection limit. Average cadmium and zinc concentrations are more than an order of magnitude lower in upper Go Creek than in Wolverine Creek.

Table 2-3:
Surface Water Quality Summary for Upper Go Creek Stations

Parameter	Units	W31		W16		W81		W15		Guideline ¹
		Average	95th %	Average	95th %	Average	95th %	Average	95th %	
Physical Tests										
pH	pH	7.9	8.1	7.8	8.1	7.8	8.0	7.7	8.0	6.5 - 9
Conductivity	uS/cm	127	150	135	153	124	145	107	127	
TSS ²	mg/L	7	16	7	15	4	5	5	11	
Hardness	mg/L	68	87	69	79	64	73	54	66	
DOC ³	mg/L	2.7	4.7	2.2	5.2	1.8	5.0	1.4	3.4	
Dissolved Anions										
Fluoride	µg/L	23	30	40	63	31	40	31	50	120
Sulphate	mg/L	8	11	8	11	9	12	8	11	100
Nutrients										
Ammonia-N	µg/L	12	20	16	49	8	20	11	22	914
Nitrate-N	µg/L	35	98	56	126	64	130	72	175	2900
Nitrite-N	µg/L	2	5	2	5	2	3	2	2	60
Total Phosphate-P	µg/L	5	9	11	28	8	21	6	11	
Total Metals										
Aluminum-Total	µg/L	22	65	35	88	26	60	30	96	100
Aluminum-Dissolved	µg/L	15	41	8	23	7	16	8	23	50 ^B
Antimony – Total	µg/L	0.12	0.50	0.12	0.50	0.22	0.10	0.09	0.24	6
Arsenic - Total	µg/L	0.23	0.50	0.25	0.50	0.17	0.30	0.20	0.50	5
Cadmium - Total	µg/L	0.01	0.02	0.08	0.12	0.02	0.04	0.02	0.03	0.15 ^A
Chromium - Total	µg/L	0.59	1.15	0.65	1.40	0.54	1.00	0.54	1.10	1
Copper - Total	µg/L	1.35	3.13	1.01	2.82	0.72	1.68	1.00	2.76	2
Iron - Total	µg/L	20	35	89	332	45	83	47	108	300
Iron -Dissolved	µg/L	14	30	22	45	14	30	17	36	350 ^B
Lead - Total	µg/L	0.12	0.50	0.14	0.50	0.05	0.10	0.11	0.50	2
Mercury - Total	µg/L	0.013	0.020	0.013	0.020	0.010	0.010	0.011	0.020	0.026
Molybdenum - Total	µg/L	0.44	1.00	0.48	1.00	0.32	0.40	0.29	0.66	73
Nickel - Total	µg/L	0.49	1.00	0.54	1.00	0.44	0.59	0.48	1.00	65
Selenium - Total	µg/L	0.56	1.00	0.62	1.00	0.55	1.00	0.63	1.00	2 ^B
Silver - Total	µg/L	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.1
Zinc - Total	µg/L	2.5	5.0	6.5	16.1	2.6	5.1	4.5	13.4	30

Bold values are greater than water quality guidelines.

1. Guidelines shown are CCME values unless otherwise noted. 2. Total Suspended Solids; 3. Dissolved Organic Carbon

A. USEPA hardness dependent chronic guideline for cadmium assuming a hardness of 50 mg/L; B. BC 30 day average guideline for protection of aquatic life.

2.3.3 Lower Go Creek and Compliance Point

Water quality in lower Go Creek has been monitored at Stations W80 and W12. Station W80 will be the compliance location monitored during operation and closure phases of the Project. Average concentrations and 95th percentile values for parameters of key interest are listed in Table 2-4. Complete baseline data set is presented in Appendix A.

In general, water quality in lower Go Creek is very similar to upper Go Creek. An exception is iron which had average iron concentration (both total and dissolved) at Station W80 of approximately double the highest average of stations in upper Go Creek. While Fe concentration was higher in lower Go Creek than upper Go Creek concentrations at W80 were below guidelines.

At station W80, aluminum, chromium, and iron 95th percentile values are greater than their water quality guideline. Copper 95th percentile is just below the CCME guideline of 2 µg/L. Concentrations of these metals are elevated when TSS levels are elevated (Figure 2-10). During freshet and other high flow events that occur during the operation phase of the Project these metals will be expected to exceed water quality guidelines.

Fluoride concentrations in Go Creek are lower than in Wolverine Creek. The average fluoride concentration in Wolverine Creek is approximately equal to the CCME guideline for inorganic fluoride of 120 µg/L. Average fluoride concentration is approximately 30 µg/L in upper Go Creek and 50 µg/L in lower Go Creek. Only 1 fluoride measurement out of 154 baseline samples from Go Creek was above 120 µg/L (Appendix A).

**Table 2-4:
Surface Water Quality Summary for Lower Go Creek Stations**

Parameter	Units	W80		W12		W13 (Pup Ck)		Guideline ¹
		Average	95th %	Average	95th %	Average	95th %	Guideline ¹
Physical Tests								
pH	pH	7.9	8.1	7.8	8.1	7.7	8.1	6.5 - 9
Conductivity	uS/cm	154	170	146	170	126	158	
TSS ²	mg/L	6	8	5	11	4	5	
Hardness	mg/L	79	89	72	88	59	76	
DOC ³	mg/L	4.8	6.2	2.1	4.3	2.5	5.4	
Dissolved Anions								
Fluoride	µg/L	51	62	56	72	68	103	120
Sulphate	mg/L	15	19	13	18	12	16	100
Nutrients								
Ammonia-N	µg/L	10	20	14	53	13	34	914
Nitrate-N	µg/L	68	279	35	123	54	177	2900
Nitrite-N	µg/L	6	4	6	5	3	4	60
Total Phosphate-P	µg/L	7	14	7	14	7	19	
Total Metals								
Aluminum-Total	µg/L	57	153	32	79	34	114	100
Aluminum-Dissolved	µg/L	7	13	9	31	14	42	50 ^B
Antimony – Total	µg/L	0.06	0.12	0.12	0.50	0.09	0.50	6
Arsenic - Total	µg/L	0.30	0.58	0.30	0.50	0.24	0.50	5
Cadmium - Total	µg/L	0.06	0.08	0.03	0.06	0.04	0.11	0.22 ^A
Chromium - Total	µg/L	0.57	1.35	0.55	1.17	0.55	1.09	1
Copper - Total	µg/L	0.87	1.90	1.08	2.71	1.09	3.50	2
Iron - Total	µg/L	176	617	90	229	105	265	300
Iron -Dissolved	µg/L	37	109	31	82	42	107	350 ^B
Lead - Total	µg/L	0.12	0.54	0.17	0.62	0.15	0.50	2
Mercury - Total	µg/L	0.010	0.010	0.013	0.020	0.012	0.020	0.026
Molybdenum - Total	µg/L	0.44	0.47	0.51	1.00	0.44	1.00	73
Nickel - Total	µg/L	0.75	1.75	0.60	1.63	0.78	1.65	65
Selenium - Total	µg/L	0.86	1.09	0.91	1.26	0.68	1.00	2 ^B
Silver - Total	µg/L	0.01	0.01	0.01	0.02	0.01	0.02	0.1
Zinc - Total	µg/L	2.4	4.9	3.1	5.5	3.3	7.6	30

Bold values are greater than water quality objectives.

1. Guidelines shown are CCME values unless otherwise noted
2. Total Suspended Solids;
3. Dissolved Organic Carbon

A. US EPA hardness dependent chronic guideline for cadmium assuming a hardness of 80 mg/L.

B. British Columbia 30 day average guideline for protection of aquatic life.

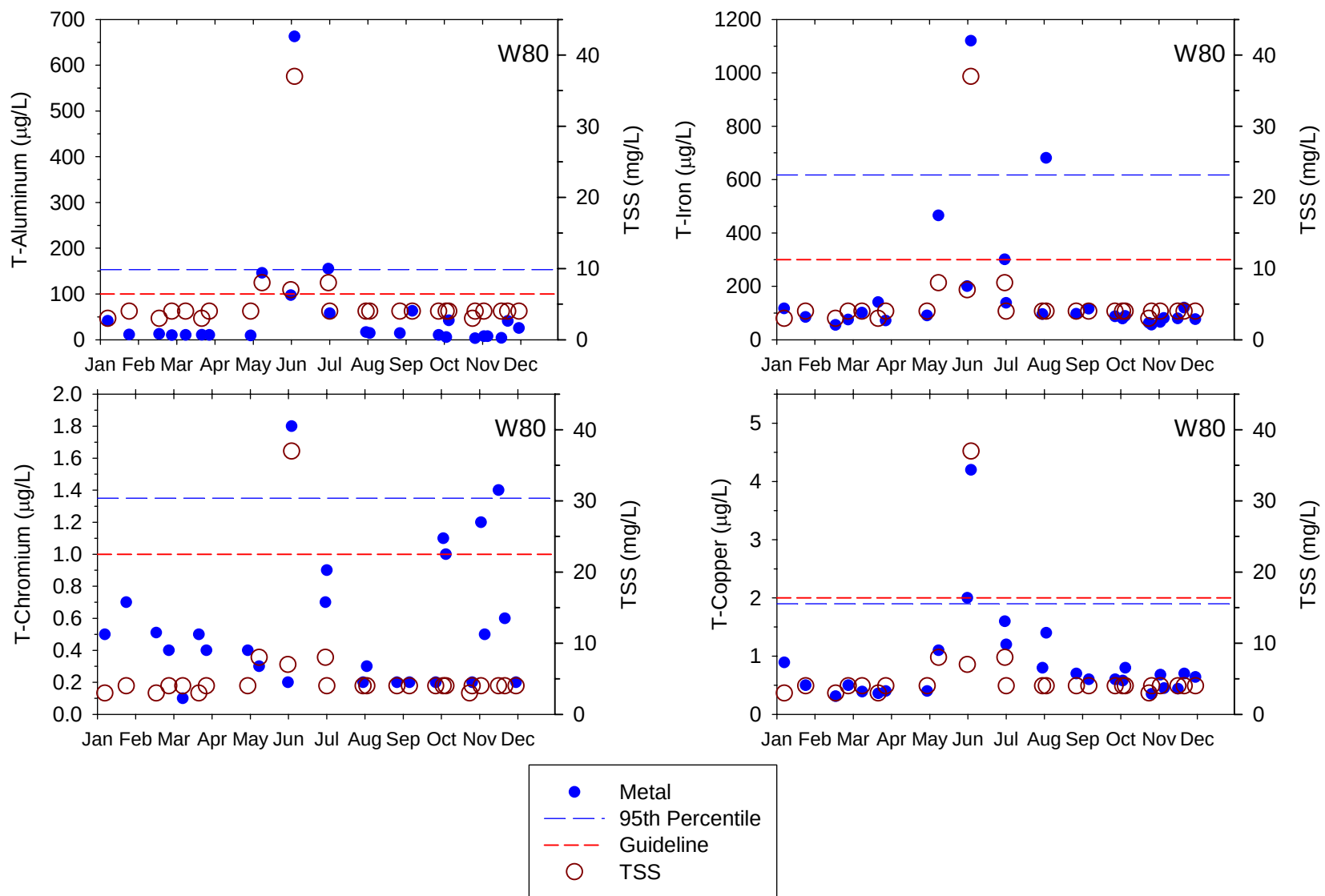


Figure 2-10 Total Suspended Solids and Total Aluminum, Iron, Chromium and Copper at Station W80 in Go Creek, 1995 - 2008

2.4 Money Creek Watershed

Baseline monitoring in Money Creek has included Station W14 (100 m downstream of Go Creek), and stations at the mouth of Money Creek both upstream of the Robert Campbell Highway (W22) and downstream of the highway (W40) (Figure 2-1). Summary water quality statistics (average and 95th percentile) are listed in Table 2-5. Complete baseline data are presented in Appendix A.

pH values in Money Creek are similar to the other streams sampled during baseline monitoring, with average pH between 7.7 and 8.0. Conductivity and hardness are higher at the downstream locations than at the upstream station W14. Average fluoride concentrations in Money Creek (70 – 90 µg/L) are below the CCME guideline of 120 µg/L while 95th percentiles (90 – 120 µg/L) are close to the guideline. Two fluoride samples out of 84 baseline measurements in Money Creek were greater than 120 µg/L.

Metals which are periodically above water quality guidelines in Go Creek (Al, Fe, Cr, and Cu), particularly when suspended sediments are elevated, are also periodically elevated in Money Creek to concentrations above guidelines (Table 2-5). Average concentrations of these metals are similar at upstream and downstream stations, while 95th percentiles are higher at the downstream stations, likely due to higher TSS concentrations at the downstream sites (i.e., W22 and W40) during high flow events. Other metals in Money Creek have 95th percentile values less than their water quality guideline.

**Table 2-5:
Surface Water Quality Summary for Money Creek Stations**

		W14		W22		W40		Guideline ¹
Parameter	Units	Average	95th %	Average	95th %	Average	95th %	
Physical Tests								
pH	pH	7.7	8.1	7.9	8.3	8.0	8.2	6.5 - 9
Conductivity	uS/cm	126	158	222	300	220	294	
TSS ²	mg/L	4	5	4	7	5	10	
Hardness	mg/L	59	76	98	153	111	157	
DOC ³	mg/L	2.5	5.4	3.1	5.8	2.8	5.7	
Dissolved Anions								
Fluoride	µg/L	68	103	89	122	78	91	120
Sulphate	mg/L	12	16	20	33	23	33	100
Nutrients								
Ammonia-N	µg/L	13	34	14	25	10	20	914
Nitrate-N	µg/L	54	177	57	207	59	169	2900
Nitrite-N	µg/L	3	4	1	2	2	4	60
Total Phosphate-P	µg/L	7	19	7	14	6	10	
Total Metals								
Aluminum-Total	µg/L	34	114	38	167	55	234	100
Aluminum-Dissolved	µg/L	14	42	12	33	9	24	50 ^B
Antimony – Total	µg/L	0.09	0.50	0.14	0.50	0.11	0.44	6
Arsenic - Total	µg/L	0.24	0.50	0.26	0.51	2.71	0.60	5
Cadmium - Total	µg/L	0.04	0.11	0.03	0.06	0.07	0.05	0.15 ^A
Chromium - Total	µg/L	0.55	1.09	0.64	1.26	0.72	1.48	1
Copper - Total	µg/L	1.09	3.50	1.10	2.31	0.82	1.68	2
Iron - Total	µg/L	105	265	96	422	99	361	300
Iron -Dissolved	µg/L	42	107	28	67	21	46	350 ^B
Lead - Total	µg/L	0.15	0.50	0.19	0.83	0.20	0.50	2
Mercury - Total	µg/L	0.012	0.020	0.013	0.020	0.011	0.020	0.026
Molybdenum - Total	µg/L	0.44	1.00	0.69	1.00	0.71	0.98	73
Nickel - Total	µg/L	1.05	1.37	1.18	2.45	1.02	1.90	65
Selenium - Total	µg/L	0.68	1.00	0.88	1.00	0.73	1.00	2 ^B
Silver - Total	µg/L	0.01	0.02	0.01	0.02	0.01	0.02	0.1
Zinc - Total	µg/L	3.3	7.6	6.5	15.2	3.5	5.9	30

Bold values are greater than water quality objectives.

- Guidelines shown are CCME values unless otherwise noted
 - Total Suspended Solids
 - Dissolved Organic Carbon
- A. US EPA hardness dependent chronic guideline for cadmium assuming a hardness of 50 mg/L.
B. British Columbia 30 day average guideline for protection of aquatic life.

2.5 *Mine Access Route*

Streams that run close to the mine access route connecting the mine site to the Robert Campbell Highway have been routinely monitored at Pitch Creek (Station W71), Putt Creek downstream of Pitch Creek (Station W72), and Bunker Creek (Station W73) (Figure 2-1). Summary water quality statistics (average and 95th percentile) for these 3 stations are listed in Table 2-6. Complete baseline data are presented in Appendix A.

Station W71, on Pitch Creek just upstream of Putt Creek and the mine access road has elevated levels of conductivity, hardness, sulphate, cadmium, molybdenum, nickel, selenium, and zinc. Many of these parameters are also elevated in Wolverine Creek downstream of the mineralized zone of the Wolverine deposit, although W71 is the only baseline station with elevated sulphate.

Many of the parameters that show natural elevations in Pitch Creek are also elevated at Station 72, in Putt Creek downstream of Pitch Creek, but to a lesser degree. Average fluoride, Cd, and Zn are above guidelines, and 95th percentile values for Al, Cr, Cu, Fe, and Se are above guidelines. At the upstream station (W73), on Bunker Creek, water quality is similar to Go Creek and Money Creek. Chromium and copper are the only parameters with 95th percentile values that are above guidelines.

Table 2-6:
Surface Water Quality Summary for Stations Adjacent to the Mine Access Route

		W71		W72		W73		Guideline ¹
Parameter	Units	Average	95th %	Average	95th %	Average	95th %	
Physical Tests								
pH	pH	8.2	8.4	8.2	8.3	8.1	8.2	6.5 - 9
Conductivity	uS/cm	621	820	373	511	227	294	
TSS ²	mg/L	8	40	6	11	5	5	
Hardness	mg/L	369	519	199	277	117	161	
DOC ³	mg/L	3.8	8.9	4.4	8.8	2.6	7.0	
Dissolved Anions								
Fluoride	µg/L	625	761	186	230	64	93	120
Sulphate	mg/L	104	148	46	58	19	30	100
Nutrients								
Ammonia-N	µg/L	8	20	16	33	8	20	914
Nitrate-N	µg/L	16	39	46	91	59	130	2900
Nitrite-N	µg/L	2	5	4	9	3	6	60
Total Phosphate-P	µg/L	16	25	22	36	7	12	
Total Metals								
Aluminum-Total	µg/L	68	457	84	198	17	52	100
Aluminum-Dissolved	µg/L	4	7	7	16	5	12	50 ^B
Antimony – Total	µg/L	0.56	0.70	0.24	0.34	0.13	0.20	6
Arsenic - Total	µg/L	0.48	0.98	1.72	2.18	0.27	0.50	5
Cadmium - Total	µg/L	2.40	4.13	0.33	0.43	0.02	0.04	0.25 ^A
Chromium - Total	µg/L	0.70	1.77	0.91	1.30	0.76	1.40	1
Copper - Total	µg/L	0.82	1.39	1.35	2.39	1.31	2.80	2
Iron - Total	µg/L	133	655	295	629	54	142	300
Iron -Dissolved	µg/L	16	30	48	105	18	41	350 ^B
Lead - Total	µg/L	0.14	0.49	0.32	0.50	0.07	0.11	2
Mercury - Total	µg/L	0.011	0.013	0.011	0.014	0.011	0.020	0.026
Molybdenum - Total	µg/L	4.91	6.47	3.02	4.23	0.51	0.66	73
Nickel - Total	µg/L	27.96	35.16	4.30	6.09	0.95	1.89	65
Selenium - Total	µg/L	5.01	7.30	1.55	2.05	0.81	1.30	2 ^B
Silver - Total	µg/L	0.01	0.02	0.01	0.02	0.01	0.02	0.1
Zinc - Total	µg/L	564.2	840.4	38.4	43.6	3.0	12.6	30

Bold values are greater than water quality objectives.

1. Guidelines shown are CCME values unless otherwise noted
2. Total Suspended Solids
3. Dissolved Organic Carbon
- A. US EPA hardness dependent chronic guideline for cadmium assuming a hardness of 100 mg/L.
- B. British Columbia 30 day average guideline for protection of aquatic life.

3. Groundwater Quality

3.1 Overview and Data Quality

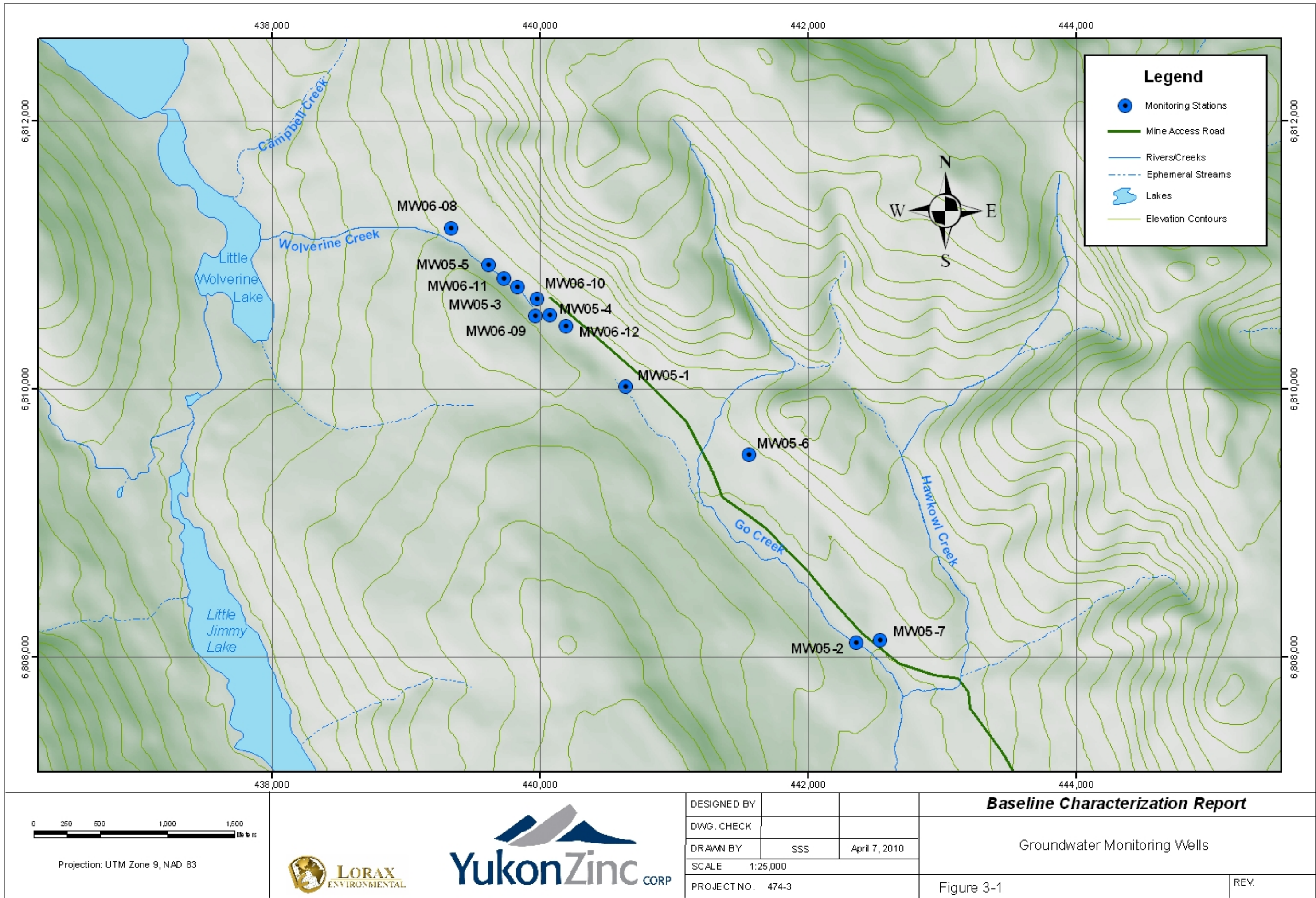
Groundwater monitoring wells for characterizing baseline groundwater conditions were installed in strategic locations at the Wolverine Project site during 2005 and 2006. Consistent monitoring of the wells commenced in June 2006, although sporadic monitoring of a few wells occurred in September 2005. The majority of groundwater monitoring wells are located downgradient of the proposed mining area within the upper Wolverine Creek basin (Figure 3-1 and Figure 3-2). A total of sixteen (16) groundwater monitoring wells have been installed at eight (8) nested locations in the Wolverine Creek basin and monitor the shallow alluvial groundwater system, the shallow bedrock and deeper bedrock aquifers.

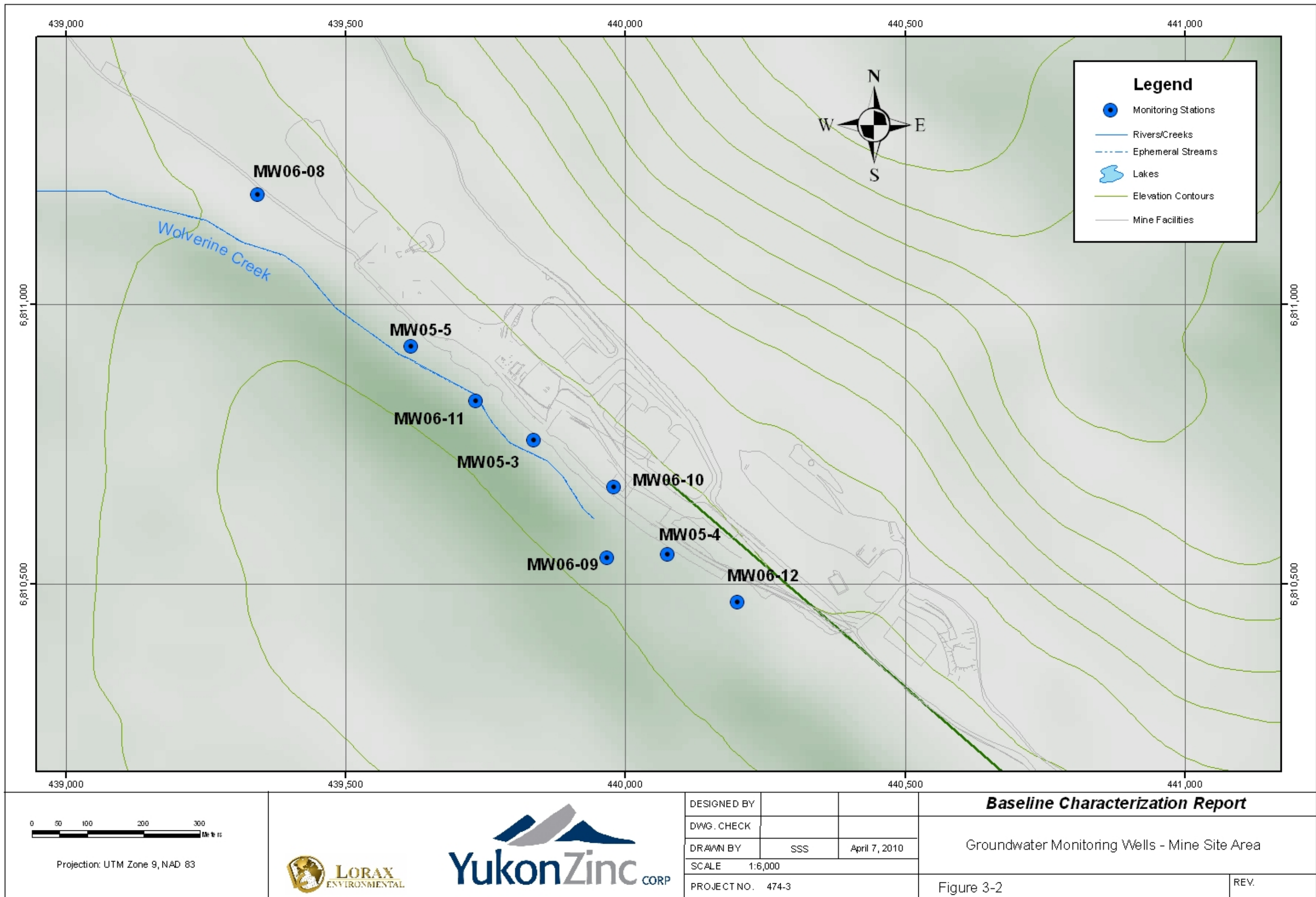
Groundwater monitoring wells are also installed in the upper Go Creek basin and immediately downgradient of the proposed tailings impoundment area (Figure 3-1). The wells in the Go Creek basin monitor the shallow alluvial and shallow bedrock aquifers.

Complete groundwater quality monitoring data for each groundwater well, for the period of 2005 to 2008, is provided in Appendix B. As illustrated in the tables, certain data have been ignored in the statistical analysis owing to either unacceptable detection limits or suspect data. Examples of what was considered suspect data are often found in the first sampling period for most of the groundwater wells for the period of June 2006. In most of the wells, very high dissolved organic carbon (DOC) concentrations were measured (> 20 mg/L) that is both inconsistent with subsequent data as well as typical groundwater systems. These elevated DOC levels were observed in both alluvial and shallow bedrock wells and may have been the result of residual drilling fluids within the wells. Irrespective of the exact cause, these data have been ignored in the statistical analysis (Appendix B).

The discussions in this chapter have been organized according to the basins being monitored (e.g. Wolverine and Go Creek) as well as aquifer system. Section 3.2 describes the baseline groundwater conditions in the Wolverine Creek basin and describes groundwater quality in the shallow alluvial, shallow bedrock and deep bedrock aquifers. Section 3.3 similarly describes the baseline groundwater quality in the Go Creek basin and further subdivides the groundwater conditions in upper Go Creek and within the tailings impoundment area.

Summary data tables, illustrating the mean and the upper 95th percentile for each station are provided and are used to characterize the baseline condition for each well.





3.2 Wolverine Creek Basin – Mine Site Area

Groundwater monitoring wells adjacent to Wolverine Creek and downgradient of the proposed underground operations have been established. Table 3-1 summarizes the well identification and depth of completion for each monitoring well in the upper Wolverine Creek basin. Well locations are also illustrated on Figures 3-1 and 3-2.

**Table 3-1:
Wolverine Creek Basin Groundwater Monitoring Wells**

Well	Depth (m)	Stratigraphic Unit
MW05-3A	19.98	Shallow bedrock
MW05-3B	4.52	Alluvial Overburden
MW05-4A	17.56	Shallow bedrock
MW05-4B	3.89	Alluvial Overburden
MW05-5A	26.5	Shallow bedrock
MW05-5B	4.39	Alluvial Overburden
MW06-08S	21.92	Shallow bedrock
MW06-08M	82.81	Bedrock
MW06-08D	184.71	Deep Bedrock
MW06-09S	21.3	Shallow bedrock
MW06-09M	80.38	Bedrock
MW06-10S	21.33	Shallow bedrock
MW06-10M	104.3	Bedrock
MW06-10D	185	Deep Bedrock
MW06-11S	21.3	Shallow bedrock
MW06-12S	21.65	Shallow bedrock

3.2.1 Baseline Alluvial Groundwater Quality

Alluvial groundwater quality in the upper Wolverine Creek basin, immediately downgradient of the proposed mine facilities and industrial complex has been monitored since June 2006 in wells MW05-3B, MW05-4B and MW05-5B (Figure 3-2). Groundwater quality varies significantly in the alluvial system over relatively short distances. A summary of the baseline groundwater quality for each well is provided in Table 3-2. As illustrated, baseline groundwater quality at station MW05-3B is naturally elevated in Cd, Se and Zn. Indeed, background mean Zn concentrations are very elevated and on the order of 1.0 mg/L. Cadmium and Se concentrations are also very elevated for groundwater systems at approximately 0.012 mg/L and 0.013 mg/L, respectively (Table 3-2).

Table 3-2:
Summary of Alluvial Groundwater Quality in Wolverine Creek Basin

Parameters	MW05-3B			MW05-4B			MW05-5B	
	Mean	95th Percentile		Mean	95th Percentile		Mean	95th Percentile
Physical Parameters								
Conductivity	249	260		231	240		298	308
Dissolved Hardness	120	133		111	119		159	169
Total Suspended Solids	4	4		4.0	4		4.0	4
Total Dissolved Solids	157	168		149	165		185	204
pH	7.8	8.1		7.7	8.0		8.1	8.2
Turbidity	1	3		9	12		5	8
DOC	0.9	11		0.9	1		1.8	6
Major Anions								
Alkalinity-Total	87	90		70	78		108	111
Acidity - Total	6.3	7.8		4.5	4.5		2.7	4.0
Bromide	0.08	0.10		0.08	0.10		0.10	0.17
Chloride	0.8	2.1		0.5	0.7		0.7	1.3
Fluoride	0.18	0.21		0.51	0.55		0.27	0.31
Sulphate	35.2	37.3		45.0	49.2		43.3	46.8
Nutrient Parameters								
Ammonial Nitrogen	0.013	0.041		0.036	0.041		0.015	0.026
Nitrate Nitrogen	0.2678	0.3172		0.0160	0.0464		0.0060	0.0164
Nitrite Nitrogen	0.0020	0.0020		0.0020	0.0020		0.0021	0.0027
Total Phosphate	0.006	0.009		0.007	0.009		0.006	0.009
Dissolved Ortho-Phosphate	0.004	0.007		0.008	0.013		0.004	0.007
Dissolved Metals								
Aluminum (Al)	0.0016	0.0047		0.0051	0.0160		0.0018	0.0040
Antimony (Sb)	0.0001	0.0002		0.0001	0.0002		0.0001	0.0001
Arsenic (As)	0.0004	0.0007		0.0051	0.0069		0.0014	0.0017
Cadmium (Cd)	0.0119	0.0142		0.00258	0.00371		0.000013	0.00002
Calcium (Ca)	40.2	44.3		39.8	43.8		52.7	55.6
Chromium (Cr)	0.00016	0.00020		0.00018	0.00020		0.00016	0.00020
Cobalt (Co)	0.00034	0.00104		0.00258	0.00281		0.00050	0.00055
Copper (Cu)	0.00271	0.00386		0.00031	0.00064		0.00024	0.00068
Iron (Fe)	0.11	0.31		0.96	1.32		0.46	0.76
Lead (Pb)	0.000185	0.000328		0.000135	0.000416		0.000038	0.000121
Magnesium (Mg)	4.86	5.40		3.05	3.21		6.63	6.96
Manganese (Mn)	0.040	0.132		2.860	2.938		0.517	0.595
Mercury (Hg)	0.00001	0.00001		0.00001	0.00001		0.00001	0.00001
Molybdenum (Mo)	0.00074	0.00079		0.00110	0.00122		0.00223	0.00313
Nickel (Ni)	0.00317	0.00392		0.00578	0.00626		0.00241	0.00282
Phosphorus (P)	0.063	0.100		0.100	0.100		0.068	0.100
Potassium (K)	1.08	1.32		1.82	2.11		0.85	0.98
Selenium (Se)	0.0129	0.0145		0.00041	0.00050		0.00030	0.00050
Silicon (Si)	4.05	4.47		6.19	6.44		3.20	3.61
Silver (Ag)	0.000008	0.000010		0.000009	0.000010		0.000008	0.000010
Sodium (Na)	3.60	9.32		1.22	1.37		0.96	1.27
Strontium (Sr)	0.139	0.173		0.145	0.157		0.108	0.117
Thallium (Tl)	0.00003	0.00005		0.00004	0.00005		0.00003	0.00005
Vanadium (V)	0.00012	0.0002		0.00006	0.00007		0.00011	0.00020
Zinc (Zn)	0.993	1.166		0.160	0.187		0.027	0.030

All units in mg/L except conductivity (uS/cm) and pH

 shaded values are considered naturally elevated in the baseline

Groundwater quality at MW05-4B is also characterized by naturally elevated concentrations of Cd and Zn, although each parameter is present at concentrations approximately an order of magnitude lower than observed at MW05-3B; Se concentrations do not appear to be naturally elevated in this portion of the alluvial aquifer. Further downgradient at station MW05-5B, groundwater contains much lower concentrations of Cd, Se and Zn. The data suggest a localized natural source of elevated Cd, Se and Zn in the upper Wolverine Creek basin alluvial aquifer in the vicinity of MW05-3B (Figure 3-3).

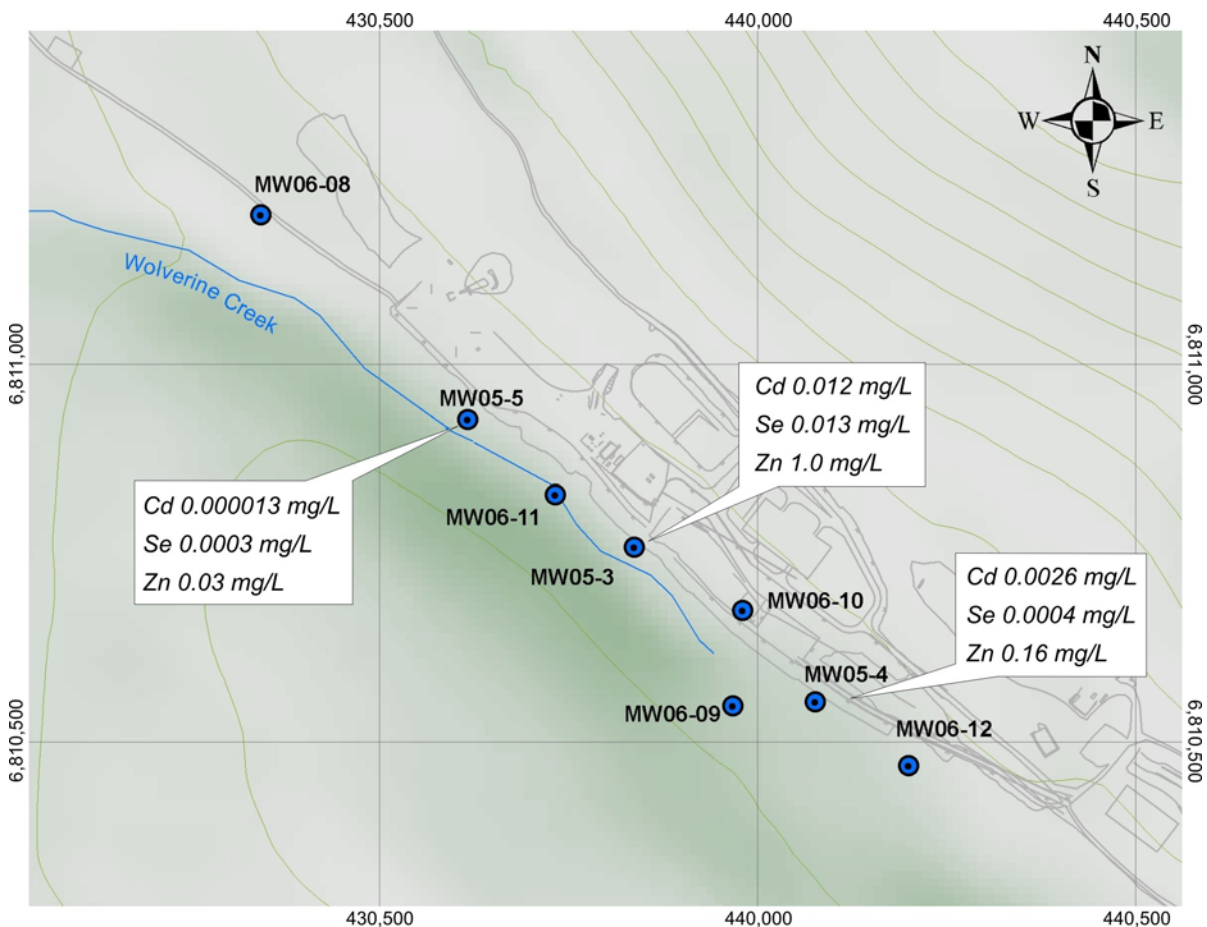


Figure 3-3: Detail of Baseline Groundwater Quality in Alluvial Aquifer – Wolverine Creek Basin

3.2.2 Baseline Shallow Bedrock Groundwater Quality

Shallow bedrock groundwater wells were installed in the Wolverine Creek basin in 2005 and 2006 and include wells MW05-3A, MW05-4A, MW05-5A, MW06-8S, MW06-9S, MW06-10S, MW06-11S and MW06-12S (Table 3-1 and Figure 3-2). Table 3-3 provides a summary of the baseline groundwater quality for the shallow bedrock aquifer in the Wolverine Creek basin.

Table 3-3:
Summary of Shallow Bedrock Groundwater Quality in Wolverine Creek Basin

Parameters	MW05-3A		MW05-4A		MW05-5A		MW06-8S		MW06-9S		MW06-10S		MW06-11S		MW06-12S	
	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile
Physical Parameters																
Conductivity	318	385	320	331	491	500	180	217	260	269	282	294	325	413	844	1017
Dissolved Hardness	173	216	173	179	290	307	79	91	139	160	140	155	192	252	322	390
Total Suspended Solids	4.3	6	13.5	44	4.2	5	4.3	6	4	5	4	4	19	87	49.5	241
Total Dissolved Solids	202	240	204	219	306	374	120	144	170	201	184	212	218	297	566	691
pH	8.0	8.3	8.1	8.3	8.2	8.4	7.6	7.9	8.3	8.9	8.2	8.3	8.4	8.8	8.3	8.5
Turbidity	16	28	26	93	16	24	20	96	1	2	0	1	2	7	28	142
DOC	1.0	2	0.9	1	0.8	2	1.1	3	0.7	1	0.9	2	0.8	1	1.1	2
Major Anions																
Alkalinity-Total	128	155	103	112	231	236	56	75	113	130	114	119	140	178	131	154
Acidity - Total	5.1	5.5	2.1	2.1	4.2	6.2	4.7	5.2	1.6	2.1	1.3	1.8	1.2	1.8	1.1	1.4
Bromide	0.10	0.18	0.09	0.18	0.10	0.24	0.10	0.28	0.08	0.15	0.07	0.10	0.08	0.16	0.09	0.14
Chloride	1.0	2.8	0.8	1.4	1.2	2.8	1.7	5.5	1.2	3.7	1.1	3.4	0.9	2.2	1.3	4.1
Fluoride	0.40	0.61	0.89	0.96	2.25	2.41	0.22	0.27	0.57	0.83	0.24	0.28	2.10	2.26	1.06	1.14
Sulphate	35.0	37.8	56.6	69.2	35.4	38.8	30.6	38.5	26.7	40.7	31.5	40.0	42.3	77.3	281.6	393.6
Nutrient Parameters																
Ammonial Nitrogen	0.016	0.037	0.011	0.021	0.073	0.098	0.030	0.054	0.032	0.094	0.022	0.045	0.166	0.247	0.147	0.240
Nitrate Nitrogen	0.0657	0.1548	0.0174	0.0286	0.0126	0.0620	0.0181	0.0565	0.0094	0.0310	0.0097	0.0336	0.0337	0.1565	0.0093	0.0308
Nitrite Nitrogen	0.002	0.002	0.0038	0.0091	0.0038	0.0108	0.0031	0.0071	0.0020	0.0020	0.0022	0.0032	0.0024	0.0046	0.0040	0.0109
Total Phosphate	0.006	0.009	0.006	0.008	0.012	0.019	0.055	0.131	0.326	0.411	0.032	0.049	0.035	0.058	0.030	0.048
Dissolved Ortho-Phosphate	0.006	0.016	0.004	0.007	0.006	0.016	0.027	0.093	0.246	0.383	0.026	0.048	0.024	0.048	0.029	0.053
Dissolved Metals																
Aluminum (Al)	0.0007	0.0018	0.0025	0.0040	0.0032	0.0106	0.005	0.008	0.0109	0.0417	0.0053	0.0080	0.0220	0.0348	0.0112	0.0533
Antimony (Sb)	0.0003	0.0005	0.0001	0.0001	0.0051	0.0063	0.0078	0.0198	0.0002	0.0011	0.0007	0.0022	0.0015	0.0038	0.0027	0.0095
Arsenic (As)	0.0005	0.0009	0.0017	0.0057	0.0035	0.0047	0.0016	0.0023	0.0086	0.0127	0.0047	0.0054	0.0038	0.0049	0.0029	0.0045
Cadmium (Cd)	0.0051	0.0077	0.000027	0.00005	0.000018	0.00003	0.000085	0.00040	0.000020	0.00005	0.000015	0.00005	0.000052	0.00009	0.000032	0.00012
Calcium (Ca)	58.2	73.1	63.1	66.3	77.7	82.4	26.1	29.9	50.2	61.6	48.6	53.1	55.8	74.2	98.4	123.4
Chromium (Cr)	0.00017	0.00020	0.00023	0.00043	0.00031	0.00092	0.00021	0.00035	0.00019	0.00030	0.00021	0.00044	0.00093	0.00339	0.00035	0.00112
Cobalt (Co)	0.00041	0.00054	0.00006	0.00010	0.00028	0.00036	0.00509	0.00731	0.00009	0.00035	0.00057	0.00232	0.00024	0.00068	0.00085	0.00189
Copper (Cu)	0.00168	0.00710	0.00024	0.00037	0.00012	0.00026	0.00020	0.00051	0.00017	0.00045	0.00016	0.00047	0.00019	0.00046	0.00030	0.00109
Iron (Fe)	1.02	2.31	1.40	5.66	1.12	1.60	1.12	2.00	0.30	0.81	0.15	0.24	0.13	0.28	0.13	0.52
Lead (Pb)	0.00022	0.00067	0.000026	0.000045	0.000082	0.000364	0.000044	0.000075	0.000045	0.000155	0.000040	0.000110	0.000041	0.000077	0.000062	0.000270
Magnesium (Mg)	6.67	8.26	3.93	4.05	23.37	24.72	3.30	4.31	5.33	8.31	4.23	5.00	12.54	15.80	16.76	20.46
Manganese (Mn)	0.167	0.258	0.742	1.015	0.173	0.360	0.654	0.787	0.160	0.256	0.108	0.200	0.065	0.095	0.280	0.388
Mercury (Hg)	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Molybdenum (Mo)	0.0011	0.0015	0.00522	0.00625	0.00803	0.00938	0.00378	0.00590	0.00833	0.01466	0.00222	0.00439	0.02531	0.03322	0.01086	0.03654
Nickel (Ni)	0.00394	0.00514	0.00048	0.00057	0.00070	0.00110	0.01510	0.02410	0.00062	0.00170	0.00198	0.00718	0.00370	0.01598	0.00260	0.00916
Phosphorus (P)	0.080	0.100	0.100	0.100	0.084	0.100	0.097	0.128	0.311	0.400	0.083	0.100	0.092	0.100	0.087	0.100
Potassium (K)	1.25	1.54	2.23	2.76	1.67	2.06	1.21	1.66	1.40	2.96	1.56	2.31	2.27	3.61	2.76	3.28
Selenium (Se)	0.00553	0.01063	0.00042	0.00050	0.00044	0.00090	0.00048	0.00125	0.00037	0.00050	0.00035	0.00050	0.00060	0.00143	0.00068	0.00198
Silicon (Si)	3.96	4.08	3.94	5.90	3.83	4.05	5.47	5.91	4.25	4.92	4.03	5.00	4.57	5.10	7.21	9.55
Silver (Ag)	0.000008	0.000010	0.000009	0.000010	0.000008	0.000010	0.000008	0.000010	0.000009	0.000010	0.000009	0.000011	0.000009	0.000010	0.000010	0.000014
Sodium (Na)	1.57	1.93	1.55	1.91	0.68	1.22	4.27	6.96	2.39	5.76	7.24	12.32	8.95	26.78	58.28	135.20
Strontium (Sr)	0.150	0.182	0.190	0.208	0.133	0.142	0.076	0.089	0.181	0.207	0.176	0.198	0.131	0.214	0.342	0.436
Thallium (Tl)	0.00004	0.00005	0.00005	0.00009	0.00004	0.00005	0.00003	0.00005	0.00004	0.00005	0.00003	0.00005	0.00004	0.00005	0.00004	0.00005
Vanadium (V)	0.0001	0.00005	0.00037	0.00091	0.00010	0.00020	0.00032	0.00110	0.00031	0.001	0.00014	0.0002	0.00103	0.002	0.00142	0.00417
Zinc (Zn)	0.730	0.842	0.0034	0.0050	0.0076	0.0271	0.128	0.361	0.0009	0.0017	0.0024	0.0062	0.0009	0.0024	0.0046	0.0193

All units in mg/L, except conductivity (uS/cm) and pH

shaded values are considered naturally elevated in the baseline

Monitoring well MW05-3A exhibits naturally elevated Cd, Se and Zn concentrations, similar in magnitude to the concentrations observed for these parameters in the overlying alluvial aquifer. Conversely, elevated concentrations of Cd and Zn were not observed in MW05-4A (Table 3-3). Naturally elevated Zn concentrations are however, observed in well MW06-8S (~0.130 mg/L) and suggest that localized sources are responsible for the widely variable groundwater quality in the alluvial and shallow bedrock aquifers. This tenet is also supported by the locally elevated sulphate concentrations measured in MW06-12S (~300 mg/L), which is not observed elsewhere in the shallow bedrock aquifer.

3.2.3 Baseline Deep Bedrock Groundwater Quality

Monitoring wells to characterize the deeper bedrock aquifer in the Wolverine Creek basin were installed in 2006 and included wells MW06-8D, MW06-9M, MW06-10M and MW06-10D (Table 3-1 and Figure 3-2). Table 3-4 provides a summary of the baseline deep bedrock groundwater quality of the upper Wolverine Creek basin.

Unlike the alluvial and shallow bedrock systems, baseline groundwater quality within the deep bedrock aquifer is less variable between wells and no parameters are considered to be naturally elevated in the background.

Table 3-4:
Summary of Deep Bedrock Groundwater Quality in Wolverine Creek Basin

Parameters	MW06-8D		MW06-9M		MW06-10M		MW06-10D	
	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile
Physical Parameters								
Conductivity	459	470	377	390	474	486	468	475
Dissolved Hardness	244	287	209	224	267	280	253	278
Total Suspended Solids	4.0	4	5.7	11	8	13	8.4	13
Total Dissolved Solids	257	326	225	248	286	311	265	304
pH	8.4	8.8	8.3	8.6	8.2	8.4	8.3	8.5
Turbidity	1	2	11	18	30	57	37	56
DOC	0.6	1	0.7	1	0.6	1	0.5	1
Major Anions								
Alkalinity-Total	204	229	165	186	203	209	219	241
Acidity - Total	2.6	3.0	1.8	2.9	4.4	4.4		
Bromide	0.07	0.10	0.10	0.18	0.07	0.10	0.06	0.10
Chloride	1.1	3.0	0.6	0.7	1.6	3.7	1.8	3.2
Fluoride	0.92	0.98	0.99	1.04	0.77	0.82	1.01	1.07
Sulphate	28.4	31.5	29.5	42.0	52.2	65.3	19.9	25.5
Nutrient Parameters								
Ammonial Nitrogen	0.070	0.078	0.078	0.151	0.062	0.086	0.088	0.149
Nitrate Nitrogen	0.0783	0.3651	0.0086	0.0270	0.0043	0.0137	0.0020	0.0020
Nitrite Nitrogen	0.0024	0.0041	0.0022	0.0028	0.0034	0.0066	0.0034	0.0064
Total Phosphate	0.014	0.036	0.044	0.073	0.030	0.064	0.015	0.024
Dissolved Ortho-Phosphate	0.009	0.024	0.011	0.033	0.007	0.014	0.007	0.014
Dissolved Metals								
Aluminum (Al)	0.0167	0.0562	0.0084	0.0316	0.0038	0.0089	0.0074	0.0172
Antimony (Sb)	0.0007	0.0027	0.0005	0.0018	0.0008	0.0039	0.00062	0.001
Arsenic (As)	0.0041	0.0056	0.0010	0.0016	0.0003	0.0005	0.0004	0.0006
Cadmium (Cd)	0.000032	0.00012	0.000017	0.00004	0.000011	0.00002	0.00001	0.00001
Calcium (Ca)	57.8	66.3	63.6	68.8	86.3	92.2	69.5	75.7
Chromium (Cr)	0.00066	0.00217	0.00017	0.00020	0.00019	0.00020	0.00020	0.00020
Cobalt (Co)	0.00030	0.00037	0.00014	0.00046	0.00018	0.00071	0.00003	0.00003
Copper (Cu)	0.00086	0.00388	0.00023	0.00065	0.00011	0.00022	0.00010	0.00010
Iron (Fe)	0.17	0.27	0.87	1.90	3.04	5.74	4.13	4.98
Lead (Pb)	0.000138	0.000579	0.000035	0.000058	0.000028	0.000060	0.000056	0.000128
Magnesium (Mg)	23.62	29.37	12.07	12.95	12.27	13.16	18.72	21.80
Manganese (Mn)	0.048	0.063	0.139	0.297	0.246	0.284	0.105	0.116
Mercury (Hg)	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Molybdenum (Mo)	0.00195	0.00334	0.00673	0.01472	0.00242	0.00390	0.00467	0.00711
Nickel (Ni)	0.00130	0.00235	0.00086	0.00260	0.00057	0.00102	0.00098	0.00206
Phosphorus (P)	0.084	0.100	0.081	0.100	0.100	0.100	0.100	0.100
Potassium (K)	1.89	1.97	2.47	4.12	2.46	5.36	3.31	5.72
Selenium (Se)	0.00074	0.00221	0.00035	0.00050	0.00045	0.00050	0.0005	0.0005
Silicon (Si)	4.61	4.97	3.74	3.96	3.84	4.10	3.55	3.94
Silver (Ag)	0.000009	0.000010	0.000008	0.000010	0.000009	0.000010	0.000010	0.000010
Sodium (Na)	1.63	4.26	1.82	6.23	3.49	6.12	1.65	3.11
Strontium (Sr)	0.153	0.172	0.096	0.142	0.155	0.206	0.169	0.173
Thallium (Tl)	0.00004	0.00005	0.00003	0.00005	0.00004	0.00005	0.00005	0.00005
Vanadium (V)	0.00091	0.00290	0.00023	0.00067	0.00007	0.000	0.00007	0.00010
Zinc (Zn)	0.0045	0.0131	0.0012	0.0035	0.0014	0.0044	0.0013	0.0032

All units in mg/L except conductivity (uS/cm) and pH

3.3 Go Creek Basin

For the purposes of the baseline groundwater characterization, Go Creek basin has been divided into the upper Go Creek basin and Tailings Impoundment area. Baseline groundwater quality in the alluvial and shallow bedrock aquifers is discussed for each area below. No deep bedrock monitoring wells have been installed in the Go Creek basin and only the shallow aquifer systems are monitored. Table 3-5 summarizes the well identification and depth of completion for each monitoring well in the Go Creek basin. Well locations are also illustrated on Figure 3-1.

Table 3-5:
Go Creek Basin Groundwater Monitoring Wells

Well	Depth (m)	Stratigraphic Unit
MW05-1A	22.7	Shallow Bedrock
MW05-1B	4.4	Alluvial Overburden
MW05-2A	22.9	Shallow Bedrock
MW05-2B	3.0	Alluvial Overburden
MW05-6A	25.1	Shallow Bedrock
MW05-6B	12.0	Alluvial Overburden
MW05-7A	28.1	Shallow bedrock
MW05-7B	4.5	Alluvial Overburden

3.3.1 Baseline Alluvial and Shallow Bedrock Groundwater Quality – Upper Go Creek Basin

Baseline alluvial and shallow bedrock groundwater conditions in the upper Go Creek basin are characterized by monitoring wells MW05-1B/MW05-6B and MW05-1A/MW05-6A, respectively. Table 3-6 provides a summary of the baseline groundwater chemistry for each of these wells in the alluvial and shallow bedrock aquifers.

Most trace metals are present at very low concentrations in both the alluvial and shallow groundwater systems in upper Go Creek (Table 3-6). Exceptions to this general observation are for dissolved Fe concentrations in upper Go Creek alluvial groundwater (~11.0 mg/L) and As concentrations in the shallow bedrock groundwater (~0.015 mg/L), as typified by concentrations observed in wells MW05-1B and MW05-1A, respectively.

Table 3-6:
Summary of Alluvial and Shallow Bedrock Groundwater Quality
in Upper Go Creek Basin

Parameters	Alluvial					Shallow Bedrock					
	MW05-1B		MW05-6B			MW05-1A		MW05-6A			
	Mean	95th Percentile	Mean	95th Percentile		Mean	95th Percentile	Mean	95th Percentile		
Physical Parameters											
Conductivity	274	328		184	196		255	262		161	188
Dissolved Hardness	152	189		101	101		135	139		87	88
Total Suspended Solids	43	167		4.0	4		4.3	5		4.0	4
Total Dissolved Solids	174	217		116	129		160	176		111	118
pH	7.8	8.1		8.4	9.0		8.0	8.1		7.9	7.9
Turbidity	48	136		0	0		10	21		5	6
DOC	4.5	8		0.8	1		0.9	2		0.8	1
Major Anions											
Alkalinity-Total	137	175		86	91		98	102		77	79
Acidity - Total	5.1	6.8					1.9	3.1			
Bromide	0.12	0.43		0.01	0.01		0.09	0.17		0.01	0.01
Chloride	0.8	1.7		0.5	0.5		1.3	2.8		0.7	1.0
Fluoride	0.15	0.27		0.05	0.07		0.48	0.53		0.17	0.18
Sulphate	4.3	13.2		10.6	15.7		30.6	35.8		14.6	18.1
Nutrient Parameters											
Ammonial Nitrogen	0.233	0.523		0.005	0.005		0.129	0.151		0.005	0.006
Nitrate Nitrogen	0.0121	0.0315		0.1965	0.2078		0.0035	0.0158		0.0020	0.0020
Nitrite Nitrogen	0.0183	0.0675		0.0030	0.0039		0.0026	0.0051		0.0020	0.0020
Total Phosphate	0.285	0.468		0.006	0.006		0.119	0.357		0.625	0.754
Dissolved Ortho-Phosphate	0.063	0.206		0.013	0.017		0.023	0.045		0.573	0.588
Dissolved Metals											
Aluminum (Al)	0.0265	0.0492		0.0291	0.0614		0.002	0.0041		0.0058	0.0180
Antimony (Sb)	0.0001	0.0004		0.0001	0.0001		0.0001	0.0003		0.0003	0.0005
Arsenic (As)	0.0054	0.0100		0.0002	0.0003		0.0146	0.0210		0.0048	0.0058
Cadmium (Cd)	0.000011	0.00002		0.000023	0.00005		0.000015	0.00002		0.000023	0.00006
Calcium (Ca)	53.4	66.8		34.4	36.1		44.9	47.7		28.5	29.8
Chromium (Cr)	0.00047	0.00108		0.00025	0.00030		0.00026	0.00044		0.00020	0.00020
Cobalt (Co)	0.00012	0.00024		0.00028	0.00038		0.00003	0.00008		0.00038	0.00048
Copper (Cu)	0.00024	0.00057		0.00127	0.00242		0.00012	0.00018		0.00027	0.00077
Iron (Fe)	11.36	24.90		0.01	0.01		1.33	3.26		0.64	0.91
Lead (Pb)	0.000058	0.000162		0.00002	0.00002		0.000034	0.000049		0.00002	0.00002
Magnesium (Mg)	4.58	5.55		2.81	2.86		5.64	5.82		3.19	3.28
Manganese (Mn)	0.541	0.886		0.117	0.166		0.232	0.259		0.329	0.351
Mercury (Hg)	0.000011	0.000017		0.00001	0.00001		0.000015	0.000027		0.00001	0.00001
Molybdenum (Mo)	0.00194	0.00412		0.00098	0.00113		0.00597	0.00732		0.00359	0.00389
Nickel (Ni)	0.00065	0.00096		0.00425	0.00475		0.00054	0.00130		0.00087	0.00133
Phosphorus (P)	0.300	0.557		0.100	0.100		0.206	0.475		0.700	0.790
Potassium (K)	1.34	2.53		1.01	1.13		1.37	1.89		1.35	1.52
Selenium (Se)	0.00038	0.00064		0.0009	0.0010		0.00037	0.00050		0.0011	0.0014
Silicon (Si)	4.65	5.26		4.04	4.15		4.51	5.46		6.45	6.72
Silver (Ag)	0.000008	0.000010		0.00001	0.00001		0.000009	0.000010		0.00001	0.00001
Sodium (Na)	1.31	1.86		1.38	1.39		1.87	2.04		3.38	3.82
Strontium (Sr)	0.133	0.164		0.048	0.049		0.147	0.155		0.033	0.036
Thallium (Tl)	0.00003	0.00005		0.00005	0.00005		0.00004	0.00009		0.00005	0.00005
Vanadium (V)	0.00102	0.002		0.00005	0.00005		0.00005	0.00005		0.00005	0.00005
Zinc (Zn)	0.0013	0.0028		0.0008	0.0012		0.0045	0.0109		0.0023	0.0075

All units in mg/L, except conductivity (uS/cm) and pH



shaded values are considered naturally elevated in the baseline

3.3.2 Baseline Alluvial and Shallow Bedrock Groundwater Quality – Tailings Impoundment Area

Tailings area monitoring wells used in establishing baseline groundwater quality conditions for alluvial and shallow bedrock aquifers include MW05-2B/MW05-7B and MW05-2A, respectively (Figure 3-1). Monitoring well MW05-7A also existed, however, the monitoring data indicated there were problems with the well integrity and the chemistry data from this well are not useable in the assessment.

Table 3-7 provides a summary of the baseline alluvial and bedrock groundwater quality in Go Creek basin in the vicinity of the tailings impoundment. The alluvial groundwater quality is variable between wells MW05-7B and MW05-2B and likely reflects the fact that well MW05-7B is located within the small catchment adjacent to Go Creek and MW05-2B is located immediately adjacent to Go Creek. For the most part, trace metal concentrations in both wells are present at very low concentrations. Well MW05-2B does measure alluvial groundwater naturally elevated in As and Fe, with concentrations observed on the order of 0.03 mg/L and approximately 9.0 mg/L, respectively. Conversely, alluvial well MW05-7B contains trace metals at very low concentrations.

The elevated As and Fe were not observed in the shallow bedrock well MW05-2A, suggesting that alluvial and shallow bedrock aquifer do not appear to be hydraulically connected. Trace metal levels in MW05-2A were all present at low concentrations.

**Table 3-7: Summary of Alluvial and Shallow Bedrock Groundwater Quality
in Upper Go Creek Basin**

Parameters	Alluvial					Shallow Bedrock		
	MW05-2B			MW05-7B		MW05-2A		
	Mean	95th Percentile		Mean		95th Percentile	Mean	95th Percentile
Physical Parameters								
Conductivity	253	259		161	179		400	410
Dissolved Hardness	135	143		79	89		226	233
Total Suspended Solids	23.5	35		4	4		4.2	5
Total Dissolved Solids	153	160		106	120		243	262
pH	7.9	8.2		8.3	9.0		8.2	8.3
Turbidity	77	110		1	4		9	15
DOC	1.1	2		0.8	2		0.9	2
Major Anions								
Alkalinity-Total	126	131		66	76		178	184
Acidity - Total	4.2	4.2		1.3	1.9		1.5	2.4
Bromide	0.07	0.18		0.06	0.10		0.17	0.55
Chloride	0.6	0.9		1.9	6.7		1.3	3.1
Fluoride	0.07	0.08		0.13	0.16		0.28	0.31
Sulphate	7.5	11.3		13.3	18.5		33.3	37.0
Nutrient Parameters								
Ammonial Nitrogen	0.039	0.069		0.011	0.029		0.093	0.118
Nitrate Nitrogen	0.0125	0.0268		0.0143	0.0275		0.0030	0.0048
Nitrite Nitrogen	0.0203	0.0618		0.0020	0.0020		0.0027	0.0040
Total Phosphate	0.160	0.231		0.043	0.052		0.006	0.010
Dissolved Ortho-Phosphate	0.042	0.165		0.037	0.051		0.004	0.006
Dissolved Metals								
Aluminum (Al)	0.0165	0.0673		0.0280	0.1059		0.0090	0.0346
Antimony (Sb)	0.0001	0.0001		0.0001	0.0002		0.0001	0.0001
Arsenic (As)	0.030	0.0362		0.0009	0.0016		0.0007	0.0011
Cadmium (Cd)	0.000013	0.00003		0.000026	0.00005		0.000008	0.00001
Calcium (Ca)	41.9	44.2		27.7	30.6		59.7	62.0
Chromium (Cr)	0.00027	0.00048		0.00020	0.00031		0.00018	0.00028
Cobalt (Co)	0.00031	0.00080		0.00016	0.00044		0.00007	0.00014
Copper (Cu)	0.00018	0.00048		0.00096	0.00396		0.00020	0.00057
Iron (Fe)	8.66	9.90		0.03	0.13		0.78	1.16
Lead (Pb)	0.000055	0.000162		0.000042	0.000107		0.000034	0.000095
Magnesium (Mg)	7.45	8.17		2.44	3.01		18.63	19.35
Manganese (Mn)	1.115	1.548		0.129	0.220		0.176	0.183
Mercury (Hg)	0.00001	0.00001		0.00001	0.00001		0.00001	0.00001
Molybdenum (Mo)	0.00177	0.00278		0.00978	0.01142		0.00274	0.00310
Nickel (Ni)	0.00058	0.00118		0.00113	0.00396		0.00049	0.00070
Phosphorus (P)	0.180	0.200		0.092	0.100		0.080	0.100
Potassium (K)	0.77	1.27		0.87	0.94		2.15	2.54
Selenium (Se)	0.00042	0.00050		0.00047	0.00080		0.00035	0.00050
Silicon (Si)	4.73	5.54		4.03	4.30		3.70	3.91
Silver (Ag)	0.000009	0.000010		0.000009	0.000010		0.000008	0.000010
Sodium (Na)	2.66	7.76		1.80	2.00		0.65	0.81
Strontium (Sr)	0.092	0.115		0.052	0.065		0.160	0.168
Thallium (Tl)	0.00004	0.00005		0.00004	0.00005		0.00003	0.00005
Vanadium (V)	0.00006	0.00007		0.00101	0.002		0.00006	0.00008
Zinc (Zn)	0.0013	0.0038		0.0013	0.0034		0.0006	0.0011

All units in mg/L, except conductivity (uS/cm) and pH



shaded values are considered naturally elevated in the baseline

4. Sediment Quality

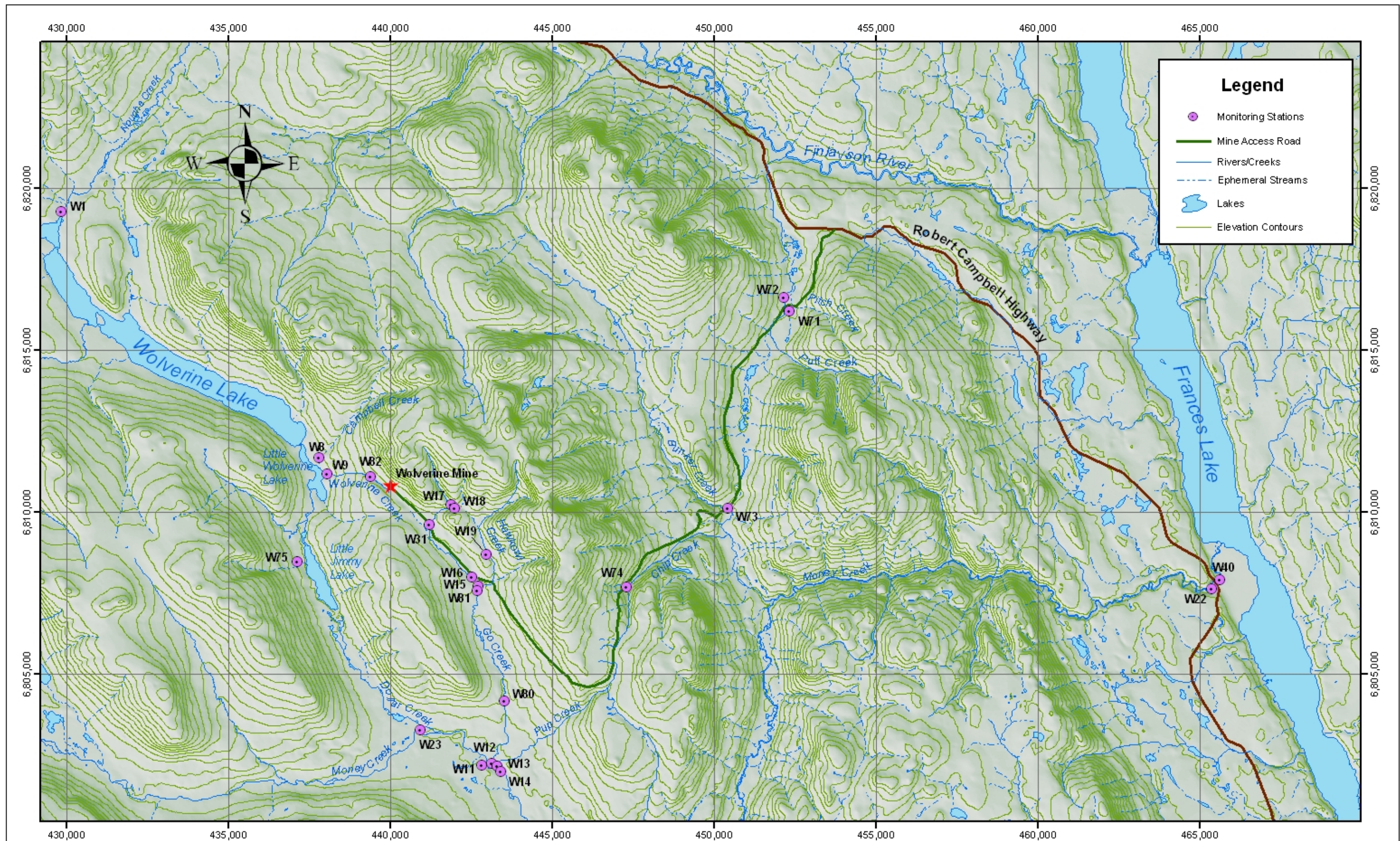
4.1 Overview

The following sections present the baseline sediment metal concentrations at selected stations within Wolverine Creek, Go Creek, Money Creek and at stream crossing locations along the mine access route. Background metal concentrations existing in sediments are defined using the mean and 95th percentile concentrations calculated from data collected from 2005 to 2008. Sediment data collected prior to 2005 has not been used in the statistical analysis due to unknown or inconsistent sampling methodology.

Baseline stream sediment sampling at key locations within the Wolverine project area was initiated in 2005. Sampling methodology included the collection of sediment samples from stream riffle areas using a 2.5 cm diameter PVC tube to extract fine sediment from below the cobble and boulder substrate. Samples are sieved in the laboratory and the <0.053 mm fraction analyzed for total metals. Since that time, additional, focused sediment sampling has been conducted as part of an ongoing monitoring program. Table 4-1 summarizes the sampling locations and monitoring periods for the sediment sampling stations considered as part of this baseline characterization; Figure 4-1 provides a station location map for the same.

**Table 4-1:
Sediment Sampling Locations and Associated Monitoring Periods**

Sampling Locations			Monitoring Period				Used for Baseline
Station	Watershed	Rationale	2005	2006	2007	2008	
W1	Wolverine Lake	Regional Reference	√				
W8	Campbell Creek	Exploration/Control	√		√		yes
W9	Wolverine Creek	Mine-Milling effects	√	√	√	√	yes
W11	Money Creek	Regional Reference	√				
W12	Go Creek	Discharge effects in Go drainage	√	√	√	√	yes
W13	Pup Creek	Regional Reference	√				
W14	Money Creek	Discharge effects	√		√		yes
W15	Hawkowl Creek	Regional effects in Go drainage	√		√		
W16	Go Creek	Discharge effects in Go drainage	√	√	√	√	yes
W18	Go Creek	Regional effects in Go drainage	√		√		
W19	Hawkowl Creek	Regional effects in Go drainage	√				
W21	Nougha Creek	Regional Reference	√		√		
W22	Money Creek	Regional Reference	√				
W23	Money Creek	Regional Reference	√				
W31	Go Creek	Regional effects in Go drainage	√		√		yes
W40	Money Creek	Regional Reference	√		√		
W71	Pitch Creek	Road route effects	√		√		yes
W72	Light Creek	Road route effects	√		√		yes
W73	Bunker Creek	Road route effects	√		√		yes
W74	Chip Creek	Road route effects	√				
W80	Go Creek	Discharge effects - Compliance Point			√		yes
W81	Go Creek	Discharge effects in Go drainage	√		√		yes
W82	Wolverine Creek	Mine-Milling effects			√		yes



Projection: UTM Zone 9, NAD 83



DESIGNED BY		
DWG. CHECK		
DRAWN BY	SSS	April 7, 2010
SCALE	1:110,000	
PROJECT NO.	474-3	

Baseline Characterization Report

Sediment Quality Monitoring Stations

Figure 4-1

REV.

For the purposes of this report, baseline stream sediment characterization has been divided into the following drainage basins: Wolverine Creek, Go Creek and Road Route drainages. As illustrated in Table 4-1, not all stations that have been sampled since 2005 were used in the baseline characterization. Complete sediment chemistry data and associated statistics for the stations utilized in the baseline characterization are provided in Appendix C.

4.2 Wolverine Creek

Stations W82 and W9 (Figure 4-1) are located within the upper and lower Wolverine Creek drainage, respectively. Station W9 has been sampled annually from 2005 to 2008, while station W82 has only been sampled in 2007. Total metals results, including calculated mean and 95th percentile, for each station is summarized in Table 4-2. Complete data results for all sampling periods are provided in Appendix C.

Table 4-2:
Baseline Mean and 95th Percentile Concentrations of Total Metals in
Wolverine Creek Sediments

Parameters	Lower Wolverine		Upper Wolverine	
	W9		W82	
	Mean	95th Percentile	Mean	95th Percentile
Soluble (2:1) pH	7.6	8.4	7.1	7.1
Total Metals (mg/kg)				
Aluminum (Al)	10091	12850	5837	6062
Antimony (Sb)	3.4	11.1	4.8	5.0
Arsenic (As)	15.9	31.8	29.6	33.2
Barium (Ba)	508	827	2340	2470
Beryllium (Be)	0.29	0.40	0.23	0.29
Bismuth (Bi)	0.42	0.81	0.3	0.3
Cadmium (Cd)	24.89	41.65	152	162
Calcium (Ca)	14110	17610	14200	16300
Chromium (Cr)	25	33	9	9
Cobalt (Co)	11.9	13.3	73.4	79.5
Copper (Cu)	82.7	112	255.3	271
Iron (Fe)	28136	34050	63167	63880
Lead (Pb)	25.4	31.3	23.3	24.2
Magnesium (Mg)	7586	9580	1313	1346
Manganese (Mn)	1227	2320	27900	30760
Mercury (Hg)	0.07	0.10	0.19	0.22
Molybdenum (Mo)	3.19	5.80	9.00	10.19
Nickel (Ni)	130	216	761	795
Phosphorus (P)	1860	2350	3230	3419
Potassium (K)	1201	1630	373	418
Selenium (Se)	3.56	5.55	11.37	12.63
Silver (Ag)	0.66	1.35	0.94	1.11
Sodium (Na)	100	100	100	100
Strontium (Sr)	54.9	69.9	72.2	77.0
Thallium (Tl)	0.16	0.27	0.32	0.35
Tin (Sn)	1.13	3.07	0.17	0.20
Titanium (Ti)	459	737	45	47
Vanadium (V)	50	80	20	21
Zinc (Zn)	3313	4335	7863	8057
Zirconium (Zr)	3.2	8.7	0.5	0.5

values considered elevated in the baseline

Station W82 is located in the upper Wolverine Creek drainage, immediately adjacent to the mineralized zone of the Wolverine deposit. The close proximity to the mineralized ore deposit has resulted in elevated metal concentrations for a number of parameters in stream sediments at this location. Most notably, As, Ba, Cd, Cu, Fe, Mn, Mo, Ni, Se and Zn are present at naturally elevated concentrations in upper Wolverine Creek sediments (Table 4-2). Cadmium (~155 mg/kg), Mn (~29,000 mg/kg) Se (~12 mg/kg) and Zn (~7,900 mg/kg) are considered to be significantly elevated in Wolverine Creek sediments at station W82.

With increasing distance downstream from the mineralized area, total metal concentrations in Wolverine Creek sediments decrease and are present at much lower concentrations (Table 4-2). At station W9 located near the mouth of Wolverine Creek, As, Cd, Cu, Se and Zn remain elevated, but are lower by generally a factor of 2 as compared to sediments at W82.

4.3 Go Creek

Sediment quality within Go Creek has been sampled at a number of locations from the upper reaches of the watershed down to the confluence with Money Creek. Five (5) stations are used to define the baseline sediment quality within Go Creek and include W31, W16, W81, W80 and W12 (Figure 4-1). Station W14, located immediately downstream of the confluence of Go Creek and Money Creek, is also used to characterize baseline sediment chemistry in upper Money Creek.

Table 4-3 provides the summary statistics for sediment monitoring stations described above and full results are provided in Appendix C. There is notable variability in sediment metal levels throughout Go Creek, particularly for Cd and Cr. Chromium concentrations in upper Go Creek (e.g. W31 and W16) are significantly higher (mean ~60 mg/kg) than at the other stations throughout Go Creek from below the confluence of Hawkowl Creek (~30 mg/kg). Station W16 also has significantly elevated baseline Cd concentrations (~3.0 mg/kg). Background Zn levels at station W16 are roughly 2 to 3 times higher than at other Go Creek sampling stations (Table 4-3).

Sediment metal concentrations present at the Go Creek compliance location, station W80, are generally low with no parameters considered elevated above typical pristine stream sediment concentrations. Stream sediment metal concentrations measured at station W81 appear to be very similar to metal levels observed at the compliance location W80.

Cadmium concentrations in lower Go Creek (W12) and upper Money Creek (W14) sediments are present at elevated concentrations as compared to concentrations observed throughout much of Go Creek.

Table 4-3:
Baseline Mean and 95th Percentile Concentrations of Total Metals for Go Creek Drainage Sediments

Parameters	Upper Go Creek						Compliance Point		Lower Go Creek-Money Creek			
	W31		W16		W81		W80		W12		W	
	Mean	95 th Percentile	Mean	95 th Percentile	Mean	95 th Percentile	Mean	95 th Percentile	Mean	95 th Percentile	Mean	
Soluble (2:1) pH	7.4	7.5	7.0	7.2	7.0	7.1	6.9	7.0	7.1	7.5	7.4	
Total Metals (mg/kg)												
Aluminum (Al)	16886	20860	16582	25300	12333	12400	10500	10940	11731	16350	9185	
Antimony (Sb)	0.1	0.1	2.0	10.2	0.2	0.3	0.2	0.2	2.2	10.7	0.2	
Arsenic (As)	1.5	1.8	3.7	6.6	6.9	7.7	5.2	5.5	9.9	29.8	5.2	
Barium (Ba)	40	45	230	456	73	77	103	112	215	302	180	
Beryllium (Be)	0.14	0.20	0.21	0.40	0.10	0.10	0.10	0.10	0.21	0.35	0.38	
Bismuth (Bi)	0.1	0.1	0.15	0.37	0.1	0.1	0.1	0.1	0.10	0.10	0.18	
Cadmium (Cd)	0.14	0.16	3.18	5.78	0.34	0.39	0.37	0.40	1.06	1.60	0.74	
Calcium (Ca)	5269	6514	7256	9400	2177	2392	2397	2544	4317	5156	3900	
Chromium (Cr)	63	70	61	82	26	28	30	40	33	43	27	
Cobalt (Co)	22.5	23.8	20.5	26.5	13.1	13.9	9.7	10.0	11.7	13.8	9.5	
Copper (Cu)	63.6	80	52.3	74	44.0	46	25.8	27	37.7	49	27.7	
Iron (Fe)	27700	31350	32191	42300	25433	25670	22800	23810	26591	31200	20025	
Lead (Pb)	3.0	10.0	5.8	18.1	10.6	12.0	7.2	7.3	8.6	10.9	13.1	
Magnesium (Mg)	14000	16310	13082	17800	7030	7329	6663	7152	7343	10190	5680	
Manganese (Mn)	538	571	1568	2970	848	881	639	690	1118	1575	1237	
Mercury (Hg)	0.05	0.05	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
Molybdenum (Mo)	0.23	0.30	1.15	1.71	0.47	0.50	0.60	0.60	0.68	0.80	0.78	
Nickel (Ni)	43.5	46.8	41.9	55.2	31.0	32.3	26	28	32	38	31	
Phosphorus (P)	748	799	940	1250	551	599	729	747	743	910	724	
Potassium (K)	421	529	376	500	327	335	351.0	393.3	444	682	626	
Selenium (Se)	0.50	0.50	1.45	2.70	0.50	0.50	0.50	0.50	1.18	2.05	0.88	
Silver (Ag)	0.05	0.05	0.27	1.11	0.10	0.12	0.07	0.08	0.30	1.10	0.08	
Sodium (Na)	100	100	100	100	100	100	100	100	100	100	100	
Strontium (Sr)	9.0	11.4	22.1	50.1	10.9	12.0	12.7	13.3	16.5	24.7	15.4	
Thallium (Tl)	0.05	0.05	0.06	0.08	0.09	0.15	0.05	0.05	0.05	0.06	0.05	
Tin (Sn)	0.36	1.36	2.07	7.48	0.10	0.10	0.10	0.10	0.65	2.46	2.60	
Titanium (Ti)	1189	1672	1108	1880	226	232	281	307	514	1106	439	
Vanadium (V)	48	57	48	74	24	25	24	25	31	45	26	
Zinc (Zn)	50	59	172	245	78	81	86	88	106	129	86	
Zirconium (Zr)	0.7	1.6	1.6	4.0	0.7	0.8	0.8	1.0	3.2	8.5	1.1	

values considered elevated in the baseline

4.4 Mine Access Route

Baseline sediment metal concentrations at stream crossings along the mine access route have been defined for Bunker Creek (W73), Pitch Creek (W71) and Putt Creek (W72). The access route also crosses Chip Creek (W74); however, only one sampling, without replicates, occurred in 2005 and therefore statistics are not possible for this location.

Table 4-4 presents the baseline summary statistics for the mine access route stream sediments for stations W73, W71 and W72. Complete datasets are also provided in Appendix C.

Table 4-4:
Baseline Mean and 95th Percentile Concentrations of Total Metals for
Mine Access Route Stream Sediments

Parameters	Mine Access Route					
	W73		W71		W72	
	Mean	95 th Percentile	Mean	95 th Percentile	Mean	95 th Percentile
Soluble (2:1) pH	7.5	7.5	7.8	7.8	7.6	7.7
Total Metals (mg/kg)						
Aluminum (Al)	11200	13435	3987	4600	9723	10285
Antimony (Sb)	1.2	1.6	2.6	3.0	3.0	3.8
Arsenic (As)	12.2	18.2	12.7	15.3	67.5	102.1
Barium (Ba)	247.7	275.0	221	251	752.7	783.8
Beryllium (Be)	0.30	0.47	0.17	0.20	0.38	0.49
Bismuth (Bi)	0.1	0.1	0.1	0.1	0.2	0.2
Cadmium (Cd)	0.6	0.6	19.21	26.01	25.93	39.04
Calcium (Ca)	5885	10338	10723	11630	10875	11385
Chromium (Cr)	63	76	9	11	33	36
Cobalt (Co)	13.5	16.9	14.1	17.7	24.5	39.7
Copper (Cu)	35.5	37.9	25.9	54	61.5	64.1
Iron (Fe)	29125	36185	18300	21710	34975	40045
Lead (Pb)	8.0	8.4	9.7	10.6	16.7	17.1
Magnesium (Mg)	9235	10453	5073	5549	6858	7072
Manganese (Mn)	1598	3770	1236	1444	15503	34669
Mercury (Hg)	0.12	0.22	0.08	0.10	0.25	0.30
Molybdenum (Mo)	1.93	2.72	5.70	7.06	11.03	24.66
Nickel (Ni)	80	118	130.4	148.9	220	344
Phosphorus (P)	950	1242	1317	1517	1508	1701
Potassium (K)	616	946	324	414	1028	1158
Selenium (Se)	1.75	3.50	3.76	4.41	4.93	5.47
Silver (Ag)	0.25	0.40	0.26	0.33	0.54	0.63
Sodium (Na)	100	101	100	100	100	100
Strontium (Sr)	33.5	53.7	49.2	55.1	88.5	106.0
Thallium (Tl)	0.08	0.14	0.11	0.15	0.20	0.27
Tin (Sn)	0.1	0.1	0.1	0.1	0.4	0.4
Titanium (Ti)	159	234	42	56	86	104
Vanadium (V)	37	49	25	30	40	46
Zinc (Zn)	138	212	2194	2416	2610	4072
Zirconium (Zr)	0.8	0.9	0.7	0.8	0.7	0.8

values considered elevated in the baseline

Sediments within Pitch Creek (W71) and lower Putt Creek (W72) contain very elevated metal concentrations for a number of parameters including As, Ba, Cd, Mn, Mo, Ni, Se and Zn. Concentrations of the above parameters are similar to the background sediment metal concentrations measured in lower Wolverine Creek (W9) and would appear to reflect the presence of a mineralized area being drained by the Pitch Creek catchment. Mean Cd and Zn concentrations observed in sediments at stations W71 and W72 are on the order of 20 mg/kg and 2500 mg/kg respectively and are considered highly elevated. Selenium concentrations of approximately 4.0 to 5.0 mg/kg in sediments at both stations are also considered to be very elevated in the baseline.

5. *Benthic Invertebrates and Periphyton*

Benthic invertebrate and periphyton monitoring was carried out in the Project area in 1996, 1997, 2005, and 2007. Benthic invertebrate monitoring involved quantitative collection of invertebrate samples followed by taxonomic identification and enumeration. Periphyton monitoring involved the quantitative collection of samples followed by laboratory analyses to determine biomass, taxonomic composition, and semi-quantitative abundance of major taxa.

Benthic invertebrates are recommended by Environment Canada as the primary indicator organisms for use in an Environmental Effects Monitoring (EEM) program for monitoring effects on fish habitat (Environment Canada 2002). Periphyton were evaluated by Environment Canada during the development of the EEM program and deemed inappropriate as a primary indicator, but are included as an optional indicator.

5.1 *Benthic Invertebrates*

Aquatic benthic invertebrates spend all or part of their life history submerged in water and in contact with the sediment. Changes to water or sediment quality may produce community level changes to benthic invertebrates by altering life histories of some species (Lehmkuhl, 1979). Examples of changes that may occur are reduced growth rate, reduced fecundity, or death of species sensitive to a stressor. Growth rate or reproduction may also be stimulated in some species that are tolerant of a stressor.

A large number of benthic invertebrate community descriptors exist. In general these include measures of the number of organisms present (*i.e.* density or abundance), the number of different taxa present (*i.e.* richness), and whether or not the community composition is dominated by a few taxa (*i.e.* diversity or evenness). In addition, indicator taxa (taxa that are known to be sensitive or tolerant of stressors in general, or to a specific stressor such as metals) may be used to identify changes to the benthic invertebrate community. The federal Metal Mining Effluent Regulations (MMER) require reporting of total invertebrate density, taxon richness, Simpson's evenness index, and the Bray Curtis index (a measure of the similarity of the benthic community at a sample site to a reference site.)

In order to assess whether a project has had an effect on a benthic invertebrate community the above indices can be used to compare reference and impact sites, and to compare impact sites before and after project development. The baseline data reported here provide indices of benthic invertebrate communities prior to any project related effects. The indices can also be used to assess the suitability of potential reference sites as representative of the benthic community at potential impact sites.

5.1.1 Methodology

5.1.1.1 Stream Samples

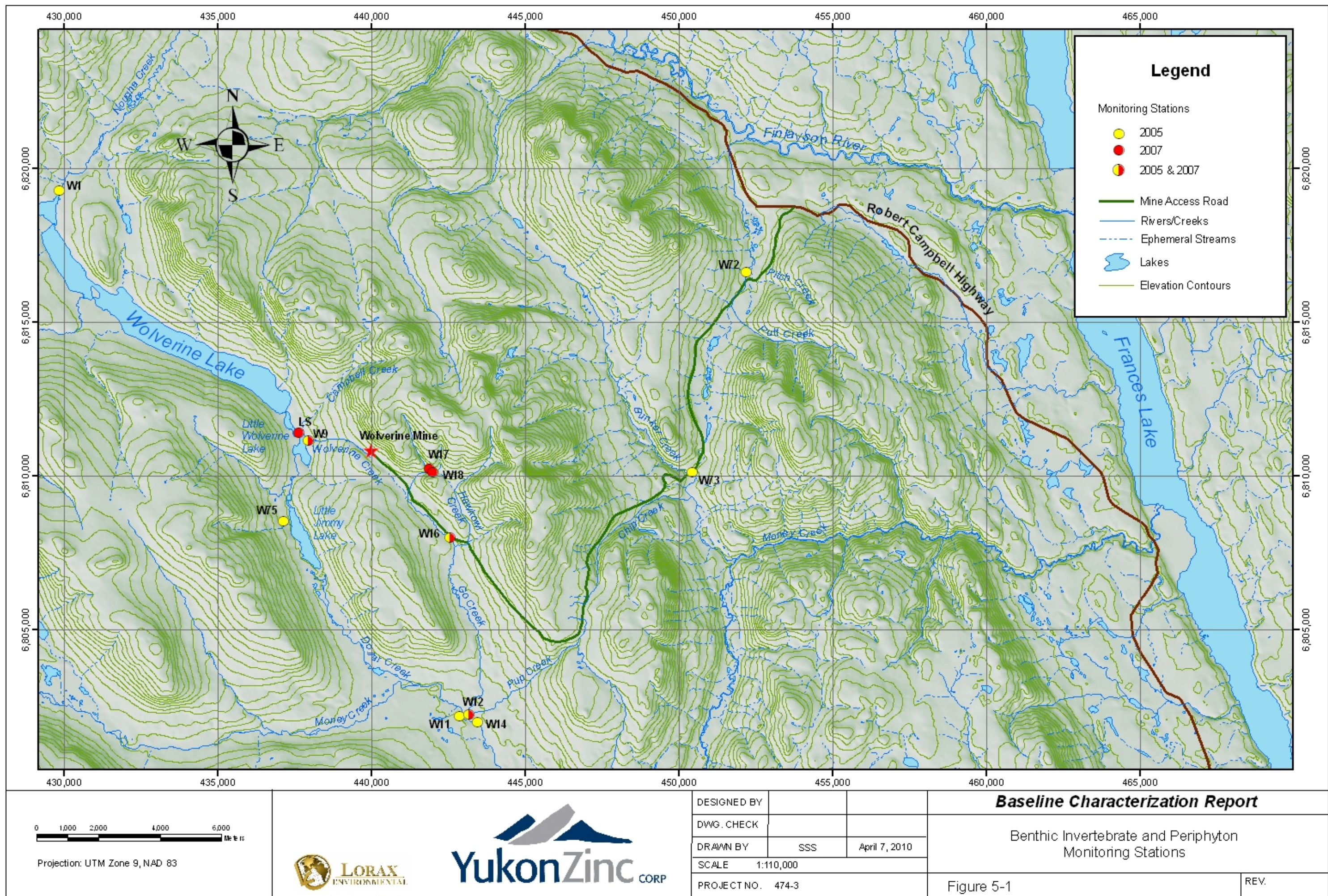
Benthic invertebrate samples from project area streams have been collected in 1996, 1997, 2005, and 2007. Stream conditions in 1996 prevented use of standard stream net-samplers (*e.g.* Hess sampler or Surber sampler). Instead artificial substrates were used. These were allowed to colonize for 5 weeks, then removed from the stream and all invertebrates present on the artificial substrate were collected. The Metal Mining EEM Guidance Document recommends against the use of artificial substrates since “these may fail to indicate the effects from effluents, particularly where non-mobile species, sediment bound contaminants, or longer term integration of effects are important” (Environment Canada, 2002). Subsequent to the 1996 monitoring program stream samples were collected with a Hess sampler, which isolates a known area of an erosional section of stream, such as a riffle, and allows all macroinvertebrates that naturally inhabit the area to be collected.

The 1997 sample program collected benthic invertebrates from only 1 site (W9 in Wolverine Creek) at 3 times of the year: May, July, and September. This sample set was designed to monitor changes in benthic community over time during the growing season.

The sites sampled in 2005 and 2007 are shown in Figure 5-1. Samples were collected from riffle habitats using a Hess sampler (0.093 m² area, 210 µm mesh size). Three samples were collected at each site (*i.e.* in terms used in the EEM guidance document, 3 *replicate stations* were sampled per *area*). Between 1 and 5 Hess sampler sets (*field sub-samples*) were composited to make up 1 sample. Therefore the area of stream sampled varies between samples, depending on the number of sets composited. Samples were fixed and preserved in 10% formalin. Benthic invertebrates were enumerated and identified to lowest practical taxonomic level (genus for most insects, family for oligochaetes) by taxonomist Charles Low (Victoria, B.C.).

5.1.1.2 Lake Samples

Benthic invertebrate samples were collected in August 1996 from 3 lakes: Wolverine Lake (3 different locations), Little Wolverine Lake (one location), and Little Jimmy Lake (one location). Three samples were collected at each location. Samples were collected using a standard 6” x 6” Ekman grab. The contents of the grab were preserved with 10 % formalin and shipped to the taxonomic lab of Charles Low (Victoria, BC). At the lab, samples were sieved first using a coarse mesh (1 mm) screen then a fine mesh (180 µm) screen. All organisms retained by the coarse screen were counted and identified, and organisms on the fine mesh screen were sub-sampled as necessary using a Folsom plankton splitter. Organisms were identified to lowest practical taxonomic level, usually to genus.



5.1.2 Results

Results of benthic invertebrate monitoring are summarized below. Taxonomic data from benthic invertebrate samples collected in 2005 and 2007 are presented in Appendix D.

5.1.2.1 Seasonal Variability

The 1997 benthic invertebrate monitoring program investigated changes in benthic communities at Station W9, at the mouth of Wolverine Creek, by sampling the same site 3 times during the growing season. Summary results are listed in Table 5-1. Over the course of the summer there was an increase in total invertebrate density, the number of taxa, and the number of sensitive taxa. Evenness decreased from May to September (an evenness index approaching 1 indicates equal density of all taxa present, whereas an evenness index near 0 indicates total density is made up predominantly of 1 or a few taxa only).

Table 5-1.
Summary of time series data from samples collected in 1997 at Station W9

Date	Density (#/m ²)	Richness (# Taxa)	# EPT Taxa ¹	Simpson's Diversity Index	Simpson's Evenness Index
May	280	18	4	0.73	0.28
July	1367	20	6	0.61	0.14
Sept.	4103	39	8	0.77	0.12

1. Number of taxa of the orders Ephemeroptera, Plecoptera, and Tricoptera.

Subsequent benthic invertebrate baseline sampling, in 2005 and 2007, was carried out in September, as the 1997 data show this is the time of year when the highest density of organisms is expected. The benthic community will also be more mature, which should reduce variability caused by recruitment, by small individuals passing through the sampling sieve, and by difficulty identifying immature stages of benthic invertebrates.

5.1.2.2 Density

Comparison of density (the number of invertebrates per square meter) among sites sampled during baseline monitoring is shown in Figure 5-2. There is high variability in density among replicates at a single site (seen as large standard deviation), among sites within a year, and between years at a station. An example of high spatial variability is seen in Figure 5-2 where Stations W17 and W18 are both in upper Go Creek and have significantly different densities in 2007. Three stations have been sampled in more than one year. Average density was markedly lower in 2007 than in 2005 at stations W9 and W16, but remained relatively unchanged at station W12 (Figure 5-3). There are many possible causes of spatial and temporal variability in density such as high flow conditions causing scouring of the stream

bed, differences in stream bed composition, interannual differences in recruitment, growth, and timing of hatching.

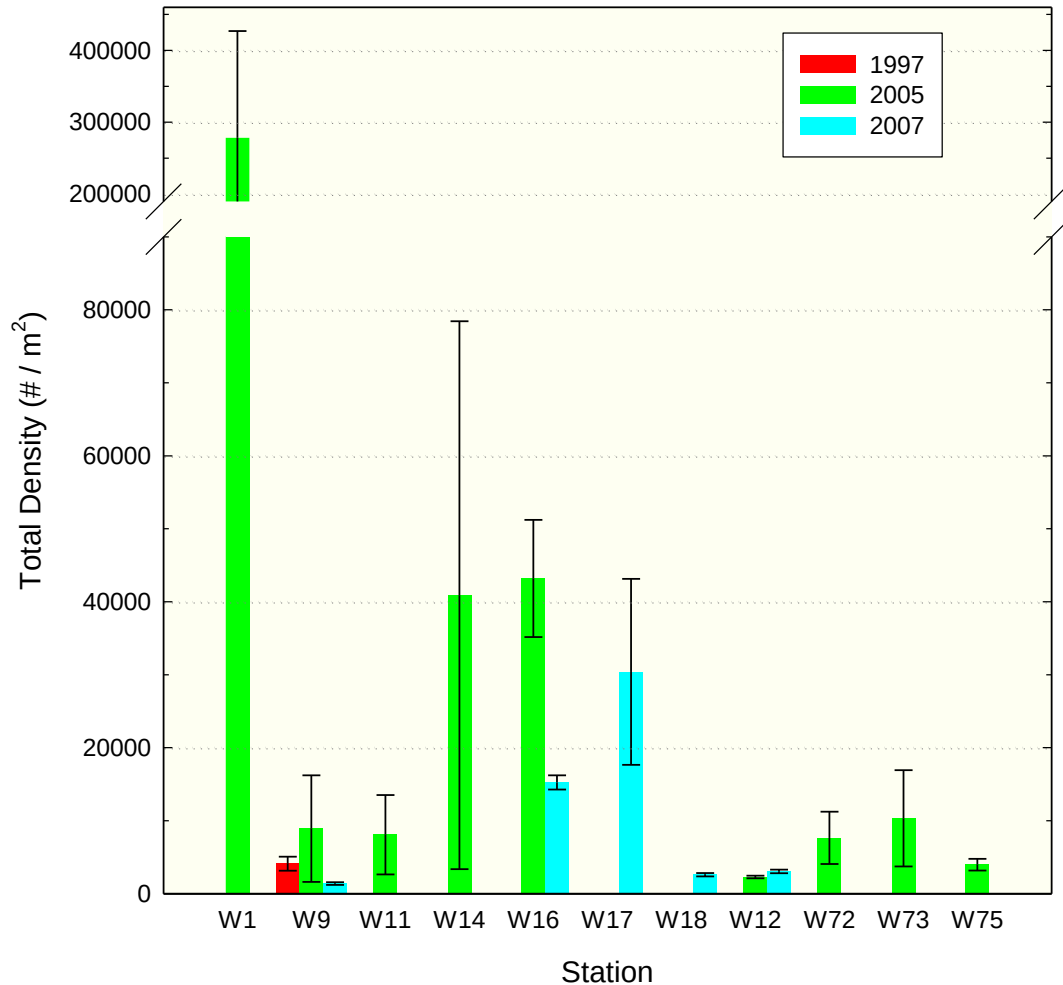


Figure 5-2: Total Benthic Invertebrate Density (± 1 Standard Deviation) from All Baseline Stream Monitoring.

Station W1 was sampled in 2005 as a potential reference site for Wolverine Creek. This station is at the outflow of Wolverine Lake. The substrate and stream flow conditions were different than those at other streams sampled. The average total density of organisms at this station was significantly greater than at other stations, between 6 and 34 times greater. The taxonomic composition was also clearly different than at other stations, with a large contribution of lake organisms whereas all other stream sites had taxonomic composition typical of streams in the Yukon. Stations W75 (tributary to Little Jimmy Lake) and W11 (Money Creek upstream of Go Creek), sampled in 2005, were sampled as potential reference

sites for Wolverine Creek and Go Creek, respectively. Stations W72 (Putt Creek) and W73 (Bunker Creek) were also sampled in 2005 as potential reference sites.

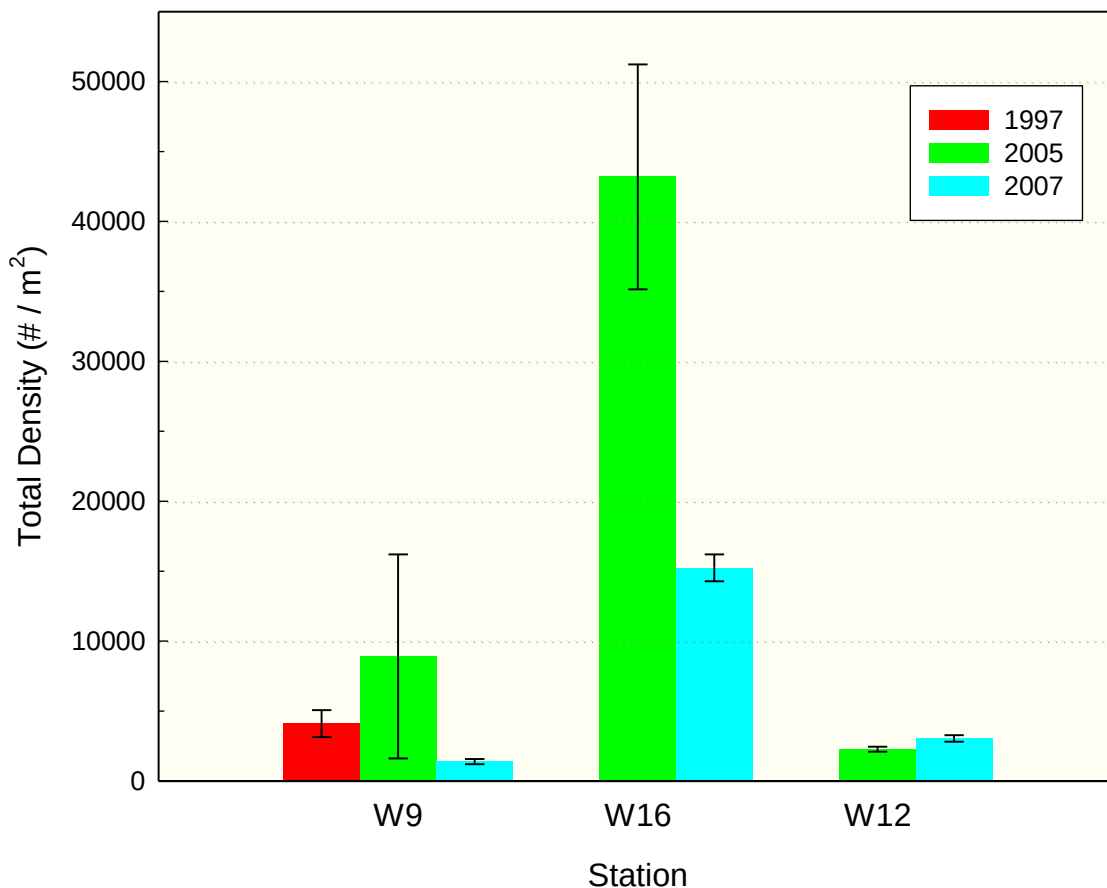


Figure 5-3 Interannual Total Benthic Invertebrate Density (± 1 Standard Deviation).

5.1.2.3 Community Composition

Benthic invertebrate community composition can be described by a number of statistics that look at abundance and taxonomic composition. Average indices of community composition that are required as part of EEM reporting are listed in Table 5-2. In addition to the averages shown in Table 5-2, the EEM program also requires that standard deviation, median, maximum, and minimum are reported. Table 5-2 also lists the number of taxa from the orders ephemeroptera (mayflies), plecoptera (stoneflies), or trichoptera (caddisflies) as these EPT taxa are considered more sensitive to contaminants than other benthic invertebrate taxa. Also shown in Table 5-2 is Simpson's diversity index which was required for EEM reporting prior to 2006.

The Bray-Curtis index is another endpoint included in EEM reporting requirements. This index measures the similarity in community structure between sites. This measure is used in EEM to evaluate the amount of dissimilarity between benthic invertebrate communities at a potential impact site and a reference site. This will be calculated after a suitable reference site is identified and sampled.

In general, stations with relatively high density of invertebrates also hosted communities with relatively high total number of taxa and EPT taxa. An exception to this generalization is Station W12 at the downstream extent of Go Creek which had relatively low density in both 2005 and 2007 but had moderate to high number of total taxa and number of EPT taxa. This characteristic at Station W12 can largely be explained by relatively low abundance of diptera (true flies) at this station. Station W9 is in Wolverine Creek, which has water quality with relatively high concentrations of some metals (*e.g.* cadmium, selenium, and zinc), has relatively low density of invertebrates, but moderate total number of taxa. The number of EPT taxa at W9 is low compared to stations in Go Creek and Money Creek, which may indicate that baseline conditions in Wolverine Creek have had an effect on the populations of sensitive species. Diversity (calculated using Simpson's Diversity Index as described in the EEM Guidance Document, Environment Canada 2002) in 2005 was lowest at Stations W9 and W75. In contrast, in 2007 diversity was relatively high at W9, but relatively low at W16. Overall these data illustrate the high spatial and temporal variability observed in benthic invertebrate communities sampled as part of the baseline monitoring program.

Table 5-2.
Community Characteristic Statistics (Averages) from
Stream Benthic Invertebrate Taxonomy Data

Stream	Year	Station	Density (#/m ²)	Richness ¹	# EPT Taxa ²	Simpson's Diversity Index	Simpson's Evenness Index
Nougha	2005	W1	278,335	56	13	0.77	0.08
Wolverine	2005	W9	8,913	40	10	0.67	0.09
Wolverine	2007	W9	1,391	40	8	0.82	0.14
Money	2005	W11	8,069	48	17	0.81	0.12
Money	2005	W14	40,891	53	27	0.86	0.14
Go	2007	W17	30,387	48	13	0.78	0.10
Go	2007	W18	2,601	41	13	0.86	0.18
Go	2005	W16	43,190	42	16	0.81	0.12
Go	2007	W16	15,238	41	15	0.68	0.08
Go	2005	W12	2,276	42	17	0.73	0.10
Go	2007	W12	3,047	55	22	0.86	0.13
Putt	2005	W72	7,650	34	14	0.82	0.17
Bunker	2005	W73	10,315	45	22	0.84	0.15
Tributary to Little Jimmy Lake	2005	W75	3,974	35	11	0.67	0.09

1. Total number of taxa from the 3 replicates at each station.

2. Total number of taxa of the orders Ephemeroptera, Plecoptera, and Tricoptera at each station.

5.1.2.4 Lake Benthic Invertebrates

Benthic invertebrates were sampled from lakes in the Project area in 1996 (Little Jimmy Lake, Wolverine Lake, and Little Wolverine Lake) and again in 2007 (Little Wolverine Lake). Results are summarized in Table 5-3. In 1996 Wolverine Lake was sampled at 3 different locations and the other 2 smaller lakes were sampled at one location. In 1996 Wolverine Lake had both the highest and lowest density of invertebrates of the 3 lakes sampled. The location with the lowest density (Station W3, west of the island) had a relatively high number of taxa and the highest diversity of the 5 locations sampled in 1996, although diversity was relatively high at all 5 locations.

Only Little Wolverine Lake was sampled again as part of baseline monitoring, in 2007. Density in 2007 was 2 orders of magnitude less than reported in 1996. The total number of taxa recorded in 2007 was also reduced compared to 1996, although the number of taxa in 2007 was high considering that relatively few individuals were present in the samples. This is reflected in the diversity index, which is approximately the same in 1996 and 2007. Both years were sampled in late August, using the same type of sediment grab, therefore the large

difference in abundance may be due to substrate sampled. The depth sampled in 1996 was 0.5 m and in 2007 samples were collected from 2 m deep.

Table 5-3.
Average Density, Number of Taxa, and Diversity
from Lake Benthic Invertebrate Taxonomy Data

Year	Year	Station	Density (#/m ²)	# Taxa ¹	Simpson's Diversity Index	Simpson's Evenness Index
Little Jimmy Lake	1996	W1	73,467	35	0.80	0.16
Wolverine Lake	1996	W3	32,583	48	0.88	0.17
Wolverine Lake	1996	W5	171,417	43	0.78	0.13
Wolverine Lake	1996	W7	113,583	36	0.82	0.16
Little Wolverine Lake	1996	W10	105,033	56	0.87	0.15
Little Wolverine Lake	2007	LS	9,230	32	0.84	0.20

1. Total number of taxa from the 3 replicates at each station.

5.2 Periphyton

Periphyton were sampled from riffle habitats in 2005 and 2007. The sample sites were the same as those sampled for stream benthic invertebrates (9 sites in 2005, 5 sites in 2007). Samples were analyzed for chlorophyll *a* as a measure of biomass, and for taxonomic composition.

5.2.1 Methodology

Collection of periphyton samples followed procedures described in the British Columbia Field Sampling Manual (Clark, 2003). Periphyton were collected from natural cobbles found in riffle habitat. Three samples were taken at each site by scraping a known area, with each sample a composite of three scrapings. Samples for analysis of chlorophyll *a* were filtered onto a 0.45 µm membrane filter, frozen, and shipped to ALS Environmental (Vancouver, BC). Taxonomy samples were preserved with Lugol's and sent to Karen Munro, Jacques Whitford Limited (Burnaby, BC) for identification and qualitative assessment (ranking of predominant, common and present species). QA/QC included comparison of triplicate field samples.

5.2.2 Results

Preiphyton biomass was measured as chlorophyll *a* concentration per unit area (Table 5-4). Three stations were sampled in both 2005 and 2007. Biomass results from these 2 years are

compared in Figure 5-4. It can be seen from this figure that there was high variability among the 3 replicates taken from each station (seen as large error bars), high variability among stations sampled in the same year, and high interannual variability at the same station.

In both years Station W16 (upper Go Creek) had the highest average biomass of all the stations sampled that year (Table 5-4) and Stations W9 and W12 had relatively low biomass. Average biomass was greater in 2007 than 2005 at all stations. The highest biomass measured in any of the 2005 samples ($1.24 \mu\text{g}/\text{cm}^2$ at W16) was less than the lowest biomass sampled at any of the 2007 sample ($1.97 \mu\text{g}/\text{cm}^2$ at W9). At Station W16 there was a 20 fold increase in biomass. This may be due to the types of periphyton present. In 2005 diatoms were the predominant periphyton and the filamentous red alga *Audouinella violacea* was present in only 1 of the 3 replicates. In 2007 the same filamentous red alga species was present at higher abundance, as well as moss, which was not observed in 2005.

Taxonomic data is presented in Appendix E and briefly described here. Taxonomic composition at Station W9 (in Wolverine Creek) was similar in 2005 and 2007. This station had relatively low abundance of diatoms. Predominant taxa were the colonial chrysophyte *Hydrurus foetidus* and crustose blue-green alga *Chamaesiphon* cf. *incrustans*.

Station W12 (lower Go Creek) had relatively greater abundance of diatoms than W9, but similar to W9 the colonial chrysophyte *Hydrurus foetidus* was a predominant species. Also similar to W9 blue green algae were present (*Lyngbya diguetii* and *Chamaesiphon* cf. *incrustans*).

Similar to the results for benthic invertebrates, the periphyton communities at stations W17 and W18 (sampled in 2007), both in upper Go Creek, were distinct from each other. Diatoms comprised > 99 % of periphyton at W17. At W18 diatoms were much less abundant (15 – 25% of periphyton) and the colonial chrysophyte *Hydrurus foetidus* was predominant, as was seen at Station W9 in Wolverine Creek. Also similar to W9, a blue-green alga was common at W18 although it was a different species, *Lyngbya diguetii*.

Table 5-4.
Periphyton Average Biomass and Total Number of Taxa

Stream	Year	Station	Chlorophyll <i>a</i> ($\mu\text{g}/\text{cm}^2$)	# Taxa ¹
Nougha	2005	W1	0.70	30
Wolverine	2005	W9	0.40	12
Wolverine	2007	W9	1.97	11
Money	2005	W11	0.29	38
Money	2005	W14	0.59	36
Go	2007	W17	15.10	28
Go	2007	W18	4.50	14
Go	2005	W16	1.24	30
Go	2007	W16	28.20	23
Go	2005	W12	0.12	23
Go	2007	W12	3.31	24
Putt	2005	W72	0.08	6
Bunker	2005	W73	0.12	22
Tributary to Little Jimmy Lake	2005	W75	0.13	19

1. Total number of taxa from the 3 replicates at each station.

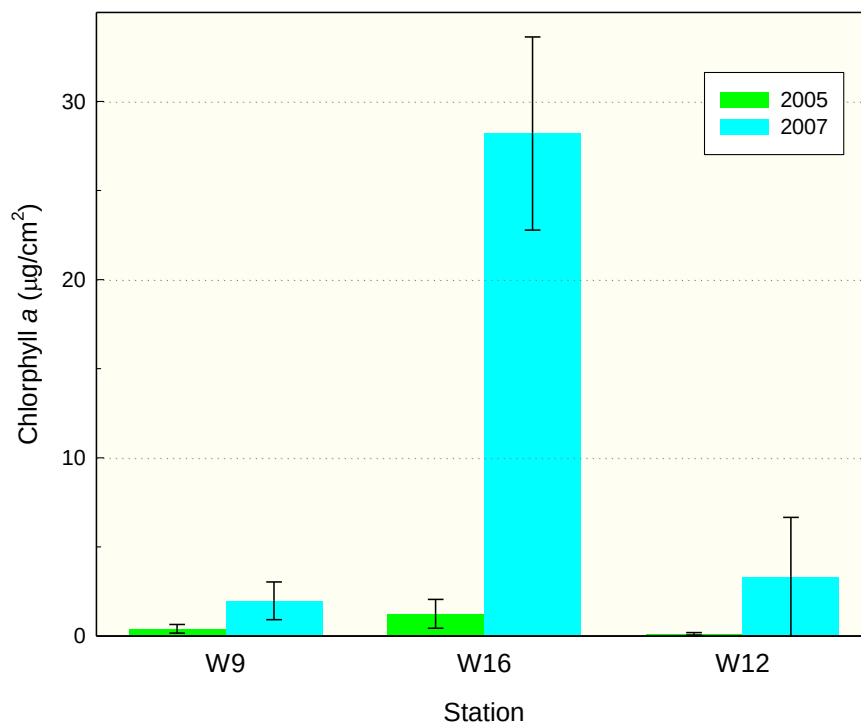


Figure 5-4: Periphyton Biomass (± 1 Standard Deviation) at Stations Sampled in 2005 and 2007.

References

- BCMOE. 1997. Methods for Deriving Site-Specific Water Quality Objectives in British Columbia and Yukon Report. Prepared by MacDonald Environmental Sciences Ltd. for the British Columbia Ministry of Environment, November 1997
- BCMOE. 2008. Ambient Water Quality Guidelines for Iron. Overview Report. Water Stewardship Division, Ministry of Environment, Province of British Columbia. March 2008.
- CCME (Canadian Council of Ministers of the Environment). 2007. Canadian water quality guidelines for the protection of aquatic life. 1999. Update 7.0. September 2007.
- Clark, M.J.R. (editor). 2003. British Columbia Field Sampling Manual. Water, Air and Climate Change Branch, Ministry of Water, Land and Air Protection, Victoria, BC, Canada. 312 pp.
- Available at www.env.gov.bc.ca/epd/wamr/labsys/field_man_pdfs/fld_man_03.pdf
- Environment Canada 2002. Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring. Environment Canada .
- Available at www.ec.gc.ca/EEM/English/MetalMining/Guidance/default.cfm
- Lehmkuhl, DM. 1979. Environmental disturbance and life histories: principles and examples. Fish. Res. Board Can., 36:329-334.

Wolverine Project

Baseline Characterization Summary Report Appendices

February 2010



Appendix A1

Surface Water Quality Data

1996 - 2008

APPENDIX A-1: SURFACE WATER QUALITY DATA (ON CD)

DATA IN EXCEL FILE “App_A1_WOLVERINE_SURFACEWQ_1996-2008.XLS”

Appendix A2

Surface Water Quality Summary Data

Table A-1
Conductivity ($\mu\text{S}/\text{cm}^2$) Summary Data

Station	# Samples	# < DL ¹	Max	Min	Median	Average	95th % ²
Wolverine Lake Watershed							
W82	16	0	230	87	208	200	223
W9	27	0	296	137	243	240	287
W1	22	0	230	93	149	155	195
L1	11	0	150	88	130	120	144
W21	24	0	630	108	200	214	267
W8	18	0	220	51	171	169	212
Go Creek Watershed							
W31	14	0	151	56	137	127	150
W16	31	0	157	39	140	135	153
W15	25	0	130	34	118	107	127
W81	15	0	146	39	130	124	145
W80	17	0	171	53	160	154	170
W12	26	0	171	51	157	146	170
W13	8	0	162	120	136	138	160
Money Creek Watershed							
W14	25	0	159	45	130	126	158
W22	18	0	300	88	209	222	300
W40	18	0	297	83	210	220	294
Road Route Monitoring							
W71	17	0	841	118	636	621	820
W72	16	0	515	186	377	373	511
W73	16	0	295	122	227	227	294

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

Table A-2
Hardness (mg/L as CaCO₃units) Summary Data

Station	# Samples	# < DL ¹	Max	Min	Median	Average	95th % ²
Wolverine Lake Watershed							
W82	26	0	140	42	105	103	127
W9	51	0	170	72	124	124	154
W1	44	0	110	48	73	75	98
L1	17	0	74	44	64	62	71
W21	41	0	348	58	99	103	132
W8	33	0	125	25	90	91	116
Go Creek Watershed							
W31	23	0	92	29	71	68	87
W16	49	0	85	19	71	69	79
W15	40	0	67	17	57	54	66
W81	24	0	75	18	66	64	73
W80	27	0	90	26	83	79	89
W12	51	0	97	26	78	72	88
W13	12	0	91	47	66	70	89
Money Creek Watershed							
W14	48	0	86	22	61	59	76
W22	32	0	173	43	96	98	153
W40	27	0	160	43	110	111	157
Road Route Monitoring							
W71	25	0	561	61	370	369	519
W72	24	0	288	97	198	199	277
W73	23	0	166	65	112	117	161

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

Table A-3
Total Alkalinity (mg/L as CaCO₃units) Summary Data

Station	# Samples	# < DL ¹	Max	Min	Median	Average	95th % ²
Wolverine Lake Watershed							
W82	26	0	99	33	80	77	89
W9	48	0	120	56	98	97	117
W1	42	0	92	42	62	64	89
L1	17	0	63	37	55	52	60
W21	39	0	290	50	87	89	111
W8	31	0	110	22	78	75	103
Go Creek Watershed							
W31	21	0	84	27	63	60	72
W16	47	0	77	17	64	61	72
W15	39	0	59	13	49	47	58
W81	23	0	67	15	58	55	63
W80	26	1	72	<0.5	66	61	71
W12	49	3	100	<0.5	63	57	74
W13	10	0	72	47	63	63	69
Money Creek Watershed							
W14	46	0	73	17	49	48	76
W22	30	0	142	31	80	82	153
W40	25	0	131	36	87	90	157
Road Route Monitoring							
W71	24	0	378	56	246	244	519
W72	23	0	238	73	150	155	277
W73	23	0	131	55	97	98	161

1. Number of samples with results less than the analytical detection limit.
2. 95th percentile of all baseline data.

Table A-4
pH Summary Data

Station	# Samples	# < DL ¹	Max	Min	Median	Average	95th % ²
Wolverine Lake Watershed							
W82	26	0	8.1	7.0	8.0	7.9	8.1
W9	48	0	8.2	7.4	8.0	7.9	8.2
W1	43	0	8.6	7.0	8.0	7.8	8.1
L1	17	0	8.0	7.7	7.9	7.9	8.0
W21	40	0	8.3	7.3	8.0	7.9	8.2
W8	32	0	8.1	7.1	8.0	7.9	8.1
Go Creek Watershed							
W31	23	0	8.1	7.1	8.0	7.9	8.1
W16	47	0	8.1	7.1	7.9	7.8	8.1
W15	40	0	8.1	6.9	7.8	7.7	8.0
W81	23	0	8.1	7.1	8.0	7.8	8.0
W80	26	0	8.1	7.0	8.0	7.9	8.1
W12	49	0	8.2	7.1	7.9	7.8	8.1
W13	11	0	8.1	7.3	7.8	7.7	8.1
Money Creek Watershed							
W14	46	0	8.1	7.0	7.9	7.7	8.1
W22	30	0	8.3	7.4	8.0	7.9	8.3
W40	26	0	8.3	7.2	8.1	8.0	8.2
Road Route Monitoring							
W71	24	0	8.4	7.7	8.2	8.2	8.4
W72	23	0	8.4	7.6	8.2	8.2	8.3
W73	23	0	8.3	7.5	8.2	8.1	8.2

1. Number of samples with results less than the analytical detection limit.
2. 95th percentile of all baseline data.

Table A-5
Total Suspended Solids (mg/L) Summary Data

Station	# Samples	# < DL ¹	Max	Min	Median	Average	95th % ²
Wolverine Lake Watershed							
W82	26	19	149	<3	4.0	12.1	43.2
W9	44	32	36	<1	4.0	4.9	6.9
W1	39	26	16	<1	4.0	4.1	9.1
L1	17	15	8	<4	4.0	4.4	6.4
W21	36	19	20	<1	4.0	5.1	11.8
W8	29	23	48	<1	4.0	7.1	25.8
Go Creek Watershed							
W31	23	20	56	<3	4.0	6.7	15.9
W16	46	37	95	<1	4.0	6.9	14.5
W15	37	29	24	<1	4.0	4.7	10.8
W81	23	21	14	<3	4.0	4.3	4.9
W80	26	21	37	<3	4.0	5.5	8.0
W12	45	30	43	<1	4.0	5.5	10.8
W13	9	7	5	<1	3.0	2.9	4.2
Money Creek Watershed							
W14	42	29	13	<1	4.0	3.7	5.4
W22	26	18	29	<1	4.0	4.2	6.7
W40	26	18	13	<3	4.0	5.1	10.3
Road Route Monitoring							
W71	24	16	47	<3	4.0	8.5	40.2
W72	23	7	20	<3	5.0	6.2	10.9
W73	23	21	33	<3	4.0	5.2	4.9

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

Table A-6
Turbidity (NTU) Summary Data

Station	# Samples	# < DL ¹	Max	Min	Median	Average	95th % ²
Wolverine Lake Watershed							
W82	26	0	28.4	0.3	1.1	2.4	4.0
W9	44	1	13.5	<0.1	0.4	1.0	5.8
W1	39	0	4.8	0.3	0.8	1.0	2.1
L1	17	0	1.8	0.7	1.0	1.1	1.6
W21	36	0	5.7	0.3	1.1	1.4	3.1
W8	29	0	18.1	0.1	0.4	1.4	6.3
Go Creek Watershed							
W31	20	2	6.0	<0.1	0.2	0.7	4.6
W16	43	1	6.0	<0.1	0.5	0.9	4.7
W15	38	3	7.4	<0.1	0.4	0.7	1.5
W81	22	0	2.1	0.1	0.2	0.4	1.1
W80	25	0	8.4	0.3	0.6	1.0	1.7
W12	46	1	5.3	<0.2	0.6	0.9	2.2
W13	9	1	1.0	<0.1	0.4	0.4	0.9
Money Creek Watershed							
W14	43	0	2.5	0.2	0.5	0.6	1.2
W22	27	0	4.4	0.1	0.4	0.7	1.6
W40	24	0	4.9	0.2	0.4	1.1	3.1
Road Route Monitoring							
W71	23	1	4.2	<0.1	0.5	0.8	2.2
W72	22	0	16.0	1.1	3.5	4.7	10.1
W73	23	0	2.2	0.1	0.4	0.5	1.1

1. Number of samples with results less than the analytical detection limit.
2. 95th percentile of all baseline data.

Table A-7
Fluoride (µg/L) Summary Data

Station	# Samples	# < DL ¹	Max	Min	Median	Average	95th % ²
Wolverine Lake Watershed							
W82	17	0	180	70	120	119	172
W9	37	0	170	36	110	109	132
W1	33	0	150	80	110	113	134
L1	11	0	100	70	80	79	90
W21	35	0	320	71	110	123	180
W8	22	0	60	26	45	45	60
Go Creek Watershed							
W31	15	6	30	<20	20	23	30
W16	34	0	100	24	40	40	63
W15	33	5	70	<20	30	31	50
W81	17	0	40	22	30	31	40
W80	18	0	70	40	50	51	62
W12	37	0	140	28	50	56	72
W13	11	0	60	20	41	43	57
Money Creek Watershed							
W14	36	1	110	<20	70	68	103
W22	29	0	280	51	80	89	122
W40	19	0	100	59	80	78	91
Road Route Monitoring							
W71	18	0	762	120	670	625	761
W72	17	0	230	160	180	186	230
W73	16	0	100	48	60	64	93

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

Bold values exceed CCME guideline for inorganic fluoride (120 µg/L)

Table A-8
Sulphate (mg/L) Summary Data

Station	# Samples	# < DL ¹	Max	Min	Median	Average	95th % ²
Wolverine Lake Watershed							
W82	26	0	64	8	23	25	37
W9	41	0	48	16	28	29	39
W1	44	1	32	<0.5	12	12	18
L1	17	1	13	<0.5	10	9	13
W21	41	0	66	5	15	17	28
W8	33	0	22	1	15	15	20
Go Creek Watershed							
W31	23	1	14	<0.5	9	8	11
W16	38	1	12	<0.03	8	8	11
W15	41	0	12	1	9	8	11
W81	24	1	20	<0.5	9	9	12
W80	27	0	29	1	16	15	19
W12	41	0	20	2	13	13	18
W13	12	0	17	3	5	9	17
Money Creek Watershed							
W14	48	0	20	1	12	12	16
W22	32	0	36	7	18	20	33
W40	27	0	34	7	24	23	33
Road Route Monitoring							
W71	25	0	154	5	108	104	148
W72	24	0	59	19	49	46	58
W73	23	0	33	8	18	19	30

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

Bold values exceed BC Aquatic Life guideline (100 mg/L)

Table A-9
Ammonia-N (µg/L) Summary Data

Station	# Samples	# < DL ¹	Max	Min	Median	Average	95th % ²
Wolverine Lake Watershed	26	7	180	<5	12	19	0
W82	37	33	50	<5	5	10	8
W9	30	18	170	<5	7	20	2
W1	17	7	82	<5	7	14	4
L1	27	22	50	<5	5	12	0
W21	30	26	232	<5	5	21	30
W8							
Go Creek Watershed	23	19	51	<5	5	12	10
W31	44	35	118	<5	5	16	2
W16	33	32	50	<5	5	11	7
W15	24	22	20	<5	5	8	0
W81	27	22	46	<5	5	10	13
W80	37	30	80	<5	5	14	35
W12	9	8	50	<5	20	23	42
W13							
Money Creek Watershed	34	28	90	<5	5	13	8
W14	18	16	50	<5	8	14	0
W22	27	22	20	<5	5	10	19
W40							
Road Route Monitoring	25	21	20	<5	5	8	22
W71	24	10	46	<5	11	16	7
W72	23	19	29	<5	5	8	11
W73	26	7	180	<5	12	19	0

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

No values exceed CCME guideline of 914 µg/L for a temperature of 8 °C and pH = 8.5.

Table A-10
Nitrate-N (µg/L) Summary Data

Station	# Samples	# < DL ¹	Max	Min	Median	Average	95th % ²
Wolverine Lake Watershed							
W82	26	0	490	77.00	294	299	378
W9	51	2	692	<2	153	186	425
W1	44	26	100	<2	5	16	58
L1	17	6	97	<2	6	31	89
W21	41	19	277	<2	5	32	118
W8	33	3	224	<5	73	83	212
Go Creek Watershed							
W31	23	6	135	<2	20	35	98
W16	49	5	142	<2	48	56	126
W15	41	3	183	<2	56	72	175
W81	24	0	138	10.00	63	64	130
W80	27	5	472	<2	35	68	279
W12	51	22	209	<2	10	35	123
W13	11	2	113	<5	68	56	107
Money Creek Watershed							
W14	48	11	300	<2	22	54	177
W22	32	4	228	<5	21	57	207
W40	27	3	181	<3	40	59	169
Road Route Monitoring							
W71	25	5	57	<2	11	16	39
W72	24	3	259	<2	31	46	91
W73	23	2	169	<2	40	59	130

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

No values exceed CCME guideline of 2900 µg/L for direct toxic effects.

Table A-11
Nitrite-N (µg/L) Summary Data

Station	# Samples	# < DL ¹	Max	Min	Median	Average	95th % ²
Wolverine Lake Watershed							
W82	26	16	7.0	<1	2.0	2.6	5.8
W9	50	39	80.0	<1	2.0	3.4	5.0
W1	43	31	5.0	<1	2.0	1.8	3.9
L1	17	11	6.0	<2	2.0	2.4	4.4
W21	40	25	5.0	<1	2.0	1.7	3.1
W8	33	27	5.0	<1	2.0	2.0	4.4
Go Creek Watershed							
W31	22	17	5.0	<1	2.0	2.1	4.9
W16	49	36	7.0	<1	2.0	2.1	5.0
W15	40	31	4.0	<1	2.0	1.6	2.1
W81	24	18	5.0	<1	2.0	2.0	3.0
W80	27	19	103.0	<1	2.0	5.7	4.4
W12	50	37	107.0	<1	2.0	5.7	5.0
W13	12	8	3.0	<1	1.0	1.2	1.9
Money Creek Watershed							
W14	47	32	36.0	<1	2.0	2.5	4.4
W22	31	20	3.0	<1	1.0	1.5	2.0
W40	27	22	5.0	<1	2.0	2.1	4.4
Road Route Monitoring							
W71	25	20	11.0	<1	2.0	2.4	5.2
W72	24	6	20.0	<1	2.0	3.6	9.4
W73	23	17	7.0	<1	2.0	2.6	5.9

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

Bold values exceed CCME guideline (60 µg/L)

Table A-12
Aluminum (µg/L) Summary Data

Station	Total Metal							Dissolved metal						
	#Samples	# < DL ¹	Max	Min	Median	Avg	95 th % ²	#Samples	#<DL ¹	Max	Min	Median	Avg	95 th % ²
Wolverine L. Watershed														
W82	25	0	333	3	25	43	103	26	0	25	2	9	10	23
W9	49	2	335	<2	14	30	80	48	8	36	<1	5	7	20
W1	41	2	175	<5	16	24	52	41	4	49	<2.8	8	11	32
L1	17	0	152	4	19	32	114	17	0	41	2	4	7	21
W21	37	1	158	<3.7	22	34	126	38	4	48	<2.5	7	10	26
W8	30	0	446	4	19	63	335	30	1	43	<0.5	7	10	25
Go Creek Watershed														
W31	18	0	68	5	13	22	65	19	0	63	4	11	15	41
W16	48	1	458	<3.5	12	35	88	46	2	42	<0.9	5	8	23
W15	37	1	341	<2.1	9	30	96	37	1	38	<1.6	5	8	23
W81	23	0	279	3	6	26	60	23	0	39	2	3	7	16
W80	26	0	663	3	13	57	153	26	0	46	1	4	7	13
W12	48	3	547	<3.3	14	32	79	47	7	49	<1.1	5	9	31
W13	9	1	70	<3.9	7	19	65	9	0	52	2	6	14	47
Money Creek Watershed														
W14	44	2	259	<4.2	24	34	114	44	3	49	<1.6	9	14	42
W22	29	2	338	<3.4	18	38	167	29	4	50	<2.2	6	12	33
W40	24	0	289	3	15	57	237	24	1	38	<1	5	9	24
Road Route Monitoring														
W71	23	1	549	<2.1	10	68	457	24	2	12	<0.5	3	4	7
W72	22	0	234	24	55	84	198	23	0	16	2	7	7	16
W73	22	0	90	2	9	17	52	23	1	18	<1.1	4	5	12

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

Bold values exceed CCME guideline (100 µg/L) for water with pH > 6.5.

Table A-13
Arsenic (µg/L) Summary Data

Station	Total Metal							Dissolved metal						
	#Samples	# < DL ¹	Max	Min	Median	Avg	95 th % ²	#Samples	#<DL ¹	Max	Min	Median	Avg	95 th % ²
Wolverine L. Watershed														
W82	25	4	0.70	<0.09	0.20	0.25	0.64	26	4	0.30	<0.06	0.20	0.16	0.30
W9	48	9	1.10	<0.1	0.30	0.35	0.60	47	7	0.50	<0.1	0.26	0.29	0.50
W1	40	1	5.00	<0.9	1.71	1.87	2.92	40	0	3.11	0.80	1.59	1.65	2.63
L1	17	0	3.00	0.80	1.50	1.54	2.12	17	0	1.80	0.92	1.30	1.28	1.64
W21	36	0	3.61	0.86	1.40	1.46	1.92	37	0	2.98	0.77	1.20	1.32	1.83
W8	29	5	0.60	<0.1	0.20	0.27	0.50	29	3	0.50	<0.09	0.15	0.20	0.50
Go Creek Watershed														
W31	18	4	0.50	<0.1	0.20	0.23	0.50	19	4	0.50	<0.1	0.20	0.24	0.50
W16	47	10	0.50	<0.09	0.20	0.25	0.50	45	10	0.50	<0.08	0.13	0.19	0.50
W15	37	11	1.16	<0.08	0.12	0.20	0.50	37	10	0.50	<0.08	0.13	0.17	0.40
W81	23	7	0.40	<0.08	0.20	0.17	0.30	23	5	0.40	<0.09	0.20	0.16	0.20
W80	26	1	0.70	<0.1	0.25	0.30	0.58	26	2	0.40	<0.15	0.20	0.24	0.40
W12	48	8	0.80	<0.1	0.26	0.30	0.50	47	8	0.50	<0.1	0.23	0.26	0.50
W13	9	4	0.50	<0.05	0.16	0.23	0.50	9.00	4.00	0.50	<0.05	0.16	0.23	0.50
Money Creek Watershed														
W14	44	5	0.50	<0.07	0.20	0.24	0.50	44	4	0.50	<0.05	0.20	0.21	0.49
W22	28	1	0.55	<0.1	0.23	0.26	0.51	28	3	0.50	<0.16	0.21	0.24	0.50
W40	24	2	0.60	<0.1	0.30	0.33	0.59	24	4	0.50	<0.1	0.20	0.25	0.49
Road Route Monitoring														
W71	23	1	1.10	<0.27	0.40	0.48	0.98	24	2	0.70	<0.2	0.45	0.46	0.70
W72	22	0	3.30	0.90	1.61	1.72	2.18	23	0	1.93	1.00	1.33	1.39	1.87
W73	22	4	0.60	<0.1	0.23	0.27	0.50	23	1	0.50	<0.16	0.20	0.25	0.40

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

No values exceed CCME guideline of 5 µg/L.

Table A-14
Cadmium (µg/L) Summary Data

Station	Total Metal							Dissolved metal						
	#Samples	# < DL ¹	Max	Min	Median	Avg	95 th % ²	#Samples	#<DL ¹	Max	Min	Median	Avg	95 th % ²
Wolverine L. Watershed														
W82	25	0	6.22	0.29	2.06	2.19	4.38	26	0	3.86	0.07	0.50	1.13	2.78
W9	50	0	2.47	0.02	1.35	1.39	1.94	49	0	1.90	0.82	1.26	1.27	1.65
W1	24	3	0.10	<0.01	0.02	0.02	0.05	25	4	0.07	<0.007	0.02	0.02	0.06
L1	17	0	0.13	0.02	0.04	0.04	0.09	17	0	0.04	0.01	0.03	0.03	0.04
W21	22	0	0.21	0.01	0.03	0.05	0.13	23	1	0.16	<0.007	0.02	0.03	0.10
W8	24	0	0.26	0.02	0.06	0.07	0.11	24	0	0.15	0.02	0.05	0.06	0.12
Go Creek Watershed														
W31	17	15	0.02	<0.005	0.01	0.01	0.02	19	12	0.03	<0.005	0.01	0.01	0.03
W16	41	0	0.31	0.03	0.08	0.08	0.12	39	2	0.11	<0.02	0.07	0.06	0.09
W15	28	22	0.21	<0.005	0.02	0.02	0.03	27	17	0.19	<0.005	0.02	0.02	0.03
W81	23	1	0.05	<0.01	0.02	0.02	0.04	23	1	0.05	<0.012	0.02	0.02	0.04
W80	24	0	0.80	0.01	0.02	0.06	0.08	24	1	0.05	<0.01	0.02	0.02	0.05
W12	32	4	0.27	<0.01	0.02	0.03	0.06	34	7	0.14	<0.009	0.02	0.03	0.09
W13	4	1	0.03	<0.017	0.02	0.02	0.03	4	2	0.09	<0.017	0.04	0.05	0.09
Money Creek Watershed														
W14	29	7	0.44	<0.007	0.02	0.04	0.11	31	6	0.12	<0.005	0.02	0.03	0.11
W22	13	1	0.07	<0.016	0.02	0.03	0.06	13	2	0.06	<0.01	0.02	0.02	0.04
W40	24	2	0.05	<0.014	0.02	0.03	0.05	24	1	0.09	<0.01	0.02	0.03	0.05
Road Route Monitoring														
W71	23	0	4.18	0.30	2.64	2.40	4.13	24	0	4.01	0.11	2.76	2.34	3.89
W72	22	0	0.58	0.21	0.32	0.33	0.43	23	0	0.24	0.06	0.16	0.15	0.23
W73	22	3	0.06	<0.006	0.01	0.02	0.04	23	6	0.05	<0.005	0.01	0.02	0.03

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

Bold values exceed USEPA guideline (0.146 µg/L) for a hardness of 100 mg/L

Table A-15
Chromium (µg/L) Summary Data

Station	Total Metal							Dissolved metal						
	#Samples	# < DL ¹	Max	Min	Median	Avg	95 th % ²	#Samples	#<DL ¹	Max	Min	Median	Avg	95 th % ²
Wolverine L. Watershed														
W82	25	8	1.30	<0.1	0.50	0.54	1.18	26	19	1.20	<0.1	0.20	0.43	1.20
W9	49	20	1.40	<0.1	0.50	0.59	1.25	48	33	1.20	<0.02	0.20	0.45	1.00
W1	41	15	1.40	<0.1	0.50	0.55	1.20	41	24	1.30	<0.1	0.20	0.46	1.00
L1	17	2	1.40	<0.1	0.40	0.59	1	17	12	1.40	<0.1	0.20	0.38	1.24
W21	37	10	1.30	<0.2	0.60	0.63	1.14	38	20	1.40	<0.1	0.35	0.57	1.22
W8	30	6	1.40	<0.2	0.70	0.67	1.20	30	20	1.60	<0.1	0.20	0.46	1.26
Go Creek Watershed														
W31	18	10	1.40	<0.2	0.45	0.59	1.15	19	13	1.20	<0.2	0.20	0.55	1.20
W16	48	19	1.70	<0.1	0.50	0.65	1.40	46	29	1.60	<0.1	0.20	0.46	1.10
W15	37	13	1.30	<0.1	0.50	0.54	1.10	37	21	1.50	<0.1	0.50	0.51	1.24
W81	23	9	1.50	<0.1	0.50	0.54	1.00	23	16	1.70	<0.1	0.20	0.41	1.29
W80	26	9	1.80	<0.1	0.45	0.57	1.35	26	20	1.60	<0.1	0.20	0.40	1.40
W12	48	22	1.50	<0.1	0.50	0.55	1.17	47	33	1.20	<0.1	0.20	0.44	1.00
W13	9	6	1.00	<0.2	0.50	0.64	1.00	9	6	1.00	<0.2	0.50	0.64	1.00
Money Creek Watershed														
W14	44	18	1.30	<0.1	0.50	0.55	1.09	44	27	1.80	<0.1	0.20	0.47	1.00
W22	29	9	1.60	<0.2	0.50	0.64	1.26	29	12	1.60	<0.1	0.50	0.66	1.42
W40	24	5	1.60	<0.2	0.70	0.75	1.49	24	15	1.30	<0.2	0.30	0.48	1.27
Road Route Monitoring														
W71	23	7	2.10	<0.1	0.50	0.70	1.77	24	14	2.00	<0.1	0.20	0.59	1.49
W72	22	3	5.35	<0.1	0.75	0.91	1.30	23	16	1.50	<0.1	0.20	0.44	1.20
W73	22	2	1.50	<0.3	0.70	0.76	1.40	23	12	1.70	<0.02	0.20	0.45	1.30

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

Bold values exceed CCME guideline for Cr(VI) (1 µg/L). CCME guideline for Cr(III) is 8.9 µg/L.

Table A-16
Copper (µg/L) Summary Data

Station	Total Metal							Dissolved metal						
	#Samples	# < DL ¹	Max	Min	Median	Avg	95 th % ²	#Samples	#<DL ¹	Max	Min	Median	Avg	95 th % ²
Wolverine L. Watershed														
W82	25	0	14.70	0.47	3.04	3.60	8.04	26	0	2.50	0.20	0.89	0.89	1.49
W9	50	6	6.00	<0.44	1.26	1.70	4.52	49	6	4.10	<0.4	1.00	1.38	3.81
W1	42	6	6.00	<0.52	0.80	1.01	1.30	42	5	3.00	<0.43	0.80	0.89	1.49
L1	17	0	1.20	0.30	0.50	0.59	1.04	17	0	0.80	0.18	0.40	0.45	0.72
W21	38	4	4.00	<0.58	1.03	1.29	2.75	39	5	2.60	<0.5	1.00	1.10	2.06
W8	30	1	7.00	<0.55	1.20	1.61	3.81	30	3	6.00	<0.5	1.00	1.20	2.12
Go Creek Watershed														
W31	18	1	3.30	<0.63	1.07	1.35	3.13	19	1	4.70	<0.6	1.10	1.53	3.44
W16	48	6	4.00	<0.31	0.71	1.01	2.82	46	6	2.00	<0.29	0.60	0.75	1.68
W15	38	3	4.00	<0.22	0.78	1.00	2.76	38	4	2.90	<0.19	0.70	0.83	2.00
W81	23	0	2.70	0.26	0.58	0.72	1.68	23	0	1.60	0.19	0.50	0.65	1.49
W80	26	0	4.20	0.31	0.62	0.87	1.90	26	0	1.70	0.22	0.51	0.65	1.44
W12	50	7	4.00	<0.34	0.90	1.08	2.71	49	8	2.90	<0.27	0.80	0.95	1.96
W13	10	3	4.00	<0.32	0.80	1.08	2.83	10	4	2.00	<0.29	1.00	0.92	1.69
Money Creek Watershed														
W14	46	4	7.20	<0.2	0.80	1.09	3.50	46	7	3.00	<0.15	0.62	0.83	2.00
W22	30	4	4.00	<0.22	0.85	1.10	2.31	30	6	2.20	<0.2	1.00	0.95	2.00
W40	24	2	1.90	<0.24	0.80	0.85	1.69	24	1	1.30	<0.23	0.58	0.65	1.19
Road Route Monitoring														
W71	23	1	2.10	<0.3	0.80	0.82	1.39	24	1	1.10	<0.28	0.56	0.60	0.99
W72	22	0	3.65	0.46	1.20	1.35	2.39	23	1	1.90	<0.2	0.73	0.79	1.66
W73	22	0	3.30	0.45	1.10	1.31	2.80	23	0	2.90	0.36	0.90	0.99	2.57

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

Bold values exceed British Columbia guideline (4 µg/L) assuming a hardness of 100 mg/L. Guideline is 2 µg/L at hardness of 50 mg/L.

Table A-17
Iron (µg/L) Summary Data

Station	Total Metal							Dissolved metal						
	#Samples	# < DL ¹	Max	Min	Median	Avg	95 th % ²	#Samples	#<DL ¹	Max	Min	Median	Avg	95 th % ²
Wolverine L. Watershed														
W82	25	0	2610	63	191	400	1086	25	4	168	<4	30	47	122
W9	51	11	820	<5	30	90	349	50	29	120	<3	12	22	62
W1	44	0	1580	30	71	128	247	44	9	400	<3	30	47	79
L1	17	0	666	74	135	196	416	17	0	100	10	24	42	98
W21	40	1	497	<30	112	137	325	41	6	244	<10	40	52	100
W8	32	9	730	<5	30	132	613	32	17	271	<5	13	26	59
Go Creek Watershed														
W31	20	8	68	<3	20	20	35	21	10	30	<2	10	14	30
W16	49	6	753	<20	49	89	332	47	11	59	<3	22	22	45
W15	40	16	520	<4	25	47	108	40	26	50	<3	10	17	36
W81	24	5	417	<7	29	45	83	24	7	32	<3	9	14	30
W80	27	0	1120	55	91	176	617	27	2	141	<4	31	37	109
W12	51	1	934	<26	60	90	229	50	9	102	<6	30	31	82
W13	12	5	94	<10	30	37	79	12	9	132	<10	30	36	95
Money Creek Watershed														
W14	39	1	452	<30	80	105	265	48	5	140	<6	30	42	107
W22	32	2	850	<5	47	96	422	32	9	120	<2	24	28	67
W40	26	2	484	<7	42	101	363	26	7	61	<4	15	21	46
Road Route Monitoring														
W71	24	6	717	<5	40	133	655	25	9	37	<5	11	16	30
W72	23	0	1020	130	256	295	629	24	2	121	<10	44	48	105
W73	22	1	161	<7	42	54	142	23	4	63	<5	12	18	41

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

Bold values exceed British Columbia guideline for total Fe (1000 µg/L) or dissolved Fe (350 µg/L)..

Table A-18
Lead (µg/L) Summary Data

Station	Total Metal							Dissolved metal						
	#Samples	# < DL ¹	Max	Min	Median	Avg	95 th % ²	#Samples	#<DL ¹	Max	Min	Median	Avg	95 th % ²
Wolverine L. Watershed														
W82	25	2	1.04	<0.02	0.08	0.14	0.35	26	10	0.94	<0.012	0.05	0.08	0.15
W9	48	16	1.22	<0.02	0.09	0.23	0.84	47	26	1.00	<0.012	0.05	0.17	0.50
W1	40	18	1.00	<0.012	0.05	0.14	0.52	39	20	4.84	<0.014	0.05	0.27	1.00
L1	17	0	1.29	0.01	0.04	0.17	0.64	17	6	0.09	<0.006	0.02	0.04	0.09
W21	36	8	3.28	<0.02	0.09	0.28	1.00	37	19	1.00	<0.01	0.05	0.19	0.88
W8	29	9	1.00	<0.02	0.12	0.24	0.77	29	17	1.00	<0.013	0.03	0.12	0.50
Go Creek Watershed														
W31	18	9	0.50	<0.01	0.03	0.12	0.50	19	9	14.00	<0.02	0.07	0.98	3.31
W16	47	26	1.00	<0.011	0.05	0.14	0.50	45	25	1.00	<0.007	0.05	0.11	0.50
W15	37	21	1.00	<0.02	0.05	0.11	0.50	37	23	9.18	<0.016	0.05	0.36	0.60
W81	23	9	0.15	<0.02	0.04	0.05	0.10	23	12	0.09	<0.01	0.04	0.04	0.08
W80	26	5	0.57	<0.012	0.05	0.12	0.54	26	10	0.45	<0.011	0.04	0.07	0.24
W12	48	16	1.00	<0.017	0.06	0.17	0.62	47	27	1.00	<0.008	0.05	0.16	0.65
W13	9	9	<0.05	<0.05	0.05	0.26	0.80	9	9	<0.05	<0.05	0.05	0.26	0.80
Money Creek Watershed														
W14	44	23	1.00	<0.015	0.05	0.15	0.50	44	27	1.00	<0.009	0.05	0.15	0.50
W22	28	10	1.00	<0.006	0.07	0.19	0.83	28	18	1.00	<0.005	0.05	0.19	0.82
W40	24	7	0.50	<0.01	0.06	0.12	0.46	24	10	0.50	<0.011	0.05	0.09	0.45
Road Route Monitoring														
W71	23	5	0.54	<0.014	0.10	0.14	0.49	24	12	22.40	<0.02	0.04	0.99	0.44
W72	22	1	2.73	<0.08	0.18	0.32	0.50	23	5	0.50	<0.02	0.05	0.07	0.10
W73	22	4	0.50	<0.008	0.05	0.07	0.11	23	8	0.50	<0.006	0.03	0.06	0.12

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

Bold values exceed CCME guideline (2 µg/L) for a hardness of 60 – 120 mg/L.

Not that where maximum dissolved concentration exceeds maximum total concentration this likely indicates contamination from the filtration process.

Table A-19
Mercury (µg/L) Summary Data

Station	Total Metal							Dissolved metal						
	#Samples	# < DL ¹	Max	Min	Median	Avg	95 th % ²	#Samples	#<DL ¹	Max	Min	Median	Avg	95 th % ²
Wolverine L. Watershed														
W82	13	13	<0.01	<0.01	0.01	0.01	0.01	13	13	<0.01	<0.01	0.01	0.01	0.01
W9	22	20	0.02	<0.01	0.01	0.01	0.02	21	19	0.02	<0.01	0.01	0.01	0.02
W1	14	14	<0.01	<0.01	0.01	0.01	0.02	14	14	<0.01	<0.01	0.01	0.01	0.02
L1	11	11	<0.01	<0.01	0.01	0.01	0.01	11	11	<0.01	<0.01	0.01	0.01	0.01
W21	16	16	<0.01	<0.01	0.01	0.01	0.02	16	15	0.02	<0.01	0.01	0.01	0.02
W8	13	13	<0.01	<0.01	0.01	0.01	0.02	13	13	<0.01	<0.01	0.01	0.01	0.02
Go Creek Watershed														
W31	12	12	<0.01	<0.01	0.01	0.01	0.02	12	11	0.02	<0.01	0.01	0.01	0.02
W16	28	25	0.02	<0.01	0.01	0.01	0.02	26	26	<0.01	<0.01	0.01	0.01	0.02
W15	15	14	0.02	<0.01	0.01	0.01	0.02	15	15	<0.01	<0.01	0.01	0.01	0.02
W81	12	12	<0.01	<0.01	0.01	0.01	0.01	12	12	<0.01	<0.01	0.01	0.01	0.01
W80	12	12	<0.01	<0.01	0.01	0.01	0.01	12	12	<0.01	<0.01	0.01	0.01	0.01
W12	19	18	0.02	<0.01	0.01	0.01	0.02	18	16	0.02	<0.01	0.01	0.01	0.02
W13	2	2	<0.02	<0.02	0.02	0.02	0.02	2	2	<0.02	<0.02	0.02	0.02	0.02
Money Creek Watershed														
W14	15	14	0.02	<0.01	0.01	0.01	0.02	15	15	<0.01	<0.01	0.01	0.01	0.02
W22	11	11	<0.01	<0.01	0.01	0.01	0.02	11	11	<0.01	<0.01	0.01	0.01	0.02
W40	15	14	0.02	<0.01	0.01	0.01	0.02	15	15	<0.01	<0.01	0.01	0.01	0.02
Road Route Monitoring														
W71	15	15	<0.01	<0.01	0.01	0.01	0.01	15	14	0.02	<0.01	0.01	0.01	0.01
W72	14	14	<0.01	<0.01	0.01	0.01	0.01	14	14	<0.01	<0.01	0.01	0.01	0.01
W73	15	14	0.02	<0.01	0.01	0.01	0.02	15	15	<0.01	<0.01	0.01	0.01	0.01

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

No values exceed CCME guideline (0.026 µg/L).

Table A-20
Molybdenum (µg/L) Summary Data

Station	Total Metal							Dissolved metal						
	#Samples	# < DL ¹	Max	Min	Median	Avg	95 th % ²	#Samples	#<DL ¹	Max	Min	Median	Avg	95 th % ²
Wolverine L. Watershed														
W82	25	0	0.62	0.23	0.33	0.34	0.44	26	1	0.44	<0.23	0.31	0.32	0.42
W9	42	8	1.16	<0.5	0.87	0.84	1.12	41	7	1.16	<0.47	0.82	0.81	1.01
W1	33	1	1.45	<0.81	1.10	1.13	1.41	33	0	1.34	0.72	1.04	1.06	1.29
L1	17	0	1.17	0.69	1.04	1.02	1.15	17	0	1.13	0.68	0.99	0.97	1.13
W21	29	1	4.28	<0.85	1.18	1.27	1.62	30	0	4.23	0.83	1.11	1.24	1.65
W8	27	3	1.00	<0.24	0.54	0.57	1.00	27	3	1.00	<0.18	0.52	0.55	1.00
Go Creek Watershed														
W31	18	3	1.00	<0.14	0.36	0.44	1.00	19	3	1.00	<0.12	0.36	0.44	1.00
W16	45	7	1.00	<0.24	0.40	0.48	1.00	43	5	1.00	<0.2	0.39	0.45	1.00
W15	34	2	1.00	<0.09	0.25	0.29	0.66	34	2	1.00	<0.07	0.23	0.28	0.69
W81	23	0	0.48	0.17	0.33	0.32	0.40	23	0	0.41	0.14	0.32	0.31	0.38
W80	26	0	0.57	0.34	0.45	0.44	0.47	26	0	0.49	0.25	0.43	0.42	0.47
W12	41	6	1.00	<0.32	0.43	0.51	1.00	40	6	1.00	<0.25	0.43	0.50	1.00
W13	7	2	1.00	<0.2	0.39	0.51	1.00	7	2	1.00	<0.2	0.41	0.52	1.00
Money Creek Watershed														
W14	37	4	1.00	<0.23	0.38	0.44	1.00	37	4	1.00	<0.19	0.36	0.43	1.00
W22	21	4	1.00	<0.43	0.65	0.69	1.00	21	4	1.00	<0.38	0.69	0.69	1.00
W40	24	2	1.00	<0.37	0.67	0.70	0.99	24	2	1.00	<0.3	0.68	0.67	0.98
Road Route Monitoring														
W71	23	0	6.66	0.74	5.55	4.91	6.47	24	0	6.05	0.67	5.43	4.78	5.88
W72	22	0	4.27	1.78	3.07	3.02	4.23	23	0	4.51	1.58	3.02	2.95	4.17
W73	22	1	1.00	<0.37	0.49	0.51	0.66	23	1	1.00	<0.36	0.50	0.50	0.62

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

No values exceed CCME guideline (73 µg/L).

Table A-21
Nickel (µg/L) Summary Data

Station	Total Metal							Dissolved metal						
	#Samples	# < DL ¹	Max	Min	Median	Avg	95 th % ²	#Samples	#<DL ¹	Max	Min	Median	Avg	95 th % ²
Wolverine L. Watershed														
W82	25	0	30.8	1.2	13.6	12.7	29.4	26	0	24.1	0.5	12.9	10.6	22.2
W9	44	2	6.9	<1	3.8	3.9	6.4	43	1	5.8	<1.82	3.3	3.5	5.5
W1	35	2	2.0	<1	1.3	1.4	2.0	35	2	2.0	<0.9	1.2	1.3	1.9
L1	17	3	4.6	<0.45	0.6	0.9	2.0	17	7	0.7	<0.43	0.5	0.5	0.6
W21	31	2	4.9	<1.42	2.0	2.2	3.7	32	1	4.4	<1	1.9	1.9	2.8
W8	28	3	5.9	<0.5	1.0	1.3	2.4	28	7	2.0	<0.5	0.7	0.8	1.4
Go Creek Watershed														
W31	18	13	1.0	<0.02	0.5	0.5	1.0	19	13	2.3	<0.04	0.5	0.6	1.1
W16	46	26	2.0	<0.12	0.5	0.5	1.0	44	27	2.0	<0.12	0.5	0.5	1.0
W15	35	24	2.0	<0.1	0.5	0.5	1.0	35	27	2.0	<0.06	0.5	0.5	1.0
W81	23	16	0.9	<0.09	0.5	0.4	0.6	23	18	0.5	<0.08	0.5	0.4	0.5
W80	26	15	6.2	<0.22	0.5	0.8	1.8	26	20	0.5	<0.21	0.5	0.4	0.5
W12	43	27	2.0	<0.1	0.5	0.6	1.6	42	28	2.0	<0.1	0.5	0.6	1.6
W13	8	5	2.0	<0.3	0.5	0.8	1.7	8	5	2.0	<0.3	0.5	0.8	1.7
Money Creek Watershed														
W14	39	17	14.0	<0.4	0.6	1.0	1.4	39	18	2.0	<0.4	0.5	0.7	1.4
W22	23	4	3.2	<0.66	1.0	1.2	2.5	23	5	2.0	<0.64	0.8	1.0	1.9
W40	24	3	2.0	<0.5	0.9	1.0	1.9	24	5	1.2	<0.5	0.7	0.8	1.1
Road Route Monitoring														
W71	23	0	47.0	5.3	28.6	28.0	35.2	24	0	34.3	2.6	28.3	25.9	31.9
W72	22	0	6.6	2.4	4.2	4.3	6.1	23	0	5.3	1.5	3.5	3.5	4.9
W73	22	5	3.0	<0.5	0.7	0.9	1.9	23	5	1.4	<0.5	0.6	0.7	1.2

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

No values exceed CCME guideline (65 µg/L) for a hardness of 60 – 120 mg/L.

Table A-22
Selenium (µg/L) Summary Data

Station	Total Metal							Dissolved metal						
	#Samples	# < DL ¹	Max	Min	Median	Avg	95 th % ²	#Samples	#<DL ¹	Max	Min	Median	Avg	95 th % ²
Wolverine L. Watershed														
W82	22	0	3.70	0.90	1.82	1.98	3.18	26	0	5.80	1.00	1.95	2.14	3.45
W9	48	0	5.70	0.59	3.00	3.18	4.47	47	0	5.20	1.70	3.10	3.29	4.68
W1	37	30	1.00	<0.32	0.50	0.69	1.00	40	33	1.00	<0.32	0.50	0.69	1.00
L1	12	4	0.70	<0.33	0.50	0.49	0.70	17	8	1.10	<0.36	0.50	0.55	0.94
W21	35	24	1.30	<0.35	0.90	0.76	1.07	37	26	1.44	<0.31	0.53	0.73	1.00
W8	25	14	1.00	<0.5	0.80	0.76	1.00	29	13	1.90	<0.5	0.90	0.86	1.24
Go Creek Watershed														
W31	18	14	1.00	<0.19	0.50	0.56	1.00	19	15	1.00	<0.27	0.50	0.57	1.00
W16	47	25	1.00	<0.34	0.50	0.62	1.00	45	20	1.00	<0.31	0.52	0.64	1.00
W15	37	28	1.00	<0.19	0.50	0.63	1.00	37	28	1.20	<0.25	0.50	0.67	1.04
W81	22	12	1.00	<0.29	0.50	0.55	1.00	23	14	1.00	<0.33	0.50	0.53	0.90
W80	23	2	1.55	<0.5	0.84	0.86	1.09	26	2	1.50	<0.5	0.90	0.88	1.10
W12	48	22	1.90	<0.5	1.00	0.91	1.26	47	19	1.70	<0.5	0.95	0.91	1.20
W13	9	8	1.00	<0.5	1.00	0.90	1.00	9	8	1.00	<0.5	1.00	0.91	1.00
Money Creek Watershed														
W14	40	30	1.30	<0.15	0.50	0.68	1.00	44	29	1.00	<0.17	0.55	0.69	1.00
W22	28	18	1.03	<0.5	1.00	0.88	1.00	28	18	1.00	<0.44	1.00	0.86	1.00
W40	22	9	1.10	<0.5	0.72	0.73	1.00	24	11	1.00	<0.45	0.66	0.70	1.00
Road Route Monitoring														
W71	21	1	7.40	<0.5	5.30	5.01	7.30	24	1	8.70	<0.5	5.61	5.54	8.06
W72	20	0	2.30	0.51	1.63	1.55	2.05	23	1	2.40	<0.42	1.80	1.65	2.29
W73	20	6	1.34	<0.5	0.83	0.81	1.30	23	3	1.43	<0.5	0.75	0.82	1.20

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

Bold values exceed British Columbia guideline (2 µg/L).

Table A-23
Silver (µg/L) Summary Data

Station	Total Metal							Dissolved metal						
	#Samples	# < DL ¹	Max	Min	Median	Avg	95 th % ²	#Samples	#<DL ¹	Max	Min	Median	Avg	95 th % ²
Wolverine L. Watershed														
W82	25	19	0.03	<0.005	0.01	0.01	0.02	26	24	0.02	<0.005	0.01	0.01	0.01
W9	43	31	0.05	<0.005	0.01	0.01	0.02	45	42	0.02	<0.005	0.01	0.01	0.02
W1	38	31	0.02	<0.005	0.01	0.01	0.02	38	36	0.02	<0.005	0.01	0.01	0.02
L1	17	17	<0.005	<0.005	0.01	0.01	0	17	16	0.06	<0.005	0.01	0.02	0
W21	34	29	0.02	<0.005	0.01	0.01	0.02	35	31	0.02	<0.005	0.01	0.01	0.02
W8	28	21	0.03	<0.005	0.01	0.01	0.02	29	27	0.10	<0.005	0.01	0.01	0.02
Go Creek Watershed														
W31	18	16	0.02	<0.005	0.01	0.01	0.02	19	17	0.03	<0.005	0.01	0.01	0.02
W16	46	43	0.02	<0.005	0.01	0.01	0.02	44	41	0.05	<0.005	0.01	0.01	0.02
W15	34	33	0.02	<0.005	0.01	0.01	0.01	36	34	0.02	<0.005	0.01	0.01	0.01
W81	23	22	0.01	<0.005	0.01	0.01	0.01	23	23	<0.005	<0.005	0.01	0.01	0.01
W80	26	25	0.02	<0.005	0.01	0.01	0.01	26	23	0.01	<0.005	0.01	0.01	0.01
W12	46	43	0.03	<0.005	0.01	0.01	0.02	45	38	0.03	<0.005	0.01	0.01	0.02
W13	8	8	<0.01	<0.01	0	0	0	8	8	<0.01	<0.01	0	0	0
Money Creek Watershed														
W14	42	40	0.02	<0.005	0.01	0.01	0.02	42	40	0.03	<0.005	0.01	0.01	0.02
W22	26	23	0.05	<0.005	0.01	0.01	0.02	26	25	0.02	<0.005	0.01	0.01	0.02
W40	24	22	0.03	<0.005	0.01	0.01	0.02	24	23	0.02	<0.005	0.01	0.01	0.02
Road Route Monitoring														
W71	23	19	0.04	<0.005	0.01	0.01	0.02	24	24	<0.005	<0.005	0.01	0.01	0.02
W72	22	13	0.02	<0.005	0.01	0.01	0.02	23	22	0.02	<0.005	0.01	0.01	0.01
W73	22	18	0.06	<0.005	0.01	0.01	0.02	23	22	0.02	<0.005	0.01	0.01	0.01

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

No values exceed CCME guideline (0.1µg/L).

Table A-24
Zinc (µg/L) Summary Data

Station	Total Metal							Dissolved metal						
	#Samples	# < DL ¹	Max	Min	Median	Avg	95 th % ²	#Samples	#<DL ¹	Max	Min	Median	Avg	95 th % ²
Wolverine L. Watershed														
W82	25	0	434.0	34.3	177.0	178.9	328.6	26	0	350.0	27.1	169.0	157.5	323.0
W9	50	1	239.0	<5	129.5	134.5	195.8	50	0	186.0	54.0	123.0	125.6	172.3
W1	44	16	7.0	<0.5	3.0	3.3	5.0	44	13	20.0	<0.5	3.6	4.0	9.6
L1	17	0	14.5	2.3	5.3	6.3	10.3	17	0	8.6	1.8	4.4	4.6	8.2
W21	40	8	28.0	<0.5	3.5	4.8	12.6	41	11	43.9	<0.5	5.0	6.0	17.0
W8	32	1	28.8	<3.6	6.0	7.8	13.7	32	0	21.1	1.8	5.6	6.4	12.6
Go Creek Watershed														
W31	20	7	5.0	<0.5	1.7	2.6	5.0	21	6	9.9	<0.7	2.7	3.9	9.7
W16	49	10	62.6	<1.4	4.5	6.5	16.1	47	11	88.0	<0.5	4.4	7.3	17.6
W15	40	19	34.7	<0.6	2.4	4.5	13.4	40	19	53.5	<0.5	4.2	6.1	25.0
W81	24	2	7.7	<0.5	2.4	2.6	5.1	24	6	11.3	<0.5	2.0	3.1	10.6
W80	27	4	7.6	<0.5	1.9	2.4	4.9	27	11	20.4	<0.5	1.4	3.4	10.5
W12	51	23	10.7	<0.5	2.3	3.1	5.5	50	26	26.0	<0.5	2.7	5.0	22.0
W13	12	10	5.0	<1	3.5	3.1	5.0	12	10	5.0	<1	4.5	3.3	5.0
Money Creek Watershed														
W14	48	18	12.8	<0.5	2.0	3.3	7.6	48	24	121.0	<0.5	3.0	7.2	24.7
W22	32	9	73.0	<1	4.6	6.5	15.2	32	16	21.0	<0.5	5.0	5.9	16.9
W40	26	7	18.3	<0.5	3.5	3.6	5.9	26	8	15.2	<0.5	2.9	4.7	13.4
Road Route Monitoring														
W71	24	0	927.0	51.9	557.5	564.2	840.4	25	0	854.0	16.5	559.0	558.6	778.4
W72	23	0	56.1	28.7	38.3	38.4	43.6	24	0	53.0	10.8	32.3	33.0	51.1
W73	22	5	15.0	<0.5	1.8	3.0	12.6	23	5	22.8	<0.5	1.9	4.4	14.4

1. Number of samples with results less than the analytical detection limit.

2. 95th percentile of all baseline data.

Bold values exceed CCME guideline (30 µg/L).

Not that where maximum dissolved concentration exceeds maximum total concentration this likely indicates contamination from the filtration process.

Appendix B
Groundwater Quality Data

Appendix B: Groundwater Quality Monitoring Data

MW05-1A

Sample name	MW05-1A	MW05-1A	MW 05-1A	MW 05-1A	MW 05-1A	MW 05-1A	MW 05-1A
Date	16-Jun-06	13-Sep-06	10-Jun-07	12-Jul-07	2-Sep-07	23-May-08	5-Sep-08
Job Number	A626470	Z2772	A725184	A731839	A741295	A825056	A846692
Parameters (mg/L)							
Physical Parameters							
Conductivity		246	263	245	258	260	260
Dissolved Hardness	140	127	136	133	138	134	136
Total Suspended Solids	5	4.8	<4	<4	<4	<4	<4
Total Dissolved Solids	152	155	146	160	166	180	160
pH	8	7.85	8.1	8	8	8.1	8
Turbidity	13	23.7	7.8	16.1	0.8	<0.1	9.4
DOC	21.9		<0.5	0.5	<0.5	2.6	<0.5
Major Anions							
Alkalinity-Total	101	101	101	102	97.7	97	86
Acidity - Total						<0.5	3.2
Bromide	<0.1	<0.05	<0.1	<0.1	<0.01	<0.1	0.2
Chloride	<0.5	<0.5	2.5	0.5	1	1	2.9
Fluoride		0.509	0.53	0.51	0.49	0.43	0.43
Sulphate	28.6	31.6	29.6	25	37.6	31	31
Nutrient Parameters							
Ammonial Nitrogen	0.142	0.155	0.128	0.083	0.132	0.137	0.123
Nitrate Nitrogen	<0.02	<0.005	<0.002	<0.002	<0.002	0.006	0.004
Nitrite Nitrogen	0.002	0.0013	0.006	0.003	<0.002	<0.002	0.002
Total Phosphate	0.412		<0.005	0.02	0.045	0.038	0.193
Dissolved Ortho-Phosphate	0.045	0.0084	0.009	0.002	0.045	0.029	0.026
Dissolved Metals							
Aluminum (Al)	0.0018	0.0013	0.0005	0.0019	0.0013	0.0048	0.0024
Antimony (Sb)	<0.00005	<0.0001	0.00009	0.00039	<0.00005	<0.00002	<0.00002
Arsenic (As)	0.0218	0.019	0.0074	0.0018	0.0174	0.0165	0.0185
Cadmium (Cd)	0.00002	<0.00002	0.00001	0.00014	0.00002	0.000012	<0.000005
Calcium (Ca)	48.4	41.2	45.1	44	45.9	44.2	45.5
Chromium (Cr)	<0.0002	<0.0005	<0.0002	0.0003	<0.0002	<0.0001	0.0003
Cobalt (Co)	<0.00002	<0.0001	<0.00002	0.00002	<0.00002	0.000019	<0.000005
Copper (Cu)	0.0001	0.00011	<0.0001	<0.0001	<0.0001	0.00017	0.00018
Iron (Fe)	1.82	2.03	0.614	3.79	0.166	0.018	0.871
Lead (Pb)	0.00004	<0.00005	<0.00002	0.00003	0.00002	0.000046	0.000029
Magnesium (Mg)	5.74	5.86	5.65	5.55	5.59	5.65	5.46
Manganese (Mn)	0.225	0.239	0.224	0.268	0.209	0.228	0.228
Mercury (Hg)			<0.00001	<0.00001	<0.00001	0.00003	
Molybdenum (Mo)	0.00575	0.0057	0.00542	0.00791	0.00519	0.00593	0.00588
Nickel (Ni)	<0.0005	<0.0005	<0.0005	0.0016	0.0006	0.00005	0.00004
Phosphorus (P)	0.5	0.4	<0.1	<0.1	<0.1	0.038	
Potassium (K)	1.13	<2	1.21	1.16	1.62	1.26	1.24
Selenium (Se)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004	<0.00004
Silicon (Si)	5.08	4.22	4.62	2.07	4.91	5.62	5.04
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005
Sodium (Na)	1.76	<2	1.74	1.8	1.75	2.06	2
Strontium (Sr)	0.148	0.151	0.14	0.139	0.14	0.154	0.155
Thallium (Tl)	<0.00005	<0.0001	<0.00005	<0.00005	<0.00005	<0.000002	<0.000002
Vanadium (V)	<0.00005	<0.001	<0.00005	<0.00005	<0.00005	<0.0002	<0.0002
Zinc (Zn)	0.0025	0.0035	0.0053	0.0035	0.0011	0.0133	0.0025

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
255	8	262
135	4	139
4.3	0.4	5
160	11	176
8.0	0.1	8
10	8	21
0.9	0.9	2
98	5.6	102
1.9	1.9	3.1
0.09	0.06	0.17
1.3	1.0	2.8
0.48	0.043	0.53
30.6	3.8	35.8
0.129	0.023	0.151
0.0035	0.0018	0.0158
0.0026	0.0016	0.0051
0.119	0.159	0.357
0.023	0.018	0.045
0.002	0.0014	0.0041
0.0001	0.0001	0.0003
0.0146	0.0072	0.0210
0.000015	0.000006	0.00002
44.9	2.18	47.7
0.00026	0.00013	0.00044
0.00003	0.00003	0.00008
0.00012	0.00004	0.00018
1.33	1.33	3.26
0.000034	0.000012	0.000049
5.64	0.13	5.82
0.232	0.018	0.259
0.000015	0.00001	0.000027
0.00597	0.00089	0.00732
0.00054	0.00052	0.00130
0.206	0.193	0.475
1.37	0.32	1.89
0.00037	0.00022	0.00050
4.51	1.16	5.46
0.000009	0.000002	0.000010
1.87	0.14	2.04
0.147	0.007	0.155
0.00004	0.0	0.00009
0.00005	0.0	0.00005
0.0045	0.0041	0.0109

Appendix B: Groundwater Quality Monitoring Data

MW05-1B

Sample name	MW05-1B	MW05-1B	MW 05-1B	MW 05-1B	MW 05-1B	MW 05-1B	MW05-1B	MW05-1B	MW 05-1B	MW 05-1B	MW 05-1B	MW 06-13S
Date	16-Jun-06	13-Sep-06	10-Jun-07	12-Jul-07	2-Sep-07	21-Sep-07	6-Oct-07	6-Oct-07	14-Feb-08	22-May-08	5-Sep-08	5-Sep-08
Job Number	A626470	Z2772	A725184	A731839	A741295	A745736	A748794	A748794	A807257	A825056	A846692	A846692
Parameters (mg/L)												
Physical Parameters												
Conductivity		328	245	315	327	296	291	291	260	100	280	280
Dissolved Hardness	160	188	130	177	191	171	164	164	121	47.1	155	155
Total Suspended Solids	<4	318	5	13	31	39	43	43	<4	<4	5	<4
Total Dissolved Solids	182	212	114	212	222	182	167	167	180	90	180	180
pH	8.1	8.01	8.2	7.9	7.3	7.9	7.5	7.5	7.7	7.7	8	7.9
Turbidity	1.8	185	18.8	33.4	32.6	86.7	95.8	95.8	9.8	0.3	6.7	6.9
DOC	39.1		<0.5	5.7	4.9	9	3.5	3.5	3.3	6.5	3.8	4.3
Major Anions												
Alkalinity-Total	145	175	110	175	172	158	149	149	130	45	120	120
Acidity - Total									6.8	<0.5	6.8	6.3
Bromide	<0.1	<0.05	<0.1	<0.1	<0.01	<0.01	<0.01	<0.01	0.7	<0.1	<0.1	0.2
Chloride	<0.5	<0.5	1	<0.5	<0.5	2.5	<0.5	<0.5	<0.5	0.6	0.6	0.9
Fluoride		0.095	0.34	0.19	0.13	0.12	0.09	0.09	0.12	0.14	0.15	0.16
Sulphate	<0.5	2.26	14.6	1.4	<0.5	0.5	2.3	2.3	<0.5	2.9	12	12
Nutrient Parameters												
Ammonial Nitrogen	0.59	<0.015	0.194	0.067	0.081	0.096	0.108	0.108	0.337	0.287	0.45	0.468
Nitrate Nitrogen	<0.02	<0.005	0.017	0.023	0.027	0.002	<0.002	<0.002	0.037	0.004	<0.002	0.004
Nitrite Nitrogen	0.003	<0.001	0.005	0.049	0.043	0.002	0.01	0.01	0.09	<0.002	0.003	<0.002
Total Phosphate	0.248		0.2	0.6	0.27	0.285	0.196	0.196	0.336	0.147	0.333	0.326
Dissolved Ortho-Phosphate	0.134	0.057	0.045	0.008	0.01	0.013	0.021	0.021	0.294	0.131	0.014	0.012
Dissolved Metals												
Aluminum (Al)	0.0167	0.0511	0.007	0.0364	0.0362	0.0319	0.0254	0.0254	0.0124	0.0184	0.0098	0.0476
Antimony (Sb)	0.00022	0.00011	0.00007	0.00008	0.00006	<0.00005	<0.00005	<0.00005	0.00004	0.00058	0.00008	0.00008
Arsenic (As)	0.0077	0.00184	0.0061	0.0128	0.0048	0.003	0.0022	0.0022	0.00228	0.00717	0.00759	0.00766
Cadmium (Cd)	0.00002	<0.00002	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	0.000007	<0.000005	0.00001
Calcium (Ca)	56.8	66	44	61.7	67.8	60.9	58	58	42.3	16.4	54.3	54
Chromium (Cr)	0.0003	0.00129	<0.0002	<0.0002	0.0009	0.0007	0.0006	0.0006	0.0002	0.0001	0.0002	0.0004
Cobalt (Co)	0.00008	0.00014	0.00011	0.00034	0.00015	0.0001	0.00009	0.00009	0.000069	0.00007	0.000059	0.000107
Copper (Cu)	0.0004	0.00018	0.0003	<0.0001	<0.0001	<0.0001	0.0001	0.0001	0.00018	0.00069	0.0002	0.00047
Iron (Fe)	1.89	8.02	3.74	14.5	23.4	24.6	24.9	24.9	4.19	0.172	3.01	3.01
Lead (Pb)	0.00017	<0.00005	0.00004	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.000033	0.000155	0.000019	0.000133
Magnesium (Mg)	4.85	5.65	4.82	5.47	5.28	4.71	4.59	4.59	3.84	1.51	4.79	4.86
Manganese (Mn)	0.379	1.03	0.233	0.746	0.768	0.694	0.668	0.668	0.352	0.0616	0.455	0.436
Mercury (Hg)			<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	0.00002		
Molybdenum (Mo)	0.00392	0.000732	0.00328	0.00092	0.00052	0.00048	0.00051	0.00051	0.00099	0.00437	0.00358	0.00343
Nickel (Ni)	<0.0005	0.00075	0.0007	0.0007	0.0011	<0.0005	<0.0005	<0.0005	0.00042	0.00067	0.00065	0.00085
Phosphorus (P)	0.3	<0.30	0.2	0.7	0.3	0.3	0.2	0.2	0.342	0.156		
Potassium (K)	3.18	<2	1.2	1.05	0.989	0.769	0.778	0.778	1.05	1.31	1.49	1.49
Selenium (Se)	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	<0.0005	<0.0005	<0.0005	0.00007	0.00006	0.00007	0.00007
Silicon (Si)	4.88	4.82	5.08	5.47	4.91	4.66	4.82	4.82	4.68	2.23	4.74	4.69
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	0.000006	<0.000005	<0.000005
Sodium (Na)	1.44	<2	1.67	1.08	0.9	0.95	1.27	1.27	1.05	0.7	1.67	1.74
Strontium (Sr)	0.136	0.159	0.115	0.163	0.141	0.13	0.123	0.123	0.12	0.055	0.165	0.16
Thallium (Tl)	<0.00005	<0.0001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002	<0.000002	<0.000002	<0.000002
Vanadium (V)	0.00232	0.001	0.00053	0.00174	0.00083	0.00085	0.00066	0.00066	0.0006	0.0017	0.0006	0.0008
Zinc (Zn)	0.0018	0.0027	0.0023	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	0.001	0.0008	0.0016	0.003

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
274	63	328
152	39	189
43	88	167
174	38	217
7.8	0.3	8
48	57	136
4.5	2.3	8
137	36.6	175
5.1	3.1	6.8
0.12	0.19	0.43
0.8	0.6	1.7
0.15	0.071	0.27
4.3	5.3	13.2
0.233	0.189	0.523
0.0121	0.0122	0.0315
0.0183	0.0279	0.0675
0.285	0.122	0.468
0.063	0.085	0.206
0.0265	0.0144	0.0492
0.0001	0.0002	0.0004
0.0054	0.0033	0.0100
0.000011	0.000005	0.00002
53.4	13.9	66.8
0.00047	0.00036	0.00108
0.00012	0.00008	0.00024
0.00024	0.00019	0.00057
11.36	10.32	24.90
0.000058	0.000058	0.000162
4.58	1.07	5.55
0.541	0.269	0.886
0.00001125	3.53553E-06	0.0000165
0.00194	0.00160	0.00412
0.00065	0.00019	0.00096
0.300	0.163	0.557
1.34	0.68	2.53
0.00038	0.00025	0.00064
4.65	0.79	5.26
0.000008	0.000002	0.000010
1.31	0.40	1.86
0.133	0.030	0.164
0.00003	0.0	0.00005
0.00102	0.0	0.002
0.0013	0.0009	0.0028

Appendix B: Groundwater Quality Monitoring Data

MW05-2A

Sample name	MW 05-02A	MW 05-2A	MW 05-2A	MW 05-2A	MW 05-2A	MW 05-2A
Date	8-Jun-07	12-Jul-07	1-Sep-07	21-Sep-07	21-May-08	3-Sep-08
Job Number	A724712	A731839	A741295	A745736	A825056	A846361
Parameters (mg/L)						
Physical Parameters						
Conductivity	392	385	400	410	400	410
Dissolved Hardness	231	220	228	215	229	233
Total Suspended Solids	<4	<4	<4	5	<4	<4
Total Dissolved Solids	234	262	242	240	260	220
pH	8.2	8.2	8.0	8.1	8.2	8.3
Turbidity	7.6	1.6	5.8	16.1	13.3	7.4
DOC	0.5	0.5	<0.5	1	2.3	0.8
Major Anions						
Alkalinity-Total	179	185	179	177	180	170
Acidity - Total					0.5	2.5
Bromide	<0.1	<0.1	<0.01	<0.01	<0.1	<0.7
Chloride	1.8	0.9	<0.5	3.5	<0.5	0.7
Fluoride	0.31	0.3	0.28	0.28	0.24	0.24
Sulphate	33.3	27.4	33.9	33.4	34	38
Nutrient Parameters						
Ammonial Nitrogen	0.077	0.063	0.09	0.122	0.101	0.107
Nitrate Nitrogen	0.004	<0.002	<0.002	<0.002	<0.01	0.005
Nitrite Nitrogen	<0.002	<0.002	<0.002	0.004	0.004	<0.002
Total Phosphate	0.006	<0.005	<0.005	<0.005	<0.005	0.011
Dissolved Ortho-Phosphate	0.003	0.004	0.004	0.007	0.002	0.002
Dissolved Metals						
Aluminum (Al)	0.0449	0.0028	0.0014	0.0014	0.0002	0.0035
Antimony (Sb)	0.00007	<0.00005	<0.00005	0.00008	<0.00005	<0.00003
Arsenic (As)	0.0009	0.0005	0.0007	0.0011	0.00038	0.00076
Cadmium (Cd)	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005
Calcium (Ca)	61.2	57.8	60.7	56.9	59.5	62.2
Chromium (Cr)	<0.0002	<0.0002	<0.0002	0.0003	<0.0001	<0.0001
Cobalt (Co)	0.00014	<0.00005	0.00004	0.00013	0.000049	0.000032
Copper (Cu)	0.0007	<0.0001	<0.0001	<0.0001	<0.00005	0.00016
Iron (Fe)	1.17	0.559	1.05	1.14	0.001	0.743
Lead (Pb)	0.00012	<0.00002	<0.00002	<0.00002	<0.000005	<0.00002
Magnesium (Mg)	18.9	18.3	18.6	17.6	19.5	18.9
Manganese (Mn)	0.164	0.181	0.17	0.18	0.178	0.184
Mercury (Hg)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.00282	0.0023	0.0029	0.00313	0.003	0.00226
Nickel (Ni)	0.0007	<0.0005	0.0007	<0.0005	0.00029	0.00027
Phosphorus (P)	<0.1	<0.1	<0.1	<0.1	<0.002	
Potassium (K)	2.08	1.97	2.68	2.03	2.02	2.12
Selenium (Se)	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004	<0.00004
Silicon (Si)	3.75	3.77	3.66	3.41	3.65	3.96
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005
Sodium (Na)	0.64	0.58	0.57	0.65	0.59	0.86
Strontium (Sr)	0.159	0.158	0.153	0.158	0.166	0.168
Thallium (Tl)	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002	<0.000002
Vanadium (V)	0.00009	<0.00005	<0.00005	<0.00005	<0.00002	<0.00002
Zinc (Zn)	0.0009	0.0005	0.0005	0.0005	0.0001	0.0012

DL too high; not used in statistical evaluation

AVG	Std Dev.	95th Percentile
400	10	410
226	7	233
4.2	0.4	5
243	16	262
8.2	0.1	8
9	5	15
0.9	0.7	2
178	4.9	184
1.5	1.4	2.4
0.17	0.26	0.55
1.3	1.2	3.1
0.28	0.029	0.31
33.3	3.4	37.0
0.093	0.021	0.118
0.0030	0.0014	0.0048
0.0027	0.0010	0.0040
0.006	0.002	0.010
0.004	0.002	0.006
0.0090	0.0176	0.0346
0.0001	0.00002	0.0001
0.0007	0.0003	0.0011
0.000008	0.000003	0.00001
59.7	2.0	62.0
0.00018	0.00008	0.00028
0.00007	0.00005	0.00014
0.00020	0.00025	0.00057
0.78	0.45	1.16
0.000034	0.000042	0.000095
18.63	0.64	19.35
0.176	0.008	0.183
0.00001	0	0.00001
0.00274	0.00037	0.00310
0.00049	0.00019	0.00070
0.080	0.044	0.100
2.15	0.26	2.54
0.00035	0.00024	0.00050
3.70	0.18	3.91
0.000008	0.000003	0.000010
0.65	0.11	0.81
0.160	0.006	0.168
0.00003	0.00002	0.00005
0.00006	0.00002	0.00008
0.0006	0.0004	0.0011

Appendix B: Groundwater Quality Monitoring Data

MW05-2B

Sample name	MW 05-02B	MW 05-2B	MW 05-2B	MW 05-2B	MW05-2B	MW 05-2B
Date	8-Jun-07	12-Jul-07	1-Sep-07	21-Sep-07	4-Oct-07	3-Sep-08
Job Number	A724712	A731839	A741295	A745736	A748794	A846361
Parameters (mg/L)						
Physical Parameters						
Conductivity	254	246	255	253	250	260
Dissolved Hardness	131	132	140	132	144	133
Total Suspended Solids	38	27	21	20	18	17
Total Dissolved Solids	160	160	160	148	142	150
pH	8.0	8.0	7.8	7.9	7.6	8.2
Turbidity	34.2	114	97	82.5	43.7	89.5
DOC	1	0.8	0.8	1.6	1.2	1
Major Anions						
Alkalinity-Total	131	124	124	125	130	120
Acidity - Total						4.2
Bromide	<0.1	<0.1	<0.01	<0.01	<0.01	<0.2
Chloride	<0.5	1.0	<0.5	<0.5	<0.5	<0.5
Fluoride	0.08	0.08	0.08	0.08	0.06	0.06
Sulphate	5.9	6.5	9.1	7.3	3.9	12
Nutrient Parameters						
Ammonial Nitrogen	0.005	0.028	0.072	0.045	0.026	0.059
Nitrate Nitrogen	0.003	0.023	<0.002	0.028	<0.002	0.017
Nitrite Nitrogen	0.002	0.043	0.002	0.068	<0.005	<0.002
Total Phosphate	0.1	0.233	0.226	0.226	0.169	0.005
Dissolved Ortho-Phosphate	0.004	0.007	0.215	0.008	0.016	0.004
Dissolved Metals						
Aluminum (Al)	0.0884	0.0013	0.001	0.0012	0.0039	0.0031
Antimony (Sb)	0.00009	<0.00005	<0.00005	<0.00005	<0.00005	<0.00002
Arsenic (As)	0.0354	0.036	0.0362	0.0278	0.0136	0.0308
Cadmium (Cd)	0.00003	<0.00001	<0.00001	<0.00001	<0.00001	0.000005
Calcium (Ca)	43.1	41	42.5	40	44.6	40.3
Chromium (Cr)	<0.0002	<0.0002	<0.0002	0.0005	0.0004	<0.0001
Cobalt (Co)	0.00092	0.00044	0.00019	0.00011	0.00007	0.00015
Copper (Cu)	0.0006	0.0001	<0.0001	<0.0001	<0.0001	0.00008
Iron (Fe)	7.42	10.3	8.63	8.21	8.7	8.71
Lead (Pb)	<0.0002	<0.00002	<0.00002	<0.00002	<0.00002	0.000048
Magnesium (Mg)	5.58	7.14	8.24	7.84	7.92	7.95
Manganese (Mn)	1.56	1.51	0.914	0.941	0.814	0.949
Mercury (Hg)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.00172	0.00137	0.00143	0.00311	0.00177	0.00119
Nickel (Ni)	0.0014	<0.0005	<0.0005	<0.0005	<0.0005	0.00008
Phosphorus (P)	<0.1	<0.2	<0.2	<0.2	<0.2	
Potassium (K)	1.42	0.512	0.818	0.674	0.582	0.62
Selenium (Se)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004
Silicon (Si)	5.79	4.75	4.43	3.96	4.78	4.66
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005
Sodium (Na)	9.85	1.18	1.08	1.05	1.5	1.27
Strontium (Sr)	0.123	0.0811	0.0826	0.0871	0.0872	0.0899
Thallium (Tl)	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002
Vanadium (V)	0.00062	0.00007	<0.00005	<0.00005	<0.0001	<0.0002
Zinc (Zn)	0.0047	0.0005	0.0005	0.0005	0.0005	0.0012

DL too high; not used in statistical evaluation

AVG	Std Dev.	95th Percentile
253	5	259
135	5	143
23.5	7.9	35
153	8	160
7.9	0.2	8
77	31	110
1.1	0.3	2
126	4.1	131
4.2		4.2
0.07	0.08	0.18
0.6	0.2	0.9
0.07	0.010	0.08
7.5	2.8	11.3
0.039	0.024	0.069
0.0125	0.0117	0.0268
0.0203	0.0284	0.0618
0.160	0.091	0.231
0.042	0.085	0.165
0.0165	0.0353	0.0673
0.0001	0.00002	0.0001
0.0300	0.0087	0.0362
0.000013	0.000009	0.00003
41.9	1.8	44.2
0.00027	0.00015	0.00048
0.00031	0.00032	0.00080
0.00018	0.00021	0.00048
8.66	0.94	9.90
0.000055	0.000072	0.000162
7.45	0.98	8.17
1.115	0.330	1.548
0.00001	0	0.00001
0.00177	0.00069	0.00278
0.00058	0.00044	0.00118
0.180	0.045	0.200
0.77	0.33	1.27
0.00042	0.00019	0.00050
4.73	0.60	5.54
0.000009	0.000002	0.000010
2.66	3.53	7.76
0.092	0.016	0.115
0.00004	0.00002	0.00005
0.00006	0.00001	0.00007
0.0013	0.0017	0.0038

Appendix B: Groundwater Quality Monitoring Data

MW05-3A

Sample name	MW05-3A	MW 05-3A	MW 05-3A	MW 05-3A	MW 05-3A	MW 05-3A
Date	15-Jun-06	10-Jun-07	13-Jul-07	2-Sep-07	23-May-08	4-Sep-08
Job Number	A626470	A725184	A731839	A741295	A825056	A846361
Parameters (mg/L)						
Physical Parameters						
Conductivity		268	277	324	320	400
Dissolved Hardness	170	140	147	175	176	229
Total Suspended Solids	4	4	<4	<4	<4	6
Total Dissolved Solids	190	158	194	208	210	250
pH	7.9	8.1	8	7.8	7.9	8.3
Turbidity	20.2	3.4	10.4	16.4	15.8	30.8
DOC	26.2	0.9	<0.6	0.6	2.1	0.8
Major Anions						
Alkalinity-Total	139	97.7	111	130	130	160
Acidity - Total					5.5	4.7
Bromide	<0.1	<0.1	<0.1	<0.01	<0.1	<0.2
Chloride	<0.5	3.5	0.5	0.5	0.5	0.5
Fluoride		0.28	0.31	0.4	0.33	0.66
Sulphate	35.1	33.4	30.9	35.6	37	38
Nutrient Parameters						
Ammonial Nitrogen	0.025	0.005	0.005	0.017	0.005	0.041
Nitrate Nitrogen	<0.05	0.178	0.085	<0.03	0.044	0.007
Nitrite Nitrogen	0.002	0.002	0.002	0.002	<0.002	<0.002
Total Phosphate	<0.005	<0.005	<0.005	0.008	0.009	<0.005
Dissolved Ortho-Phosphate	0.006	0.004	0.004	0.019	0.003	0.002
Dissolved Metals						
Aluminum (Al)	0.001	0.0005	0.0002	0.0004	0.0002	0.0021
Antimony (Sb)	0.00054	0.00026	0.00021	0.00025	<0.00025	0.00026
Arsenic (As)	0.0007	0.0005	0.0005	0.0004	0.00025	0.00094
Cadmium (Cd)	0.00705	0.00792	0.00655	0.00452	0.00405	0.000653
Calcium (Ca)	57.5	47	49.3	59.3	58.3	77.7
Chromium (Cr)	<0.0002	<0.0002	<0.0002	0.0002	<0.0001	<0.0001
Cobalt (Co)	0.00044	<0.00025	0.00042	0.0005	0.000556	0.000298
Copper (Cu)	0.0094	0.0002	<0.0002	<0.0001	0.00012	0.00007
Iron (Fe)	1.14	0.393	0.696	1.25	0.002	2.66
Lead (Pb)	0.00084	<0.0001	0.00011	0.00014	0.000005	0.000107
Magnesium (Mg)	6.32	5.48	5.74	6.6	7.29	8.58
Manganese (Mn)	0.196	0.0756	0.126	0.166	0.162	0.279
Mercury (Hg)		<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.00112	0.00105	0.00097	0.00091	0.00099	0.00164
Nickel (Ni)	0.0034	0.003	0.0039	0.0053	0.00467	0.00338
Phosphorus (P)	0.1	0.1	<0.1	<0.1	<0.002	
Potassium (K)	1.27	0.958	1.05	1.54	1.19	1.52
Selenium (Se)	0.008	0.0115	0.0071	0.0035	0.00301	0.00007
Silicon (Si)	4.05	4.05	4.09	3.91	3.97	3.67
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005
Sodium (Na)	1.88	<1.15	1.32	1.46	1.64	1.95
Strontium (Sr)	0.145	0.121	0.135	0.147	0.16	0.189
Thallium (Tl)	<0.00005	<0.00005	<0.00005	<0.00005	0.000011	0.000007
Vanadium (V)	<0.00005	<0.00005	<0.00005	<0.00005	<0.0002	<0.0002
Zinc (Zn)	0.725	0.786	0.797	0.857	0.74	0.475

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
318	52	385
173	31	216
4.3	0.8	6
202	30	240
8.0	0.2	8
16	9	28
1.0	0.6	2
128	21.7	155
5.1		5.5
0.10	0.06	0.18
1.0	1.2	2.8
0.40	0.154	0.61
35.0	2.6	37.8
0.016	0.015	0.037
0.0657	0.0607	0.1548
0.002	0.0	0.002
0.006	0.002	0.009
0.006	0.006	0.016
0.0007	0.0007	0.0018
0.0003	0.00012	0.0005
0.0005	0.0002	0.0009
0.0051	0.0026	0.0077
58.2	10.8	73.1
0.00017	0.00005	0.00020
0.00041	0.00012	0.00054
0.00168	0.00378	0.00710
1.02	0.93	2.31
0.00022	0.00031	0.00067
6.67	1.13	8.26
0.167	0.068	0.258
0.00001	0	0.00001
0.0011	0.0003	0.0015
0.00394	0.00088	0.00514
0.080	0.044	0.100
1.25	0.24	1.54
0.00553	0.00411	0.01063
3.96	0.15	4.08
0.000008	0.000003	0.000010
1.57	0.32	1.93
0.150	0.023	0.182
0.00004	0.00002	0.00005
0.0001	0	0.00005
0.730	0.133	0.842

Appendix B: Groundwater Quality Monitoring Data

MW05-3B

Sample name	MW05-3B	MW 05-3B	MW 05-3B	MW 05-3B	MW05-3B	MW 05-3B	MW 05-3B-DUP	MW 05-3B	MW 05-3B
Date	15-Jun-06	10-Jun-07	13-Jul-07	2-Sep-07	6-Oct-07	15-Feb-08	15-Feb-08	23-May-08	4-Sep-08
Job Number	A626470	A725184	A731839	A741295	A748794	A807257	A807257	A825056	A846361
Parameters (mg/L)									
Physical Parameters									
Conductivity		253	240	246	235	250	250	260	260
Dissolved Hardness	120	129	99.9	119	129	115	105	129	135
Total Suspended Solids	<4	<4	<4	<4	<4	<4	<4	<4	<4
Total Dissolved Solids	148	138	160	168	167	150	160	160	160
pH	7.4	8	7.9	7.6	7.6	7.8	7.8	7.7	8.1
Turbidity	<0.1	0.2	1.5	0.3	0.5	2.6	2.5	<0.1	0.1
DOC	17.3	<0.5	1.3	0.9	<0.5	<0.5	<0.5	1.8	0.9
Major Anions									
Alkalinity-Total	79.1	85.8	87.1	86.2	84.9	89	89	90	89
Acidity - Total						5.5	8.1	5.8	5.7
Bromide	<0.1	<0.1	<0.1	<0.01	<0.01	<0.1	<0.1	<0.1	0.1
Chloride	<0.5	3.1	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride		0.2	0.18	0.19	0.16	0.21	0.19	0.16	0.16
Sulphate	32.5	37	33	34.6	34.9	37.1	37.4	36	34
Nutrient Parameters									
Ammonial Nitrogen	0.005	<0.005	0.058	0.015	<0.005	0.014	<0.005	<0.005	<0.005
Nitrate Nitrogen	0.16	0.238	0.226	0.316	0.318	0.283	0.283	0.284	0.302
Nitrite Nitrogen	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Phosphate	<0.005	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	0.01
Dissolved Ortho-Phosphate	0.007	0.003	0.004	0.006	0.006	<0.001	0.001	0.001	0.003
Dissolved Metals									
Aluminum (Al)	0.0061	0.0011	0.001	<0.0002	0.0006	0.0014	0.0009	<0.0002	0.0025
Antimony (Sb)	0.00014	0.00013	0.00018	0.00013	0.00011	0.00016	0.00019	0.00015	0.00014
Arsenic (As)	0.0005	0.0004	0.0006	0.0007	0.0004	0.00017	0.00036	0.00006	0.00007
Cadmium (Cd)	0.012	0.0134	0.00721	0.0106	0.013	0.0124	0.0112	0.013	0.0147
Calcium (Ca)	41.6	43.4	32.3	39.7	43.3	38.7	34.9	42.7	44.9
Chromium (Cr)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt (Co)	<0.00002	<0.00002	0.00099	0.00032	<0.00002	0.000433	0.00107	0.000119	0.000024
Copper (Cu)	0.0038	0.0039	0.0016	0.0005	0.0034	0.00335	0.0027	0.00235	0.00283
Iron (Fe)	0.033	<0.005	0.317	0.13	<0.005	0.168	0.291	<0.001	0.004
Lead (Pb)	0.00036	0.00028	0.00023	0.00019	0.00003	0.000169	0.000233	0.000041	0.000133
Magnesium (Mg)	4.55	5.05	4.66	4.82	5.03	4.48	4.36	5.36	5.43
Manganese (Mn)	0.0017	0.00281	0.113	0.03	0.00253	0.0557	0.145	0.0114	0.00224
Mercury (Hg)		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.0007	0.00065	0.00074	0.00075	0.00068	0.0008	0.00078	0.00078	0.00076
Nickel (Ni)	0.0024	0.0029	0.004	0.0033	0.0026	0.00325	0.00379	0.00314	0.00319
Phosphorus (P)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.002	<0.002	<0.002	
Potassium (K)	0.922	0.918	1.15	1.43	1.09	0.96	1.06	1.05	1.1
Selenium (Se)	0.0149	0.0139	0.0122	0.0128	0.0129	0.0125	0.0122	0.0133	0.0116
Silicon (Si)	3.95	4.07	4.12	4.05	4.16	3.61	3.59	4.45	4.49
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005	<0.000005	<0.000005
Sodium (Na)	1.08	1.15	11.4	4.93	1.73	2.24	6.19	1.79	1.93
Strontium (Sr)	0.119	0.122	0.181	0.133	0.123	0.141	0.161	0.137	0.136
Thallium (Tl)	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.000013	0.000018	0.000015	0.000015
Vanadium (V)	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.0002	<0.0002	<0.0002	<0.0002
Zinc (Zn)	1.02	1.08	0.649	0.895	1.05	1.02	0.907	1.13	1.19

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
249	9	260
120	12	133
4	0	4
157	10	168
7.8	0.2	8
1	1	3
0.9	0.5	11
87	3.3	90
6.3	1.2	7.8
0.08	0.04	0.10
0.8	0.9	2.1
0.18	0.020	0.21
35.2	1.8	37.3
0.013	0.017	0.041
0.2678	0.0512	0.3172
0.0020	0.0000	0.0020
0.006	0.002	0.009
0.004	0.002	0.007
0.0016	0.0018	0.0047
0.0001	0.0000	0.0002
0.0004	0.0002	0.0007
0.011946	0.002148	0.01418
40.2	4.2	44.3
0.00016	0.00005	0.00020
0.00034	0.00042	0.00104
0.00271	0.00110	0.00386
0.11	0.13	0.31
0.000185	0.000107	0.000328
4.86	0.38	5.40
0.040	0.054	0.132
0.00001	0	0.00001
0.00074	0.00005	0.00079
0.00317	0.00051	0.00392
0.063	0.051	0.100
1.08	0.16	1.32
0.01292	0.00100	0.01450
4.05	0.31	4.47
0.000008	0.000003	0.000010
3.60	3.41	9.32
0.139	0.020	0.173
0.00003	0.0	0.00005
0.00012	0.0	0.000
0.993	0.160	1.166

Appendix B: Groundwater Quality Monitoring Data

MW05-4A

Sample name	MW05-4A	MW05-4A	MW 05-4A	MW 05-4A	MW 05-4A	MW 05-4A
Date	16-Jun-06	13-Sep-06	10-Jun-07	14-Jul-07	2-Sep-07	4-Sep-08
Job Number	A626470	Z2772	A725184	A731839	A741295	A846361
Parameters (mg/L)						
Physical Parameters						
Conductivity		304	334	319	321	320
Dissolved Hardness	180	172	174	167	172	174
Total Suspended Solids	10	54.8	<4	<4	<4	<4
Total Dissolved Solids	214	196	188	220	206	200
pH	7.9	8.1	8.2	8.1	8.1	8.3
Turbidity	108	48	0.4	0.4	0.2	1.2
DOC	20		<0.5	0.7	0.9	1.3
Major Anions						
Alkalinity-Total	91.2	95.2	112	110	110	100
Acidity - Total						2.1
Bromide	<0.1	<0.05	<0.1	<0.1	<0.01	0.2
Chloride	1.2	<0.5	1.4	<0.5	<0.5	0.5
Fluoride		0.739	0.9	0.93	0.97	0.89
Sulphate	73.3	56.2	56.8	52	49.1	52
Nutrient Parameters						
Ammonial Nitrogen	0.011	0.0147	0.023	<0.005	<0.005	<0.005
Nitrate Nitrogen	<0.02	0.0245	<0.002	0.023	0.03	0.005
Nitrite Nitrogen	0.011	0.0035	0.002	<0.002	<0.002	<0.002
Total Phosphate	0.006		<0.005	<0.005	<0.005	0.009
Dissolved Ortho-Phosphate	0.008	<0.001	0.003	0.004	0.003	0.005
Dissolved Metals						
Aluminum (Al)	0.0026	0.0042	0.002	0.0015	0.0013	0.0035
Antimony (Sb)	0.00011	0.00011	0.0001	0.00009	0.00011	0.0001
Arsenic (As)	0.0071	0.00158	0.0005	0.0003	0.0002	0.00053
Cadmium (Cd)	0.00001	<0.00002	0.00002	0.00003	0.00006	0.000023
Calcium (Ca)	67.3	62.1	63	60.7	62.5	63.2
Chromium (Cr)	<0.0002	<0.0005	<0.0002	<0.0002	<0.0002	<0.0001
Cobalt (Co)	0.00008	<0.0001	0.00005	0.00006	0.00003	0.000033
Copper (Cu)	<0.0001	0.00012	0.0002	0.0003	0.0003	0.00039
Iron (Fe)	7.28	0.793	0.031	0.045	0.023	0.255
Lead (Pb)	<0.00002	<0.00005	<0.00002	<0.00002	<0.00002	0.000028
Magnesium (Mg)	4.05	4.05	3.99	3.82	3.79	3.88
Manganese (Mn)	1.04	0.94	0.737	0.76	0.572	0.4
Mercury (Hg)			<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.0025	0.00564	0.00579	0.0052	0.00576	0.0064
Nickel (Ni)	<0.0005	0.00059	<0.0005	<0.0005	<0.0005	0.0003
Phosphorus (P)	<0.1	<0.30	<0.1	<0.1	<0.1	
Potassium (K)	2.04	<2	1.99	2.12	2.91	2.31
Selenium (Se)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004
Silicon (Si)	6.67	3.51	3.57	3.43	3.13	3.35
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005
Sodium (Na)	1.63	<2	1.38	1.37	1.34	1.6
Strontium (Sr)	0.213	0.192	0.182	0.191	0.174	0.19
Thallium (Tl)	<0.00005	<0.0001	<0.00005	<0.00005	<0.00005	<0.000002
Vanadium (V)	<0.00005	<0.001	<0.00005	<0.00005	<0.00005	<0.0002
Zinc (Zn)	0.0039	0.0053	0.0027	0.003	0.002	0.0033

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
320	11	331
173	4	179
13.5	20.4	44
204	12	219
8.1	0.1	8
26	44	93
0.9	0.3	1
103	8.8	112
2.1		2.1
0.09	0.06	0.18
0.8	0.4	1.4
0.89	0.088	0.96
56.6	8.7	69.2
0.011	0.007	0.021
0.0174	0.0113	0.0286
0.0038	0.0036	0.0091
0.006	0.002	0.008
0.004	0.002	0.007
0.0025	0.0011	0.0040
0.0001	0.00001	0.0001
0.0017	0.0027	0.0057
0.000027	0.000017	0.00005
63.1	2.2	66.3
0.00023	0.00014	0.00043
0.00006	0.00003	0.00010
0.00024	0.00011	0.00037
1.40	2.89	5.66
0.000026	0.000012	0.000045
3.93	0.12	4.05
0.742	0.234	1.015
0.00001	0	0.00001
0.00522	0.00138	0.00625
0.00048	0.00010	0.00057
0.100	0.000	0.100
2.23	0.35	2.76
0.00042	0.00019	0.00050
3.94	1.34	5.90
0.000009	0.000002	0.000010
1.55	0.25	1.91
0.190	0.013	0.208
0.00005	0.00003	0.00009
0.00037	0.00055	0.00091
0.0034	0.0011	0.0050

Appendix B: Groundwater Quality Monitoring Data

MW05-4B

Sample name	MW05-4B	MW 05-4B	MW 05-4B	MW 05-4B	MW 05-4B
Date	16-Jun-06	10-Jun-07	14-Jul-07	2-Sep-07	4-Sep-08
Job Number	A626470	A725184	A731839	A741295	A846361
Parameters (mg/L)					
Physical Parameters					
Conductivity		239	221	224	240
Dissolved Hardness	120	113	104	109	109
Total Suspended Solids	<4	<4	<4	<4	<4
Total Dissolved Solids	168	132	142	152	150
pH	7.3	8	7.8	7.6	8
Turbidity	10.1	12.8	8.7	3.5	8
DOC	15	0.9	1	0.8	0.9
Major Anions					
Alkalinity-Total	80.6	69.4	66.5	67.3	66
Acidity - Total					4.5
Bromide	<0.1	<0.1	<0.1	<0.01	0.1
Chloride	<0.5	0.7	<0.5	<0.5	<0.5
Fluoride		0.5	0.52	0.55	0.46
Sulphate	49.6	47.8	41.7	39.8	46
Nutrient Parameters					
Ammonial Nitrogen	0.032	0.032	0.042	0.037	0.035
Nitrate Nitrogen	<0.02	0.003	0.002	0.002	0.053
Nitrite Nitrogen	<0.002	<0.002	<0.002	<0.002	<0.002
Total Phosphate	<0.005	0.007	0.007	<0.005	0.009
Dissolved Ortho-Phosphate	0.01	0.006	0.006	0.014	0.002
Dissolved Metals					
Aluminum (Al)	0.0016	0.0193	0.001	0.0007	0.0029
Antimony (Sb)	0.00016	0.00011	0.00007	0.00009	0.0001
Arsenic (As)	0.0039	0.0065	0.007	0.0057	0.00247
Cadmium (Cd)	0.00095	0.00383	0.00321	0.00245	0.00245
Calcium (Ca)	44.7	40.2	36.9	38.5	38.5
Chromium (Cr)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0001
Cobalt (Co)	0.00282	0.00276	0.00255	0.0024	0.00239
Copper (Cu)	0.0004	0.0007	0.0002	0.0001	0.00013
Iron (Fe)	1.01	1.34	1.26	0.676	0.507
Lead (Pb)	0.00005	0.0005	0.00008	<0.00002	0.000025
Magnesium (Mg)	3.05	3.07	2.84	3.06	3.24
Manganese (Mn)	2.76	2.93	2.92	2.75	2.94
Mercury (Hg)		<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.00103	0.00102	0.00108	0.00123	0.00116
Nickel (Ni)	0.0056	0.0064	0.0056	0.0057	0.00558
Phosphorus (P)	<0.1	<0.1	<0.1	<0.1	
Potassium (K)	1.81	1.69	1.75	2.18	1.68
Selenium (Se)	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004
Silicon (Si)	6.51	6.17	6.16	6.01	6.12
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005
Sodium (Na)	1.38	1.14	1.15	1.09	1.32
Strontium (Sr)	0.159	0.143	0.142	0.133	0.147
Thallium (Tl)	<0.00005	<0.00005	<0.00005	<0.00005	0.000021
Vanadium (V)	<0.00005	0.00007	<0.00005	<0.00005	<0.0002
Zinc (Zn)	0.152	0.189	0.18	0.147	0.134

AVG	Std Dev.	95th Percentile
231	10	240
111	6	119
4.0	0.0	4
149	13	165
7.7	0.3	8
9	3	12
0.9	0.1	1
70	6.1	78
4.5		4.5
0.08	0.04	0.10
0.5	0.1	0.7
0.51	0.038	0.55
45.0	4.1	49.2
0.036	0.004	0.041
0.0160	0.0221	0.0464
0.0020	0.0000	0.0020
0.007	0.002	0.009
0.008	0.005	0.013
0.0051	0.0080	0.0160
0.0001	0.00003	0.0002
0.0051	0.0019	0.0069
0.002578	0.001078	0.00371
39.8	3.0	43.8
0.00018	0.00004	0.00020
0.00258	0.00020	0.00281
0.00031	0.00025	0.00064
0.96	0.36	1.32
0.000135	0.000205	0.000416
3.05	0.14	3.21
2.860	0.096	2.938
0.00001	0	0.00001
0.00110	0.00009	0.00122
0.00578	0.00035	0.00626
0.100	0	0.100
1.82	0.21	2.11
0.00041	0.00021	0.00050
6.19	0.19	6.44
0.000009	0.000002	0.000010
1.22	0.13	1.37
0.145	0.009	0.157
0.00004	0.00001	0.00005
0.00006	0.00001	0.00007
0.1604	0.0232	0.1872

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

Appendix B: Groundwater Quality Monitoring Data

MW05-5A

Sample name	MW05-5A	05-5A	05-5A	05-05A	MW 05-05A	MW 05-5A	MW 05-5A	MW 05-5A	MW05-5A	MW 05-5A	MW 05-5A	MW 05-5A	MW 05-5A
Date	15-Jun-06	14-Mar-07	26-Apr-07	9-May-07	8-Jun-07	13-Jul-07	2-Sep-07	23-Sep-07	4-Oct-07	15-Feb-08	21-May-08	3-Sep-08	28-Nov-08
Job Number	A626470	A710946	A717990	A719951	A724712	A731839	A741295	A745736	A748794	A807257	A825056	A846361	A866642
Parameters (mg/L)													
Physical Parameters													
Conductivity		498	481		494	478	497	494	477	490	490	500	500
Dissolved Hardness	300	290	257	297	301	280	291	278	300	275	311	304	286
Total Suspended Solids	<4	5	<4	<4	<4	5	5	<4	<4	<4	<4	<4	<4
Total Dissolved Solids	290	336	298	278	288	288	318	288	280	430	280	300	300
pH	8.2	8.2	8.2	8.4	8.4	8.2	8	8	7.9	8.2	8.2	8.3	8
Turbidity	13.1	21.9	0.4	3.2	13.3	13.2	18.6	18	19.1	19.6	23.6	19.5	24.6
DOC	50			<0.5	<0.5	1.7	0.5	0.8	<0.5	<0.5	1.3	<0.5	1
Major Anions													
Alkalinity-Total	234	236	225	236	235	228	232	231	225	230	230	230	230
Acidity - Total										5.4	<0.5	4.6	6.3
Bromide	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01	<0.1	<0.1	0.2	0.3
Chloride	<0.5	3.2	0.9	2.4	2.5	0.9	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	2.3
Fluoride					2.34	2.23	2.4	2.07	2.15	2.16	2.16	2.16	2.41
Sulphate	37.3	24.3	36.2	37.3	35.6	33.4	33.8	38.4	34	38.6	35	39	37
Nutrient Parameters													
Ammonial Nitrogen	0.081	0.086	0.115	0.069	0.044	0.081	0.061	0.068	0.071	0.058	0.061	0.077	0.081
Nitrate Nitrogen	0.04	0.007	0.002	0.003	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.095	0.003
Nitrite Nitrogen	0.018	<0.002	<0.002	<0.002	0.002	<0.002	0.005	0.003	<0.002	0.002	0.006	<0.002	<0.002
Total Phosphate	0.006				0.009	0.015	0.012	0.019	0.012	0.018	0.013	0.01	0.009
Dissolved Ortho-Phosphate	0.006		0.006	0.005	0.003	0.004	0.019	0.014	0.007	0.005	<0.001	0.003	0.004
Dissolved Metals													
Aluminum (Al)	0.0022	0.0011	0.0006	0.0012	0.0023	0.0022	0.0019	0.0013	0.0015	0.0207	<0.0002	0.0039	0.0022
Antimony (Sb)	0.00583	0.00107	0.00433	0.00544	0.00666	0.00378	0.00438	0.00605	0.0061	0.00579	0.00522	0.00595	0.00571
Arsenic (As)	0.0042	0.0014	0.0011	0.0031	0.0047	0.0032	0.004	0.0044	0.0045	0.00415	0.00149	0.00429	0.00471
Cadmium (Cd)	0.00003	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.000037	<0.000005	<0.000005	<0.000005
Calcium (Ca)	81.5	76.5	68.9	79.5	80.5	74.5	77.8	74.4	80	75.2	82.9	82	76.3
Chromium (Cr)	<0.0002	0.0008	<0.0002	0.0003	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0001	<0.0001	<0.0001	0.0011
Cobalt (Co)	0.00027	0.0003	0.00035	0.00033	0.00024	0.00037	0.00034	0.00032	0.00028	0.000262	0.000173	0.000211	0.00019
Copper (Cu)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.00046	<0.00005	0.00007	0.00013
Iron (Fe)	1.1	1.58	0.017	0.518	1.25	1.49	1.62	1.27	1.4	1.37	0.004	1.44	1.55
Lead (Pb)	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.000788	<0.000005	0.000017	0.000081
Magnesium (Mg)	23.9	24	20.7	23.9	24.3	22.9	23.6	22.4	24.4	21.1	25.2	24.2	23.2
Manganese (Mn)	0.216	0.545	0.237	0.16	0.0928	0.176	0.167	0.0815	0.0925	0.121	0.144	0.119	0.0919
Mercury (Hg)		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001		<0.00001
Molybdenum (Mo)	0.00876	0.00811	0.0103	0.00748	0.00715	0.00854	0.00771	0.0074	0.00761	0.00767	0.00727	0.00821	0.00815
Nickel (Ni)	<0.0005	<0.0005	<0.0005	0.0008	0.0011	<0.0005	0.0009	0.0011	<0.0005	0.00075	0.0006	0.00066	0.00067
Phosphorus (P)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.024	<0.002		
Potassium (K)	1.67	1.51	2.04	1.67	1.61	1.8	2.08	1.52	1.7	1.51	1.54	1.59	1.52
Selenium (Se)	0.0007	0.0006	0.0012	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004	<0.00004	<0.00004	<0.00004
Silicon (Si)	3.89	4.06	3.82	4.04	3.85	3.97	3.8	3.57	3.92	3.26	3.89	3.69	4.04
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005	<0.000005	<0.000005
Sodium (Na)	0.85	0.76	1.49	0.5	0.4	0.86	0.46	0.32	0.59	1.04	0.4	0.68	0.55
Strontium (Sr)	0.142	0.133	0.143	0.135	0.135	0.128	0.123	0.125	0.132	0.131	0.123	0.137	0.139
Thallium (Tl)	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002	<0.000002	<0.000002	<0.000002
Vanadium (V)	<0.00005	0.00007	0.00009	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00002	<0.0002	<0.0002	<0.0002
Zinc (Zn)	0.0042	<0.0005	0.0024	0.0029	0.005	0.0019	0.0022	0.004	0.0042	0.059	0.0014	0.0054	0.0058

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
491	9	500
290	15	307
4.2	0.4	5
306	41	374
8.2	0.2	8
16	7	24
0.8	0.4	2
231	3.7	236
4.2	2.6	6.2
0.10	0.08	0.24
1.2	1.0	2.8
2.25	0.121	2.41
35.4	3.8	38.8
0.073	0.017	0.098
0.0126	0.0269	0.0620
0.0038	0.0045	0.0108
0.012	0.004	0.019
0.006	0.005	0.016
0.0032	0.0053	0.0106
0.0051	0.00146	0.0063
0.0035	0.0013	0.0047
0.000018	0.000010	0.00003
77.7	3.9	82.4
0.00031	0.00030	0.00092
0.00028	0.00006	0.00036
0.00012	0.00010	0.00026
1.12	0.57	1.60
0.000082	0.000213	0.000364
23.37	1.31	24.72
0.173	0.122	0.360
0.00001	0	0.00001
0.00803	0.00084	0.00938
0.00070	0.00022	0.00110
0.084	0.035535386	0.100
1.67	0.19	2.06
0.00044	0.00033	0.00090
3.83	0.22	4.05
0.000008	0.000002	0.000010
0.68	0.32	1.22
0.133	0.007	0.142
0.00004	0.00002	0.00005
0.00010	0.00007	0.00020
0.0076	0.0155	0.0271

Appendix B: Groundwater Quality Monitoring Data

MW05-5B

Sample name	MW05-5B	MW 05-5B	MW 05-5B	MW05-5B	MW 05-5B	MW 05-5B	MW 05-5B
Date	15-Jun-06	10-Jun-07	13-Jul-07	6-Oct-07	15-Feb-08	21-May-08	3-Sep-08
Job Number	A626470	A725184	A731839	A748794	A807257	A825056	A846361
Parameters (mg/L)							
Physical Parameters							
Conductivity		302	290	295	290	300	310
Dissolved Hardness	170	160	156	165	145	153	167
Total Suspended Solids	<4	<4	<4	<4	<4	<4	<4
Total Dissolved Solids	186	156	191	182	180	210	190
pH	8	8.1	8.1	7.9	8.1	8.1	8.2
Turbidity	2.3	3.7	3	7.9	6.4	6	6.7
DOC	24	0.8	<0.5	0.6	<0.5	7.7	0.8
Major Anions							
Alkalinity-Total	111	108	108	107	110	100	110
Acidity - Total					4.1	<0.5	3.5
Bromide	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	0.2
Chloride	<0.5	1.5	0.7	<0.5	<0.5	<0.5	<0.5
Fluoride		0.28	0.27	0.23	0.32	0.27	0.25
Sulphate	42.2	44.1	39.6	42.9	47.1	41	46
Nutrient Parameters							
Ammonial Nitrogen	0.03	0.017	0.013	0.011	0.011	<0.005	0.015
Nitrate Nitrogen	<0.02	0.006	<0.002	<0.002	<0.002	0.002	0.008
Nitrite Nitrogen	<0.002	<0.002	<0.002	<0.002	0.002	0.003	<0.002
Total Phosphate	<0.005	0.006	<0.005	0.006	0.01	<0.005	0.005
Dissolved Ortho-Phosphate	0.004	0.003	0.004	0.008	0.002	0.003	0.002
Dissolved Metals							
Aluminum (Al)	0.0021	0.0047	0.0008	0.0012	0.0014	<0.0002	0.0025
Antimony (Sb)	0.00007	0.00013	<0.00005	<0.00005	0.00006	0.00004	0.00004
Arsenic (As)	0.0009	0.0014	0.0013	0.0016	0.00154	0.00097	0.00176
Cadmium (Cd)	0.00001	0.00003	<0.00001	<0.00001	0.000013	0.00001	0.000005
Calcium (Ca)	55.6	53.3	51.6	55	48.1	49.9	55.5
Chromium (Cr)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0001	<0.0001	<0.0001
Cobalt (Co)	0.00048	0.00047	0.00045	0.00054	0.000553	0.000496	0.000543
Copper (Cu)	0.0001	0.0002	<0.0001	<0.0001	0.00088	0.00011	0.00019
Iron (Fe)	0.324	0.306	0.478	0.602	0.668	0.002	0.805
Lead (Pb)	0.00003	0.00016	<0.00002	<0.00002	0.000011	<0.000005	0.000017
Magnesium (Mg)	6.62	6.68	6.5	6.85	5.94	7.01	6.79
Manganese (Mn)	0.422	0.439	0.517	0.512	0.556	0.56	0.61
Mercury (Hg)		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.00346	0.00236	0.00204	0.00213	0.00185	0.00179	0.002
Nickel (Ni)	0.0018	0.0029	0.0022	0.0023	0.00253	0.0025	0.00264
Phosphorus (P)	<0.1	<0.1	<0.1	<0.1	0.007	<0.002	
Potassium (K)	0.95	0.71	0.797	0.919	0.99	0.73	0.83
Selenium (Se)	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004	<0.00004	<0.00004
Silicon (Si)	3	2.99	3.24	3.41	2.83	3.26	3.69
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005	<0.000005
Sodium (Na)	0.91	0.8	0.8	0.96	1.34	0.82	1.09
Strontium (Sr)	0.108	0.103	0.104	0.104	0.11	0.108	0.12
Thallium (Tl)	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002	0.000002	<0.000002
Vanadium (V)	<0.00005	<0.00005	<0.00005	<0.00005	<0.0002	<0.0002	<0.0002
Zinc (Zn)	0.0161	0.0298	0.0298	0.0307	0.0296	0.0225	0.0277

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
298	8	308
159	9	169
4.0	0.0	4
185	16	204
8.1	0.1	8
5	2	8
1.8	2.9	6
108	3.7	111
2.7	1.9	4.0
0.10	0.05	0.17
0.7	0.4	1.3
0.27	0.030	0.31
43.3	2.7	46.8
0.015	0.008	0.026
0.0060	0.0066	0.0164
0.0021	0.0004	0.0027
0.006	0.002	0.009
0.004	0.002	0.007
0.0018	0.0015	0.0040
0.0001	0.00003	0.0001
0.0014	0.0003	0.0017
0.000013	0.000008	0.00002
52.7	2.9	55.6
0.00016	0.00005	0.00020
0.00050	0.00004	0.00055
0.00024	0.00029	0.00068
0.46	0.27	0.76
0.000038	0.000055	0.000121
6.63	0.34	6.96
0.517	0.067	0.595
0.00001	0	0.00001
0.00223	0.00057	0.00313
0.00241	0.00035	0.00282
0.068	0.049341328	0.100
0.85	0.11	0.98
0.00030	0.00025	0.00050
3.20	0.29	3.61
0.000008	0.000003	0.000010
0.96	0.20	1.27
0.108	0.006	0.117
0.00003	0.00003	0.00005
0.00011	0.00008	0.00020
0.0266	0.0054	0.0304

Appendix B: Groundwater Quality Monitoring Data

MW05-6A

Sample name	MW05-6A	MW05-6A	MW 05-6A	MW 05-6A	MW05-6A
Date	8-Sep-05	10-May-05	2-Sep-07	21-Sep-07	5-Oct-07
Job Number			A741295	A745736	A748794
Parameters (mg/L)					
Physical Parameters					
Conductivity	166	84.8	180	184	189
Dissolved Hardness			88.1	86.6	84.8
Total Suspended Solids			<4	<4	<4
Total Dissolved Solids			118	100	114
pH	7.75	7.9	7.8	7.9	7.9
Turbidity			4.8	6.3	4.1
DOC			0.9	1.1	<0.5
Major Anions					
Alkalinity-Total	78.2	78.6	70.3	79.1	78.6
Acidity - Total					
Bromide			<0.01	<0.01	<0.01
Chloride			<0.5	1	<0.5
Fluoride	0.135	0.17	0.18	0.17	0.17
Sulphate	18.5	12.9	16.3	12.5	12.9
Nutrient Parameters					
Ammonial Nitrogen			0.006	<0.005	<0.005
Nitrate Nitrogen			0.002	<0.002	<0.002
Nitrite Nitrogen			<0.002	<0.002	<0.002
Total Phosphate			0.776	0.54	0.56
Dissolved Ortho-Phosphate			0.56	0.57	0.59
Dissolved Metals					
Aluminum (Al)	0.0219	0.0017	0.001	0.0026	0.0017
Antimony (Sb)			0.00033	0.00047	0.00016
Arsenic (As)	0.00446	0.0044	0.0061	0.0045	0.0044
Cadmium (Cd)	0.000076	<0.00001	0.00001	<0.00001	<0.00001
Calcium (Ca)	25.3	28.8	29.9	29.5	28.8
Chromium (Cr)			<0.0002	<0.0002	<0.0002
Cobalt (Co)			0.00049	0.00029	0.00037
Copper (Cu)	0.00094	<0.0001	<0.0001	<0.0001	<0.0001
Iron (Fe)			0.947	0.39	0.595
Lead (Pb)			<0.00002	<0.00002	<0.00002
Magnesium (Mg)			3.29	3.13	3.15
Manganese (Mn)			0.295	0.341	0.352
Mercury (Hg)			<0.00001	<0.00001	<0.00001
Molybdenum (Mo)			0.00392	0.00361	0.00324
Nickel (Ni)			0.0014	0.0007	<0.0005
Phosphorus (P)			0.8	0.6	0.7
Potassium (K)			1.54	1.2	1.31
Selenium (Se)	<0.001	0.0014	0.0009	0.0006	0.0014
Silicon (Si)			6.76	6.31	6.27
Silver (Ag)			<0.00001	<0.00001	<0.00001
Sodium (Na)			2.78	3.86	3.5
Strontium (Sr)			0.0288	0.0362	0.0351
Thallium (Tl)			<0.00005	<0.00005	<0.00005
Vanadium (V)			<0.00005	<0.00005	<0.00005
Zinc (Zn)	0.0092	<0.0005	0.0006	<0.0005	<0.0005

 DL too high; not used in statistical evaluation

 Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
161	43	188
87	2	88
4.0	0.0	4
111	9	118
7.9	0.1	8
5	1	6
0.8	0.3	1
77	3.7	79
0.01	0.00	0.01
0.7	0.3	1.0
0.17	0.017	0.18
14.6	2.7	18.1
0.005	0.001	0.006
0.0020	0.0000	0.0020
0.0020	0.0000	0.0020
0.625	0.131	0.754
0.573	0.015	0.588
0.0058	0.0090	0.0180
0.0003	0.00016	0.0005
0.0048	0.0007	0.0058
0.000023	0.000030	0.00006
28.5	1.8	29.8
0.00020	0	0.00020
0.00038	0.00010	0.00048
0.00027	0.00038	0.00077
0.64	0.28	0.91
0.00002	0	0.00002
3.19	0.09	3.28
0.329	0.030	0.351
0.00001	0	0.00001
0.00359	0.00034	0.00389
0.00087	0.00047	0.00133
0.700	0.1	0.790
1.35	0.17	1.52
0.0011	0.0003	0.0014
6.45	0.27	6.72
0.00001	0	0.00001
3.38	0.55	3.82
0.033	0.004	0.036
0.00005	0.00000	0.00005
0.00005	0.00000	0.00005
0.0023	0.0039	0.0075

Appendix B: Groundwater Quality Monitoring Data

MW05-6B

Sample name	MW05-6B	MW 05-6B	MW 05-6B
Date	8-Sep-05	1-Sep-07	21-Sep-07
Job Number		A741295	A745736
Parameters (mg/L)			
Physical Parameters			
Conductivity	172	183	197
Dissolved Hardness		101	101
Total Suspended Solids		<4	<4
Total Dissolved Solids		102	130
pH	9.11	8	8.1
Turbidity		0.2	<0.1
DOC		1	<0.5
Major Anions			
Alkalinity-Total	81	83.4	92.1
Acidity - Total			
Bromide		<0.01	<0.01
Chloride		<0.5	<0.5
Fluoride	0.068	0.04	0.04
Sulphate	16.6	7.3	8
Nutrient Parameters			
Ammonial Nitrogen		<0.005	<0.005
Nitrate Nitrogen		0.209	0.184
Nitrite Nitrogen		0.004	<0.002
Total Phosphate		<0.005	0.006
Dissolved Ortho-Phosphate		0.017	0.009
Dissolved Metals			
Aluminum (Al)	0.0667	0.0074	0.0133
Antimony (Sb)		0.00006	<0.00005
Arsenic (As)	<0.001	0.0003	<0.0001
Cadmium (Cd)	<0.00005	0.00001	<0.00001
Calcium (Ca)	31.2	35.8	36.1
Chromium (Cr)		<0.0002	0.0003
Cobalt (Co)		0.00039	0.00017
Copper (Cu)	0.00262	0.0006	0.0006
Iron (Fe)		<0.005	<0.005
Lead (Pb)		<0.00002	<0.00002
Magnesium (Mg)		2.87	2.74
Manganese (Mn)		0.171	0.0624
Mercury (Hg)		<0.00001	<0.00001
Molybdenum (Mo)		0.00115	0.0008
Nickel (Ni)		0.0048	0.0037
Phosphorus (P)		<0.1	<0.1
Potassium (K)		1.14	0.87
Selenium (Se)	<0.001	0.0009	0.0009
Silicon (Si)		4.16	3.91
Silver (Ag)		<0.00001	<0.00001
Sodium (Na)		1.39	1.37
Strontium (Sr)		0.047	0.0492
Thallium (Tl)		<0.00005	<0.00005
Vanadium (V)		<0.00005	<0.00005
Zinc (Zn)	0.0013	<0.0005	<0.0005

AVG	Std Dev.	95th Percentile
184	13	196
101	0	101
4.0	0.0	4
116	20	129
8.4	0.6	9
0	0	0
0.8	0.4	1
86	5.8	91
0.01	0.00	0.01
0.5	0.0	0.5
0.05	0.016	0.07
10.6	5.2	15.7
0.005	0.000	0.005
0.1965	0.0177	0.2078
0.0030	0.0014	0.0039
0.006	0.001	0.006
0.013	0.006	0.017
0.0291	0.0327	0.0614
0.0001	0.00001	0.0001
0.0002	0.0001	0.0003
0.000023	0.000023	0.00005
34.4	2.7	36.1
0.00025	7.07107E-05	0.00030
0.00028	0.00016	0.00038
0.00127	0.00117	0.00242
0.01	0.00	0.01
0.00002	0	0.00002
2.81	0.09	2.86
0.117	0.077	0.166
0.00001	0	0.00001
0.00098	0.00025	0.00113
0.00425	0.00078	0.00475
0.100	0	0.100
1.01	0.19	1.13
0.0009	0.0001	0.0010
4.04	0.18	4.15
0.00001	0	0.00001
1.38	0.01	1.39
0.048	0.002	0.049
0.00005	0.00000	0.00005
0.00005	0.00000	0.00005
0.0008	0.0005	0.0012

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

Appendix B: Groundwater Quality Monitoring Data

MW05-7A

Sample name	MW 05-07A	MW 05-7A	MW 05-7A	MW 05-7A
Date	8-Jun-07	12-Jul-07	1-Sep-07	21-Sep-07
Job Number	A724712	A731839	A741295	A745736
Parameters (mg/L)				
Physical Parameters				
Conductivity	3010	695	8120	5710
Dissolved Hardness	2420	393	2160	1470
Total Suspended Solids	4	4	4	4
Total Dissolved Solids	1050	353	1840	1380
pH	12.1	11.5	12.5	12.4
Turbidity	0.1	0.1	0.8	0.3
DOC	9.5	7.3	1.3	3
Major Anions				
Alkalinity-Total	811	213	2100	1410
Acidity - Total				
Bromide	0.1	0.1	0.01	0.01
Chloride	6.5	1.1	2.5	2.1
Fluoride	0.11	0.12	0.07	0.08
Sulphate	7.2	14	0.5	4.7
Nutrient Parameters				
Ammonial Nitrogen	0.064	0.048	0.068	0.092
Nitrate Nitrogen	0.044	0.03	0.025	0.027
Nitrite Nitrogen	0.005	0.003	0.002	0.003
Total Phosphate	0.013	0.007	0.005	0.005
Dissolved Ortho-Phosphate	0.002	0.003	0.006	0.005
Dissolved Metals				
Aluminum (Al)	0.0496	0.134	0.0262	0.029
Antimony (Sb)	0.00012	0.00058	0.00006	<0.0003
Arsenic (As)	0.0007	0.0007	0.0001	0.0007
Cadmium (Cd)	0.00002	0.00001	0.00001	0.00005
Calcium (Ca)	969	157	866	602
Chromium (Cr)	0.0077	0.0015	0.0081	0.005
Cobalt (Co)	0.00057	0.00002	0.00024	0.0003
Copper (Cu)	0.0073	0.0033	0.0017	0.0054
Iron (Fe)	0.012	0.005	0.005	0.005
Lead (Pb)	0.00412	0.00032	0.00185	0.0013
Magnesium (Mg)	0.05	0.05	0.05	0.05
Manganese (Mn)	0.00058	0.00025	0.00003	0.0002
Mercury (Hg)	0.00001	0.00001	0.00001	0.00001
Molybdenum (Mo)	0.00483	0.00683	0.00197	0.0043
Nickel (Ni)	0.0166	0.0005	0.0124	0.013
Phosphorus (P)	0.1	0.1	0.1	0.1
Potassium (K)	13.6	5.01	3.4	6.13
Selenium (Se)	0.0017	0.0008	0.0005	<0.003
Silicon (Si)	0.23	2.96	0.16	0.36
Silver (Ag)	0.00001	0.00001	0.00001	0.00005
Sodium (Na)	8.47	3.15	3.28	3.9
Strontium (Sr)	2.01	0.377	0.687	1.11
Thallium (Tl)	0.00005	0.00005	0.00005	<0.0003
Vanadium (V)	0.00058	0.00282	0.00008	0.0008
Zinc (Zn)	0.269	0.0047	0.0475	0.026

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

Appendix B: Groundwater Quality Monitoring Data

MW05-7B

Sample name	MW05-7B	05-7B	05-7B	MW 05-07B	MW 05-7B	MW 05-7B	MW 05-7B-98	MW 05-7B	MW05-7B	MW 05-7B	MW 05-7B
Date	8-Sep-05	27-Apr-07	13-May-07	7-Jun-07	12-Jul-07	1-Sep-07	2-Sep-07	21-Sep-07	4-Oct-07	21-May-08	3-Sep-08
Job Number		A717990	A719951	A724712	A731839	A741295	A741295	A745736	A748794	A825056	A846361
Parameters (mg/L)											
Physical Parameters											
Conductivity	177	175		158	146	153	150	157	153	180	160
Dissolved Hardness		86.5	81.8	75.4	71.5	75.2	74.7	78.6	78.1	91	79.3
Total Suspended Solids		<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Total Dissolved Solids		120	88	102	96	112	98	112	93	120	120
pH	7.58	8	8	8.3	8.5	9	8.4	8.9	8.1	8.1	8.1
Turbidity		6.1	0.2	<0.1	<0.1	0.2	1.7	<0.1	0.3	0.2	0.2
DOC			0.7	0.5	<0.5	0.8	0.7	0.6	<0.5	2.7	0.5
Major Anions											
Alkalinity-Total	71.8	72.5	62.3	56.1	61.3	66.5	61.3	67.3	60.6	79	63
Acidity - Total										<0.5	2
Bromide		<0.1	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01	<0.01	<0.1	0.1
Chloride		<0.5	8.1	5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	2.4
Fluoride	0.166			0.14	0.14	0.13	0.13	0.13	0.14	0.09	0.12
Sulphate	22.2	14.1	6.2	14.8	13.7	12.4	12.2	14.8	13.9	8	14
Nutrient Parameters											
Ammonial Nitrogen		<0.005	0.006	<0.005	0.038	0.007	<0.005	0.017	0.016	<0.005	<0.005
Nitrate Nitrogen		0.032	0.015	0.005	0.01	0.019	0.022	0.007	0.008	0.014	0.011
Nitrite Nitrogen		<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002
Total Phosphate				0.041	0.043	0.047	0.043	0.051	0.04	0.03	0.052
Dissolved Ortho-Phosphate		0.014	0.033	0.027	0.041	0.045	0.045	0.052	0.05	0.024	0.036
Dissolved Metals											
Aluminum (Al)	0.112	0.0997	0.0226	0.0367	0.0066	0.0053	0.0059	0.0049	0.0061	0.0003	0.0074
Antimony (Sb)		0.00032	0.00013	0.00013	0.00012	0.00012	0.00013	0.00009	0.0001	0.00012	0.00011
Arsenic (As)	0.00054	0.0019	0.0008	0.0012	0.0012	0.0011	0.0011	0.0005	0.0009	0.00047	0.00057
Cadmium (Cd)	<0.00005	0.00004	0.00004	0.00003	0.00002	0.00003	0.00002	0.00002	0.00003	<0.000005	0.000006
Calcium (Ca)	27.8	29.9	28.7	26.3	25.1	26.6	26.4	27.6	27.4	31.3	27.7
Chromium (Cr)		<0.0002	<0.0002	0.0004	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0001	<0.0001
Cobalt (Co)		0.00057	0.00027	0.00022	0.00009	0.00005	0.00006	0.00006	0.00006	0.000118	0.000067
Copper (Cu)	0.00552	0.0024	0.0007	0.001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	0.00018	0.00016
Iron (Fe)		0.179	0.028	0.066	<0.005	0.005	<0.005	0.005	0.011	0.002	0.018
Lead (Pb)		0.00012	0.00004	0.00007	0.00009	<0.00002	<0.00002	<0.00002	<0.00002	<0.000005	0.000017
Magnesium (Mg)		2.87	2.46	2.36	2.13	2.15	2.14	2.37	2.35	3.13	2.45
Manganese (Mn)		0.159	0.151	0.124	0.109	0.0793	0.0867	0.0964	0.0986	0.27	0.117
Mercury (Hg)		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)		0.012	0.0098	0.00907	0.00924	0.00969	0.0107	0.00985	0.0107	0.00769	0.00909
Nickel (Ni)		0.0049	0.0028	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.00022	0.00014
Phosphorus (P)		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.031	
Potassium (K)		0.915	0.848	0.845	0.811	0.96	0.837	0.882	0.903	0.84	0.87
Selenium (Se)	<0.001	<0.0005	<0.0005	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004	<0.00004
Silicon (Si)		3.82	3.96	3.82	3.97	4.05	4.03	4.04	4.06	4.19	4.39
Silver (Ag)		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005
Sodium (Na)		1.59	1.72	1.81	1.63	1.79	1.77	1.76	1.89	1.93	2.06
Strontium (Sr)		0.0693	0.0534	0.0461	0.0472	0.0445	0.0464	0.0497	0.0485	0.0587	0.0553
Thallium (Tl)		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002	<0.000002
Vanadium (V)		0.0021	0.00204	0.00097	0.00137	0.00103	0.00112	0.00028	0.00066	<0.0002	0.0003
Zinc (Zn)	0.0047	0.0019	0.0008	0.0015	0.0015	<0.0005	<0.0005	<0.0005	<0.0005	0.0003	0.002

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
161	12	179
79	6	89
4	0	4
106	12	120
8.3	0.4	9
1	2	4
0.8	0.7	2
66	6.6	76
1.3	1.1	1.9
0.06	0.05	0.10
1.9	2.6	6.7
0.13	0.020	0.16
13.3	4.1	18.5
0.011	0.011	0.029
0.0143	0.0082	0.0275
0.0020	0.0000	0.0020
0.043	0.007	0.052
0.037	0.012	0.051
0.0280	0.0400	0.1059
0.0001	0.0001	0.0002
0.0009	0.0004	0.0016
0.000026	0.000014	0.00005
27.7	1.7	30.6
0.00020	0.00008	0.00031
0.00016	0.00016	0.00044
0.00096	0.00166	0.00396
0.03	0.06	0.13
0.000042	0.000038	0.000107
2.44	0.33	3.01
0.129	0.056	0.220
0.00001	0	0.00001
0.00978	0.00117	0.01142
0.00113	0.00153	0.00396
0.092	0.023	0.100
0.87	0.04	0.94
0.00047	0.00026	0.00080
4.03	0.17	4.30
0.000009	0.000002	0.000010
1.80	0.14	2.00
0.052	0.008	0.065
0.00004	0.0	0.00005
0.00101	0.0	0.002
0.0013	0.0013	0.0034

Appendix B: Groundwater Quality Monitoring Data

MW06-8S

Sample name	MW06-8S	MW06-8S	MW 06-08S	MW 06-8S	MW 06-8S	MW 06-8S	MW05-8S	MW05-8S-98	MW 05-8S	MW 06-8S	MW06-8S	MW 06-8S
Date	14-Jun-06	13-Sep-06	7-Jun-07	11-Jul-07	31-Aug-07	22-Sep-07	8-Oct-07	8-Oct-07	15-Feb-08	24-May-08	1-Sep-08	28-Nov-08
Job Number	A626573	Z2772	A724712	A731839	A741295	A745736	A748794	A748794	A807257	A825056	A845319	A866642
Parameters (mg/L)												
Physical Parameters												
Conductivity		199	234	140	168	173	170	171	180	180	190	170
Dissolved Hardness	98	82.7	70.4	63.7	74	81.2	82.8	83.9	75	85	76.9	75.6
Total Suspended Solids	<4	187	7	<4	<4	<4	<4	<4	<4	<4	<4	<4
Total Dissolved Solids	134	135	140	92	112	148	114	110	110	130	100	110
pH	7.4	7.69	8.1	7.8	7.6	7.7	7.5	7.5	7.8	7.6	7.4	7.4
Turbidity	<0.1	199	3.3	2	0.2	0.8	0.9	1.1	8.5	11.8	7.2	7
DOC	13.9		3.3	1.2	0.9	0.6	<0.5	<0.5	0.5	1	<0.5	1.6
Major Anions												
Alkalinity-Total	61.4	59.4	90.9	54.1	54.6	50.2	49.7	51.2	51	48	48	49
Acidity - Total									4.9	3.9	4.6	5.2
Bromide	<0.1	<0.05	<0.1	<0.1	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	0.5
Chloride	<0.5	<0.5	2.6	<0.5	<0.5	2.4	<0.5	<0.5	4.9	<0.5	0.5	6.3
Fluoride		0.217	0.28	0.17	0.17	0.2	0.22	0.2	0.24	0.23	0.24	0.26
Sulphate	41.1	36.4	21.9	14.9	24.9	30.9	32	31.4	31.9	33	35	34
Nutrient Parameters												
Ammonial Nitrogen	0.043	0.0607	0.126	0.03	0.027	0.021	0.014	0.015	0.021	0.013	0.047	0.042
Nitrate Nitrogen	<0.02	<0.005	0.016	0.047	0.018	0.022	<0.002	<0.002	0.002	0.005	0.068	0.01
Nitrite Nitrogen	0.004	<0.001	0.002	0.011	0.003	<0.002	<0.002	<0.002	0.004	<0.002	<0.002	<0.002
Total Phosphate	0.053		0.03	0.037	0.031	<0.005	0.022	0.022	0.019	0.122	0.131	0.131
Dissolved Ortho-Phosphate	0.063	0.0052	0.005	0.006	0.023	0.009	0.019	0.019	0.008	0.015	0.129	0.027
Dissolved Metals												
Aluminum (Al)	0.0045	0.0077	0.0133	0.0046	0.0055	0.0036	0.0034	0.0036	0.0083	0.0048	0.0057	0.0038
Antimony (Sb)	0.0155	0.00241	0.00893	0.025	0.0139	0.00722	0.00614	0.00549	0.00314	0.00288	0.00154	0.00172
Arsenic (As)	0.0012	0.00214	0.0024	0.0013	0.0012	0.0006	0.0013	0.0014	0.00194	0.00189	0.0015	0.00173
Cadmium (Cd)	0.00082	0.000055	0.00001	0.00001	0.00002	0.00003	0.00002	0.00002	0.000009	<0.000005	0.000009	0.000012
Calcium (Ca)	31.8	26.4	23.4	21.1	24.6	26.1	27.7	28.1	25.5	28.3	25.6	25
Chromium (Cr)	<0.0002	<0.0005	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002	0.0002	<0.0001	<0.0001	0.001
Cobalt (Co)	0.00786	0.00543	0.00201	0.00243	0.00342	0.0061	0.00686	0.00652	0.00454	0.00504	0.0055	0.00535
Copper (Cu)	0.0002	0.00042	0.0001	<0.0001	0.0002	0.0002	<0.0001	<0.0001	0.00061	0.0001	0.00009	0.00014
Iron (Fe)	0.032	0.44	2.32	1.34	1.24	0.152	1.39	1.39	1.73	1.38	1	0.983
Lead (Pb)	0.00002	0.000061	0.00006	0.00004	0.00007	0.00003	0.00004	0.00003	0.000045	0.000025	0.000025	0.00008
Magnesium (Mg)	4.6	4.07	2.92	2.69	3.05	3.08	3.31	3.33	2.74	3.48	3.14	3.22
Manganese (Mn)	0.726	0.824	0.702	0.757	0.722	0.659	0.679	0.633	0.609	0.614	0.434	0.489
Mercury (Hg)			<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001		<0.00001
Molybdenum (Mo)	0.00462	0.00747	0.00283	0.00349	0.00335	0.00299	0.00301	0.00314	0.00343	0.00377	0.00369	0.00354
Nickel (Ni)	0.0185	0.0104	0.0039	0.0047	0.0075	0.0193	0.0209	0.0193	0.0158	0.0138	0.028	0.0191
Phosphorus (P)	<0.1	<0.30	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.028	0.146		
Potassium (K)	1.28	<2	0.984	1.17	1.34	1.26	1.39	0.959	1.08	1.12	0.99	0.96
Selenium (Se)	<0.0005	<0.0005	0.0018	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004	<0.00004	<0.00004	<0.00004
Silicon (Si)	5.25	4.79	5.9	5.46	5.43	5.14	5.91	5.91	4.82	5.89	5.24	5.84
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005	<0.000005	<0.000005
Sodium (Na)	4.99	7.8	6.28	3.3	3.51	2.89	3.66	3.72	6.08	2.98	3.14	2.91
Strontium (Sr)	0.0879	0.0819	0.0596	0.0627	0.0734	0.0908	0.0848	0.0847	0.0811	0.0755	0.0668	0.0628
Thallium (Tl)	<0.00005	<0.0001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002	<0.000002	<0.000002	<0.000002
Vanadium (V)	0.00076	<0.001	0.00143	0.00028	<0.00005	<0.00005	0.00008	0.00006	<0.0002	<0.0002	<0.0002	<0.0002
Zinc (Zn)	0.14	0.0158	0.0009	0.0036	0.0081	0.116	0.0976	0.0943	0.104	0.108	0.503	0.219

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
180	23	217
79	9	91
4.3	0.9	6
120	17	144
7.6	0.2	8
20	56	96
1.1	0.9	3
56	11.9	75
4.7	0.6	5.2
0.10	0.13	0.28
1.7	2.0	5.5
0.22	0.035	0.27
30.6	7.0	38.5
0.030	0.016	0.054
0.0181	0.0203	0.0565
0.0031	0.0026	0.0071
0.055	0.049	0.131
0.027	0.036	0.093
0.005	0.002	0.008
0.0078	0.00709	0.0198
0.0016	0.0005	0.0023
0.000085	0.000232	0.00040
26.1	2.7	29.9
0.00021	0.00010	0.00035
0.00509	0.00175	0.00731
0.00020	0.00016	0.00051
1.12	0.65	2.00
0.000044	0.000020	0.000075
3.30	0.55	4.31
0.654	0.110	0.787
0.00001	0	0.00001
0.00378	0.00125	0.00590
0.01510	0.00725	0.02410
0.097	0.030051807	0.128
1.21	0.29	1.66
0.00048	0.00049	0.00125
5.47	0.42	5.91
0.000008	0.000002	0.000010
4.27	1.63	6.96
0.076	0.011	0.089
0.00003	0.0	0.00005
0.00032	0.0	0.00110
0.128	0.140	0.361

Appendix B: Groundwater Quality Monitoring Data

MW06-8D

Sample name	MW06-8D	MW 06-08D	MW 06-8D	MW 06-8D	MW 06-8D	MW 06-8D	MW06-8D
Date	14-Jun-06	7-Jun-07	11-Jul-07	1-Sep-07	22-Sep-07	24-May-08	1-Sep-08
Job Number	A626573	A724712	A731839	A741295	A745736	A825056	A845319
Parameters (mg/L)							
Physical Parameters							
Conductivity		457	450	468	456	470	450
Dissolved Hardness	90	276	262	270	275	291	245
Total Suspended Solids	<4	<4	<4	<4	<4	<4	<4
Total Dissolved Solids	122	268	266	294	340	270	240
pH	9	8.4	8.3	8.2	8.2	8.3	8.2
Turbidity	0.1	1.5	2	1.6	1	<0.1	1.1
DOC	7.4	<0.5	<0.5	<0.5	0.7	<0.5	0.8
Major Anions							
Alkalinity-Total	90.8	228	230	222	224	220	210
Acidity - Total						3.1	2
Bromide	<0.1	<0.1	<0.1	<0.01	<0.01	<0.1	<0.1
Chloride	<0.5	<0.5	0.7	3.7	0.5	<0.5	1.4
Fluoride		0.98	0.96	0.95	0.97	0.86	0.79
Sulphate	20.5	29	28.2	28.8	30.4	30	32
Nutrient Parameters							
Ammonial Nitrogen	0.056	0.074	0.063	0.069	0.079	0.077	0.074
Nitrate Nitrogen	0.51	<0.002	<0.002	<0.002	<0.002	0.003	0.027
Nitrite Nitrogen	0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Phosphate	0.044	0.008	0.008	0.006	0.006	0.01	0.018
Dissolved Ortho-Phosphate	0.031	0.004	0.005	0.007	0.009	<0.001	0.006
Dissolved Metals							
Aluminum (Al)	0.0753	0.006	0.0085	0.0053	0.0044	0.0061	0.0116
Antimony (Sb)	0.00021	0.00039	0.00009	0.00017	0.00033	0.00027	0.00372
Arsenic (As)	0.0005	0.0058	0.0044	0.0052	0.0045	0.00366	0.00497
Cadmium (Cd)	0.00017	<0.00001	<0.00001	<0.00001	<0.00001	0.000008	0.000007
Calcium (Ca)	31.5	64.4	60.5	63.2	60.1	67.1	57.7
Chromium (Cr)	0.0028	0.0003	<0.0002	<0.0002	0.0003	<0.0001	0.0007
Cobalt (Co)	0.00016	0.00038	0.00036	0.00034	0.00036	0.000274	0.000238
Copper (Cu)	0.0055	0.0001	<0.0001	<0.0001	<0.0001	0.00005	0.00008
Iron (Fe)	0.048	0.258	0.177	0.246	0.167	0.006	0.268
Lead (Pb)	0.00081	0.00004	<0.00002	0.00002	<0.00002	0.000036	0.000019
Magnesium (Mg)	2.81	27.9	27	27.2	25.9	30	24.5
Manganese (Mn)	0.0302	0.0514	0.0678	0.0528	0.0528	0.0395	0.0396
Mercury (Hg)		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.00336	0.00136	0.00144	0.00141	0.00137	0.00145	0.00328
Nickel (Ni)	0.0025	0.002	<0.0005	0.0011	0.0017	0.00075	0.00052
Phosphorus (P)	<0.1	<0.1	<0.1	<0.1	<0.1	0.004	
Potassium (K)	1.84	1.87	1.86	1.96	1.78	1.94	1.98
Selenium (Se)	0.0029	0.0006	<0.0005	<0.0005	<0.0005	<0.00004	0.00011
Silicon (Si)	4.15	4.63	4.71	4.56	4.3	4.89	5
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005
Sodium (Na)	3.49	0.8	0.59	0.59	0.48	0.9	4.59
Strontium (Sr)	0.0747	0.162	0.166	0.152	0.171	0.172	0.17
Thallium (Tl)	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002	<0.000002
Vanadium (V)	0.00307	0.00033	0.00012	<0.00005	0.00011	<0.0002	0.0025
Zinc (Zn)	0.0106	0.0028	0.0011	<0.0005	0.0007	0.0141	0.0015

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
459	9	470
244	69	287
4.0	0.0	4
257	67	326
8.4	0.3	9
1	1	2
0.6	0.1	1
204	50.1	229
2.6	0.8	3.0
0.07	0.04	0.10
1.1	1.2	3.0
0.92	0.076	0.98
28.4	3.7	31.5
0.070	0.008	0.078
0.0783	0.1906	0.3651
0.0024	0.0011	0.0041
0.014	0.014	0.036
0.009	0.010	0.024
0.0167	0.0259	0.0562
0.0007	0.00132	0.0027
0.0041	0.0017	0.0056
0.000032	0.000061	0.00012
57.8	12.0	66.3
0.00066	0.00096	0.00217
0.00030	0.00008	0.00037
0.00086	0.00205	0.00388
0.17	0.10	0.27
0.000138	0.000297	0.000579
23.62	9.33	29.37
0.048	0.012	0.063
0.00001	0	0.00001
0.00195	0.00093	0.00334
0.00130	0.00078	0.00235
0.084	0.039191836	0.100
1.89	0.07	1.97
0.00074	0.00098	0.00221
4.61	0.30	4.97
0.000009	0.000002	0.000010
1.63	1.68	4.26
0.153	0.035	0.172
0.00004	0.00002	0.00005
0.00091	0.00129	0.00290
0.0045	0.0055	0.0131

Appendix B: Groundwater Quality Monitoring Data

MW06-9S

Sample name	MW06-9S	MW05-16S	06-9S	MW 06-9S	MW 06-9S	MW 06-9S	MW 06-9S	MW06-9S	MW 05-9S	MW 06-9S	MW06-9S
Date	17-Jun-06	17-Jun-06	14-Mar-07	6-Jun-07	14-Jul-07	2-Sep-07	23-Sep-07	4-Oct-07	14-Feb-08	22-May-08	4-Sep-08
Job Number	A626446	A626446	A710946	A724712	A731839	A741295	A745736	A748794	A807257	A825056	A846361
Parameters (mg/L)											
Physical Parameters											
Conductivity			267	266	249	263	259	256	250	260	270
Dissolved Hardness	170	110	138	144	133	143	144	146	121	136	149
Total Suspended Solids	<4	<4	<4	5	<4	<4	<4	<4	<4	<4	<4
Total Dissolved Solids	182	210	186	164	154	170	192	162	140	160	150
pH	9.2	8.6	8.1	8.2	8.2	8.3	8.2	8.1	8.3	8.2	8.3
Turbidity	0.1	0.3	0.3	0.8	1.1	2.2	0.2	1.8	0.6	0.5	0.5
DOC	26.4	31.5		0.8	1.1	<0.5	1.5	<0.5	<0.5	<0.5	0.5
Major Anions											
Alkalinity-Total	129	130	102	114	109	113	111	112	110	100	110
Acidity - Total									2.1	<0.5	2.1
Bromide	<0.1	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01	<0.1	<0.1	0.2
Chloride	1.5	<0.5	4.9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.8
Fluoride				0.88	0.56	0.41	0.4	0.41	0.7	0.74	0.45
Sulphate	37	44.3	26.1	24.4	22.9	21.6	22.3	22.3	24.8	22	26
Nutrient Parameters											
Ammonial Nitrogen	0.041	0.147	0.019	0.016	0.018	0.019	0.025	0.02	0.011	0.012	0.024
Nitrate Nitrogen	0.04	<0.02	0.005	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	0.022
Nitrite Nitrogen	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002
Total Phosphate	0.315	0.021		0.323	0.396	0.416	0.209	0.397	0.393	0.383	0.404
Dissolved Ortho-Phosphate	0.326	0.008		0.179	0.235	0.406	0.205	0.201	0.355	0.289	0.253
Dissolved Metals											
Aluminum (Al)	0.0128	0.0706	0.0041	0.0073	0.0038	0.0044	0.0049	0.0029	0.0032	0.0003	0.0056
Antimony (Sb)	0.00009	0.00213	0.00011	0.00008	<0.00005	<0.00005	<0.00005	<0.00005	0.00003	0.00003	0.00003
Arsenic (As)	0.0132	0.0011	0.0063	0.0054	0.0095	0.0122	0.01	0.0111	0.00821	0.00765	0.00994
Cadmium (Cd)	0.00005	0.00005	0.00001	0.00002	0.00002	0.00002	0.00002	0.00001	<0.000005	<0.000005	<0.000005
Calcium (Ca)	62.3	60.8	47.2	49.4	45.8	49.5	47.7	50.6	41.9	45.9	51.6
Chromium (Cr)	0.0003	<0.0002	0.0003	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0001	<0.0001	<0.0001
Cobalt (Co)	0.00002	0.00064	<0.00002	0.00003	0.00003	0.00006	0.00006	0.00004	0.000023	0.000036	0.000033
Copper (Cu)	0.0004	0.0005	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	0.00007	0.0001	0.00009
Iron (Fe)	0.03	0.022	0.046	0.121	0.62	0.782	0.017	0.845	0.337	0.002	0.496
Lead (Pb)	0.00006	0.00005	0.00002	0.00025	<0.00002	<0.00002	<0.00002	<0.00002	0.000011	<0.000005	0.000016
Magnesium (Mg)	4.66	11.4	4.88	5.05	4.65	4.64	4.42	4.85	4.01	5.22	4.89
Manganese (Mn)	0.123	0.328	0.105	0.115	0.158	0.183	0.184	0.178	0.115	0.115	0.151
Mercury (Hg)			<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.00972	0.0196	0.00681	0.00568	0.00698	0.00716	0.00708	0.00702	0.00667	0.00737	0.00752
Nickel (Ni)	<0.0005	0.0025	<0.0005	<0.0005	<0.0005	<0.0005	0.0009	<0.0005	0.00012	0.00018	0.00015
Phosphorus (P)	0.4	<0.1	0.3	0.2	0.4	0.4	0.2	0.4	0.395	0.311	
Potassium (K)	1.2	4.65	1.27	1.04	1.27	0.998	0.89	0.699	1.02	1.23	1.16
Selenium (Se)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004	<0.00004	<0.00004
Silicon (Si)	4.51	3.74	4.48	4.09	4.29	4.22	3.99	4.34	3.5	4.28	5.33
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005	<0.000005
Sodium (Na)	2.34	9.18	2.2	1.37	1.9	1.44	1.24	1.46	1.5	1.95	1.75
Strontium (Sr)	0.216	0.179	0.164	0.161	0.176	0.182	0.198	0.196	0.16	0.169	0.195
Thallium (Tl)	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002	<0.000002	<0.000002
Vanadium (V)	0.00147	0.00078	0.00021	<0.00005	0.00009	0.00009	<0.00005	<0.00005	<0.0002	<0.0002	<0.0002
Zinc (Zn)	0.0016	<0.0005	<0.0005	0.0011	0.0011	<0.0005	0.0018	<0.0005	0.001	<0.0001	0.0014

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
260	7	269
139	15	160
4	0	5
170	21	201
8.3	0.3	9
1	1	2
0.7	0.4	1
113	9.3	130
1.6	0.9	2.1
0.08	0.06	0.15
1.2	1.4	3.7
0.57	0.184	0.83
26.7	7.3	40.7
0.032	0.039	0.094
0.0094	0.0126	0.0310
0.0020	0.0000	0.0020
0.326	0.124	0.411
0.246	0.111	0.383
0.0109	0.0200	0.0417
0.0002	0.0006	0.0011
0.0086	0.0034	0.0127
0.000020	0.000016	0.00005
50.2	6.2	61.6
0.00019	0.00007	0.00030
0.00009	0.00018	0.00035
0.00017	0.00014	0.00045
0.30	0.33	0.81
0.000045	0.000070	0.000155
5.33	2.04	8.31
0.160	0.063	0.256
0.0001	0	0.00001
0.00833	0.00386	0.01466
0.00062	0.00066	0.00170
0.311	0.110	0.400
1.40	1.09	2.96
0.00037	0.00021	0.00050
4.25	0.47	4.92
0.000009	0.000002	0.000010
2.39	2.28	5.76
0.181	0.018	0.207
0.00004	0.0	0.00005
0.00031	0.0	0.001
0.0009	0.0005	0.0017

Appendix B: Groundwater Quality Monitoring Data

MW06-9M

Sample name	MW06-9M	MW 06-9M	MW 06-9M	MW 06-9M	MW 06-9M	MW06-9M
Date	17-Jun-06	6-Jun-07	14-Jul-07	2-Sep-07	22-May-08	4-Sep-08
Job Number	A626446	A724712	A731839	A741295	A825056	A846361
Parameters (mg/L)						
Physical Parameters						
Conductivity		364	363	378	390	390
Dissolved Hardness	170	217	205	213	221	225
Total Suspended Solids	<4	13	5	<4	<4	<4
Total Dissolved Solids	198	204	238	250	240	220
pH	8.6	8.3	8.2	8.2	8.2	8.4
Turbidity	0.2	18.1	17.1	13.5	9.1	8.5
DOC	32.6	<0.5	1.4	<0.5	0.7	<0.5
Major Anions						
Alkalinity-Total	132	191	171	168	170	160
Acidity - Total					<0.5	3
Bromide	<0.1	<0.1	<0.1	<0.01	<0.1	0.2
Chloride	<0.5	0.7	<0.5	<0.5	<0.5	0.6
Fluoride		1.05	1.02	0.97	0.98	0.91
Sulphate	44.6	10.2	30.1	30.2	28	34
Nutrient Parameters						
Ammonial Nitrogen	0.171	0.008	0.057	0.064	0.09	0.08
Nitrate Nitrogen	0.02	<0.002	0.003	0.002	0.003	0.033
Nitrite Nitrogen	<0.002	<0.002	0.003	<0.002	<0.002	<0.002
Total Phosphate	0.019	0.075	0.057	0.066	0.039	0.006
Dissolved Ortho-Phosphate	0.007	0.004	0.004	0.042	0.006	0.003
Dissolved Metals						
Aluminum (Al)	0.0405	0.0006	0.0018	0.0022	<0.0002	0.0048
Antimony (Sb)	0.00232	<0.00005	0.00008	<0.00005	0.00011	0.00022
Arsenic (As)	0.0008	0.0003	0.0011	0.0014	0.00102	0.00163
Cadmium (Cd)	0.00004	0.00001	0.00003	0.00001	<0.000005	0.000008
Calcium (Ca)	50.1	66.6	62.5	65.9	66.8	69.5
Chromium (Cr)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0001	<0.0001
Cobalt (Co)	0.00059	0.00006	0.00006	0.00004	0.000045	0.000063
Copper (Cu)	0.0008	0.0002	<0.0001	<0.0001	<0.00005	0.00012
Iron (Fe)	0.016	0.256	1.99	1.62	0.068	1.25
Lead (Pb)	0.00003	0.00005	0.00006	<0.00002	<0.000005	0.000045
Magnesium (Mg)	10.8	12.3	11.8	11.9	13.1	12.5
Manganese (Mn)	0.222	0.322	0.114	0.0612	0.0743	0.0434
Mercury (Hg)		<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.0179	0.0036	0.00466	0.00485	0.00419	0.00518
Nickel (Ni)	0.0033	<0.0005	<0.0005	<0.0005	0.00007	0.00031
Phosphorus (P)	<0.1	<0.1	<0.1	<0.1	0.006	
Potassium (K)	4.78	2.06	1.87	2.06	2.13	1.93
Selenium (Se)	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004	<0.00004
Silicon (Si)	3.77	3.98	3.67	3.54	3.88	3.58
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005
Sodium (Na)	8.07	0.45	0.52	0.59	0.58	0.72
Strontium (Sr)	0.159	0.0854	0.0788	0.077	0.09	0.0846
Thallium (Tl)	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002	<0.000002
Vanadium (V)	0.00083	<0.00005	<0.00005	<0.00005	<0.0002	<0.0002
Zinc (Zn)	<0.0005	<0.0005	0.0041	<0.0005	<0.0001	0.0016

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
377	13	390
209	20	224
5.7	3.6	11
225	21	248
8.3	0.2	9
11	7	18
0.7	0.4	1
165	19.3	186
1.8	1.8	2.9
0.10	0.06	0.18
0.6	0.1	0.7
0.99	0.053	1.04
29.5	11.2	42.0
0.078	0.054	0.151
0.0086	0.0136	0.0270
0.0022	0.0004	0.0028
0.044	0.027	0.073
0.011	0.015	0.033
0.0084	0.0158	0.0316
0.0005	0.00091	0.0018
0.0010	0.0005	0.0016
0.000017	0.000014	0.00004
63.6	7.0	68.8
0.00017	0.00005	0.00020
0.00014	0.00022	0.00046
0.00023	0.00028	0.00065
0.87	0.86	1.90
0.000035	0.000020	0.000058
12.07	0.78	12.95
0.139	0.110	0.297
0.00001	0	0.00001
0.00673	0.00550	0.01472
0.00086	0.00121	0.00260
0.081	0.042038078	0.100
2.47	1.13	4.12
0.00035	0.00024	0.00050
3.74	0.17	3.96
0.000008	0.000003	0.000010
1.82	3.06	6.23
0.096	0.031	0.142
0.00003	0.00002	0.00005
0.00023	0.00030	0.00067
0.0012	0.0015	0.0035

Appendix B: Groundwater Quality Monitoring Data

MW06-10S

Sample name	MW06-10S	MW 06-10S	MW 06-10S	MW 06-10S	MW 06-10S	MW06-10S	MW 05-10S	MW06-10S	MW06-10S
Date	15-Jun-06	6-Jun-07	11-Jul-07	31-Aug-07	22-Sep-07	8-Oct-07	14-Feb-08	24-May-08	31-Aug-08
Job Number	A626573	A724712	A731839	A741295	A745736	A748794	A807257	A825056	A845319
Parameters (mg/L)									
Physical Parameters									
Conductivity		296	275	274	278	273	290	290	280
Dissolved Hardness	160	141	136	115	144	138	129	148	146
Total Suspended Solids	<4	<4	<4	<4	<4	<4	<4	<4	<4
Total Dissolved Solids	200	180	168	184	194	166	220	180	160
pH	8.2	8.2	8.1	8.3	8.2	8.1	8.3	8.1	8.1
Turbidity	0.2	0.3	0.5	0.4	0.3	0.5	0.7	0.5	0.9
DOC	1.9	0.7	1.4	<0.5	1.4	<0.5	<0.5	<0.5	<0.5
Major Anions									
Alkalinity-Total	116	116	118	111	115	112	120	110	110
Acidity - Total							1.8	<0.5	1.5
Bromide	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1
Chloride	<0.5	4.9	<0.5	<0.5	1.1	<0.5	<0.5	<0.5	0.5
Fluoride		0.26	0.28	0.22	0.24	0.23	0.27	0.22	0.21
Sulphate	44.6	29.5	28.4	29.4	29.7	29.7	33.2	30	29
Nutrient Parameters									
Ammonial Nitrogen	0.058	0.017	0.015	0.01	0.025	0.02	0.015	0.012	0.026
Nitrate Nitrogen	0.04	<0.002	0.009	<0.002	<0.002	0.003	<0.002	0.003	0.024
Nitrite Nitrogen	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Phosphate	0.007	0.051	0.044	0.045	0.02	0.025	0.046	0.027	0.024
Dissolved Ortho-Phosphate	0.006	0.054	0.022	0.04	0.02	0.029	0.023	0.018	0.018
Dissolved Metals									
Aluminum (Al)	0.0087	0.0053	0.0055	0.0069	0.0052	0.0039	0.0046	0.0028	0.005
Antimony (Sb)	0.00332	0.00039	0.00034	0.00033	0.00041	0.00028	0.00032	0.00035	0.00043
Arsenic (As)	0.003	0.0053	0.005	0.0044	0.0047	0.0046	0.00458	0.00498	0.00544
Cadmium (Cd)	0.00007	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005	<0.000005
Calcium (Ca)	54.1	49.8	47.6	40.6	48.8	48.6	45.3	51.5	50.9
Chromium (Cr)	0.0006	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0001	<0.0001	<0.0001
Cobalt (Co)	0.00368	0.00019	0.00014	0.00011	0.00027	0.00019	0.000157	0.000181	0.000202
Copper (Cu)	0.0003	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	0.00058	0.00005
Iron (Fe)	0.119	0.207	0.182	0.041	0.048	0.117	0.16	0.189	0.269
Lead (Pb)	0.00015	0.00003	<0.00002	0.00003	0.00005	<0.00002	0.000013	0.000027	0.000024
Magnesium (Mg)	5.19	4.1	4.1	3.27	4.08	4.15	3.76	4.72	4.7
Manganese (Mn)	0.252	0.09	0.0916	0.0487	0.0998	0.0845	0.0853	0.0979	0.122
Mercury (Hg)		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.00577	0.00199	0.00184	0.00232	0.00161	0.00184	0.00161	0.00155	0.00145
Nickel (Ni)	0.0105	0.0014	<0.0005	<0.0005	0.0022	<0.0005	0.00078	0.00072	0.00074
Phosphorus (P)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.03	0.033	
Potassium (K)	2.39	1.22	1.2	1.91	1.24	1.18	2.19	1.47	1.27
Selenium (Se)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004	<0.00004	<0.00004
Silicon (Si)	3.31	3.96	4.14	5.41	3.57	4.39	3.49	4.15	3.84
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	0.000011	<0.000005
Sodium (Na)	9.21	9.03	7.16	14.4	3.91	7.56	5.25	5.32	3.31
Strontium (Sr)	0.194	0.164	0.168	0.145	0.177	0.175	0.172	0.186	0.201
Thallium (Tl)	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002	0.000005	<0.000002
Vanadium (V)	0.00011	0.00018	0.0001	0.00019	0.0001	<0.00005	<0.0002	<0.0002	<0.0002
Zinc (Zn)	0.009	0.0006	0.0013	0.0014	0.0021	0.0019	0.002	0.0013	0.0019

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
282	9	294
140	13	155
4	0	4
184	19	212
8.2	0.1	8
0	0	1
0.9	0.5	2
114	3.6	119
1.3	0.7	1.8
0.07	0.05	0.10
1.1	1.5	3.4
0.24	0.026	0.28
31.5	5.1	40.0
0.022	0.015	0.045
0.0097	0.0135	0.0336
0.0022	0.0007	0.0032
0.032	0.015	0.049
0.026	0.014	0.048
0.0053	0.0017	0.0080
0.0007	0.0010	0.0022
0.0047	0.0007	0.0054
0.000015	0.000021	0.00005
48.6	3.9	53.1
0.00021	0.00015	0.00044
0.00057	0.00117	0.00232
0.00016	0.00017	0.00047
0.15	0.07	0.24
0.000040	0.000042	0.000110
4.23	0.57	5.00
0.108	0.057	0.200
0.00001	0	0.00001
0.00222	0.00136	0.00439
0.00198	0.00324	0.00718
0.083	0.032	0.100
1.56	0.47	2.31
0.00035	0.00023	0.00050
4.03	0.62	5.00
0.000009	0.000002	0.000011
7.24	3.40	12.32
0.176	0.017	0.198
0.00003	0.0	0.00005
0.00014	0.0	0.000
0.0024	0.0025	0.0062

Appendix B: Groundwater Quality Monitoring Data

MW06-10M

Sample name	MW06-10M	06-10M	06-10M	MW 06-10M	MW 06-10M	MW 06-10M	MW 06-10M	MW06-10M	MW06-10M
Date	16-Jun-06	27-Apr-07	9-May-07	6-Jun-07	11-Jul-07	31-Aug-07	22-Sep-07	8-Oct-07	31-Aug-08
Job Number	A626446	A717990	A719951	A724712	A731839	A741295	A745736	A748794	A845319
Parameters (mg/L)									
Physical Parameters									
Conductivity		488		467	463	479	473	470	480
Dissolved Hardness	260	256	282	277	262	271	267	271	261
Total Suspended Solids	<4	<4	5	10	10	7	14	<4	12
Total Dissolved Solids	258	316	288	286	304	256	290	296	280
pH	8.4	8.2	8.3	8.3	8.3	8.2	8.1	8.1	8.1
Turbidity	4.3	2.6	39.8	39.7	48.5	49.9	19.7	3.8	61.2
DOC	42.5		<0.5	<0.5	0.9	<0.5	0.6	<0.5	<0.5
Major Anions									
Alkalinity-Total	189	204	196	202	208	207	205	204	210
Acidity - Total									4.4
Bromide	<0.1	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01	<0.1
Chloride	<0.5	<0.5	4.1	0.9	0.9	2.8	3	<0.5	0.9
Fluoride				0.83	0.78	0.79	0.79	0.74	0.68
Sulphate	61	61.3	67.9	53	43.5	38.7	44.6	48.9	51
Nutrient Parameters									
Ammonial Nitrogen	0.096	0.063	0.066	0.057	0.043	0.059	0.045	0.062	0.07
Nitrate Nitrogen	0.02	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	0.002	2.37
Nitrite Nitrogen	<0.002	<0.002	0.006	<0.002	0.006	<0.002	0.007	<0.002	<0.002
Total Phosphate	<0.005		0.056	0.067	0.027	0.007	<0.005	0.042	
Dissolved Ortho-Phosphate	0.006	0.006	0.006	0.003	0.004	0.02	0.006	0.006	0.002
Dissolved Metals									
Aluminum (Al)	0.0063	<0.0002	0.0009	0.0037	0.0038	0.0107	0.0042	0.0007	0.0036
Antimony (Sb)	0.0064	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00002
Arsenic (As)	0.0005	0.0001	<0.0001	0.0004	0.0003	0.0004	0.0005	0.0002	0.00039
Cadmium (Cd)	0.00002	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.000005
Calcium (Ca)	86.9	83.6	93.7	90	83.9	86.8	81.8	86.9	82.8
Chromium (Cr)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0001
Cobalt (Co)	0.00113	0.00007	0.00007	0.00009	0.00005	0.00005	0.00007	0.00003	0.000034
Copper (Cu)	<0.00001	<0.0001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	<0.0001	0.00005
Iron (Fe)	1.33	0.176	2.81	4.84	4.41	4.17	2.69	0.552	6.34
Lead (Pb)	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00008	0.00003	<0.00002	0.000025
Magnesium (Mg)	10.3	11.4	11.7	12.7	12.7	13.2	12.2	13.1	13.1
Manganese (Mn)	0.3	0.244	0.186	0.235	0.259	0.25	0.252	0.233	0.258
Mercury (Hg)		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.00468	0.00211	0.002	0.00202	0.00202	0.00216	0.00203	0.00202	0.00274
Nickel (Ni)	0.0009	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0011	<0.0005	0.00011
Phosphorus (P)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Potassium (K)	7.56	1.69	1.95	1.95	1.79	2.06	1.83	1.43	1.86
Selenium (Se)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004
Silicon (Si)	3.8	3.78	4.19	3.89	3.96	3.85	3.53	3.69	3.83
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005
Sodium (Na)	7.95	2.86	3.38	3.15	2.76	2.84	2.45	2.87	3.14
Strontium (Sr)	0.24	0.148	0.151	0.142	0.139	0.133	0.145	0.14	0.154
Thallium (Tl)	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002
Vanadium (V)	<0.00005	0.00012	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.0002
Zinc (Zn)	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	0.0034	0.005	0.0006	0.0013

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
474	9	486
267	9	280
8	4	13
286	20	311
8.2	0.1	8
30	23	57
0.6	0.1	1
203	6.5	209
4.4		4.4
0.07	0.05	0.10
1.6	1.4	3.7
0.77	0.052	0.82
52.2	9.6	65.3
0.062	0.015	0.086
0.0043	0.0064	0.0137
0.0034	0.0022	0.0066
0.030	0.026	0.064
0.007	0.005	0.014
0.0038	0.0033	0.0089
0.0008	0.0021	0.0039
0.0003	0.0002	0.0005
0.000011	0.000004	0.00002
86.3	3.8	92.2
0.00019	0.00003	0.00020
0.00018	0.00036	0.00071
0.00011	0.00008	0.00022
3.04	2.08	5.74
0.000028	0.000020	0.000060
12.27	0.97	13.16
0.246	0.030	0.284
0.00001	0	0.00001
0.00242	0.00088	0.00390
0.00057	0.00028	0.00102
0.100	0.000	0.100
2.46	1.92	5.36
0.00045	0.00015	0.00050
3.84	0.18	4.10
0.000009	0.000002	0.000010
3.49	1.69	6.12
0.155	0.033	0.206
0.00004	0.0	0.00005
0.00007	0.0	0.000
0.0014	0.0016	0.0044

Appendix B: Groundwater Quality Monitoring Data

MW06-10D

Sample name	MW06-10D	MW 06-10D	MW 06-10D	MW 06-10D	MW 06-10D
Date	19-Jun-06	6-Jun-07	11-Jul-07	31-Aug-07	22-Sep-07
Job Number	A626446	A724712	A731839	A741295	A745736
Parameters (mg/L)					
Physical Parameters					
Conductivity		463	460	475	473
Dissolved Hardness	170	278	266	274	276
Total Suspended Solids	<4	13	11	7	7
Total Dissolved Solids	170	272	286	288	308
pH	8.5	8.4	8.3	8.2	8.2
Turbidity	0.2	49.4	53.9	57.1	24.3
DOC	29.1	<0.5	<0.5	<0.5	0.6
Major Anions					
Alkalinity-Total	140	237	242	236	239
Acidity - Total					
Bromide	<0.1	<0.1	<0.1	<0.01	<0.01
Chloride	<0.5	3.4	0.9	2.4	1.6
Fluoride		1.08	1.01	0.98	0.95
Sulphate	26.4	21.8	15.5	19.2	16.4
Nutrient Parameters					
Ammonial Nitrogen	0.157	0.043	0.117	0.059	0.066
Nitrate Nitrogen	0.24	<0.002	<0.002	<0.002	<0.002
Nitrite Nitrogen	0.004	0.002	0.007	<0.002	<0.002
Total Phosphate	<0.005	0.025	0.019	0.022	0.005
Dissolved Ortho-Phosphate	0.005	0.003	0.003	0.015	0.01
Dissolved Metals					
Aluminum (Al)	0.0046	0.0196	0.0031	0.0076	0.0022
Antimony (Sb)	0.0371	0.00108	0.00038	0.00064	0.00039
Arsenic (As)	0.0006	0.0003	0.0003	0.0003	0.0004
Cadmium (Cd)	0.00071	<0.00001	<0.00001	<0.00001	0.00001
Calcium (Ca)	48.5	75	73.1	75.9	75
Chromium (Cr)	<0.0002	<0.0002	<0.0002	<0.0002	0.0002
Cobalt (Co)	0.00027	0.00003	<0.00002	<0.00002	0.00003
Copper (Cu)	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Iron (Fe)	0.047	5.04	4.55	4.64	2.3
Lead (Pb)	<0.00002	0.00014	<0.00002	0.00008	<0.00002
Magnesium (Mg)	11	22.1	20.3	20.6	19.6
Manganese (Mn)	0.117	0.0976	0.112	0.0995	0.0995
Mercury (Hg)		<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum (Mo)	0.00776	0.0045	0.00324	0.00423	0.00363
Nickel (Ni)	0.0023	<0.0005	<0.0005	<0.0005	0.0011
Phosphorus (P)	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium (K)	6.46	2.74	2.39	2.63	2.31
Selenium (Se)	0.0031	<0.0005	<0.0005	0.0005	<0.0005
Silicon (Si)	3.14	4	3.62	3.68	3.29
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Sodium (Na)	3.54	1.39	1.09	1.18	1.04
Strontium (Sr)	0.17	0.169	0.168	0.163	0.174
Thallium (Tl)	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Vanadium (V)	0.0001	0.00008	<0.00005	<0.00005	<0.00005
Zinc (Zn)	<0.0005	0.0038	0.0008	<0.0005	0.0008

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
468	7	475
253	47	278
8.4	3.6	13
265	55	304
8.3	0.1	8
37	24	56
0.5	0.0	1
219	44.1	241
0.06	0.05	0.10
1.8	1.2	3.2
1.01	0.056	1.07
19.9	4.4	25.5
0.088	0.047	0.149
0.0020	0	0.0020
0.0034	0.0022	0.0064
0.015	0.010	0.024
0.007	0.005	0.014
0.0074	0.0071	0.0172
0.00062	0.00033	0.001
0.0004	0.0001	0.0006
0.00001	0	0.00001
69.5	11.8	75.7
0.00020	0.00000	0.00020
0.00003	0.00001	0.00003
0.00010	0.00000	0.00010
4.13	1.24	4.98
0.000056	0.000054	0.000128
18.72	4.41	21.80
0.105	0.009	0.116
0.00001	0	0.00001
0.00467	0.00180	0.00711
0.00098	0.00078	0.00206
0.100	0	0.100
3.31	1.77	5.72
0.0005	0.0000	0.0005
3.55	0.34	3.94
0.000010	0.000000	0.000010
1.65	1.07	3.11
0.169	0.004	0.173
0.00005	0.00000	0.00005
0.00007	0.00002	0.00010
0.0013	0.0014	0.0032

Appendix B: Groundwater Quality Monitoring Data

MW06-11S

Sample name	MW06-11S	MW05-16M	MW06-11S	MW 06-11S	MW 06-11S	MW 06-11S	MW 06-11S	MW06-11S	MW06-11S	MW06-11S
Date	18-Jun-06	18-Jun-06	13-Sep-06	10-Jun-07	13-Jul-07	3-Sep-07	23-Sep-07	8-Oct-07	23-May-08	3-Sep-08
Job Number	A626446	A626446	Z2772	A725184	A731839	A741295	A745736	A748794	A825056	A846361
Parameters (mg/L)										
Physical Parameters										
Conductivity			141	326	310	326	337	336	420	400
Dissolved Hardness	220	260	86.6	191	162	169	180	185	242	223
Total Suspended Solids	<4	<4	155	<4	<4	<4	<4	<4	<4	<4
Total Dissolved Solids	289	304	83	160	218	194	244	208	240	240
pH	8.6	8.7	8.81	8.3	8.3	8.4	8.3	8.2	8.3	8.4
Turbidity	1	0.2	11.6	0.4	0.4	0.5	0.3	0.5	0.5	0.4
DOC	35.9	38.3		<0.5	0.7	0.8	1.3	<0.5	0.9	0.9
Major Anions										
Alkalinity-Total	159	176	42.1	137	133	134	138	139	180	160
Acidity - Total									<0.5	1.9
Bromide	<0.1	<0.1	<0.05	<0.1	<0.1	<0.01	<0.01	<0.01	<0.1	0.2
Chloride	<0.5	<0.5	<0.5	1.8	<0.5	<0.5	2.6	<0.5	<0.5	0.9
Fluoride			1.53	2.17	2.1	2.15	2.27	2.08	2.25	2.21
Sulphate	80.5	73.4	30.2	30.4	31.3	33.6	35.8	35.4	36	36
Nutrient Parameters										
Ammonial Nitrogen	0.17	0.177	0.294	0.162	0.088	0.133	0.146	0.164	0.189	0.14
Nitrate Nitrogen	0.17	0.14	<0.005	<0.002	<0.002	0.002	0.002	<0.002	0.003	0.009
Nitrite Nitrogen	0.005	0.004	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Phosphate	0.043	0.048		0.027	0.021	0.025	0.028	0.032	0.064	0.031
Dissolved Ortho-Phosphate	0.013	0.02	<0.001	0.016	0.016	0.027	0.025	0.029	0.064	0.027
Dissolved Metals										
Aluminum (Al)	0.033	0.0346	0.0305	0.035	0.0181	0.0145	0.0165	0.0109	0.005	0.022
Antimony (Sb)	0.00376	0.0039	0.0012	0.0005	0.00208	0.00115	0.00065	0.00114	0.00031	0.00059
Arsenic (As)	0.0043	0.0054	0.00261	0.0036	0.0031	0.0042	0.0039	0.0042	0.00322	0.00365
Cadmium (Cd)	0.00009	0.00006	<0.00002	0.00005	0.00005	0.00007	0.00008	0.00005	0.000006	0.000047
Calcium (Ca)	69.8	77.4	20.8	56.9	46	48.6	49.7	54.1	70.3	64.3
Chromium (Cr)	0.0051	0.001	<0.0005	<0.0002	<0.0002	<0.0002	0.0004	0.0003	<0.0001	0.0013
Cobalt (Co)	0.0006	0.00074	<0.0001	0.00021	0.00005	0.00004	0.00016	0.00017	0.000159	0.000128
Copper (Cu)	0.0005	0.0004	0.00017	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.00011	0.00017
Iron (Fe)	0.009	0.029	<0.030	0.271	0.183	0.181	0.006	0.212	0.002	0.287
Lead (Pb)	0.00005	0.00003	<0.00005	0.00005	0.0001	0.00003	0.00005	0.00002	<0.000005	0.000022
Magnesium (Mg)	12	15.3	8.4	11.8	11.5	11.4	11.5	12.2	16.2	15.1
Manganese (Mn)	0.0438	0.0484	0.0279	0.0969	0.0625	0.0435	0.092	0.0721	0.0783	0.0844
Mercury (Hg)				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.0289	0.0206	0.0157	0.0214	0.0303	0.0356	0.0257	0.03	0.0184	0.0265
Nickel (Ni)	0.0025	0.003	0.00105	<0.0005	<0.0005	<0.0005	0.0013	<0.0005	0.00051	0.0266
Phosphorus (P)	<0.1	<0.1	<0.30	<0.1	<0.1	<0.1	<0.1	<0.1	0.034	
Potassium (K)	4.37	2.69	<2	1.3	2.03	2.59	1.9	1.68	1.91	2.23
Selenium (Se)	0.0017	0.0011	<0.0005	0.0005	<0.0005	0.0006	<0.0005	<0.0005	<0.00004	<0.00004
Silicon (Si)	5.15	4.76	3.36	4.5	4.57	4.63	4.33	4.85	4.52	5.04
Silver (Ag)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.000006	<0.000005
Sodium (Na)	32	20.4	7.3	3.15	3.83	4.42	4.48	4.89	4.45	4.56
Strontium (Sr)	0.218	0.208	0.114	0.0977	0.0978	0.0987	0.109	0.105	0.128	0.13
Thallium (Tl)	<0.00005	<0.00005	<0.0001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002	<0.000002
Vanadium (V)	0.00225	0.00172	<0.001	0.00171	0.00093	0.00074	0.00059	0.00087	<0.0002	0.0003
Zinc (Zn)	<0.0005	<0.0005	<0.001	<0.0005	0.0007	0.0007	0.0026	<0.0005	0.0002	0.0022

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
325	84	413
192	49	252
19	48	87
218	64	297
8.4	0.2	9
2	4	7
0.8	0.3	1
140	38.5	178
1.2	1.0	1.8
0.08	0.06	0.16
0.9	0.7	2.2
2.10	0.238	2.26
42.3	18.5	77.3
0.166	0.053	0.247
0.0337	0.0644	0.1565
0.0024	0.0012	0.0046
0.035	0.014	0.058
0.024	0.016	0.048
0.0220	0.0107	0.0348
0.0015	0.0013	0.0038
0.0038	0.0008	0.0049
0.000052	0.000025	0.00009
55.8	16.2	74.2
0.00093	0.00152	0.00339
0.00024	0.00024	0.00068
0.00019	0.00014	0.00046
0.13	0.12	0.28
0.000041	0.000026	0.000077
12.54	2.34	15.80
0.065	0.023	0.095
0.00001	0	0.00001
0.02531	0.00619	0.03322
0.00370	0.00810	0.01598
0.092	0.023	0.100
2.27	0.84	3.61
0.00060	0.00049	0.00143
4.57	0.49	5.10
0.000009	0.000002	0.000010
8.95	9.55	26.78
0.131	0.045	0.214
0.00004	0.0	0.00005
0.00103	0.0	0.002
0.0009	0.0008	0.0024

Appendix B: Groundwater Quality Monitoring Data

MW06-12S

Sample name	MW06-12S	MW06-12S	06-12S	06-12S	06-12S	MW 06-12S	MW 06-12S	MW 06-12S	MW 06-12S	MW06-12S	MW 05-12S	MW06-12S	MW 06-12S
Date	16-Jun-06	13-Sep-06	14-Mar-07	26-Apr-07	10-May-07	10-Jun-07	12-Jul-07	2-Sep-07	21-Sep-07	8-Oct-07	14-Feb-08	22-May-08	5-Sep-08
Job Number	A626470	Z2772	A710946	A717990	A719951	A725184	A731839	A741295	A745736	A748794	A807257	A825056	A846692
Parameters (mg/L)													
Physical Parameters													
Conductivity		1050	983	871		801	777	799	780	791	810	820	800
Dissolved Hardness	200	175	262	319	353	314	331	358	373	382	343	391	390
Total Suspended Solids	<4	596	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Total Dissolved Solids	234	741	658	642	576	494	604	578	606	570	580	550	530
pH	7.7	8.42	8	8.6	8.4	8.2	8.3	8.3	8.3	8.2	8.4	8.3	8.2
Turbidity	0.2	350	0.2	2.8	<0.1	0.1	0.3	0.7	1.7	0.3	0.6	0.3	1.4
DOC	20.2				2.1	1.6	0.6	0.8	1.9	0.5	<0.5	1	0.8
Major Anions													
Alkalinity-Total	64.5	85.6	112	158	151	132	141	143	146	146	150	150	130
Acidity - Total											1.4	<0.5	1.3
Bromide	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	0.05	0.05	0.06	<0.1	<0.1	0.2
Chloride	1.4	1.36	5.8	<0.5	3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	0.7
Fluoride		0.915				1.14	1.13	1.09	1.12	1.05	1.05	1.07	0.93
Sulphate	99.2	426	372	285	287	273	263	274	277	271	293	270	270
Nutrient Parameters													
Ammonial Nitrogen	0.058	0.308	0.139	0.195	0.193	0.194	0.115	0.143	0.19	0.128	0.104	0.094	0.044
Nitrate Nitrogen	0.45	<0.005	0.003	0.013	0.003	<0.002	0.002	<0.002	<0.002	0.005	0.011	0.024	0.039
Nitrite Nitrogen	0.005	0.0198	<0.002	<0.002	0.005	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	0.004
Total Phosphate	0.022				0.022	0.037	0.019	0.051	0.051	0.015	0.031	0.034	0.043
Dissolved Ortho-Phosphate	0.005	0.0563		0.05	0.043	0.018	0.027	0.028	0.046	0.024	0.025	0.024	0.007
Dissolved Metals													
Aluminum (Al)	0.0278	0.0915	0.0074	0.0023	0.0026	0.0012	0.0016	0.0011	0.0024	0.0012	0.0029	<0.0002	0.0033
Antimony (Sb)	0.00683	0.0136	0.00207	0.0019	0.00199	0.00137	0.00108	0.00071	0.00088	0.00115	0.00107	0.00144	0.00092
Arsenic (As)	0.0007	0.0049	0.0043	0.0041	0.004	0.0028	0.0029	0.0031	0.0033	0.0018	0.00191	0.00225	0.00205
Cadmium (Cd)	0.00023	<0.00004	0.00003	0.00003	0.00002	0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.000005	<0.000005	<0.000005
Calcium (Ca)	38.1	51.6	79.5	102	112	95.6	102	112	111	119	109	124	123
Chromium (Cr)	0.0013	<0.001	0.0004	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0001	0.0001
Cobalt (Co)	0.0035	0.00075	0.00072	0.00077	0.00062	0.00042	0.00045	0.00055	0.00081	0.00078	0.000339	0.000552	0.000737
Copper (Cu)	0.0023	<0.0002	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.00011	0.00028	0.00016
Iron (Fe)	0.096	0.136	0.008	0.007	<0.005	<0.005	0.095	0.262	0.624	0.009	0.015	0.006	0.447
Lead (Pb)	0.00036	0.00021	0.00002	0.00005	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00002	0.00002	<0.000005	0.000019
Magnesium (Mg)	4.25	11.2	15.5	15.6	18.2	18.3	18.3	19.2	19	20.7	17.5	19.8	20.3
Manganese (Mn)	0.169	0.186	0.21	0.364	0.407	0.197	0.284	0.331	0.376	0.325	0.192	0.272	0.329
Mercury (Hg)			<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum (Mo)	0.0125	0.0468	0.0297	0.0123	0.0082	0.00577	0.00496	0.00473	0.00385	0.0035	0.00289	0.00354	0.0025
Nickel (Ni)	0.0121	0.0072	0.0028	0.002	0.0013	0.001	<0.0005	<0.0005	0.002	<0.0005	0.00105	0.00137	0.00154
Phosphorus (P)	<0.1	<0.30	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.029	0.031	
Potassium (K)	2.07	3.3	3.27	2.26	2.77	2.5	2.78	3.19	2.96	2.19	2.66	2.81	3.07
Selenium (Se)	0.0035	0.00097	0.0008	0.0005	<0.0005	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.00004	<0.00004	<0.00004
Silicon (Si)	3.06	4.2	6.34	9.04	9.74	8.37	8.06	7.7	7	7.44	6.51	9.43	6.85
Silver (Ag)	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.000005	<0.000005
Sodium (Na)	34.2	161	118	65.6	60.2	58.1	45.7	42.2	34	36.4	34.7	37.3	30.2
Strontium (Sr)	0.0886	0.196	0.253	0.441	0.375	0.343	0.361	0.349	0.384	0.393	0.417	0.432	0.413
Thallium (Tl)	<0.00005	<0.00002	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.000002	<0.000002	<0.000002
Vanadium (V)	0.00063	0.0055	0.00246	0.00329	0.00227	0.00136	0.00073	0.00035	0.00036	0.0006	0.0004	0.0003	<0.0002
Zinc (Zn)	0.033	0.009	<0.0005	0.0102	<0.0005	<0.0005	0.0007	<0.0005	0.001	0.0009	0.0009	0.0002	0.002

DL too high; not used in statistical evaluation
Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
844	90	1017
322	70	390
49.5	164.2	241
566	117	691
8.3	0.2	8
28	97	142
1.1	0.6	2
131	28.0	154
1.1	0.5	1.4
0.09	0.04	0.14
1.3	1.5	4.1
1.06	0.082	1.14
281.6	72.7	393.6
0.147	0.070	0.240
0.0093	0.0115	0.0308
0.0040	0.0049	0.0109
0.030	0.012	0.048
0.029	0.016	0.053
0.0112	0.0252	0.0533
0.0027	0.00364	0.0095
0.0029	0.0012	0.0045
0.000032	0.000061	0.00012
98.4	26.7	123.4
0.00035	0.00037	0.00112
0.00085	0.00081	0.00189
0.00030	0.00060	0.00109
0.13	0.20	0.52
0.000062	0.000104	0.000270
16.76	4.53	20.46
0.280	0.082	0.388
0.00001	0	0.00001
0.01086	0.01306	0.03654
0.00260	0.00335	0.00916
0.087	0.028319926	0.100
2.76	0.41	3.28
0.00068	0.00089	0.00198
7.21	1.93	9.55
0.000010	0.000004	0.000014
58.28	38.76	135.20
0.342	0.103	0.436
0.00004	0.00002	0.00005
0.00142	0.00158	0.00417
0.0046	0.0092	0.0193

Appendix C
Stream Sediment Quality Data

Appendix C: Stream Sediment Quality Data

W8

Maxxam ID		W8	W8A	W8B	W8C
Sampling Date		10-Sep-05	8/25/2007	8/25/2007	8/25/2007
Lab Report	Units	A536970	8196643	8196643	8196643
Misc. Inorganics					
Soluble (2:1) pH	pH Units	7.54	7.18	7.12	7.15
Total Metals by ICPMS					
Total Aluminum (Al)	mg/kg	11100	9150	8740	10200
Total Antimony (Sb)	mg/kg	1.2	1	1	1.1
Total Arsenic (As)	mg/kg	9	7.1	5.7	5.8
Total Barium (Ba)	mg/kg	292	231	204	231
Total Beryllium (Be)	mg/kg	0.2	0.2	0.2	0.3
Total Bismuth (Bi)	mg/kg	0.2	0.2	0.2	0.2
Total Cadmium (Cd)	mg/kg	1.06	1.72	2.09	2.18
Total Calcium (Ca)	mg/kg	4720	6760	7730	10000
Total Chromium (Cr)	mg/kg	34.3	33	26	37
Total Cobalt (Co)	mg/kg	12.1	10.4	10	11.2
Total Copper (Cu)	mg/kg	108	52.1	53.8	61
Total Iron (Fe)	mg/kg	27400	22600	18700	21000
Total Lead (Pb)	mg/kg	56.4	16.7	15.9	16.1
Total Magnesium (Mg)	mg/kg	9390	7150	5820	6700
Total Manganese (Mn)	mg/kg	490	415	335	388
Total Mercury (Hg)	mg/kg	<0.05	0.06	0.07	0.07
Total Molybdenum (Mo)	mg/kg	1.8	1.5	1.3	1.9
Total Nickel (Ni)	mg/kg	44.6	47.7	39	52
Total Phosphorus (P)	mg/kg	1090	881	821	991
Total Potassium (K)	mg/kg	586	513	482	556
Total Selenium (Se)	mg/kg	1.9	2.2	2.5	3.2
Total Silver (Ag)	mg/kg	0.25	0.34	0.35	0.34
Total Sodium (Na)	mg/kg	<100	<100	<100	<100
Total Strontium (Sr)	mg/kg	23.3	26	27.4	31.2
Total Thallium (Tl)	mg/kg	0.09	<0.05	<0.05	<0.05
Total Tin (Sn)	mg/kg	6.9	0.3	0.3	0.3
Total Titanium (Ti)	mg/kg	914	582	556	531
Total Vanadium (V)	mg/kg	40.3	30	26	30
Total Zinc (Zn)	mg/kg	301	280	267	286
Total Zirconium (Zr)	mg/kg	4.6	1	1	0.8

AVG	Std Dev.	95th Percentile
7.2	0.2	7.5
9798	1064	10965
1.1	0.1	1.2
6.9	1.5	8.7
240	37	283
0.23	0.05	0.29
0.2	0.0	0.2
1.76	0.51	2.17
7303	2193	9660
33	5	37
10.9	0.9	12.0
68.7	26.5	101
22425	3683	26680
26.3	20.1	50.4
7265.0	1520.5	9054.0
407	65	479
0.06	0.01	0.07
1.63	0.28	1.89
46	5	51
946	119	1075
534.3	45.9	581.5
2.45	0.56	3.10
0.32	0.05	0.35
100	0	100
27.0	3.3	30.6
0.06	0.02	0.08
1.95	3.30	5.91
646	180	864
32	6	39
284	14	299
1.9	1.8	4.1

Appendix C: Stream Sediment Quality Data

W9

Maxxam ID		W9	W9A	W9B	W9C	W9	W9A	W9B	W9C	W9A	W9B	W9C
Sampling Date		10-Sep-05	6-Oct-06	6-Oct-06	6-Oct-06	14-Sep-06	25-Aug-07	25-Aug-07	25-Aug-07	24-Aug-08	24-Aug-08	24-Aug-08
Lab Report	Units	A536970	A648127	A648127	A648127	Z2770	A740704	A740704	A740704	A844051	A844051	A844051
Misc. Inorganics												
Soluble (2:1) pH	pH Units	8.84	7.26	7.29	7.61		7.58	7.79	7.65	7.40	7.35	7.46
Total Metals by ICPMS												
Total Aluminum (Al)	mg/kg	12400	11500	9310	10800	13300	8890	9200	8550	8940	8630	9480
Total Antimony (Sb)	mg/kg	1.6	1.7	1.8	1.5	<20	1.5	1.8	1.7	2.1	2.2	2
Total Arsenic (As)	mg/kg	12.8	13.2	13.6	12.2	<50	12.2	11.2	12	13.5	12.7	11.3
Total Barium (Ba)	mg/kg	383	362	430	364	303	382	569	398	743	873	781
Total Beryllium (Be)	mg/kg	0.3	0.3	0.3	0.2	<0.5	0.3	0.2	0.2	0.3	0.3	0.3
Total Bismuth (Bi)	mg/kg	0.9	0.3	0.5	0.4	<20	0.2	0.4	0.2	0.7	0.3	0.3
Total Cadmium (Cd)	mg/kg	12.3	15.9	23.7	14.3	9.9	22	32.1	25.1	35.2	48	35.3
Total Calcium (Ca)	mg/kg	9170					11300	16700	12200	15100	18000	16300
Total Chromium (Cr)	mg/kg	29.3	31	26	35	31.0	21	20	20	19	19	21
Total Cobalt (Co)	mg/kg	11.9	11.5	10.5	11.2	12.9	11.1	11	11.7	13.2	13.4	12.5
Total Copper (Cu)	mg/kg	67.9	81.7	83.4	75.9	41.5	60	98.1	70	107	112	112
Total Iron (Fe)	mg/kg	28500	27900	24700	25800	32400	23600	23700	21700	34000	33100	34100
Total Lead (Pb)	mg/kg	32.5	28.9	26.7	22.7	<30	19.5	22.8	19.6	28.5	25.5	23.1
Total Magnesium (Mg)	mg/kg	10200	8960	6840	8610	08290	7280	6880	6970	6220	6040	7160
Total Manganese (Mn)	mg/kg	802	861	925	830	1040	867	1020	1000	1620	3020	1510
Total Mercury (Hg)	mg/kg	<0.05	<0.05	0.05	<0.05		<0.05	0.07	0.06	0.09	0.1	0.1
Total Molybdenum (Mo)	mg/kg	2.7	2.6	2.5	3.1	6.6	2.2	2.2	2.4	2.8	5	3
Total Nickel (Ni)	mg/kg	82.5	93.7	110	90.4	63.9	118	157	131	153	271	161
Total Phosphorus (P)	mg/kg	1910	2120	1750	2130	1560	1410	1580	1420	1910	2570	2100
Total Potassium (K)	mg/kg	1580	1540	1170	1470	1680	1030	964	936	911	934	1000
Total Selenium (Se)	mg/kg	2.2	1.9	3	2.2	<2	3.1	5.9	3.8	5.2	4.8	5.1
Total Silver (Ag)	mg/kg	0.53	0.46	0.57	0.38	<2	0.36	0.57	0.39	0.64	0.66	0.7
Total Sodium (Na)	mg/kg	<100	<100	<100	<100		<100	<100	<100	<100	<100	<100
Total Strontium (Sr)	mg/kg	46.8	47.1	51.8	43.6	48.8	48.6	68.5	53.3	61.3	71.2	62.6
Total Thallium (Tl)	mg/kg	0.2	0.13	0.13	0.19	<50	0.11	0.13	0.11	0.15	0.32	0.16
Total Tin (Sn)	mg/kg	2.3	1.9	1.8	3.7	<10	0.2	0.3	0.2	0.3	0.3	0.3
Total Titanium (Ti)	mg/kg	704	585	386	567	0769	385	310	377	307	308	356
Total Vanadium (V)	mg/kg	59.3	59	45	58	100.0	47	35	36	35	36	38
Total Zinc (Zn)	mg/kg	2860	2710	3300	2730	1370	3340	4390	3440	3950	4280	4070
Total Zirconium (Zr)	mg/kg	3.3	8.9	6.5	8.5		0.6	0.6	0.5	1	0.7	1

DL too high; not used in statistical evaluation

AVG	Std Dev.	95th Percentile
7.6	0.5	8.4
10091	1648	12850
3.4	5.5	11.1
15.9	11.3	31.8
508	200	827
0.29	0.08	0.40
0.42	0.23	0.81
24.89	11.78	41.65
14110	3255	17610
25	6	33
11.9	1.0	13.3
82.7	22.8	112
28136	4603	34050
25.4	4.3	31.3
7586.4	1274.0	9580.0
1227	654	2320
0.07	0.02	0.10
3.19	1.37	5.80
130	57	216
1860	358	2350
1201	302	1630
3.56	1.47	5.55
0.66	0.46	1.35
100	0	100
54.9	9.5	69.9
0.16	0.06	0.27
1.13	1.22	3.07
459	167	737
50	19	80
3313	882	4335
3.2	3.5	8.7

Appendix C: Stream Sediment Quality Data

W82

Maxxam ID		W82A	W82B	W82C
Sampling Date		30-Aug-07	30-Aug-07	30-Aug-07
Lab Report	Units	A740626	A740626	A740626
Misc. Inorganics				
Soluble (2:1) pH	pH Units	7.1	7.09	7.14
Total Metals by ICPMS				
Total Aluminum (Al)	mg/kg	5450	6070	5990
Total Antimony (Sb)	mg/kg	5	4.3	5
Total Arsenic (As)	mg/kg	33.7	26.7	28.3
Total Barium (Ba)	mg/kg	2480	2160	2380
Total Beryllium (Be)	mg/kg	0.2	0.2	0.3
Total Bismuth (Bi)	mg/kg	0.3	0.3	0.3
Total Cadmium (Cd)	mg/kg	157	137	162
Total Calcium (Ca)	mg/kg	11600	16500	14500
Total Chromium (Cr)	mg/kg	9	9	9
Total Cobalt (Co)	mg/kg	79.8	63.9	76.4
Total Copper (Cu)	mg/kg	236	273	257
Total Iron (Fe)	mg/kg	63700	63900	61900
Total Lead (Pb)	mg/kg	22.8	22.6	24.4
Total Magnesium (Mg)	mg/kg	1280	1350	1310
Total Manganese (Mn)	mg/kg	31000	24100	28600
Total Mercury (Hg)	mg/kg	<0.16	<0.22	0.18
Total Molybdenum (Mo)	mg/kg	10.3	7.5	9.2
Total Nickel (Ni)	mg/kg	799	724	760
Total Phosphorus (P)	mg/kg	3020	3440	3230
Total Potassium (K)	mg/kg	306	392	421
Total Selenium (Se)	mg/kg	10.2	12.8	11.1
Total Silver (Ag)	mg/kg	0.77	0.93	1.13
Total Sodium (Na)	mg/kg	<100	<100	<100
Total Strontium (Sr)	mg/kg	67.6	77.6	71.4
Total Thallium (Tl)	mg/kg	0.36	0.29	0.3
Total Tin (Sn)	mg/kg	0.1	0.2	0.2
Total Titanium (Ti)	mg/kg	44	47	44
Total Vanadium (V)	mg/kg	21	19	19
Total Zinc (Zn)	mg/kg	8030	7500	8060
Total Zirconium (Zr)	mg/kg	0.5	0.5	0.5

AVG	Std Dev.	95th Percentile
7.1	0.0	7.1
5837	337	6062
4.8	0.4	5.0
29.6	3.7	33.2
2340	164	2470
0.23	0.06	0.29
0.3	0.0	0.3
152	13	162
14200	2464	16300
9	0	9
73.4	8.4	79.5
255.3	18.6	271
63167	1102	63880
23.3	1.0	24.2
1313.3	35.1	1346.0
27900	3503	30760
0.19	0.03	0.22
9.00	1.41	10.19
761	38	795
3230	210	3419
373	60	418
11.37	1.32	12.63
0.94	0.18	1.11
100	0	100
72.2	5.0	77.0
0.32	0.04	0.35
0.17	0.06	0.20
45	2	47
20	1	21
7863	315	8057
0.5	0.0	0.5

Appendix C: Stream Sediment Quality Data

W12

Maxxam ID		W12	W12A	W12B	W12C	W12	W12A	W12B	W12C	W12A	W12B	W12C
Sampling Date		7-Sep-05	5-Oct-06	5-Oct-06	5-Oct-06	8-Sep-06	26-Aug-07	26-Aug-07	26-Aug-07	24-Aug-08	24-Aug-08	24-Aug-08
Lab Report	Units	A536970	A648127	A648127	A648127	Z2770	A740704	A740704	A740704	A844051	A844051	A844051
Misc. Inorganics												
Soluble (2:1) pH	pH Units	7.49	6.93	7.07	7.54		6.96	6.83	6.54	7.21	7.25	7.12
Total Metals by ICPMS												
Total Aluminum (Al)	mg/kg	14500	7120	8420	11500	18200	11400	11700	12500	11100	11100	11500
Total Antimony (Sb)	mg/kg	0.3	1.3	0.3	0.3	<20	0.3	0.3	0.3	0.3	0.3	0.4
Total Arsenic (As)	mg/kg	7.4	9.6	5.2	6.4	<50	5.7	6.2	5.4	4.3	3.9	5
Total Barium (Ba)	mg/kg	302	91.4	128	301	148	248	252	264	215	196	218
Total Beryllium (Be)	mg/kg	0.2	0.1	<0.1	0.2	<0.5	0.2	0.2	0.2	0.2	0.2	0.2
Total Bismuth (Bi)	mg/kg	0.1	0.1	<0.1	0.1	<20	0.1	0.1	0.1	0.1	0.1	0.1
Total Cadmium (Cd)	mg/kg	1.14	0.79	0.92	1.19	<2	1.02	1.15	1.16	0.77	0.61	0.86
Total Calcium (Ca)	mg/kg	4720					4290	5210	5030	3860	3190	3920
Total Chromium (Cr)	mg/kg	38.5	26	34	38	47.5	31	30	33	30	27	29
Total Cobalt (Co)	mg/kg	13.5	10	12	12.4	14.0	11.7	12	12.2	10.3	10.0	10.4
Total Copper (Cu)	mg/kg	54	40	25.5	42.2	35.9	38.1	38.8	43.5	30.5	29.9	36.7
Total Iron (Fe)	mg/kg	30400	19700	21100	25800	32000	23900	25500	25200	29000	30000	29900
Total Lead (Pb)	mg/kg	12.2	8.2	5.5	9.2	<30	8.7	8.8	9.3	7.7	7.7	8.7
Total Magnesium (Mg)	mg/kg	9080	4960	6300	7110	11300	6870	7320	7220	6890	6670	7050
Total Manganese (Mn)	mg/kg	1470	1020	1160	1680	1340	992	1060	886	872	908	911
Total Mercury (Hg)	mg/kg	<0.05	<0.05	<0.05	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Molybdenum (Mo)	mg/kg	0.8	0.6	0.7	0.8	<4.0	0.6	0.6	0.6	0.7	0.7	0.7
Total Nickel (Ni)	mg/kg	36.7	27.3	34	35.1	39.0	30.8	30.6	31.8	30.2	28.9	30.1
Total Phosphorus (P)	mg/kg	919	483	555	900	626	737	750	758	832	807	802
Total Potassium (K)	mg/kg	543	217	251	472	820	459	494	485	369	359	411
Total Selenium (Se)	mg/kg	1.2	0.9	<0.5	1.5	<2	1.5	1.5	2.1	<0.5	<0.5	0.8
Total Silver (Ag)	mg/kg	0.17	0.07	0.06	0.15	<2	0.15	0.2	0.19	0.12	0.09	0.12
Total Sodium (Na)	mg/kg	<100	<100	<100	<100		<100	<100	<100	<100	<100	<100
Total Strontium (Sr)	mg/kg	20.5	10.2	8.5	20.1	28.8	16.1	18.4	17.7	14	13.3	13.9
Total Thallium (Tl)	mg/kg	0.06	<0.05	<0.05	<0.05	<50	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Total Tin (Sn)	mg/kg	1.8	0.2	0.3	3	<10	0.2	0.2	0.2	0.2	0.2	0.2
Total Titanium (Ti)	mg/kg	712	239	361	510	1500	390	403	419	397	342	378
Total Vanadium (V)	mg/kg	37.7	22	30	34	52.1	29	28	30	26	25	27
Total Zinc (Zn)	mg/kg	140	86	77	118	087	112	109	118	105	108	110
Total Zirconium (Zr)	mg/kg	3	7.7	9.1	7.8		<0.5	<0.5	<0.5	0.7	0.8	0.9

DL too high; not used in statistical evaluation

AVG	Std Dev.	95th Percentile
7.1	0.3	7.5
11731	2887	16350
2.2	5.9	10.7
9.9	13.4	29.8
215	69	302
0.21	0.10	0.35
0.10	0.000	0.10
1.06	0.37	1.60
4317	719	5156
33	6	43
11.7	1.4	13.8
37.7	7.7	49
26591	4010	31200
8.6	1.7	10.9
7343	1627	10190
1118	269	1575
0.05	0.00	0.05
0.68	0.08	0.80
32	4	38
743	137	910
444	161	682
1.18	0.59	2.05
0.30	0.57	1.10
100	0	100
16.5	5.6	24.7
0.05	0.003	0.06
0.65	0.965	2.46
514	348	1106
31	8	45
106	18	129
3.2	3.6	8.5

Appendix C: Stream Sediment Quality Data

W16

Maxxam ID		W16	W16A	W16B	W16C	W16	W16A	W16B	W16C	W16A	W16B	W16C
Sampling Date		8-Sep-05	5-Oct-06	5-Oct-06	5-Oct-06	8-Sep-06	26-Aug-07	26-Aug-07	26-Aug-07	24-Aug-08	24-Aug-08	24-Aug-08
Lab Report	Units	A536970	A648127	A648127	A648127	Z2770	A740704	A740704	A740704	A844051	A844051	A844051
Misc. Inorganics												
Soluble (2:1) pH	pH Units	6.81	7	7.15	6.71		7.09	7.18	7.18	6.94	6.95	6.94
Total Metals by ICPMS												
Total Aluminum (Al)	mg/kg	20500	14600	14600	14700	30100	16000	15400	14600	14200	14200	13500
Total Antimony (Sb)	mg/kg	0.4	0.2	0.2	0.2	<20	0.1	0.2	0.2	0.3	0.3	0.2
Total Arsenic (As)	mg/kg	8.1	2.9	3.2	3.1	<5	2	2.3	3.1	3.8	3.7	3.1
Total Barium (Ba)	mg/kg	453	215	190	217	114	122	149	175	459	233	204
Total Beryllium (Be)	mg/kg	0.3	0.1	0.2	0.1	<0.5	0.2	0.2	0.1	0.2	0.2	0.2
Total Bismuth (Bi)	mg/kg	<0.1	<0.1	0.6	<0.1	<20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Cadmium (Cd)	mg/kg	7.53	2.61	3.07	2.74	<2	1.73	2.06	2.41	3.74	4.03	3.01
Total Calcium (Ca)	mg/kg	9820					5490	6380	5970	8010	8420	6700
Total Chromium (Cr)	mg/kg	67.3	60	58	58	96.5	57	56	55	52	55	53
Total Cobalt (Co)	mg/kg	25.9	20.3	21	20.7	27.0	18.6	17.6	17.8	18.2	20.9	18.0
Total Copper (Cu)	mg/kg	91	45.8	54.7	45	35.5	47.2	50.9	44.9	56.5	56.7	47.1
Total Iron (Fe)	mg/kg	38300	27500	28100	28100	45500	26500	24800	25600	39100	37000	33600
Total Lead (Pb)	mg/kg	28.9	3.1	4.8	3.1	<30	2.1	2.3	2.2	3.7	4.4	2.9
Total Magnesium (Mg)	mg/kg	14000	12400	12000	12200	21600	13100	11900	11900	11400	12000	11400
Total Manganese (Mn)	mg/kg	4120	1720	1820	1770	1470	698	577	995	1240	1490	1350
Total Mercury (Hg)	mg/kg	0.06	<0.05	<0.05	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Molybdenum (Mo)	mg/kg	1.8	1.3	1.6	1.5	<4.0	0.5	0.5	0.6	1.2	1.4	1.1
Total Nickel (Ni)	mg/kg	53.2	41.9	39.9	39.8	57.1	39.4	38.3	38.1	37.6	40.1	35.6
Total Phosphorus (P)	mg/kg	1230	912	886	847	307	832	957	872	1220	1270	1010
Total Potassium (K)	mg/kg	569	335	356	336	430	329	344	319	387	388	346
Total Selenium (Se)	mg/kg	3.3	<0.5	1.8	0.6	<2	0.8	1.1	1.6	1.7	2.1	<0.5
Total Silver (Ag)	mg/kg	0.21	0.06	0.1	0.06	<2	0.09	0.12	0.09	0.1	0.1	0.09
Total Sodium (Na)	mg/kg	<100	<100	<100	<100		<100	<100	<100	<100	<100	<100
Total Strontium (Sr)	mg/kg	29.7	15.6	14.1	15.4	70.4	13.2	16.6	15.9	18.5	18.6	15.6
Total Thallium (Tl)	mg/kg	0.06	<0.05	0.1	<0.05	<50	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Tin (Sn)	mg/kg	10.5	3.8	3.6	2.1	<10	0.1	0.1	0.1	0.2	0.1	0.1
Total Titanium (Ti)	mg/kg	952	1130	1090	1110	2630	981	867	910	847	834	838
Total Vanadium (V)	mg/kg	56.6	50	47	47	91.1	39	40	39	38	42	36
Total Zinc (Zn)	mg/kg	309	152	168	148	140	149	151	161	178	181	160
Total Zirconium (Zr)	mg/kg	1.7	4.1	3.9	3.7		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

DL too high; not used in statistical evaluation

AVG	Std Dev.	95th Percentile
7.0	0.2	7.2
16582	4858	25300
2.0	6.0	10.2
3.7	1.7	6.6
230	118	456
0.21	0.11	0.40
0.15	0.158	0.37
3.18	1.61	5.78
7256	1546	9400
61	13	82
20.5	3.2	26.5
52.3	14.2	74
32191	6879	42300
5.8	8.2	18.1
13082	2923	17800
1568	942	2970
0.05	0.00	0.06
1.15	0.47	1.71
41.9	6.8	55.2
940	266	1250
376	72	500
1.45	0.86	2.70
0.27	0.57	1.11
100	0	100
22.1	16.6	50.1
0.06	0.016	0.08
2.07	3.32	7.48
1108	517	1880
48	16	74
172	47	245
1.6	1.6	4.0

Appendix C: Stream Sediment Quality Data

W31

Maxxam ID		W31	W31A	W31B	W31C	W31-98A	W31-98B	W31-98C
Sampling Date		10-Sep-05	8/27/2007	8/27/2007	8/27/2007	8/27/2007	8/27/2007	8/27/2007
Lab Report	Units	A536970	A740626	A740626	A740626	A740626	A740626	A740626
Misc. Inorganics								
Soluble (2:1) pH	pH Units	7.53	7.47	7.45	7.54	7.46	7.24	7.22
Total Metals by ICPMS								
Total Aluminum (Al)	mg/kg	22600	16700	15500	13900	16300	16400	16800
Total Antimony (Sb)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
Total Arsenic (As)	mg/kg	1.9	1.4	1.7	1.3	1.4	1.6	1.4
Total Barium (Ba)	mg/kg	46.3	41.2	35.4	40	37.2	41.9	37.6
Total Beryllium (Be)	mg/kg	0.2	0.1	0.2	<0.1	0.1	0.1	0.2
Total Bismuth (Bi)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Cadmium (Cd)	mg/kg	0.16	0.14	0.13	0.12	0.14	0.15	0.15
Total Calcium (Ca)	mg/kg	5660	5610	4530	3880	4680	6880	5640
Total Chromium (Cr)	mg/kg	70.8	64	59	58	67	61	64
Total Cobalt (Co)	mg/kg	23.8	22.2	22.5	20.7	22.8	21.5	23.8
Total Copper (Cu)	mg/kg	85.4	64.4	60.1	45.5	57.6	68.1	64.4
Total Iron (Fe)	mg/kg	32100	28000	26600	24200	27600	25800	29600
Total Lead (Pb)	mg/kg	13.7	1.4	1.2	1	1.5	1.4	1.1
Total Magnesium (Mg)	mg/kg	17000	13800	13000	12100	14300	13100	14700
Total Manganese (Mn)	mg/kg	514	536	517	540	576	523	559
Total Mercury (Hg)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Molybdenum (Mo)	mg/kg	0.2	0.3	0.2	0.2	0.2	0.3	0.2
Total Nickel (Ni)	mg/kg	47.9	44.3	41.7	41	44.3	41.6	44
Total Phosphorus (P)	mg/kg	819	739	746	697	743	742	752
Total Potassium (K)	mg/kg	566	405	378	324	392	440	442
Total Selenium (Se)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Silver (Ag)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05
Total Sodium (Na)	mg/kg	<100	<100	<100	<100	<100	<100	<100
Total Strontium (Sr)	mg/kg	12.1	9.5	8	5.8	9.4	9.9	8.3
Total Thallium (Tl)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Tin (Sn)	mg/kg	1.9	0.1	<0.1	<0.1	<0.1	0.1	<0.1
Total Titanium (Ti)	mg/kg	1870	1130	1030	850	1090	1210	1140
Total Vanadium (V)	mg/kg	60.9	47	45	41	46	48	46
Total Zinc (Zn)	mg/kg	63.2	50	46	43	48	47	50
Total Zirconium (Zr)	mg/kg	2.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

AVG	Std Dev.	95th Percentile
7.4	0.1	7.5
16886	2711	20860
0.1	0.0	0.1
1.5	0.2	1.8
40	4	45
0.14	0.05	0.20
0.1	0.0	0.1
0.14	0.01	0.16
5269	985	6514
63	5	70
22.5	1.1	23.8
63.6	12.1	80
27700	2587	31350
3.0	4.7	10.0
14000	1583	16310
538	23	571
0.05	0.00	0.05
0.23	0.05	0.30
43.5	2.4	46.8
748	36	799
421	75	529
0.50	0.00	0.50
0.05	0.00	0.05
100	0	100
9.0	1.9	11.4
0.05	0.00	0.05
0.36	0.68	1.36
1189	321	1672
48	6	57
50	6	59
0.7	0.6	1.6

Appendix C: Stream Sediment Quality Data

W80

Maxxam ID		W80A	W80B	W80C
Sampling Date		8/27/2007	8/27/2007	8/27/2007
Lab Report	Units	A740626	A740626	A740626
Misc. Inorganics				
Soluble (2:1) pH	pH Units	7.02	6.88	6.94
Total Metals by ICPMS				
Total Aluminum (Al)	mg/kg	11000	10400	10100
Total Antimony (Sb)	mg/kg	0.2	0.2	0.2
Total Arsenic (As)	mg/kg	5.2	5.5	4.9
Total Barium (Ba)	mg/kg	113	92.5	102
Total Beryllium (Be)	mg/kg	0.1	0.1	0.1
Total Bismuth (Bi)	mg/kg	<0.1	<0.1	<0.1
Total Cadmium (Cd)	mg/kg	0.4	0.38	0.32
Total Calcium (Ca)	mg/kg	2570	2310	2310
Total Chromium (Cr)	mg/kg	26	41	23
Total Cobalt (Co)	mg/kg	10	9.7	9.4
Total Copper (Cu)	mg/kg	27.2	24.8	25.4
Total Iron (Fe)	mg/kg	23000	23900	21500
Total Lead (Pb)	mg/kg	7.2	7.1	7.3
Total Magnesium (Mg)	mg/kg	6630	7210	6150
Total Manganese (Mn)	mg/kg	699	607	611
Total Mercury (Hg)	mg/kg	<0.05	<0.05	<0.05
Total Molybdenum (Mo)	mg/kg	0.6	0.6	0.6
Total Nickel (Ni)	mg/kg	25	28	24.2
Total Phosphorus (P)	mg/kg	748	703	737
Total Potassium (K)	mg/kg	400	320	333
Total Selenium (Se)	mg/kg	0.5	<0.5	<0.5
Total Silver (Ag)	mg/kg	0.06	0.06	0.08
Total Sodium (Na)	mg/kg	<100	<100	<100
Total Strontium (Sr)	mg/kg	13.3	11.6	13.3
Total Thallium (Tl)	mg/kg	<0.05	<0.05	<0.05
Total Tin (Sn)	mg/kg	0.1	<0.1	<0.1
Total Titanium (Ti)	mg/kg	308	295	240
Total Vanadium (V)	mg/kg	25	24	23
Total Zinc (Zn)	mg/kg	88	86	85
Total Zirconium (Zr)	mg/kg	1	0.7	0.6

AVG	Std Dev.	95th Percentile
6.9	0.1	7.0
10500	458	10940
0.2	0.0	0.2
5.2	0.3	5.5
103	10	112
0.10	0.00	0.10
0.1	0.0	0.1
0.37	0.04	0.40
2397	150	2544
30	10	40
9.7	0.3	10.0
25.8	1.2	27
22800	1212	23810
7.2	0.1	7.3
6663.3	530.8	7152.0
639	52	690
0.05	0.00	0.05
0.60	0.00	0.60
26	2	28
729	23	747
351.0	42.9	393.3
0.50	0.00	0.50
0.07	0.01	0.08
100	0	100
12.7	1.0	13.3
0.05	0.00	0.05
0.10	0.00	0.10
281	36	307
24	1	25
86	2	88
0.8	0.2	1.0

Appendix C: Stream Sediment Quality Data

W81

Maxxam ID		W81A	W81B	W81C
Sampling Date		8/27/2007	8/27/2007	8/27/2007
Lab Report	Units	A740626	A740626	A740626
Misc. Inorganics				
Soluble (2:1) pH	pH Units	6.93	7.08	7.09
Total Metals by ICPMS				
Total Aluminum (Al)	mg/kg	12200	12400	12400
Total Antimony (Sb)	mg/kg	0.3	0.2	0.2
Total Arsenic (As)	mg/kg	7.8	6	7
Total Barium (Ba)	mg/kg	76.9	74.3	67.5
Total Beryllium (Be)	mg/kg	<0.1	0.1	<0.1
Total Bismuth (Bi)	mg/kg	0.1	<0.1	0.1
Total Cadmium (Cd)	mg/kg	0.4	0.31	0.32
Total Calcium (Ca)	mg/kg	2420	2140	1970
Total Chromium (Cr)	mg/kg	26	28	24
Total Cobalt (Co)	mg/kg	13.1	14	12.1
Total Copper (Cu)	mg/kg	46.4	43.7	41.8
Total Iron (Fe)	mg/kg	25400	25200	25700
Total Lead (Pb)	mg/kg	12.2	9.4	10.1
Total Magnesium (Mg)	mg/kg	6960	7370	6760
Total Manganese (Mn)	mg/kg	850	884	810
Total Mercury (Hg)	mg/kg	<0.05	<0.05	<0.05
Total Molybdenum (Mo)	mg/kg	0.5	0.4	0.5
Total Nickel (Ni)	mg/kg	31.7	32.4	28.9
Total Phosphorus (P)	mg/kg	605	541	508
Total Potassium (K)	mg/kg	336	316	330
Total Selenium (Se)	mg/kg	<0.5	<0.5	<0.5
Total Silver (Ag)	mg/kg	0.12	0.1	0.08
Total Sodium (Na)	mg/kg	<100	<100	<100
Total Strontium (Sr)	mg/kg	12.2	10.5	10
Total Thallium (Tl)	mg/kg	<0.05	<0.05	0.16
Total Tin (Sn)	mg/kg	<0.1	<0.1	<0.1
Total Titanium (Ti)	mg/kg	228	232	218
Total Vanadium (V)	mg/kg	25	25	23
Total Zinc (Zn)	mg/kg	81	76	76
Total Zirconium (Zr)	mg/kg	0.7	0.8	0.7

AVG	Std Dev.	95th Percentile
7.0	0.1	7.1
12333	115	12400
0.2	0.1	0.3
6.9	0.9	7.7
73	5	77
0.10	0.00	0.10
0.1	0.0	0.1
0.34	0.05	0.39
2177	227	2392
26	2	28
13.1	1.0	13.9
44.0	2.3	46
25433	252	25670
10.6	1.5	12.0
7030.0	311.0	7329.0
848	37	881
0.05	0.00	0.05
0.47	0.06	0.50
31	2	32
551	49	599
327.3	10.3	335.4
0.50	0.00	0.50
0.10	0.02	0.12
100	0	100
10.9	1.2	12.0
0.09	0.06	0.15
0.10	0.00	0.10
226	7	232
24	1	25
78	3	81
0.7	0.1	0.8

Appendix C: Stream Sediment Quality Data

W14

Maxxam ID		W14	W14A	W14B	W14C
Sampling Date		8-Sep-05	8/27/2007	8/27/2007	8/27/2007
Lab Report	Units	A536970	A740626	A740626	A740626
Misc. Inorganics					
Soluble (2:1) pH	pH Units	7.25	7.48	7.36	7.44
Total Metals by ICPMS					
Total Aluminum (Al)	mg/kg	11800	8820	7860	8260
Total Antimony (Sb)	mg/kg	0.3	0.2	0.2	0.2
Total Arsenic (As)	mg/kg	4.4	6.1	5.3	4.9
Total Barium (Ba)	mg/kg	173	235	154	156
Total Beryllium (Be)	mg/kg	0.2	0.5	0.5	0.3
Total Bismuth (Bi)	mg/kg	0.1	0.2	0.2	0.2
Total Cadmium (Cd)	mg/kg	0.62	0.98	0.74	0.63
Total Calcium (Ca)	mg/kg	3970	4290	3860	3480
Total Chromium (Cr)	mg/kg	34.7	29	22	21
Total Cobalt (Co)	mg/kg	10.8	11.2	8	8.1
Total Copper (Cu)	mg/kg	50.1	21.6	19.9	19.2
Total Iron (Fe)	mg/kg	22900	21500	18000	17700
Total Lead (Pb)	mg/kg	34.4	6.1	6.1	5.9
Total Magnesium (Mg)	mg/kg	7240	5590	5100	4790
Total Manganese (Mn)	mg/kg	916	1790	1090	1150
Total Mercury (Hg)	mg/kg	<0.05	<0.05	<0.05	<0.05
Total Molybdenum (Mo)	mg/kg	0.6	1.1	0.7	0.7
Total Nickel (Ni)	mg/kg	30.2	35.6	28.6	28
Total Phosphorus (P)	mg/kg	857	948	600	490
Total Potassium (K)	mg/kg	556	729	568	649
Total Selenium (Se)	mg/kg	0.6	0.9	1.1	0.9
Total Silver (Ag)	mg/kg	0.08	0.08	0.09	0.08
Total Sodium (Na)	mg/kg	<100	<100	<100	<100
Total Strontium (Sr)	mg/kg	14.5	16.3	15.2	15.7
Total Thallium (Tl)	mg/kg	0.06	0.05	<0.05	<0.05
Total Tin (Sn)	mg/kg	9	0.6	0.4	0.4
Total Titanium (Ti)	mg/kg	717	357	347	336
Total Vanadium (V)	mg/kg	33	27	22	20
Total Zinc (Zn)	mg/kg	112	86	72	72
Total Zirconium (Zr)	mg/kg	2.7	<0.5	<0.5	<0.5

AVG	Std Dev.	95th Percentile
7.4	0.1	7.5
9185	1787	11353
0.2	0.1	0.3
5.2	0.7	6.0
180	38	226
0.38	0.15	0.50
0.2	0.1	0.2
0.74	0.17	0.94
3900	334	4242
27	6	34
9.5	1.7	11.1
27.7	15.0	46
20025	2579	22690
13.1	14.2	30.2
5680.0	1090.9	6992.5
1237	382	1694
0.05	0.00	0.05
0.78	0.22	1.04
31	3	35
724	214	934
625.5	80.4	717.0
0.88	0.21	1.07
0.08	0.01	0.09
100	0	100
15.4	0.8	16.2
0.05	0.01	0.06
2.60	4.27	7.74
439	185	663
26	6	32
86	19	108
1.1	1.1	2.4

Appendix C: Stream Sediment Quality Data

W71

Maxxam ID		W71	W71A	W71B	W71C	W71-98A	W71-98B	W71-98C
Sampling Date		7-Sep-05	8/28/2007	8/28/2007	8/28/2007	8/28/2007	8/28/2007	8/28/2007
Lab Report	Units	A536970	A740626	A740626	A740626	A740626	A740626	A740626
Misc. Inorganics								
Soluble (2:1) pH	pH Units	7.8	7.68	7.76	7.81	7.81	7.7	7.81
Total Metals by ICPMS								
Total Aluminum (Al)	mg/kg	4720	3900	3710	4320	3600	3790	3870
Total Antimony (Sb)	mg/kg	2.1	2.4	2.5	2.8	3	2.8	2.9
Total Arsenic (As)	mg/kg	9.6	10.8	12.9	12.6	14.2	12.9	15.8
Total Barium (Ba)	mg/kg	256	200	184	212	240	227	228
Total Beryllium (Be)	mg/kg	0.2	0.2	0.1	0.1	0.2	0.2	0.2
Total Bismuth (Bi)	mg/kg	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
Total Cadmium (Cd)	mg/kg	14.6	21.6	14.3	18.4	27.9	17.9	19.8
Total Calcium (Ca)	mg/kg	10900	10700	10000	11900	11000	9560	11000
Total Chromium (Cr)	mg/kg	11.7	8	8	8	8	8	8
Total Cobalt (Co)	mg/kg	9.6	13	16.4	11.2	18.3	15.6	14.8
Total Copper (Cu)	mg/kg	67.6	17.8	17	18.4	21.4	18	21.3
Total Iron (Fe)	mg/kg	16400	16200	18700	18400	17400	18000	23000
Total Lead (Pb)	mg/kg	879	8.5	9.7	9.7	10.2	9.4	10.7
Total Magnesium (Mg)	mg/kg	5630	4690	5360	5310	4640	4690	5190
Total Manganese (Mn)	mg/kg	785	1370	1280	988	1350	1430	1450
Total Mercury (Hg)	mg/kg	0.1	0.08	0.06	0.08	0.1	0.07	0.07
Total Molybdenum (Mo)	mg/kg	3.7	5.5	5.7	5.3	6.5	5.9	7.3
Total Nickel (Ni)	mg/kg	115	131	121	124	154	137	131
Total Phosphorus (P)	mg/kg	1280	1520	1250	1470	1120	1070	1510
Total Potassium (K)	mg/kg	445	316	268	343	323	293	277
Total Selenium (Se)	mg/kg	3.1	3.7	3.3	3.7	4.5	3.8	4.2
Total Silver (Ag)	mg/kg	0.24	0.27	0.22	0.28	0.35	0.23	0.21
Total Sodium (Na)	mg/kg	<100	<100	<100	<100	<100	<100	<100
Total Strontium (Sr)	mg/kg	49.8	46.1	43.7	55	55.1	43.7	50.7
Total Thallium (Tl)	mg/kg	0.16	0.13	0.09	0.1	0.12	0.07	0.07
Total Tin (Sn)	mg/kg	180	0.1	0.1	0.1	0.1	0.1	0.1
Total Titanium (Ti)	mg/kg	62.8	39	35	41	38	41	40
Total Vanadium (V)	mg/kg	30.4	23	22	28	25	21	23
Total Zinc (Zn)	mg/kg	2080	2140	2020	2100	2470	2260	2290
Total Zirconium (Zr)	mg/kg	4.4	0.6	0.8	0.7	0.6	0.5	0.7

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
7.8	0.1	7.8
3987	395	4600
2.6	0.3	3.0
12.7	2.0	15.3
221	24	251
0.17	0.05	0.20
0.1	0.0	0.1
19.21	4.64	26.01
10723	758	11630
9	1	11
14.1	3.0	17.7
25.9	18.5	54
18300	2280	21710
9.7	0.7	10.6
5073	397	5549
1236	252	1444
0.08	0.02	0.10
5.70	1.11	7.06
130.4	12.7	148.9
1317	186	1517
324	60	414
3.76	0.48	4.41
0.26	0.05	0.33
100	0	100
49.2	4.9	55.1
0.11	0.03	0.15
0.1	0.0	0.1
42	9	56
25	3	30
2194	155	2416
0.7	0.1	0.8

Appendix C: Stream Sediment Quality Data

W72

Maxxam ID		W72	W72A	W72B	W72C
Sampling Date		7-Sep-05	8/28/2007	8/28/2007	8/28/2007
Lab Report	Units	A536970	A740626	A740626	A740626
Misc. Inorganics					
Soluble (2:1) pH	pH Units	7.69	7.44	7.55	7.6
Total Metals by ICPMS					
Total Aluminum (Al)	mg/kg	8490	10200	10300	9900
Total Antimony (Sb)	mg/kg	4	2.5	2.7	2.6
Total Arsenic (As)	mg/kg	110	51.5	57.6	50.8
Total Barium (Ba)	mg/kg	2490	732	789	737
Total Beryllium (Be)	mg/kg	0.3	0.5	0.4	0.3
Total Bismuth (Bi)	mg/kg	0.2	0.2	0.2	0.2
Total Cadmium (Cd)	mg/kg	42.1	20.6	21.7	19.3
Total Calcium (Ca)	mg/kg	10500	11300	11400	10300
Total Chromium (Cr)	mg/kg	26.5	35	36	36
Total Cobalt (Co)	mg/kg	43.5	18.3	18.4	17.6
Total Copper (Cu)	mg/kg	317	61	64.4	59.2
Total Iron (Fe)	mg/kg	41200	32200	33500	33000
Total Lead (Pb)	mg/kg	338	16	17.1	17.1
Total Magnesium (Mg)	mg/kg	6520	7100	6900	6910
Total Manganese (Mn)	mg/kg	39400	7860	7740	7010
Total Mercury (Hg)	mg/kg	0.13	0.27	0.3	0.28
Total Molybdenum (Mo)	mg/kg	28	5.5	5.7	4.9
Total Nickel (Ni)	mg/kg	374	167	175	164
Total Phosphorus (P)	mg/kg	1740	1480	1420	1390
Total Potassium (K)	mg/kg	830	1020	1090	1170
Total Selenium (Se)	mg/kg	3.6	5.3	5.5	5.3
Total Silver (Ag)	mg/kg	0.35	0.57	0.63	0.61
Total Sodium (Na)	mg/kg	<100	<100	<100	<100
Total Strontium (Sr)	mg/kg	110	83.4	83	77.4
Total Thallium (Tl)	mg/kg	0.29	0.17	0.17	0.17
Total Tin (Sn)	mg/kg	68.2	0.4	0.4	0.4
Total Titanium (Ti)	mg/kg	108	74	81	82
Total Vanadium (V)	mg/kg	46.8	36	38	39
Total Zinc (Zn)	mg/kg	4430	2000	2040	1970
Total Zirconium (Zr)	mg/kg	7.3	0.8	0.7	0.7

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
7.6	0.1	7.7
9723	839	10285
3.0	0.7	3.8
67.5	28.5	102.1
752.7	31.6	783.8
0.38	0.10	0.49
0.2	0.0	0.2
25.93	10.83	39.04
10875	556	11385
33	5	36
24.5	12.7	39.7
61.5	2.6	64.1
34975	4184	40045
16.7	0.6	17.1
6857.5	243.1	7071.5
15503	15936	34669
0.25	0.08	0.30
11.03	11.32	24.66
220	103	344
1508	159	1701
1027.5	145.2	1158.0
4.93	0.89	5.47
0.54	0.13	0.63
100	0	100
88.5	14.6	106.0
0.20	0.06	0.27
0.4	0.0	0.4
86	15	104
40	5	46
2610	1214	4072
0.7	0.1	0.8

Appendix C: Stream Sediment Quality Data

W73

Maxxam ID		W73	W73A	W73B	W73C
Sampling Date		7-Sep-05	8/28/2007	8/28/2007	8/28/2007
Lab Report	Units	A536970	A740626	A740626	A740626
Misc. Inorganics					
Soluble (2:1) pH	pH Units	7.54	7.52	7.46	7.4
Total Metals by ICPMS					
Total Aluminum (Al)	mg/kg	13900	10800	9900	10200
Total Antimony (Sb)	mg/kg	1.7	1.2	1	1
Total Arsenic (As)	mg/kg	19.6	10.4	9.2	9.5
Total Barium (Ba)	mg/kg	903	266	201	276
Total Beryllium (Be)	mg/kg	0.5	0.2	0.2	0.3
Total Bismuth (Bi)	mg/kg	0.1	0.1	<0.1	<0.1
Total Cadmium (Cd)	mg/kg	2.61	0.62	0.58	0.58
Total Calcium (Ca)	mg/kg	11400	4100	3720	4320
Total Chromium (Cr)	mg/kg	77.9	53	58	64
Total Cobalt (Co)	mg/kg	17.6	13.2	11.3	12
Total Copper (Cu)	mg/kg	174	38	31.9	36.6
Total Iron (Fe)	mg/kg	37700	27600	23800	27400
Total Lead (Pb)	mg/kg	52.5	8.2	7.4	8.4
Total Magnesium (Mg)	mg/kg	10700	8910	8280	9050
Total Manganese (Mn)	mg/kg	4300	765	690	635
Total Mercury (Hg)	mg/kg	0.24	0.09	0.07	0.09
Total Molybdenum (Mo)	mg/kg	2.9	1.7	1.6	1.5
Total Nickel (Ni)	mg/kg	127	65.4	60.3	67.2
Total Phosphorus (P)	mg/kg	1310	855	815	821
Total Potassium (K)	mg/kg	1020	525	432	486
Total Selenium (Se)	mg/kg	3.9	1	0.9	1.2
Total Silver (Ag)	mg/kg	0.43	0.21	0.17	0.18
Total Sodium (Na)	mg/kg	101	<100	<100	<100
Total Strontium (Sr)	mg/kg	58.3	27.3	22.6	25.9
Total Thallium (Tl)	mg/kg	0.15	<0.05	<0.05	<0.05
Total Tin (Sn)	mg/kg	20	0.1	0.1	0.1
Total Titanium (Ti)	mg/kg	249	120	117	149
Total Vanadium (V)	mg/kg	51.4	33	30	32
Total Zinc (Zn)	mg/kg	230	113	100	110
Total Zirconium (Zr)	mg/kg	4.9	0.9	0.7	0.9

DL too high; not used in statistical evaluation

Suspect data, not used in statistical evaluation

AVG	Std Dev.	95th Percentile
7.5	0.1	7.5
11200	1838	13435
1.2	0.3	1.6
12.2	5.0	18.2
247.7	40.7	275.0
0.30	0.14	0.47
0.1	0.0	0.1
0.6	0.0	0.6
5885	3685	10338
63	11	76
13.5	2.8	16.9
35.5	3.2	37.9
29125	5977	36185
8.0	0.5	8.4
9235.0	1032.5	10452.5
1598	1802	3770
0.12	0.08	0.22
1.93	0.66	2.72
80	31	118
950	240	1242
615.8	272.2	945.8
1.75	1.44	3.50
0.25	0.12	0.40
100	1	101
33.5	16.6	53.7
0.08	0.05	0.14
0.1	0.0	0.1
159	62	234
37	10	49
138	61	212
0.8	0.1	0.9

Appendix D

Benthic Invertebrate Taxonomy Data

2005 and 2007

2005 DATA REPRODUCED FROM APPENDIX E OF THE AQUATIC RESOURCES ADDENDUM TO YUKON ZINC CORPORATION WOLVERINE PROJECT ENVIRONMENTAL ASSESSMENT REPORT, PREPARED BY JAQUES WHITFORD LIMITED, MARCH 2006

2007 DATA REPRODUCED FROM APPENDIX B OF JAQUES WHITFORD MEMO (APRIL 17, 2008) REGARDING RESULTS OF THE 2007 BENTHIC SAMPLING PROGRAM FOR YUKON ZINC CORP.'S WOLVERINE PROJECT.

APPENDIX E

2005 Benthic Invertebrate Taxonomy Results

FROM

AQUATIC RESOURCES ADDENDUM TO

YUKON ZINC CORPORATION WOLVERINE PROJECT

ENVIRONMENTAL ASSESSMENT REPORT



UKon Zinc 1000261	W1-1	W1-2	W1-3	W9-1	W9-2	W9-3	W11-1	W11-2	W11-3	W12-1	W12-2	W12-3	W14-1	W14-2	W14-3	W16-1	W16-2	W16-3	W72-1	W72-2	W72-3	W73-1	W73-2	W73-3	Wc1	Wc2	Wc3
Minerals split to:	0	1/2	1/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Coarse split to:	1/64	1/32	1/2	0	1/4	1/4	1/2	0	0	0	0	0	1/4	1/4	0	1/2	1/2	1/2	0	0	0	0	1/2	1/2	1/2	1/2	
Fines split to:	1/128	1/256	1/128	1/2	1/16	1/4	1/8	1/2	1/8	1/2	1/2	1/4	1/64	1/16	1/8	1/32	1/32	1/32	1/16	1/8	1/4	1/8	1/4	1/16	1/4	1/4	
Ephemeroptera																											
Ameletus sp							8	1	1		1		128	48	43	32	32	4				32	16	16	8	6	12
Baetis sp	336	768	238	1		12	56	4	65	25	15	20	3924	1520	619	2012	1923	1966	50	272	236	226	177	564		4	
Cinygmula sp							24	4		7	3	2	496	252	168	64	32	64	32	24	8	202	89	42	4		
Drunella doddsi													4	12	13							6					
Drunella flavilinea																							4				
Drunella grandis	7	2	2				4	1	1				4	28	17												
Epeorus (Iron) sp							158	20	80	4	2	1	332	104	52							38	68	28			
Ephemerellidae J	80						80	10	148	24	4		284	156	15							8	4	8			
Paraleptophlebia sp	129		284	1																							
Rhithrogena sp													64	4	1				1			2					
Plecoptera																											
Capnia sp		32					108	16		16	29	11	596	220	141	2	2	32		8	12	28	31			68	104
Isoperla sp											2	1			1		2	10			4		1				
Leuctra sp				259	320	104		4					4	8	9		2			2	6	5		34		8	
Megarcys sp					12	4									1		2										
Paraperla sp												2	8														
Podmosta sp										10		4	4	4		2									458	334	534
Skwala curvata										8		1	4	12	3									4			
Sweltsa sp group	80	64	98	49	48	44	6	2	7	9	24	14	288	128	46	42	36	506	1	16	16	116	73	8	10		
Taenionema sp													146	128	162						16	14					
Zapada sp	129	64	42	50	2273	308	74		63	57	18	56	1412	400	131	1394	1954	1606	567	400	308	212	62	322			
Trichoptera Unid J						4	10	4	2		3	1	68				97		2						4		
Agraylea sp							6	2	1																		
Arctopsyche sp													64		10	18	4	52	16			10	2	14			
Brachycentrus sp														4	24												
Ceraclea sp	10	11	6																								
Clostoea sp																									2		
Ecclisomyia sp	8			2							1		1												8	2	
Glossosoma sp																						8					
Grensia sp			2											2	1												
Hydropsyche sp	609	1056	12	1																							
Hydroptilidae J							8																				
Hydroptila sp	195	936	194						1															2			
Micrasema sp	128	2	2				32		11		6		157	42	52	12	17	35	1	1				2			
Philoscaspa sp				1	25																				6		
Rhyacophila sp J								16				3	4			9	4	34	40		4			1			
Rhyacophila acropedes or vao														68		1	14	18	8	23	4	4	4	25			
Rhyacophila hyalina																						1					
Rhyacophila vepulsa											2	1		4	16	1											
Diptera Unid L						8																				6	
Chironomidae P	64	32	4		3			1					80	20	11		2	2					2				
Chironomidae L	22209	57056	15122	25	112	48	690	13	468	27	36	9	6240	1964	977	3432	3974	5477	160	1202	196	1232	164	1756	26	6	40
Brillia sp	64		138							1						8	2	2									
Cardiocladius sp	449	864	130	26	1033	96	36	6	5	7	3	1	408	136	47	66	184	354	73	274	88	212	25	462	14	54	
Cricotopus sp	22515	20832	52	18	36	16	754	272	823	299	233	406	3928	816	341	198	396	204	16	24	20	256	52	96	18	10	14
Cricotopus nostocladus	16	64	36										72		1												
Diamesa sp	8836	14688	2050	17	713	88	98	4	56	10	4	12	1492	444	207	844	804	2095	369	668	240	62	5	350	18	40	16
Eukiefferiella sp	5056	988	3328	2	16		36			4	1		392	32	33	32		4	16			34		22			
Euryhopsis sp	512	544								2	8			4	8			2				18		78	2		4
Micropsectra sp	2948	8288	5640	25	16	4	858	80	394	46	59	9	1092	176	171	612	500	826	225	80	4	338	92	260			
Pagastiella sp			128				16	8	1		6	4	64	18	32		32		18								
Phaenopsectra sp			8																								
Potthastia sp	32	64	26				26	4	1																		
Stempellinella sp							8																				
Thienemannimyia sp																										4	
Thienemannimyia sp	2563	4576	2256	16	16		88	63	161	4	2	1	12	32	10								4				
Ceratopogonidae																											
Mallochohelia sp							10	4		2			16	20	10												
Empididae																											
Chelifera sp					20		22			13	10	6	10	8	36	1	70	10	4	25	19	6	10	6			
Hemerodromia sp	128		6	1																							
Weidemannia sp			2	2		4																					
Muscidae																											
Limnophora sp					8																						
Psychodidae																											
Pericoma sp	3		8				26	17	33	22	24	21	80	48	10		4		75	9		2		26			
Simuliidae A												1												2			
Cnephia sp	819	1568	4											16												4	
Simulium sp L	4178	17	24	1282	10	16							64	4	16	86	64	52	112	32			4	24	4	4	12
Simulium sp P	80		2																							2	
Twinnia sp L				2																						6	4
Twinnia sp P																										2	2
Tabanidae																											
Chrysops sp						4																					

[illegible]

APPENDIX B

2007 Benthic Invertebrate Taxonomy Results

Jacques Whitford AXYS / Yukon Zinc 2007		Site	W9-1	W9-2	W9-3	W12-1	W12-2	W12-3	W16-1	W16-2	W16-3	W17-1	W17-2	W17-3	W18-1	W18-2	W18-3	LS-1	LS-2	LS-3
Numbers reported are total per sample		Fines split to:	1/2			1/2			1/8	1/4	1/8	1/8	1/16	1/8	1/2	1/2				
Composites			5	4	3	3	3	3	3	2	2	2	2	2	4	4	4			
Area of sampler (m ²)			0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.093	n/a	n/a	n/a
Area Sampled (m ²)			0.47	0.37	0.28	0.28	0.28	0.28	0.28	0.19	0.19	0.19	0.19	0.19	0.37	0.37	0.37			
	Family	Genus/ species																		
Ephemeroptera																				
Ephemeroptera A													33	16						
Ephemeroptera Unid J						34	82	47	8	8					86	163	172			
	Ameletidae	Ameletus sp								4		1			69	171	17	1		
	Betidae	Baetis sp		1	1	44	56	57	1994	1482	448	233	1456	964	5	16	21			
	Ephemerellidae	Drunella flavolinia						3												
	Heptageniidae	Cinigmula sp					3	3	2	3		1		10	20	6	5			
	Heptageniidae	Epeorus (Iron) sp					1								4					
	Heptageniidae	Rithrogena sp													2					
Plecoptera																				
Plecoptera Unid J			123	108	16	281	219	262	222	4	49	99	586	256	180	61	215	1		1
	Capniidae	Capnia sp			9	5	43	28							22	202	76			
	Chloroperlidae	Sweltsa sp group	47	20	14	26	58	28	299	41	35	74	193	126	85	81	110			
	Leuctridae Unid Juv		165	127	44	4		1	1	13	1				4	2	14			
	Nemouridae	Zapada sp		42	106		6	23	14	2	11	7	7	15	1	3	8			
	Perlodidae	Cultus sp				1														
	Perlodidae	Megarcys sp								1	1									
	Perlodidae	Skwala curvata				3	13	6												
	Perlodidae	Skwala paralella						2												
	Taeniopterygidae	Taenionema sp					4	6												
Trichoptera																				
Trichoptera Unid J					1	2	6	8	10	16	2	10	51	18						
	Brachycentridae	Brachycentrus sp						1												
	Glossosomatidae Unid J					1														
	Glossosomatidae	Glossosoma sp					2													
	Hydropsychidae	Arctopsyche sp					2		4				1							
	Limnophilidae Unid J					4						2								
	Limnophilidae	Philocasca sp	1	1																
	Limnophilidae	Ecclysomyia sp											1							
	Limnophilidae	Pseudostenophylax sp				1														
	Psychomyiidae	Tinodes sp									1									
	Rhyacophilidae Unid J					1	7	1			1				3					
	Rhyacophilidae	Rhyacophila acropedes or vao							1	13	2	9	56	52	12		36			
	Rhyacophilidae	Rhyacophila verrula									1									
	Uenoidae	Neothremma sp											19							
Diptera																				
Diptera Unid J			27	12	8	1	2	2				2	5	17		4				
Diptera A					1	4		1	1	1					4		1			
	Ceratopogonidae	Bezzia or Palpomyia sp					1				2		1							
	Chironomidae Adult			1					1	2			1		2	4	3			
	Chironomidae Pupa			3					45	21	6	10	6	11		2	3			

Jacques Whitford AXYS / Yukon Zinc 2007		Site	W9-1	W9-2	W9-3	W12-1	W12-2	W12-3	W16-1	W16-2	W16-3	W17-1	W17-2	W17-3	W18-1	W18-2	W18-3	LS-1	LS-2	LS-3
Numbers reported are total per sample		Fines split to:	1/2			1/2			1/8	1/4	1/8	1/8	1/16	1/8	1/2	1/2				
	Chironomidae Unid J		211	63	82	146	101	62	1232	1132	1168	1507	2001	857	294	94	183	78	19	9
	Chironomidae	Cardiocladius sp	16	5	93	6	2	1	152	106	138	104	202	76	2	12	46			
	Chironomidae	Corynoneura sp				13	3	2			16	67	70	1						
	Chironomidae	Cricotopus sp	1	3	1	47	18	17	319		194	169	381	220	3	20	6			
	Chironomidae	Diamesa sp		1	4				37			1		1		1	3			
	Chironomidae	Eukiefferiella sp			1	2	33	15	2		148		2	9				1		1
	Chironomidae	Euryhapsis sp				24	3	3	14			14				1				
	Chironomidae	Limnophyes sp			1															
	Chironomidae	Micropsectra sp																4	1	1
	Chironomidae	Phaenopsectra sp																4	1	1
	Chironomidae	Procladius sp																9	1	
	Chironomidae	Rheocricotopus sp			3								18	1						
	Chironomidae	Rheotanytarsus sp										2						7		
	Chironomidae	Stempellina sp																		4
	Chironomidae	Synorthocladius sp				3	3	2	20		4	26	45	10			4			
	Chironomidae	Thienemanniella sp					1													
	Chironomidae	Thienemannimyia sp					1											1		
	Empididae Pupa								1											
	Empididae	Chelifera sp	2	5	1	6	8	7	25			20	14	10	1	2				
	Empididae	Wiedemannia sp	1	2									1		6	18	16			
	Psychodidae	Pericoma sp		2		8	7	9					1	1						
	Simuliidae	Simuliidae Unidentified pupa						1	8											
	Simuliidae	Simulium sp Larva						2												
	Simuliidae	Prosimulium sp Larva		3	3				16				64	9						
	Tipulidae	Dicronota sp	5		1	2	12	7	80		28	65	46	9	4	18	14			
	Tipulidae	Hexatoma sp									2	5	3							
	Tipulidae	Ormosia sp	1		1															
Amphipoda	Gammaridae	Gammarus lacustris																	6	
Collembola	Isotomidae	Isotomurus sp	12	3	6	2	1	1							4	12	4	5		
	Hypogastruridae	Hypogastrura sp			2															
Homoptera																				
Homoptera N																	4			
Homoptera A						1														
	Aphidae																2			
Hydracarina																				
Hydracarina Unid J			16	11	1	23	17	19			72	8	96	24	22	20	54			
	Hygrobatidae	Atractides sp									1	17	3							
	Lebertiidae	Lebertia sp				5	2	6			32	10	7	17	2	12	15			
	Protziidae	Wandesia sp	6	2		2		1												
		Oribatei sp		1		3		1				8					2			
	Sperchonidae	Sperchon sp				5	5	7				1	112	54	20	14	8			

Jacques Whitford AXYS / Yukon Zinc 2007		Site	W9-1	W9-2	W9-3	W12-1	W12-2	W12-3	W16-1	W16-2	W16-3	W17-1	W17-2	W17-3	W18-1	W18-2	W18-3	LS-1	LS-2	LS-3
Numbers reported are total per sample		Fines split to:	1/2			1/2			1/8	1/4	1/8	1/8	1/16	1/8	1/2	1/2				
	Unionicolidae	Neumannia sp											16		6		1			
	Unionicolidae	Unioncola sp			1	97	72	114			104	80	323	168	8	2	6	2		
Hymenoptera																				
Hymenoptera A					1		2													
Copepoda	Harpacticoida		22	4	1	2	10	6				8		8				109	3	10
	Cyclopoida																	131	8	4
Ostracoda	Candoniidae	Candona sp	2	3	1	25	19	5			152	2409	2177	594	3	8	2	2	1	4
	Cyprididae	Cypria sp					1											37	12	18
Oligochaeta	Enchytraidae		2	1		47	7	9				17	35	17						
	Lumbriculidae																			
		Kincaidiana hexatheca									1							1		
	Naidiae			1																
	Naidiae	Unidentified Juvenile																5		
	Naidiae	Nais sp																14	1	11
	Naidiae	Prisitna sp																10	1	
	Tubificidae	Unidentified Juvenile																5		
Cladocera	Bosminidae	Bosmina longirostris																10		
	Chydoridae	Alona sp		1								8						11		
	Chydoridae																			2
	Chydoridae	Chydorus sphaericus																3	2	
	Macrothricidae	Ilyocryptus sordidus																		1
Bivalavia	Sphaeriidae	Pisidium sp																22	10	3
	Sphaeriidae	Sphaerium sp																4		
Gastropoda	Valvaridae	Valvata sincera																1		
Platyhelminthes																				
	Planariidae	Polycelis coronata	2	6	4			2	1						6	7	7			
Hydra																		1		
Thysenoptera N			1			1							1			4				
Tardigrada													16							
Nematoda			42	6	5	38	10	9			28	129	191	20	1	1	1	8		
Aranaea (terr)														1	1					
Coleoptera																				
Coleoptera L (terr)																1				
Total			705	438	413	920	843	787	4509	2849	2648	5123	8241	3592	882	962	1059	487	66	70
Organisms per m²			1516	1177	1480	3297	3022	2821	16161	15317	14237	27543	44306	19312	2371	2586	2847			

Appendix E

Periphyton Taxonomy Data

2005 and 2007

2005 DATA REPRODUCED FROM APPENDIX D OF THE AQUATIC RESOURCES ADDENDUM TO YUKON ZINC CORPORATION WOLVERINE PROJECT ENVIRONMENTAL ASSESSMENT REPORT, PREPARED BY JAQUES WHITFORD LIMITED, MARCH 2006

2007 DATA REPRODUCED FROM APPENDIX D OF JAQUES WHITFORD MEMO (APRIL 17, 2008) REGARDING RESULTS OF THE 2007 BENTHIC SAMPLING PROGRAM FOR YUKON ZINC CORP.'S WOLVERINE PROJECT.

APPENDIX D

Periphyton

APPENDIX TABLE D-1: Periphyton Species, Wolverine Project Area 2005

Taxon	
BACILLARIOPHYCEAE (diatoms)	CHLOROPHYCEAE (green algae)
<i>Achnanthes</i> spp.	<i>Chaetophora pisiformis</i> (Roth) C.A. Ag.
<i>Amphipleura pellucida</i> Kuetz	<i>Closterium</i> sp.
<i>Amphora ovalis</i> (Kuetz.) Kuetz.	<i>Microspora</i> cf. <i>tumidula</i>
<i>Anomoeoneis</i> sp.	<i>Mougeotia</i> sp.
<i>Cocconeis placentula</i> Ehr.	<i>Oedogonium</i> sp.
<i>Cymbella</i> spp.	<i>Ulothrix zonata</i> (Weber & Mohr) Kuetz.
<i>Cymbella affinis</i> Kuetz.	unidentified basal cells (Chaetophorales)
<i>Cymbella minuta</i> Hilse ex Rabenh.	<i>Zygnema</i> sp.
<i>Denticula elegans</i> Kuetz.	CYANOPHYCEAE (bluegreen algae)
<i>Diatoma hiemale</i> (Roth) Heib.	<i>Chamaesiphon</i> cf. <i>incrustans</i>
<i>Diatoma hiemale</i> v. <i>mesodon</i> (Ehr.) Grun.	<i>Lyngbya diguetii</i> Gom.
<i>Diatoma tenue</i> Ag.	<i>Nostoc</i> .
<i>Didymosphenia geminata</i> (Lyngb.) M. Schm.	<i>Phormidium</i> sp.
<i>Diploneis</i> sp.	CHRYSTOPHYCEAE (golden algae)
<i>Epithemia sorex</i> Kuetz.	<i>Hydrurus foetidus</i> (Vill.) Trev.
<i>Epithemia turgida</i> (Ehr.) Kuetz.	RHODOPHYTA (red algae)
<i>Eunotia</i> spp.	<i>Audouinella violacea</i> (Kuetz.) Hamel.
<i>Fragilaria construens</i> (Ehr.) Grun	
<i>Gomphonema</i> spp.	
<i>Gomphonema angustatum</i> (Kuetz.) Rab.	
<i>Gomphonema</i> cf. <i>subclavatum</i>	
<i>Hannaea arcus</i> (Ehr.) Patr.	
<i>Melosira</i> sp.	
<i>Meridion circulare</i> (Grev.) Ag.	
<i>Navicula</i> spp.	
<i>Nitzschia</i> spp.	
<i>Rhopalodia gibba</i> (Ehr.) O. Muell.	
<i>Surirella</i> sp.	
<i>Synedra rumpens</i> Kuetz.	
<i>Synedra ulna</i> (Nitz.) Ehr.	
<i>Tabellaria fenestrata</i> (Lyngb.) Kuetz.	

**APPENDIX TABLE D-2: Wolverine Project Periphyton Abundance, Sept 2005
Site W1**

Taxon	Rep 1	Rep 2	Rep 3	Summary
BACILLARIOPHYCEAE	>99%	25%	>99%	
<i>Achnanthes</i> spp.			+	present
<i>Cocconeis placentula</i>	+		+	present
<i>Cymbella</i> spp.	+	+	+	present
<i>Cymbella</i> cf. <i>affinis</i>	+	+		present
<i>Cymbella minuta</i>	+		+	present
<i>Cocconeis placentula</i>	+			present
<i>Denticula elegans</i>	+			present
<i>Diatoma tenue</i>		+		present
<i>Didymosphenia geminata</i>	++	++	++	common
<i>Epithemia turgida</i>	+++	+++	+++	predominant
<i>Epithemia sorex</i>	+	++		common in one
<i>Fragilaria</i> cf. <i>capucina</i>		+	+	present
<i>Fragilaria construens</i>	++	++	+	common
<i>Gomphonema</i> spp.	+			present
<i>Melosira</i> sp. (5 um dia)	++	+	+	common in one
<i>Melosira</i> cf. <i>granulata</i>	+			present
<i>Melosira italica</i>	+	+		present
<i>Melosira varians</i>	+		+	present
<i>Navicula</i> sp. (100 um)	+	+	+	present
<i>Navicula</i> spp. (25 to 50 um)	+	+	+	present
<i>Nitzschia acicularis</i>			+	present
<i>Rhopalodia gibba</i>		+	+	present
<i>Surirella</i> sp.		+		present
<i>Synedra rumpens</i>	+			present
CHLOROPHYCEAE				
<i>Closteriopsis longissima</i>	+	+		present
<i>Scenedesmus</i> sp.	+		+	present
<i>Mougeotia</i> sp.		+		present
<i>Oedogonium</i> sp.		+	+	present
<i>Ulothrix zonata</i>		+		present
CYANOPHYCEAE				
<i>Nostoc pruniforme</i> (colonies)		75%		predominant in one
NUMBER OF SPECIES	20	18	16	30
+++ = predominant (>25%), ++ = common (5 to 25%), + = present (<5%)				
all three samples contain sponge (cells and spicules)				

**APPENDIX TABLE D-3: Wolverine Project Periphyton Abundance, Sept 2005
Site W9**

Taxon	Rep 1	Rep 2	Rep 3	Summary
BACILLARIOPHYCEAE	45%	45%	24%	
<i>Achnanthes</i> spp.	+	+	+	present
<i>Cocconeis placentula</i> (empty)		+		present
<i>Diatoma hiemale</i> var. <i>mesodon</i>	+++	+++	+	predominant
<i>Epithemia turgida</i> (empty)	+	+	+	present
<i>Gomphonema</i> spp.	+	+		present
<i>Hannaea arcus</i>	+		+	present
<i>Meridion circulare</i>	++			present
<i>Synedra rumpens</i>	+	+		present
CHLOROPHYCEAE				
<i>Ulothrix zonata</i>	+			present
CHRYSOPHYCEAE				
<i>Hydrurus foetidus</i>	50%	50%	75%	predominant
CYANOPHYCEAE				
<i>Chamaesiphon</i> cf. <i>incrusters</i>	5%	5%	1%	common
<i>Lyngbya diguetii</i>	+	+	+	present
NUMBER OF SPECIES	11	9	7	12
+++ = predominant (>25%), ++ = common (5 to 25%), + = present (<5%)				
one atypical <i>Hannaea arcus</i> (notch in frustule)				

APPENDIX TABLE D-4: Wolverine Project Periphyton Abundance, Sept 2005 Site W11

Taxon	Rep 1	Rep 2	Rep 3	Summary
BACILLARIOPHYCEAE	82%	99%	>99%	
<i>Achnanthes</i> spp.	+	+	+	present
<i>Amphipleura pellucida</i>	+++	++	+	common
<i>Cocconeis placentula</i>	+	+	+	present
<i>Cymbella</i> cf. <i>affinis</i>	+	+	+	present
<i>Cymbella cistula</i>	+	+	+	present
<i>Cymbella minuta</i>	+	+	+	present
<i>Cocconeis placentula</i>	+			present
<i>Diatoma tenue</i>	++	+		common in one
<i>Didymosphenia geminata</i>		+		present
<i>Epithemia turgida</i>	++	++	++	common
<i>Eunotia</i> sp.		+		present
<i>Eunotia pectinalis</i> var. <i>minor</i>	+			present
<i>Fragilaria construens</i>	+	++		common in one
<i>Gomphonema</i> spp.		+		present
<i>Gomphonema brebissonii</i>		+		present
<i>Gomphonema</i> cf. <i>subclavatum</i>	+	+	+	present
<i>Melosira italica</i>		+		present
<i>Melosira varians</i>		+		present
<i>Navicula</i> sp. (100 um)	+	+	+	present
<i>Navicula</i> cf. <i>radiosa</i> (50 um)	+	+	+	present
<i>Nitzschia</i> spp.	++	++	+	common
<i>Rhopalodia gibba</i>	+	+	+	present
<i>Surirella</i> sp.		+		present
<i>Synedra rumpens</i>	+	+	+	present
<i>Synedra ulna</i>	+++	+++	+++	predominant
<i>Tabellaria fenestrata</i>	+	++	++	common
CHLOROPHYCEAE				
<i>Closterium</i> sp.		+	+	present
<i>Cosmarium</i> sp.	+	+		present
<i>Chaetophora</i> cf. <i>pisiformis</i>	10%			common in one
<i>Microspora loefgrenii</i>			+	present
<i>Mougeotia</i> sp.	+	+		present
<i>Oedogonium</i> sp.	1%	+		present
<i>Zygnema</i> sp.	+			present
RHODOPHYCEAE				
<i>Audouinella violacea</i>		+		present
CYANOPHYCEAE				
<i>Calothrix</i> sp. (6 um at base)	1%	1%		present
<i>Lyngbya diguetii</i>	5%			common in one
<i>Nostoc</i> sp.	+			present
<i>Phormidium</i> sp. (5 um dia)	1%			present
NUMBER OF SPECIES	28	30	17	38
+++ = predominant (>25%), ++ = common (5 to 25%), + = present (<5%)				

**APPENDIX TABLE D-5: Wolverine Project Periphyton Abundance, Sept 2005
Site W14**

Taxon	Rep 1	Rep 2	Rep 3	Summary
BACILLARIOPHYCEAE	45%	43%	95%	
<i>Achnanthes</i> spp.	+	++	++	common
<i>Amphipleura pellucida</i>	+	++	+	common in one
<i>Amphora ovalis</i>		+		present
<i>Cocconeis placentula</i>	+	+	+	present
<i>Cymbella</i> spp.		+	+	present
<i>Cymbella</i> cf. <i>affinis</i>	+	+	+	present
<i>Cymbella minuta</i>	+	+	+	present
<i>Cocconeis placentula</i>	+	+	+	present
<i>Diatoma hiemale</i> var. <i>mesodon</i>	+	+	+	present
<i>Diatoma tenue</i>	++	++	+	common
<i>Didymosphenia geminata</i>	+	+	+	present
<i>Diploneis</i> sp.		+	+	present
<i>Epithemia turgida</i>		++	+	common in one
<i>Frustulia rhomboides</i>		+		present
<i>Gomphonema</i> spp.	+			present
<i>Hannaea arcus</i>	++	++	+	common
<i>Navicula</i> sp. (100 um)	+	+	+	present
<i>Navicula</i> cf. <i>radiosa</i> (50 um)	+	+	+	present
<i>Nitzschia</i> spp.	+	++	++	common
<i>Rhopalodia gibba</i>		+		present
<i>Synedra rumpens</i>	++	++	++	common
<i>Synedra ulna</i>	++	++	+++	predominant/common
<i>Tabellaria fenestrata</i>	+	+		present
CHLOROPHYCEAE				
<i>Closterium</i> sp.	+			present
<i>Cosmarium</i> sp.			+	present
<i>Chaetophora</i> cf. <i>pisiformis</i>	+	50%	5%	predominant/common
<i>Microspora loefgrenii</i>		5%		common
<i>Mougeotia</i> sp.	+	+		present
<i>Staurastrum</i> sp.		+		present
<i>Ulothrix tenerrima</i>		1%		present
<i>Ulothrix zonata</i>		1%	+	present
<i>Zygnema</i> sp.	+			present
RHODOPHYCEAE				
<i>Audouinella violacea</i>	10%	+	+	common in one
CYANOPHYCEAE				
<i>Calothrix</i> sp.		+		present
<i>Chamaesiphon</i> cf. <i>incrustans</i>	+	+		present
<i>Lyngbya diguetii</i>	35%		+	predominant in one
<i>Nostoc</i> sp.	+			present
<i>Phormidium</i> sp. (3 um dia)	10%	+	+	common in one
NUMBER OF SPECIES	26	33	23	36
+++ = predominant (>25%), ++ = common (5 to 25%), + = present (<5%)				
note: <i>Synedra ulna</i> , atypical form (undulating, not straight)				

**APPENDIX TABLE D-6: Wolverine Project Periphyton Abundance, Sept 2005
Site W16**

Taxon	Rep 1	Rep 2	Rep 3	Summary
BACILLARIOPHYCEAE	50%	95%	95%	
<i>Achnanthes</i> spp.	+	+	++	common in one
<i>Amphipleura pellucida</i>	+			present
<i>Cocconeis placentula</i>	+	+		present
<i>Cymbella</i> spp.	+	+	+	present
<i>Cymbella</i> cf. <i>affinis</i>	++	++	++	common in one
<i>Cymbella cistula</i>	+	+	+	present
<i>Cymbella minuta</i>	++	++	++	common in one
<i>Diatoma hiemale</i> var. <i>mesodon</i>	+		+	present
<i>Denticula elegans</i>			+	present
<i>Epithemia turgida</i>	+		+	present
<i>Fragilaria construens</i>	+		+	present
<i>Frustulia rhomboides</i>	+	+	+	present
<i>Gomphonema</i> spp.	+		+	present
<i>Hannaea arcus</i>	+	+	+	present
<i>Meridion circulare</i>	+	+		present
<i>Navicula</i> sp. (100 um)	+	+	++	common in one
<i>Navicula</i> cf. <i>radiosa</i> (50 um)	+	++	+	common in one
<i>Nitzschia</i> spp.	++	++	++	common
<i>Surirella</i> sp.	+			present
<i>Synedra rumpens</i>	++		++	common
<i>Synedra ulna</i>	+++	++	++	predominant/common
<i>Tabellaria flocculosa</i>			+	present
CHLOROPHYCEAE				
<i>Closterium</i> sp.	+		+	present
<i>Microspora loefgrenii</i>		+	+	present
<i>Oedogonium</i> sp.			5%	common
RHODOPHYCEAE				
<i>Audouinella violacea</i>	50%	5%	+	predominant in one
CYANOPHYCEAE				
<i>Chamaesiphon</i> cf. <i>incrustans</i>	+	+		present
<i>Lyngbya diguetii</i>			+	present
<i>Nostoc</i> sp.	+			present
<i>Phormidium</i> sp. (3 um dia)	+	+	+	present
NUMBER OF SPECIES	25	17	24	30
+++ = predominant (>25%), ++ = common (5 to 25%), + = present (<5%)				

**APPENDIX TABLE D-7: Wolverine Project Periphyton Abundance, Sept 2005
Site W12**

Taxon	Rep 1	Rep 2	Rep 3	Summary
BACILLARIOPHYCEAE	70%	80%	50%	
<i>Achnanthes</i> spp.	+	+	+	present
<i>Amphipleura pellucida</i>	+	++	+	common in one
<i>Amphora ovalis</i>	+	+		present
<i>Cymbella</i> cf. <i>affinis</i>	+	+		present
<i>Cymbella minuta</i>	+	+		present
<i>Diatoma hiemale</i> var. <i>mesodon</i>	+	+	+	present
<i>Didymosphenia geminata</i>		+		present
<i>Epithemia turgida</i>	+	+		present
<i>Fragilaria construens</i>		+		present
<i>Gomphonema</i> sp. (30 um)	+			present
<i>Hannaea arcus</i>	+	+		present
<i>Meridion circulare</i>	+			present
<i>Navicula</i> sp. (100 um)	+	+		present
<i>Navicula</i> cf. <i>radiosa</i> (50 um)	+	+		present
<i>Nitzschia</i> spp.	++	++	+	common
<i>Nitzschia acicularis</i>	++	+		common in one
<i>Rhopalodia gibba</i>		+		present
<i>Synedra rumpens</i>	+	+	+	present
<i>Synedra ulna</i>	+++	+++	++	predominant
CHLOROPHYCEAE				
<i>Closterium</i> sp.	+	5%		common in one
<i>Chaetophora</i> sp. (large cells)	20%	5%	+	common
RHODOPHYCEAE				
<i>Audouinella violacea</i>		+		present
CYANOPHYCEAE				
<i>Lyngbya diguetii</i>	10%	10%	50%	predominant/common
NUMBER OF SPECIES	19	21	8	23
+++ = predominant (>25%), ++ = common (5 to 25%), + = present (<5%)				
note: <i>Synedra ulna</i> , atypical form (undulating, not straight)				

**APPENDIX TABLE D-8: Wolverine Project Periphyton Abundance, Sept 2005
Site W72**

Taxon	Rep 1	Rep 2	Rep 3	Summary
BACILLARIOPHYCEAE				
<i>Achnanthes</i> spp.			+	
<i>Navicula</i> sp.		+	+	
<i>Nitzschia</i> spp.		+	+	
RHODOPHYCEAE				
<i>Audouinella violacea</i>	+		+	
CYANOPHYCEAE				
<i>Chamaesiphon</i> cf. <i>incrustans</i>	+			
<i>Lyngbya diguetii</i>		+		
NUMBER OF SPECIES	2	3	4	6
+++ = predominant (>25%), ++ = common (5 to 25%), + = present (<5%)				
SAMPLES CONTAINED VIRTUALLY NO ALGAE				

APPENDIX TABLE D-9: Wolverine Project Periphyton Abundance, Sept 2005 Site W73

Taxon	Rep 1	Rep 2	Rep 3	Summary
BACILLARIOPHYCEAE	90%	90%	80%	
<i>Achnanthes</i> spp.	+	+		present
<i>Anoemoeneis</i> sp.	+	+		present
<i>Cocconeis placentula</i>	+	+		present
<i>Cymbella</i> cf. <i>affinis</i>	+	+	+	present
<i>Cymbella cistula</i>	+			present
<i>Cymbella minuta</i>	+		+	present
<i>Diatoma hiemale</i>	+		+	present
<i>Diatoma tenue</i>	+++	+	+	predominant in one
<i>Didymosphenia geminata</i>			+	present
<i>Hannaea arcus</i>	++	++	+++	predominant/common
<i>Navicula</i> spp.	+	+	+	present
<i>Rhoicosphenia curvata</i>		+		present
<i>Synedra rumpens</i>	+	+	+	present
<i>Synedra ulna</i>	++	+	++	common
CHLOROPHYCEAE				
<i>Chaetophora</i> cf. <i>pisiformis</i>	+	5%	5%	common
<i>Closterium</i> sp.			+	present
<i>Staurostrum</i> sp.			+	present
RHODOPHYCEAE				
<i>Audouinella violacea</i>	+	+		present
CYANOPHYCEAE				
<i>Chamaesiphon</i> cf. <i>incrustans</i>	+	+	5%	present
<i>Lyngbya diguetii</i>	10%	5%	10%	common
<i>Nostoc</i> sp.			+	present
<i>Phormidium</i> sp. (5 um dia)	+	+	+	present
NUMBER OF SPECIES	17	15	16	22
+++ = predominant (>25%), ++ = common (5 to 25%), + = present (<5%)				

APPENDIX TABLE D-10: Wolverine Project Periphyton Abundance, Sept 2005 Site W75

Taxon	Rep 1	Rep 2	Rep 3	Summary
BACILLARIOPHYCEAE	60%	20%	>99%	
<i>Achnanthes</i> spp.	+	+	++	common in one
<i>Cymbella</i> cf. <i>affinis</i>	+		++	common in one
<i>Cymbella minuta</i>			++	common in one
<i>Diatoma tenue</i>			+	present
<i>Didymosphenia geminata</i> (empty)	+	+		present
<i>Diploneis</i> sp.			+	present
<i>Epithemia turgida</i>	+	+	+	present
<i>Gomphonema angustatum</i>	+			present
<i>Gomphonema brebissonii</i>	+		+	present
<i>Hannaea arcus</i>	++	++	+++	predominant/common
<i>Melosira</i> sp. (5 um dia)		+		present
<i>Navicula</i> spp.			+	present
<i>Synedra rumpens</i>		+	+	present
<i>Tabellaria fenestrata</i>	+	+	+	present
CHLOROPHYCEAE				
unidentified basal cells (<i>Chaetophora</i> ?)	20%	10%		common
RHODOPHYCEAE				
<i>Audouinella violacea</i>	+			present
CYANOPHYCEAE				
<i>Chamaesiphon</i> cf. <i>incrustans</i>	+	10%	+	common in one
<i>Lyngbya diguetii</i>	20%			common in one
<i>Nostoc</i> sp.	+			present
NUMBER OF SPECIES	13	10	12	19
+++ = predominant (>25%), ++ = common (5 to 25%), + = present (<5%)				

APPENDIX D

2007 Periphyton Taxonomy Results

Wolverine Project Periphyton, August 2007
Site W9

Taxon	Rep 1	Rep 2	Rep 3	Summary
BACILLARIOPHYCEAE	5%	1%	1%	
<i>Diatoma hiemale</i> var. <i>mesodon</i>	++	+	+	common in one
<i>Eunotia</i> sp.	+			present
<i>Gomphonema</i> spp.	+	+		present
<i>Hannaea arcus</i>		+		present
<i>Meridion circulare</i>	++	+	+	common in one
<i>Navicula</i> spp.	+	+	+	present
CHLOROPHYCEAE				
<i>Microspora</i> cf. <i>amoena</i>	+	+		present
CHRYSOPHYCEAE				
<i>Hydrurus foetidus</i>	10%	50%	50%	predominant
XANTHOPHYCEAE				
<i>Tribonema</i> sp.		+		present
CYANOPHYCEAE				
<i>Chamaesiphon</i> cf. <i>incrustans</i>	85%	49%	49%	predominant
<i>Lyngbya diguetii</i>	+		+	present
NUMBER OF SPECIES	9	9	6	11
+++ = predominant (>25%), ++ = common (5 to 25%), + = present (<5%)				
one atypical <i>Hannaea arcus</i> (notch in frustule)				

Wolverine Project Periphyton, August 2007
Site W12

Taxon	Rep 1	Rep 2	Rep 3	Summary
BACILLARIOPHYCEAE	1%	74%	5%	
<i>Achnanthes</i> spp.	+	++	+	common in one
<i>Amphipleura pellucida</i>		+		present
<i>Cocconeis placentula</i>		+		present
<i>Cymbella</i> spp.		++	+	common in one
<i>Cymbella</i> cf. <i>affinis</i>		+		present
<i>Cymbella minuta</i>		+		present
<i>Diatoma hiemale</i> var. <i>mesodon</i>		++		common in one
<i>Epithemia turgida</i>		++	+	common in one
<i>Fragilaria construens</i>		+		present
<i>Frustulia rhomboides</i>		+		present
<i>Gomphonema olivaceum</i>		+		present
<i>Gomphonema acuminatum</i>		+		present
<i>Hannaea arcus</i>		+++	++	common - predominant
<i>Navicula</i> spp.		+	+	present
<i>Nitzschia</i> spp.		+	+	present
<i>Synedra ulna</i>	+	+++	++	common - predominant
CHLOROPHYCEAE				
<i>Cosmarium</i> sp.		+		present
<i>Microspora</i> cf. <i>amoena</i> (25 um dia)		+		present
<i>Oedogonium</i> sp.		+		present
<i>Stigeoclonium</i> sp.		+	+	present
RHODOPHYCEAE				
<i>Audouinella violacea</i>			+	present
CYANOPHYCEAE				
<i>Chamaesiphon</i> cf. <i>incrustans</i>	99%	20%	70%	predominant
<i>Lyngbya diguetii</i>	+	5%	20%	common
<i>Phormidium</i> sp.		1%	5%	present
NUMBER OF SPECIES	4	23	12	24
+++ = predominant (>25%), ++ = common (5 to 25%), + = present (<5%)				
note: <i>Synedra ulna</i> , one cell is an atypical form (undulating, not straight)				

Wolverine Project Periphyton, August 2007
Site W16

Taxon	Rep 1	Rep 2	Rep 3	Summary
BACILLARIOPHYCEAE	94%	99%	95%	
<i>Achnanthes</i> spp.	+++	+++	+++	predominant
<i>Amphora ovalis</i>	+	+		present
<i>Anomoeneis</i> sp.	+	+	+	present
<i>Cymbella</i> spp.	+++	++	+++	predominant
<i>Cymbella</i> cf. <i>affinis</i>	++	++	+	common
<i>Cymbella minuta</i>	++	++	++	common
<i>Diatoma hiemale</i> var. <i>mesodon</i>	++	++	+	common
<i>Fragilaria construens</i>	++	+	++	common
<i>Frustulia rhomboides</i>	++	++	+	common
<i>Gomphonema angustatum</i>	++	++	++	common
<i>Gomphonema olivaceum</i>	+	+	+	present
<i>Hannaea arcus</i>	++	+	++	common
<i>Meridion circulare</i>	++	++	++	common
<i>Melosira</i> cf. <i>italica</i>	+	+	+	present
<i>Navicula</i> spp.	++	++	++	common
<i>Neidium</i> sp.	+			present
<i>Nitzschia</i> spp.	++	++	++	common
<i>Synedra ulna</i>	+	+	+	present
<i>Tabellaria flocculosa</i>	+	+		present
CHLOROPHYCEAE				
<i>Cosmarium</i> sp.	+			present
<i>Microspora</i> cf. <i>amoena</i> (25 um dia)	5%	+	+	present
RHODOPHYCEAE				
<i>Audouinella violacea</i>	+		+	present
CYANOPHYCEAE				
<i>Phormidium</i> sp.	1%	1%	5%	present
NUMBER OF SPECIES	23	20	19	23
+++ = predominant (>25%), ++ = common (5 to 25%), + = present (<5%)				

**Wolverine Project Periphyton, August 2007
Site W17**

Taxon	Rep 1	Rep 2	Rep 3	Summary
BACILLARIOPHYCEAE	>99%	>99%	>99%	
<i>Achnanthes</i> spp.	+	+	+	present
<i>Amphora ovalis</i>	+		+	present
<i>Cocconies placentula</i>			+	present
<i>Cymbella</i> spp.	++	+	++	common in two
<i>Cymbella</i> cf. <i>affinis</i>	+		+	present
<i>Cymbella cistula</i>				present
<i>Cymbella minuta</i>	++	+	++	common in two
<i>Cymbella sinuata</i>	+			present
<i>Diatoma hiemale</i> var. <i>mesodon</i>	+		++	common in one
<i>Eunotia</i> sp.			+	present
<i>Fragilaria</i> cf. <i>capucina</i>			+	present
<i>Fragilaria construens</i>	++	+	++	common in two
<i>Frustulia rhomboides</i>	+		++	common in one
<i>Gomphonema acuminatum</i>	+			present
<i>Gomphonema angustatum</i>	+			present
<i>Gomphonema olivaceum</i>	+		+	present
<i>Hannaea arcus</i>	++	+	+	common in one
<i>Melosira</i> cf. <i>italica</i>	++		+	common in one
<i>Meridion circulare</i>	++	+	++	common in two
<i>Navicula</i> spp.	++	+	++	common in two
<i>Nitzschia</i> spp.	+	+	+	present
<i>Pinnularia</i> sp.	+		+	present
<i>Synedra ulna</i>	++	++	+	common
<i>Tabellaria fenestrata</i>	+		+	present
<i>Tabellaria flocculosa</i>			+	present
CHLOROPHYCEAE				
<i>Microspora</i> cf. <i>amoena</i> (25 μ m dia)	+	+		present
<i>Staurostrum</i>	+			present
RHODOPHYCEAE				
<i>Audouinella violacea</i>			+	present
CYANOPHYCEAE				
<i>Phormidium</i> sp.			+	present
NUMBER OF SPECIES	22	10	23	29
+++ = predominant (>25%), ++ = common (5 to 25%), + = present (<5%)				
note: <i>Cymbella</i> cf. <i>affinis</i> , atypical form (undulating, not straight)				

Wolverine Project Periphyton, August 2007
Site W18

Taxon	Rep 1	Rep 2	Rep 3	Summary
BACILLARIOPHYCEAE	25%	15%	15%	
<i>Cymbella minuta</i>	+	+		present
<i>Diatoma hiemale</i> var. <i>mesodon</i>	++	+++	+++	predominant - common
<i>Gomphonema</i> spp.	+			present
<i>Gomphonema angustatum</i>	+++		+	predominant in one
<i>Gomphonema olivaceum</i>	+			present
<i>Gomphonema subclavatum</i>	+			present
<i>Hannaea arcus</i>	++	+++	+++	predominant - common
<i>Meridion circulare</i>		+		present
<i>Navicula</i> spp.	+	+	+	present
<i>Synedra rumpens</i>		++	++	common in two
CHRYSOPHYCEAE				
<i>Hydrurus foetidus</i>	50%	75%	75%	common in one
CYANOPHYCEAE				
<i>Chamaesiphon</i> cf. <i>incrusters</i>	10%			common in one
<i>Lyngbya diguetii</i>	10%	10%	10%	common
<i>Phormidium</i> sp.	5%			common in one
NUMBER OF SPECIES	12	8	7	14
+++ = predominant (>25%), ++ = common (5 to 25%), + = present (<5%)				