Wolverine Project

MONITORING AND SURVEILLANCE PLAN

VERSION 2006-01

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Prepared for:
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1 Introduction

This report was prepared by Lorax Environmental Services Ltd. in conjunction with Klohn Crippen Berger for Yukon Zinc Corporation. The following sections provide details pertaining to the monitoring and reporting with respect to ground and surface water quality, water quantity, and the monitoring of the tailings facility structures.

2 Groundwater Monitoring

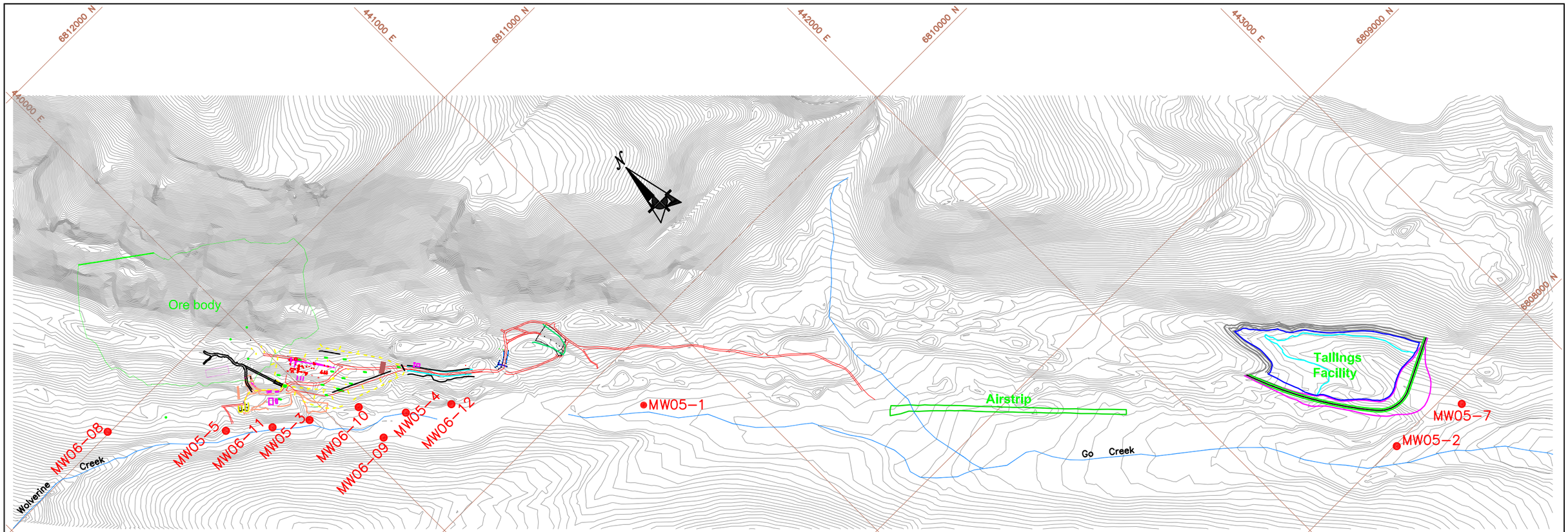
Monitoring of groundwater conditions around the Wolverine Mine facilities will focus on groundwater conditions in the upper Wolverine Creek and Go Creek basins. More specifically, monitoring of groundwater will occur in those areas downgradient of the underground and process plant operations, immediately adjacent to Wolverine Creek, as well as downgradient of the tailings facility in the upper reaches of Go Creek. Monitoring will consist of physical (e.g. piezometric water levels) and water quality determinations at all locations.

2.1 Wolverine Creek Basin

Groundwater monitoring wells adjacent to Wolverine Creek and downgradient of the proposed underground operations have been established and are currently being monitored as part of the continuing baseline groundwater characterization program. Well locations are depicted in Figure 2-1. The objectives of the groundwater monitoring program for the underground and process plant areas within the upper Wolverine Creek basin are as follows:

- Provide information to delineate the direction of groundwater flow;
- Provide information to estimate the velocity and quantitative rate of groundwater flow;
- Monitor and delineate potential effects of mine dewatering on Wolverine Creek; and
- Provide sampling locations to continue to document baseline groundwater quality prior to operations and to monitor for any impacts to groundwater quality that result from mining or mining related activities during operations and at closure.

A total of sixteen (16) groundwater monitoring wells have been installed at eight (8) nested locations in the Wolverine Creek basin, as illustrated in Figure 2-1.



Drawing By Lorax Environmental Services Ltd - June 16, 2006

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Wolverine Project

Figure 2-1

Groundwater Monitoring Well Locations

Table 2-1 summarizes the well identification and depth of completion for each monitoring well in the upper Wolverine Creek basin.

Table 2-1. 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

As illustrated, the wells have been designed 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.

2.1.1 Groundwater Levels

Groundwater levels will be monitored monthly, with static levels recorded prior to sampling. Data will be summarized and reported annually. Reports will include elevation versus time graphs, interpreted equipotentials and updated assessments of the groundwater flow.

2.1.2 Groundwater Quality

Groundwater quality samples will also be collected monthly and analyzed for a suite of parameters including physical parameters, major anions, nutrients and dissolved metals; total metals will not be monitored for groundwater wells. Wells will be purged prior to each sampling following static water level measurements to ensure representative samples are collected.

Analytical parameters to be monitored are listed in Table 2-2. QA/QC measures will include a travel blank, a field blank prepared from distilled water, a filter blank prepared from the distilled water, a blind field duplicate and a laboratory duplicate.

Table 2-2. Groundwater Quality Monitoring Parameters and Detection Limits

Parameter	Symbol	Detection Limit	Units
Physical Parameters			
Conductivity		2	µS/cm
Hardness		0.5	mg/L
Total Dissolved Solids	TDS	10	mg/L
pH	pH	0.1	pH
Turbidity	NTU	0.1	NTU
Major Anions			
Alkalinity-Total	$CaCO_3$	0.5	mg/L
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	N	0.005	mg/L
Nitrate Nitrogen	N	0.005	mg/L
Nitrite Nitrogen	N	0.001	mg/L
Dissolved Ortho-Phosphate	P	0.005	mg/L
Dissolved Trace Metals			
Aluminum	Al	0.001	mg/L
Antimony	Sb	0.0001	mg/L
Arsenic	As	0.0001	mg/L
Barium	Ba	0.001	mg/L
Boron	B	0.008	mg/L
Cadmium	Cd	0.000017	mg/L
Calcium	Ca	0.05	mg/L
Chromium	Cr	0.0005	mg/L
Cobalt	Co	0.001	mg/L
Copper	Cu	0.0002	mg/L
Iron	Fe	0.005	mg/L
Lead	Pb	0.00005	mg/L
Magnesium	Mg	0.05	mg/L
Manganese	Mn	0.001	mg/L
Molybdenum	Mo	0.001	mg/L
Nickel	Ni	0.0005	mg/L
Phosphorus	P	0.1	mg/L
Potassium	K	1	mg/L
Selenium	Se	0.0005	mg/L
Silicon	Si	0.05	mg/L
Silver	Ag	0.00001	mg/L
Sodium	Na	0.05	mg/L
Strontium	Sr	0.001	mg/L
Thallium	Tl	0.0001	mg/L
Vanadium	V	0.001	mg/L
Zinc	Zn	0.001	mg/L

Groundwater quality sampling frequency may be reduced to quarterly sampling following sufficient data collection and a demonstration that the data is of adequate quality to justify a less frequent sampling program without compromising the integrity of the groundwater monitoring program.

2.2 Go Creek Basin

Monitoring of groundwater conditions in the upper Go Creek basin focuses on monitoring the performance of the tailings facility, in particular the integrity of the Enviroliner system installed to prevent tailings water seepage. The objectives of the groundwater monitoring of the upper Go Creek basin are therefore to:

- Provide information to delineate the direction of groundwater flow;
- Provide information to estimate the velocity and quantitative rate of groundwater flow;
- Continue to document baseline groundwater quality prior to operations and to monitor for any impacts to groundwater quality that result from operation of the tailings facility during operations and at closure.

Existing groundwater monitoring well nests MW05-7A, MW05-7B and MW05-2A are located immediately downgradient of the proposed tailings facility and seepage collection pond. Unlike the Wolverine Creek groundwater wells, only the shallow alluvial and shallow bedrock conditions will be monitored; deeper bedrock installations are not warranted at these locations. Table 2-3 summarizes the well identification and depth of completion for each monitoring well in the upper Go Creek basin.

Table 2-3. Go Creek Basin Groundwater Monitoring Wells

Well	Depth (m)	Stratigraphic Unit
MW05-1A	22.9	Shallow Bedrock
MW05-1B	5.0	Alluvial Overburden
MW05-2A	22.9	Shallow Bedrock
MW05-2B	5.0	Alluvial Overburden
MW05-7A	30.2	Shallow bedrock
MW05-7B	4.6	Alluvial Overburden

2.2.1 Groundwater Levels

Groundwater levels will be monitored on a quarterly basis, with static levels recorded prior to sampling. Because there are no dewatering activities in the area, monthly monitoring of groundwater levels are not warranted as compared to the Wolverine Creek basin. Data will be summarized and reported annually. Reports will include elevation versus time graphs, interpreted equipotentials and updated assessments of the groundwater flow.

2.2.2 Groundwater Quality

Groundwater quality samples will also be collected quarterly. Wells will be purged prior to each sampling following static water level measurements to ensure representative samples are collected.

Water quality parameter list will be as indicated in Table 2-2.

2.3 Summary of Groundwater Monitoring

Table 2-4 provides a summary of the proposed groundwater monitoring program for the Wolverine Creek and upper Go Creek basins including monitoring throughout the life-cycle of the Wolverine operation.

Table 2-4. Summary of Groundwater Monitoring Program for Wolverine Creek and Go Creek Basins

Site	Purpose	Pre-Construction	Construction	Operations	Closure	Post Closure
Existing Wells						
MW05-1A/B	Monitor upper reaches of Go Creek groundwater basin	Quarterly	Quarterly	Quarterly	Quarterly	Annual
MW05-2A/B	To monitor impact of tailings facility	Quarterly	Quarterly	Quarterly	Quarterly	Annual
MW05-3A/B	To monitor impact of underground and plantsite	Quarterly	Quarterly	Monthly	Quarterly	Annual
MW05-4A/B	To monitor impact of underground and plantsite	Quarterly	Quarterly	Monthly	Quarterly	Annual
MW05-5A/B	To monitor impact of underground and plantsite	Quarterly	Quarterly	Monthly	Quarterly	Annual
MW05-7A/B	To monitor impact of tailings facility	Quarterly	Quarterly	Quarterly	Quarterly	Annual
MW06-8 S/M/D	To monitor impact of underground	Quarterly	Quarterly	Monthly	Quarterly	Annual
MW06-9 S/M	To monitor groundwater quality on west side of Wolverine Creek (not affected by operations)	Quarterly	Quarterly	Monthly	Quarterly	Annual
MW06-10 S/M/D	To monitor impact of underground and plantsite	Quarterly	Quarterly	Monthly	Quarterly	Annual
MW06-11 S	To monitor impact of underground and plantsite			Monthly		
MW06-12 S	To monitor impact of underground and plantsite			Monthly		

3 Surface Water Monitoring

3.1 Introduction

The surface water monitoring program for the Wolverine Project includes the monitoring of hydrologic flows and water quality at strategic locations and 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;
- Better constrain watershed base flows, particularly in Wolverine Creek;
- Document water quality in the receiving environment and to verify compliance during discharge periods from the water treatment facility;
- 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.

3.2 Surface Water Hydrology

A surface water hydrology monitoring network has been established for the Wolverine Project that provides continuous stream flow data for watercourses in the immediate vicinity of mine site operations as well as more regional coverage (Figure 3-1 and Figure 3-2).

Stations W9 and W82 have been established on Wolverine Creek at the mouth and in the upper reaches immediately adjacent to the underground operations, respectively (Picture 3.1 and Picture 3.2). These stations will be utilized to closely monitor the influence of underground dewatering on flow conditions in Wolverine Creek.

Monitoring of flow conditions in Go Creek occurs at stations W80 and W12 (Figure 3-2). W80 represents the compliance monitoring point for seasonal water treatment plant discharges and flow conditions are closely monitored in conjunction with water quality conditions. Station W12 is also located on Go Creek, just upstream of the confluences of Money Creek and Pup Creek with Go Creek. This station has been historically monitored for flow and monitoring will continue throughout operations to provide data to permit refinements to site water balance conditions.

Regional hydrology is monitored via stations W21 on Nougha Creek and station W22 on Money Creek.

Each hydrology station is equipped with a continuous reading datalogger. Stations will receive at least two annual inspections, once immediately prior to freshet and again in the late summer fall prior to winter low flow conditions. During inspections, equipment will be calibrated. During the initial five years of the operation, stream gauging will occur at each station at least four times per year. Stream gauging data will be used to update each watercourse stage discharge curve. After the first five years, stream gauging will be limited to twice annually.

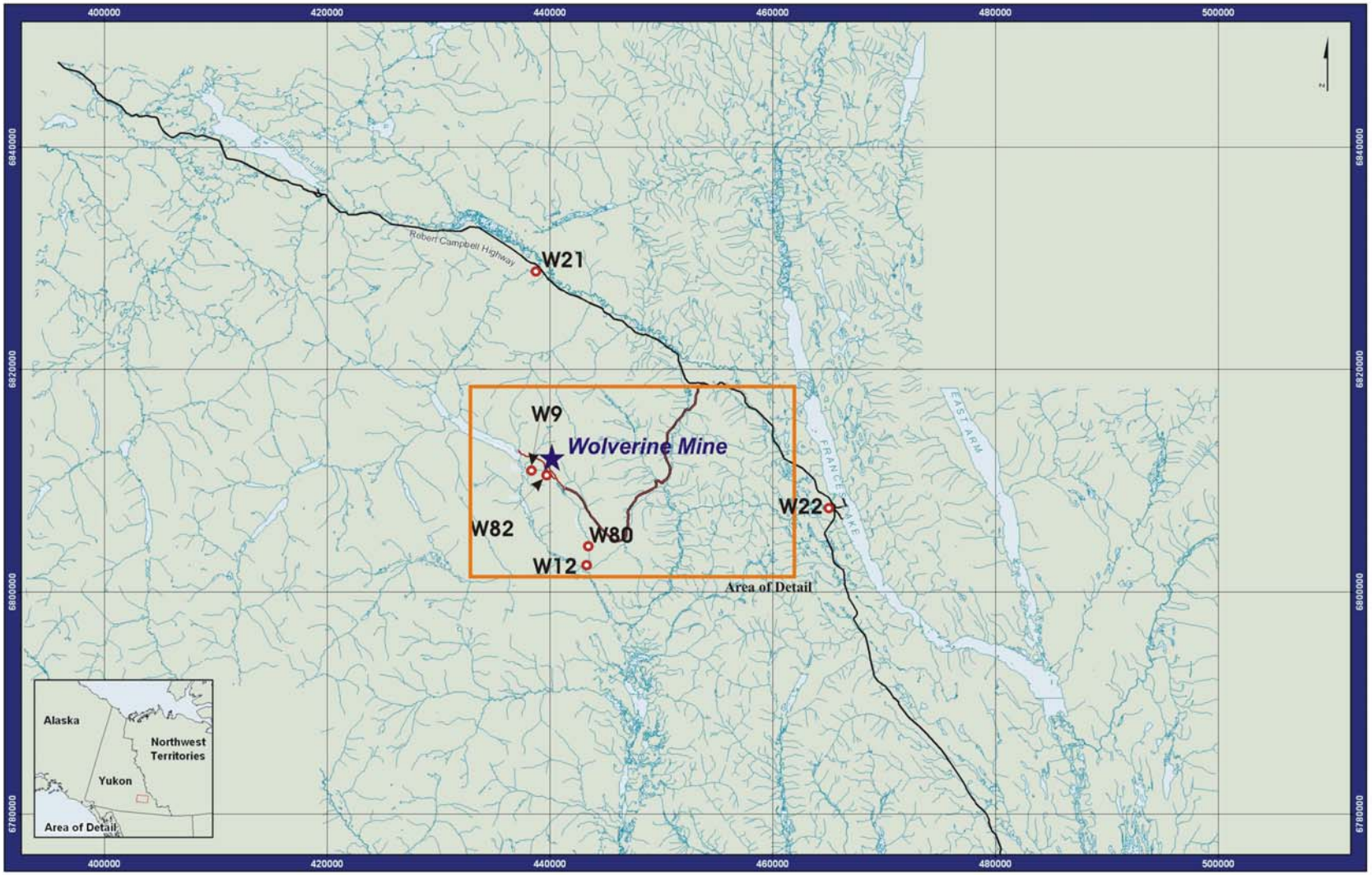

Figure 3-1. Locations of Continuous Hydrology Monitoring Stations in the Immediate Vicinity of Wolverine Project Operations and Regional Stations

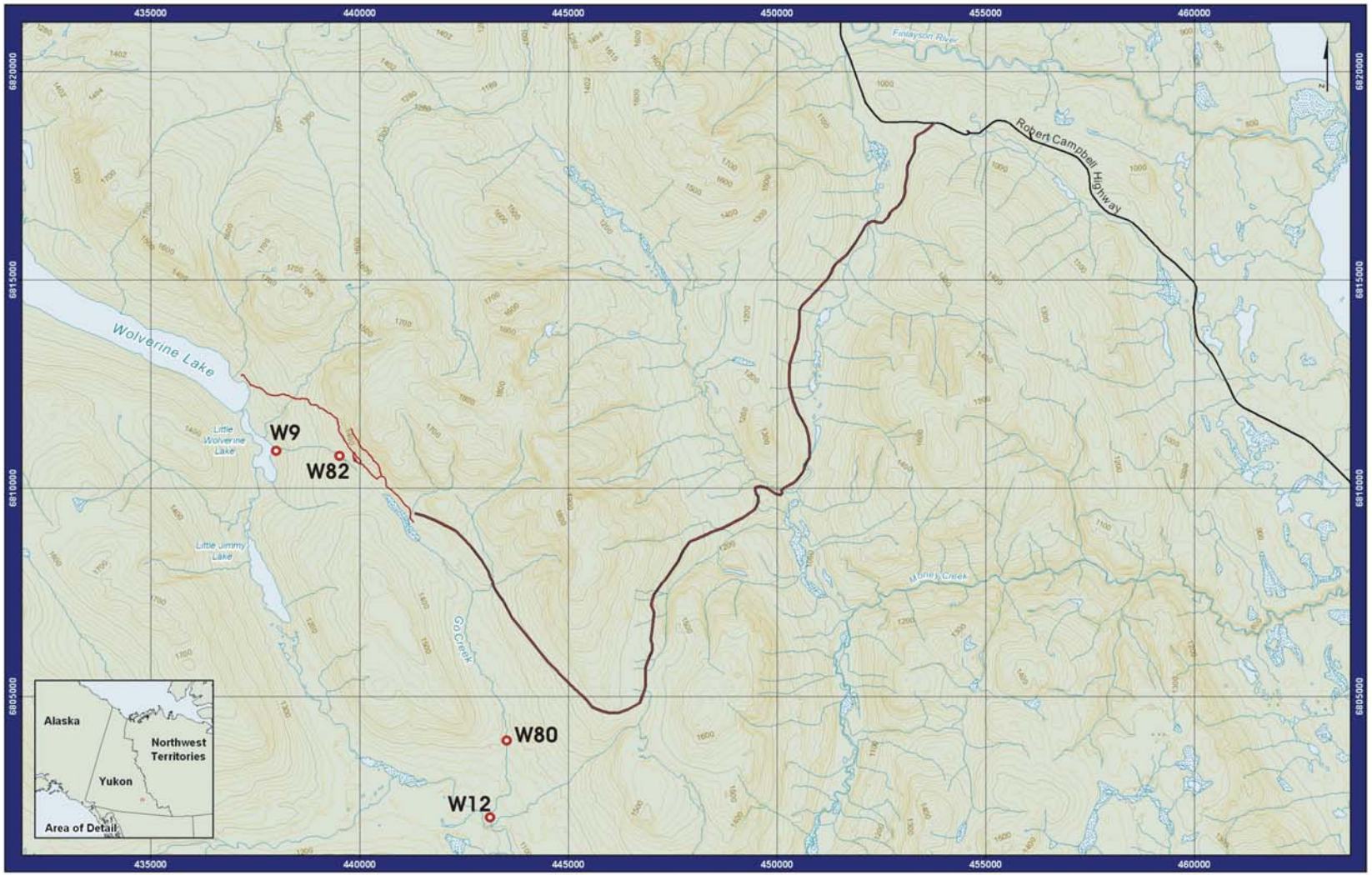

Figure 3-2. Detail of Station Locations of Continuous Hydrology Monitoring Stations in the Immediate Vicinity of Wolverine Project

Picture 3.1. Hydrology Monitoring Station W9 on lower Wolverine Creek

Picture 3.2. Hydrology Monitoring Station W82 on upper Wolverine Creek

3.3 Surface Water Quality

The following section presents the proposed monitoring program for receiving waters for the pre-construction, construction, operational and closure phases of the Wolverine Project. Both surface water and water treatment plant discharge monitoring programs are essential to the overall objective of obviating environmental impacts to the receiving environment and maintaining compliance with water quality objectives in Go Creek. In

addition, water quality monitoring at key locations along the road route will also be maintained.

The water quality parameters and detection limits to be used in the monitoring program of the receiving surface waters are shown in Table 3-1 and are similar to those used for previous baseline surveys. Particular attention has been paid to achieving the lowest possible detection limits for key parameters including cadmium and selenium. The list of parameters may be modified at a future date to reflect site-specific conditions of the project.

Table 3-1. Surface Water Quality Monitoring Parameters and Detection Limits

Parameter	Symbol	Detection Limit	Units
Physical Parameters			
Conductivity		2	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	NTU	0.1	NTU
Major Anions			
Alkalinity-Total	$CaCO_3$	0.5	mg/L
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	N	0.005	mg/L
Nitrate Nitrogen	N	0.005	mg/L
Nitrite Nitrogen	N	0.001	mg/L
Dissolved Ortho-Phosphate	P	0.005	mg/L
Total and Dissolved Trace Metals			
Aluminum	Al	0.001	mg/L
Antimony	Sb	0.0001	mg/L
Arsenic	As	0.0001	mg/L
Barium	Ba	0.001	mg/L
Boron	B	0.008	mg/L
Cadmium	Cd	0.000017	mg/L
Calcium	Ca	0.05	mg/L
Chromium	Cr	0.0005	mg/L
Cobalt	Co	0.001	mg/L
Copper	Cu	0.0002	mg/L
Iron	Fe	0.005	mg/L
Lead	Pb	0.00005	mg/L
Magnesium	Mg	0.05	mg/L
Manganese	Mn	0.001	mg/L
Molybdenum	Mo	0.001	mg/L
Nickel	Ni	0.0005	mg/L
Phosphorus	P	0.1	mg/L
Potassium	K	1	mg/L
Selenium	Se	0.0005	mg/L
Silicon	Si	0.05	mg/L
Silver	Ag	0.00001	mg/L
Sodium	Na	0.05	mg/L
Strontium	Sr	0.001	mg/L
Thallium	Tl	0.0001	mg/L
Vanadium	V	0.001	mg/L
Zinc	Zn	0.001	mg/L

Surface water quality monitoring stations have been established in all key watersheds of the project area including the Wolverine Creek - Wolverine Lake watershed (stations W1, W21, L1, W8, W82 and W9); Go Creek watershed (stations W31, W16, W15, W81, W80 and W12); Money Creek watershed (stations W14, W22 and W40) and along the road route (stations W71, W72 and W73) (Figure 3-3 and 3-4).

Table 3-2 provides a summary of the surface water monitoring program from pre-construction phase through to closure for all monitoring stations, including the monitoring of key components of the water management system. For all stations in the Wolverine, Go Creek, Money Creek and road route watersheds, surface water quality monitoring during the pre-construction, construction and operational phase of the mine will occur on a monthly basis. For the compliance monitoring point in Go Creek at station W80, water quality monitoring will occur daily during periods of active water treatment plant discharge.

During closure, stations will be sampled monthly, but only on a seasonal basis during the ice free period of May to October. The exceptions to this include stations W21, W8, W71, W72 and W73 where sampling during the closure period will be quarterly during the ice free period (Table 3-2).

Surface water quality monitoring of the key components of the water management system include monthly monitoring of the tailings impoundment water and daily sampling of the water treatment plant retention pond when the latter is operating during the ice-free period of May to October. Monitoring of the tailings impoundment and water treatment plant retention pond will be at the proposed frequency as long as these systems are operational, which will likely include the early phases of closure of the mine. The retention pond will be decommissioned at final closure and only seasonal (i.e. monthly during ice free periods) monitoring of the tailings impoundment will continue.

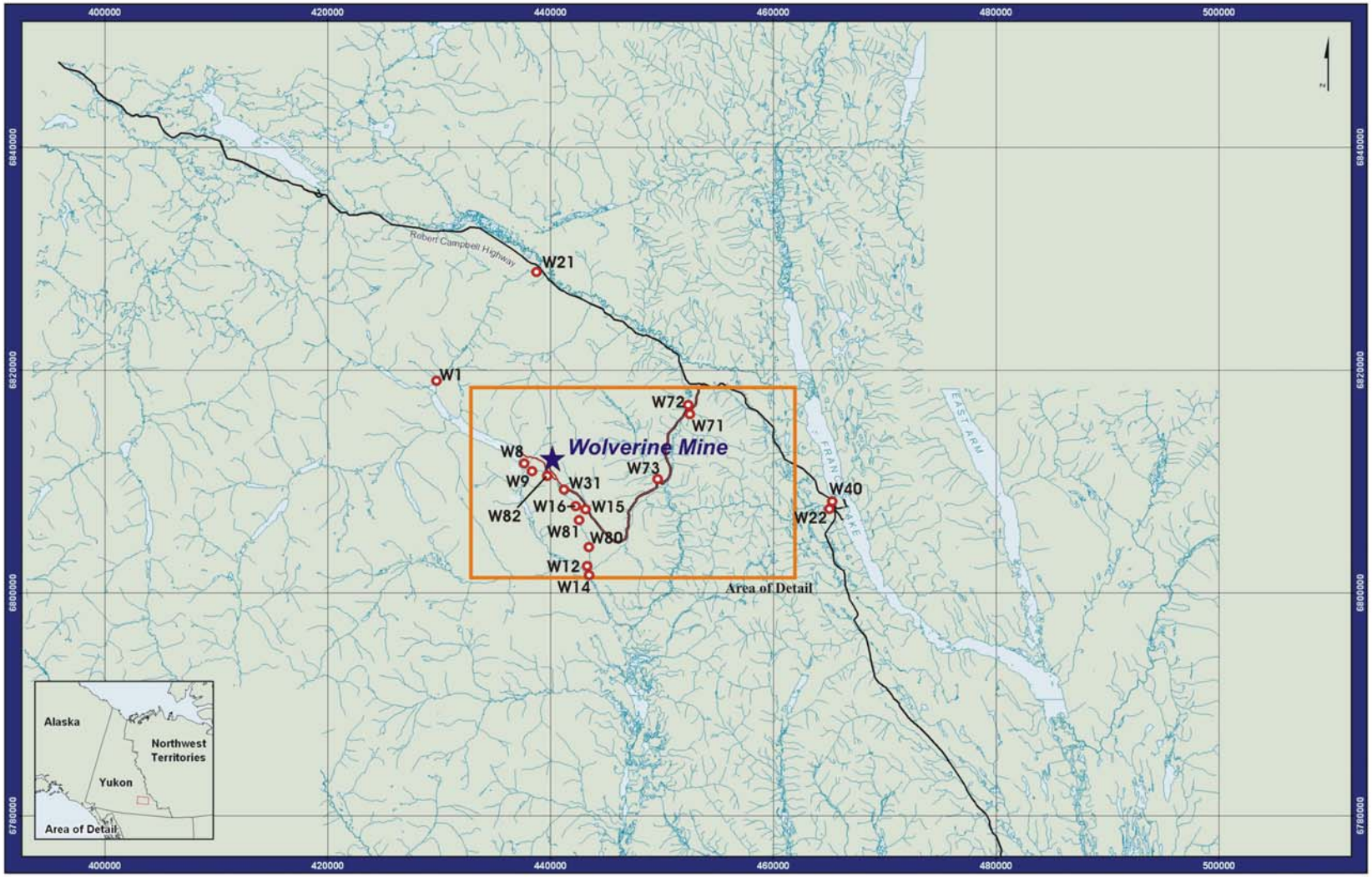

Figure 3-3. Locations of Surface Water Quality Monitoring Stations for the Wolverine Project Operations and Along the Road Route

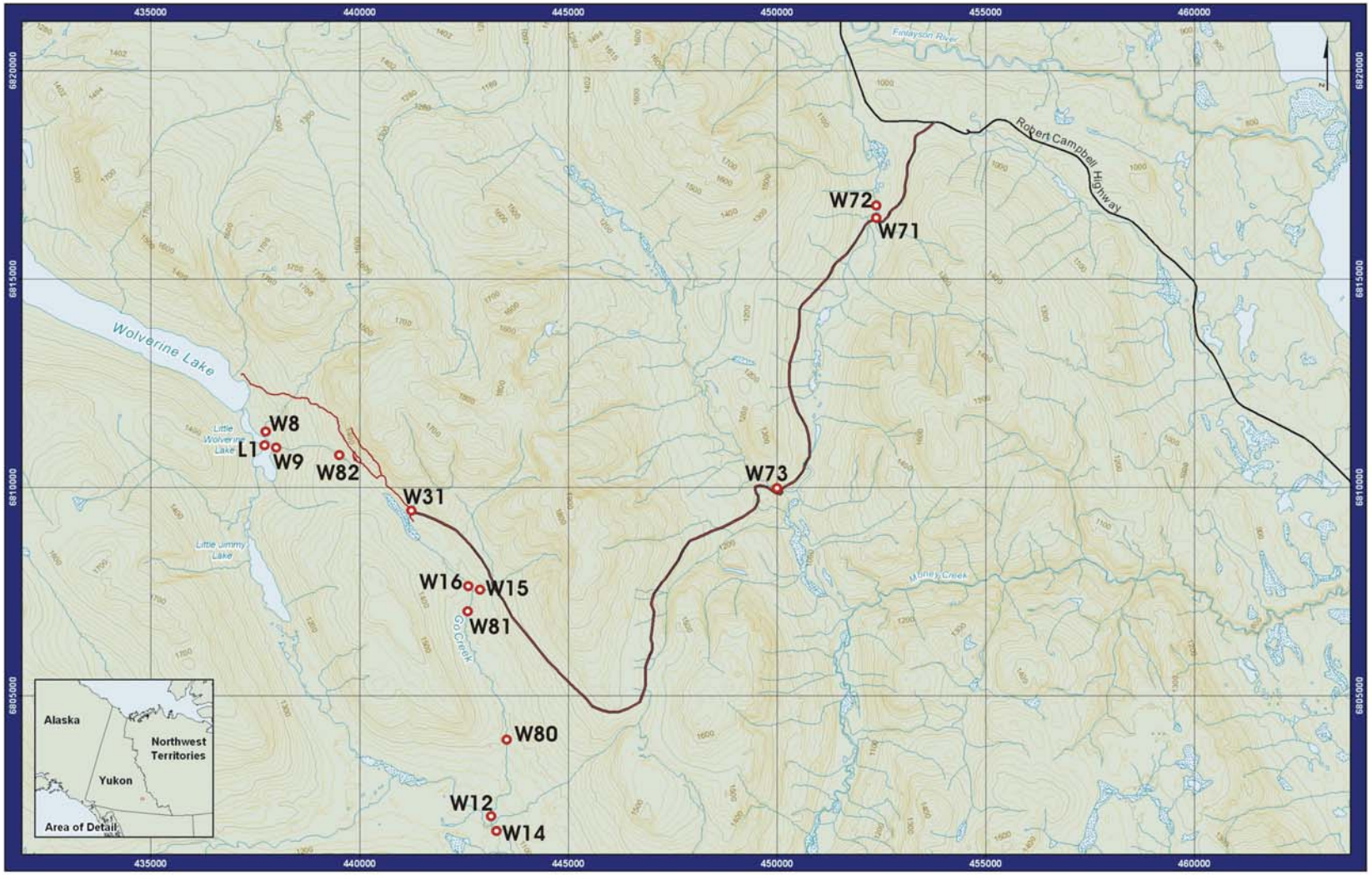

Figure 3-4. Detail of Surface Water Quality Monitoring Stations in the Immediate Vicinity of Wolverine Project Operations and Along the Road Route

Table 3-2. Summary of Surface Water Monitoring Program for Wolverine Project

Site	Purpose	Pre-Construction	Construction	Operations	Closure
Wolverine Watershed					
W1	Monitor water quality of Wolverine Lake	Monthly	Monthly	Monthly	Seasonal[1]
L1	Monitor water quality of Little Wolverine Lake	Monthly	Monthly	Monthly	Seasonal
W21	Monitor water quality of Nougha Creek	Monthly	Monthly	Monthly	Quarterly
W8	Monitor water quality of Campbell Creek	Monthly	Monthly	Monthly	Quarterly
Go Creek Watershed					
W31	Monitor upper reaches of Go Creek prior to tailings facility	Monthly	Monthly	Monthly	Seasonal
W16	Monitor upper Go Creek immediately upstream of discharge location	Monthly	Monthly	Monthly	Seasonal
W15	To monitor Hawkowl Creek prior to joining Go Creek	Monthly	Monthly	Monthly	Seasonal
W81	100 m downstream of confluence of Hawkowl Creek with Go Creek. Intermediate station in Go Creek monitoring influence of discharge	Monthly	Monthly	Monthly	Seasonal
W80	Compliance point in Go Creek	Monthly	Monthly	Daily[2]	Seasonal
W12	Go Creek prior to Money Creek	Monthly	Monthly	Monthly	Seasonal
Money Creek Watershed					
W14	Monitor water quality in upper reaches of Money Creek	Monthly	Monthly	Monthly	Seasonal
W22	Monitor water quality in Money Creek upstream of highway	Monthly	Monthly	Monthly	Seasonal
W40	Monitor water quality in Money Creek downstream of highway	Monthly	Monthly	Monthly	Seasonal
Road Route Monitoring					
W71	Monitor water quality at Pitch Creek road crossing	Monthly	Monthly	Monthly	Quarterly
W72	Monitor water quality in Light Creek	Monthly	Monthly	Monthly	Quarterly
W73	Monitor water quality at Bunker Creek road crossing	Monthly	Monthly	Monthly	Quarterly
Water Management					
Tailings Pond	To monitor water quality in the tailings impoundment			Monthly	Seasonal
Retention Pond	Monitor water quality in the retention pond			Daily[2]	

1: Seasonal monitoring during closure will include monthly monitoring during the ice free period of May to October
2: Daily monitoring during discharge periods during operations and early closure

4 Tailings Facility Geotechnical Stability Monitoring

Monitoring of the tailings pond will be carried out during all the phases of its life: construction, operations and post-operations. Prior to and during construction, piezometers will be used to monitor pore pressures within the foundation. As well, survey monuments and slope inclinometers will be installed to monitor settlement and deformation of the structure. An operations, maintenance and surveillance (OMS) manual will be developed for the tailings dam (as per Canadian Dam Association guidelines) which will contain procedures and requirements for the operation of the tailings facility. Scheduled inspections of the structure by qualified geotechnical personnel will be carried out. A comprehensive monitoring database will be developed to track the performance of the dam during and following construction. Post-construction monitoring of the dam will be carried out until the structure is officially decommissioned. The following inspection and maintenance procedures will be employed:

- Four piezometers will be installed in the downstream shell/foundation of the dam to monitor groundwater levels and pore pressures.
- Ten survey monuments on the crest/downstream slope to be measured quarterly.
- Four groundwater monitoring wells installed downstream of the dam, with screened locations in the foundation soils and weathered bedrock unit. Water quality testing will be carried out quarterly on samples collected from the wells.
- The water balance will be updated annually to include: actual precipitation/runoff and mill inflows (tailings, DMS, waste rock, and transport water), actual surveyed bathymetry of pond and volumes of water treated for discharge.
- Minimum monthly visual inspections of dam and area directly downstream of the dam.
- Annual dam safety review by a qualified professional geotechnical engineer.

5 Water Management Structures Monitoring

All primary collection ditches, diversion channels, discharge channels, culverts and settling ponds will be inspected for any indications of instability or excessive erosion at the start and end of the freshet season each year, after major storms and in the fall before the first snow. Particular attention will be paid to avoiding ice blockage of the structures. Maintenance of the diversion ditches will not be required after the ditches are decommissioned at mine closure.

Monitoring of the tailings impoundment spillway will occur twice annually during the first five (5) years following closure and annually thereafter to ensure that the spillway is operating freely and as designed. Particular attention will be paid to that period immediately prior to freshet to ensure that the structure is free from ice blockages and can readily pass the freshet flows.