capstone
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

Minto Mine

Environmental Monitoring, Surveillance and Reporting Plan

2016-02

Prepared by:
Minto Explorations Ltd.
Minto Mine
July 2016

Minto Mine Environmental Monitoring, Surveillance and Reporting Plan

First Issue: June 2014

Revision History

Revision Number	Issue Date	Description and Revisions Made
2014-1	June 2014	First issue
2015-1	December 2015	Revisions made as per requirements of WUL QZ14-031
2016-1	February 2016	Revisions made as per EMRSP comments from the Yukon Government and Selkirk First Nation
2016-02	July 2016	Revisions made as per direction from Yukon Water Board letter April 26, 2016

Table of Contents

List of Tables

List of Figures

List of Appendices

List of Acronyms

Acronym	Definition
A2P	Area 2 Pit
AAS-GF	Atomic Absorption Spectroscopy – Graphite Furnace
ABA	Acid-Base Accounting
AP	Acid generating potential
ARD	Acid Rock Drainage
BMP	Best management practices
C(T)	Total copper
CALA	Canadian Association for Laboratory Accreditation
Capstone	Capstone Mining Corporation
CEQG	Canadian Environmental Quality Guidelines
COC	Chain of command
CPUE	Catch per Unit Effort
DOC	Dissolved organic carbon
DPP	Drive point piezometer
DRP	Minto Mine Decommissioning and Reclamation Plan
DSTSF	Dry stack tailings storage facility
EEM	Environmental Effects Monitoring
EMSRP	Environmental Monitoring, Surveillance and Reporting Plan
ICP	Inductively coupled plasma
ICP-MS	Inductively coupled plasma – mass spectrometry
IROD	Ice-rich overburden dump
MCDS	Minto Creek Detention Structure
Minto	Minto Explorations Ltd.
MintoEx	Minto Explorations Ltd.
MMER	Metal Mine Effluent Regulations
MVF	Mill valley fill
MVFES2	Mill Valley Fill Extension Stage 2
MWD	Main waste dump
NP	Neutralizing potential
PRL	Plan Requirement Letter
QA/QC	Quality Assurance/Quality Control
QML	Quartz Mining Licence
RISS	Regulatory Information Submission System
ROD	Reclamation overburden dump
SECP	Sediment and Erosion Control Plan
S(T)	Total sulphur
SFN	Selkirk First Nation
SOP	Standard operating procedure
SWD	South West Dump
TSS	Total suspended solids
WSP	Water Storage Pond
WUL	Water Use Licence QZ14-031

Acronym	Definition
YISC	Yukon Invasive Species Council
YWB	Yukon Water Board

1 Introduction

The *Environmental Monitoring, Surveillance and Reporting Plan* (EMSRP) is a requirement of Quartz Mining Licence QML-0001 (QML) and Water Use Licence QZ14-031 (WUL). The QML defines the EMSRP as *“a plan that describes methods and techniques for collecting monitoring information regarding environmental conditions at the Undertaking, as well as quantitative thresholds which trigger the implementation of adaptive management strategies”.*

The contents of the EMSRP include requirements of both the QML and WUL including the conditions related to the water monitoring program, geochemical monitoring program, meteorological monitoring program, physical monitoring program, aquatic environmental monitoring program, terrestrial environment monitoring program, progressive reclamation effectiveness monitoring program and quality assurance and quality control programs. The EMSRP has been developed to meet the requirements of the QML Plan Requirements Letter (dated in 2014-12-18 (PRL)), and WUL conditions 83 through 104.

Additionally, as a metal mine in the Yukon, the Minto Mine is required to comply with the *Metal Mine Effluent Regulations* (MMER) (Metal Mine Effluent Regulations, 2002), which regulates the monitoring frequency and reporting of effluent discharged from the Minto Mine.

The requirements are summarized below, as they pertain to the Minto Mine. Table 1-1 summarizes the regulatory monitoring requirements and key personnel involved with the management of the requirements, as well as the section of the EMSRP which provides details of the monitoring programs. This EMSRP replaces the previous 2014 *Environmental Monitoring, Surveillance and Reporting Plan*, submitted in July 2014 by Minto Explorations Ltd. and approved in December 2014.

The content of this EMSRP was originally derived from the *Plan Requirement Guidance for Quartz Mining Projects* (Yukon Government, 2013) and this recent itineration and has been prepared to meet the requirements of the WUL and the QML.

Table 1-1: 2016 EMSRP Regulatory Concordance Table

	2016 EMSRP Regulatory Concordance Table			
Monitoring Program	**Associated Licence or Regulation**	**EMSRP Licence Required Updates**	**Regulatory Monitoring Programs - Key Managers**	**EMSRP Section**
Water Monitoring Program	**WUL**		Environmental Manager	2
Surface Water Surveillance Program	WUL	WUL 85, 86, Schedule 1	Environmental Manager	2.1
Groundwater Monitoring Program	WUL	WUL 90 a-i, 91	Environmental Manager	2.2
Seepage Monitoring Program	WUL	WUL 92 a-b, 93	Environmental Manager	2.3

	2016 EMSRP Regulatory Concordance Table			
Monitoring Program	Associated Licence or Regulation	EMSRP Licence Required Updates	Regulatory Monitoring Programs - Key Managers	EMSRP Section
Geochemical Monitoring Program	**WUL**	WUL 94 / QML PRL 3 (c)	Chief Geologist	3
Acid Base Accounting (ABA) Monitoring Program	WUL	WUL 95	Chief Geologist	3.1
Waste Rock Management Verification Program	WUL	WUL 95	Chief Geologist	3.2
Meteorological Monitoring Program	**WUL**		Environmental Manager	4
Climate Monitoring Program	WUL	WUL 96	Environmental Manager	4.1
Snow Survey Program	WUL	WUL 96	Environmental Manager	4.2
Physical Monitoring Program	**WUL / QML**	WUL 97 a-h, 98, 99 a-b / QML PRL 3(a) (b)	Chief Engineer	5
Aquatic Environmental Monitoring Program	**WUL / MMER**	WUL 102	Environmental Manager	6
Metal Mine Effluent Regulations Monitoring Programs	WUL / MMER	WUL 101 a	Environmental Manager	6.1
Sediment Quality and Toxicity Monitoring	WUL	WUL 101 b	Environmental Manager	6.2
Periphyton and Benthic Invertebrate Tissue Monitoring	WUL	WUL 101 c	Environmental Manager	6.3
Fish Monitoring Program	WUL / MMER	WUL 101 a	Environmental Manager	6.4
Terrestrial Environment Monitoring Program	**QML**		Environmental Manager	7
Invasive Plant Species Monitoring Program	QML		Environmental Manager	7.1
Wildlife Monitoring Program	QML		Environmental Manager	7.2
Erosion and Sedimentation Monitoring Program	QML		Environmental Manager	7.3

	2016 EMSRP Regulatory Concordance Table			
Monitoring Program	**Associated Licence or Regulation**	**EMSRP Licence Required Updates**	**Regulatory Monitoring Programs - Key Managers**	**EMSRP Section**
Vegetation Metal Uptake Program	QML	QML PRL 3 (d)	Environmental Manager	7.4
Progressive Reclamation Effectiveness Monitoring Program	**WUL / QML**		Environmental Manager	8
Quality Assurance and Quality Control Programs	**WUL**	WUL 103, 104	Environmental Manager	9

1.1 Project Description

The Minto Mine is a copper-gold mine owned 100% by Minto Explorations Ltd. (Minto), a wholly owned subsidiary of Capstone Mining Corporation (Capstone). The Minto Mine commenced commercial production in October 2007. The Minto Mine is located within Selkirk First Nation (SFN) Category A Settlement Land Parcel R-6A, approximately 240 km northwest of Whitehorse, Yukon and 41 km southwest of Pelly Crossing (Figure 1-1). After crossing the Yukon River, either by summer barge or winter ice bridge, access to the mine site is via a 27 km access road along the Yukon River and up the Minto Creek drainage (Figure 1-2). Crews and supplies are transported by air during the spring thaw and fall freeze-up.

The Minto Mine is an existing and fully operational copper and gold mine. The Minto Mine is currently an open pit and underground mining operation with conventional crushing, grinding, and flotation to produce copper concentrates with significant gold and silver credits. Concentrates are exported internationally via the Port of Skagway, Alaska for smelting and sale. Minto Mine is currently in Phase V/VI of development.

Figure 1-1: Minto Mine Location Map

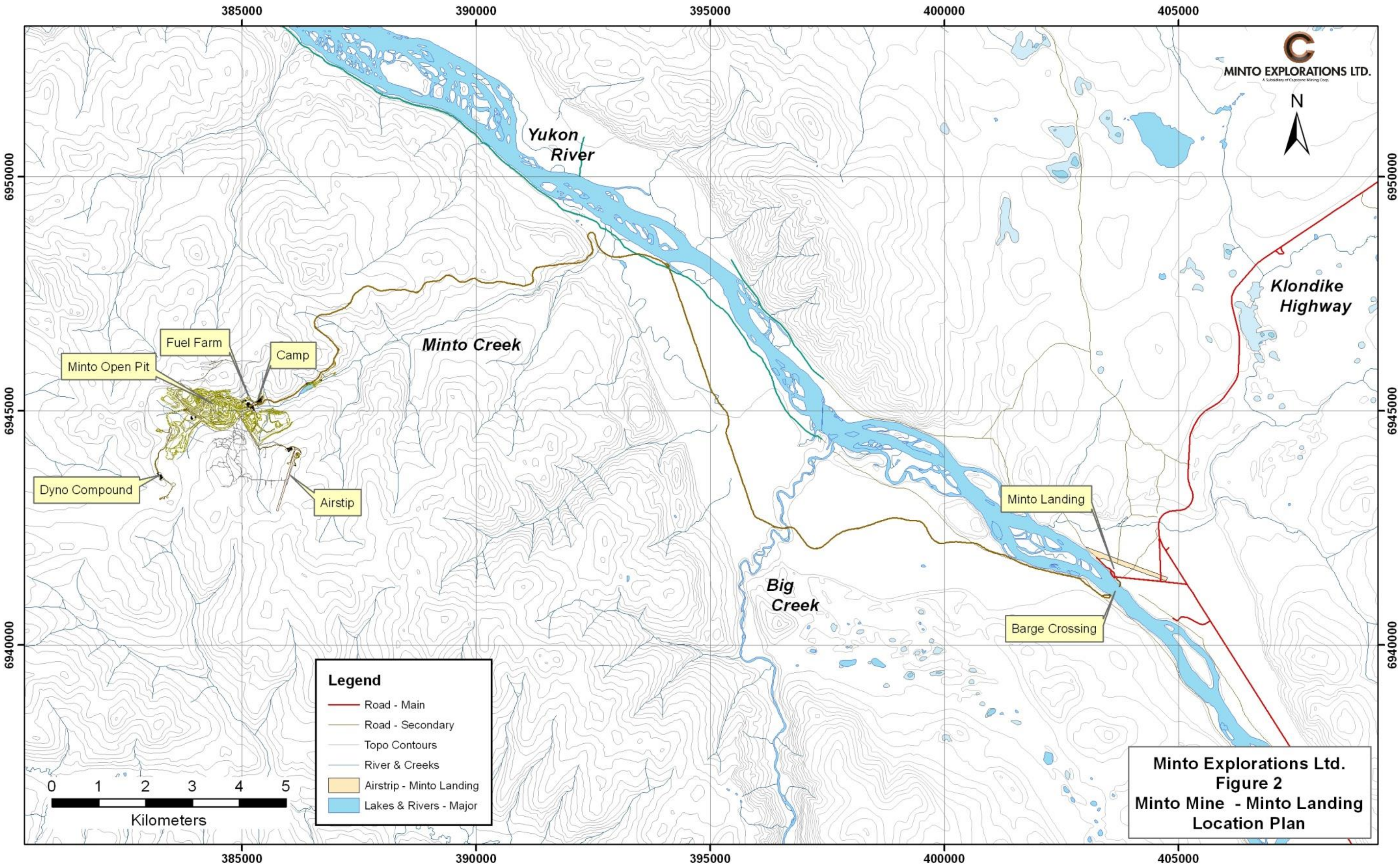


Figure 1-2: Minto Mine Access Location

2 Water Monitoring Program

Water quality and hydrology monitoring at the Minto Mine is conducted in accordance with the requirements outlined in WUL and in the MMER. Monitoring programs for water quality and hydrology at the Minto Mine, McGinty Creek, groundwater, and seepage are detailed below in Sections 2.1 through 2.3; details regarding water monitoring and the MMER are presented in Section 6.1. Monitoring stations are described in Table 2-1 and are shown in Figure 2-1, and Figure 2-2. The locations of several monitoring stations are not identified in Table 2-1 and Figure 2-1 as a result of monitoring stations not having been developed as the associated Phase V/VI structures have not been constructed. As the Phase V/VI mine plan progresses the specific locations of these monitoring stations will be identified and included in the Annual Report.

The location description, and expected frequency of monitoring are summarized in the tables within this section.

Table 2-1: Minto Mine Monitoring Station Descriptions and Coordinates

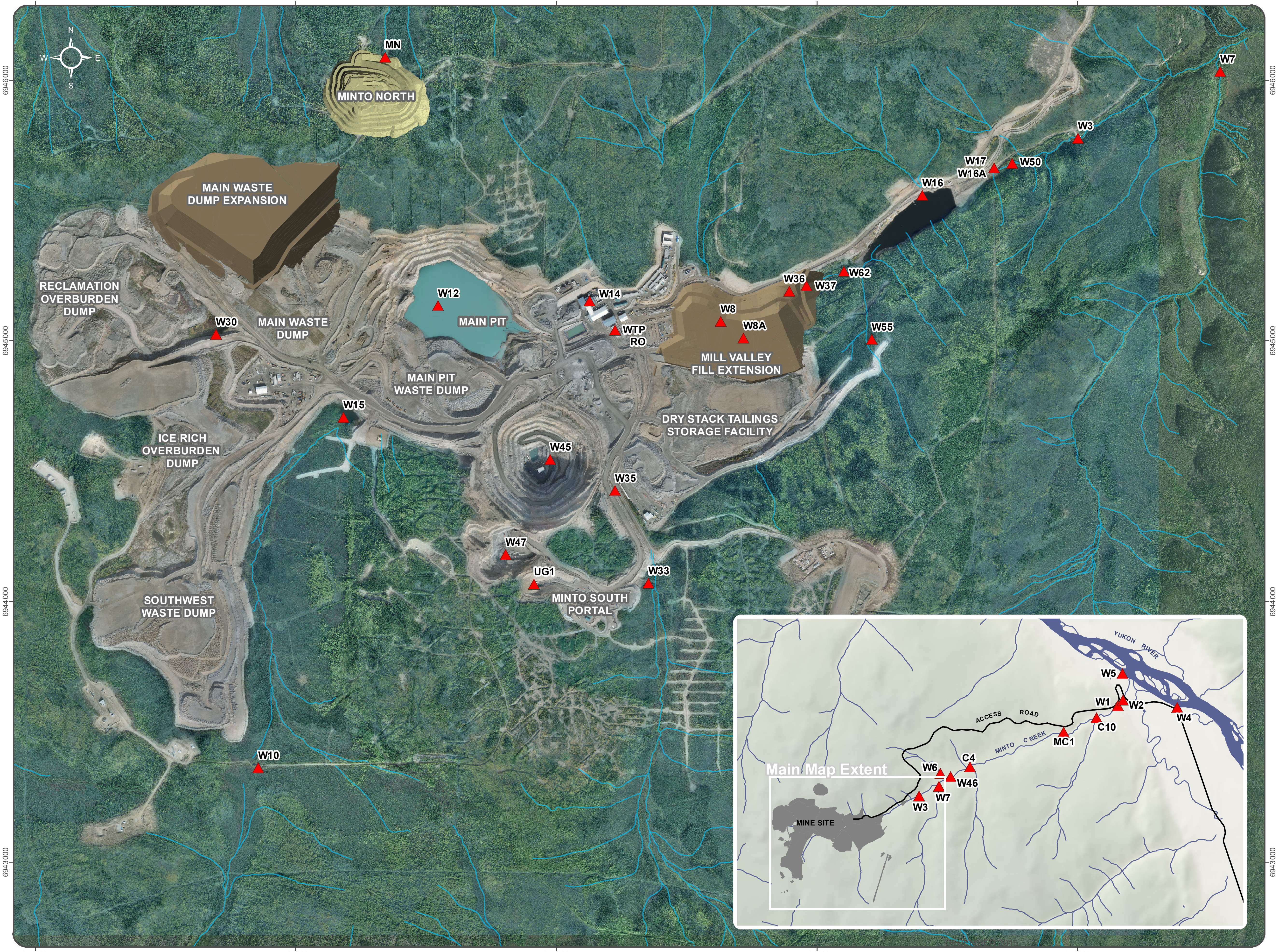
Station	Description	UTM Coordinates – Zone 8	
		Easting	Northing
W1	Lower Reach of Minto Creek	392445	6948251
W2	Minto Creek, upstream of the Minto Creek/Yukon River confluence where the access road crosses Minto Creek	392584	6948402
W3	Minto Creek, at the federal MMER compliance point	387000	6945778
W4	Yukon River, upstream of the confluence with Minto Creek	394070	6948203
W5	Yukon River, downstream of the confluence with Minto Creek	392583	6949119
W6	Tributary on the North side of Minto Creek	387583	6946392
W7	Mouth of the tributary on the south side of Minto Creek, approximately 0.8 km downstream of W3	387546	6946034
W8	Western collection sump from the DSTSF	385629	6945076
W8A	Eastern collection sump from the DSTSF	385716	6945012
W10	Headwaters of Minto Creek (south-west fork at headwaters)	383855	6943364
W12	Main Pit and Main Pit Tailings Management Facility	384544	6945137
W12A	Discharge from Main pit		
W14	Tailings thickener overflow	385223	6945089
W15	Upper Minto Creek storm water collection sump, downstream of the overburden dump, just upstream of Main Pit	384181	6944708
W16	Water Storage Pond	386402	6945559
W16A	Discharge from the Water Storage Pond	386679	6945664
W17	Water Storage Pond dam seepage	386679	6945664
W30	Headwaters Minto Creek (north-west fork)	383693	6945026

Station	Description	UTM Coordinates – Zone 8	
		Easting	Northing
W33	Upgradient of South Diversion Ditch	385351	6944072
W35	South Diversion Ditch	385223	6944427
W36	Minto Creek detention structure (MCDS)	385892	6945191
W37	100 m downstream of MCDS (W36 collection sump) and upstream of Water Storage Pond	386180	6945294
W45	Area 2 Pit and Area 2 Pit Tailings Management Facility	384912	6944068
W46	Minto Creek, downstream of W7 and W6 tributaries	387873	6946301
W47	Area 118 Pit water	384775	6944153
W50	Minto Creek, approximately 50 m downstream of the toe of the Water Storage Pond Dam and downstream of the inflow of the treated water	386747	6945682
MC-1	Minto Creek upstream of Canyon	390967	6947528
WTP	Treated water from water treatment plant when RO not operating	385126	6945154
RO	Treated water from RO	385126	6945154
W51	Area 2 Stage 3 Pit		
W52	Ridgetop North Pit and Ridgetop North Pit Tailings Management Facility		
W53	Ridgetop South Pit		
W54	Main Dam seepage		
W55	Tailings Diversion Ditch	386209	6945007
W62	MVFES2 Collection Sump	386079	6945335
C4	Tributary on the south side of Minto Creek, downstream of W3	388407	6946571
C10	Tributary on the south side of Minto Creek, downstream of W3	391868	6947914
MN	Minto North pit water	384342	6946090
MN-0.2	Upper west arm of McGinty Creek (Reference Station)	382267	6947299
MN-0.5	West arm of McGinty Creek just upstream of the confluence with the east arm	385251	6951262
MN-1.5	Upper east arm of McGinty Creek downstream of the Minto North deposit	384473	6947055
MN-2.5	East arm of McGinty Creek just upstream of confluence with the west arm	385493	6950788
MN-4.5	Lower mainstream McGinty Creek near confluence with Yukon River	386231	6952851
UG 1	Minto South underground mine dewatering	384916	6944098
UG 2	Wildfire underground mine dewatering		

Station	Description	UTM Coordinates – Zone 8	
		Easting	Northing
UG 3	Copper Keel underground mine dewatering		
UG 4	Minto East underground mine dewatering		

Deviations from the WUL Schedule 1 Part 1 and the EMSRP Table 2-1 include the following:

- In Table 2-1, the site described as "Main Pit Dam Seepage" has been named "W54". In WUL Schedule 1, Part 1 the monitoring site nomenclature "W53" was repeated twice and the second occurrence was used in the site described as "Main Pit Dam Seepage". To avoid confusion, this site has been renamed to W54 in Table 2-1.



MINTO MINE

ENVIRONMENTAL MONITORING, SURVEILLANCE AND REPORTING PLAN

FIGURE 2-1

SURFACE WATER SURVEILLANCE PROGRAM MONITORING STATION LOCATIONS

DECEMBER 2015

▲ Surface Water Surveillance Program Monitoring Station Locations

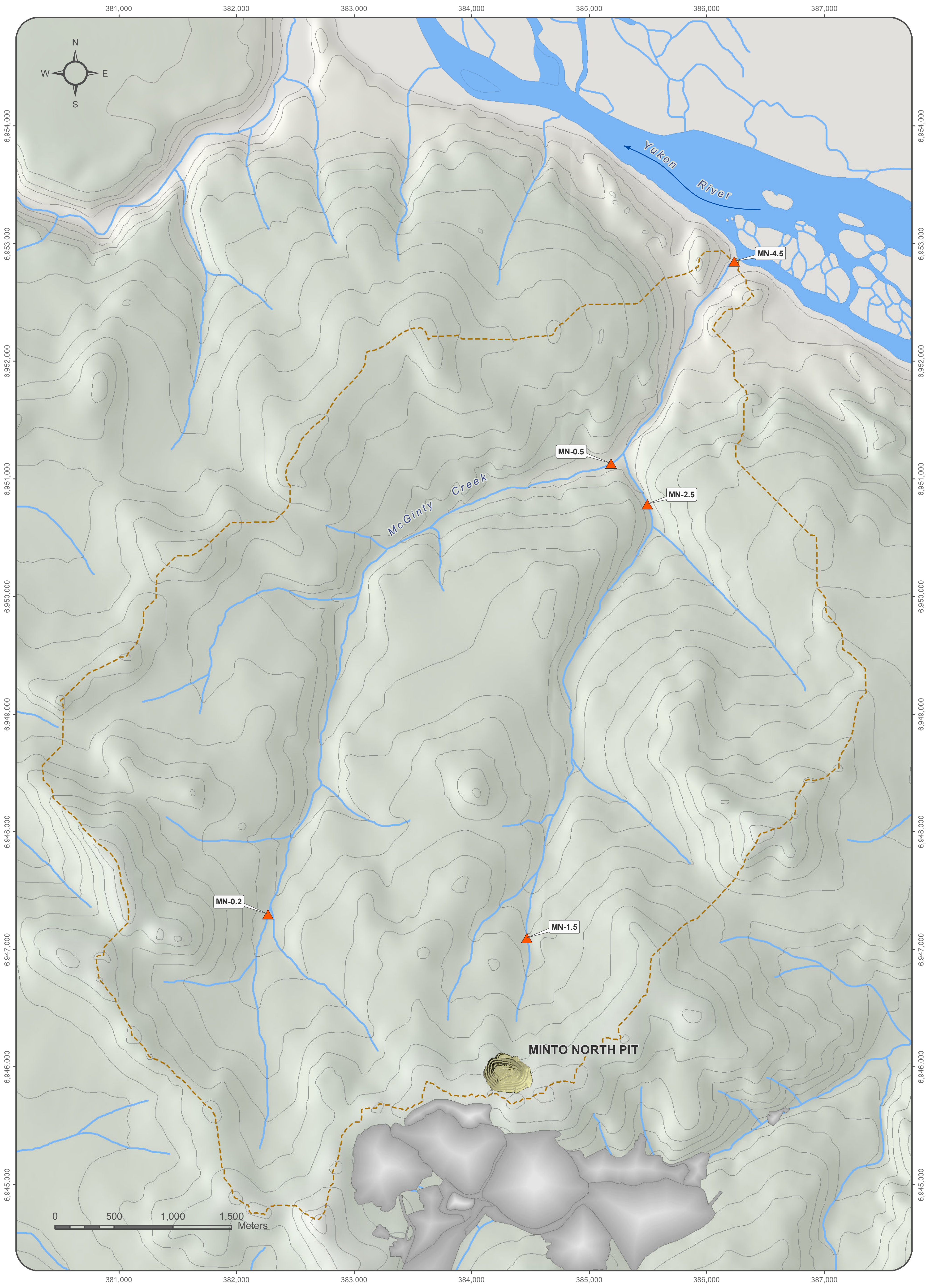
1:13,987 *when printed on 11 x 17 inch paper*

0 250 500
Meters

Aerial imagery obtained from Challenger Geomatics. Imagery acquired September 9^{th} 2014. Hydrology data provided by Minto Explorations Ltd, May 2009.

Datum: NAD 83 Projection: UTM Zone 8N

I:\Minto\gis\mxd\Overview_Maps\04-WaterQuality\01-General\General_December_2015.mxd
(*Last edited by: mducharme; 12/1/2015/14:33 PM*)



▲	Monitoring Station
🟨	Minto North Pit
▢	Other Mine Feature Footprints
—	Contour (100 ft interval)
⬚	McGinty Creek Catchment

National topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Reproduced under license from Her Majesty the Queen, as represented by the Minister of Natural Resources Canada. All rights reserved.
Datum: NAD 83; Projection: UTM Zone 8N

This drawing has been prepared for the use of Alexco Environmental Group Inc.'s client and may not be used, reproduced or relied upon by third parties, except as agreed by Alexco Environmental Group Inc. and its client, as required by law or for use of governmental reviewing agencies. Alexco Environmental Group Inc. accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without Alexco Environmental Group Inc.'s express written consent.

ENVIRONMENTAL MONITORING, SURVEILLANCE AND REPORTING PLAN

FIGURE 2-2

SURFACE WATER SURVEILLANCE PROGRAM MCGINTY CREEK MONITORING STATION LOCATION

DECEMBER 2015

I:\Minto\gis\mxd\Overview_Maps\04-WaterQuality\02-McGuinty Creek\Monitoring_Stations_November_2015.mxd
(*Last edited by: mducharme; 12/1/2015/14:38 PM*)

2.1 Surface Water Surveillance Program

The objective of the Surface Water Surveillance Program is to monitor surface water quality and hydrological conditions at stations within the operational mine area, downstream stations which are influenced by mine effluent discharge, and downstream reference stations which are not exposed to effluent. Water quality and hydrology monitoring is conducted in accordance with the requirements outlined in the WUL and reflected in Table 2-2. Monitoring areas can generally be characterized as sites at or near the active mine site and associated facilities, and on Minto Creek, the Yukon River, McGinty Creek and non-impacted drainages. Sampling locations and coordinates are updated annually as part of the WUL Annual Report.

The Surface Water Surveillance Program monitoring schedule contains weekly, monthly, and quarterly water quality monitoring requirements, and continuous, weekly and monthly monitoring requirements for surface water hydrology and water conveyance flows (Table 2-2). Analytical requirements include in-situ field parameters, physical parameters, nutrients, total and dissolved metals, dissolved organic carbon (DOC), and bioassays. Water quality analysis is performed by an external laboratory (for physical parameters, nutrients, total and dissolved metals and DOC) and the Minto Mine internal laboratory (for copper, aluminum, cadmium, selenium, ammonia, nitrite, nitrate and total suspended solids). A combination of continuous water level indicators and inline flow metering systems are used for sites that require continuous monitoring. Calculated flow measurements, determined using the mid-section method with a current meter, are used for sites that require weekly and monthly monitoring.

Monitoring procedures for the water quality monitoring are guided by the *Minto Mine Surface Water Quality Monitoring Standard Operating Procedures* (Appendix 1). The water quality standard operating procedures (SOPs) were developed in accordance with the best management practices (BMP) found in the *Protocols Manual for Water Quality Sampling in Canada* (CCME, 2011), *Guidance Document for the Sampling and Analysis of Metal Mining Effluents* (Environment Canada, 2001) and *Ambient Freshwater and Effluent Sampling Manual* (Clark, 2003).

Monitoring procedures for the hydrological monitoring are guided by the *Minto Mine Surface Water Hydrology Standard Operating Procedure* (Appendix 2). The hydrology SOPs were developed in accordance with the BMPs found in the *Guidance Document for Flow Measurement of Metal Mining Effluents* (Environment Canada, 2001) and in the *Manual of British Columbia Hydrometric Standards* (Ministry of Environment, 2009).

The *Minto Mine Surface Water Quality Monitoring Standard Operating Procedures* and *Minto Mine Surface Water Hydrology Standard Operating Procedure* are updated on an as-required basis to ensure that the BMPs described in the documents remain current.

Table 2-2: Water Quality and Hydrology Monitoring Program Requirements

Station	Flow	Water Level	Field Parameters Frequency	External Analytical Suite		Internal Suite	96-Hr LT50	48-Hr LT50	Chronic Toxicity Testing	
				Frequency	Analytical Suite	Frequency			Frequency	Test
W1	C	-	-	-	-	-	-	-		
W2	-	-	W/Wd	W/Wd	A,N,DOC	Wd	-	-	Md	CD-7d
									Q	CD-7d, CT-30d, CA-72hr
W3	C	-	W/Wd	W/Wd	A,N,DOC	Wd	Md	Md	-	-
W4	-	-	Q	Q	A,N, DOC	-	-	-	-	-
W5	-	-	Q	Q	A,N, DOC	-	-	-	-	-
W6	M	-	M	M	A,N, DOC	-	-	-	-	-
W7	C	-	M	M	A,N,DOC	-	-	-	-	-
W8	-	-	W	W	A,N	W	-	-	-	-
W8A	-	-	W	W	A,N	W	-	-	-	-
W10	-	-	M	M	A,N	-	-	-	-	-
W12	-	W-WL, TV	M	M	A,N	-	-	-	-	-
W12A	Wd		Wd	Wd	A,N					
W14	-	-	M	M	B	-	-	-	-	-
W15	C	-	M	M	A,N, DOC	Wd	-	-	-	-
W16	-	W-WL	Mnf/Wd	Mnf/Wd	A,N, DOC	Wnf	-	-	-	-
W16A	Wd	-	Wd	Wd	A,N,DOC	Wd	Md	Md	-	-
W17	C	-	W/Wd	W/Wd	A,N, DOC	Wd	-	-	-	-
W30	M	-	M	M	A,N	-	-	-	-	-
W33	M	-	M	M	A,N	-	-	-	-	-
W35	C	-	M	M	A,N, DOC	Wd			-	-
W36	C	-	M	M	A,N	-	-	-	-	-
W37	M	-	M	M	A,N	-	-	-	-	-
W45	Cdw	W-WL, TV	M	M	A,N	-	-	-	-	-
W46	M	-	M	M	A,N,DOC	-	-	-	-	-
W47	Cdw	W-WL	M	M	A,N	-	-	-	-	-
W50	M/Wd	-	M/Wd	M/Wd	A,N,DOC	Wd	M	M	M	CD-7d
MC-1	C	-	M/Wd	M/Wd	A,N,DOC	-	-	-	-	-
WTP	Wd	-	Wd	Wd	A,N,DOC	Wd	-	-	-	-
RO	Wd	-	Wd	Wd	A,N,DOC	Wd	-	-	-	-
W51	Cdw	W-WL	M	M	A,N	-	-	-	-	-
W52	Cdw	W-WL, TV	M	M	A,N	-	-	-	-	-

Station	Flow	Water Level	Field Parameters Frequency	External Analytical Suite		Internal Suite	96-Hr LT50	48-Hr LT50	Chronic Toxicity Testing	
				Frequency	Analytical Suite	Frequency			Frequency	Test
W53	Cdw	W-WL	M	M	A,N	-	-	-	-	-
W54	C	-	M	M	A,N	-	-	-	-	-
W55	M	-	M	M	A,N	-	-	-	-	-
W62	C		M	M	A,N					
C4	M	-	M	M	A,N,DOC	-	-	-	-	-
C10	M	-	M	M	A,N,DOC	-	-	-	-	-
MN	Cdw	W-WL	M	M	A,N	-	-	-	-	-
MN-0.2	M	-	M	M	A,N,DOC	-	-	-	-	-
MN-0.5	M	-	M	M	A,N,DOC	-	-	-	-	-
MN-1.5	C	-	M	M	A,N,DOC	-	-	-	-	-
MN-2.5	C	-	M	M	A,N,DOC	-	-	-	-	-
MN-4.5	C	-	M	M	A,N,DOC	-	-	-	-	-
UG 1	Cdw	-	M	M	A,N	-	-	-	-	-
UG 2	Cdw	-	M	M	A,N	-	-	-	-	-
UG 3	Cdw	-	M	M	A,N	-	-	-	-	-
UG 4	Cdw	-	M	M	A,N	-	-	-	-	-

C: Continuously	**A**: Physical parameters, conductivity, total suspended solids, total dissolved solids, hardness, alkalinity, sulphate, ICP scan- total metals, ICP – dissolved metals
W: Weekly	**B:** Physical parameters, conductivity, total dissolved solids, alkalinity, sulphate, ICP – dissolved metals
Wd: Weekly while discharging	**N**: Nutrients: Ammonia-N, Nitrate-N, Nitrite-N
Wnf: Weekly, when not frozen	**Field parameters:** In-situ pH, Conductivity, Temperature, Dissolved Oxygen
M: Monthly	**Internal lab parameters:** dissolved metals: copper, aluminum, cadmium, selenium; ammonia, nitrite, nitrate and total suspended solids
Md: Monthly while discharging	**DOC**: Dissolved organic carbon
Mnf: Monthly, when not frozen	**96 hr LT50**: LT50 Rainbow trout static bioassay, 96 hrs at 100%, pH non-adjusted
Cdw: Continuous when dewatering	**48 hr LT50**: LT50 *Daphnia magna* static bioassay, 48 hrs at 100%, pH non-adjusted
WL: Surface Water Level Elevation	**CD-7d**: Chronic Toxicity – *Ceriodaphnia dubi*a 7 day test (EPS 1/RM/21)
TV: Track Tailings Volume	**CT-30-d:** Chronic toxicity – 30 day Early Stage Toxicity for Rainbow Trout (EPS 1/RM/28)
	CA-72hr: Chronic Toxicity – 72-hour for Algae (EPS 1/RM/25)

Definitions made in the EMSRP Table 2-2 that are not included in the WUL include the following:

- The "B" Analytical Suite has been defined in Table 2-2 as physical parameters, conductivity, total dissolved solids, alkalinity, sulphate, ICP – dissolved metals. No definition of the suite was provided in the WUL.
- The metals description in the internal lab parameters have been defined as dissolved metals: copper, aluminum, cadmium and selenium in lieu of copper, aluminum, cadmium selenium as described in the WUL.
- The acronym Wnf has been defined as "weekly, when not frozen".
- The description of the 48-hr LT50 has been amended to reflect that the test is a 48-hour test and not a 96 hour test as described in the WUL.
- W62 has been added as a monitoring site as the MVFE2 Collection Sump. Monitoring of W62 will occur on a monthly basis.

2.1.1 Hydrology Rating Curve Development

Minto collects hydrometric data throughout the open water season using the velocity-area method of discharge calculation. Measurements are conducted manually and paired with staff gauge observations and site photographs. Paired Solinst leveloggers and barologgers are utilized to collect the continuous stage record.

The rating curves are developed using Aquarius Time-Series data management software. Date, time, staff gauge height and discharge measured is imported into the software and the rating curve is built. Any suspect measurements are verified against photos and field notes (e.g. if they differ greatly from the stage-discharge relationship). This can be due to the effects of ice or other changing control conditions. Rating curve development thus considers which measurements should be included and when and where shifts to the rating are appropriate. All measurements within the continuous period are included in the hydrographs (in the Annual Report). Rating curve shifts are used at some Minto sites where appropriate.

Barometrically compensated Solinst water level data are then imported into Aquarius software from .CSV files which are exported from Solinst software following compensation. Aquarius allows for adjustment of the Solinst record to match the staff gauge observations, for development of rating curves with the field data, and for automatic processing of continuous discharge records. This preserves the raw data in an easy to reference format and changes can be made to the data at any time which then cascade through the various time series. For example, at new sites, rating curves may improve after several seasons and alter a previous year's continuous record as high or low ends of the rating curve become well defined. Stage time series are adjusted for drift, offset and erroneous data are deleted or excluded from discharge computation if they are deemed ice affected. The rating curve is automatically applied to the continuous stage record for a specified time period to create the continuous discharge time series.

2.2 Groundwater Monitoring Program

The objective of the Groundwater Monitoring Program is to monitor potential impacts on groundwater from the mine project components. Groundwater-related monitoring at Minto is accomplished through monitoring groundwater wells, vibrating wire piezometers and thermistors. The Groundwater Monitoring Program includes several components including groundwater water quality, aquifer characterization, evaluation of longitudinal flow paths, leaching tests, and the monitoring of long-term phreatic levels in tailing management facilities. Details of the Groundwater Monitoring Program components are discussed in the *Groundwater Monitoring Plan* in Appendix 3.

Monitoring areas are both up-gradient and down-gradient of mine activities and include, but are not limited to, the dry stack tailings storage facility (DSTSF), mill area, Main Pit Tailings Management Facility, Area 2 Pit Tailings Management Facility, Minto North Pit, mill valley fill, waste rock dumps, water storage pond (WSP), and areas where future mine components are planned. The purpose of the monitoring wells is to provide information to better understand the potential for off-site migration of contamination and to better understand and define source terms and conditions of waste emplacement, for comparison to source terms used in the Water Balance and Water Quality model. Groundwater monitoring instrumentation locations are shown on

Figure 2-3.

Groundwater wells are sampled for water quality monitoring, as per the procedures summarized in the *Standard Guide for Sampling Ground-Water Monitoring Wells* (ASTM, 2013).

Groundwater samples will be collected and analyzed for the parameters described below:

- Physical Parameters, Conductivity, Total Dissolved Solids, Alkalinity, Sulphate, ICP Scan - Dissolved Metals.
- Nutrients: Ammonia-N, Nitrate-N, Nitrite-N and Phosphorous.
- In-situ Field Parameters: pH, Conductivity and Temperature.

Groundwater samples will be submitted to an accredited laboratory for analysis.

Groundwater wells at Minto include multi-level monitoring wells, stand pipe wells, and drivepoint wells. The "Westbay MP" multilevel monitoring system allow for monitoring below shallow permafrost as the system can be operated with antifreeze in the sealed access pipe. Standpipe wells are simple wells consisting of a standpipe tube inserted into a borehole. Drivepoint wells are small diameter wells that are used to monitor shallow groundwater conditions.

Thermistor strings are used to measure ground temperature profiles in boreholes, and in particular permafrost conditions at Minto. Thermistor strings consist of multiple temperature sensor nodes distributed along a single multi-conductor cable, installed within or attached to the outside of grouted PVC pipe. EBA and RST thermistor strings have been installed on site. Thermistors are read using a basic ohmmeter and RST thermistors are read using the RST TH2016B readout unit.

Vibrating wire piezometer strings are used to measure pore water pressure profiles in boreholes. They consist of multiple vibrating wire sensors installed on PVC pipe in grouted boreholes. RST vibrating wire piezometers are installed on site and data is collected with the RST VW2106 readout unit.

Lysimeters will be used for monitoring the water within the waste rock piles. Passive lysimeters will provide data needed to complement and refine the existing soil cover and geochemical models, as well as characterize the variability in waste rock and candidate cover soils. Results of the lysimeter monitoring will be used to augment the understanding of how water moves through the WRDs, providing a basis for more accurate water and load balance prediction. Proposed locations and the installation details are outlined in the Minto Mine *Groundwater Monitoring Plan* (Appendix 3).

The groundwater monitoring station locations, category and frequencies are provided in Table 2-3 for operational monitoring. Details on the locations and monitoring frequencies for vibrating wire piezometers and thermistor strings are provided in the *Physical Monitoring Plan*. Planned stations (such as MP-1 and A2P-1) will follow the same monitoring frequency as existing stations outlined in the *Physical Monitoring Plan* (Appendix 4). The Minto Mine *Groundwater Monitoring Plan* has been included as Appendix 3 and includes details on the criteria used for selection of the monitoring points.

Table 2-3: Operational Groundwater Monitoring

Mine Project Component	Monitoring Installation	Westbay Zone Depth or description	Quality	Level	Monitoring Frequency
Up-gradient of Mine Activities	MW16-08	TBD (Zones not defined)	X	X	Quarterly
Southwest Waste Dump	MW12-DP1	NA	X	X	Quarterly
	MW12-DP2	NA	X	X	Quarterly
	MW12-DP3	NA	X	X	Quarterly
	MW16-09	TBD (Zones not defined)	X	X	Quarterly
Main Waste Dump	MW09-01	Zone 1 (44 mbgs)	X	X	Quarterly
	MW09-01	Zone 2 (34 mbgs)	X	X	Quarterly
	MW09-01	Zone 3 (26 mbgs)	X	X	Quarterly
	MW16-10	TBD (Zones not defined)	X	X	Quarterly
Dry Stack Tailings Storage Facility and Mill Valley Fill Expansion	MW12-06	Zone 1 (142 mbgs)		X	Quarterly
		Zone 2 (123 mbgs)	X	X	Quarterly
		Zone 3 (93 mbgs)		X	Quarterly
		Zone 4 (66 mbgs)	X	X	Quarterly
		Zone 5 (35 mbgs)		X	Quarterly
		Zone 6 (18 mbgs)	X	X	Quarterly
Main Pit	MW12-07	Zone 1 (115 mbgs)	X	X	Quarterly
		Zone 2 (88 mbgs)	X	X	Quarterly
		Zone 3 (66 mbgs)		X	Quarterly
Minto North Pit	MW09-03	Zone 1 (38 mbgs)	X	X	Quarterly
		Zone 2 (24 mbgs)	X	X	Quarterly
		Zone 3 (11 mbgs)	X	X	Quarterly
	MW16-11	TBD (Zones not defined)	X	X	Quarterly
Water Storage Pond	MW12-05	Zone 1 (132 mbgs)	X	X	Quarterly
		Zone 2 (110 mbgs)	X	X	Quarterly
		Zone 3 (94 mbgs)	X	X	Quarterly

		Zone 4 (69 mbgs)	X	X	Quarterly
		Zone 5 (52 mbgs)	X	X	Quarterly
		Zone 6 (26 mbgs)	X	X	Quarterly
		Zone 7 (15 mbgs)	X	X	Quarterly
	MW16-12	TBD (Zones not defined)	X	X	Quarterly

As part of its Groundwater Monitoring Program, Minto has designed a tracer study with the objective to evaluate the natural gradient flow paths from source(s) to receptors via groundwater pathways. Details on this study, including groundwater monitoring locations sampled and sampling frequency, is provided within the *Groundwater Monitoring Plan* (Appendix 3).

Figure 2-3: Groundwater Monitoring Site Locations

2.3 Seepage Monitoring Program

The objective of the Seepage Monitoring Program is to assess and monitor potential acid rock drainage and metal leaching conditions at the Minto Mine. The program includes a survey for seepage of all project components including pit wall seepage; ore stockpile areas; overburden dumps; waste rock dumps including low grade, medium grade and high grade waste storage areas; dry stack tailing storage facility (DSTSF); mill valley fill (MVF) area (extension 1 and 2); mill area; and other known seepage locations. The monitoring locations and monitoring frequency are summarized in Table 2-4, and the analytical parameters required for seepage samples are also detailed in Table 2-4. Seepage survey locations and routes are shown on

There are several monitoring sites in the Surface Water Surveillance Program that provide seepage water quality information. The scheduled monitoring frequency and analytical parameters for these sites is detailed in Section 2.1. The Surface Water Surveillance Program monitoring sites that provide information related to seepage water quality include: W8, W8A, W17, W36, W37 and W62.

As a result of the construction of the Mill Valley Fill Extension Stage 2 (MVFES2) the Minto Creek Detention Structure (MCDS) will be decommissioned and replaced with the MVFES2 Collection Sump. The MVFE2 Collection Sump, once completed, will be monitored as monitoring site W62 (detailed in Section 2.1). Water quality monitoring at W62 is scheduled on a monthly basis for in-situ field parameters, nutrients, physical parameters, conductivity, total suspended solids, total dissolved solids, hardness, alkalinity, sulphate, total and dissolved metals. Flow monitoring will be measured continuously. Physical monitoring of the MVFE2 Collection Sump is detailed in Section 5 as part of the Physical Monitoring Program.

Table 2-4: Seepage Monitoring Survey Locations and Sampling Frequency

Survey Locations	Monitoring Frequency	Analytical Parameters
Ore stockpile areas	Twice yearly; once in spring runoff conditions (typically May) and once in early fall conditions (typically September). Note that Pit walls can only be surveyed if safe conditions are present.	Physical parameters, Conductivity, Total Dissolved Solids, Alkalinity, Sulphate, ICP Scan- Dissolved Metals Ammonia-N, Nitrate-N, Nitrite-N and Phosphorous In-situ parameters- pH, Conductivity and Temperature
Overburden dumps		
Waste rock dumps		
Drystack tailings storage facility		
Mill Area		
Mill Valley Fill Extension (Stage 1 and 2)		
Water Storage Pond Dam Seepage		
Pit Walls		

Seepage surveys are carried out along the toe of each location shown on Figure 2-4. For each seepage monitoring event, survey routes are recorded using the tracking function of a GPS. Where actively flowing seepage is encountered, a sample is collected according to the following protocols:

1. Record sample location using GPS.
2. Take three photos at each station: one close-up photograph, showing the substrate the seepage is interacting with; one upgradient photograph, showing the area from which the seepage is flowing; and one downgradient photograph, showing the seepage flow path and area that the seepage reports to.
3. Take water quality sample as per the *Minto Mine Surface Water Quality Monitoring Standard Operating Procedures*.

For each sample, field data and observations are recorded on a purpose-designed form. This form includes fields for the following information:

- Date and time of sample collection;
- Coordinates of station location;
- Weather at time of sample collection;
- Reference numbers of photographs taken;
- Field measurements of pH, conductivity, temperature;
- Sketch of the sampling location, showing any relevant features (e.g. location of toe, pools of water, trace of surface water flow, site features such as roads, ditches, sumps);
- Water colour, turbidity, and presence of any precipitates or mineral staining; and
- Colour of sediment on filter and number of filters used.

Where the location of the downgradient toe of the monitoring location changes over time, the route surveyed will change such that, for any given monitoring event, monitoring will be carried out along the downgradient toe.

Results from the Seepage Monitoring Program will be compared to the source terms used in the Water Balance and Water Quality Model; additionally results will be summarized in the WUL Annual Report.

The feasibility of measuring flow rates at seeps as part of the Seepage Monitoring Program development and implementation was evaluated. However, based on site observations, the seeps have insufficient flow to be able to determine accurate flow measurements. Additionally, estimating the flows would not be appropriate and could potentially provide erroneous information.

SEEPAGE MONITORING TARGETS

① ORE STOCKPILE AREAS
② OVERBURDEN DUMPS
③ WASTE ROCK DUMPS
④ DRY STACK TAILING STORAGE FACILITY
⑤ MILL AREA
⑥ MILL VALLEY FILL DRY STACK TAILING STORAGE FACILITY
⑦ DAM SEEPAGE

capstone
MINTO MINE

MINTO MINE

ENVIRONMENTAL MONITORING, SURVEILLANCE AND REPORTING PLAN

FIGURE 2-4

SEEPAGE MONITORING PROGRAM SURVEY LOCATIONS

DECEMBER 2015

▲ WUL Seepage Water Quality Station

--- Seepage Monitoring Survey

1:13,000

when printed on 11 x 17 inch paper

0 100 200 300 400 500

Meters

ALEXCO ENVIRONMENTAL GROUP

Aerial imagery obtained from Challenger Geomatics.
Imagery acquired September 9th 2014.

Datum: NAD 83 Projection: UTM Zone 8N

This drawing has been prepared for the use of Access Mining Consultants Ltd.'s client and may not be used, reproduced or relied upon by third parties, except as agreed by Access Mining Consultants Ltd. and its client, as required by law or for use of governmental reviewing agencies. Access Mining Consultants Ltd. accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without Access Mining Consultants Ltd.'s express written consent.

I:\Minto\gis\mxd\Studies\SeepMonitoring\2015 MonitoringPlan\SeepMonitoring_2015_v3.mxd
(*Last edited by: mducharme;12/1/2015/14:36 PM*)

3 Geochemical Monitoring Program

The Geochemical Monitoring Program is comprised of the following components:

- The Acid Base Accounting (ABA) Program, which provides for monitoring of overburden and waste rock derived from the underground and open pit mining operations, and tailings from milling;
- The Waste Rock Management Verification Program; and
- Low Grade and Oxide Ore Metals Leaching Characterization Program.

These programs are detailed in Sections 3.1 to 3.2. Details relating to the waste rock sampling and analysis is provided in the *Minto Mine Phase V/VI Expansion Waste Rock and Overburden Management Plan* (WROMP) (Minto, 2014).

3.1 Acid Base Accounting (ABA) Monitoring Program

3.1.1 Internal (On-site) Monitoring

On-site ABA monitoring is carried out on drill cuttings from every blast hole. Samples are collected for grade control purposes, and a portion of each sample is sent for total sulphur (S(T)) and total carbon (C(T)) analyses at the on-site laboratory.

Following analysis, S(T) and C(T) results are converted into equivalent acid potential (AP-S(T)) and neutralization potential (NP-C(T)) values, and NP-C(T):AP-S(T) ratios are calculated for each sample. The NP-C(T):AP-S(T) values are plotted for each drill hole in a given blast pattern (along with other assay results), and mine geologists use the mine’s grade control software to define polygons outlining contiguous zones of waste rock types- either bulk waste or waste with an NP-C(T):AP-S(T) ratio less than 3.0. Additional details about on-site monitoring and waste handling procedures can be found in the WROMP (Minto, 2014).

3.1.2 External (Off-site) Verification

Composite samples from each waste class for each blast are formed from the individual samples that are subject to on-site monitoring for S(T) and C(T). These composite samples are both tested on-site and sent off-site to a commercial laboratory to provide external verification for quality control purposes. The external verification samples will be analysed for a broader range of parameters, including paste pH, total sulphur, sulphate sulphur, total inorganic carbon, modified neutralization potential (Modified NP) and metals by aqua regia digestion with ICP finish. Modified NP will be analysed using the MEND (1991) method to allow direct comparison with pre-production characterization (MEND, 1991).

3.1.3 Summary of Sampling and Analytical Frequency

A summary of the ABA sampling methods that are used by Minto for collection of overburden, waste rock, tailings solids, and construction materials are summarized in sections 3.1.5, 3.1.6, and 3.1.7 respectively. ABA sample frequency, sample type and analysis requirements are summarized in Table 3-1.

Table 3-1: Acid Base Accounting Monitoring Program Requirements

Material	Sample Frequency	Sampling Type	Analytical Requirement
Overburden	Sampled when overburden is mined	Representative sampling whenever overburden is mined	1. Internal Laboratory: S(T) and C(T) 2. External Laboratory: ABA and trace element analyses
Open Pit Waste Rock	Each blast hole	Split of grade control sample (single hole composite of blast hole cuttings)	1. Internal Laboratory: S(T) and C(T)
	Pre-selected based on the drill pattern, the ABA sampling occurs every 4-5 drill holes equilaterally in a drill pattern which is typically 20-25 m apart. The aim is to ensure even coverage for ABA analysis throughout the drill pattern.	Composite ABA samples are created based on the waste zone polygons. The number of ABA samples that go into the composite sample will depend on the size of the waste zone polygon and number of ABA samples taken within that polygon.	1. Internal Laboratory: S(T) and C(T) 2. External Laboratory: ABA and trace element analyses
Underground Waste Rock	One sample for every 50m of development (represents ~ 3300 tonnes of waste rock)	Representative composite grab sample from transfer pad pile	1. Internal Laboratory: S(T) and C(T) 2. External Laboratory: ABA and trace element analyses
Tailings Solids	Monthly	One composite sample per month comprised of weekly final tailings sample	1. External Laboratory: ABA and trace element analyses

3.1.4 ABA Program Reporting

Analytical results are added to the existing mine ABA database and will be reported on an annual basis as part of the WUL and QML Annual Report. The report will include:

- Comparison between new and historical data (including discussion), and

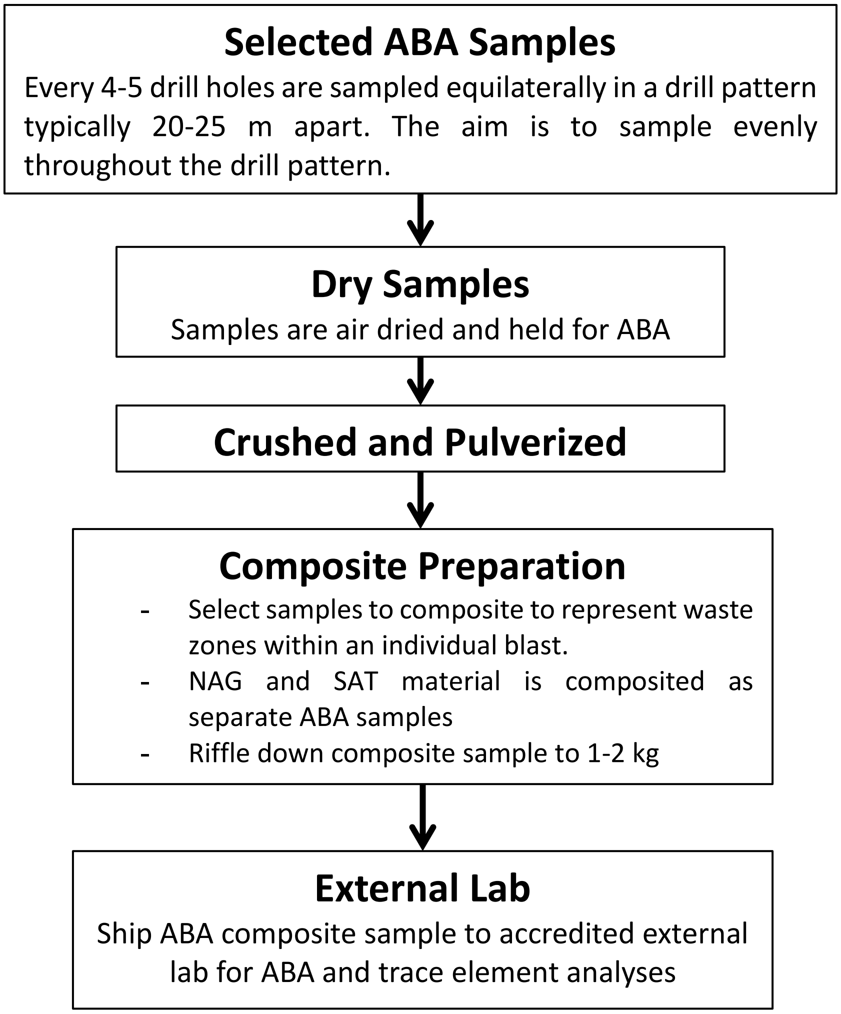
- Comparison of NP/AP and sulphide sulphur (log NP/AP versus log percent sulphide sulphur graph).

3.1.5 Overburden and Waste Rock

The objective of the overburden and waste rock ABA test program is to classify all overburden, waste rock and low grade, partially oxidized material mined at the Minto Mine and disposed of on surface. Classification is done through a combination of logging of lithology and related characteristics by the mine geologist during sample collection, and subsequent chemical analysis (determination of copper, sulphur and carbon content). Further details of the segregation of waste rock at Minto Mine is detailed in the WROMP. SOPs support the execution of the program and ensure that consistent field observations and sampling protocols are followed. Brief summaries of sampling procedures for open pit and underground waste rock are included in the following two subsections for reference.

3.1.5.1 Open Pit Waste Rock

The sampling procedure for sampling for open pit development waste is summarized in Figure 3-1.



Selected ABA Samples

Every 4-5 drill holes are sampled equilaterally in a drill pattern typically 20-25 m apart. The aim is to sample evenly throughout the drill pattern.

Dry Samples

Samples are air dried and held for ABA

Crushed and Pulverized

Composite Preparation

- Select samples to composite to represent waste zones within an individual blast.
- NAG and SAT material is composited as separate ABA samples
- Riffle down composite sample to 1-2 kg

External Lab

Ship ABA composite sample to accredited external lab for ABA and trace element analyses

Figure 3-1: Open Pit Drill Hole ABA Sampling Flow Chart

3.1.5.2 Underground Development Waste

The sampling procedure for sampling for underground development waste is summarized in Figure 3-2, and is detailed below.

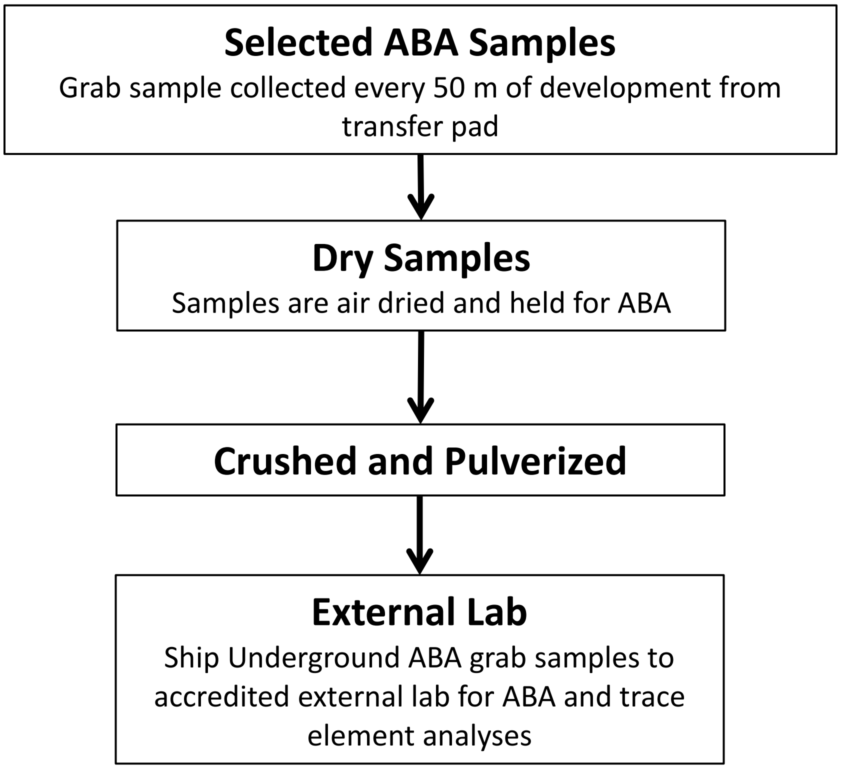


Figure 3-2: Underground Waste Rock ABA Sampling Flow Chart

3.1.6 Tailings Solids

The objective of the tailings solids monitoring program is to maintain an inventory of the geochemical properties of the tailings produced during the project life. This is achieved through analysis of monthly composite tailings samples that are formed by combining weekly grab samples. Each week, a grab sample is collected which contributes the monthly composite sample. The monthly composite is air dried and sent to an accredited laboratory for ABA and trace element analysis. Analytical results are added to the existing mine database and reported on an annual basis as part of the WUL and QML Annual Report.

3.1.7 Construction Materials

ABA test work must be conducted on all mined materials proposed for use in construction. Testing of potential construction material will occur during routine pit operations as described in Section 3.1.5, and will be carried out on-site. Construction material must meet the requirements outlined in the WUL and QML to be used for construction:

Table 3-2: Criteria for Construction Grade Waste Rock as per the WUL and QML

WUL	QML
Total copper content of <0.10%	Copper content no greater than 0.10%
NP:AP greater than or equal to 3	NP:AP of at least 3:1
Total sulphur content of less than 0.3%	Total sulphur content of no greater than 0.3%

3.2 Waste Rock Management Verification Program

The Waste Rock Management Verification Program supports the waste rock management procedures at the mine. The results of this program will be detailed in the WUL and QML Annual Report.

The program includes detailed record-keeping on the types and quantity of waste rock placed at each location, and monitoring and verification of the characteristics of the waste rock stored at each location as per the WROMP.

Minto tracks all material dispatched between sources and destinations generated using the mine's production tracking database system. This data is based on load count sheets compiled by the mining contractor.

A monthly dump sampling program takes place at Minto. The procedure is as follows:

1. At monthly intervals, mine personnel will visit every dump crest that was active over the preceding month, as determined by an analysis of the production tracking database system.
2. At 25 m intervals along each active dump crest, the waste rock will be manually sampled.
3. For each sample, one shovel-full of material will be collected and labelled. Particles greater than fist size will be manually rejected at the time of sampling.
4. The resulting samples will be crushed, pulverized, and split in Minto's assay lab such that a representative sample is obtained.
5. Each sample will be analyzed at site for copper, total sulphur (S(T)), and total carbon (C(T)) content using an Eltra CS-800 induction furnace with infrared detectors.
6. S(T) and C(T) values are converted into equivalent acid potential (AP-S(T)) and neutralization potential (NP-C(T)) values, and NP-C(T):AP-S(T) ratios are calculated for each sample.
7. Resulting NP-C(T):AP-S(T) ratio values are compared to the segregation criteria and assigned 'Pass' or 'Fail' verification designations.

If two or more adjacent failures occur, the crest will be resampled at 5 m intervals over each 25 m crest section represented by the failed samples. Sampling and analysis will follow steps 3 through 6 in the procedure described above. The average copper grade and NP-C(T) and AP-S(T) for the suspect zone will be calculated, and then the (Average NP-C(T)) : (Average AP-S(T)) ratio value for the zone will be calculated. Isolated failures will be accepted with no further action.

If the calculated bulk zone NP-C(T):AP-S(T) ratio is below the segregation criteria for the dump, further sampling will be carried out to define the limits of the zone in three dimensions. Should the material remain non-conforming it will be evaluated as to whether it is appropriate to remain in place or excavate it to a waste rock dump that will be saturated at closure. If it is determined to be a geochemical risk (i.e. large volume concentrated in one area) to the waste dump it will be excavated and relocated to one of the waste rock dump locations that will ultimately be saturated; no relocation will occur if the non-conforming waste rock is already located where saturated conditions will exist in the long term (i.e. in an in-pit dump below the expected final water table elevation).

3.3 Low Grade and Oxide Ore Metals Leaching Characterization Program

3.3.1 Introduction

Clause 94 of Water Licence QZ94-031 included a requirement to update the Geochemical Monitoring Program to include detailed metals leaching characterization from low-grade ore and oxide ore. The text of Clause 94 is copied here for ease of reference:

> *94) The Licensee shall update the Geochemical Monitoring Program to include a monitoring and geochemical characterization program that will produce detailed metals leaching characterization from the low-grade ore and oxide ore.*

This section of the EMSRP is intended to satisfy the Clause 94 requirement. However, Minto does not characterize any of the mined material on site as either low-grade ore or oxide ore and therefore in the strictest sense it is not possible to comply with this licence condition. In an attempt to address the intent of this clause, Minto has assumed that testing of the lowest grade ore material (categorized as Blue Ore by the site mine operations department) and of partially oxidized ore (categorized as POX by the site mine operations department) will be adequate.

3.3.2 Material Descriptions

Blue Ore is defined as ore grade material having a total copper content range of 0.5 to 0.99%. On site, Blue Ore is stockpiled in the ore stockpiles area south of the mill, between the ridge hosting the Area 2 Stage 2 Pit and the combined Dry Stack Tailings Storage Facility and the Mill Valley Fill Extension.

POX is defined as ore grade material that is partially oxidized and having a similar copper content range as Blue ore (0.5 to 0.99%). POX was stockpiled west of the Main Pit and east of the Main Waste Dump- in the past, two separate ore stockpiles (one POX and one Blue Ore stockpile) had been developed in this general area.

3.3.3 Conceptual Study Design

The study will consist of one large scale on-site leaching test for each material type (Blue Ore and POX), paired with static laboratory tests to define the geochemical characteristics of the materials being tested.

The on-site leaching tests will consist of large leach pads (nominally 5m x 5m, with actual size dependent on location details once a suitable location is identified following plan approval) lined with a geosynthetic liner and loaded to a depth of 1 to 2 m with run-of-stockpile test material (POX or Blue Ore). The leach pads would be subject to ambient site temperature and precipitation conditions, with collection of leachate accomplished by appropriate grading of the leach pad base and installation of a drain pipe through the liner to allow collection of leachate samples.

Static laboratory testing would consist of sampling and analysis of test materials during the initial construction of the test in the manner described for both internal and external laboratory analysis of waste rock under the ABA Monitoring Program.

The Meteorological Monitoring Program results will provide companion meteorological data to complement the leaching tests.

This approach to study design overcomes several issues that are common to smaller-scale site or laboratory leaching tests, including how to adjust for differences between test and site conditions for temperature, flushing rate, and particle size

3.3.4 Monitoring

Monitoring of leach pads will consist of monthly collection and analysis of water samples from each drain pipe during non-frozen months, with sampling and analysis protocols adopted from the Seepage Monitoring Program. The study will continue for a period 13 to 18 months, with the minimum 13 month period representing a monitoring period beginning in September of the construction year and terminating following September sampling of the following year. This duration will allow the monitoring results to capture a measure of variability

3.3.5 Implementation Schedule

Minto will begin detailed planning of the study within 3 months of receipt of approval of the EMSRP. While timing of approval is beyond Minto's control, the hope is that the tests can be constructed in Q2 2017 and that monitoring would be complete following the sampling round in September 2018.

4 Meteorological Monitoring Program

Meteorological Monitoring at the Minto Mine consists of meteorological monitoring and data collecting, including data on rainfall, snowfall, temperature, evaporation, wind speed and direction, and total sunshine hours. The Meteorological Monitoring Program is comprised of the Climate Monitoring Program (section 4.1) and the Snow Survey Program (section 4.2).

Data collected under the Meteorological Monitoring Program, along with baseline climatic data, provides input for the following mine projects:

- Site water management;
- Prediction for yearly water events (e.g. freshet);
- Design of water storage, conveyance and discharge systems; and
- Design of flood control structures on the road network.

4.1 Climate Monitoring Program

The objective of the Climate Monitoring Program is to collect climatic data specifically for the Minto Mine site. The monitoring areas consist of a meteorology station located north east of the Minto Mine airstrip. The meteorological station logs parameters at hourly intervals. The loggers are downloaded twice per month. During the download process, staff inspect the meteorological station for inoperative equipment.

The meteorology station is a research grade Campbell Scientific station that records the following parameters: maximum wind speed, minimum wind speed, average wind speed, wind direction, precipitation (rain and snow), temperature, relative humidity, pan evaporation, barometric pressure, solar radiation, outgoing radiation and calculated evapotranspiration.

The meteorology station was installed October 15, 2010 and runs on a Campbell Scientific CR1000 datalogger. Met Station 2 consists of a 10 m tower with instrumentation to measure air temperature, incident solar radiation, outgoing radiation, precipitation – rain and snowfall, barometric pressure, evapotranspiration, relative humidity, and wind speed, direction and events.

Data are averaged over the one-hour archiving period and then saved to the datalogger. In late November 2014, a wireless link was established with the Met Station 2 to allow remote real-time data viewing and downloads. Additionally, in November 2014, a Geonor T200 vibrating wire precipitation gauge was installed.

Winter precipitation is measured with the Geonor T200 precip gauge that uses antifreeze to melt solid precipitation into a container. The amount of precipitation is measured by using vibrating wire load sensors.

Incoming solar radiation is measured with a SP Lite2 Silicon Pyranometer. The SP Lite2 measures incoming solar radiation (sun plus sky radiation) with a photodiode detector. Output from the photodiode is a current, which is converted to voltage by an internal shunt resistor. The SP Lite2 can be used in solar energy applications such as plant growth, thermal convection and evapotranspiration.

The evapotranspiration calculation was incorporated into the Campbell Scientific program in July 2012.

Evapotranspiration is calculated as mm of water loss per hour. The datalogger measures energy fluxes required to calculate evapotranspiration utilizing the solar radiation sensor.

An evaporation pan and sensor for measuring outgoing radiation will be commissioned in 2016.

Data is downloaded, compiled and reported in monthly and annual WUL reporting.

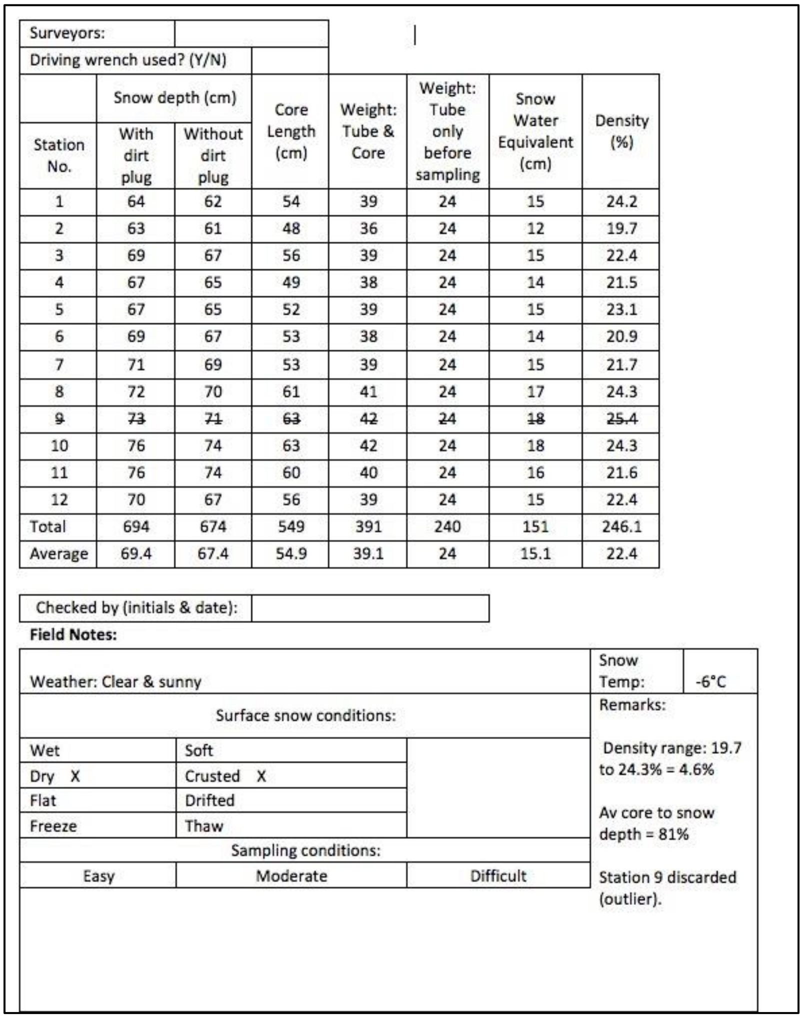
4.2 Snow Survey Program

The objective of the Snow Survey Program is to collect snow data used for calculating the snow water equivalent specifically at the Minto Mine. Snow water equivalents are inputs to the Minto Mine Site Water Balance models. Three courses are surveyed during the first week of February, March & April each year. If conditions permit, Minto will additionally survey the snow courses in May. These courses are East-facing (near the Dyno compound), North-facing (near the airstrip) and South-facing (above the Tank Farm), detailed in Table 4-1. Along each course, ten stations are sampled using a machined core tube with cutting end and scale with assembly. The parameters collected during the surveys include snow depth, core length, core weight, snow density, weather, site conditions, snowpack conditions, crust layers, and snow temperature.

Table 4-1: Snow Survey Course Locations

Course Location	Description	Aspect	UTM	
			Easting	Northing
Dyno	East of the Dyno compound on an east facing slope along a cut line surrounded by moderately densely tree area.	East Facing	8V 383 594	694 3377
Fuel Farm	North of the Minto Mine fuel farm on a south facing slope in a sparse to moderately densely treed area.	South Facing	8V 385 061	694 5318
Airstrip	Northeast of the Minto Mine airstrip on a north facing slope in a sparsely treed area.	North Facing	8V 386 255	694 4284

Snow sampling procedures are conducted following a standard operating procedure, developed in accordance with the BC Ministry of Environment's *Snow Survey Sampling Guide* (Ministry of Environment, 1981). The Snow Survey Program was reviewed and authorized as part of the licencing process for QZ14-031. A sample field data sheet is provided in Figure 4-1.



Surveyors:

Driving wrench used? (Y/N)

	Snow depth (cm)		Core Length (cm)	Weight: Tube & Core	Weight: Tube only before sampling	Snow Water Equivalent (cm)	Density (%)
Station No.	With dirt plug	Without dirt plug					
1	64	62	54	39	24	15	24.2
2	63	61	48	36	24	12	19.7
3	69	67	56	39	24	15	22.4
4	67	65	49	38	24	14	21.5
5	67	65	52	39	24	15	23.1
6	69	67	53	38	24	14	20.9
7	71	69	53	39	24	15	21.7
8	72	70	61	41	24	17	24.3
~~9~~	~~73~~	~~71~~	~~63~~	~~42~~	~~24~~	~~18~~	~~25.4~~
10	76	74	63	42	24	18	24.3
11	76	74	60	40	24	16	21.6
12	70	67	56	39	24	15	22.4
Total	694	674	549	391	240	151	246.1
Average	69.4	67.4	54.9	39.1	24	15.1	22.4

Checked by (initials & date):

Field Notes:

Weather: Clear & sunny

Snow Temp: -6°C

Surface snow conditions:

Wet	Soft
Dry X	Crusted X
Flat	Drifted
Freeze	Thaw

Sampling conditions:

Easy	Moderate	Difficult

Remarks:

Density range: 19.7 to 24.3% = 4.6%

Av core to snow depth = 81%

Station 9 discarded (outlier).

Figure 4-1: Sample Snow Survey Field Form

5 Physical Monitoring Program

The objective of the Physical Monitoring Program is to monitor the performance of key mine infrastructure and workings. Outlined in Table 5-1 is the mine infrastructure that requires monitoring under the Physical Monitoring Program; the infrastructure descriptions and instrumentation in place are further outlined in Table 5-1.

The Physical Monitoring Program consists of two main components: instrumentation to measure ground conditions and deformation; and, regular geotechnical inspections. Instrumentation to measure ground conditions and deformation include the following:

- Survey hubs;
- Inclinometers;
- Thermistors; and

- Vibrating Wire Piezometers.

Instrumentation (new or replaced) is installed in accordance with design reports / recommendations of third-party engineer, including those from past geotechnical inspections.

Monitoring and inspection schedules for each structure and associated reporting requirements are detailed in the *Physical Monitoring Plan* (Appendix 4).

Table 5-1: Physical Monitoring Program Mine Structures and Instrumentation

Structure	Description	Instrumentation
Area 2 Pit and Area 2 Pit Tailings Management Facility (A2PTMF)	The Area 2 Pit was completed in 2015 to the extents licensed under Phase IV (Stages 1 and 2); the pit will be extended to the south as part of Phase V/VI (Stage 3). Tailings deposition into the pit began in March, 2015 and the pit is now maintained as a tailings management facility.	• Survey hubs • Piezometer (proposed)
Area 118 Pit	Mining of the Area 118 Pit was carried out in 2014. The pit is currently inactive and the access is barricaded.	• Survey hubs
Area 118 Underground	The Area 118 underground began development in 2013 and is accessed by a portal and decline south of the Area 2 and Area 118 Pits. Production mining is currently taking place using a longhole stoping method and is expected to be completed in 2016.	None
Big Creek Bridge	Bridge on the Minto access road crossing Big Creek, located at Km 19. Licenced under Type B water licence MS04-227.	None
Camp	The camp consists of several connected bunkhouse buildings (Sherwood, Minto, Selkirk), a kitchen building, and several separate buildings including the gym and Site Services offices.	None
Dry Stack Tailings Storage Facility (DSTSF)	Construction of the DSTSF with filtered tailings placement was carried out from 2007 to November 2011. As part of progressive reclamation activities in 2012-2013, the DSTSF was covered with a layer of overburden approximately one to four meters thick. The DSTSF began showing deformation in 2009, interpreted as primarily horizontal sliding towards the north/northeast on an ice-rich layer in the underlying overburden, several meters above bedrock. The movement has continued since then but at a decreasing rate in response to construction of the Mill Valley Fill waste rock buttress.	• Survey hubs • Thermistors • Inclinometers • Piezometers
Ice Rich Overburden Dump (IROD)	Originally constructed as a free-standing rockfill structure to contain ice-rich overburden. The IROD is no longer active and is now entirely surrounded by the Southwest Waste Dump rockfill.	None
Main Pit (Area 1 Pit) and Main Pit Tailings Management Facility (MPTMF)	Mining in the Main Pit was completed in 2011. Instability in the south wall of the pit occurred in 2009 during mining of Stage 3 of the pit, and subsequently a larger failure occurred in 2011 after completion of Stage 5. Continued sloughing and creep movement of the south wall led to the design and construction of a waste rock buttress, known as the South Wall Buttress, completed in 2013. Slurry tailings deposition into the pit began in 2012 and the pit is now maintained as a tailings management facility. Dumping of NP: AP<3 waste rock (SAT), intended to be below the final water table at closure, continues into the pit, forming several benches of "in-pit	• Survey hubs • Inclinometer • Piezometer (proposed)

Structure	Description	Instrumentation
	dumps". Tension cracking on the west in-pit dump is monitored with a series of survey hubs installed in 2015 as recommended in previous inspection reports.	
Main Pit Dam	The Main Pit Dam is included in the Phase V/VI licence and has not been constructed yet. The dam will be located on the east end of the Main Pit to increase the tailings storage capacity of the MPTMF.	• Thermistors
Main Pit Dump	The Main Pit Dump is included in the Phase V/VI licence and has not commenced yet. The dump will be located on the southwest side of the Main Pit, partially on top of the South Wall Buttress.	N/A
Main Waste Dump (MWD)	The Main Waste Dump stores waste rock released during the mining of the first three stages of the Main Pit. The dump is no longer active however dumping is taking place nearby on the Main Waste Dump Expansion.	• Inclinometers
Main Waste Dump Expansion (MWDE)	This dump is an extension of the MWD and is currently the main active waste rock dump storing waste rock released from the Minto North Pit.	• Inclinometers
Mill Site	The mill site consists of the mill building, crusher and crusher stockpile pad.	None
Mill Valley Fill Extension (MFVE)	A waste rock buttress to the north of the DSTSF, constructed from January 2012 to March 2013 to prevent or decrease further movement of the DSTSF.	• Survey hubs
Mill Valley Fill Extension 2 (MVFE2)	An extension of the MVFE waste rock buttress to begin in Q4 2015 to further decrease movement of the DSTSF.	• Piezometers • Survey hubs
Mill Valley Fill Extension 2 Collection Sump	A replacement sump for the MCDS to be constructed in November 2015. It will detain surface water considered impacted from upstream sub-catchment areas and will direct it to the MPTMF or water treatment plant.	None
Mill Water Pond (MWP)	A small water storage pond that was previously used for excess process water and recirculation of mill process water. Currently not in use.	• Thermistors
Minto Access Road	Road from the Yukon River barge crossing to the mine site. Licenced under Type B water licence MS04-227.	None
Minto Creek Detention Structure (MCDS)	A small sump to detain surface water considered impacted from upstream sub-catchment areas (DSTSF) and direct it back to the Main Pit or water treatment plant.	None
Minto East, Area 2, Copper Keel, Wildfire Underground	The Area 2, Minto East, Copper Keel and Wildfire underground are in the phase V/VI mining plan and have not commenced yet.	N/A
Minto North Pit	Mining of the North Pit commenced in August 2015 and is scheduled to be completed in 2016.	• Radar
Ore Stockpiles	There are two primary ore stockpiles on site – North and South stockpile. These are located south of the crusher and east of the Area 2 pit.	None

Structure	Description	Instrumentation
Reclamation Overburden Dump (ROD)	Received the bulk of the overburden released as part of Phase IV and earlier mining of the Main Pit. The material in the ROD is available for use in reclamation of the mine at closure.	None
Ridgetop Pit (Ridgetop North Pit, Ridgetop South Pit)	The Ridgetop Pit (North and South) is included in the Phase V/VI licence and has not commenced yet.	• Thermistors
Ridgetop Waste Dump	The Ridgetop Waste Dump is included in the Phase V/VI licence and has not commenced yet.	N/A
South Diversion Ditch (SDD)	A diversion ditch located southeast of the Area 2 Pit to divert unaffected surface water around the mine workings.	None
South Wall Buttress (SWB)	Waste rock buttress constructed against the Main Pit south wall from 2009-2011 as a result of instability in the south wall of the pit.	• Survey hubs[1]
Southwest Waste Dump (SWD)	The Southwest Waste Dump (SWD) stores waste rock released during phase IV mining. Dumping at the SWD is now complete and reclamation re-sloping began in 2015. Re-sloping is expected to be completed in 2016.	• Survey hubs • Inclinometers • Thermistors • Piezometers
Tailings Diversion Ditch (TDD)	A diversion ditch located south of the DSTSF to divert unaffected water around the tailings facility.	None
Water Storage Pond Dam (WSP)	The Water Storage Pond and Dam are located east of the mine along Minto Creek. The dam was constructed in 2006 as a clay-core water retention dam for collecting precipitation and surface water runoff at the site. Maximum depth of water at the face of the dam is approximately 15 m.	• Survey hubs • Thermistors • Piezometers

1. As per Clause 97 (e) of QZ14-031, in-situ monitoring devices were installed in 2015 and are presented in the survey hub section of Physical Monitoring Plan as M82, M83, M84, and M87.

Roles and responsibilities for the Physical Monitoring Program are detailed in Table 5-2, below.

Table 5-2: Physical Monitoring Program Roles and Responsibilities

Role	Responsibilities
Mine Technician Assistants	• Collect instrumentation data at specified frequencies • Input data into monitoring spreadsheets/databases • Internal reporting of monitoring data • Maintain equipment
Geotechnical Engineers	• QA/QC of data collection • Ensure compliance with license requirements • Monthly and Annual reporting • Visual inspections at specified frequencies • Communicate with consultants as required • Review and update *Physical Monitoring Plan*

Role	Responsibilities
Environmental Department	- Compile Monthly and Annual reports - Visual inspections of water diversion/collection structures
Chief Engineer	- Review Annual Physical Monitoring report - Ensure compliance with license requirements

The Physical Monitoring Program is updated annually as part of the WUL and QML Annual Report. New instrumentation, replaced damaged instrumentation and changes in monitoring methods and procedures are detailed if applicable. Results and interpretation of the program are detailed in the Annual Report. Furthermore, the Physical Monitoring Program is reported as part of the WUL monthly reporting; each month a Geotechnical Engineer reviews, summarizes and signs a report detailing the information collected as part of the Physical Monitoring Program.

6 Aquatic Environmental Monitoring Program

Under the WUL Minto is required to implement an Aquatic Environmental Monitoring Program (AEMP) as part of the EMSRP. The AEMP includes several elements as listed in the WUL. Specifically, Clause 101 of the WUL indicates:

> *The Aquatic Environmental Monitoring Program shall be updated to include:*
>
> *a) MMER Environmental Effects Monitoring;*
>
> *b) Sediment Toxicity sampling, analyses and reporting; and*
>
> *c) Invertebrate Tissue Chemistry sampling, analyses and reporting.*

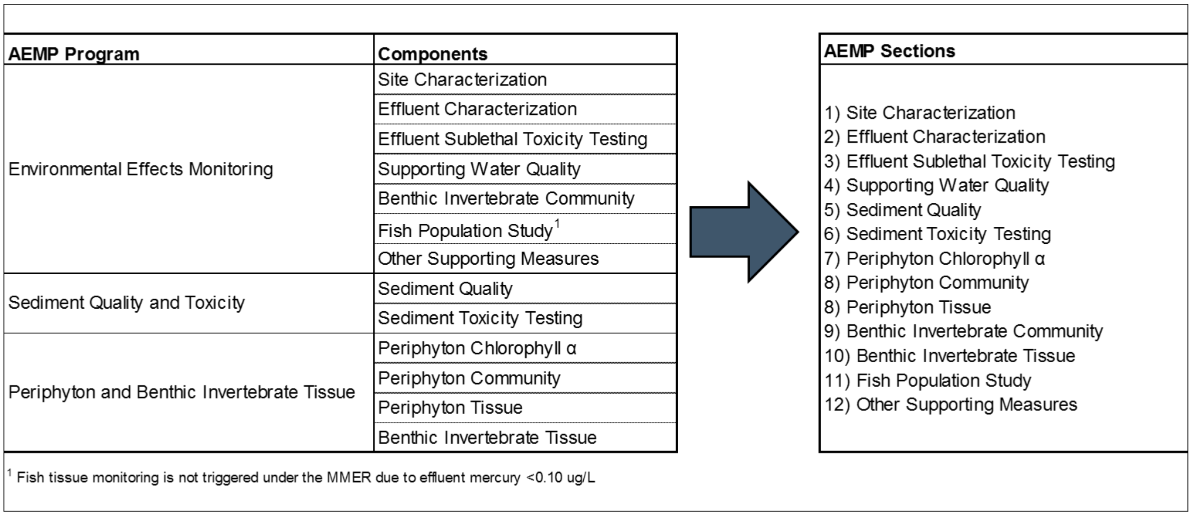
Clause 102 of the WUL indicates:

> *The Licensee shall review and evaluate the Aquatic Environmental Monitoring Program design every three (3) years and submit the findings to the Board, along with any recommendations for further refinements, as a part of the Annual Report, starting in 2016.*

The WUL re-iterates the need for Environmental Effects Monitoring (EEM) under the Metal Mining Effluent Regulations (MMER) of the federal Fisheries Act in WUL Clauses 87 and 88. Minto has been implementing all aspects of the MMER (including EEM) in accordance with the regulation (Government of Canada, 2015) and technical guidance for EEM (Environment Canada, 2012) since becoming subject to the regulation on July 10, 2006. Similarly, the Minto Mine has been implementing environmental monitoring programs in accordance with WUL requirements since the issue of the first WUL in 1996 (WUL QZ96-006).

Section 6 provides an overview of the integrated AEMP, which includes EEM and the additional aquatic environmental monitoring requirements of the WUL. The Minto Mine's substantial routine effluent and water quality monitoring program, also implemented to meet requirements of both the MMER and the WUL, is presented elsewhere. Current components of the integrated AEMP include: site characterization, effluent characterization, effluent sublethal toxicity testing, supporting water quality, sediment quality, sediment toxicity testing, periphyton chlorophyll α, periphyton tissue quality, periphyton community, benthic invertebrate community, benthic invertebrate tissue quality, fish population study, and other supporting measures (Table 6-1, Figure 6-1, Figure 6-2). In accordance with WUL Clause 108, the AEMP study design will be reviewed and evaluated every three years, with the findings and recommendations for further refinements submitted to the Yukon Water Board as part of the Annual Report starting in 2016. Each of the current AEMP components is described in the sections that follow. Additionally, a summary table of the AEMP programs and study design components and AEMP supporting measures is presented in Appendix 5.

Table 6-1: AEMP Programs and Components

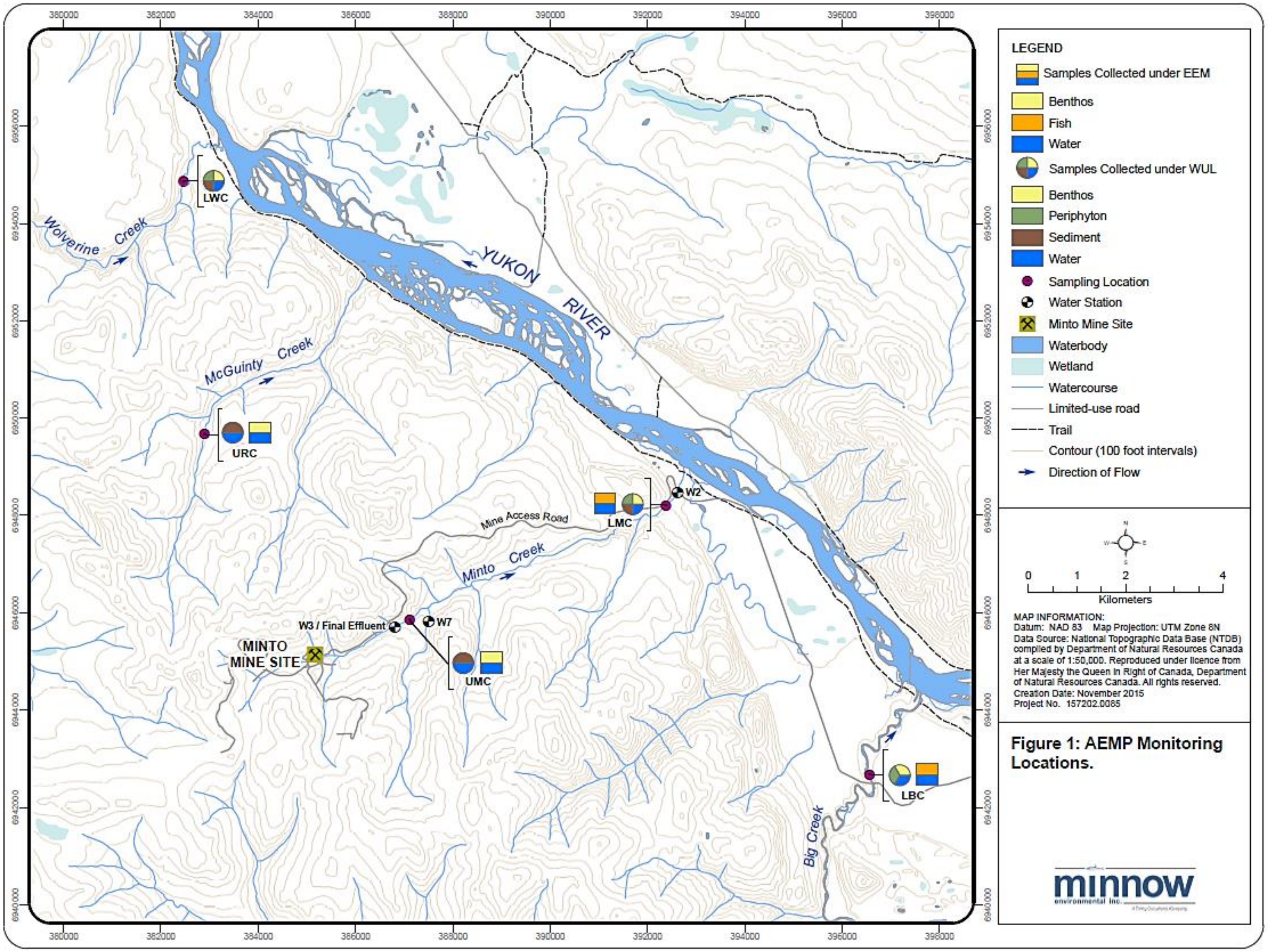


AEMP Program	Components
Environmental Effects Monitoring	Site Characterization
	Effluent Characterization
	Effluent Sublethal Toxicity Testing
	Supporting Water Quality
	Benthic Invertebrate Community
	Fish Population Study[1]
	Other Supporting Measures
Sediment Quality and Toxicity	Sediment Quality
	Sediment Toxicity Testing
Periphyton and Benthic Invertebrate Tissue	Periphyton Chlorophyll α
	Periphyton Community
	Periphyton Tissue
	Benthic Invertebrate Tissue

AEMP Sections

1) Site Characterization
2) Effluent Characterization
3) Effluent Sublethal Toxicity Testing
4) Supporting Water Quality
5) Sediment Quality
6) Sediment Toxicity Testing
7) Periphyton Chlorophyll α
8) Periphyton Community
8) Periphyton Tissue
9) Benthic Invertebrate Community
10) Benthic Invertebrate Tissue
11) Fish Population Study
12) Other Supporting Measures

[1] Fish tissue monitoring is not triggered under the MMER due to effluent mercury <0.10 ug/L



MAP INFORMATION:
Datum: NAD 83 Map Projection: UTM Zone 8N
Data Source: National Topographic Data Base (NTDB) compiled by Department of Natural Resources Canada at a scale of 1:50,000. Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.
Creation Date: November 2015
Project No. 157202.0085

Figure 1: AEMP Monitoring Locations.

Figure 6-1: AEMP Monitoring Locations

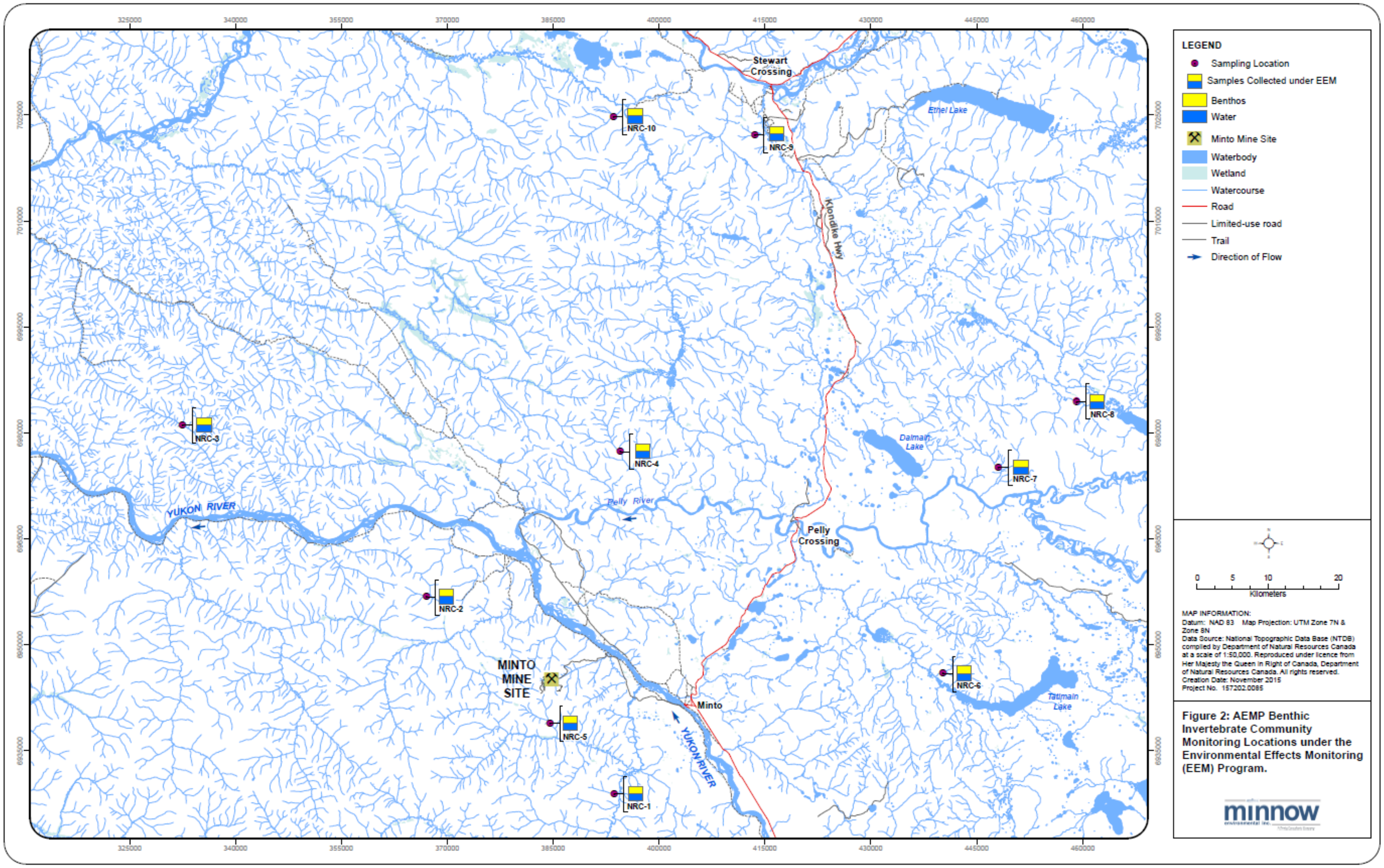


Figure 6-2: AEMP Benthic Invertebrate Community Monitoring Locations under the EEM Program

6.1 Metal Mine Effluent Regulations Monitoring Programs

The *Metal Mine Effluent Regulations* (MMER) Monitoring Programs are composed of Effluent Monitoring and the Environmental Effects Monitoring programs. Sections 6.1.1 and 6.1.2 describe each program.

6.1.1 Metal Mine Effluent Monitoring

The *Metal Mine Effluent Regulations* (MMER) outline requirements for monitoring and reporting of discharged effluent volume and quality under the MMER to Environment Canada. The Metal Mine Effluent Program aims to maintain compliance with the MMER and the program will be revised should regulation amendments occur. Specifically, the Metal Mine Effluent Program requires effluent monitoring with sampling at station W3, downstream of the end of pipe discharge (Figure 2-1). Effluent monitoring requirements are outlined in Table 6-2. Effluent monitoring samples are collected when there is a deposit of water at W3; testing occurs weekly for deleterious substances. Radium 226 and acute lethality tests are conducted quarterly due to the reduced frequency guidelines outlined in the MMER. The MMER specifies requirements for increased testing frequencies if the Radium 226 or acute lethality tests do not meet the prescribed standards as detailed in the MMER.

Weekly effluent monitoring samples are tested for the deleterious substances as described in the MMER including the total metals arsenic, copper, lead, nickel and zinc; total suspended solids (TSS) and pH. Weekly samples are collected at least 24 hours apart.

Reporting of the effluent monitoring results, and discharge volumes is required quarterly and annually to Environment Canada, under the Regulatory Information Submission System (RISS).

Table 6-2: Metal Mine Effluent Monitoring Program Requirements and Frequency

Water Quality Monitoring Stations	Monitoring Frequency	Analytical Parameters
W3 – Compliance Point	Weekly	1. Effluent Volume 2. Water Quality: in-situ field parameters, physical parameters, nutrients, and total metals
	Quarterly	3. Water Quality: Radium 226 and acute lethality tests on both Daphnia magna and Rainbow trout (*Oncorhynchus mykiss*).

6.1.2 Environmental Effects Monitoring

Environmental Effects Monitoring under the MMER includes Site Characterization, Effluent Characterization, Effluent Sublethal Toxicity and Supporting Water Quality Monitoring.

6.1.2.1 Site Characterization

Site characterization is prescribed for EEM under the MMER (Government of Canada, 2015), with requirements described in associated technical guidance (Environment Canada, 2012). Site characterization is required with every EEM Study Design Report, which is submitted to Environment Canada for review and approval every three years prior to the implementation of EEM biological monitoring. The purpose of site characterization is to provide a review and update of features of the site and the effluent receiving environment pertinent to the design of the EEM study (Table 6-3).

Table 6-3: Site Characterization Information in the EEM Study Design Report

Component	Consideration
Mine History	Date of startup
	Dates of major operational changes
	Dates of changes to tailings management
	Dates of changes to effluent management
Current Operations	Mining processes
	Milling processes
	Water management
	Waste rock disposal
	Tailings disposal
	Wastewater disposal
	Reagent use
	Environmental protection processes
	Effluent management and discharge
	Effluent mixing
Effluent Quality	MMER routine compliance monitoring
	MMER effluent characterization
	MMER sublethal toxicity
	Other regulations applicable to effluent
Water Quality	MMER water quality characterization
Habitat Inventory and Classification	Habitat classification
	Physiography and geomorphology
	Hydrology
	Geology
	Substrates
	Plant communities
	Chemistry
Fish and Other Aquatic Resources	Fish community
	Population abundance

Component	Consideration
	Benthic communities
	Other
Potential Confounding Factors	Historical versus current influences
	Other historical or current discharges or seeps

6.1.2.2 Effluent Characterization

Effluent characterization is also prescribed under MMER (Government of Canada, 2015) and described in associated technical guidance (Environment Canada, 2012). Briefly, MMER effluent characterization is conducted four times per year, not less than one month apart. Effluent characterization includes a broader suite of analytes than routine effluent monitoring under the MMER, including hardness, alkalinity, aluminum, cadmium, iron, mercury, molybdenum, selenium, ammonia and nitrate (Government of Canada, 2015). In accordance with the MMER, Minto no longer has to include mercury as concentrations have been less than 0.10 µg/L in 12 consecutive samples collected for effluent characterization. As previously indicated, the Minto Mine completes substantial additional effluent quality monitoring, described elsewhere in the EMSRP.

6.1.2.3 Effluent Sublethal Toxicity Testing

Effluent sublethal toxicity testing is also prescribed under MMER (Government of Canada, 2015) and associated technical guidance (Environment Canada, 2012). Effluent toxicity testing is required using a total of four tests; one each of a fish, invertebrate, algae and plant species. Minto Mine initially implemented these tests twice per year, but in accordance with the MMER now implements them once per year as more than three years of testing have been completed. Tests are completed using Environment Canada Biological Test Methods and include sublethal tests of rainbow trout (*Oncorhynchus mykiss*) development or fathead minnow (*Pimephales promelas*) survival and growth, the invertebrate *Ceriodaphnia dubia* survival and reproduction, the algae *Pseudokerchneriella subcapitata* growth, and the plant *Lemna minor* growth using Environment Canada test methods (1998, 2007, 2011).

6.1.2.4 Supporting Water Quality

Water quality monitoring is also prescribed under MMER (Government of Canada, 2015) and associated technical guidance (Environment Canada, 2012). Briefly, MMER water quality monitoring is conducted four times per year, not less than one month apart. MMER water quality monitoring is completed in lower Minto Creek (Station W2) and a reference tributary to Minto Creek (Station W7; Figure 6-1) and includes pH, hardness, alkalinity, electrical conductivity, aluminum, arsenic, cadmium, copper, iron, lead, molybdenum, nickel, selenium, zinc, total suspended solids, ammonia and nitrate (Government of Canada, 2015). In accordance with the MMER, Minto Mine no longer has to include mercury or radium-226 as relaxation conditions have been met based on previous monitoring results. Water samples are also collected as supporting measures for biological sampling (periphyton, benthic invertebrates and fish) and include, at minimum, all analytes listed above (and generally those listed in Table 6-4). As with effluent quality monitoring, and as previously indicated, the Minto Mine completes substantial additional water quality monitoring, described elsewhere.

Table 6-4: AEMP Laboratory Analysis for Water, Sediment and Tissue samples

Water	Sediment	Periphyton and Benthic Tissue
Conductivity	Total Kjeldahl Nitrogen	Total Aluminum (Al)
Hardness (as $CaCO_3$)	Particle Size	Total Antimony (Sb)
pH	Inorganic Carbon	Total Arsenic (As)
Total Suspended Solids	Inorganic Carbon (as $CaCO_3$ Equivalent)	Total Barium (Ba)
Total Dissolved Solids	Total Carbon by Combustion	Total Beryllium (Be)
Turbidity	Total Organic Carbon	Total Bismuth (Bi)
Alkalinity, Total	Total Aluminum (Al)	Total Boron (B)
Ammonia, Total (as N)	Total Antimony (Sb)	Total Cadmium (Cd)
Chloride (Cl)	Total Arsenic (As)	Total Calcium (Ca)
Fluoride (F)	Total Barium (Ba)	Total Cesium (Cs)
Nitrate (as N)	Total Beryllium (Be)	Total Chromium (Cr)
Nitrite (as N)	Total Bismuth (Bi)	Total Cobalt (Co)
Phosphorus (P)-Total dissolved	Total Cadmium (Cd)	Total Copper (Cu)
Phosphorus (P)-Total	Total Calcium (Ca)	Total Iron (Fe)
Sulfate (SO_4)	Total Chromium (Cr)	Total Lead (Pb)
Cyanide, Total	Total Cobalt (Co)	Total Lithium (Li)
Dissolved Organic Carbon	Total Copper (Cu)	Total Magnesium (Mg)
Total Organic Carbon	Total Iron (Fe)	Total Manganese (Mn)
Total Inorganic Carbon	Total Lead (Pb)	Total Mercury (Hg)
Total and Dissolved Metals	Total Lithium (Li)	Total Molybdenum (Mo)
Aluminum (Al)	Total Magnesium (Mg)	Total Nickel (Ni)
Antimony (Sb)	Total Manganese (Mn)	Total Phosphorus (P)
Arsenic (As)	Total Mercury (Hg)	Total Potassium (K)
Barium (Ba)	Total Molybdenum (Mo)	Total Rubidium (Rb)
Beryllium (Be)	Total Nickel (Ni)	Total Selenium (Se)
Bismuth (Bi)	Total Phosphorus (P)	Total Sodium (Na)
Boron (B)	Total Potassium (K)	Total Strontium (Sr)
Cadmium (Cd)	Total Selenium (Se)	Total Tellurium (Te)
Calcium (Ca)	Total Silver (Ag)	Total Thallium (Tl)
Chromium (Cr)	Total Sodium (Na)	Total Tin (Sn)
Cobalt (Co)	Total Strontium (Sr)	Total Uranium (U)
Copper (Cu)	Total Thallium (Tl)	Total Vanadium (V)
Iron (Fe)	Total Tin (Sn)	Total Zinc (Zn)
Lead (Pb)	Total Titanium (Ti)	Total Zirconium (Zr)
Lithium (Li)	Total Uranium (U)	
Magnesium (Mg)	Total Vanadium (V)	
Manganese (Mn)	Total Zinc (Zn)	
Mercury (Hg)		

Water	Sediment	Periphyton and Benthic Tissue
Molybdenum (Mo)		
Nickel (Ni)		
Phosphorus (P)		
Potassium (K)		
Selenium (Se)		
Silicon (Si)		
Silver (Ag)		
Sodium (Na)		
Strontium (Sr)		
Thallium (Tl)		
Tin (Sn)		
Titanium (Ti)		
Uranium (U)		
Vanadium (V)		
Zinc (Zn)		

6.2 Sediment Quality and Toxicity Monitoring

The Sediment Quality and Toxicity Monitoring components of the AEMP are described in the following sections.

6.2.1 Sediment Quality

The objective of sediment quality monitoring is to determine if the Minto Mine has influenced the sediment quality of Minto Creek. Sediment quality monitoring is completed annually in September in both upper and lower Minto Creek (Figure 6-1, Appendix 5). Sediment quality of upper Minto Creek (immediately downstream of Station W3) is monitored and compared to the reference area located at upper McGinty Creek (Figure 6-1, Appendix 5). Sediment quality of lower Minto Creek is monitored and compared to the reference area lower Wolverine Creek (Figure 6-1, Appendix 5). Depositional areas, quiescent pools and wetted backwater locations are targeted as these areas contain more fine sediment (silt and clay) and the most recently deposited sediment.

At upper Minto and upper McGinty creeks, sediment samples are collected using a stainless steel or Teflon spoon (Figure 6-1, Appendix 5). Fine surficial sediment is collected from five stations to represent each area. A sample for sediment chemistry is collected at each station. Because sediment is sparsely distributed in the upper creek areas, one supporting sample for sediment physical characterization (particle size analysis) is collected as a composite sample from all five stations to represent the area. This effectively captures spatial variability within the area. Each sample is made up of at least 10 scoops. Samples in lower Minto and lower Wolverine Creek are collected using a hand corer for chemical characterization and a petite ponar grab sampler for particle size characterization. Fine surficial sediment is collected from five stations to represent each area. The top 2 cm of three cores or grabs, respectively, are collected to make a composite sample for each station. Field sieving of the sediment samples is not necessary due to the particle size distributions. However, laboratory sieving to < 2.0 mm is standard practice and is applied in the AEMP sediment monitoring. Thus, all metal results are for < 2.0 mm sediment.

Following collection, sediment samples are kept cool and are sent to a Canadian Association for Laboratory Accreditation (CALA) accredited analytical laboratory for analysis as soon as possible. Sediment quality analytes include particle size, total organic carbon, total Kjeldahl nitrogen, metals and metalloids (Table 6-4).

Sediment quality of Minto Creek is evaluated in comparison to Canadian Environmental Quality Guidelines (CEQG) for sediment (CCME, 2014), by statistical contrast of exposed (Minto Creek) and reference areas and by comparison to previous sediment quality data to evaluate temporal change. Simultaneously extracted metals (SEM) and acid volatile sulfides (AVS) testing were considered but are most relevant to anoxic and sub-oxic sediment. The SEM and AVS tests would have limited value in upper Minto Creek where sediment is only present as a skim over sand or sand and rocks. Furthermore, sediment toxicity testing is captured with the ten-day toxicity tests.

6.2.2 Sediment Toxicity Testing

The objective of the sediment toxicity testing program is to determine if Minto Creek sediment adversely affects survival or growth of toxicity test organisms. Toxicity is evaluated using two standard sediment toxicity tests once a year in September, concurrent with sediment collections for sediment quality. Sediment toxicity tests are the 10-day *Chironomus dilutus* test of survival and growth (Environment Canada, 1997) and the 14-day *Hyalella azteca* test of survival and growth (Environment Canada, 2013). Sediment from lower Minto Creek and the reference area (lower Wolverine Creek) are tested (Figure 6-1, Appendix 5). Sediment in upper Minto Creek is too sparse to justify performing these tests.

Sediment for toxicity testing is collected using a petite ponar grab sampler as described above, with samples collected at the same five replicate stations in lower Minto Creek and lower Wolverine Creek (Figure 6-1, Appendix 5). At each station, the top 2 cm of sediment is collected from three ponar grabs and combined to provide sediment for both toxicity tests. Samples are kept cool until they can be sent to an experienced toxicity testing laboratory. Percent survival and dry weight (mg) of both organisms are measured in each test.

Sediment toxicity test results for lower Minto Creek are evaluated by statistical comparison to laboratory control results and reference sediment (lower Wolverine Creek) results, and by comparison to previous sediment toxicity test data to evaluate temporal change. Relationships between any observed sediment toxicity and sediment chemistry are also evaluated.

6.3 Periphyton and Benthic Invertebrate Tissue Monitoring

The Periphyton and Benthic Invertebrate Tissue Monitoring components of the AEMP are described in the following sections.

6.3.1 Periphyton Chlorophyll α

The objective of periphyton monitoring is to evaluate chlorophyll *α* (productivity), community composition and tissue chemistry of periphyton in Minto Creek. Periphyton is made up of an assemblage of algae, bacteria, fungi and meiofauna attached to submerged substrates. The periphyton monitoring program is conducted on an annual basis (September).

Chlorophyll α, a photosynthetic pigment, is used to characterize periphyton productivity in lower Minto Creek. Samples for chlorophyll α are collected at five stations in each of lower Minto Creek and lower Wolverine Creek (reference; Figure 6-1, Appendix 5). At each station, samples are collected by first collecting five rocks from locations of similar depth and velocity. Periphyton is then scraped from the five rocks using a stainless steel razor blade and combined to form a composite sample. A sufficient volume of periphyton is scraped from the five rocks to be visible on the filter paper, and the associated surface area scraped is measured and recorded. Once all of the rocks are scraped, the filter paper is folded and placed in a black vial to avoid exposure to light (and potential photodegradation of chlorophyll *α*). The samples are frozen and later sent to a CALA accredited analytical laboratory for analysis of chlorophyll *α*.

The volume of chlorophyll *α* per unit area of stream (rock) surface is calculated as an index of periphyton productivity (mg/m^2) and is evaluated in comparison to the British Columbia Water Quality Guideline for the protection of aquatic life (100 mg/m^2; (BC MOE, 1985)), by statistical contrast of exposed (Minto Creek) and the reference area, and by comparison to previous chlorophyll *α* data to evaluate temporal change.

6.3.2 Periphyton Community

The objective of the periphyton community monitoring is to determine if the Minto Mine has influenced the periphyton community of Minto Creek. Samples are collected from lower Minto Creek and lower Wolverine Creek (Figure 6-1, Appendix 5) at five replicate stations following the collection of representative rocks as described above. Periphyton community samples are collected by scraping a 4x4 cm^2 area on each of the five rocks collected at each station. Samples are placed in small plastic jars with water and preserved with Lugol's solution. Periphyton community samples are kept cool and sent to a taxonomist for identification. Samples from all five stations are analyzed separately.

The periphyton community of lower Minto Creek is evaluated on the basis of summary metrics of organisms per sample, number of taxa, Simpson's Diversity, Simpson's Evenness, Bray-Curtis Index (Environment Canada , 2012), density (cells/cm^2), biomass (µg/cm^2) and relative proportions of dominant taxon groups. Summary metrics are evaluated by statistical contrast of exposed (Minto Creek) and the reference area, and by comparison to previous periphyton community data to evaluate temporal change.

6.3.3 Periphyton Tissue

The objective of the periphyton tissue monitoring is to determine if the Minto Mine has influenced periphyton tissue quality of Minto Creek. Samples are collected from lower Minto Creek, lower Wolverine Creek (reference), and lower Big Creek (reference; Figure 6-1, Appendix 5) at five replicate stations following the collection of representative rocks as described above. Periphyton tissue samples are collected by scraping the five rocks per replicate station to form a composite sample. At least 0.2 g wet weight of periphyton is collected and placed in small plastic jars. Samples are kept cool and sent to a CALA accredited analytical laboratory for analysis of metals and metalloids (Table 6-4). Samples from all five stations are analyzed separately.

Periphyton tissue quality of Minto Creek is evaluated by statistical contrast of exposed (Minto Creek) and reference areas and by comparison to previous periphyton tissue quality data to evaluate temporal change. Relationships between periphyton tissue quality and water chemistry are also evaluated.

In 2016, weekly water quality sampling of lower Minto Creek and lower Big Creek will commence two months prior to periphyton tissue sample collection. This will aid in a comparison of Kd values that are averaged over the year versus those calculated in the two months prior.

6.3.4 Benthic Invertebrate Community

The objective of benthic invertebrate community monitoring is to monitor benthic invertebrate community condition of lower and upper Minto Creek and compare them to respective reference areas. Benthic invertebrate community monitoring falls under two different regulatory requirements, the WUL and EEM. The WUL monitoring in undertaken annually (September) whereas the EEM is implemented every three years (also in September). The benthic invertebrate collection and assessment program is consistent with previously authorized versions.

Benthic invertebrate community monitoring under the WUL is completed at three areas, lower Minto Creek (exposed), lower Wolverine Creek (reference) and lower Big Creek (reference; Figure 6-1, Appendix 5), with five replicate stations per area. Benthic invertebrate community samples are collected using a Hess sampler (0.1 m2 sampling area; 500 µm mesh), with each replicate sample collected as a composite of three sub-samples. All sampling locations, both within and among areas, are selected based on similar substrate characteristics, water depths and water velocity. To collect the sample, all substrate within the Hess sampler is scrubbed until the area is cleaned of organisms, with organisms washed into the collection net by the current. The three sub-samples within a station are combined to form a composite. Composite samples are preserved with 10% buffered formalin and sent to a taxonomist for identification to the “lowest practical level”.

Benthic invertebrate community monitoring under the EEM is currently undertaken using the Reference Condition Approach (RCA). Three stations in upper Minto Creek (the exposed area) are evaluated relative to the reference condition defined by ten RCA reference areas (chosen from reference sites evaluated in the previous EEM; Minnow 2015; Figure 2; Table 4) in accordance with the Canadian Aquatic Biomonitoring Network (CABIN) protocol for RCA studies (CABIN, 2012). Unlike the WUL benthic monitoring (a control-impact approach), only one sample is collected from each area (referred to as a site under CABIN). Samples are collected using a Hess sampler as described above.

Under both programs, benthic invertebrate community characteristics of Minto Creek are evaluated on the basis of summary metrics of invertebrate density (number of organisms per m2 calculated based on a sample area of 0.3 m2), number of taxa, Simpson's Diversity, Simpson's Evenness and Bray-Curtis Index (Environment Canada, 2012), and the relative proportions of dominant taxon groups. Summary metrics are evaluated by statistical contrast of exposed (Minto Creek) and the reference areas (using either a control-impact contrast or an RCA model) and by comparison to previous benthic invertebrate community data to evaluate temporal change. Relationships between benthic invertebrate community condition and water chemistry are also evaluated.

The RCA is a study design approach that can be applied to any sampling methodology (as long as the methodology is the same at every site). Benthic invertebrate community sampling under the EEM is completed by Hess sampling, targeting habitat of the same depth, water velocity and substrate composition, which likely provides a tighter comparison among areas than kick-and-sweep sampling. Deviations from the CABIN protocol are described in the EEM reports submitted to Environment Canada. At each site, Hess samples are collected as three-grab composites, with each grab collected by completely washing the substrate within the Hess sampler (allowing dislodged organisms to be swept into the collection net). In turn, each of the three grabs that make up the composite sample is collected over a period of five to ten minutes of continuous disturbance and washing of the substrate within the Hess sampler.

A SOP on Benthic Sampling procedures can be found in Appendix 6.

6.3.4.1 Benthic Invertebrate Tissue

The objective of the benthic invertebrate tissue monitoring is to determine if the Minto Mine has influenced benthic invertebrate tissue quality of Minto Creek. Samples are collected from lower Minto Creek, lower Wolverine Creek (reference), and lower Big Creek (reference; Figure 6-1, Appendix 5) at five replicate stations. Benthic invertebrate tissue samples are collected by using the kick-and-sweep method (CABIN, 2012) or by hand until approximately 2.0 g of benthic invertebrate tissue is collected. Samples are collected from all five stations in each area (Figure 6-1, Appendix 5). Collected benthic invertebrate samples are frozen and then sent to a CALA accredited analytical laboratory for analysis of metal and metalloid concentrations (Table 6-4).

Benthic invertebrate tissue quality of Minto Creek is evaluated by statistical contrast of exposed (Minto Creek) and reference areas and by comparison to previous benthic invertebrate tissue quality data to evaluate temporal change. Samples from all five stations are analyzed separately. Relationships between benthic invertebrate tissue quality and water chemistry are also evaluated.

In 2016, weekly water quality sampling of lower Minto Creek and lower Big Creek will commence two months prior to benthic invertebrate tissue sample collection. This will aid in a comparison of Kd values that are averaged over the year versus those calculated in the two months prior.

6.4 Fish Monitoring Program

The objective of the fish monitoring program is to monitor, assess and characterize fish usage of Minto Creek and to determine if the Minto Mine influences the health of a sentinel fish species of Minto Creek. Based on previous findings of fish use of Minto Creek, fish monitoring includes two elements: 1) ongoing characterization of fish use of lower Minto Creek; and 2) a mobile laboratory-based evaluation of the effects of exposure of juvenile Chinook salmon (*Oncorhynchus tshawytshca*) to Minto Mine effluent.

Ongoing characterization of the use of lower Minto Creek by fish is undertaken in lower Minto Creek, with lower Big Creek serving as a reference (Figure 6-1, Appendix 5). Although fish monitoring is only required under EEM, the *in-situ* fish monitoring is typically conducted annually to characterize fish usage of Minto Creek, with fishing conducted on several occasions during the open water season (typically conducted between June and October). In Minto Creek, fishing effort is restricted to the area downstream of a natural barrier located approximately 1.5 km upstream of the creek mouth. Fishing for the evaluation of fish usage is implemented using minnow traps baited with Yukon River origin Chinook salmon roe and set in areas of known juvenile Chinook salmon habitat. This typically includes eddies, pools and calm water with overhead cover and/or woody debris. The minnow traps are left for 24 hours and any fish caught are identified, enumerated, measured (fork or total length, mm) and any abnormalities are noted. Trap location information is recorded and catch per unit effort (CPUE) is calculated and used to quantify use of Minto Creek. CPUE, fish size data and fish condition are evaluated by statistical contrast of exposed (Minto Creek) and the reference area and by comparison to previous data to evaluate temporal differences.

Previous studies of the usage of Minto Creek by fish has documented that the most consistent use of lower Minto Creek is by juvenile Chinook salmon, which typically use lower Minto Creek between June and October. Individual fish spend only short periods of time in the creek (typically less than two weeks) during out-migration along the Yukon River from upstream spawning areas and Chinook salmon do not spawn in Minto Creek (Access and Minnow, 2014). Several other fish species have been observed to use lower Minto Creek less frequently and at much lower abundance than juvenile Chinook, including slimy sculpin (*Cottus cognatus*), arctic grayling (*Thymallus arcticus*) and round whitefish (*Prosopium cylindraceum*; Access and Minnow, 2014).

Based on the current understanding of fish use of Minto Creek, the potential effects of Minto Mine effluent on survival and growth of juvenile Chinook salmon are evaluated every three years under EEM. Due to often limited fish captures in situ, a mobile laboratory exposure is set up to evaluate fish survival and growth using hatchery-sourced juvenile Chinook salmon. If Chinook salmon are not available for the study a surrogate for Chinook salmon will be required. Kokanee salmon have been identified as an appropriate surrogate for Chinook salmon and have been approved for use by Environment Canada. The mobile laboratory exposure system set up consists of three large tanks (approximately 4,000 liters) with 150 juvenile Chinook salmon per tank. Two Minto Mine effluent concentrations (1:3 and 1:6) and a Minto Creek control are evaluated. Growth and condition are monitored prior to exposure and in all exposures at two-week intervals to six weeks of exposure. At each monitoring, all fish are measured for length, weight and abnormalities.

Effluent-exposed juvenile chinook salmon are evaluated on the basis of endpoints of growth (length-frequency distribution), energy use (length and weight) and energy storage or condition (weight-at-length) by statistical contrast of Minto Creek results against those of the control group in accordance with technical guidance for non-lethal EEM fish populations surveys (Environment Canada, 2012) and by comparison to previous results to evaluate temporal differences. Relationships between juvenile Chinook salmon health endpoints and water chemistry are also evaluated.

6.4.1 Supporting Measurements

To support the chemical and biological monitoring components outlined in previous sections, water chemistry and other supporting measures are collected (Figure 6-1 and Figure 6-2; Appendix 5). At each monitoring location, GPS coordinates and water quality meter measurements (dissolved oxygen, pH, temperature and conductivity) are recorded, and water quality samples are collected (Appendix 5). To support sediment quality monitoring in the lower reaches, depth at all stations and penetration depth of all hand corer samples are recorded (Appendix 5). Photographs are taken of all core and petite ponar samples, as well as substrate type (Appendix 5). To support periphyton monitoring, the area scraped for chlorophyll α and community samples is recorded. Photographs of the rocks collected for periphyton samples are also taken (Appendix 5).

To support benthic invertebrate community monitoring during both the WUL (annual basis) and EEM (every three years), depth and velocity at every Hess sampler location is recorded (Appendix 5). Photographs and a 100 pebble count (CABIN, 2012) are conducted at every station. At one station per area (except for upper Minto Creek during EEM where all three stations are sampled) a habitat assessment is also conducted (Appendix 5). To support in situ fish monitoring, the following additional supporting measures are collected at every station: weather, photographs and trap location with a description of the station (Appendix 5).

Quantitative supporting measurement data (e.g., water quality meter measurements, water depth, water velocity and water chemistry) are evaluated by statistical contrast of exposed (Minto Creek) and reference areas. They are also used to investigate potential causes of any observed biological effects by correlation analysis.

7 Terrestrial Environment Monitoring Program

The Terrestrial Environment Monitoring Program is designed to monitor terrestrial features of the Minto Mine and surrounding environment. The objective of the program is to monitor invasive plant species, wildlife and erosion and sedimentation occurring in and around the mine site. These programs are detailed in sections 7.1 through 7.3.

7.1 Invasive Plant Species Monitoring Program

Invasive species largely refer to non-native, foreign, or exotic species, although a few native species, if introduced into new and suitable environments, can become problematic (e.g. Foxtail barley). It is important to note that the term invasive species includes plant, animal, fungus, and bacterium. The main pathways by which invasive species may be introduced to the Minto Mine site include distribution through reclamation efforts, and introduction though vehicle traffic to the mine site. The Invasive Plant Species Monitoring Program includes invasive plant mitigation, monitoring and reporting.

7.1.1 Invasive Plants Mitigation

Invasive plant mitigation techniques at Minto include site access measures, appropriate plant selection, erosion control and soil salvage techniques.

7.1.1.1 Site access

The following site access mitigation measures aid in reducing the possibility of propagules spreading across Minto by means of vehicles and equipment:

- Wherever possible, vehicle use (including ATVs) will be restricted to roads and existing pathways so as to limit additional disturbance to ecosystems and plants;
- Wherever possible, vehicles entering site will be clean (e.g., no large, obvious clods of mud), so as to limit the spread of invasive plant propagules. This will be monitored as part of the walk around inspection done prior to site access.

7.1.1.2 Plant Selection

The following plant selection measures will reduce the possibility invasive plants are utilized in reclamation at Minto:

- Ensure plants for reclamation are not included in the list of Yukon invasive species.
- Ensure any straw used for erosion control or other projects around site is certified to be weed free or at a minimum is locally sourced.
- Use locally gathered seed whenever possible.

- Establish woody species early in reclamation. This will give woody species time to establish and grow above the height where they will be affected invasive plants (grasses and non-woody plants).
- Whenever possible, ensure seedlings brought to site were grown in sterile potting mixes (ex. potting soil and perlite) and not from regional sources.

7.1.1.3 Erosion Control

Exposed soil will be managed in such a manner so as to discourage the production of fugitive dust and colonization by invasive plant species. Techniques may include covers, dust suppressants, and temporary or permanent planting. Listed below are several erosion control techniques to discourage invasive plant colonization at Minto:

- Reduce the amount of seed that is sown on site. If seed is necessary it will be limited to weed free certified seed mix.
- Reduce the amount of areas that require fast growing grasses for erosion control by planning lower angle slopes.
- Plant local colonizing species on exposed slopes.

7.1.1.4 Soil Salvage

Properly segregated topsoil and woody overburden collected during any stripping activities will allow for a natural seed bank and reduce the need for imported seed mixes and fertilizers when reclamation is required. The following techniques will aid with soil salvage at Minto:

- Stripping activities should be monitored by an environmental employee to ensure that quality material is being stored separately.
- Suitable soils should be placed directly on reclamation slopes whenever possible to reduce re-handling and increase viability of natural seed reserves within the soil matrix.
- Salvaged soils storage should be planned with the Mine Technical department to ensure it is stored in such a manner that do not require temporary seeding vegetated in order to prevent erosion.

7.1.2 Invasive Plants Monitoring

Invasive plant monitoring at Minto includes detailed vegetation surveys in areas of reclamation and coarse vegetation surveys in areas where there are invasive species pathways.

Detailed vegetation surveys were established in September 2012 on the Main Waste Dump (MWD). The detailed vegetation surveys identify vegetative cover and species types (within the dry land seed mix) and should invasive species be detected, the following information will be included in the survey:

- Location;
- Species Name;
- Health and size of the plant;
- Photos (for verification of plant and location); and
- Percent coverage in the area.

Coarse vegetation surveys typically take place in areas where there are invasive species pathways such as roads with high visitor traffic, recently exposed areas and areas that have been recently reclaimed. The meander or roadside method may be utilized to inventory invasive plants in pathways with high visitor traffic. High priority species as determined by the Yukon Invasive Species Council (YISC) will be identified, and the distribution and location of the plant will be recorded. Incidental surveys may also take place as field staff are routinely collecting data for various programs within the EMSRP; should an invasive plant be located the field staff will record its distribution and location. Data from the coarse vegetation surveys is entered into an invasive plant tracking record.

High priority plant species in the Yukon, as defined by YISC, are summarized in Table 7-1. A full list of invasive species found in the Yukon by taxonomy is provided in Appendix 7.

Table 7-1: Common and Scientific Names of High Priority Yukon Invasive Plant Species, as defined by YISC

Common Name	Latin Name
Bird vetch	*Vicia cracca*
Common tansy	*Tanacetum vulgare*
Creeping thistle	*Cirsium arvense*
Hawkweeds	*Crepis tectorum*
Leafy spurge	*Euphorbia esula*
Oxeye daisy	*Leucanthemum vulgare*
Perennial sow-thistle	*Sonchus arvensis*
Scentless chamomile	*Tripleurospermum perforata*
Spotted knapweed	*Centaurea stoebe*

7.1.3 Invasive Plants Reporting

Should any high priority invasive plant species listed by the YISC be encountered, Minto will report the findings to YISC through the YISC Spotters Network Program.

7.2 Wildlife Monitoring Program

The *Minto Mine Wildlife Protection Plan* establishes guidelines for minimizing wildlife disturbance at the Minto Mine site and along the development corridor to the site. The *Wildlife Protection Plan* establishes the guidelines for the monitoring program in order to yield information about wildlife use in the area. Monitoring program results will be used in closure planning activities and will help refine closure objectives related to ensuring unobstructed passage through the area by wildlife.

The activities under the Wildlife Monitoring Program are summarized in Table 7-2, including the area monitored and the frequency of monitoring. Wildlife sightings around site are entered into a *Wildlife and Hazing Tracking Form* which is in a spreadsheet format (Table 7-4). Wildlife sightings from site personnel are collected either via a *Wildlife Sighting Log* form or through communication with the Environmental and Safety Departments. Any direct sighting by the Environmental Department are additionally entered into the *Wildlife and Hazing Tracking Form*.

An example *Wildlife Sighting Log* form is provided in Table 7-3. Wildlife Sighting Logs are posted at all main offices and around camp, and all staff are encouraged to record all wildlife observations. The logs are collected regularly and data entered into the Wildlife and Hazing Tracking Form spreadsheet, displayed in

Site personnel are encourage to immediately report all interactions with dangerous wildlife to the Environmental or Safety Department. Information gathered on dangerous wildlife includes hazing techniques applied, the animal response and previous hazing attempts (if known).

A review of the data is conducted annually in order to build a picture of wildlife use in the area, to inform wildlife protection activities and to evaluate any effects that the mining operation may be having on wildlife values identified in baseline studies. Further details of the wildlife protection measures are found in the *Minto Mine Wildlife Protection Plan*.

Table 7-2: Wildlife Monitoring Activities

Area Monitored	Monitoring Activities	Frequency
Wildlife Monitoring	• Wildlife monitoring consists of maintaining a wildlife observation log onsite and reporting wildlife encounters as per the Wildlife Act. • Environmental personnel on site will monitor project activities and modify operations to address wildlife concerns.	Ongoing
Migratory Birds	• Monitoring to determine if waterfowl and shorebirds settle on impacted water bodies, such as the Main or Area 2 Pits. • Environmental personnel on site will monitor project activities and modify operations to address wildlife concerns.	Seasonal during migratory periods
Species at Risk/of Concern	• Any caribou observations will be reported to the Conservation Officer in Carmacks.	As necessary

Area Monitored	Monitoring Activities	Frequency
	- Bank swallows have been observed to nest in residuum piles in the summer months, in which case these piles are cordoned off and left undisturbed until after the late summer migration, or resloped prior to nesting season to deter nesting.	

Table 7-3: Wildlife Sighting Log

Wildlife Sighting Log

We are obliged to monitor wildlife in the mine area under the conditions of our Quartz Mining Licence.
Please help the Environment Department do this by recording any wildlife you see on this form.

Date	Time	Species	Number	Location	**Notes:** *(e.g. condition, behaviour, adult/young, weather conditions)*	Name

Table 7-4: Wildlife and Hazing Tracking Form

Date	Time	Type of Animal	Number of Animals	Location	Description: Size/Color/Markings and Additional Notes	Reported By (Name)	Was the animal hazed?	What hazing technique was used?	What was the animal's response?	Who performed the hazing?	Has this animal been hazed in 2015?	Reportable Incident (Yes/No)	Notes
6-Jan-15	14:30	Fox	1	Dyno Rd	Orange/ black	Helaina	no	N/a	N/a	N/a	n/a	No	Running away with rabbits foot in mouth
18-Jan-15	14:00	Fox	1	KM 1.5	Not too scared hazed down road	Ron	no	N/a	N/a	N/a	n/a	No	Not too scared hazed down road
23-Jan-15	16:00	Moose	2	Vent raise road	One cow and one calf	Dave	No	N/a	N/a	N/a	N/a	No	
9-Mar-15	5:00	Moose	1	In camp	Looking at me	Don	No	N/a	N/a	N/a	n/a	No	Looking at me
28-Mar-15	19:30	Hare	1	Km 3.5 Access Road	Dead hare on Access Road. Observed by a runner on road. Reported to Conservation Officer.	Rob	No	N/a	N/a	N/a	N/a	Yes	
28-Mar-15	19:00	Rabbit/Hare	1	3.5 Km	Dead hare on Access Road. Observed by a runner on road. Reported to Conservation Officer.	Rob	No	N/a	N/a	N/a	n/a	No	

7.3 Erosion and Sedimentation Monitoring Program

The *Minto Mine Sediment and Erosion Control Plan* (SECP), a requirement of the QML, details erosion and sediment monitoring strategies, sources and best management practices for control. The Erosion and Sedimentation Monitoring Program is derived from the SECP and monitoring activities are summarized in Table 7-5.

Initial erosion can be visually inspected by searching for light surface material (litter or soil) movement, while sedimentation resulting from erosion can be found by searching for deposition of soil particles at the bottom of slopes and depressions. Riling, gullying, pedestalling, unusual compaction, hoof shearing and trailing are also indicators of erosion problems.

Ditches will be examined during heavy runoff events and the outlets of culverts and pipes visually inspected regularly to ensure that roads and other permanent structures are not being compromised and sediment loads are not becoming excessive. Movement of the lighter and finer top soils before vegetation has taken root on reclamation plots will be monitored closely and mitigation efforts employed to prevent compromising the seed and soil. Further details of the erosion and sedimentation control methods and areas of concern at the Minto Mine are provided in the SECP.

Table 7-5: Erosion and Sediment Monitoring Schedule

Activity	Location	Frequency
Visual inspections	Bottoms of slopes and depressions of large structures.	As needed following heavy rain events, and during freshet.
	Road routes: ditches and outlets of culverts and pipes.	As needed following heavy rain events, and during freshet.
Water quality monitoring for total suspended solids (TSS) [1.]	Water quality monitoring stations W2, W50 and W17	Weekly and during heavy runoff periods.
Physical inspection of surface facilities by a Yukon registered Engineer [2]	Water Storage Pond Dam, Mill Water Pond, all waste rock and overburden dumps, all water diversion and conveyance structures and the dry stack tailings storage facility.	After the spring thaw period in May/June of each year.

1. Water quality monitoring locations and frequency described in detail in section 2.1. 2. Physical Monitoring Program details are described in section 5. 2

7.4 Vegetation Metal Uptake Program

The main objective of the Vegetation Metal Uptake Program is to monitor and measure metal uptake in vegetation on the mine site and surrounding areas. The *Vegetation Metal Uptake Monitoring Plan* (Appendix 8, (Minto, 2015)) describes the program in detail and employs the following components for program implementation:

- Utilizes previously established or documented conditions, monitoring results or predictive efforts, where appropriate and possible;
- Establishes a network of plots for monitoring both soil and vegetation metal concentrations; and
- Allows for an ongoing evaluation of the extent and degree that metals from mining activity is affecting vegetation in the proximity of the project site.

The Vegetation Monitoring Uptake program consists of a monitoring network of site (exposure) or control stations (Figure 7-1). Progression of the mine plan and analysis of the monitoring results may result in the creation of additional monitoring locations. For example, progressive reclamation of waste dumps may allow for areas that have been revegetated to be included into the monitoring network. Site sampling stations are located in areas anticipated to accumulate the most dust based on meteorological data collected at site. Plant species selection is subject to change based on discussions with SFN which also drive the sample stations.

The following procedures are performed at each monitoring network site:

- Selection of an appropriate microsite in the vicinity of the station identified on the map;
- Generation of a station ID and documentation of relevant ecological attributes of the station area;
- Soil sampling; and
- Vegetation sampling.

Soil and vegetation samples will be sent to an accredited laboratory for the following analysis: metals, pH, texture and cation exchange capacity. The initial study will take place in July or August any given year before seasonal desiccation of vegetative material occurs. Continued monitoring should occur every three years after initial study, to determine any changes in dust dispersal and vegetation metal uptake.

Figure 7-1: Vegetation Metal Uptake Program Monitoring Stations

8 Progressive Reclamation Effectiveness Monitoring Program

The Progressive Reclamation Effectiveness Monitoring Program is a requirement of the EMSRP, and is required to monitor the effectiveness of progressive reclamation and post closure reclamation at the Minto Mine. Progressive reclamation activities at Minto are detailed in the *Minto Mine Reclamation and Closure Plan* (RCP). The Progressive Reclamation Effectiveness Monitoring Program is used to support the progressive reclamation activities that occur during mine operation; while post-closure monitoring is described in the RCP. The objective of the Progressive Reclamation Effectiveness Monitoring Program is to identify and evaluate reclamation and remediation technologies that are considered both promising and feasible for incorporation into the evolving mine RCP.

Reclamation research at the Minto Mine has focused primarily on key closure methods proposed for the site including soil covers, vegetation, and semi-passive treatment. Monitoring areas included the Main Waste Dump (MWD) vegetation study plots in 2013-2014. Test pitting and soil modeling for cover material characterization was also completed in 2013-2014. The first four phases (i.e. information gathering, conceptual design, pilot scale, and demonstration scale) of developing a constructed wetland treatment system have also been implemented with the first three phases being completed in 2013-2014.

The processes for identifying optimal reclamation design is based on the BMPs discussed in guidance documents such as the *Mining Waste Treatment Technology Selection Website* (Interstate Technology Regulatory Council, 2010) and the *Yukon Revegetation Manual: Practical Approaches and Methods* (Mathues & Omtzigt, 2013). Further information on reclamation research can be found in the *Minto Mine Reclamation and Closure Plan.*

9 Quality Assurance and Quality Control Programs

A primary objective of quality assurance and quality control (QA/QC) programs is to ensure that data collected, analyzed and evaluated through environmental monitoring programs at Minto is representative and of high quality and to provide confidence in the data collected for all environmental monitoring and sampling programs. QA/QC procedures at Minto have been designed after generally recognized QA/QC protocols. This section summarizes the use of duplicate, field and trip blanks, on-site laboratory and field equipment calibration, external and on-site laboratory QA/QC, on-site laboratory verification, and a description of QA/QC protocols for other site monitoring activities including meteorology, hydrology, and hydrogeology with respect to the Minto Mine. Results and interpretations of the QA/QC programs are detailed in the WUL Annual Report.

9.1 Quality Assurance

Quality assurance protocols help ensure that the programs as described in the EMSRP are quantifiable and able to produce quality data. Minto is continuously involved in consultation with professionals and technical experts regarding program design, standard operating procedures, and data review. Ongoing staff training and job observations of staff (new hires and experienced employees) performing monitoring activities ensure that data collection and results are consistent, representative and of high quality.

The steady improvement of quality assurance protocols involves developing more detailed and program specific verification processes and automated checks, as well as peer reviews and audits by external professionals on a regular basis. Effective quality assurance will identify potential problem areas and necessary corrections to procedures and data management, and facilitates evaluation and improvement of the monitoring program.

Examination and evaluation of field data and data entry is an integral part of quality assurance. While it is not possible to check all aspects of input data, calculations, and interpretations, checks can be performed on selected sets of data at appropriate intervals. A review of work procedures and data collection methods will identify potential sources of error.

Reported data is reviewed and evaluated by Minto staff on a monthly and annual basis. For example, the data associated with the Water Monitoring Program (Section 2) is reviewed by cross checking the Minto Water Quality Database with the sample tracking and log spreadsheet. The database is frequently audited by Minto personnel and a professional consultant on an annual basis. If inconsistences are found, further investigation is performed using field notes, Chain of Custody, and lab result files depending on the nature of the error.

9.2 Quality Control

Quality control protocols are the set of routine procedures and methods designed to achieve and maintain a recognized level of quality. Some of the most common quality-related problems introduced in surface water quality sampling include the mislabeling or switching of bottles, failure to add proper preservatives, improper storage conditions, and sample contamination from sampling equipment or other sources. Quality control samples are collected and analyzed to verify the integrity of water samples and detect errors introduced during sampling. Quality control samples represent 10% of the total number of samples collected and consist of a random combination of the types provided in Table 9-1. Field staff are responsible for documenting when and where quality control samples are prepared on the field forms and in the Minto Water Quality Database.

Table 9-1: Quality Control Sample Descriptions

Type	Description and Sample Purpose
Trip Blank (TB)	A sealed container of deionized water sent from the laboratory used to detect any widespread contamination during transport and storage. The trip blank is transported with the sample bottles for the entire duration of the sampling event. Trip blanks indicate contamination within the bottle or from volatile compounds.
Field Blank (FB)	A sample of deionized water that is prepared in the field using the same procedures as for collecting the field sample. Preservative, if required, is added after the sample is collected. Field blanks measure contamination from bottles, collection methods, the sampling environment, and preservatives.
Duplicate (DUP)	Duplicate samples are independent samples collected from the same place and time to determine the precision of environment and laboratory heterogeneity. Duplicate samples measure the reproducibility of the sampling and analysis.
Field Spilt (FS)	Aliquots taken from the same sample container and assumed to be identical. Split samples can be sent to separate laboratories for analysis and the results can be used to determine inter-lab variability. Care must be taken to ensure that the samples are split homogeneously.

9.3 Environmental Monitoring Programs QA/QC

Hydrology, meteorology and hydrogeology program QA/QC is discussed in Sections 9.3.1 to 9.3.3.

9.3.1 Hydrology QA/QC

The primary objective of hydrology data collection under the WUL is to monitor the quantity of water moving around Minto Mine as well as the quantity moving down the Minto Creek watershed. Minto Mine currently uses a variety of techniques and instrumentation for the collection of hydrology data, including; continuous measurements using Solinst level loggers, continuous measurements using inline flow meters, measurements using a calibrated flume as well as volumetric measurements and manual measurements using a Hach FH950 Electromagnetic Velocity Meter.

For current meter measurements, errors in the measurement of width, depth, and velocity as well as the lack of care in choosing the number of vertical measurements and observations in a vertical measurement, all combine to reduce the overall accuracy of water quantity data. To a large extent, human errors can be avoided by careful attention to detail and by adhering to established and proven techniques and routines. Systematic errors can be reduced significantly by proper maintenance and calibration of instruments and equipment, and by adequate training. However, random errors will always occur. A significant reduction in these errors can be achieved if field staff performing the measurement can recognize the potential problem areas and can take the appropriate precautionary measures to avoid or minimize them. SOPs used as field guides have been prepared to minimize human error, and manual measurements are generally conducted at the same location to minimize variability. Typically, field staff perform quality control on 10% of the manual measurements by performing duplicate flow measurements during the same monitoring event.

Standardized management of data collected in the field is important in hydrological monitoring programs. Standard protocols and systems are in place to ensure ease of data processing and less likely prone to error. Processing of data can involve returning to the original field notes to cross check suspicious values or to analyze site conditions that might have been responsible for anomalies in the logger records. Therefore, supportive values and observations are well documented by field staff.

All water quantity data including field notes, photographs and datalogger download files are carefully handled, organized and stored to ensure the information can be located for future use.

9.3.2 Meteorology Monitoring Program QA/QC

Monitoring of meteorological parameters is done with a research-grade weather station, containing Campbell Scientific meteorology instrumentation, a data logger and a 10-m tower. The Campbell Scientific station is located approximately 100m northeast of the airstrip and has been operating since 2010. Data from the station has been collected regularly and is used for prediction and operational planning purposes.

QA/QC of data by Minto staff includes validation of equipment by comparing trends in the data sets for the meteorological station. Furthermore, a monthly review of the data takes place as a result of monthly reporting activities. Along with the QA/QC performed by Minto staff, the compiled data is frequently sent to external consultants for further QA/QC to ensure the data is representative of the meteorological condition that occur at Minto Mine.

9.3.3 Hydrogeology Monitoring Program QA/QC

QA/QC for groundwater well monitoring includes either field duplicate, trip blank or field blank samples that are collected at a frequency of one QA/QC sample per ten groundwater monitoring samples (10%).

9.4 External Laboratory QA/QC

Every sample report received from an external lab is accompanied by a Quality Assurance Report, which includes a calculated percent recovery for all applicable parameters, as well as QC limits. The QC tests include: matrix spike (within 80-120% recovery), spiked blank (80-120% recovery), method blank value, and Relative Percent Difference for duplicates (less than 20%). Each report also details any deviations from procedure, including exceeding standard holding time. A QC batch number is assigned to each sample for traceability.

The external laboratory utilized for water monitoring programs such as the Surface Water Surveillance Program is accredited under the International Organization for Standardization ISO/IC 17025:2005 standard. This accreditation includes both the laboratory and the tests that are performed at the laboratory.

9.5 On-site Laboratory QA/QC

In the on-site laboratory, metals are analyzed using an atomic absorption spectrometer; specifically a Varian 240 G is used. Copper, aluminum and cadmium are analyzed using a graphite tube atomizer. Selenium is analyzed using a Hydride vapour gas accessory.

Ammonia, nitrite and nitrates are analyzed using a Hach DR2800 spectrophotometer. Total solids are determined gravimetrically.

The parameter specific methods used to establish the above criteria are as follows:

- **Ammonia -** Hach Method 8155 Nitrogen Ammonia Salicylate Method
- **Nitrites -** Hach Method 8507 USEPA Diazotization Method.
- **Nitrates -** Hach Method 8039 Nitrogen Nitrates, Cadmium Reduction Method
- **TSS -** Method Derived from Standard Methods for Water and Wastewater Treatment
- **Copper -** Graphite Furnace Atomic Absorption Spectrometer: Operation and Maintenance
- **Aluminum -** Graphite Furnace Atomic Absorption Spectrometer: Operation and Maintenance
- **Cadmium -** Graphite Furnace Atomic Absorption Spectrometer: Operation and Maintenance

- **Selenium -** VGA-77 gas generator for Hydride Generation using Varian Atomic Absorption Spectrophotometers

The on-site lab calibrations are performed using the manufacturers' specifications. Laboratory atomic absorption spectrometry and spectrophotometer equipment require calibration, which is conducted by on-site lab personnel that are trained in the use of the equipment.

The on-site lab commenced testing samples in March 2012, and began establishing Standard Operating Procedures (SOPs) and a QA/QC program. The SOPs that form the basis of the on-site lab QA/QC program are:

- *Lab QA/QC Guidelines SOP;*
- *AAS-GF Set-up and Operation SOP;*
- *Replacing and/or Aligning a Hallow Cathode or D2 Lamp SOP;*
- *Replacing a Graphite Tube and Aligning the graphite furnace SOP;*
- *Alignment of the PSD -120 SOP, Dilutions and Standards SOP;*
- *Preparation of Dissolved and Total Metals (Cu, Al, Cd) SOP; and*
- *Preparation of Dissolved and Total Selenium SOP, and Total Suspended Solids SOP.*

All of the aforementioned SOPs are stored in the on-site lab for immediate reference. The SOPs are updated as required to maintain consistency with manufacturers' specifications.

9.5.1 On-site Lab Verification

The intent of on-site lab verification is to demonstrate the ability of the Minto Mine on-site water quality laboratory to produce results from water analysis that are reasonably comparable to those results obtained at an accredited external lab, and verify that on-site results are reliably reported at or below WUL effluent quality standards for most metals. The verification of the on-site laboratory was initiated in March 2012 to demonstrate compatibility between the results obtained at the Minto on-site laboratory and accredited external labs. Two external, CALA or ISO/IEC 17025 certified laboratories were used: Maxxam Analytics and ALS Environmental. It is to be noted there is, as expected, variation in the results due to method and instrumentation differences. The detection limits reported by the external labs using Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) can be as much as an order of magnitude lower than an Atomic Absorption Spectroscopy-Graphite Furnace (AAS-GF).

Table 9-2 demonstrates the ability of Minto on-site laboratory to reasonably correlate with an external accredited lab (Maxxam Analytics) for metal analysis with the exception of cadmium. It is important to note that the poor correlation with cadmium is due to the difference in instrumentation (AAS-GF and ICP-MS). Unfortunately this correlation cannot be resolved to a greater degree, as the majority of the variance comes from the superior capability of an ICP-MS to discern trace amounts of cadmium.

Table 9-2: Coefficient of Correlation between Minto Mine On-site Laboratory and Maxxam for Total and Dissolved Metals

Metal	Coefficient of Correlation
Cu Dissolved	0.8
Cu Total	0.9
Al Dissolved	0.8
Al Total	0.6
Cd Dissolved	0.04
Cd total	0.2
Se dissolved	0.9
Se total	0.9

Nutrient and Total Suspended Solids (TSS) coefficients of correlation between on-site and external laboratories are provided in Table 9-3. Nitrate and TSS correlations are reasonable, indicating that the labs resolve these in a similar fashion. For Nitrite, the on-site laboratory and ALS have good correlation, while the correlation with Maxxam is poor, most likely because of a difference in the detection limits between the labs. Ammonia has poor correlation across all labs, this correlation may be due to differences in testing time and detection limits.

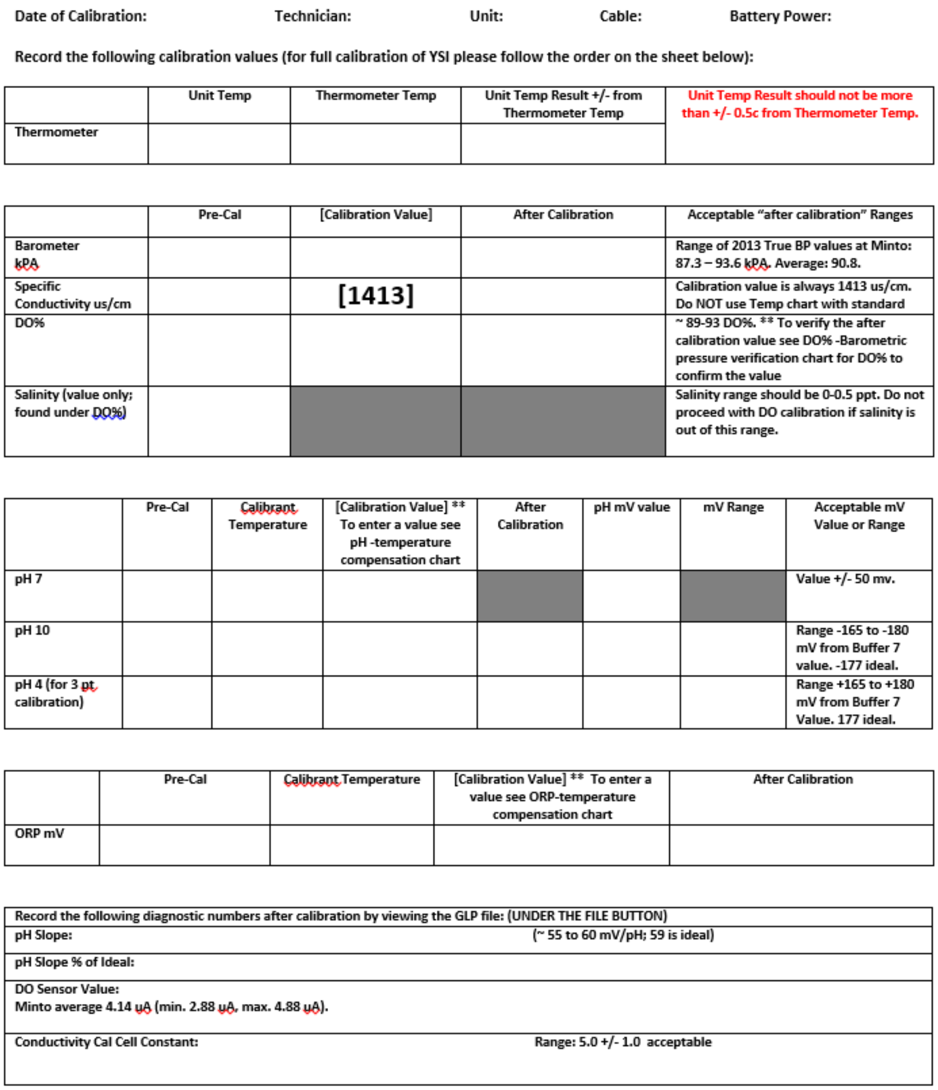
Table 9-3: Correlation between Minto Mine On-site Laboratory, Maxxam and ALS for Nutrients and TSS

Lab Comparisons	Ammonia	Nitrate	Nitrite	TSS
Maxxam vs. On-site	0.32	0.81	0.37	0.92
Maxxam vs. ALS	0.22	1.00	0.89	0.99
On-site vs. ALS	0.15	0.75	0.99	0.98

Ongoing verification of the external and on-site laboratory results occurs on a monthly basis with monthly comparison of results detailed in the monthly WUL reports.

9.6 Field Instrumentation QA/QC

Field instrumentation are maintained according to manufacturers' specifications. Equipment that exhibits performance problems are not utilized to collect data; rather, the equipment is repaired according to the manufacturer's specifications. Certain field equipment, such as the YSI in-situ multi parameter meter and a Eutech (Oakton) PCTestr 35 handheld meter require calibration; calibration is conducted by field staff according to manufacturers' specifications and Minto SOPs. An example calibration log is presented in Figure 9-1.



Date of Calibration: **Technician:** **Unit:** **Cable:** **Battery Power:**

Record the following calibration values (for full calibration of YSI please follow the order on the sheet below):

	Unit Temp	Thermometer Temp	Unit Temp Result +/- from Thermometer Temp	Unit Temp Result should not be more than +/- 0.5c from Thermometer Temp.
Thermometer				

	Pre-Cal	[Calibration Value]	After Calibration	Acceptable "after calibration" Ranges
Barometer kPA				Range of 2013 True BP values at Minto: 87.3 – 93.6 kPA. Average: 90.8.
Specific Conductivity us/cm		[1413]		Calibration value is always 1413 us/cm. Do NOT use Temp chart with standard
DO%				~ 89-93 DO%. ** To verify the after calibration value see DO% -Barometric pressure verification chart for DO% to confirm the value
Salinity (value only; found under DO%)				Salinity range should be 0-0.5 ppt. Do not proceed with DO calibration if salinity is out of this range.

	Pre-Cal	Calibrant Temperature	[Calibration Value] ** To enter a value see pH -temperature compensation chart	After Calibration	pH mV value	mV Range	Acceptable mV Value or Range
pH 7							Value +/- 50 mv.
pH 10							Range -165 to -180 mV from Buffer 7 value. -177 ideal.
pH 4 (for 3 pt calibration)							Range +165 to +180 mV from Buffer 7 Value. 177 ideal.

	Pre-Cal	Calibrant Temperature	[Calibration Value] ** To enter a value see ORP-temperature compensation chart	After Calibration
ORP mV				

Record the following diagnostic numbers after calibration by viewing the GLP file: (UNDER THE FILE BUTTON)

pH Slope: **(~ 55 to 60 mV/pH; 59 is ideal)**

pH Slope % of Ideal:

DO Sensor Value:
Minto average 4.14 uA (min. 2.88 uA, max. 4.88 uA).

Conductivity Cal Cell Constant: **Range: 5.0 +/- 1.0 acceptable**

Figure 9-1: In-situ Field Parameters Calibration Log

10 Data Evaluation and Reporting

EMSRP data evaluation and reporting will be conducted in accordance with the WUL and QML.

The QML requires that the Licensee provide, as part of the annual report, "*a summary of the programs undertaken for environmental monitoring and surveillance as outlined in the Environmental Monitoring, Surveillance and Reporting Plan and the Wildlife Protection Plan, including an analysis of these data and any action taken or adaptive management strategies implemented to monitor or address any changes in environmental performance*".

Additionally, the WUL requires that the Licensee "shall *collect and submit each month's requires EMSRP data…to the board as part of the Monthly Report*" and "*as part of the annual Report*".

All data collected in the previous year is submitted to the Yukon Government, Energy, Mines and Resources Branch and to the Yukon Water Board as a single report by March 31st of the following year.

EMSRP reporting requirements are summarized in Table 10-1.

Table 10-1: EMSRP Monitoring Program Reporting Requirements

Monitoring Program	Reporting Requirements		
	External Reporting Requirements		
	Monthly Report	Annual Report	Other
Water Monitoring Program			
Surface Water Surveillance Program	Monthly Report	Annual Report	
Groundwater Monitoring Program		Annual Report	
Seepage Monitoring Program		Annual Report	
Geochemical Monitoring Program			
Acid Base Accounting (ABA) Monitoring Program	Monthly Report	Annual Report	
Waste Rock Management Verification Program		Annual Report	
Meteorological Monitoring Program			
Climate Monitoring Program	Monthly Report	Annual Report	
Snow Survey Program		Annual Report	

Monitoring Program	Reporting Requirements		
	External Reporting Requirements		
	Monthly Report	Annual Report	Other
Physical Monitoring Program	Monthly Report	Annual Report	Semi-Annual Site-wide Geotechnical Inspection Report (Spring and Fall)
Aquatic Environmental Monitoring Program			
Metal Mine Effluent Regulations Monitoring Programs		Annual Report	MMER
Sediment Quality and Toxicity Monitoring		Annual Report	
Periphyton and Benthic Invertebrate Tissue Monitoring		Annual Report	MMER
Fish Monitoring Program		Annual Report	MMER
Terrestrial Environment Monitoring Program			
Invasive Plant Species Monitoring Program		Annual Report	YISC
Wildlife Monitoring Program		Annual Report	Environment Yukon
Erosion and Sedimentation Monitoring Program		Annual Report	
Vegetation Metal Uptake Program		Annual Report	
Progressive Reclamation Effectiveness Monitoring Program		Annual Report	
Quality Assurance and Quality Control Programs		Annual Report	

11 References

Access and Minnow. (2014). *Aquatic Resources Baseline Report – YESAB Project Proposal Phase V/VI. .* Prepared for Minto Explorations Ltd. July 2014.

ASTM. (2013). *Standard Guide for Sampling Ground-Water Monitoring Wells.* ASTM International.

BC MOE. (1985). *Water Quality Criteria for Nutrients and Algae: Technical Appendix. .* Prepared by Richard Nordin, Water Quality Unit, Resource Quality Section, Water Management Branch. October 1985.

CCME. (2011). *Protocols Manual for Water Quality Sampling in Canada.* Canadian Council of Ministers of the Environment. Ottawa: Canadian Council of Ministers of the Environment.

CCME. (2014, January 15). *Sediment Quality Guidelines for the Protection of Aquatic Life.* Retrieved February 12, 2014, from Canadian Environmental Quality Guidelines Summary Table: http://st-ts.ccme.ca

Clark, M. (2003). *British Columbia Field Sampling Manual.* Water, Air and Climate Change Branch Ministry of Water, Land and Air Protection. Victoria: Province of British Columbia.

Duncan, D., & Bruynesteyn, A. (1979). Determination of acid production potential of waste materials. (p. 10). Metallurgical Society of AIME paper A-79-29.

Environment Canada . (2011). *Metal Mining EEM Guidance Document. Chapter 4 - Effects on Fish Habitat: Benthic Invertebrate Community Structure Survey.* Ottawa.

Environment Canada. (1997). *Biological Test Method: Test for Survival and Growth in Sediment Using the Larvae of Freshwater Midges (Chironomus tentans or Chironomus riparius). Environment Canada Environmental Technology Centre, Ottawa, Ontario.* Environmental Protection Series. : Report EPS 1/RM/28. July 1998.

Environment Canada. (2001). *Guidance Document for Flow Measurement of Metal Mining Effluent.* Ottawa: Minister of Public Works and Government Services Canada.

Environment Canada. (2001). *Guidance Document for the Sampling and Analysis of Metal Mining Effluents.* Ottawa: Minister of Public Works and Government Services Canada.

Environment Canada. (2007). *Biological Test Method: Growth Inhibition Test Using a Freshwater Alga. Environment Canada Environmental Technology Centre, Ottawa, Ontario. .* Environmental Protection Series. Report EPS 1/RM/25. Second Edition. March 2007.

Environment Canada. (2007). *Biological Test Method: Test for Measuring the Inhibition of Growth Using the Freshwater Macrophyte Lemna minor. Environment Canada Environmental Technology Centre, Ottawa, Ontario. .* Environmental Protection Series. Report 1/RM/37. Second Edition. January.

Environment Canada. (2007). *Biological Test Method: Test of Reproduction and Survival Using the Cladoceran Ceriodaphnia dubia. .* Environment Canada Environmental Technology Centre, Ottawa, Ontario. Environmental Protection Series. Report EPS 1/RM/21. Second Edition. February 2007.

Environment Canada. (2011). *Biological Test Method: Test of Larval Growth and Survival using Fathead Minnows. Environment Canada Science and Technology Branch, Ottawa, Ontario. .* Environmental Protection Series. Report EPS 1/RM/22. February 2011.

Environment Canada. (2011). *Field Manual: Wadeable Streams.* Canadian Aquatic Biomonitoring Network, Science and Technology Branch. Dartmouth: Environment Canada.

Environment Canada. (2012). *Metal Mining Effects Monitoring (EEM) Technical Guidance Document.* Government of Canada.

Environment Canada. (n.d.). *Biological Test Method: Test for Survival and Growth in Sediment and Water Using the Freshwater Amphipod Hyalella azteca. .* Environment Canada Science and Technology Branch, Ottawa, Ontario. Environmental Protection Series. Report EPS 1/RM/33. .

Environment Canada. (n.d.). *Toxicity Tests Using Early Life Stages of Salmonid Fish (Rainbow Trout). Environment Canada Environmental Technology Centre, Ottawa, Ontario. .* Report EPS 1/RM/28. July 1998.: Environmental Protection Series.

Government of Canada. (2015). *Metal Mining Effluent Regulations, Consolidation. SOR/2002-222.* Current to November 16th, 2015.

Interstate Technology Regulatory Council. (2010, August). *Mining Waste Treatment Technology Selection*. Retrieved February 11, 2014, from http://www.itrcweb.org/miningwaste-guidance/

Mathues, P., & Omtzigt, T. (2013). *Yukon Revegetation Manual: Practical Approaches and Methods.* Retrieved January 22, 2014, from http://www.yukoncollege.yk.ca/downloads/YEPbk_reveg_CH1.pdf

MEND. (1991). *Mine Environment Neutral Drainage Program: Acid Rock Drainage Prediction Manual, MEND Project 1.16.1 (b). Prepared by Coastech Research Inc., North Vancouver, B.C. March 1991.*

Metal Mine Effluent Regulations, SOR/2002-222 (06 06, 2002).

Mills, C. (1997). *An Assessment of the Results of Acid Base Accounting (ABA) and Mineralogical Test Work on Eight Samples from the Proposed Minto Project, Yukon Territory.* Consulting Environmental & Mineral Process Engineer for the Selkirk First Nation, Pelly Crossing, Yukon Territory, Vancouver.

Ministry of Environment. (1981). *Snow Survey Sampling Guide.* Province of British Columbia, Water Management Branch Surface Water Section, Victoria.

Ministry of Environment. (2009). *Manual of British Columbia Hydrometric Standards.* Science and Information Branch. Victoria: Resources Information Standards Committee.

Minto. (2014). *Minto Mine Phase V/VI Expansion, Waste Rock and Overburden Management Plan.*

Minto. (2015). *Vegetation Metal Uptake Monitoring Plan.* Prepared by Access Consulting for Minto Explorations Ltd.

Yukon Government. (2002). *Contaminated Sites Regulations O.I.C. 2002/171.*

Yukon Government. (2013, August). *Plan Requirement Guidance for Quartz Mining Projects.* Retrieved from http://www.yukonwaterboard.ca/forms/quartz/Plan%20Requirement%20Guideline%20for%20Quartz%20Mining%20Projects%20-%20August%202013-kh.pdf

MINTO MINE
SURFACE WATER QUALITY MONITORING
STANDARD OPERATING PROCEDURES

Prepared by: Minto

Explorations Ltd

October 2012

Last Revised, July 6th, 2015

TABLE OF CONTENTS

TABLE OF APPENDICES

1. Purpose

The standard operating procedures (SOP) in this document serve as a guideline for the collection of surface water quality samples from water bodies at Minto Mine (Minto) specified by Water Use Licence QZ96-006. The Minto Mine Water Quality Monitoring SOP follows methods and procedures described in *Protocols Manual for Water Quality Sampling in Canada* (CCME, 2011), *Guidance Document for the Sampling and Analysis of Metal Mining Effluents* (Environment Canada, 2001) and *Ambient Freshwater and Effluent Sampling Manual* (RISC, 2003). This document is intended for Minto Mine employees familiar with the location of water quality sites at Minto, and who are knowledgeable in surface water sampling methods. Along with on the job training, the purpose of this document is to ensure the Minto Mine Water Quality Monitoring Program is carried out consistently and that all surface water samples are representative of the environmental conditions at the time of sampling.

2. Responsibilities

The reliability and quality of data generated by the Water Quality Monitoring Program is dependent on the staff involved and attention given to the sampling procedures, quality control protocols, and field equipment. It is crucial that water quality samples be collected in a consistent manner with the appropriate equipment to generate the most accurate field measurements and analytical results. Erroneous results which do not represent the water body being sampled can lead to inaccurate conclusions about water quality and have the potential to influence management actions.

The following sections outline the typical allocation of responsibilities associated with the Water Quality Monitoring Program at Minto.

Field Staff

Field staff must have the appropriate knowledge to collect representative samples and protect samples from contamination and deterioration. A sampler is responsible for minimizing field error and collecting the best sample possible. This includes consistency in sampling procedure, correct use of sampling equipment, accurate labelling, and completion of detailed field notes.

Field staff are responsible for coordinating all sampling events in accordance with the requirements of the current WUL, including sampling locations, sampling frequency, and parameter requirements. Staff performing sampling and monitoring duties shall ensure that all site and sample specific details are clearly documented, and that all quality assurance and quality control (QA/QC) protocols are being followed.

Field staff must be experienced in the operation and safety requirements for all field instruments, sampling gear, equipment and reagents used for sampling. They are responsible for maintaining equipment and maintaining stock and inventory of sampling supplies.

Field staff are also responsible for submitting all samples to the appropriate laboratory for analysis in a timely manner, and performing data entry related to the Water Quality Monitoring Program.

Supervisors

Supervisors are responsible for ensuring field staff understand the requirements of the WUL and that all WUL requirements and internal QA/QC protocols are being met and documented. Supervisors are responsible for ensuring sample and data collection and management procedures are being carried out consistently and identifying variance from standard procedures. This includes ensuring digital copies of all field data and laboratory results are saved with the correct file names to the appropriate location on the server.

The first step in ensuring proper sampling techniques is to provide staff with training for the sampling conditions they encounter. Supervisors are responsible for providing appropriate levels of training to all field staff and ensuring that all samplers are proficient to carry out their responsibilities or are adequately supervised.

It is the responsibility of supervisors to compare water quality data to the applicable standards and to previously collected data to review trends, outliers, etc.

Supervisors must also periodically review sampling procedures and the content of this SOP to ensure the best methods are being used and that adequate QA/QC is being incorporated into the program.

3. Safety

Safety is the most important component of any field program. All staff must be aware of all potential safety hazards and personal protective equipment (PPE) requirements for any task they are completing. At no time should field staff feel unsafe and all questions or concerns about safety must be brought to the attention of a supervisor.

It is crucial that monitoring activities are completed in a safe manner. This includes having first aid equipment, communication equipment, and wearing proper footwear and gloves for the job. Field staff and supervisors should review all appropriate Job Hazard Analyses and Safe Work Procedures to ensure that the safety related elements of all tasks related to sampling are understood.

Water quality sampling and related tasks are to be carried out by at least two people at the following sites:
W1, W2, W4, W5, MC1, W6, W7, W10, W32, W33, W37, W38, W39, W40, W41, W46, W50, LDP, C4, C10 and the five Minto North sites.

Water quality sampling and related tasks can be carried out by an employee working alone at the following sites:
W3, W8, W8A, W12, W13, W13A, W14, W15, W16, W16A, W17, W30, W35, W42, W43, WTP, WC.

Seasonal conditions, bear activity and other factors may cause single-person sites to be temporarily re-classified as two-person sites, and vice versa, but employees may not deviate from the classifications listed above without the authorization of their supervisor.

4. General Guidelines for Surface Water Quality Monitoring

Water samples, field measurements, and observation of site conditions are collected from the same area for every sampling event whenever possible to achieve representative results over time.

Standard field forms are used to document all the required details for each sampling event, including thorough descriptions of unusual conditions and variations to the sample site or procedure. This data is stored in the Minto Water Quality Database.

The following procedures, practices, and considerations will be followed by all staff involved in the Water Quality Monitoring Program:

- All field staff will have the appropriate training and experience with field equipment, sampling procedures and objectives prior to performing monitoring duties or be accompanied by experienced staff.
- Organize a sufficient supply of bottles, labels, preservatives and filters to complete the sampling ahead of time. Sufficient quantities of these items should be stocked at the mine at all times.
- Sample containers are supplied by the analytical laboratory pre-cleaned and capped. Hands should be clean prior to sampling and clean gloves worn. Metal jewellery should not be worn on hands or wrists and smoking is not permitted while sampling.
- Do not use a preservative after the expiry date and always store preservatives where they will not freeze or overheat. Return expired preservatives to the laboratory for proper disposal.
- Do not take a sample or wade into a stream if conditions are unsafe. Ensure safe footing and solid points if contact when sampling from shore.
- Rinsing of bottles should be done slightly downstream from the actual sample location to prevent contaminants from entering the sample bottle.
- Sampling ponded water should be avoided as it will not provide accurate representation of water quality. Avoid collecting sediment and surface films if present.
- When wading to sample, always collect the sample while facing upstream to ensure that contaminants that may be on the sampler do not flow into the container. Care must be taken to avoid stirring up any sediment.
- During sample collection, the inner portion of sample bottles and caps must not be touched with anything other than sample water.
- Filter and/or add preservatives immediately or as soon as possible after sample collection.

- Gloves, syringes and filters will be kept in clean, sealed plastic bags.

- If a particular parameter cannot be completed for the site (e.g. the pH probe is not working) a note must be made on the field data form explaining why it could not be taken.

- As much as possible at a mine site, sample containers should be kept in a clean environment. Bottles must be capped at all times. Vehicle cleanliness is an important factor in minimizing the risk of contamination.

- All samples should be kept upright, and as close as possible to 4°C at all times until they are delivered to the laboratory. They must not be allowed to freeze unless freezing is part of the preservation protocol.

- Ship samples to the external laboratory as soon as reasonably possible. Samples should be analyzed within the time limits specified by the analytical laboratory.

5. Surface Water Sampling Procedures

Preparation

Prior to departure for sampling, staff will ensure that all field equipment is checked for functionality and cleanliness and that sample bottles are clean and unopened. All equipment, calibration standards, preservatives, sampling gear and sample bottles will be organized and stored in a clean environment and transported in clean, dry containers. Field instruments should be tested to ensure batteries are charged and all parts are accounted for.

Sample bottles, preservatives, syringes, filters and coolers are currently supplied by Maxxam Analytics. Current contact information and shipping label for Maxxam Analytics is provided in Appendix 1.

Preparation for water quality sampling must also include provision for quality control samples. The number of quality control samples taken must correspond to a minimum of 10% of the total number of samples taken for all sampling events.

The following is a list of equipment and sampling supplies regularly used to complete surface water quality monitoring:

- Sample bottles and labels
- Field notebook and/or field forms
- Water quality meter
- Nitrile gloves
- Syringes and filters
- Sample preservatives
- Cooler and sufficient ice packs

- Deionized water
- Cooler labels and laboratory Chain Of Custody (COC)
- Chisel, axe and/or ice auger (when sampling under ice)
- Spare parts and batteries

General field gear typically includes:

- PPE
- Radio
- Rubber boots or waders
- Camera
- Pencils, pens, permanent marker
- Sample site map, GPS
- Flagging tape
- Multi tool
- First aid kit
- Appropriate clothing
- Water and food

Maintenance of Field Instruments

All instruments used for performing field measurements are stored and calibrated in accordance with manufacturer's specifications. Proper maintenance of field instruments is very important as instruments must be in good working condition in order to produce accurate readings. Field staff are trained how to calibrate and use all water quality field instruments prior to going in the field.

Minto primarily uses an YSI Professional Plus handheld multi-parameter meter (YSI) for monitoring water quality field parameters. Performance of the meter is tracked and verified through daily checks and regular calibrations. Calibration checks are recorded to identify problems and to review in the event of equipment malfunction.

Alternatively, a Eutech (Oakton) PCTestr 35 handheld meter is used for monitoring sites W13 and W14. The meter measures temperature, pH, and conductivity only and is checked prior to use and calibrated according to the manufacturer's specifications.

Routine maintenance on all field instruments is performed according to the manufacturer with a record of all repairs and maintenance stored on site.

Field Measurement of Water Quality Parameters

Water quality field parameters are recorded with every water sample including water temperature, pH, conductivity, dissolved oxygen (DO), and oxidation reduction potential (ORP). Water quality meters are used according to the instructions provided by the manufacturer for greatest efficiency. The following procedures and considerations are followed by trained Minto staff:

- Field measurements are always made in situ (in the water body) or using a sub-sample taken in a separate container which is discarded once the measurements are recorded. Sub-samples are not used for further chemical analyses.

- Instrumentation must display stable in-situ parameters before field staff record parameters. For example, field staff will allow the YSI to stabilize in-situ for 10-15 minutes ensuring that dissolved oxygen readings are stable.

- Dissolved oxygen measurements are always taken in-situ rather than from a sample container.

- Field parameters are measured just below the water surface (0.1 m depth).

- Water quality data is screened on site during sample collection and suspicious readings are re-measured to prevent the recording of false information. Any indication of malfunctioning equipment is recorded in the notes for that station.

Sample Collection

Surface water samples should be collected mid-stream whenever possible to reduce potential contamination from foreign material, sediments, and/or other effects from stream banks, back eddies, seepage areas, etc. When the stream is small, the current is too strong, water too deep, or ice is too thin, samples should be collected from the stream bank reaching as far out into the stream as safely possible. When field staff are able to safely wade into a stream, the sampling location should be approached from downstream. Samples are always collected upstream of the sampler.

The following surface water sampling procedures are followed by trained Minto staff:

- Locate the station using a station map or GPS coordinates then select an area representative of the stream to collect the sample.
- Clearly label all sample bottles with station name, date, time (24 hour clock), and analysis code (provided in Table 1).
- Put on clean nitrile gloves prior to collecting the sample.
- Handle sample bottles and caps appropriately to avoid contact with internal surfaces.
- Plunge the bottle under the water with the mouth facing upstream away from the sampler's hand.
- All bottles will be triple-rinsed.
- Ensure that samples requiring filtering are rinsed with filtered water only.
- Collect the water sample until the bottle is full and remove it from the water. Pour some water out to

- Use new syringes and filters for every station.

- Filter at the sampling location whenever possible and otherwise from a sub-sample taken in a separate container in a clean environment as soon as possible after sample collection.
- Add preservatives to the required samples as soon as possible after sample collection and filtering.
- Replace caps immediately and tightly to prevent sample loss. Invert bottles to mix preserved samples.
- Place samples in a cooler with sufficient ice packs.

The following tables list the current requirements for water quality samples sent to Maxxam Analytics and the Minto On Site Laboratory (Minto Lab).

Table 1: Sample Requirements for Samples Analyzed by Maxxam Analytics

Analysis Name	**Analysis Code**	**Parameters (not inclusive)**	**Bottle (plastic)**	**Filter**	**Preservative**
Physical Parameters	RAW	TSS, TDS, pH, EC, hardness, alkalinity	1 L	Not required	Not required
Nutrients/Anions	RAW	SO_4, Cl, Fl, NO_2, NO_3	500 mL	Not required	Not required
Nutrients/Anions	NH4, TP	P, NH_3	120 mL	Not Required	1 mL Sulphuric Acid (H2SO4)
Total Metals	TM	Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, U, Zn, Na, K, Ca, Mg, S	120 mL	Not required	1 mL Nitric Acid (HNO3)
Dissolved metals	DM	Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, U, Zn, Na, K, Ca, Mg, S	120 mL	Required (0.45 µm filter)	1 mL Nitric Acid (HNO3)
Dissolved Organic Carbon	DOC	DOC	120 mL	Required (0.45 µm filter)	1 mL Sulphuric Acid (H2SO4)
Total Organic Carbon	TOC	TOC	120 mL	Not required	1 mL Sulphuric Acid (H2SO4)
Cyanide	CN	CN	120 mL	Not Required	1 mL Sodium Hydroxide (NaOH)
Radium	Ra 226	Ra 226	1 L	Not required	4 mL Nitric Acid (HNO3)

Table 2: Sample Requirements for Samples Analyzed by Minto Lab.

Analysis Name	Analysis Code	Parameters	Bottle (plastic)	Filter	Preservative
Physical Parameters/ Nutrients	RAW	TSS, NO_2, $NO_{3,}$ NH_4	1 L	Not required	Not required
Total Metals	TM	Al, Cd, Cu, Se	120 mL	Not required	1 mL Nitric Acid (HNO3)
Dissolved metals	DM	Al, Cd, Cu, Se	120 mL	Required (0.45 µm filter)	1 mL Nitric Acid (HNO3)

Under Snow or Ice Sampling

During winter months water quality monitoring stations will freeze over and water quality samples will need to be collected from under snow and/or ice. Only field staff specifically trained in ice safety will follow these procedures:

- Store and transport chisels, axes and augers in clean environments to limit contamination.
- When sampling on ice always work with a partner and proceed with caution at all times. If the ice is unsafe or you are unsure stop work immediately.
- Ice thickness must be tested with a drill with and auger bit, axe or chisel prior to walking onto a frozen water body and every few steps afterwards. A survival suit should be worn when ice thickness is being determined. Special care must be taken at outflow and inflow areas as conditions are constantly changing.
- Clear snow and loose ice away from the sampling location and drill through the ice with an ice auger, either motorized or a hand auger. The area around the drill hole should be kept clean and free from potential contamination such as gas, dirt from the drill or work boots, etc.

- Once the hole is drilled, all the ice chips and slush should be removed from the hole using a slotted spoon, etc. Allow several minutes for the water to flow freely under the ice, allowing potential contaminants to clear before taking a sample.

Field Notes and Photographic Record

In addition to recording water quality field parameters and the samples collected at each site, trained field staff must document all relevant environmental conditions observed at the time of sampling and any unusual occurrences. Deviations from standard protocols whether deliberate or accidental (e.g. samples taken from a different location due to safety or access considerations, procedures used that differ from those outlined in this

SOP) must be recorded in the field notes.

Standard field forms are used as much as possible to ensure all the required information, water samples and field parameters are collected. A current copy of the Minto Water Quality Field Form is provided in Appendix 2. If a field notebook is used, as a minimum the field notes must include the following information:

- Station name, date, time, and names of field staff present;
- Weather conditions and observations on the physical conditions at the sampling location;
- GPS coordinates for new sites or when the sampling location has changed (more specific to winter sampling); and
- Details of any other site specific information relevant to the sampling event.

Field notes must always be clear, concise, and include the station name and date. All field notes should be completed on site. Finally, it is good practice to refrain from erasing mistakes when recording field notes. Crossing out the error and rerecording the data is preferred. Field notes are entered into the Minto Water Quality Database upon return from the field and all field notes and field forms are stored on site.

Photographs can be taken during any sampling event to document current conditions at each station. At a minimum, photos must be taken to show changes in physical conditions at the sampling location. Photos from one sampling event will typically include one upstream and one downstream facing shot. Aerial photos should also be taken when the opportunity is available. Photographs are an important tool to assist with data interpretation. Photos are stored in digital format and must be accurately labeled by field staff upon return from the field.

Sample Custody and Shipment

Water quality samples are handled at all times to prevent damage and potential sample loss, thereby reducing the risk of contamination. Samples are transported around the mine site in sealed coolers with sufficient ice packs until they are placed in a sample fridge or delivered to the Minto Lab. Samples are stored upright in clean refrigerators equipped with thermometers. Samples are maintained as close to 4°C as possible from the time of collection until they are delivered to a laboratory.

After surface water quality samples have been transported back to the office, field staff are responsible for inspecting the samples to ensure they are properly preserved, labeled, and sealed. If the samples are to be analyzed on site they should be delivered to the Minto Lab as soon as possible.

Samples that require external analysis must be shipped to the appropriate laboratory with a completed chain of custody (COC) form. An example of a COC form is provided in Appendix 3. This form is used to request sample analysis and track sample custody. Filling out a COC should be done with field forms and samples on hand to confirm that all the sample containers for each station are accounted for and labeled correctly.

All samples must be submitted to the appropriate laboratory for analysis based on the maximum sample hold time. Each parameter has a specific hold time that ensures the results generated are accurate. However, due to the remoteness of Minto Mine the maximum hold times for some samples will not be met. For this reason it is essential that samples be shipped to the laboratory as soon as possible. It may be necessary to ship samples on the same day as they are collected to preserve the accuracy of the sample analysis. It is the responsibility of field staff to ensure the hold times are met where possible.

All samples must be well sealed and packed with paper, bubble wrap, etc. to prevent spills or breakage. Pack each cooler with sufficient ice packs to maintain the samples at 4°C. Samples collected during the winter will be cooler and will not require the same amount of packaging and ice packs as samples collected in the summer. Samples must not be permitted to freeze. If samples are being shipped in temperatures significantly below freezing, collapsible jugs of warm water may need to be added to the packaging.

Enclose a printed copy of the COC form in a sealed plastic bag or envelope and place it inside one of the coolers with the sample shipment. Label all coolers or shipping containers with the address of the laboratory and the sender and attach it with enough clear tape to protect the label. An example of a laboratory shipping label is provided in Appendix 1.

Data Management

All water quality data including field notes, photographs, completed COC forms and laboratory results are carefully handled, organized and stored to ensure the information can be located for future use. The information collected during water quality sampling events is critical to the interpretation of the data, in some cases even several months or years after the sampling event has taken place.

The following surface data management procedures are followed by trained Minto staff:

- After completing a COC form, an electronic copy is saved with the appropriate file name to the designated location on the server.
- When samples are received at the lab, an automated confirmation email is sent to Minto environment staff. The lab job number is entered into the Minto Water Quality Database.
- When lab results are received by email they are reviewed by supervising staff at the earliest opportunity. Supervisors are responsible for importing the data into the Minto Water Quality Database regularly.
- If reviewing new results in comparison to past trends suggests that results are suspect, or if the results exceed the applicable standards for a particular parameter, an investigation will be initiated. The lab should be requested to review their QA/QC for that batch and re-run the sample, or analyze waters from another sample bottle for the suspect parameter(s).
- Unless it is obvious that the anomalous result that is over discharge criteria is false, new samples should be taken and sent immediately.

6. Quality Assurance and Quality Control

The Minto Quality Assurance and Quality Control plan has been created to provide confidence in the data collected for all environmental monitoring and sampling programs. QA/QC is an integral component to quality surface water quality sampling. General QA/QC procedures that apply to the Water Quality Monitoring Program are described in this section.

Quality Control

Quality control protocols are the set of routine procedures and methods designed to achieve and maintain a recognized level of quality. Therefore, the collection of reliable surface water quality field data at Minto is accomplished by following the procedures described in this document. Quality assurance includes the procedures that keep track of those procedures and provide a check on the quality of the data produced.

Some of the most common quality-related problems introduced in surface water quality sampling include the mislabelling or switching of bottles, failure to add proper preservatives, improper storage conditions, and sample contamination from sampling equipment or other sources.

Quality control samples are collected and analyzed to verify the integrity of water samples, detect errors introduced during sampling. Quality control samples represent 10% of the total number of samples collected and consist of a random combination of the types provided in Table 3. Field staff are responsible for documenting where quality control samples are prepared on the field forms and in the Minto Water Quality Database.

Table 3: Quality Control Sample Descriptions

Type	Description and Sample Purpose
Trip Blank (TB)	A sealed container of deionized water sent from the laboratory used to detect any widespread contamination during transport and storage. The trip blank is transported with the sample bottles for the entire duration of the sampling event. Trip blanks indicate contamination within the bottle or from volatile compounds.
Field Blank (FB)	A sample of deionized water that is prepared in the field using the same procedures for collecting the field sample. Preservative is added after the sample is collected. Field blanks measure contamination from bottles, collection methods, the sampling environment, and preservatives.
Duplicate (DUP)	Duplicate samples are independent samples collected from the same place and time to determine the precision of environment and laboratory heterogeneity. Duplicate samples measure the reproducibility of the sampling and analysis.
Field Split (FS)	Aliquots taken from the same sample container and assumed to be identical. Split samples can be sent to separate laboratories for analysis and the results can be used to determine inter-lab variability. Care must be taken to ensure that the samples are split homogeneously.

Quality Assurance

Quality assurance protocols help ensure that the Minto Water Quality Monitoring Program is quantifiable and able to produce quality data. Minto Mine is continuously involved in consultation with professionals and technical experts regarding program design, standard operating procedures, and data review. Ongoing staff training and inspections of staff (especially new hires) performing monitoring activities ensure data collection and results are consistent, representative and high quality.

The steady improvement of quality assurance protocols involves developing more detailed and program specific verification processes and automated checks, as well as peer reviews and audits by external professionals on a regular basis. Effective quality assurance will identify potential problem areas and necessary corrections to procedures and data management, and facilitates evaluation and improvement of the monitoring program.

Quality Assurance on Data

Examination and evaluation of field data and data entry is an integral part of quality control. While it is not possible to check all aspects of input data, calculations, and interpretations, checks can be performed on selected sets of data at appropriate intervals. A review of work procedures and data collection methods will identify potential sources of error.

Reported water quality data is reviewed, and evaluated by Minto Mine staff on a monthly, quarterly and annual basis. The water quality database is audited by Minto Mine and a professional consultant on an annual basis. As mentioned previously the Minto water quality database is checked on a monthly basis and is completed by cross checking the database with the sample tracking and log spreadsheet. The sample tracking log and spreadsheet are reviewed against field notes on a weekly basis; additionally all samples and Chains of Command that are sent out to the external laboratory are checked by two staff. If inconsistences are found, further investigation is performed using field notes, COC, and lab result files depending on the nature of the error.

7. Closure

Not all of the situations encountered by field staff have been included in this document (e.g. water column/depth profile sampling) as they are not part of routine sampling events. A JHA should be conducted prior to completing any new or irregular task to identify what work will take place, list all of the potential hazards that could be encountered during the work, and the measures necessary to avoid or mitigate the hazards.

8. References

Resources Information Standards Committee (RISC). 2003. Ambient Freshwater and Effluent Sampling Manual.

Environment Canada. 2001. Guidance Document for the Sampling and Analysis of Metal Mining Effluents.

Canadian Council of Ministers of the Environment (CCME). 2011. Protocols Manual for Water Quality Sampling in Canada.

Appendix 1: Current Maxxam Contact and Shipping Label

Minto Explorations Ltd. **COC #________________**

Suite 900-999 West Hastings Street
Vancouver, BC V6C 2W2
Mine Tel: (604) 759 0860

Maxxam Analytics Inc.

attn: Kelly Janda
4606 Canada Way
Burnaby, BC V5G 1K5
Ph: (604) 638 5019

Air North Cargo: Please deliver to address above
c/o Air North Account # 15979218

Regular Delivery

Appendix 2: Minto Environment Water Quality Field Form

Minto Water Quality Field Form

Sample Site:	Date:	Time:	Sampler(s):
Sky:	Temp:	Precip:	Wind:
Lab Analysis? E I	QA/QC taken? Y N DUP TB FB		

Photos? Y N	YSI Callibration? Y N

RAW 1 L	RAW 500 ml	NUT 120 ml	TM 120 ml	DM 120 ml	DOC 120 ml	TOC 120 ml	Ra 226 1L	Bioassay *various*

Temp C	DO %	DO mg/L	SPC µs/cm	EC µs/cm	pH	ORP mv	Turb NTU

Flow Recorded? Y N	Staff Gauge (m):	Flume RIGHT (ft):	Flume LEFT (L/S):

Notes (site conditions or variations from normal, i.e. ice cover, sediment, flows, etc.)

Data entered:	Data reviewed:

Appendix 3: Sample Chain of Custody Form

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #:

COC #: EB530912

Page: 1 of 1

Invoice To: Require Report? Yes ☐ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancovuer, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail minto_environment@mintomine.com

PO #: 113796
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by:

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

○ Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:

Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only Lab Identification	Sample Type	Date/Time(24hr) Sampled	Field Filtered? ☑ Y ☐ N Dissolved Metals (DM)	Field Acidified? ☑ Y ☐ N	Field Acidified? ☑ Y ☐ N Total Metals	☑ Ammonia ☑ Nitrite ☑ Nitrate	☑ TDS ☑ Total Suspended Solids (TSS)	☑ Alkalinity ☑ Conductivity ☑ pH	☑ Sulphate ☑ Fluoride ☑ Chloride	Phosphate	DOC (Diss'd Organic Carbon)	TOC (Total Organic Carbon)	Ra 226																		Number of Containers
1																																	
2																																	
3																																	
4																																	
5																																	
6																																	
7																																	
8																																	
9																																	
10																																	
11																																	
12																																	

Print name and sign ***Relinquished By:**	Date (yy/mm/dd):	Time (24hr):	Print name and sign **Received by :**	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive
						☑

Laboratory Use Only

Temperature on Receipt (^oC)
A) B) C)
Just sampled & rec'd on ice: ☐

Custody Seal	Yes	No
Present?	☐	☐
Intact?	☐	☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

BBY FCD-00077R2_C

Maxxam Analytics Success Through Science ©

MINTO MINE
SURFACE WATER HYDROLOGY
STANDARD OPERATING PROCEDURES

Prepared by:

Minto Explorations Ltd

October 2012

Last Revised, July 6th, 2015.

TABLE OF CONTENTS

TABLE OF APPENDICES

Appendix 1: Minto Environment Hydrology Field Form

1. Purpose

The standard operating procedures (SOP) in this document serve as a guideline for the collection of water quantity (flow, discharge) data from water bodies at Minto Mine (Minto) specified by Water Use Licence QZ96-006. Water quantity data is critical for a variety of assessment and planning purposes at Minto and is used to interpret water quality data, prepare site water balances, create operating plans, etc. The Minto Mine Hydrology SOP follows methods and procedures described in Guidance Document for Flow Measurement of Metal Mining Effluents (Environment Canada, 2001) and Manual of British Columbia Hydrometric Standards (RISC, 2009). This document is intended for Minto Mine employees familiar with the location of hydrology stations and the data collection methods outlined in this document. Along with on the job training, this SOP will to ensure that surface water hydrology data at Minto Mine is collected consistently and the data produced is reliable and representative.

2. Responsibilities

The quality of flow measurements and water quantity data collected at Minto Mine is dependent on the staff involved and the attention given to field procedures, field equipment, and quality control protocols. It is crucial that flow measurements be carried out in a consistent manner with the appropriate equipment to generate the most accurate results.

The following is a typical allocation of responsibilities associated with the collection of surface water hydrology data at Minto:

Field Staff

Field staff must have the appropriate knowledge and training to take precise flow measurements and collect representative data while minimizing field error as much as possible. This includes following all procedures correctly and consistently, correct use of field equipment, and completion of detailed field notes.

Field staff are responsible for coordinating all station visits in accordance with the requirements of the current WUL, including sampling locations, sampling frequency, etc. Staff performing station visits shall ensure that all site conditions and other required information are clearly documented, and that all quality assurance and quality control (QA/QC) protocols are being followed.

Field staff must be experienced in the operation and maintenance of all field instruments and the equipment used for measuring water quantity data. They are responsible for maintaining equipment and identifying equipment malfunction.

Field staff are also responsible for performing data entry related to surface water hydrology on site.

Supervisors

Supervisors are responsible for ensuring field staff understand the requirements of the WUL and that all procedures and protocols are being followed and documented. Supervisors are responsible for ensuring data collection and data management procedures are being carried out consistently and identifying variance from standard procedures.

Supervisors are responsible for providing appropriate levels of training to all field staff and ensuring that all field staff are proficient to carry out their responsibilities or are adequately supervised. This is especially important when field staff are processing data and completing field activities such as station installs and surveying.

It is the responsibility of supervisors to compare water quantity data collected throughout the year and review trends, outliers, etc. This is often completed with input from external professionals.

Supervisors must also periodically review data collection procedures including the content of this SOP to ensure the best methods are being used and that adequate QA/QC is being incorporated into the program.

3. Hydrometric Station Installation

There are many factors to consider when selecting and installing a hydrometric station in an open channel. Hydrometric stations at Minto typically consist of a pressure sensor and data logger installed in a perforated PVC tube. This instrumentation is accompanied by a staff gauge. All components are attached to a wooden frame and anchored to shore. Minto currently consults with external professionals regarding the establishment of new stations, however the following guidelines will be considered by trained Minto staff when selecting and installing hydrometric stations:

- Site can be accessed safely by field staff through the full range of stage;
- Site is located where the stream cross-section is stable, typically in a pool or run, avoiding turbulent riffle or cascade sections;
- The staff gauge and pressure sensor are able to record accurate water levels through the full range of stage and discharge can be accurately measured at all stages using acceptable flow measurement methods;
- All station components are structurally sound and will not move in any direction;
- Install staff gauges so they are protected from damage by floating debris and ice and are not affected by drawdown or pileup of water. It is typically easiest to read the staff gauge with the face parallel to the current;

- Ideally the depth and velocity of the stream should be fairly uniform with good cross-sections for flow measurements using a flow meter (e.g. single channel, no undercut banks, minimal obstructions, no backwater eddies); and
- No tributaries exist between the hydrometric station and wading cross-sections.

4. Field Instruments

All instruments used for collecting water quantity data are used and maintained according to the manufacturer's specifications. Prior to departure for sampling, staff will ensure that all field equipment is checked for functionality.

Minto currently uses a Hach FH950 Electromagnetic Velocity Meter (current meter) with a top-setting wading rod to perform manual discharge measurements whenever possible. Electromagnetic current meters are factory calibrated and require little maintenance. The Hach FH950 current meter performs a diagnostic self-test each time it is powered on and instructions for checking zero velocity settings are provided in the user manual. Records of all checks and maintenance are stored on site.

Continuous water level readings and barometric pressure are recorded using Solinst data loggers for open channels and inline flow meters for pipe flows. These instruments are received factory tested and calibrated, and are installed, programmed and maintained according to the manufacturer. All information provided with the flow measurement equipment is kept and stored on site.

5. Safety

Wading is the most common method for taking flow measurements at Minto and can also be one of the most dangerous.W35 is the only site where manual flows are taken and where it is permissible to work alone, if the need arises. However, it is always preferable that two people conduct manual flow measurements. Waders with wading belts, safety lines and life vests are available for all staff. Always explore the streambed for large obstacles or holes while wading carefully into the stream. Stream substrates are often slippery. If it is safe to wade the stream then the measurement can begin. Always assess and mitigate safety risks.

When the stream is too high and/or too swift for wading, then either an alternative method should be used or the measurement should not be taken. If conditions do not seem safe or you are unsure, do not attempt to wade the stream. If it is possible to take a measurement from shore, always ensure safe footing and solid points of contact.

6. Field Notes and Photographic Record

Detailed documentation of conditions and observations during station visits is necessary to ensure the quality and accuracy of the data collected. Field staff are responsible for thoroughly documenting site conditions including staff stage readings, stream characteristics up and downstream of the flow measurement site, weather conditions, deviation from standard procedures, and any other significant details about the visit. Standard field forms are used to ensure all the required information is collected. A current copy of the Minto Mine Hydrology Field Form is provided in Appendix 1.

All field notes should be completed at the station immediately following the observations. Field notes must be clear, concise, and include the station name, date and time. It is good practice to refrain from erasing mistakes when recording field notes. Crossing out the error and rerecording the data is preferred. Field notes are entered into the Minto Water Quantity Database upon return from the field and all field notes and field forms are stored on site.

Data logger files downloaded from the pressure sensors should be transferred immediately from the field laptop or Solinst handheld and saved with the correct file names to the appropriate location on the server.

Photographs should be taken to document current conditions at each station. At a minimum, photos must be taken to show changes in physical conditions around the station. Photos from one station visit will typically include one upstream and one downstream facing shot. Aerial photos should also be taken when the opportunity is available. Photographs are stored in digital format and must be accurately labelled by field staff upon return from the field.

7. Water Quantity Data Collection Methods

An explanation of the water quantity data collection methods carried out at Minto Mine and detailed procedures for each method are described in this section.

Staff Gauges

Staff gauges are used to record the stage (water level) of a water body. All discharge measurements and continuous water level readings are referenced to the staff gauge, therefore it is extremely important to read the staff gauge carefully and correctly each visit. Taking a photograph of the water level on the staff gauge is a useful reference in the field for ensuring accurate readings. Staff gauge readings should be taken before and after flow measurements as water levels can change in a small amount of time. Always record stage to three decimal places and document the exact time the reading was taken.

Depending on the orientation of the staff gauge, high flow conditions may sometimes result in water stacking up on the gauge. Readings should be taken at the downstream side of the gauge where the water is calmer.

It is also possible to have no surface flow when the station is visited. These conditions are very important to developing accurate discharge records. Zero flow conditions must be thoroughly documented and photographed. It is also possible to read a water level on a staff gauge when there is no visible flow. This must also be thoroughly documented if encountered.

Surveying and Tracking Staff Gauge Drift

Due to ice movement and natural freeze-thaw cycles, staff gauges are subject to move or drift over time. If a staff gauge moves the reference elevation to which all other measurements and records at that site are compared to changes. Always document conditions that may suggest the staff gauge moved in any direction. Photos and any estimates of amount and direction of drift are very useful when correcting data records and planning repairs.

Annual surveying of staff gauge elevation (typically in the spring) tracks changes in staff gauge location and allows for correction of water level records if needed. Detailed procedures for level surveys are not provided in this SOP; however the following elevation points must be collected:

- Elevation of 0.000m on the staff gauge (should be relative to an arbitrary elevation assigned to a benchmark in the area, typically a spike in the base of a large nearby tree);
- Elevations of at least two benchmarks; and
- Elevation of the water surface at the gauge;

Bench marks are permanent reference points with known elevations. They are established at each station in a stable location close enough to the gauge to allow for efficient surveying, anchored where they are not likely to move or be damaged. The ability of the benchmark to maintain its position in the local environment is essential. At Minto, benchmarks are typically a spike or lag bolt in a mature tree.

Discharge Measurement using a Current Meter

Minto uses the mid-section method for measuring flows using a current meter. This is a standard discharge measurement technique where the depth and velocity are measured at a number of verticals along a cross-section. Velocity measurements at a percentage of the stream depth are assumed to represent the average velocity through the vertical water column. Accurate current metering is critical to the accuracy of the discharge measurement.

Preparation

Upon arrival at the site, field staff will conduct an overall station inspection. Observing and documenting the overall channel conditions will help identify conditions that may affect the measurement and the stage-discharge relationship. Assessing channel conditions is also important in deciding whether or not it is safe to complete the measurement. This includes the presence of aquatic plants and floating debris, any obstructions in the stream, and signs of channel bank erosion and deposition in vicinity of the station.

Field staff are responsible for selecting the best cross-section to carry out discharge measurements during each station visit. The location of the cross-section often varies with changes in water levels or channel conditions.

The best sections for low, medium, and high flow measurements should be established and used as much as possible.

Make a preliminary crossing before stringing the tagline. Try to obtain an overall impression of the depths and velocities while wading. Select an appropriate cross-section where the bed and banks of the watercourse are straight and uniform and the channel bed is free from vegetation, immovable rocks, and other obstructions. Avoid muddy and sandy bottoms, backwater eddies, obstacles, etc. as much as possible.

Improve the cross-section by removing boulders and debris from the section and the area immediately above it. Remove significant vegetation from the area upstream and downstream from the section. On smaller watercourses it may be possible to construct small dikes to cut off sections of shallow flows and dead water. Once complete, allow sufficient time for conditions to stabilize before proceeding with the measurement. Improvements should not affect the staff gauge reading. Do not make changes to the cross-section during the course of the discharge measurement.

Performing the measurement

Proceed with the measurement as follows:

1. Note the date and time and record the staff gauge reading. This step is absolutely essential for plotting the results of the discharge measurement.

2. Secure the tagline (measuring tape) on either shore and string it across channel perpendicular to the direction of flow. Determine the overall width of the metering section. Assess the approximate spacing of the verticals, according to the channel width and flow pattern.

3. Record the distance along the tagline of the left or right bank. Left and right bank are determined facing downstream. If there is a steep drop at the edge of the stream, the first "vertical" depth and velocity observation should be taken as close to the edge as possible.

4. Begin the measurement at the first vertical along the tagline. Record the distance of the reading along the tagline then measure and record the water depth at each location using the wading rod. The water depth is the point where the water surface intersects the rod. Observations should be made to the nearest centimeter. This is used to calculate the total cross-sectional area.

5. Where water depth in the vertical is <1.0 m, observations are made at 0.6 depth from the water surface. To position the current meter sensor correctly, adjust the sliding rod to line up the scale on the rod to the value of the observed depth. Detailed instructions on how to adjust the rod are provided by the manufacturer.

6. Where water depth in the vertical is >1.0 m, the velocity is measured at both 0.2 and 0.8 depth from the water surface and the mean velocity is calculated. To set the current meter on 0.2 depth position, double

the value of the observed depth and adjust the sliding rod to line up the scale to read this value. For 0.8 depth position the scale to read half of the observed depth.

Note: The 0.2-0.8 method is not entirely satisfactory if the channel bed is very rough, irregular, or covered with aquatic growth. These conditions will often produce erratic results for the observation at the 0.8 depth. In some situations, more reliable results will be obtained by computing the average velocity on the basis of the 0.2 and 0.8 depths and averaging the computed value with the velocity from the 0.6 depth. This is known as the three-point method.

7. Allow sufficient time for the current meter to adjust to water conditions. Observe velocities for a minimum of forty seconds. The adjustment time will be a relatively short at high velocities and significantly longer at low velocities.
8. Continue the measurements across the stream until you reach the opposite bank and record the distance on the tagline. After taking the discharge measurement record the second staff gauge reading and the time.
9. After the measurement, download data logger readings, record real time data from the Solinst data logger, and service the instrument by checking the battery voltage and inspecting all of the cables and connections. During every visit to a hydrometric station, a complete inspection of the data logger and all related components should be conducted. Any sign of malfunction or deterioration of the station components must be recorded and repaired as soon as possible.

To obtain accurate measurements by wading, field staff must pay attention to detail and technique. There are many things to consider and numerous opportunities for error. The following guidelines will help obtain reliable results:

Number and Spacing of Verticals

All discharge measurements should include 20 verticals with no less than 10 observations of both depth and velocity for most cross-sections. The distance between verticals must be at least 5 cm when using the Hach FH950 current meter (equal to or greater than the width of the current meter).

The spacing of verticals along the metering section is not usually uniform. Where the water is shallow and/or slow moving, the spacing will be greater than where the water is deep and swift. Spacing depends largely on the several factors including overall width of the stream, unevenness of the channel bed, and variation in velocity across the channel.

Position of Field Staff

Field staff should stand to the side and downstream of the current meter to prevent any interference or effect on velocity readings. In very small channels the presence of a person in the water may significantly affect the flow measurement. In this case a plank can be placed across the stream for field staff to stand on.

Position of the current meter

Hold the wading rod in a vertical position and the current meter parallel to the direction of flow while measuring velocity.

Uneven Channel Bed

Measuring depths in a channel bed that is extremely soft or scattered with boulders requires extra attention. Be careful not to allow the bottom of the wading rod to sink into soft channel bed material. If the channel bed is very rough, take time to adjust the width of verticals so the observed depths so reflect the tops of the boulders and the depths between them.

Rated Structure

Minto currently has a prefabricated flume combined with a pressure sensor constructed in a four season shelter at W3. Water levels are read off an embedded staff gauge on the flume during each visit.

For optimal performance the flume floor and walls should be kept clean and free of sediment and algae growth and upstream of the structure should be kept free of sediment accumulation and debris.

Volumetric Measurements

Volumetric measurements are taken at the outlets of elevated pipes and culverts, and periodically at select stations when appropriate. This method involves collecting water in a container of known volume and recording the time it takes to fill in seconds. There must be a minimum of three trials to produce an average time. Volumetric containers should be calibrated and stopwatches should be water resistant.

8. Data Processing

Hydrology data is compiled by Minto Mine staff on a monthly and yearly basis, including discharge calculations and water level record corrections. Processing data into stage discharge curves, hydrographs, and other discharge records is presently completed or largely supported by a third party (Access Consulting Group) and is not included in this SOP.

Discharge Calculations

Discharge is defined as the volume of water flowing through a given cross-section of a stream over a given period of time. Discharge is typically expressed in L/s or m3/s. For any stream location there is a correlation between water level and discharge called the stage-discharge relationship. Once this is established, discharge can be estimated from recorded water levels and staff gauge readings to create a continuous discharge record. To develop this relationship, manual discharge measurements are obtained at the hydrometric station over the maximum range of stage possible. These corresponding points are graphed, then a stage-discharge curve can be drawn that best represents these points.

All field data from station visits is entered into the Minto Water Quantity Database and processed into discharge values using a template and standard formulas in Excel. Care must be taken to ensure the formulas are not modified during data entry.

Current Meter Measurements

The mid-section method allows for mean discharge (Q) to be calculated by multiplying the mean stream velocity (V) and the cross-sectional area (A); thus Q=VA. In this method the stream is divided into a number of panels. The flow in each panel is calculated by multiplying the mean velocity measured at each vertical by the corresponding width measured along the surface tape or cord. This width should be equal to the sum of half the distance between adjacent verticals. The velocity in the two half widths next to the banks can be estimated. For a detailed description of the mid-section method of computing discharge measurements, please refer to the Manual of British Columbia Hydrometric Standards (RISC, 2009).

Table 1 illustrates an example of a completed discharge calculation for a current meter measurement.

Table 1 Discharge Calculation

Site:	MC1	Start Time:		Staff Gauge:	0.249
Date:	8-Aug-12	End Time:	16:50	Staff Gauge:	0.249
Observations		Calculations		Samplers:	CB/PE
Tape Distance (m)	Depth (m)	Width (m)	Area (m^2)	Velocity (m/sec)	Discharge (m^3/s)
0.46	0	LB			
0.60	0.06	0.12	0.01	0.062	0.000
0.70	0.10	0.10	0.01	0.150	0.002
0.80	0.14	0.10	0.01	0.131	0.002
0.90	0.11	0.10	0.01	0.186	0.002
1.00	0.10	0.10	0.01	0.216	0.002
1.10	0.12	0.10	0.01	0.282	0.003
1.20	0.08	0.10	0.01	0.278	0.002
1.30	0.14	0.10	0.01	0.271	0.004
1.40	0.15	0.10	0.02	0.203	0.003
1.50	0.14	0.10	0.01	0.141	0.002
1.60	0.15	0.10	0.02	0.262	0.004
1.70	0.13	0.10	0.01	0.226	0.003
1.80	0.13	0.10	0.01	0.182	0.002
1.90	0.08	0.10	0.01	0.050	0.000
2.00	0.00	RB			
		Total Discharge (m^3/s)			0.0320

Continuous Water Level and Inline Pipe Flow Meter Data

Continuous water level readings from pressure sensors and inline flow meters are downloaded and compensated as needed using the manufacturer's software. At this time, instructions for compensating this data are not included in this SOP.

All continuous water level readings from pressure sensors require reference to the water level during station visits. Therefore, staff gauge readings must be accurate and always documented including the time of the observation. Basically, water level data is compensated by calculating the difference between the pressure sensor water depth and staff gauge reading for each point in time and the average of all these differences can be applied to the entire data record as a single offset adjustment.

Volumetric Measurements

To calculate discharge from a volumetric measurement the following formula is used:

Discharge = Volume of container (litres) / Average time to fill (seconds)

9. Quality Assurance and Quality Control

The Minto Quality Assurance and Quality Control plan has been created to provide confidence in the data collected for all environmental monitoring and sampling programs. QA/QC is an integral component to quality surface water hydrology data.

Quality Control

Quality control protocols are the set of routine procedures and methods designed to achieve and maintain a recognized level of quality. Therefore, the collection of reliable surface water hydrology data at Minto is accomplished by following the procedures described in this document.

For current meter measurements, errors in the measurement of width, depth, and velocity as well as the lack of care in choosing the number of verticals and observations in a vertical, all combine to reduce the overall accuracy of water quantity data. To a large extent, human errors can be avoided by careful attention to detail and by adhering to established and proven techniques and routines. Systematic errors can be reduced significantly by proper maintenance and calibration of instruments and equipment, and by adequate training. However, random errors will always occur. A significant reduction in these errors can be achieved if field staff performing the measurement can recognize the potential problem areas and can take the appropriate precautionary measures to avoid or minimize them. For a detailed description of common factors that lead to inaccuracies in current meter discharge measurements, please refer to the Manual of British Columbia Hydrometric Standards (RISC, 2009).

Quality Assurance

Quality assurance includes the procedures that provide a check on the quality of the data produced. Minto Mine is continuously involved in consultation with professionals and technical experts regarding program design, standard operating procedures, and data review. Ongoing staff training and inspections of staff (especially new hires) performing data collection activities help to ensure the results are consistent, representative and high quality.

Standardized management of data collected in the field is important in hydrological monitoring programs. Standard protocols and systems make the task of data processing easier and less likely prone to error. Processing of data often involves returning to the original field notes to cross check suspicious values or to analyze site conditions that might have been responsible for anomalies in the logger records. Therefore, it is easiest to evaluate the quality of water quantity data successfully when supportive values and observations have been well documented.

The steady improvement of quality assurance protocols involves developing more detailed and program specific verification processes and automated checks, as well as peer reviews and audits by external professionals on a regular basis. Effective quality assurance will identify potential problem areas and necessary corrections to procedures and data management, and facilitates evaluation and improvement of the monitoring program.

Quality Assurance on Data

Examination and evaluation of field data and data entry is an integral part of quality control. All data should be reviewed to determine if it is comparable to past recordings. While it is not possible to check all aspects of input data, calculations, and interpretations, checks can be performed on selected sets of data at appropriate intervals. A review of work procedures and data collection methods will identify potential sources of error.

All water quantity data including field notes, photographs and datalogger download files are carefully handled, organized and stored to ensure the information can be located for future use. Corrections or adjustments to abnormal or inaccurate data logger records rely on the availability of complete documentation.

10. References

Guidance Document for Flow Measurement of Metal Mining Effluents, Environment Canada, 2001

Manual of British Columbia Hydrometric Standards, Resources Information Standards Committee (RISC), 2009

Standard Operating Protocol Surface Water Hydrology Data Collection and Management, Access Consulting Group, 2010.

Appendix 1: Minto Environment Mine Hydrology Field Form

Minto Hydrology Field Form

Site:	Date:	Initials:	
Start Time:		Start Staff Gauge:	
End Time:		End Staff Gauge:	
Datalogger download: Y / N		Photos Taken: Y / N	

Notes (**precipitation**, changes to site conditions, datalogger info, etc):

Left & right banks chosen looking downstream

Left Bank Measurement:	Left Bank Depth:
Right Bank Measurement:	Right Bank Depth:

Section	**Tape Distance (m)**	**Depth (m)**	**Velocity (m/s)**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

MINTO MINE
Groundwater Monitoring PLAN
VERSION 2016-02

Prepared for:
Minto Mine

Prepared by:
Minto Explorations Limited,
with contributions from SRK Consulting

Vancouver, British Columbia
July 2016

Minto Mine Groundwater Monitoring Plan

First Issue: March 2013

Revision History

Revision Number	Issue Date	Description and Revisions Made
2013-01	March 2013	First Issue for WUL/QML applications
2015-01	December 2015	Update required for additional wells for licence
2016-01	February 2016	Updated based on comments from reviewers
2016-02	July 2016	Updated based on YWB request for additional

Table of Contents

List of Tables

List of Figures

1 Introduction

Minto Explorations Ltd. (Minto) was issued Water Use Licence QZ14-031 (WUL) on August 5, 2015. The WUL included a number of conditions including Clauses 90 and 91, which requires Minto to file an updated Groundwater Monitoring Plan as part of the Environmental Monitoring, Surveillance and Reporting Plan (EMSRP) within 120 days of the effective date of the licence amendment. This document constitutes the required updated plan.

For reference, the text of Conditions 90 and 91 are as follows:

90) The Licensee shall update the Groundwater Monitoring Program to include the following additional components:

> *a) multi-level monitoring wells up-gradient and down-gradient of mine activities;*
>
> *b) at a minimum, one lysimeter in each waste rock pile;*
>
> *c) at a minimum, one multi-level groundwater well hydrogeologically downgradient of each waste rock pile;*
>
> *d) a multi-level monitoring well located at the most downstream extent of the Licensees claims in the Minto Creek catchment;*
>
> *e) a multi-level monitoring well hydrogeologically down-gradient of the Minto North Pit;*
>
> *f) an aquifer characterization at all new wells in the form of constant discharge tests and measurements collected to ascertain the vertical flow direction of groundwater;*
>
> *g) evaluation of longitudinal flow paths using non-toxic tracer testing and use these results to refine the numerical groundwater model;*
>
> *h) at each new well location specified in d) and e) of this clause, aggressive leaching tests, such as toxicity characteristic leaching procedure on the different lithological materials that are intercepted during well drilling to ascertain the background composition of the geology in the areas; and*
>
> *i) increased sampling frequency as determined by a qualified hydrogeologist.*

91) The Licensee shall monitor groundwater levels to refine the estimates of the long-term phreatic levels in the tailings management facilities.

This updated Groundwater Monitoring Plan (GMP) provides details of the current monitoring system and monitoring schedule designed to meet the requirements of the WUL.

2 Groundwater-related Monitoring

2.1.1 Groundwater Wells

A variety of groundwater wells have been installed at the Minto Mine site over the life of the project. These wells have been installed for a range of purposes and the information available for these wells varies case-by-case. Table 1 provides summary information of the installed wells, including wells to be installed in the future.

Table 1: Summary of Existing, Planned and Inoperable Groundwater Wells, Minto Mine

Groundwater Well Name	Location	Status
P94-20	Main Water Dam area	*Destroyed*
P93-E	Main Pit area	*Destroyed during mining*
MW09-01	Main Waste Dump area	Operational
MW09-02	DSTSF Area	*Destroyed*
MW09-03	Downgradient of Minto North Pit	Operational
MW09-04	Main Pit area	*Destroyed*
MW11-01A	Downgradient of Main Pit	Buried during Mill Water Pond decommissioning (monitoring function fulfilled by MW12-07)
MW11-02	NE of Ridgetop North Pit	Operational (sometimes frozen)
MW11-03	SE of Ridgetop North Pit	Operational (sometimes frozen)
MW11-04A	S of Ridgetop South Pit	Operational
MW12-DP1	West of Southwest Waste Dump	Operational
MW12-DP2	West of Southwest Waste Dump	Operational
MW12-DP3	West of Southwest Waste Dump	Operational
MW12-DP4	Downgradient of MVF/DSTSF	Destroyed
MW13-DP5	Downgradient of MVF/DSTSF	Destroyed
MW12-05	Downgradient of WSP	Operational
MW12-06	Downgradient of MVF/DSTSF	Operational
MW12-07	Downgradient of Main Pit	Operational
MW16-08	Up-gradient of Southwest Waste Dump and all other mine activities	To be installed
MW16-09	Down-gradient of Southwest Waste Dump	To be installed
MW16-10	Down-gradient of Main Waste Dump	To be installed
MW16-11	Down-gradient of Minto North Pit	To be installed
MW16-12	Additional well down gradient of DSTF and all other mine activities.	To be installed
Unnamed auxiliary well near mill	Mill area	Operational
Unnamed camp water well	Camp area	Operational
08SWC270	Southwest Waste Dump area	*Destroyed*
08SWC271	Southwest Waste Dump area	*Destroyed*
08SWC272	Southwest Waste Dump area	*Destroyed (Buried by waste rock)*
08SWC273	Southwest Waste Dump area	*Destroyed*
08SWC274	Southwest Waste Dump area	*Destroyed*
08SWC275	Southwest Waste Dump area	*Destroyed*
08SWC277	Southwest Waste Dump area	*Destroyed*
08SWC278	Southwest Waste Dump area	*Destroyed*
08SWC280	Southwest Waste Dump area	*Destroyed (Buried by waste rock)*

General positions related to the monitoring well objectives are listed in Table 1. Monitoring well locations, current and additional wells to be installed in 2016, are shown in Figure 1

2.1.2 Vibrating Wire Piezometers

Vibrating wire piezometers have been installed during geotechnical investigations at the Minto Mine, as referenced in the Physical Monitoring Plan (see reference list). The Physical Monitoring Plan should be referred to for the current list of instrumentation. The piezometric data are used to augment the understanding of the phreatic surface across the mine site and incorporated into the groundwater modelling program.

These instruments provide measurements of both piezometric pressure and temperature, the latter used to increase the accuracy of the calculated pressure measurements, when temperatures are above 0°C. The instruments will also continue to provide temperature data when temperatures are below 0°C and the transducer is frozen.

Table 2 provides summary information about the existing vibrating wire piezometers.

An additional VWP string will be installed in the Main Pit and Area 2 Pit to provide pore pressure and thermal data as the pits are backfilled with tailings.

Table 2: Summary of Existing, Planned and Inoperable Vibrating Wire Piezometers, Minto Mine

Vibrating Wire Piezometer Name	Location	Status
DSP-1	DSTSF area	Operational
DSP-2	DSTSF area	Operational
DSP-3	DSTSF area	Operational
DSP-4	DSTSF area	Operational
15-DSP-7	DSTSF area	To be installed
15-DSP-8	DSTSF area	To be installed
15-DSP-9	DSTSF area	To be installed
15-DSP-10	DSTSF area	To be installed
SDP-1	Southwest Dump area	Destroyed
SDP-2	Southwest Dump area	Operational
SDP-3	Southwest Dump area	Operational
SDP-4	Southwest Dump area	Operational
A2P-1	Area 2 Pit	To be installed
MP-1	Main Pit	To be Installed

Note: installations at the Main Water Dam are excluded from this table

2.1.3 Ground Temperature Monitoring

Several thermistor strings (ground temperature cables) have been installed during geotechnical investigations at Minto Mine. These instruments provide measurements of temperature at various depths below ground at each location, but do not provide any piezometric data. However, the thermal data is an important aspect of the hydrogeological assessment of the site as it provides a better understanding of permafrost distribution, so is an integral part of the hydrogeological modelling program.

Table 3 provides summary information about the existing thermistor cables. As with the VWP installation, the Physical Monitoring Plan will document any updates to this list of instrumentation.

Table 3: Summary of Existing Ground Temperature Cables, Minto Mine

Ground Temperature Cable Name	Location	Status
DST-1	DSTSF area	Destroyed
DST-2	DSTSF area	Destroyed
DST-3	DSTSF area	Operational
DST-4	DSTSF area	Operational
DST-5	DSTSF area	Destroyed
DST-6	DSTSF area	Operational
DST-7	DSTSF area	Destroyed
DST-8	DSTSF area	Destroyed
DST-9	DSTSF area	Destroyed
DST-12	DSTSF area	Operational
96-G08	DSTSF area	Destroyed
MWPT-1	Mill Water Pond area	Destroyed
MWPT-2	Mill Water Pond area	Destroyed
SDT-1	Southwest Dump area	Operational
SDT-2	Southwest Dump area	Operational
SDT-3	Southwest Dump area	Operational
SDT-4	Southwest Dump area	Operational
08SWC271	Southwest Dump area	Destroyed
08SWC274	Southwest Dump area	Destroyed
08SWC275	Southwest Dump area	Destroyed
08SWC277	Southwest Dump area	Destroyed
08SWC278	Southwest Dump area	Destroyed
08SWC280	Southwest Dump area	Buried under Southwest Dump

Note: installations at the Water Storage Dam are excluded from this table

2.1.4 Waste Rock Pile Lysimeters

Clause 90-b calls for, at a minimum, one lysimeter in each waste rock pile. To respond to this license requirement, lysimeters will be installed in the Main Waste Dump and the Southwest Waste Dump. Results of the lysimeter monitoring will be used to augment the understanding of how water moves through the WRDs, providing a basis for more accurate water and load balance prediction from these sources.

A description of the lysimeter design and installation procedure can be found in Section 4.4.

2.2 Sampling Frequency

Clause 90-i calls for an increased sampling frequency as determined by a qualified hydrogeologist. To conform to this, SRK has recommended an increase in frequency to quarterly monitoring and Minto adopted this recommendation in Q2 2016. This frequency rate should provide appropriate coverage for any fluctuations due to seasonal changes in infiltration/recharge to the groundwater system and potential lag times between recharge source areas and monitoring wells.

2.3 Water Level Monitoring

Clause 91 calls for the Licensee to monitor long-term phreatic levels in the tailings management facilities. This requirement will be complied by means of monitoring:

- Direct water levels and VWP in the Main Pit TMF
- Direct water levels and VWP in the Area 2 Pit TMF
- The current and any future VWPs installed in the DSTSF

These data will be to further refine the understanding of phreatic levels within the tailings facilities.

3 Groundwater Monitoring Plan

3.1 Monitoring Objectives

As stipulated in the WUL, this groundwater monitoring plan is to provide for monitoring up-gradient and down-gradient of all mine activities in order to provide input required to refine the numerical groundwater model for the site. The monitoring system will be used to assess unimpacted groundwater above all of the current and planned mine activities and the affects downgradient of mining activities.

Specific monitoring points will be used in the site environmental tracer study test, as discussed in Section 2

3.2 Monitoring Requirements

Table 4 summarizes the operational monitoring requirements. Monitoring systems have been installed both up and down gradient of the expected final design footprint of the respective mine components.

It should be noted that monitoring points (i.e., zones in the Westbay wells separated by packers) were selected based on observations from core logs.

Core logging included:

* Photograph of the run;

* Total core recovery;

* Rock quality designation;

* Identification of major structures;

* Identification and characterisation of joint conditions;

* Microdefect intensity;

* Alteration, if present; and

* Estimated intact rock strength.

Once the logging was completed for each drill hole, Westbay MP well designs were drafted and completed to target specific ground conditions. If a major structure was encountered, a zone was placed around it. Otherwise, the zones were designed to isolate particular lithological targets (either overburden, weathered bedrock or fresh bedrock) where ground conditions permitted. Since it was not possible to identify precise locations of preferential flow (e.g. a specific fracture), longer zone intervals were used to capture as much groundwater as possible within a specified lithological target.

Every Westbay zone includes a measurement port, but certain Westbay monitoring zone also include a “pumping port” that allows for water to be removed from the zone at higher rates than from a standard measurement port. Each of the zones with pumping ports was developed until field parameters stabilized and these zones are now used for on-going monitoring.

For MW12-05 alone, the monitoring has been expanded to include routine sampling of all zones (including the pressure monitoring zones with no pumping ports) in 2016, in response to a request from YG arising from the interest in better understanding groundwater sulphate concentrations in this area.

3.3 Sampling Protocol

Groundwater samples will be collected according to the procedures summarized in ASTM D4448-01- Standard Guide for Sampling Ground-Water Monitoring Wells (ASTM 2007).

Table 4: Operational Groundwater Monitoring Requirements

Mine Project Component	Monitoring Installation	Westbay Zone Depth or description	Quality	Level	Monitoring Frequency
Up-gradient of Mine Activities	MW16-08	TBD (Zones not defined)	X	X	Quarterly
Southwest Waste Dump	MW12-DP1	NA	X	X	Quarterly
	MW12-DP2	NA	X	X	Quarterly
	MW12-DP3	NA	X	X	Quarterly
	MW16-09	TBD (Zones not defined)	X	X	Quarterly
Main Waste Dump	MW09-01	Zone 1 (44 mbgs)	X	X	Quarterly
	MW09-01	Zone 2 (34 mbgs)	X	X	Quarterly
	MW09-01	Zone 3 (26 mbgs)	X	X	Quarterly
	MW16-10	TBD (Zones not defined)	X	X	Quarterly
Dry Stack Tailings Storage Facility and Mill Valley Fill Expansion	MW12-06	Zone 1 (142 mbgs)		X	Quarterly
		Zone 2 (123 mbgs)	X	X	Quarterly
		Zone 3 (93 mbgs)		X	Quarterly
		Zone 4 (66 mbgs)	X	X	Quarterly
		Zone 5 (35 mbgs)		X	Quarterly
		Zone 6 (18 mbgs)	X	X	Quarterly
Main Pit	MW12-07	Zone 1 (115 mbgs)	X	X	Quarterly
		Zone 2 (88 mbgs)	X	X	Quarterly
		Zone 3 (66 mbgs)		X	Quarterly
Minto North Pit	MW09-03	Zone 1 (38 mbgs)	X	X	Quarterly
		Zone 2 (24 mbgs)	X	X	Quarterly
		Zone 3 (11 mbgs)	X	X	Quarterly
	MW16-11	TBD (Zones not defined)	X	X	Quarterly
Water Storage Pond	MW12-05	Zone 1 (132 mbgs)	X	X	Quarterly
		Zone 2 (110 mbgs)	X	X	Quarterly
		Zone 3 (94 mbgs)	X	X	Quarterly
		Zone 4 (69 mbgs)	X	X	Quarterly
		Zone 5 (52 mbgs)	X	X	Quarterly
		Zone 6 (26 mbgs)	X	X	Quarterly
		Zone 7 (15 mbgs)	X	X	Quarterly
	MW16-12	TBD (Zones not defined)	X	X	Quarterly

3.4 Analytical Suite for Groundwater Samples

Groundwater samples will be collected and analyzed for the parameters described below.

These analytical suites are defined as follows:

- Physical Parameters, Conductivity, Total Dissolved Solids, Alkalinity, Sulphate, ICP Scan - Dissolved Metals.
- Nutrients: Ammonia-N, Nitrate-N, Nitrite-N and Phosphorous.
- In-situ Field Parameters: pH, Conductivity and Temperature.

Groundwater samples will be submitted to an accredited laboratory for analysis.

3.5 Quality Control and Quality Assurance

Quality control samples will be collected and analyzed to verify the integrity of groundwater samples. Quality control samples for the Groundwater Monitoring Program will represent 10% of the total number of samples collected and may include trip blanks, field blanks, duplicates or field splits.

Quality assurance is achieved in the Groundwater Monitoring Program through regular review of groundwater data. Additionally, in support of the Groundwater Monitoring Program a standard operating protocol (SOP) for groundwater monitoring is utilized to conduct the groundwater monitoring. The SOP ensures consistency with groundwater monitoring techniques and is updated on an as required basis should modifications be necessary.

3.6 Reporting

Results of the groundwater monitoring program will be included as part of the annual report for the WUL.

4 Environmental Tracer Study

4.1 Background

Tracer studies in fractured rock environments are typically conducted to achieve similar objectives as tracer studies in porous media (i.e., unconsolidated sediments, such as sand or gravel). These objectives can be used to gain information on specific flow paths that could transmit solutes, to understand solute transport parameters in groundwater such as advection, dispersion or attenuation, or to understand how long it takes a solute to travel through a given medium (i.e., travel time). While objectives for fractured rock and porous media tracer studies may be similar, fractured rock studies are subject to certain complicating factors that are not typically encountered in porous media.

4.1.1 Overview of Fractures and Fracture Flow

In fractured rock systems, groundwater (and solutes) travel through fractures in the rocks. Fractures are discontinuities in the rock that are made up of subsets such as joints (usually defined as tension features showing no lateral movement) or cracks that have had either side of the opening offset from each other, with both commonly referred to as fractures. Fractures showing offsets are similar in definition to faults, though the offsets may be minor and not necessarily justify being called a fault. Fractures can be of widely variable length and characteristics, and the number of fractures can vary significantly over relatively short distances. Additionally, the fractures are separated by areas of solid rock.

For water (or solute) to flow through fractures, whether they be joints or fractures with offsets, the fractures need to have an opening (aperture) for water to move through them. The characteristics of these openings can also vary widely, even along a single fracture. Mineral filling, weathering products, or even just the surface features of the fractures themselves can cause the openings capable of transmitting water to have complicated connections (tortuosity) or can terminate abruptly. When considering groundwater and solute flow over any appreciable distance, it can be the connection between many different fractures that combine to provide the groundwater flow path. Characterizing fracture sets and their connectivity always has an element of uncertainty, even with extensive investigation programs such as those completed for pit slope geotechnical design programs, because only a sub-set of the entire fracture system can be measured.

4.1.2 Overview of Tracer Testing Methods

Tracer studies are completed using one of two methods: natural gradient tests, and forced gradient tests. In natural gradient tests, a tracer is monitored under the hydraulic gradient that is naturally present in the groundwater system. In these tests, results can indicate how a tracer moves under the conditions that are actually present in the system. A challenge with natural gradient tests in fractured rock is that the travel time for groundwater to move any appreciable distance can be quite long due to low gradients and/or poor connectivity. Alternatively, if the tracer source and monitoring locations are close together and connected by an open fracture, the travel time can be very short.

Forced gradient tests involve injecting a tracer then trying to make the tracer move relatively quickly by artificially increasing the gradient between wells, by methods such as pumping from one of the wells or injecting the tracer under high pressure.

A drawback to this type of test in fractured rocks (and porous media) is that tracer observations do not necessarily indicate how the system works under natural conditions. For example, in fractured rock under forced conditions, open sections in boreholes can result in vertical flow that verifies cross-connection between zones with different heads, which does not occur under the natural state or in sealed boreholes. These forced gradient tests answer different questions, such as transport porosity and longitudinal dispersivity, than are posed in the requirement for Minto; forced gradient tests cannot be used to provide flow directions under natural conditions.

4.1.3 Challenges with Tracer Tests in Fractured Rock

As noted, both natural-gradient and forced-gradient tests are subject to challenges that relate to the method-natural gradient tests can be subject to slow groundwater velocities and long arrival times, while forced-gradient tests induced unnatural flow conditions and can therefore providing results that do not represent the natural flow system.

Another challenge for conducting tracer tests in fractured rock is that identifying which fractures do transmit water is typically not possible prior to the test. Even if drill holes are designed based on known fracture orientations, and even if multiple drill holes are completed, there is always a risk that the fractures of interest are not intersected by the detection drill holes. This can result in the tracer not being observed at the monitoring locations and bypassing (falsely indicating the tracer did not flow through the rock mass), or may only appear at a limited number of observation points. If this happens, results can be difficult to interpret or extrapolate to wider areas. There is evidence at the site that groundwater hydrochemistry is variable and it may be possible to associate with mine sources to serve as existing tracers of flow paths in the system. Additional monitoring locations can be added to complement the existing network and data to use the 3-D spatial and temporal groundwater chemistry and water isotopes for interpreting the flow system conditions, in essence as a natural gradient tracer test with multiple analytes and lines of evidence to provide a robust interpretive conditions.

An alternative approach to tracer studies is to use natural tracers in groundwater or chemical constituents that may be introduced to the groundwater system from the project of interest to gain a broader understanding of the spatial distribution and timing of solute transport. For fractured rock environments, one of the assumptions is that the combined fracture system in the rocks acts similarly to a porous media when viewed at a large enough scale; the characteristics of specific fractures or individual travel paths is not necessarily the objective of the study. These types of studies often fall into the category of environmental tracer studies. In these studies, naturally occurring isotopes or chemical elements that are naturally introduced into the system can be measured at multiple locations (groundwater and surface water) and used to infer how groundwater is moving across a site, and sometimes to allow estimation of the age of groundwater (i.e., “old” or “new” water in a relative sense, or perhaps ages more relevant to the age of the project). This type of approach can provide more information on how groundwater (or solutes) move across larger areas than can necessarily be obtained by smaller scale, localized tracer studies (i.e., the existing hydrochemistry and isotopes of key elements of compounds and water should provide spatial variability controlled by the flow paths from operational areas)..

4.1.4 Proposed Approach to Testing

For Minto, it is recommended that the groundwater and surface water monitoring network be used to conduct an environmental tracer study based on hydrochemical and isotope distributions in the context of source/input areas (including groundwater recharge) and hydraulic head and conductivity distributions. After completion of the additional monitoring wells (Figure 1), samples will be collected from multiple locations and analyzed for a suite of chemical constituents and isotopes to identify changes or trends in groundwater quality as it moves from higher elevation recharge areas across the site and towards the groundwater discharge locations at Minto Creek. The variability of these hydrochemical parameters using the 3-D monitoring network and temporal variability should provide patterns for confirming groundwater flow paths. The planned steps and general sampling plan will involve:

1. Drill, test, develop, and install multi-level groundwater monitoring systems in the new monitoring locations.
2. Collect samples from the five new wells, existing groundwater monitoring wells across the site, the Area 2 Pit, the Main Pit, surface water stations on Minto Creek and the seepage monitoring point below the Dry Stack Tailings Storage Facility.
3. Analyse samples for tritium (to establish groundwater age), oxygen and hydrogen isotopes (to see if groundwater recharge or surface water interactions can be identified), sulphur isotopes (to determine if different sulphur sources can be determined), and standard chemical analytes (e.g., anions, dissolved metals, etc.) to further constrain other trends or characteristics of different waters.

This approach will provide characteristics of waters across the site that can be used to infer groundwater travel characteristics at a broader scale than would be achievable with a localized controlled tracer test, such as with a fluorescent dye or other injected non-toxic tracer. This approach is expected to provide results that would be more useful than a localized controlled tracer test for overall site groundwater management, and will provide results that can be used to support interpretation of the large existing groundwater quality database. Ultimately, the results of this testing will be used to refine the site wide groundwater modelling and provide a higher confidence in the ability to predict groundwater movement up and down gradient of the site.

4.1.5 Uncertainty and Risk

Any tracer study is subject to uncertainty and risk that results do not provide complete clarity on groundwater movement. Groundwater systems have inherent uncertainty by the simple fact that the entire system cannot be seen or measured; this uncertainty is typically higher in fractured rock systems. Thus, there is a risk, even if every available monitoring point were sampled, that results do not clearly identify where or how groundwater from the site travels.

Uncertainty will be reduced by sampling at multiple locations across the site that are located in different types of settings that are expected to be within the main groundwater pathways of interest (e.g., upgradient of the mine, downgradient of open pits and within the Minto Creek valley).

The risk of ambiguous results will be reduced (but not eliminated) by sampling for multiple constituents or isotopes that, together, should allow identification of characteristics to inform the longitudinal transport of groundwater and solutes of concern within that groundwater.

4.1.6 Study Design

Table 5 summarizes locations, samples to be collected, and the sampling frequency. Most of the sampling rounds will overlap with the schedule for routine sampling completed as part of the EMSRP. An additional sampling round is included for a period shortly after new wells are installed, to provide additional samples for early times after installation of new wells.

Sampling locations are identified in Figure 2 to Figure 4.

Table 5: Tracer Sampling Locations, Parameters, and Schedule

			May/June, 2016				Sept, 2016				Oct, 2016				Dec, 2016			
Well or Location	**Location Description**	**Westbay Zone Depth or description**	Standard	O/H	Trit	^{34}S	Standard	O/H	Trit	^{34}S	Standard	O/H	Trit	^{34}S	Standard	O/H	Trit	^{34}S
Groundwater																		
MW09-01	Main Dump	Zone 1 (44 mbgs)	X	X		X	X	X	X	X	X	X	X	X	X	X		X
MW09-03	Minto North	Zone 1 (38 mbgs)	X	X		X	X	X	X	X	X	X	X	X	X	X		X
		Zone 2 (24 mbgs)	X	X		X	X	X	X	X	X	X	X	X	X	X		X
		Zone 3 (11 mbgs)	X	X		X	X	X	X	X	X	X	X	X	X	X		X
MW12-05	Minto Creek valley down gradient of Water Storage Pond	Zone 1 (132 mbgs)	X	X		X	X	X	X	X	X	X	X	X	X	X		X
		Zone 2 (110 mbgs)	X	X		X	X				X	X	X	X	X			
		Zone 3 (94 mbgs)	X	X		X	X	X	X	X	X	X	X	X	X	X		X
		Zone 4 (69 mbgs)	X	X		X	X				X	X	X	X	X			
		Zone 5 (52 mbgs)	X	X		X	X	X	X	X	X	X	X	X	X	X		X
		Zone 6 (26 mbgs)	X	X		X	X				X	X	X	X	X			
		Zone 7 (15 mbgs)	X	X		X	X	X	X	X	X	X	X	X	X	X		X
MW12-06	Minto Creek valley up gradient of Water Storage Pond	Zone 1 (142 mbgs)					X				X	X	X	X	X			
		Zone 2 (123 mbgs)	X	X		X	X	X	X	X	X	X	X	X	X	X		X
		Zone 3 (93 mbgs)					X				X	X	X	X	X			
		Zone 4 (66 mbgs)	X	X		X	X	X	X	X	X	X	X	X	X	X		X
		Zone 5 (35 mbgs)					X				X	X	X	X	X			
		Zone 6 (18 mbgs)	X	X		X	X	X	X	X	X	X	X	X	X	X		X
MW12-07	Down gradient of Main Pit	Zone 1 (115 mbgs)	X	X		X	X	X	X	X	X	X	X	X	X	X		X
		Zone 2 (88 mbgs)	X	X		X	X	X	X	X	X	X	X	X	X	X		X
		Zone 3 (66 mbgs)					X				X	X	X	X	X			
MW16-08	Up gradient all activity	TBD (Background)					X	X	X	X	X	X	X	X	X	X		X
MW16-09	Below SW Waste Dump	TBD					X	X	X	X	X	X	X	X	X	X		X
MW16-10	Below Main Waste Dump	TBD					X	X	X	X	X	X	X	X	X	X		X
MW16-11	Below Minto North Pit	TBD					X	X	X	X	X	X	X	X	X	X		X
MW16-12	Below all mine activity (Minto Creek valley down gradient of Water Storage Pond)	TBD					X	X	X	X	X	X	X	X	X	X		X
W44	Area 118 underground sump		X	X		X	X	X	X	X	X	X	X	X	X	X		X
Surface Water																		
MC-1	Minto Creek at canyon		X	X		X	X	X	X	X	X	X	X	X	X	X		X
W-3	Minto Creek below WSP		X	X		X	X	X	X	X	X	X	X	X	X	X		X
W-16	Water Storage Pond (WSP)		X	X		X	X	X	X	X	X	X	X	X	X	X		X
W36/37/8/8a	Minto Creek above WSP		X	X		X	X	X	X	X	X	X	X	X	X	X		X
W45	Area 2 Pit		X	X		X	X	X	X	X	X	X	X	X	X	X		X
W12	Main Pit		X	X		X	X	X	X	X	X	X	X	X	X	X		X
W15	Minto Creek (in mine)		X	X		X	X	X	X	X	X	X	X	X	X	X		X
W10	Minto Creek (background)		X	X		X	X	X	X	X	X	X	X	X	X	X		X
Seeps																		
SS32	Background (camp)		X	X		X	X	X	X	X	X	X	X	X	X	X		X
SS35	Mill valley fill		X	X		X	X	X	X	X	X	X	X	X	X	X		X
SS36	DSTSF		X	X		X	X	X	X	X	X	X	X	X	X	X		X
SS7 or SS8	Ore stockpile		X	X		X	X	X	X	X	X	X	X	X	X	X		X
SS12	Main Dump		X	X		X	X	X	X	X	X	X	X	X	X	X		X
SS28 or SS29	SW Dump		X	X		X	X	X	X	X	X	X	X	X	X	X		X
SS31	SW Dump		X	X		X	X	X	X	X	X	X	X	X	X	X		X
SS51	SW Dump		X	X		X	X	X	X	X	X	X	X	X	X	X		X
Precipitation/Snow																		
up gradient						X		X	X	X		X	X	X		X		X

5 Installation Plans

5.1 Additional Groundwater Well Installations

Sub clauses 90-a, b, d and e of Water License QZ14-031 call for the installation of additional multi-level monitoring wells up and down gradient of mine activities including waste rock piles, at the downstream extent of the Licensees claims in the Minto Creek catchment, and down-gradient of the Minto North Pit.

5.1.1 Monitoring Well Locations

Locations of current and proposed wells are illustrated on Figure 1.

Table 6 lists the additional monitoring wells and specific license clauses that each fulfills. The current wells have been installed over the last six years to monitor groundwater quality and phreatic levels in order to allow for monitoring of potential impacts from mining on the groundwater system and provide input data for predictive modelling of the site operations and future operating and closure scenarios.

Precise locations of the new wells will be discussed with Minto's site geologists to best target possible structural and lithological contact features, areas of bedrock lows, etc. that could influence groundwater movement, ensure adequate monitoring coverage for the mining activities, allow for long-term survivability (relative to mining activities and closure works), and allow for safe long-term access in summer and winter conditions. This would be done as part of the detailed planning process prior to site mobilisation and drill pad construction.

In addition to monitoring wells where water samples can be collected, there are 18 vibrating wire piezometers (VWPs) installed on the mine site, with four more planned for installation during construction of the Mill Valley Fill Extension Stage 2, located north and downslope of the DSTSF . These provide both water pressure (levels) and temperature data, so are integrated into the GMP and inform assessment of the groundwater regime at site. The VWPs are also shown on Figure 1. These installations were taken into account when siting the new wells in order to correlate water pressure/level data for assessing site gradients and other groundwater-related characteristics more thoroughly. Table 6 summarizes monitoring wells and the corresponding license conditions that each fulfills.

Table 6. Monitoring Wells and Related License Condition

Monitoring Well	License Condition	Notes
MW16-08	90) a): Up-gradient of mine activities	Proposed well to be installed up-gradient of mine activities
MW16-09	90) c): Hydrogeologically down gradient of each waste rock pile	Immediately down gradient of the Southwest Waste Dump
MW16-10	90) c): Hydrogeologically down gradient of each waste rock pile	Immediately down gradient of the Main Waste Dump and completed at least 20m below minimum Main Pit lake elevation.
MW16-11	90) e): Down-gradient of the Minto North Pit	New well adds to monitoring system and compliments existing well MW09-03. Both are downgradient of the Minto North Pit
MW16-12	90) a): Down gradient of mine activities 90) d): Most downstream extent of licensee claims in Minto Creek catchment	MW16-12 will all be down gradient of mine activities and adds to existing monitoring system with wells MW12-05 and MW12-06. MW16-12 and MW12-05 are at the downstream extent of licensee claims
A2P-1	91): long term phreatic levels in the tailings management facilities	Area 2 Pit Tailings Management Facility
MP-1	91): long term phreatic levels in the tailings management facilities	Main Pit Tailings Management Facility

5.1.2 Monitoring Well Design

Current monitoring wells in the GMP were installed using the "Westbay MP" multi-level monitoring system to allow for monitoring below shallow permafrost as the system can be operated with anti-freeze in the sealed access pipe. In proposed well locations where permafrost is expected, we recommend installing additional MP wells. In areas where ground conditions are above 0˚C, standpipes can be utilised if desired to reduce capital costs, however, if drilling deeper than 100 m, it may be less expensive installing an MP well.

Actual well designs (depth and number /description of zones) will be determined based on drilling results as little data are available in the areas where installations are planned. Based on previous drilling/installations we have assumed the probable depths and number of zones for each well listed in Table 77.

The wells will be designed to monitor the overburden contact, the shallow, potentially more weathered/fractured bedrock, and the deeper rock mass profile. This will provide data that can better delineate the dominant flow regimes on site and vertical gradients at specific locations.

Additional multi-level wells (MW16-08 to MW16-12) will be installed in a similar method to the current monitoring wells.

Monitoring systems for phreatic levels in the Area 2 Pit and Main Pit (monitoring wells A2P-1 and MP-1) will use vibrating wire piezometers (VWPs). For A2P-1, a flexible HDPE pipe will be laid on the pit slope to provide a protective conduit for the VWP string. The VWP will be in a slotted section of the HDPE pipe to monitor tailings pore pressures as the pit is filled and begins to consolidate. This mean of installation can fail due to consolidation movement breaking the HDPE, but it is far simpler and more cost effective than drilling a hole once tailings have been emplaced. More importantly, it allows for data to be collected during the tailings emplacement and consolidation phase.

For MP-1 (Main Pit) monitoring instrumentation will be installed by direct push or other appropriate drilling method. Phreatic levels will be monitored at different levels in the tailings as dictated by site specific conditions. Exact methods will be determined in conjunction with Minto staff and pertinent geotechnical and long-term accessibility limitations related to worker safety and closure works.

Table 7. Proposed Multi-Level Monitoring Well Details

Well ID	Length (m)	Dip/Azimuth	Well Type	Number of Zones
MW16-08	50	70/TBD[1]	MP Multi-level	3
MW16-09	50	70/90	MP Multi-level	3
MW16-10	100	70/200	MP Multi-level	5
MW16-11	100	70/90	MP Multi-level	6
MW16-12	150	70/180	MP Multi-level	8
A2P-1	na	na	VWP	1
MP-1	na	na	VWP	1

1. TBD = to be determined following structural reconnaissance.

5.1.3 Installation Program

As with previous well installation programs at Minto, we assume the following for the installations:

a) SRK will mobilise all installation supplies and materials to Whitehorse, for further transhipment to site by Minto.

b) Minto will supply a heated tent and layout trestles for MP well installations. These will be moved to each well location as the installation program progresses.

c) Drill pads will be prepared by Minto.

d) Drilling contractor (supplied by Minto) will drill first hole.

e) Drill core will be logged by Minto geological staff.

f) SRK will mobilise to site to arrive just prior to completion of the first hole.

g) SRK staff will review the drill core with Minto geologist and design MP well installation (with samples for geochemical testing collected at this time).

h) With the drill rods still in the hole, SRK will supervise an airlift test for aquifer characterisation. The constant discharge test will also be used to develop drill fluids from the drillhole.

i) SRK will install the well with assistance from the drilling contractor and Minto staff (if available/desired).

j) Following installation, the drill contractor will pull off the hole and move to the next installation site.

k) SRK will redevelop, test, and sample the well while next hole is being drilled.

l) Steps g – k will be repeated until all holes installed and tested/sampled.

We assume that Minto will provide one staff member to assist with the installations and testing. If this is not possible, we can provide two SRK staff for this.

We have also assumed that installations and testing will only occur on the day shift, so the drill may have to go on standby if the hole is completed during the night shift.
Detailed scheduling and costs for the installations will be provided to Minto separately.

5.2 Aquifer Characterisation Tests

Clause 90-f requires Minto to carry out "aquifer characterization at all new wells in the form of constant discharge tests and measurements collected to ascertain the vertical flow direction of groundwater". This work will be completed as part of the initial well development and later monitoring testing tasks.

5.2.1 Aquifer Characterisation

As most of the new MP wells will be located in areas where we anticipate permafrost conditions in the upper parts of the drillhole, freezing of the system during a constant discharge test is a significant risk as the fresh formation water would be introduced to the MP casing interior and could freeze during the testing. Because of this, we recommend that the drillhole be tested using airlift techniques prior to installation of the MP System casing. This will not only allow for characterisation of the rockmass, but also greatly increase the ability to "develop" or remove drilling fluids from the surrounding rock.

This task would be completed using an onsite air compressor and HDPE eductor pipe to convey the compressed air down hole. The eductor would extend below the base of the drill rods if hole conditions are expected to remain stable, or within the rods if unstable conditions. As surface casing will likely extend to base of the overburden, flow up the overburden annulus will be prevented, as this could cause stability issues.

Data collection would be carried out using a transducer installed below the compressed air eductor pipe outlet. This allows for the transducer to be in the test hole during the entire test process so no data are lost inserting the transducer after air is turned off.

Data would be analysed using standard draw down recovery methods.

5.2.2 Vertical Flow Direction

Vertical flow direction in the well will be controlled by the pressure distribution in the rock mass, with water flowing from zones of higher pressure to lower pressure. The ability of the multilevel MP wells to measure pressures from multiple zones allows for the long term monitoring of the pressure differential in the monitored rock profile, providing a clear understanding of this pressure distribution and resulting water movement.

A hypothetical pressure profile, as can be obtained using the MP wells, is illustrated in Figure 5. This pressure distribution was measured in a well monitoring an injection process, so shows that water would be moving both upwards and downwards away from the higher pressure middle zones, exhibiting the level of detail obtainable with a multi-level system.

5.3 Leach Testing

Clause 90-h requires “aggressive leach tests, such as toxicity characteristic leaching procedure on the different lithological materials that are intercepted during well drilling to ascertain the background composition of the geology in the areas”.

This license requirement will be met by collecting representative samples from each lithology (or 25 m interval if same lithology) in each of the new drill holes and submitting for TCLP testing using USEPA certified test method 1311: (http://www3.epa.gov/epawaste/hazard/testmethods/faq/faq_tclp.htm)

Core samples will be collected and bagged or wrapped in cellophane for transport. All samples will be kept chilled at approximately 4˚C until submitted to the laboratory. Once at the lab, the samples will be crushed to allow for the analysis.

The parameters obtained from the lab analysis and detection limits are presented in Table 8.

Table 8. TCLP Parameter Suite and Detection Limits

Analysis	Units	RDL
Hardness	mg/L as $CaCO_3$	0.05
Sulphate	mg/L	2
Al	mg/L	0.01
Sb	mg/L	0.02
As	mg/L	0.01
Ba	mg/L	0.0001
Be	mg/L	0.0001
Bi	mg/L	0.05
B	mg/L	0.002
Cd	mg/L	0.001
Ca	mg/L	0.02
Cr	mg/L	0.001
Co	mg/L	0.001
Cu	mg/L	0.003
Fe	mg/L	0.002
Pb	mg/L	0.007
Li	mg/L	0.1
Mg	mg/L	0.003
Mn	mg/L	0.0001
Hg	mg/L	0.00001
Mo	mg/L	0.01
Ni	mg/L	0.004
P	mg/L	0.009
K	mg/L	0.002
Se	mg/L	0.01
Si	mg/L	0.02
Ag	mg/L	0.08
Na	mg/L	0.01
Sr	mg/L	0.0002
S	mg/L	0.03
Tl	mg/L	0.004
Sn	mg/L	0.02
Ti	mg/L	0.001
U	mg/L	0.1
V	mg/L	0.001
Zn	mg/L	0.002
Zr	mg/L	0.001

5.4 Lysimeter Installations

5.4.1 Waste Rock Pile Lysimeters

Clause 90-b calls for at least one lysimeter to be installed in each waste rock pile. To respond to this license requirement, lysimeters will be installed in the Main Waste Dump and the Southwest Waste Dump. Results of the lysimeter monitoring will be used to augment the understanding of how water moves through the WRDs, providing a basis for more accurate water and load balance prediction from these sources.

Passive capillary lysimeters (passive lysimeters from here on) are a relatively new development, which makes use of a fiber glass wick to keep the soil suction in the sampling columns in equilibrium with that of the natural soil surrounding the installation. Porewater from the soil sample is transferred into the sample collection vessel through the wick due to passive capillary forces. The sample is evacuated by application of pressure to a port.

In the context of the Minto closure program the objective of a lysimeters program is for monitoring the hydraulic performance of waste rock overlain by 0.5 m of cover soils. A passive lysimeter program will provide the data needed to complement and refine the existing soil cover designs, as well as characterize the variability in waste rock and candidate cover soils.

5.4.2 Preliminary Program Design

At this time passive lysimeters will be installed on two waste rock dumps: the Main Waste Dump, and the Southwest Dump. The Main Pit Dump has not yet been completed and as such permanent instrumentation cannot be installed. On each of the dumps a set of three passive lysimeters will be installed: two on the top surface and one on the slope. The exact location of the lysimeters will be determined in the next stage of detailed planning, taking into consideration the dump geometry and the short and medium term interim closure activities planned for these areas.

The lysimeters will be installed by burial to about 0.3 m below the waste rock surface. Figure 6 shows a typical installation (reproduced from www.decagon.com). One of the lysimeters on top of the dump and the one on the slope will then be covered with an additional 0.5 m of cover soil, in accordance with the cover proposed closure cover design. The soil will be selected from the stockpiles to be used for the final cover construction and will cover an area with a minimum diameter of 2 m around the lysimeter installation. The third lysimeter location will not receive a cover, being retained as control. In this way the cover performance can be measured against the uncovered waste rock.

The water collected in the sampling reservoir will be evacuated monthly in the first year, to establish a baseline. The frequency of emptying the lysimeter will then be adjusted to match the needs for keeping the reservoir form overflowing, but no less than monthly. The volume of the evacuated water will be recorded. Corroborating these data with precipitation data collected from the weather stations will allow an evaluation of the cover performance and a refinement of the predictive soil covers model previously completed.

Samples of the collected water will be sent to a laboratory for chemical analysis. A schedule for the laboratory analysis will be developed at the next stage of detailed design. The porewater sampling program could be complemented with suction lysimeters if the detailed monitoring plan identifies any waste rock areas of special concern.

Monitoring of the lysimeters should be continued for several years, with a minimum of one year necessary to achieve equilibrium of the installation with the surrounding soils.

6 References

Water Use License QZ14-013. Yukon Water Board. August 5, 2015.

Minto Explorations Ltd. 2014. Capstone Minto Mine – Physical Monitoring Plan. Date accessed: November, 2015.

SRK. 2013. 2012 Minto Mine Groundwater Monitoring Well Installation Report. Prepared for Minto Explorations Ltd. February, 2013.

Notes:
1. Data presented in NAD 1983 UTM Zone 8N.
2. Base orthophoto provided by Minto Mine, 2014.
3. Final pit designs provided by Minto Mine, 2015.

310 155 0 310 Meters
1:13,000

srk consulting

capstone
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

Groundwater 2016

Site Map

Job No: 21CM002.041
Filename: Figure1_1CM002.041_Rev02.mxd

MINTO MINE

Date: July 2016
Approved: JM
Figure: 1

\\VAN-SVR0\Projects\01_SITES\Minto\1CM002.041_Groundwater-2015\!040_AutoCAD\Figure1_1CM002.041.mxd

Notes:
1. Data presented in NAD 1983 UTM Zone 8N.
2. Base orthophoto provided by Minto Mine, 2014.
3. Final pit designs provided by Minto Mine, 2015.

310 155 0 310 Meters
1:13,000

srk consulting

capstone
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

Job No: 21CM002.041
Filename: Figure1_1CM002.041_Rev02.mxd

MINTO MINE

Groundwater 2016

Groundwater - Tracer Sample Locations

Date: July 2016
Approved: JM
Figure: 2

\\VAN-SVR0\Projects\01_SITES\Minto\1CM002.041_Groundwater-2015\040_AutoCAD\Figure1_1CM002.041.mxd

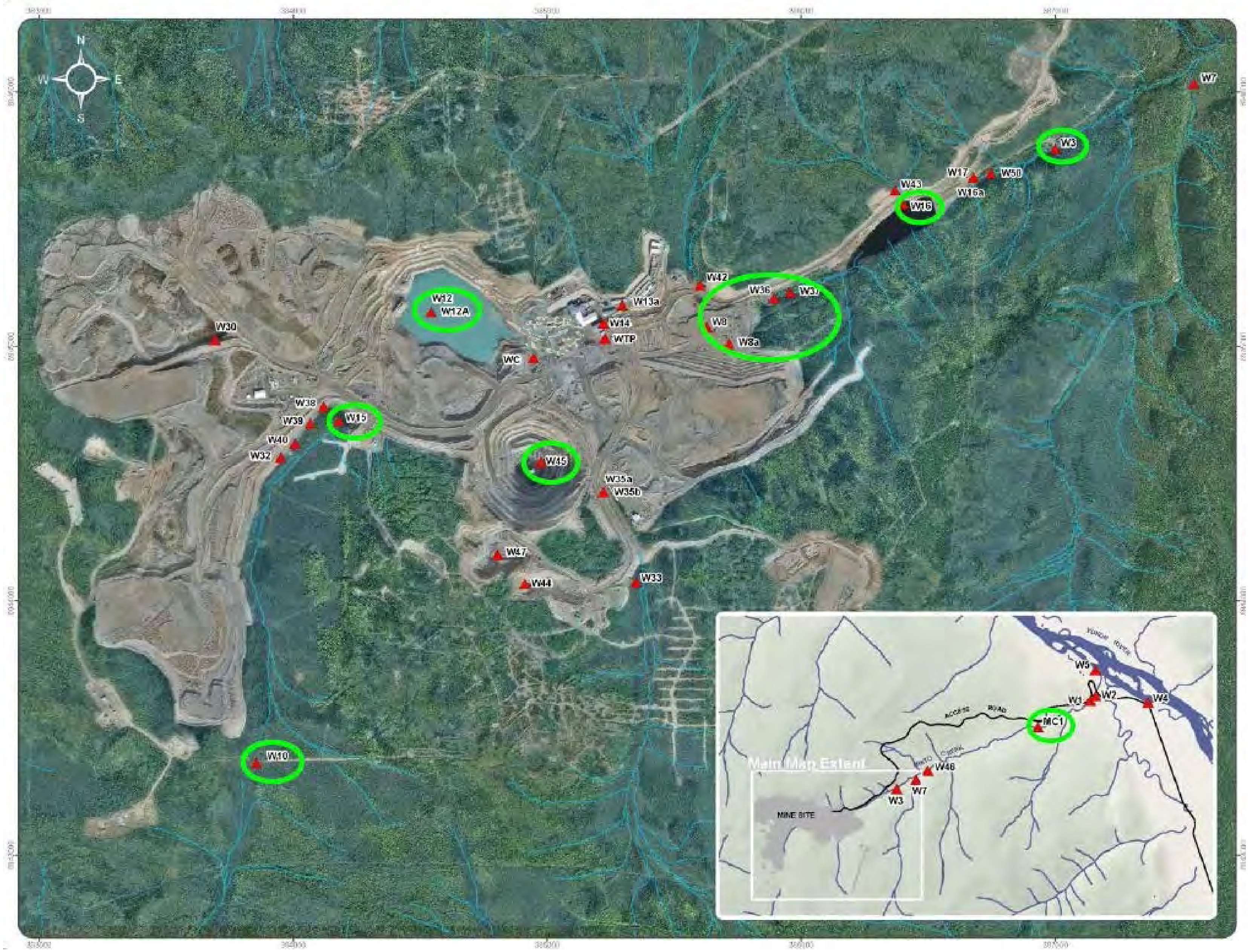
srk consulting

capstone MINING CORP

Minto Groundwater Monitoring 2016

Seeps -
Tracer Sampling Locations

Job No:	1CM002.041	MINTO MINE	Date: July 2016
Filename:	Figure 3_Seeps – tracer_rev01-dm.pdf		Approved: DM
			Figure: 3



srk consulting

capstone MINING CORP

Minto Groundwater Monitoring 2016

Surface Water – Tracer Sampling Locations

Job No: 1CM002.041

Filename: Figure 4_Surface Water – tracer_rev01-dm.pdf

MINTO MINE

Date:	Approved:	Figure:
July 2016	DM	4

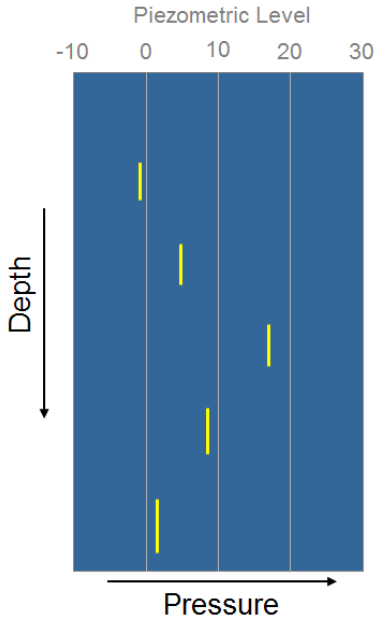


Figure 5: Hypothetical vertical pressure profile used to determine vertical groundwater movement

Figure 6: Typical Installation of Passive Lysimeter

Revision 2015-1
Physical Monitoring Plan
Minto Mine, YT

Prepared by:
Minto Explorations Ltd.
Minto Mine
November 2015

Minto Mine Physical Monitoring Plan

First Issue: June 2014

REVISION INFORMATION

Rev. Number	Issue Date	Description & Revisions Made
-	June, 2014	First issue
2015-1	November, 2015	Annual update of existing instrumentation and monitoring frequencies. Instruments Added: A215, A216, A217, A218, A2RAMP01, A2RAMP02, A2RAMP03, A2RAMP04, DSSH-26, DSSH-27, M82, M83, M84, M85, M86, M87, SWD06 Instruments Removed: DSI-14, DSI-21, DSSH-21, DSSH-22, DSSH-23, DSSH-25, WSP2

Created by:

Nov 25, 2015

Heather Friday, EIT

Geotechnical Engineer-In-Training

Reviewed by:

PROFESSIONAL ENGINEER
YUKON TERRITORY
KEVIN CYMBALISTY

Nov.25, 2015

Kevin Cymbalisty, P.Eng.

Chief Engineer

PROFESSIONAL ENGINEER
YUKON TERRITORY
POOYA MOHSENI

Nov 25, 2015

Pooya Mohseni, P.Eng.

Mine Manager

Table of Contents

List of Tables

List of Appendices

1 Introduction

The following document describes the instrumentation and monitoring program currently in place at Minto to monitor the stability of mining structures including waste rock, tailings, and water storage facilities. The program consists of two main components: instrumentation to measure ground conditions and deformation, and regular geotechnical inspections. The following sections summarize inspection and data collection frequencies, instrument installation details and locations, and data collection procedures.

Mining and monitoring activities at Minto included in this plan are licensed under the following:

- Type A Water Licence QZ14-031, August, 2015
- Type B Water Licence MS04-227, February 2007
- Quartz Mining Licence QML-0001, December, 2014

Existing mine structures at Minto are shown in Figure 1-1, and described in the following section.

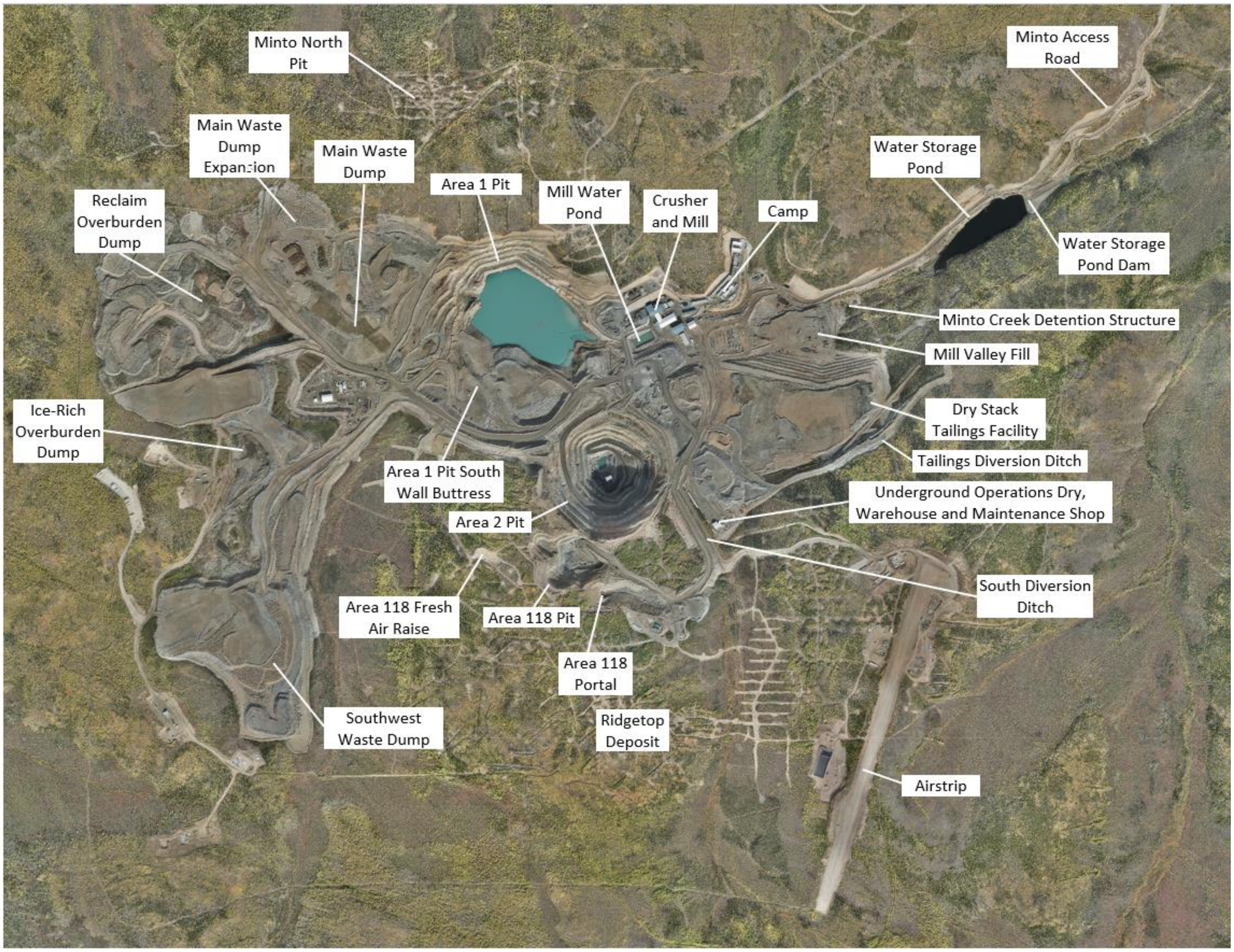


Figure 1-1: Minto site plan (October 2014)

2 Mine Structures

Mine structures currently being monitored at Minto as well as future structures included in the Phase V/VI plan are listed in Table 1.

Table 1: Description of Mine Structures at Minto

Structure	Description	Instrumentation
Area 2 Pit and Area 2 Pit Tailings Management Facility (A2PTMF)	The Area 2 Pit was completed in 2015 to the extents licensed under Phase IV (Stages 1 and 2); the pit will be extended to the south as part of Phase V/VI (Stage 3). Tailings deposition into the pit began in March, 2015 and the pit is now maintained as a tailings management facility.	• Survey hubs
Area 118 Pit	Mining of the Area 118 Pit was carried out in 2014. The pit is currently inactive and the access is barrricaded.	• Survey hubs
Area 118 Underground	The Area 118 underground began development in 2013 and is accessed by a portal and decline south of the Area 2 and Area 118 Pits. Production mining is currently taking place using a longhole stoping method and is expected to be completed in 2016.	None
Big Creek Bridge	Bridge on the Minto access road crossing Big Creek, located at Km 19. Licenced under Type B water licence MS04-227.	None
Camp	The camp consists of several connected bunkhouse buildings (Sherwood, Minto, Selkirk), a kitchen buidling, and several separate buildings including the gym and Site Services offices.	None
Dry Stack Tailings Storage Facility (DSTSF)	Construction of the DSTSF with filtered tailings placement was carried out from 2007 to November 2011. As part of progressive reclamation activities in 2012-2013, the DSTSF was covered with a layer of overburden approximately one to four meters thick. The DSTSF began showing deformation in 2009, interpreted as primarily horizontal sliding towards the north/northeast on an ice-rich layer in the underlying overburden, several meters above bedrock. The movement has continued since then but at a decreasing rate in response to construction of the Mill Valley Fill waste rock buttress.	• Survey hubs • Thermistors • Inclinometers • Piezometers
Ice Rich Overburden Dump (IROD)	Originally constructed as a free-standing rockfill structure to contain ice-rich overburden. The IROD is no longer active and is now entirely surrounded by the Southwest Waste Dump rockfill.	None
Main Pit (Area 1 Pit) and Main Pit Tailings Management Facility (MPTMF)	Mining in the Main Pit was completed in 2011. Instability in the south wall of the pit occurred in 2009 during mining of Stage 3 of the pit, and subsequently a larger failure occurred in 2011 after completion of Stage 5. Continued sloughing and creep movement of the south wall led to the design and construction of a waste rock buttress, known as the South Wall Buttress, completed in 2013. Slurry tailings deposition into the pit began in 2012 and the pit is now maintained as a tailings management facility. Dumping of NP:AP<3 waste rock (SAT), intended to be below the final water table at closure, continues into the pit, forming several benches of “in-pit dumps”. Tension cracking on the west in-pit dump is monitored with a series of survey hubs installed in 2015 as recommended in previous inspection reports.	• Survey hubs • Inclinometer

Structure	Description	Instrumentation
Main Pit Dam	The Main Pit Dam is included in the Phase V/VI licence and has not been constructed yet. The dam will be located on the east end of the Main Pit to increase the tailings storage capacity of the MPTMF.	• Thermistors
Main Pit Dump	The Main Pit Dump is included in the Phase V/VI licence and has not commenced yet. The dump will be located on the southwest side of the Main Pit, partially on top of the South Wall Buttress.	N/A
Main Waste Dump (MWD)	The Main Waste Dump stores waste rock released during the mining of the first three stages of the Main Pit. The dump is no longer active however dumping is taking place nearby on the Main Waste Dump Expansion.	• Inclinometers
Main Waste Dump Expansion (MWDE)	This dump is an extension of the MWD and is currently the main active waste rock dump storing waste rock released from the Minto North Pit.	• Inclinometers
Mill Site	The mill site consists of the mill building, crusher and crusher stockpile pad.	None
Mill Valley Fill Extension (MFVE)	A waste rock buttress to the north of the DSTSF, constructed from January 2012 to March 2013 to prevent or decrease further movement of the DSTSF.	• Survey hubs
Mill Valley Fill Extension 2 (MVFE2)	An extension of the MVFE waste rock buttress to begin in Q4 2015 to further decrease movement of the DSTSF.	• Piezometers • Survey hubs
Mill Valley Fill Extension 2 Collection Sump	A replacement sump for the MCDS to be constructed in November 2015. It will detain surface water considered impacted from upstream sub-catchment areas and will direct it to the MPTMF or water treatment plant.	None
Mill Water Pond (MWP)	A small water storage pond that was previously used for excess process water and recirculation of mill process water. Currently not in use.	• Thermistors
Minto Access Road	Road from the Yukon River barge crossing to the mine site. Licenced under Type B water licence MS04-227.	None
Minto Creek Detention Structure (MCDS)	A small sump to detain surface water considered impacted from upstream sub-catchment areas (DSTSF) and direct it back to the Main Pit or water treatment plant.	None
Minto East, Area 2, Copper Keel, Wildfire Underground	The Area 2, Minto East, Copper Keel and Wildfire underground are in the phase V/VI mining plan and have not commenced yet.	N/A
Minto North Pit	Mining of the North Pit commenced in August 2015 and is scheduled to be completed in 2016.	• Radar
Ore Stockpiles	There are two primary ore stockpiles on site – North and South stockpile. These are located south of the crusher and east of the Area 2 pit.	None
Reclamation Overburden Dump (ROD)	Received the bulk of the overburden released as part of Phase IV and earlier mining of the Main Pit. The material in the ROD is available for use in reclamation of the mine at closure.	None

Structure	Description	Instrumentation
Ridgetop Pit (Ridgetop North Pit, Ridgetop South Pit)	The Ridgetop Pit (North and South) is included in the Phase V/VI licence and has not commenced yet.	• Thermistors
Ridgetop Waste Dump	The Ridgetop Waste Dump is included in the Phase V/VI licence and has not commenced yet.	N/A
South Diversion Ditch (SDD)	A diversion ditch located southeast of the Area 2 Pit to divert unaffected surface water around the mine workings.	None
South Wall Buttress (SWB)	Waste rock buttress constructed against the Main Pit south wall from 2009-2011 as a result of instability in the south wall of the pit.	• Survey hubs
Southwest Waste Dump (SWD)	The Southwest Waste Dump (SWD) stores waste rock released during phase IV mining. Dumping at the SWD is now complete and reclamation re-sloping began in 2015. Re-sloping is expected to be completed in 2016.	• Survey hubs • Inclinometers • Thermistors • Piezometers
Tailings Diversion Ditch (TDD)	A diversion ditch located south of the DSTSF to divert unaffected water around the tailings facility.	None
Water Storage Pond Dam (WSP)	The Water Storage Pond and Dam are located east of the mine along Minto Creek. The dam was constructed in 2006 as a clay-core water retention dam for collecting precipitation and surface water runoff at the site. Maximum depth of water at the face of the dam is approximately 15 m.	• Survey hubs • Thermistors • Piezometers

3 Design and Monitoring References

Table 2 lists the design reports for each structure and the monitoring/inspection guidance reports used to develop the inspection (Section 5) and instrumentation (Section 6) programs for each structure.

Table 2: Design Documents and Monitoring/Inspection Guidance Documents

Structure	Design Reports	Monitoring/Inspection Guidance Reports
Area 2 Pit and Area 2 Pit Tailings Management Facility (A2PTMF)	*Prefeasibility Geotechnical Evaluation, Phase IV, Minto Mine.* SRK, December 2009. *Review of Minto Area 2 West Wall Stability*. SRK, September 11, 2012. *Review of Minto Area 2 West Wall Stability-April 2013*. SRK, April 18, 2013. *Review of Minto Area 2 West Wall Stability-September 2013*. SRK, September 30, 2013. *Main Dam – Area 2 Pit Stability Assessment.* SRK Consulting Project: 1CM002.003.0701, February, 2015.	*Operation, Maintenance, and Surveillance Manual - Area 2 Pit Tailings Management Facility.* Minto, under development, expected completion in December, 2015.
Area 118 Pit	*Prefeasibility Geotechnical Evaluation, Phase IV, Minto Mine.* SRK, December 2009. *Review of Final Area 118 Pit Design*. SRK Consulting, Project: 219500.070. January, 2015.	-
Area 118 Underground	*Minto 118-Zone – FLAC3D Analysis of the Longhole Base Case Option.* Itasca, August 2014. *Geotechnical Characterization of Existing and Proposed Longhole Open Stope Mining Areas.* Golder Associates File: 1528754-002-R-Rev0-3000. July 30, 2015.	*Minto Mine Ground Control Plan – Underground Operations. Minto. 2014.*
Big Creek Bridge	-	-
Camp	-	-
Dry Stack Tailings Storage Facility (DSTSF)	*Geotechnical Design Report, Dry Stack Tailings Storage Facility, Minto Mine, Yukon*. EBA File: 1200173. January 2007.	*Operation, Maintenance, and Surveillance Manual, Dry Stack Tailings Storage Facility, Minto Mine, YT.* Revision 2014-1 SRK Consulting, November 2014. *Minto Mine Phase V/VI Adaptive Management Plan.* Minto, November 2014.
Ice Rich Overburden Dump (IROD)	*Geotechnical Design Ice-Rich Overburden Dump, Minto Mine, Minto, YT.* EBA file: 1200173. January 2006. *Ice-Rich Overburden Dump Containment Berm Inspection Report, Minto Mine Site, Minto Yukon.* EBA File: 1200173.001. June 19, 2007.	*Geotechnical Design Ice-Rich Overburden Dump, Minto Mine, Minto, YT.* EBA file: 1200173. January 2006. EBA, 2007. *Minto Mine Phase V/VI Adaptive Management Plan.* Minto, November 2014.

Structure	Design Reports	Monitoring/Inspection Guidance Reports
Main Pit (Area 1 Pit) and Main Pit Tailings Management Facility (MPTMF)	*Pit Slope Evaluation for Area 1 Open Pit.* SRK Consulting, Project: 2CM022.03, July 2007.	*Operation, Maintenance, and Surveillance Manual - Main Pit Tailings Management Facility.* Minto, under development, expected completion in December, 2015.
Main Pit Dam	*Main Dam Preliminary Design Report.* SRK Consulting Project: 1CM002.018, May 2014. *Main Dam – Area 2 Pit Stability Assessment.* SRK Consulting Project: 1CM002.003.0701, February, 2015.	-
Main Pit Dump	*Phase V/VI Main Pit Dump Physical Stability Assessment.* SRK Consulting Project: 1CM002.003.0701, November, 2013. *Update to the Main Pit Dump Physical Stability Assessment.* SRK Consulting Project: 1CM002.003.0701. February, 2015.	-
Main Waste Dump (MWD)	*Geotechnical Evaluation Proposed Main Waste Dump Minto Mine, Minto, YT.* EBA. April, 1998.	*Geotechnical Evaluation Proposed Main Waste Dump Minto Mine, Minto, YT.* EBA. April, 1998. *Minto Mine Phase V/VI Adaptive Management Plan.* Minto, November 2014.
Main Waste Dump Expansion (MWDE)	*Minto Mine Phase V/VI Expansion Waste Rock and Overburden Management Plan.* Minto. June, 2014. *Phase V/VI Main Waste Dump Expansion – Physical Stability Assessment.* SRK Consulting Project: 1CM002.012.012, November, 2013	*Minto Mine Phase V/VI Adaptive Management Plan.* Minto, November 2014.
Mill Site	-	-
Mill Valley Fill Extension (MFVE)	*Waste Rock and Overburden Management Plan, Phase IV Development, Minto Mine YT.* EBA File: W14101068.015. September 9, 2011. *Upstream Water Management for the Mill Valley Fill Expansion and Dry Stack Tailings Storage Facility.* EBA File: W14101168.013. September 14, 2011.	*Minto Mine Phase V/VI Adaptive Management Plan.* Minto, November 2014.
Mill Valley Fill Extension 2 (MVFE2)	*Minto Mine Phase V/VI Expansion Waste Rock and Overburden Management Plan.* Minto. June, 2014. *Mill Valley Fill Extension Stage 2 Preliminary Design Report.* SRK Consulting Project: 1CM002.015. March, 2014 *Mill Valley Fill Extension Stage 2 Final Design Report.* SRK Consulting Project: 1CM002.040. September, 2015.	*Mill Valley Fill Extension Stage 2 – Expected Performance and Evaluation Criteria.* SRK Consulting Project: 1CM002.040, November, 2015. *Minto Mine Phase V/VI Adaptive Management Plan.* Minto, November 2014.
Mill Valley Fill Extension 2 Collection Sump	*Design for the MVFE Stage 2 Collection Sump.* SRK Consulting Project: 1CM002.020. June, 2015.	-

Structure	Design Reports	Monitoring/Inspection Guidance Reports
Mill Water Pond (MWP)	-	*Construction Quality Assurance Manual for Waste Dumps, Tailings/Water Dam, Mill Water Pond, and Diversion Ditch, Minto Project, Yukon.* EBA File 0201-95-11509. August, 1997.
Minto Access Road	-	-
Minto Creek Detention Structre (MCDS)	*Conveyance Network Detention Structure and Water Collection Sump Design.* EBA. November 5, 2009. *Minto Project: Minto Creek Detention Structure Seepage Monitoring Program.* EBA File: W14101068.001. October 25, 2011.	*Minto Project: Minto Creek Detention Structure Seepage Monitoring Program.* EBA File: W14101068.001. October 25, 2011.
Minto East, Area 2, Copper Keel, Wildfire Underground	*Geotechnical Characterization of Existing and Proposed Longhole Open Stope Mining Areas,* Golder Associates, Reference No. 1528754-002-R-Rev0-3000, July, 2015. *Minto Mine Underground Reserve Update Geotechnical Input*, Golder Associates, Reference No. 1528754-003-R-Rev0-3000, July, 2015. *Minto Phase VI Underground Geotech Evaluation*, SRK Consulting Project: 2UC031.005,	-
Minto North Pit	*Minto Phase VI Preliminary Feasibility Study Technical Report.* SRK, January 2012.	*Minto Open Pit Ground Control Plan_Rev0. Minto, June, 2014.*
Ore Stockpiles	-	-
Reclamation Overburden Dump (ROD)	*Geotechnical Design Proposed Reclamation Overburden Dump, Minto Mine, Yukon.* EBA File: W14101068.004. February 2008. *Reclamation Overburden Dump Expansion Geotechnical Design Report.* EBA File: W14101068.0040. June 29, 2010.	*Reclamation Overburden Dump Expansion Geotechnical Design Report.* EBA File: W14101068.0040. June 29, 2010. *Minto Mine Phase V/VI Adaptive Management Plan.* Minto, November 2014.
Ridgetop Pit (Ridgetop North Pit, Ridgetop South Pit)	*Pre-Feasibility Geotechnical Evaluation Phase IV Minto Mine,* SRK Consulting Project: 2CM022.006, December, 2009. *Ridgetop North Pit TMF Stability Assessment,* SRK Consulting Project: 1CM002.003.710, February, 2015.	-
Ridgetop Waste Dump	*Phase V/VI Ridgetop Waste Dump Physical Stability Assessment.* SRK Consulting Project: 1CM002.012.0.12, November, 2013.	-
South Diversion Ditch (SDD)	*Phase 1 – Preliminary Engineering, Stormwater Diversion Ditches Minto Mine, YT,* EBA File: W14101068.013	-

Structure	Design Reports	Monitoring/Inspection Guidance Reports
South Wall Buttress	*Area 1 South Wall Buttress Design Report, Minto Mine, Yukon.* EBA File: W141010668.012, July 2011.	-
Southwest Waste Dump (SWD)	*Geotechnical Design Proposed Southwest Waste Dump, Minto Mine, Yukon.* EBA File: W14101068.005. September 2008.	*Geotechnical Design Proposed Southwest Waste Dump, Minto Mine, Yukon.* EBA File: W14101068.005. September 2008. *Minto Mine Phase V/VI Adaptive Management Plan.* Minto, November 2014.
Tailings Diverion Ditch (TDD)	*Preliminary Design of the Tailings Diversion Ditch Upgrade,* SRK Consulting Project: 1CM002.012.006, November, 2013.	-
Water Storage Pond Dam (WSP)	*Geotechnical Design Tailings/Water Dam, Minto Project, Yukon.* EBA File: 0201-95-11509. Dec. 1995. *As-built Construction Report, Water Retention Dam, Minto Mine, Minto, YT.* EBA File: 1200173.001. April 2008.	*Operation, Maintenance and Surveillance Manual, Water Retention Dam, Minto Mine, Minto, YT.* EBA File: W14103414-01. August 2014.

4 Roles and Responsbilities

Table 3 lists the roles and responsibilites for physical monitoring on the site.

Table 3: Roles and Responsibilities

Role	Responsibilities
Mine Technician Assistants	• Collect instrumentation data at specified frequencies • Input data into monitoring spreadsheets/databases • Internal reporting of monitoring data • Maintain equipment
Geotechnical Engineers	• QA/QC of data collection • Ensure compliance with license requirements • Monthly and annual Water License reporting • Visual inspections at specified frequencies • Communicate with consultants as required • Review and update Physical Monitoring Plan
Environmental Officers	• Compile monthly and annual Water Licence reports • Visual inspections of water diversion/collection structures
Chief Engineer	• Review annual Water Licence report • Ensure compliance with license requirements

5 Inspections

Table 4 lists the regular, required inspections.

Table 4: Inspections

Structure	Frequency	Description
Area 2 Pit and Area 2 Pit Tailings Management Facility (A2PTMF)	Weekly (while access to the pit bottom is required)	Visual inspection by Geotechnical Engineer and review of monitoring data as per OMS Manual.
Area 118 Pit	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Area 118 Underground	Quarterly	Visual inspection by Geotechnical Engineer as per Underground Ground Control Plan.
Big Creek Bridge	Annually	Visual inspection by a Professional Engineer as per MS04-227.
Camp	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Dry Stack Tailings Storage Facility (DSTSF)	Monthly	Visual inspection by Geotechnical Engineer and review of monitoring data as per OMS Manual.
Ice Rich Overburden Dump (IROD)	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Main Pit (Area 1 Pit) and Main Pit Tailings Management Facility (MPTMF)	Quarterly	Visual inspection by Geotechnical Engineer and review of monitoring data as per OMS Manual.
Main Pit Dam	N/A	N/A – structure does not exist yet.
Main Pit Dump	N/A	N/A – structure does not exist yet.
Main Waste Dump (MWD)	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.

Structure	Frequency	Description
Main Waste Dump Expansion (MWDE)	Minimum every 4 hours during active dumping Semi-Annually – May/June post thaw, and September pre freeze-up	Visual inspection by the supervisor or other competent person (typically the Pelly Shifter or Minto Operations Supervisor) as per O.I.C. 2006/178 Clause 15.44. Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Mill Site	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Mill Valley Fill Extension (MFVE)	Monthly	Visual inspection by Geotechnical Engineer and review of monitoring data as part of DSTSF monthly inspection.
Mill Valley Fill Extension 2 (MVFE2)	Minimum every 4 hours during active dumping Monthly	Visual inspection by the supervisor or other competent person (typically the Pelly Shifter or Minto Operations Supervisor) as per O.I.C. 2006/178 Clause 15.44. Visual inspection by Geotechnical Engineer and review of monitoring data as part of DSTSF monthly inspection.
Mill Valley Fill Extension 2 Collection Sump	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Mill Water Pond (MWP)	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Minto Access Road	Annually	Visual inspection by a Professional Engineer as per MS04-227.
Minto Creek Detention Structure (MCDS)	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Minto East, Area 2, Copper Keel, Wildfire Underground	N/A	N/A – structure does not exist yet.
Minto North Pit	Weekly (during active mining)	Visual inspection by Geotechnical Engineer/Geologist/Mine Engineer and review of monitoring data.
Ore Stockpiles	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.

Structure	Frequency	Description
Reclamation Overburden Dump (ROD)	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Ridgetop Pit (Ridgetop North Pit, Ridgetop South Pit)	N/A	N/A – structure does not exist yet.
Ridgetop Waste Dump	N/A	N/A – structure does not exist yet.
South Diversion Ditch (SDD)	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
South Wall Buttress (SWB)	Quarterly	Visual inspection by Geotechnical Engineer and review of monitoring data as part of the MPTMF quarterly inspection.
Southwest Waste Dump (SWD)	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Tailings Diversion Ditch (TDD)	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Water Storage Pond Dam (WSP)	Monthly	Visual inspection by Geotechnical Engineer as per OMS Manual.

6 Instrumentation

A map of sitewide active instrumentation is shown in Appendix A. Installation information and data collection schedules are contained in the following sections.

Inclinometers

Inclinometers are used to measure lateral, differential ground movement in a borehole. Inclinometer stations consist of grouted, slotted PVC pipe into which the inclinometer probe is lowered and deflection is measured at 0.5m intervals. The current probe used on site is an RST digital MEMS inclinometer system.

Table 5: Inclinometers

Area	ID	Northing (m)	Easting (m)	Elevation (m)	A0 Azimuth	Hole Depth (m)	Date Installed	Reading Frequency
Dry Stack Tailings Storage Facility	A2I-1	6944164.73	385298.95	822.46	302	55.5	2013-04-26	Quarterly
Dry Stack Tailings Storage Facility	DSI-10	6944926.43	386114.98	780.13	-	85	2010-11-12	Quarterly
Main Pit (Area 1 Pit) and Main Pit Tailings Management Facility (MPTMF)	MDI -2	6945013.08	384217.20	858.67	93	50.5	2010-02-10	Quarterly
Southwest Waste Dump	SDI-3	6944591.11	383966.00	847.42	90	46.5	2010-02-11	Quarterly

Survey Hubs

Survey hubs are used to monitor surface movement of structures and are comprised of steel posts cemented into waste rock or bedrock and equipped with a threaded base to which a high precision RTK-corrected GPS instrument is attached. The GPS currently used on site is a Trimble R8.

Table 6: Survey Hubs

Area	ID	Northing (m)	Easting (m)	Elevation (m)	Date Installed	Frequency
Area 2 Pit	A210	6944268.42	384934.69	861.28	2011-07-01	Monthly
Area 2 Pit	A215	6944649.45	385155.49	808.72	2015-09-17	Monthly
Area 2 Pit	A216	6944749.21	385046.39	805.78	2015-09-17	Monthly
Area 2 Pit	A217	6944756.78	384852.52	806.68	2015-09-17	Monthly
Area 2 Pit	A218	6944707.23	384783.21	806.83	2015-09-17	Monthly
Area 2 Pit	A2RAMP01	6944406.29	384866.97	777.24	2015-09-28	Weekly
Area 2 Pit	A2RAMP02	6944391.46	384867.81	776.08	2015-09-28	Weekly
Area 2 Pit	A2RAMP03	6944392.39	384894.81	773.95	2015-09-28	Weekly
Area 2 Pit	A2RAMP04	6944386.13	384911.18	772.20	2015-09-28	Weekly
Dry Stack Tailings Storage Facility	ASH05	6944280.52	385830.65	850.16	2011-03-07	Monthly
Dry Stack Tailings Storage Facility	ASH06	6944331.73	385623.79	824.17	2011-03-07	Monthly
Dry Stack Tailings Storage Facility	DSSH-12	6944933.16	385704.30	773.99	2010-04-06	Weekly
Dry Stack Tailings Storage Facility	DSSH-14	6944920.27	385606.55	782.88	2012-04-21	Weekly
Dry Stack Tailings Storage Facility	DSSH-15	6944942.65	385503.43	782.61	2012-04-21	Weekly
Dry Stack Tailings Storage Facility	DSSH-20	6945137.83	385730.25	765.83	2014-02-28	Weekly
Dry Stack Tailings Storage Facility	DSSH-24	6944757.90	385712.10	792.07	2014-02-28	Weekly
Dry Stack Tailings Storage Facility	DSSH-26	6944601.28	385490.96	796.35	2015-07-28	Weekly
Dry Stack Tailings Storage Facility	DSSH-27	6944755.11	385894.59	792.70	2015-07-28	Weekly
Main Pit	M81	6944971.63	384890.13	806.83	2012-05-08	Monthly
Mill Valley Fill Extension	DSSH-06	6944971.61	385553.16	773.83	2010-04-06	Weekly
Mill Valley Fill Extension	DSSH-10	6944992.62	385807.51	763.12	2010-04-06	Weekly
Mill Valley Fill Extension	DSSH-17	6944980.74	385896.26	772.07	2012-04-21	Weekly
Mill Valley Fill Extension	DSSH-18	6945069.81	385522.12	771.39	2014-02-28	Weekly
Mill Valley Fill Extension	DSSH-19	6945085.22	385642.14	769.16	2014-02-28	Weekly
Mill Valley Fill Extension 2	DSSH-28	To be installed after completion of MVFE2				
Mill Valley Fill Extension 2	DSSH-29	To be installed after completion of MVFE2				

Area	ID	Northing (m)	Easting (m)	Elevation (m)	Date Installed	Frequency
Mill Valley Fill Extension 2	DSSH-30	To be installed after completion of MVFE2				
Mill Valley Fill Extension 2	DSSH-31	To be installed after completion of MVFE2				
Mill Valley Fill Extension 2	DSSH-32	To be installed after completion of MVFE2				
South Wall Buttress	M73	6944723.57	384312.30	840.77	2011-05-23	Monthly
South Wall Buttress	M75	6944639.43	384475.64	837.55	2011-05-23	Monthly
South Wall Buttress	M76	6944623.10	384560.12	835.27	2011-05-23	Monthly
South Wall Buttress	M79	6944846.97	384208.90	847.66	2011-09-04	Monthly
South Wall Buttress	M80	6944931.70	384256.33	842.06	2011-09-04	Monthly
South Wall Buttress	M82	6944844.39	384433.50	820.17	2015-05-23	Bi-weekly
South Wall Buttress	M83	6944947.98	384475.79	809.06	2015-01-08	Bi-weekly
South Wall Buttress	M84	6945021.46	384445.11	807.37	2015-01-08	Bi-weekly
South Wall Buttress	M85	6944846.60	384315.66	826.08	2015-07-27	Monthly
South Wall Buttress	M86	6944668.03	384400.26	837.96	2015-07-27	Monthly
South Wall Buttress	M87	6944894.30	384383.86	821.67	2015-09-19	Bi-weekly
Southwest Waste Dump	SWD01	6944760.85	384077.86	859.07	2011-03-07	Monthly
Southwest Waste Dump	SWD02	6944570.23	383884.64	870.82	2011-03-07	Monthly
Southwest Waste Dump	SWD02A	6944741.35	384108.95	840.78	2011-03-07	Monthly
Southwest Waste Dump	SWD04A	6944161.48	383793.96	861.32	2011-03-07	Monthly
Southwest Waste Dump	SWD05A	6943939.94	383837.70	869.16	2011-03-07	Monthly
Southwest Waste Dump	SWD06	6944762.06	384189.37	836.42	2015-07-27	Monthly
Water Storage Pond Dam	WSP1	6945613.04	386480.98	723.31	2011-06-09	Monthly
Water Storage Pond Dam	WSP3	6945551.85	386548.62	719.73	2011-06-09	Monthly
Water Storage Pond Dam	WSP4	6945531.56	386555.22	719.93	2011-06-09	Monthly
Water Storage Pond Dam	WSP5	6945504.74	386560.23	721.02	2011-06-09	Monthly

Thermistors

Thermistor strings are used to measure ground temperature profiles in boreholes, and in particular permafrost conditions at Minto. Thermistor strings consist of multiple temperature sensor nodes distributed along a single multi-conductor cable, installed within or attached to the outside of grouted PVC pipe. EBA and RST thermistor strings have been installed on site. EBA thermistors are read using a basic ohmmeter and RST thermistors are read using a RST TH2016B readout unit.

Table 7: Thermistors

Area	ID	Northing (m)	Easting (m)	Elevation (m)	Thermistor String No.	Nodes	Hole Depth (m)	Date Installed	Reading Frequency
Area 2 Pit	A2T-1	6944162.01	385305.61	822.39	3491	16	63.4	2013-04-21	Quarterly
Dry Stack Tailings Storage Facility	DST-10	6944584.06	385489.49	797.13	3492	16	63.4	2013-04-17	Quarterly
Dry Stack Tailings Storage Facility	DST-11	6944899.64	385538.89	787.66	3494	16	86.9	2013-04-05	Quarterly
Dry Stack Tailings Storage Facility	DST-13	6945014.60	386271.29	777.01	3495	16	101.5	2013-04-02	Quarterly
Dry Stack Tailings Storage Facility	DST-14	6944769.09	385713.42	791.47	3497	16	66.5	2013-04-12	Quarterly
Dry Stack Tailings Storage Facility	DST-15	6945033.78	385958.17	764.51	3493	16	64.0	2013-03-25	Quarterly
Main Pit Dam	MPDT-1	6944998.17	384975.94	791.50	3702	16	59.5	2014-05-31	Quarterly
Main Pit Dam	MPDT-2	6944877.14	384855.38	811.36	3703	16	95.5	2014-06-04	Quarterly
Mill Water Pond	MWPT1	6944992.23	385062.50	784.12	2070	16	23.8	2007-11-02	Quarterly
Mill Water Pond	MWPT2	6945015.72	385113.61	784.22	2071	16	23.8	2007-11-02	Quarterly
Mill Water Pond	MW11-01A	6945010.90	385097.00	784.50	2320	11	101.70	2011-11-20	Quarterly
Water Storage Pond	WDT-1	6945523.08	386550.83	720.03	2072	16	42.49	2007-11-16	Monthly
Water Storage Pond	WDT-2	6945532.89	386574.77	713.66	2073	6	44.50	2007-11-07	Monthly
Water Storage Pond	WDT-3	6945544.10	386544.43	719.78	2074	16	49.42	2007-11-11	Monthly
Water Storage Pond	WDT-4	6945534.98	386547.90	719.85	2075	16	49.42	2007-11-10	Monthly

Water Storage Pond	WDT-5	6945504.57	386557.50	721.03	2076	16	35.13	2007-11-13	Monthly
Water Storage Pond	WDT-6	6945505.55	386556.32	721.03	2077	16	33.72	2007-11-13	Monthly
Water Storage Pond	WDT-7	6945504.65	386556.39	721.08	2078	16	33.92	2007-11-13	Monthly
Water Storage Pond	WDT-8	6945532.89	386574.77	713.66	2079	16	34.14	2007-11-07	Monthly
Southwest Waste Dump	SDT-1	6944766.71	384779.13	836.36	2220	16	59.1	2010-02-04	Quarterly
Southwest Waste Dump	SDT-2	6944595.06	383971.30	847.11	2221	16	14.6	2010-01-31	Quarterly
Southwest Waste Dump	SDT-3	6944333.87	383824.67	860.17	2222	16	15.8	2010-01-28	Quarterly
Southwest Waste Dump	SDT-4	6944163.62	383783.54	860.99	2223	16	13.1	2010-01-30	Quarterly

Vibrating Wire Piezometers

Vibrating wire piezometer strings are used to measure pore water pressure profiles in boreholes. They consist of multiple vibrating wire sensors installed on PVC pipe in grouted boreholes. RST vibrating wire piezometers are installed on site and data is collected with an RST VW2106 readout unit.

Table 8: Vibrating Wire Piezometers

Area	ID	Northing (m)	Easting (m)	Elevation (m)	Sensor	No.	Sensor Elevation (m)	Date Installed	Reading Frequency
Dry Stack Tailings Storage Facility	DSP-5	6944769	385713	791.47	DSP-5A	VW24851	765.47	2013-04-16	Monthly
					DSP-5B	VW24853	761.47		
Dry Stack Tailings Storage Facility	DSP-6	6944900	385539	787.66	DSP-6A	VW24850	769.56	2013-04-05	Monthly
					DSP-6B	VW24852	765.56		
Dry Stack Tailings Storage Facility	DSP-7	-	-	-	DSP-07	To be installed Q4 2015			
Dry Stack Tailings Storage Facility	DSP-8	-	-	-	DSP-08	To be installed Q4 2015			
Dry Stack Tailings Storage Facility	DSP-9	-	-	-	DSP-09	To be installed Q4 2015			
Dry Stack Tailings Storage Facility	DSP-10	-	-	-	DSP-10	To be installed Q4 2015			
Southwest Waste Dump	SDP-2	6944595.06	383971.30	843.41	SDP-2A	VW12912	843.414	2010-01-31	Monthly
					SDP-2B	VW12911	842.714		
Southwest Waste Dump	SDP-3	6944333.87	383824.67	854.27	SDP-3A	VW12906	854.266	2010-01-28	Monthly
					SDP-3B	VW12907	853.566		
Southwest Waste Dump	SDP-4	6944163.62	383783.54	858.49	SDP-4A	VW12908	858.494	2010-01-30	Monthly
					SDP-4B	VW12909	857.794		
Water Storage Pond	WDP-2	6945632	386545	701.67	WDP-2	VW7212	701.67	2007-11-04	Monthly
Water Storage Pond	WDP-3A	6945618	386498	712.62	WDP-3A	VW7557	712.62	2007-11-28	Monthly
Water Storage Pond	WDP-3	6945609	386500	712.60	WDP-3	VW7202	712.60	2007-11-12	Monthly
Water Storage Pond	WDP-4	6945609	386500	702.60	WD -4	VW7210	702.60	2007-11-14	Monthly

Water Storage Pond	WDP-5	6945605	386526	712.35	WDP-5	VW7204	712.35	2007-11-20	Monthly
Water Storage Pond	WDP-6	6945605	386526	701.50	WDP-6	VW7214	701.50	2007-11-20	Monthly
Water Storage Pond	WDP-7	6945605	386526	689.20	WDP-7	VW7208	689.20	2007-11-20	Monthly
Water Storage Pond	WDP-8	6945554	386542	693.10	WDP-8	VW7200	693.10	2007-11-18	Monthly
Water Storage Pond	WDP-9	6945554	386542	687.93	WDP-9	VW7206	687.93	2007-11-18	Monthly
Water Storage Pond	WDP-10	6945554	386542	676.17	WDP-10	VW7211	676.17	2007-11-18	Monthly
Water Storage Pond	WDP-11	6945523	386551	712.96	WDP-11	VW7201	712.96	2007-11-16	Monthly
Water Storage Pond	WDP-12	6945523	386551	694.64	WDP-12	VW7209	694.64	2007-11-16	Monthly
Water Storage Pond	WDP-13	6945533	386578	684.55	WDP-13	VW7205	684.55	2007-11-07	Monthly

7 Instrumentation Procedures and Documentation

Data collection manuals for all monitoring devices are included in Appendix B.

After collection, data is input into a series of spreadsheets and databases used for storing, tracking and interpreting instrumentation data. Instructions for data input are contained in the instrumentation manuals in Appendix B.

8 Quality Assurance/Quality Control

Planned job obsrevations (PJO's) are routinely performed and documented on Mine Technician Assistants to verify data collection is consistent with the designed procedures.

Data collection equipment is returned to the manufacturers as per their recommended calibration schedules, typically annually.

All data is reviewed and summarized by the Geotechnical Engineer monthly as part of the Water Licence reporting.

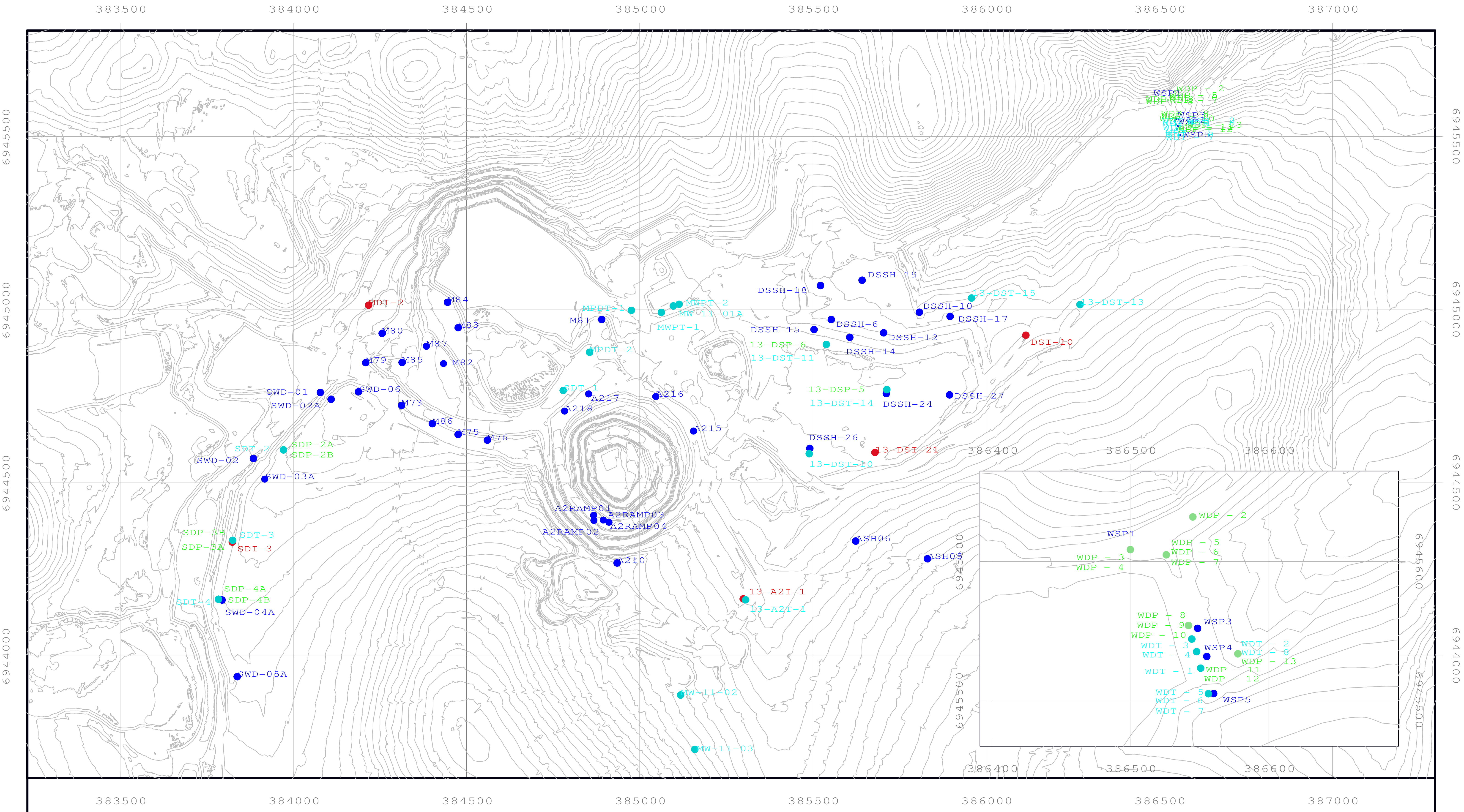
9 Reporting

Regular processing and review of monitoring data is completed and presented in the following documents.

Table 9: Reporting

Report	Frequency	Submission
Pit Wall Inspection Reports	Weekly	Submitted internally each week
Minto Mine Type A Water Licence QZ14-031 Monthly Report (Clause 4.4)	Monthly	Submitted to Yukon Water Board maximum 30 days following each month
DSTSF Inspection Reports	Monthly	Filed internally within one week of the inspection
Water Storage Pond Dam Inspection Reports	Monthly	Filed internally within one week of the inspection
Area 2 and Main Pit Tailings Storage Facility Inspection Reports	Quarterly	Filed internally within one month of the inspection
Semi-Annual Site-wide Geotechnical Inspection Report	After spring melt (May/June) and before freeze-up (September)	Submitted to Yukon Water Board within 60 days of inspections. Q2 report must be submitted to EMR within 60 days of the inspection.
Minto Mine Type A Water Licence QZ14-031 Annual Report (Clause 4.5)	Annually	Submitted to Yukon Water Board by March 31 each year
Minto Mine Type B Water Licence MS04-227 Annual Inspection Report (Clauses 46 and 48)	Annually	Submitted to Yukon Water Board within 30 days of the inspection

Appendix A: Instrumentation Map



DESIGNED BY: HF	DATE PLOTTED: 30-Nov-2015
CHECKED BY:	SCALE:

Monitoring Instrumentation

Comments:

LEGEND

● SURVEY HUBS
● THERMISTORS
● PIEZOMETERS
● INCLINOMETERS

capstone
MINTO MINE

Appendix B: Data Collection and Input Manuals

Inclinometer Measurements

Please refer to RST MEMS Digital Inclinometer System Instruction Manual for complete instruction.

System Overview:

Figure 1 – System Overview

1. Soft Shell Case
2. Digital Inclinometer Probe (w/ protective end cap)
3. Reel Battery Charger
4. 70mm/2.75" OD Cable Grip
5. 85mm/3.34" OD Cable Grip
6. Ultra-Rugged Field PC
7. 12V DC car adapter for Reel Battery Charger or Ultra-Rugged Field PC
8. Spare Reel Battery
9. Silicone Lubricant (for use on connectors)
10. USB Cable for Ultra-Rugged Field PC
11. AC Adapter (110-240V) for Reel Battery Charger
12. AC Adapter (110-240V) for Ultra-Rugged Field PC
13. Cable Reel with Wireless Communication System and protective end cap
14. Reel Carrying Case

1. Make sure the battery for the reel and the Field PC are charged.
2. Lift up protective box with two hands and put it on side as a work bench.

3. Remove cap from inclinometer casing and look for A_0 marking (black mark).

4. Remove excess water inside the probe and the cable connector.
   Probe is very sensitive and susceptible to vibration. **DO NOT BANG THE PROBE**. Use a paper towel to wipe it.

5. Apply silicon lubricant to probe and cable connector when needed.

6. Connect the inclinometer cable to the probe by aligning the keyways and threading the connector onto the probe. Turn the threaded ring, but not the cable.

7. Turn on the power of the reel. A green light indicates that the power is on. This energizes the accelerometers and makes them less susceptible to shock.

8. Check the depth of the hole. Turn on Field PC and select the hole you are going to measure.

9. Always start with **UPPER** Wheel in the A_0 direction.

10. Lower the probe gently and carefully. When it gets close to the bottom lower it very gently to avoid bouncing the probe off the bottom of the hole. The cable has aluminum sleeve marks which are spaced at 0.5m and it has a red measure mark with label every 5m.

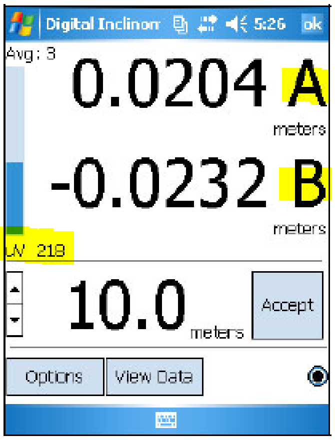
11. Lower the probe gently to ensure the bottom of the hole is encountered. (Slightly passed the designated depth). Double check your correct depth by pulling out reel to the next 5m mark and counting back each 0.5m for each increment.

12. Place the cable grip on top of the casing and hang the cable by the aluminum crimps.

13. Connect the Field PC to the reel. Use the pen attached to the field PC and press “*Connections”.*

14. Once connected, hit “*Readings*”.


15. At each depth allow the A and B readings as well as the noise level become stabilized before you accept the readings. Ideally noise level should be at or below 30 µV.

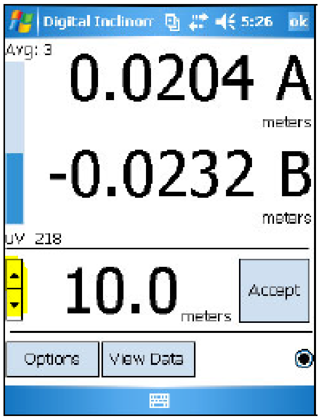


Avg: 3
0.0204 A
meters
-0.0232 B
meters
µV 218
10.0 meters

16. Wear gloves as the Envirobind inside the inclinometer casing can be sticky and irritable. Pull up gently to the next marker and let the aluminum crimp to sit on the metal grip. Wait for the readings and noise level to stabilize and then hit *“Accept”*.


17. If you accidentally pull the probe too far (more than an inch), lower the probe back down to the previous bead then pull up to the bead you want to measure. This will ensure that the readings remain consistent.

18. At each 5m mark, check that you are at the right location. If you miss or overpass a reading, go back to the previous 5m depth. For examples, if something goes wrong at 41.5m, go back to 45m and drop the cable to 45.5m. Then gently pull up to 45m and hit *"Accept"* again. There are arrow keys on the Field PC which allow you to adjust your depth.



Avg: 3
0.0204 A
meters
-0.0232 B
meters
uV 218
10.0
meters
Accept

19. Once the last reading (0.5m) is taken, gently take out the probe and turn it 180° so that the **Lower** wheel is now in the A_0 direction.

20. Go back gently to the bottom of hole and take the second set of readings.

21. During the measurement of the second set of readings, checksum data will appear in a smaller font below the current readings. Checksum should be reasonably small and consistent. Ideally it should be somewhere between -0.0035m to +0.0045m.

22. If the checksum is large (> 0.01m) and inconsistent, check the following:
    - Is the probe at the right depth?
    - Is the probe in the correct direction?
    - Lower the probe to the previous depth and retake the reading again.

    It is possible that checksum is high due to differential pressure in the ground. In that case continue measurement and keep monitoring checksum.

23. Once readings are completed, take out the probe and wipe away the Envirobind gently. Put the caps back onto the probe and connector.

Data Input

Note: Windows Mobile Device Center must be installed on the computer in order to collect the readout unit to the computer.

1. Connect the USB cable from the readout unit to the computer and turn the power on.
2. Open DMM for Windows

3. *File – Open – Project Database*
   The database for all inclinometer data is stored here:
   [X:\Mine Technical\03 - Monitoring\! Inclinometers\Master Database]()

4. *File – Import – Import RPP file*
   Navigate to the mobile device and select the .rpp file for the appropriate monitoring station and date. The data will then import and save in the database automatically.

Thermistor Readings

Two different types of thermistors are currently installed on site – RST and EBA thermistors.

To read RST thermistors:

1. Connect adapter cord to the TH2016B Readout Box.
2. Record the resistivity (Ohms) for each thermistor node on paper or store the data in the readout box with the following steps:
    a. Scroll with the Up/Down arrows to the ***Memory*** screen and press enter (arrow key)

    b. Scroll with the Up/Down arrows to the ***Store Data*** screen and press enter

    c. Scroll with the Up/Down arrows to the station being monitored and press enter to store the reading

    d. The data is now stored and the readbox can be turned off by pressing the escape button (ESC) three times to get back to the main menu and scrolling to Power Off.

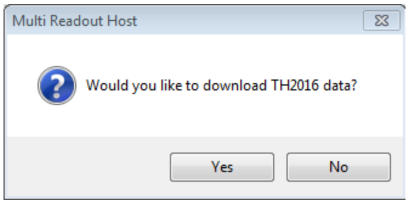
To read EBA thermistors:

1. Connect the EBA 16 Point Ground Temperature Dial into the thermistor cable.
2. Connect the multi-meter to the EBA 16 Point Ground Temperature Dial.
3. Record on paper the resistance in Ohm’s (Ω) for each point.

Data Downloading

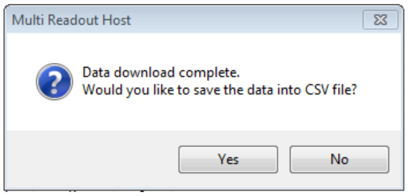
1. Connect USB cord from computer to the readout box.
2. Open the software Multi Readout Host.

3. Turn on the power on the readout box.
4. The software will recognize the readout unit and prompt to download data. Choose “Yes” to download the data from the readout unit.



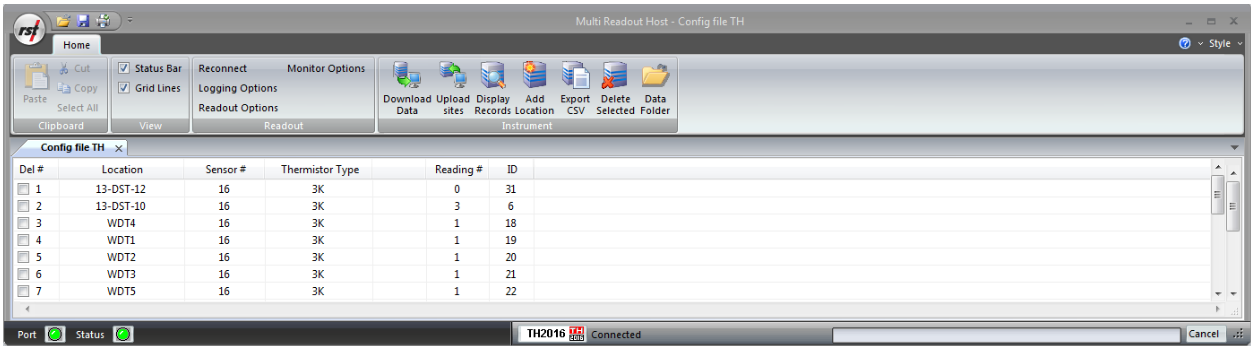
Would you like to download TH2016 data?

5. Once data is downloaded you will have the option to save all data as .csv file. Choose “Yes” and the data will be stored in My Documents in a folder named “TH2016data”.



Data download complete.
Would you like to save the data into CSV file?

6. The software can be used to setup new locations or view data but no further steps are required.



Del #	Location	Sensor #	Thermistor Type		Reading #	ID
☐ 1	13-DST-12	16	3K		0	31
☐ 2	13-DST-10	16	3K		3	6
☐ 3	WDT4	16	3K		1	18
☐ 4	WDT1	16	3K		1	19
☐ 5	WDT2	16	3K		1	20
☐ 6	WDT3	16	3K		1	21
☐ 7	WDT5	16	3K		1	22

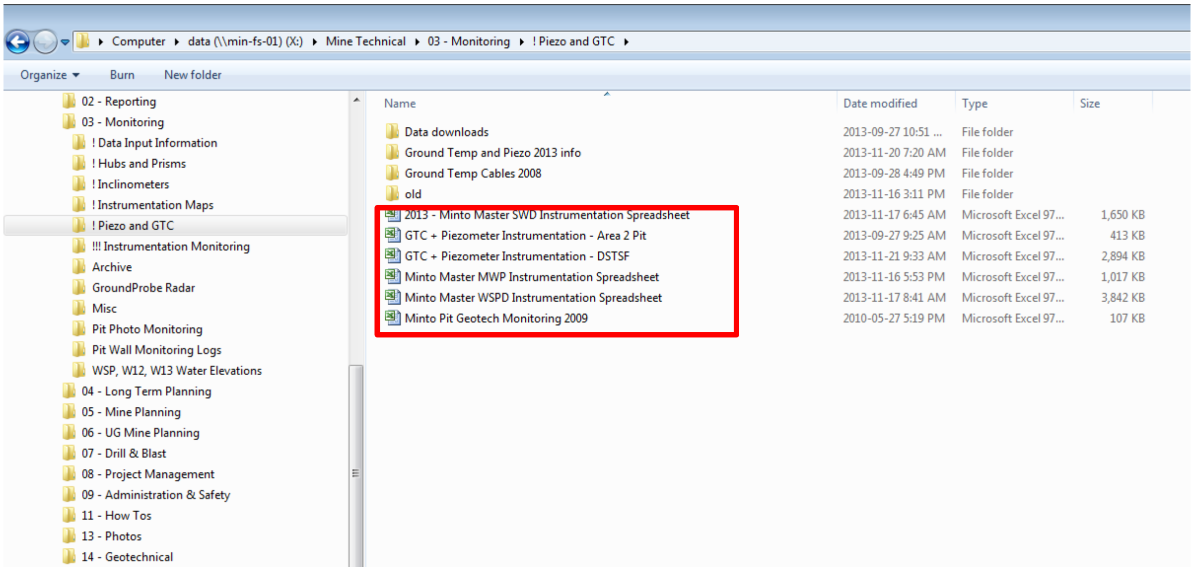
TH2016 Connected

Data Input

Spreadsheets for piezometer data input and tracking are stored here:

<u>X:\Mine Technical\03 - Monitoring\! Piezo and GTC</u>

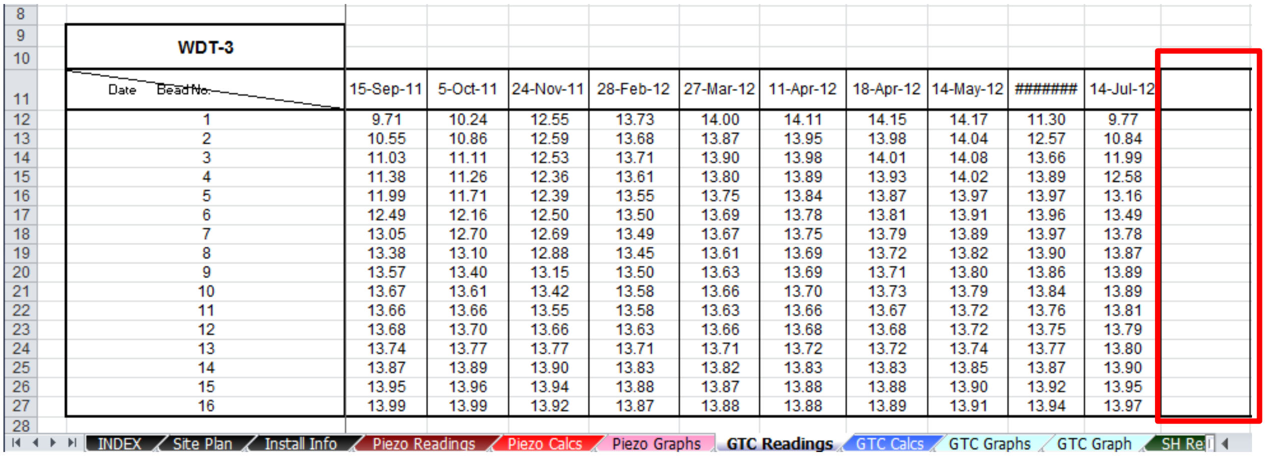
1. Open the spreadsheet for the area monitored



Name	Date modified	Type	Size
Data downloads	2013-09-27 10:51 ...	File folder	
Ground Temp and Piezo 2013 info	2013-11-20 7:20 AM	File folder	
Ground Temp Cables 2008	2013-09-28 4:49 PM	File folder	
old	2013-11-16 3:11 PM	File folder	
2013 - Minto Master SWD Instrumentation Spreadsheet	2013-11-17 6:45 AM	Microsoft Excel 97...	1,650 KB
GTC + Piezometer Instrumentation - Area 2 Pit	2013-09-27 9:25 AM	Microsoft Excel 97...	413 KB
GTC + Piezometer Instrumentation - DSTSF	2013-11-21 9:33 AM	Microsoft Excel 97...	2,894 KB
Minto Master MWP Instrumentation Spreadsheet	2013-11-16 5:53 PM	Microsoft Excel 97...	1,017 KB
Minto Master WSPD Instrumentation Spreadsheet	2013-11-17 8:41 AM	Microsoft Excel 97...	3,842 KB
Minto Pit Geotech Monitoring 2009	2010-05-27 5:19 PM	Microsoft Excel 97...	107 KB

2. Open the tab “GTC Readings”

3. In a new column enter the date and copy the resistivity data (Ohms) from the paper records, or from the .csv file saved in either “TH2016data” or “VW2016data” saved in My Documents.



WDT-3

Date Bead No.	15-Sep-11	5-Oct-11	24-Nov-11	28-Feb-12	27-Mar-12	11-Apr-12	18-Apr-12	14-May-12	#######	14-Jul-12	
1	9.71	10.24	12.55	13.73	14.00	14.11	14.15	14.17	11.30	9.77	
2	10.55	10.86	12.59	13.68	13.87	13.95	13.98	14.04	12.57	10.84	
3	11.03	11.11	12.53	13.71	13.90	13.98	14.01	14.08	13.66	11.99	
4	11.38	11.26	12.36	13.61	13.80	13.89	13.93	14.02	13.89	12.58	
5	11.99	11.71	12.39	13.55	13.75	13.84	13.87	13.97	13.97	13.16	
6	12.49	12.16	12.50	13.50	13.69	13.78	13.81	13.91	13.96	13.49	
7	13.05	12.70	12.69	13.49	13.67	13.75	13.79	13.89	13.97	13.78	
8	13.38	13.10	12.88	13.45	13.61	13.69	13.72	13.82	13.90	13.87	
9	13.57	13.40	13.15	13.50	13.63	13.69	13.71	13.80	13.86	13.89	
10	13.67	13.61	13.42	13.58	13.66	13.70	13.73	13.79	13.84	13.89	
11	13.66	13.66	13.55	13.58	13.63	13.66	13.67	13.72	13.76	13.81	
12	13.68	13.70	13.66	13.63	13.66	13.68	13.68	13.72	13.75	13.79	
13	13.74	13.77	13.77	13.71	13.71	13.72	13.72	13.74	13.77	13.80	
14	13.87	13.89	13.90	13.83	13.82	13.83	13.83	13.85	13.87	13.90	
15	13.95	13.96	13.94	13.88	13.87	13.88	13.88	13.90	13.92	13.95	
16	13.99	13.99	13.92	13.87	13.88	13.88	13.89	13.91	13.94	13.97	

Vibrating Wire Piezometer Readings

1. Connect adapter cord to the VW2106 Readout Box.
2. Connect the coloured wires to the correct wire clips on the extension cable. Make sure the wires do not touch each other.
3. Record the **DATE** and **TIME** as barometric pressure will be needed to calibrate the water level.
4. Record the measurement (between 7000B to 9000B) and the temperature (°C) for each piezometer. The piezometer ID should be labeled on the wire (eg. P5a and P5b).

5. Alternatively the data can be stored in the readout box:

   a. Scroll with the Up/Down arrows to the ***Memory*** screen and press enter (arrow key)

   b. Scroll with the Up/Down arrows to the ***Store Data*** screen and press enter

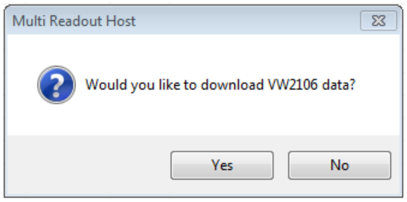
c. Scroll with the Up/Down arrows to the station being monitored and press enter to store the reading

d. The data is now stored and the readout box can be turned off by pressing the escape button (ESC) three times to get back to the main menu and scrolling to Power Off.

Data Downloading

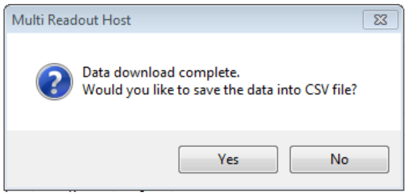
7. Connect USB cord from computer to the readout box.
8. Open the software Multi Readout Host.

9. Turn on the power on the readout box.
10. The software will recognize the readout unit and prompt to download data. Choose “Yes” to download the data from the readout unit.



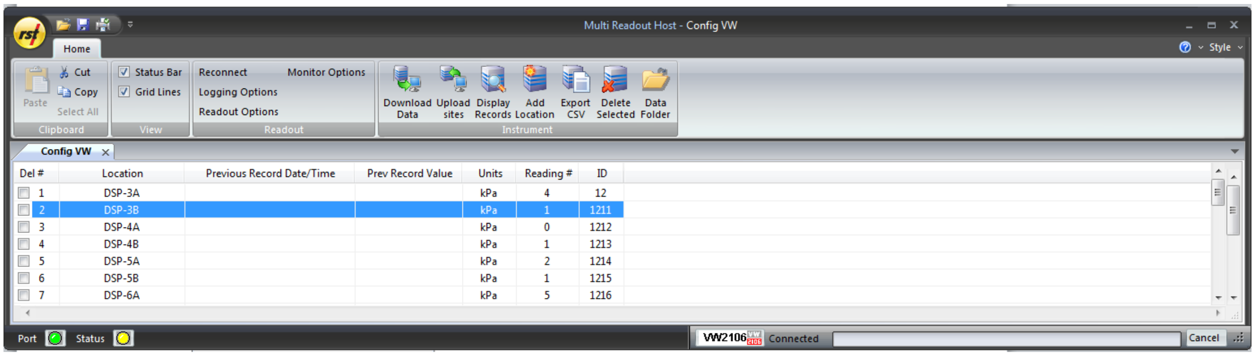
Would you like to download VW2106 data?

11. Once data is downloaded you will have the option to save all data as .csv file. Choose “Yes” and the data will be stored in My Documents in a folder named “VW2016data”.



Data download complete.
Would you like to save the data into CSV file?

12. The software can be used to setup new locations or view data but no further steps are required.



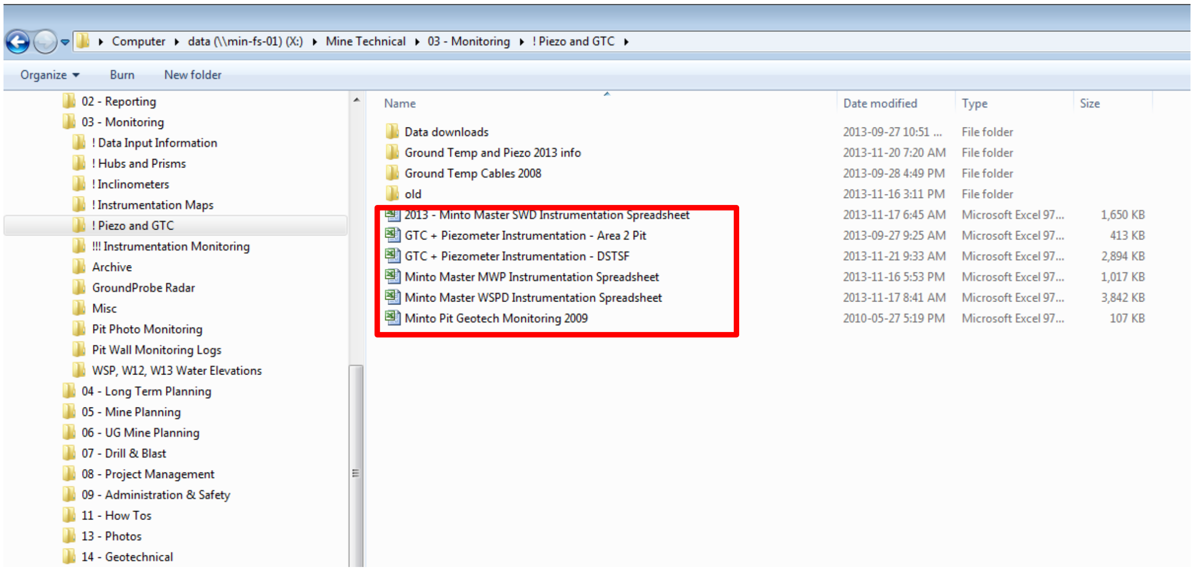
Del #		Location	Previous Record Date/Time	Prev Record Value	Units	Reading #	ID
☐	1	DSP-3A			kPa	4	12
☐	2	DSP-3B			kPa	1	1211
☐	3	DSP-4A			kPa	0	1212
☐	4	DSP-4B			kPa	1	1213
☐	5	DSP-5A			kPa	2	1214
☐	6	DSP-5B			kPa	1	1215
☐	7	DSP-6A			kPa	5	1216

Data Input

Spreadsheets for piezometer data input and tracking are stored here:

X:\Mine Technical\03 - Monitoring\! Piezo and GTC

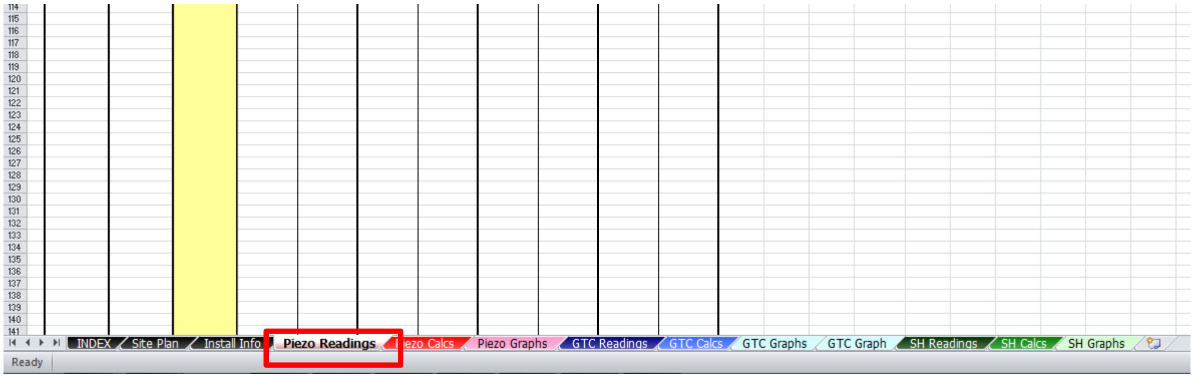
4. Open the spreadsheet for the area monitored



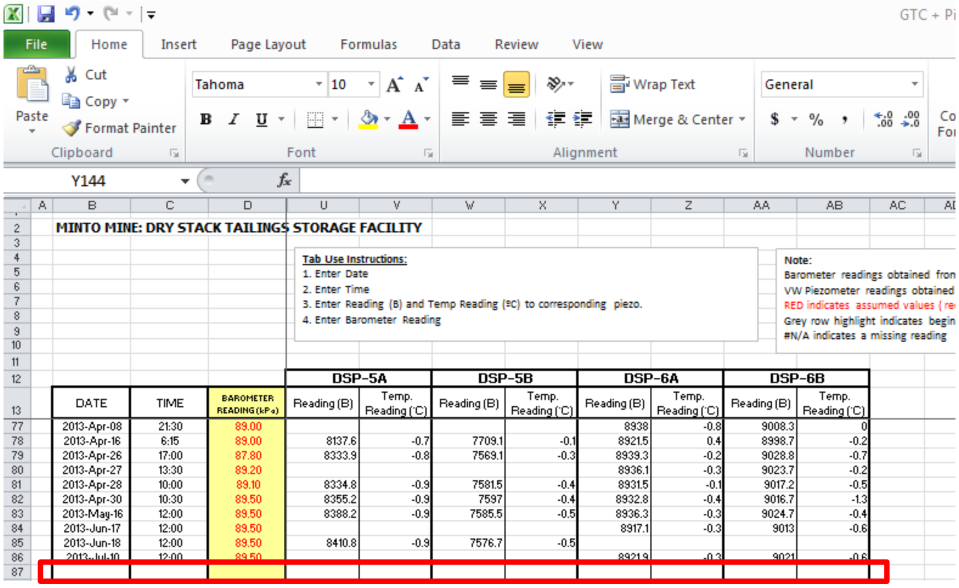
- 02 - Reporting
- 03 - Monitoring
  - ! Data Input Information
  - ! Hubs and Prisms
  - ! Inclinometers
  - ! Instrumentation Maps
  - ! Piezo and GTC
  - !!! Instrumentation Monitoring
  - Archive
  - GroundProbe Radar
  - Misc
  - Pit Photo Monitoring
  - Pit Wall Monitoring Logs
  - WSP, W12, W13 Water Elevations
- 04 - Long Term Planning
- 05 - Mine Planning
- 06 - UG Mine Planning
- 07 - Drill & Blast
- 08 - Project Management
- 09 - Administration & Safety
- 11 - How Tos
- 13 - Photos
- 14 - Geotechnical

Name	Date modified	Type	Size
Data downloads	2013-09-27 10:51 ...	File folder	
Ground Temp and Piezo 2013 info	2013-11-20 7:20 AM	File folder	
Ground Temp Cables 2008	2013-09-28 4:49 PM	File folder	
old	2013-11-16 3:11 PM	File folder	
2013 - Minto Master SWD Instrumentation Spreadsheet	2013-11-17 6:45 AM	Microsoft Excel 97...	1,650 KB
GTC + Piezometer Instrumentation - Area 2 Pit	2013-09-27 9:25 AM	Microsoft Excel 97...	413 KB
GTC + Piezometer Instrumentation - DSTSF	2013-11-21 9:33 AM	Microsoft Excel 97...	2,894 KB
Minto Master MWP Instrumentation Spreadsheet	2013-11-16 5:53 PM	Microsoft Excel 97...	1,017 KB
Minto Master WSPD Instrumentation Spreadsheet	2013-11-17 8:41 AM	Microsoft Excel 97...	3,842 KB
Minto Pit Geotech Monitoring 2009	2010-05-27 5:19 PM	Microsoft Excel 97...	107 KB

5. Open the tab “Piezo Readings”



6. In a new row, input the date, time, barometric pressure, B-unit and temperature readings for each instrument.



MINTO MINE: DRY STACK TAILINGS STORAGE FACILITY

Tab Use Instructions:
1. Enter Date
2. Enter Time
3. Enter Reading (B) and Temp Reading (ºC) to corresponding piezo.
4. Enter Barometer Reading

Note:
Barometer readings obtained fron
VW Piezometer readings obtained
RED indicates assumed values (re
Grey row highlight indicates begin
#N/A indicates a missing reading

				DSP-5A		DSP-5B		DSP-6A		DSP-6B	
13	DATE	TIME	BAROMETER READING (kPa)	Reading (B)	Temp. Reading (°C)	Reading (B)	Temp. Reading (°C)	Reading (B)	Temp. Reading (°C)	Reading (B)	Temp. Reading (°C)
77	2013-Apr-08	21:30	89.00					8938	-0.8	9008.3	0
78	2013-Apr-16	6:15	89.00	8137.6	-0.7	7709.1	-0.1	8921.5	0.4	8998.7	-0.2
79	2013-Apr-26	17:00	87.80	8333.9	-0.8	7569.1	-0.3	8939.3	-0.2	9028.8	-0.7
80	2013-Apr-27	13:30	89.20					8936.1	-0.3	9023.7	-0.2
81	2013-Apr-28	10:00	89.10	8334.8	-0.9	7581.5	-0.4	8931.5	-0.1	9017.2	-0.5
82	2013-Apr-30	10:30	89.50	8355.2	-0.9	7597	-0.4	8932.8	-0.4	9016.7	-1.3
83	2013-May-16	12:00	89.50	8388.2	-0.9	7585.5	-0.5	8936.3	-0.3	9024.7	-0.4
84	2013-Jun-17	12:00	89.50					8917.1	-0.3	9013	-0.6
85	2013-Jun-18	12:00	89.50	8410.8	-0.9	7576.7	-0.5				
86	2013-Jul-10	12:00	89.50					8921.9	-0.3	9021	-0.6
87											

Barometric pressure can be obtained from the site’s weather monitoring stations. Data is stored here:

X:\Environmental\Environmental Monitoring Program\1 MASTER LOGS\Meteorology Station Data\Met Station 1 and 2 Data Summary.xlsx

Summary of Minto Mine Aquatic Environmental Monitoring Program (AEMP) study design components.

AEMP Component	Area	Area Description	Program	Method	Replication	Frequency
Effluent Sublethal Toxicity Testing	Upper Minto Creek	Minto final effluent	EEM	Evaluation of effluent will be measured in 4 toxicity tests; rainbow trout embryos, *Ceriodaphnia dubia* , *Pseudokerchneriella subcapitata* and *Lemna minor* .	Approximately 100 L of final effluent	Once every 3 years[1]
Supporting Water Chemistry	Lower Wolverine Creek	Reference area for Lower Minto Creek.	WUL	Water quality sampling for laboratory analysis[3].	1 station per area.	Once a year
	Lower Big Creek	Reference area for Lower Minto Creek.				
			EEM			Once every 3 years
	Lower Minto Creek	Farthest field exposure below water storage pond (WSP).	WUL			Once a year
			EEM			Once every 3 years
	Upper McGinty Creek	Reference area for Upper Minto Creek.	WUL			Once a year
	Upper Minto Creek[2]	Exposure area just below WSP.				
			EEM		3 stations per area for EEM.	Once every 3 years
	10 RCA Reference Creeks	The 10 most appropriate reference creeks chosen from Phase 3 IOC.			1 station per area.	
	1:3 Effluent:Receiving Water	A 1:3 ratio between effluent and receiving water.			4 times over the exposure period.	
	1:6 Effluent:Receiving Water	A 1:6 ratio between effluent and receiving water.				
Sediment Chemistry	Lower Wolverine Creek	Reference area for Lower Minto Creek.	WUL	A hand corer and petite ponar is used to collected sediment for laboratory analysis[3].	3 hand corer composite for metals and 3 ponar composite for particle size at each station. 5 stations per area.	Once a year
	Lower Minto Creek	Farthest field exposure area below WSP.				
	Upper McGinty Creek	Reference area for Upper Minto Creek.		A stainless steel spoon used to collected sediment for laboratory analysis[3].	1 jar for metals at each station and 1 bag for particle size at each area. 5 stations per area.	
	Upper Minto Creek	Exposure area just below WSP.				
Sediment Toxicity Testing	Lower Wolverine Creek	Reference area for Lower Minto Creek.	WUL	A petite ponar is used to collect sediment for toxicity testing. A 14d *Hyalella azteca* and a 10d *Chironomus dilutus* sediment toxicity test will be conducted.	3 ponar composite will be collected at each stations per area. 5 stations per area.	Once a year
	Lower Minto Creek	Farthest field exposure area below WSP.				
Periphyton Chlorophyll α	Lower Wolverine Creek	Reference area for Lower Minto Creek.	WUL	Periphyton from a 4x4 cm^2 template is collected on filter paper and wrapped in aluminum foil.	5 rock composite from each station per area. 5 stations per area.	Once a year
	Lower Minto Creek	Farthest field exposure area below WSP.				
Periphyton Community	Lower Wolverine Creek	Reference area for Lower Minto Creek.	WUL	Periphyton from a 4x4 cm^2 template is collected and placed in small plastic jars with water and Lugol's solution.	5 rock composite from each station per area. 5 stations per area.	Once a year
	Lower Minto Creek	Farthest field exposure area below WSP.				
Periphyton Tissue Chemistry	Lower Wolverine Creek	Reference area for Lower Minto Creek.	WUL	Periphyton from a 4x4 cm^2 template is collected and placed in small plastic jars with little or no water for laboratory analysis[3].	5 rock composite from each station per area. 5 stations per area.	Once a year
	Lower Big Creek	Reference area for Lower Minto Creek.				
	Lower Minto Creek	Farthest field exposure area below WSP.				
Benthic Invertebrate Community	Lower Wolverine Creek	Reference area for Lower Minto Creek.	WUL	Rocks scrubbed within Hess sampler to collect benthic invertebrate community.	3 composite samples collected per station. Area includes 5 stations.	Once a year
	Lower Big Creek	Reference area for Lower Minto Creek.				
	Lower Minto Creek	Farthest field exposure area below WSP.				
	Upper Minto Creek[2]	Exposure area just below WSP.	EEM		3 composite samples collected per station. Area includes 3 stations.	Once every 3 years
	10 RCA Reference Creeks	The 10 most appropriate reference creeks chosen from Phase 3 IOC.			3 composite samples collected per station. Area includes 1 station.	
Benthic Invertebrate Tissue Chemistry	Lower Wolverine Creek	Reference area for Lower Minto Creek.	WUL	Either the kick and sweep or flipping rocks method used to collect 2 g of benthic tissue samples for laboratory analysis[3].	1 sample collected at each station, 5 stations per area.	Once a year
	Lower Big Creek	Reference area for Lower Minto Creek.				
	Lower Minto Creek	Farthest field exposure area below WSP.				

Summary of Minto Mine Aquatic Environmental Monitoring Program (AEMP) study design components.

AEMP Component	Area	Area Description	Program	Method	Replication	Frequency
Fish Community	Lower Big Creek	Reference area for Lower Minto Creek.	EEM	Minnow traps used to characterize fish use and associated population sizes.	Fishing will be done to confirm time, extent and magnitude of use by fish.	Twice a year every 3 years
	Lower Minto Creek	Farthest field exposure area below WSP.				
Fish Field/Lab Testing	Lower Minto Creek	Farthest field exposure area below WSP.	EEM	Mobile laboratory exposure system will be set up on site to evaluate survival and growth.	Exposure includes 3 tanks (Control, 1:3 and 1:6) with 150 fish per tank.	Once every 3 years
	1:3 Effluent:Receiving Water	A 1:3 ratio between effluent and receiving water.				
	1:6 Effluent:Receiving Water	A 1:6 ratio between effluent and receiving water.				
Supporting Measures	Lower Wolverine Creek	Reference area for Lower Minto Creek.	WUL	Physical observations (depth and velocity), meter measurements of temperature, dissolved oxygen, conductivity and pH.	Depth and velocity taken at locations where Hess sampler used. 5 depths taken at 1 station per area. Meter measurements taken at 5 stations per area. Area includes 5 stations.	Once a year
	Lower Big Creek	Reference area for Lower Minto Creek.				
	Lower Minto Creek	Farthest field exposure area below WSP.			Depth and velocity taken at locations where Hess sampler used. 5 depths taken at 1 station per area. Meter measurements taken at 5 stations per area. Area includes 5 stations.	
	Upper McGinty Creek	Reference area for Upper Minto Creek.			Meter measurements taken at 5 stations per area.	
	Upper Minto Creek[2]	Exposure area just below WSP.			Meter measurements taken at 5 stations per area.	
			EEM		Depth and velocity taken at locations where Hess sampler used. Meter measurements and 5 depths taken at 3 stations per area. Area includes 3 stations.	Once every 3 years
	10 RCA Reference Creeks	The 10 most appropriate reference creeks chosen from Phase 3 IOC.			Depth and velocity taken at locations where Hess sampler used. Meter measurements and 5 depths taken at 1 station per area. Area includes 1 station.	
	1:3 Effluent:Receiving Water	A 1:3 ratio between effluent and receiving water.			Meter measurements taken 4 times over the exposure period.	
	1:6 Effluent:Receiving Water	A 1:6 ratio between effluent and receiving water.				

[1] Sublethal toxicity testing is conducted once a year after the mine has subjected to section 7 of the MMER for three years, previous to this sublethal toxicity testing occurs twice a year.

[2] Under RCA design upper Minto Creek, for EEM, will include 3 stations whereas references areas will only include 1 station. All sampling will occur at each individual station for upper Minto Creek.

[3] Laboratory analysis includes for water, sediment and periphyton and benthic tissue chemistry described in Table 4.

WUL = Water Use Licence

EEM = Environmental Effects Monitoring Program

RCA = Reference Condition Approach

Supporting Measures for Monitoring Programs Under the AEMP, Minto Mine.

Monitoring Program	Supporting Measures		Replication
Sediment	Meter measurements[1]		every station
	GPS coordinates		every station
	Depth (lower reaches)	Depth of station	every station
		Core penetration depth	every core
	Photographs (lower reaches)	Core and Ponar samples	every station
		Substrate type	every station
Periphyton	GPS coordinates		every station
	Area scraped	Chlorophyll *α*	every rock
		Community	every rock
	Photographs	Rocks after scraping	every rock
Benthic Invertebrate	Meter measurements[1]		every station
	GPS coordinates		every station
	Water chemistry sampling		1 station per area[2]
	Depth and velocity		each Hess location
	100 Pebble Count	Intermediate axis	every station
		Embeddness on 10% of pebbles	every station
	Photographs	Upstream, downstream, across, substrate	every station
	Habitat assessment	Description of area sampled	1 station per area[2]
Fish Monitoring	Meter measurements[3]		every station
	GPS coordinates		every station
	Water chemistry sampling		1 station per area
	Weather		every station
	Trap location	With a description of area	every station
	Photographs	Upstream, downstream, across, substrate	every station

[1] Meter measurements include: dissolved oxygen, pH, temperature and conductivity

[2] Sampling occurs at all 3 stations for upper Minto Creek during EEM.

[3] Meter measurements include: dissolved oxygen, temperature, specific conductivity and flow

WUL = Water Use Licence

EEM = Environmental Effects Monitoring Program

STANDARD OPERATING PROCEDURE FOR BENTHIC INVERTEBRATE COMMUNITY MONITORING UNDER THE MINTO MINE ENVIRONMENTAL MONITORING, SURVEILLANCE AND REPORTING PLAN (EMSRP)

TABLE OF CONTENTS

1.0 INTRODUCTION

The Minto Mine Environmental Monitoring, Surveillance and Reporting Plan (EMSRP) includes benthic invertebrate community monitoring, with data collection using a Hess sampler. This Standard Operating Procedure (SOP) outlines the procedures applied to benthic invertebrate community monitoring under the EMSRP. Benthic invertebrate community monitoring is included in the EMSRP to evaluate potential impacts of effluent discharged into Minto Creek. Community metrics are compared between Minto Creek and associated reference areas and among years.

Two sampling programs are included in the overall EMSRP at the Minto Mine, the Biological Monitoring Program (BMP) and the Environmental Effects Monitoring program (EEM). A Hess sampler is used for both programs, but collection methods differ between programs. The BMP monitoring assessed 3 areas, with 5 stations per area, for a total of 15 samples each of which is a three grab composite (described in Section 3.1). The EEM includes 11 areas (1 exposed area and 10 reference area), with triplicate samples collected at the sole exposed area and single sample collected at the 10 reference areas, for a total of 13 samples each of which is a three grab composite (described in Section 3.2). Sample consolidation, labelling, preservation, documentation, and potential sampling hazards are the same for both programs.

Prior to sampling, carefully review the study plan (design), order water sampling bottles (including preservatives and filters) and gather all equipment from the equipment list (Table 1). Erosional Benthic Grab Sample Collection field sheets (Figure 1) must be prepared on waterproof paper and some initial information can be pre-filled out, including: waterbody, program, sampling device, mesh size and sampler size. Coordinates of sampling stations from previous years should be obtained and inputted into a GPS; all attempts should be made to sample the same stations as in previous sampling events.

Upon arrival at the sampling location, a visual assessment of the site must be undertaken to evaluate any safety/hazard concerns and to identify the most appropriate placement of the sampling stations based on the erosional habitat and substrate. After a visual inspection, flow and depth are measured to identify three appropriate sampling locations that are similar (flow, depth, substrate). Flow is measured using a flow meter (Marsh McBirney Flo-Mate 2000) and depth is measured either using a wading rod or a meter stick. If no suitable locations are found at previous sampling stations, move to a more appropriate location keeping stations at least six bankfull widths apart. Once a suitable station is found, record depth and flow of all locations and the GPS coordinates. At this time, more information can be filled out on the field sheet,

Table 1: Equipment list for benthic invertebrate community sampling.

Equipment	Amount
Water Quality Sampling	
YSI (temp, DO, pH, specific conductivity)	1
Calibration solutions	1 bottle each of pH 4, 7 and 10
Back up water quality reader (pen, DO kit)	1 set
Flow mate with wading rod	1
Meter stick	1
Water Sampling	
Water bottle from Analytical Laboratory	25 sets
Preservatives	25 sets
Syringes (large)	25
Polypropylene 0.4 µm filters	25
Benthic Invertebrate Sampling	
Wide mouth bottles (1 L)	35
Hess (500 um)	1
Surber (500um) as back-up	1
Long gloves (and fleece liners)	2 pair
White plastic tub	4
Squeeze bottles	2
Formalin	4 L
Borax	1 L
Nail brush	2
Internal labels	40
30 cm ruler	2
Measuring cup	2
Miscellaneous	
Camera with charger	1
GPS	1
Sharpies	5
Pencils	5
Extra batteries for YSI, SPOT, GPS	many
Field sheets on waterproof paper	35
Field notebook - waterproof	1
Health and Safety	
bear spray	1
EPIRB or SPOT device	1
Floater coat	1

Erosional Benthic Grab Sample Collection

MINTO MINE

Program: ________

Date/Time: ________

Field Crew: ________

Waterbody: ________

Station Identifier: ________

Sampling Device: ________

Sampler Size: ________

Mesh Size: ________

Grabs in Composite: ________

Water Velocity (mean): ________ m/s

Station Depth (m): ________

Habitat Sheet Completed: ☐

Benthic Tissue Sample Collected: ☐

SAMPLE CHARACTERISTICS

Number of Jars: ________

Average Depth that Sampler is Pushed into Substrate (where applicable): ________ cm

Average Depth to Which Substrate is Sampled/Cleaned: ________ cm

Average Sampling Time per Grab: ________ min

Sample Texture: Cobble (%) ________ Gravel (%) ________ Sand and Finer (%) ________ Organic (%): ________

Comments: ________

Macrophytes (in sample): none sparse common abundant

Algae (in sample): none sparse common abundant

List Macrophyte/Algae Type/Species (in sample; to the extent possible):

Periphyton Community Sample Collected: ☐

Periphyton Tissue Sample Collected: ☐

***** 3 measurements per station for flow, depth and substrate (each replicate) *****

Latitude ________

Longitude ________

Temperature ________

DO mg/L ________

pH ________

Sp Cond ________

DO % Sat ________

Depth (cm): ________

Flow (m/s): ________

Pictures:
Field Sheet
US
DS
Across
Substrate

Signature: ________

Figure 1: Erosional Benthic Grab Sample Collection Field Sheet.

including: date/time, field crew and station identifier. Before any sampling occurs, take pictures of the station in the following order: field sheet, upstream view, downstream view, across the river and of the substrate (after completion this can be checked off in the field sheet).

All required *in situ* water quality measurements (temperature, dissolved oxygen, pH and specific conductivity) and water samples should be obtained prior to disturbing the substrate and water column. Water quality is measured using an YSI 650 MDS (Multi-parameter Display System) field meter equipped with a YSI 6600 Sonde (Yellow Springs Instruments, Yellow Springs, OH) or a Hanna 4M Multi-parameter meter (Woonsocket, RI). These measurements should be taken upstream of all determined sampling locations. Record all measurements in the Erosional Benthic Grab Sample Collection field sheet (Figure 1). Water samples should be taken upstream of the field technicians standing location so not to cause any contamination of the sample.

2.0 SAMPLING DEVICE

A Hess sampler is a large cylindrical device (36 cm diameter) open at either end and covered with mesh on the sides with one side forming a collection bag (Figure 2; Dynamic Aqua-Supply Ltd. 2016). The collection bag is closed by tightly tying a string around the end. Double check that the collection bag is completely closed and there are no gaps. Using the handles push the Hess sampler into the substrate and positioned so the collection bag is downstream. Substrate within the Hess is disturbed and washed, and benthic invertebrates are swept into the collection bag by the current flowing through the mesh. The standard Hess used for both program has a 0.10 m^2 sampling area and is outfitted with a 500 µm mesh.

Figure 2: Hess sampling device (Dynamic Aqua-Supply Ltd. 2016).

3.0 SAMPLING METHODS

At each area, sampling commences at the furthest downstream station in riffle/run habitat. Subsequent stations are sampled moving upstream. Suitable areas are evaluated by looking for cobble/gravel substrates in erosional habitats and finding sample locations with similar depths and flow. Flow is measured using a flow meter (Marsh McBirney Flo-Mate 2000) and depth is measured either using a wading rod or a meter stick. Flow should be between 0.20 - 0.40 m/s and depth should be greater than 10 cm or the water will not flow properly into the collection bag. Once an ideal sampling location is identified, the bottom of the Hess sampler is firmly placed in the substrate with the mesh collection bag facing downstream. A nail brush is used to clean rocks within the Hess sampler to disturb substrate. This disturbance causes detritus and benthic invertebrates to be passively collected within the collection bag by the stream current. Cleaned rocks are removed from the Hess sampler and 100 are saved to measure intermediate axis for supporting data. The substrate is disturbed to a depth of approximately 5 cm over a period of about 10 minutes or until the area has been cleared. It is important that the rocks are fully cleaned and all organisms and debris is allowed to flow into the collection bag to capture the majority of the benthic invertebrates and ensure consistency among samples. Each sample is made up of a three grab composite; all grabs are collected in the Hess sampler before consolidation. After each individual grab, the Hess sampler is moved to the next sub-sampling location. Care must be taken to make sure that material within the collection bag does not fall out between each individual grab. The procedure is repeated two more times for a total of three grabs, which will make up a composite sample. Number of grabs in composite is recorded in the Erosional Benthic Grab Sample Collection field sheet (Figure 1) and the following sample characteristics are recorded: average depth that the sampler is pushed into substrate, average depth which the substrate was cleaned, average sampling time per grab and sample texture (while cleaning rocks make an estimate of percent substrate size, cobble, gravel, sand/finer and organic). If there are any macrophytes or algae in the sample a semi-qualitative description of quantity (none, sparse, common or abundant) and type/species is recorded.

3.1 BMP Sampling Methods

Lower Minto Creek and two reference areas, lower Wolverine and lower Big Creek, are sampled for the BMP. Sampling is conducted in erosional habitat and there are a total of five replicates (stations) per area. Each station is made up of a three grab composite. The procedure described in Section 3.0 is completed at each area. A total of 15 benthic invertebrate community samples are collected for the BMP.

3.2 EEM Sampling Methods

For the EEM benthic invertebrate community monitoring, a Reference Condition Approach (RCA) is applied. Under an RCA design, a greater number of reference areas are typically used to characterize the reference condition and then to determine whether or not the exposure area is within the reference condition. In the case of the Minto Mine EEM, the exposure area (upper Minto Creek) is evaluated against reference condition defined by a total of 10 references areas. At each area, the procedure described above in Section 3.0 is conducted. For each reference areas, only one sample (site) is collected but the exposure area is sampled in triplicate. All samples are three grab composites. During the EEM, a total of 13 benthic invertebrate community samples are collected.

4.0 SAMPLE CONSOLIDATION

Following each composite sample collection, material must be consolidated and removed from the Hess and placed in a sample jar. Material captured by the Hess can be easily removed by first washing the contents down into the mesh collection bag by forcefully splashing ambient water at the outside of the Hess. Once the sample is rinsed down into the collection bag, bring the Hess sampler to the sample jar without spilling any of the contents in the collection bag. A white plastic tub is placed under the sample jar so any benthic invertebrates that may fall from the net will not be lost. Once over the sample jar/plastic tub, untie the string holding the collection bag closed. The contents are washed from the collection bag into a sample jar using a squirt bottle filled with ambient water.

When transferring the benthic invertebrate sample from the Hess into the sample jar, care should be taken to remove all invertebrates from the Hess, paying particular attention to net seams. Any benthic invertebrates remaining on the inside of the sampler are removed by lightly picking them off the mesh by hand. The tray is checked and any organisms found are placed into the sample jar. Some ambient water can be added to the sample jar to cover all material, if needed.

5.0 LABELLING

All benthic sample jars are labelled using a Sharpie on both the lid and jar wall. An internal label is also prepared, using pencil written on either a wooden tongue depressor or waterproof paper. The wooden tongue depressor is preferable, as it is more resistant to abrasion from the sample contents. The lid, jar wall and internal label are marked with the project number, sample ID, date (e.g., "7-Sep-16"), and samplers' initials. If multiple jars are required for one sample, the jars should each be labelled with a jar number and the total number of jars (e.g., "Jar 1 of 3"). The number of jars used is recorded in the Erosional Benthic Grab Sample Collection field sheet (Figure 1).

6.0 PRESERVATION

Once the sample is in the sample jar, a preservative (commercially available 37% formalin solution) must be added to prevent sample degradation. Formalin is a carcinogen, so safety procedures must be strictly followed:

- Work outside or in a well-ventilated room;
- Wear the appropriate PPE: safety glasses, long nitrile gloves, and a respirator fitted with N7500-2 acid gas cartridges; and,
- Store an MSDS with the formalin.

In the field, formalin solution is diluted when it is added to the sample; the final volume is to be nine parts ambient water and sample material to one part formalin.

Formalin is acidic and may cause decalcification of invertebrates or increase hardening of other tissues. Therefore, the sample is buffered using borax, which is added at a ratio of ¼ to ½ cup per litre of the formalin solution. The samples are placed in a cooler and stored until ready to be shipped to the analytical laboratory. Chains of custody (COC) must be prepared before shipping any samples, this is described in Section 7.0.

7.0 DOCUMENTATION

Field sheets, field notes and a Chain of Custody (COC) forms must all be filled out. Photocopies of all these documents are required as a record and in case originals become lost or damaged. Both benthic invertebrate community samples and water samples require a COC form.

7.1 Field Sheets

Sampling records are kept by completing the standardized Erosional Benthic Grab Sample Collection field sheet (Figure 1) and recording any additional relevant information in a waterproof field notebook. A variety of information is required, including: date/time, sampling device, station identifier, depth, flow, sample characteristics, GPS coordinates and water quality measurements. Once photographs of the station have been taken they are also checked off. The field sheet also has check boxes for other sampling associated with the BMP; once they are completed they can be checked off. These other sampling requirements include checking that: the habitat field sheet was completed, the benthic tissue sample was collected, the periphyton community sample was collected, and the periphyton tissue sample was collected. Once all information is recorded, the field sheet is reviewed to make sure everything has been collected and there are no recording errors. After review, the field sheet is signed by the field crew leader.

7.2 Chain of Custody

A COC must accompany all samples being submitted to ensure that the required analyses are completed, and to confirm receipt of samples by the laboratory. The form is especially crucial if the project is being carried out for legal reasons (e.g., compliance monitoring). The chain-of-custody record portion of the form is critical because it documents sample possession from the time of collection through to final disposal of the sample. A sample is considered to be in a person’s custody if any of the following criteria are met:

- The sample is in the person’s possession;
- The sample is in the person’s view after being in possession;
- The sample is in the person’s possession and is being transferred to a designated secure area; and
- The sample has been locked up to prevent tampering after it was in the person’s possession.

The analytical request portion of the form provides information to the laboratory regarding what analyses are to be performed on the samples that are shipped. Information on the record must include:

- Laboratory name;
- Contact person name and contact information;
- Sampler name and contact information;
- Project number;
- Date results required by;
- Sample identifiers;
- Sample date;
- Sample matrix;
- Laboratory analyses;
- Number of containers;
- Submission date and time (24-hour clock); and
- Comments on any unusual conditions or other important information.

Most commercial analytical laboratories will provide a COC Record for samples submitted to their laboratory. If the laboratory does not have a COC one can created as a spreadsheet (Figure 3).

Minto Mine

Telephone: (604) 759-4659

CHAIN OF CUSTODY RECORD

Laboratory Address:

Page of

Minto Mine Contact:

Program:

Contact:

Phone: e-mail:

Date Results Required By:

Sample Number	Sample ID	Date Sampled	Collection Method	Sampler Size		Mesh Size	Grabs in Sample	Number of Containers	Comments
				Per Grabs	Total Grabs				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

Samples Relinquished to Lab By:
(Employee Signature)

Date:

Shipment Method:

Samples Received in Lab By:
(Lab Employee Signature)

Date:

Sample Condition upon Receipt:

SUBMIT ORIGINAL TO LAB WITH SAMPLES AND RETAIN TWO PHOTOCOPIES

Figure 3: Chain of Custody form.

8.0 SHIPPING

While packing the samples to be shipped, fill out the COC at the same time. This allows you to reconcile what has been physically placed in the shipping container to the COC. Once samples are packed the COC is placed in a Ziploc^{TM} bag and added to the shipping containers. From the Minto Mine, a bus or driver must be organized to ship the samples to Whitehorse, YT. From Whitehorse, benthic invertebrate samples are shipped by bus to the laboratory. Water samples can either be dropped off to a local laboratory or shipped by plane for same day delivery to a laboratory.

Water samples must be sent in a cooler packed with ice packs, from Minto Mine the same day of collection or the following day due to short holding times for several required analyses. Date of collection must consider when the samples will arrive at the laboratory. Samples will need to arrive when the laboratory is opened; during the week day and not on holidays or weekends.

Benthic invertebrate community samples do not have a hold time so shipping can occur any time after sampling. Samples are shipped in a cooler and no ice packs are required. Since samples are preserved in formalin the appropriate safety labels must be visible on the cooler and a copy of the MSDS is added to the cooler.

9.0 POTENTIAL HAZARDS

Potential hazards	**Mitigation**
Formalin	- Wear PPE. - Work in a well-ventilated area. - Have access to the formalin MSDS.
Working on water: falling, current, and drowning	- Mindfulness and awareness of surroundings. - Work in pairs, communicate with your partner. - Wear personal flotation device when working in or around water bodies.

10.0 REFERENCES

Dynamic Aqua-Supply Ltd. 2016. Hess Sampler. Available from http://www.dynamicaqua.com/streamsampling.html [Accessed 2 March 2016].

STANDARD OPERATING PROCEDURE FOR BENTHIC INVERTEBRATE TISSUE QUALITY MONITORING UNDER THE MINTO MINE ENVIRONMENTAL MONITORING, SURVEILLANCE AND REPORTING PLAN (EMSRP)

TABLE OF CONTENTS

1.0 INTRODUCTION

The Minto Mine Environmental Monitoring, Surveillance and Reporting Plan (EMSRP) includes collection of benthic invertebrates for tissue chemistry under the Biological Monitoring Program (BMP). Collection of benthic invertebrate tissue is undertaken in conjunction with the benthic invertebrate community sampling, but is completed after community samples are collected to avoid disturbance that could distort the community characterization (see Minto Mine SOP – Benthic Invertebrate Community). This Standard Operating Procedure (SOP) outlines the procedures applied to benthic invertebrate tissue monitoring under the EMSRP. Benthic invertebrate tissue sampling is included in the EMSRP to evaluate potential impacts of effluent discharge to Minto Creek. Tissue sample chemistry is compared among lower Minto Creek and reference areas (lower Wolverine Creek and lower Big Creek) and among years.

Prior to sampling, carefully review the study plan (design), gather all equipment needed (kick net, Whirl-Pak^{TM} bags, tweezers, white plastic tub, squeeze bottle, waterproof field notebook, GPS and a 10 g Pesola balance). Coordinates of the sampling stations from previous years should be obtained and input into a handheld GPS; all attempts should be made to sample the same stations used in previous sampling events.

Upon arrival at the sampling location, a visual assessment of the site must be undertaken to evaluate any safety/hazard concerns and to identify the most appropriate place to collect benthic tissue samples. Since benthic invertebrate tissue is sampled concurrent with benthic invertebrate community sampling, supporting measures such as water quality meter measurements, water samples and photographs will not need to be repeated. There are no field sheets associated with benthic invertebrate tissue sampling. Notes on the number, types and weight of taxa collected can be recorded in a waterproof field notebook.

Tissue samples can be collected by either a kick net or by overturning rocks by hand to collect organisms. Priority is placed on collecting adequate tissue mass and not the method used to collect benthic invertebrate tissue samples. Benthic invertebrate tissue samples are collected at three areas (lower Minto, lower Wolverine, and lower Big Creek), with samples collected at five stations within each area.

2.0 SAMPLING DEVICE

The dimensions, mesh size and type of kick net can vary as type of device used is not as important as the mass of tissue required for chemical analysis. A kick net that is consistent with the Canadian Aquatic Biomonitoring Network (CABIN) protocol is commonly used (CABIN 2010). This net has a triangular opening (36 x 36 x 36 cm), 400 µm mesh and a detachable plastic collection bottle with a screen bottom which is screwed onto the end of the net (Figure 1; Halltech Aquatic Research Inc. 2016).

Figure 1: Kick net sampling device (Halltech Aquatic Research Inc. 2016).

3.0 SAMPLING METHODS

At each area, sampling commences at the furthest downstream station and subsequent locations are sampled moving upstream. Suitable areas are selected by looking for cobble/gravel substrates in riffle/run areas. Using a technique commonly referred to as the kick-and-sweep method, the kick net is firmly placed on the substrate immediately downstream of the feet of the sampling technician. Samples are collected by kicking (toe or heel) and twisting your feet to ensure that the substrate is fully dislodged. Moving along the creek, the technician makes sure the kick net stays on the substrate and shadows the technician's feet. Ensuring a specific depth of kicking or amount of time sampling is not necessary as this tissue collection is not quantitative; ensuring that the required mass of tissue is collected is the priority. Samples can also be collected by overturning rocks and picking organisms by hand.

4.0 SAMPLE CONSOLIDATION

Following the kick and sweep, material must be consolidated and removed from the kick net and placed in a Whirl-Pak^{TM} bag. It is common for large rocks and sticks to be captured in the kick net; these can be carefully washed into the net using a squirt bottle with ambient water. Material captured by the kick net can be easily removed by first washing the contents down into the bottle by forcefully splashing ambient water at the outside of the net. Once the sample is rinsed down into the bottle, it can be removed by unscrewing the bottle cap from the bottle. The contents from the net and bottle are then emptied into a white plastic tub. Tweezers are used to pick benthic invertebrates from the plastic tub and place them into a Whirl-Pak^{TM} bag. If benthic invertebrates are obtained from overturned rocks, they are also placed into the Whirl-Pak^{TM} bag. Use a Pesola spring balance to measure an empty Whirl-Pak^{TM} bag, use this value to subtract from a Whirl-Pak^{TM} bag with sample in it. This value is the weight of the sample. Continue to pick as many benthic invertebrates from the plastic tub as possible until the target sample weight has been achieved (2 - 5 g). If the desired sample weight has not been achieved, continue using the kick net or overturning rocks to collect more benthic invertebrates. Using a waterproof field notebook, record the sample weight and estimate the proportion of major taxon groups based on the number and volume of the organisms.

5.0 LABELLING AND PRESERVATION

All Whirl-Pak^{TM} bags are labelled using a Sharpie and are marked with the project number, sample ID, date (e.g., "7-Sep-16"), and samplers' initials.

Once the sample is in the Whirl-Pak^{TM} bag it is placed in a cooler with ice packs and later transferred to a freezer. Samples are kept in the freezer until they are ready to be sent to the analytical laboratory.

6.0 DOCUMENTATION

In a waterproof field notebook, record the approximate weight of the sample and an estimate of the taxon groups that make up the sample (by number and mass). In the Erosional Benthic Grab Sample Collection field sheet (see Minto Mine SOP – Benthic Invertebrate Community) check off that the benthic invertebrate tissue sample has been collected. Photocopy any field notes made as a record and in case originals become lost or damaged.

Most commercial analytical laboratories will provide a Chain of Custody (COC) for samples submitted to their laboratory. Fill out this COC form and make two photocopies for your records.

A COC must accompany all samples being submitted to ensure that the required analyses are completed and to confirm receipt of samples by the laboratory. The form is especially crucial if the project is being carried out for legal reasons (e.g., compliance monitoring). The chain-of-custody record portion of the form is critical because it documents sample possession from the time of collection through to final disposal of the sample. A sample is considered to be in a person's custody if any of the following criteria are met:

- The sample is in the person's possession;
- The sample is in the person's view after being in possession;
- The sample is in the person's possession and is being transferred to a designated secure area; and
- The sample has been locked up to prevent tampering after it was in the person's possession.

The analytical request portion of the form provides information to the laboratory regarding what analyses are to be performed on the samples that are shipped. Information on the record must include:

- Laboratory name;
- Contact person name and contact information;
- Sampler name and contact information;
- Project number;
- Date results required by;
- Sample identifiers;
- Sample date;
- Sample matrix;
- Laboratory analyses;

- Number of containers;
- Submission date and time (24-hour clock); and
- Comments on any unusual conditions or other important information.

7.0 SHIPPING

When samples are ready to be shipped, fill out the COC at the same time. This allows you to reconcile what has been physically placed in the shipping container to the COC. Once samples are packed, the COC is placed in a Ziploc^{TM} bag and added to the shipping container. From the Minto Mine, a bus or driver must be organized to ship the samples to Whitehorse, YT. From Whitehorse, samples can either be dropped off to a local laboratory or shipped by plane for same day delivery to a laboratory.

Benthic invertebrate tissue samples are to be packed in a small cooler with ice. Shipping time must be sufficiently short that the samples do not thaw. Consideration must be given to shipping date, as samples will need to arrive when the laboratory is opened; during the week day and not on holidays or weekends.

8.0 POTENTIAL HAZARDS

Potential hazards	**Mitigation**
Formalin	- Wear PPE. - Work in a well-ventilated area. - Have access to the formalin MSDS.
Working on water: falling, current, and drowning	- Mindfulness and awareness of surroundings. - Work in pairs, communicate with your partner. - Wear personal flotation device when working in or around water bodies.
Unnatural objects	- Do not kick and sweep sample in area where it is expected that foreign objects may be concealed in the substrate (i.e. rusted metal or urban refuse).

9.0 REFERENCES

CABIN (Canadian Aquatic Biomonitoring Network). 2010. Field Manual: Wadeable Streams. Environment Canada. March 2010.

Halltech Aquatic Research Inc. 2016. Kick net sampler. Available from http://www.halltechaquatic.com/cabin-protocol-benthic-kick-net/296.html [Accessed 3 March 2016].

Invasiveness Rank
1 - highly invasive - may displace or replace native ecosystems
2 - aggressive - widespread, persistent, but may not replace native species or change ecosystem function
3 - taxa present in the territory that area not known to be invasive here - but have been found to be invasive in other jurisdictions
4 - has been reported in the territory. Has not been shown to be problematic, may not persist
5 - species that likely don't persist
6 - false reports
7 - native and introduced populations exist

General Abundance
C common - widespread established
F falsely reported,
P possible but not yet documented
R rare known from only 1 or two localities,
U unknown
X possibly not persistent,
? possibly native,

Persistence
1=widespread
2=local
3=not persistent,
4=falsely reported

Alaska Invasiveness Rank
not ranked
<40 = Very Weakly Invasive
40-49 = Weakly Invasive
50-59 = Modestly Invasive
60-69 = Moderately Invasive
70-79 = Highly Invasive
>80 = Extremely Invasive
Ranking from: Matthew L. Carlson, Irina V. Lapina, Michael Shephard, Jeffery S. Conn, Roseann Densmore, Page Spencer, Jeff Heys, Julie Riley, and Jamie Nielsen. 2008.
Invasiveness Ranking System for non-native plants if Alaska. USDA Forest Service Alaska Region R10-TP-143 http://www.fs.fed.us/r10/spf/fhp/invasive/invasiveness%20ranking%20report.pdf
Introduced Plants of the Yukon - Source Cody, 1996 (cody et al 1998, 2000, 2001, 2002, 2003, 2004, 2005) Bennett, B. et al. (2008)
revised by B.A. Bennett December 2011 - this is a tentative list for review purpose only

Invasiveness Rank	Family	Genus	Species	Common Name	Abundance	Persistence	Alaska Rank	Source	Date of first collection
1	Grass family	Agropyron	cristatum	Crested Wheat Grass	C	1	nr	revegetation	1947
4	Grass family	Agropyron	fragile	Siberian Wheat Grass	U	2	nr	revegetation	1949
4	Grass family	Agrostis	capillaris	Colonial Bent Grass	R	2	nr	agriculture, revegetation	1993
3	Grass family	Agrostis	gigantea	Redtop	R	2	nr	revegetation	1916
P	Grass family	Agrostis	stolonifera	Creeping Bent Grass	P	P	nr	revegetation	
5	Grass family	Aira	caryophyllea	Silver Hair Grass	X	3	nr	transportation	1946
5	Grass family	Alopecurus	geniculatus	Water Foxtail	R	2	49	agriculture	1899
3	Grass family	Alopecurus	pratensis	Meadow Foxtail	C	1	52	agriculture	1947
3	Grass family	Avena	fatua	Wild Oasts	R	3	nr	agriculture	1943
5	Grass family	Avena	sativa	Cultivated Oats	X	3	nr	agriculture, transportation	1949
4	Grass family	Bromus	carinatus	California Brome	R	2		revegetation	1995
5	Grass family	Bromus	japonicus	Japanese Brome	X	3		revegetation	2003
5	Grass family	Bromus	racemosus	Bald Brome	X	3		agriculture	1902
1	Grass family	Bromus	inermis	Smooth Brome	C	1	62	agriculture, revegetation	1943
5	Grass family	Bromus	secalinus	Rye Brome	X	3	nr	agriculture	**1902**
5	Grass family	Bromus	tectorum	Downy Brome	X	3	78	agriculture	1916
2	Grass family	Dactylis	glomerata	Orchard Grass	R	3	53	revegetation	2000
5	Grass family	Deschampsia	danthonioides	Annual Hairgrass	X	3	nr	unknown	1902
5	Grass family	Deschampsia	elongata	Slender Hairgrass	X	3	35	transportation (railway)	1902

Invasiveness Rank	Family	Genus	Species	Common Name	Abundance	Persistence	Alaska Rank	Source	Date of first collection
2	Grass family	Elymus	repens	Creeping Wild Rye	U	2	59	revegetation	1949
2	Grass family	Elymus	sibiricus	Siberian Wild Rye	C	1	53	revegetation	1980
3	Grass family	Festuca	rubra ssp. rubra	Red Fescue	C	1		revegetation	
4	Grass family	Festuca	trachyphylla	Hard Fescue	R	2		agriculture	1949
5	Grass family	Hordeum	vulgare	Common Barley	R	3	39	agriculture	1983
1	Grass family	Leymus	angustus	Narrow-leaved (Altai) Lyme Grass	R	2	nr	revegetation	1998
4	Grass family	Lolium	multiflorum	Annual Rye Grass	R	1	41	revegetation	1902
2	Grass family	Lolium	perenne	Perennial Rye Grass	R	1	52	revegetation	1994
5	Grass family	Lolium	temulentum	Bearded Rye Grass	X	3	nr	unknown	1902
1	Grass family	Phalaris	arundinacea	Reed Canary Grass	?	1	83	agriculture, revegetation	1979
5	Grass family	Phalaris	canariensis	Common Canary Grass	X	3	nr	agriculture	1941
4	Grass family	Phleum	pratense	Common Timothy	C	1	54	agriculture	1902
3	Grass family	Poa	annua	Annual Blue Grass	C	1	46	transportation	1968
3	Grass family	Poa	compressa	Canada Blue Grass	U	1	39	revegetation	1980
7	Grass family	Poa	nemoralis	Forest Blue Grass	?	2		revegetation	
2	Grass family	Poa	pratensis ssp. pratensis	Kentucky Blue Grass	C	1	52	unknown	
3	Grass family	Poa	trivialis	Rough Blue Grass	U	1	52	revegetation	1902
5	Grass family	Polypogon	monospeliensis	Rabbit's-foot Grass	X	3		unknown	**1902**
3	Grass family	Psathyrostachys	juncea	Russian Wild-Rye	R	2	nr	agriculture	1960
7	Grass family	Puccinellia	distans	Spreading Alkali Grass	?C	1			
3	Grass family	Schedonorus	arundinaceus	Tall Fescue	R	2	66	revegetation	1980
5	Grass family	Secale	cereale	Common Rye	R	3	nr	agriculture, transportation	1949
5	Grass family	Setaria	viridis	Green Bristle Grass	X	3	nr	transportation	1998
4	Grass family	Thinopyrum	intermedium	Intermediate Wheat Grass	R	2		transportation	1999
2	Grass family	Thinopyrum	ponticum	Tall Wheat Grass	R	1	nr	agriculture	2000
5	Grass Family	Triticum	aestivum	Common Wheat	X	3	nr	agriculture, transportation	**1943**
5	Grass family	Vulpia	myuros	Rat-tail Six-weeks Grass	X	3	nr	unknown	**1902**
5	Nettle family	Urtica	urens	Burning Nettle	X	3	nr	unknown	1904
5	Goosefoot family	Atriplex	patula	Spear Saltbush	X	3	nr	unknown	
5	Knotweed family	Fagopyrum	esculentum	Buckwheat	X	3	nr	agriculture (birdseed)	1997
2	Knotweed family	Polygonum	achoreum	Leathery Knotweed	U	1		transportation	1997
7	Knotweed family	Polygonum	buxiforme	Prairie Knotweed	?C	1	45	transportation	
3	Knotweed family	Fallopia	convolvulus	Eurasian Black-bindweed	C	1	50	horticulture	1975
5	Knotweed family	Polygonum	fowleri	Fowler's Knotweed	X	3		unknown	**1943**
6	Knotweed family	Persicaria	maculosa	Spotted Lady's-Thumb	F	4	47		
3	Knotweed family	Rheum	rhaponticum	Rhubarb	C	1	nr	agriculture	1999
4	Knotweed family	Rumex	acetosella	Sheep Sorrel	R	2	51	unknown	**1994**
3	Knotweed family	Rumex	crispus	Curled Dock	R	2	48	unknown	**1980**
3	Knotweed family	Rumex	longifolius	Door-yard Dock	R	2	48	transportation	1980
3	Knotweed family	Rumex	pseudonatronatus	Field Dock	R	2	nr	transportation	2004

Invasiveness Rank	Family	Genus	Species	Common Name	Abundance	Persistence	Alaska Rank	Source	Date of first collection
3	Goosefoot family	Chenopodium	album	Lamb's-Quarter	C	1	37	unknown	1883
4	Pink family	Cerastium	fontanum	Common Mouse-ear Chickweed	U	1	36	unknown	1968
4	Goosefoot family	Spinacia	oleracea	Spinach	R	2		agriculture	1980
4	Pink family	Cerastium	glomeratum	Sticky Mouse-ear Chickweed	R	2	36	horticulture	2004
4	Pink family	Cerastium	nutans	Nodding Chickweed	R	2		horticulture	1996
5	Pink family	Dianthus	plumarius	Carnation	R	3		horticulture	**1994**
5	Pink family	Gypsophila	elegans	Showy Baby's-breath	R	3	nr	unknown	1980
3	Pink family	Silene	noctiflora	Night-flowering Catchfly	R	2	43	revegetation	1996
2	Pink family	Silene	vulgaris	Bladder Campion	R	2	42	agriculture, horticulture	1984
5	Pink family	Spergula	arvensis	Corn Spurry	X	3	32	unknown	**1902**
4	Pink family	Spergularia	rubra	Red Sandspurry	R	2	34	unknown	1977
2	Pink family	Stellaria	media	Common Chickweed	C	1	42	agriculture, horticulture	1943
5	Pink family	Vaccaria	hispanica	Cowcockle	R	3	nr	agriculture (birdseed)	1902
2	Buttercup family	Clematis	tangutica	Golden Clematis	R	1	nr	horticulture	1958
5	Buttercup family	Ranunculus	repens	Creeping Buttercup	X	3	54	transportation	1977
4	Buttercup family	Thalictrum	dasycarpum	Purple Meadow-rue	R	2		agriculture	1991
4	Buttercup family	Thalictrum	venulosum	Veiny Meadow-rue	?R	2		unknown	1949
4	Poppy family	Papaver	croceum	Saffron Poppy	U	2	39	horticulture	1949
4	Mustard family	Arabis	caucasica	Gray Rockcress	R	2		horticulture	2001
4	Mustard family	Arabis	glabra	Tower Mustard	?R	2	nr	transportation	1977
6	Mustard family	Armoracia	rusticana	Horse Radish	F	4			
3	Mustard family	Brassica	rapa	Bird's Rape	R	1	50	agriculture, revegetation	1980
4	Mustard family	Camelina	microcarpa	Little-pod False Flax	R	2	nr	unknown	1943
5	Mustard family	Camelina	sativa	Large-seeded False Flax	R	3	nr	agriculture	2007
3	Mustard family	Capsella	bursa-pastoris	Shepherd's Purse	C	1	40	agriculture	1916
4	Mustard family	Descurainia	sophia	Herb-Sophia	U	2	41	unknown	1943
5	Mustard family	Erysimum	cheiri	Wallflower	X	3		horticulture	2001
3	Mustard family	Hesperis	matronalis	Dames Rocket	R	2	41	horticulture	2010
3	Mustard family	Lepidium	ramosissimum	Branched Pepperwort	C	1	nr	unknown	1979
5	Mustard family	Lepidium	sativum	Garden Pepperwort	X	3	nr	horticulture	1902
5	Mustard family	Neslia	paniculata	Yellow Ball-mustard	X	3	nr	agriculture	1904
5	Mustard family	Rorippa	curvipes var. truncata	Blunt-leaved Yellowcress	R	3		unknown	1982
5	Mustard family	Sinapis	alba	White Mustard	X	3	nr	unknown	1902
5	Mustard family	Sinapis	arvensis	Corn Mustard	R	3	36	unknown	2002
5	Mustard family	Sisymbrium	altissimum	Tall Hedge Mustard	R	3	nr	unknown	1916
3	Mustard family	Thlaspi	arvense	Field Pennycress	C	1	42	agriculture	1949
5	Rose family	Potentilla	biennis	Biennial Cinquefoil	X	3	nr	unknown	1902
2	Rose family	Prunus	padus	Maytree or European Bird Cherry	C	2	74	horticulture	2003
2	Rose family	Sorbaria	sorbifolia	False Spiraea	R	2	nr	horticulture	1992
2	Pea family	Astragalus	cicer	Chick-pea Milk-vetch	R	2	nr	revegetation	1995

Invasiveness Rank	Family	Genus	Species	Common Name	Abundance	Persistence	Alaska Rank	Source	Date of first collection
2	Pea family	Caragana	arborescens	Siberian Peashrub	R	2	74	horticulture	1949
3	Pea family	Lotus	corniculatus	Garden Bird's-foot Trefoil	R	3	63	revegetation	2000
1	Pea family	Medicago	falcata	Lucerne	C	1	64	argiculture	1967
3	Pea family	Medicago	lupulina	Black Medick	R	2	48	transportation	2007
2	Pea family	Medicago	sativa	Alfalfa	C	1	59	agriculture, revegetation	1980
1	Pea family	Melilotus	alba	White Sweetclover	C	1	81	agriculture	1935
1	Pea family	Melilotus	officinalis	Yellow Sweetclover	C	1	69	argiculture	1980
3	Pea family	Onobrychis	viciifolia	Common Sainfoin	R	2	nr	revegetation	1980
5	Pea family	Trifolium	cyathiferum	Cup Clover	X	3		agriculture	1902
2	Pea family	Trifolium	hybridum	Alsike Clover	C	1	57	agriculture, revegetation	1902
2	Pea family	Trifolium	pratense	Red Clover	C	1	53	agriculture, revegetation	1902
2	Pea family	Trifolium	repens	White Clover	C	1	59	agriculture, revegetation	1916
7	Pea family	Vicia	americana	American Vetch	?R	1		unknown	
3	Pea family	Vicia	angustifolia	Garden Vetch	R	2		unknown	1992
1	Pea family	Vicia	cracca	Tufted Vetch	C	2	73	agriculture, transportation, horticulture	1943
5	Pea family	Vicia	villosa	Wolly Vetch	X	3	53	unknown	1916
3	Maple family	Acer	negundo	Manitoba or Ash-leaf Maple	R	2	nr	horticulture	1998
1	Euphorbia family	Euphorbia	esula	Leafy Spurge	R	2	84	argiculture	1992
4	Violet family	Viola	tricolor	Johnny-jump-up	C	1	34	horticulture	**1995**
4	Oleaster family	Hippophae	rhamnoides	Sea-Buckthorn	R	2		horticulture	2007
3	Carrot family	Heracleum	sibiricum	Siberian Cow-parsnip	R	2		unknown	1991
5	Carrot family	Pastinaca	sativa	Wild parsnip	R	3	nr	agriculture	1949
3	Mallow family	Malva	neglecta	Common Mallow	R	2	nr	agriculture	2008
5	Jacob's ladder family	Gilia	capitata	Blue-headed Gily Flower	X	3		unknown	**1902**
3	Forget-me-not family	Amsinckia	menziesii	Menzies' Fiddleneck	R	2	nr	unknown	1943
5	Forget-me-not family	Asperugo	procumbens	German Mad-wort	X	3	nr	horticulture	1949
7	Forget-me-not family	Hackelia	deflexa	Nodding Stickseed	?X	3		unknown	
3	Forget-me-not family	Lappula	squarrosa	European Stickseed	U	2	44	unknown	1973
5	Forget-me-not family	Myosotis	scorpioides	True Forget-me-not	R	3	54	horticulture	2000
7	Forget-me-not family	Plagiobothrys	scouleri	Scouler's Popcornflower	?R	3		unknown	
6	Verbena family	Verbena	hastata var. scabra	Simpler's-Joy	F	4			
5	Mint family	Dracocephalum	thymiflorum	Thyme-flowered Dragonhead	R	3	nr	agriculture	1949
3	Mint family	Galeopsis	tetrahit var. bifida	Bifid Hemp-nettle	R	1	50	revegetation, horticulture	1980
4	Mint family	Lamium	amplexicaule	Common Dead-nettle	R	3	nr	horticulture	2007
7	Mint family	Stachys	pilosa	Hedge-nettle	?R	2		unknown	
1	Figwort family	Linaria	dalmatica	Dalmatian Toadflax	X	3	58	unknown	2004
1	Figwort family	Linaria	vulgaris	Butter-and-Eggs	C	1	69	horticulture	1970
5	Figwort family	Veronica	arvensis	Corn Speedwell	R	3		unknown	**1970**
4	Figwort family	Veronica	longifolia	Long-leaf Speedwell	R	2	nr	agriculture, horticulture	1980
5	Figwort family	Veronica	serpyllifolia	Thyme-leaf Dragonhead	R	3	36	unknown	**1970**

Invasiveness Rank	Family	Genus	Species	Common Name	Abundance	Persistence	Alaska Rank	Source	Date of first collection
5	Plantain family	Plantago	aristata	Large-bract Plantain	X	3		unknown	**1902**
7	Plantain family	Plantago	major	Great Plantain	?C	1	44	unknown	
5	Bedstraw family	Galium	aparine	Sticky-willy	X	3		agriculture (birdseed)	2007
6	Bedstraw family	Galium	palustre	Common Marsh Bedstraw	F	4			
3	Valerian family	Valeriana	officinalis	Garden Valerian or Allheal	R	2	nr	horticulture	2007
4	Sunflower family	Achillea	ptarmica	Sneezeweed	R	2	46	horticulture	2011
5	Sunflower family	Anthemis	cotula	Stinking Chamomile	X	3	41	agriculture	**1902**
7	Sunflower family	Artemisia	biennis	Biennial Wormwood	R	4	nr	unknown	
5	Sunflower family	Centaurea	cyanus	Cornflower	X	3		horticulture	1998
1	Sunflower family	Centaurea	stoebe	Spotted Knapweed	X	3	86	unknown	1995
5	Sunflower family	Chrysanthemum	ircutianum	Early Daisy	X	3		unknown	1949
1	Sunflower family	Leucanthemum	vulgare	Oxeye daisy	R	1	61	horticulture, transportation	1980
1	Sunflower family	Cirsium	arvense	Creeping (Canada) Thistle	R	2	76	transportation	1995
5	Sunflower family	Crepis	capillaris	Smooth Hawksbeard	X	3	nr	transportation	1998
1	Sunflower family	Crepis	tectorum	Narrow-leaved Hawksbeard	C	1	56	transportation	1957
4	Sunflower family	Gaillardia	aristata	Great Blanket-flower	R	2	nr	agriculture	1973
7	Sunflower family	Gnaphalium	uliginosum	Marsh Cudweed	?R	2	nr	unknown	
5	Sunflower family	Helianthus	subrhomboideus	Stiff Sunflower	X	3		unknown	**1904**
1	Sunflower family	Hieracium	caespitosum	Field Hawkweed	R	2	79	transportation	2009
5	Sunflower family	Madia	glomerata	Mountain Tarplant	X	3	nr	unknown	1902
3	Sunflower family	Matricaria	discoidea	Pineapple Weed	C	1	32	unknown	1902
1	Sunflower family	Tripleurospermum	inodoratum	Scentless Chamomile	R	1	48	unknown	1980
5	Sunflower family	Senecio	eremophilus	Dryland Ragwort	R	3		transportation	1968
3	Sunflower family	Senecio	vulgaris	Common Ragwort	R	2	36	horticulture, agriculture	1902
1	Sunflower family	Sonchus	arvensis ssp. uliginosus	Field Sow-thistle	C	1	73	unknown	1980
2	Sunflower family	Sonchus	asper	Prickly Sow-thsitle	R	2	46	horticulture	1904
6	Sunflower family	Sonchus	oleraceus	Common Sow-thistle	F	4	46		
1	Sunflower family	Tanacetum	vulgare	Common Tansy	U	2	60	horticulture, transportation	1995
4	Sunflower family	Taraxacum	erythrospermum	Red-seeded Dandelion	X	2		unknown	1949
2	Sunflower family	Taraxacum	officinale	Common Dandelion	C	1	58	unknown	1943
2	Sunflower family	Tragopogon	dubius	Yellow Goat'sbeard	R	2	50	transportation	1995

VEGETATION METAL UPTAKE MONITORING PLAN

FOR MINTO MINE

September 2015

Prepared for:

MINTO EXPLORATIONS LTD.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

Heavy metal contamination on mine sites is a common issue due to both the extraction of highly mineralized rock, which is transported, milled and stored in these areas, and the exposure of mined materials to environmental influences. Metals can leach from mining waste into the immediate aquatic environment via direct surface water runoff or infiltration of precipitation (aqueous transport). In terrestrial systems, in-situ soils may already have heightened concentrations of metals due to local mineralization of the surficial parent material. Dust from blasting, ore crushing and waste dumping, can be wind (aeolian) transported to surrounding terrestrial areas, settling on the ground and the surface of plant leaves, stems and fruits. These receiving environments can, over time, accumulate contaminants to the point that biological functioning can be affected in aquatic and terrestrial ecosystems.

The potential for these effects, and the degree to which they occur, are a function of a number of variables, and the accumulation processes can be highly complex. Generally speaking, plants can become intermediaries or vectors in transferring heavy metals to higher trophic levels when consumed by herbivores, which in turn become prey for carnivorous species. Harvesting and consumption of country foods by humans can also present an exposure pathway.

Monitoring of metal uptake in plants in mining areas has been used to assess potential and ongoing risks to these receptors. Understanding this potential can be useful in guiding mine operations.

Access Consulting Group (ACG) was retained by Minto Explorations Ltd (Minto) to develop a Vegetation Metals Uptake (VMU) Monitoring Plan (the Plan). The Plan is required by the Government of Yukon, Department of Energy Mines, and Resources (EMR), to form part of the revised Minto Phase V/VI Environmental, Monitoring, Surveillance and Reporting Plan (EMSRP). Specifically, the VMU Monitoring Plan will meet requirement (d) of EMR's Plan Requirement Letter (December, 2014). to Minto which specifies that the following be submitted:

> *a program for monitoring and measuring metal uptake in vegetation on the mine site, and in areas surrounding the mine site.*

2 PROGRAM OBJECTIVES

The main objective of the VMU Monitoring Program is to develop and execute a plan that monitors and measures metal uptake in vegetation on the mine site and surrounding areas that:

- Utilizes previously established or documented conditions, monitoring results or predictive efforts, where appropriate and possible;
- Establishes a network of plots for monitoring both soil and vegetation metal concentrations; and
- Allows for an ongoing evaluation of the extent and degree that metals from mining activity is affecting vegetation in the proximity of the project site.

3 VMU MONITORING PLAN DEVELOPMENT

A number of tasks were undertaken as part of the development of a VMU Monitoring Plan for the Minto Mine. These tasks were scoped to result in a detailed VMU Monitoring Plan (Section 4) that met the program objectives presented previously in Section 2:

- Review relevant previous work (management plans, monitoring information, predictive modeling) for the mine site;
- Identify a study area based on this previous review;
- Identify potential exposure pathways for metals through vegetation;
- Select vegetation species to monitor based on exposure pathways and documented or expected use;
- Identify metals of concern for focus in the analysis; and
- Formulate a detailed vegetation metal uptake monitoring plan.

The following sections provide more information regarding these tasks and the key aspects considered in the development of a meaningful VMU Monitoring Plan for the Minto Mine.

3.1 DOCUMENT REVIEW

To help inform the development of the VMU Monitoring Plan, ACG reviewed a number of existing documents that were potentially relevant. Table 1 outlines the documents reviewed, and delineates how information was used or incorporated into the Plan.

Table 1: Documents Reviewed

Document Review	Potentially Relevant Information	Use in VMU Monitoring Plan
Access Consulting Group. 2010. Minto Mine Environmental Baseline Ecosystems and Vegetation Report	Ten soil samples were collected from the following ecological plots: M07, M29, M35, M54, M54A, M76A, M80, M84, M85, M90A, and M93. These are permanent plots with full description of ecological parameters.	Some of these plots can be used as controls to determine natural background metal concentrations or sampling sites. Need to revisit previously established ecoplots as per recommendations to monitor ecological changes and collect plant samples.
2010 Reclamation Research Report by Access Consulting Group	Lab analysis of 12 soil samples for metals, nutrient levels and texture. Soil samples from revegetation plots. Metal analysis of grasses used in revegetation and naturally regenerating willows.	Gives metal concentrations of soils within project area, can be used to augment sample size of soil samples taken in VMU program. Gives indication of willow and grass uptake of specific metals in three locations within the project site.
2007, 2008 and 2009 Revegetation Trial Reports by Stu Withers/Access Consulting Group	Two soil samples were collected from the overburden stockpile in late March 2007 and were analyze for texture, metals (ICP Method) and nutrients. The analysis results were similar for both samples, with both looking reasonably good for reclamation purposes. (ACG, 2007)	Additional soils data for metal content, furthers characterization of soils on site.
Minto Mine Phase V/VI, YESAB Project Proposal, Minto Climate Baseline Report, 2014	Provides meteorology data and climate trends, such as; prevailing wind directions, precipitation and temperature.	Important information on which to formulate VMU plan for sampling sites based on dust source locations and prevailing wind direction.
Minto Mine Phase V/VI Reclamation and Closure Plan version 5.1	Reclamation schedule indicates timing of closure for specific dust sources. Health and safety objectives	Guides VMU plan objectives in the future, and contributes an understanding of projected revegetation efforts and waste cover prescriptions, that will reduce dust sources and runoff.
Vegetation Metal Uptake studies completed for Casino baseline, Keno closure and during Red Dog mine operations.	To ensure the degree of detail for VMU is consistent with other mineral extraction projects in northern jurisdictions.	To check VMU procedures and EMR expectations.

3.2 STUDY AREA AND MONITORING NETWORK

The identification of a study area took the following elements into consideration:

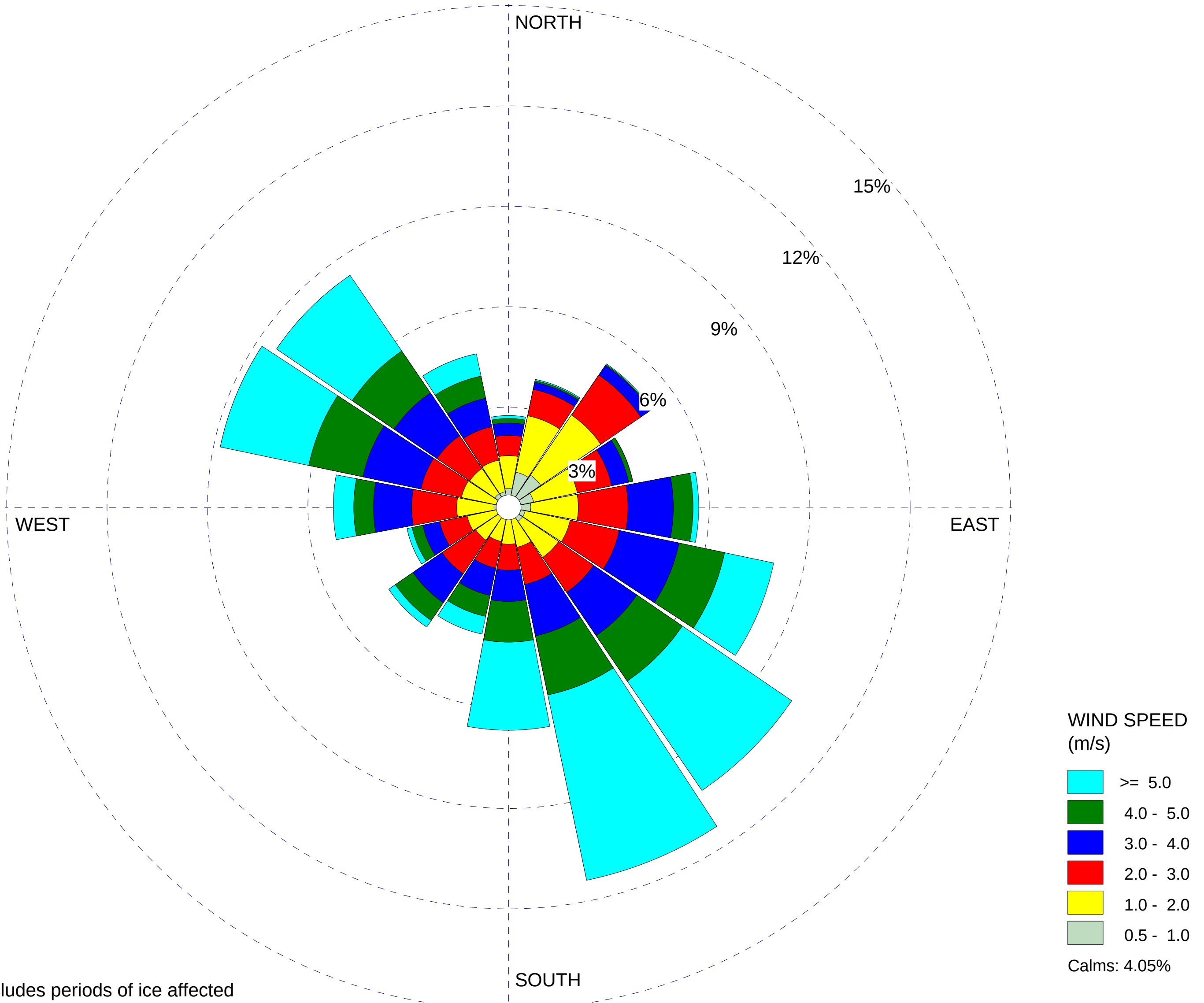
1. Area of direct disturbance (and reclamation) by mining activities;
2. Previous monitoring locations;
3. Access – road/ground based access to monitored areas was preferential; and
4. Anticipated dispersal mechanisms and extent of metal contamination.

The proposed VMU monitoring network is presented in Figure 2 in Section 4.1. The VMU sampling sites were selected in the areas anticipated to receive higher density dust fallout, and control or outlying stations were positioned outside of the projected dispersion area. This involved utilizing, where possible and accessible, ecosystem plots established in 2010 where soil and vegetation information data were collected. The stations to be monitored are divided into 'site' stations (within or upon the direct mine footprint area) and 'control' stations (outside the anticipated zone of influence of the mining activities.)The proposed monitoring station network is presented in Section 4.1.

The meteorological data collected on site, over a five year period, shows that the prevailing winds between April to October are from the northwest and the southeast (Figure 1). The areas that have been observed to generate the greatest loads of dust are the crushing and conveying infrastructure areas near the mill. To a much lesser degree, pit blasting and waste rock dumping would also contribute to dust loading and dispersion. To this end, the VMU sampling sites have been located in vegetated areas near the perimeter of these dust sources and extend roughly along a NW to SE axis.

DISPLAY:

Wind Speed
Direction (blowing from)



Excludes periods of ice affected
or missing data
Anemometer height: 10m

DATA PERIOD:

Start Date: 10/15/2010 - 00:00
End Date: 7/14/2015 - 08:00

TOTAL COUNT:	CALM WINDS:
23412 hrs.	**4.05%**

AVG. WIND SPEED:

3.37 m/s

MODELER:LISA KNIGHT

DATE:

7/16/2015

FIGURE 1

Minto Wind Rose Plot April to October 2010 to 2015 (partial)

WRPLOT View - Lakes Environmental Software

3.3 SELECTED TARGET VEGETATION SPECIES

There are numerous plants species that are either known or expected to be consumed directly by wildlife in the study area. To a lesser degree, there are some plant species in the study area which are known to be consumed by humans as part of traditional gathering in other areas. Actual anticipated future use, particularly by humans in traditional gathering is uncertain, however key species in both of these areas of potential exposure have been selected for monitoring. A review of other vegetation metal uptake programs as outlined in Table 1 also informed the species selection. The selected species and the rationale is provided in Table 2 below.

Table 2: Selected Species

Target Plants	Plant Part to be Collected	Rationale for Selection
Willows (Salix spp.)	Leaves	Moose browse
Horsetail (Equisetum spp.)	Plant	Moose browse
Blueberries (Vaccinium spp.) or Soapberries	Fruit	Human gathering/bear forage
Grasses (Species used in revegetation)	Culm and leaves, roots	Used for revegetation, potential for browse for a variety of species

3.4 METALS OF CONCERN

Based on the Canadian Council of Ministry of Environment (CCME), the Yukon Environment Act and U.S. Environmental Protection Agency (U.S. EPA) certain metals are identified Constituents of Potential Concern (COPC), since exposure and/or bioaccumulation to relatively high concentrations of these elements can resulted in damage to plants, aquatic organisms, terrestrial wildlife, and human health. Of these COPC, only the metals that are known to have elevated concentrations as compared to background levels at the Minto site are of interest. It should be noted that toxic effects usually require persistent exposure to high concentrations of the metals listed, and that as a confirmed mineralized area, elevated metals concentrations in soil (and to some degree in vegetation) are indeed expected in the baseline condition in the vicinity of the mine site, as noted previously.

Initial analysis will focus on metals listed below that have been identified as occurring at the Minto mine site during previous soil sampling done in 2009 and 2010 (Appendix B). These metals are considered to be COPC according to CCME. This list may be revised based on the results of the first sampling event as the program proceeds in the future:

Aluminum (Al), Antimony (Sb), Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Mercury (Hg), Molybdenum (Mo), Nickle (Ni), Silver (Ag), Zinc (Zn), and Selenium (Se).

4 DETAILED VMU MONITORING PLAN

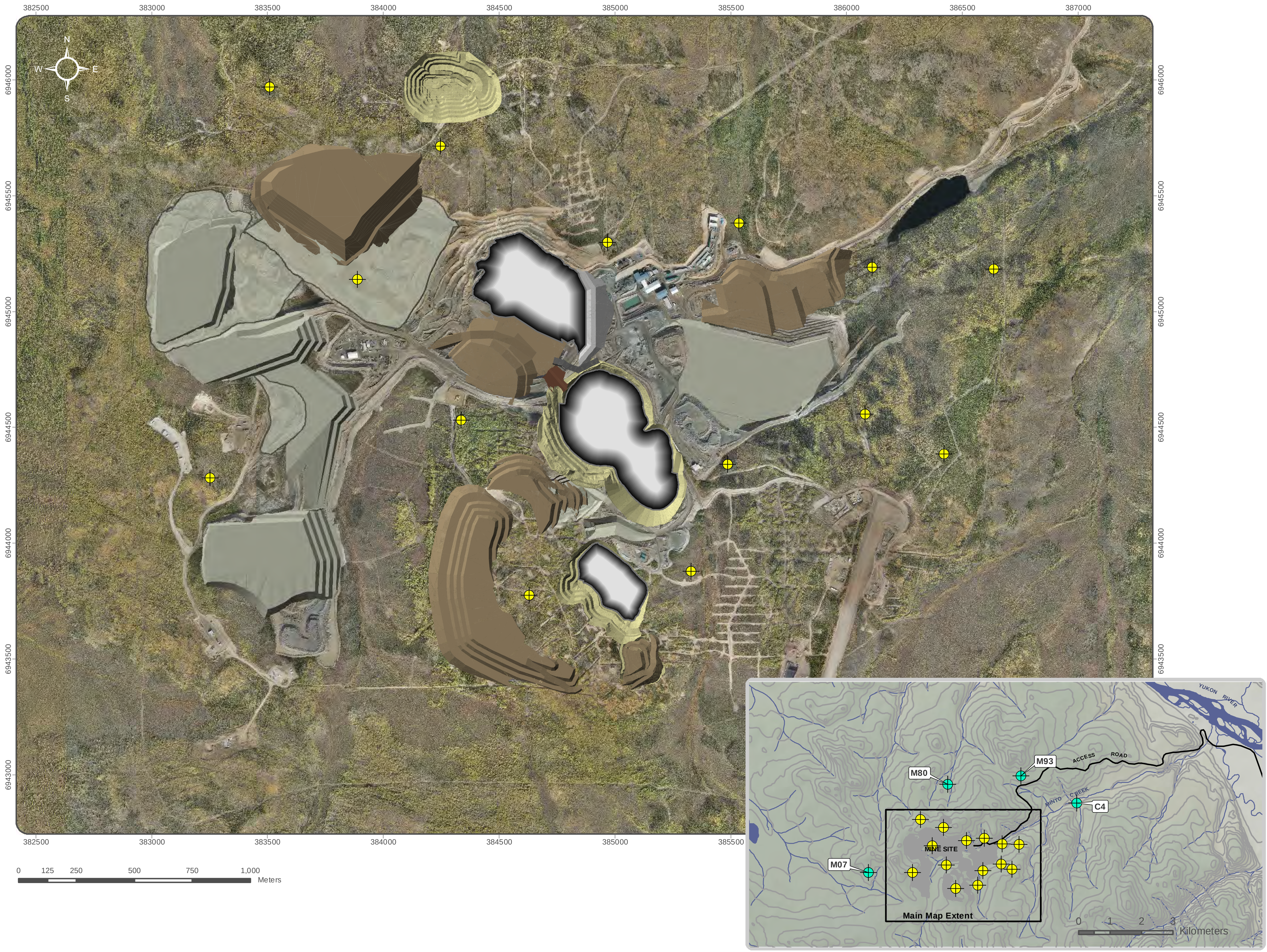
The following sections present the detailed elements of the VMU Monitoring Plan. This section has been developed to allow competent monitors to execute the program using consistent methods that allow for comparison between sampling events.

4.1 MONITORING NETWORK

The network of monitoring stations is presented on Figure 2. Stations are either designated as site (exposure) or control stations. Progression of the mine plan (waste dump covering) and analysis of the monitoring results may result in recommendations for additional monitoring locations. For example, progressive reclamation of waste dumps may allow for areas that have been revegetated to be included into the monitoring network.

Dust dispersal is predicted to be spread unevenly due to local meteorological influences. The two predominant wind directions at site are S to SE and N to NW. Average wind speed is 2.64 m/s at 3 m height and 2.9 m/s at 10 m. In addition, the local topography is varied and different mining sources produce particular matter of different sizes at different rates. Site sampling stations are located in areas anticipated to accumulate the most dust based on meteorological data collected at site.

Three of the four control plots selected for the VMU monitoring network were established during 2010 ecosystem mapping (M07, M80 and M90A). Summaries of these plots ecological characteristics can be found in Appendix A. Also, results of soil analysis for metal concentration, pH, texture and nutrient parameters for these control plots are provided in Appendix B. The fourth control plot selected is adjacent to the water quality station C4 which is approximately two km downstream of the dam on Minto Creek. The control at C4 will need to be established and its ecological properties recorded and soils tested to the same level as the other control plots. A sample Ecosystem Data form is provided in Appendix C.



MINTO MINE

capstone MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

VEGETATION METAL UPTAKE MONITORING PLAN

FIGURE 2
MONITORING NETWORK

SEPTEMBER 2015

Monitoring Stations

- ⊕ Control Plot
- ⊕ Survey Plot

Phase V / VI Features

- ▭ Phase V/VI Tailings
- ▭ Phase V/VI Pits
- ▭ Phase V/VI Dumps
- ▭ Phase IV Features
- ▭ Dam
- ▭ Spillway

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired September 9th 2014. Modelled boundary of annual TSP digitized from the map inset of figure 6 of the Minto Mine Phase V/VI Expansion Project Particulate Matter Dispersion Modelling Report by RWDI Consulting Engineers & Scientists.

Datum: NAD 83 Projection: UTM Zone 8N

This drawing has been prepared for the use of Alexco Environmental Group Inc.'s client and may not be used, reproduced or relied upon by third parties, except as agreed by Alexco Environmental Group Inc. and its client, as required by law or for use of governmental reviewing agencies. Alexco Environmental Group Inc. accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without Alexco Environmental Group Inc.'s express written consent.

I:\Minto\gis\mxd\Studies\Metal_Uptake_Soil_2015\WorkPlan_20150914.mxd
(*Last edited by: mducharme;9/14/2015/17:01 PM*)

4.2 METHODOLOGY

Observations and sampling at each station will include the following steps:

1. Selection of an appropriate microsite in the vicinity of the station identified on the map;
2. Generation of a station ID and documenting relevant ecological attributes of the station area (see Appendix C);
3. Soil sampling; and
4. Vegetation sampling.

4.2.1 Microsite Selection

The points provided as UTM coordinates and on the map are meant to guide the sampler to a vicinity not to an exact point. The sampler(s) must use their best judgement of the appropriateness of each microsite based on ground conditions. The following steps and considerations should be followed in selecting and documenting a microsite:

1. Locations that have been disturbed to the extent that soil is exposed and vegetation is damaged should be avoided;
2. The microsite should have at least two of the plant species listed in Table 2;
3. Look around the general location to find a relatively undisturbed site where soil pedon are not fragmented and vegetation is established (early successional communities are fine);
4. Situate the soil pit where the roots of the plants to be sampled are present;
5. Hang two pieces of flagging tape at the plot with the plot number, project, and date to ease relocation for future monitoring.
6. GPS the location with station ID and note coordinates; and
7. Fill out ecological attribute form for station, including:
    a. Mesoslope position, slope and aspect;
    b. Dominant vegetation and main cover heights;
    c. Plant species sampled;
    d. Successional stage;
    e. Signs of wildlife diggings, browsing and/or grazing;

f. Signs of site disturbance;

g. Distance from possible dust source (can be determined from map); and

h. Take photographs of soil pit and a representative shot of the site.

4.2.2 Soil Sampling

The depth of soil sampling is contingent upon the drainage properties of soils, amount of precipitation, and migration ability of metal ions. The soil textures common in the Minto area are silty to sandy loams. The area is semi-arid receiving an average annual rainfall of 1.74 cm. Due to these conditions, soil samples should be collected from the top surface layer of mineral soil at a depth of 4–10 cm (within the rooting zone of plants to be sampled) and again at 20-30 cm, where possible, to determine migration potential of specific metals through the pedon. If soils are not deep, try to obtain one sample in the rooting zone and one about 10 cm deeper, if this is still not possible then collect soils in the rooting zone.

The inductively coupled plasma mass spectrometry (ICP-MS) analysis for metal concentrations is sensitive in detecting concentrations in the range of micrograms per kilogram. Due to this level of sensitivity, cross contamination of soil samples needs to be carefully avoided throughout sample collection and shipping or results will be compromised. The following protocol for soil sampling needs to be follow to ensure soil samples are of high quality:

1. If possible, one member of the field sampling team can fill out site data sheets, take photographs and collect vegetation samples, while the other member(s) collects the soil samples.

2. Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area.

3. Dig a soil pit to a depth of 40 cm. After a soil pit is dug, scrape the vertical surface where soil will be extracted with a clean trowel or knife. This is necessary to minimize the effects of contamination due to smearing of material from other levels. Start with the lower sample depth at 25 cm, clean tools and change gloves before taking the next sample in the rooting zone at 4-10 cm depth.

4. A clean pair of nitrile disposable gloves should be worn each time a different soil sample is collected and digging tools cleaned with deionized water and paper towels prior to each soil sample taken. The gloves should be donned immediately prior to sampling.

5. Put approximately 300 g or four cups of soil in a fresh plastic sample bag which should be labeled with sample site identifier, date, project number and sampler’s initials. Labs usually supply these bags. Ensure sample bags are well sealed so no soil can leak out.

6. Sample bags with soils suspected of containing high concentrations of contaminants shall be handled and stored separately from control samples and vegetation samples. And,

7. Keep all samples cool and out of the light. Coolers with ice packs will suffice for storage, but samples should be sent to the lab within five days of collection date.

4.2.3 Vegetation Sampling

Table 2 in Section 3.3 identifies which parts of the plant should be sampled. Vegetation samples should be collected in plastic bags provided by the laboratory, and stored in a cool dark location until shipped. For each vegetation sample a minimum of 150 g should be collected from the plants or approximately four compacted handfuls. Sample only healthy mature leaves or berries, avoid collecting old, dead or damaged leaves.

It is best that the person collecting vegetation samples is not the same person sampling soils, as residual soils can be left on clothing, hair and hands, which could be unintentionally transferred to the plant material. Use fresh nitrile gloves for each plant collection. Leaves can be stripped off branches of willows. Horsetails can be pinched off just above ground level.

Grasses can be also cut (use stainless steel or ceramic knife washed with deionized water prior to each collection) about 2 cm above ground avoid including dead plant material. Grass root samples are to be collected to determine intermediate uptake in the root systems. Shake dirt from roots prior to putting into sample bag. The lab will wash the remaining soil off the roots before analysis.

4.2.4 Laboratory Analysis - Sample Preparation

The evaluation of metal uptake in plants versus metal accumulation on plant surface due to dust dispersal requires that the lab prepare samples in a specific manner. These following directions need to be clearly communicated to the lab on receipt of soil and vegetation samples.

Plant samples (leaves and berries) have been gathered to determine the effects of dust settlement from potential mine sources on nearby vegetation. In order to understand the degree of metal contamination being contribute by dust, each vegetation sample needs to be divided in two (except for root samples). Only one half of each vegetation sample is to be wash prior to ICP-MS analysis. The remaining half of the vegetation sample is not washed or prepared in a manner that would remove surface dust. The unwashed vegetation analysis will then reflect the total amount of contaminates both external and internal. The analysis of the washed half of the sample will reflect only metal contaminants residing within the plant tissues. The difference between the two sets of results will give the amount of contaminants that were dust-borne.

Soil samples will be dealt with as per usual by the lab prior to metal analysis. Other parameters to be obtained for each soil sample by lab analysis include: pH, texture and cation exchange capacity (CEC).

4.3 SCHEDULE

This monitoring should take place in July or early August of any given year before seasonal desiccation of vegetative material occurs. Continued monitoring should occur every three years after initial study, to determine any changes in dust dispersal and vegetation metal uptake.

4.4 QUALITY CONTROL AND QUALITY ASSURANCE (QA/QC)

There are eighteen sites selected for vegetation and soil sampling. At two of these sites duplicate samples should be taken and submitted to the lab under a pseudonym sample number. The lab results will be compared to ensure that the lab procedures and results are consistent. All other QA/QC protocols have been identified in the sampling methodology in the previous section.

4.5 REPORTING AND EVALUATION

Existing and gathered soils and vegetation data will be compiled into a workable data base. Soil and plant tissue metal concentrations results will be compared to CCME guidelines (as a benchmark), and site station data statistics will be compared with the control station data located outside of the zone of influence. Other soil and vegetation metal concentrations taken in previous studies will be used to make the sample pool more robust for comparative analysis and definition of patterns occurring in vegetation metal uptake.

Results will be presented with an interpretation in the Project's Annual Report under the Quartz Mining License.

5 REFERENCES

Access Consulting Group, 2007. Minto Mine, Reclamation Research Program, Detailed Decommissioning and Reclamation Plan, 2007 Activities. Prepared for Minto Explorations Ltd., a subsidiary of Capstone Mining Ltd.

Access Consulting Group, 2008. Minto Mine, Reclamation Research Program, Detailed Decommissioning and Reclamation Plan, 2008 Activities. Prepared for Minto Explorations Ltd., a subsidiary of Capstone Mining Ltd.

Access Consulting Group, 2009. Minto Mine, Reclamation Research Program, Detailed Decommissioning and Reclamation Plan, 2009 Activities. Prepared for Minto Explorations Ltd., a subsidiary of Capstone Mining Ltd.

Access Consulting Group, 2010. Minto Mine, Reclamation Research Program, Detailed Decommissioning and Reclamation Plan, 2010 Activities. Prepared for Minto Explorations Ltd., a subsidiary of Capstone Mining Ltd.

Access Consulting Group, 2010. Minto Mine, Reclamation Research Program, Decommissioning and Reclamation Plan, 2010 Activities. Prepared for Minto Explorations Ltd., a subsidiary of Capstone Mining Ltd.

Access Consulting Group, 2012. Keno District Soils and Vegetation Metals. Prepared for Elsa Reclamation and Development Company.

Access Consulting Group, 2014. Minto Mine Phase V/Vl, YESAB Project Proposal, Minto Climate Baseline Report.

CACAR II. 2003. Canadian Arctic Contaminants Assessment Report (CACAR) II, Northern Contaminants Program, Indian Affairs and Northern Development, Ottawa.

Canadian Council of Ministers of the Environment (CCME). 1999a. *Canadian Environmental Quality Guidelines*. Canadian Council of Ministers of the Environment. Winnipeg, MB.

Canadian Council of Ministers of the Environment (CCME). 2006. Canadian soil quality guidelines for the protection of environment and human health: Introduction. In Canadian Council of Ministers of the Environment. *Canadian environmental quality guidelines*. Winnipeg, MB.

Carter, M.R, and E. G. Gregorich, Eds. 2008. Canadian Society of Soil Science. Sampling and Methods of Analysis 2nd ed. Taylor & Francis Group, LLC.

Environmental Dynamics Inc. (EDI), 2013. Casino Project: Vegetation Baseline Report. Project #: 13-Y-0045, Yukon.

Gamberg, M. 2008. Contaminants in Arctic Moose and Caribou – 2006. Technical Report. Northern Contaminants Program.

Horizon Ecosystem Consultants, 2010. Minto Mine Environmental Baseline Ecosystems and Vegetation Report.

Teck Cominco, 2005. Summary of Mine Related Fugitive Dust Studies. Red Dog Mine, Alaska.

APPENDIX A

CONTROL PLOT SUMMARIES

PLOT M07

Status: Permanent ***(Control, soil sampled)*** **Location**: UTM: 0383864E, 6944289N

Vegetation Plot Summary

Shrub species cover	$At_5Pl_4W_1$
Age in years (dominant species)	20
Height in meters (avg dominant species)	8
Soil moisture and nutrient values (SMR/SNR)	3/C
Crown cover for polygon in %	40
Succession Stage	Young forest
Aspect (^{0})	204
Elevation (m)	890
Slope %	22
Meso slope position	Upper
Drainage	Well
Coarse woody debris%/Snags#	11/2

Site description: South west facing open forest. Fire regeneration. Bare ground ~20% covered with leaf litter. Poorly developed herb layer, 6% grass (Calamagrostis purpurascens).

Plant community: Trembling Aspen – Pine - Bunchgrass

Comments: Selected control for mixed aspen/pine forest, southern aspect, outside of mine influences.

PLOT M80

Status: Permanent (Control, soil sampled) **Location**: UTM: 0384380E, 6947083N

Vegetation Plot Summary

Shrub species cover	$Pl_5W_3At_2$
Age in years (dominant species)	15
Height in meters (avg dominant species)	5
Soil moisture and nutrient values (SMR/SNR)	3/B
Crown cover for polygon in %	40
Succession Stage	Young forest
Aspect (^{0})	140
Elevation (m)	817
Slope %	10
Meso slope position	Middle
Drainage	Well
Coarse woody debris%/Snags#	5/0

Site description: South east facing slope, poorly developed herb layer, mainly moss/lichen with bare soil patches, about 10% exposed rocks.

Plant community: Pine - Willow - Aspen

Comments: Helicopter access

PLOT M90A

Status: Permanent (soil sample) **Location**: UTM: 0387045E, 6947197N

Vegetation Plot Summary

Plant species cover	$At_5Sw_3Pl_2$
Age in years (dominant species)	75
Height in meters (avg dominant species)	10
Soil moisture and nutrient values (SMR/SNR)	3/C
Crown cover for polygon in %	40
Succession Stage	Mature forest
Aspect (^{0})	179
Elevation (m)	792
Slope %	22
Meso slope position	Middle
Drainage	Well
Coarse woody debris%/Snags#	2/1

Site description: South facing slope ground cover predominantly kinnikinnick (*Arctostaphylos uva-ursi*) and grass (*Calamagrostis purpurascens*). Large canopy gaps with grassland attributes

Plant community: Aspen - White Spruce - Pine (grassland)

Comments: Minto Road 200m south of plot

APPENDIX B

SOIL AND VEGETATION LAB RESULTS 2009 AND 2010

Driven by service and Science
www.maxxamanalytics.com

Your Project #: MIN-09-05 REVEGETATION MONITOR
Your C.O.C. #: 08304612, F143924, F143925

Attention: Colleen Roche
MINTO EXPLORATIONS LTD.
#900 - 999 WEST HASTINGS ST.
VANCOUVER, BC
CANADA V6C2W2

Report Date: 2009/10/06

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: A953654
Received: 2009/09/25, 01:05

Sample Matrix: Soil
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Cation Exchange Capacity (1)	3	2009/10/02	2009/10/06	EENVSOP-00034	EPA SW846 6010C
Conductivity (Soluble)	3	2009/09/30	2009/10/01	BRN SOP-00267 R3.0	Based Carter 18.3.1
Elements by ICPMS (total)	3	2009/10/01	2009/10/01	BRN SOP-00203 R5.0	Based on EPA 200.8
pH (2:1 DI Water Extract) (4)	3	2009/10/01	2009/10/01	BRN SOP-00266 R6.0	Carter, SSMA 16.2
Saturated Paste	3	2009/09/30	2009/10/01	BRN SOP-00268 R5.0	Carter SSMA 18.2.2
Sublet (ORGANICS) (2)	3	N/A	2009/10/05		
Total Kjeldahl Nitrogen - Soil (1,4)	3	2009/10/02	2009/10/02	CAL SOP-00072	SM - 4500N
TOC Soil Subcontract (3)	3	2009/10/02	2009/10/02		

Sample Matrix: VEGETABLES
Samples Received: 24

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Elements by CRC ICPMS (total) - Plant	24	2009/10/02	2009/10/02	BRN SOP-00206 R7.0	Based on EPA 200.8

* Results relate only to the items tested.

(1) This test was performed by Maxxam Calgary
(2) This test was performed by Ext. Sublet from Vancouver
(3) This test was performed by Maxxam Bedford(From Burnaby)
(4) SCC/CAEAL

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

VIREN THAKER, BBY Customer Service
Email: VIREN.THAKER@MaxxamAnalytics.com
Phone# (604) 444-4808 Ext:232

==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. SCC and CALA have approved this reporting process and electronic report format.

Total cover pages: 1

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		Q95936		Q95937	Q95938		
Sampling Date		2009/09/21		2009/09/21	2009/09/21		
	Units	**TOE OF TAILINGS SOIL**	**QC Batch**	**SOIL SAMPLE LOWER IROD**	**SOIL SAMPLE UPPER IROD**	**RDL**	**QC Batch**
Misc. Inorganics							
Total Kjeldahl Nitrogen	mg/kg	3500(1)	3461533	1500(1)	570(1)	100	3461533
Parameter							
Subcontract Parameter	N/A	ATTACHED	3463366	ATTACHED	ATTACHED	N/A	3465804
Elements							
Cation exchange capacity	cmol+/Kg	35	3461568	24	16	10	3461568
Soluble Parameters							
Soluble Conductivity	uS/cm	2580	3456164	402	284	1	3456164
Saturation %	%	160	3455655	57	47	1	3455655

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Detection limits raised due to dilution to bring analyte within the calibrated range.

ELEMENTS BY ATOMIC SPECTROSCOPY (VEGETABLES)

Maxxam ID		Q95926	Q95927	Q95928	Q95929	Q95930	Q95931	Q95932	Q95933	Q95934		
Sampling Date		2009/09/22	2009/09/21	2009/09/21	2009/09/21	2009/09/21	2009/09/21	2009/09/21	2009/09/21	2009/09/21		
	Units	**YUKON RIVER PLANE-LEAF WILLOW LEAVES**	**COPPER KEEL BIRCH TWIGS**	**COPPER KEEL BIRCH LEAVES**	**WASTE ROCK DUMP 1ST LEVEL LEAF WILLLOW TWIGS**	**TOE OF WASTE ROCK 1ST LIFT WILLOW TWIGS (LITTLE TREE)**	**PLANE-LEAF WILLOW TOE OF WASTE ROCK DUMP 1ST LEVEL**	**TOE OF WASTE ROCK DUMP-WILLOW LEAVES (LITTLE)**	**YUKON RIVER LITTLE TREE**	**YUKON RIVER LITTLE TREE WILLOW TWIGS**	**RDL**	**QC Batch**
Total Metals by ICPMS												
Total Aluminum (Al)	mg/kg	46	27	34	149	158	1740	1120	40	17	1	3461873
Total Antimony (Sb)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3461873
Total Arsenic (As)	mg/kg	0.10	<0.01	0.01	0.07	0.07	0.66	0.40	0.04	0.02	0.01	3461873
Total Barium (Ba)	mg/kg	14.8	58.9	143	3.9	4.7	20.3	13.9	109	8.9	0.1	3461873
Total Beryllium (Be)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3461873
Total Bismuth (Bi)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3461873
Total Boron (B)	mg/kg	50	8	47	12	8	25	26	73	9	5	3461873
Total Cadmium (Cd)	mg/kg	0.51	0.06	0.03	1.15	1.68	2.92	4.78	6.77	0.20	0.01	3461873
Total Calcium (Ca)	mg/kg	28200	6330	20200	6780	3570	41100	19200	31700	6410	10	3461873
Total Chromium (Cr)	mg/kg	1.4	<0.5	<0.5	<0.5	<0.5	1.5	<0.5	<0.5	<0.5	0.5	3461873
Total Cobalt (Co)	mg/kg	0.4	<0.1	<0.1	0.1	0.2	1.0	1.3	0.2	<0.1	0.1	3461873
Total Copper (Cu)	mg/kg	7.7	7.2	6.6	20.4	18.8	145	96.5	3.5	7.5	0.5	3461873
Total Iron (Fe)	mg/kg	97	71	71	199	216	2280	1540	73	33	10	3461873
Total Lead (Pb)	mg/kg	0.19	0.07	0.06	0.08	0.07	0.65	0.48	0.14	0.09	0.01	3461873
Total Magnesium (Mg)	mg/kg	5210	606	1840	1020	692	8880	6400	4180	743	10	3461873
Total Manganese (Mn)	mg/kg	37.9	22.2	107	55.1	83.5	447	954	136	5.8	0.1	3461873
Total Mercury (Hg)	mg/kg	0.02	<0.01	0.01	<0.01	<0.01	0.02	0.02	0.02	<0.01	0.01	3461873
Total Molybdenum (Mo)	mg/kg	1.1	<0.1	0.4	<0.1	0.1	1.3	2.1	1.8	<0.1	0.1	3461873
Total Nickel (Ni)	mg/kg	3.0	0.3	0.2	0.6	0.6	1.7	1.6	0.7	0.8	0.1	3461873
Total Phosphorus (P)	mg/kg	4270	1350	1420	920	890	856	1100	6820	1330	10	3461873
Total Potassium (K)	mg/kg	8270	2410	6090	2710	2330	9460	8170	3700	2560	10	3461873
Total Selenium (Se)	mg/kg	0.89	0.02	0.01	0.99	0.27	3.77	1.00	0.29	0.30	0.01	3461873
Total Silver (Ag)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	3461873
Total Sodium (Na)	mg/kg	10	<10	13	12	11	92	27	<10	<10	10	3461873
Total Strontium (Sr)	mg/kg	113	13.1	31.1	52.8	27.2	293	123	184	29.0	0.1	3461873
Total Thallium (Tl)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	3461873
Total Tin (Sn)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3461873
Total Titanium (Ti)	mg/kg	2	1	2	5	6	65	44	2	<1	1	3461873
Total Uranium (U)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	<0.05	0.05	3461873
Total Vanadium (V)	mg/kg	<2	<2	<2	<2	<2	5	3	<2	<2	2	3461873
Total Zinc (Zn)	mg/kg	60.5	97.6	127	70.3	44.9	101	41.4	142	56.5	0.1	3461873

RDL = Reportable Detection Limit

ELEMENTS BY ATOMIC SPECTROSCOPY (VEGETABLES)

Maxxam ID		Q95935	Q95939	Q95940	Q95941	Q95942	Q95943	Q95944	Q95945		
Sampling Date		2009/09/21	2009/09/21	2009/09/21	2009/09/21	2009/09/21	2009/09/21	2009/09/21	2009/09/21		
	Units	**YUKON RIVER PLANE-LEAF WILLOW TWIGS**	**TUFTED HAIRGRASS LOWER IROD**	**SHEEP FESCUE LOWER IROD**	**VIOLET WHEATGRASS LOWER IROD**	**R.M. FESCUE LOWER IROD**	**TUFTED HAIRGRASS TOE OF TAILINGS**	**VIOLET WHEATGRASS TOE OF TAILINGS**	**GLAUCOUS BLUEGRASS TOE OF TAILINGS**	**RDL**	**QC Batch**
Total Metals by ICPMS											
Total Aluminum (Al)	mg/kg	33	1060	978	702	559	1160	795	637	1	3461873
Total Antimony (Sb)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3461873
Total Arsenic (As)	mg/kg	0.03	0.39	0.31	0.17	0.19	0.21	0.16	0.22	0.01	3461873
Total Barium (Ba)	mg/kg	61.4	76.0	47.6	20.4	25.6	25.0	21.8	73.1	0.1	3461873
Total Beryllium (Be)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3461873
Total Bismuth (Bi)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3461873
Total Boron (B)	mg/kg	16	<5	<5	<5	<5	<5	<5	6	5	3461873
Total Cadmium (Cd)	mg/kg	3.81	0.22	0.17	0.09	0.06	0.08	0.09	0.35	0.01	3461873
Total Calcium (Ca)	mg/kg	12400	4480	3630	4000	1880	2810	3500	8690	10	3461873
Total Chromium (Cr)	mg/kg	<0.5	1.0	0.9	0.6	2.1	1.5	1.6	0.7	0.5	3461873
Total Cobalt (Co)	mg/kg	<0.1	0.7	0.6	0.3	0.4	0.7	0.5	0.8	0.1	3461873
Total Copper (Cu)	mg/kg	5.3	100	81.3	58.5	49.9	213	133	113	0.5	3461873
Total Iron (Fe)	mg/kg	54	1750	1570	1000	882	2610	1800	1460	10	3461873
Total Lead (Pb)	mg/kg	0.15	0.49	0.49	0.32	0.33	0.52	0.44	0.47	0.01	3461873
Total Magnesium (Mg)	mg/kg	830	1550	1430	1310	666	1180	1210	3930	10	3461873
Total Manganese (Mn)	mg/kg	35.6	354	366	173	205	150	212	593	0.1	3461873
Total Mercury (Hg)	mg/kg	0.01	0.01	0.01	<0.01	<0.01	0.01	0.01	0.01	0.01	3461873
Total Molybdenum (Mo)	mg/kg	1.0	2.6	1.4	1.0	1.1	1.2	1.1	2.3	0.1	3461873
Total Nickel (Ni)	mg/kg	0.4	2.5	0.9	0.5	1.8	1.2	1.1	1.4	0.1	3461873
Total Phosphorus (P)	mg/kg	1250	830	666	178	604	309	608	1090	10	3461873
Total Potassium (K)	mg/kg	3110	5880	4650	2500	2870	1770	6240	9710	10	3461873
Total Selenium (Se)	mg/kg	0.26	0.24	0.13	0.24	0.12	0.24	0.19	0.21	0.01	3461873
Total Silver (Ag)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	0.09	0.06	0.06	0.05	3461873
Total Sodium (Na)	mg/kg	<10	23	23	17	14	33	29	31	10	3461873
Total Strontium (Sr)	mg/kg	58.7	24.5	17.5	18.3	10.1	15.6	17.6	42.3	0.1	3461873
Total Thallium (Tl)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	3461873
Total Tin (Sn)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3461873
Total Titanium (Ti)	mg/kg	1	50	47	29	26	80	56	43	1	3461873
Total Uranium (U)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	3461873
Total Vanadium (V)	mg/kg	<2	4	3	<2	<2	5	3	3	2	3461873
Total Zinc (Zn)	mg/kg	128	55.1	28.0	19.8	24.0	25.3	18.5	123	0.1	3461873

RDL = Reportable Detection Limit

ELEMENTS BY ATOMIC SPECTROSCOPY (VEGETABLES)

Maxxam ID		Q95946		Q95947	Q95948	Q95949	Q95950	Q95951	Q95952		
Sampling Date		2009/09/21		2009/09/21	2009/09/21	2009/09/21	2009/09/21	2009/09/21	2009/09/21		
	Units	**R.M. FESCUE TOE OF TAILINGS**	**QC Batch**	**SHEEP FESCUE TOE OF TAILINGS**	**VIOLET WHEATGRASS UPPER IROD**	**TUFTED HAIRGRASS UPPER IROD**	**SHEEP FESCUE UPPER IROD**	**GLAUCOUS BLUEGRASS UPPER IROD**	**R.M. FESCUE UPPER IROD**	**RDL**	**QC Batch**
Total Metals by ICPMS											
Total Aluminum (Al)	mg/kg	1320	3461873	601	855	1150	320	363	340	1	3461891
Total Antimony (Sb)	mg/kg	<0.1	3461873	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3461891
Total Arsenic (As)	mg/kg	0.35	3461873	0.13	0.32	0.48	0.16	0.27	0.16	0.01	3461891
Total Barium (Ba)	mg/kg	90.4	3461873	31.6	71.0	63.6	25.8	151	28.6	0.1	3461891
Total Beryllium (Be)	mg/kg	<0.1	3461873	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3461891
Total Bismuth (Bi)	mg/kg	<0.1	3461873	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3461891
Total Boron (B)	mg/kg	<5	3461873	<5	<5	7	<5	6	<5	5	3461891
Total Cadmium (Cd)	mg/kg	0.19	3461873	0.19	0.17	0.26	0.10	0.11	0.03	0.01	3461891
Total Calcium (Ca)	mg/kg	5380	3461873	3630	4010	4260	2690	5410	1700	10	3461891
Total Chromium (Cr)	mg/kg	3.1	3461873	0.9	0.9	1.3	<0.5	<0.5	<0.5	0.5	3461891
Total Cobalt (Co)	mg/kg	1.1	3461873	0.5	0.5	0.8	0.2	0.5	0.2	0.1	3461891
Total Copper (Cu)	mg/kg	233	3461873	108	65.0	114	26.2	39.1	25.0	0.5	3461891
Total Iron (Fe)	mg/kg	2880	3461873	1360	1380	1960	525	729	559	10	3461891
Total Lead (Pb)	mg/kg	0.88	3461873	0.70	0.52	0.65	0.69	0.43	0.20	0.01	3461891
Total Magnesium (Mg)	mg/kg	2600	3461873	1890	1380	1410	1020	2090	634	10	3461891
Total Manganese (Mn)	mg/kg	498	3461873	325	174	136	123	462	121	0.1	3461891
Total Mercury (Hg)	mg/kg	<0.01	3461873	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	3461891
Total Molybdenum (Mo)	mg/kg	1.5	3461873	2.7	1.4	4.8	1.7	1.9	0.9	0.1	3461891
Total Nickel (Ni)	mg/kg	2.7	3461873	0.9	1.0	2.2	1.1	2.5	1.0	0.1	3461891
Total Phosphorus (P)	mg/kg	852	3461873	1080	439	1060	807	1030	585	10	3461891
Total Potassium (K)	mg/kg	4720	3461873	13300	5090	5690	5960	5180	3240	10	3461891
Total Selenium (Se)	mg/kg	0.30	3461873	0.15	0.15	0.21	0.07	0.20	0.07	0.01	3461891
Total Silver (Ag)	mg/kg	0.12	3461873	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	0.05	3461891
Total Sodium (Na)	mg/kg	40	3461873	28	20	29	16	15	19	10	3461891
Total Strontium (Sr)	mg/kg	30.1	3461873	20.9	21.5	21.1	12.5	29.3	9.0	0.1	3461891
Total Thallium (Tl)	mg/kg	<0.05	3461873	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	3461891
Total Tin (Sn)	mg/kg	0.1	3461873	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3461891
Total Titanium (Ti)	mg/kg	91	3461873	45	48	57	16	17	18	1	3461891
Total Uranium (U)	mg/kg	<0.05	3461873	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	3461891
Total Vanadium (V)	mg/kg	6	3461873	3	3	4	<2	<2	<2	2	3461891
Total Zinc (Zn)	mg/kg	89.3	3461873	44.0	13.6	34.7	21.0	98.3	18.8	0.1	3461891

RDL = Reportable Detection Limit

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		Q95936	Q95937	Q95938		
Sampling Date		2009/09/21	2009/09/21	2009/09/21		
	Units	**TOE OF TAILINGS SOIL**	**SOIL SAMPLE LOWER IROD**	**SOIL SAMPLE UPPER IROD**	**RDL**	**QC Batch**
Misc. Inorganics						
Soluble (2:1) pH	pH Units	5.23	7.04	8.45	0.01	3458063
Total Metals by ICPMS						
Total Aluminum (Al)	mg/kg	15300	14200	12800	100	3459879
Total Antimony (Sb)	mg/kg	0.5	0.5	0.3	0.1	3459879
Total Arsenic (As)	mg/kg	6.5	5.3	6.5	0.2	3459879
Total Barium (Ba)	mg/kg	279	215	183	0.1	3459879
Total Beryllium (Be)	mg/kg	0.5	0.3	0.5	0.1	3459879
Total Bismuth (Bi)	mg/kg	0.1	0.1	<0.1	0.1	3459879
Total Cadmium (Cd)	mg/kg	0.29	0.25	0.15	0.05	3459879
Total Calcium (Ca)	mg/kg	8960	9890	11800	100	3459879
Total Chromium (Cr)	mg/kg	28	29	29	1	3459879
Total Cobalt (Co)	mg/kg	8.3	10.0	11.6	0.3	3459879
Total Copper (Cu)	mg/kg	163	123	59.6	0.5	3459879
Total Iron (Fe)	mg/kg	20900	24900	26100	100	3459879
Total Lead (Pb)	mg/kg	6.3	6.4	5.6	0.1	3459879
Total Magnesium (Mg)	mg/kg	6420	8330	11200	100	3459879
Total Manganese (Mn)	mg/kg	178	460	467	0.2	3459879
Total Mercury (Hg)	mg/kg	<0.05	<0.05	<0.05	0.05	3459879
Total Molybdenum (Mo)	mg/kg	2.1	1.3	0.6	0.1	3459879
Total Nickel (Ni)	mg/kg	23.6	32.1	53.7	0.8	3459879
Total Phosphorus (P)	mg/kg	586	742	858	10	3459879
Total Potassium (K)	mg/kg	787	1130	1470	100	3459879
Total Selenium (Se)	mg/kg	1.0	0.6	0.6	0.5	3459879
Total Silver (Ag)	mg/kg	0.14	0.12	0.09	0.05	3459879
Total Sodium (Na)	mg/kg	217	275	278	100	3459879
Total Strontium (Sr)	mg/kg	59.0	60.3	60.1	0.1	3459879
Total Thallium (Tl)	mg/kg	0.09	0.10	0.11	0.05	3459879
Total Tin (Sn)	mg/kg	0.5	0.5	0.4	0.1	3459879
Total Titanium (Ti)	mg/kg	805	928	682	1	3459879
Total Vanadium (V)	mg/kg	62	64	59	2	3459879
Total Zinc (Zn)	mg/kg	69	71	58	1	3459879
Total Zirconium (Zr)	mg/kg	2.9	3.5	3.0	0.5	3459879

RDL = Reportable Detection Limit

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**	**% Recovery**	**QC Limits**
3455655	Saturation %	2009/10/01					<1	%	9.1	25		
3456164	Soluble Conductivity	2009/10/01			98	80 - 120	<1	uS/cm	21.2	N/A		
3458063	Soluble (2:1) pH	2009/10/01			100	96 - 104			0.1	20		
3459879	Total Arsenic (As)	2009/10/01	99	75 - 125	98	75 - 125	<0.2	mg/kg			84	70 - 130
3459879	Total Beryllium (Be)	2009/10/01	113	75 - 125	105	75 - 125	<0.1	mg/kg				
3459879	Total Cadmium (Cd)	2009/10/01	108	75 - 125	100	75 - 125	<0.05	mg/kg			83	70 - 130
3459879	Total Chromium (Cr)	2009/10/01	105	75 - 125	98	75 - 125	<1	mg/kg			93	70 - 130
3459879	Total Cobalt (Co)	2009/10/01	105	75 - 125	101	75 - 125	<0.3	mg/kg			87	70 - 130
3459879	Total Copper (Cu)	2009/10/01	105	75 - 125	102	75 - 125	<0.5	mg/kg			89	70 - 130
3459879	Total Lead (Pb)	2009/10/01	108	75 - 125	95	75 - 125	<0.1	mg/kg	2.0	35	92	70 - 130
3459879	Total Mercury (Hg)	2009/10/01	109	75 - 125	97	75 - 125	<0.05	mg/kg				
3459879	Total Nickel (Ni)	2009/10/01	104	75 - 125	98	75 - 125	<0.8	mg/kg			89	70 - 130
3459879	Total Selenium (Se)	2009/10/01	109	75 - 125	107	75 - 125	<0.5	mg/kg				
3459879	Total Vanadium (V)	2009/10/01	119	75 - 125	113	75 - 125	<2	mg/kg			111	70 - 130
3459879	Total Zinc (Zn)	2009/10/01	NC	75 - 125	105	75 - 125	<1	mg/kg			90	70 - 130
3459879	Total Aluminum (Al)	2009/10/01					<100	mg/kg			105	70 - 130
3459879	Total Antimony (Sb)	2009/10/01					<0.1	mg/kg			93	70 - 130
3459879	Total Barium (Ba)	2009/10/01					<0.1	mg/kg			112	70 - 130
3459879	Total Calcium (Ca)	2009/10/01					<100	mg/kg			91	70 - 130
3459879	Total Iron (Fe)	2009/10/01					<100	mg/kg			98	70 - 130
3459879	Total Magnesium (Mg)	2009/10/01					<100	mg/kg			102	70 - 130
3459879	Total Manganese (Mn)	2009/10/01					<0.2	mg/kg			124	70 - 130
3459879	Total Molybdenum (Mo)	2009/10/01					<0.1	mg/kg			86	70 - 130
3459879	Total Phosphorus (P)	2009/10/01					<10	mg/kg			77	70 - 130
3459879	Total Silver (Ag)	2009/10/01					<0.05	mg/kg			83	70 - 130
3459879	Total Strontium (Sr)	2009/10/01					0.1, RDL=0.1	mg/kg			128	70 - 130
3459879	Total Thallium (Tl)	2009/10/01					<0.05	mg/kg			76	70 - 130
3459879	Total Titanium (Ti)	2009/10/01					<1	mg/kg			111	70 - 130
3459879	Total Bismuth (Bi)	2009/10/01					<0.1	mg/kg				
3459879	Total Potassium (K)	2009/10/01					<100	mg/kg				
3459879	Total Sodium (Na)	2009/10/01					<100	mg/kg				
3459879	Total Tin (Sn)	2009/10/01					<0.1	mg/kg				
3459879	Total Zirconium (Zr)	2009/10/01					<0.5	mg/kg				
3461533	Total Kjeldahl Nitrogen	2009/10/02	NC	75 - 125	104	80 - 120	<10	mg/kg	18.2	35	84	60 - 121
3461568	Cation exchange capacity	2009/10/06							NC	35		
3461873	Total Arsenic (As)	2009/10/02	108	75 - 125	105	75 - 125	<0.01	mg/kg	12.0	35		
3461873	Total Beryllium (Be)	2009/10/02	110	75 - 125	110	75 - 125	<0.1	mg/kg	NC	35		
3461873	Total Cadmium (Cd)	2009/10/02	111	75 - 125	112	75 - 125	<0.01	mg/kg	2.4	35		
3461873	Total Chromium (Cr)	2009/10/02	107	75 - 125	108	75 - 125	<0.5	mg/kg	NC	35		
3461873	Total Cobalt (Co)	2009/10/02	107	75 - 125	108	75 - 125	<0.1	mg/kg	NC	35		

MINTO EXPLORATIONS LTD.
Client Project #: MIN-09-05 REVEGETATION MONITOR

Maxxam Job #: A953654
Report Date: 2009/10/06

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**	**% Recovery**	**QC Limits**
3461873	Total Copper (Cu)	2009/10/02	106	75 - 125	107	75 - 125	<0.5	mg/kg	0.2	35		
3461873	Total Lead (Pb)	2009/10/02	105	75 - 125	111	75 - 125	<0.01	mg/kg	0.3	35		
3461873	Total Mercury (Hg)	2009/10/02	103	75 - 125	107	75 - 125	0.01, RDL=0.01	mg/kg	NC	35		
3461873	Total Nickel (Ni)	2009/10/02	106	75 - 125	107	75 - 125	<0.1	mg/kg	2.6	35		
3461873	Total Selenium (Se)	2009/10/02	112	75 - 125	114	75 - 125	0.01, RDL=0.01	mg/kg	9.6	35		
3461873	Total Uranium (U)	2009/10/02	110	75 - 125	113	75 - 125	<0.05	mg/kg	NC	35		
3461873	Total Vanadium (V)	2009/10/02	111	75 - 125	107	75 - 125	<2	mg/kg	NC	35		
3461873	Total Zinc (Zn)	2009/10/02	NC	75 - 125	112	75 - 125	<0.1	mg/kg	1.5	35		
3461873	Total Aluminum (Al)	2009/10/02					1, RDL=1	mg/kg	2.2	35		
3461873	Total Antimony (Sb)	2009/10/02					<0.1	mg/kg	NC	35		
3461873	Total Barium (Ba)	2009/10/02					<0.1	mg/kg	2.0	35		
3461873	Total Bismuth (Bi)	2009/10/02					<0.1	mg/kg	NC	35		
3461873	Total Boron (B)	2009/10/02					<5	mg/kg	1.1	35		
3461873	Total Calcium (Ca)	2009/10/02					<10	mg/kg	1.5	35		
3461873	Total Iron (Fe)	2009/10/02					<10	mg/kg	11.2	35		
3461873	Total Magnesium (Mg)	2009/10/02					<10	mg/kg	0.5	35		
3461873	Total Manganese (Mn)	2009/10/02					<0.1	mg/kg	1.9	35		
3461873	Total Molybdenum (Mo)	2009/10/02					<0.1	mg/kg	1.2	35		
3461873	Total Phosphorus (P)	2009/10/02					<10	mg/kg	1.5	35		
3461873	Total Potassium (K)	2009/10/02					<10	mg/kg	0.5	35		
3461873	Total Silver (Ag)	2009/10/02					<0.05	mg/kg	NC	35		
3461873	Total Sodium (Na)	2009/10/02					<10	mg/kg	NC	35		
3461873	Total Strontium (Sr)	2009/10/02					<0.1	mg/kg	1.6	35		
3461873	Total Thallium (Tl)	2009/10/02					<0.05	mg/kg	NC	35		
3461873	Total Tin (Sn)	2009/10/02					<0.1	mg/kg	NC	35		
3461873	Total Titanium (Ti)	2009/10/02					<1	mg/kg	NC	35		
3461891	Total Arsenic (As)	2009/10/02	110	75 - 125	111	75 - 125	<0.01	mg/kg	5.7	35		
3461891	Total Beryllium (Be)	2009/10/02	111	75 - 125	110	75 - 125	<0.1	mg/kg	NC	35		
3461891	Total Cadmium (Cd)	2009/10/02	115	75 - 125	115	75 - 125	<0.01	mg/kg	7.7	35		
3461891	Total Chromium (Cr)	2009/10/02	109	75 - 125	112	75 - 125	<0.5	mg/kg	NC	35		
3461891	Total Cobalt (Co)	2009/10/02	107	75 - 125	110	75 - 125	<0.1	mg/kg	NC	35		
3461891	Total Copper (Cu)	2009/10/02	NC	75 - 125	110	75 - 125	<0.5	mg/kg	0.09	35		
3461891	Total Lead (Pb)	2009/10/02	107	75 - 125	110	75 - 125	<0.01	mg/kg	1	35		
3461891	Total Mercury (Hg)	2009/10/02	104	75 - 125	104	75 - 125	<0.01	mg/kg	NC	35		
3461891	Total Nickel (Ni)	2009/10/02	107	75 - 125	110	75 - 125	<0.1	mg/kg	7.4	35		
3461891	Total Selenium (Se)	2009/10/02	110	75 - 125	114	75 - 125	0.01, RDL=0.01	mg/kg	2.9	35		
3461891	Total Uranium (U)	2009/10/02	110	75 - 125	111	75 - 125	<0.05	mg/kg	NC	35		
3461891	Total Vanadium (V)	2009/10/02	111	75 - 125	111	75 - 125	<2	mg/kg	NC	35		
3461891	Total Zinc (Zn)	2009/10/02	NC	75 - 125	115	75 - 125	<0.1	mg/kg	0.3	35		
3461891	Total Aluminum (Al)	2009/10/02					1, RDL=1	mg/kg	0.08	35		

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
3461891	Total Antimony (Sb)	2009/10/02					<0.1	mg/kg	NC	35		
3461891	Total Barium (Ba)	2009/10/02					<0.1	mg/kg	0.4	35		
3461891	Total Bismuth (Bi)	2009/10/02					<0.1	mg/kg	NC	35		
3461891	Total Boron (B)	2009/10/02					<5	mg/kg	NC	35		
3461891	Total Calcium (Ca)	2009/10/02					<10	mg/kg	1.7	35		
3461891	Total Iron (Fe)	2009/10/02					<10	mg/kg	1.6	35		
3461891	Total Magnesium (Mg)	2009/10/02					<10	mg/kg	0.9	35		
3461891	Total Manganese (Mn)	2009/10/02					<0.1	mg/kg	0.4	35		
3461891	Total Molybdenum (Mo)	2009/10/02					<0.1	mg/kg	1	35		
3461891	Total Phosphorus (P)	2009/10/02					<10	mg/kg	0.7	35		
3461891	Total Potassium (K)	2009/10/02					<10	mg/kg	1.5	35		
3461891	Total Silver (Ag)	2009/10/02					<0.05	mg/kg	NC	35		
3461891	Total Sodium (Na)	2009/10/02					<10	mg/kg	NC	35		
3461891	Total Strontium (Sr)	2009/10/02					<0.1	mg/kg	0.3	35		
3461891	Total Thallium (Tl)	2009/10/02					<0.05	mg/kg	NC	35		
3461891	Total Tin (Sn)	2009/10/02					<0.1	mg/kg	NC	35		
3461891	Total Titanium (Ti)	2009/10/02					<1	mg/kg	0.9	35		

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Spiked Blank: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Maxxam Analytics Inc

8577 Commerce Court
Burnaby, BC V5A 4N5
www.maxxamanalytics.com

Phone: (604) 444-4808
Fax.: (604) 444-4511
Toll-Free: 1-800-440-4808

CHAIN-C ...RD AND ANALYSIS REQUEST

08304612

PAGE 1 OF 13

A953654

LAB USE ONLY
MAXXAM JOB #

ANALYSIS REQUEST

LAB USE ONLY
COC #

COMPANY NAME: Minto Explorations Ltd.	CLIENT PROJECT NO.: MIN-09-05 Revegetation Monitoring Sept 09
COMPANY ADDRESS:	TEL.: E-MAIL: scott@accessconsulting.ca colleenr@mintomine.com FAX:

SAMPLER NAME (PRINT): Stu Withers	PROJECT MANAGER: Scott Keesey/Colleen Roche	LABORATORY CONTACT: Kimberley Webber

	FIELD SAMPLE ID	MAXXAM LAB # (LAB USE ONLY)	MATRIX: GROUNDWATER	SURFACE WATER	DRINKING WATER	SOIL	OTHER	SAMPLING: DATE DD/MM/YY	TIME	# CONTAINERS	ICP Metals
1	Yukon River Plane-leaf Willow Leaves						x	2009/09/22	16:00	1	x
2	Copper Keel Birch Twigs						x	2009/09/21	17:00	1	x
3	Copper Keel Birch Leaves						x	2009/09/21	17:00	1	x
4	Waste Rock Dump 1st level Leaf Willow Twigs									1	X
5	Toe of Waste Rock 1st lift willow twigs (little)									1	X
6	Plane-leaf willow - toe of waste rock dump 1st level									1	X
7	Toe of waste Rock Pump - willow leaves (little)									1	X
8	Yukon River little tree'									1	X
9	Yukon River little tree willow twigs									1	X
10	Yukon River plane-leaf willow twigs									1	X
11	Toe of Tailings soil									1	X
12	Soil sample lower Irod									1	X

TAT (Turnaround Time)

LESS THAN 5 DAY TAT MUST HAVE PRIOR APPROVAL

* Some exceptions apply - please contact laboratory

STANDARD	5 BUSINESS DAYS	X
RUSH	3 BUSINESS DAYS	
RUSH	2 BUSINESS DAYS	
URGENT	1 BUSINESS DAY	

OTHER BUSINESS DAYS ____

PO NUMBER OR QUOTE NUMBER: PR 7041

SPECIAL DETECTION LIMITS / CONTAMINANT TYPE:

☐ CCME
☐ CSR
☐ AB TIER 1
☐ OTHER

ACCOUNTING CONTACT:

SPECIAL REPORTING OR BILLING INSTRUCTIONS:

JARS USED:

LAB USE ONLY

ARRIVAL TEMPERATURE °C:

DUE DATE:

LOG IN CHECK:

RELINQUISHED BY SAMPLER: S. Withers	DATE: DD/MM/YY 23/09/09	TIME: 20:00	RECEIVED BY:
RELINQUISHED BY:	DATE: DD/MM/YY	TIME:	RECEIVED BY:
RELINQUISHED BY:	DATE: DD/MM/YY 25/09/09	TIME: 1:05	RECEIVED BY LABORATORY:

CUSTODY

Maxxam Analytics

8577 Commerce Court
Burnaby, BC V5A 4N5
www.maxxamanalytics.com

Phone: (604) 444-4808
Fax: (604) 444-4511
Toll Free: 1-800-440-4808

A953654

CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST PAGE 2 OF 3

MAXXAM JOB # ____ ANALYSIS REQUEST **F 143924**

COMPANY NAME: Minto

PH. #:
E-mail:
FAX #:

COMPANY ADDRESS:

CLIENT PROJECT ID: (#) MIN-09-05 Revegetation Monitoring Sept 09

SAMPLER NAME (PRINT): Stu Withers

PROJECT MANAGER: Scott Keesey / Colleen Roche

LAB USE ONLY

	FIELD SAMPLE ID	MAXXAM LAB # (Lab Use Only)	MATRIX GROUND WATER	SURFACE WATER	SOIL	DRINKING WATER	OTHER	# CONTAINERS	SAMPLING DATE DD/MM/YY	TIME	HEADSPACE VAPOUR	☐ BTEX / LH ☐ BTEX / VPH ☐ MTBE	☐ VOC's / VPH	☐ EPH ☐ TEH	☐ PAH ☐ LEPH/HEPH	CCME-PHC (FRACTIONS 1-4 PLUS BTEX)	CCME-PHCS (FRACTIONS 2-4)	CCME BTEX (FRACTION 1 PLUS BTEX)	☐ PHENOLS BY 4AAP ☐ PHENOLS BY GCMS	☐ TOTAL O&G ☐ MINERAL O&G	Dissolved Metals Field Filtered? ☐ YES ☐ NO Field Preserved? ☐ YES ☐ NO	Total Metals Field Preserved? ☐ YES ☐ NO	☐ NITRATE ☐ NITRITE ☐ AMMONIA	☐ CHLORIDE ☐ FLUORIDE ☐ SULPHATE	TOTAL SUSPENDED SOLIDS (NFR)	☐ CYANIDE SAD ☐ WAD	☐ LEACHABLE LEAD (AA) ☐ (TCLP)	☐ LEACHABLE BTEX (AA) ☐ (TCLP)	ICP Metals											HOLD
1	Soilsample Upper Irod							1																					X											
2	Tufted hairgrass Lower Irod																																							
3	Sheep Fescue Lower Irod																																							
4	Violet Wheatgrass Lower Irod																																							
5	R.M. Fescue Lower IRod																																							
6	Tufted hairgrass Toe of Tailings																																							
7	Violet Wheatgrass Toe of Tailings																																							
8	Glaucous Bluegrass Toe of Tailings																																							
9	R.M. Fescue Toe of Tailings																																							
10	Sheep Fescue Toe of Tailings																																							
11																																								
12																																								

TAT (Turnaround Time)

<5 DAY TAT MUST HAVE PRIOR APPROVAL

some exceptions apply please contact lab

STANDARD 5 BUSINESS DAYS ☒
RUSH 3 BUSINESS DAYS ☐
RUSH 2 BUSINESS DAYS ☐
URGENT 1 BUSINESS DAY ☐
OTHER BUSINESS DAYS ____

CUSTODY

P.O. NUMBER / QUOTE NUMBER:

SPECIAL DETECTION LIMITS / CONTAMINANT TYPE:

☐ CCME
☐ CSR
☐ ALBERTA TIER 1
☐ OTHER

LAB USE ONLY
ARRIVAL TEMPERATURE °C:
DUE DATE:
LOG IN CHECK:

ACCOUNTING CONTACT:

SPECIAL REPORTING OR BILLING INSTRUCTIONS:

SOIL JARS USED AND NOT SUBMITTED:

RELINQUISHED BY SAMPLER:
DATE: DD/MM/YY
TIME:
RECEIVED BY:

RELINQUISHED BY:
DATE: DD/MM/YY
TIME:
RECEIVED BY:

Maxxam Analytics

8577 Commerce Court
Burnaby, BC V5A 4N5
www.maxxamanalytics.com

Phone: (604) 444-4808
Fax: (604) 444-4511
Toll Free: 1-800-440-4808

A953654

CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST

PAGE 3 OF 3

MAXXAM JOB # ______ ANALYSIS REQUEST F 143925

COMPANY NAME: Minto

PH. #:
E-mail:
FAX #:

COMPANY ADDRESS:

CLIENT PROJECT ID: (#) MIN-09-05 Revegetation Monitoring Sept 09

SAMPLER NAME (PRINT): Stu Withers

PROJECT MANAGER: Scott Keesey/Colleen Roche

LAB USE ONLY

#	FIELD SAMPLE ID	MAXXAM LAB # (Lab Use Only)	MATRIX: GROUND WATER	SURFACE WATER	SOIL	DRINKING WATER	OTHER	# CONTAINERS	SAMPLING: DATE DD/MM/YY	TIME	HEADSPACE VAPOUR	BTEX / LH ☐ BTEX / VPH ☐ MTBE ☐	VOC's / VPH ☐	EPH ☐ TEH ☐	PAH ☐ LEPH/HEPH ☐	CCME-PHC (FRACTIONS 1-4 PLUS BTEX)	CCME-PHCS (FRACTIONS 2-4)	CCME BTEX (FRACTION 1 PLUS BTEX)	PHENOLS BY 4AAP ☐ PHENOLS BY GCMS ☐	TOTAL O&G ☐ MINERAL O&G ☐	Dissolved Metals: Field Filtered? YES ☐ NO ☐	Field Preserved? YES ☐ NO ☐	Total Metals Field Preserved? YES ☐ NO ☐	NITRATE ☐ NITRITE ☐ AMMONIA ☐	CHLORIDE ☐ FLUORIDE ☐ SULPHATE ☐	TOTAL SUSPENDED SOLIDS (NFR)	CYANIDE SAD ☐ WAD ☐	LEACHABLE LEAD (AA) ☐ (TCLP) ☐	LEACHABLE BTEX (AA) ☐ (TCLP) ☐	HOLD
1	Violet Wheatgrass Upper Irod																													
2	Tufted Hairgrass Upper Irod																													
3	Sheep fescue Upper Irod																													
4	Glaucous Bluegrass Upper Irod																													
5	R.M. Fescue Upper Irod																													
6																														
7																														
8																														
9																														
10																														
11																														
12																														

TAT (Turnaround Time)

<5 DAY TAT MUST HAVE PRIOR APPROVAL

some exceptions apply please contact lab

STANDARD 5 BUSINESS DAYS ☐
RUSH 3 BUSINESS DAYS ☐
RUSH 2 BUSINESS DAYS ☐
URGENT 1 BUSINESS DAY ☐
OTHER BUSINESS DAYS ______

P.O. NUMBER / QUOTE NUMBER:

SPECIAL DETECTION LIMITS / CONTAMINANT TYPE:

☐ CCME
☐ CSR
☐ ALBERTA TIER 1
☐ OTHER

LAB USE ONLY

ARRIVAL TEMPERATURE °C:

DUE DATE:

LOG IN CHECK:

ACCOUNTING CONTACT:

SPECIAL REPORTING OR BILLING INSTRUCTIONS:

SOIL JARS USED AND NOT SUBMITTED:

RELINQUISHED BY SAMPLER:

DATE: DD/MM/YY

TIME:

RECEIVED BY:

RELINQUISHED BY:

DATE: DD/MM/YY

TIME:

RECEIVED BY:

CUSTODY

Maxxam Analytics Inc

8577 Commerce Court
Burnaby, BC V5A 4N5
www.maxxamanalytics.com

Phone: (604) 444-4808
Fax.: (604) 444-4511
Toll-Free: 1-800-440-4808

CHAIN-OF CUSTODY RECORD AND ANALYSIS REQUEST

PAGE 1 OF 1

Subcontracted

LAB USE ONLY MAXXAM JOB #:

ANALYSIS REQUEST

LAB USE ONLY COC #:

COMPANY NAME: Minto Explorations Ltd.
CLIENT PROJECT NO.: MIN-09-05 Revegetation Monitoring Sept 09
COMPANY ADDRESS:
TEL.:
E-MAIL: scott@accessconsulting.ca
colleenr@mintomine.com
FAX:
SAMPLER NAME (PRINT): Stu Withers
PROJECT MANAGER: Scott Keesey/Colleen Roche
LABORATORY CONTACT: Kimberley Webber

- ICP Metals —
- pH/EC —
- Texture —
- TOC → BEDV
- C:N Ratio → Pacific Soil Sub
- CEC → CALC Sub, Calgary
- Total N → Calgary,
- Nutrients → Basic Fertility Package #1 @ PACIFIC SOIL
- pH, N, P, K, Ca, Mg, Org. matter

	FIELD SAMPLE ID	MAXXAM LAB # (LAB USE ONLY)	GROUNDWATER	SURFACE WATER	DRINKING WATER	SOIL	OTHER	DATE DD/MM/YY	TIME	# CONTAINERS	ICP Metals	pH/EC	Texture	TOC	C:N Ratio	CEC	Total N	Nutrients
1	Upper IROD Soils					x		09/21/2009	13:00	1	x	x	x	x	x	x	x	x
2	Lower IROD Soils					x		09/21/2009	15:00	1	x	x	x	x	x	x	x	x
3	Toe of Tailings Soils					x		09/21/2009	11:00	1	x	x	x	x	x	x	x	x
4	Upper IROD Violet Wheatgrass						x	09/21/2009	13:00	1	x							
5	Upper IROD Tufted Hairgrass						x	09/21/2009	13:00	1	x							
6	Upper IROD R.M. Fescue						x	09/21/2009	13:00	1	x							
7	Upper IROD Sheep Fescue						x	09/21/2009	13:00	1	x							
8	Upper IROD Glaucous Bluegrass						x	09/21/2009	13:00	1	x							
9	Lower IROD Violet Wheatgrass						x	09/21/2009	15:00	1	x							
10	Lower IROD Tufted Hairgrass						x	09/21/2009	15:00	1	x							
11	Lower IROD R.M. Fescue						x	09/21/2009	15:00	1	x							
12	Lower IROD Sheep Fescue						x	09/21/2009	15:00	1	x							

TAT (Turnaround Time)
LESS THAN 5 DAY TAT MUST HAVE PRIOR APPROVAL
* Some exceptions apply - please contact laboratory

STANDARD	5 BUSINESS DAYS	x
RUSH	3 BUSINESS DAYS	
RUSH	2 BUSINESS DAYS	
URGENT	1 BUSINESS DAY	

OTHER BUSINESS DAYS ______

PO NUMBER OR QUOTE NUMBER: PR 7041
SPECIAL DETECTION LIMITS / CONTAMINANT TYPE:
☐ CCME
☐ CSR
☐ AB TIER 1
☐ OTHER
JARS USED:

LAB USE ONLY
ARRIVAL TEMPERATURE °C:
DUE DATE:
LOG IN CHECK:

ACCOUNTING CONTACT:
SPECIAL REPORTING OR BILLING INSTRUCTIONS: Bill To Minto Explorations Ltd.

RELINQUINSHED BY SAMPLER: S. Withers
DATE: DD/MM/YY 23/09/09
TIME: 20:00
RECEIVED BY:

RELINQUINSHED BY:
DATE: DD/MM/YY
TIME:
RECEIVED BY:

RELINQUINSHED BY:
DATE: DD/MM/YY
TIME:
RECEIVED BY LABORATORY:

CUSTODY RECORD

Your Project #: MIN - 110466
Your C.O.C. #: 08322883, 08322884

Attention: Scott Keesey
ACCESS CONSULTING GROUP
#3 Calcite
151 Industrial Road
WHITEHORSE, YT
CANADA Y1A 3C8

Report Date: 2010/10/07

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B092008
Received: 2010/09/27, 08:30

Sample Matrix: VEGETATION
Samples Received: 10

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Elements by CRC ICPMS (total) - Plant	10	2010/09/30	2010/10/05	BRN SOP-00206 R7.0	Based on EPA 200.8

Sample Matrix: Soil
Samples Received: 12

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Cation Exchange Capacity (1)	12	2010/10/01	2010/10/01	AB SOP-00042	EPA 200.7
Conductance - soil	12	2010/10/01	2010/10/01	BRN SOP-00269 R2.0	Based on SM - 18.2.4
Elements by ICPMS (total)	12	2010/09/30	2010/09/30	BRN SOP-00203 R5.0	Based on EPA 200.8
Potassium (Available) (1)	12	2010/10/01	2010/10/01	AB SOP-00042	EPA 200.7
Nitrate-N (Available) (1)	12	2010/10/01	2010/10/01	AB SOP-00023	SM 4110-B
Phosphorus (Available by ICP) (1)	12	2010/10/01	2010/10/01	AB SOP-00042	EPA 200.7
pH (2:1 DI Water Extract)	12	2010/09/30	2010/09/30	BRN SOP-00266 R6.0	Carter, SSMA 16.2
Sublet (Inorganics) (2)	12	N/A	2010/09/30		
Texture by Hydrometer (1)	12	N/A	2010/10/01	CAL SOP-00033	MMFSPA Ch9
Texture Class (1)	12	N/A	2010/10/01	CAL SOP-00033	MMFSPA Ch9

* Results relate only to the items tested.

(1) This test was performed by Maxxam Calgary
(2) This test was performed by Ext. Sublet from Vancouver

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

KIMBERLEY WEBBER, BBY Customer Service
Email: kim.webber@maxxamanalytics.com
Phone# (604) 638-3254

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

NPK (AVAILABLE)

Maxxam ID		X23895	X23896	X23897	X23898	X23899	X23900		
Sampling Date		2010/09/15	2010/09/15	2010/09/15	2010/09/15	2010/09/15	2010/09/15		
	Units	**RECLAMATION B TOE OF WASTE ROCK**	**RECLAMATION F MINTO CR FLAME**	**RECLAMATION E MINTO RD KM 2**	**RECLAMATION D TOE OF DAM S.**	**R1 (IROD) PLOT A**	**R1 (IROD) PLOT B**	**RDL**	**QC Batch**
Nutrients									
Available (NH4F) Nitrogen (N)	mg/kg	<2	<2	<2	<2	<2	<2	2	4305435
Available (NH4F) Phosphorus (P)	mg/kg	<1	<1	22	3	<1	<1	1	4305771
Available (NH4OAc) Potassium (K)	mg/kg	73	38	60	40	30	51	2	4305594

Maxxam ID		X23901	X23902	X23903	X23904	X23905	X23906		
Sampling Date		2010/09/15	2010/09/15	2010/09/15	2010/09/15	2010/09/15	2010/09/15		
	Units	**R3 TAILINGS DUMP PLOT A**	**R3 TAILINGS DUMP PLOT B**	**R3 TAILINGS DUMP PLOT C**	**R4 MINTO RD KM 3 PLOT A**	**R4 MINTO RD KM 3 PLOT B**	**R4 MINTO R KM 3 PLOT C**	**RDL**	**QC Batch**
Nutrients									
Available (NH4F) Nitrogen (N)	mg/kg	<2	<2	<2	<2	<2	<2	2	4305435
Available (NH4F) Phosphorus (P)	mg/kg	<1	<1	<1	5	23	<1	1	4305771
Available (NH4OAc) Potassium (K)	mg/kg	57	50	47	35	64	33	2	4305594

RDL = Reportable Detection Limit

Maxxam Job #: B092008
Report Date: 2010/10/07

ACCESS CONSULTING GROUP
Client Project #: MIN - 110466

Sampler Initials: LK

ELEMENTS BY ATOMIC SPECTROSCOPY (VEGETATION)

Maxxam ID		X23975	X23976	X23977	X23978	X23979		
Sampling Date		2010/09/15	2010/09/15	2010/09/15	2010/09/15	2010/09/15		
	Units	**RECLAMATION (B) TOE OF WASTE ROCK - GRASS FESTUCA OVINA**	**RECLAMATION (B) TOE OF WASTE ROCK - GRASS AGROPYRON VIOLA**	**PLOT R1 (IROD) TREMBLING ASPEN**	**PLOT R1 (IROD) LITTLE TREE WILLOW**	**PLOT R1 (IROD) GREY LEAF WILLOW**	**RDL**	**QC Batch**
Total Metals by ICPMS								
Total Aluminum (Al)	mg/kg	669	415	248	663	959	1	4303157
Total Antimony (Sb)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	4303157
Total Arsenic (As)	mg/kg	0.36	0.22	0.13	0.31	0.49	0.01	4303157
Total Barium (Ba)	mg/kg	46.6	36.5	47.7	34.6	26.8	0.1	4303157
Total Beryllium (Be)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	4303157
Total Bismuth (Bi)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	4303157
Total Boron (B)	mg/kg	<5	5	18	37	59	5	4303157
Total Cadmium (Cd)	mg/kg	0.14	0.16	2.80	6.02	2.44	0.01	4303157
Total Calcium (Ca)	mg/kg	4110	4580	23300	25000	16900	10	4303157
Total Chromium (Cr)	mg/kg	4.4	2.1	1.9	0.8	1.8	0.5	4303157
Total Cobalt (Co)	mg/kg	0.5	0.3	1.5	1.9	1.8	0.1	4303157
Total Copper (Cu)	mg/kg	56.7	34.9	20.7	48.0	77.1	0.5	4303157
Total Iron (Fe)	mg/kg	1170	726	477	1140	1620	10	4303157
Total Lead (Pb)	mg/kg	0.36	0.24	0.18	0.46	0.53	0.01	4303157
Total Magnesium (Mg)	mg/kg	1410	1030	2740	8000	4540	10	4303157
Total Manganese (Mn)	mg/kg	406	199	149	787	245	0.1	4303157
Total Mercury (Hg)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	4303157
Total Molybdenum (Mo)	mg/kg	3.7	1.8	1.2	2.4	1.3	0.1	4303157
Total Nickel (Ni)	mg/kg	2.8	2.0	2.8	10.9	5.6	0.1	4303157
Total Phosphorus (P)	mg/kg	1300	621	3200	8630	4430	10	4303157
Total Potassium (K)	mg/kg	11300	6070	8530	11100	13400	10	4303157
Total Selenium (Se)	mg/kg	0.44	0.27	0.09	0.35	0.12	0.01	4303157
Total Silver (Ag)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4303157
Total Sodium (Na)	mg/kg	24	21	17	39	35	10	4303157
Total Strontium (Sr)	mg/kg	29.9	34.4	98.9	97.3	76.9	0.1	4303157
Total Thallium (Tl)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4303157
Total Tin (Sn)	mg/kg	<0.1	<0.1	<0.1	<0.1	0.2	0.1	4303157
Total Titanium (Ti)	mg/kg	41	25	10	26	31	1	4303157
Total Uranium (U)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4303157
Total Vanadium (V)	mg/kg	2	<2	<2	2	3	2	4303157
Total Zinc (Zn)	mg/kg	23.6	9.8	321	452	248	0.1	4303157

RDL = Reportable Detection Limit

ACCESS CONSULTING GROUP
Maxxam Job #: B092008
Client Project #: MIN - 110466
Report Date: 2010/10/07

Sampler Initials: LK

ELEMENTS BY ATOMIC SPECTROSCOPY (VEGETATION)

Maxxam ID		X23980	X23981	X23982	X23983	X23984		
Sampling Date		2010/09/15	2010/09/15	2010/09/15	2010/09/15	2010/09/15		
	Units	**PLOT R3 TAILINGS TOE GREY LEAF WILLOW**	**PLOT R3 TAILINGS TOE LITTLE TREE WILLOW**	**PLOT R3 TAILINGS TOE GRASS CALAMAGROSH'S**	**RECLAMATION F MINTO CR GREY LEAF WILLOW**	**R4 KM 3 MINTO RD GREY LEAF WILLOW**	**RDL**	**QC Batch**
Total Metals by ICPMS								
Total Aluminum (Al)	mg/kg	660	314	935	194	197	1	4303157
Total Antimony (Sb)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	4303157
Total Arsenic (As)	mg/kg	0.17	0.09	0.24	0.06	0.06	0.01	4303157
Total Barium (Ba)	mg/kg	19.2	10.2	62.4	22.3	85.5	0.1	4303157
Total Beryllium (Be)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	4303157
Total Bismuth (Bi)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	4303157
Total Boron (B)	mg/kg	36	37	9	56	80	5	4303157
Total Cadmium (Cd)	mg/kg	1.65	1.30	0.11	0.65	1.01	0.01	4303157
Total Calcium (Ca)	mg/kg	18400	15000	5510	20300	14900	10	4303157
Total Chromium (Cr)	mg/kg	1.1	0.7	4.5	0.7	1.0	0.5	4303157
Total Cobalt (Co)	mg/kg	1.2	1.2	0.7	0.9	2.3	0.1	4303157
Total Copper (Cu)	mg/kg	187	86.0	209	39.4	11.0	0.5	4303157
Total Iron (Fe)	mg/kg	1610	744	2230	406	361	10	4303157
Total Lead (Pb)	mg/kg	0.39	0.28	0.48	0.13	0.14	0.01	4303157
Total Magnesium (Mg)	mg/kg	3880	4620	2040	4940	2520	10	4303157
Total Manganese (Mn)	mg/kg	219	395	854	159	553	0.1	4303157
Total Mercury (Hg)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	4303157
Total Molybdenum (Mo)	mg/kg	2.1	1.8	3.1	0.3	1.9	0.1	4303157
Total Nickel (Ni)	mg/kg	3.3	3.3	2.7	6.6	2.6	0.1	4303157
Total Phosphorus (P)	mg/kg	2130	1840	701	4770	2900	10	4303157
Total Potassium (K)	mg/kg	14700	13500	4940	13100	9620	10	4303157
Total Selenium (Se)	mg/kg	0.24	0.13	0.28	0.06	0.01	0.01	4303157
Total Silver (Ag)	mg/kg	0.07	<0.05	0.14	<0.05	<0.05	0.05	4303157
Total Sodium (Na)	mg/kg	59	88	36	16	24	10	4303157
Total Strontium (Sr)	mg/kg	69.5	51.0	31.1	163	128	0.1	4303157
Total Thallium (Tl)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4303157
Total Tin (Sn)	mg/kg	<0.1	<0.1	0.1	0.1	<0.1	0.1	4303157
Total Titanium (Ti)	mg/kg	35	20	59	11	13	1	4303157
Total Uranium (U)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4303157
Total Vanadium (V)	mg/kg	3	<2	4	<2	<2	2	4303157
Total Zinc (Zn)	mg/kg	168	104	28.2	101	102	0.1	4303157

RDL = Reportable Detection Limit

ACCESS CONSULTING GROUP
Client Project #: MIN - 110466

Sampler Initials: LK

Maxxam Job #: B092008
Report Date: 2010/10/07

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		X23895	X23896	X23897	X23898	X23899		X23900		
Sampling Date		2010/09/15	2010/09/15	2010/09/15	2010/09/15	2010/09/15		2010/09/15		
	Units	**RECLAMATION B TOE OF WASTE ROCK**	**RECLAMATION F MINTO CR FLAME**	**RECLAMATION E MINTO RD KM 2**	**RECLAMATION D TOE OF DAM S.**	**R1 (IROD) PLOT A**	**QC Batch**	**R1 (IROD) PLOT B**	**RDL**	**QC Batch**
CONVENTIONALS										
Soluble (5:1) Conductivity	uS/cm	105	154	33	70	149	4306513	135	1	4306513
Parameter										
Subcontract Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	4311892	ATTACHED	N/A	4311892
Elements										
Cation exchange capacity	cmol+/Kg	14	25	<10	<10	24	4304356	22	10	4304359
Physical Properties										
% sand by hydrometer	%	59	75	76	81	57	4304707	63	2	4304707
% silt by hydrometer	%	22	17	17	11	34	4304707	29	2	4304707
Clay Content	%	19	8	7	8	9	4304707	8	2	4304707
Texture	N/A	SANDY LOAM	SANDY LOAM	SANDY LOAM	LOAMY SAND	SANDY LOAM	4294603	SANDY LOAM	N/A	4294603

Maxxam ID		X23901	X23902	X23903	X23904	X23905	X23906		
Sampling Date		2010/09/15	2010/09/15	2010/09/15	2010/09/15	2010/09/15	2010/09/15		
	Units	**R3 TAILINGS DUMP PLOT A**	**R3 TAILINGS DUMP PLOT B**	**R3 TAILINGS DUMP PLOT C**	**R4 MINTO RD KM 3 PLOT A**	**R4 MINTO RD KM 3 PLOT B**	**R4 MINTO R KM 3 PLOT C**	**RDL**	**QC Batch**
CONVENTIONALS									
Soluble (5:1) Conductivity	uS/cm	102	136	105	16	33	17	1	4306513
Parameter									
Subcontract Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	4311892
Elements									
Cation exchange capacity	cmol+/Kg	23	25	24	<10	19	11	10	4304359
Physical Properties									
% sand by hydrometer	%	52	43	58	69	71	89	2	4304707
% silt by hydrometer	%	39	48	34	22	20	8	2	4304707
Clay Content	%	9	9	8	9	9	3	2	4304707
Texture	N/A	LOAM	LOAM	SANDY LOAM	SANDY LOAM	SANDY LOAM	SAND	N/A	4294603

N/A = Not Applicable
RDL = Reportable Detection Limit

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		X23895	X23896	X23897	X23898	X23899	X23900		
Sampling Date		2010/09/15	2010/09/15	2010/09/15	2010/09/15	2010/09/15	2010/09/15		
	Units	**RECLAMATION B TOE OF WASTE ROCK**	**RECLAMATION F MINTO CR FLAME**	**RECLAMATION E MINTO RD KM 2**	**RECLAMATION D TOE OF DAM S.**	**R1 (IROD) PLOT A**	**R1 (IROD) PLOT B**	**RDL**	**QC Batch**
Physical Properties									
Soluble (2:1) pH	pH Units	8.16	8.29	6.00	7.79	7.36	8.13	0.01	4302430
Total Metals by ICPMS									
Total Aluminum (Al)	mg/kg	13000	9880	11900	10200	12700	13300	100	4302308
Total Antimony (Sb)	mg/kg	0.8	0.3	0.2	0.2	0.4	0.4	0.1	4302308
Total Arsenic (As)	mg/kg	5.7	3.7	2.6	3.3	6.2	7.0	0.2	4302308
Total Barium (Ba)	mg/kg	207	151	181	121	215	254	0.1	4302308
Total Beryllium (Be)	mg/kg	0.5	0.3	0.4	0.4	0.4	0.3	0.1	4302308
Total Bismuth (Bi)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	4302308
Total Cadmium (Cd)	mg/kg	0.46	0.09	0.10	0.09	0.13	0.20	0.05	4302308
Total Calcium (Ca)	mg/kg	7740	8550	2680	5340	9930	13600	100	4302308
Total Chromium (Cr)	mg/kg	21	16	14	12	27	25	1	4302308
Total Cobalt (Co)	mg/kg	10.8	7.1	6.2	7.9	10.3	11.1	0.3	4302308
Total Copper (Cu)	mg/kg	687	23.6	6.7	79.4	79.2	179	0.5	4302308
Total Iron (Fe)	mg/kg	25400	19800	18100	23100	23600	26200	100	4302308
Total Lead (Pb)	mg/kg	7.5	4.2	3.8	3.0	6.1	6.0	0.1	4302308
Total Magnesium (Mg)	mg/kg	7610	6210	4510	6710	8160	9120	100	4302308
Total Manganese (Mn)	mg/kg	488	439	395	586	382	574	0.2	4302308
Total Mercury (Hg)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4302308
Total Molybdenum (Mo)	mg/kg	1.9	0.5	0.4	0.6	0.7	0.8	0.1	4302308
Total Nickel (Ni)	mg/kg	24.0	15.1	9.2	11.4	37.7	31.8	0.8	4302308
Total Phosphorus (P)	mg/kg	793	718	527	845	910	957	10	4302308
Total Potassium (K)	mg/kg	2220	1330	1740	2200	1170	2660	100	4302308
Total Selenium (Se)	mg/kg	1.0	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	4302308
Total Silver (Ag)	mg/kg	0.10	0.05	<0.05	<0.05	0.06	0.06	0.05	4302308
Total Sodium (Na)	mg/kg	127	198	<100	103	258	297	100	4302308
Total Strontium (Sr)	mg/kg	50.4	60.7	23.3	24.9	53.3	57.8	0.1	4302308
Total Thallium (Tl)	mg/kg	0.14	0.06	0.07	0.09	0.08	0.12	0.05	4302308
Total Tin (Sn)	mg/kg	0.4	0.3	0.3	0.3	0.4	0.4	0.1	4302308
Total Titanium (Ti)	mg/kg	538	467	484	580	655	832	1	4302308
Total Vanadium (V)	mg/kg	50	41	41	52	55	60	2	4302308
Total Zinc (Zn)	mg/kg	89	54	54	61	54	72	1	4302308
Total Zirconium (Zr)	mg/kg	4.0	1.5	<0.5	1.6	2.6	2.3	0.5	4302308

RDL = Reportable Detection Limit

ACCESS CONSULTING GROUP
Client Project #: MIN - 110466

Sampler Initials: LK

Maxxam Job #: B092008
Report Date: 2010/10/07

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		X23901	X23902	X23903	X23904	X23905	X23906		
Sampling Date		2010/09/15	2010/09/15	2010/09/15	2010/09/15	2010/09/15	2010/09/15		
	Units	**R3 TAILINGS DUMP PLOT A**	**R3 TAILINGS DUMP PLOT B**	**R3 TAILINGS DUMP PLOT C**	**R4 MINTO RD KM 3 PLOT A**	**R4 MINTO RD KM 3 PLOT B**	**R4 MINTO R KM 3 PLOT C**	**RDL**	**QC Batch**
Physical Properties									
Soluble (2:1) pH	pH Units	7.79	8.04	7.76	6.75	6.13	6.88	0.01	4302430
Total Metals by ICPMS									
Total Aluminum (Al)	mg/kg	11600	11400	10600	7430	9940	10900	100	4302308
Total Antimony (Sb)	mg/kg	0.5	0.5	0.4	0.5	0.3	0.1	0.1	4302308
Total Arsenic (As)	mg/kg	6.0	9.0	6.5	5.2	2.9	1.1	0.2	4302308
Total Barium (Ba)	mg/kg	187	187	185	143	174	131	0.1	4302308
Total Beryllium (Be)	mg/kg	0.4	0.3	0.4	0.3	0.3	0.4	0.1	4302308
Total Bismuth (Bi)	mg/kg	<0.1	0.1	0.1	<0.1	<0.1	<0.1	0.1	4302308
Total Cadmium (Cd)	mg/kg	0.22	0.27	0.25	0.21	0.10	<0.05	0.05	4302308
Total Calcium (Ca)	mg/kg	8780	11400	9280	3550	3250	4570	100	4302308
Total Chromium (Cr)	mg/kg	25	25	23	20	13	8	1	4302308
Total Cobalt (Co)	mg/kg	9.9	10.4	9.7	7.4	5.3	6.5	0.3	4302308
Total Copper (Cu)	mg/kg	96.4	114	422	19.9	9.8	7.5	0.5	4302308
Total Iron (Fe)	mg/kg	22800	23600	22900	17000	17400	19500	100	4302308
Total Lead (Pb)	mg/kg	6.1	6.0	5.9	4.5	3.5	2.4	0.1	4302308
Total Magnesium (Mg)	mg/kg	6910	7130	6320	3240	3670	6060	100	4302308
Total Manganese (Mn)	mg/kg	366	392	493	325	307	519	0.2	4302308
Total Mercury (Hg)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4302308
Total Molybdenum (Mo)	mg/kg	0.8	2.0	1.0	0.7	0.4	0.2	0.1	4302308
Total Nickel (Ni)	mg/kg	26.4	27.6	25.6	17.3	9.5	6.2	0.8	4302308
Total Phosphorus (P)	mg/kg	935	964	975	819	489	672	10	4302308
Total Potassium (K)	mg/kg	1140	934	1010	634	1220	1870	100	4302308
Total Selenium (Se)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	4302308
Total Silver (Ag)	mg/kg	0.06	0.07	0.17	0.05	<0.05	<0.05	0.05	4302308
Total Sodium (Na)	mg/kg	256	267	237	<100	<100	<100	100	4302308
Total Strontium (Sr)	mg/kg	48.9	53.4	46.3	23.5	24.8	29.2	0.1	4302308
Total Thallium (Tl)	mg/kg	0.08	0.08	0.07	0.06	0.05	0.06	0.05	4302308
Total Tin (Sn)	mg/kg	0.4	0.3	0.3	0.2	0.3	0.2	0.1	4302308
Total Titanium (Ti)	mg/kg	668	628	580	394	427	562	1	4302308
Total Vanadium (V)	mg/kg	55	55	52	36	38	38	2	4302308
Total Zinc (Zn)	mg/kg	61	59	60	45	40	67	1	4302308
Total Zirconium (Zr)	mg/kg	2.5	3.2	2.4	2.2	0.5	1.7	0.5	4302308

RDL = Reportable Detection Limit

Package 1	9.0°C

Each temperature is the average of up to three cooler temperatures taken at receipt

General Comments

Maxxam Job #: B092008
Report Date: 2010/10/07

ACCESS CONSULTING GROUP
Client Project #: MIN - 110466

Sampler Initials: LK

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4302308	Total Arsenic (As)	2010/10/01	103	75 - 125	104	75 - 125	<0.2	mg/kg	1.2	30	91	70 - 130
4302308	Total Beryllium (Be)	2010/10/01	103	75 - 125	107	75 - 125	<0.1	mg/kg	NC	30		
4302308	Total Cadmium (Cd)	2010/10/01	108	75 - 125	110	75 - 125	<0.05	mg/kg	1.5	30	95	70 - 130
4302308	Total Chromium (Cr)	2010/10/01	NC	75 - 125	99	75 - 125	<1	mg/kg	0.3	30	98	70 - 130
4302308	Total Cobalt (Co)	2010/10/01	101	75 - 125	101	75 - 125	<0.3	mg/kg	2.8	30	96	70 - 130
4302308	Total Copper (Cu)	2010/10/01	NC	75 - 125	105	75 - 125	<0.5	mg/kg	0.1	30	91	70 - 130
4302308	Total Lead (Pb)	2010/10/01	NC	75 - 125	106	75 - 125	<0.1	mg/kg	0.1	35	98	70 - 130
4302308	Total Mercury (Hg)	2010/10/01	92	75 - 125	96	75 - 125	<0.05	mg/kg	3.4	35		
4302308	Total Nickel (Ni)	2010/10/01	NC	75 - 125	102	75 - 125	<0.8	mg/kg	1.2	30	98	70 - 130
4302308	Total Selenium (Se)	2010/10/01	105	75 - 125	107	75 - 125	<0.5	mg/kg	NC	30		
4302308	Total Vanadium (V)	2010/10/01	NC	75 - 125	103	75 - 125	<2	mg/kg	0.9	30	100	70 - 130
4302308	Total Zinc (Zn)	2010/10/01	NC	75 - 125	108	75 - 125	<1	mg/kg	1.2	30	91	70 - 130
4302308	Total Aluminum (Al)	2010/10/01					<100	mg/kg	1.9	35	99	70 - 130
4302308	Total Antimony (Sb)	2010/10/01					<0.1	mg/kg	1.0	30	89	70 - 130
4302308	Total Barium (Ba)	2010/10/01					<0.1	mg/kg	2.0	35	106	70 - 130
4302308	Total Calcium (Ca)	2010/10/01					<100	mg/kg	2.3	30	94	70 - 130
4302308	Total Iron (Fe)	2010/10/01					<100	mg/kg	0.09	30	96	70 - 130
4302308	Total Magnesium (Mg)	2010/10/01					<100	mg/kg	1.5	30	96	70 - 130
4302308	Total Manganese (Mn)	2010/10/01					<0.2	mg/kg	0.2	30	97	70 - 130
4302308	Total Molybdenum (Mo)	2010/10/01					<0.1	mg/kg	1.5	35	102	70 - 130
4302308	Total Phosphorus (P)	2010/10/01					<10	mg/kg	2.5	30	98	70 - 130
4302308	Total Silver (Ag)	2010/10/01					<0.05	mg/kg	22.7	35	63(1)	70 - 130
4302308	Total Strontium (Sr)	2010/10/01					<0.1	mg/kg	0.09	35	91	70 - 130
4302308	Total Thallium (Tl)	2010/10/01					<0.05	mg/kg	NC	30	84	70 - 130
4302308	Total Titanium (Ti)	2010/10/01					<1	mg/kg	1.4	35	100	70 - 130
4302308	Total Bismuth (Bi)	2010/10/01					<0.1	mg/kg	NC	30		
4302308	Total Potassium (K)	2010/10/01					<100	mg/kg	3.2	35		
4302308	Total Sodium (Na)	2010/10/01					<100	mg/kg	NC	35		
4302308	Total Tin (Sn)	2010/10/01					<0.1	mg/kg	2.8	35		
4302308	Total Zirconium (Zr)	2010/10/01					<0.5	mg/kg	NC	30		
4302430	Soluble (2:1) pH	2010/09/30			102	96 - 104			2.1	20		
4303157	Total Aluminum (Al)	2010/10/05					11, RDL=1(2)	mg/kg	7.9	35		
4303157	Total Antimony (Sb)	2010/10/05					<0.1	mg/kg	NC	35		
4303157	Total Arsenic (As)	2010/10/05					<0.01	mg/kg	13.3	35		
4303157	Total Barium (Ba)	2010/10/05					<0.1	mg/kg	4.9	35		
4303157	Total Beryllium (Be)	2010/10/05					<0.1	mg/kg	NC	35		
4303157	Total Bismuth (Bi)	2010/10/05					<0.1	mg/kg	NC	35		
4303157	Total Boron (B)	2010/10/05					<5	mg/kg	NC	35		
4303157	Total Cadmium (Cd)	2010/10/05					<0.01	mg/kg	7.0	35		
4303157	Total Calcium (Ca)	2010/10/05					25, RDL=10(3)	mg/kg	5.3	35		

ACCESS CONSULTING GROUP
Maxxam Job #: B092008
Client Project #: MIN - 110466
Report Date: 2010/10/07

Sampler Initials: LK

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**	**% Recovery**	**QC Limits**
4303157	Total Chromium (Cr)	2010/10/05					<0.5	mg/kg	37.1(1, 4)	35		
4303157	Total Cobalt (Co)	2010/10/05					<0.1	mg/kg	NC	35		
4303157	Total Copper (Cu)	2010/10/05					<0.5	mg/kg	11.5	35		
4303157	Total Iron (Fe)	2010/10/05					<10	mg/kg	6.6	35		
4303157	Total Lead (Pb)	2010/10/05					<0.01	mg/kg	9.5	35		
4303157	Total Magnesium (Mg)	2010/10/05					<10	mg/kg	8.0	35		
4303157	Total Manganese (Mn)	2010/10/05					<0.1	mg/kg	3.2	35		
4303157	Total Mercury (Hg)	2010/10/05					<0.01	mg/kg	NC	35		
4303157	Total Molybdenum (Mo)	2010/10/05					<0.1	mg/kg	8.5	35		
4303157	Total Nickel (Ni)	2010/10/05					<0.1	mg/kg	25.2	35		
4303157	Total Phosphorus (P)	2010/10/05					<10	mg/kg	5.0	35		
4303157	Total Potassium (K)	2010/10/05					<10	mg/kg	6.0	35		
4303157	Total Selenium (Se)	2010/10/05					<0.01	mg/kg	1.3	35		
4303157	Total Silver (Ag)	2010/10/05					<0.05	mg/kg	NC	35		
4303157	Total Sodium (Na)	2010/10/05					<10	mg/kg	NC	35		
4303157	Total Strontium (Sr)	2010/10/05					<0.1	mg/kg	6.0	35		
4303157	Total Thallium (Tl)	2010/10/05					<0.05	mg/kg	NC	35		
4303157	Total Tin (Sn)	2010/10/05					<0.1	mg/kg	NC	35		
4303157	Total Titanium (Ti)	2010/10/05					<1	mg/kg	4.6	35		
4303157	Total Uranium (U)	2010/10/05					<0.05	mg/kg	NC	35		
4303157	Total Vanadium (V)	2010/10/05					<2	mg/kg	NC	35		
4303157	Total Zinc (Zn)	2010/10/05					<0.1	mg/kg	2.7	35		
4304356	Cation exchange capacity	2010/10/01							NC	35		
4304359	Cation exchange capacity	2010/10/01							NC	35		
4304707	% sand by hydrometer	2010/10/01							1.9	35	110	89 - 111
4304707	% silt by hydrometer	2010/10/01							2.3	35	93	78 - 122
4304707	Clay Content	2010/10/01							NC	35	93	86 - 114
4305435	Available (NH4F) Nitrogen (N)	2010/10/01	100	80 - 120	109	90 - 111	<2	mg/kg	NC	35		
4305594	Available (NH4OAc) Potassium (K)	2010/10/01			95	80 - 120	<2	mg/kg	3.4	35	111	75 - 125

Maxxam Job #: B092008
Report Date: 2010/10/07

ACCESS CONSULTING GROUP
Client Project #: MIN - 110466

Sampler Initials: LK

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**	**% Recovery**	**QC Limits**
4305771	Available (NH4F) Phosphorus (P)	2010/10/01			99	80 - 120	<1	mg/kg	NC	35		
4306513	Soluble (5:1) Conductivity	2010/10/01			100	80 - 120	1, RDL=1	uS/cm	2.3	35		

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Spiked Blank: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.
(1) - Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.
(2) - Blank outside acceptance criteria . All results higher than 10x Blank concentration.
(3) - Blank outside acceptance criteria. All results higher than 20x Blank concentration.
(4) - Duplicate RPD above control limit - Non-homogenous sample - Increased variability of results

Maxxam Analytics Inc

8577 Commerce Court
Burnaby, BC V5A 4N5
www.maxxamanalytics.com

Phone: (604) 444-4808
Fax.: (604) 444-4511
Toll-Free: 1-800-440-4808

CHAIN-O 08322883 **ANALYSIS REQUEST**

PAGE 1 OF 2

MAXXAM JOB #: B092008

ANALYSIS REQUEST

COC #:

COMPANY NAME: Access Consulting Group

CLIENT PROJECT NO.: MIN-10466

COMPANY ADDRESS:
#3 Calcite Business Center
151 Industrial Rd.
Whitehorse, YT
Y1A 2V3

TEL.:

E-MAIL:

FAX: 867-667-6680

SAMPLER NAME (PRINT): Lisa Knight

PROJECT MANAGER: Scott Keesey

LABORATORY CONTACT: Kim Webber

	FIELD SAMPLE ID	[redacted]	MATRIX: GROUNDWATER	MATRIX: SURFACE WATER	MATRIX: DRINKING WATER	MATRIX: SOIL	MATRIX: OTHER	SAMPLING: DATE DD/MM/YY	SAMPLING: TIME	# CONTAINERS	ICP Metals	pH/EC	Texture	TOC	C:N ratio	CEC	Total N	Nutrients											
1	Reclamation B toe of Waste Roc	[redacted]				X		15/09/10		1	X	X	X	X	X	X	X	X											
2	Reclamation E Minto Cr Flume	[redacted]				X				1	X	X	X	X	X	X	X	X											
3	" " " E Minto Rd Km 2	[redacted]				X				1	X	X	X	X	X	X	X	X											
4	Reclamation D Toe of Dam S.	[redacted]				X				1	X	X	X	X	X	X	X	X											
5	R1 (IROD) Plot A	[redacted]				X				1	X	X	X	X	X	X	X	X											
6	R1 (IROD) Plot B	[redacted]				X				1	X	X	X	X	X	X	X	X											
7	R3 Tailings Dump Plot A	[redacted]				X				1	X	X	X	X	X	X	X	X											
8	R3 Tailings Dump Plot B	[redacted]				X				1	X	X	X	X	X	X	X	X											
9	R3 Tailings Dump Plot C	[redacted]				X				1	X	X	X	X	X	X	X	X											
10	R4 Minto Rd Km 3 Plot A	[redacted]				X				1	X	X	X	X	X	X	X	X											
11	R4 Minto Rd Km 3 Plot B	[redacted]				X				1	X	X	X	X	X	X	X	X											
12	R4 Minto R Km 3 Plot C	[redacted]				X				1	X	X	X	X	X	X	X	X											

TAT (Turnaround Time)

LESS THAN 5 DAY TAT MUST HAVE PRIOR APPROVAL

* Some exceptions apply - please contact laboratory

STANDARD	5 BUSINESS DAYS	☐
RUSH	3 BUSINESS DAYS	☐
RUSH	2 BUSINESS DAYS	☐
URGENT	1 BUSINESS DAY	☐

OTHER BUSINESS DAYS ______

PO NUMBER OR QUOTE NUMBER:

SPECIAL DETECTION LIMITS / CONTAMINANT TYPE:

☐ CCME
☐ CSR
☐ AB TIER 1
☐ OTHER

ARRIVAL TEMPERATURE °C: 9 9 9

DUE DATE:

LOG IN CHECK:

ACCOUNTING CONTACT:

SPECIAL REPORTING OR BILLING INSTRUCTIONS:

JARS USED:

RELINQUISHED BY SAMPLER: Lisa Knight	DATE: DD/MM/YY 24/09/10	TIME: 13:30	RECEIVED BY:
RELINQUINSHED BY: Paul	DATE: DD/MM/YY 24/09/10	TIME: 15:00	RECEIVED BY: 09 27 10
RELINQUINSHED BY:	DATE: DD/MM/YY	TIME: 0830	RECEIVED BY LABORATORY: C. ROSEN

CUSTODY RECORD

Maxxam Analytics Inc

8577 Commerce Court
Burnaby, BC V5A 4N5
www.maxxamanalytics.com

Phone: (604) 444-4808
Fax.: (604) 444-4511
Toll-Free: 1-800-440-4808

CHAIN-OF (NALYSIS REQUEST

08322884

PAGE 2 OF 2

MAXXAM JOB #:

ANALYSIS REQUEST

COC #:

COMPANY NAME: Access Consulting Group

CLIENT PROJECT NO.: MIN-110466

COMPANY ADDRESS:
#3 Calcite Business Center
151 Industrial Rd.
Whitehorse, YT
Y1A 2V3

TEL.:

E-MAIL:

FAX: 867-667-6680

SAMPLER NAME (PRINT): Lisa Knight

PROJECT MANAGER: Scott Keesey

LABORATORY CONTACT:

		FIELD SAMPLE ID	MATRIX: GROUNDWATER	MATRIX: SURFACE WATER	MATRIX: DRINKING WATER	MATRIX: SOIL	MATRIX: OTHER	SAMPLING: DATE DD/MM/YY	SAMPLING: TIME	# CONTAINERS	ICP metals
	1	Reclamation (B) Toe of Waste Rock					X	15/09/10		1	X
1	2	- Grass Festuca ovina					X			1	X
2	3	- Grass Agropyron viola					X			1	X
3	4	Plot R1 (IROD) Trembling Aspen					X			1	X
4	5	Plot R1 (IROD) Little tree willow					X			1	X
5	6	Plot R1 " Grey leaf willow					X			1	X
6	7	Plot R3 Tailings Toe Grey leaf wil					X			1	X
7	8	Plot R3 " " Little Tree wil					X			1	X
8	9	Plot R3 " " Grass Calamagros					X			1	X
9	10	Reclamation F Minto Cr Gr					X			1	X
10	11	R4 Km 3 Minto Rd Grey leaf					X			1	X
	12										

TAT (Turnaround Time)

LESS THAN 5 DAY TAT MUST HAVE PRIOR APPROVAL

* Some exceptions apply - please contact laboratory

STANDARD 5 BUSINESS DAYS ☐
RUSH 3 BUSINESS DAYS ☐
RUSH 2 BUSINESS DAYS ☐
URGENT 1 BUSINESS DAY ☐

OTHER BUSINESS DAYS ______

PO NUMBER OR QUOTE NUMBER:

SPECIAL DETECTION LIMITS / CONTAMINANT TYPE:

☐ CCME
☐ CSR
☐ AB TIER 1
☐ OTHER

ARRIVAL TEMPERATURE °C: 9 9 9

DUE DATE:

LOG IN CHECK:

ACCOUNTING CONTACT:

SPECIAL REPORTING OR BILLING INSTRUCTIONS:

JARS USED:

RELINQUISHED BY SAMPLER: Lisa Knight	DATE: DD/MM/YY 24/09/10	TIME: 13:30	RECEIVED BY:
RELINQUISHED BY: Paul Inglis	DATE: DD/MM/YY 24/09/10	TIME: 15:00	RECEIVED BY: 092710
RELINQUISHED BY:	DATE: DD/MM/YY	TIME: 0830	RECEIVED BY LABORATORY: C. Rosen

CUSTODY RECORD

COCFORM - BC - 20070822

Analytical Report

Bill To: Maxxam Analytics
Report To: Maxxam Analytics
4606 Canada Way
Burnaby, BC, Canada
V5G 1K5
Attn: Kimberley Webber
Sampled By:
Company:

Project:
ID: Job #B092008
Name:
Location:
LSD:
P.O.:
Acct code:

Lot ID: **765203**
Control Number:
Date Received: Sep 29, 2010
Date Reported: Oct 4, 2010
Report Number: 1361913

		Reference Number	765203-1	765203-2	765203-3	
		Sample Date	Sep 15, 2010	Sep 15, 2010	Sep 15, 2010	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	X23895-01R \ Reclamation	X23896-01R \ Reclamation	X23897-01R \ Reclamation	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Classification						
C:N Ratio			29	25	26	0.1
Nitrogen	Total	%	0.03	0.10	0.07	0.01
Organic Matter	Total	%	1.66	4.97	3.52	
Carbon	Total Organic	%	0.83	2.49	1.76	0.02

Analytical Report

Bill To: Maxxam Analytics
Report To: Maxxam Analytics
4606 Canada Way
Burnaby, BC, Canada
V5G 1K5
Attn: Kimberley Webber
Sampled By:
Company:

Project:
ID: Job #B092008
Name:
Location:
LSD:
P.O.:
Acct code:

Lot ID: **765203**
Control Number:
Date Received: Sep 29, 2010
Date Reported: Oct 4, 2010
Report Number: 1361913

		Reference Number	765203-4	765203-5	765203-6	
		Sample Date	Sep 15, 2010	Sep 15, 2010	Sep 15, 2010	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	X23898-01R \ Reclamation	X23899-01R \ R1 (IROD) Plot	X23900-01R \ R1 (IROD) Plot	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Classification						
C:N Ratio			>50	23.0	17.9	0.1
Nitrogen	Total	%	<0.01	0.14	0.12	0.01
Organic Matter	Total	%	0.95	6.50	4.38	
Carbon	Total Organic	%	0.48	3.25	2.19	0.02

Exova
#104, 19575-55 A Ave.
Surrey, British Columbia
V3S 8P8, Canada

T: +1 (604) 514-3322
F: +1 (604) 514-3323
E: Surrey@exova.com
W: www.exova.com

Analytical Report

Bill To: Maxxam Analytics
Report To: Maxxam Analytics
4606 Canada Way
Burnaby, BC, Canada
V5G 1K5
Attn: Kimberley Webber
Sampled By:
Company:

Project:
ID: Job #B092008
Name:
Location:
LSD:
P.O.:
Acct code:

Lot ID: **765203**
Control Number:
Date Received: Sep 29, 2010
Date Reported: Oct 4, 2010
Report Number: 1361913

		Reference Number	765203-7	765203-8	765203-9	
		Sample Date	Sep 15, 2010	Sep 15, 2010	Sep 15, 2010	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	X23901-01R \ R3 Tailings D	X23902-01R \ R3 Tailings D	X23903-01R \ R3 Tailings D	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Classification						
C:N Ratio			17.3	13.7	16.4	0.1
Nitrogen	Total	%	0.22	0.18	0.17	0.01
Organic Matter	Total	%	7.63	4.87	5.59	
Carbon	Total Organic	%	3.82	2.44	2.79	0.02

Analytical Report

Bill To: Maxxam Analytics
Report To: Maxxam Analytics
4606 Canada Way
Burnaby, BC, Canada
V5G 1K5
Attn: Kimberley Webber
Sampled By:
Company:

Project:
ID: Job #B092008
Name:
Location:
LSD:
P.O.:
Acct code:

Lot ID: **765203**
Control Number:
Date Received: Sep 29, 2010
Date Reported: Oct 4, 2010
Report Number: 1361913

		Reference Number	765203-10	765203-11	765203-12	
		Sample Date	Sep 15, 2010	Sep 15, 2010	Sep 15, 2010	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	X23904-01R \ R4 Minto Rd K	X23905-01R \ R4 Minto Rd K	X23906-01R \ R4 Minto R KM	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Classification						
C:N Ratio			>20	16.6	>10	0.1
Nitrogen	Total	%	<0.01	0.24	<0.01	0.01
Organic Matter	Total	%	0.49	7.84	0.22	
Carbon	Total Organic	%	0.24	3.92	0.11	0.02

Approved by: Andrew Garrard
Andrew Garrard, BSc
General Manager

Exova
#104, 19575-55 A Ave.
Surrey, British Columbia
V3S 8P8, Canada

T: +1 (604) 514-3322
F: +1 (604) 514-3323
E: Surrey@exova.com
W: www.exova.com

Methodology and Notes

Bill To: Maxxam Analytics
Report To: Maxxam Analytics
4606 Canada Way
Burnaby, BC, Canada
V5G 1K5
Attn: Kimberley Webber
Sampled By:
Company:

Project:
ID: Job #B092008
Name:
Location:
LSD:
P.O.:
Acct code:

Lot ID: **765203**
Control Number:
Date Received: Sep 29, 2010
Date Reported: Oct 4, 2010
Report Number: 1361913

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Total Carbon, Nitrogen & Sulfur by Leco Combustion	SSSA Book Series 5	*	Nitrogen-Total, Ch 37	01-Oct-10	Exova Surrey
Total Carbon, Nitrogen & Sulfur by Leco Combustion	SSSA Book Series 5	*	Total Carbon, Organic Carbon, and Organic Matter, Ch 34	01-Oct-10	Exova Surrey

** Reference Method Modified*

Comments:

Please direct any inquiries regarding this report to our Client Services group.
Results relate only to samples as submitted.
The test report shall not be reproduced except in full, without the written approval of the laboratory.

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		W68609	W68610	W68611	W68612		
Sampling Date		2010/07/19	2010/07/22	2010/07/18	2010/07/20		
	Units	**M07**	**M029**	**M035**	**M54A**	**RDL**	**QC Batch**
Parameter							
Subcontract Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	4091595
Elements							
Cation exchange capacity	cmol+/Kg	<10	19	12	<10	10	4248901

Maxxam ID		W68613	W68614	W68615	W68616	W68617	W68618		
Sampling Date		2010/07/21	2010/07/21	2010/07/21	2010/07/21	2010/07/22	2010/07/22		
	Units	**M76A**	**M80**	**M85**	**M87**	**M90**	**M93**	**RDL**	**QC Batch**
Parameter									
Subcontract Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	4091595
Elements									
Cation exchange capacity	cmol+/Kg	<10	<10	<10	11	<10	11	10	4248901

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		W68609	W68610	W68611	W68612	W68613	W68614	W68615	W68616	W68617	W68618		
Sampling Date		2010/07/19	2010/07/22	2010/07/18	2010/07/20	2010/07/21	2010/07/21	2010/07/21	2010/07/21	2010/07/22	2010/07/22		
	Units	**M07**	**M029**	**M035**	**M54A**	**M76A**	**M80**	**M85**	**M87**	**M90**	**M93**	**RDL**	**QC Batch**
Total Metals by ICP													
Total Sulphur (S)	mg/kg	45	65	52	67	65	42	47	82	53	36	5	4255008

N/A = Not Applicable
RDL = Reportable Detection Limit

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		W68618		
Sampling Date		2010/07/22		
	Units	M93	RDL	QC Batch
Misc. Inorganics				
Soluble (2:1) pH	pH Units	5.68	0.01	4244124
Total Metals by ICPMS				
Total Aluminum (Al)	mg/kg	12900	100	4244137
Total Antimony (Sb)	mg/kg	0.4	0.1	4244137
Total Arsenic (As)	mg/kg	5.1	0.2	4244137
Total Barium (Ba)	mg/kg	138	0.1	4244137
Total Beryllium (Be)	mg/kg	0.3	0.1	4244137
Total Bismuth (Bi)	mg/kg	<0.1	0.1	4244137
Total Cadmium (Cd)	mg/kg	<0.05	0.05	4244137
Total Calcium (Ca)	mg/kg	3150	100	4244137
Total Chromium (Cr)	mg/kg	26	1	4244137
Total Cobalt (Co)	mg/kg	6.5	0.3	4244137
Total Copper (Cu)	mg/kg	14.9	0.5	4244137
Total Iron (Fe)	mg/kg	20900	100	4244137
Total Lead (Pb)	mg/kg	5.7	0.1	4244137
Total Magnesium (Mg)	mg/kg	4740	100	4244137
Total Manganese (Mn)	mg/kg	219	0.2	4244137
Total Mercury (Hg)	mg/kg	<0.05	0.05	4244137
Total Molybdenum (Mo)	mg/kg	0.4	0.1	4244137
Total Nickel (Ni)	mg/kg	14.9	0.8	4244137
Total Phosphorus (P)	mg/kg	252	10	4244137
Total Potassium (K)	mg/kg	563	100	4244137
Total Selenium (Se)	mg/kg	<0.5	0.5	4244137
Total Silver (Ag)	mg/kg	<0.05	0.05	4244137
Total Sodium (Na)	mg/kg	<100	100	4244137
Total Strontium (Sr)	mg/kg	25.7	0.1	4244137
Total Thallium (Tl)	mg/kg	<0.05	0.05	4244137
Total Tin (Sn)	mg/kg	0.3	0.1	4244137
Total Titanium (Ti)	mg/kg	753	1	4244137
Total Vanadium (V)	mg/kg	52	2	4244137
Total Zinc (Zn)	mg/kg	43	1	4244137
Total Zirconium (Zr)	mg/kg	2.8	0.5	4244137

RDL = Reportable Detection Limit

ACCESS CONSULTING GROUP

Maxxam Job #: B079893
Report Date: 2010/09/15

Your P.O. #: MN-110466
Sampler Initials: LK

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4244124	Soluble (2:1) pH	2010/09/10			102	96 - 104			0.9	20		
4244137	Total Arsenic (As)	2010/09/10	101	75 - 125	97	75 - 125	<0.2	mg/kg	1.7	30	98	70 - 130
4244137	Total Beryllium (Be)	2010/09/10	100	75 - 125	95	75 - 125	<0.1	mg/kg	NC	30		
4244137	Total Cadmium (Cd)	2010/09/10	105	75 - 125	100	75 - 125	<0.05	mg/kg	NC	30	93	70 - 130
4244137	Total Chromium (Cr)	2010/09/10	100	75 - 125	96	75 - 125	<1	mg/kg	1.8	30	99	70 - 130
4244137	Total Cobalt (Co)	2010/09/10	100	75 - 125	96	75 - 125	<0.3	mg/kg	3.4	30	95	70 - 130
4244137	Total Copper (Cu)	2010/09/10	100	75 - 125	101	75 - 125	<0.5	mg/kg	1.9	30	90	70 - 130
4244137	Total Lead (Pb)	2010/09/10	101	75 - 125	99	75 - 125	<0.1	mg/kg	3.5	35	98	70 - 130
4244137	Total Mercury (Hg)	2010/09/10	85	75 - 125	85	75 - 125	<0.05	mg/kg	NC	35		
4244137	Total Nickel (Ni)	2010/09/10	99	75 - 125	98	75 - 125	<0.8	mg/kg	1.8	30	93	70 - 130
4244137	Total Selenium (Se)	2010/09/10	101	75 - 125	102	75 - 125	<0.5	mg/kg	NC	30		
4244137	Total Vanadium (V)	2010/09/10	NC	75 - 125	98	75 - 125	<2	mg/kg	0.9	30	101	70 - 130
4244137	Total Zinc (Zn)	2010/09/10	NC	75 - 125	105	75 - 125	<1	mg/kg	4.1	30	89	70 - 130
4244137	Total Aluminum (Al)	2010/09/10					<100	mg/kg	6.9	35	98	70 - 130
4244137	Total Antimony (Sb)	2010/09/10					<0.1	mg/kg	NC	30	107	70 - 130
4244137	Total Barium (Ba)	2010/09/10					<0.1	mg/kg	2.4	35	104	70 - 130
4244137	Total Calcium (Ca)	2010/09/10					<100	mg/kg	6.1	30	93	70 - 130
4244137	Total Iron (Fe)	2010/09/10					<100	mg/kg	2.6	30	95	70 - 130
4244137	Total Magnesium (Mg)	2010/09/10					<100	mg/kg	8.7	30	95	70 - 130
4244137	Total Manganese (Mn)	2010/09/10					<0.2	mg/kg	2.9	30	101	70 - 130
4244137	Total Molybdenum (Mo)	2010/09/10					<0.1	mg/kg	NC	35	103	70 - 130
4244137	Total Phosphorus (P)	2010/09/10					<10	mg/kg	4.3	30	90	70 - 130
4244137	Total Silver (Ag)	2010/09/10					<0.05	mg/kg	NC	35	78	70 - 130
4244137	Total Strontium (Sr)	2010/09/10					<0.1	mg/kg	3.7	35	96	70 - 130
4244137	Total Thallium (Tl)	2010/09/10					<0.05	mg/kg	NC	30	86	70 - 130
4244137	Total Titanium (Ti)	2010/09/10					<1	mg/kg	3.3	35	99	70 - 130
4244137	Total Bismuth (Bi)	2010/09/10					<0.1	mg/kg	NC	30		
4244137	Total Potassium (K)	2010/09/10					<100	mg/kg	1.1	35		
4244137	Total Sodium (Na)	2010/09/10					<100	mg/kg	NC	35		
4244137	Total Tin (Sn)	2010/09/10					<0.1	mg/kg	NC	35		
4244137	Total Zirconium (Zr)	2010/09/10					<0.5	mg/kg	NC	30		

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4248901	Cation exchange capacity	2010/09/10							NC	35		
4255008	Total Sulphur (S)	2010/09/13					<5	mg/kg	7.8	30		

N/A = Not Applicable

RPD = Relative Percent Difference

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.

Spiked Blank: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.

NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Maxxam
Analytics Inc

8577 Commerce Court
Burnaby, BC V5A 4N5
www.maxxamanalytics.com

Phone: (604) 444-4808
Fax: (604) 444-4511
Toll-Free: 1-800-440-4808

08321901

CHAIN-OF CUSTODY RECORD AND ANALYSIS REQUEST

PAGE 1 OF 1

LAB USE ONLY
MAXXAM JOB #
B079893

ANALYSIS REQUEST

LAB USE ONLY
COC #

COMPANY NAME:
Access Consulting Group

COMPANY ADDRESS:
#3 Calcite Business Center
151 Industrial Rd
Whitehorse, YT
Y1A 2V3

CLIENT PROJECT #/NAME:

TEL: 867-668-6463
EMAIL: mducharme@accessconsulting.ca
skeesey@accessconsulting.ca
horizoneco@northwestel.net
FAX: 867-667-6680

SAMPLER NAME (PRINT): Lisa Knight, Brett Elliot
PROJECT MANAGER: Scott Keesey
LABORATORY CONTACT: Kimberley Webber

	FIELD SAMPLE ID	LAB USE ONLY	GROUNDWATER	SURFACE WATER	[illegible]	SOIL	OTHER	DATE DD/MM/YY	TIME	# CONTAINERS	cation exchange ratio/CEC	C:N Ratio	% Organic Matter and TOC	Total Metals	Sulphur	pH
1	M67					x		19/07/2010		x	x	x	x	x	x	x
2	M029					x		22/07/2010		x	x	x	x	x	x	x
3	M035					x		19/07/2010		x	x	x	x	x	x	x
4	M54A					x		20/07/2010		x	x	x	x	x	x	x
5	M76A					x		21/07/2010		x	x	x	x	x	x	x
6	M90					x		21/07/2010		x	x	x	x	x	x	x
7	M95					x		21/07/2010		x	x	x	x	x	x	x
8	M97					x		21/07/2010		x	x	x	x	x	x	x
9	M90					x		22/07/2010		x	x	x	x	x	x	x
10	M93					x		22/07/2010		x	x	x	x	x	x	x
11																
12																

TAT (Turnaround Time)
LESS THAN 5 DAY TAT MUST HAVE PRIOR APPROVAL
* Some exceptions apply - please contact laboratory
STANDARD 5 BUSINESS DAYS
RUSH 3 BUSINESS DAYS
RUSH 2 BUSINESS DAYS
URGENT 1 BUSINESS DAY
OTHER BUSINESS DAYS

PO NUMBER OR QUOTE NUMBER: MN-110498
ACCOUNTING CONTACT:
SPECIAL DETECTION LIMITS / CONTAMINANT TYPE:
SPECIAL REPORTING OR BILLING INSTRUCTIONS:

COOLER TYPE: BOX / ARTIFIC / OTHER
JARS USED:

LAB USE ONLY
ARRIVAL TEMPERATURE (°C): 9/9/9
DUE DATE:
LOGIN CHECK:

RELINQUISHED BY SAMPLER: Paul Inglis
DATE DD/MM/YY: 24/08/2010
TIME: 14:00
RECEIVED BY:

RELINQUISHED BY:
DATE DD/MM/YY:
TIME:
RECEIVED BY:

RELINQUISHED BY:
DATE DD/MM/YY: 2/9/10
TIME: 15:05
RECEIVED BY LABORATORY: NICK SANROF

CUSTODY RECORD

1

Maxxam
Analytics Inc

8577 Commerce Court
Burnaby, BC V5A 4N5
www.maxxamanalytics.com

Phone: (604) 444-4808
Fax: (604) 444-4511
Toll-Free: 1-800-440-4808

08321901

CHAIN-OF CUSTODY RECORD AND ANALYSIS REQUEST

PAGE 1 OF 1

LAB USE ONLY
MAXXAM JOB #
B079893

ANALYSIS REQUEST

LAB USE ONLY
COC #

COMPANY NAME:
Access Consulting Group

CLIENT PROJECT NO.:

COMPANY ADDRESS:
#3 Calcite Business Center
151 Industrial Rd
Whitehorse, YT
Y1A 2V3

TEL: 867-668-6463
EMAIL: mducharme@accessconsulting.ca
skeesey@accessconsulting.ca
horizone00@northwestel.net
FAX: 867-667-6680

SAMPLER NAME (PRINT):
Lisa Knight, Brett Elliot

PROJECT MANAGER:
Scott Keesey

LABORATORY CONTACT:
Kimberley Webber

	FIELD SAMPLE ID	MAXXAM LAB #	MATRIX					SAMPLING		# CONTAINERS	cation exchange incl. CEC	C:N Ratio	% Organic Matter and TOC	Total Metals	Sulphur	pH
			GROUNDWATER	SURFACE WATER	DRINKING WATER	SOIL	OTHER	DATE DD/MM/YY	TIME							
1	M67					x		19/07/2010		x	x	x	x	x	x	x
2	M028					x		22/07/2010		x	x	x	x	x	x	x
3	M035					x		19/07/2010		x	x	x	x	x	x	x
4	M54A					x		20/07/2010		x	x	x	x	x	x	x
5	M76A					x		21/07/2010		x	x	x	x	x	x	x
6	M80					x		21/07/2010		x	x	x	x	x	x	x
7	M85					x		21/07/2010		x	x	x	x	x	x	x
8	M87					x		21/07/2010		x	x	x	x	x	x	x
9	M90					x		22/07/2010		x	x	x	x	x	x	x
10	M93					x		22/07/2010		x	x	x	x	x	x	x
11																
12																

TAT (Turnaround Time)
LESS THAN 5 DAY TAT MUST HAVE PRIOR APPROVAL
* Some surcharges apply - please contact laboratory
STANDARD 5 BUSINESS DAYS
RUSH 3 BUSINESS DAYS
RUSH 2 BUSINESS DAYS
URGENT 1 BUSINESS DAY
OTHER BUSINESS DAYS

PO NUMBER OR QUOTE NUMBER:
MN-110498

SPECIAL DETECTION LIMITS / CONTAMINANT TYPE:

ACCOUNTING CONTACT:

SPECIAL REPORTING OR BILLING INSTRUCTIONS:

TYPE
BOX
ARTIFACT
OTHER
JARS USED

LAB USE ONLY
ARRIVAL TEMPERATURE (°C)
9/9/9
DUE DATE:
LOGIN CHECK:

RELINQUISHED BY SAMPLER:
Paul Inglis
DATE: DD/MM/YY 24/08/2010
TIME: 14:00
RECEIVED BY:

RELINQUISHED BY:
DATE: DD/MM/YY
TIME:
RECEIVED BY:

RELINQUISHED BY:
DATE: DD/MM/YY 2/9/10
TIME: 15:05
RECEIVED BY LABORATORY:
NICK SANDOR

CUSTODY RECORD

Exova
#104, 19575-55 A Ave.
Surrey, British Columbia
V3S 8P8, Canada

T: +1 (604) 514-3322
F: +1 (604) 514-3323
E: Surrey@exova.com
W: www.exova.com

Analytical Report

Bill To: Maxxam Analytics
Report To: Maxxam Analytics
4606 Canada Way
Burnaby, BC, Canada
V5G 1K5
Attn: Kimberley Webber
Sampled By:
Company:

Project:
ID:
Name:
Location:
LSD:
P.O.: B079893
Acct code:

Lot ID: **760926**
Control Number:
Date Received: Sep 3, 2010
Date Reported: Sep 14, 2010
Report Number: 1355314

			Reference Number	760926-1	760926-2	760926-3	
			Sample Date	Aug 19, 2010	Aug 22, 2010	Aug 18, 2010	
			Sample Time	NA	NA	NA	
			Sample Location				
			Sample Description	W68609-01R \ M07	W68610-01R \ M029	W68611-01R \ M035	
			Matrix	Soil	Soil	Soil	
Analyte		**Units**		**Results**	**Results**	**Results**	**Nominal Detection Limit**
Classification							
C:N Ratio				40	15	>50	0.1
Nitrogen	Total	%		0.02	0.04	<0.01	0.01
Organic Matter	Total	%		1.25	1.35	1.08	
Carbon	Total Organic	%		0.62	0.68	0.54	0.02

Analytical Report

Bill To: Maxxam Analytics
Report To: Maxxam Analytics
4606 Canada Way
Burnaby, BC, Canada
V5G 1K5
Attn: Kimberley Webber
Sampled By:
Company:

Project:
ID:
Name:
Location:
LSD:
P.O.: B079893
Acct code:

Lot ID: **760926**
Control Number:
Date Received: Sep 3, 2010
Date Reported: Sep 14, 2010
Report Number: 1355314

		Reference Number	760926-4	760926-5	760926-6	
		Sample Date	Aug 20, 2010	Aug 21, 2010	Aug 21, 2010	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	W68612-01R \ M54A	W68613-01R \ M76A	W68614-01R \ M80	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	**Nominal Detection Limit**
Classification						
C:N Ratio			45	25	31	0.1
Nitrogen	Total	%	0.04	0.05	0.04	0.01
Organic Matter	Total	%	3.98	2.38	2.22	
Carbon	Total Organic	%	1.99	1.19	1.11	0.02

Exova
#104, 19575-55 A Ave.
Surrey, British Columbia
V3S 8P8, Canada

T: +1 (604) 514-3322
F: +1 (604) 514-3323
E: Surrey@exova.com
W: www.exova.com

Analytical Report

Bill To: Maxxam Analytics
Report To: Maxxam Analytics
4606 Canada Way
Burnaby, BC, Canada
V5G 1K5
Attn: Kimberley Webber
Sampled By:
Company:

Project:
ID:
Name:
Location:
LSD:
P.O.: B079893
Acct code:

Lot ID: **760926**
Control Number:
Date Received: Sep 3, 2010
Date Reported: Sep 14, 2010
Report Number: 1355314

		Reference Number	760926-7	760926-8	760926-9	
		Sample Date	Aug 21, 2010	Aug 21, 2010	Aug 22, 2010	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	W68615-01R \ M85	W68616-01R \ M87	W68617-01R \ M90	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	**Nominal Detection Limit**
Classification						
C:N Ratio			28	30	27	0.1
Nitrogen	Total	%	0.03	0.06	0.03	0.01
Organic Matter	Total	%	1.78	3.59	1.81	
Carbon	Total Organic	%	0.89	1.79	0.90	0.02

Exova
#104, 19575-55 A Ave.
Surrey, British Columbia
V3S 8P8, Canada

T: +1 (604) 514-3322
F: +1 (604) 514-3323
E: Surrey@exova.com
W: www.exova.com

Exova

Analytical Report

Bill To: Maxxam Analytics
Report To: Maxxam Analytics
4606 Canada Way
Burnaby, BC, Canada
V5G 1K5
Attn: Kimberley Webber
Sampled By:
Company:

Project:
ID:
Name:
Location:
LSD:
P.O.: B079893
Acct code:

Lot ID: **760926**
Control Number:
Date Received: Sep 3, 2010
Date Reported: Sep 14, 2010
Report Number: 1355314

Reference Number 760926-10
Sample Date Aug 22, 2010
Sample Time NA
Sample Location
Sample Description W68618-01R \ M93
Matrix Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Classification						
C:N Ratio			28			0.1
Nitrogen	Total	%	0.02			0.01
Organic Matter	Total	%	1.15			
Carbon	Total Organic	%	0.57			0.02

Approved by: Andrew Garrard

Andrew Garrard, BSc
General Manager

Methodology and Notes

Bill To: Maxxam Analytics
Report To: Maxxam Analytics
4606 Canada Way
Burnaby, BC, Canada
V5G 1K5
Attn: Kimberley Webber
Sampled By:
Company:

Project:
ID:
Name:
Location:
LSD:
P.O.: B079893
Acct code:

Lot ID: **760926**
Control Number:
Date Received: Sep 3, 2010
Date Reported: Sep 14, 2010
Report Number: 1355314

Method of Analysis

Method Name	Reference	Method	Date Analysis Started	Location
Total Carbon, Nitrogen & Sulfur by Leco Combustion	SSSA Book Series 5	* Nitrogen-Total, Ch 37	09-Sep-10	Exova Surrey
Total Carbon, Nitrogen & Sulfur by Leco Combustion	SSSA Book Series 5	* Total Carbon, Organic Carbon, and Organic Matter, Ch 34	09-Sep-10	Exova Surrey

** Reference Method Modified*

Comments:

Please direct any inquiries regarding this report to our Client Services group.
Results relate only to samples as submitted.
The test report shall not be reproduced except in full, without the written approval of the laboratory.

APPENDIX C

ACCESS ECOSYSTEM FORM

ACCESS
CONSULTING GROUP

PROJECT ID:

WEATHER:

PLOT #:	**SURVEYORS:**	**DATE:**	**START TIME:**	**END TIME:**
TYPE/ # OF SAMPLES:		**PHOTO #'S:**		

GPS ZONE	E N
ASPECT (^{0})	
SLOPE (%)	
ELEVATION (m)	

HUMUS FORM (ENTER X, if trained)		
MOR	MO	
MORMODER	MM	
MODER	MD	
MULLMODER	MR	
MULL	MU	
SOIL COLOUR (ENTER X)		
DARK	D	
MEDIUM	M	
LIGHT	L	
NOT APPLICABLE	N/A	

SOIL DRAINAGE		**SNR**	
VR	VERY RAPIDLY	**A**	VERY POOR
R	RAPIDLY	**B**	POOR
W	WELL	**C**	MEDIUM
MW	MODERATELY WELL	**D**	RICH
I	IMPERFECTLY	**E**	VERY RICH
P	POORLY	**F**	SALINE
VP	VERY POORLY	**SMR (if trained)**	
SEEPAGE		**0**	VERY XERIC
P	PRESENT	**1**	XERIX
A	ABSENT	**2**	SUBXERIC
Open Water Present (%)		**3**	SUBMESIC
Plot		**4**	MESIC
		5	SUBHYGRIC
ROCKY SUBSTRATES (%)		**6**	HYGRIC
COBBLES/ STONES		**7**	SUBHYDRIC
BEDROCK		**8**	HYDRIC
		9	AQUATIC

SITE CLASSIFICATION

←UNIFORM TO VARIABLE →				
1	2	3	4	5

SURFACE SHAPE		**MICROTOPOGRAPHY**		**PLOT POSITION MESO**	
CV	CONCAVE	**SM**	SMOOTH	**C**	CREST
CX	CONVEX	**MO**	MOD. MOUNDED	**UP**	UPPER SLOPE
ST	STRAIGHT	**ST**	STRONGLY MOUNDED	**MS**	MID SLOPE
UN	UNDULATING	**EX**	EXTREMELY MOUNDED	**LS**	LOWER SLOPE
				T	TOE
				D	DEPRESSION
				L	LEVEL

SURFACE COMPOSITION (MUST EQUAL 100%)						
ROCK	**COBBLE**	**GRAVEL**	**SOIL**	**VEG**	**ORG.**	**CWD**

COMMENTS/ SITE DISTURBANCES/ SAMPLES

VEGETATION COVER	%
TREE LAYER (A)	
SHRUB LAYER (B)	
HERB LAYER (C)	
MOSS LAYER (D)	

WILDLIFE SIGN (SCAT, TRACKS, BROWSE, CALL, ENCOUNTER, DEN, ETC.) (EMPHASIZE BROWSE, GRAZING OR ROOT DIGGING)

TREE LAYER (A)							
SPECIES	A1 (ht ____m) Dominant %	A2 (ht ____m) Main Cover %	A3 (ht ____m) Sub-canopy %	SPECIES	A1 (ht ____m) Dominant %	A2(ht ____m) Main Cover %	A3 (ht ____m) Sub-canopy %

SHRUB LAYER (B)					
SPECIES	B1 (2m – 10m) %	B2 (<2m) %	SPECIES	B1 (2m – 10m) %	B2 (<2m) %

TREE REGENERATION <1m			
SPECIES	%	SPECIES	%

HERB LAYER (C)						MOSS LAYER		LICHEN LAYER	
SPECIES	%	SPECIES	%	SPECIES	%	SPECIES	%	SPECIES	%
HEIGHT (M)		SUCCESSIONAL STAGE			STRUCTURAL STAGE				

SITE SKETCH: (1 cm = ________________) (JUST DOMINANT PLANTS, SHRUBS AND TREES)