Project Proposal: Phase V/VI Expansion of Mining and Milling

Minto Mine

VERSION I

July 2013

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A2PTMF	Area 2 Pit Tailings Management Facility
ANFO	ammonium nitrate/fuel oil
AO	Assessment Office
ACR	acute-chronic ratios
ARD	Acid Rock Drainage
BCM/ day	bank cubic meters per day
BLM	biotic ligand model
BTWG	bi-lateral technical working group
CEAA	Canadian Environmental Assessment Act
CCME	Canadian Council of Ministers of the Environment
CGCM2	Environment Canada's Coupled Global Climate Model 2
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPUE	catch per unit effort
CWQG	Canadian Water Quality Guideline
CWB	community well-being
DIAND	Department of Indian and Northern Affairs
DRP	Decommissioning and Reclamation Plan
DSTSF	dry stack tailings storage facility
EA	Effects Assessment
EARPGO	Environmental Assessment Review Process Guidelines Order
EDI	Environmental Dynamics Inc.
EEM	Environmental Effects Monitoring
EMR	Department of Energy, Mines & Resources
FEARO	Federal Environmental Assessment Review Office
FN	First Nation
GPS	global positioning system
GWh	Gigawatt Hours
ha	Hectare (100 meters X 100 meters)
HRIA	Heritage Resource Impact Assessment
HROA	Heritage Resource Overview Assessment
IWQC	interim water quality criteria
JCS	juvenile Chinook salmon
kVA	Kilovolt amperes
LOM	life-of-mine
LSA	local study area
m^3/s or m^3/ hr or m^3/ day	cubic meters per second/ hour/ day
Matrix	Matrix Research Limited
MAAT	mean annual average temperature
MAR	mean annual runoff
m asl	metres above sea level
ML/ ARD	metal leaching/ acid rock drainage
MMER	Metal Mining Effluent Regulations
MPTMF	Main Pit Tailings Management Facility
MSU	Minto South Underground
Mt	million tonnes
MVFE	Mill Valley Fill Extension
NAD	North American Datum
NAG	non-acid generating (i.e., NP:AP>3)
NP/AP	Neutralization potential/ acid potential
QMA	Quartz Mining Act
QML	quartz mining license

RO	reverse osmosis
ROM	run-of-mine
ROQ	run-of-quarry
RSA	regional study area
RWDI	RWDI Consulting and Engineering Services
SAG	semi-autogenous grinding
SARA	Species at Risk Act
SFN	Selkirk First Nation
SSWQO	site-specific water quality objectives
tpd	tonnes per day
TMF	tailings management facility
TMP	tailings management plan
TSS	Total suspended solids
UG	Underground
UTM	Universal Transverse Mercator
VESCs	valued environmental and socio-economic components
WKA	wildlife key area
WMA	waste management area
WMP	water management plan
wmt	wet metric tons
WROMP	waste rock and overburden management plan
WSP	water storage pond
WUL	water use license
YE/YEC	Yukon Energy/Yukon Energy Corporation
YEAA	Yukon Environmental Assessment Act (until 2004, when replaced by YESAB)
YESAA	Yukon Environmental and Socio-economic Assessment Act
YESAA DO	(YESAA) designated office
YESAB	Yukon Environmental and Socio-economic Assessment Board
YWB	Yukon Water Board
YG	Yukon Government
YQMA	Yukon Quartz Mining Act
YWCHSB	Yukon Workers' Compensation Health and Safety Board

1 Introduction

The Minto Mine is a copper-gold mine owned 100% by Minto Explorations Ltd. (Minto), a wholly owned subsidiary of Capstone Mining Corp. (Capstone). It 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.

A predecessor of Capstone, Sherwood Copper Corp., acquired Minto Explorations and all other project interests, including a partially constructed but dormant construction site, in June 2005. Within two years from acquisition, the mineral resources were re-drilled to mineral reserve standards, a bankable feasibility study was completed, project financing arranged, and a new mine built. Commercial production commenced on October 1, 2007. Since then nine new deposits within the existing ore body have been discovered and mining operations have been expanded twice, increasing the initial processing plant design throughput of 1,563 tonnes per day (tpd) to the present throughput of 3,850 tpd.

The Minto Mine is currently an open pit mining operation with conventional crushing, grinding, and flotation to produce copper concentrates with significant gold and silver credits. Underground mining is licenced and expected to commence in Q3 of 2013; development work began in Q3 2012.

Concentrates are exported internationally via the Port of Skagway, Alaska for smelting and sale.

1.1 Overview

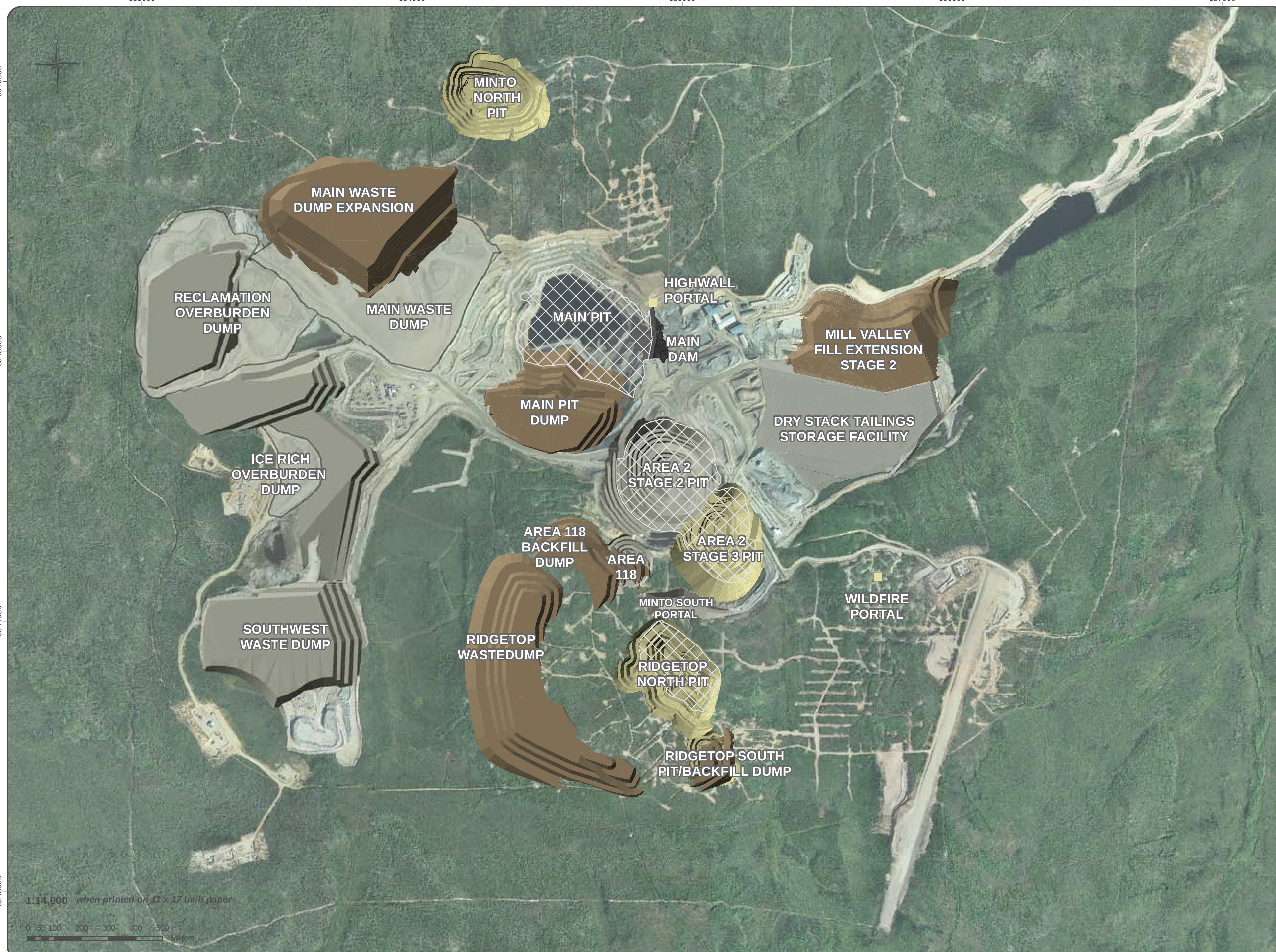
This document is the Project Proposal for the Phase V/VI expansion of mining and milling activities at Minto Mine and is being submitted to Yukon Environmental and Socio-economic Assessment Board (YESAB). An assessment under the Yukon Environmental and Socio-economic Assessment Act (YESAA) is required in order to obtain amendments to Minto's existing Quartz Mining Licence (QML-0001) and Type A Water Licence (QZ96-006).

1.1.1 General Project Overview and Purpose of the Project

The purpose of the proposed Minto Mine Phase V/VI is to expand upon Minto's Phase IV mine plan (assessed under YESAA as Project 2010-0198) and includes both open pit and underground development. Timely regulatory approvals for the Phase V/VI expansion will allow mine and mill production to continue uninterrupted.

In terms of open pit mining, Phase V/VI will create three new open pits and expand another pit currently under development (Figure 1-1). Specifically, the Area 2 Pit first presented in Phase IV will be expanded with a third pushback (noted in this proposal as Area 2, Stage 3), while the Ridgetop North, Ridgetop South, and Minto North pits are new. Details regarding open pit mining can be found in Section 3.1.

Phase V/VI also adds significant new underground reserves relative to those assessed in the Phase IV application. The underground mining presented as part of Phase IV is now known as the Minto South Underground (MSU). Phase V/VI adds reserves in areas known as Copper Keel and Minto East (East Keel), to be accessed from a new portal located east of the Main pit, and a third series of stopes known as Wildfire, to be accessed via a separate existing portal near the access road to the mine's airstrip. Details regarding underground mining can be found in Section 3.23.2.



MINTO MINE PHASE V/VI EXPANSION

FIGURE 1-1 MINTO MINE OVERVIEW OF PHASE V/VI DEVELOPMENT

JULY 2013

CAPSTONE MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

- Phase V/VI Tailings
- Phase V/VI Pits
- Phase V/VI Dumps
- Phase V/VI Dam
- Phase IV Features

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 14 th 2012.

Datum: NAD 83 Projection: UTM Zone 8N

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(*Last edited by: mducharme;02/07/2013/12:05 PM*)

1.2 Scope of the Project

The scope of the Project consists of an expansion of the mining areas and an extension of the operating mine life at the Minto Mine. Development and activities being undertaken as part of the Phase V/VI expansion primarily occur within the existing Minto Mine footprint. While the Project involves new development (both open pit and underground), this area lies in close proximity to the active mining area and within previously disturbed exploration areas. Minto estimates that approximately 82.04 ha of land will be cleared in the Phase V/VI expansion.

Phase V/VI will extend surface mining at Minto to 2017, underground mining to 2019, and milling of stockpiled ore to 2022. For further details of the Project's temporal scope, please refer to Section 1.2.3 for the proposed schedule of activities.

The following subsections outline the proposed activities included in the Phase V/VI Minto Mine expansion, the schedule of activities and the activities outside of the scope of assessment.

1.2.1 Principal Project Activities

The principal activities associated with the Project are:

- Mining of Phase V/VI pits (Area 2 Stage 3, Minto North, Ridgetop North, and Ridgetop South) using conventional surface mining methods, including an expanded network of haul roads (2.3 km of new roads) to accommodate the mining activities;
- Open pit mining at a rate of 12,800 BCM/day, followed by a decrease to 7,200 BCM/day after the completion of Area 2 Stage 3;
- Mining of a new East Keel Underground, with its own separate decline and surface infrastructure, from a portal located near the Main Pit highwall;
- Mining of a new Wildfire Underground, which will be accessed through its own separate decline and possess its own surface infrastructure separate from that developed for the Minto South Underground;
- An increase in open pit mine life to Q2-2017, underground mine life to Q4-2019, and milling of stockpiled ore to Q2-2022;
- New management practices for waste rock and overburden mined from the Phase V/VI pits; specifically, cessation of waste rock segregation on the basis of copper grade and adoption of material dispatching based on on-site assessments of acid-generating potential;
- Creation of a new waste rock dump (Main Pit Dump) within the footprint of the mined-out Main pit;
- Continued placement of waste rock on the existing Main Waste Dump, including an expansion beyond its currently permitted design footprint and capacity;

- Backfilling of the completed Area 118 and Ridgetop South pits with overburden, and the further stacking of overburden on the footprints of these pits;
- Creation of a new waste rock dump (Ridgetop Dump) to the west of the Ridgetop North and South pits;
- The potential extension of the current Mill Valley Fill to further stabilize dry stack tailings storage facility; and
- The expanded use of the Main Pit and Area 2 Pit – and the new use of the Ridgetop pit – as storage locations for slurry tailings from milling.
- Construction of a small dam to retain tailings within the footprint of the Main pit.

Details on the principal project activities can be found in Section 3.

1.2.2 Accessory Activities

The associated accessory activities include:

- Dewatering infrastructure, laydown, and waste/ore handling areas outside the development;
- Minor realignments of surface water diversions and upgrades to existing diversions;
- Installation of services such as drill water and dewatering pipes, electrical cable, heating and ventilation ducting in the underground workings;
- Closure and reclamation of all Phase V/VI Project components following completion of Phase V/VI mining and milling.

No changes are planned for the following components apart from the duration of their use; therefore, they are not included in the scope of the current assessment:

- Fuel handling/storage and electrical power supply;
- Water storage dam, explosives facilities, barge landings or access roads;
- Footprint of the mill facilities;
- Traffic to and from site;
- Chemicals used and stored on site;
- Blasting frequencies and explosives use associated with surface and underground mining; nor
- Closure of currently authorized facilities/project components.

1.2.3 Proposed Schedule of Activities

Activities for the Phase V/VI development are summarized in Table 1-1, by year, to provide a temporal frame of reference, and to further define the temporal scope of the project.

Table 1-1: Proposed Schedule of Phase V/VI Activities.

Year	Summary of Main Project Activity
2013	Mining of Phase IV continues; Area 2 Stage 2 is expected to be complete and mining of Area 118 will be under way.
2014	It is anticipated that the necessary authorizations will be granted by early 2014 to allow Phase V/VI mining to commence. Mining of Minto North begins, releasing ore early in the third quarter. Stripping in Area 2 Stage 3 begins as the final benches of Minto North are mined out. Underground production (which will have been underway at Phase IV stopes) ramps up to 2,000 tonnes of ore per day.
2015	Mining continues in Stage 3 of Area 2 until the pit is completed in the fourth quarter of the year. Stripping of Ridgetop South begins as the last benches of Area 2 Stage 3 are mined; production of near-surface ore follows approximately one month later. The mining rate is slowed to 7,200 BCM/day.
2016	Ridgetop North starts production. Underground mine operations continue in parallel from the Minto South Underground and the East Keel Underground at a steady rate of 2,000 ore tpd.
2017	Ridgetop North production ends mid-2017, concluding open pit mining. Underground operations continue at 2,000 ore tpd. Open pit stockpile drawdown begins.
2018	Minto South Underground and East Keel Underground production finishes, while development on the Wildfire Underground begins.
2019	Mining of the Wildfire Underground finishes; all mining operations complete.
2020 - 2022	Stockpiles are processed through the mill until they are depleted.

1.3 Assessment Requirements

1.3.1 Requirement for YESAB Designated Office Assessment

Some of the proposed activities are assessable under YESAA at a Designated Office (DO) level based on the following Schedule I trigger:

Part 1–Mining–Item 3: On other than an Indian reserve, construction, operation, modification, decommissioning or abandonment of, or other activity in relation to, a mine–other than a coal or placer mine–but not including exploration for the purpose of quartz mining or other activity in relation to exploration for the purpose of quartz mining.

- Proposed modifications and/or activities related to mining for this mine expansion program include:
    - Expansion of the mining area to include new ore zones;
    - Continuation of underground mining in addition to open pit mining for the extraction of mineral resources;
    - Implementation of new waste management practices.

1.3.2 Past Environmental Assessments

Previous environmental assessment activities undertaken for the Minto Mine are listed in Table 1-2.

Table 1-2: Past Environmental Assessments for Minto Mine.

Filed By/Activity	Period	Sources
Minto Explorations Ltd. Barge, bridge, road/culverts construction	1995 to 1996	CEAA Screening Type B Water Licence WUL MS95-013 Land Use and Quarry Permit YA5F045
Minto Explorations Ltd. Minto Mine development, operation and closure	1997 to 1998	Government and company reports, 1996. DIAND EARP Screening and Decision Report Water Licence QZ96-006
Minto Explorations Ltd. Minto Mine development, operation and closure Cumulative effects assessment	1999	Company report on Cumulative Effects, 1999. Quartz Mining Licence QML-9902.
Minto Explorations Ltd. Minto Mine development, operation and closure licence amendments – expiry extensions and temporary closure modifications Mining and milling rate increase, Minto Project	2004 to 2006	Government and company reports, 2004. YG Development Assessment Branch YEAA Screening WUL MS04-227 Amendment WUL QZ96-006 Amendment Quartz Mining Licence QML-0001 and Amendments
Minto Explorations Ltd. Mining and milling rate increase, Minto Project	2008	Company Reports, 2008. YESAA DO Assessment 2008-0117 Quartz Mining Licence QML-0001 Amendment
Minto Explorations Ltd. Water management and milling rate amendments, Minto Project	2009 to 2010	Company Reports, 2009 YESAA DO Assessment 2009-0206 Quartz Mining Licence QML-0001 Amendment WUL QZ96-006 Amendment
Minto Explorations Ltd. Minto Mine expansion-–Phase IV Mining and milling rate increase, Minto Project	2010 to 2012	Company Reports, 2010 YESAB Project Proposal 2010-0198 Quartz Mining Licence QML-0001 Amendment WUL QZ96-006 Amendment
Minto Explorations Ltd. Air emissions permit renewal, Minto Mine	2012	YESAB Project Proposal 2012-0001 Air Emissions Permit Renewal 60-30

1.4 Regulatory Approval Requirements

1.4.1 Licensing Requirements for Phase V/VI

As noted earlier, the expansion of the Minto Mine into Phase V/VI development will require licence amendments to its current Quartz Mining Licence QML-001 and Type A Water Licence QZ96-006.

1.4.2 Past Regulatory Approvals

Several government agencies, both federal and territorial, are involved in reviewing, assessing, authorizing, and monitoring Minto Mine in the form of regulatory and guideline-based instruments. The major instruments or authorizations and their attendant assessment and amendment histories are summarized below.

1.4.2.1 Type B Water Use License

In August 1995, the company submitted a Type B water use licence (WUL) application, which was filed with the Yukon Water Board (YWB) for construction of the Yukon River barge landing sites, the Big Creek Bridge, and Minto Creek road culvert installations. In October 1995, a land use and quarry permit application for the access road construction was filed with the Department of Indian and Northern Development (DIAND) Land Resources.

An integrated Canadian Environmental Assessment Act (CEAA) screening of the Type B water and land use applications was completed and a positive determination was made in August 1996. Type B WUL MS95-013 and Land and Quarry Permit YA5F045 were issued in August 1996 and the initial 16 km of the Minto Mine access road, barge landings and Big Creek Bridge were installed in September and October 1996.

1.4.2.2 Type A Water Use License

In February 1997, Minto submitted a Type A WUL application (QZ96-006). The YWB convened a public hearing into the application in May 1997, and after its deliberations issued a Type A WUL in April 1998, pursuant to *Yukon Waters Act* (YWA) and Regulations for mine and milling operations. The expiry date for the initial Type A WUL was June 30, 2006. This licence was subsequently extended to 2016, as discussed below in Section 1.4.3 - Amendments and Current Licencing.

1.4.2.3 Yukon Quartz Mining License

In 1999, *Yukon Quartz Mining Act* (YQMA) was amended and Section 139 of the Act required that all development and production activities related to quartz mining in Yukon be carried out in accordance with a licence issued by the Minister. In June 1999, the company filed an application with DIAND Minerals for a Yukon Quartz Mining Licence, which included a cumulative effects assessment for the Project to ensure that the provisions of CEAA were met. DIAND issued Yukon Quartz Mining Licence QLM-9902 in October 1999 with a licence expiry date of June 30, 2006. This licence was subsequently extended until June 30, 2016 (see chronology of amendments in the following section).

1.4.3 Amendments and Current Licencing

WUL QZ96-006 was amended (Amendment #1) to revise the decommissioning requirements for the Project, and to request the submission of an interim plan as the project was not yet constructed. Minto Mine is still subject to WUL QZ96-006.

In addition, the federal Metal Mining Effluent Regulations (MMER) under the *Fisheries Act* currently applies to the Minto Mine. These regulations are a law of general application and the requirements of this legislation are the responsibility of Minto. Generally, the Type A WUL is considered more restrictive than the MMER; however, Environment Canada requires separate reporting for effluent discharge and water monitoring.

As the Type A WUL (QZ96-006), Type B WUL (MS95-013), and Yukon Quartz Mining Licence (QML-9902) were set to expire in June 2006, and in recognition of project development delays, licence amendment applications to extend the licences to June 30, 2016 were filed with the YWB and Yukon Government (YG), Department of Energy, Mines & Resources (EMR) in October 2004. YWB completed a YEAA screening of the

Type B application and subsequently issued the amended Type B WUL (MS04-227) in February 2005. YG Development Assessment Branch completed a YEAA screening of the Type A WUL and Yukon Quartz Mining Licence using the previous Environmental Assessment Review Process Guidelines Order (EARPGO) screening, and issued their screening report in March 2005.

YWB issued the amended Type A WUL (QZ04-064) in September 2005 (Amendment #2) and YG Energy, Mines and Resources (EMR) issued amendments to Yukon Quartz Mining Licence QLM 0001, Amendment No. 05-001 in December 2005 and Amendment No. 05-002 to change the mill rate to 2,500 tpd in October 2006. The Type A WUL was further amended on April 6, 2006 (Amendment #3) following an application by Minto to address an apparent inconsistency in the original licence regarding the milling of sulphide ore.

In July 2008, Minto submitted a proposal to YESAB that outlined a proposed increase to the mining and milling rate. The Mayo District Office (DO) issued a recommendation that the project proceed, and YG EMR, as the decision body, released a decision document that concurred with the assessment recommendations. Subsequently, QML-0001 was amended to increase the milling rate (and associated mining rate) to 3,200 tpd on July 24, 2008.

In response to exceptional precipitation received in the site area in late August 2008 and an imminent release of water from the water storage pond (WSP) that would not meet water licence discharge standards, Minto applied on August 25, 2008 to YWB for an emergency amendment to Water Use License QZ96-006 under section 21 (4), c.19 of the Yukon *Waters Act*. The application to release 350,000 m^3 of water from the WSP using the MMER effluent discharge criteria was approved, and Amendment #4 to the WUL was issued on August 26, 2008.

The melting of significant snowpack accumulations in the winter of 2008/2009 required the retention of freshet runoff in the open pit and prompted concern about the stability of the South Pit wall, should additional summer precipitation events need to be directed there as well. As a result, Minto applied again for an amendment to the WUL QZ96-006 under the same provision in June of 2009, to allow the release of water that would provide additional capacity for such an event. On June 26, 2009, the YWB approved Amendment #5, which authorized the release of 300,000 m^3 of water from the site, subject to the same MMER criteria as previously applied, with additional monitoring requirements.

On August 3, 2009, Minto received an Inspector's Direction from YG EMR to empty the pit of accumulated runoff water prior to October 15, 2009. Subsequently, Minto, in order to remain compliant with both the Inspector's Direction and with its WUL, applied for another amendment to WUL QZ96-006, again under the emergency provision of the Yukon *Waters Act*. The YWB approved this amendment (Amendment #6) and Minto was permitted to release an additional 705,000 m^3 of water from the Minto Mine site, provided it met amended discharge standards.

Minto applied for an additional amendment (WUL Application #QZ09-094) to WUL QZ96-006 in November of 2009 to authorize changes to the water management plan (WMP) and effluent discharge standards. A minor milling rate increase and other housekeeping items were also included; this application was approved as Amendment #7.

In August of 2010, a proposal for the mine expansion known as Phase IV was submitted for environmental assessment (YESAB #2010-0198). Assessed activities included mining of Phase IV ore zones, underground mining of Area 2 and Area 118, the development of an exploration decline, new waste management practices, and construction of the Mill Valley Fill Extension. The Mayo DO issued its evaluation report in February 2011 and decision documents were issued in March 2011. YG EMR issued an updated QML in May 2011 and approved a number of operational plans related to Phase IV mining. An application for a WUL amendment was submitted in September 2011; a public hearing was held in July 2012, and Amendment #8 to the WUL was issued in October 2012.

Subsequently, in December of 2012, QML-0001 was amended to increase the milling rate to 4,200 tpd and the mining rate to a maximum of 2.5 million tonnes per year.

The above noted licences have an expiry date of June 30, 2016.

The Air Emissions Permit 60-30 which expired on December 31, 2011 has recently undergone an assessment under YESAA at the DO level (YESAB 2012-001) and was renewed until December 31, 2014.

Examples of other relevant legal, regulatory, and guideline-based instruments that govern the Project include:

- SFN (Selkirk First Nation) Cooperation Agreement;
- Metal Mining Effluent Regulations of the federal *Fisheries Act*;
- Mining land use permit;
- Fish collection permits;
- Waste management permits;
- Land treatment facility permit; and
- Special waste permit.

1.5 Previously Assessed and Licenced Activities

Project activities that are currently permitted or licenced and are considered outside the scope of this assessment are presented in Table 1-3 below:

Table 1-3: Activities Outside of the Scope of Assessment.

Activity	Licencing Parameters – Currently Licenced Activities	Applicable Authorization(s)
Access	Construction, operation, and maintenance of a road and power network.	QML-0001
Airstrip	This is currently licenced.	QML-0001
Camp	Construction of a 300-person camp with roads, office space, and wastewater deposit.	QML-0001 WUL QZ96-006
Ore stockpiles	This activity is currently licenced.	QML-0001
Fuel containment facility	This activity is currently licenced.	QML-0001
Storage and use of explosives	This activity is currently licenced.	QML-0001
Development of Area 2 (Stages 1 and 2) and Area 118	This activity is currently licenced.	QML-0001
Development of the MSU portal area	This activity is currently licenced.	QML-0001
Milling	Milling rate of up to 4,200 tpd.	QML-0001 WUL QZ96-006
Mill Water Treatment Plant	This activity is currently licenced.	QML-0001
Water storage dam	This activity is currently licenced.	QML-0001
Production	Mining rate of up to 2.5 million tonnes per year.	QML-0001
Concentrate	Production, storage, and transport off the site.	QML-0001
Waste rock and overburden facilities	Main waste dump (MWD), Southwest dump (SWD), Reclamation overburden dump (ROD), ice-rich overburden dump (IROD).	QML-0001
Dry stack tailings facility	Total volume of tailings not to exceed 5.9 million tonnes in Main Pit and Area 2 Pit.	QML-0001 WUL QZ96-006
O&M of bridge, culvert, barge landings and flood control structures	Big Creek Bridge, Minto Creek culvert, Yukon River barge landing.	WUL MS04-227
Water use	Obtain maximum of 1,000 m^3/day from Yukon River, Minto Creek and groundwater (includes well water for camp).	WUL QZ96-006
Deposit overburden	From A2, 118 and portal areas.	QML-0001
Deposit waste rock	From A2, 118 and underground workings.	QML-0001
Deposit slurry tailings	In Main Pit and Area 2 Pit.	QML-0001
Water storage	In Water storage pond, Mill water pond and Area 2 Pit.	WUL QZ96-006
Water diversion	Minto Creek and its tributaries.	WUL QZ96-006
Deposit effluent	Into Minto Creek.	WUL QZ96-006
Water treatment plant	Operation of water treatment plant.	WUL QZ96-006

NOTES:

WUL QZ96-006, WUL MS04-227, and QML-0001 expire on June 16, 2016
WUL QZ96-006 is Amendment 8 of WUL QZ96-006.

1.6 Project Location and Background

1.6.1 Geographical Location

The Minto Mine is located on the west side of the Yukon River within Selkirk First Nation Category A Settlement Land Parcel R-6A, approximately 240 km northwest of Whitehorse, Yukon (Figure 1-2 and Figure 1-3) and is centered at 62°370020032'N latitude and 137°15'W longitude (NAD 83, UTM Zone 8 coordinates 6945000N, 384000E). Highway 2 (North Klondike Highway) is located on the east side of the Yukon River; the mine can be accessed in the summer by barge crossing or in winter by the ice bridge crossing at Minto Landing.

MINTO MINE

CAPSTONE MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

MINTO MINE EXPANSION
PHASE V/VI
PROJECT PROSOSAL

FIGURE 1-2
PROJECT LOCATION

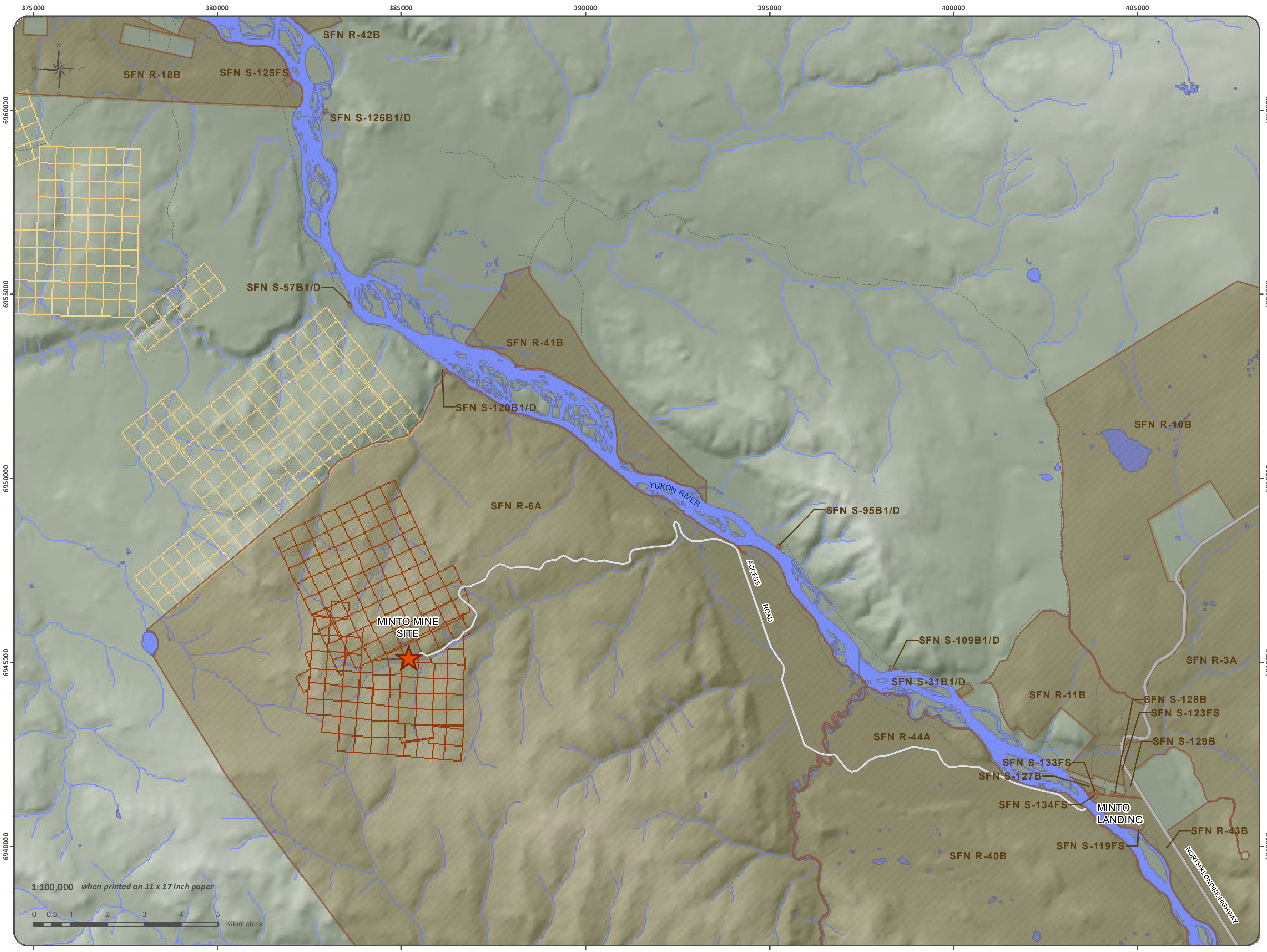
ACCESS

MINTO MINE EXPANSION PHASE V/VI

PROJECT PROPOSAL

FIGURE 1-3
AREA OVERVIEW

MAY 2013



Minto Mine Site
Mine Access Road
Road
Trail
Selkirk First Nation Settlement Lands
Minto Creek Catchment

Quartz Claims

Minto Explorations Ltd. Claims
Other Claims

First Nation Settlement land obtained from Natural Resource Canada. Quartz claim boundaires and ownership are current as of Feb 18th 2013. Data obtained from Mineral Resources Branch, Energy Mines and Resources Department, Government of Yukon.Site hydrology data provided by Minto Explorations Ltd, May 2009.

Datum: NAD 83 Projection: UTM Zone 8N

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1.6.2 Land Tenure

Minto is the registered 100% owner of the 164 claims that comprise the Minto Mine.

1.6.3 First Nations Territory

Minto Mine is located within SFN's traditional territory, and within SFN Category A Settlement Land Parcel R-6A (Figure 1-3).

1.6.3.1 Cooperation Agreement with Selkirk First Nation

Minto and SFN are parties to a Cooperation Agreement originally dated September 16, 1997 and amended November 4, 2009. In addition to establishing cooperation with respect to permitting and environmental monitoring, this confidential document deals with other economic and social measures and communication between SFN and Minto.

1.6.4 Yukon Land Use Planning Region

Minto Mine is located in the Northern Tutchone Yukon Land Use planning region, for which no formal land use plan has been developed to date.

1.6.5 Environmental and Socio-economic Context

Table 1-4 below summarizes existing environmental and socio-economic conditions in the Minto Mine area. The information was compiled from various published and unpublished reports. Table 1-4 is not intended to provide a thorough reflection of the environmental setting, but rather a succinct overview of the key environmental parameters. A more detailed description of the environmental conditions in the Minto Mine area is presented in the environmental baseline reports appended to this report.

Table 1-4: Summary of Environmental and Socio-economic Conditions in the Minto Mine Area.

Project Area Attribute Description	Project Area Attribute Description
Region:	Yukon
Topographic map sheet:	NTS 115 I/10, 115 I/11
Geographic location name code:	Minto Project
Latitude:	62° 36' N
Longitude:	137° 15' W
Drainage region:	Yukon River
Watersheds:	Yukon River, Big Creek, Wolverine Creek, Dark Creek, McGinty Creek, and Minto Creek.
Nearest community:	Pelly Crossing, Yukon, approx. 33 km north on Klondike Highway.
Access:	Klondike Highway, Barge crossing on Yukon River at Minto Landing, Minto Mine access road. Airstrip on site.
Traditional territory:	Northern Tutchone, Selkirk First Nation peoples. Traditionally used for hunting, trapping and fishing.
Surrounding land status:	Selkirk First Nation settlement lands and federal Crown land.
Special designations:	Lhutsaw wetland habitat protection area located approx. 17 km NE of Minto Landing (outside the Project area).
Ecoregion:	Yukon Plateau (Central) - Pelly River ecoregion.
Study area elevation:	Rolling hills above mine site at 1131 to 600 m at the Yukon River Valley bottom.
Site climate:	Temperature ranges from –43.2°C (November 2006) to 30.3°C (July 2009). Mean annual temperature of –1.8°C. Mean annual rainfall is 174mm.
Vegetation communities:	Riparian, black spruce, white spruce, paper birch, lodgepole pine, buck brush/willow and ericaceous shrubs, feather moss, sedge, sagewort, grassland, mixed forest (aspen, balsam, and sub-alpine). Discontinuous permafrost is present on site. Site has been subject to recent forest fires.
Wildlife species:	Moose, caribou, Dall sheep, mule deer, grizzly and black bear, varying hare, beaver, lynx, marten, ermine, deer mouse, fox, mink, wolverine, least weasel, wolf, squirrel, porcupine coyote, muskrat, otter and wood frog. Bird species include: spruce, blue, ruffed, and sharp-tail grouse, waterfowl, raptors, and a variety of smaller birds.
Fish species:	In the Yukon River, Chinook, Coho, and chum salmon, rainbow trout, lake trout, least cisco, Bering cisco, round whitefish, lake whitefish, inconnu, Arctic grayling, northern pike, burbot, longnose sucker and slimy sculpin; In Big Creek, Chinook and chum salmon, Arctic grayling and whitefish species; In Wolverine Creek, Chinook salmon, Arctic grayling, and slimy sculpin; In Minto Creek (lower reaches only), Chinook salmon, slimy sculpin, round whitefish, Arctic grayling, longnose sucker, burbot; In McGinty Creek (lower reaches only), slimy sculpin, Arctic grayling
Known heritage resources:	East side of Yukon River in the vicinity of Minto Landing four historic sites designated KdVc-2 (Minto Landing), KdVc-3 (MintoEx Resort), KdVc-4 (Old Tom's Cabin), and KdVD-1 (Minto Creek).
Registered trapline concessions	Several registered trapping concessions (RTCs) are held in the project area. Trapper access to the project area has been identified and will be maintained in accordance with the Cooperation Agreement. Compensation agreements have been negotiated with the RTC #146 & #145 trap line holders of the trapping areas impacted by the mine and access road.
Registered outfitting concessions	Two outfitting concessions fall within the project area. Registered Outfitting Concessions #13 is held by Tim Mervyn (Mervyn Outfitting) and #14 is held by Curt Thompson (Trophystone Safaris).

The Minto Mine property lies in the eastern portion of the Dawson Range, which is part of the Klondike Plateau Physiographic Region, an uplifted surface that has been dissected by erosion. The area was largely unglaciated during the last ice age and topography consists of deep and narrow valleys, rounded rolling hills, and ridges with relief of up to 600 m (2,000 ft.). The highest elevation on the property is 975 m (3,200 ft.) above sea level, compared to lower elevations in the region with elevations of 460 m (1,500 ft.) along the Yukon River.

The Minto Mine is near the height of land with relatively gentle slopes and smooth ridges that often have spines of bedrock outcrops (tors) at their crests left from long periods of weathering. Broad ridges are typically mantled with felsenmeer (fields of angular, frost-heaved, in situ rock fragments). Below the ridge crests, bedrock exposures are limited or negligible. The Project area lies in a zone of extensive discontinuous (50–90%) permafrost and is included in the western portion of the Yukon plateau central ecozone. North-facing slopes in the area are commonly underlain by permafrost. Valley-bottom deposits and upland soils usually contain ice-rich horizons. Well-drained uplands may have permafrost-free soils.

As the ecoregion is largely unglaciated, the dominant parent materials are stony residual materials along ridge tops and summits, coarse colluvium on upper slopes, and silty colluvium and loess, rich in organic matter, on lower slopes and floors of main valleys. Muck is usually capped with peat and underlain by permafrost. In the Minto Mine area, much of the colluvium on ridge slopes is coarse sand derived from decomposition of the largely granitic bedrock in the area. Overburden of relic soils that predate the last glaciation includes lacustrine deposits overlain by colluvium and organic silt in some upper valleys, some of which was exposed during excavation on the south side of the pit.

The mine development area is in the transition from the forested to non-forested (alpine) zone. Below the treeline (elev. ~1,000 m) the vegetation patterns reflect the discontinuous distribution of permafrost with stunted black spruce woodlands on cold, north-facing sites and mixed (aspen, white spruce, minor birch) forests on warm, south-facing slopes. The area has been burned over by several wild fires, the latest of which was in 2010 (Minto Landing to lower Minto Creek area). Many of the burnt trees have blown down and natural regeneration of pine and alder is occurring over much of the property and the Project area.

The climate of the region is continental with short, warm summers and very cold winters. Annual precipitation ranges from 300 to 500 mm. Mean annual temperatures are near –5^{o}C with mean mid-winter temperatures of –23^{o}C to –32^{o}C, in July from +10^{o}C to +15^{o}C and extremes in the lower valleys ranging from –60^{o}C to +35^{o}C.

The area is drained by tributaries of the Yukon River. The rate of runoff is controlled by almost total vegetation ground cover and moderate slope gradients. Infiltration rate is expected to be high in areas of thicker colluvium. However, permafrost and seasonally frozen soils inhibit vertical percolation.

Topography in the Dawson Range is moderate and the active geomorphological processes in the study area are typically limited to include slow mass movement (solifluction) and some minor gully erosion. Although there are no reports of large-scale active natural landslides in the Minto Project area, smaller scale instabilities have recently been documented in the Minto Creek catchment area, downstream of the mine site. Substantial sediment loading in lower Minto Creek in the absence of effluent discharge from the site was observed throughout the open water months of 2011 (Appendix G, *Minto Creek Water Quality Characterization*). This prompted a targeted water quality survey and an aerial investigation of the creek and tributaries in spring of 2012 in an attempt to identify the source(s) of the sediment. Two areas were identified in tributaries on the southern side of the Minto Creek catchment, below the area of control of the mine, where soil materials had slumped and transported a significant amount of material into the creek channel. Although ground investigations were not conducted, it is suspected that these instances may be related to thawing of frozen ground conditions, or may simply be small-scale instability of fine textured (lacustrine) soils.

Characterization and management of potential effects on environmentally valued components have been incorporated into the project proposal. The Project is not expected to have a significant adverse effect on the environment.

Section 12 presents the socio-economic effects assessment and outlines mitigation and management measures.

For more information about the effect assessment methodology used, please see Environmental and Socio-economic Effects Assessment Approach (Section 1.7) as well as the *Socio-economic Study Report* (Appendix T) and Section 17.3 Cumulative Effects Assessment.

1.7 Environmental and Socio-economic Effects Assessment Approach

YESAA directs proponents to consider the significance of potential environmental or socio-economic effects of their project when preparing a project proposal.

For the purpose of Minto Mine's Phase V/VI project proposal, effects assessment methodology has generally been based on available YESAB documentation (i.e., *YESAB Guide to Socio-economic Effects Assessment* (YESAB 2006)). Spatial and temporal boundaries of the Project and relevant baseline data were determined and have been taken into consideration. Valued environmental and socio-economic components (VESECs) were identified based on a review of previous environmental assessments, as well as engagement with SFN, land users, regulators and other stakeholders. To determine whether adverse environmental and socio-economic effects were significant, several criteria were taken into consideration. These include: magnitude; geographic extent; duration; frequency; reversibility; socio-economic context; and direction.

Where a potentially significant adverse effect was identified, mitigation measures and strategies were developed and evaluated for their effectiveness in the elimination, reduction, control of, or compensation for that effect. If any effects (i.e., residual effects) remained after applying the mitigation strategies, the residual effect was characterized for significance. An iterative loop between mitigation and significance characterization was conducted until there were no remaining potentially significant adverse effects.

Effects assessments have been conducted for key VESECs and can be found in the following sections:

Section 8 – Aquatic Resources Effects Assessment and Management

Section 9 – Air Quality Effects Assessment and Management

Section 10– Wildlife Effects Assessment and Management

Section 11 – Vegetation Effects Assessment and Management

Section 12 – Socio-economic Effects Assessment and Management

Section 13 – Heritage and Historic Resources Effects Assessment and Management

Minto has discussed the effects of the environment on the project in Section 16 and although it is not a requirement under YESAA for this project, has also provided a Cumulative Effects Assessment (Section 17).

2 Existing Facilities and Development

2.1 Introduction

The Minto Mine has been in commercial operation since October 2007 and has been conducting operations under the Phase IV Mine Plan since February 2011. All existing facilities and development described in Section 2 have been assessed by YESAB (Minto Mine Phase IV Expansion, Project Assessment 2012-0198) and licensed under amendments to the QML-0001 and WUL QZ96-006 (Sections 1.3.2, 1.4.2 and 1.4.3) for information on previous assessments and licence amendments.

The Minto Mine infrastructure is typical of an open pit and underground mining operation. Figure 2-1 and Figure 2-2 display an overview of Minto Mine 2012 site layout and existing site infrastructure, respectively.

From 2007 through April 2011, mining at Minto took place in what is known as the Main Pit. Exploration during those years identified several other high-grade areas of the ore deposit that are amenable to both surface and underground mining. These areas were upgraded from resources to reserves by a series of prefeasibility studies completed in 2010, 2011, and 2012.

The first of these reserves were submitted to YESAB for assessment in November of 2010 as application 2010-0198 (the Phase IV Project Proposal). That application presented two new pits and an underground mine, extending mining operations to early 2014 and milling operations to 2016. Figure 2-3 shows the site layout at the completion of Phase IV surface mining activities. In February 2011, the Designated Office issued its evaluation report.

Prestripping of the Area 2 Pit commenced in April 2011, with ore processing following in May 2012. Processing of stockpiled ore from the Main Pit continued during the prestripping period; some low-grade and partially oxidized ore from the Main Pit still remains to be processed.

Development of the underground mining assessed in Phase IV commenced in August 2012 with stripping of overburden around the portal access; ore production is expected in Q3 2013.

MINTO MINE PHASE V/VI EXPANSION

PROJECT PROPOSAL

FIGURE 2-1
MINTO MINE
2012 SITE LAYOUT

JUNE 2013

CAPSTONE MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

Water flow

1:14,000

when printed on 11 by 17 inch paper

0 125 250 500 750
Meters

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 14th 2012.
Site contours derived from 2012 aerial imagery obtained from Challenger Geomatics.

Hydrology data provided by Minto Explorations Ltd, May 2009.

Datum: NAD 83 Projection: UTM Zone 8N

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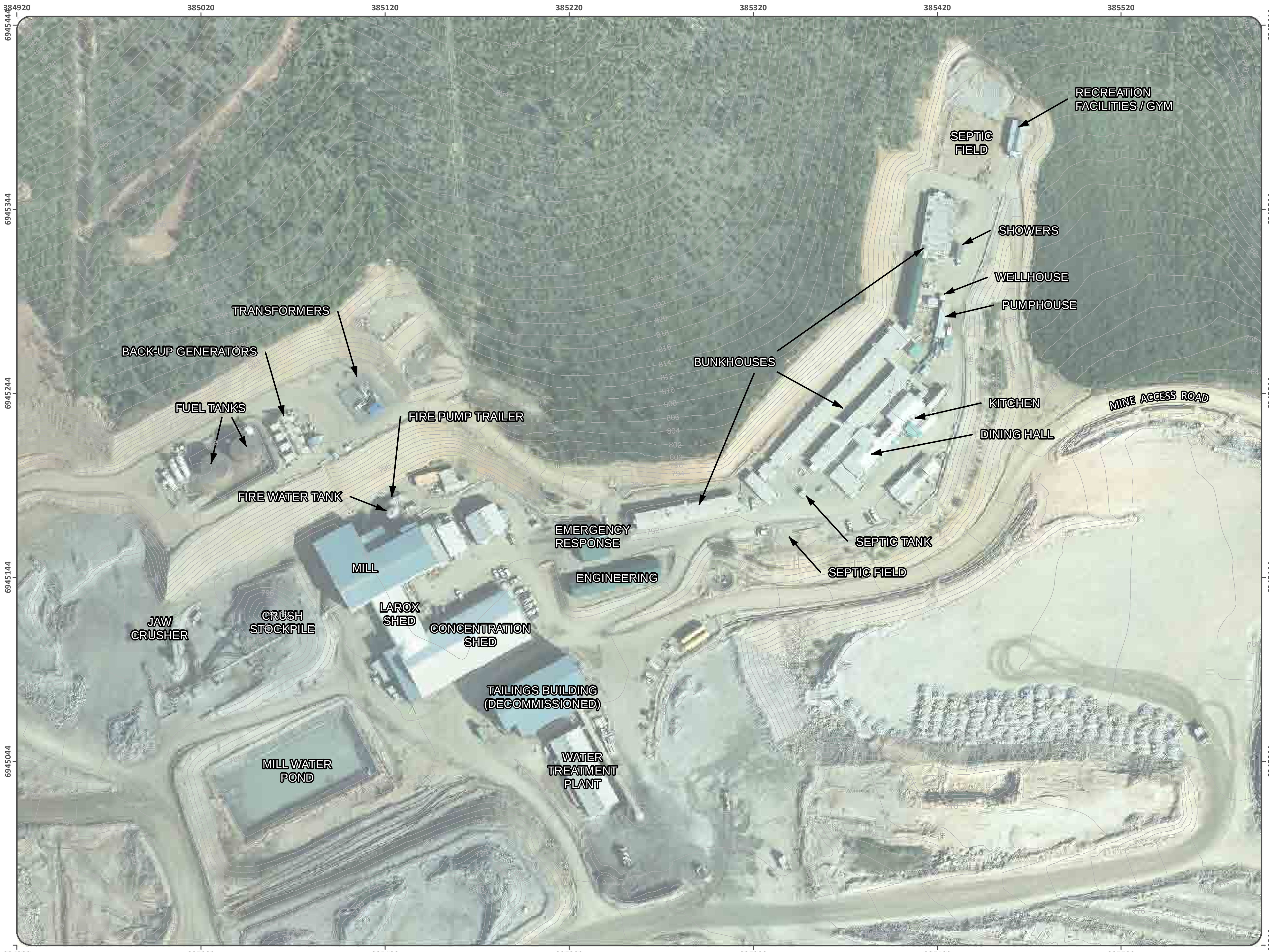

MINTO MINE EXPANSION
PHASE V/VI

PROJECT PROPOSAL

FIGURE 2-2
EXISTING SITE INFRASTRUCTURE

MAY 2013

CAPSTONE MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

Contours *(2m Intervals)*

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 14th 2012.
Site contours derived from 2012 aerial imagery obtained from Challenger Geomatics.

Datum: NAD 83 Projection: UTM Zone 8N

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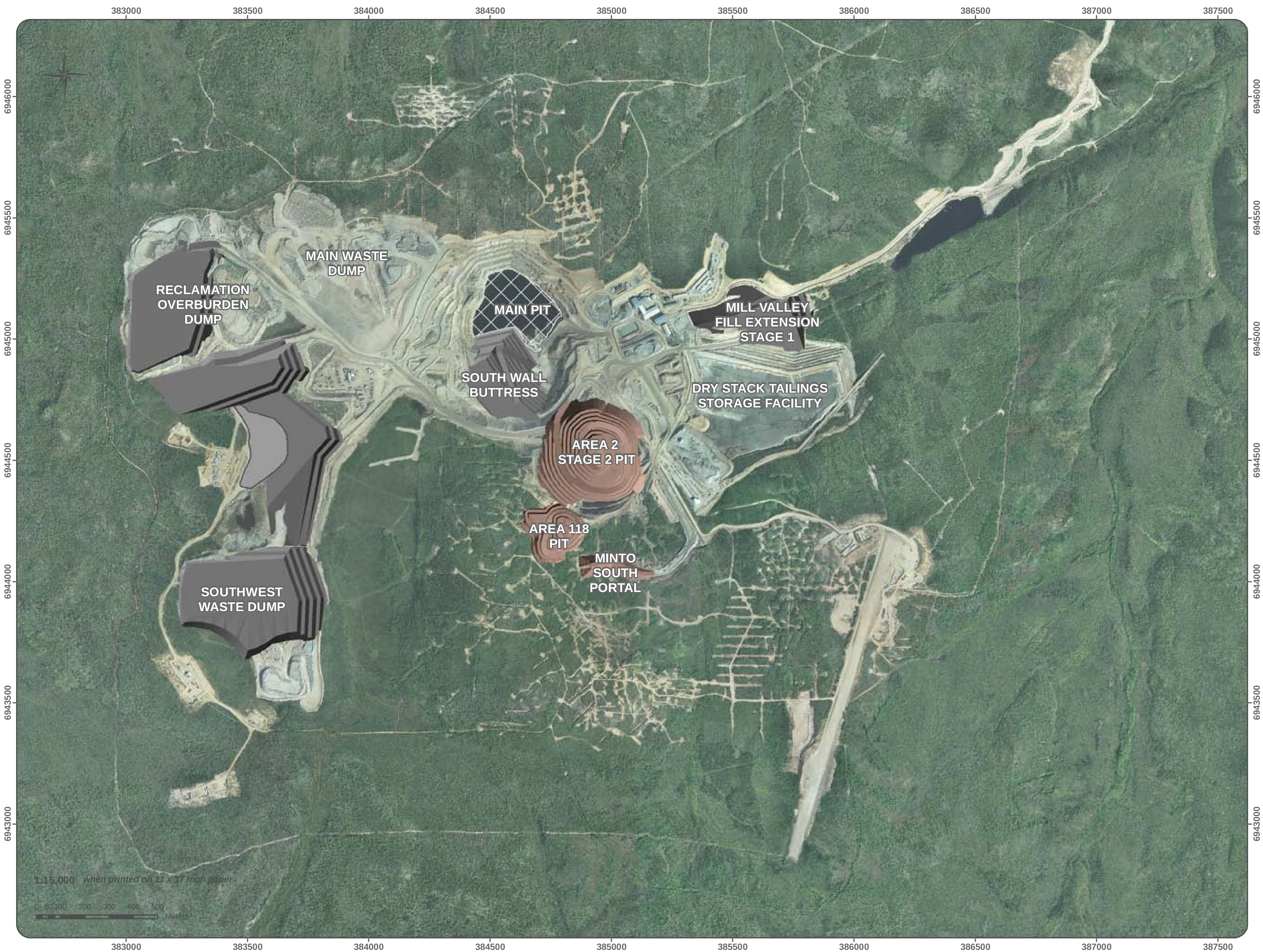

MINTO MINE EXPANSION PHASE V/VI

FIGURE 2-3

END OF PHASE IV SITE LAYOUT

JUNE 2013

Minto Explorations Ltd.

A SUBSIDIARY OF CAPSTONE MINING LTD.

Phase IV Tailings

Phase IV Dumps

Phase IV Pits

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 14th 2012.

Datum: NAD 83 Projection: UTM Zone 8N

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2.2 Existing Site Infrastructure

2.2.1 Access to Mine Site

The Minto Mine is accessible from Whitehorse, Yukon, by means of the Klondike Highway (YG Highway No. 2) to Minto Crossing (240 km). Passage across the Yukon River can be made by barge in the summer or by ice-bridge in the winter. The highway, river crossing, and gravel access road are suitable for heavy transport traffic. The barge has a 75,000 kg (165,000 lb.) net capacity capable of hauling loaded B-train transport trailers across the river. The Yukon River crossing experiences an impassable freeze-up and thaw period of approximately November through December and April through May, respectively. Normally, operations personnel and freight are transported to and from site by bus. During the river freeze and thaw periods, personnel and freight are transported by aircraft.

A 28 km-long, 10 m-wide gravel access road provides access from the west side of the Yukon River to the Minto Mine and is a well maintained class A all-weather gravel road, complete with drainage ditches, road signage and runaway lanes on steeper downhill sections. Roadbed material is fluvial sand or gravel along its lower reaches along the Yukon River and coarse sand along its upper reaches. The road crosses one major tributary of the Yukon River, Big Creek, by way of a single lane bridge made with reinforced concrete abutments and deck. The approaches to the bridge have been stabilized with berms and modifications to the spillway were constructed to divert any floodwaters exceeding the bridge capacity. In May of 2012, five new 48" culverts were installed at the 18.5 km mark to accommodate spring runoff and prevent washouts, and new chevrons were installed at the Big Creek Bridge. The road is maintained by mine personnel.

2.2.2 Site Power Supply

Power is being supplied to Minto Mine from a 32 km, 34 kV power line from Minto Landing. The power supplier is Yukon Energy Corporation (YEC). The current YEC's current power purchase agreement with Minto Mine allows for a total capacity of 4,400 kVA with a total annual consumption limitation of 32.5 GWh. Minto Mine currently uses approximately 3,800 kVA of its allotted capacity.

The Mine's power is distributed from a YEC-owned substation at 5 kV. The system configuration uses a main switch room in the mill with two smaller switch rooms in the tailings building. Previously, Minto Mine was powered by diesel generators and continues to use these generators during electrical service disruptions.

As approved under Minto Mine Phase IV, to accommodate the loads required for the underground mining operation, a 600A-rated power line at 4,160 V has been installed and is fed from a 300A-rated switch in the tailings building's power distribution switch room. The power line follows the existing site haul road from the tailings building to the Minto South Portal laydown area. From there the pole line transitions from an overhead line to a 350A-rated surface Teck cable to the underground portal for approximately 320 meters. Three 100 KVA pole-mount transformers have been installed, providing power to the underground mobile equipment shop. Cutout switches for isolation have been installed, both at the start and end of the power line, as well as at the underground mobile equipment shop transformers. The power line is designed with adequate clearance to ensure a haul truck with its box in the upright position can pass under without incident.

During the summer of 2013, the following significant improvements, previously approved under Minto Mine Phase IV, will be made:

- The installation of 600A-rated switches in both the mill and tailings buildings' power distribution rooms will be completed in order to take advantage of the full capacity of the overhead line and for expected future loads.
- A sub-soil 18 m x 18 m ground grid approximately 500 meters from the portal will also be installed, per CSA Use of Electricity in Mines, to reduce the impedance of the system ground.
- The installation of a neutral ground resistor, per CSA Use of Electricity in Mines to ensure that the ground fault voltage is limited to 100V or less.
- The 4,160 V overhead power line will be extended past the portal to the new fresh air raise, which is anticipated to be completed and in operation in fall 2013. The fresh air raise will comprise 2 x 300hp ventilation fans with associated motor starters, controls, and distribution equipment for the propane-heated fresh air.
- The surface feed from the power line to the underground operation will be moved closer to the portal and upgraded to provide 600A-rated capacity at 4,160V.
- A fibre optic cable will be strung along the pole line to the underground mobile shop, underground mine and the fresh air raise to provide voice, data, and SCADA control and monitoring of key systems underground and on surface.

2.2.3 Fuel Storage

Diesel fuel is stored in a diesel storage facility located just north of the process plant. Six large diesel tanks have a combined storage capacity of approximately 3.2 million litres (L); sufficient for supplying open pit and underground mine equipment for two months as is required during the Yukon River freeze and thaw periods, during which vehicle access to the site is not possible. A fuel tank inventory, including the types of products and volumes is presented in Table 2-1.

Table 2-1: Summary of the Fuel Tanks Inventory at the Minto Mine Site.

Summary - Totals		
Quantity of Storage Tanks (#)	**Product Type**	**Volume (L)**
6	Diesel	3,267,668
1	Gasoline	8,000
6	Propane	911,000

2.2.4 Camp and Camp Services

The existing workforce camp at the Minto Mine consists of eight single-story modular housing units capable of housing a total of 208 people (Figure 2-2). Each housing unit consists of individual sleeping rooms with common showers, washrooms, and recreation areas. The main building houses the kitchen and dining hall and recreation facilities; a separate building has been provided to serve as a gym. Units are connected by interior corridors except for some of the outlying buildings.

Domestic water and firewater are provided from a well and storage tank system located in the camp area. Sanitary sewage is directed to septic tanks connected to two septic fields that are currently operating at maximum capacity. Power for the camp is provided from the main sub-station via a transformer located in the camp area.

The existing camp buildings and septic fields are using the majority of available space on the upper bench, east of the mill and north of the Mill Valley Fill Extension.

2.2.4.1 Minto Camp Upgrade and Expansion

A camp upgrade, as already approved under Minto Mine Phase IV, is currently underway and will see the number of camp spaces increased to 248 through the use of three-storey modular housing units that will be installed in phases as the old buildings are decommissioned. The majority of the three-storey housing units will have 10 bedrooms per floor for a total of 30 people per unit. A washroom will be provided for each bedroom and a common lounge area and laundry room will be provided on each floor; plans have been sent to EMR (Energy, Mines and Resources), with completion expected in the fall of 2013. The new modular units will be constructed on concrete or pressure treated foundations.

The new camp buildings will be connected with an interior corridor that will also contain the building electrical, communication and water distribution services. A common mudroom will be provided at the south end of the camp.

A modular sewage treatment plant, approved under Phase IV, is in the process of being installed and will be commissioned to replace the septic fields. It will be installed so that the septic field at the north end of the camp can be decommissioned to provide space for the first of the new housing units. New temporary and permanent sanitary piping, manholes and a grinder lift station will be required to direct sanitary sewage to the new sewage plant.

Propane lines and electrical distribution equipment will be relocated and upgraded to service the new camp buildings. IT cabling will be re-routed to connect to the new camp buildings and to maintain service as the existing buildings are removed.

2.2.5 Solid Waste Management

Minto manages solid waste under permit #81-005 issued by Yukon Environment; this permit was last updated March 11, 2013.

The waste management area (WMA) is designed for staging, burning, incineration and burial of materials generated from site. The WMA is open 2 hours daily with an attendant directing traffic and monitoring waste disposal during this time and is locked outside of these hours. A 100-foot pole barn structure is used to stage all special waste and some recyclables before they are shipped off site for final disposal. The burn pit is designated to burn untreated wood and cardboard. An incinerator is used to dispose of all food waste and the majority of other camp and office waste. The landfill is used for burial of non-recyclable construction materials and other non-hazardous materials. No material is placed in the landfill that could potentially attract animals.

Supporting infrastructure includes an exclusion (bear) fence set up around the burn pit and incinerator. A bear-proof container is used to store all camp waste prior to being incinerated. Any recyclables that could be an animal-attractan are staged in a sea container before being shipped off-site. A fluorescent bulb breaker, oil filter crusher and drum crusher are in place to reduce environmental risk. Garbage disposal in camp and around the site has been segregated into five major categories to allow for better handling of materials, they include metal, incinerator, inert waste, aerosols, wood & cardboard. Kitchen waste is removed from camp twice a day during the spring and summer months when there is a greatest risk of attracting wildlife.

2.2.6 Warehouse and Mechanical Shops

There are several facilities on the site used for warehousing and mechanical work. The Minto warehouse and light-duty mechanics' shop is located beside the process plant. Pelly Construction Ltd. (mining contractor) utilises an 80 x 135-foot stretched fabric and aluminum structure as a heavy-duty mechanics' shop, and has several other ancillary facilities at the Pelly laydown. The underground operation is supported by the underground shop, which allows the space for equipment maintenance, repair, and some office support.

Under Phase IV operations, site warehousing will erect an 80'x 100-foot all- steel industrial warehouse with a cement floor and pallet storage as well as industrial shelving. The facility will be located on the existing Mill Valley Fill Extension (MVFE) and will house the warehousing needs for the mine operation. The location will facilitate better offloading of trucks and centralize services to the entire site. It will also ensure better control of regulated products.

2.2.7 Explosives Storage

The explosives storage facility is run by the explosives contractor, Dyno Nobel. The explosive magazine is located at the southwest region of the mine site and is isolated from any main infrastructure. The mine is currently authorized, through Natural Resources Canada license F72384, to store 180,200 kg of emulsion explosive and 1,500,000 kg of ammonium nitrate (unmixed with fuel oil). Minto also has two explosives magazines on site, allowing for the storage of 10,000 detonators and 60,000 kg of explosives under Yukon Workers' Compensation Health and Safety Board (YWCHSB), permit numbers YT534 and YT533, respectively.

2.3 Mining and Waste Management Activities

Under existing Phase IV approvals, open pit mining is currently proceeding in the Area 2 Pit. Preliminary stripping took place at the Area 118 Pit in November and December 2012; that pit will be mined when Area 2 is mined to the limits of its approved Phase IV design. Waste rock from mining operations is being deposited in several locations including the southwest waste dump, the Main Pit south wall buttress, and the Mill Valley Fill extension. Overburden is being deposited in the reclamation overburden dump or in the ice-rich overburden dump, depending on the ice content of the material. Additional overburden material is being placed as a preliminary cover on the dry stack tailings storage facility.

Mining and waste placement in the following locations are currently authorized and in development as part of the Minto Mine Phase IV activities:

- **Main Pit**
  The Main Pit is centered in the Minto Creek valley west of the mill area. It hosted the Minto deposit, which was the first deposit mined at the Minto Mine. Mining in the Main Pit ended in April 2011 with the completion of the Stage 5 pushback. The tailings management plan for Phase IV entails the placement of slurry tailings in the Main Pit which began on November 1, 2012.
- **Area 2 Pit**
  The Area 2 Pit is located south of the mill area and southeast of the Main Pit. As part of the Phase IV mine plan, the pit was mined in two stages, the first of which was started in April of 2011. The second stage, and the final one approved as part of Phase IV, is currently underway, and involves pushing back the walls and deepening the pit; it is expected to be completed by Q4 2013. Once open pit mining of Area 2 Stage 2 is complete, it is scheduled to receive slurry tailings under the final stages of the Phase IV mine plan.
- **Area 118 Pit**
  Area 118 is a small pit that is scheduled to be the final open pit mining under the Phase IV mine plan. It will be located uphill and southwest of the Area 2 Stage 2 Pit, and is scheduled to be backfilled with overburden as part of the Phase IV reclamation activities.
- **Minto South Underground**
  Development of the surface excavation and surrounding infrastructure for the Minto South Underground commenced in August 2012 as per the Phase IV mine plan. Decline development is ongoing, with initial ore production expected in Q3 2013. Seven stopes located under the Area 2 and Area 118 pits, totaling 1,591,000 tonnes of ore, were assessed under the scope of Phase IV.
- **Main Waste Dump (MWD)**
  The MWD is located west of the Main Pit, and was the first waste rock storage facility constructed at Minto. The MWD contains waste rock from the initial phases of mining in the Main Pit, and is at its original design capacity under Phase IV.

- **Southwest Waste Dump (SWD)**
  Construction of the SWD began in March 2009; it has received waste rock continuously since that time, initially from the final stages of mining of the Main Pit, and later from mining of Area 2 Pit (Stage 1 and Stage 2). Expansions of the dump's height and footprint were permitted as part of Phase IV.
- **Dry Stack Tailings Storage Facility (DSTSF)**
  The DSTSF received the mine's tailings output until the licensing of Phase IV authorized Minto to begin using the completed Main Pit for tailings storage. Tailings placement in the DSTSF ended on November 1, 2012. The DSTSF contains all tailings from milling of Main Pit ore as well as tailings from approximately seven months of milling of Area 2 ore (approximately 5.1 million dry metric tonnes). The DSTSF is accepting cover material from Area 2 Pit and Area 118 Pit excavations.
- **Mill Valley Fill Extension (MVFE)**
  This dump is located at the toe of the DSTSF in the Minto Creek valley, immediately east of the original Mill Valley Fill that was constructed early in the mine life to provide space for milling and related activities. Construction of the MVFE was part of the Phase IV mine plan to be used as a buttress to mitigate the down-slope movement of the DSTSF.
- **South Wall Buttress (SWB)**
  The SWB is a rock fill structure that is designed to buttress the south wall of the Main Pit and preserve the remaining volume in the Main Pit for tailings and water storage purposes. Construction of the SWB began in May of 2011; it has received rock from the Area 2 Pit since that time. It is scheduled for completion to the design capacity before Phase IV open pit mining is completed.
- **Reclamation Overburden Dump (ROD)**
  The ROD is located west of the Main Waste Dump, and contains overburden materials released from both the Area 2 Pit and the Main Pit.

2.4 Ore Processing

Minto is currently authorized to mill ore at a rate of up to 4,200 tpd. The following sections describe the major components of the ore processing and storage facilities at Minto.

2.4.1 Crushing Circuit

Run-of-mine ore is first passed through a two-stage crushing circuit located outdoors on a pad west of the main process plant. Ore is first loaded into a hopper using a Caterpillar 980 front-end loader. A screen over the hopper rejects boulders larger than the crusher opening; these are moved aside and broken using an excavator-mounted hydraulic rock-breaking tool.

The primary crusher was originally intended to operate six hours per day, 365 days per year at 75% availability but, due to increased throughput, now operates 24 hours per day, 365 days per year at an availability of 75%.

2.4.2 Processing Plant

The processing plant consists of the following main unit operations:

- Two-stage grinding circuit comprised of a single SAG (semi-autogenous grinding) mill and two ball mills;
- Bulk flotation in rougher and scavenger stages, followed by cleaner flotation;
- Centrifugal gravity concentration of coarse gold;
- Concentrate thickening and pumping;
- Concentrate filtration;
- Concentrate storage (on-site);
- Tailings thickening and pumping to an in-pit deposition location; and,
- Water reclamation.

The mill circuit operates 24 hours per day, 365 days per year at an availability of approximately 93%. Availability is defined as the operating hours in a 24-hour day.

2.4.3 Concentrate Building

The concentrate storage shed on site is capable of holding 18,000 tonnes of concentrate. Shipping from site stops in the fourth quarter, while the Yukon River freezes up and the ice bridge is built, and in the second quarter, for spring thaw.

2.4.4 Tailings Filtration Building

The tailings filtration building currently holds all of the equipment formerly used to produce filtered cake, including a 13.5 m tailings thickener and five Lasta pressure filters. Dry stack tailings operations ceased in November 2012. The tailings thickener is still operational and thickened tailings are directed to the Main Pit using a combination of sub-aerial and sub-aqueous deposition over the life of deposition into the Main Pit.

2.5 Water Conveyance and Water Treatment

Please refer to Section 2.5 for details regarding current water conveyance and treatment.

2.6 Health, Safety and Emergency Response

Having been an operating mine for several years, Minto has a comprehensive health and safety program and emergency response procedures that have been developed and refined over several years. Minto is committed to providing a safe and healthy working environment for all employees; this philosophy is shared by senior management, supervisors, workers and all onsite contractors.

2.6.1 Health and Safety Program

The health and safety program (HSP) is primarily focused on preventing workplace accidents and injuries. The program complies with all required internal policies and procedures, as well as Yukon Territory's legislated requirements. All work at the site is planned and performed under the rules and guidelines laid out by the HSP; some of the components include:

- Workplace Inspections and on-the-job worker observations;
- External and Internal program audits;
- Risk assessments and job hazard analyses;
- Daily and weekly crew safety meetings;
- Safety orientations for all site visitors, contractors and employees;
- Onsite training (e.g. fire extinguisher, fall arrest, confined space entry etc.);
- Joint occupational health and safety committees; and
- Industrial hygiene and fatigue management programs for the underground.

All safety concerns are documented, assigned responsibility, and tracked until rectified. The HSP has been developed to meet and/or exceed regulatory standards and the health and safety department work closely with regulators at YWCHSB. Minto is the first quartz mining operation in Yukon to become *COR™* safety-certified and ensure all supervisors complete "First Line Supervisor" training as required by YWCHSB. As well, please see Minto's *Fatigue Management Plan* in Appendix C.

2.6.2 Underground Mine Safety

As part of the ongoing Phase IV development, the working face is currently within 500 metres of the portal, and the emergency escape is directly to the surface via the portal. Once development progresses further, the ventilation raise will be established with dedicated manways equipped with ladders and platforms providing a secondary exit in case of emergency.

Additional underground safety measures currently in place include portable refuge stations, automatic fire suppression systems on equipment, self-rescuers, and a mine-wide stench gas warning system installed at the main intake raise to alert underground workers in the event of an emergency.

2.6.3 Emergency Response

Minto's emergency response plan (ERP) outlines the steps necessary in responding to an emergency at the mine. The ERP includes protocols for initial response, accountabilities, and responsibilities in the event of multiple different types of emergencies. Minto has a trained mine rescue team, on-site medics and first aid attendants and personnel trained in Hazmat response.

There are also protocols outlined in the ERP for responding to specific emergencies involving major power failure, fire, medical emergencies, site evacuations, tug and barge at the Yukon River, missing persons, outbreak of sickness, and release of hazardous materials.

Further information on mine safety and emergency response is provided in the *Spill Contingency Plan* and the *Emergency Response Plan* in Appendix B.

3 Project Description

Section 3 provides a description of the proposed activities that are collectively referred to as Phase V/VI, or the Project. This project description describes both primary and ancillary activities, and attempts to provide the reader with a firm understanding of the discrete undertaking that is to be evaluated for potential effects and their significance when compared to pre-existing conditions, which were laid out in the preceding sections.

3.1 Surface Mining

The expansion of surface mining as part of Phase V/VI activities consists of three new open pits – Minto North, Ridgetop South, and Ridgetop North – and the expansion of the Area 2 Pit previously presented in Phase IV with a third pushback (referred to as Area 2 Stage 3).

Area 2 was first added to the mine's mineral reserves by a prefeasibility study (PFS) completed in November 2007, though the pit design created at that time did not include the Stage 3 pushback proposed in this application. The subsequent Phase IV PFS confirmed the design, still without the Stage 3 pushback; this design formed the basis for the Phase IV mine plan. The Phase V PFS expanded Area 2 to include the Stage 3 pushback.

The Minto North deposit was brought into the mine's reserves in late 2009 with the release of the Phase IV prefeasibility study; the Phase V and Phase VI studies updated the reserve to reflect changes in the cut-off grade and optimization of the pit design. The Ridgetop North and Ridgetop South pits were added to the reserve as part of a technical report prepared in June 2008 and updated in subsequent prefeasibility studies. These pits were not included in the Phase IV project proposal because insufficient information was available at the time.

These pits will extend surface mining at Minto to 2017.

3.1.1 Mineral Reserves

Table 3-1 shows Minto's open pit ore reserves as of January 1, 2013.

Table 3-1: Open Pit Reserve Estimate as of January 1, 2013.

	Mineral Reserve Class	Tonnes (K tonnes)	Diluted Grade Cu (%)	Diluted Grade Au (g/t)	Diluted Grade Ag (g/t)	Contained Metal Cu (MLb)	Contained Metal Au (k troy oz)	Contained Metal Ag (k troy oz)
North	Proven	1,596	2.26	1.21	8.12	80	62	417
	Probable	9	1.68	0.58	6.92	0	0	2
	Subtotal	1,605	2.26	1.21	8.11	80	62	419
Ridgetop	Proven	1,073	1.02	0.25	2.12	24	9	73
	Probable	1,020	1.00	0.28	2.97	22	9	97
	Subtotal	2,093	1.01	0.26	2.53	47	18	171
118	Proven					0	0	0
	Probable	483	1.28	0.10	1.81	14	2	28
	Subtotal	483	1.28	0.10	1.81	14	2	28
Area 2	Proven	2,310	1.43	0.53	4.80	73	39	357
	Probable	1,578	1.02	0.29	3.40	36	15	173
	Subtotal	3,888	1.27	0.43	4.23	108	54	529
Open Pit Subtotal	Proven	4,979	1.61	0.69	5.29	177	110	846
	Probable	3,090	1.06	0.26	3.02	72	25	300
	Subtotal	8,069	1.40	0.52	4.42	249	136	1,147

It should be noted that in Table 3-1 the reserves are quoted for the entire Area 2 Pit, including the portion mined in Phase IV. The Ridgetop North and South pits are reported as a combined total.

In addition to the ore reserves described above, these pits will release the following volumes of waste rock and overburden as shown in Table 3-2 and Table 3-3.

Table 3-2: Volume of Waste Rock Released from Phase V/VI Mine Components.

Source Location	Quantity (BCM)	Swell Factor	Waste Rock Volume (m^3)
Minto North	3,269,000	1.3	4,250,000
Area 2 Stage 3	1,465,000	1.3	1,905,000
Ridgetop South	482,000	1.3	627,000
Ridgetop North	2,628,000	1.3	3,416,000
Underground	102,000	1.3	133,000
		Total Waste Rock (Phase V/VI)	**10,331,000**

Table 3-3: Volume of Overburden Released from Phase V/VI Mine Components.

Source Location	Quantity (BCM)	Swell Factor	Overburden Volume (m^3)
Minto North	697,000	1.3	906,000
Area 2 Stage 3	2,230,000	1.3	2,899,000
Ridgetop South	135,000	1.3	176,000
Ridgetop North	702,000	1.3	913,000
Underground	0	1.3	0
	Total Overburden (Phase V/VI)		**4,894,000**

The following figures provide an overview of the locations and designs for all open pit development in Phase V/VI. No waste dumps are shown, but the site configuration for Phase V/VI including proposed waste dumps is presented in Section 4 – Waste Rock and Overburden Characterization and Management.

MINTO MINE PHASE V/VI EXPANSION

FIGURE 3-1

OVERVIEW OF PHASE V/VI OPEN PITS

JULY 2013

CAPSTONE MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

Phase V/VI Open Pits

Phase IV Features

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 14th 2012.

Datum: NAD 83 Projection: UTM Zone 8N

I:\Minto\gis\mxd\Phase_5-6\Permitting\YESAB\Project-Proposal\03-1_Phase5_6_Pit_Overview_20130704.mxd
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MINTO MINE PHASE V/VI EXPANSION

FIGURE 3-2
PHASE V/VI OVERVIEW OF MINTO NORTH PIT

JULY 2013

Contours (1m intervals)

Phase V/VI Pit

1:3,000 *when printed on 11 x 17 inch paper*

0 25 50 75 100 Meters

Coutour lines provided by Capstone Ltd. Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 14 th 2012.
Site contours derived from 2012 aerial imagery obtained from Challenger Geomatics.

Hydrology data provided by Minto Explorations Ltd, May 2009.

Datum: NAD 83 Projection: UTM Zone 8N

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(*Last edited by: mducharme;04/07/2013/11:38 AM*)

3.1.2 Open Pit Mining Sequence

Of the Phase V/VI pits, Minto North is planned to be mined first, as it represents the highest-grade reserve. The mining sequence then moves to Area 2 Stage 3, the completion of which will allow for tailings deposition into the full volume of the Area 2 Pit. Mining will then move to Ridgetop South and conclude with the Ridgetop North pit.

Figure 3-4 below presents the proposed open pit mining schedule for the Phase V/VI mining plan.

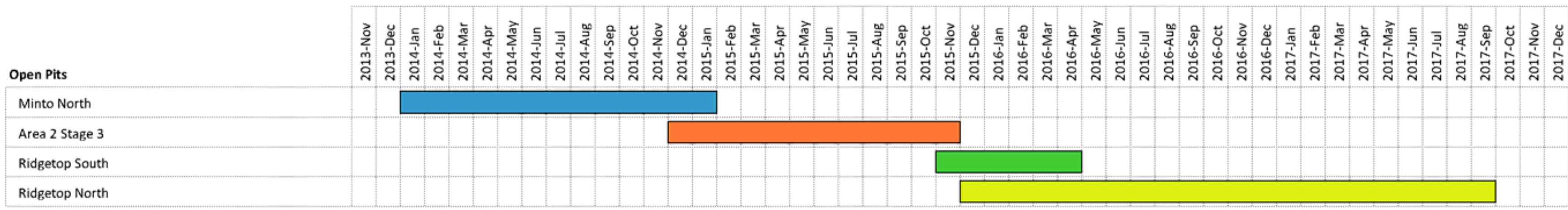


Figure 3-4: Phase V/VI Open Pit Mining Schedule.

Mining of Minto North and Area 2 Stage 3 are currently scheduled to proceed at a rate of 12,800 BCM/day, this rate being set around a number of operational constraints, chiefly the need to complete pits in a timely manner so that Area 2 Stage 3 can be used for tailings storage. Ridgetop will be mined at a reduced rate of 7,200 BCM/d, as its tailings storage volume is not time-critical, and its ore release will supplement ongoing feed from stockpiles and the underground operation.

At these rates, open pit mining will require 47 months to complete. Individual pits have the following lifetimes as shown in Table 3-4; note that mining of consecutive pits will overlap slightly.

Table 3-4: Lifetimes of Phase V/VI Pits.

	Mining Duration (months)
Minto North	13
Area 2 Stage 3	11
Ridgetop South	5
Ridgetop North	22

Mining in the first of the Phase V/VI pits, Minto North, is currently scheduled to begin in January of 2014, or as shortly thereafter as procurement of appropriate authorizations allows. The release of material for all the Phase V/VI pits is shown in the schedule below:

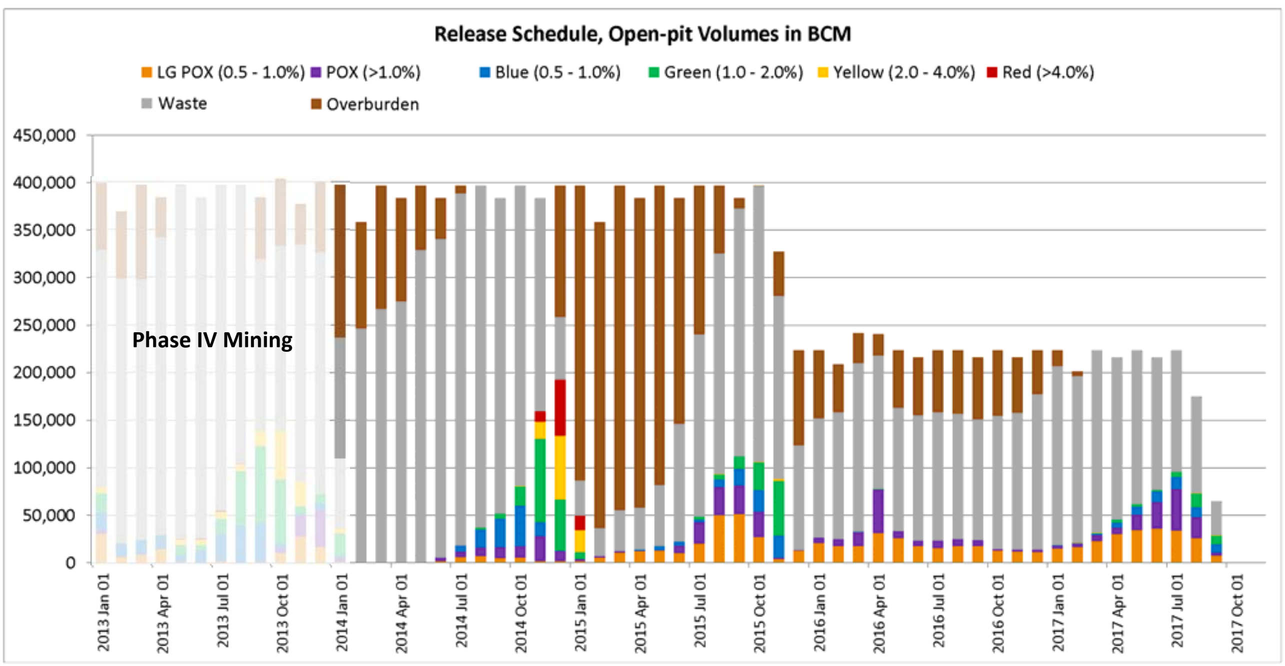


Figure 3-5: Material Release Schedule for Phase V/VI mining.

The mining sequence described here may change as Minto further evaluates Project economics, and timing of regulatory approvals. Waste disposal locations would not be affected by any change of mining sequence.

3.1.3 Mine Equipment

The open pit portion of the mine will continue to operate as a conventional truck/excavator operation using diesel-powered excavators, trucks, drills, and auxiliary equipment. Rock will be broken by blasting using ANFO where ground- and surface-water conditions permit and by emulsion where the presence of water makes the use of ANFO impractical. Overburden will be ripped and pushed using dozers or blasted.

The scale of the operation will initially remain similar to that in Phase IV; therefore, the basic composition of the mining fleet will remain relatively similar. When mining of Ridgetop South commences in 2015, Minto will see a reduction in trucks, excavators, drills, and dozers in proportion to the drop in mining rate.

Table 3-5 lists the major heavy equipment expected to be in use at Minto.

Table 3-5: Open Pit Equipment Fleet for Phase V/VI Mining.

Equipment Type	No. of units
Hydraulic Excavators, Hitachi EX1200 or similar	3
100-ton Haul Trucks, Cat 777 or similar	9
60-ton Haul Trucks, Cat 773 or similar	4
Front-end loaders, Cat 990 or similar	2
Small Hydraulic Excavators, Cat 330 or similar	2
D11-class dozer	2
D10-class dozers	2
Graders, 16' blade	2
Blast hole drills, 9 7/8" hole diameter	2
Blast hole drills, 6 ¾" hole diameter	2
Blast hole drills, 4" hole diameter	1

The mining fleet will continue to be contractor-owned and operated.

The mine will continue to operate with two 11-hour shifts per day, seven days per week, year-round.

3.1.4 Grade Control and Material Segregation Practices

Accurate in-pit separation of ore from waste, as well as segregation of various types of waste, will continue to be essential to the successful operation of the mine. Overburden from pit stripping will be stockpiled separately for use at closure as a cover/reclamation medium, and Minto will place overburden on completed dumps as part of progressive reclamation activities during mining (see the Project Development and Closure/Reclamation Activities Schedule in Appendix W). Further detail on waste handling and placement can be found in Section 4 and in the *Waste Rock and Overburden Management Plan* (Appendix A).

Grade control practices for waste rock and ore can be summarized as follows:

- Drill cuttings from every blast hole are sampled, tagged, and sent for assay at the on-site lab prior to blasting;
- Representative samples of the cuttings are assayed using atomic absorption (AA) to determine the metal content;
- The on-site assay lab, under supervision of the chief assayer, tests each sample for copper, soluble copper, and silver content;
- The environmental assay lab tests the sample for total sulfur and total inorganic carbon content, allowing for a determination of NP/AP ratio;
- The assay results are sent to the geology department for interpretation;
- The geology department plots the results spatially, then draws polygons enclosing holes with similar assay results to identify regions of similar average grade (for ore) or similar waste class (for waste);
- After blasting, the aforementioned polygons are laid out in the field by the mine surveyor working with the production geologist, using stakes and flags of various predefined colours;
- Mine operations personnel, under the supervision of the pit foreman, excavate and haul material to the destination designated for the material type. Destinations are communicated to foremen and operators by the production geologist.

3.1.5 Explosives Use and Management

Surface mining of Phase V/VI will continue the explosives use and management practices used in both the Main Pit and Phase IV.

The mine is currently authorized, through Natural Resources Canada license F72384, to store 180,200 kg of emulsion explosive and 1,500,000 kg of ammonium nitrate (unmixed with fuel oil).

Minto also has two explosives magazines on site, allowing for the storage of 10,000 detonators and 60,000 kg of explosives under YWCHSB permit numbers YT534 and YT533, respectively.

Due to cost considerations and the relatively small quantity of emulsion permitted on site, ANFO is the mine's preferred explosive. In areas where the ground is dry, ANFO is loaded directly into blast holes. If there is a small quantity of water within a blast hole, an attempt will be made to pump it dry: if successful, a waterproof plastic liner will be inserted into the hole, which will then be loaded with ANFO.

Where a hole cannot be pumped dry—for example, if the water table is high—a water-resistant emulsion blend will be used.

3.2 Underground Mining

Through Minto's prefeasibility studies, the most recent of which was completed in August of 2012, several distinct areas have been demonstrated to have grade, volume, and continuity sufficient to justify underground mining. These areas are to be accessed from three separate portals, each of which will have its own surface infrastructure:

- Minto South Underground (MSU);
- East Keel Underground (EKU);
- Wildfire Underground (WFU).

The MSU (Minto South Underground) describes development underneath and around the Area 2 and Area 118 pits, accessed from the Minto South Portal, which is southwest of the Area 2 Pit. This underground development was presented in the Phase IV application to YESAB and approved in subsequent major licence amendments. Sections 1.4 and 1.5 outline previously assessed and approved underground activities in the Minto South area.

The East Keel Underground describes an underground mining complex accessed from the proposed Highwall Portal to be located east of the Main Pit. It will access two distinct areas known as Copper Keel and Minto East.

The Wildfire Underground is a third underground mining complex designed to target the Wildfire ore zone. This area will be accessed through a proposed Wildfire Portal and will have its own dedicated infrastructure. It will be mined after the completion of the MSU and the EKU; underground mining activity will transition to the Wildfire Underground (WFU) as the other underground zones near completion.

3.2.1 Underground Reserves

Table 3-6 summarizes the underground reserves.

Table 3-6: Underground Reserves (including Phase IV Minto South Underground Reserves).

Underground								
Minto East	Proven	0	0	0	0	0	0	0
	Probable	709	2.28	1.04	6.15	36	24	140
	Sub-total	709	2.28	1.04	6.15	36	24	140
Area 2/118	Proven	0	0	0	0	0	0	0
	Probable	1731	1.76	0.74	7.19	67	41	400
	Sub-total	1731	1.76	0.74	7.19	67	41	400
Copper Keel	Proven	106	1.74	0.61	6.30	4	2	21
	Probable	1455	1.81	0.65	6.70	58	30	313
	Sub-total	1561	1.81	0.65	6.67	62	32	335
Wildfire	Proven	301	1.80	0.65	6.06	12	7	59
	Probable	59	1.59	0.77	7.85	2	2	15
	Sub-total	360	1.77	1.00	6.35	14	9	74
Underground Subtotal	Proven	407	1.78	0.81	6.12	16	10	80
	Probable	3954	1.87	0.73	6.83	163	97	869
	Sub-total	4361	1.86	0.76	6.77	179	107	949

3.2.2 Underground Mining Methods

Each of the areas summarized in the reserves consist of many separated lenses of ore, ranging in size from hundreds of tonnes to hundreds of thousands of tonnes. The physical characteristics of each ore zone determine which mining methods can be applied. The general characteristics of the underground ore zones are summarized in Table 3-7.

Table 3-7: Summary of Deposit Characteristics and Context.

Parameters	Unit	Value	Comment
Depth below surface	m	100-320	
Dip	deg.	10-30	
Thickness	m	3-25	10 m average
Size (aerial)	m	100x150	Average size
Production capacity	t/vm	10,000	Approximate tonnes per vertical metre
Mineral value	$/t NSR	98	Average value
Mineralization	Mineralized zones are visually and geochemically obvious due to density of visible sulphides and the degree of foliation.		
Continuity	The zones appear to be continuous over tens of metres.		
Regularity	The deposits appear to be well-defined zones that are thick in the middle and thin toward the edges with sharp hangingwall and footwall contacts.		
Geotechnical	Generally very favourable rock conditions with strong granitic rock in deposit and in FW and HW. Some faulting but generally not seen to be a significant issue. No anticipated concerns with seismic activity created by mine excavations		
Hydrogeology	Not well defined, but tightness of the rock infers that there will likely not be hydrogeological issues.		
Constraints	There are no known constraints such as heat, radiation, groundwater, or rock stress.		

The irregular geometry of the mineralization, with thicknesses averaging 10 m but highly variable, and a 20° average dip angle, constrain the choice of mining method. Sub-level caving and sub-level open stoping would not be suitable for the deposit because of these geometric constraints, while the value of the ore, in most parts of the deposit, cannot support the economics of a drift and fill method with cemented backfill.

Two methods were found to be suitable for underground mining at Minto: room-and-pillar (RAP) where the deposit thickness is approximately ten m or less, and post-pillar cut-and-fill (PPCF) where the thickness is greater.

3.2.3 Description of Room-and-pillar Mining

The most suitable mining method for deposits less than 10m thick was found to be RAP. The method is simple and has numerous examples of success in low-dipping, moderately thick, shallow deposits with favourable rock conditions. The method allows excellent production capacity potential and relatively low cost while still providing mining flexibility and low dilution.

RAP mining utilizes un-mined rock as pillars to support a series of “rooms” around the pillars. The method is often designed with pillars in a checkerboard pattern (Figure 3-6), but pillar location may be modified within the geotechnical constraints to maximize recovery of higher-grade ore. The pillars can sometimes be extracted on retreat to help improve the overall recovery.

At Minto, many of the mineralized zones are thicker than can be mined in a single pass: the RAP mining method is applicable to deposits of up to 10m thickness, while the standard drift round height is approximately half that. In these areas, two cuts will be made: a first hangingwall cut via drifting, and, after the back is supported, a bottom cut via benching. This sequence requires that the back only be supported (rockbolted) once, improving productivity, and reducing costs.

Productivity from RAP mines is normally very high due to multiple available mining faces, and the method has a simple, repetitive mining sequence. Mobile equipment required for RAP is the same as that used in development mining; therefore, specialty equipment is not required.

The strong, massive nature of the Minto rock and shallow depth of the deposits mean that fairly high extraction ratios (plus 75%) would reasonably be expected.

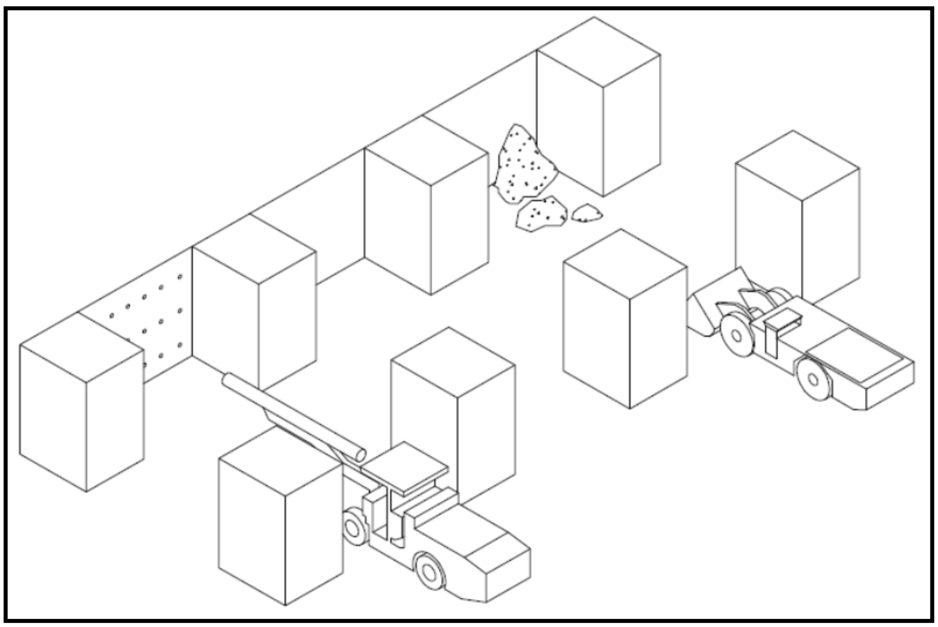


Figure 3-6: Simplified RAP Mining Method Illustration.

3.2.4 Description of Post-Pillar Cut-and-fill Method

Stopes higher than 10 m will generally be mined via PPCF. Because the pillar dimensions required to ensure stability increase substantially as deposit height increases, RAP ceases to be economically viable at large stope heights. PPCF overcomes this problem by supporting the pillars at their bases using uncemented rockfill (Figure 3-7).

The method is similar to RAP in that a checkerboard pattern of tunnels is driven into the deposit and pillars are left behind to support the back. The first cut is at the bottom of the deposit rather than at the top, and when extraction of a level is completed, uncemented rock fill is placed to provide confining support to the bases of the pillars. In this way, pillar sizes can be kept small.

The primary drawback of the method is that, because mining starts at the bottom of the deposit and proceeds toward the top, the back must be supported after each cut. This lowers productivity and increases mining costs, disadvantages that are weighed against the increased extraction ratio enabled by the method.

Once established with a sufficient number of headings, PPCF can be a productive mining method. Maintaining satisfactory production rates is based upon developing and following an efficient mining cycle of ground support, drilling, blasting, mucking, hauling, and filling. In order to maintain strength and continuity, the pillars of each lift must be surveyed and positioned exactly over the pillars from the previous cut.

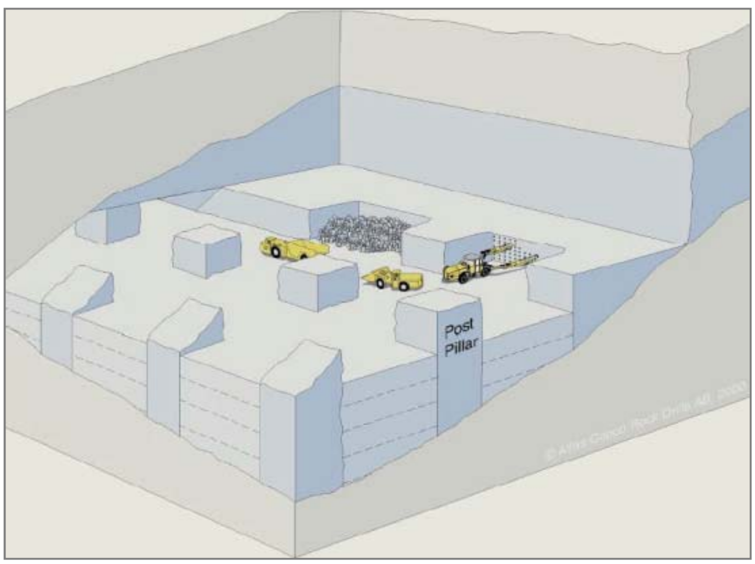


Figure 3-7: Simplified PPCF Mining Method Illustration (from Atlas Copco).

3.2.5 Other Mining Methods

In-fill/definition drilling completed from within the underground workings may identify regions of sufficient thickness and lateral extents to justify open stoping methods. Such mining would involve the addition of long hole drills to the equipment fleet, as well as remote-control for LHDs.

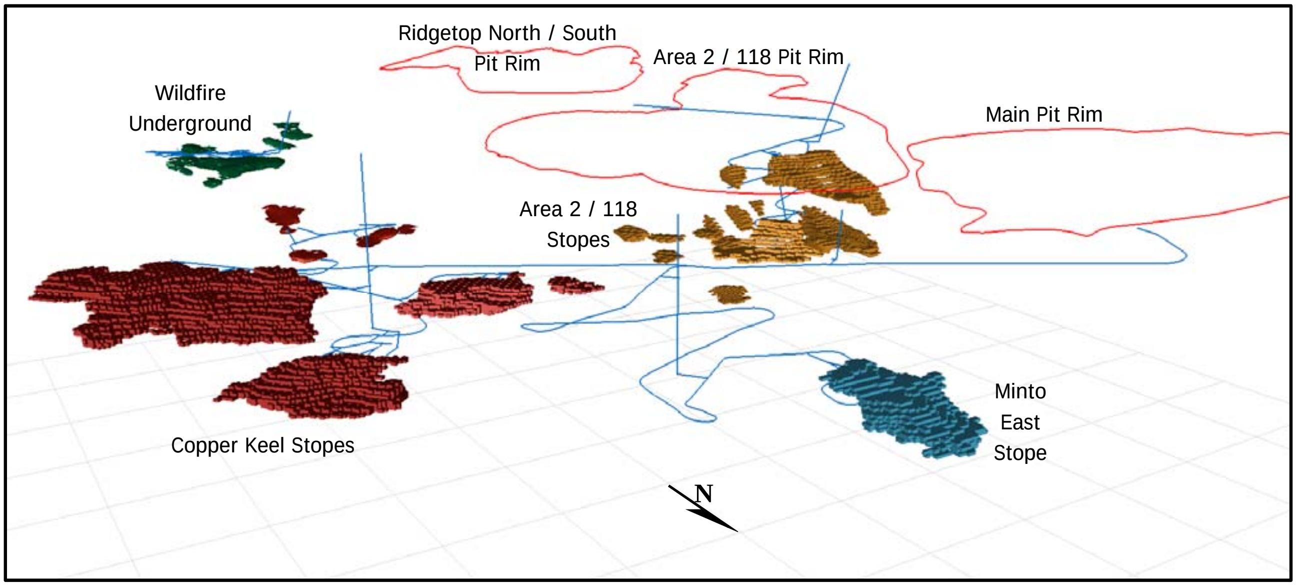


Figure 3-8: Perspective View, Looking Southwest, of Underground Stopes and Development.

3.2.6 Mining Plan – East Keel Underground

Access from surface will be via a single 5x5 m decline; Figure 3-8 and Figure 3-9 show the locations of the Copper Keel and Minto East zones targeted by the EKU.

Total production from all underground operations will be 2,000 tonnes of ore per day; this is unchanged from Phase IV. Development and ore production will take place concurrently in MSU and EKU.

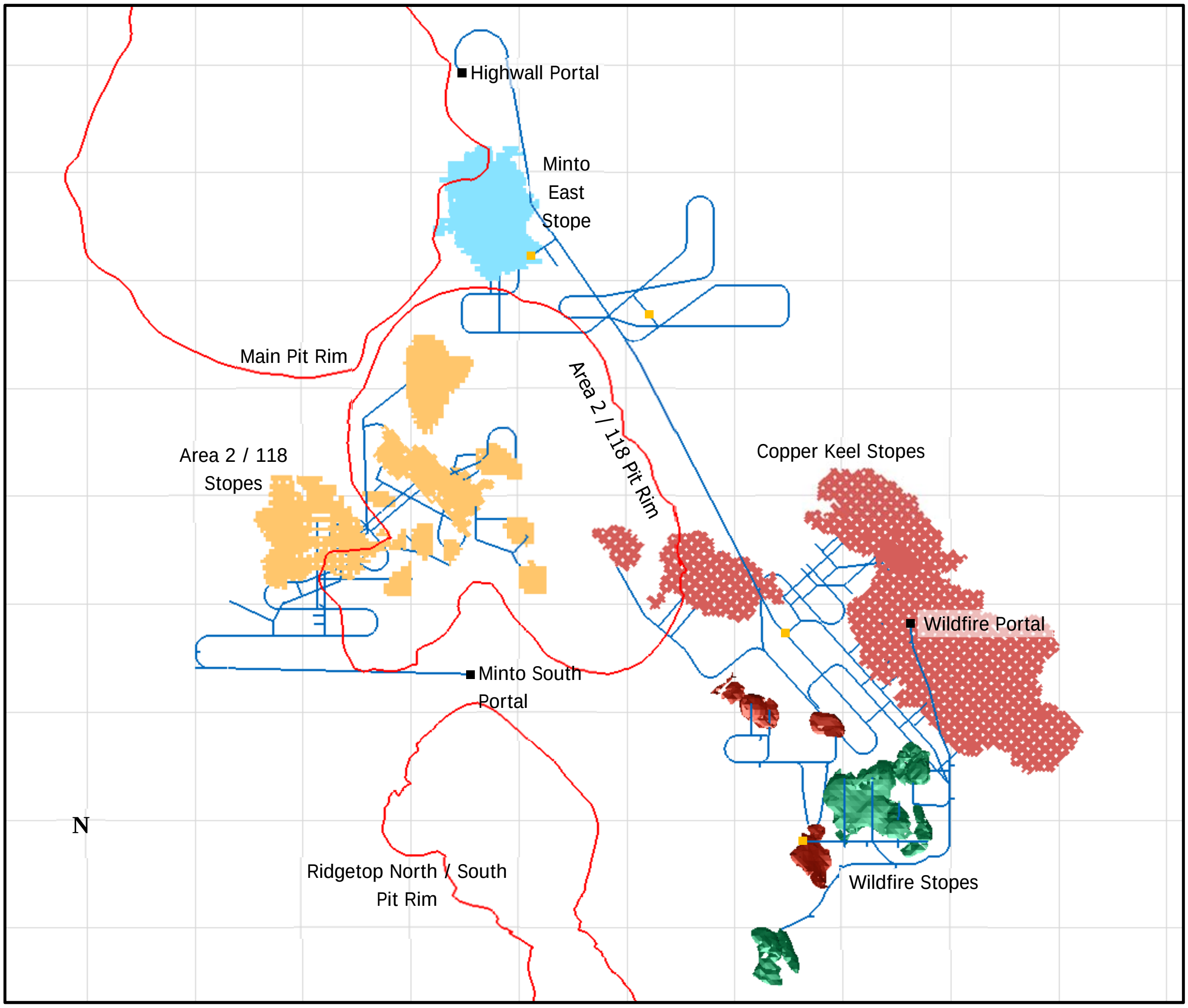


Figure 3-9: Plan View of the Minto South Underground Deposit and Wildfire Underground.

The East Keel Underground requires the construction of new fresh air and exhaust raises, which will be mined via an Alimak system. The Alimak system is a method for developing raises starting from the bottom and advancing vertically. It comprises an operator cage and drill platform, running up a rail system that advances up the raise as development progresses. From the cage/platform, miners drill the rock above them and load it with explosives. The cage/platform is then retracted, the explosives are fired, and blasted material falls to the bottom of the raise where it is loaded and then hauled away. Three raises are planned: a fresh air raise near the top of the ramp system and two exhaust raises, one for the Copper Keel area and one for Minto East.

At the planned mining rate of 2,000 tonnes of diluted ore per day, the combination of the MSU and the EKU (which will be mined in parallel) will produce ore for 5.5 years. In actuality, ore release will be preceded by several months of development, and there will be a gradual increase to full production rate throughout 2013 and early 2014. Development of the MSU, assessed under Phase IV, started in September of 2012, with expected production of first ore in September of 2013. Development of the East Keel Underground and the Highwall Portal will commence upon receipt of the necessary licenses.

3.2.7 Mining Plan – Wildfire Underground

The Wildfire Underground will be accessed via a single decline developed at a –15% gradient, which will serve as the sole means of ore and waste haulage and personnel access (Figure 3-10). It will also be used as an exhaust airway. The decline will be sized at 5.0 m x 5.0 m to accommodate the same equipment fleet used in the MSU and EKU.

The decline will measure 660 m in length. An additional 165 m of supplemental development will take place in the form of remuck bays, a ventilation raise access, and sumps.

The ventilation raise to surface will be approximately 100m in length, driven as a 3.0 m x 3.0 m Alimak raise. A manway will be installed so that the raise can serve as an emergency egress from the mine.

The mine will use the same RAP and PPCF mining methods as the MSU and EKU. At the planned mining rate of 2,000 diluted tpd, the 360,000 tonne reserve of the Wildfire Underground will provide for six months of production once development is complete.

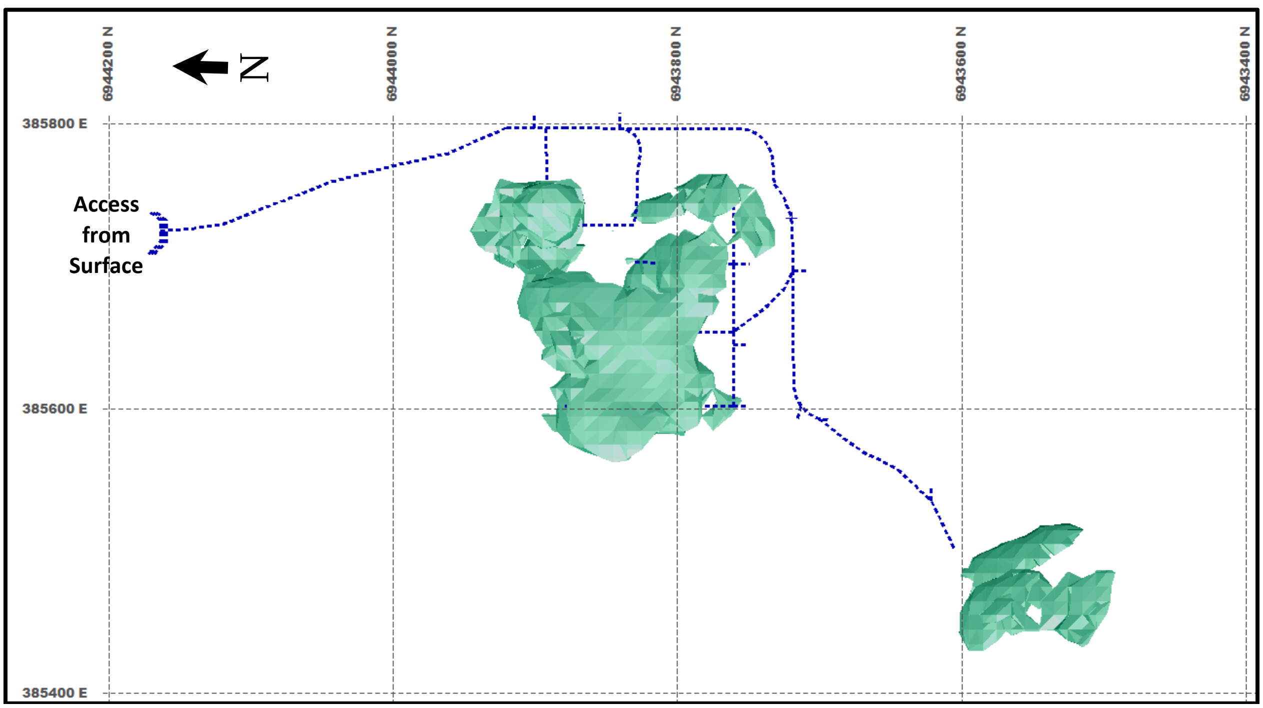


Figure 3-10: Plan View of Wildfire Underground.

3.2.8 Ground Support

Ground support will generally take the form of fully grouted resin rebar bolts on the back and the walls of the ramp, with welded wire mesh and shotcrete as needed. Ground support standards will be established under the supervision of Minto's engineering staff with assistance from geotechnical engineering consultants where needed.

Ground support will be installed using mechanized rockbolters, and in some cases manually from the blasted rock muck pile, or from a scissor lift platform using jacklegs and stopers.

3.2.9 Equipment Fleet

The mine will use equipment typical of a RAP/PPCF operation accessed through a trackless decline. Production mucking will use rubber-tired load-haul-dump (LHD) units with 10-yd^3 buckets, loading 40 tonne underground haul trucks. Drilling of both development and ore production headings will be done by two-boom electric-hydraulic jumbo drills with diesel engines for propulsion. Ground support will be installed using a combination of integrated scissor deck/drilling units and mobile self-propelled scissor decks/manually operated air drills.

The underground fleet will also include a number of smaller utility/service machines, such as underground-rated light utility vehicles, smaller LHD units for cleanup tasks, explosives carriers, telehandlers, etc.

The mine fleet will increase in size as needed to produce at the target rate of 2,000 tpd. Initially, Minto will supplement the fleet with equipment from a mining contractor.

3.2.10 Ventilation

The design basis of the ventilation system at Minto underground operation is to dilute exhaust gases produced by underground diesel equipment adequately. Air volume was calculated based on a factor of 0.064 m^3/s per installed kW of diesel engine power (100 cfm per installed hp). The kW rating of each piece of underground equipment was determined and then utilization factors, representing the diesel equipment in use at any time, applied to estimate the amount of air required.

The East Keel Underground will require three ventilation raises, while Wildfire will require one.

Underground workings will be heated to a temperature sufficient to prevent freezing of drill water and icing of ramps and accesses. Mine air for the underground portions of both Phase IV and Phase V/VI will be heated using propane burners.

3.2.11 Services

The major electrical power consumption in the mine will be from the following:

- Main and auxiliary ventilation fans;
- Drilling equipment;
- Mine dewatering pumps;
- Air compressors; and
- Maintenance shop.

High voltage cable will enter the mine via the decline and be distributed to electrical sub-stations located near production stopes. The power cables will be suspended from the back of development headings. All equipment and cables will be fully protected to prevent electrical hazards to personnel.

High voltage power will be delivered at 4.16 kV and reduced to 600 V at electrical sub-stations. All power will be three-phase. Lighting and convenience receptacles will be single-phase 120 V power.

Table 3-8 lists equipment power usage for the East Keel Underground, while Table 3-9 lists the requirements for the Wildfire Underground.

Table 3-8: Electrical Power Requirements for East Keel Underground.

Description	Quantity	Unit (kW)	Load Factor (%)	Utilization (%)	Power Consumption (kWh/yr)
Surface					
Shop equipment	1	50	80	20	70,080
Air compressor	1	100	80	10	70,080
Lighting	1	10	80	60	42,048
Office	1	10	80	80	56,064
Parking lot	1	10	80	30	21,024
Main ventilation fan	1	350	80	100	2,452,800
Pumps	1	10	85	67	49,888
Heat trace	1	25	80	60	105,120
Underground					
Jumbo, two-boom	3	135	95	60	2,022,246
Rockbolter	2	70	95	60	699,048
Exploration drill	1	75	95	50	312,075
Portable compressor	2	100	80	30	420,480
Portable welder	2	34	80	10	47,654
Exhaust fan (Minto East or Copper Keel)	1	475	80	100	3,328,800
Auxiliary fan, 75 kW	2	75	80	90	946,080
Auxiliary fan, 50 kW	2	50	80	90	630,720
Auxiliary fan, 40 kW	2	40	80	90	504,576
Refuge chamber	2	5	80	100	70,080
Main dewatering pump	1	100	85	67	498,882
Portable pump	4	15	85	50	223,380
				Sub-total:	12,571,126
Miscellaneous power allowance	10%				833,129
				Total power:	13,828,238

Table 3-9: Electrical Power Requirements for Wildfire Underground.

Equipment	Quantity	Unit (kW)	Load Factor	Utilization Factor	Power Consumption kWh/year
Surface					
Wildfire Ventilation Fan	1	150	80%	100%	1,051,200
Pumps	1	10	85%	67%	49,888
Heat Trace	1	25	80%	60%	105,120
Underground					
Jumbo, two-boom	2	135	95%	60%	1,348,164
Rockbolter	1	70	95%	60%	349,524
Portable Compressor	1	100	80%	30%	210,240
Portable Welder	1	34	80%	10%	23,827
Auxiliary Vent Fan, 40 kW	2	40	80%	90%	504,576
Refuge chamber	1	5	80%	100%	35,040
Portable Pump	3	15	85%	50%	167,535
				Sub-total:	3,845,114
Miscellaneous Power Allowance	0.1				384,511
				Total Power:	5,229,626

3.2.12 Explosives

Blasting practices will continue unchanged from the mining assessed in Phase IV: ANFO will be used as the major explosive for mine development and production. Packaged emulsion or nitroglycerin-based dynamite will be used as a primer for ANFO-loaded holes and as a bulk explosive in loading lifter holes (holes at the toe of a round, very likely to be wet) in development and production headings.

Initially, bulk explosives will be stored in Minto's existing magazines alongside the products used for surface mining and transported underground as needed. As ore production begins and the number of working faces increases, explosives magazines will be constructed underground.

Powder factors in underground development are significantly higher than in surface mining. Ramp development, PPCF ore production, and ore production from the first level of a RAP stope will typically employ a powder factor of 0.6 kg/tonne. Subsequent cuts in a RAP stope will have lower powder factors due to the availability of two free faces into which blasted rock can expand.

At a production rate of 2,000 t/day, the underground operation will use approximately 900 kg of explosives per day. For comparison, the surface mining operation used 7,300 kg/day in 2011.

3.2.13 Fuel Storage and Distribution

An average fuel consumption rate of approximately 5,482 L/d is estimated at full production; details are presented in Table 3-10.

Haulage trucks, LHDs, and all auxiliary vehicles will be fuelled at fuel stations on surface. The fuel/lube cassette will be used for the fuelling/lubing of drills, rockbolters, and other less mobile equipment.

Table 3-10: Daily Fuel Requirements for the Underground Equipment Fleet.

Description	Quantity	Consumption (L/hr)	Load Factor (%)	Utilization (%)	Total Fuel (L/day)
LHD, 5.4 m^3	3	57.5	75	80	1,768
Truck, 40t	4	68.9	70	80	2,637
Jumbo, two-boom	3	22	50	10	56
Rockbolter	2	18	50	20	62
Grader	1	36	75	30	138
Explosives truck	1	27	50	20	46
ANFO loader	2	22	50	30	113
Cassette carrier	2	27	70	50	323
Mechanics truck	1	22	50	25	47
Scissor lift	2	27	50	25	115
Supervisor vehicle	3	22	50	20	113
Electrician vehicle	1	22	50	30	56
Forklift	1	16	60	20	33
Total					**5,482**

3.2.14 Equipment Maintenance

Mobile underground equipment will be maintained in a mechanical shop located on the surface. Some small maintenance and emergency repairs will be performed in a service bay underground.

3.2.15 Personnel

There is no significant change to the expected number of personnel employed by the underground mine relative to the operation assessed in Phase IV, as Phase V/VI represents an increase to the length of the mine life rather than a production rate increase.Table 3-11, taken from the Phase IV Project Proposal, details the number of personnel expected to be required for a 2,000 t/day operation. Personnel requirements are lower in the first year of the operation, as ore production will not reach the full rate until several stopes are simultaneously activated. By the end of the second year, the mine will employ 83 people within a combination of production, supervisory, and technical roles.

Table 3-11: Personnel Requirements for Underground Mining.

Job	Year 1	Year 2 +
Technical Services		
Senior Engineer	1	1
Mine Engineer	1	1
Mine Technician	1	2
Surveyors	2	2
Geologist	1	1
Geological Technician	1	1
Subtotal	**7**	**8**
Maintenance		
Superintendent	1	1
Mechanical/Electrical G.F	1	1
Maintenance Planner/ Clerk	1	1
Dry/Lampman/ Bitman	1	1
Mechanics, Lead Hand	4	4
Mechanics, stationary	2	2
Mechanics, mobile	4	4
Mechanics, mobile app	2	2
Electricians, instrumentation	2	2
Subtotal	**18**	**18**
Mining		
Superintendent	1	1
Mine Captain	1	1
Shift boss	4	4
Safety/Training	1	1
Subtotal	**7**	**7**
Jumbo/LH operator *	6	8
LHD operator *	6	8
Truck driver *	10	12
Ground support/ services *	4	8
Helpers	10	12
Backfill/construction/utility		2
Subtotal	**36**	**50**
Total Manpower	**68**	**83**

As the end of mine life approaches in 2019, there will be a gradual reduction in workforce as the number of working faces decreases and the resulting ore production declines.

4 Waste Rock and Overburden Management

This section summarizes information presented in the Minto Phase V/VI Expansion Waste Rock and Overburden Management Plan (WROMP) (Appendix A). The WROMP defines the categorization and quantities of both waste material types that will be produced during Phase V/VI mining and presents how these materials will be managed.

The Phase V/VI mine plan will release overburden and waste rock from several sources (Table 4-1); the volumes released define the Phase V/VI dump volume required.

Table 4-1: Waste Rock and Overburden Sources and Volumes.

Source Location	Waste Rock Volume (loose m^3)	Overburden Volume (loose m^3)
Minto North (open pit)	4,250,000	906,000
Area 2 Stage 3 (open pit)	1,905,000	2,899,000
Ridgetop South (open pit)	627,000	176,000
Ridgetop North (open pit)	3,416,000	913,000
Underground	133,000	0
Total	**10,331,000**	**4,894,000**

4.1 Waste Rock Classification and Segregation Practices

All waste rock from Phase V/VI development will be classified based on the ratio of its neutralization potential (NP) to its acid generating potential (AP), calculated on the basis of total carbon and total sulfur. This will be a continuation of practices modified from ore characterization and control procedures in 2012 and implemented as part of Phase IV open pit operations. These practices are summarized as follows:

1. Samples of cuttings from each blast hole are collected for grade control purposes. One sample is collected per hole.
2. Cuttings samples are split into aliquots for grade control (copper analysis) and for determination of total sulphur (S(T)) and total carbon (C(T)) content.
3. S(T) and C(T) are measured for each sample using an Eltra CS-800 induction furnace with infrared detectors.
4. Test results are imported into the mine's grade control software for processing by the mine geologists.
5. 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.
6. NP-C(T):AP-S(T) values are plotted for each drill hole in a given blast pattern, 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.

7. Ore grade polygons are drawn for material above the mine's operational cut-off grade, with the result being that all material in a blast is classified as ore, bulk waste, or NP:AP<3 waste rock.
8. A map of the final ore and waste classifications is provided to the pit operations team to guide the dispatching of all rock released from the pit.

Material is then segregated according to the following procedure:

1. The pit operations team uses the blast classification maps to stake out the boundaries of each ore and waste class. Each class is represented by stakes in different colours. The maps are also used to communicate the shift's plans with equipment operators and supervisors at the beginning of each shift. This is standard grade control practice and has been adapted to include waste classification.
2. Haul trucks are loaded by a loader or excavator, the operator of which is responsible for knowing the material class being excavated and for communicating the class of each load to the haul truck operator.
3. The haul truck driver then delivers the load to the crusher or to the appropriate stockpile (if ore) or waste storage facility (if waste).

Rock having an NP:AP ratio greater than 3.0 will be classified as bulk waste and deposited to one of several rock dumps, while material with a ratio less than 3.0 will be deposited either below the final flooded levels of mined-out open pits or in mined-out stopes underground to minimize oxidation and metal leaching.

Extrapolation from Phase IV mining to date suggests that approximately 17% of the waste rock from the Minto South pits (Area 2 Stage 3, Ridgetop North and Ridgetop South) will have an NP:AP ratio less than 3.0, while estimation based on sulfur grades in Minto's resource model predicts 13%. For planning purposes, Minto has chosen to allow for 20% of the waste rock from the Minto South pits to be stored in locations that will be saturated post-closure. This approach is considered to be appropriately conservative in that it will ensure that slightly more volume will be reserved for NP:AP<3 waste rock than will likely be produced.

Drill core from the waste rock intervals within the planned Minto North Pit had uniformly low total sulphur content and NP:AP>3, and on that basis, no allowance for waste rock with NP:AP<3 is made for Minto North.

For all Phase V/VI operations, actual dispatching of waste rock will be done on the basis of blast hole analyses rather than on preproduction estimates.

To address the uncertainty around the estimation of NP:AP<3 volumes, the rock dumps associated with Phase V/VI are sized for the total volume of waste rock released by Phase V/VI mining (10,331,000 m^3).

Further capacity for waste rock is contained within the optional Mill Valley Fill Extension (MVFE) Stage 2, which is discussed further in Section 4.3.

4.2 Overburden Classification and Segregation Practices

Overburden will be segregated from waste rock on the basis of visual determination. Overburden is clearly identifiable as an unconsolidated soil material with digging characteristics that differ markedly from waste rock.

To avoid the potential stability issues that could arise from thawing of ice-rich overburden that was incorporated into storage facilities designed for bulk disposal, ice-rich overburden will be segregated and stored in locations where it will not impact the stability of dumps.

4.3 Waste Rock and Overburden Deposition Locations

Phase V/VI waste materials will be deposited to several new dumps chosen based on a process of alternatives assessment and stakeholder consultation, as well as preliminary geotechnical work indicating their likely stability. These dumps are:

- Main Waste Dump Expansion: a combined waste rock and overburden dump, placed on the existing Main Waste Dump and raising its height from 930m to 961m. It will receive material from the Minto North Pit.

- Main Pit Dump: an expansion of the existing South Wall Buttress to an elevation of approximately 840m that will provide additional dump space for Phase V/VI while remaining wholly within the previously impacted Main Pit footprint. This dump will receive a combination of waste rock and overburden from Area 2 Stage 3 Pit, from Ridgetop North and South pits, and from underground.

- Ridgetop Waste Dump: a new dump to be developed west of the ridge hosting the future Ridgetop North and South pits. The proposed footprint is underlain by a thaw-stable foundation.

- Area 118 Backfill Dump: the mined-out Area 118 pit will be backfilled with overburden from Area 2 Stage 3, and an overburden dump will be constructed above the original ground surface such that the new dump expands roughly along contour in both directions beyond the Area 118 Pit footprint.

- Ridgetop South Backfill Dump: the mined-out Ridgetop South Pit will be backfilled with overburden from Ridgetop North, and a small overburden dump will be placed within the footprint disturbed by the pit.

- Progressive reclamation: the Southwest Waste Dump, DSTSF, Main Waste Dump Expansion, and portions of Main Pit Dump will be available during open pit mining to receive overburden covers.

Two optional dumps are also described in the WROMP:

- Mill Valley Fill Extension, Stage 2: The MVFE assessed and subsequently built under Phase IV has slowed movement of the DSTSF but has not halted it at the time of application. Stage 2 is a further extension of the MVFE rockfill both vertically as well as to the east along the axis of the Minto Creek valley. As of June 2013, Minto has completed an extensive campaign of geotechnical drilling and instrumentation, and is in undertaking a laboratory-testing program to provide information to support engineering analyses to further characterize the nature of the movement and understand what additional mitigating measures, if any, may be required. The MVFE Stage 2 represents Minto's current thinking as to the maximum potential extent of the Mill Valley Fill Extension; the concept is included in this application to allow its environmental implications to be assessed by YESAB. Any material placed in the MVFE Stage 2 would require a corresponding decrease in the volume stored in other dumps (most likely the MPD).

- Reclamation Overburden Dump (ROD): this dump receives all Phase IV overburden other than that used for progressive reclamation. It will not be built to the full extent permitted under Phase IV and will therefore be available to store Phase V/VI overburden, if required.

Table 4-2 shows the locations and capacities of all of the aforementioned waste management facilities, as well as Phase V/VI pits and dumps developed as part of Phase IV. The locations are also shown on Figure 4-1: Key Phase IV and V/VI Site Components..

The capacities of the planned waste rock dumps are as follows:

Table 4-2: Waste Rock Dump Capacities.

Dump Location	Dump Capacity (m^3)
Main Waste Dump Expansion	5,156,000
Main Pit Dump	3,014,000
Ridgetop Waste Dump	3,416,000
Mill Valley Fill Extension, Stage 2 (optional)	2,930,000

The quantities of overburden to be deposited are estimated inTable 4-3..

Table 4-3: Overburden Quantities.

Location	Volume (m^3)
Southwest Waste Dump cover	671,000
Main Waste Dump Expansion cover	400,000
DSTSF / MVFE cover	490,000
Main Waste Dump Expansion	906,000
Area 118 Backfill Dump	1,338,000
Main Pit Dump	349,000
Ridgetop South Backfill Dump	740,000
Total	4,894,000

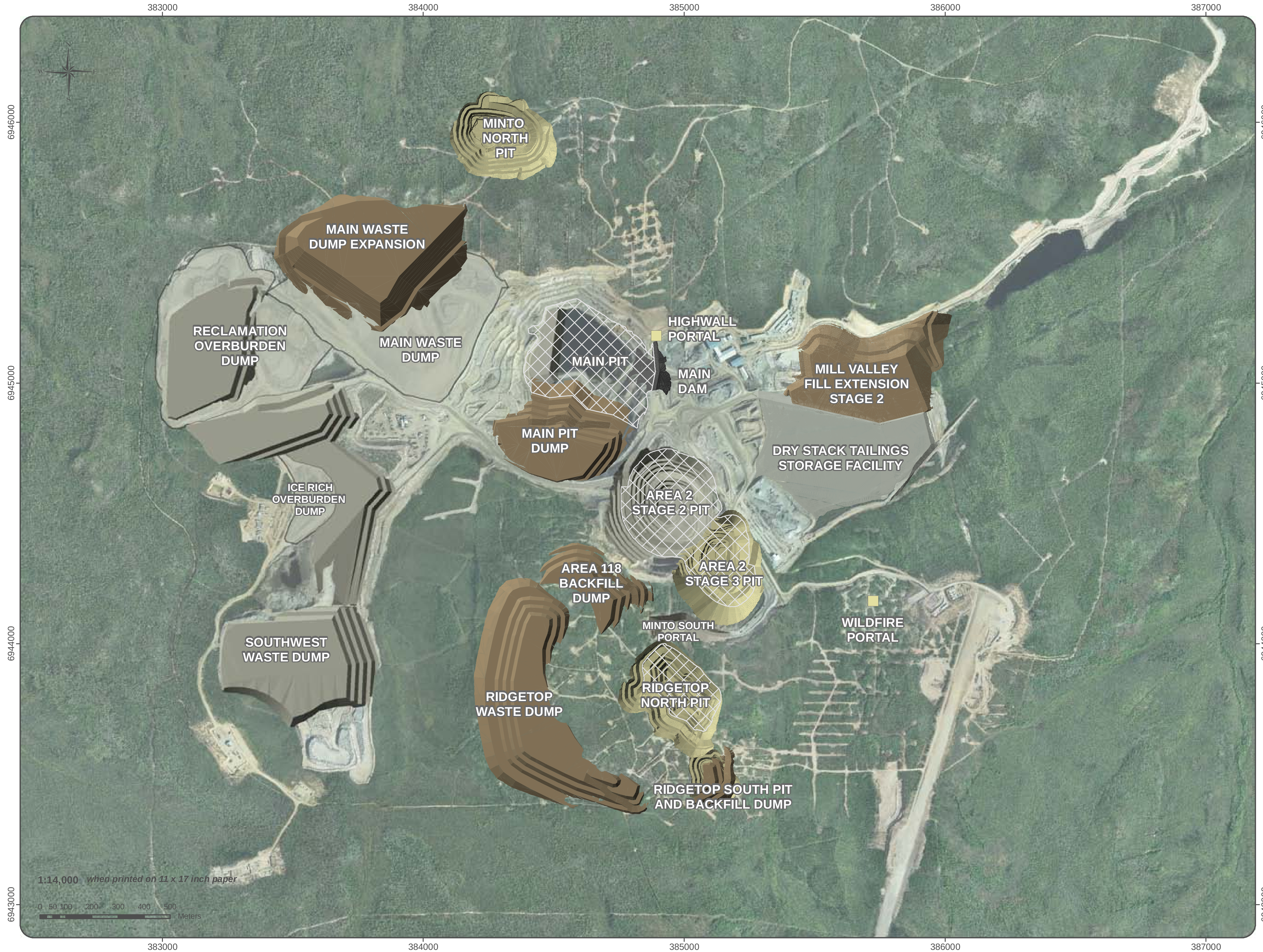
4.4 Ice-Rich Overburden Deposition Locations

Overburden that does not meet the criteria for thaw-stability will be designated as ice-rich overburden, and will be handled separately as follows:

- Ice-rich overburden from the North will be co-disposed with thaw-stable overburden. This overburden will be placed in the northwest corner of the dump, where it will be buttressed by a large quantity of waste rock.
- The portions of the Area 118 Backfill Dump and the Ridgetop South Backfill Dump that are below the elevations of the lowest point along the pit rim will be able to receive ice-rich overburden co-disposed with thaw-stable overburden.
- Ice-rich overburden will be placed together with thaw-stable overburden as part of the progressive reclamation work done on Phase IV dumps. With the anticipated placed overburden thicknesses of up to a few metres thick, any ice entrained in the cover layer is expected to thaw within one year of placement and any excess water that results will drain or evaporate.

4.5 Scheduling

The schedules for the development of the open pit mine components and waste dumps are shown in Figure 4-2, Figure 4-3 and Figure 4-4. Underground mining is not shown, but will be in progress when Phase V/VI begins and run until December of 2019; the small quantities of waste rock release are accounted for in this plan's dump volumes but are not scheduled out in detail.



MINTO MINE PHASE V/VI EXPANSION

FIGURE 4-1
KEY PHASE IV AND V/VI SITE COMPONENTS

JULY 2013

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- Phase V/VI Tailings
- Phase V/VI Pits
- Phase V/VI Dumps
- Phase V/VI Dam
- Phase IV Features

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 14th 2012.

Datum: NAD 83 Projection: UTM Zone 8N

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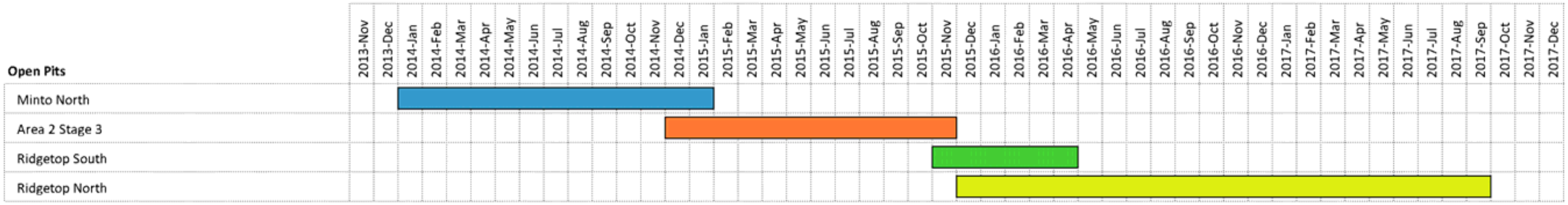


Figure 4-2: Phase V/VI Open Pit Mining Schedule.

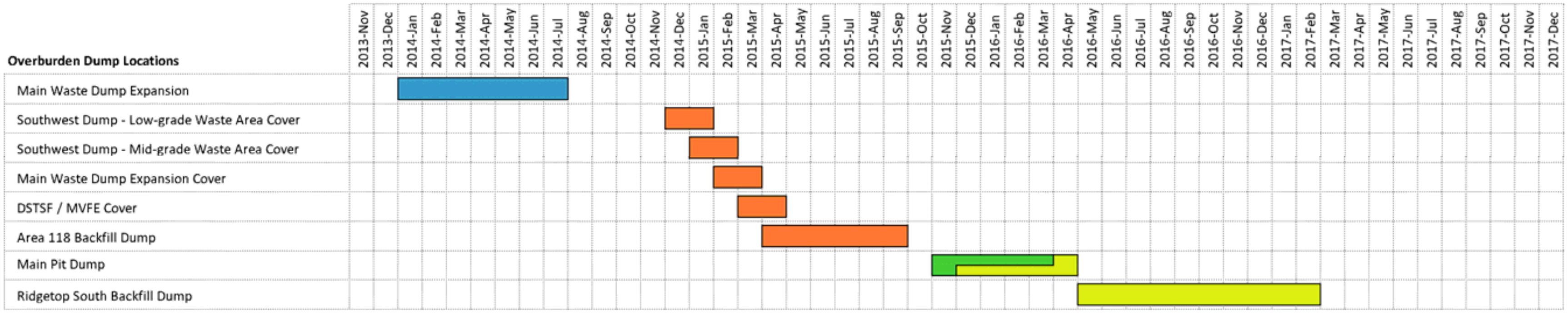


Figure 4-3: Phase V/VI Overburden Placement Schedule.

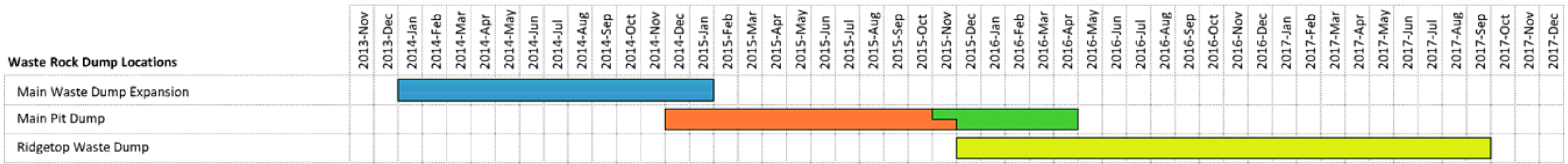


Figure 4-4: Phase V/VI Waste Rock Placement Schedule.

5 Tailings Management

This section summarizes information presented in the Minto Phase V/VI Tailings Management Plan (TMP), which is provided as Appendix D-A. The reader is directed to the TMP for complete information on tailings production, quantities, and handling during Phase V/VI mining.

5.1 Tailings Management Overview

Tailings resulting from Phase V/VI operations will be discharged as slurry to the Main Pit, Area 2 Pit (both Stage 2 and Stage 3), and the Ridgetop North Pit. Tailings may also be used for underground backfill in selected areas depending on the outcome of future engineering evaluations. There will be sufficient storage capacity in the in-pit facilities described herein for all Phase V/VI tailings should tailings backfill not be required for underground support.

As discussed in Section 4, waste rock with NP:AP<3 will be co-disposed with tailings in locations that will be saturated post-closure. The tailings management facilities (TMFs) are shown in orange on Figure 5-1.

6 Water Resources Characterization

6.1 Surface Water Hydrology

The baseline surface hydrology of the Minto Creek watershed prior to mining activity was detailed in Clearwater Consultants Ltd.'s Memorandum CCL-MC6 *Minto Copper Project—Surface Water Hydrology Conditions* (baseline memorandum attached as part of Appendix E). CCL-MC6 also covered conditions during mine operations until 2009. This CCL-MC6 report has been supplemented with onsite data collection from 2009 until the end of the 2012 open water season. Additionally since 2009, data has been gathered from the McGinty Creek catchment which is located directly north of the Minto Creek catchment. The McGinty Creek catchment is similar in size to Minto Creek, and it also drains into the Yukon River and (Figure 6-1). An updated *Surface Hydrology Baseline Conditions Report* prepared by ACG (2013) is presented in Appendix E.

Hydrological data have been gathered by either ACG or Minto representatives. Data coverage from year to year varies, depending on when in situ dataloggers were installed and removed, and when instantaneous discharge measurements were taken. Instantaneous discharge is measured using the velocity-area method and a current meter. Solinst Water Leveloggers are used to collect continuous stage readings which are then corrected based on physical staff gauge measurements. The records are processed into continuous discharge based on the stage-discharge relationship. This relationship (stage and discharge) is established each season through rating measurements obtained during regular field visits to the sites.

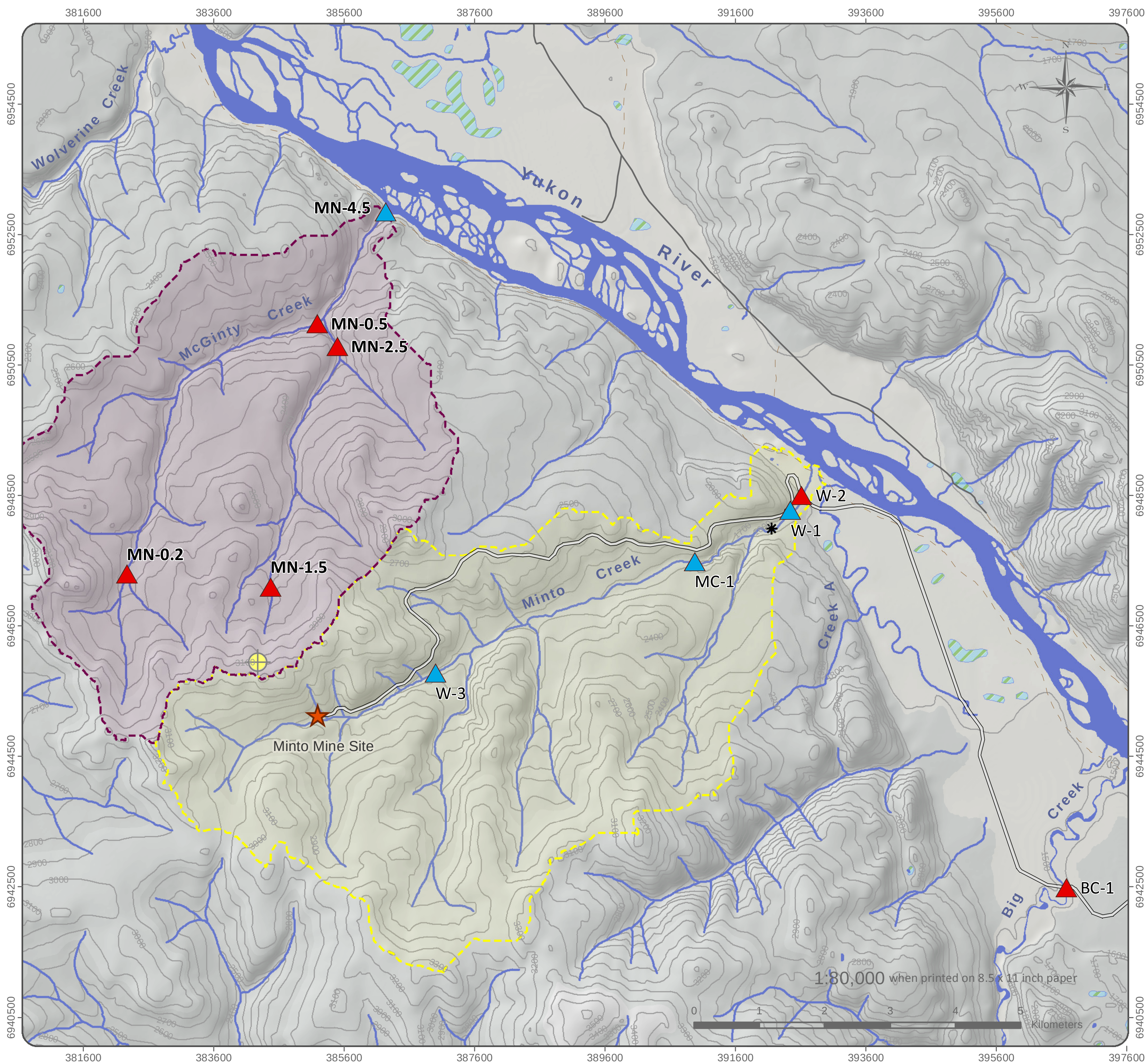
The locations for which the greatest amount of data have been collected are stations W1, Minto Creek near the mouth (catchment area of 42 km^2); and W3, Minto Creek downstream of water storage pond dam (catchment area of 10.4 km^2 area). In 2010, another continuously monitored hydrometric site called MC1 was added, approximately 2 km upstream of W1. In 2011, data collection did not allow for processing of stage records into continuous discharge; however, improved monitoring allowed for successful processing in 2012.

In addition to Minto Creek, the catchment to the north has been monitored since 2009 to support development of the Minto North deposit, and is referred to as McGinty Creek. There are five stations on McGinty Creek at which discharge is measured. In 2009, four stations were established including MN-4.5, MN-2.5, MN-1.5 and MN-0.5; in 2011 a fifth site, MN-0.2, was added (Figure 6-1). Continuous hydrometric data has been collected at MN-4.5 since 2009, and additional continuous logging instruments were added to stations MN-2.5 and MN-0.5 in late 2012.

All mining to date has taken place within the Minto Creek catchment area. Phase V/VI will include the development of the Minto North Pit, which is in the McGinty Creek catchment area. McGinty Creek was named by SFN elders after the family whose traditional trapping area is in the vicinity of the Minto Mine.

MINTO MINE PHASE V/VI EXPANSION

FIGURE 6-1
MINTO AND MCGINTY CREEK CATCHMENT AREAS



Water Quality Station

Hydrometric Station

Obeserved Fish Barrier - Minto Creek

Minto North Deposit

Minto Access Road

Limited-use road

Trail

Contours (ft)

Watercourse

Minto Creek Catchment

McGuinty Creek Catchment

Waterbody

Wetland

NAD 83 UTM Zone 8N

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6.1.1 Minto Creek

Monitoring of hydrological parameters on Minto Creek began in 1993 and has continued intermittently at sites W1 and W3 (Figure 6-1). Monitoring has been more intensive since mine commissioning in 2007. W3 is an in-stream trapezoidal flume with a manufacturer-specified stage-discharge relationship. Both discharge and stage are read on an integrated gauge in the throat of the flume. A Solinst Levelogger record is calibrated with these field observations to process a continuous discharge record at this site. Sites MC1 and W1 are natural stream channels where manual velocity measurements are taken across the channel and discharge is calculated using the velocity area method. Continuous water levels from Solinst Leveloggers are processed into continuous discharge using these rating measurements. Updated mean monthly flows for W1 and W3 are presented in Table 6-1 andTable 6-2, respectively.

Table 6-1: Mean Monthly[1] Discharge (m^3/s) on Minto Creek at Station W1.

	April	May	June	July	August	September	October
1993						0.069	
1994		0.312	0.058	0.095	0.007	0.073	
1995		0.027	0.001	0.091		0.133	
1996		0.031	0.024	0.324		0.146	
1997		1.447			0.265		
1998		0.161			0.003		
1999					0.033		
2000		1.004					
2001		0.467					
2002							
2003					0.129		
2004				0.118			
2005		0.097	0.012	0.127	0.209	0.219	0.134
2006	0.203	0.354	0.15	0.02	0.0068		0.031
2007	0.645	0.175	0.053	0.061	0.025	0.034	0.035
2008		0.117	0.015	0.026	0.184	0.184	0.026
2009		0.868	0.351	0.249	0.139	0.026	
2010	0.560	0.081	0.038	0.106	0.118	0.125	0.092
2011			0.229	0.200	0.200	0.082	
2012		0.174	0.071	0.048	0.048	0.077	0.066
Mean							
Pre-mine 1993 to 2006	-[4]	0.433	0.049	0.129	0.093	0.128	0.083
Mining period 2007 to 2012	-[4]	0.283	0.126	0.115	0.119	0.088	0.055
All data 1993 to 2012	-[4]	0.380	0.091	0.122	0.105	0.106	0.064

[1]*Monthly flows calculated by averaging all available flow data for a given month. Average flow in months with only a single spot flow measurement assumed equal to the spot flow measurement.*
[2]*Flows impacted by storage within and emergency releases from the Water Storage Pond in August and September 2008 and in June through October 2009.*
[3]*2010-2012 flows impacted by storage and/or release from the Water Storage Pond as evidenced by the discharge record at W3.*
[4]*Insufficient data for calculation.*

Table 6-2: Mean Monthly1 Discharge (m3/s) on Minto Creek at Station W3.

	April	May	June	July	August	September	October
1993						0.028	
1994		0.101	0.028	0.039	0.011	0.028	
1995			0.0035	0.017		0.027	0.008
1996		0.013		0.087		0.021	
1997		0.554					
1998					0.006		
1999					0.006		
2000							
2001		0.16					
2002							
2003					0.037		
2004				0.026			
2005		0.046	0.008	0.014	0.017	0.022	0.02
2006	0.018	0.128	0.042	0.006	0.0149	0.0093	0.01
2007	0.0012	0.0118	0.0088	0.0062			
2008					0.064	0.122	0.003
2009			0.026	0.106	0.092	0.124	0.11
2010	0.002	0.004	0.005	0.034	0.071	0.086	0.070
2011			0.005	0.005	0.006	0.005	
2012	0.004	0.020	0.003	0.004	0.004	0.004	0.004
Mean							
Pre-mine 1993 to 2006	-[4]	0.167	0.02	0.032	0.015	0.023	0.013
Mining period 2007 to 2012	-[4]	0.012	0.010	0.031	0.047	0.068	0.047
All data 1993 to 2012	-[4]	0.115	0.014	0.031	0.030	0.043	0.032

[1]*Monthly flows calculated by averaging all available flow data for a given month. Average flow in months with only a single spot flow measurement assumed equal to the spot flow measurement.*

[2]*Flows impacted by storage within and emergency releases from the Water Storage Pond in August and September 2008 and in June through October 2009.*

[3]*2010-2012 flows impacted by storage and/or release from the Water Storage Pond as evidenced by the discharge record at W3.*
[4]*Insufficient data for calculation.*

Table 6-3 shows the discharge data gathered to date at station MC1. Appendix E contains the associated baseline report and the available hydrographs from 2007-2012 for stations W1, W3, and MC1.

Table 6-3: Instantaneous (2011) and Mean Monthly Discharge (2012) (m^3/s) Measured on Minto Creek at Station MC1.

	Month					
	May	June	July	August	September	October
2011[1]					0.118	0.093
2012	0.153	0.059	0.048	0.038	0.096	

[1] 2011 data based on two spot flows in September and four in October.

6.1.2 McGinty Creek

Instantaneous discharge readings gathered on McGinty Creek since 2009 are included in McGinty Creek Water Quality Characterization (Appendix H). These values have been averaged to show the mean discrete discharge measured during a given month (Table 6-4). Caution should be exercised in using these to represent the actual mean monthly discharge. Comparison of the mean discrete flows for MN-4.5 (Table 6-4) to the mean monthly flows calculated from the continuous discharge (Table 6-5) show that the mean discrete measurements are generally higher. Dataloggers were installed at MN-2.5 and MN-0.5 late in the season in 2012; no continuous data are available at this time. Review of future continuous discharge records at these sites will provide better accounting of surface flows for McGinty Creek.

Table 6-4: Mean Discrete Discharge (m^3/s) measured on McGinty Creek, at station MN4.5.

	Month						
	April	May	June	July	August	September	October
MN-4.5	0.447	0.347	0.152	0.192	0.162	0.067	0.016
MN-2.5		0.161	0.043	0.070	0.050	0.018	0.010
MN-1.5	0.024	0.027	0.015	0.016	0.012	0.005	0.008
MN-0.5		0.216	0.097	0.116	0.111	0.054	0.016

Table 6-5: Mean Monthly Discharge (m^3/s) Calculated from Continuous Discharge Records on McGinty Creek, at Station MN-4.5.

	Month						
	April	May	June	July	August	September	October
2009		0.018	0.033	0.019	0.031	0.016	0.013
2010		0.028	0.051	0.079	0.047	0.034	
2011		0.482	0.096	0.13	0.138	0.068	
2012	0.224	0.245	0.189	0.082	0.052	0.173	
Mean	0.224	0.193	0.092	0.077	0.067	0.073	0.013

Grey values computed with partial data

Hydrographs from 2009–2012 at MN-4.5 are shown in the corresponding base line study (Appendix E). Based on a combination of spot flow measurements and the hydrographs, it appears that maximum monthly discharge on McGinty Creek occurs in May. These data points suggest a later peak runoff on McGinty Creek than on Minto Creek; this could arise from McGinty Creek having a more northerly exposure and a resultant delayed snowmelt. However, April discharge needs to be more thoroughly documented to determine the timing of McGinty Creek's maximum monthly discharge.

6.2 Meteorology

The existing meteorology of the Project area and the climate trends and projections of the Minto region of Yukon were described in detail in EBA's report *Minto Mine – 2010 Climate Baseline Report* and subsequently in ACG's *Minto Climate Baseline Report* (2012) (Appendix F). The meteorological data contained in the report was recorded by two on-site meteorological stations over a period of about seven years. Snow depth data was provided from ten annual on-site snow surveys since 1994. The data used in climate trend analyses was sourced from regional monthly and annual records provided by the Meteorological Service of Canada and applied to the Project area. Environment Canada's CGCM2 provided future temperature and precipitation scenarios for the purpose of climate forecasting for the region. Details of the data collection program and the procedures used for analysis are provided in the Climate Baseline Report in Appendix F.

6.2.1 General Regional Climate

The climate in the Minto region is subarctic continental characterized by long, cold winters and short, cool summers. The area experiences moderate precipitation in the form of rain and snow and a large range of temperatures on a yearly basis with a mean annual temperature below 0°C.

6.2.2 Summary of Meteorological Conditions (2005-2012)

Two meteorological stations installed at the property have recorded wind speed and direction, air temperature, relative humidity, barometric pressure, solar radiation and rainfall in one-hour intervals since September 7, 2005 for the HOBO and October 15, 2010 for the Campbell Scientific station.

6.2.2.1 Wind

Severe rime ice build-up on the HOBO anemometer cups has resulted in extended periods of recorded zero or diminished wind speeds during the winter (EBA 2010). The Campbell Scientific anemometer has shown to be much less prone to icing. Based on the wind record from the two meteorological stations, and excluding periods where the anemometer was iced up, 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.

6.2.2.2 Air Temperature

Summer is characterized by temperatures in the range of 10°C to 20°C. Winter is characterized by a much larger day-to-day variation in temperatures, typically between –10°C and –30°C. Diurnal variation in air temperatures tends to be less during the winter period than during the summer period. The transitions between winter and summer are characterized by a quick rise or fall in air temperatures. July has been the warmest month on average (14.6°C) while the coldest has been January (–19.1°C). The mean annual air temperature at the site is –1.8°C. The maximum air temperature ever recorded was 30.3°C. The minimum air temperature ever recorded was –43.2°C.

6.2.2.3 Relative Humidity

Relative humidity is highest during the winter months (typically in the range of 75% to 95%) and lowest during the spring and early summer, typically in the range of 40% to 60%. Relative humidity has a much larger day-to-day variability during the summer. The lowest recorded %RH was 10.25%. The highest was 100%. Annually, mean relative humidity is 71%.

6.2.2.4 Barometric Pressure

Barometric pressure recorded on-site at 885 m elevation has been converted into a meteorological standard sea level equivalent. Barometric pressure is slightly higher on average between May and September (above 1009 hPa), and lowest between October and April (below 1006 hPa), with the exception of February. Mean annual sea level equivalent barometric pressure is 1007.5 hPa.

6.2.2.5 Solar Incident Radiation

As would be expected at a latitude of 62.6°N, a strong seasonal pattern is evident in solar radiation, with a maximum being received near the summer solstice in late June (daily maximums on the order of 750 W/m^2), and daily maximums slightly above zero around the winter solstice. The average amount of solar radiation received at the site annually is 111 W/m^2. The highest daily average is received in June (230 W/m^2). The lowest is in December (5 W/m^2).

6.2.2.6 Precipitation

Rainfall

The tipping bucket rain gauge mechanism used to record precipitation at site is designed to record rainfall. However, wet snow falling into the catch tube and melting in the bucket at temperatures near 0°C would result in an instance of recorded precipitation. In order to provide an accurate estimate of total rainfall only, any recorded precipitation occurring when air temperatures were below zero was omitted from the record (EBA 2010). Based on a cumulative of average monthly rainfall, 174.2 mm of rain is expected on average at site in a single year (EBA 2010). August is the rainiest month with an average rainfall of 51.0 mm. The largest monthly rainfall total was 101.8 mm (July 2011). The largest one-day rainfall was 28.2 mm (August 25, 2008). Rainfall has been recorded in every month of the year.

Total Precipitation

On October 14, 2011, a snowfall conversion adaptor was installed on the tipping bucket of the Campbell Scientific station; however, the total precipitations record is not long enough yet to provide meaningful statistics. Environment Canada's Canadian Climate Normals (1971-2000) for Pelly Ranch indicate that on average, annual precipitation occurs 64% as rainfall and 36% as snow. With the assumption that regional precipitation is homogeneous and ignoring any significance of elevation, orographic effects or valley orientation, the Minto property can be estimated to receive an additional 100 mm of water-equivalent precipitation in the form of snow annually for a total annual precipitation of approximately 274 mm (EBA 2010).

Snowpack

Based on the ten years of snow surveys, the average water-equivalent snow depth remaining on the first day of March and April is 95.0 mm and 96.8 mm respectively. In four of the seven May surveys, the snowpack had melted entirely by May 1. In the three years where snow remained on the ground on May 1 (1995, 2006, and 2008), the mean snowpack had reduced to 10%, 27%, and 20%, respectively, of the peak measured snowpack in that year. The data indicates that the majority of runoff due to snowmelt occurs in April.

6.2.2.7 Evaporation

No evaporation data have been recorded at the Minto site. Applying Environment Canada's average daily evaporation estimates from Pelly Ranch over the period 1971–1999, corrected for elevation, suggests an annual evaporation rate at site on the order of 400 mm/year (EBA 2010). An instruction for evapotranspiration (ET) calculation was incorporated into the Campbell Scientific program and will provide ET estimates starting in July 2012.

6.2.3 Regional Climate Trends

6.2.3.1 Temperature

Past Trends

The annual mean temperature has been increasing at Pelly Ranch by 0.06°C per year on average over a 50-year period, corresponding to a total average increase of 3.0°C between 1957 and 2006. January (winter) mean temperatures have experienced the highest rate of increase (0.13°C per year on average), corresponding to a total average increase of 6.5°Cover the 50-year period. The mean annual temperature at Carmacks has been increasing by 0.06°C per year on average, corresponding to a total average increase of 3.0°C between 1964 and 2011. With respect to seasonality, January mean temperatures have been increasing by 0.19°C per year on average, corresponding to a total average increase of 9.3°C from 1964 to 2011. A close correlation between monthly average temperatures recorded at Minto and at Pelly ranch and Carmacks, as well as the proximity of the stations to the property, suggests that the 50-year trend would also be applicable to the Minto property. Winter temperatures at Minto however are approximately 3°C to 5°C higher due to a predominant Yukon winter temperature inversion of +8°C/ km up to an elevation of 1200 m (EBA 2010).

Future Trends

Using the average of five Global Climate Models that were found to perform best over Alaska and the Arctic, averages have been calculated using a 50 km buffer around the Minto Mine site, and suggest an increase in mean annual temperature of 2.0 to 2.2°C by 2030 and 2.6 to 3.8°C by 2050 from the 1961–1990 baseline.

6.2.3.2 Precipitation

Past Trends

Environment Canada monthly precipitation records at Pelly Ranch and Carmacks show a general increase in total annual precipitation over the last 60 years of 1.1 mm/year and 1.4 mm/year on average respectively, corresponding to an increase in annual precipitation between 1955 and 2006 of between 60 and 80 mm over the region (EBA 2010).

Future Trends

Many GCMs predict increasing mean annual precipitation at high latitudes of North America (Nohara et al. 2006). The Scenarios Network for Alaska and Arctic Planning projections suggest an increase in annual precipitation ranging from 8 to 13% by 2030 and 12 to 20% by 2050 from the 1961–1990 baseline.

6.3 Surface Water Quality

Surface water quality is a key consideration in the evaluation of potential effects of mining and mineral development projects. Effects from mining activities can be observed for significant distances downstream and changes to water quality parameters have the potential to impact aquatic resources and to affect human use of water resources. Both Minto and McGinty Creeks have been monitored for water quality conditions, with more intensity and duration of sampling in Minto Creek as part of the initial baseline and more recently the intensive operational monitoring under the mine water quality monitoring programs (licenced and otherwise). Characterization reports for water quality in these two watersheds have been developed with the intention of presenting either baseline or existing water quality conditions as the foundation of assessing potential effects from proposed mine expansion activities. These characterization reports are included as Appendix G (Minto Creek) and Appendix H (McGinty Creek). Key findings from the characterization reports are included below.

6.3.1 Minto Creek

The characterization of Minto Creek water quality includes January 2005 to December 2012 monitoring data. Minto Creek water quality data has been reviewed and characterized for key water quality monitoring stations for the pre-mine operation phase and for the operational phase (during both periods of mine effluent discharge to Minto Creek and without mine effluent discharge). A background water quality data set was also redeveloped with the addition of new appropriate data to a previous data set prepared by Minnow Environmental (Minnow 2009).

6.3.1.1 Background Water Quality

In 2009, to support the redevelopment of the mine WMP, Minnow Environmental compiled Minto Creek water quality monitoring data into a pooled data set that reflected background (unimpacted by development activities) conditions. This data set was screened against the CWQG to determine a rate of exceedance. An exceedance rate of >10% triggered the development of a site-specific water quality objective (SSWQO). SSQWOs were calculated for the following parameters: aluminum, chromium, copper, and iron. These SSWQOs were intended to be used as comparative metrics for ongoing water quality monitoring, for parameters that are naturally elevated above the generic CWQGs. Together, these water quality objectives (WQOs) provide a useful tool for evaluating changes in water quality, and to provide an indication of potential effect thresholds. These WQOs are not appropriate for (and were never intended to be used as) licenced water quality limits, as transpired through the mine water licence amendment process in 2010.

The mine water-quality monitoring program has continued to monitor stations within the operational area, downstream stations which are exposed to the influence of mine effluent discharge, and downstream stations which are not exposed to effluent. Data from these non-exposed stations are considered to be relevant the background water quality condition in Minto Creek, and were therefore added to the pre-existing 2009 background data set. New background data sets were developed for periods up to the end of 2010 and to the end of 2012. A comparison of the summary statistics of these two data sets shows the substantial change in background water quality in Minto Creek in 2011 and 2012 without the influence of any site effluent discharge (see discussion below).

The 2012 background data set was utilized to redevelop SSWQOs and followed the same process as Minnow in 2009 (with the exception of removing high TSS results.) This resulted in a substantial increase in the SSWQOs for the 2009 parameters (aluminum, chromium, copper, iron) and the addition of SSWQOs for the parameters fluoride and phosphorus. These SSWQOs (in addition to the 2009 SSWQOs and combined with the CWQGs) are used for screening purposes in the Aquatic Resources Effects Assessment analyses in section 8. The background water quality data are also used in the water quality prediction work (presented in section 7 and the associated appendices) as the ‘unimpacted’ source term for undisturbed catchment areas.

6.3.1.2 Downstream Water Quality (Station W2)

Generally speaking, during the pre-mine operation phase, aluminum, cadmium, chromium, copper, and iron concentrations showed exceedances of the CWQGs. These natural elevations were primarily associated with natural mineralization and/or elevated TSS concentrations. A much more robust data set exists for the operations with no discharge phase which also showed exceedances of the CWQGs for the same parameters as during pre-operations: aluminum, cadmium, chromium, copper, and iron.

In 2011 TSS levels in lower Minto Creek were observed to increase at stations MC1 and W2, the source of which has since been identified as a substantial natural release of soil materials into a tributary of the Minto Creek watershed (downstream of the mine.) This had a leveraging effect upon metal concentrations, increases of which have also been observed in the lower stations of Minto Creek.

At station W2, the following observations are made of the water quality between the discharge and non-discharge phases, as compared to the W2 non-freshet water licence limits:

- Exceedances of the aluminum limit are highest during the operations with no discharge phase; in particular, the limit was exceeded more often than not during 2011 and 2012.
- Cadmium exceedances at W2 compared to the non-freshet limit are higher during mine discharge periods.
- Copper exceedances at W2 compared to the non-freshet limit appear to remain the same between the discharge and non-discharge periods.
- Frequency of iron exceedances is highest during the non-discharge periods.
- Selenium and nitrate frequency of exceedance is substantially higher during periods of mine discharge.
- The total phosphorus limit is exceeded for most of the samples.

These comparative results illustrate the propensity for water quality in lower Minto Creek to exceed the W2 water use licence standards frequently, in mine non-discharge periods. This is the primary initial rationale supporting the removal of the licenced water quality limits at station W2 (see section 7) and further rationale for appropriateness of the proposed revised water quality limits on mine effluent in protecting the existing downstream aquatic resources is provided in Section 8 – Aquatic Resources Effects Assessment and Management.

6.3.2 McGinty Creek

Water quality data for McGinty Creek has accumulated at five stations over the course of more than three years of monthly monitoring since May 2009, as conditions allowed. Activities to date within the upper watershed consisted of exploration drilling in the vicinity of the Minto North deposit in 2008 and early 2009 (all predating the water quality monitoring activities.)

Parameters that show regular exceedances of the CWQG include total aluminum, cadmium, chromium, copper, iron, lead, zinc, and fluoride. Parameters that have been shown to infrequently exceed the CWQG include arsenic, mercury, silver, ammonia, and pH. Many parameters show spikes in concentrations in the summers of 2010 (August), 2011 (July) and 2012 (June). These spikes in parameters correspond with spikes in TSS and can be attributed to corresponding heavy precipitation events. When TSS concentrations are elevated due to heavy rains or freshet runoff, it is not uncommon for TSS-associated metals to be elevated as well.

Concentrations are typically highest at station MN-1.5. Parameter concentrations appear lowest in the winter, rising again in the spring with peak levels recorded in July and August during precipitation/runoff events. A set of WQOs was developed for McGinty Creek (using the entire McGinty Creek monitoring data set to identify SSWQOs, and the CWQGs where they were not routinely exceeded.) The WQOs are utilized as a screening tool in section 8 where they are compared with predictive water quality modeling for the McGinty Creek catchment. The summary statistics for the water quality data set also provided for the appropriate development of an ‘unimpacted’ source term for the water quality modeling work.

6.4 Groundwater Conditions

In August 2010, SRK produced a Groundwater Baseline Conditions report for the Minto Mine area. The 2010 report included an assessment of data collected from groundwater wells in the area and resulted in a conceptual model of the groundwater flow system and its interaction with receiving surface water bodies. A monitoring program was devised and subsequently upgraded to monitor any effects on groundwater quality and quantity as the Phase IV mine plan was carried out. In 2013, an updated *Minto Mine Phase V/VI Expansion: Hydrogeological Characterization Report* was provided by SRK (Appendix I-B).

SRK used drilling information and piezometer installation information to inform the conceptual model and help determine appropriate locations for the multi-layer wells that were installed in 2009 and 2012. These wells were installed downgradient of the waste rock and overburden dumps, Main pit, Minto North and the DSTSF.

Generally, the groundwater chemistry was observed to be similar to the surface water mean annual concentrations (significantly less than 1 order of magnitude) (Groundwater Baseline Conditions report, SRK 2010, Appendix I-A).

Groundwater flow is dominated by topography and most will be confined below the permafrost layer where it occurs. Minor seasonal shallow subsurface flow will occur above the permafrost in those areas. It is believed that flows both above and below site permafrost ultimately reports to Minto Creek. The site is broken down into sub areas and flow regimes are described in detail within the 2013 *Minto Mine Phase V/VI Expansion: Hydrogeological Characterization Report* (Appendix I-B).

7 Water Management

Management of water at the Minto Mine plays an important part in the mine planning as described in previous sections; strategies and systems for managing water are already in place with the current mining operations. The existing site water management plan has been refined through extensive planning and authorization amendment processes since the inception of the original water management plan prepared and presented with the original project water licence application in 1996. Most recently, these optimizations have been presented in applications for Water Use Licence QZ96-006 amendments 7 and 8. Amendment 7 was specific to the water management plan, and involved amendments to the effluent quality limits, whereas Amendment 8 involved relatively minor changes specific to the Phase IV mine expansion.

The purpose of water management at the mine is to ensure that the mine operations do not result in unacceptable impacts on surface and groundwater systems, including downstream water quality.

This section describes the following aspects of water management at the Minto Mine:

- The overall site water management strategy;
- The site water balance;
- Load balance model and water quality predictions;
- The Water Management Plan (WMP); and
- Proposed changes to water management, including infrastructure and currently licenced effluent quality limits.

7.1 Water Management Strategy

Runoff from developed mine areas (mine water) can mobilize metals and mine-sourced contaminants, such as nitrate, that could have potential adverse effects to the water quality in the receiving environment. The water management strategy in place and proposed for Phase V/VI is intended to limit and manage the inventory of mine water stored on site by segregating clean runoff from mine water that has been impacted by mining activities.

Clean runoff is to be diverted to Minto Creek while mine water is to be used for milling of ore and sub-aqueous deposition of tailings and waste rock.

The strategy for managing the mine water inventory can be summarized as follows:

- Discharge-compliant (clean) runoff will be collected and diverted to the Water Storage Pond (WSP), and from there to Minto Creek. The release of clean runoff is expected to effectively control the inventory of mine water on site.

- Runoff from developed mine areas (mine water) will be collected and stored in the Main Pit Tailings Management Facility (MPTMF) and the Area 2 Pit Tailings Management Facility (A2PTMF). Mine water will be used for ore processing and deposition of tailings and waste rock.
- Water diversion and conveyance infrastructure will be upgraded to ensure efficient segregation of runoff from undisturbed and developed catchments.
- Water inventory targets will be defined based on forecasts of water demand and runoff volumes. Regular tracking of mine water inventory will allow operators to determine if the inventory is on target; or, if water must be withheld or released from site.

7.2 Water Balance

Understanding the site water balance is integral for the development of the water management strategy. The water balance is influenced by a number of factors including the geography of the site, precipitation, evaporation and evapotranspiration, surface runoff, site water inventory, and water use.

7.2.1 Water Balance Model

The water balance model for Phase V/VI was built on previous water balance modelling work prepared for the Phase IV Yukon Environmental and Socioeconomic Assessment Board (YESAB) application (SRK 2010) and for the Water License Amendment 8 application (SRK 2012). The water balance includes the development of a stochastic water balance model that incorporates historical water balance data and produced predictions of the range of future precipitation and surface runoff events for the proposed development through to post-closure. These predictions contribute to the refinement of options for managing both discharge to the environment and water inventory at the mine site. More details regarding the water balance model can be found in Appendix K.

The water balance model divides the site and surrounding areas into catchments and sub-catchments within the Upper Minto Creek (Minto Mine site) catchment as well as the sub-catchment for the Minto North Pit, which is located within the adjacent McGinty Creek catchment. The area of the sub-catchments are calculated and classified as undisturbed, developed, or partially developed. Undisturbed catchments typically produce clean runoff that is of similar quality as background water quality in lower Minto Creek; developed catchments produce mine water runoff (how actual load source terms are applied to particular sub-catchments is detailed in Appendix K-B; and sub-catchments are illustrated in Figures 2.5 and 2.6 of the same appendix.)

7.2.2 Precipitation and Runoff

Assessments of the annual water balance for the site have concluded that the portion of precipitation that ultimately is collected as runoff is approximately 30% of the total annual precipitation. Thus, an estimated 70% of the annual precipitation is lost through evapotranspiration, sublimation, and groundwater recharge. Table 7-1 shows the estimated range of annual precipitation and site-wide runoff.

Table 7-1 Minto Mine Site Precipitation and Runoff Estimates

		1:100 Dry Year	Average Annual Precipitation	1:200 Wet Year
Precipitation	mm	205	329	498
Estimated Site-Wide Runoff	m^3/year	450,000	850,000	1,400,000

7.2.3 Annual Operational Water Balance

The operational water demand for Phase V/VI include sub-aqueous deposition of tailings and NP:AP<3 waste rock. Table 7-2 shows a summary of the annual operational water balance for Minto Phase V/VI. The annual water balance shows that runoff yields approximately 240,000m^3 of water in excess of the operational demands in a year with average precipitation. This volume corresponds to approximately 28% of all surface runoff collected from the Minto Mine site catchment. This water either can be stored on site or be released to Minto Creek. In a 1 in 100 dry year, the runoff volume would not be sufficient to cover the operational water demand, while runoff in excess of the operational demand would amount to approximately 790,000 m^3 in a 1 in 200 wet year.

Table 7-2: Annual Operational Water Balance Summary for Minto Phase V/VI.

Water Balance Component	Unit	1:100 Dry Year	Average Annual Precipitation	1:200 Wet Year
Water Input				
Annual site-wide runoff	m^3/year	450,000	850,000	1,400,000
Operational Water Demand				
Water to tailings pores	m^3/year	550,000	550,000	550,000
Water to waste rock pores[A]	m^3/year	60,000	60,000	60,000
Water in Excess of Operational Demands				
Water to store on site or to Minto Creek	m^3/year	-160,000	240,000	790,000
Water to store on site or to Minto Creek	% of total runoff	-36%	28%	56%

Notes: [A]NP:AP<3 waste rock

7.3 Load Balance Model and Water Quality Predictions

SRK integrated the water balance model summarized above with the following considerations relevant to the proposed Phase V/VI mining activities to prepare a load balance model and set of effluent and downstream water quality predictions for the Phase V/VI mine life:

- Mine plan and mining waste disposal areas;
- Catchments and sub-catchments for mining (upper Minto/McGinty Creek) areas and downstream areas;

- Contaminant loading estimates; and
- Water management, including diversions, storage, and treatment (presented further in Section 7.4 Water Management Plan below and Appendix J.)

The water and load balance model was built on previous water balance modelling work prepared for the Phase IV Yukon Environmental and Socioeconomic Assessment Board (YESAB) application (SRK 2010) and for the Water License Amendment 8 application (SRK 2012). The model covers the end of Phase IV (current operation) and Phase V/VI though closure and post-closure and model predictions of annual flow and quality of water within and downstream of the Minto Mine site were developed for 'expected case' and 'reasonable worst case' scenarios. The water and load balance modelling work for Phase V/VI is presented in detail in the *Minto Mine Phase V/VI Expansion: Water and Load Balance Model Report* (Appendix K-B).

The water and load balance model for Minto was developed using the GoldSim software package. Loadings were incorporated in the model by associating loadings source terns with the corresponding water flows or mine components as follows:

- Concentration based source terms were applied as constant values to monthly runoff volumes from corresponding sub-catchments.
- Loading-based source terms were incorporated into the model as a "dry" load either to runoff or to water reservoirs. For example, loadings from tailings solids were applied to the water in the reservoir where tailings were deposited.

The development of loadings source terms is described in detail in *Minto Mine Phase V/VI Expansion: ML/ARD Assessment and Inputs to Water Quality Predictions* (Appendix K-A). Table 7-3 below (from Appendix K-B, Table 3-1) shows a summary of geochemical source terms developed for the Phase V/VI water and load balance, which were allocated by sub-catchment or mine component.

Table 7-3: Summary of Load Balance Source Terms.

Source Term	Units	Applies to
Background lower Minto Creek	mg/L	Undisturbed catchments downstream of the Minto Mine site
Background upper Minto Creek	mg/L	Undisturbed catchments within the Minto Mine site
Dry Stack Talings Seepage	mg/L	Runoff from the Dry Stack Tailings Storage Facility
Main Pit TMF Unsaturated Tailings Load	mg/year	Main Pit TMF
Mill Area Loadings	mg/year	Mill Area
Minto North Background	mg/L	Undisturbed sub-catchments in McGinty Creek
Minto North Pit Loadings	mg/year	Minto North Pit
Nitrogen Contribution	mg/L	Added to all water released from the mine to account for loadings of nitrogen species
Ore Stockpile Concentrations	mg/L	Ore Stockpile Area, Operations
Ore Stockpile Loadings	mg/year	Ore Stockpile Area, Closure
Pit Wall Loadings	mg/year	All pit walls
Ridgetop TMF Unsaturated Tailings Load	mg/year	Ridgetop North TMF
Tailings Slurry	mg/L	Tailings slurry supernatant
TSS Contribution	mg/L	Added to all water released from the mine to account for composition of suspended solids
Waste Rock Loadings	$mg/m^3/year$	Large Waste Rock Dumps and Mill Valley Fill Expansion (Stage 1 and Stage 2)

Table 7-4 below (from Appendix K-B, Table 4-1) present details of the runoff and mine water conveyance assumptions incorporated into the load balance model. Diversion efficiencies for collection and conveyance systems were also varied at 60% and 80%.

Table 7-4: Modelled Routing of Runoff and Mine Water Conveyance

Input	Period	Reservoir	Output	Period
Surface runoff	Always	WSP	Minto Creek	Always
W15	Until 2022			
W35a	Until 2022			
Area 2 Pit	2028 onwards			
W37	Until 2017	Main Pit	to Area 2	2018 onwards
Surface runoff	Always			
Minto North Pit	2014 to 2015		to Water Treatment	Intermittently during operation
Area 2 dewatering	2013-2014		Evaporation	Open water seasons
Tailings slurry water	Intermittently 2013 to 2021		Reclaim Water	2013 to 2018
W37	2017 to 2022	Area 2 Pit	Main Pit	2013-2014
Surface runoff	Always			
W35a sump	2022 onwards		to Water Treatment	Intermittently during operation
Ridgetop North Pit water (sump + supernatant)	2015 to 2022		Evaporation	Open water seasons
Main Pit	2018 onwards		Reclaim Water	2018 to 2022
Tailings slurry water	Intermittently 2013 to 2021		to WSP	2028 onwards
Surface runoff	Always	Ridgetop North Pit	to Area 2	2015 to 2022
Tailings slurry water	2018 to 2019		to W35a	2022 onwards
Surface runoff	Always	Minto North Pit	to Main Pit	2014 to 2015
			to McGinty Creek	2018 onwards

In the load balance model, water treatment was assumed to be required if water from the Main Pit or Area 2 Pit had to be released from site during the operational period in order to manage water inventory. For periods when release of pit water was required, the model assumed that the RO process would be used for treatment during the operational period. The RO process was implemented in the model by removing 95% of loadings from the feed water and returning the removed loadings to the Main or Area 2 Pit, according to the origin of the feed water. In the model, water was not treated after operations ended.

Table 7-5 through Table 7-8 below present monthly typical and upper limit concentrations for both the operational and post closure periods of Phase V/VI for the Minto Creek catchment. These concentrations are presented for both expected case and reasonable worst-case scenarios at the WSP (effluent) and lower Minto Creek for key parameters during open water months.

Table 7-5: Expected Case Predictions for Effluent Quality (WSP) for Key Parameters during Open Water Season.

Parameter	Ag	Al	Ammonia	As	Cd	Cr	Cu	Fe	Fluoride	Hg	Mo	Ni	Nitrate	Nitrite	Pb	Se	Sulphate	Zn
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Operational Period - Typical Concentrations																		
Apr	0.00010	0.63	0.60	0.0010	0.000088	0.0020	0.030	1.4	0.28	0.000042	0.0030	0.0029	8.2	0.10	0.00055	0.0013	43	0.013
May	0.00010	0.64	0.60	0.00093	0.000086	0.0018	0.027	1.3	0.25	0.000037	0.0027	0.0029	8.2	0.10	0.00052	0.0011	40	0.013
Jun	0.00010	0.69	0.60	0.00091	0.000087	0.0018	0.026	1.3	0.24	0.000035	0.0026	0.0030	8.1	0.10	0.00053	0.0010	40	0.013
Jul	0.00010	0.71	0.59	0.00093	0.000087	0.0019	0.026	1.4	0.24	0.000039	0.0026	0.0030	8.1	0.10	0.00054	0.0010	39	0.013
Aug	0.00010	0.73	0.59	0.00094	0.000087	0.0019	0.025	1.4	0.25	0.000043	0.0026	0.0030	8.1	0.10	0.00055	0.0010	37	0.013
Sep	0.00010	0.72	0.61	0.00094	0.000085	0.0019	0.025	1.4	0.26	0.000042	0.0026	0.0030	8.4	0.11	0.00055	0.0010	36	0.013
Oct	0.00010	0.71	0.61	0.00095	0.000086	0.0019	0.026	1.4	0.26	0.000042	0.0026	0.0030	8.3	0.11	0.00055	0.0010	37	0.013
Operational Period - Upper Limit Concentrations																		
Apr	0.00011	0.72	0.64	0.0012	0.00010	0.0024	0.036	1.7	0.34	0.000053	0.0037	0.0036	8.8	0.11	0.00066	0.0016	54	0.016
May	0.00011	0.71	0.64	0.0012	0.00010	0.0023	0.034	1.6	0.31	0.000048	0.0034	0.0033	8.8	0.11	0.00062	0.0015	49	0.015
Jun	0.00010	0.71	0.64	0.0010	0.000090	0.0020	0.028	1.4	0.26	0.000040	0.0027	0.0032	8.8	0.11	0.00057	0.0011	44	0.014
Jul	0.00010	0.74	0.64	0.0010	0.000090	0.0020	0.028	1.5	0.26	0.000046	0.0027	0.0032	8.8	0.11	0.00058	0.0011	44	0.014
Aug	0.00010	0.74	0.64	0.0010	0.000090	0.0020	0.028	1.5	0.28	0.000046	0.0027	0.0032	8.8	0.11	0.00058	0.0011	41	0.014
Sep	0.00010	0.74	0.64	0.0010	0.000089	0.0020	0.028	1.5	0.28	0.000045	0.0027	0.0032	8.8	0.11	0.00058	0.0011	40	0.014
Oct	0.00011	0.73	0.64	0.0010	0.000090	0.0021	0.028	1.5	0.29	0.000046	0.0028	0.0032	8.8	0.11	0.00059	0.0012	41	0.014
Post-Closure Period - Typical Concentrations																		
Apr	0.00011	0.74	0.085	0.0013	0.000096	0.0018	0.028	1.2	0.51	0.000049	0.0074	0.0028	1.2	0.015	0.00055	0.0021	42	0.013
May	0.00011	0.74	0.083	0.0013	0.000095	0.0018	0.028	1.2	0.50	0.000046	0.0074	0.0028	1.1	0.014	0.00054	0.0021	43	0.013
Jun	0.00011	0.75	0.082	0.0012	0.000094	0.0018	0.027	1.2	0.49	0.000045	0.0073	0.0028	1.1	0.014	0.00054	0.0021	44	0.012
Jul	0.00010	0.75	0.081	0.0012	0.000094	0.0018	0.027	1.2	0.48	0.000047	0.0072	0.0028	1.1	0.014	0.00054	0.0021	43	0.012
Aug	0.00010	0.76	0.079	0.0012	0.000094	0.0018	0.027	1.2	0.49	0.000049	0.0072	0.0028	1.1	0.014	0.00055	0.0021	42	0.012
Sep	0.00011	0.76	0.078	0.0012	0.000093	0.0018	0.027	1.2	0.49	0.000049	0.0072	0.0028	1.1	0.013	0.00055	0.0021	41	0.012
Oct	0.00011	0.75	0.077	0.0013	0.000093	0.0018	0.027	1.2	0.49	0.000048	0.0072	0.0028	1.0	0.013	0.00054	0.0021	41	0.012
Post-Closure Period - Upper Limit Concentrations																		
Apr	0.00011	0.78	0.12	0.0015	0.00010	0.0020	0.031	1.3	0.71	0.000055	0.014	0.0030	1.7	0.02	0.00060	0.0035	58	0.014
May	0.00011	0.78	0.12	0.0015	0.00010	0.0020	0.031	1.3	0.70	0.000054	0.014	0.0030	1.6	0.02	0.00059	0.0034	59	0.014
Jun	0.00011	0.78	0.12	0.0014	0.00010	0.0020	0.030	1.3	0.67	0.000051	0.013	0.0030	1.6	0.02	0.00058	0.0033	59	0.013
Jul	0.00011	0.79	0.12	0.0014	0.00010	0.0020	0.029	1.3	0.65	0.000054	0.013	0.0030	1.6	0.02	0.00059	0.0033	58	0.013
Aug	0.00011	0.79	0.11	0.0014	0.00010	0.0020	0.029	1.3	0.65	0.000054	0.013	0.0030	1.6	0.02	0.00059	0.0032	56	0.013
Sep	0.00011	0.79	0.11	0.0014	0.00010	0.0020	0.029	1.3	0.65	0.000054	0.013	0.0030	1.5	0.02	0.00059	0.0032	55	0.013
Oct	0.00011	0.78	0.11	0.0014	0.00010	0.0019	0.029	1.3	0.66	0.000053	0.013	0.0030	1.5	0.02	0.00059	0.0032	55	0.013

Table 7-6: Reasonable Worst Case Predictions for Effluent Quality (WSP) for Key Parameters during Open Water Season.

Parameter	Ag	Al	Ammonia	As	Cd	Cr	Cu	Fe	Fluoride	Hg	Mo	Ni	Nitrate	Nitrite	Pb	Se	Sulphate	Zn
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Operational Period - Typical Concentrations																		
Apr	0.000027	0.27	0.080	0.00048	0.000048	0.00094	0.011	0.51	0.13	0.000014	0.0010	0.0011	1.0	0.030	0.00020	0.00032	12	0.0054
May	0.000069	6.2	0.11	0.0033	0.00015	0.013	0.023	11	0.17	0.000014	0.0011	0.012	1.0	0.015	0.0031	0.00062	31	0.029
Jun	0.000024	0.69	0.092	0.00078	0.000041	0.0017	0.0075	1.4	0.20	0.000038	0.0010	0.0026	1.0	0.016	0.00042	0.00053	19	0.0079
Jul	0.000046	3.4	0.11	0.0021	0.000088	0.0065	0.015	5.7	0.26	0.000041	0.0014	0.0072	1.0	0.016	0.0017	0.00057	8	0.017
Aug	0.000048	3.0	0.10	0.0024	0.000082	0.0058	0.014	6.0	0.64	0.000017	0.0011	0.0077	1.0	0.016	0.0018	0.00052	12	0.017
Sep	0.000031	0.39	0.089	0.00066	0.000024	0.0011	0.0075	1.1	0.24	0.000017	0.00087	0.0022	1.1	0.014	0.00037	0.00052	14	0.0051
Oct	0.000021	0.19	0.094	0.00055	0.000035	0.00065	0.0075	0.61	0.22	0.000014	0.0011	0.0017	1.1	0.017	0.00018	0.00053	10	0.0031
Operational Period - Upper Limit Concentrations																		
Apr	0.000029	0.28	0.096	0.00051	0.000050	0.00099	0.012	0.55	0.42	0.000015	0.0013	0.0012	1.3	0.033	0.00021	0.00054	23	0.0057
May	0.000072	7.2	0.18	0.0037	0.00016	0.015	0.024	12	0.18	0.000015	0.0014	0.014	2.0	0.033	0.0036	0.00067	32	0.032
Jun	0.000070	6.3	0.15	0.0034	0.00015	0.013	0.023	11	0.20	0.000040	0.0012	0.013	1.9	0.027	0.0032	0.00063	32	0.029
Jul	0.000050	3.5	0.16	0.0022	0.000091	0.0068	0.016	5.9	0.27	0.000041	0.0015	0.0075	1.7	0.025	0.0017	0.00059	19	0.017
Aug	0.000050	3.5	0.16	0.0024	0.000091	0.0068	0.016	6.1	0.67	0.000041	0.0015	0.0077	1.7	0.025	0.0018	0.00059	13	0.018
Sep	0.000048	3.0	0.11	0.0024	0.000082	0.0058	0.014	6.1	0.67	0.000017	0.0011	0.0077	1.1	0.017	0.0018	0.00054	14	0.018
Oct	0.000030	0.22	0.10	0.00056	0.000037	0.00079	0.0079	0.73	0.23	0.000017	0.0011	0.0019	1.2	0.018	0.00028	0.00055	14	0.0044
Post-Closure Period - Typical Concentrations																		
Apr	0.000039	0.34	0.027	0.00064	0.000055	0.0010	0.013	0.59	0.23	0.000020	0.0025	0.0014	0.25	0.011	0.00025	0.00071	17	0.0064
May	0.000074	5.2	0.042	0.0029	0.00014	0.011	0.023	8.9	0.25	0.000020	0.0027	0.011	0.26	0.0065	0.0027	0.00096	32	0.025
Jun	0.000035	0.86	0.034	0.00095	0.000051	0.002	0.010	1.6	0.26	0.000039	0.0024	0.0029	0.24	0.0062	0.00051	0.00085	23	0.0090
Jul	0.000054	3.0	0.039	0.0020	0.000089	0.0058	0.017	5.0	0.32	0.000043	0.0027	0.0065	0.25	0.0057	0.0015	0.00089	13	0.016
Aug	0.000056	2.8	0.038	0.0023	0.000085	0.0053	0.016	5.4	0.64	0.000022	0.0025	0.0070	0.24	0.0055	0.0016	0.00085	17	0.017
Sep	0.000042	0.53	0.029	0.00084	0.000036	0.0013	0.011	1.2	0.32	0.000022	0.0024	0.0025	0.24	0.0046	0.00044	0.00088	18	0.0065
Oct	0.000034	0.28	0.030	0.00070	0.000045	0.00082	0.011	0.69	0.30	0.000021	0.0026	0.0018	0.27	0.0054	0.00024	0.00090	16	0.0046
Post-Closure Period - Upper Limit Concentrations																		
Apr	0.000044	0.38	0.044	0.00072	0.000060	0.0011	0.015	0.64	0.49	0.000023	0.0044	0.0015	0.54	0.021	0.00028	0.0012	30	0.0070
May	0.000079	5.4	0.064	0.0031	0.00014	0.011	0.025	9.2	0.31	0.000023	0.0045	0.011	0.48	0.017	0.0028	0.0014	38	0.027
Jun	0.000078	5.4	0.063	0.0031	0.00014	0.011	0.025	9.2	0.31	0.000042	0.0044	0.011	0.48	0.0088	0.0028	0.0013	38	0.026
Jul	0.000058	3.1	0.058	0.0021	0.000094	0.0061	0.018	5.2	0.37	0.000044	0.0042	0.0068	0.44	0.0087	0.0016	0.0012	26	0.017
Aug	0.000058	3.1	0.056	0.0023	0.000093	0.0061	0.018	5.3	0.70	0.000044	0.0040	0.0070	0.43	0.0079	0.0016	0.0012	21	0.017
Sep	0.000058	2.7	0.055	0.0023	0.000086	0.0052	0.016	5.3	0.70	0.000024	0.0039	0.0070	0.43	0.0077	0.0016	0.0012	23	0.017
Oct	0.000044	0.32	0.045	0.00076	0.000050	0.00098	0.012	0.80	0.35	0.000024	0.0043	0.0021	0.48	0.0081	0.00033	0.0012	23	0.0059

Table 7-7: Expected Case Predictions for Lower Minto Creek (W1) for Key Parameters during Open Water Season.

Parameter	Ag	Al	Ammonia	As	Cd	Cr	Cu	Fe	Fluoride	Hg	Mo	Ni	Nitrate	Nitrite	Pb	Se	Sulphate	Zn
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Operational Period - Typical Concentrations																		
Apr	0.00018	0.73	0.97	0.0014	0.00016	0.0029	0.052	1.8	0.32	0.00022	0.0045	0.0039	21	0.60	0.00055	0.0033	83	0.018
May	0.00016	0.73	0.97	0.0012	0.00014	0.0026	0.045	1.7	0.28	0.00018	0.0039	0.0036	21	0.60	0.00052	0.0027	72	0.017
Jun	0.00015	0.76	0.96	0.0012	0.00013	0.0025	0.041	1.7	0.27	0.00015	0.0036	0.0036	21	0.59	0.00053	0.0024	68	0.016
Jul	0.00015	0.78	0.96	0.0012	0.00013	0.0025	0.041	1.7	0.28	0.00016	0.0036	0.0037	21	0.59	0.00054	0.0024	67	0.016
Aug	0.00015	0.80	0.96	0.0012	0.00013	0.0025	0.040	1.7	0.28	0.00016	0.0036	0.0037	21	0.59	0.00055	0.0024	65	0.016
Sep	0.00015	0.79	0.99	0.0012	0.00013	0.0025	0.040	1.7	0.29	0.00016	0.0036	0.0036	22	0.61	0.00055	0.0024	64	0.016
Oct	0.00016	0.79	0.99	0.0012	0.00013	0.0026	0.042	1.8	0.30	0.00017	0.0037	0.0037	22	0.61	0.00055	0.0025	66	0.016
Operational Period - Upper Limit Concentrations																		
Apr	0.00021	0.87	1.0	0.0017	0.00019	0.0037	0.066	2.3	0.40	0.00028	0.0057	0.0048	23	0.64	0.00066	0.0043	107	0.022
May	0.00020	0.82	1.0	0.0016	0.00018	0.0034	0.061	2.1	0.36	0.00026	0.0052	0.0045	23	0.64	0.00062	0.0039	98	0.021
Jun	0.00017	0.80	1.0	0.0013	0.00015	0.0028	0.046	1.8	0.30	0.00018	0.0040	0.0040	23	0.64	0.00057	0.0028	78	0.018
Jul	0.00017	0.83	1.0	0.0013	0.00015	0.0028	0.046	1.9	0.30	0.00019	0.0040	0.0040	23	0.64	0.00058	0.0028	77	0.018
Aug	0.00017	0.83	1.0	0.0013	0.00014	0.0028	0.045	1.9	0.31	0.00019	0.0039	0.0040	23	0.64	0.00058	0.0028	74	0.017
Sep	0.00017	0.82	1.0	0.0013	0.00014	0.0028	0.046	1.9	0.32	0.00019	0.0040	0.0040	23	0.64	0.00058	0.0029	74	0.018
Oct	0.00017	0.82	1.0	0.0014	0.00015	0.0029	0.048	1.9	0.32	0.00020	0.0042	0.0041	23	0.64	0.00059	0.0030	77	0.018
Post-Closure Period - Typical Concentrations																		
Apr	0.00016	0.89	0.14	0.0024	0.00018	0.0030	0.050	1.5	0.71	0.00014	0.015	0.0039	3.0	0.084	0.0012	0.0042	68	0.019
May	0.00016	0.89	0.14	0.0023	0.00018	0.0029	0.048	1.5	0.69	0.00014	0.015	0.0038	3.0	0.083	0.0011	0.0041	68	0.018
Jun	0.00015	0.88	0.13	0.0022	0.00017	0.0028	0.047	1.4	0.67	0.00013	0.014	0.0038	2.9	0.082	0.0011	0.0040	68	0.018
Jul	0.00015	0.89	0.13	0.0022	0.00017	0.0028	0.047	1.5	0.67	0.00013	0.014	0.0038	2.9	0.080	0.0011	0.0040	66	0.018
Aug	0.00015	0.90	0.13	0.0022	0.00017	0.0028	0.047	1.5	0.67	0.00013	0.014	0.0038	2.8	0.079	0.0011	0.0040	65	0.018
Sep	0.00015	0.89	0.13	0.0022	0.00017	0.0028	0.047	1.5	0.68	0.00013	0.014	0.0038	2.8	0.078	0.0011	0.0040	65	0.018
Oct	0.00015	0.89	0.12	0.0022	0.00017	0.0028	0.047	1.5	0.68	0.00013	0.014	0.0038	2.7	0.076	0.0011	0.0040	65	0.018
Post-Closure Period - Upper Limit Concentrations																		
Apr	0.00018	0.96	0.20	0.0028	0.00021	0.0034	0.056	1.6	0.96	0.00016	0.023	0.0044	4.3	0.12	0.0014	0.0067	90	0.021
May	0.00018	0.95	0.19	0.0028	0.00021	0.0034	0.055	1.5	0.95	0.00016	0.023	0.0043	4.3	0.12	0.0014	0.0066	90	0.021
Jun	0.00017	0.94	0.19	0.0026	0.00020	0.0032	0.053	1.5	0.90	0.00015	0.022	0.0043	4.2	0.12	0.0013	0.0063	88	0.020
Jul	0.00017	0.96	0.19	0.0026	0.00019	0.0032	0.052	1.5	0.89	0.00015	0.022	0.0043	4.1	0.12	0.0013	0.0062	87	0.020
Aug	0.00017	0.96	0.19	0.0026	0.00019	0.0032	0.052	1.5	0.88	0.00015	0.021	0.0042	4.0	0.11	0.0013	0.0061	85	0.020
Sep	0.00017	0.95	0.18	0.0026	0.00019	0.0032	0.052	1.5	0.88	0.00015	0.021	0.0042	4.0	0.11	0.0013	0.0061	84	0.020
Oct	0.00017	0.95	0.18	0.0026	0.00019	0.0032	0.052	1.5	0.89	0.00015	0.021	0.0042	3.9	0.11	0.0013	0.0061	84	0.020

Table 7-8: Reasonable Worst Case Predictions for Lower Minto Creek (W1) for Key Parameters during Open Water Season.

Parameter	Ag	Al	Ammonia	As	Cd	Cr	Cu	Fe	Fluoride	Hg	Mo	Ni	Nitrate	Nitrite	Pb	Se	Sulphate	Zn
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Operational Period - Typical Concentrations																		
Apr	0.000037	0.28	0.12	0.00053	0.000056	0.0011	0.014	0.57	0.14	0.000036	0.0012	0.0013	2.4	0.087	0.00020	0.00058	18	0.0060
May	0.000077	6.2	0.15	0.0033	0.00016	0.013	0.025	11	0.17	0.000032	0.0013	0.012	2.6	0.074	0.0031	0.00083	35	0.029
Jun	0.000030	0.70	0.14	0.00081	0.000046	0.0018	0.0092	1.4	0.20	0.000051	0.0011	0.0026	2.5	0.074	0.00042	0.00069	22	0.0083
Jul	0.000053	3.4	0.15	0.0021	0.000094	0.0066	0.017	5.7	0.27	0.000055	0.0015	0.0073	2.6	0.075	0.0017	0.00074	11	0.017
Aug	0.000054	3.0	0.15	0.0024	0.000088	0.0059	0.015	6.1	0.65	0.000031	0.0013	0.0078	2.6	0.074	0.0018	0.00068	15	0.018
Sep	0.000037	0.40	0.14	0.00069	0.000029	0.0012	0.0094	1.1	0.25	0.000031	0.0010	0.0023	2.7	0.077	0.00037	0.00069	17	0.0055
Oct	0.000028	0.20	0.14	0.00058	0.000041	0.00074	0.010	0.65	0.23	0.000030	0.0012	0.0017	2.8	0.081	0.00018	0.00072	14	0.0036
Operational Period - Upper Limit Concentrations																		
Apr	0.000042	0.30	0.15	0.00057	0.000062	0.0012	0.015	0.63	0.42	0.000044	0.0016	0.0014	3.1	0.10	0.00021	0.00086	29	0.0065
May	0.000083	7.2	0.26	0.0037	0.00016	0.015	0.027	12	0.18	0.000041	0.0015	0.014	5.1	0.14	0.0036	0.00097	38	0.032
Jun	0.000079	6.4	0.24	0.0034	0.00016	0.013	0.026	11	0.21	0.000056	0.0013	0.013	4.8	0.14	0.0032	0.00084	36	0.030
Jul	0.000055	3.5	0.23	0.0022	0.000098	0.0069	0.018	6.0	0.27	0.000058	0.0016	0.0076	4.4	0.13	0.0017	0.00079	23	0.018
Aug	0.000055	3.5	0.23	0.0024	0.000098	0.0069	0.018	6.1	0.67	0.000058	0.0016	0.0078	4.4	0.13	0.0018	0.00078	17	0.018
Sep	0.000055	3.0	0.16	0.0024	0.000088	0.0059	0.016	6.1	0.67	0.000035	0.0013	0.0078	2.9	0.082	0.0018	0.00075	18	0.018
Oct	0.000038	0.23	0.15	0.00060	0.000045	0.00088	0.010	0.78	0.23	0.000035	0.0013	0.0020	3.0	0.088	0.00028	0.00078	18	0.0049
Post-Closure Period - Typical Concentrations																		
Apr	0.000054	0.39	0.038	0.00094	0.000078	0.0014	0.019	0.66	0.28	0.000045	0.0046	0.0017	0.62	0.031	0.00042	0.0013	24	0.0080
May	0.000088	5.2	0.055	0.0032	0.00016	0.011	0.029	9.0	0.30	0.000044	0.0046	0.011	0.64	0.021	0.0028	0.0015	39	0.027
Jun	0.000047	0.89	0.045	0.0012	0.000070	0.0023	0.015	1.6	0.31	0.000059	0.0040	0.0031	0.57	0.019	0.00065	0.0013	29	0.010
Jul	0.000066	3.0	0.052	0.0023	0.00011	0.0060	0.021	5.0	0.36	0.000063	0.0044	0.0067	0.59	0.019	0.0016	0.0014	19	0.017
Aug	0.000068	2.8	0.050	0.0025	0.00010	0.0056	0.020	5.5	0.69	0.000043	0.0042	0.0073	0.58	0.018	0.0018	0.0013	22	0.018
Sep	0.000055	0.56	0.039	0.0011	0.000057	0.0016	0.016	1.3	0.37	0.000044	0.0042	0.0027	0.58	0.017	0.00059	0.0014	25	0.0079
Oct	0.000048	0.32	0.041	0.00098	0.000067	0.0011	0.016	0.75	0.35	0.000044	0.0046	0.0021	0.63	0.019	0.00040	0.0014	22	0.0061
Post-Closure Period - Upper Limit Concentrations																		
Apr	0.000063	0.43	0.066	0.0011	0.000090	0.0015	0.022	0.73	0.57	0.000054	0.0072	0.0019	1.3	0.050	0.00050	0.0021	39	0.0091
May	0.000096	5.4	0.085	0.0034	0.00017	0.011	0.032	9.3	0.38	0.000053	0.0072	0.011	1.2	0.044	0.0030	0.0023	47	0.029
Jun	0.000094	5.4	0.084	0.0034	0.00017	0.011	0.031	9.3	0.37	0.000065	0.0069	0.011	1.2	0.035	0.0030	0.0022	46	0.028
Jul	0.000072	3.2	0.077	0.0024	0.00012	0.0064	0.024	5.2	0.42	0.000068	0.0064	0.0071	1.1	0.032	0.0017	0.0020	33	0.018
Aug	0.000073	3.2	0.074	0.0026	0.00012	0.0064	0.024	5.4	0.76	0.000068	0.0062	0.0073	1.1	0.032	0.0018	0.0019	28	0.019
Sep	0.000073	2.7	0.073	0.0026	0.00011	0.0055	0.022	5.4	0.76	0.000050	0.0062	0.0073	1.1	0.032	0.0018	0.0020	30	0.018
Oct	0.000060	0.37	0.064	0.0011	0.000077	0.0013	0.019	0.87	0.41	0.000050	0.0068	0.0024	1.2	0.034	0.00052	0.0021	30	0.0076

Table 7-9 below (from Table 5-4 in Appendix K-B) shows the predicted average and maximum concentrations for the scoping exercise for lower McGinty Creek, with average and maximum concentrations from the baseline water quality monitoring program. The results show how changes in water quality in the post-mining condition in McGinty Creek are expected to be minimal.

Table 7-9: Water Quality Modelling Results for McGinty Creek at Mouth.

Parameter*/Unit		Baseline Conditions		After Mining at Minto North	
				Worst Case	
		Average	Max	Average	Max
Ammonia	mg/L	0.0355	0.27	not predicted- expect no change	
F	mg/L	0.20	0.43	0.23	0.43
$N\text{-}NO_2$	mg/L	0.0064	0.025	not predicted- expect no change	
$N\text{-}NO_3$	mg/L	0.073	0.3	not predicted- expect no change	
Sulphate	mg/L	3.1	9.1	3.2	9.1
Al	mg/L	0.55	3.3	0.55	3.3
As	mg/L	0.00062	0.0022	0.00065	0.0022
Cd	mg/L	0.000031	0.000095	0.000032	0.000095
Cr	mg/L	0.0011	0.0063	0.0012	0.0063
Cu	mg/L	0.0035	0.012	0.0036	0.012
Fe	mg/L	1.0	5.4	1.00	5.4
Pb	mg/L	0.00043	0.0021	0.00044	0.0021
Mn	mg/L	0.052	0.20	0.053	0.20
Hg	mg/L	0.0000042	0.000012	0.0000047	0.000012
Mo	mg/L	0.00069	0.0016	0.00085	0.0016
Ni	mg/L	0.0021	0.0074	0.0021	0.0074
Se	mg/L	0.00014	0.00031	0.00015	0.00031
Ag	mg/L	0.0000073	0.000029	0.0000084	0.000029
Tl	mg/L	0.0000049	0.000026	0.0000054	0.000026
Zn	mg/L	0.0067	0.033	0.0067	0.033

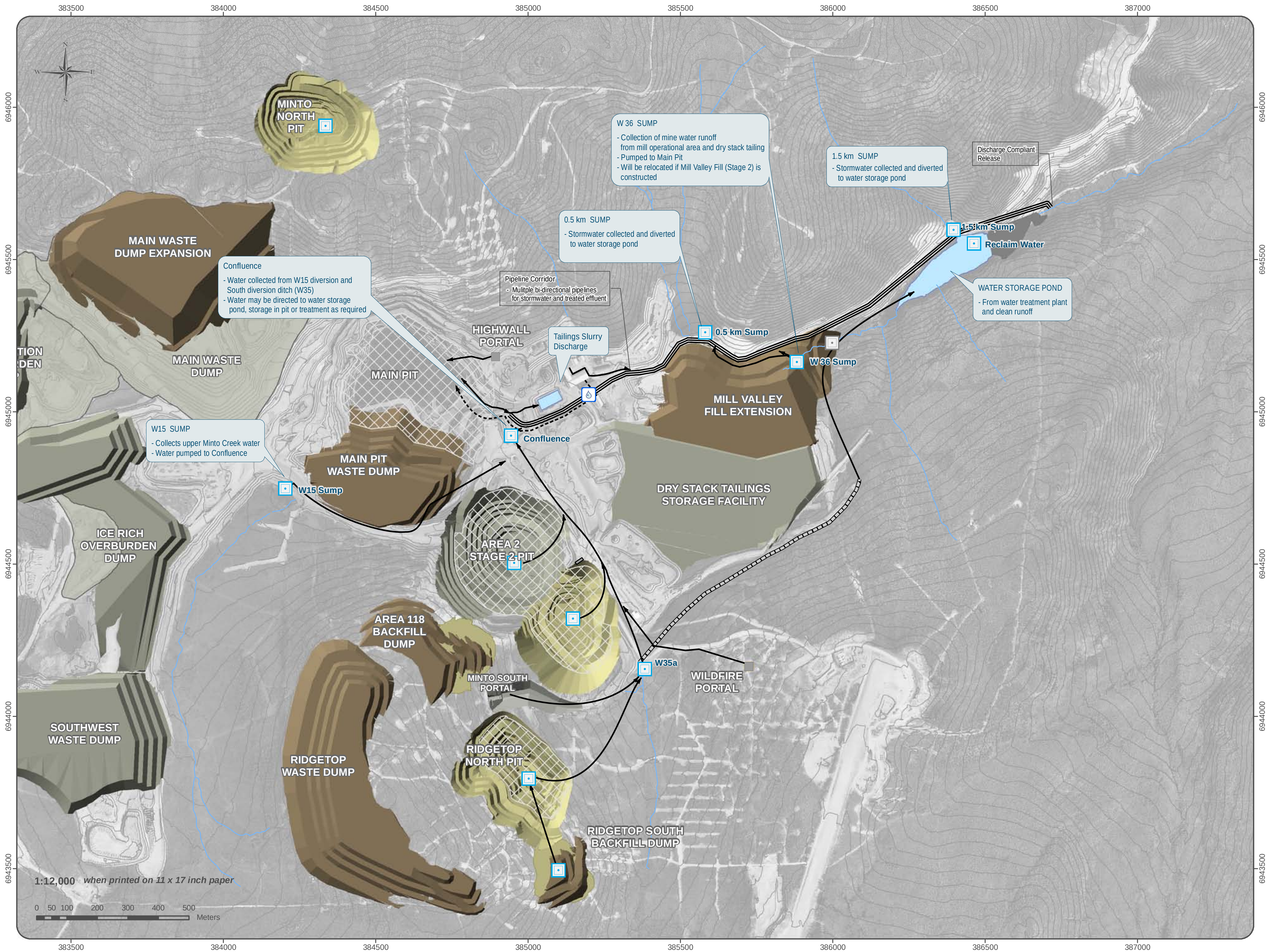
7.4 Water Management Plan

This section outlines the operational water management plan for Phase V/VI of the Minto Mine development, including the details of the diversion of clean runoff, water management reservoirs, discharge management, and mine water treatment. More detail can be found in the *Water Management Plan* (WMP) in Appendix J.

As outlined in previous sections, the overall management strategy is to divert and release clean runoff to Minto Creek which can be achieved through the use of a series of collection points, diversion structures, and decision making on water management.

Figure 7-1 contains an overview of the Phase V/VI water management and details of the current and proposed water management infrastructure is explained further in section 7.5.1.

The primary objective of the Phase V/VI WMP is to manage the inventory of mine water stored on the site. The mine operation must have sufficient water to operate but an excess of mine water that cannot be released to Minto Creek without treatment is a potential operational and environmental liability.



MINTO MINE PHASE V/VI EXPANSION

FIGURE 7-1

PROPOSED PHASE V/VI OPERATIONAL WATER MANAGEMENT

JULY 2013

CAPSTONE MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

- Collection Point/Sump
- W-36 Potential location for relocation
- Water Treatment Plant
- Pipe Alignment
- Piping Corridor
- Tailings Slury Discharge
- Diversion Ditch
- Tailings
- Dumps
- Pits
- Phase IV Features
- Main Pit Dam

ACCESS

Aerial imagery obtained from Challenger Geomatics.
Imagery acquired August 14 th 2012.
Site contours derived from 2012 aerial imagery obtained from Challenger Geomatics.

Hydrology data provided by Minto Explorations Ltd, May 2009.

Datum: NAD 83 Projection: UTM Zone 8N

I:\Minto\gis\mxd\Phase_5-6\Permitting\YESAB\Baseline-Appendices\Water Management Plan\4-2_Minto Mine Proposed Phase 56 Water Conveyance_20130703.mxd
(*Last edited by: mducharme;04/07/2013/15:17 PM*)

7.4.1 WMP Operating Principle

During Phase V/VI water collected at the Minto Mine will be segregated on the basis of clean runoff and mine water. Clean runoff will be diverted around the active mining areas to the water storage pond, and mine water will be contained in the Main Pit Tailings Management Facility (MPTMF) and the Area 2 Pit Tailings Management Facility (A2PTMF). Runoff is classified as clean if the water meets the water quality limits defined in the applicable water use license. Runoff that does not meet water quality limits is categorized as mine water. For Phase V/VI, clean runoff is intended to be released to Minto Creek from the Water Storage Pond (WSP) while mine water will be used for processing of ore and for sub-aqueous deposition of tailings and waste rock.

To ensure that the mine operation has sufficient volumes of water for operation and be able to identify excess water volume to be diverted or treated, the WMP describes in detail how the operation must monitor mine water inventories and update inventory targets on a routine basis.

7.4.2 Water Management Reservoirs

The WMP was developed in conjunction with the waste rock management plan and the tailings management plan (Appendix A and D, respectively). The tailings management plan was developed to make use of three tailings management facilities planned for Phase V/VI, namely the MPTMF, A2PTMF and the Ridgetop North Pit TMF (RNPTMF). The WMP will primarily rely on the water storage available in the MPTMF and the A2PTMF.

7.4.3 Discharge management

Operational water management decisions for Phase V/VI can be summarized as follows:

1. The primary water management decision for Phase V/VI is whether or not water (clean runoff or mine water) must be released from site.
2. Secondary decisions include:
    a. The quantity of water;
    b. The preferred water source; and
    c. Timing of the release.

If the mine water inventory is running a surplus, the following actions will be taken in the order listed to release water from site:

1. **Divert water from W35a to WSP:** water will be diverted from the southwest catchment (collected at station W35a) to the WSP. Historically, the water at W35a has been of a similar quality to clean runoff measured in lower Minto Creek.
2. **Divert water from W15 to WSP:** if diversion of water from W35a is insufficient to meet water inventory and release targets, then water collected at W15 can be diverted to the WSP. Water collection point W15 collects runoff from undisturbed areas and from waste rock. The water

quality parameter concentrations have historically been elevated compared to undisturbed catchments but have generally met water quality limits in the months of May, June, July, and August.

3. **Release mine water stored in the MPTMF or A2PTMF to WSP.** The mine water stored on site may typically (but not always) require water treatment. Water treatment considerations are discussed in Section 7.4.4.

Water will only be released from the WSP to Minto Creek when the water quality complies with limits prescribed in the water use license. On-going water quality monitoring will ensure that water in the WSP remains in compliance with the water use license water quality limits. In addition, the water quality, flow, and channel conditions of lower Minto Creek must be considered before a decision is made to release water from the WSP to Minto Creek.

7.4.4 Water Treatment

Water treatment may be required if:

- Water stored in the WSP does not meet water quality limits prescribed in the water use license.
- Mine water stored in the MPTMF or the A2PTMF is to be released to Minto Creek but the water does not meet water quality limits prescribed in the water use license.

The WSP is intended as a clean water reservoir where discharge-compliant water is stored and monitored prior to release to Minto Creek. However, storm events, seepage losses from the Mill Valley or other events may cause certain water quality parameter concentrations to exceed water use license water quality limits. When treating WSP water, it may be necessary to release the treated water directly to Minto Creek from the water treatment plant rather than returning the water to the WSP. It is likely that mine water stored in the MPTMF or the A2PTMF must be treated before it can be released to the WSP.

The first stage of the water treatment plant at Minto was constructed in 2010. The water treatment process included a ballasted lamella clarifier unit (Actiflo®) system for removal of TSS, total metals and dissolved copper. The plant was designed for a maximum capacity of 3,600 m^3/day but had proved to operate reliably at flows of approximately 4,000 m^3/day.

In 2012, two reverse osmosis (RO) trains capable of handling 2,500 m^3/day per train were added to the treatment process downstream of the existing clarification and filtration units, for the purpose of treating nitrate and selenium, based on water quality limits received in the Water Use Licence Amendment 7. Treated effluent from the RO units may also be amended, when necessary, with sodium bicarbonate to adjust the pH and add salinity and alkalinity.

The RO process removes 95–99% of all constituents in the feed water. The feed water for the RO unit is the effluent from clarification and filtration unit, which is operated as a pretreatment step. The RO unit produces a clean effluent stream that consists of approximately 75% of the feed water (the RO permeate). The by-product of the process is a brine stream, which consists of about 25% of the feed water and 95–99% of constituent loadings. The brine stream will be pumped to the MPTMF or A2PTMF. Because of this brine by-product, RO cannot be considered a true water treatment process but is rather a process that concentrates mine water into a smaller volume with higher constituent concentrations.

During Phase IV, feed water for the plant could be pumped from the Main Pit reservoir or from the WSP. Treated effluent could be directed to the Main Pit, the WSP or directly to Minto Creek. Sludge or RO brine is pumped to the Main Pit for disposal. The Phase IV configuration will be maintained through the transition to Phase V/VI; until 2017, when the option of conveying water from and to the A2PTFM will be added to the conveyance network.

7.4.4.1 Water treatment limitations

Although RO is considered to be a conventional technology, the treatment process described above for removal of selenium to ultra-low concentrations (0.003 mg/L) is outside the realm of conventional technology. The use of RO alone for removal of selenium or any other constituent is, in effect, a mine water concentration process, rather than a true water treatment process. If RO alone is used for "treatment" of mine water at Minto, the brine would be pumped back to the MPTMF or the A2PTMF where the loadings removed would mix with the untreated mine water. This would result in a gradual increase in all parameter concentrations over time. If RO is used for an extended period of time, the parameter concentrations in the mine water reservoir may increase to a point where RO is no longer effective. In other words, long-term use of RO alone simply causes a gradual worsening of the mine water quality and is therefore not a sustainable water treatment method.

7.5 Proposed Changes to Water Management

Proposed changes to the WMP for Phase V/VI affect two main areas:

1. Changes to storage and conveyance requirements and systems resultant from the configuration of the new mining or waste placement areas in the Phase V/VI mine plan; and

2. Changes to the effluent quality limits and removal of the downstream water quality standards based on a review of treatment requirements, new water quality monitoring data from both the site and the lower Minto Creek watershed, and a more critical look at the potential effects from site effluent on the receiving environment.

7.5.1 Water Management Infrastructure

The Minto Mine water conveyance network consists of diversion ditches, culverts, sumps, pumps, and pipelines installed throughout the mine site. The system is designed to segregate clean runoff and mine water. Clean water is conveyed to the WSP while mine water is conveyed to the mine water storage reservoirs, which includes the Main Pit for Phase IV and the MPTFM and A2PTFM for Phase V/VI.

The mine water infrastructure conveyance infrastructure that is in place for the Phase IV operation is described in Table 7-10. Infrastructure for diverting clean runoff includes the W35a sump, south diversion ditch, tailings diversion ditch, and the 0.5 km and 1.5 km sumps and ditches. Mine water conveyance infrastructure includes the W15 sump and the W37/W36 sump.

Infrastructure planned for Phase V/VI is shown in Figure 7-1 and described inTable 7-11. Major changes to the conveyance network for the Phase V/VI expansion include:

- Further development of the Main Pit into a tailings management facility (the MPTMF), and as a reservoir for storage of mine water;
- Development of the Area 2 Pit into a tailings management facility (the A2PTMF) and as a reservoir for storage of mine water;
- Addition of mine water sumps and mine water pipelines to dewater the Ridgetop North and South pits, and a sump for the Minto North Pit;
- Additional pipelines to dewater the underground workings at portal locations;
- Addition of tailings slurry and reclaim lines from the mill to the A2PTMF and the Ridgetop North TMF;
- Modification of the tailings diversion ditch to increase capacity, and to include piping of runoff from the eastern end of the ditch to the WSP; and
- Decommissioning of the south diversion ditch and modification to the W35A collection point to allow for conveyance of several features.

The infrastructure upgrades were planned to maximize the ability to divert clean runoff away from developed mine areas and towards the WSP. The conveyance network is intended to provide a high degree of operational flexibility such that appropriate water management actions can be taken, based on informed management decisions.

Table 7-10: Minto Mine Phase IV Water Management Infrastructure.

Reservoirs	
Main Pit	The main reservoir for storage of mine water. Total capacity to the natural spill elevation is approximately 4.9 Mm^3.
Mill pond	Reservoir for storage of process water. Total capacity is approximately 5,000 m^3.
WSP	Stores clean water destined for release to Minto Creek. Total capacity is approximately 320,000 m^3.
Water Conveyance	
W15 sump	Collects runoff and seepage from the western sub-catchments on the Minto Site and conveys the water via a 24-inch pipeline to the Main Pit or WSP (see Figure 2-1).
W35a sump	Collects runoff and seepage from the southern undisturbed sub-catchments on the Minto Site and conveys the water to the Main Pit or WSP (see Figure 2-1).
W37/W36 sump	Collects and pumps Mill Valley seepage to the Main Pit.
0.5 km and 1.5 km sumps and ditches	Collects runoff from sub-catchments north of the Minto Mine access road. Runoff collected is diverted to the WSP.
South Diversion Ditch	Collects runoff from sub-catchments located south of the dry-stack tailings facility.
Area 2 Pit sump	Water collected in the area 2 Pit sump is pumped to the Main Pit via an 8-inch pipeline.
Minto South Portal sump	Water collected in the South Portal sump is pumped via a water truck to the Main Pit or an 8-inch pipeline.
Confluence	Hub located between the Main Pit and Area 2 pit where water from W15 and W35a may be directed to the Main Pit or to the WSP.
WSP Discharge	Pumps and pipes for releasing water at a rate up to 15,000 m^3/day from the WSP to Minto Creek.
Reclaim Water	
Reclaim water line from the WSP to the mill	Conveys up to 4,500 m^3/day of water from the WSP to the mill.
Reclaim water line from the Main Pit to the mill	Conveys up to 4,500 m^3/day of water from the Main Pit to the mill.
Tailings Conveyance	
Tailings line from the mill to the Main Pit	Conveys slurried tailings and water from the Mill to the Main Pit.
Water Treatment	
Water treatment plant	Accepts feed water from the Main Pit or WSP and discharges treated water to the Main Pit, WSP or Minto Creek. Sludge and brine produced in the treatment process is pumped to the Main Pit.

Table 7-11: Minto Mine Proposed Phase V/VI Water Management Infrastructure.

Reservoirs	
Main Pit	To be developed further as a tailings management facility (MPTFM).
Area 2 Pit	To be developed as a tailings management facility (A2PTMF) after completion of mining.
Mill pond	Operated as in Phase IV.
WSP	Operated as in Phase IV.
Water Conveyance	
W15 sump	Operated as in Phase IV.
W35a sump	Modified as part of the decommissioning of the south diversion ditch and diversion to the tailings diversion ditch.
W37/W36 sump	If the Mill Valley Fill Expansion extends further, the W36 sump may be relocated approximately 200 m downstream towards the WSP such that the toe of the W36 containment berm will be equal to the water storage pond dam spillway elevation.
0.5 km and 1.5 km sumps and ditches	Operated as in Phase IV.
South diversion ditch	Decommissioned; flow diverted via the tailings diversion ditch.
Tailings diversion ditch	Modified to allow for greater flow capacity, and to include piping of runoff from the eastern end of the ditch to the WSP.
Area 2 Pit sump	Operated as in Phase IV during development and mining. Developed as a TMF after completion of mining.
Minto South portal sump	Water collected in the South Portal sump is pumped to the Main Pit via an 8-inch pipeline.
Confluence	Hub located between the Main Pit and Area 2 pit where water from W15 and W35a may be directed to the Main Pit or to the WSP.
WSP Discharge	Configured as in Phase IV.
Ridgetop North sump	Runoff collected in the Ridgetop North Pit and Ridgetop North TMF is pumped to the A2PTFM.
Ridgetop South sump	Runoff collected in the Ridgetop South Pit is pumped to the MPTMF.
Minto North sump	Runoff collected in the Minto North Pit is pumped to the MPTMF.
Reclaim Water	
Reclaim water line from the WSP to the mill	Configured as in Phase IV.
Reclaim water line from the MPTMF to the mill	Configured as in Phase IV.
Reclaim water line from the A2PTMF to the mill	New reclaim line that conveys up to 4,500 m^3/day of water from the Main Pit to the mill.
Tailings	
Tailings line from the mill to the Main Pit	Conveys slurried tailings and water from the mill to the MPTMF or the A2PTMF.
Water Treatment	
Water treatment plant	Accepts feed water from the MPTMF, the A2PTMF or the WSP and discharges treated water to the MPTMF, A2PTMF, WSP or Minto Creek. Sludge and brine produced in the treatment process is pumped to the MPTMF.

7.5.2 Proposed Changes to Effluent and Water Quality Standards

The Phase V/VI WMP (Appendix J) outlines the proposed infrastructure and protocols to govern the release of water from the Minto site for Phase V/VI. The effective implementation of all previously-mentioned water management elements at the site is limited by constraints to discharge of effluent from the Minto site. In particular, water storage requirements are substantially higher on site when discharge of effluent is constrained. Water treatment requirements—technology and effort—are naturally also particularly sensitive to discharge constraints.

While Minto recognizes the importance of limitations to effluent discharge and discharge quality, certain existing discharge limitations present significant barriers to the otherwise responsible release of water from the site. These include the following limitations which were introduced in the Water Use Licence Amendment 7:

- Water quality standards in the downstream receiving environment on Minto Creek at water quality monitoring station W2; and
- Effluent quality limits for nitrate, nitrite and selenium parameters.

The specific proposed changes and supporting rationale are provided in the following sections.

7.5.2.1 Revision of Effluent Quality Limits

7.5.2.1.1 Amendment 7/8 Effluent Quality Limits

In 2009, Minto was granted an Emergency Discharge Amendment to release water that had unexpectedly accumulated in the Main Pit. Following this event, Minto commissioned a study to evaluate options for implementing a permanent water treatment plant at the mine. Shortly after the completion of the water treatment evaluation, Minto commissioned detailed design, procurement, and construction of a water treatment plant.

The water treatment plant installed at Minto in 2010 was designed to remove suspended solids and dissolved metals; in particular, copper and cadmium. The design was based on meeting effluent quality limits in effect at the time (Water Use Licence QZ96-006 Amendment 6). The total copper concentration limit of 0.01 mg/L was the primary water treatment challenge.

In June 2010, Minto applied for amended effluent quality limits. In the WUL Amendment application (Application QZ09-094 to Yukon Water Board entitled Water Management Plan), Minto applied CCME's "Use Protection Strategy" to the development of revised effluent limits. Briefly, this conservative approach involved the identification of a protection target (aquatic life in lower Minto Creek) and water quality guidelines/objectives to protect the specified use. The guidelines and objectives were then used to determine (model) effluent concentrations that would achieve the guidelines and objectives for lower Minto Creek, considering a dilution ratio based on relative catchment sizes between the mine site catchment and the entire Minto Creek catchment. These revised effluent limits and rationale were proposed in the WUL amendment application.

When Amendment 7 of the Water Use Licence came into effect in March 2011, Minto completed an evaluation of water treatment technologies that would be suitable for producing effluent that would meet the new effluent quality limits. The water treatment evaluation concluded that the main water treatment challenges would be to meet the selenium, nitrate and (to a lesser extent) nitrite limits specified in Amendment 7 (0.003 mg/L, 7.65 mg/L and 0.15 mg/L, respectively). Minto's existing plant would not be effective at removing these parameters.

The water treatment evaluation concluded that technology for treatment for nitrite and nitrate can be considered "conventional technology", although rarely implemented by the mining industry. However, treatment of selenium to the low levels of 3 ppb is challenging and outside of the realm of conventional water treatment, as well as unprecedented for mining operations in Canada.

Faced with these treatment challenges and the associated water management and discharge constraints, Minto pursued a three-pronged approach to evaluating optimizations to the management of mine water since 2011:

- Water balance approach;
- Water treatment approach, and
- Effects assessment approach.

These approaches are described in the sections following.

7.5.2.1.2 Water Balance Approach

This approach evaluated whether mine water at the Minto Site could be managed solely on the basis of "keeping clean water clean". Following this approach, runoff would be collected from relatively undisturbed sub-catchments with a history of clean runoff (i.e., water quality better than effluent quality limits) and diverted to the WSP. Here, the water quality would be monitored to ensure that the water would be suitable for release. If the water exceeded effluent quality limits, it would be held in the WSP, pumped to the Main Pit or to the water treatment plant.

A water balance study concluded that under most circumstances it likely would be possible to manage Minto's site water inventory by diverting clean runoff to the WSP. However, under some circumstances other measures would be required to ensure that sufficient water would be released from site.

However, in 2011 and 2012, Minto was not able to release water for the majority of the year even though the water on site met effluent quality limits at the mine's release point because of the water quality standards in effect at W2. At that time, water in lower Minto Creek exceeded quality standards at W2 because of loadings from a downstream tributary, which was outside of Minto's control. This resulted in an increase in the site water inventory between 2011 and 2012. At that time, Minto had no choice but to convey clean runoff to the Main Pit where impacted mine water was stored. This development resulted in a situation that rendered the water balance approach insufficient for managing the water inventory on site. Other measures had to be implemented to reduce the inventory of mine water on site.

7.5.2.1.3 Water Treatment Approach

As mentioned above, in 2011 Minto evaluated options for upgrading the water treatment plant to meet the new effluent quality limits. The most significant challenge was to identify suitable water treatment technologies that would produce effluent with very low selenium concentrations (less than 0.003 mg/L). In addition, treatment options considered were to meet the following basic list of criteria:

- Proven technology for mine water treatment;
- Suitable for northern operations (i.e., not highly complex nor difficult to operate);
- Should not produce deleterious by-products (i.e., solve one problem but create another);
- Require a relatively short lead-time for delivery and ramp-up; and
- Non-prohibitive in terms of capital and operating costs.

The evaluation concluded that no one existing technology would meet all listed criteria. Conventional options for true selenium treatment include ferric co-precipitation and biological treatment. However, these options have historically been implemented to treat feed water with selenium concentrations that are orders of magnitude higher than the expected feed water at Minto (estimated between 0.006 and 0.01 mg/L). In fact, conventional options typically aim to produce effluent with selenium concentrations in the 0.01 to 0.03 mg/L range. Therefore, it would be necessary to combine conventional water treatment with RO to achieve the effluent quality limit for selenium. One such option was to combine RO with anaerobic water treatment. Another option under consideration was ion exchange coupled with biological treatment, but this technology was still at the development stage with no examples of full-scale applications. Both cases would result in complex and very costly water treatment systems.

Reverse osmosis (RO) was identified as an option that would enable Minto to produce WUL-compliant effluent in the short term until a long-term option could be developed. As previously detailed in section 7.4.4 Water Treatment, Minto chose to procure and install an RO unit as a short-term mitigation measure with awareness of the limitations of the technology. The RO plant filters out dissolved water quality parameters but does not remove them; they are returned to the feed water reservoir (the Main Pit, in this case). As a result, operating the RO plant over time will gradually decrease the inventory of water in the pit but will cause water quality parameter concentrations to increase proportionally. Rather than "treating" the pit water, the water simply becomes more concentrated over time. Thus, while RO offers a short-term solution to the water management challenge faced by Minto, it was recognized that the solution is not suitable in the long term, and that a re-evaluation of the effluent limits should be undertaken.

7.5.2.1.4 Effects Assessment Approach

Although the generic CWQGs are recognized as being protective of the most sensitive species and life stages of aquatic life, it is recognized that there are other modifying factors to toxicity and exposure in the receiving environment which have the potential to introduce excessive and unnecessary conservatism in the effluent limits developed based on CWQGs alone. As a re-evaluation of the "Use Protection Strategy" used in effluent limit development in 2009 (relying strictly on water quality objectives and guidelines to test for effects in the receiving environment), Minto initiated an evaluation of the potential effects of releasing water with parameter concentrations greater than the effluent quality limits defined in the WUL Amendment 7.

Minto first identified the particular parameter effluent limits which necessitated the direction of otherwise acceptable runoff water to the pit and ultimately to treatment. These parameters were identified as:

- Nitrite ($N\text{-}NO_2$) – effluent limit 0.15 mg/L;
- Nitrate ($N\text{-}NO_3$) – effluent limit 7.65 mg/L; and
- Selenium (Se) – effluent limit 0.003 mg/L.

Secondly, a historical data review was conducted to identify any other limits which have been exceeded or almost exceeded by otherwise discharge-ready water in the Water Storage Pond. These parameters/limits were:

- Ammonia (NH_4) – effluent limit 0.89 mg/L; and
- Cadmium (Cd) – effluent limit 0.00015 mg/L.

Based on these initial steps, the water treatment team proposed alternative effluent limits for these five parameters that would provide the mine with greater flexibility in managing site runoff and release water, and enable them to keep to the principles of the water management plan for the site—namely, to avoid the mixing of impacted water and site runoff where possible. These preliminary limits were translated into conservative water quality estimates for lower Minto Creek by assuming effluent release at exactly the proposed limit and applying a dilution ratio of 3:1.

These water quality estimates were then evaluated specifically for potential effects to the documented resources in lower Minto Creek in a screening evaluation, in the context of the actual observed conditions (geochemical, physiological, and biological) in lower Minto Creek's receiving environment. In contrast to the 2009 approach where the generic water quality guidelines or site-specific water quality objective concentrations were used as the only "test" for anticipated effects to aquatic resources, the effects assessment team incorporated more relevant considerations into the evaluation, including:

- Aquatic environment character: erosional system, naturally elevated contaminant concentrations, marginal habitat, limited productivity, etc.;
- Modifying factors to toxicity: hardness, pH, temperature, dissolved organic carbon, and chloride; and
- Resource Use: duration and nature of use, species distribution, and life stage, etc.

This screening evaluation was re-evaluated once the water quality predictions for lower Minto Creek were finalized, based on the comprehensive water and load balance model developed for the Phase V/VI assessment (as presented in Appendix K and summarized above). The predicted water quality incorporates all the appropriate elements of the project proposal (i.e., waste deposition and water management) and the natural catchment conditions represented in the water balance, across a range of conditions and under a number of cases.

Section 8 presents an evaluation of potential effects of predicted water quality at lower Minto Creek (Station W1, analogous to Station W2). The effects assessment provides an evaluation of the nature and significance of potential effects from certain key prediction scenarios (expected case and reasonable worst case, upper limit conditions). The effects assessment also evaluates the potential effects from periodic site treatment or management upset conditions whereby site discharge may exceed upper limit predictions for short durations. In all anticipated cases under the proposed water management plan, with the proposed mitigations and discharge standards in place, a reasonable determination of no anticipated significant adverse effects to aquatic life was concluded.

7.5.2.1.5 Proposed Effluent Quality Limits

The results of the initial aquatic life effects assessment was used along with operational considerations to develop the proposed effluent quality limits shown in Table 7-12. The effects assessment screening evaluated targets for long-term effluent water quality in the form of expected case concentrations. These concentrations were then adjusted according to standard operability practices. Treatment plant operations may occasionally experience short-term fluctuations in performance because of changing feed water conditions, because of minor upsets or when optimizing the plant operation. Therefore, water treatment plants typically define operating effluent quality targets that are 30% to 50% lower than the regulatory effluent quality limits. Operating at these lower effluent targets allows for occasional short-term effluent quality fluctuations without exceeding effluent quality limits. In other words, the proposed limits should *not* be viewed as the target operating limits but rather as limits that are not to be exceeded even by short-term fluctuations in effluent quality.

Based on the considerations discussed above, and on the results of the effects assessment evaluation conducted (see Section 8), as part of the Phase V/VI Project, Minto is proposing amendments to the effluent quality limits currently stipulated in Water Use License QZ96-006 for parameters as compared in the table below:

Table 7-12: Comparison of Existing and Proposed Effluent Quality Limits in Water Use Licence QZ96-006.

		Water Use Licence QZ96-006 Amendment 8				Proposed Water Use Licence Limits		
		Water Treatment Plant Effluent Discharge to Minto Creek	**Freshet[A] at W50 and W17**	**Non-Freshet at W50 and W17**	**Non-Freshet at W2**	**All Discharge from Site (Freshet)**	**All Discharge from Site (Non-Freshet)**	**Proposed WUL Limits for Non-Freshet at W2**
pH	units	6.5 to 9.0	6.5 to 9.0	6.5 to 9.0	6.5 to 9.0	No Change	No Change	**No Standard**
Ammonia	mg/L	0.89	0.89	0.89	0.35	**1.5**	**1.5**	**No Standard**
N-NO2	mg/L	0.15	0.15	0.15	0.06	**0.7**	**0.7**	**No Standard**
N-NO3	mg/L	7.65	7.65	7.65	2.9	**30**	**30**	**No Standard**
Oil and Grease		none visible	none visible	none visible	none visible	No Change	No Change	**No Standard**
Total Suspended Solids	mg/L	15	30	15	-	No Change	No Change	**No Standard**
Phosphorus (total)	mg/L	-	-	-	0.02	No Change	No Change	**No Standard**
Aluminum (total)	mg/L	2.7	2.7	2.7	0.62	No Change	No Change	**No Standard**
Arsenic (total)	mg/L	-	-	-	0.005	No Change	No Change	**No Standard**
Cadmium (total)	mg/L	0.00015	0.00015	0.00015	0.00004	**0.0003**	**0.0003**	**No Standard**
Chromium (total)	mg/L	0.008	0.008	0.008	0.002	No Change	No Change	**No Standard**
Copper (total)	mg/L	0.05	0.08	0.05	0.013	No Change	No Change	**No Standard**
Iron (total)	mg/L	3.5	3.5	3.5	1.1	No Change	No Change	**No Standard**
Lead (total)	mg/L	0.02	0.02	0.02	0.004	No Change	No Change	**No Standard**
Molybdenum (total)	mg/L	0.4	0.4	0.4	0.073	No Change	No Change	**No Standard**
Nickel (total)	mg/L	0.5	0.5	0.5	0.11	No Change	No Change	**No Standard**
Selenium (total)	mg/L	0.003	0.003	0.003	0.001	**0.02**	**0.02**	**No Standard**
Zinc (total)	mg/L	0.15	0.15	0.15	0.03	No Change	No Change	**No Standard**

Notes:
[A]April 1 to May 31

7.5.2.2 Removal of Water Quality Standards for Lower Minto Creek (Station W2)

In the application to amend Water Use Licence QZ96-006 (Application QZ09-094 to Yukon Water Board entitled Water Management Plan) in June 2010, Minto applied a use protection strategy (CCME 2003) to the development of effluent limits. Briefly, the approach involved the identification of a protection target (aquatic life in lower Minto Creek) and water quality guidelines/objectives to protect the specified use. The guidelines and objectives were then used to determine (model) effluent concentrations that would achieve the guidelines and objectives for lower Minto Creek.

Under Amendment 7 of the Minto Mine Water Use Licence, YWB accepted the effluent limits proposed by Minto for station W50, but also adopted the generic and site-specific water quality guidelines/objectives as standards for the receiving environment Station W2 in lower Minto Creek. The Water Board felt that this was required by Condition 4 in the decision document, which states:

> "The amended water use licence [shall] specify a suitable water quality standard to be applied at the receiving environment compliance point. It is further recommended that the water quality standard be protective of the most sensitive life stage of representative species, include all contaminants of potential concern, and consider chronic toxicity (as opposed to acute toxicity) and inhibitory effects on fish olfactory senses."

Based on conventional definitions and application of water quality standards, water quality guidelines, and water quality objectives, these are not inter-changeable. For example, Minto Mine water quality objectives for aluminum, iron, chromium and copper were based on available water quality monitoring data that represent a background/reference condition, using an approach consistent with national guidance (CCME 2003). This approach involves the calculation of 95th percentile background concentrations; concentrations which will naturally be exceeded at an average frequency of 5%. Furthermore, to eliminate the clear leveraging effect of occasional high total suspended solids on the concentrations of these metals, the objectives were calculated as 95th percentiles following the removal of all data with a TSS concentration greater than 50 mg/L (Minnow 2009). This approach was implemented with the rationale that the objectives would provide a precautionary means of distinguishing concentrations (either within the natural range (lower than the objective) or not within the natural range (greater than the objective)) and that require further investigation to determine whether they were mine-associated. In fact, their intended use was clearly set out during initial development (Minnow 2009):

> "It is further recommended that exceedance of these SSWQOs at a rate of 10% or more (or identification of an unusually high concentration or a known cause), is used to trigger more detailed examination of the data including comparison to background concentrations of dissolved metals, comparison to the relationships between background concentrations of total metals and TSS, and comparison to the results of the water effect ratio procedure for copper at hardness of 120 mg/L or greater."

Furthermore, Minnow (2009) recommended that the SSWQOs be adopted for use in Minto Creek "…applicable at TSS concentrations less than 50 mg/L…" The adoption of the objectives as standards is problematic due to the fact that the objectives were proposed as numbers that were expected to be exceeded at a low frequency (but to identify conditions that warrant further consideration) and there is a virtual certainty of natural exceedance. This is particularly the case with higher TSS events which were observed more frequently in lower Minto Creek in 2011 and have been documented consistently in the absence of direct mine effluent discharge. Figure 7-2 shows TSS concentrations measured at W2 between 2005 and 2012 during non-discharge periods, to compare to a reference monitoring station in the McGinty Creek catchment, located directly to the west of Minto Creek, for 2009 to July 2012.

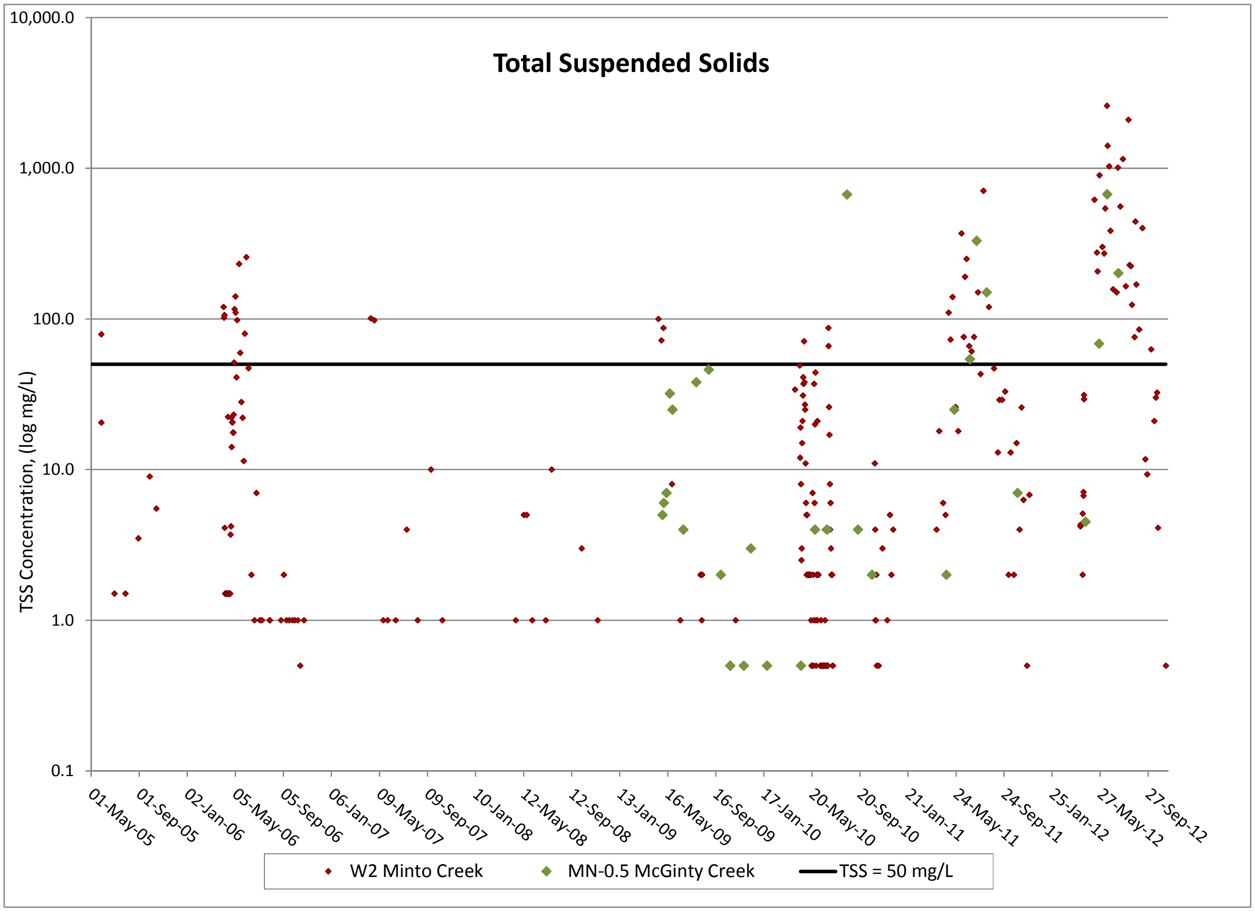


Figure 7-2 Total suspended solids concentrations from W2 in lower Minto Creek and MN-0.5 reference station on McGinty Creek: 2005–2012.

In 2011, TSS levels in both catchments continued to rise after spring freshet through the summer months, exceeding 50 mg/L several times; a common trend originally attributed to substantial rainfall/runoff events experienced that year. Further monitoring and investigations, however, have identified a natural TSS source downstream of the mine in Minto Creek (see below for discussion).

Table 7-13 below is from Table E.2 from Minnow 2009 (Application of Potential SSWQOs to the Water Quality of lower Minto Creek Station W2; all TSS values) which was part of the Application QZ09-094, and shows that even during 2005-2008, the 2009 SSWQOs were exceeded frequently when all non-discharge period data from station W2 were considered. That is, application of the SSWQOs would result in up to 19% of the values requiring more detailed examination as described above.

Table 7-13: W2 Exceedances of SSWQOs during Non-Discharge Condition from 2005–2008. (Table E.2, Minnow 2009)

Parameter Units	**Al-T** **mg/L**	**Cr-T** **mg/L**	**Cu-T** **mg/L**	**Fe-T** **mg/L**
2009 SSWQO	0.62	0.002	0.013	1.1
	W2 2005-2008 (No Discharge)			
Count	83	83	83	83
Count Over SSWQO	16	14	7	16
% Over SSWQO	19%	17%	8%	19%

The same comparison of SSWQOs and Canadian Water Quality Guidelines applied as licenced standards with non-discharge period W2 data for 2009–2010 returned similar exceedance results, as did the W2 data in 2011-2012 with no active discharge. These comparisons are presented in Table 7-14 below.

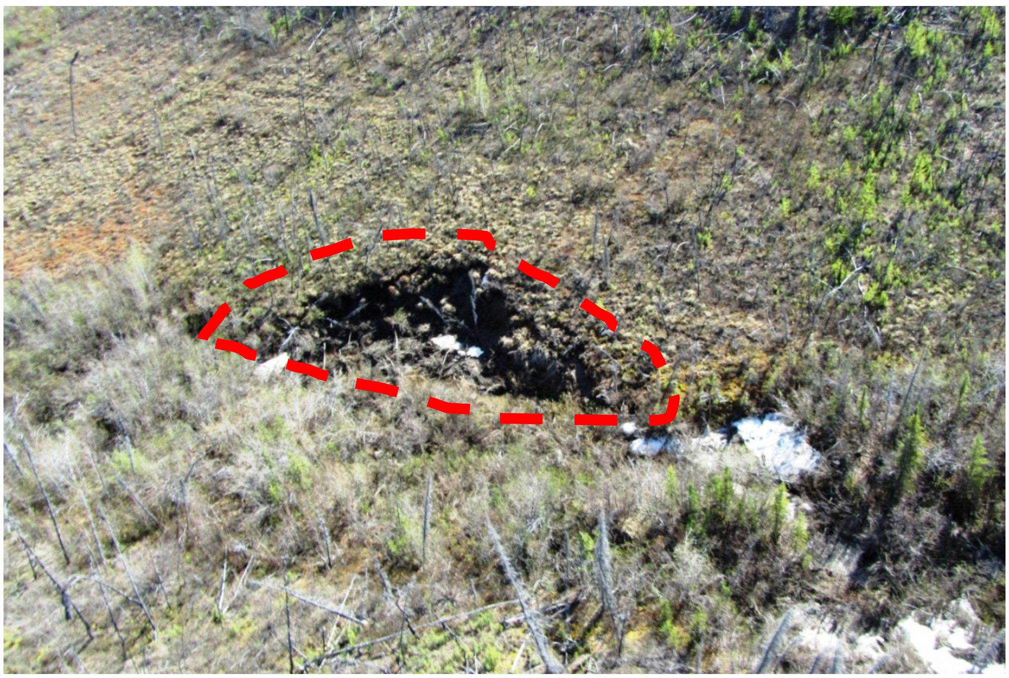
Table 7-14: W2 Exceedances of 2009 SSWQOs in Non-Discharge Periods 2009-2010, and W2 Exceedances of Clause 57 Limits in 2011-2012.

Parameter Units	Al-T mg/L	Cr-T mg/L	Cu-T mg/L	Fe-T mg/L
2009 SSWQO	0.62	0.002	0.013	1.1
	W2 2009-2010 (No Discharge)			
Count	105	105	105	105
Count Over SSWQO	16	8	8	15
% Over SSWQO	15%	8%	8%	14%

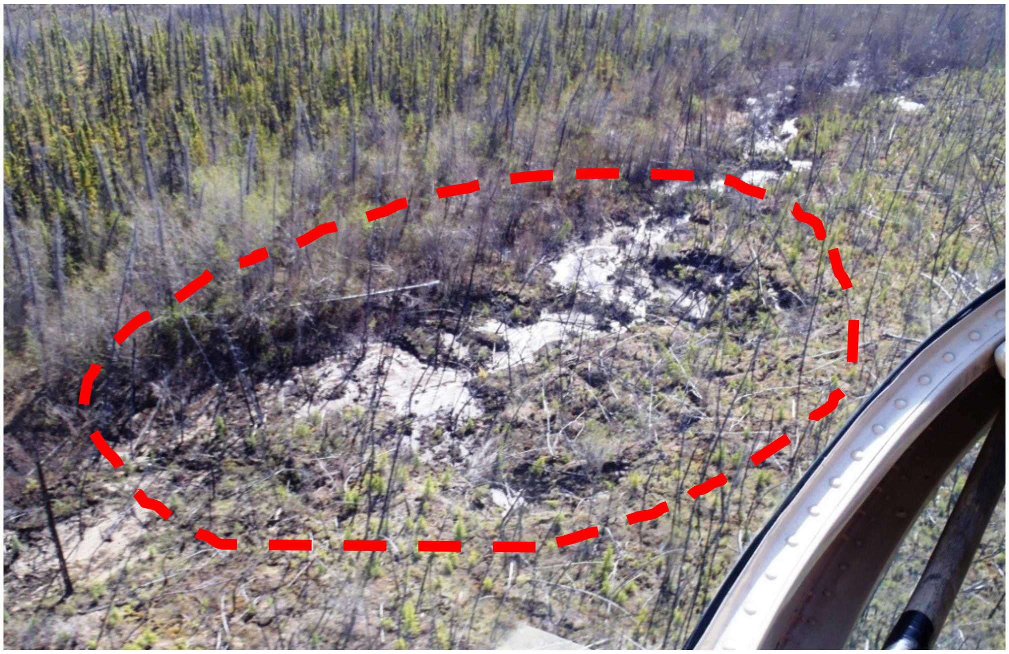
	W2 2011 - 2012 (Non-Freshet)														
Parameter Units	Al-T mg/L	Cr-T mg/L	Cu-T mg/L	Fe-T mg/L	As-T mg/L	Cd-T mg/L	Mo-T mg/L	Ni-T mg/L	Pb-T mg/L	P-T mg/L	Se-T mg/L	Zn-T mg/L	N-NO2 mg/L	N-NO3 mg/L	Ammonia mg/L
W2 Non-Freshet WUL	0.62	0.002	0.013	1.1	0.005	0.00004	0.073	0.11	0.004	0.02	0.001	0.03	0.06	2.9	0.35
Count	56	56	56	56	56	56	56	56	56	55	56	56	56	56	53
Count Over Standard	36	30	16	40	8	32	0	0	9	50	0	10	0	0	0
% Over Standard	64%	54%	29%	71%	14%	57%	0%	0%	16%	91%	0%	18%	0	0	0

Further monitoring of these key stations and the continuation of the water quality trend in lower Minto Creek is documented in *Minto Creek Water Quality Characterization* (Appendix G).

This report briefly discusses the identification of the source of the TSS loading from a middle tributary of Minto Creek—downstream of the area of influence and control of the mining operations. A natural slumping of soil materials into the creek channel in the headwaters of a southern tributary to Minto Creek was identified in several separate locations during an aerial survey with representatives of SFN Lands Department on May 24, 2012. Photographs 7-1 and 7-2 below outline two of the failure areas in red.



Photograph 1: Natural Soil Slumping into Tributary Downstream of Minto Mine.



Photograph 2: Additional Natural Soil Slumping into Tributary Downstream of Minto Mine.

TSS loading from these sources was observable to the naked eye (and supported in water quality monitoring) from this area along the entirety of the tributary and from the confluence of the tributary with Minto Creek all the way to the mouth of Minto Creek.

This report also includes the results of the redevelopment of the Minto Creek background data set at two points in time: at the end of 2010 and at the end of 2012. The comparison of the summary statistics from these two data sets is striking and illustrative of the changed nature of the background conditions of Minto Creek. The two pooled background data sets (2010 and 2012) differ only in the inclusion of additional W7 data and—more importantly—data from 2012 sampling of new stations C4 and C10 downstream of recently-identified natural TSS loading sources discussed above.

Minto cannot be responsible for natural elevations in water quality constituents. The water quality standards set in Clause 57 of the WUL are at levels frequently exceeded under natural conditions in Minto Creek and in the absence of any active effluent discharge from the mining operations. However, there is no mechanism in the license that accounts for those natural system contributions. These elevated concentrations in Minto Creek will place the mine and its management in a position of non-compliance with Clause 57 of the Water Use License if they actively discharge effluent, *regardless of quality*. This has resulted in most runoff water during 2011, 2012 and to date in 2013 being stored on site (in the Water Storage Pond and Main Pit). The only discharge during the 2011-2013 period has been during the freshet period (April 1 – May 31) when the W2 water quality standards are not in effect.

This is clearly an unsustainable operational condition for the site, and contravenes all the principles upon which the water management plan for the site has been developed in recent years—preventing mixing of relatively clean and impacted runoff streams, and discharging runoff from site as soon as possible after it reports to control structures, etc.

8 Aquatic Resources Effects Assessment and Management

8.1 Existing Conditions

A complete report on Aquatic Resources is presented in the *Aquatic Resources Baseline Report* (ACG 2012) (Appendix L), which constitutes an update to EBA's 2010 report. A summary of the key findings of ACG's report is presented in the sections below.

The Minto Mine region includes the Yukon River and its smaller tributaries, including 7 km upstream to Big Creek and 13 km downstream to Wolverine Creek. The local study area related to the Minto Mine centres on three small drainages in the mine area that drain directly to the Yukon River: Minto Creek, Creek A, and McGinty Creek (Figure 6-1).

8.1.1 Minto Creek

Minto Creek, with its headwaters in the mine area, is the primary drainage affected by Phase V/VI. Minto Creek flows northeast from the existing mine site ~17 km to the Yukon River, and covers an approximate area of 41 km^2. The creek has five primary tributaries along its length, and flows through large tracts of land that have been recently influenced by forest fire. Water from the mine area flows into the upper reaches of Minto Creek through the water storage pond and other conveyances. Investigations into Minto Creek have found it to be generally shallow, ephemeral in nature, and to have frequent build-ups of layered ice during the winter (sometimes to the substrate).

8.1.2 Creek A

Creek A is a small watercourse that drains an area adjacent to the Minto Mine access road and the Yukon River. The headwaters of Creek A originate approximately 4 km southeast of Minto Creek and flow for 7 km along a riparian floodplain into the Yukon River. The drainage area of Creek A is traversed by the Minto Mine access road, including one direct watercourse crossing.

8.1.3 McGinty Creek

McGinty Creek (formerly referred to as Unnamed Creek B) is located to the north of Minto Creek and flows north-northeast for 9.5 km to the Yukon River confluence. Minto North Pit, which is to be mined as part of Phase V/VI, is located near McGinty Creek headwaters and within the McGinty Creek catchment area.

8.1.4 Fish and Fish Habitat

8.1.4.1 Regional Overview

Yukon River

A variety of resident and migratory fish species inhabit the Yukon River near Minto Mine. These include Chinook, Coho and chum salmon, lake trout, least cisco, Bering cisco, round whitefish, lake whitefish, inconnu, Arctic grayling, northern pike, burbot, longnose sucker, and slimy sculpin.

Previous studies on the Yukon River within the vicinity of Minto Mine have identified both spawning and rearing areas for salmon. Spawning shoals are present in the Ingersoll Islands (downstream of the Project area) as well as around islands upstream of Minto Mine, near Big Creek. These offer an extensive network of side channels and sloughs which provide good spawning gravel.

This portion of the Yukon River also provides rearing habitat for Chinook salmon, as evidenced by past studies in the Project area. Juvenile Chinook salmon (JCS) generally spend up to 1.5 years feeding and growing in fresh water tributaries prior to out-migrating to the ocean, and feed or stage in various tributaries to the Yukon River during this slow out-migration. Usage of the Project area tributaries by JCS is outlined further below.

As outlined in Appendix L, Yukon River salmon runs have observed moderate variability over the last 50 years; however, there has been a general decrease in salmon returns over the last ten to fifteen years. Chinook returns began to drop markedly beginning in 1998, and poor runs are still observed to this time. Chum salmon returns demonstrated a marked reduction in 1997 through 2002, but have been demonstrating trends that are more positive for summer and fall since 2001 and 2003, respectively.

8.1.4.2 Local Fish Habitat Investigations

Minto Creek

Fish and fish habitat studies of Minto Creek have been ongoing for many years, with contemporary studies including those from 1994 through to 2012. A summary of effort and catches is presented in Table 8-1 while complete results can be found in Appendix L. Generally, Minto Creek has been noted to provide only limited habitat to fish. Flows within the stream are quite variable on a yearly basis, with intermittent flows and extensive ice build-up during winter that limits the potential for overwintering habitat for fish. Also, the distribution of fish within Minto Creek has been observed to be limited to the lower 1.5 km of the watercourse, as there is a barrier and steep canyon upstream of that location. As noted above, Chinook salmon, slimy sculpin, Arctic grayling, longnose sucker, burbot, and round whitefish have been captured in Minto Creek; however, the latter have not been observed since the original baseline studies in 1994. Slimy sculpin have been observed consistently, but at a low density.

During baseline studies, it was noted that trends in annual Chinook salmon occurrence in Minto Creek can be related to water temperature on a seasonal basis. During the early summer (e.g., May/June), the occurrence of JCS has been low, with individuals captured more frequently near the Yukon River confluence. Catches in July, August, and September have generally been higher; presumably, because out-migrating Chinook seek out non-natal tributaries as foraging habitat and cover. During the summer of 2009, there was a marked increase in Chinook salmon captures which coincided with an emergency release of water from the Minto Mine tailings dam (catch per unit effort (CPUE) of at least three times the previous highest catch records). Similarly, high numbers of JCS were captured in 2010, when the mine was discharging water into Minto Creek. It is believed that the stable, elevated flow and warmer, more consistent temperature regime (i.e., a narrower diurnal temperature fluctuation) associated with the release may have attracted JCS into the system from the Yukon River. In response to the observed high density of JCS in Minto Creek during these releases, a fish transfer program was initiated during the fall of 2009 and 2010 to prevent these fish being stranded by the onset of winter.

Creek A

Creek A was investigated during the 1994 baseline study program at the Project site, at which time no fish were observed or captured (including a site at the road-crossing location). Creek A is not considered to offer high quality habitat for fish.

McGinty Creek

Arctic grayling and slimy sculpin were captured in McGinty Creek in 1994, through electrofishing and minnow trapping. Because substantial deadfall caused by a forest fire changed creek conditions, only minnow trapping was used in 2009–2011, yielding very low numbers of slimy sculpin. Since these captures were consistently made in close proximity to the Yukon River, these fish were presumed to be associated with the Yukon River, as opposed to McGinty Creek. These results are similar to those found in the 1994 survey, in that fish were only captured in close proximity to the Yukon River confluence. The physical nature of the McGinty Creek drainage is not conducive to a consistent year-round use by fish. Many factors, including gradient, discharge volume, depth, configuration, and paucity of an upstream reservoir, limit wintering habitat potential for fish. Also, several potential natural fish barriers were observed and documented in the lower reach of McGinty Creek.

Table 8-1: Minto Fish Habitat Studies: 1994-2012.

Study Timing		Study Type	Minto Creek		Creek A		McGinty Creek	
Year	Month		Effort	Catches	Effort	Catches	Effort	Catches
1994	June	Baseline Environmental Studies	EF, MT	Rw, Ss	EF	-	EF, MT	Ss, Ag
	August	Baseline Environmental Studies	EF, MT, A	Ss, Ag	EF	-	EF, MT	Ss, Ag
	September	Baseline Environmental Studies	EF, MT	Ag	EF	-	EF	-
2006	September	Baseline / Permitting	MT	-	-	-	-	-
2007	May	Baseline / Permitting	EF, MT	Cs	-	-	-	-
	June	Baseline / Permitting	EF, MT	Cs, Ss	-	-	-	-
	August	Baseline / Permitting	MT	Cs, Ag, Ss	-	-	-	-
	September	Baseline / Permitting	MT	Cs	-	-	-	-
2008	June	EEM, Cycle 1	EF, MT	-	-	-	-	-
	September	EEM, Cycle 1	EF, MT	Cs	-	-	-	-
2009	May	Baseline, Minto North	-	-	-	-	MT	Ss
	June	Baseline, Minto North	MT	-	-	-	MT	Ss
	July	Ongoing Monitoring	MT	Cs, Ss	-	-	-	-
	September/ October	Fish Relocation, Minto North	-	-	-	-	MT	-
2010	June	Mark-Recapture Study	MT	Cs, Ss	-	-	-	-
	July	Mark-Recapture Study, Minto North	MT	Cs, Ss	-	-	MT	Ss
	August	Mark-Recapture Study	MT	Cs, Bb, Ag	-	-	-	-
	September	Mark-Recapture Study	MT	Cs, Bb, Ss, Ag	-	-	-	-
	October	Mark-Recapture Study	MT	Cs, Bb	-	-	-	-
	November	Fish Relocation	MT	Cs	-	-	-	-
2011	July	Ongoing Monitoring	MT	Cs, Ss	-	-	-	-
	August	Ongoing Monitoring	MT	Cs, Ls	-	-	-	-
	September	Ongoing Monitoring, Minto North	MT	Cs, Ss, Ls	-	-	MT	-
	October	Ongoing Monitoring	MT	Cs, Ss	-	-	-	-
2012	June	Ongoing Monitoring	MT, EF	Ss, Ag	-	-	-	-
	July	Ongoing Monitoring	MT	Ss	-	-	-	-
	August	Ongoing Monitoring	MT	-	-	-	-	-
	September	Ongoing Monitoring	MT	Cs, Ss	-	-	-	-

Effort: EF=backpack electrofishing, MT=minnow trapping, A=angling
Catches: Cs=Chinook salmon, Ag=Arctic grayling, Ss=slimy sculpin, Rw=round whitefish, Bb=burbot, Ls=longnose sucker

8.1.5 Aquatic Environment and Habitat

8.1.5.1 Stream Sediments

Stream sediments were studied for particle size and metal concentrations in 1994, and annually since 2006. Sediment particle size distribution was notably different when comparing earlier sampling years to more recent years. The change in distribution from 1994–2009 compared to 2010–2012 reflects methodological changes that were implemented in 2010. Sediment metal concentrations were also complicated by the change in methodology. With this qualification in mind, concentrations of arsenic, copper, and occasionally chromium exceeded the interim sediment quality guideline (ISQG) levels over the years but not greater than the probable effect level (PEL). Copper was the only metal that consistently exceeded guideline levels every year, including during baseline sampling in 1994. This could indicate that there are naturally high levels of copper at the exposure area. Arsenic was above the ISQG in most sampling years except during baseline sampling in 2007 and 2009.

Additional detailed results for sediment physical and chemical parameters are available in Appendix L.

8.1.5.2 Benthic Invertebrate Community

Benthic macroinvertebrates (benthos) are non-backboned animals inhabiting the bottom substrates of aquatic habitats. The abundance, diversity, and taxonomic composition of benthos can be used as indicators of changing environmental conditions as their distribution and abundance can be influenced by a wide variety of physical parameters. Baseline and numerous other benthic invertebrate studies were undertaken in the Minto Mine area from 2006–2012.

Basic results of the 2008 and 2011 environmental effects monitoring (EEM) benthic analyses indicated that Minto Creek (treatment) had a significantly higher benthic invertebrate density and slightly lower number of taxa (not significant) compared to McGinty Creek (reference). The 2011 EEM benthic results show that Minto Creek had significantly higher number of taxa and higher density compared to both reference sites. Increased taxa, higher density, and lower evenness are indicative of a site that is experiencing nutrient enrichment.

Under the terms of Minto's Water Use License #QZ06-006, benthic macroinvertebrate communities are required to be annually monitored in Minto Creek. In 2011, the mean number of taxa in lower Minto Creek was less than in the reference area in lower Wolverine Creek and less than the 1994 baseline (this result is contrary to the 2011 EEM results, but could be explained by the use of a different reference site, or by temporal variability). However, the 2011 count was an increase over that measured in 2006, another year that the mine did not discharge. Changes in density and evenness over time likely reflected high temporal variability of benthic invertebrate communities in the region, also evident at reference areas.

A detailed report on Minto Creek sediment, periphyton and benthic invertebrate community was prepared by Minnow (2012) and is presented in Appendix F of Appendix L.

8.1.5.3 Periphyton

Periphytic algae are simple aquatic plants which inhabit the substrate of water bodies. They can provide a valuable biological monitoring tool to assess potential impacts of nutrient enrichment and metal toxicity. Chlorophyll a is the primary photosynthetic pigment common to all algae. Determining chlorophyll a concentrations provides a measure of algae biomass and thus, the primary productivity of a given location. Periphyton was sampled in 1994, 2011, and 2012, in Minto Creek (exposure) and Wolverine Creek (reference). Overall, the periphyton community of lower Minto Creek relative to lower Wolverine Creek had lower density and taxon richness. Periphyton communities of lower Minto Creek and lower Wolverine Creek in 2011 both differed from the community documented at lower Minto Creek in 1994.

Detailed results and analysis are presented within Appendix L (specifically appendices F and I to Appendix L).

8.2 Context for Potential Effects Characterization and Assessment

The protection of fisheries and aquatic resources through the protection of the aquatic environment (primarily water quality and quantity) is an important objective for Minto in the development of Phase V/VI of the Minto Mine. Activities associated with Phase V/VI have the potential to alter certain chemical and physical conditions within Minto Creek or McGinty Creek. Potential effects and associated mitigations are discussed in the following sections, as well as the context in which they should be evaluated.

When evaluating potential effects of the Project on aquatic resources of Minto Creek and McGinty Creek, it is important to consider the extent (magnitude and frequency) of potential exposure. Given that Minto Creek and McGinty Creek do not constitute preferred habitats for fish, as described in the Aquatic Resources Baseline Report (presented in Appendix L and summarized below), fish exposure to any potential effect in these two creeks is limited.

8.2.1 Minto Creek Fish Investigations

Numerous fish-related investigations have been undertaken in Minto Creek for various purposes, and are listed in Table 8-2 below.

Table 8-2: Minto Creek Fish Investigations.

Year	Months	Purpose of Study	Conducted by
1994	June, August, September	Baseline collection	Hallam Knight Piesold (HKP)
2006	September	Baseline collection	Access Consulting Group (ACG)
2007	May, June, August, September	Environmental Effects Monitoring study design development	ACG / Minnow Environmental Ltd. (MEL)
2008	June, September	Environmental Effects Monitoring, Cycle I	ACG / Minnow
2009	June, July	Monitoring	ACG
2009	September, October	Fish re-location	ACG
2010	June, July, August, September, October	Juvenile Chinook salmon mark-recapture program, compliance monitoring	ACG
2011	July, August, September, October	Environmental Effects Monitoring, Cycle II; compliance monitoring	ACG / Minnow
2011	July, August	EEM – growth trials	ACG / Minnow
2012	May, June, July, August, September	Compliance monitoring, Se in tissue study	ACG / MEL

8.2.2 Key Fish and Fish Habitat Information for Minto Creek

8.2.2.1 Minto Creek Fish Community Characteristics

JCS comprise 97% of fish using the system, as determined by the above investigations (2,565 of 2,634 fish captured between 1994 and 2012). Other species encountered during sampling events include: round whitefish, Arctic grayling, slimy sculpin, longnose sucker and burbot. Of these additional species, only slimy sculpin have been captured on a regular basis.

JCS have never been encountered in the creek before July and their numbers tend to peak in late August or early September. Moreover, the mark-recapture investigation conducted in 2010 on JCS (ACG 2010b), indicates that use of the creek is transient (the majority of JCS using Minto Creek stay in the system for less than two or three weeks). Spawning has never been observed in Minto Creek, nor is it expected, given the substrate and morphological attributes of the system.

JCS presence in Minto creek was observed to be influenced by mine water discharge (ACG 2010b). During non-discharge periods, and prior to operations (baseline), numbers of JCS and other species of fish in the system were found to be very low. In contrast, during the two major discharge events (in 2009 and 2010), numbers of JCS were 32 to 175 times higher (Table 8-3), indicating that they may have been attracted into the system as a result of the discharge. The density of other fish species during discharge events did not increase.

Table 8-3: Maximum Catch per Unit Effort (CPUE) of Juvenile Chinook Salmon in Minto Creek using Baited Minnow Traps: 1994-2012.

Year	Month	JCS – CPUE (#fish/trap-day)	Minto Creek Conditions
1994	September	0	Predevelopment – no discharge
2006*	September	0	Preoperational – no discharge
2007**	June	4.8	Preoperational – no discharge
2008	September	0.91	Operational – no discharge
2009	September/October	13.6	Discharge
2010	August	33.2	Discharge
2011	September	0.43	No discharge – high TSS contribution from tributary
2012	September	0.19	No discharge – high TSS contribution from tributary

**Very minimal trapping effort*
*** Fish captured presumed to be associated with the Yukon River, due to the location of captures*

A hatchery based fish (JCS) study, conducted as part of the Cycle 2 EEM program, indicated that Minto Creek water mixed with mine effluent (at a concentration comparable to conditions in lower Minto Creek) provided a condition that slightly enhanced growth as compared to water derived from an artesian spring that is used as the water supply at the hatchery facility where the exposure trials were conducted (Minnow and ACG 2012).

8.2.2.2 Minto Creek Fish Habitat Characteristics

Minto Creek freezes in the winter and therefore is not a viable habitat for overwintering or for fall spawning. Lower Minto Creek is also periodically subject to low- or zero-flow conditions during periods in the summer when a portion (or all) of the flow infiltrates the ground following passage through a canyon located approximately 2.0 km upstream of the Yukon River. A natural barrier to fish passage exists approximately 1.2 km upstream from the Yukon River, limiting fish use to the reach downstream of the barrier. This barrier is largely comprised of woody, large organic debris (LOD) and can be considered to be temporary as it will likely degrade over the short-term. New temporary barriers however may be established in any given year and could occur both upstream and further downstream of the current barrier location. However, a canyon located upstream of the current barrier is a permanent barrier to fish passage, due to its high gradient (21%), thus limiting fish habitat to the lower 2.0 km of the system.

Water temperature tends to remain cooler in Minto Creek than in the Yukon River until late June or early July. This likely deters fish, in particular JCS, from entering the system until creek temperatures equilibrate with the Yukon River. Minto Creek is subject to large diurnal fluctuations in temperature (up to 5°C or more) throughout the open water season. This daily variation is not ideal for fish and may limit their interest in using the creek for rearing.

Minto Creek bottom substrate is comprised mostly of fines (silt/sand) with limited sections of cobble/gravel (which are more desirable for fish). Accordingly, bottom substrate at the mouth of Minto Creek and at the Yukon River confluence does not provide suitable habitat for salmonid spawning (Arctic grayling, Chinook salmon, etc.), which is confirmed by the fact that no spawning has been observed.

Significant input of suspended solids from a tributary since 2011 may be further limiting the use of the system by JCS and other species.

8.2.3 Minto Creek Benthic Invertebrate Community

The benthic invertebrate community of Minto Creek was characterized in 1994 (HKP 1994) and has been assessed as part of a number of monitoring studies undertaken in the Minto Mine area from 2006–2012 (Table 8-4).

Table 8-4: Summary of Key Benthic Macroinvertebrate Monitoring Studies, Minto Mine.

Year	Firm and Study	Scope of Studies
1994	Hallam Knight Piesold – IEE for Minto Creek	Collection of benthic samples at 6 sites in Minto Creek in conjunction with baseline studies.
2006	Access Consulting Group	Collection of benthic invertebrate samples under the terms of the water use license.
2008	Minnow Environmental	Collection of benthic invertebrate samples under the terms of the water use license.
2008	Minnow Environmental & Access Consulting Group	Collection of benthic samples as part of the EEM, Cycle 1 program
2010-2012	Minnow Environmental	Collection of benthic invertebrate samples under the terms of the water use license.
2010	Minnow Environmental	Collection of invertebrate samples in McGinty Creek
2011	Minnow Environmental & Access Consulting Group	Collection of benthic samples as part of the EEM, Cycle 2 program

Based on control-impact comparisons of benthic invertebrate community data, lower Minto Creek supports a healthy erosional benthic invertebrate community, as indicated by a greater taxon richness/diversity and a lower dominance by chironomids when compared to Wolverine Creek. In addition, in 2012, percent EPT taxa was higher (but not significantly so) at lower Minto Creek than at lower Wolverine Creek [in 2012; Minnow 2013c]. Given that chironomids are generally considered to be tolerant of pollutants and EPT taxa are generally considered to be sensitive to pollutants, this pattern suggests limited influence of the Mine on the benthic invertebrate community of lower Minto Creek (Minnow 2013c). Despite the general findings based on comparison of lower Minto Creek to lower Wolverine Creek, it should be noted that high temporal variability has been observed in both creeks (Minnow 2009, 2011, 2012), presumably due to inter-annual variability in environmental conditions (e.g., flow, ice scour). In consideration of both the control-impact comparisons of lower Minto Creek to lower Wolverine Creek, which documented some community differences, the Reference Condition Approach (RCA) results for both creeks and results from other studies in Minto Creek, Minnow (2102) concluded that there is no clear evidence of mine-related impact to the erosional benthic invertebrate community of lower Minto Creek.

In conclusion, Minto Creek supports a healthy benthic community, which doesn't seem to have been significantly affected by the mine activities to date.

8.2.4 McGinty Creek Fish Investigations

The fish-related investigations undertaken in McGinty Creek are listed in Table 8-5.

Table 8-5: McGinty Creek Fish Investigations.

Year	Months	Purpose of Study	Conducted by
1994	June, August, September	Baseline collection	Hallam Knight Piesold
2009	May, June, September	Baseline collection	Access Consulting Group
2010	July	Baseline collection	Access Consulting Group
2011	September	Baseline collection	Access Consulting Group

8.2.5 Key Fish and Fish Habitat Information for McGinty Creek

8.2.5.1 McGinty Creek Fish Community Characteristics

The studies listed above determined that very few fish use McGinty Creek. Only one species, the slimy sculpin, was documented over three sampling seasons (2009 to 2011), and due to the consistent location of the captures (near the mouth), these fish were presumed to be associated with the Yukon River as opposed to McGinty Creek. These results are similar to those found in the 1994 survey, in that fish were only captured in close proximity to the Yukon River confluence. No JCS were encountered during the 1994 or 2009–2011 surveys. However, during the 1994 investigations, Arctic grayling were captured (HKP 1994). As with Minto Creek, Arctic grayling and other species can migrate into the lower reach of McGinty Creek but their use of the creek appears to be very low and transitory.

8.2.5.2 McGinty Creek Fish Habitat Characteristics

The physical nature of the McGinty Creek drainage is not conducive to consistent year-round use by fish. The gradient, discharge volume, depth, configuration, and absence of an upstream reservoir limit the overwintering habitat potential. Very minimal to no flows were observed in McGinty Creek during the winter (see Hydrology Baseline Report in Appendix E). Fish likely use the creek, if at all, only after temperatures between the creek and Yukon River equilibrate, as is the case in similar systems along the Yukon River (Bradford et al. 2001). McGinty Creek offers very minimal pool/resting habitat and fish would have to exert much energy to sustain themselves in the system for any period of time. This is likely a strong deterrent for fish to enter and/or remain in the creek for any length of time. Several potential natural fish barriers were also observed and documented in the lower reach of McGinty Creek, the first of which is located roughly 50m upstream of the mouth, further limiting potential habitat upstream.

8.2.6 McGinty Creek Benthic Invertebrates Community

Baseline benthic invertebrate data was collected in McGinty Creek in 2010, and also as part of the EEM program in 2008 and 2011, where it was used as a reference site (Table 8-4).

Overall, it was observed that McGinty Creek had significantly lower number of taxa, Bray-Curtis Index and proportion of chironomids (midges), and significantly higher Simpson's Evenness and proportion of EPT taxa (mayflies, stoneflies and caddisflies), compared to Minto Creek. This appeared to be caused, at least partly, by colder water temperatures compared to Minto Creek. Water temperature data collected at station MN-4.5 between 2009 and 2012 indeed show that the mean monthly water temperature in McGinty Creek is on average 2.0°C colder than in lower Minto Creek (for periods of non-discharge of mine water) during the summer period (June–September, inclusive.).

8.3 Potential Effects

Activities associated with Phase V/VI have the potential to alter certain chemical and physical parameters of Minto Creek or McGinty Creek, which could in turn influence aquatic resources downstream, including:

- Increase in contaminant concentration (metals, metalloids, nutrients)
- Change in creek physical parameters (water temperature and flow)
- Increase in total suspended solids (sediment loading)

These potential effects and associated mitigations are discussed below.

8.3.1 Increase in Contaminant Concentrations

According to the water quality predictions presented in Appendix K, it is anticipated that some metals, metalloids, and nutrients may become elevated in Minto Creek due to mine effluent discharge during Phase V/VI operational and closure conditions. The scenarios modeled include the expected case typical and upper limits as well as the reasonable worst-case typical and upper limits, for both the operational and post-closure periods (typical concentrations correspond with SRK's presented 'average' concentrations, and upper limit concentrations correspond with SRK's presented 'maximum' concentrations). The parameters of concern under one or more scenarios include nitrogen compounds (nitrite, nitrate, and ammonia), selenium, copper cadmium, and fluoride. These parameters are discussed in detail in the following sections. The effects assessment also considers periodic site treatment or management upset conditions whereby site discharge may exceed upper limit predictions for short durations. The assessment of these infrequent, short-duration events is based on the proposed revised effluent quality limits presented in Section 7.5.2.

Analytes that are elevated mainly due to background conditions in Minto Creek include aluminium, chromium and iron, and site-specific water quality guidelines (SSWQOs) were developed to address this issue, using the 95th percentile of background data (refer to Minto Creek Water Quality Characterization Report in Appendix G). Expected case typical concentrations (Table 8-6) and reasonable worst-case upper limit concentrations (Table 8-7) for the operational and post-closure scenarios (refer to SRK Water Quality Predictions in Appendix K) are shown against the SSQWOs developed in 2009 and the updated SSWQOs from 2013 (developed from a larger data set). Exceedances of the 2009 SSWQOs are shown in red while no exceedances of the updated 2013 SSWQOs are anticipated, confirming that elevated levels are mostly driven by background concentrations. For this reason, these parameters are not considered to be of concern and are not further discussed in the following sections.

Table 8-6: Expected Case Predicted Typical Concentrations for Al, Cr, and Fe at W1 in Comparison to SSWQOs.

	Al (mg/L)		Cr (mg/L)		Fe (mg/L)	
	Operations	Post-closure	Operations	Post-closure	Operations	Post-closure
January	0.09	0.20	0.0007	0.0008	0.3	0.4
February	0.10	0.21	0.0007	0.0008	0.2	0.4
March	0.11	0.22	0.0007	0.0008	0.3	0.4
April	0.27	0.34	0.0009	0.0010	0.5	0.6
May	6.16	5.19	0.0126	0.0106	10.6	8.9
June	0.69	0.86	0.0017	0.0020	1.4	1.6
July	3.37	2.97	0.0065	0.0058	5.7	5.0
August	3.02	2.75	0.0058	0.0053	6.0	5.4
September	0.39	0.53	0.0011	0.0013	1.1	1.2
October	0.19	0.28	0.0007	0.0008	0.6	0.7
November	0.20	0.29	0.0007	0.0009	0.5	0.6
December	0.13	0.23	0.0007	0.0009	0.3	0.4
SSWQOs 2009	**0.62**		**0.0020**		**1.1**	
SSWQOs 2013	**21.38**		**0.0387**		**37.7**	

Table 8-7: Reasonable Worst-case Predicted Upper Limit Concentrations for Al, Cr, and Fe at W1 in Comparison to SSWQOs

	Al (mg/L)		Cr (mg/L)		Fe (mg/L)	
	Operations	Post-closure	Operations	Post-closure	Operations	Post-closure
January	0.12	0.28	0.0008	0.0013	0.4	0.5
February	0.12	0.29	0.0009	0.0013	0.4	0.5
March	0.15	0.31	0.0009	0.0013	0.4	0.5
April	0.30	0.43	0.0012	0.0015	0.6	0.7
May	7.16	5.42	0.0145	0.0114	12.3	9.3
June	6.36	5.42	0.0131	0.0114	11.0	9.3
July	3.54	3.15	0.0069	0.0064	6.0	5.2
August	3.54	3.15	0.0069	0.0064	6.1	5.4
September	3.01	2.70	0.0059	0.0055	6.1	5.4
October	0.23	0.37	0.0009	0.0013	0.8	0.9
November	0.22	0.36	0.0009	0.0014	0.7	0.8
December	0.22	0.36	0.0009	0.0014	0.5	0.7
SSWQOs 2009	**0.62**		**0.0020**		**1.1**	
SSWQOs 2013	**21.38**		**0.0387**		**37.7**	

McGinty Creek

It is not anticipated that McGinty Creek water will be influenced by the Minto Mine during the operational period, as mine water runoff from Minto North mine area will be collected and pumped to the Main Pit Tailings Management Facility (MPTMF) within the Minto Creek catchment area, and managed appropriately with the mine water management systems from that point forward. There will be minimal (if any) anticipated surface discharge from the Minto North Pit in the post-closure period. Water quality predictions presented in Appendix K indicate that fluoride is the only parameter for which the maximum concentration could exceed the 95th percentile of baseline concentration under the worst-case loadings from Minto North. Fluoride is discussed in section 8.3.1.5.

8.3.1.1 Nitrogen Compounds

Mine blasting activities are a source of nitrogen compounds that can enter Minto Creek, including ammonia, nitrite, and nitrate. These compounds have the potential to be directly toxic to aquatic organisms, while nitrate is also an important plant nutrient and can stimulate primary production, potentially resulting in eutrophication if loading rates are high.

Nitrogen compounds are only of concern during the operational stage of the mine because their source is the use of explosives, which will cease at closure and nitrogen concentrations found in Minto Creek are expected to decrease accordingly. Potential effects resulting from these compounds entering Minto

Creek are discussed below. Mitigations common to all nitrogen species are discussed at the end of section 8.3.1.1.

Nitrite

"Nitrite is toxic to vertebrates including fish and a principal effect is the conversion of haemoglobin to methaemoglobin which is incapable of oxygen transport although there are circulatory and tissue effects as well. The toxic species is the nitrite ion (NO_2^-) which is believed to enter the blood via the branchial chloride/bicarbonate exchange and fish such as salmonids with high chloride uptake rates are more susceptible than those with low chloride uptake rates." (Eddy et al. 1987) Chronic effects include tissue damage, growth suppression, and mortality. (Lewis et al. 1986)

The Canadian water quality guideline for the protection of aquatic life in freshwater is 0.060 mg/L for nitrite-nitrogen (equivalent to 0.197 mg/L of nitrite) (CCME 2007a). Table 8-8 below summarizes water quality predictions for nitrite-N, which are further detailed in SRK's report presented in Appendix K. While "expected case" typical and upper limit nitrite-nitrogen concentrations at W1 are all below the CCME guideline (predicted upper limit of 0.033 mg/L, April), "reasonable worst case" predictions indicate upper limit concentrations of nitrite-nitrogen ranging from 0.082 mg/L (September) to 0.144 mg/L (May) in lower Minto Creek (W1) for the operational period. These predicted values do not, however, account for nitrification potential within the creek or the presence of chloride, which both have a beneficial effect by reducing nitrite concentration or reducing its bioavailability, respectively.

Table 8-8: Water Quality Predictions at W1 for Nitrite-N (mg/L).

	Phase V/VI Operations				Post-Closure			
	Expected Case		Reasonable Worst-case		Expected Case		Reasonable Worst-case	
	Typical	Upper Limit	Typical	Upper Limit	Typical	Upper Limit	Typical	Upper Limit
January	0.014	0.017	0.072	0.087	0.005	0.008	0.019	0.039
February	0.014	0.017	0.072	0.087	0.005	0.008	0.019	0.038
March	0.014	0.017	0.072	0.087	0.005	0.008	0.019	0.038
April	0.030	0.033	0.087	0.103	0.011	0.021	0.031	0.050
May	0.015	0.033	0.074	0.144	0.006	0.017	0.021	0.044
June	0.016	0.027	0.074	0.139	0.006	0.009	0.019	0.035
July	0.016	0.025	0.075	0.127	0.006	0.009	0.019	0.032
August	0.016	0.025	0.074	0.127	0.005	0.008	0.018	0.032
September	0.014	0.017	0.077	0.082	0.005	0.008	0.017	0.032
October	0.017	0.018	0.081	0.088	0.005	0.008	0.019	0.034
November	0.016	0.018	0.081	0.088	0.005	0.008	0.019	0.034
December	0.016	0.017	0.080	0.087	0.005	0.007	0.018	0.033

Nitrification

Nitrification is the biological oxidation of ammonia into nitrite followed by the oxidation of nitrite into nitrate. A review of water quality data in Minto Creek during periods of mine water discharge indicates that some nitrification occurs between W3 and W2. The measured nitrite-N concentration at W2 was on average 75% lower than the predicted value based on the nitrite-N concentration at W3 and the dilution factor (Figure 8-1). No clear correlation was obtained with pH or water temperature. Figure 8-2 shows the nitrification rate in Minto Creek between W3 and W2 as a function of water temperature. Applying this 75% nitrification rate to predicted nitrite-N concentrations would result in worst-case upper limits ranging from 0.021 mg/L (September) to 0.036 mg/L (May) at W1, which is well below the CCME guideline. Note that the nitrification process also converts ammonia into nitrite, before converting it to nitrate, but this is accounted for in the estimate above.

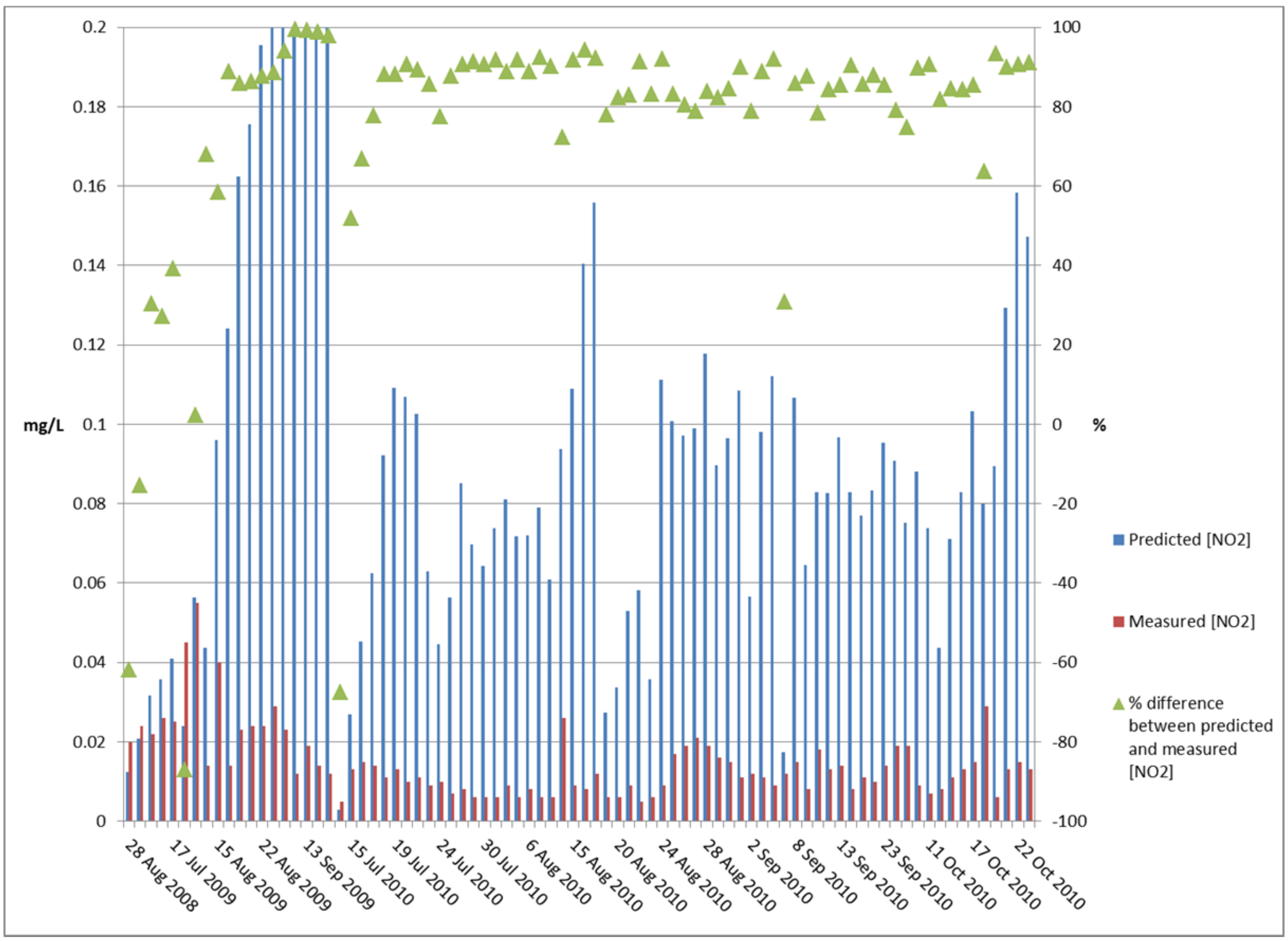


Figure 8-1: Predicted and Measured Nitrite Concentrations at W2, and Percent Difference.

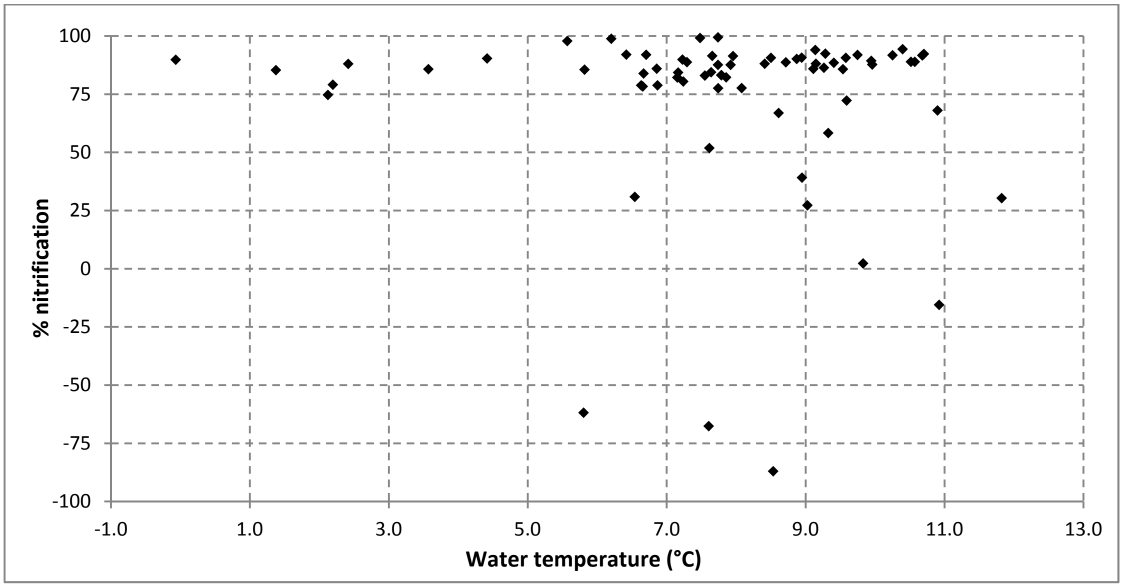


Figure 8-2: Nitrification Rate in Minto Creek between W3 and W2 as a Function of Water Temperature.

Note: Negative nitrification rates are attributable to a reduction in flow between W3 and W2, likely caused by water infiltrating underground.

Chloride

Nitrite toxicity is strongly alleviated by chloride, which competes with nitrite for transport across the gill epithelium and therefore slows the rate of nitrite uptake by competitive inhibition (Lewis et al. 1986, Tomasso 1994). The concentration ratio of these ions is of great importance in assessing toxicity. A number of studies showed that the relationship between nitrite toxicity and chloride concentration is linear. No chloride-toxicity relationship is available for Chinook salmon, but a linear regression was conducted on a data set from Russo and Thurston (1977) and showed that 1.0 mg/L of chloride offsets 0.29 mg/L of nitrite-N (Lewis et al. 1986) for rainbow trout. The predicted chloride concentration in lower Minto Creek during the operational period ranges from 0.70 mg/L to 3.02 mg/L (Appendix K). Applying the chloride-toxicity relationship for rainbow trout, the toxicity of a minimum of 0.20 mg/L of nitrite-N could be offset by chloride, which is greater than the maximum predicted nitrite-N value at W1.

When accounting for the nitrification process and the effect of chloride in lower Minto Creek, it is not anticipated that nitrite will have negative effects on the aquatic resources. The highest predicted number at W1 is 0.144 mg/L of nitrite-N ("reasonable worst case" operational period upper limit, May), but this number is assuming no nitrification (which likely reduces nitrite-N by 75%). The added ameliorating effect of chloride and resulting reduced bioavailablility of nitrite ensures that predicted levels of nitrite discharge will be protective in the receiving environment. Should a short duration system upset cause the nitrite-N concentration to reach the proposed effluent limit of 0.7 mg/L (see section 7.4.3) in the water storage pond (WSP) (instead of the maximum value of 0.64 mg/L used in the modeled reasonable worst case scenario), the resulting anticipated short term concentration at W1, obtained using the same dilution ratio as in the SRK model (Appendix K), would approximate 0.158

mg/L. When accounting for a nitrification rate of about 75% and the beneficial effect of chloride, this value would remain protective of the aquatic environment.

Nitrate

Nitrate is an essential nutrient for plant growth. Too much nitrate in an aquatic system can however contribute to excessive primary production (plant and algal growth) and in extreme cases can cause depletion of oxygen in the water as the organic material degrades. The nitrate ion can also have toxic effects on aquatic organisms.

Small increases in primary productivity (periphyton/plant) can have a modest stimulatory influence on secondary producers (benthic invertebrates) and fisheries. Large increases in primary productivity can change the community of primary producers (periphyton/plant) and can result in a secondary decrease in dissolved oxygen (concentration and cycling) resulting in modification of benthic invertebrate community (e.g., replacement of intolerant with tolerant forms) and decrease in fish habitat quality, plus potential tertiary effects of lower DO/redox on metal speciation.

In a study conducted by Minnow in 2011, concentrations of chlorophyll a in lower Minto Creek were found to be low and similar to those in lower Wolverine Creek, resulting in a classification of oligotrophic (low primary productivity) (Minnow 2012), and indicating that no significant enrichment has been detected in Minto creek to date.

The periphyton community of lower Minto Creek differs significantly from that of lower Wolverine Creek in terms of a number of parameters, but general taxonomic dominance (particularly the dominance of the blue-green algae) is similar (Minnow 2012). "The observed differences are likely due to subtle differences in habitat conditions. Periphyton communities of both lower Minto Creek and lower Wolverine Creek in 2011 differed from the community documented at lower Minto Creek in 1994. This suggests a possible natural temporal shift in community structure." (Minnow 2013c) As described in section 8.2.3, although some differences were observed between lower Minto creek and lower Wolverine creek benthic communities, there is no clear evidence of mine-related impact to the erosional benthic invertebrate community of lower Minto Creek.

"A series of studies of laboratory cultures of algae and of natural marine phytoplankton populations in the period from the 1930s to the 1950s (Redfield 1958) led to a concept that algae, under reasonably good growth conditions, will have an elemental composition with relatively defined atomic ratios. These ratios have become known as the Redfield ratios. For N to P this ratio is about 15 to 16:1. Natural systems in which the atomic ratio of other elements to P is greater than the Redfield ratio are often assumed to be systems in which algal growth or biomass is ultimately limited by P or at least that algal growth rates in such systems will be greatly reduced." (Correll 1999) Other studies found that that phosphorus limitation was relieved at N:P molar ratio < 10:1 and that the optimal N:P supply ratio for most phytoplankton species was between 11:1 and 20:1 (Hecky et al. 1988).

In the case of lower Minto Creek, algal growth can be limited by either nitrogen or phosphorus (Figure 8-3). Based on data collected at W2 between 2006 and 2012, total nitrogen (obtained from the sum of nitrate, nitrite, and total Kjeldahl nitrogen) is plotted against total phosphorus. The Redfield ratio is indicated by the red line and the optimum range by the dotted lines. No consistent difference can be observed between periods of mine water discharge and periods of non-discharge. Note that only a limited number of points had all the data necessary to calculate total nitrogen (TN), therefore reducing the total number of data points available for this analysis.

Other factors can also limit algal growth, such as water temperature and light (Correll 1999, Jahnke et al. 1986, Goldman et al. 1974). Bierman & Dolan (1981) elaborated a model of phytoplankton-nutrient dynamics in Lake Huron and found that temperature and light were relatively more growth limiting than nutrients on an annual average basis.

An exponential relationship can be used to model the phytoplankton maximum growth rate's dependence on temperature (Goldman et al. 1974, Bissinger et al. 2008). Gross primary production was also found to be more intensely related to temperature for stream periphyton than for ocean or lake periphyton (Morin et al. 1999). In addition, a positive relationship between temperature and N-nitrate uptake was observed in many studies (Reay et al. 2001). Because water temperature in Minto Creek is generally cold (section 8.3.2.1), eutrophication potential is low.

The degree to which light can limit algal growth depends on penetration depth (which itself depends on water turbidity) and total depth (Bierman et al. 1981). High turbidity (or TSS content), as observed in lower Minto Creek in 2011 and 2012, could considerably reduce light penetration and associated algal growth. It is difficult to predict whether turbidity of lower Minto Creek will remain high, as it is mostly due to natural sediment loading from a tributary. Much of Minto Creek however has a vegetative canopy cover during open water season which greatly reduces light penetration.

Overall, nitrate is not the main limiting factor to algal growth in lower Minto Creek, as phosphorus, water temperature and light are considered to play more important roles in determining algal growth.

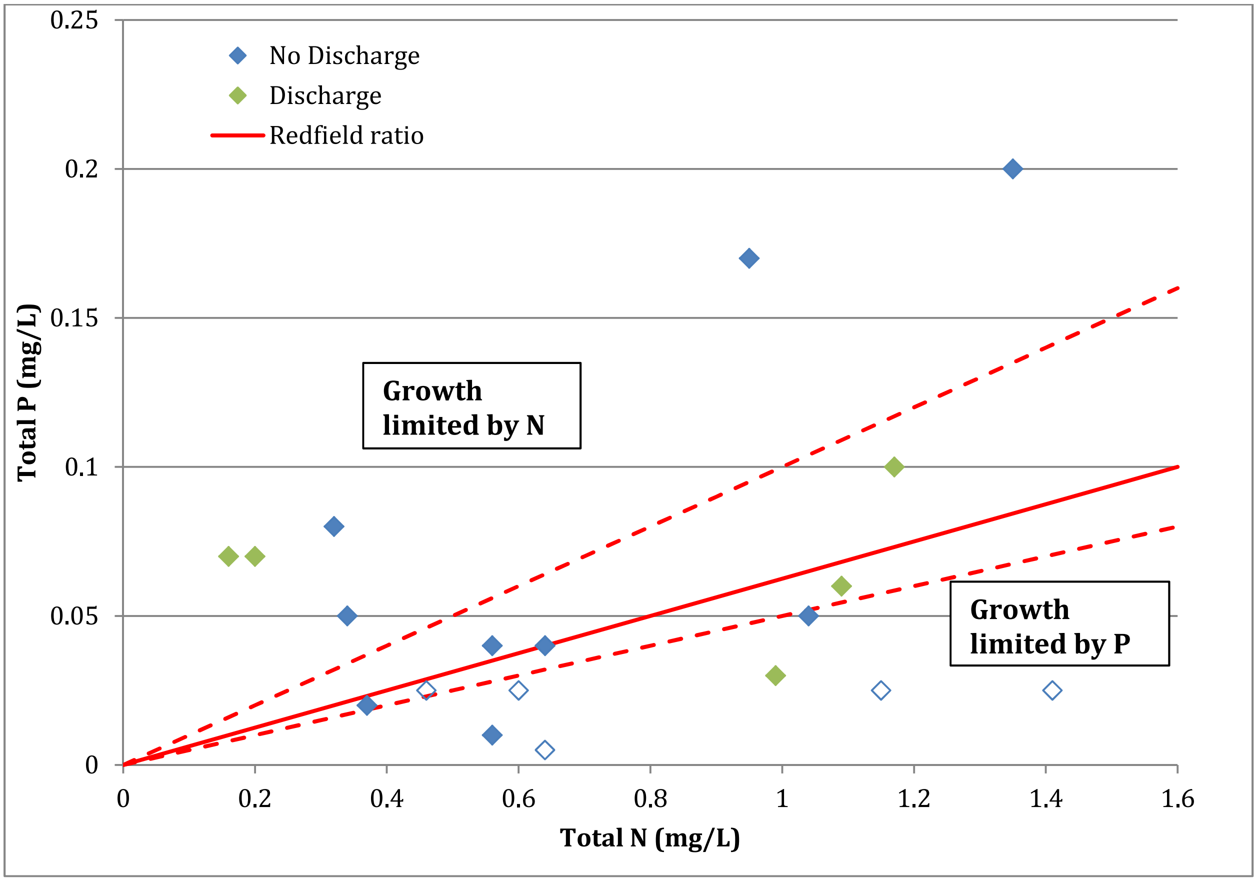


Figure 8-3: Concentration of total nitrogen and total phosphorus in Minto creek at W2: 2006-2012.

Note: Hollow data points indicate that TP was below detection limit and ½ the detection limit was used as an approximation in the graph

Regarding toxicity of the nitrate ion, there are two suspected mechanisms: "a) through methaemoglobin formation, resulting in a reduction in the oxygen carrying capacity of blood and b) through the inability of the organisms to maintain proper osmoregulation under high salt contents associated with elevated nitrate levels (Colt and Armstrong 1981)" (CCME 2012). The CCME WQ guideline (chronic) for protection of aquatic life is set at 3.0 mg NO_3^--N/L, while the CCME guideline for short-term exposure (acute) is 124 NO_3^--N/L.

A review of nitrate data collected at W2 between 2005 and 2012 indicates that exceedances of the chronic guideline have occurred during periods of emergency mine water discharge (Figure 8-4), but the acute CWQG was never exceeded. Table 8-9 below summarizes water quality predictions for nitrate-N, which are further detailed in SRK's report presented in Appendix K. While "expected case" typical and upper limit predicted nitrate-N concentrations at W1 are all below the CCME guideline (predicted upper limit of 1.97 mg/L, May), "reasonable worst case" predictions indicate upper limit concentrations of nitrate-N ranging from 2.89 mg/L (September) to 5.07 mg/L (May) in lower Minto creek (W1) for the operational period. While some of these values would exceed the CCME chronic guideline, it should be noted that this guideline is leveraged by a low toxicity value (14 mg/L NO_3^-) for early life stage lake trout (egg to swim-up fry). Since no early life stage lake trout are encountered in lower Minto Creek, the chronic species sensitivity distribution (SSD) can be recreated using the next lowest toxicity value of 50 mg/L NO_3^-, which would result in a 5th percentile value of approximately 18 mg/L nitrate (versus 13 mg/L) or 4 mg/L of nitrate-N (instead of 3 mg/L).

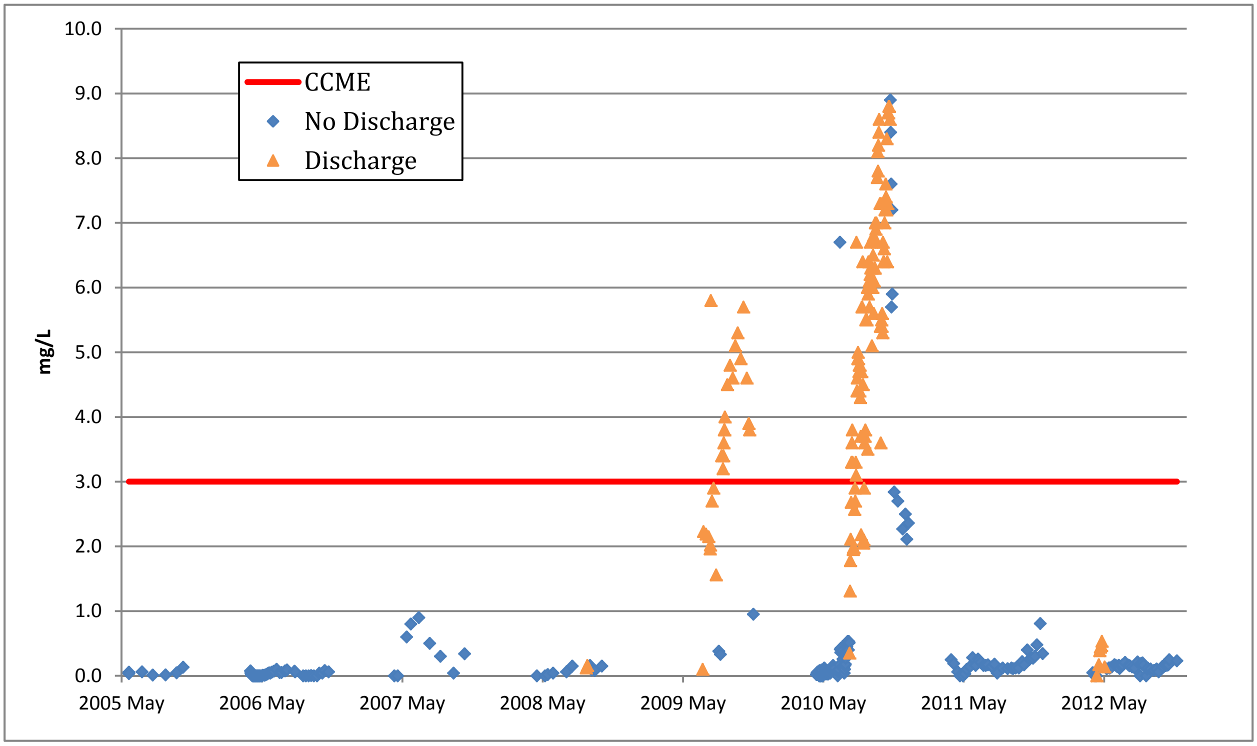


Figure 8-4: Nitrate concentration at W2: 2005-2012.

Table 8-9: Water Quality Predictions at W1 for Nitrate-N (mg/L).

	Phase V/VI Operations				Post-Closure			
	Expected Case		Reasonable Worst-case		Expected Case		Reasonable Worst-case	
	Typical	Upper Limit	Typical	Upper Limit	Typical	Upper Limit	Typical	Upper Limit
January	1.17	1.43	2.68	3.27	0.41	0.73	0.79	1.53
February	1.22	1.43	2.73	3.27	0.43	0.73	0.82	1.52
March	1.15	1.41	2.66	3.25	0.39	0.70	0.76	1.49
April	0.95	1.30	2.44	3.08	0.25	0.54	0.62	1.27
May	1.00	1.97	2.56	5.07	0.26	0.48	0.64	1.21
June	0.99	1.88	2.50	4.81	0.24	0.48	0.57	1.19
July	1.03	1.74	2.59	4.45	0.25	0.44	0.59	1.08
August	1.01	1.74	2.55	4.45	0.24	0.43	0.58	1.06
September	1.05	1.13	2.69	2.90	0.24	0.43	0.58	1.10
October	1.12	1.21	2.82	3.05	0.27	0.48	0.63	1.17
November	1.14	1.24	2.85	3.08	0.29	0.49	0.64	1.17
December	1.13	1.24	2.83	3.08	0.28	0.49	0.63	1.16

A number of additional factors should also be taken into account when assessing the potential toxicity of nitrate to aquatic life in lower Minto Creek including:

- Nitrate toxicity generally decreases with increasing hardness (CCME 2012). Average hardness at is relatively high in Minto Creek, 154 mg/L at W2 (Appendix G), which is favourable;
- Nitrate was found to be most toxic when tested at the optimal temperature range for two species of fish out of four in a short-term study by Moore and Poirier (2010) (CCME 2012); the less than optimal water temperature in Minto Creek (see section 8.3.2.1) could reduce nitrate toxicity to JCS;
- Potential chronic exposure is reduced by the limited fish use and the generally short residence time in Minto Creek. See *Aquatic Resources Baseline Report* (Appendix L);
- Maximum concentrations are predicted to occur in May, when fish use of the system is negligible;
- A nitrate level of 10 mg/L NO_3-N is generally considered safe in an aquaculture context (Pillay et al. 2005). In most aquaculture systems, nitrate levels are below 50 mg/L (equivalent to 11.3 mg/L nitrate-N) but often exceed 100 mg/L (equivalent to 22.6 mg/L nitrate-N) in intensive systems. Levels can even reach 200 mg/L (equivalent to 45.1 mg/L nitrate-N) in recirculating systems that have limited fresh water input (Hrubec et al. 1996);

- The data set used to derive the CCME chronic guideline is limited (12 points only) and the resulting 5th percentile value from the SSD analysis could change considerably as additional research results become available.

Based on all the considerations above, it is not anticipated that predicted nitrate concentrations in lower Minto creek will be a source of eutrophication or chronic toxicity to aquatic organisms. Should a short duration system upset cause the nitrate-N concentration to reach the proposed effluent limit of 30 mg/L (see section 7.4.3) in the WSP (instead of the maximum value of 22.7 mg/L used in the modeled reasonable worst case scenario), the resulting anticipated short term concentration at W1, obtained using the same dilution ratio as in the SRK model (Appendix K), would approximate 6.71 mg/L. Since this concentration would only occur for short periods of time, it is appropriately compared to the CCME guideline for short-term exposure (acute) of 124 NO_3^--N/L. Since it is well below that value, there are no anticipated acute toxic effects associated with these possible isolated higher concentrations.

Ammonia

In aquatic environments, ammonia is present in two forms: ionized ammonium (NH_4^+), and un-ionized ammonia (NH_3). The term "total ammonia" is used to describe the sum of ammonia (NH_3) and ammonium (NH_4^+) concentrations. Ammonium "does not easily cross fish gills and is less bioavailable than the un-ionized form (…). The un-ionized form (NH_3) can cross from water into fish, and once inside, some converts to the ionized form (NH_4^+), which then causes cellular damage." (Levit 2010) Both pH and water temperature affect how much of the toxic form of ammonia (NH_3) is present in the water. Higher pH and higher temperatures result in a higher proportion of the total ammonia being present in its toxic un-ionized form (NH_3).

"Ammonia can be acutely toxic to fish mainly due to its effect on the central nervous system, because it causes "acute ammonia intoxication" (…). Concentrations of ammonia that are acutely toxic to fish may cause loss of equilibrium, hyperexcitability, increased breathing, cardiac output, and oxygen uptake, and, in extreme cases, convulsions, coma, and death (…). Lower concentrations of ammonia can cause a reduction in hatching success, reduction in growth rate and morphological development, and pathologic changes in tissues of gills, livers, and kidneys." (Levit 2010)

The Canadian water quality guideline for the protection of aquatic life in freshwater is 0.019 mg/L (or ppm) for ammonia in its un-ionized form (NH_3). (CCME 2010)

The equation below is used to calculate the fraction of total ammonia that is un-ionized (NH_3) based on pH and water temperature (CCME 2010):

$$f = \frac{1}{\left[10^{\left(0.0902+\left(\frac{2729.92}{T}\right)-pH\right)} + 1\right]}$$

where: f = *fraction of total ammonia that is un-ionized*
T = temperature in K = temperature in °C + 273.15

Using the CWQG guideline of 0.019 mg/L and the equation above, Table 8-10 was constructed indicating what total ammonia concentrations result in 0.019 mg/L of un-ionized ammonia at various pH and temperature scenarios that may occur in Minto Creek based on review of historical data. The scenarios where the 0.019 mg/L threshold for NH_3 could be exceeded at a total ammonia concentration of 0.25 mg/L or less are highlighted.

Table 8-10: Total Ammonia Concentration (ppm) that Result in NH_3 Concentration of 0.019 mg/L (ppb) as a Function of Temperature and pH.

Temp (°C)/pH	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7
8.0	11.968	9.511	7.559	6.008	4.776	3.798	3.021	2.403	1.913	1.523	1.214	0.968	0.773	0.618	0.495	0.397	0.319	0.257
8.5	11.504	9.142	7.265	5.775	4.591	3.651	2.904	2.310	1.839	1.465	1.167	0.931	0.744	0.595	0.476	0.382	0.307	0.248
9.0	11.058	8.788	6.984	5.552	4.414	3.510	2.792	2.222	1.769	1.409	1.123	0.896	0.716	0.572	0.458	0.368	0.296	0.239
9.5	10.632	8.449	6.715	5.338	4.244	3.375	2.685	2.137	1.701	1.355	1.080	0.862	0.689	0.551	0.442	0.355	0.286	0.231
10.0	10.223	8.125	6.457	5.133	4.081	3.246	2.582	2.055	1.636	1.304	1.039	0.830	0.663	0.530	0.425	0.342	0.275	0.223
10.5	9.832	7.814	6.210	4.937	3.926	3.122	2.484	1.977	1.574	1.254	1.000	0.798	0.638	0.511	0.410	0.329	0.265	0.215
11.0	9.457	7.516	5.974	4.749	3.776	3.003	2.390	1.902	1.515	1.207	0.963	0.769	0.614	0.492	0.395	0.317	0.256	0.207
11.5	9.097	7.230	5.747	4.569	3.633	2.890	2.299	1.830	1.458	1.162	0.927	0.740	0.592	0.474	0.380	0.306	0.247	0.200
12.0	8.752	6.956	5.529	4.396	3.496	2.781	2.213	1.762	1.403	1.118	0.892	0.713	0.570	0.457	0.367	0.295	0.238	0.193
12.5	8.422	6.694	5.321	4.230	3.364	2.676	2.130	1.696	1.351	1.077	0.859	0.686	0.549	0.440	0.354	0.285	0.230	0.187
13.0	8.105	6.442	5.121	4.072	3.238	2.576	2.050	1.632	1.301	1.037	0.828	0.661	0.529	0.424	0.341	0.275	0.222	0.180
13.5	7.801	6.201	4.929	3.919	3.117	2.480	1.974	1.572	1.252	0.999	0.797	0.637	0.510	0.409	0.329	0.265	0.214	0.174
14.0	7.510	5.969	4.745	3.773	3.001	2.388	1.901	1.514	1.206	0.962	0.768	0.614	0.492	0.394	0.317	0.256	0.207	0.168
14.5	7.230	5.747	4.569	3.633	2.890	2.299	1.830	1.458	1.162	0.927	0.740	0.592	0.474	0.380	0.306	0.247	0.200	0.163
15.0	6.962	5.534	4.400	3.499	2.783	2.215	1.763	1.404	1.119	0.893	0.713	0.570	0.457	0.367	0.295	0.239	0.193	0.158
15.5	6.705	5.330	4.237	3.370	2.681	2.133	1.698	1.353	1.079	0.861	0.688	0.550	0.441	0.354	0.285	0.230	0.187	0.152
16.0	6.458	5.133	4.081	3.246	2.582	2.055	1.636	1.304	1.039	0.830	0.663	0.530	0.425	0.342	0.275	0.223	0.181	0.147
16.5	6.220	4.945	3.932	3.127	2.488	1.980	1.577	1.256	1.002	0.800	0.639	0.512	0.410	0.330	0.266	0.215	0.175	0.143
17.0	5.993	4.764	3.788	3.013	2.397	1.908	1.520	1.211	0.966	0.771	0.616	0.494	0.396	0.318	0.257	0.208	0.169	0.138
17.5	5.774	4.591	3.650	2.904	2.310	1.839	1.465	1.167	0.931	0.744	0.595	0.476	0.382	0.307	0.248	0.201	0.164	0.134
18.0	5.565	4.424	3.518	2.798	2.227	1.773	1.412	1.126	0.898	0.717	0.574	0.460	0.369	0.297	0.240	0.194	0.158	0.130
18.5	5.363	4.264	3.391	2.697	2.147	1.709	1.361	1.085	0.866	0.692	0.553	0.444	0.356	0.287	0.232	0.188	0.153	0.126
19.0	5.170	4.110	3.269	2.600	2.070	1.648	1.313	1.047	0.835	0.667	0.534	0.428	0.344	0.277	0.224	0.182	0.148	0.122
19.5	4.984	3.963	3.152	2.507	1.996	1.589	1.266	1.010	0.806	0.644	0.515	0.413	0.332	0.268	0.217	0.176	0.144	0.118
20.0	4.805	3.821	3.039	2.418	1.924	1.533	1.221	0.974	0.778	0.622	0.498	0.399	0.321	0.259	0.210	0.170	0.139	0.115

Therefore, total ammonia levels up to 0.25 mg/L in the receiving environment would only be of concern during periods where both temperature and pH are elevated in Minto Creek. A detailed review of temperature and pH data from 2006 to date indicated that such conditions were never encountered in lower Minto Creek, either during periods when the mine was discharging water into Minto Creek or during periods of non-discharge (Figure 8-5).

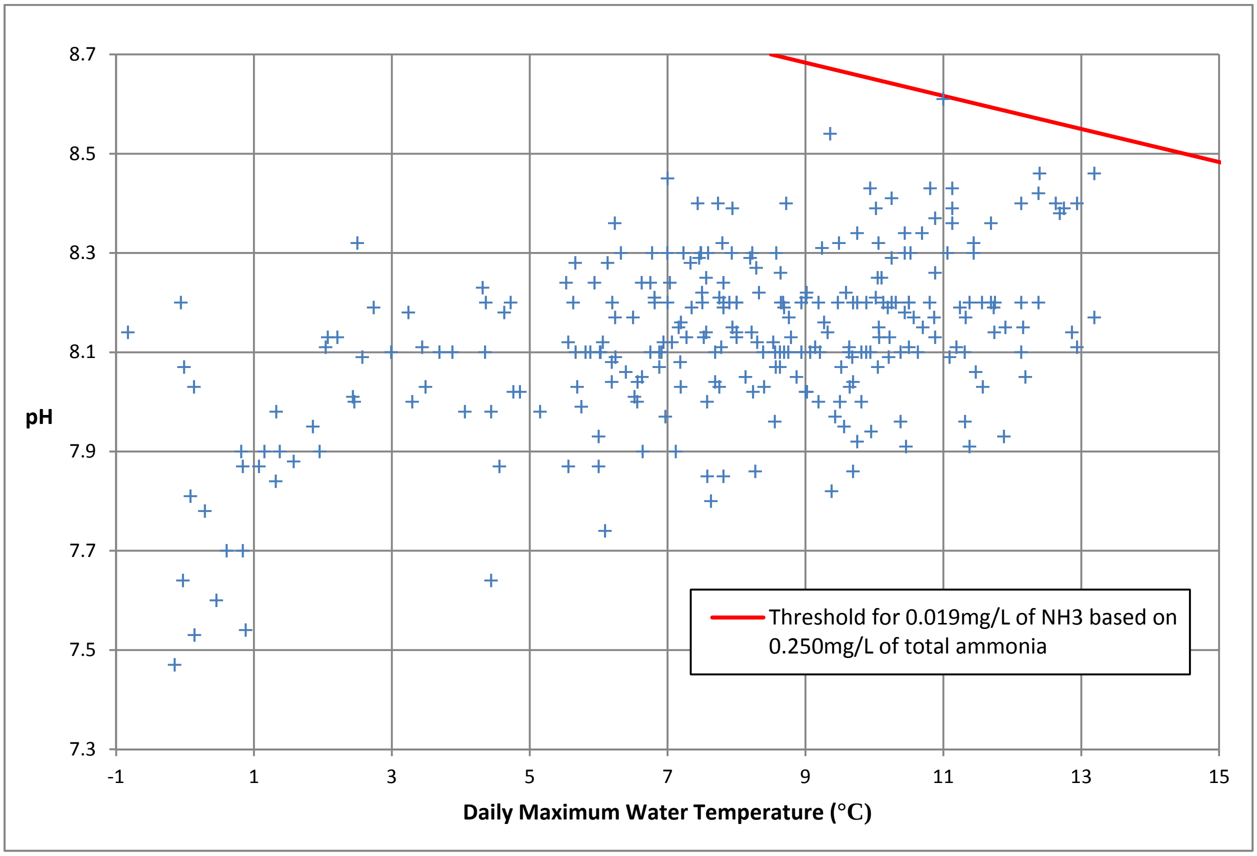


Figure 8-5: Water Temperature and pH in Lower Minto Creek: 2006-2012.

Notes: *Daily maximum water temperature was obtained from hourly data at W1.*
The highest of field or lab pH was used when both were available for a given day, pH data is from W2.

Figure 8-5 shows that over six years of data collection and 284 data points, only one approached the threshold, without exceeding it, on July 18, 2009, during a period of mine water emergency discharge. Note also that the figure above presents the worst-case scenario by using the daily maximum water temperature and the highest of field or lab pH when both were available, both factors contributing to increasing the fraction of total ammonia in the un-ionized form (NH_3).

Therefore, a total ammonia level of 0.25 mg/L or less in the receiving environment of lower Minto Creek will be protective of aquatic life. Table 8-11 below summarizes water quality predictions for total ammonia, which are further detailed in SRK's report presented in Appendix K. While "expected case" typical and upper limit predicted total ammonia concentrations at W1 are all below 0.25 mg/L (upper limit of 0.18

mg/L, May), “reasonable worst case” predictions indicate that upper limit concentrations of total ammonia could reach 0.26 mg/L (May) during the operational period. This value is only slightly above the protective level of 0.25 mg/L and would have to co-occur with elevated water temperatures and pH in order for the un-ionized portion to exceed the CCME guideline of 0.019 mg/L. Because this maximum concentration is predicted to occur in May, water temperature will still be cold and the un-ionized potion will be under 0.019 mg/L. Also, fish have not been observed in the system in May, so exposure is negligible. Moreover, this predicted value does not account for the nitrification process described above (in the nitrite discussion), which would bring the predicted concentrations well below the protective value of 0.25 mg/L. Although more data are needed to calculate a reliable nitrification rate for ammonia in Minto Creek, it is estimated to be around 55%, based on limited data available at the time of writing this proposal.

Should a short duration system upset cause the total ammonia concentration to reach the proposed effluent limit of 1.5 mg/L (see section 7.4.3) in the WSP (instead of the maximum value of 1.04 mg/L used in the modeled reasonable worst case scenario), the resulting anticipated short term concentration at W1, obtained using the same dilution ratio as in the SRK model (Appendix K), would approximate 0.38 mg/L. Again, when accounting for nitrification (which could represent an approximate reduction of 55%), the resulting total ammonia concentration is well below the 0.25 mg/L threshold for conversion into the CCME guideline of 0.019 mg/L of un-ionized ammonia.

Table 8-11: Water Quality Predictions at W1 for Total Ammonia (mg/L).

	Phase V/VI Operations				Post-Closure			
	Expected Case		Reasonable Worst-case		Expected Case		Reasonable Worst-case	
	Typical	Upper Limit	Typical	Upper Limit	Typical	Upper Limit	Typical	Upper Limit
Jan	0.08	0.11	0.12	0.16	0.03	0.05	0.04	0.07
Feb	0.07	0.09	0.12	0.14	0.02	0.04	0.03	0.06
Mar	0.08	0.09	0.12	0.14	0.02	0.04	0.03	0.06
Apr	0.08	0.10	0.12	0.15	0.03	0.04	0.04	0.07
May	0.11	0.18	0.15	0.26	0.04	0.06	0.06	0.08
Jun	0.09	0.15	0.14	0.24	0.03	0.06	0.05	0.08
Jul	0.11	0.16	0.15	0.23	0.04	0.06	0.05	0.08
Aug	0.10	0.16	0.15	0.23	0.04	0.06	0.05	0.07
Sep	0.09	0.11	0.14	0.16	0.03	0.06	0.04	0.07
Oct	0.09	0.10	0.14	0.15	0.03	0.04	0.04	0.06
Nov	0.10	0.11	0.15	0.16	0.03	0.05	0.04	0.07
Dec	0.10	0.11	0.15	0.16	0.03	0.05	0.04	0.07

Should trends in water quality indicate that ammonia is approaching levels of the proposed limits, Minto will investigate other ways to remove ammonia from effluent which could include aeration of water prior to treatment—possibly in the Water Storage Pond.

Mitigations Common to all Nitrogen Compounds

Certain mitigations have been implemented by Minto to reduce the amount of nitrogen compounds entering Minto Creek as a result of mining activities. In the spring of 2010, Minto implemented source controls in the form of education of site personnel and mitigative measures such as lining blast holes with a plastic liner to minimize transfer of nitrogen compounds to water. In June 2011, these were formalized in an explosives management plan filed with YG EMR (Energy, Mines and Resources) under QML-001. The management plan can be accessed at:

http://www.emr.gov.yk.ca/mining/pdf/mml_minto_explosives_management_plan.pdf.

Best management practices include:

- Efficient use of blasting materials to ensure accumulation of residue on waste rock is minimized,
- Spill prevention and cleanup,
- Blasting as soon as possible after blast holes are charged with ANFO to prevent seepage of nitrates into the groundwater,
- Use of ANFO in dry holes only (pumped dry if necessary and use of a plastic liner), or use of emulsion type explosives in wet holes, as these contain agents that prevent the dissolution of nitrates in water,
- Disposal of blasting reagent packaging and related waste done in accordance with the Blast Site Safety Manual Disposal Guidance document (Dyno Nobel North America, Appendix B of the Explosives Management Plan).

8.3.1.2 Selenium

Selenium (Se) is an essential element that can bioaccumulate to toxic levels under certain biogeochemical conditions. Table 8-12 below summarizes water quality predictions for selenium, which are further detailed in SRK's report presented in Appendix K. During the operational period, even under "reasonable worst case" conditions, upper limit concentrations of selenium in lower Minto Creek (W1) during effluent discharge periods were projected to be slightly lower than the CCME guideline of 1 µg/L (CCME 1999) and approximately half of the British Columbia guideline of 2 µg/L (BCMOE 2001a). Under "expected case" conditions, typical selenium concentrations during the operational period were projected to range from 0.3 to 0.6 µg/L, which is well below the CCME guideline. During the post-closure period, under "reasonable worst case" conditions, upper limit concentrations of selenium were projected to exceed the CCME guideline and approach or exceed the BC guideline (1.9 to 2.3 µg/L, depending on month). Under "expected case" conditions during the post-closure period, typical selenium concentrations were projected to range from 0.7 to 1 µg/L, the latter having been rounded up from just below the CCME guideline.

Table 8-12: Water Quality Predictions at W1 for Selenium (µg/L).

	Phase V/VI Operations				Post-Closure			
	Expected Case		Reasonable Worst-case		Expected Case		Reasonable Worst-case	
	Typical	Upper Limit	Typical	Upper Limit	Typical	Upper Limit	Typical	Upper Limit
January	0.4	0.4	0.6	0.7	0.8	1.2	1.3	2.1
February	0.4	0.4	0.6	0.7	0.8	1.2	1.3	2.1
March	0.5	0.5	0.7	0.9	0.8	1.3	1.4	2.2
April	0.3	0.5	0.6	0.9	0.7	1.2	1.3	2.1
May	0.6	0.7	0.8	1.0	1.0	1.4	1.5	2.3
June	0.5	0.6	0.7	0.8	0.9	1.3	1.3	2.2
July	0.6	0.6	0.7	0.8	0.9	1.2	1.4	2.0
August	0.5	0.6	0.7	0.8	0.9	1.2	1.3	1.9
September	0.5	0.5	0.7	0.7	0.9	1.2	1.4	2.0
October	0.5	0.5	0.7	0.8	0.9	1.2	1.4	2.1
November	0.4	0.5	0.6	0.8	0.8	1.2	1.3	2.1
December	0.4	0.4	0.6	0.7	0.8	1.2	1.3	2.0

Selenium presents a unique case and a unique challenge from an effects assessment perspective due to several factors. Firstly, the most sensitive mechanism by which elevated concentrations of selenium can cause adverse effects is different from other metals (food chain mediated rather than due to direct exposure in water). Second, the concentration of selenium required to cause adverse effects is highly site-specific (depending on the physical, chemical, and biological features of the environment). These factors, and current scientific understanding of them, are briefly reviewed in the following paragraph, setting the context for the subsequent effects assessment.

Aqueous selenium concentrations of less than 2 µg/L present low risk to aquatic life (e.g., Lemly and Skorupa 2007, Ohlendorf et al. 2011). However, at higher selenium concentrations, risk associated with selenium in water is difficult to assess, and recent reviews of the technical literature on selenium toxicity have returned a body of evidence indicating that water concentrations are poor predictors of biological effects because the critical exposure pathway is through the food chain (Stewart et al. 2010, Hodson et al. 2010, Ohlendorf et al. 2011, DeForest et al. 2012, Janz 2012). This differs from most metals, for which the critical exposure pathway is interaction at the gill (e.g., Pagenkopf 1983, Playle et al. 1993, and Playle 1998). The most sensitive aquatic organisms are egg-laying vertebrates, including fish (Presser and Luoma 2010, Janz et al. 2010, Ohlendorf et al. 2012, DeForest et al. 2012, and Janz, 2012) and therefore, better tools (than water concentrations) are available for the assessment of effects to sensitive aquatic organisms, the best of which are effect thresholds for ripe egg and/or ovary tissue in fish (e.g., Janz et al. 2010, DeForest et al. 2012). In recognition of this, the current state of the science of selenium effects has moved towards the identification of critical body burdens that cause reproductive failure or teratogenicity (birth defects), particularly maternal egg or ovary concentrations (Ohlendorf et al. 2011, DeForest et al. 2012, and Janz 2012). The threshold (i.e., concentration above which effects may start to occur in sensitive species) for selenium in ovaries/eggs of aquatic organisms is about 20 mg/kg dry weight (Janz et al. 2010, DeForest et al. 2012) but individual species can be much higher (e.g., 54 mg/kg for Dolly Varden char, McDonald et al. 2010, and DeForest et al. 2012).

Incorporation of selenium into the food chain and transfer through the food chain to sensitive vertebrates (e.g., fish) begins with incorporation of selenium into microorganisms at the base of the food chain and this step is a critical determinant of selenium concentrations at higher trophic levels (Stewart et al. 2010; Presser and Luoma, 2010). Because selenium incorporation into the food chain is dependent on abiotic factors such as hydrology (retention time), temperature, pH, redox conditions and the abundance of organic matter, and on biotic factors such as uptake and depuration kinetics of site species and food web structure (Beak 2002, Sappington 2002, Luoma and Presser 2009, Stewart et al. 2010, and Presser and Luoma 2010), selenium bioavailability and bioaccumulation is highly site-specific. In general, the mobilization of selenium into the aquatic food chain appears to be much higher in lentic (standing water) habitats than in lotic (flowing water) habitats (Lillebo et al. 1988, Canton and Van Derveer 1997, Lemly 1999, Orr et al. 2006, Presser and Luoma 2010, and Orr et al. 2012). For example, in the Elk Valley (southeast British Columbia), cutthroat trout ovary selenium concentrations remain lower than thresholds in lotic habitats despite high selenium water concentrations (up to 43 µg/L) whereas in lentic habitats, concentrations moderately above 2 µg/L can result in ovary selenium concentrations pushing the threshold (Orr et al. 2012). Furthermore, concentrations of selenium in ovaries of Elk Valley cutthroat trout from lotic areas showed little increase over an 8-fold increase in water concentrations from 5 to 40 µg/L (Orr et al. 2012). The latter observation was similar to findings of a literature review (Brix et al. 2005). Overall, the more productive an aquatic environment and the longer the food chain, the greater the risk of selenium-related effects (e.g., Presser and Luoma 2010, Orr et al. 2012).

In light of current scientific understanding of the mechanisms of selenium effects to aquatic organisms, several features of the Minto Creek/Yukon River receiving environment would indicate a low risk associated with selenium exposure. These include:

1. The receiving environment is lotic (flowing) and is predominantly erosional (sand bottom) with limited opportunity for selenium accumulation in deposited sediment and limited development of the type of biological community that would result in substantial enrichment and trophic transfer of selenium;

2. The receiving environment is also a low productivity system and does not support the type of (detrital) food chain considered to be conducive to the conversion of selenium to bioavailable forms and mobilization into the food chain; and

3. Exposure of sensitive species/life stages is limited. The greatest use of Minto Creek by fish is the transient use by juvenile Chinook salmon. Use by juvenile Chinook salmon is for a very short period of their life history, and perhaps more importantly, they do not use Minto Creek when laying down reproductive tissue, and accordingly their limited exposure within Minto Creek is likely not significant in contributing to ovary selenium concentrations. Slimy sculpin may use Minto Creek for a longer duration and over a more relevant period of their life history (than do

Chinook salmon), but are present in limited numbers on a seasonal basis and move between lower Minto Creek and the Yukon River (Minto Explorations 2010). Accordingly, meaningful exposure of fish to Minto Mine effluent is limited.

Overall, the combination of selenium concentrations that can generally be considered low (i.e., a predicted reasonable worst-case upper limit concentration of 1.0 µg/L during the operational stage and 2.3 µg/L post closure (Appendix K) compared to effect data for similar environments and/or site relevant fish genera (Table 8-13), the physical, chemical and biological features of Minto Creek that limit mobilization into the food chain and transfer up the food chain, and limited exposure experienced by fish all support a conclusion of no harmful effects associated with selenium.

Should a short duration system upset cause selenium concentration to reach the proposed effluent limit of 20 µg/L (see section 7.4.3) in the WSP (instead of the maximum value of 6.7 µg/L used in the modeled reasonable worst case scenario), the resulting anticipated short term concentration at W1, obtained using the same dilution ratio as in the SRK model (Appendix K), would approximate 6.8 µg/L. These possible isolated higher concentrations are still considered low when compared to effect data for similar environments and/or site relevant fish genera (Table 8-13), and for the reasons outlined above, are not anticipated to pose a significant risk to aquatic life.

Table 8-13: Studies on Selenium Concentration in Water and Effects on Fish.

Species	Location	Type of Environment	Se Concentration in water	Effect	Reference
Rainbow trout		Lab	4.4 - 53 µg/L	No significant increase in mortality below 28 µg/L. Decreased red blood cell volumes at 35 µg/L or greater and decreased cellular blood iron at 16 µg/L or greater.	Hodson et al. (1980)
Rainbow trout		Lab	Up to 100 µg/L	No significant increase in mortality below 47 µg/L. Calcium concentrations in backbone decrease at 12 µg/L or greater.	Hunn et al. (1987)
White suckers	Lethbridge, Alberta	Agricultural drain water	0.4 to 26.7 µg/L	Although fish did not exhibit the classic stress response, the results suggest that the fish are mobilizing energy reserves as Se increases.	Miller et al. (2009)
Westslope cutthroat trout	Elk Valley, BC	Lotic and lentic	Up to 44 µg/L	Very little increase in ovary Se in lotic habitats, greater accumulation of Se in ovaries in lentic areas.	Orr et al. (2012)

Mitigations and Monitoring

In response to the uncertainty over application of a water-based guideline or standard, the Minto Mine requested an integrated assessment of selenium in Minto Creek. Accordingly, Access Consulting Group (ACG) and Minnow Environmental Inc. (Minnow) undertook monitoring of selenium in additional aquatic environmental compartments in 2012, including water, sediment, periphyton, benthic invertebrates and fish tissue. Results and recommendations are presented in a memorandum by Minnow (2013b) in Appendix M. Furthermore, the mine intends to continue the comprehensive environmental monitoring (of water, sediment, benthic invertebrates and fish) currently required under their water use licence and the

MMER of the federal *Fisheries Act* and to continue monitoring of selenium in water, sediment, periphyton, benthic macroinvertebrates, and fish in 2013. This program will be implemented in accordance with recommendations made following monitoring in 2012 (Minnow 2013b) and will include the collection of slimy sculpin ovary tissue to determine the potential for adverse effects (or to put such concerns to rest).

8.3.1.3 Copper

Note: *The following assessment of potential effects of aqueous copper through the use of a biotic ligand model was conducted utilizing predicted copper concentrations that have subsequently changed marginally as a result of a minor modeling optimization. The revised upper limit worst case concentrations (31 µg/L in the post closure condition compared with 29 µg/L previously, for example) are not expected to change the conclusions reached in the following analysis, but it is appropriate that the reader is alerted to this minor discrepancy.*

In addition to acute toxicity caused by exposure to high copper concentrations, chronic exposure to lower concentrations can have sublethal effects on fish reproduction, behavior, growth, osmoregulation, olfaction, respiration and metabolism, enzyme activity, teratogenesis and resistance to disease (USEPA 2007). Copper toxicity has been well studied and includes effects at low concentrations (low parts per billion range) under certain water quality conditions. However, it is widely recognized that the aquatic fate, bioavailability, and toxicity of copper are strongly influenced by a complex combination of physical, chemical, and biological conditions (e.g., Paquin et al. 2002, USEPA 2007, and Grosell 2012). In natural waters, the bioavailability and toxicity of waterborne copper are particularly influenced by dissolved organic carbon, pH, and hardness (USEPA 2007, Kennedy et al. 2012, and Grosell 2012).

Table 8-14 below summarizes water quality predictions for copper, which are further detailed in SRK's report presented in Appendix K. During the operational period, under "reasonable worst case" conditions, upper limit concentrations of copper in lower Minto Creek (W1) during effluent discharge periods were projected to range from 9 µg/L (January) to 27 µg/L (May). Under "expected" conditions, typical copper concentrations during the operational period were projected to range from 4 µg/L (January) to 23 µg/L (May). During the post-closure period, under "reasonable worst case" conditions, upper limit concentrations of copper were projected to be moderately higher than during operations (17 to 32 µg/L, depending on month). Under "expected" conditions during the post-closure period, typical copper concentrations were projected to range from 8 to 23 µg/L. Although these concentrations are higher than the CCME guideline (2 µg/L to 4 µg/L[1]; CCME 1999) and background SSQWOs developed from the 95th

[1] *CCME guideline is hardness dependent and calculated according to the following equation (CCME 1999):*

$$WQG\ (\mu g/L) = e^{\{0.8545[ln(hardness)]-1.465\}} * 0.2 \qquad \textit{where hardness is in mg/L}$$

The minimum value is 2 µg/L, regardless of hardness; and the maximum is calculated from a maximum hardness value of 280 mg/L at W2.

percentile of concentrations in Minto Creek in 2009 (13 µg/L; Minto Creek Water Quality Characterization – Appendix G, Table 17), they do not exceed the SSWQOs developed in 2013 from a larger data set (53 µg/L; Appendix G, Table 17). In addition, certain chemical conditions within Minto Creek (i.e., pH typically in the range of 7.8-8.2 and dissolved organic carbon typically in the range of 9.7-18.4 mg/L [25th-75th percentile ranges]) reduce the bioavailability and toxicity of waterborne copper.

Table 8-14: Water Quality Predictions at W1 for Copper (µg/L).

	Phase V/VI Operations				Post-Closure			
	Expected Case		Reasonable Worst-case		Expected Case		Reasonable Worst-case	
	Typical	Upper Limit	Typical	Upper Limit	Typical	Upper Limit	Typical	Upper Limit
January	5	6	7	9	8	11	14	17
February	7	9	9	12	10	12	16	19
March	9	10	12	14	12	13	17	20
April	11	12	14	15	13	15	19	22
May	23	24	25	27	23	25	29	32
June	7	23	9	26	10	25	15	31
July	15	16	17	18	17	18	21	24
August	14	16	15	18	16	18	20	24
September	8	14	9	16	11	16	16	22
October	8	8	10	10	11	12	16	19
November	8	8	10	11	11	12	16	19
December	6	8	9	11	10	12	15	19

Potential effects of the projected copper concentrations were assessed using the biotic ligand model (DiToro et al. 2001, Santore et al. 2001, Paquin et al. 2002, HydroQual 2007, and USEPA 2007). The principal advantage of applying the biotic ligand model (BLM) is that it allows evaluation of the potential effects of copper under the specific water quality conditions that co-occur with the copper concentrations (Niyogi and Wood 2004, Erickson 2013). Key determinants of copper effects (i.e., determinants of copper bioavailability and toxicity), such as pH and concentrations of dissolved organic carbon and major cations, all vary over time (along with copper) and thus copper effects are best assessed taking the modifying influence of these water quality conditions into account. Copper effects are modified principally by complexation (e.g., with dissolved organic carbon) and competition for uptake at a biological tissue (e.g., from major cations). The combination of the three C's concentration, complexation, and competition determines the potential for copper to cause an adverse biological effect (e.g., Paquin et al. 2002, Grosell 2012). The BLM was used to calculate Instantaneous Water Quality Criteria (IWQC) for copper (USEPA 2007) applicable to each month of the year using the projected water quality data. As pH, dissolved organic carbon, and alkalinity were not projected (Appendix K), monthly mean data for lower Minto Creek were calculated based on data from 2005-2012 and were used for modeling. Refer to the biotic ligand model in *Supporting Data* (Appendix N). Projected concentrations of copper[2] were then compared to the IWQC (both acute [short-term] and chronic [long-term] criteria) and expressed as acute toxic units and chronic toxic units. Additional BLM predictions of acute toxicity to fish and invertebrates were also calculated (Appendix N) but are not integral to this effects assessment (i.e., this assessment is based on more stringent benchmarks). Furthermore, a sensitivity analysis was performed on several determinants of copper bioavailability and toxicity (temperature, pH, dissolved organic carbon, and alkalinity), and indicate that BLM predictions are most sensitive to changes in pH and dissolved organic carbon (Appendix N).

Application of the BLM to water quality projections for the operational period indicated that even under “reasonable worst case” conditions, projected monthly upper limit copper concentrations remain below the concurrent IWQC-acute and IWQC-chronic values (Figure 8-6 and Appendix N). In fact, even when highest copper concentrations are projected to occur (26.3 µg/L in May[3], the number of chronic copper toxic units is 0.54 (the highest number of acute toxic units is 0.34 (Figure 8-7). This indicates that no toxic effects associated with copper are likely under “reasonable worst case” conditions (it would take approximately 1.85-times more copper to become toxic under chronic exposure (Figure 8-7). Under “expected” conditions, the projected number of toxic units is lower (0.29 acute and 0.47 chronic (Figure 8-8 and Appendix N), but *the* differences among scenarios (in most months) are relatively small due to concurrent differences in a number of other parameters that modify copper toxicity.

Application of the BLM to water quality projections for the post-closure period indicated that even under “reasonable worst case” conditions, projected monthly upper limit copper concentrations remain below the concurrent IWQC-acute and IWQC-chronic values (Figure 8-9 and Appendix N). Even when highest copper concentrations are projected to occur (29.5 µg/L in May and 28.8 µg/L in June[4]), the number of chronic copper toxic units are 0.59 and 0.60 (the number of acute toxic units are 0.37 and 0.38 (Figure 8-10). This indicates that no toxic effects associated with copper are likely under “reasonable worst case” conditions (it would take approximately 1.67-times more copper to become toxic under chronic exposure (Figure 8-10). Under “expected” conditions, the projected number of toxic units is lower (0.29 and 0.09 acute and 0.47 and 0.14 chronic in May and June, respectively (Figure 8-11 and Appendix N), but, as noted above, the differences among scenarios (in most months) are relatively small because of concurrent differences in a number of other parameters that modify copper toxicity.

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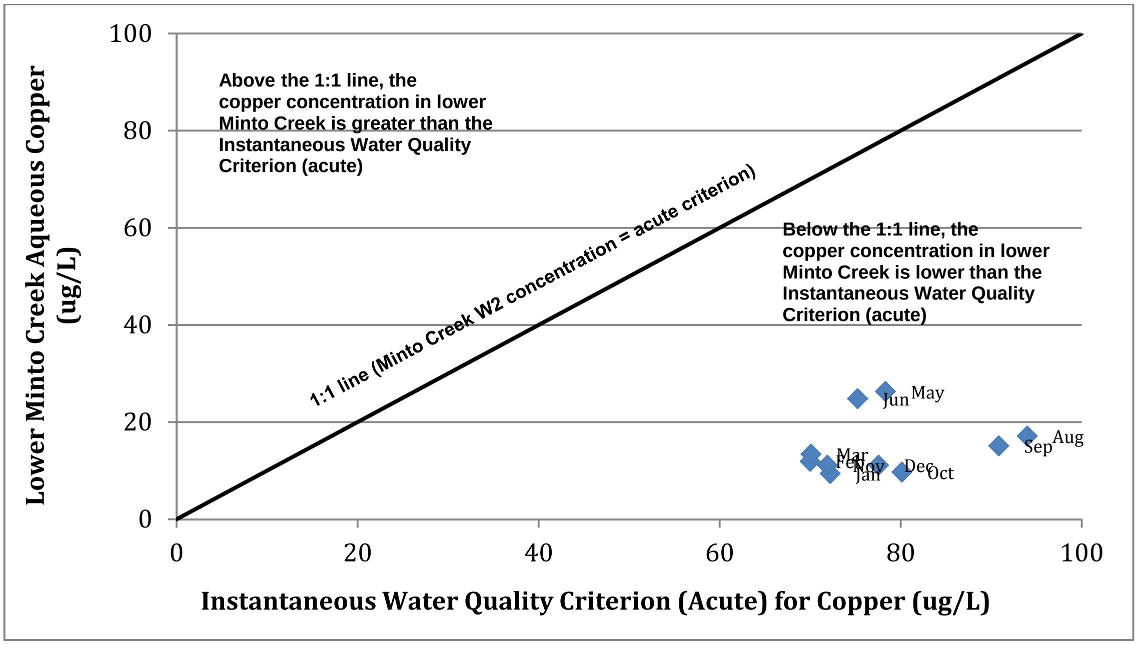
[2] *Note that projected copper concentrations (presented in Appendix K) have been updated since their incorporation into the BLM presented here, but differences are minor and do not affect the outcome of the model.*

[3] *Note that projected copper concentrations (presented in Appendix K) have been updated since their incorporation into the BLM presented here, but differences are minor and do not affect the outcome of the model.*

Overall, the evaluation of projected copper concentrations in the operational stage and post-closure indicates that harmful effects associated with copper are unlikely. This evaluation is conservative in that it evaluates “reasonable worst case” (typical case is better) and it treats total copper concentrations as though they were dissolved (dissolved copper is more bioavailable than total (Morel 1983, Pagenkopf 1983). Both sources of conservatism are significant. Under average case conditions, the maximum number of chronic toxic units is projected to be 0.47 during operations and 0.45 post-closure (Figures 8-8 and 8-11, respectively, and Appendix N). Furthermore, Minto Mine discharge is expected to include particle-associated copper and further particulate complexation of dissolved copper is likely to occur in Minto Creek (e.g., Horowitz 1991, Sposito 2004). Consideration of the BLM results and of the resource conditions of lower Minto Creek (described in Section 8.2) support a conclusion of no significant adverse effects associated with aqueous copper.

A) Acute



B) Chronic

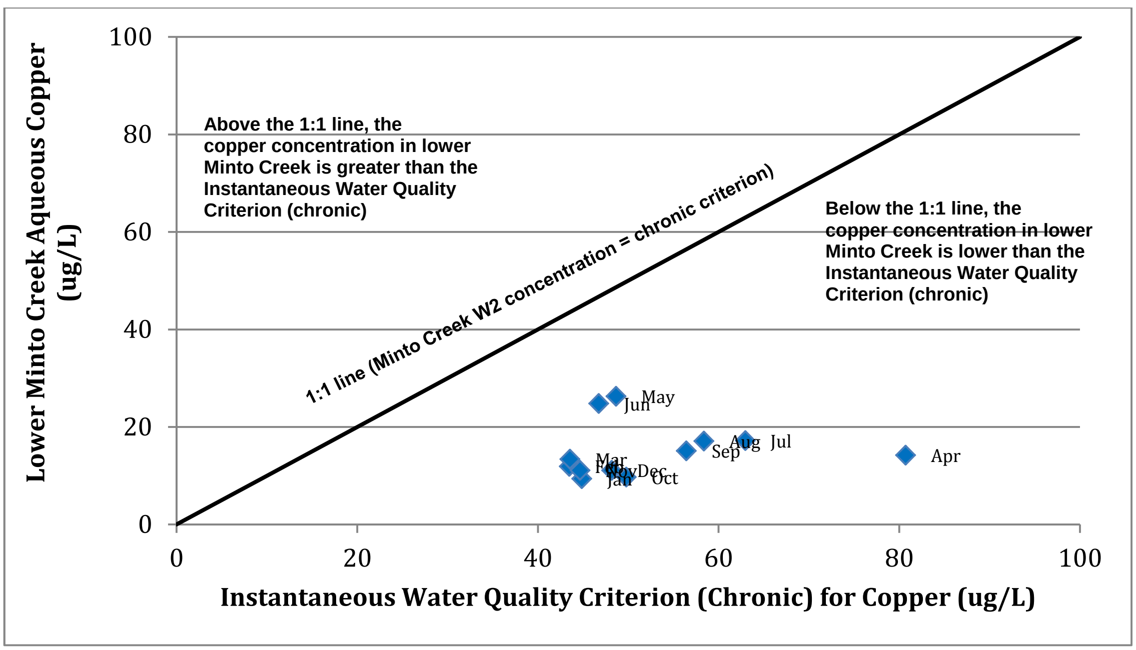
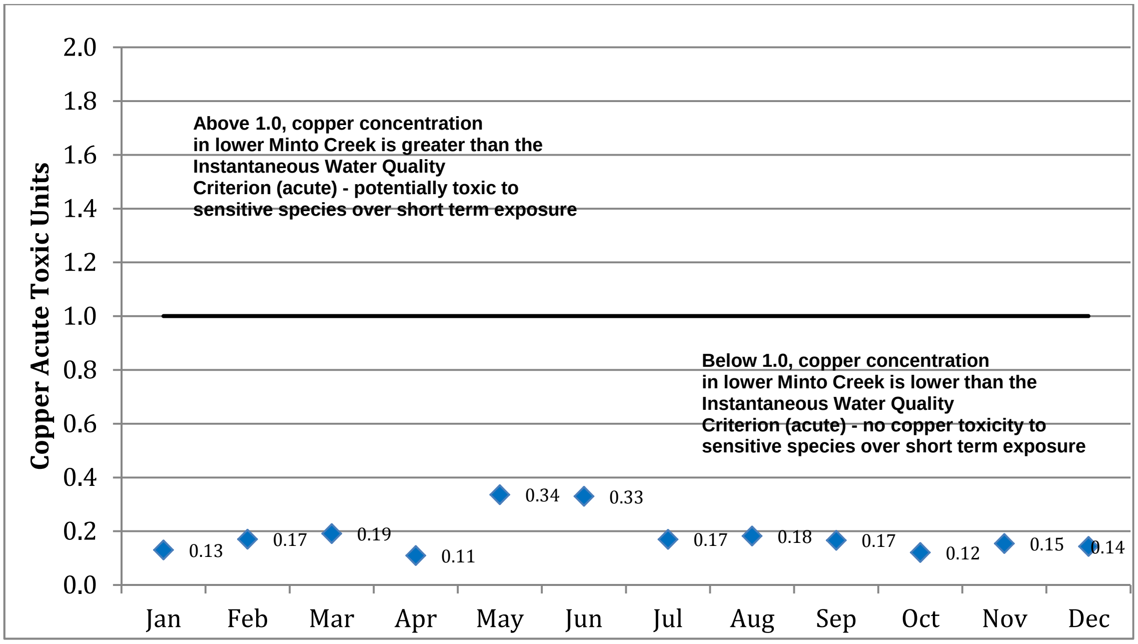


Figure 8-6: Comparison of Upper Limit Projected Copper Concentrations ("Reasonable Worst Case Operational Stage") to Concurrent Instantaneous Water Quality Criteria (IWQC): Expressed as Acute IWQC (A) or Chronic IWQC (B).

A) Acute



B) Chronic

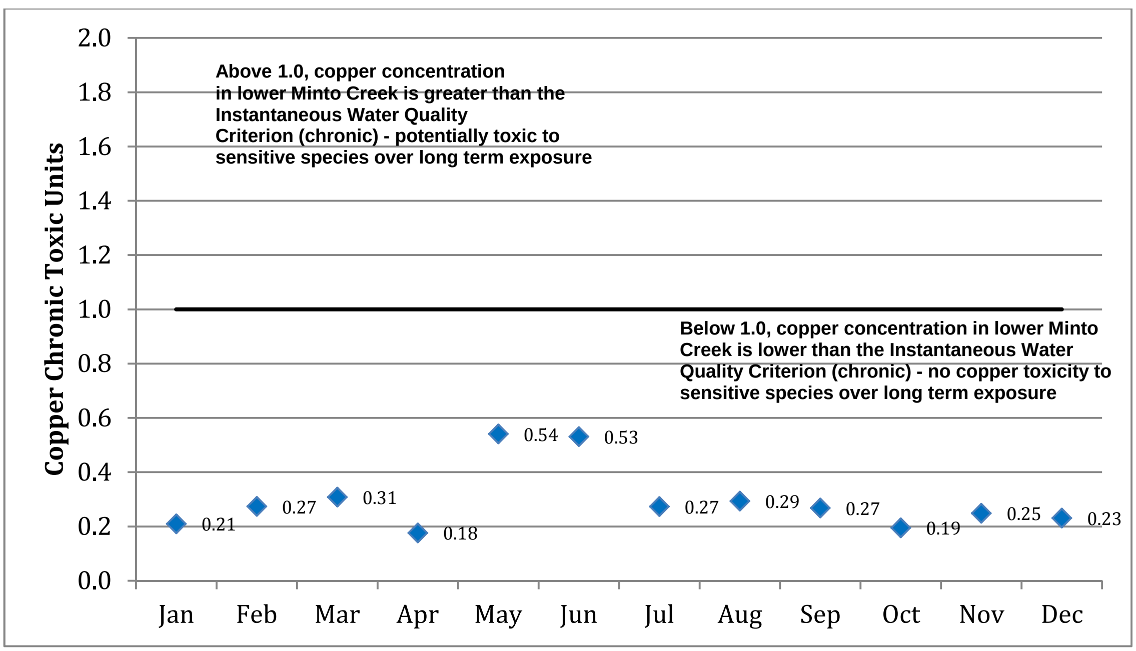
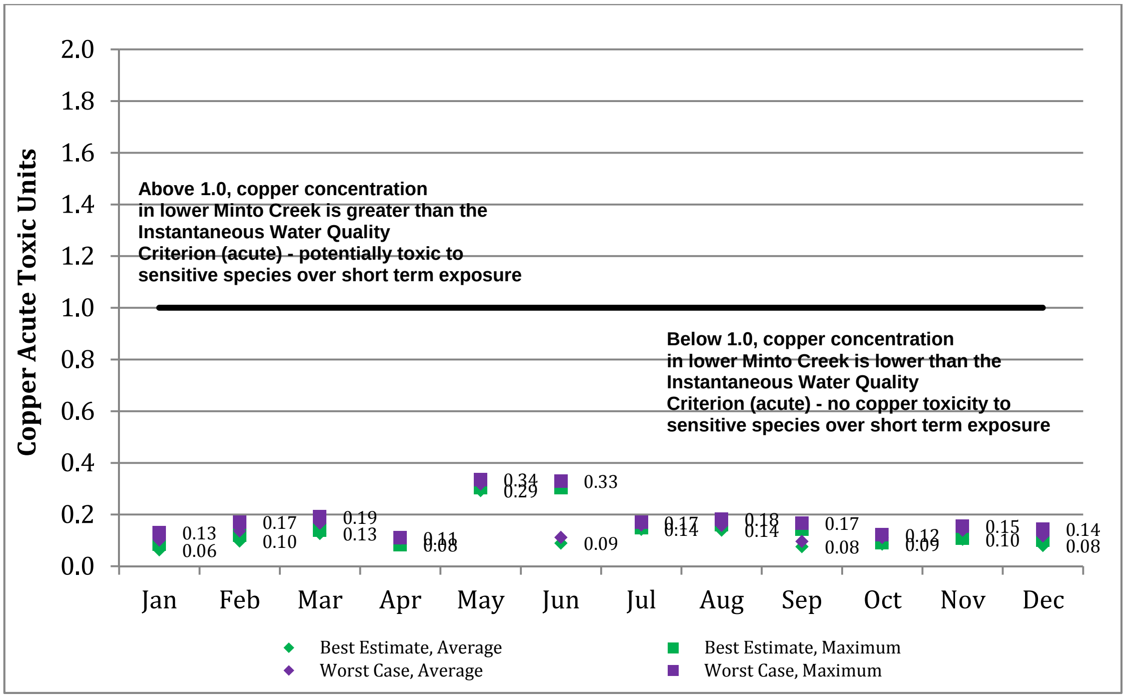


Figure 8-7: Projected Upper Limit Copper Concentrations ("Reasonable Worst Case Operational Stage"): Expressed as Acute Toxic Units (A) or Chronic Toxic Units (B).

A) Acute



B) Chronic

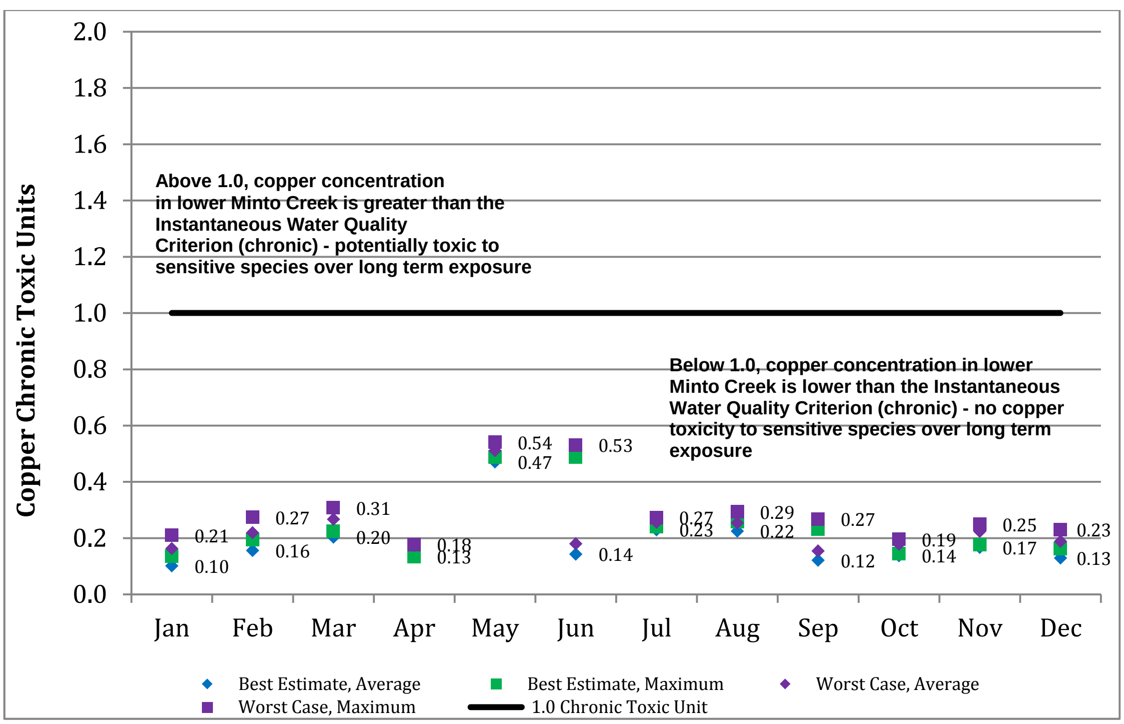
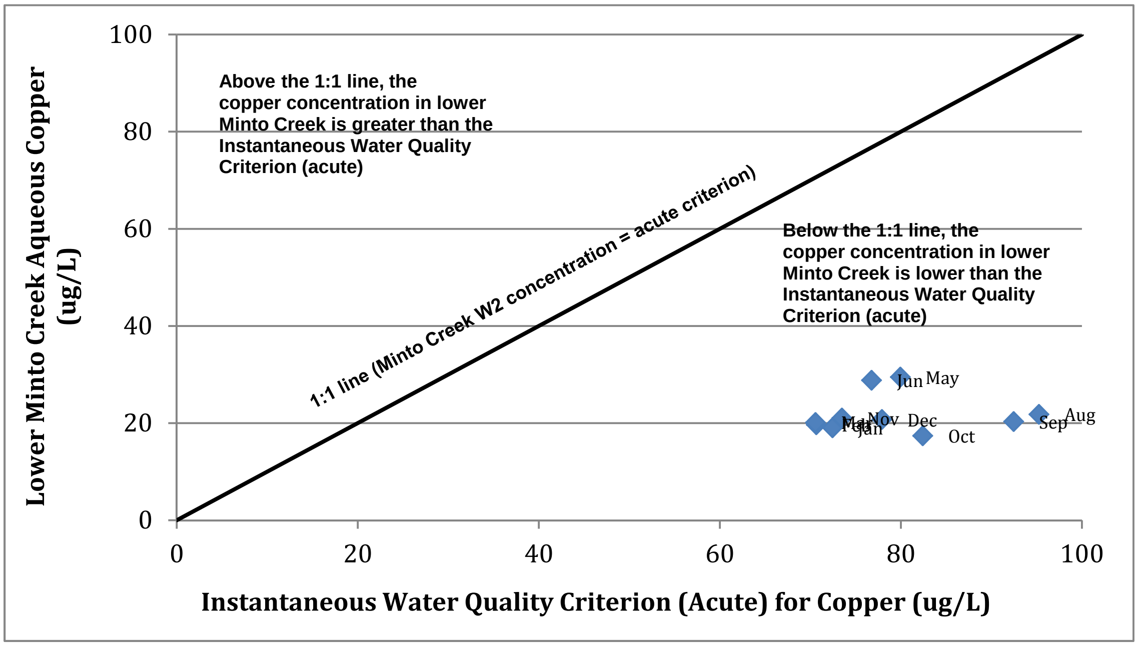


Figure 8-8: Projected Copper Concentrations (All Modeled Scenarios, Operational Stage): Expressed as Acute Toxic Units (A) or Chronic Toxic Units (B).

A) Acute



B) Chronic

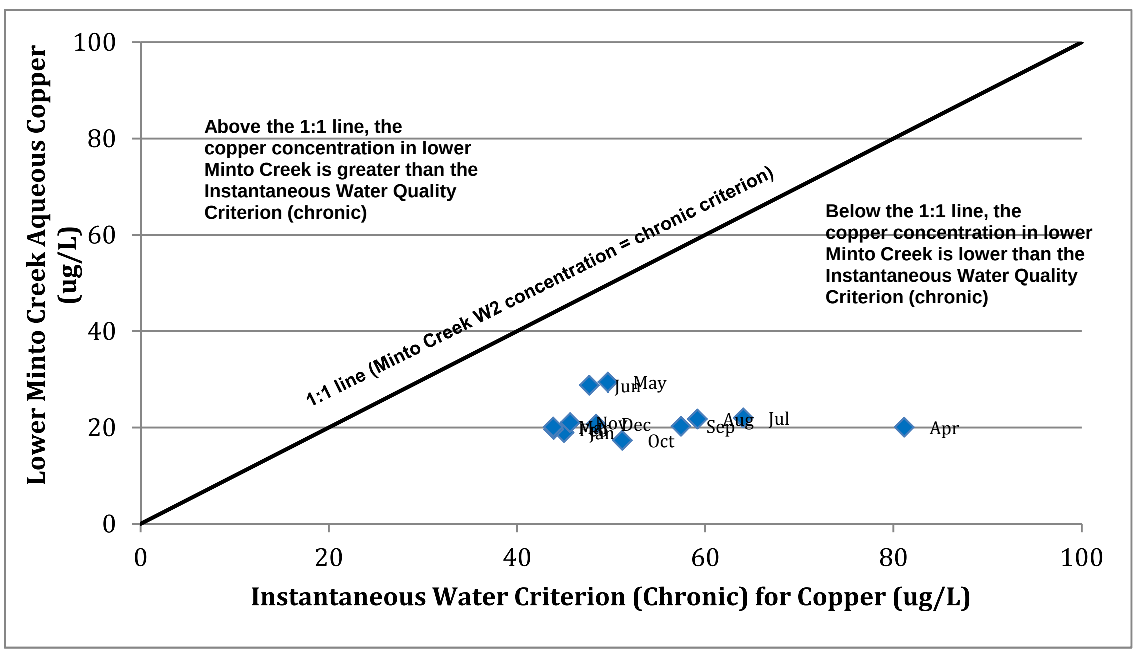
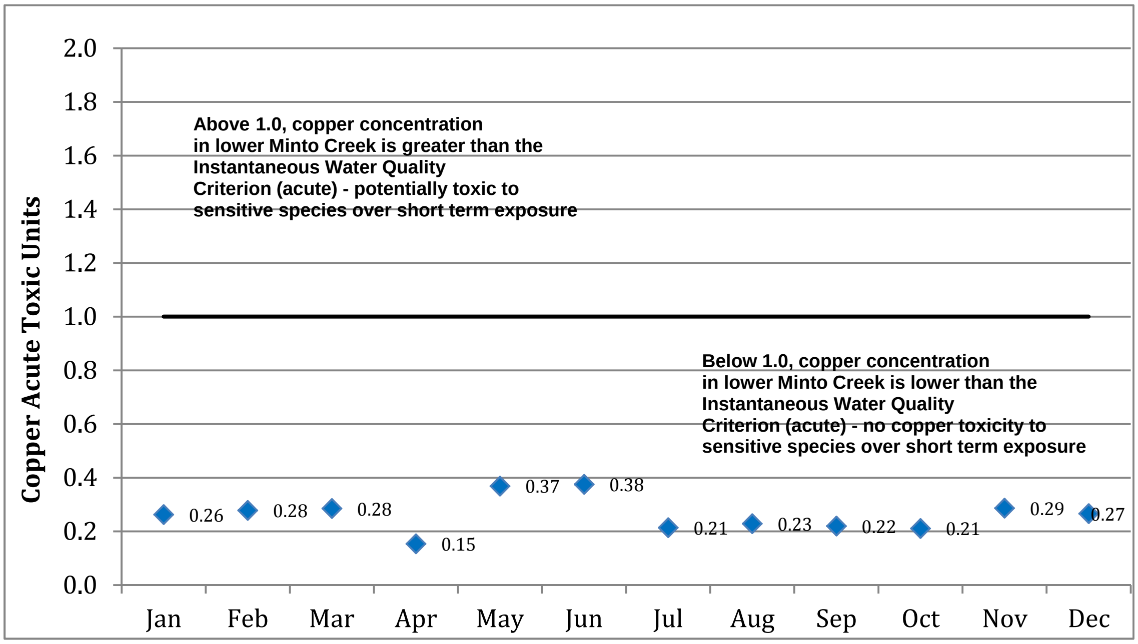


Figure 8-9: Comparison of Upper Limit Projected Copper Concentrations ("Reasonable Worst Case Post-closure") to Concurrent Instantaneous Water Quality Criteria (IWQC): expressed as Acute IWQC (A) or Chronic IWQC (B).

A) Acute



B) Chronic

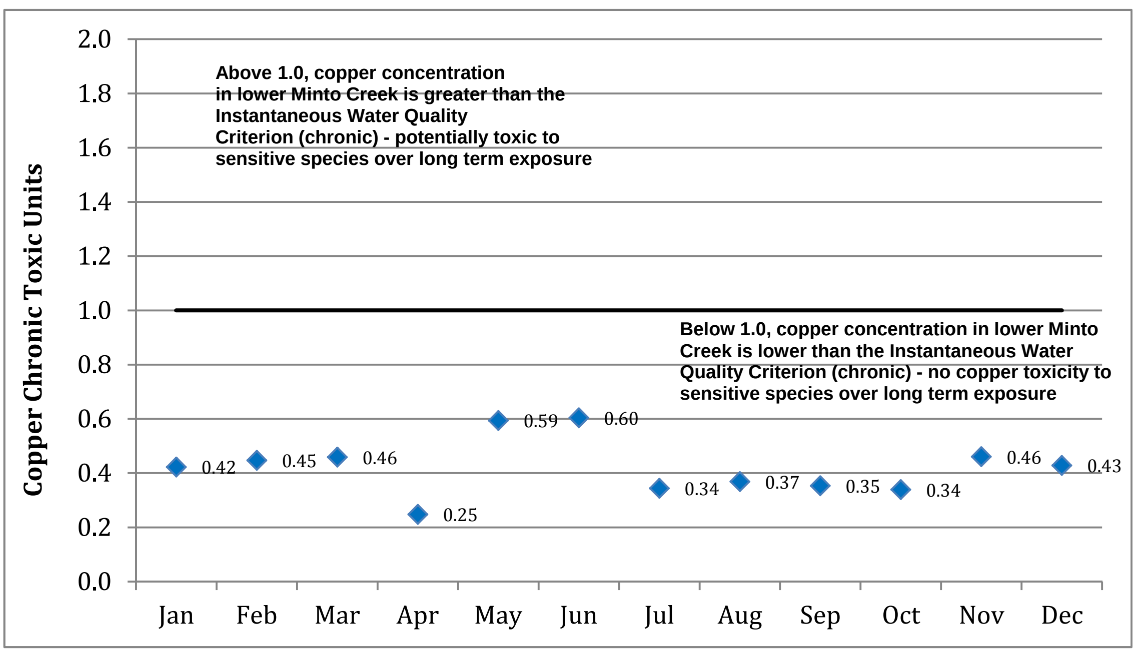
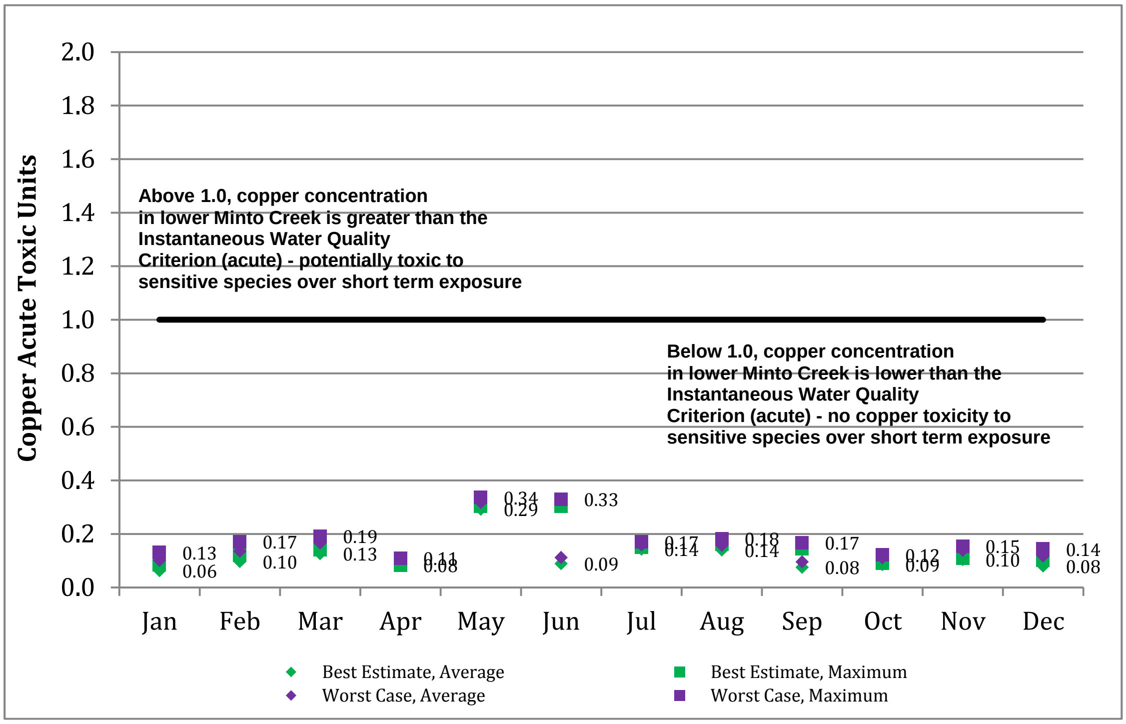


Figure 8-10: Projected Upper Limit Copper Concentrations ("Reasonable Worst Case Post-closure"): Expressed as Acute Toxic Units (A) or Chronic Toxic Units (B).

A) Acute



B) Chronic

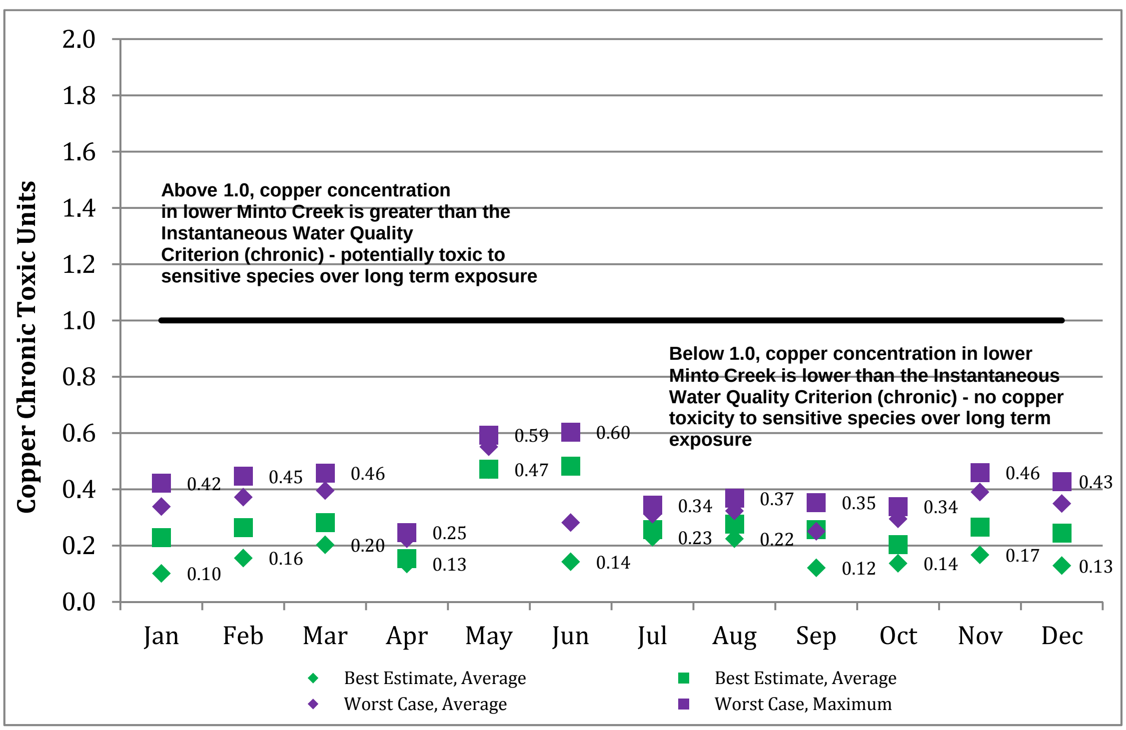


Figure 8-11: Projected Copper Concentrations (All Modeled Scenarios, Post-closure): Expressed as Acute Toxic Units (A) or Chronic Toxic Units (B).

Mitigations and Monitoring

Minto is proposing mitigation in the form of effluent treatment using best available technology that is economically achievable. Specifically, the water treatment plant design incorporates the use of an inorganic aluminum-based coagulant as the best option to facilitate settling of TSS and metal sulphides. Sulphide chemistry is then used to achieve sufficient removal of copper, by first converting dissolved metals to metal sulphides, and then using a flocculent to achieve settling of the coagulated TSS and metal sulphides (see Section 7.2).

Furthermore, the Mine intends to continue the comprehensive environmental monitoring (of water, sediment, benthic invertebrates and fish) currently required under the water use licence and the MMER of the federal *Fisheries Act*. In addition, the previous recommendation (Minnow 2013a) to evaluate the potential for effects associated with aqueous copper concentrations using the BLM IWQC will be applied in the annual interpretation of the water quality of lower Minto Creek.

8.3.1.4 Cadmium

Cadmium toxicity has been found to be variable in fish, with salmonids being particularly susceptible (CCME 1999a). Adverse impacts include reduced growth (due to increased metabolic burden and/or impaired olfactory system), decreased recruitment (due to young fish being more sensitive and spawning adults avoiding contaminated areas), and mortality (Morris 2010). Sub-lethal exposure can cause accumulations in the olfactory systems or affect the central nervous system, and cause changes in behavior (social, foraging, predator avoidance) (Morris 2010).

Aquatic organisms take up cadmium from both their diet and respiratory surfaces (Chapman 2012, McGeer et al. 2012). Cadmium toxicity depends on a number of physical and chemical parameters, including pH, salinity, and hardness (Environment Canada 1994, McGeer et al. 2012). Currently, the primary quantitative correlation used to modify metal toxicity estimates is water hardness. Hardness has a direct effect on cadmium toxicity, since calcium and magnesium ions compete with the metal for binding sites on the gill, but it also serves as a surrogate for pH, alkalinity and ionic strength as these parameters are usually positively correlated with hardness (USEPA 2001).

The current CCME interim guideline for cadmium can be calculated on a site-specific basis according to the following equation (CCME 1999a):

$$WQG = 10^{\{0.86[\log(hardness)]-3.2\}}$$

where the water quality guideline (WQG) is in µg/L and hardness is measured as $CaCO_3$ equivalents in mg/L.

Based on data collected in Minto Creek between 2005 and 2012, hardness at W2 generally ranges between 44 mg/L and 280 mg/L, putting the CCME interim guideline between 0.0162 and 0.0803 µg/L, with an average value of 0.0480 µg/L. Figure 8-12 shows the range of water hardness and cadmium concentration observed in lower Minto Creek between 2005 and 2012. Note that the CCME interim guideline is regularly exceeded, even during periods of non-discharge of mine water. Similar exceedances are found in many natural systems, for instance the mean total cadmium concentration in Yukon surface waters is 0.1 µg/L, and ranges from <0.1 µg/L to 1.3 µg/L (Environment Canada 1994).

"Cadmium toxicity to aquatic organisms depends on its speciation; the free ion (Cd^{2+}) concentration is proportional to bioavailability […]. Thus, the use of total Cd concentration in the CCME WQGs is conservative and over-protective." (Chapman 2012) For comparison, the Canadian interim WQG for Cd is an order of magnitude lower than the US Cd water quality criteria (USEPA 2001) which is based on dissolved (not total) concentration, and more than an order of magnitude lower than other countries that base their guideline or criteria on total Cd concentrations (Chapman 2012). Accordingly, the application of the safety factor of 0.1 in the current CWQG has been considered arbitrary and perhaps excessive.

For the reasons above, the fact that the interim guideline is below the detection limit of most analytical instruments and that its derivation method has high dependence on a single study, the CCME interim guideline for the protection of aquatic life is currently being revised using a species sensitivity distribution analysis, according to the revised protocol (CCME 2007b). Draft guidelines for short-term and long-term exposure were released for public review in October 2012 and are now being finalized. The draft equations for the new guidelines are as follows:

Short-Term Exposure Guideline: $WQG = 10^{\{1.016[\log(hardness)]-1.71\}}$

Long-Term Exposure Guideline: $WQG = 10^{\{0.83[\log(hardness)]-2.46\}}$

where the water quality guideline (WQG) is in µg/L and hardness is measured as $CaCO_3$ equivalents in mg/L.

Using the draft long-term exposure guideline equation and the range of hardness in Minto Creek mentioned above, the new chronic CWQG would range from 0.080 to 0.373 µg/L, with an average value of 0.227 µg/L in lower Minto Creek. The new draft short and long-term CWQGs are also shown on Figure 8-8, where we can see that the new acute guideline would never have been exceeded in Minto Creek between 2005 and 2012 and the chronic guideline would have been exceeded on occasions, both during periods of mine water discharge and periods of non-discharge. Note however that most exceedances would be for total Cd, not dissolved Cd, and that punctual exceedances of the chronic guideline do not represent a risk to aquatic life (as opposed to regular exceedances of the chronic guideline or punctual exceedances of the acute guideline).

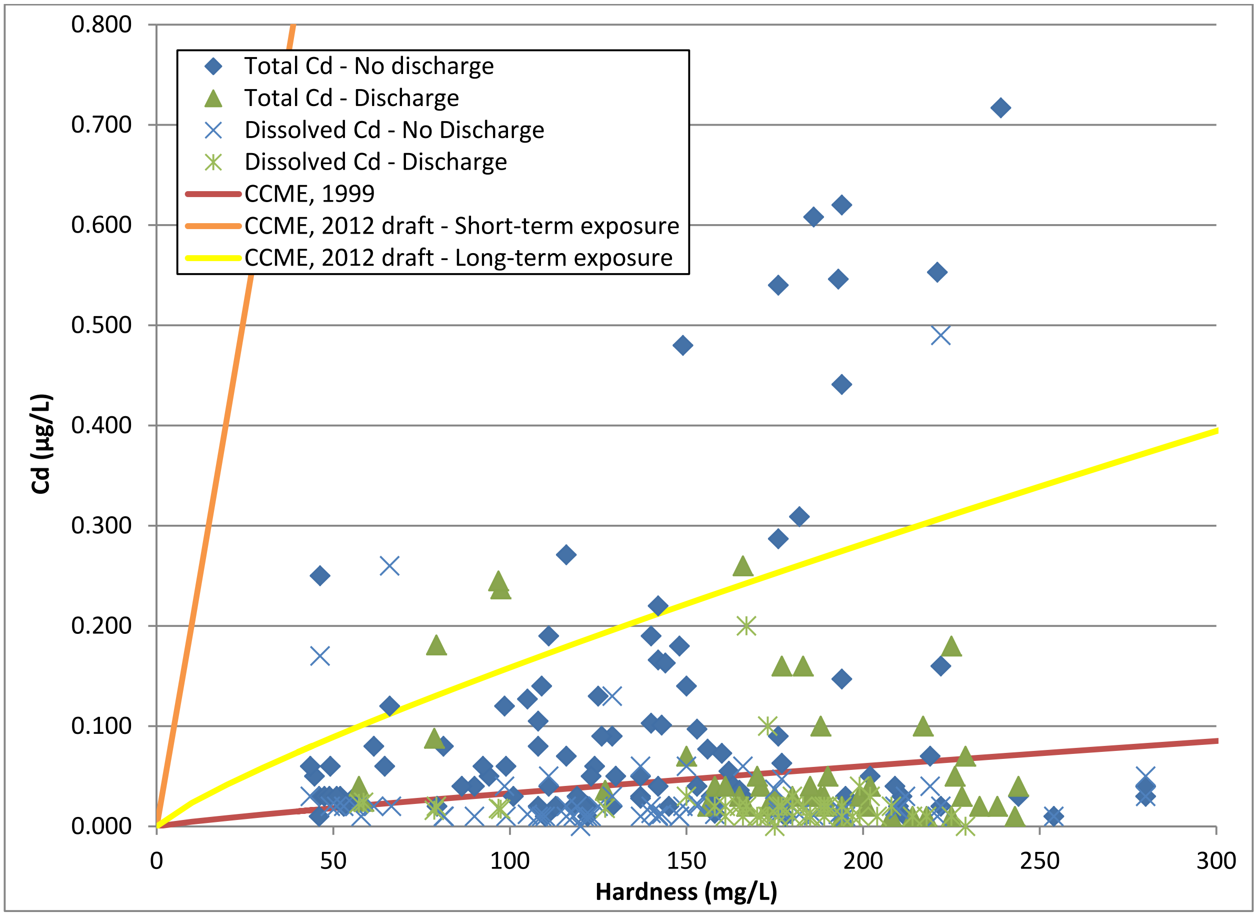


Figure 8-12: Total and Dissolved Cadmium Concentrations and Water Hardness at W2: 2005-2012.

Table 8-15 below summarizes water quality predictions for cadmium, which are further detailed in SRK's report presented in Appendix K. The "expected case" typical and upper limit cadmium concentrations range from 0.020 µg/L to 0.149 µg/L and from 0.026 µg/L to 0.161 µg/L respectively during the operational period. At post-closure, "expected case" typical and upper limit concentrations would range from 0.033 µg/L to 0.139 µg/L and from 0.040 µg/L and 0.145 µg/L respectively. The highest concentrations are predicted to occur in May, while the lowest would occur in January. Based on the historical range of water hardness at W1 (which is not expected to change significantly), these expected concentrations would very rarely, if at all, exceed the new CCME chronic guideline (average value of 0.227 µg/L).

Similarly, the predicted reasonable worst-case upper limit Cd concentrations for the operational period range from 0.035 µg/L (January) to 0.163 µg/L (May), and would therefore very rarely exceed, if at all, the new chronic guideline based on the historical hardness. Predictions for the post-closure period indicate that reasonable worst-case upper limit Cd concentrations would range from 0.068 µg/L (September) to 0.174 µg/L (May) which again would very rarely exceed, if at all, the new chronic guideline based on the historical hardness range. Moreover, the highest values are anticipated to occur in May, when fish have not been observed in Minto Creek. A site-specific water quality objective (SSWQO) was also derived for cadmium, based on the 95th percentile of 2005-2012 background data, and was calculated to be 0.368 µg/L, per *Minto Creek Water Quality Characterization* (Appendix G). This SSWQO is not expected to be exceeded, under operational or post-closure stages.

Should a short duration system upset cause cadmium concentration to reach the proposed effluent limit of 0.300 µg/L (see section 7.4.3) in the WSP (instead of the maximum value of 0.209 µg/L used in the modeled reasonable worst case scenario), the resulting anticipated short term concentration at W1, obtained using the same dilution ratio as in the SRK model (Appendix K), would approximate 0.250 µg/L. Since this concentration would only occur for short periods of time, it is appropriately compared to the new CCME guideline for short-term exposure (acute). A back-calculation using the short-term equation presented above shows that a hardness value of about 12.5 mg/L would be required to reach the CCME acute guideline at this cadmium concentration. Since such a low hardness has never been observed in lower Minto Creek in 8 years of monitoring (2005-2012), and hardness is not expected to change under Phase V/VI, there are no anticipated acute toxic effects associated with these possible isolated higher concentrations.

Table 8-15: Water Quality Predictions at W1 for Cadmium (µg/L).

	Phase V/VI Operations				Post-Closure			
	Expected Case		Reasonable Worst-case		Expected Case		Reasonable Worst-case	
	Typical	Upper Limit	Typical	Upper Limit	Typical	Upper Limit	Typical	Upper Limit
January	0.020	0.026	0.027	0.035	0.033	0.040	0.055	0.068
February	0.032	0.038	0.039	0.047	0.042	0.050	0.064	0.079
March	0.025	0.038	0.033	0.048	0.036	0.050	0.059	0.078
April	0.048	0.050	0.056	0.062	0.055	0.060	0.078	0.090
May	0.149	0.161	0.156	0.163	0.139	0.145	0.161	0.174
June	0.041	0.152	0.046	0.159	0.051	0.144	0.070	0.171
July	0.088	0.091	0.094	0.098	0.089	0.094	0.108	0.117
August	0.082	0.091	0.088	0.098	0.085	0.093	0.104	0.117
September	0.024	0.082	0.029	0.088	0.036	0.086	0.057	0.109
October	0.035	0.037	0.041	0.045	0.045	0.050	0.067	0.077
November	0.061	0.070	0.067	0.078	0.067	0.077	0.089	0.105
December	0.038	0.070	0.045	0.078	0.047	0.077	0.070	0.104

Furthermore, pending the final CCME guidelines publication, potential effects of the projected “reasonable worst case” upper limit cadmium concentrations were also assessed using the biotic ligand model (BLM) for the purposes of this project proposal[5]. Projected monthly cadmium concentrations are well below 1.0 acute toxic unit (ACU) for the most sensitive species (rainbow trout). During the operational period, the highest ACU is projected to occur in June at 0.0112 (Figure 8-13), while it is predicted to occur in May (at 0.0079) at post-closure (Figure 8-14) which indicate that no acute toxic effects associated with cadmium are likely under "reasonable worst case" conditions.

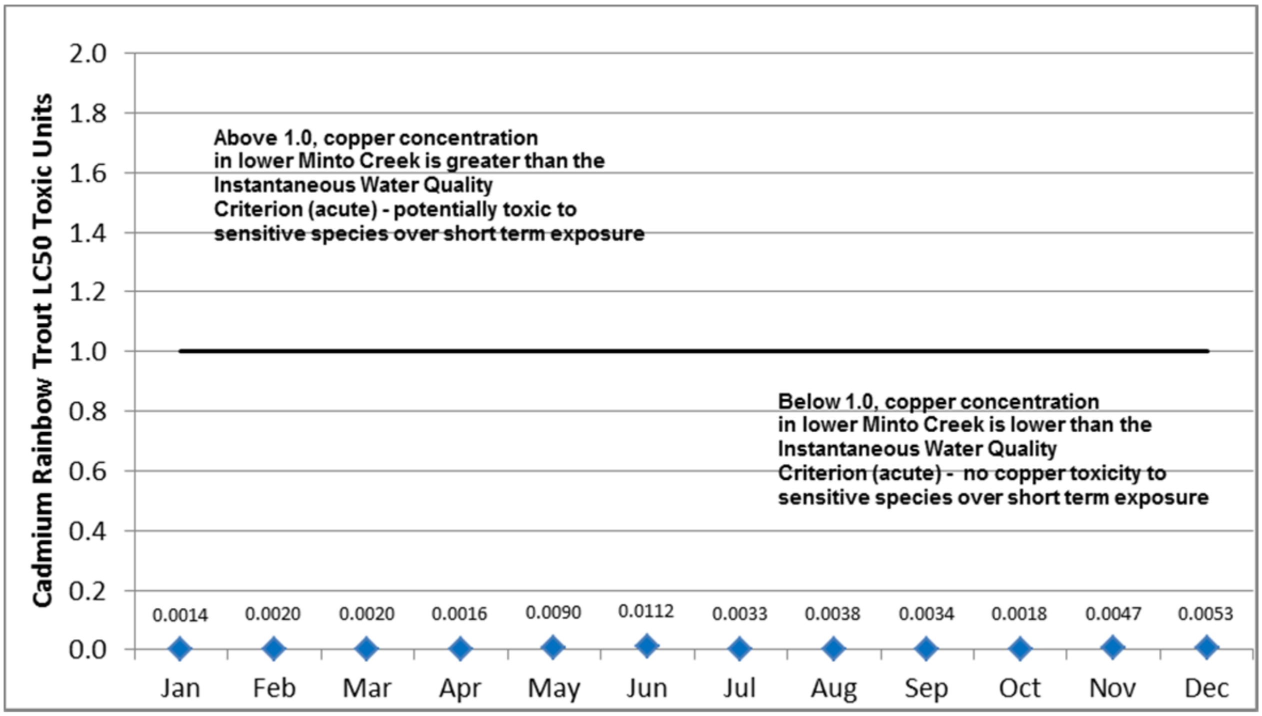


Figure 8-13: Cadmium in Minto Creek Relative to Rainbow Trout LC50: Operational Worst Case, Upper Limit

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[5] *This BLM assessment was conducted using predicted cadmium concentrations that have subsequently changed marginally as a result of a minor modeling optimization. The revised upper limit worst case concentrations (0.174 µg/L in the post-closure condition compared with 0.161 µg/L previously, for example) are not expected to change the conclusions reached in this analysis, but it is appropriate that the reader is alerted to this minor discrepancy.*

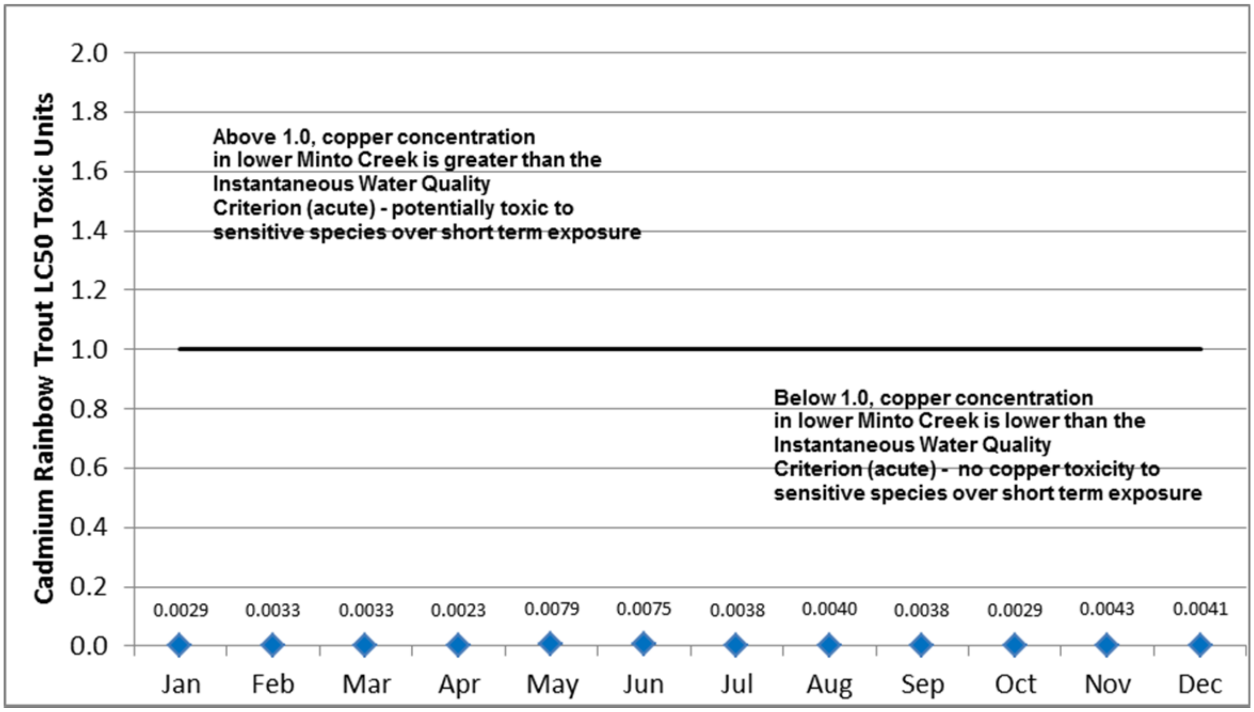


Figure 8-14: Cadmium in Minto Creek Relative to Rainbow Trout LC50: Post-closure Worst Case, Maximum.

The BLM for cadmium does not predict chronic toxicity, but acute-chronic ratios (ACRs) can be used predict chronic toxicity in aquatic organisms when the acute toxicity is known but chronic data are absent or limited. The USEPA provides cadmium-specific ACRs for a number of species, and the value is 0.9021 for Chinook salmon (USEPA 2001), which is the main species of concern in Minto Creek. Applying this ACR to rainbow trout LC50 values results in a maximum projected chronic toxic unit value of 0.0101 in June during the operational period and of 0.0072 in May at post-closure, which indicate that no chronic toxic effects associated with cadmium are likely under "reasonable worst case" conditions.

Mitigations and Monitoring

The Minto Mine is proposing mitigation in the form of effluent treatment using best available technology that is economically achievable. Specifically, the water treatment plant design (already on site) incorporates the use of an inorganic aluminum-based coagulant as the best option to facilitate settling of TSS and metal sulphides. Sulphide chemistry is then used to achieve sufficient removal of cadmium, by first converting dissolved metals to metal sulphides, and then using a flocculent to achieve settling of the coagulated TSS and metal sulphides (see Section 7.4.4 Water Treatment.)

Furthermore, the Mine intends to continue the comprehensive environmental monitoring (of water, sediment, benthic invertebrates and fish) currently required under the water use licence and the MMER of the federal *Fisheries Act*.

8.3.1.5 Fluoride

The most common ailment associated with an excess of fluoride is fluorosis, which relates to the retention of excess fluoride within the body and its deleterious integration into biochemical pathways (Fleiss 2010). Migration patterns of adult salmon can also be disrupted by high fluoride concentrations (Damkaer et al. 1989). A wide range of environmental (water temperature, pH, salinity, and hardness) and genetic factors cause fish to respond differently to given levels of fluoride (Sigler et al. 1972, Fleiss 2010).

The current CCME interim guideline for fluoride is 0.12 mg/L, and was derived by applying a safety factor of 0.01 to the lowest acceptable adverse effect level reported (CCME 2002). Because fluoride concentrations in Minto Creek and McGinty Creek are naturally elevated, SSWQOs were also derived using the 95th percentile of background concentrations. This approach resulted in SSWQOs of 0.43 mg/L for Minto Creek and 0.33 mg/L for McGinty Creek.

Table 8-16 below summarizes water quality predictions for fluoride, which are further detailed in SRK's report presented in Appendix K. The "expected case" typical value ranges from 0.13 mg/L (April) to 0.64 mg/L (August) and the upper limit from 0.18 mg/L (May) to 0.67 mg/L (September) for the operational period. For post-closure, the "expected case" typical value ranges from 0.23 mg/L (April) to 0.64 mg/L (August) and the upper limit ranges from 0.31 mg/L (June) to 0.70 mg/L (September). The "reasonable worst case" upper limit fluoride concentration is 0.67 mg/L in September for the operations period and 0.76 mg/L in September for the post-closure period.

Predicted upper limit concentration in McGinty Creek is 0.43 mg/L (in October) for both the operations and post-closure periods.

Table 8-16: Water Quality Predictions at W1 for Fluoride (mg/L).

	Phase V/VI Operations				Post-Closure			
	Expected Case		Reasonable Worst Case		Expected Case		Reasonable Worst Case	
	Typical	Upper Limit	Typical	Upper Limit	Typical	Upper Limit	Typical	Upper Limit
January	0.40	0.41	0.40	0.42	0.45	0.50	0.50	0.57
February	0.41	0.42	0.41	0.42	0.45	0.50	0.50	0.57
March	0.41	0.42	0.41	0.42	0.45	0.50	0.50	0.57
April	0.13	0.42	0.14	0.42	0.23	0.49	0.28	0.57
May	0.17	0.18	0.17	0.18	0.25	0.31	0.30	0.38
June	0.20	0.20	0.20	0.21	0.26	0.31	0.31	0.37
July	0.26	0.27	0.27	0.27	0.32	0.37	0.36	0.42
August	0.64	0.67	0.65	0.67	0.64	0.70	0.69	0.76
September	0.24	0.67	0.25	0.67	0.32	0.70	0.37	0.76
October	0.22	0.23	0.23	0.23	0.30	0.35	0.35	0.41
November	0.25	0.26	0.25	0.27	0.32	0.37	0.37	0.44
December	0.37	0.41	0.37	0.41	0.42	0.50	0.47	0.56

Even though some of these predicted concentrations exceed the CCME interim guideline and the SSWQOs, no adverse effects on aquatic resources are anticipated for the following reasons:

- Fish use of Minto and McGinty creeks is limited and transient (short average residence time), per *Aquatic Resources Baseline Report* (Appendix L), therefore limiting potential chronic exposure. Also, since the creeks are not used by spawning salmon (see sections 8.2.2.1 and 8.2.5.1), the risk of disrupting their migration patterns is insignificant;

- The local natural fluoride levels are important in assessing the toxicological effects, because local populations may already be adapted to fluoride exposure (Fleiss 2011, Sigler et al. 1972). Since background concentrations are naturally elevated in both Minto Creek and McGinty Creek, local populations of invertebrates are likely acclimatized to fluoride exposure;

- The aquatic toxicity of fluoride is influenced by environmental factors such as temperature, hardness, pH, salinity, and the presence of ion-exchange materials (CCME 2002, Fleiss 2010). Several conditions in both Minto and McGinty creeks contribute to reducing fluoride toxicity. Specifically:

  - Fluoride toxicity increases with increasing water temperature (CCME 2002). Relatively cold temperatures in both creeks (see sections 8.2.6 and 8.3.2.1) are therefore favourable;
  - Fluoride toxicity is negatively correlated with water hardness (CCME 2002). Relatively high (>50mg/L) average background hardness values in both creeks (154 mg/L for Minto Creek (W2) and 73 mg/L for McGinty (MN-4.5)) are therefore favourable;
  - Fluoride toxicity increases with a downshift in pH (Fleiss 2010). Average pH values in Minto (W2) and McGinty (MN-4.5) Creeks are 8.0 and 7.8, respectively, per Minto and McGinty Creek Water Quality Characterizations (Appendices G and H), which are slightly alkaline and therefore favourable;
  - The presence of cations such as calcium, magnesium, and potentially selenium or anions such as chloride, all of which are found in both creeks in varying concentrations, can reduce the toxicity of fluoride (CCME 2002).

- The CCME guideline is interim only and likely overprotective, since it uses a safety factor of 0.01. Criteria in other jurisdictions are generally higher (Fleiss 2010). For example, British Columbia uses a hardness-dependent criterion, which is calculated according to the following equation (BCMOE 2011):

  $$WQC = 0.01 * (-51.73 + 92.57\ log_{10}\ (hardness))$$

  where WQC and hardness are in mg/L.

  Using the historical hardness range measured at W2 (minimum = 44 mg/L, maximum = 280 mg/L, average = 154 mg/L), the WQC for Minto Creek would range between 1.00 and 1.75 mg/L (average of 1.51 mg/L). Similarly, for McGinty Creek, the historical hardness range at MN-4.5 (minimum = 28 mg/L, maximum = 109 mg/L, average = 73 mg/L) would yield a WQC between 0.82 and 1.37 mg/L (average of 1.21 mg/L).

8.3.1.6 Conclusion

In light of all the considerations above, including the limited fish use of Minto Creek, natural physical, chemical and biological processes acting on the bioavailability or toxicity of the contaminants of concern, as well as the mitigation measures such as source control and water treatment, the Project is not anticipated to result in significant adverse effects on aquatic resources from an increase in contaminant concentrations.

8.3.2 Change in Physical Parameters

A review of available data from 2006 to 2012 indicates that both water temperature and flow in lower Minto Creek were affected during periods of mine water discharge. As discussed in section 8.2.2.1, numbers of juvenile Chinook salmon were 32 to 175 times higher in the system during the two major discharge events (2009, 2010), indicating that they may have been attracted into the system as a result of the discharge. Numbers of other species of fish during discharge events did not increase at volumes released in 2009 and 2010. Future mine water discharge could have similar effects on JCS, although likely to a lesser extent, as discharge events in 2009 and 2010 were emergency releases.

No change in McGinty Creek temperature or flow is anticipated as mine water runoff from Minto North mine area will be collected and pumped to the Main Pit Tailings Management Facility (MPTMF). There will be minimal (if any) surface discharge from the Minto North Pit in the post-closure period.

8.3.2.1 Temperature

Mean monthly water temperature in lower Minto Creek was higher during periods of mine water discharge than during periods of non-discharge, as shown in Tables 8-17 and 8-18 and Figure 8-15. The average diurnal temperature range was also reduced during periods of mine water discharge (Tables 8-9 and 8-10 and Figure 8-16).

Table 8-17: Monthly Water Temperature Statistics at W1: 2006-2012 – Non-Discharge.

Month	Extreme Daily Minimum	Average Daily Minimum	Mean	Average Daily Maximum	Extreme Daily Maximum	Average Diurnal Temperature Range	# days of data
4	-0.45	-0.44	-0.10	0.49	1.07	0.93	9
5	-1.51	0.40	2.08	4.29	13.26	3.89	143
6	-0.25	4.46	6.11	7.91	14.75	3.44	199
7	1.00	6.39	7.97	9.63	19.88	3.24	168
8	2.09	5.31	6.56	7.81	11.31	2.50	155
9	-0.48	2.48	3.46	4.51	7.50	2.02	108
10	-2.81	0.00	0.32	0.70	3.94	0.70	65

Table 8-18: Monthly Water Temperature Statistics at W1: 2006-2012 – Discharge.

Month	Extreme Daily Minimum	Average Daily Minimum	Mean	Average Daily Maximum	Extreme Daily Maximum	Average Diurnal Temperature Range	# days of data
5	-1.10	-1.04	-0.53	0.39	1.32	1.43	8
6	3.44	6.01	7.41	8.96	10.88	2.95	5
7	6.57	8.49	9.65	10.84	13.19	2.35	49
8	3.38	7.94	8.89	9.80	12.87	1.86	45
9	0.44	4.84	5.57	6.29	8.94	1.45	56

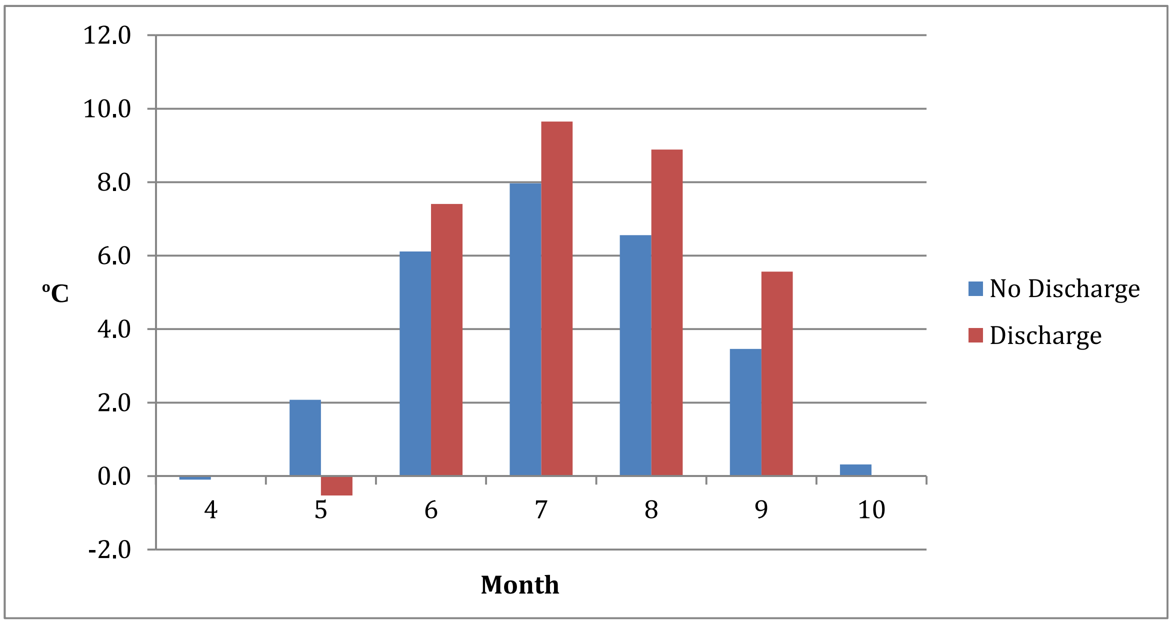


Figure 8-15: Mean Monthly Water Temperature at W1: 2006-2012.

Note: May discharge period mean temperature is lower due to limited number of days of data (8) and the fact that available data are early in the month (May 4 to May 11, 2012)

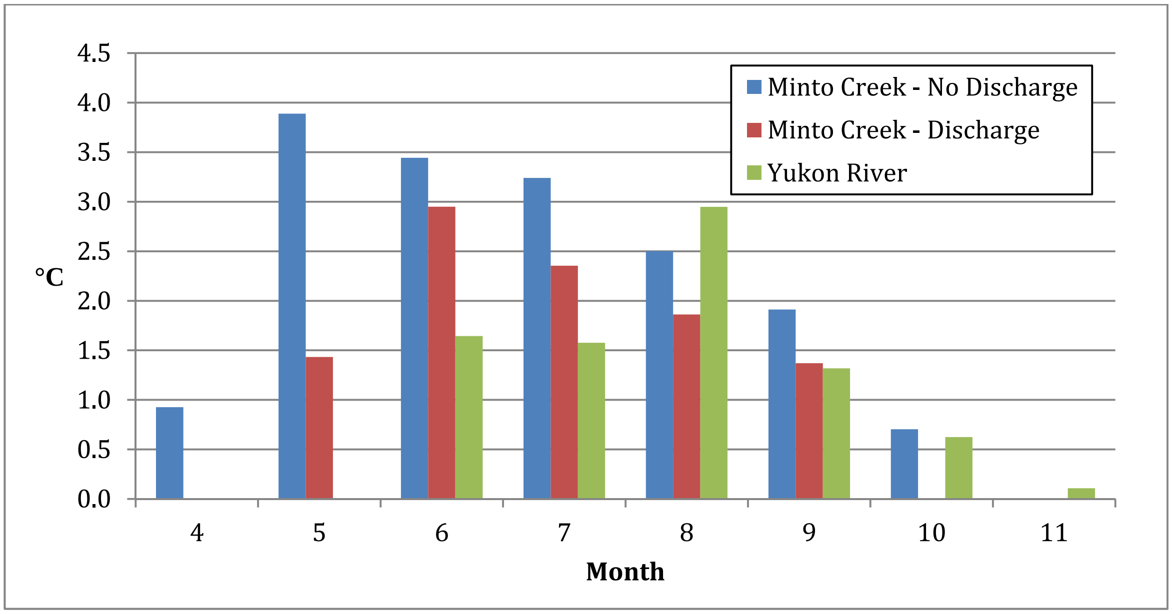


Figure 8-16: Average Diurnal Water Temperature Range in Minto Creek and in the Yukon River.

Notes: *Minto creek data collected at W1 between 2006 and 2012.*
Yukon River data collected near the mouth of Minto Creek (upstream) in 2007, 2010 and 2012.

The optimum rearing temperature range for Chinook salmon is 10 to 15.5°C (BCMOE 2001b)[6]. It appears that JCS are attracted into Minto Creek once its temperature has equilibrated with the Yukon River (typically not before late June or early July) and while the Yukon River water temperature would also fall within their optimal range (Table 8-19), predator avoidance would be the main driving factor to move into Minto Creek. The higher mean water temperature during mine water discharge periods could therefore contribute to attracting JCS into lower Minto Creek, since it brings the average water temperature closer to their optimal rearing range.

[6] *Optimal rearing temperature range cited here is based on BC Chinook populations, but the optimal temperature is likely lower for Yukon River Chinook populations.*

Table 8-19: Monthly Water Temperature Statistics, Yukon River: 2007, 2010, and 2012.

Month	Extreme Daily Minimum	Average Daily Minimum	Mean	Average Daily Maximum	Extreme Daily Maximum	Average Diurnal Temperature Range	# days of data
6	6.91	9.23	9.97	10.88	13.67	1.65	30
7	7.14	12.52	13.28	14.10	17.46	1.58	81
8	8.67	11.64	13.12	14.59	20.41	2.95	46
9	4.71	7.93	8.57	9.24	12.22	1.32	60
10	0.00	3.34	3.63	3.96	7.14	0.63	46
11	0.02	0.05	0.10	0.16	0.36	0.11	8

Notes: Water temperature data is only available for 2007, 2010 and 2012.
Data collected near the mouth of Minto Creek (upstream).

JCS growth rate is directly related to water temperature and a reduced diurnal range is likely more beneficial to them. The diurnal temperature range is typically greater in Minto Creek than in the Yukon River, but it is considerably reduced during periods of mine water discharge (Figure 8-16).

8.3.2.2 Flow

The average flow in lower Minto Creek has generally been higher during periods of emergency mine water discharge than during periods of no discharge (Figure 8-17). Between 2006 and 2012, the mean monthly flow at W1 was on average 131% higher during periods of emergency mine water discharge than during periods of non-discharge.

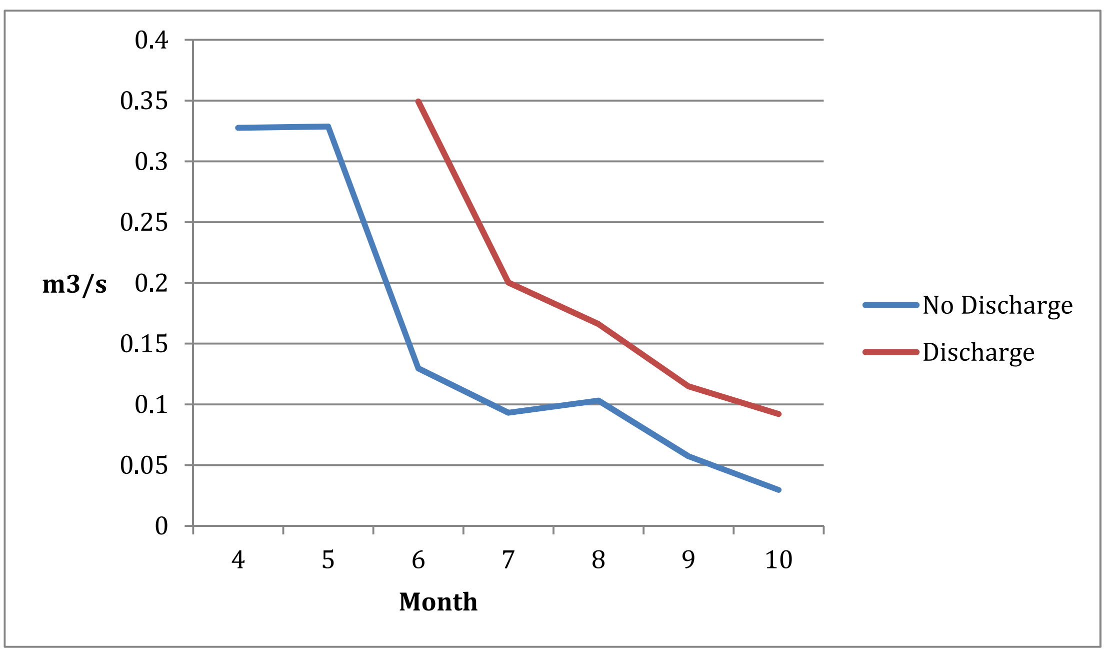


Figure 8-17: Mean Monthly Flow at W1: 2006–2012.

Lower Minto Creek naturally experiences large variations in flow being highly responsive to precipitation events, and is even subject to low- or zero-flow conditions during periods in the summer when a portion (or all) of the flow sometimes infiltrates the ground following passage through a canyon located approximately 2.0 km upstream of the Yukon River. The emergency mine water discharge events resulted in a more consistent flow regime, which in turn may have made the system more attractive to fish in concert with a more ideal temperature regime.

8.3.2.3 Mitigations and Monitoring

If JCS are attracted into Minto Creek by a more optimal and consistent temperature and flow regime during periods of mine water discharge, there is a risk that they may consider Minto Creek as a potential overwintering site and get stranded at freeze-up. As discussed previously, Minto Creek freezes completely during winter months and does not provide overwintering habitat for fish.

To avoid this situation, Minto plans to maximize water discharge during spring freshet, when natural flows are much higher and when JCS and other fish have not yet entered Minto Creek (as discussed above, JCS typically enter lower Minto Creek in late June or early July). Subsequent to that, mine water discharge will align with natural flow variations to the extent possible. Much of the water captured in the watershed above the W3 compliance point is considered non-contact water and is now diverted around the mine site.

The annual fish monitoring program in Minto Creek will continue during the open water season. Should high numbers of fish (above what would be expected under normal conditions) still be found in lower Minto Creek prior to freeze-up in the fall and considered at risk for stranding, water discharge from the site can be temporarily reduced in order to provide a cue to the fish that they are not in overwintering habitat. This should in turn encourage them to emigrate from the creek and discourage additional immigration. If a significant number of fish do not respond to a temporary reduction in flow, a fish re-location program could be implemented as has been successfully undertaken previously (ACG 2009, ACG 2010a).

Also note that temperature and flow data presented above for periods of mine water discharge are largely based on an “emergency discharge” (2009 and 2010) situation, and that future mine water discharge will be done according to the water management plan presented in Appendix J, and is expected to have much less influence on temperature and flow regimes.

8.3.2.4 Conclusion

With the application of the mitigations outlined above, the Project is not anticipated to result in significant adverse effects on aquatic resources arising from a change in water temperature or flow regimes in Minto Creek.

8.3.3 Increase in Total Suspended Solids (TSS)

TSS is not anticipated to increase in Minto Creek as a result of mining activities. The effluent discharge standard for TSS will continue to be met during Phase V/VI, as required under the Water Licence QZ96-006 and the MMER.

An increase in suspended solid load is possible in McGinty Creek as a result of point source disturbances during construction activities (road building/upgrades, etc.) or erosion near the creek. Sediment loading can occur naturally as a result of high rainfall events or natural erosional processes but loading can be exacerbated by human influenced activities.

Increased sediment loads can impact fish habitat downstream by filling substrate interstitial space, thereby simplifying bed features important for macroinvertebrate colonization and growth. High loads can fill in pool habitat, reducing structural diversity of a stream/river ecosystem. Since McGinty Creek is not used for spawning, high TSS loads covering incubating eggs is not a concern. High TSS loading for sustained periods can directly be abrasive to fish gill epithelium and result in direct harm to the organism.

8.3.3.1 Mitigations

Some erosion control strategies are already in place around the mine site and will be applied during the construction and the mining phase of Minto North pit. These existing measures, as well as proposed initiatives, are discussed in the erosion and sediment control plan (http://www.emr.gov.yk.ca/mining/pdf/mml_minto_sediment_erosion_control.pdf) and include best management practices such as:

- Swales and tail ditches to limit sediment mobilization on roads;
- Recovering and reseeding of disturbed areas in order to establish a vegetative mat to address erosion; and
- Recontouring of disturbed surfaces to minimize the distance and control the direction of water flow across them.

8.3.3.2 Conclusion

As TSS concentrations are not anticipated to increase in Minto Creek for Phase V/VI, the Project is not anticipated to result in significant adverse effects related to total suspended solids on aquatic resources in Minto Creek.

In light of the fact that McGinty Creek sees very limited fish use, and with the application of the mitigations outlined above, the Project is not anticipated to result in significant adverse effects on aquatic resources from an increase in total suspended solids in McGinty Creek.

8.3.4 Aquatic Effects Assessment Summary

Table 8-20: Summary of Potential Effects to Aquatic Resources in Minto Creek.

Potential Effect	Specific Consideration	Duration	Mitigations	Summary Comments	Conclusions
Increase in Contaminant Concentrations	Nitrogen Compounds	Short-term	• Explosives management plan in place • Effluent discharge standards • Water treatment in place if required	• Nitrate – acute CWQG not predicted to be exceeded • Nitrite – nitrification and chloride ameliorate concentrations/toxicity; short term increases not expected to exceed CWQG • Ammonia – nitrification reduces short term elevated concentrations downstream, not expected to exceed CWQG	No anticipated significant adverse effects to Minto Creek aquatic resources from increases in nitrogen compound concentrations
		Long-term	• Water treatment if required, but N sources expected to reduce significantly with the cessation of blasting • Effluent discharge standards • Isolation of wastes (covers) • Diverson of clean runoff	• Nitrate – highest predicted concentrations during operational period. Some predicted exceedances of chronic CWQG, but hardness, temperature, seasonal concentration vs. resource use, and resource residence time all reduce toxicity/risk associated with nitrate concentrations in Minto Creek • Nitrite – nitrification and chloride ameliorate concentrations/toxicity; not expected to exceed CWQG • Ammonia – highest predicted concentrations in May – no resource use; nitrification further reduces concentrations – not expected to exceed CWQG	
	Selenium	Short-term	• Waste handling practices • Water treatment/management in place during operations	• Water column concentrations not a good indicator of Se toxicity • Minto Creek physiological character not amenable to trophic transfer of Se – erosional, low productivity • Exposure to sensitive species/life stages low • Overall, Minto Creek resources not at risk of Se toxicity	No anticipated significant adverse effects to Minto Creek aquatic resources from increases in aqueous selenium concentrations
		Long-term	• Waste handling practices • Waste isolation and passive treatment • Contingency active water treatment		
	Copper	Short-term	• Waste handling practices • Effluent discharge standard • Water treatment/management in place during operations	• Predicted exceedances of 2009 SSWQO, but not 2012 SSWQO • pH, DOC and alkalinity all modify Cu toxicity • Biotic Ligand Model calculates instantaneous WQO for Cu • All cases (expected, reasonable worst) returned results below IWQO – harmful effects associated with Cu are unlikely	No anticipated significant adverse effects to Minto Creek aquatic resources from increases in aqueous copper concentrations
		Long-term	• Waste handling practices • Waste isolation and passive treatment • Contingency active water treatment • Effluent discharge standard		
	Cadmium	Short-term	• Waste handling practices • Effluent discharge standard • Water treatment/management in place during operations	• No predicted exceedances of draft acute CWQG • BLM does not predict exceedances of IWCG • No anticipated short-term harmful effects associated with Cd	No anticipated significant adverse effects to Minto Creek aquatic resources from increases in aqueous cadmium concentrations
		Long-term	• Waste handling practices • Waste isolation and passive treatment • Contingency active water treatment • Effluent discharge standard	• Only predicted exceedances of draft chronic CWQG are in May when resources are not at risk, and would have to occur with historic low hardness – not expected • No predicted exceedances of 2012 SSWQO • No anticipated chronic effects associated with Cd	
	Fluoride	Short-term	• Waste handling practices Water treatment/management in place during operations	• Some predicted exceedances of SSWQO and interim CWQG, but CWQG is interim with 100x safety factor • No harmful effects anticipated - fluoride toxicity modified by hardness, temperature, pH and ion-exchange cations in Minto Creek • Resource use limited with no spawning in Minto Creek	No anticipated significant adverse effects to Minto Creek aquatic resources from increases in fluoride concentrations
		Long-term	• Waste handling practices • Waste isolation and passive treatment • Contingency active water treatment		
Change in Physical Parameters	Temperature and Flow	n/a	• Water management strategies and proposed discharge standards will allow more water released from site when runoff occurs • Fish monitoring will continue, fish relocation if required	• Proposed water management changes will reduce likelihood of changes to temperature and flow regimes in lower Minto Creek as a result of delayed discharge	No anticipated significant adverse effects to Minto Creek aquatic resources from changes to physical parameters in Minto Creek
Increase in TSS	n/a	n/a	• Site source and sediment control • Effluent discharge standard • Water management/treatment, as required	• Elevated natural TSS loads significantly higher than predicted site releases and resource use limited • No anticipated increase/effects associated with TSS	No anticipated significant adverse effects to Minto Creek aquatic resources from increased TSS in Minto Creek

Note: Predicted short/long term changes in the McGinty Creek receiving environment as a result of development and closure activities at Minto North are very minor, and therefore no significant adverse effects to the McGinty Creek aquatic system are anticipated.

9 Air Quality Effects Assessment and Management

The atmosphere is a critical pathway for the transport of contaminants to the environment. Thus, poor air quality has the potential to affect important environmental components such as the health and wellbeing of humans, wildlife, vegetation, and aquatic resources. Furthermore, these adverse effects have the potential to extend to socio-economic values that are interrelated to environmental components. Examples of potentially affected socio-economic values include, but are not limited to community wellness, traditional economy, and connections to the land and water.

The Project is expected to release atmospheric emissions. These emissions, including dust during construction, operations, and closure, have the potential to affect air quality. Examples of project activities that have the potential to adversely affect air quality in the Project area include emissions from fugitive dust sources (materials handling and processing operations, stockpiles, blasting activities, drilling operations, and bulldozing activities) and fossil fuel combustion (exhaust from project equipment and facilities).

9.1 Existing Conditions

The closest complete air-quality monitoring station is Environment Canada's national air pollution surveillance network (NAPS) station in Whitehorse, Yukon. Due to the distance between Minto and Whitehorse, as well as Minto's remote/isolated location, it is assumed to be non-representative of the Project area. For the same reasons, air quality conditions in the Minto area are considered to be unimpacted by influences other than the current Minto mine mining activities.

To characterize operational air quality during Phase IV mining, particulate monitoring at Minto has been undertaken in recent years and is summarized below; however, the record since installation is not complete (see subsection 9.2.1 for further detail) and does not include parameters beyond $PM_{2.5}$.

9.2 Potential Effects Characterization

Throughout the Project's history, air quality has been raised as a concern, specifically by SFN citizens. Potentially impacted resources are of critical importance to local citizens who rely on them for food and livelihood. Potential effects on air quality from Phase V/VI activity emissions may include oxides of nitrogen and sulphur, dust, and other fine particulates being released into the atmosphere. These emissions can be transported beyond the direct mine site. Sources of air emissions include mining operations (e.g., drilling, blasting, and crushing), vehicle and heavy equipment use on access and haul roads, and use of diesel fuelled vehicles, heavy equipment, and machinery.

Dust from mining activities at the Minto Mine are generated from: drill, blast, load, and haul activities in the open pit and crushing and conveyer activities at remote crushing stations and at crushers located outside of the mill. Dust is generated from the fraction of dry aggregate that is less than 75 µm (or passes through a #200-mesh screen). These fine particles are easily disaggregated and released to the atmosphere. The moisture content also has an effect on the mobility of these fine particles. Typically, material at Minto has moisture content of less than four percent and therefore, without some means of dust control, particles become airborne. The transfer, handling, and mechanical breakdown of the material that contributes to dust mobilization is also compounded by natural forces such as wind.

Significant effort has recently been put into mitigation of dust generation, which are outlined in the Section 9.3. Further mitigation measures are being incorporated that going forward that will reduce the emissions and potential effects of dust generation substantially. These mitigations are also outlined in Section 9.3. Furthermore, a fugitive dust best management practices document has been developed by RWDI Consulting and Engineering Services and will be adapted by Minto (Appendix O).

Currently, Minto monitors particulate matter at the site which provides details on $PM_{2.5}$. This program is further described below.

9.2.1 Particulate Matter Air Quality Monitoring

A particulate matter monitor (SHARP 5030) was installed at the northeastern end of camp in October 2010. 30-minute $PM_{2.5}$ values from February 2011 to April 2013 were analyzed and compiled into 24-hour averages, to be comparable to Yukon ambient air quality standard (YAAQS) of 30 $\mu g/m^3$. Results are presented in Figure 9-1 below. Note that instrument malfunction caused some data gaps during that period and that data from October 2010 to February 2011 was overwritten before it could be downloaded. No exceedances of the YAAQS were observed to date, with an average 24-hr value of 4.39 $\mu g/m^3$ and a maximum of 24.55 $\mu g/m^3$, recorded on January 29, 2013. It is anticipated that activities associated with Phase V/VI will cause fewer dust emissions compared to existing Phase IV conditions, since additional mitigation measures will be implemented as part of Phase V/VI, and the surface mining will stop by 2017 (section 3.1.2), considerably reducing airborne dust sources.

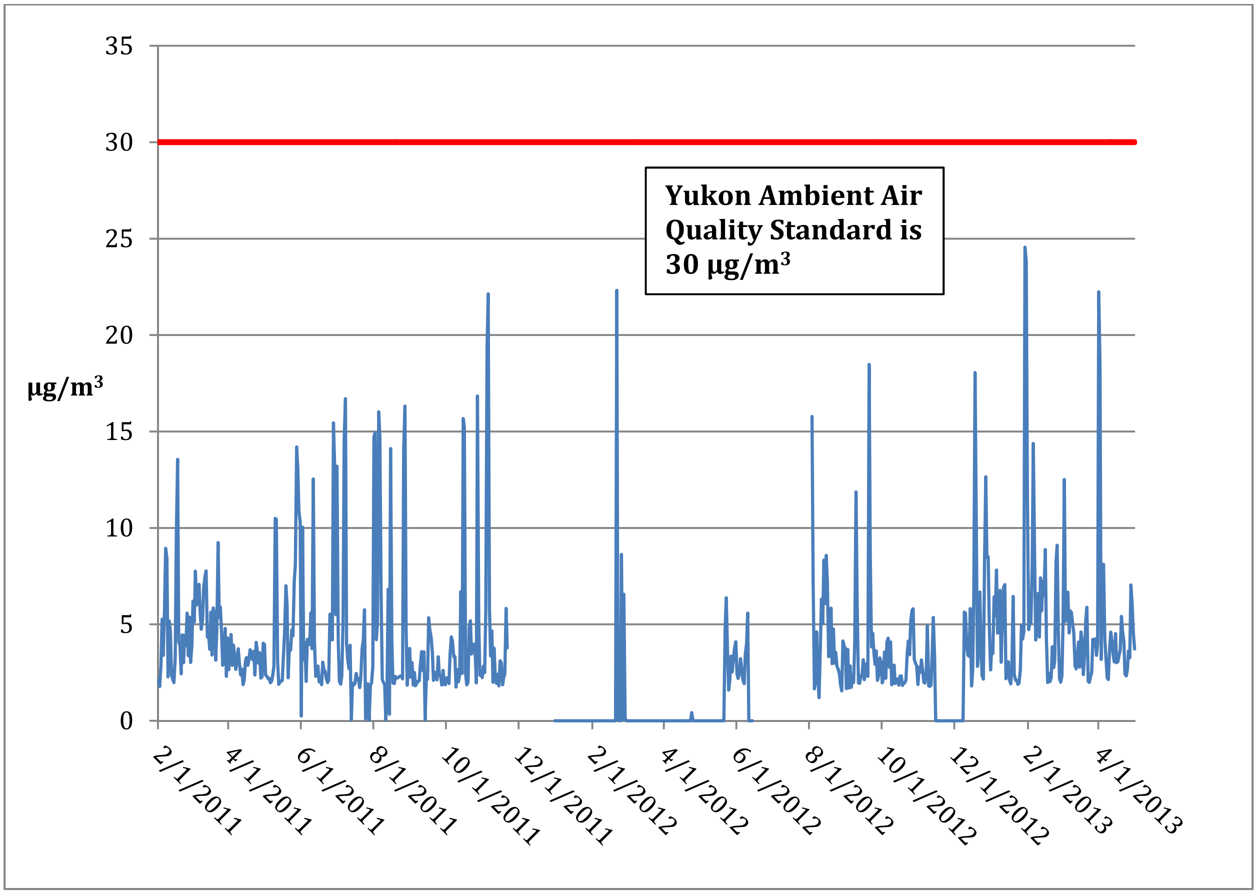


Figure 9-1: Minto $PM_{2.5}$ 24-hour Average.

9.3 Mitigations

In addition to the best management practices outlined in Appendix O, the following mitigation measures will be implemented, or are currently in place:

- Employees and visitors to site will adhere to speed limits in order to limit the production of fugitive dust;
- Low speeds for all mobile mine site equipment will be enforced;
- Roads will be watered during dry periods to reduce dust levels, and appropriate dust suppressants may also be used;
- The DSTSF will be covered by overburden to reduce dust;
- Drills will use water at all times while drilling to collar the production holes and to cut down on dust generation. Current drills have dust collector systems built-in on the current rigs, using the air from the drill's compressor;
- Minto will optimize blasts to minimize the amount of explosive product used and to achieve the best possible confinement of explosive energy. This optimization serves to lower dust dispersion.

- If a secondary mobile crusher is used at the Minto site, dust control measures will be in place at three locations of the process: at the cone-crusher feed, the lower vibrating screen, and at the stacker conveyor. A mixture of Envirobind© and water will be applied through custom nozzles at these locations; and,
- The crusher circuit will be upgraded to eliminate the Envirobind©/water nozzles at the stacker conveyor in favor of a telescoping wind protection 'skirt' covering the drop from the conveyor discharge to the top of the live pile.

9.4 Conclusion

With the continued application of measures to reduce dust and other potential air contaminants, in combination with the mitigations to be implemented for Phase V/VI operations, the Project is not anticipated to result in significant adverse effects to air quality. Moreover, one of the main sources of airborne dust (surface mining) will be discontinued as of 2017. Final reclamation and closure measures will ensure that dust generation is controlled in the long term.

10 Wildlife Effects Assessment and Management

10.1 Existing Conditions

Wildlife assessments were completed within, or near, the Project area between 1994 and 2012. These assessments are summarized in ACG's *Summary of Wildlife Baseline Surveys Conducted 1994–2012* (Appendix P).

The completed assessments mainly focused on moose (*Alces alces*), Dall's sheep (*Ovis dalli*), caribou (*Rangifer tarandus dalli*), and raptors. Other wildlife observations and sign (tracks, scat, browse, etc.) were also recorded during these surveys. The existing conditions for wildlife at the Minto Mine are summarized in Table 10-1 (EBA 2010), which lists the wildlife surveys and studies conducted since 1994 in the Minto Mine area.

Table 10-1: Wildlife Surveys and Studies Undertaken in the Minto Mine Project Area.

Dates	Type of Survey	Conducted By
January–March 2012	Late Winter Ungulate Studies	EDI, Environment Yukon
Fall 2012	Klaza Caribou Herd Study	Environment Yukon
March 2011	Late Winter Ungulate Study	EDI, Environment Yukon on behalf of Casino Mining Corporation
July 2010	Baseline Ecosystems and Vegetation Report*	Access Consulting Group
March 2010	Minto Mine Environmental Baseline Ecosystems and Vegetation Report	EBA Engineering Consultants Ltd.
February 2010	Late Winter Moose (Aerial)	Access Consulting Group
December 2010	Post-rut Moose Survey (Aerial)	Access Consulting Group
June 2009	Dall Sheep Survey (Aerial)	Environment Yukon
2007	Moose Survey	Environment Yukon
2003	Klaza Caribou Herd Survey	Environment Yukon
1994	Spring Wildlife Survey Spring Dall Sheep Survey Summer Raptor Survey Summer Wildlife Ground Pellet Survey	Hallam Knight Piesold Ltd.

*The 2010 Baseline Ecosystems and Vegetation Study (ACG 2010a) was not focused primarily on wildlife; however, general wildlife observations were made during the vegetation survey and were recorded on plot data sheets. This ground-based survey provided information regarding the presence of smaller animals as well as larger mammals that can be more easily seen by aerial surveys.

Since the last wildlife baseline studies inventory (EBA 2010a), there have been three YG-led wildlife studies conducted that included the Minto site and vicinity. Two of these were late-winter ungulate surveys performed in 2011 and 2012. The survey area encompassed the Carmacks West moose management unit and the Klaza caribou herd range, for a total area of 6,430 km^2. In January 2013, ACG contacted the Mayo Regional Biologist, Mark O'Donoghue, for further information on these studies. Mr. O'Donoghue provided the following bulleted summary (via email) regarding recent ungulate surveys in the Project area:

- "A late-winter distribution survey of moose and caribou in March 2011 covering a very large area west and south of the Yukon River (south to about the Nansen Road, west to about the Klotassin River, so covering the Minto Mine area). This was repeated by EDI in March 2012.
- "A survey of sheep along the Yukon River from Minto to Fort Selkirk in June 2011 and June 2012—these have been done since 2000.
- "A census of Klaza caribou in October 2012 (which followed a composition survey in September). This was done in alpine areas to the west and southwest of the mine.
- "A survey to map lambing range of sheep and alpine raptor nests in the Dawson Range in May 2012, to the west and southwest of the Minto Mine. This was only partially completed because of poor weather and we are aiming to complete it in 2013 so there's no survey report yet. This survey was well to the west and southwest of the mine site, though."

The sheep survey referenced is attached in Appendix Q which includes a figure of the surveyed area. Other surveys were not officially available as of March 2013.

10.1.1 Moose

The following section summarizes the existing information on moose in the Project area.

2007 Early-Winter Moose Survey

The early-winter 2007 moose survey for the Carmacks West Moose Management Unit was conducted by YDOE. The following information has been summarized from O'Donoghue et al. (2008).

This survey was conducted in a much larger study area than the surveys conducted by ACG during the winter of 2009/2010, which were specifically focused on the area surrounding the Minto Mine site. However, the densities should be comparable as they are similar habitat types and YG's survey included the study area of the ACG 2010 surveys. The total survey area within this management unit is 4,206 km^2, of which 4,081 km^2 was considered to be suitable moose habitat. A stratified sampling approach was used for this survey, in which the survey area is covered by a grid and each square within the grid is classified as to contain high quality moose habitat or low quality moose habitat (methods as per Kellie and DeLong 2006).

During this survey, a total of 208 moose were observed, with a total population estimate of 520 moose for the study area. The calculated moose density of 124 moose per 1,000 km^2 is considered low. Average moose densities for Yukon Territory are 150 to 249 per 1,000 km^2 (EDI 2011). From the survey data, biologists estimated a ratio of 21 calves and 10 yearlings per 100 cows; this suggests that the survival rate for the previous two years was relatively low. The sex ratio of 75 bulls per 100 cows is considered to be a healthy sex ratio. The average sex ratio for other areas surveyed within Yukon is 68 bulls per 100 cows.

Aerial Moose Survey - Winter 2009/2010

Aerial moose surveys were completed on December 15, 2009 (post-rut) and February 23, 2010 (late-winter) by ACG (2010). For both of these surveys, the study area included the Minto and McGinty creek drainages (Figure 3 in ACG's *Summary of Wildlife Baseline Surveys Conducted* (2012) (Appendix P)). Results of the 2009 and 2010 moose surveys are presented in Table 10-2. More detailed information for these surveys can be found in the ACG 2010 report.

Assuming a 600 m visibility on both sides of the helicopter, the total area surveyed was 112 km^2. Using this survey area, the moose density for the post-rut survey was estimated to be approximately 125 moose per 1,000 km^2, which is nearly the same density found in the 2007 early-spring aerial survey conducted by YG. The calf-to-cow ratio estimated from this data was 25 calves and no sub-adults for every 100 adult cows, and the estimated adult sex ratio was 50 mature bulls for 100 cows, which is low and could be a factor in the low recruitment ratio.

For the late-winter survey, estimated densities were approximately 45 moose per 1,000 km^2. The yearling to cow ratio was 1:1 sub-adults to cows, and no calves were observed during this survey. The estimated adult sex ratio was 300 mature bulls for 100 cows. The difference in this ratio from the YG survey result could be attributed to a small survey area, low number of observations and lack of visual confirmation of gender. It should be noted that on seven occasions during this survey fresh tracks were observed without an associated moose observation.

Table 10-2: Summary of Moose Observations during the 2009 and 2010 Winter Surveys.

Survey	Total	Adult Male	Adult Female	Sub-adult	Calf	Unknown
Post-rut survey December 15, 2009	14	4	8	0	2	0
Late-winter survey February 23, 2010	5	3	1	1	0	0

10.1.2 Caribou

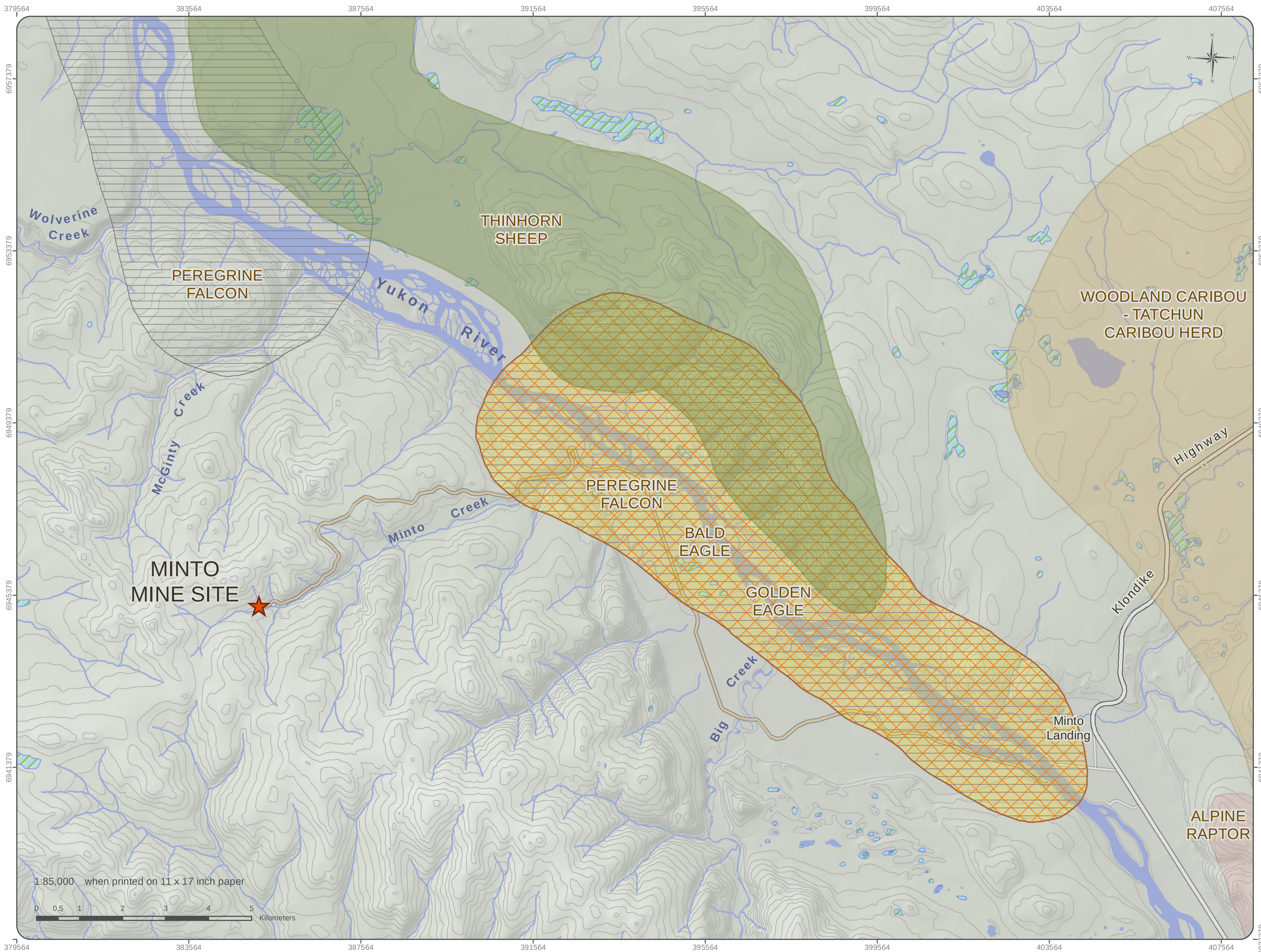
Two woodland caribou herds have the potential to occur within the Minto Mine area: the Klaza and Tatchun. Although neither range for these herds overlap with the Project area, caribou may still occasionally pass through, as documented by HKP during baseline surveys in 1994. No caribou were observed in the Project area during the 2009 and 2010 aerial surveys conducted by ACG.

Klaza Herd

In 2005, the Klaza herd population was estimated at 650 and predicted to increase (Yukon Environment 2005). There are concerns for this caribou herd, as the impacts of increased exploration projects and road development may combine to reduce their population. The herd's range is west of the Minto site. Because the area around the Minto Mine site has experienced numerous fires recently, the habitat is of minimal value for caribou, according to Troy Hegel of Environment Yukon, a caribou, sheep, & goat biologist (pers. comm.). A wildlife key area (WKA) for woodland caribou winter range was identified approximately 9 km west-northwest of the Project area (Yukon Environment 2010). Members of Klaza herd could travel through the site area occasionally and sightings should be recorded and reported. A recent fall (rut) count of the Klaza herd was conducted by Environment Yukon, Environmental Dynamics Inc. (EDI), and Little Salmon Carmacks First Nation members in 2012. The results of this study have yet to be released.

Tatchun Herd

The Tatchun Caribou herd's range is to the east of the Yukon River and does not overlap with the Minto Mine Project area (Figure 10-1). This caribou herd is small, heavily harvested, and should be managed carefully. In 2005, the population estimate for the Tatchun herd was 500 animals. A rutting season composition survey that focused on this range was conducted in 2007, and indicated that the count was much lower than in previous years. The reduced count could result from caribou congregating in areas such as tree cover, where they could not be detected (Yukon Environment 2007). Another count was conducted in the fall of 2012; results are still under analysis and the report is pending.



MINTO MINE PHASE V/VI EXPANSION

FIGURE 10-1
WILDLIFE KEY AREAS

JUNE 2013

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- Minto Mine Site
- Highway
- Local Road
- Mine Access Road
- Contours
- Waterbody
- Wetland

Wildlife Key Areas

- Bald Eagle
- Peregrine Falcon
- Alpine Raptor
- Golden Eagle
- Thinhorn Sheep
- Woodland Caribou

Wildlife Key Area data compiled by the Yukon Department of Environment.
Publication Date: May 2009
Obtained from Geomatics Yukon.

Projection: NAD 83 UTM Zone 8N

ACCESS

I:\Minto\gis\mxd\Phase_5-6\Permitting\YESAB\Project-Proposal\10-1_AreaOverviewWKA_20130517.mxd
(*Last edited by: jlindeman;13/06/2013/12:56 PM*)

10.1.3 Sheep

Dall's sheep are known to inhabit the Project area, particularly the Minto Bluffs along the east side of Yukon River (O'Donoghue 2009). Although the access road to the Minto Mine passes near sheep habitat (Figure 10-1), sheep habitat within the project area itself is limited, and sheep are not expected to occur in the project area for any extended length of time.

Between 2000 and 2009, Yukon Department of Environment conducted annual sheep surveys within close proximity of the Minto Mine site. The survey area extends from the Minto Landing airstrip downstream (north) along the Yukon River to Fort Selkirk (O'Donoghue 2009). Surveys have also been conducted opportunistically by air (in 1989, 1991, 1994, and 2000) and by boat (2000–2009). Between 2000 and 2008, sheep surveys of the Minto–Pelly Bluffs resulted in the observations of between 31 and 91 sheep annually; with the majority of observations being ewes, yearlings, and lambs. During the 2009 survey, 97 sheep were observed, 34 of which were observed on the Minto Bluffs (which is located about 8 kilometres downstream of Minto, across the river from the Minto Mine site). This is the highest recorded population for this area. Most sheep observed during these surveys have been located on the Minto Bluffs, Split Mountain, and Mount Hansen (O'Donoghue 2009).

Aerial sheep surveys were conducted in 1994 as part of the wildlife baseline studies conducted prior to the start-up of Minto Mine. This survey focused on the cliffs on the northeast side of the Yukon River from Minto Landing. Unfortunately, data from this survey were not included in the final report. This report did indicate that sheep were observed, but location(s) were not mentioned.

10.1.4 Other Wildlife

Fur and big game harvest statistics indicate that the following species occur in the Minto project area: grizzly bear, black bear, coyote, gray wolf, red fox, wolverine, marten, least weasel, river otter, beaver, and lynx. Cougars may also have the potential to occur in the area as they are known to follow mule deer (Smith et al. 2004); however, the probability of an occurrence is considered to be low.

Of the species listed above, the following species or sign of the species have been observed, on site: grizzly bear, black bear, gray wolf, lynx, river otter (HKP 1994, Capstone 2007, Capstone 2008, ACG and Horizon Ecological Consultants 2010).

Small mammals common to the area include red squirrel, varying hare, fox, mink, weasel, vole, and shrew. The Minto Mine site is situated at the apex of five drainages that are part of the Yukon River watershed, so wildlife uses the area to access the valleys offering conduits from lowlands to highlands for seasonal foraging and hunting (ACG 2010).

A total of 13 raptor species (*Summary of Wildlife Baseline Surveys Conducted* (2012) (Appendix P)) have the potential to occur within the study area. Raptors may breed throughout the study area, with select areas attracting higher breeding densities (e.g., riparian zones) than other areas (e.g., pine stands). Species that have been observed and documented in the Project area include the red-tailed hawk (HKP 1994), peregrine falcon (Mossop, pers. comm. as cited in HKP 1994), and golden eagle. Only one aerial-based raptor survey was conducted as part of the Minto Mine baseline studies (HKP 1994).

High quality riparian cliff habitat for raptors exists along the Yukon River downstream of the Minto Mine access road. A WKA (wildlife key area) for golden eagle summer nesting habitat has been identified approximately 3 km to the east of the project area (Yukon Environment 2010b) (Figure 10-1). This WKA is primarily associated with the steep bluffs along the Yukon River and includes a buffer area. No cliff-nesting raptor habitat has been identified within the Project area itself. The access road to the Minto Mine, however, runs adjacent to potential nesting areas for cliff-nesting raptors, such as the golden eagle and peregrine falcon.

Game birds that have been observed or that have the potential to occur in the study area include grouse (spruce, ruffed, sharp-tailed) and ptarmigan (willow, white-tailed, and rock). Of the species of grouse that live in Yukon, the sharp-tailed grouse is currently the only species of management concern. Sharp-tailed grouse have a limited distribution in Yukon due to the lack of suitable habitat. Gravel outwashes with fairly stable aspen parkland habitat and wet sedge-hummock meadows after fire are considered suitable habitat for this species. Sharp-tailed grouse have been observed in the Project area.

10.1.5 Species at Risk

There are currently eleven wildlife species in Yukon rated as "threatened," "of conservation concern," or "of special concern" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2011). Ten of these species have ranges that could include the area around Minto Mine site. Species that have the potential to occur in the study area are listed in Table 10-3

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Table 10-3: List of Species at Risk in Yukon Considered Possible to Occur in the Study Area.

Species	Status	Source
Birds		
Peregrine Falcon* (Falco peregrinus anatum - tundrius)	Special concern	COSEWIC (2007), Yukon Wildlife Act (2002)
Short Eared Owl* (Asio flammeus)	Special concern	COSEWIC (2008)
Common Nighthawk* (Chordeiles minor)	Threatened	COSEWIC (2007)
Olive-sided Fly Catcher* (Contopus cooperi)	Threatened	COSEWIC (2007)
Rusty Blackbird* (Euphagus carolinus)	Special concern	COSEWIC (2006)
Gyrfalcon (Falco rusticolus)	Specially protected	Yukon Wildlife Act (2002)
Trumpeter Swan (Cygnus buccinator)	Specially protected	Yukon Wildlife Act (2002)
Barn Swallow* (Hirundo rustica)	Threatened	COSEWIC (2011)
Bank Swallow* (*Riparia riparia*)	Conservation concern	Yukon Environment (2011)
Canada Warbler (Wilsonia canadensis)	Threatened	COSEWIC (2008)
Northern Shrike (Lanius excubitor)	Conservation concern	Yukon Environment (2011)
Mammals		
Wolverine* (Gulo gulo)	Special concern	COSEWIC (2004)
Grizzly Bear* (Ursus arctos)	Special concern	COSEWIC (2009)
Woodland Caribou* (Rangifer tarandus caribou)	Special concern	COSEWIC (2002), SARA (2002)
Mule Deer (Odocoileus hemionus)	Specially protected	Yukon Wildlife Act (2002)
Mountain Goat (Oreamnos americanus)	Conservation concern	Yukon Environment (2011)
Cougar (Puma concolor)	Specially protected	Yukon Wildlife Act (2002)
Collared Pika* (Ochotona collaris)	Special concern	COSEWIC (2011)
Little Brown Bat (*Myotis lucifugus)*	Endangered	COSEWIC (2012)

* *confirmed presence in the mine site vicinity*

10.2 Potential Effects Characterization and Assessment

The Minto Mine has a limited footprint. While most of the infrastructure required for the Phase V/VI mining development currently exists and is in use, there are plans for new (and expanded) waste dump areas, open pits, and further underground mine development (Figure 1-1).

Milling and other accessory mine operations are anticipated to remain at current levels. The potential effects of day-to-day mining activities are expected remain constant in terms of frequency and intensity, with duration increased by the proposed extension of mining operations. Minor habitat loss and displacement of wildlife by new project infrastructure is expected and has been identified in the analysis of project effects; however, these effects are minor and relevant mitigations serve to reduce the significance of these effects. Identified potential effects and mitigations to be implemented are outlined below:

- Habitat loss in expansion areas (e.g., waste dumps, pits) that may affect small-ranging species such as birds and small mammals;
- Changes in wildlife movements, wildlife displacement or avoidance of the mine operations area (e.g., by moose) and habitat fragmentation directly in the mine area;
- Direct injury/mortality to wildlife.

10.2.1 Habitat Loss

Habitat and habitat use may be altered during mine operations and post-closure, through activities such as general site construction, mining (e.g., stripping of pits and portal areas), and to a much lesser extent by traffic (both light and heavy equipment), and use of the camp and facilities.

Minto Phase V/VI involves an expansion of an existing mine and much of the required land has been cleared; however clearing will occur in some currently undeveloped areas. It is estimated that 82.04 ha of land will be impacted, and site clearing/vegetation removal will result in direct loss of some habitat.

Sensory disturbances may occur as a result of the Project, and may cause wildlife to avoid otherwise suitable habitat. Noise resulting during construction and operation may result in habitat becoming less suitable for species in the area (i.e., moose, caribou, and bears). Generally, wildlife will avoid areas with substantial noise; however, their long-term response and ability to adapt varies species by species.

10.2.1.1 Mitigation Measures

Minto will follow their *Wildlife Protection Plan* (2011) (Appendix R). Specifically, Table 2 in the plan includes the wildlife monitoring and protection measures that are in place. The following mitigation measures are examples of what is currently being done, and what will be implemented for Phase V/VI:

- The disturbance footprint and related vegetation clearing will be limited to the extent necessary to minimize habitat loss;
- The Project footprint as a whole is relatively small, and an updated site reclamation plan has been prepared for progressive and final *Decommissioning and Reclamation and Closure Plan* (Appendix W).

10.2.1.2 Conclusion

With the application of these mitigative measures, the Project is not anticipated to result in significant adverse effects on wildlife from the direct loss or alteration of wildlife habitat. The footprint for new development is limited, and progressive reclamation and final closure will reclaim disturbed areas effectively, so potential effects on wildlife are not long term. Because similar activity has been occurring at the site, it is likely wildlife in the area is already acclimatized to these types of sensory disturbances, or may have been avoiding the area for some time.

10.2.2 Changes to Wildlife Movement Patterns

Project activities may result in wildlife changing their movement patterns at or near the Project area. Activities at site may attract some species and may deter others.

Some wildlife may be avoiding the Project area already. The Project involves the expansion of an existing mine site that has been active since 2004. While the Project involves new development (both open pit and underground), this area lies in the direct proximity to previously disturbed areas and other active exploration areas.

10.2.2.1 Mitigative Measures

Minto will follow the measures in the *Wildlife Protection Plan* (2011) (Appendix R) as laid out in Table 2 of that Plan. The following mitigation measure is an example of what is currently in place, and what will be implemented for Phase V/VI:

- If a road dissects a well-used wildlife trail or creek system, signage needs to be put in place to warn drivers to reduce speed because of the possibility of animals on the road.

10.2.2.2 Conclusion

With the application of the *Wildlife Protection Plan* (2011) and mitigations outlined in previous sections, potential significant effects on wildlife movement are not anticipated.

10.2.3 Direct Injury/Mortality of Wildlife

Project activities have the potential to result in wildlife injury and/or mortality through wildlife-vehicle collisions, wildlife-human encounters, and increased hunting pressure. Wildlife mortalities at the site are listed in Table 10-4. As mentioned before, Minto plans to comply with their *Wildlife Protection Plan (2011) (*Appendix R), and the terms and conditions outlined in Minto's Waste Management Permit No. 81-005.

Table 10-4: Wildlife Mortality 2010–2012.

Year	Wildlife	Detail
2010	1 Bear	Destroyed
2011	3 Bear	Destroyed
	2 fox	1 in the Pit 1 on the main haul road
	1 Ptarmigan	Found dead at the Mill building
2012	1 Raven	Found dead on the access road

There is presently traffic at the Minto site from current activities. The risk of collision to wildlife is reduced because speed limits on all roads are relatively slow (60 km/h).

During the winter months, the risk increases because wildlife take advantage of the snow-cleared road. After plowing, there can be more risk to wildlife potentially as snow banks may obstruct sight lines and make it more difficult for wildlife to leave the roadway to avoid traffic.

Wildlife—particularly bears—may become habituated to activity on site, and human-wildlife encounters can occur. Bears become habituated to routine activity and noise, and if attractants (i.e., fuel, food, and waste) are not properly managed, bears may come to the Project area, resulting in human-bear encounters.

The Project is not anticipated to result in increased hunting pressure. The Minto Mine site is well established and not known to be an important hunting area. The main site access road incorporates a barge crossing that is only available to authorized personnel and vehicles. Minto will continue to enforce the "no hunting" policy among all mine site visitors and employees to further reduce effects to wildlife, as outlined below.

10.2.3.1 Mitigation Measures

Minto will follow the measures in the *Wildlife Protection Plan* (2011) as laid out in Table 2 of that plan. The following mitigation measures are examples of what is currently in place, and what will be implemented for Phase V/VI:

- Continued adherence to the "no hunting" policy for Minto Mine employees; firearms are banned from the mine site, with the exception of one firearm strictly controlled and used for deterrence of nuisance wildlife (i.e., bears).
- All site access/haul roads have 60 km/h speed limits, to help reduce the risk of wildlife-vehicle collisions.
- Breaks will be created in the snow banks along the access road.
- Consistent with Section 92 of *Yukon Wildlife Act*, a "no wildlife harassment" policy will be enforced for company and contractors' employees while working within the Project area. This policy comprises: safe deposit of garbage, employee wildlife education, and wildlife avoidance.
- Continued use of wildlife logs to record wildlife sightings and encounters.
- Waste will be handled according to wildlife protection measures of Waste Management Permit No: 81-005.
- Camp is kept clean, combustible waste is incinerated completely on a daily basis, and food waste is incinerated twice daily, including after the evening meal, to eliminate odours that may attract wildlife.
- All nuisances/problems with wildlife will be reported to the local conservation officer (CO) immediately to help identify ways to reduce wildlife mortality. The CO will also be communicated with and used as a resource to manage mitigative measures responsively.

Conclusion

With the application of these mitigative measures, the Project is not anticipated to result in significant adverse effects on wildlife by injury or mortality.

11 Vegetation Effects Assessment and Management

11.1 Existing Conditions

The Minto Mine lies within the Boreal Cordillera ecozone and is situated in the far western part of the Yukon Plateau ecoregion, adjacent to the Klondike Plateau ecoregion in the west. This area was part of the eastern extent of Beringia, which remained ice-free approximately 15–20 thousand years ago. Endemic and rare plant species are associated with the Beringia area as it was a unique and isolated ecosystem. These remnant species are usually associated with grasslands and wetlands.

The Minto property lies within the eastern part of the Dawson Range, with elevations from 700 to 950 m; the landscape has rounded mountains intersected by broad valleys and drainages that are part of the Yukon River watershed. Discontinuous permafrost occurs on northern slopes and low-lying areas where sunlight is reduced.

Forest fires are frequent in this part of Yukon as it lies in the rain shadow of the St. Elias–Coast Mountains and receives less than 300mm of precipitation per year (Smith et al. 2004). As a result, the study area around Minto Mine has experienced numerous fires over the last forty years, rendering it a complex mosaic of plant communities at various stages of succession.

The following subsections summarize vegetation surveys conducted in the Project area. For further detail, please see the *Vegetation Baseline Survey* (2010) in Appendix S.

11.1.1 Vegetation Survey (2010)

Vegetation surveying and mapping was undertaken by ACG and Horizon Ecosystem Consulting in 2010 and resulted in the *Vegetation Baseline Survey* (2010) (Appendix S). A previous survey was conducted in 1994 by Hallam Knight Piesold (HKP), before any mine development had begun in the area. The 2010 report provides a record of current vegetation communities that exist within a 3,626 ha study area and estimates the type and area of vegetation to be removed in the Project area. In the intervening years between the 1994 and 2010 studies, the local landscape has been altered by the footprint of the current mine, further exploration and three major fires (Figure 3–Fire History Map, of the *Vegetation Baseline Report*, ACG 2010).

In the 2010 Vegetation Baseline Survey, different vegetation communities that exist within the study area were identified through aerial photo interpretation and delineated into polygons. Since most of the study area is regenerating from past fire disturbances, a mosaic of vegetation communities at different successional stages was delineated and classified. It was found that willow and trembling aspen have the greatest crown cover within the study area as they are indicative of early forest succession. Lodgepole pine is a later successional species that will gradually dominate mid and upper slopes of well-drained southern aspects.

Shade-tolerant white spruce was often found in the understory as seedlings. It is a climax species that will eventually overgrow the pine and trembling aspen communities, particularly on cooler aspects. Black spruce is also a climax species that is adapted to wetter, cooler sites, often the persistent species in white/black spruce mixed areas along the toe of slopes and valley bottoms. Small areas of grasslands are scattered along dry crests and steep south facing slopes; these locations do not retain enough moisture to sustain tree growth and are more likely to contain rare or uncommon plants.

Approximately 82.04 ha of vegetated land will be disturbed by the proposed mine expansion. Most of the planned expansion is along ridge tops and mid slopes; the main vegetation to be removed are upland willow species, trembling aspen, Lodgepole pine, and associated understory growth. These areas have already been impacted by drilling, road development, and other exploration activities.

The ecosystem map (Appendix S) was designed to be used as a land management and planning tool. As the mine expands its footprint, the map can be referred to for a quick assessment of which type of vegetation communities will be directly disturbed and how much area is involved. Sensitive areas that should be avoided, if possible, include: riparian corridors, bog/wetlands, mature forests, and grasslands.

11.1.2 Site Conditions: Vegetation Types

During the survey, plants species with 0.5% or greater coverage were identified and recorded on data sheets at each plot. Rare or uncommon species were searched for within plots and between plots, as well as uncommon ecosystems, i.e., wetlands and grasslands. No rare plants were found during the field investigations. That does not mean that the rare species do not exist within the study area, only that they were not located in the areas or in the season that the fieldwork was undertaken. The main plant communities identified in and around the Minto property are briefly described in the subsections below.

11.1.2.1 Trembling Aspen/Lodgepole Pine

This association is found in early successional forests originating after fire disturbance, on mesic to subxeric sites. Lodgepole pine (*Pinus contorta latifolia*) is more dominant than trembling aspen (*Populus tremuloides)* on well-drained south facing slopes and terraces. Coarse soils are often exposed, and lichens are well represented in the ground cover. Typically, these sites have low growing shrubs such as lingonberry (*Vaccinum vitis idaea*), kinnikinnick (*Arctostaphylos uva-ursi*), and prickly rose (*Rosa acicularis*).

11.1.2.2 Black Spruce/Labrador Tea/Sphagnum

Found in low lying areas and north facing slopes (cool sites), usually sparse to open forests (<50% crown cover), common shrubs in this ecosystem include Labrador tea, scrub birch, willow, and bog blueberry. Herbs present were sweet coltsfoot (*Petasites frigidus*), cloudberry (*Rubus chamaemorus*), and horsetail (*Equisetum sp.)* Sites are poorly drained (hydric to mesic) with peat horizons over mineral soils, often associated with permafrost.

11.1.2.3 White/Black Spruce

This association is typically located on south facing lower slopes with upland willow species and Labrador tea. A thick carpet of feather mosses and sphagnum covers the mineral soil. Ground cover shrubs include lingonberry, bog blueberry, and crowberry.

11.1.2.4 Willow/Trembling Aspen

This was the most common vegetation association in study area, indicative of regenerative growth (>10yrs) after a fire event. Most trees and shrubs are less than 5 m tall; cover can be open to closed as the canopy layer is of uniform height. Other species that may be present include: Alder (*Alnus crispa*) and Alaskan birch (*Betula neoalaskan*) on north facing slopes. Lodgepole pine and white spruce are also present in the understory and will eventually overtop other competing species to form the dominant canopy as the forest matures. The moisture regime ranges from subhygric to subxeric.

11.1.2.5 Willow/Scrub Birch

Willow (*Salix sp.)* and scrub birch (*Betula glandulosa*) occur in fluvial ecosystems adjacent to streams and fens. Other shrubs present are bog blueberry (*Vaccinum uliginosum*), Labrador tea (*Ledum groenlandicum*), and shrubby cinquefoil (*Potentilla fruticosa*). Associated graminoids include water sedge (*Carex aquatilis*), bluejoint grass (*Calamagrostis canadensis*), and rushes (*Juncus sp*.). Sphagnum, feather, and glow mosses are common.

11.1.2.6 Trembling Aspen/Grassland

This association features sparse to open cover of trembling aspen (*Populus tremuloides*), often with lodgepole pine (*Pinus contorta latifolia*) present as a minor component. Found on steep south and southwest facing slopes, its understory shrubs include prickly rose (*Rosa acicularis*), soapberry (*Shepherdia canadensis*), kinnikinnick (*Arctostaphylos uva-ursi*), purple reedgrass (*Calamagrostis purpurascens*), Glaucous bluegrass (Poa glauca), Threadleaf sedge (Carex filifolia), Death camas (*Zygadenus elegans*), common yarrow (*Acillea millefolium*), pussytoes (*Antennaria sp*.), and prickly saxifrage (*Saxifraga tricuspidata*).

11.2 Potential Effects Characterization and Assessment

The geographic scope of the vegetation effects assessment includes the Project area and surrounding region. The Project will be active year round. The effects to ecosystems and vegetation resulting from the expansion of the Minto Mine are largely associated with infrastructure placement and development, as well as general on-site activities during all phases of mining (e.g., construction through to closure and decommissioning). All potential effects and associated mitigation measures are outlined below.

Potential effects associated with the expansion of the Minto Mine are:

- Loss of/disturbance to ecosystems and plant species due to infrastructure development and placement;
- Physical and physiological effects related to fugitive dust deposits on plants in the vicinity of mine operations; and
- Reduction in ecosystem integrity and displacement of native plant species due to the introduction of invasive plant species.

11.2.1 Loss of Ecosystems and Plants due to Infrastructure Placement

The expansion of the Minto Mine will inevitably result in the loss and disturbance of ecosystems and plants in the footprint area. Much of the development, however, will occur in areas that have already been affected by existing mine operations.

Project activities such as land clearing, maintaining the Project area (including existing access roads), and construction/maintenance of new haul roads, will result in the direct loss of vegetation. Minto estimates that approximately 82.04 ha of land will be cleared in the Phase V/VI expansion, as shown on the Vegetation Effects Assessment map (Figure 11-1). As noted above, no rare or uncommon plant species/communities have been identified in the Project area.

11.2.1.1 Mitigations

Minto has committed to a number of mitigations that will reduce adverse effects over the life of the Project. Minto already has or will implement the following measures to address potential effects associated with direct loss of vegetation:

- Progressive reclamation will be implemented throughout the life of mine to effectively re-vegetate any disturbed areas and to minimize the production of fugitive dust;
- Only the minimum amount of clearing (removal of vegetation) will be completed, so that Project operations remain effective and safe;
- The extent of grubbing, stripping, and the removal of shrubs and herbaceous species will be minimized where possible;
- When clearing is required, the vegetative mat will be retained wherever possible;
- Topsoil will be stripped off first and stockpiled separately from overburden, wherever possible. The topsoil is needed as it contains the biological agents needed to induce natural nutrient cycling for plants used in revegetation efforts. More detail can be found in the *Waste Rock Overburden Management Plan (*Appendix A);
- Vegetation buffers will be maintained around wetland and riparian zones; and,

- Placement of new infrastructure will occur within existing disturbed/development areas wherever possible, in an effort to reduce the amount of new vegetation clearing and general site disturbance required.

11.2.1.2 Conclusion

With the application of these mitigative measures, the Project is not anticipated to result in significant adverse effects on vegetation and terrain from direct loss. The footprint for new development is limited, and progressive reclamation and final closure will reclaim disturbed areas effectively.

MINTO MINE EXPANSION PHASE V/VI

FIGURE 11-1 - VEGETATION EFFECTS ASSESSMENT

JUNE 2013

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- Areas Impacted by Proposed phase 5/6 Development
- At - Trembling Aspen
- D - Alder
- Ea - Alaskan Birch
- Es - Scrub Birch
- G - Gramnoids
- Pl - Lodgepole Pine
- Sb - Black Spruce
- Sw - White Spruce
- W - Willow

1:12,500 *when printed on 11 x 17 inch paper*

0 50 100 200 300 400 500
Meters

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 14th 2012.

Datum: NAD 83 Projection: UTM Zone 8N

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11.2.2 Effects of Dust Deposition

Dust generated from Project activities has the potential to affect vegetation adversely. Dust may accumulate on the surface of plants, which has the potential to alter bio-chemical or physical processes. Dust may also increase metal concentrations in plant tissue as the result of the uptake of metals and other constituents from soil. These effects have the potential to impede growth and reproduction of vegetation, and to introduce metals into the food chain. Dust effects were raised as a concern during consultation activities with SFN.

Activities that will increase the amount of dust in the Project area include: development and use of access and haul roads, open pit mining (e.g., hauling waste rock, blasting), and ore processing (e.g., crushing). Dust will be generated during the construction and operational phases of the Project. Unpaved roads and ore crushing are likely to remain the main sources of dust at the Minto Mine.

Vegetation responses to dust depend primarily upon the amount of dust deposited, the duration and frequency of dusting events, the physiology of receptor plant species, and the chemical properties of dust particles.

Minto will continue to implement dust management measures to ensure the potential effects of fugitive dust release are kept to a minimum.

11.2.2.1 Mitigations

Mitigations that Minto has incorporated (or will implement for their Phase V/VI activities) that will reduce or eliminate the potential effects to vegetation from dust deposition are outlined in Section 9.3.

11.2.2.2 Conclusion

With the application of the mitigative measures outlined in Section 9.3, the Project is not anticipated to result in significant adverse effects on vegetation from dust generation and deposition. The dust suppression measures, in combination with progressive reclamation, will effectively address dust generation. Final reclamation and closure measures will ensure that dust generation is controlled in the long term.

11.2.3 Effects of Invasive Plants

Plant species whose establishment and often-rapid spread can adversely affect the integrity or health of ecosystems, habitats, and/or other species are termed “invasive” (Haber 1997). Invasive plants largely refer to non-native, foreign, or exotic species, although a few native species, if introduced into new and suitable environments, can become problematic.

The establishment of invasive plant species into an area is dependent upon several factors, including:

- Creation of habitat;
- Access to, and transport of, invasive plant sources; and
- Presence of invasive plant dispersal mechanisms.

Exposed soil can be quickly colonized by invasive plants, a situation common to most construction sites. Vehicles traveling to and from the site can inadvertently act as transport and dispersal mechanisms for plant propagules (seeds and/or vegetative parts) that have become embedded in tires and/or mud on the surface and undercarriage.

Preventing the establishment of invasive plants in an area is often more efficient and cost-effective than trying to remove them once they've become established (Clark 2003, Polster 2005, USDA 2006). Much of the Minto Mine area has been disturbed; however, it is possible that areas with exposed soil (both existing and new) could become increasingly susceptible to colonization by invasive plant species due to continued vehicular traffic and on-site activity.

Currently, the extent to which invasive plants may be present on the site is unknown. Periodic monitoring (during vegetation surveys and reclamation monitoring) will be carried out to ensure invasive species do not become problematic, if present.

11.2.3.1 Mitigation Measures

The following mitigation measures, if not already in place, will be implemented in order to reduce the significance of the associated effect:

- 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 and leaving the site will be clean (e.g., no large, obvious clods of mud), so as to limit the spread of invasive plant propagules;
- Exposed soil will be managed in such a manner as to discourage the production of fugitive dust and colonization by invasive plant species, e.g., covers, dust suppressants, temporary or permanent seeding of exposed soil;
- Reclamation plans will include provisions to limit human access in order to reduce the exploitation of undisturbed lands in the vicinity of the mine site and reduce the potential and inadvertent spread of invasive plant species;
- Implement an approved closure plan for the Project, identifying the re-establishment of a self-sustaining native vegetative cover as a reclamation objective;
- The reclamation overburden dump will supply a reclamation medium for revegetation activities during closure; and,
- Integration of SFN's objectives for closure planning and site reclamation.

The following best practices will also be implemented (Table 11-1):

Table 11-1: Best Practices to Avoid Invasive Plant Infestations.

Key Best Practice to Avoid Invasive Plant Infestation	Action
Identify invasive plants and plan key activities	Know local problem plants and invasive plants.
Record and report invasive plants	Contact Yukon Invasive Species Council coordinator: info@yukoninvasives.com
Minimize disturbance and retain native plant communities	Minimize unnecessary disturbance of surface soil and retain desirable vegetation where possible. Stored top soil should not be left bare but seeded with certified weed-free clean seed.
Effectively manage source and waste materials	Make best efforts not to use aggregate, borrow or other soil material containing invasives.
Revegetation	Re-establish vegetation as soon as practical after ground disturbance if appropriate, using certified seed.
(ISCBC 2013)	

11.2.3.2 Conclusion

With the application of these mitigative measures, the Project is not anticipated to result in significant adverse effects on vegetation from the introduction of invasive species. The mitigation measures outlined above, in combination with progressive reclamation, will effectively address the introduction of invasive species. Final reclamation and closure measures will ensure that effects are controlled in the long term.

12 Socio-economic Effects Assessment and Management

12.1 Socio-economic Baseline

The Minto Mine, operated by Minto, is located 240 km northwest of Whitehorse on the west side of the Yukon River. The mine is situated on SFN Category A Settlement Land, with the nearest communities being Minto and Pelly Crossing. Pelly Crossing is the current administrative center of the SFN.

Regional and local study areas (RSA and LSA, respectively) were defined to reflect those areas within Yukon that may experience direct and/or indirect socio-economic effects as a result of the Project.

The RSA was defined as Yukon, as certain project-related benefits (e.g., employment, etc.) accrue to the entire territory; however, specific emphasis was placed on communities along the Klondike Highway between the mine and the Yukon/British Columbia border (i.e., Carmacks, Braeburn, Whitehorse, and Carcross).

The LSA was defined according to the area(s), communities, and/or individual(s) whose property, community, and/or traditional territory is directly influenced by the mine footprint or accessory project activities, including those located in Minto Landing. The LSA, which is wholly within the SFN traditional territory, includes:

- SFN;
- Pelly Crossing;
- Minto, including Minto Landing;
- Minto Mine;
- Registered trapline concessions #145 and #146; and
- Portions of guide outfitter concessions 13 and 14.

The cumulative effects assessment considered an expanded LSA spatial boundary to consider potential community effects within the broader SFN traditional territory.

Socio-economic baseline conditions in the RSA and LSA are described in the following sub-sections with respect to the identified valued socio-economic components (VSECs). In developing the baseline, all 14 VSECs (see Section 2 Methodology - Appendix T) were examined with the focus being on those where potential project effects were identified, as well as on areas of particular interest to the SFN.

The data and information presented in this Study was compiled from a variety of primary and secondary quantitative and/or qualitative sources.[7] Primary data collection was focused on the communities in the LSA and employed an adaptive, community-based process established during the confidential Minto–Selkirk First Nation traditional knowledge study (KCB 2011) and from ongoing engagement with the SFN community.

Additional detail on all items addressed in the summary can be found in the *Minto Phase V/VI Socio-economic Study* appended to this proposal (Appendix T).

12.1.1 Baseline Conditions

12.1.1.1 Business Opportunities

Economic activity in Yukon and the RSA and LSA is characterized by the mining and mineral exploration (mineral production was expected to total approximately $450 million[8] in 2012), construction (value of building permits was expected to be $150 million in 2012), and trade industries (expected to total approximately $675 million in 2012) (Yukon Government 2013). The oil and gas and tourism industries also contribute to Yukon economy; however, the overall value of these industries was not available. Mining and mineral exploration is discussed in more detail below, as this sector is particularly relevant to the project.

Mining and Mineral Exploration

Yukon's mining industry is experiencing a period of strong growth (Yukon Government 2013). As of March 2013, there were 27 active[9] mining-related projects within a 50 km radius of the project registered with the YESAB Online Registry. These included 11 placer projects, 15 quartz mining projects (not including the Minto Mine), and 1 coal mining project (YESAB Online Registry). In addition, there are also numerous other placer mining operations as well as two commercially operating mines active in the territory: these are the Wolverine Mine located approximately 840 km by road southeast of Minto (via Ross River), and the Bellekeno Mine located approximately 220 km by road north of Minto.

Two quartz mining projects are located within 80 km of the Minto Mine Property; these are the Carmacks Copper Project (located approximately 38 km southeast of the project) and the Casino Project (located approximately 80 km west of the project). Both projects are currently involved in permitting activities.

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[7] *Given the nature of the statistics, data is not always consistent between VSECs in terms of temporal scope given the different data collection periods. Further, aggregated statistics specific to the LSA or RSA were not available as the LSA and RSA boundaries are not consistent with statistical boundaries.*
[8] *All monetary values presented in this report are presented in Canadian dollars, unless otherwise specified.*
[9] *'Active' projects were defined in this study as those listed on the YESAB registry. Projects with 'assessment discontinued' status were not considered as 'active' projects.*

These are two of the six mining projects in Yukon that are currently at the permitting, advance exploration, or feasibility stage (Yukon Government 2013).

In 2012, Minto budgeted over $32 million for capital expenditures (Yukon Government 2013). In 2012, Minto expended approximately $80.5 million on suppliers within the RSA and approximately $413,000 on suppliers in the LSA.

SFN Economy

The wage economy in Pelly Crossing is based on a limited number of business opportunities, and the SFN is working to improve the diversity of economic opportunities for its citizens. The Selkirk Development Corporation, the economic arm of the SFN, is involved in a number of initiatives focused on increasing local employment opportunities for SFN citizens and generating own source revenues that will contribute to SFN's ability to invest in the development of Pelly Crossing (Inukshuk Planning & Development 2007). The traditional economy is discussed in Section 12.1.1.5.

12.1.1.2 Employment Opportunities

Employment opportunities by industry remained fairly constant between 2006 and 2013. In February 2013, the majority of employed Yukoners (85.2% or 15,500) were in the service-producing sector and 15.4% (2,800) were in the goods-producing sector (YBOS 2013)[10]. This is consistent with the 2006 census data, which revealed that 86.7% (15,020) of Yukoners were employed in the service-producing sector, and 13.2% (2,290) were employed in the goods-producing sector (YBOS 2009).

Yukon's unemployment rate was 6.9% in 2012 (YBOS 2013b). Between 2003 and 2012, the highest unemployment rate in Yukon was experienced in 2003 (10.1%) (YBOS 2013b). Employment in Yukon has since changed: in November 2012, the unemployment rate of 5.5% was the fourth-lowest in Canada and was 1.7% below the national rate of 7.2% (YBOS 2012c). In 2006, approximately 69% of all employed Yukoners were based in Whitehorse (YBOS 2009).

Unemployment rates in Yukon communities are typically higher in rural areas than in Whitehorse or the territory as a whole. For example, in 2006, when Yukon unemployment rate was 9.4% and Whitehorse unemployment rate was 7.4%, the unemployment rates in Pelly Crossing, Carcross, Carmacks, Mayo, and Dawson City were 24%, 21%, 19%, 17%, and 13% respectively (Statistics Canada 2007, 2007b, 2007c, 2007d, 2008, and 2008b). Of particular note, Pelly Crossing had the highest unemployment rate of all Yukon communities in 2006 (YBOS 2009).

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[10] *The service-producing sector comprises industries that provide services (e.g. trade, business, health care, education, etc.), and the goods-producing sector involves those industries that extract or processes resources from the earth (e.g. mining, forestry, fishing, etc.).*

The major employers in the LSA (Pelly Crossing) are the SFN Administration, the Mine, and Yukon Territorial Government. In December 2012, there were 64 positions with the SFN Administration (T.L. Isaac, pers. comm., December 14, 2012); though nine of these positions were vacant at the time. This marked a 220% increase in SFN administration employment since 1994, when only approximately 20 SFN citizens were employed by the SFN Administration (Hallam Knight Piesold Ltd. 1994).

Individuals may be employed at the Mine site directly by Minto, or indirectly by one of its contractors. In 2012[11], Minto employed 148 workers at the Mine, of whom 55% were based out of British Columbia and 35% were based out of Yukon. Approximately 21.5% of Minto's 2012 employees self-identified themselves as being of Aboriginal ethnicity, which included 16 employees (11.5%) who noted that they were SFN beneficiaries. In 2012, the majority of Minto SFN employees resided in Whitehorse (40%), followed by Pelly Crossing (27%), Carmacks (20%), and British Columbia (14%).

As of December 31, 2012, there were an additional 180 permanent contractor employees with the actual number varying throughout the year depending on activities at the site. As of 2012, the SFN had seven joint ventures that currently have ongoing contracts. These include: Parkland Fuel (fuel contract), Dyno Nobel (explosives contract), Sodexo (catering and janitorial), Pelly Construction (mining services), Driftwood Diamond Drilling (exploration drilling), Glacier Drilling (exploration drilling support), and, SGS Canada (contract lab services) (data received from Minto).

12.1.1.3 Employment Income

The most recent data related to median total income is available from 2010, when Yukon's median income was $86,930 in comparison to Canada's $69,860 (Statistics Canada 2012e). Both Canada and Yukon have experienced an increase in total median income between 2006 and 2012 (Table 12-1).

Table 12-1: Canada and Yukon total median income (all census families): 2006 to 2010.

Area	Year				
	2006	2007	2008	2009	2010
Canada	$63,600	$66,550	$68,860	$68,410	$69,860
Yukon	$76,000	$81,080	$85,070	$84,640	$86,930

Source: Statistics Canada 2012e

There are no data available to indicate the average weekly earnings of Pelly Crossing residents. Census Canada data indicate that the median total income of persons 15 years of age and older in Pelly Crossing was $16,277 in 2001 and $23,680 in 2005, with earnings from income representing 81.6% and 86.9% of total income respectively (Statistics Canada 2003; Statistics Canada 2008). In addition, approximately 14.6% of employed individuals in Pelly Crossing earned in excess of $60,000 per year in 2006, while 10.4% earned

[11] *Data received from Minto, September 2012. No specific date was provided with the data file received.*

less than $10,000 per year (Statistics Canada 2003). Further, for SFN citizens working at the Minto Mine and residing in the LSA (Pelly Crossing), the average annual income was approximately $56,347 in 2012 (data received from Minto). For those SFN beneficiaries residing in the RSA, the average annual income was approximately $57,447 in 2012 (data received from Minto).

12.1.1.4 Royalties and Donations

One of the ways in which Minto supports communities throughout the RSA is through financial donations. This includes a $30,000 donation to the Whitehorse General Hospital in 2010 towards their MRI machine. Minto also provides financial donations to the SFN within the LSA. Since 2009, Minto has provided donations to the SFN community totaling approximately $61,000.00 to support a variety of initiatives including community wellness, cultural activities, recreation, school trips for youth, and travel to different events and activities.

Additional income is provided to the SFN through royalties from Minto. Since 2008, Minto has paid $12.6 million in royalties to the SFN (Yukon Government 2012). In July 2012, all SFN citizens received an individual, one-time royalty payment from the SFN Administration (INT06)[12].

12.1.1.5 Traditional Economy

Traditional activities continue to provide an important source of income and contribute to the well-being of many SFN citizens. The SFN economy is comprised of a combination of traditional (e.g., trapping, hunting, fishing, and gathering) and contemporary pursuits. In many cases individuals, particularly those living within or with access to the SFN territory, participate in both traditional and contemporary economic activities. It is of importance to the SFN to maintain their traditional economy as they work to develop economic opportunities across their territory (Inukshuk Planning & Development 2007).

Though no quantitative data was identified to describe the current value of the SFN traditional economy or the proportion of SFN citizens involved, discussions with the community indicate that a portion of many SFN families' annual income is derived from traditional activities including trapping, hunting, fishing, berry picking, and creating crafts and other goods (i.e., mukluks, baby clothes, dolls) (Yukon Government 2004). These products may be sold, used for subsistence purposes, or traded. SFN citizens interviewed as part of the study's primary data collection shared that many people still actively engage in traditional-use activities throughout the year.

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[12] *These references refer to primary data collected through interviews.*

12.1.1.6 Community Stability

The VSEC of community stability considers the potential for the project to influence changes to community demographics (i.e., size, composition, and mobility). To provide the baseline required to assess this VSEC, this section addresses population and demographics, particularly population, age distribution, mobility, and family make-up.

Population

Yukon and key LSA and RSA communities experienced overall population growth between 2001 and 2011 (Table 12-2). Yukon had a total population of 33,897 in 2011, which represented an 11.6% increase since 2006 and an 18.2% increase since 2001 (Statistics Canada 2012; Statistics Canada 2007). Whitehorse, the largest population center in Yukon, had a population of 27,323 in June 2012 (YBOS 2012). The June 2012 population was the highest that Whitehorse has experienced in the past six years and comprised 76% of Yukon's population at that time. Population growth in Whitehorse is a major influence on Yukon's overall growth.

Table 12-2 Census populations 2001 to 2011.

Community	Population (#)			Population change (%)
	2001	2006	2011	2001–2011
Yukon	28,674	30,372	33,897	18.2%
Whitehorse	21,405	22,898[13]	23,276	8.7%
Carcross	152	331	289	90%
Carmacks	431	425	503	16.7%
Minto	N/A	N/A	N/A	N/A
Pelly Crossing	328	296	336	2.4%

(Statistics Canada 2012, 2012b, 2012c, 2012d, 2007, 2007b, 2007c, and 2007d.)

Of particular note are the population fluctuations experienced in Pelly Crossing during this time. Though the population has only increased by 2.4% between 2001 and 2011, a 9.8% population decrease from 2001 to 2006 was followed by a 13.5% increase between 2006 and 2011 (Table 12-2). These fluctuations follow a 37.8% population increase between 1996 and 2001, when the population grew from 238 to 328. In June 2012, the population of Pelly Crossing was 332 (YBOS 2012).

Yukon Aboriginal population comprised approximately 25% of Yukon's population in 2006 (Government of Yukon and Statistics Canada n.d.). At the time, approximately 85% of the Pelly Crossing population and 18%

[13] *The 2006 Whitehorse population data was referenced from the 2006 Census (Statistics Canada 2007b).*

of the Whitehorse population were considered to be of Aboriginal identity (Statistics Canada 2007; Statistics Canada 2007b).

Selkirk First Nation

The total registered population of the SFN was 576 citizens in December 2012, a 24.7% increase from the 462 citizens registered in December 1993, and a 13.2% increase from the 509 registered in December 2009 (AANDC 2012a, Minto Explorations Ltd. 2010, Hallam Knight Piesold Ltd. 1994). In December 2012, approximately 49.8% of the total registered SFN population lived on SFN “own crown land,” and approximately 44.1% lived “off reserve” (AANDC 2012a).

12.1.1.7 Housing

The VSEC of housing considers the potential for the project to influence the current demand for housing in the LSA and RSA and for housing conditions to affect population growth. Housing in Yukon is considered to be in a state of crisis and an impediment to economic growth, particularly as the territory anticipates the demand to continue to increase as the economy expands (DPRA 2011). The majority of private and other residential housing stock in the RSA as well as temporary accommodation (e.g., motels, hotels), is located in Whitehorse, with smaller numbers of housing units available in other communities. Housing in Whitehorse is considered to be more than a decade behind current demand (DPRA 2011).

Within the LSA, SFN residential housing and a limited number of privately owned residences and temporary accommodation units are concentrated in Pelly Crossing. Over the last 18 years, SFN residential housing has increased by 33% (from 100 homes in 1994 to 133 in 2012), privately owned housing has decreased by 73 to 80% (from 15–20 homes in 1994 to 4 in 2012), and Yukon Government housing has increased by 83% (from 6 in 1994 to 11 in 2012) (Hallam Knight Piesold Ltd. 1994). In 2012, there were 133 SFN residential housing units, four privately owned houses and 11 Yukon Government-staff houses located in Pelly Crossing (T.L. Isaac, personal communication, December 14, 2012; Yukon Housing Corporation 2012).

Availability of SFN residential housing in Pelly Crossing is an important issue for the community as demand currently exceeds supply (INT12). SFN citizens must apply for SFN housing through an application process with the SFN Administration. In 2012, it reportedly took an average of five years to be assigned a home once the required housing application was complete (INT12). The SFN Administration is working to build homes to help address the housing shortage in the community.

12.1.1.8 Health Status and Services

Health Status

Health status was not characterized for the RSA, as the project is unlikely to affect the health of residents in this area.

Limited statistical information related to the health and health conditions of the residents within Pelly Crossing and the SFN is publically available. Through this study's primary data collection, it was learned that diabetes education is one of the major health focuses in the Pelly Crossing community (INT08).

The SFN participated in phase 1 (2002/2003) and phase 2 (2008/2010) of the First Nations' regional health survey which documented information about the health and health conditions of the community at those times. This data is not currently accessible; however, Minto and SFN are working together to establish the necessary parameters to access this data and potentially consider it to help define a more detailed health baseline and help define the determinants of health in Pelly Crossing and for the SFN.

Health Services

Healthcare in Whitehorse, the health care center of Yukon, is provided by the Whitehorse General Hospital, a public health office, and two continuing care facilities. Healthcare in the remainder of the RSA and LSA is provided predominately by community nursing in community health care facilities. Health services in the LSA are located in Pelly Crossing and are provided through the Pelly Crossing Health Centre, a social worker, and emergency medical and fire services. SFN has a Department of Health and Social Programs that provides a variety of health-related services, alongside SFN citizens who commonly practice traditional medicine.

12.1.1.9 Education and Training

Education and training opportunities in the RSA and LSA are facilitated by various educational institutions and service providers. Educational opportunities in the LSA are available in Pelly Crossing, primarily through the Eliza Van Bibber School which provides schooling for grades kindergarten to 12, and Yukon College. The Pelly Crossing Yukon College campus is the busiest campus per capita in Yukon (INT06). The college works closely with the SFN Chief and Council to identify academic and vocational programs reflective of SFN community needs and interests (INT06). Yukon Government also supports education and training opportunities in the LSA and RSA.

The SFN Education Department works with local educational institutions, and other organizations such as Minto, to provide support and programming that meets the educational needs of its citizens. Minto is working with the SFN Education Department, local educational institutions, and Yukon Government to develop and support educational opportunities for SFN citizens. Specifically, the Eliza Van Bibber School and Minto are working together to develop opportunities for students to observe and learn about the careers available at the Minto Mine.

Eliza Van Bibber School student achievement was a priority of the 2012/2013 School Growth Plan (Yukon Education n.d.). This report indicated that the Pelly Crossing community had concerns about how students were being graded as it was observed that students transferred to Whitehorse schools were "dropped a grade level" as they were not able to complete the level of work required for their grade (Yukon Education n.d., p.2). This report indicated that in the 2010/2011 school year, four of five students who wrote their

British Columbia Provincial science 10 exams passed, and three of five students passed their British Columbia Provincial math exam (Yukon Education n.d.). In 2006, approximately 46% of Pelly Crossing residents had no certificate, diploma or degree compared to approximately 23% for Yukon overall (Statistics Canada 2007).

Minto and Minto contractors at the mine provide a variety of training opportunities for their staff. Minto is also currently working in partnership with Yukon College and Yukon Mine Training Association to develop such future training opportunities as apprenticeships and internships.

12.1.1.10 Community Well-being

Statistics Canada Community Well-being

Community well-being (CWB) was assessed in 2006 as part of Statistics Canada's CWB Index that assesses CWB based on employment, education, income, and housing. Scores for CWB can range between 0 (lowest) to 100 (highest) (AANDC 2012a).

First Nation communities were examined separately from non-Aboriginal communities. In both First Nation and non-Aboriginal communities in the LSA and RSA, education was the lowest scoring component. In the LSA and RSA, the non-Aboriginal communities of Whitehorse and Carmacks received CWB scores of 85 and 70 respectively, and the First Nation communities of Carcross and Pelly Crossing received CWB scores of 74 and 71, respectively (AANDC 2012b).

The CWB score for SFN is available based on the 2001 Census, in which they scored 80 (Indian and Northern Affairs Canada 2008)[14]. In comparison, the average First Nations score at the time was 79, the average non-First Nations average score was 86, and the lowest community score was 69 (Indian and Northern Affairs Canada 2008).

SFN Community Well-being

Community well-being is defined differently by every community but generally refers to the environmental, social, and economic conditions that support a quality of life that promote the health and well-being of all residents. The 2007 Integrated Community Sustainability Plan for SFN/Pelly Crossing stated that the overall community well-being was considered to comprise the following facets: self-government empowerment, education, increased governance capacity, and economic diversification (Inukshuk Planning & Development 2007).

[14] *Please note, as the 2001 CWB score was assessed for SFN, and was assessed for Pelly Crossing 2006, these scores may not be directly comparable.*

During the primary data collection of this study, emotional well-being, social cohesion, and cultural well-being were identified as important contributors to SFN community well-being. Interviewees shared that supporting the development of positive self-esteem and self-confidence is important to achieving a healthy emotional well-being. Social cohesion included supporting intergenerational relationships between members, and providing opportunities for community members to share experiences together through various organized community events and activities. Supporting cultural activities, events, and initiatives that promote the sharing and teaching of cultural knowledge and the Northern Tutchone language is a priority for the SFN community. Cultural well-being is an important component of SFN community wellness and therefore is also considered as a separate VSEC, and discussed in Section 12.1.1.10.

Minto is working with SFN and YG through the tri-partite socio-economic working group to define wellness further, so that this VSEC can be monitored and assessed in the future. Furthermore, Minto and SFN are working to determine how Minto may contribute to the SFN community well-being. To date, Minto has provided in-kind financial donations to cultural activities, events, and initiatives that support various aspects of community well-being, including: a traditional dance group, sponsorship to attend a spiritual development event, and funding to support SFN citizens attending various cultural events.

Other Contributors to Community Well-being

Communities in the RSA area offer a range of infrastructure and services related to health, justice, education, safety and emergency services, general infrastructure and services (e.g., banks, post office, community hall, garbage services, water delivery, churches, etc.), recreation, and social services, among others, to their residents with the nature of the infrastructure and services varying from community to community. Community infrastructure and services in Pelly Crossing are provided by the SFN Administration, Yukon Territorial Government, and private companies. A limited amount of infrastructure is available in Minto.

Justice

The Royal Canadian Mounted Police (RCMP) serves Pelly Crossing and surrounding areas. As of the summer of 2012, the detachment was understaffed with only two of the three positions filled (RCMP, personal communication, August 15, 2012).

Crime rates (measured as the total number of violations per 100,000 people) varied throughout the LSA and RSA from 2006 to 2011. During this time, Pelly Crossing had the greatest number of total criminal code violations and Whitehorse had the least (YBOS 2012d, 2012e, 2012f, and 2012g). Pelly Crossing experienced an 85% increase in total criminal code violations between 2006 and 2011 with the most prevalent type of violation being property-related criminal code violations (YBOS 2012f). This was the largest increase of total criminal code violations experienced by all communities examined in the local and regional study areas.

Traffic

Access from the Klondike Highway to the Minto Mine barge landing is maintained by Minto. The barge landing facilitates access to the Mine during the summer months, by barge, and by an ice bridge in the winter. Mine employees are transported to and from the site in commercial buses from Whitehorse when the barge or ice bridge is in operation. There are two buses a week to and from Whitehorse, and smaller vans from Pelly Crossing one to two times a week. During the spring and fall, personnel are flown to site from Whitehorse via a charter air service that lands on the Minto Mine's 1,300 m airstrip located at the Mine (two to three flights per week).

An average of three to five concentrate trucks leave the mine site daily when the barge or ice bridge is operational. During the four to six week winter 'freeze-up' and spring 'break-up' periods on the Yukon River, when the barge and ice bride are not operational, concentrate is stored to be transported later.

The only data available indicating the type of traffic (cars and trucks) was collected in 1999 and 2000. In those years, truck traffic comprised 1.5% and 2.2%, respectively, of the total traffic (Yukon Highways and Public Works 2011).

The average daily traffic volume experienced in different parts of Yukon varies greatly; however, there has been little change in the volume of traffic over the past two decades within the RSA and LSA (Table 12-3) (Yukon Highways and Public Works 2011).

Table 12-3 Klondike highway traffic counts (1993-1994, 2011).

Location	Average summer daily count		Average annual daily count	
Carcross North	803 (1993)	886 (2011)	814 (1993)	821 (2011)
Carmacks North	403 (1993)	435 (2011)	239 (1994)	295 (2011)

Source: Yukon Highways and Public Works 2011

Based on data gathered in 2010 by Yukon Highways and Public Works, the average daily traffic volume on the Klondike highway within the LSA ranged between 150 and 299 vehicles a day, while traffic in the RSA ranged between150 and 2400 vehicles a day (Yukon Highways and Public Works 2011, p.8).

12.1.1.11 Cultural Well-being

This VSEC was only examined within the LSA, since the potential effects on cultural well-being are anticipated to be greatest in this area. Cultural well-being is an important component of the well-being of the SFN community. Supporting cultural activities, events, and initiatives that promote the sharing and teaching of cultural knowledge and the Northern Tutchone language is a priority for the SFN community. One of the current community initiatives contributing to cultural well-being is the Selkirk Spirit Dancers which is a community dance group comprising dancers and drummers. Other community programs and initiatives, such as the Pelly Crossing Community Garden and the use of the Northern Tutchone language were also shared as being important contributions to the community's cultural well-being. Furthermore, cultural well-being may also be developed through culturally relevant employment opportunities and through the sharing and teaching of cultural knowledge. Elders play an integral role in the transmission of cultural knowledge and in supporting cultural well-being.

12.1.1.12 Traditional and Current Use

Traditional and current use, focused on connections to the land and water, were examined within the LSA as the SFN culture and community is intrinsically linked to these resources within its traditional territory. The connection that SFN has with the land and water is complex and involves many different components, some of which were shared with the study research team.

Traditional use activities are actively pursued by SFN citizens throughout the year across their traditional territory and are a culturally significant way in which they maintain their connection with the land and water. Several citizens shared the importance of fishing (INT29, INT18, INT10, INT71, INT13, and INT26), hunting (INT29, INT18, INT10, INT17, INT13, and INT26), berry picking (INT17, INT26), medicinal plant gathering (INT10, INT17, and INT26), and trapping (INT18, INT26). One SFN member shared that the fish and animals are an important part of SFN culture and contribute a large part of many family's diets; they wondered if future generations would be able to continue harvesting fish and animals from the land, and if they would be of a good enough quality to eat (INT10, INT17, and INT13TK). Connections to land and water are further described in detail in the confidential Minto–SFN Traditional Knowledge Study (KCB 2011).

Other Resource and Land Use

The majority of the land tenure in the immediate area surrounding the Mine site is held under title by the SFN. This includes parcels of land located on both the east and west side of the Yukon River, categorized as both Category A and Category B land. The land tenure selections made by SFN reflect the significance of the Minto Mine and Minto Landing areas for traditional and historic use. Several fee simple titled properties are located on the east side of the Yukon River in the Minto Landing area.

Other resource and land use in the LSA include registered outfitter concessions #13 (Mervyn Outfitting) and #14 (Trophy Stone Outfitting). A number of registered trapline concessions, including two (registered trapline concession #145 and #146) that directly overlap the Minto Mine footprint, are also located within the LSA.

12.1.1.13 Intergenerational Equity

Sustainability was examined in the LSA by considering intergenerational equity (i.e., legacy socio-economic benefits of the project) and the Minto–SFN relationship.

Since key Minto–SFN agreements are currently confidential and unavailable for consideration in this study, the existing condition of this value was characterized by qualitative community-based information about intergenerational equity and the Minto–SFN relationship. Ensuring that the Minto Mine leaves a positive legacy of intergenerational equity for future SFN generations was identified as being important by interviewees. Citizens identified a number of means that could contribute to inter-generational equity including:

- Setting aside Minto Mine royalty money for future SFN generations, including those citizens under the age of 21 when the one-time royalty payment was made to SFN citizens in the summer of 2012 (INT25),
- Providing educational and training opportunities that develop and support life skills and transferrable employment skills would help contribute to positive community development (INT26), and
- Creating a diversified economy in Pelly Crossing, which would contribute to increased employment opportunities (INT26).

Intergenerational equity is an important value that may be realized through such joint Minto–SFN initiatives as providing educational and training opportunities aimed at developing life skills and transferrable employment skills that would help support a diversified economy in Pelly Crossing (INT26). Royalties received by the SFN also have the potential to contribute to legacy socio-economic benefits, as defined by the community.

12.1.1.14 Minto–SFN Relationship

Minto and SFN entered into a cooperation agreement in September 1997, which was reviewed in November 2009 after the mine commenced production. In addition to establishing cooperation with respect to permitting and environmental monitoring, this confidential document deals with other social and economic measures and outlines preferred methods for how communication between SFN and Minto should be carried out. The 2009 cooperation agreement outlines mechanisms and procedures for providing opportunities for SFN citizens to maximize employment opportunities. Minto is also working with the SFN, on a number of levels, to improve communications and to identify the means through which SFN would like to participate in the mining operations and mine closure.

The Minto Mine and the SFN have been developing their relationship since before the mine's operations began and are working together to continue to develop the relationship. Minto and SFN participate in a number of joint initiatives and are working to expand their activities relative to increasing SFN citizen participation at the Mine and to enhance communication with the community.

12.2 Socio-economic Effects Assessment (SEA)

12.2.1 Study Objectives

The objectives of the socio-economic effects assessment were to:

- To identify, assess, and characterize potential Project effects on the VSECs in the LSA and/or RSA.
- To identify existing or potential mitigation and enhancement measures. Where potential residual effects were identified, mitigation measures were reviewed to determine if it was possible to reduce potential residual effects further.
- To identify and characterize potential residual effects.

As effects identified were neutral or positive, residual effects were not assessed.

12.2.2 Spatial and Temporal Boundaries

The spatial boundaries for the SEA are the same as those defined in the *Socio-economic Baseline Summary*. In completing the SEA, business opportunities, employment opportunities, employment income, royalties, donations, community stability, and housing were assessed for both the RSA and LSA while the remaining VSECs were assessed for the LSA. The temporal boundaries are generally consistent with Project activities; however, the temporal boundaries of certain VSECs may vary depending on the nature of the potential effect(s) identified.

12.2.3 Valued Socio-economic Components

The SEA reflects the 14 valued socio-economic components (VSECs) identified in consultations with SFN, residents of Pelly Crossing, and Minto Landing (Table 12-4). VSECs were grouped according to the socio-economic condition to which they were related and presented in that order in the SEA.

Table 12-4: Socio-economic Conditions and VSECs.

Socio-economic Condition	VSEC	Scale Considered	Rationale
Material Well-Being	Business Opportunities	RSA LSA	Potential for the Project to influence the type and level of business opportunities.
	Employment Opportunities	RSA LSA	Potential for the Project to influence employment opportunities.
	Employment Income	RSA LSA	Potential for the Project to influence employment income.
	Royalties and Donations	RSA LSA	Potential for the Project to influence royalties and donations to the SFN
	Traditional Economy	LSA	Potential for the Project to influence participation in the traditional economy and the role of the traditional economy.
Population	Community Stability	RSA LSA	Potential for the Project to influence changes to community demographics (i.e., size, composition, mobility) and, in turn, community stability.
	Housing	RSA LSA	Potential for Project-related population changes to influence housing demand and supply.
Health	Health Status and Services	LSA	Potential for the Project to influence community health, safety, the type and level of health services provided.
Education and Capacity	Education and Training	LSA	Potential for the Project to affect demand for and availability of educational and training opportunities and the types of education provided and the influence this may have on capacity development.
Community Wellness	Community Well-being	LSA	Potential for the Project to influence community wellness and social cohesion.
	Cultural Well-being	LSA	Potential for the Project to influence the cultural values and activities (i.e., language, traditional use activities, etc.).
Connections to the Land and Water	Traditional and Current Use	LSA	Potential for the Project to influence activities/ outcomes related to trapping, hunting and harvesting.
Sustainability	Intergenerational Equity	LSA	Potential for the Project and its legacy to influence future generations.
	Minto-SFN Relationship	LSA	Potential to develop the Minto-SFN relationship further to enhance operations and legacy effects of the Project and mitigate potential negative effects.

It is important to note that although some of the items discussed in the baseline (i.e., infrastructure and services, justice, and traffic) did not translate directly into VSECs, they are considered in the identified VSECs.

12.2.4 Effects Assessment

The socio-economic effects assessment study methodology was generally based on the YESAB Guide to Socio-economic Effects Assessments (YESAB 2006), and iteratively developed with the SFN community and the tri-partite socio-economic working group. Interactions between the VSECs and the Project were identified and, based on available data, an assessment was made as to the extent to which the Project and associated activities during all Project stages (i.e., operations, decommissioning, and closure) could affect the VSECs.

For the purpose of this SEA, Phase IV was considered to be the baseline with recognition that Phase IV would have continued through to decommissioning and closure without the Project. As such, the majority of potential effects are a continuation of existing effects.

A construction phase was not considered in the assessment as there is no distinct construction phase associated with the Project. Further, although it is recognized that a temporary closure during Project operations would result in socio-economic effects; the nature and significance of these effects cannot be determined as they will depend on the nature of the closure (i.e., length of closure, etc.) and the socio-economic setting at that time. As such, temporary closure is not specifically discussed in the assessment of each VSEC.

If conflicting socio-economic effects were identified (i.e., an effect was found to have potential positive and negative effects), all effects were considered and assessed and a conclusion made as to the overall effect. Once identified, the overall effect on the VSEC was characterized according to the following: magnitude, spatial scale, duration, direction, frequency, reversibility, and socio-economic context. Input received from interested parties (e.g., SFN, land-users, tri-partite socio-economic working group, and government agencies) through the course of the study was also considered in the assessment, and in the characterization of the effects.

Following characterization, the intent was to identify mitigation measures for those effects that were characterized as adverse and potentially significant. However, it was determined that the effects were neutral or positive as they were essentially a continuation of existing Phase IV effects. As such, mitigation was not required and residual effects were not considered further. However, given the interest of the SFN in potential project effects, potential enhancement measures are identified where potential neutral or positive effects were identified.

It is important to note that there are VSECs where additional baseline information or discussion with the SFN community is required to assess fully the potential Project effects (i.e., health and safety, community well-being). However, based on available information and discussions with the community, it is anticipated that effects will be positive or neutral, and that there will not be significant negative residual effects related to any of the VSECs (Table 12-5 and Table 12-6). However, it will be important for these VSECs to be considered in the ongoing socio-economic effects monitoring program to confirm the assessment of effects being either positive or neutral.

Minto recognizes that the key to confirming and adaptively managing effects and enhancing benefits will be to adapt proposed and future mitigations to respond to potential issues and opportunities identified by the socio-economic monitoring program. This program will be undertaken by the tri-partite socio-economic working group. Although a formal monitoring program is not currently in place, Minto and SFN have been working together during Phase IV to mitigate Project-related effects and enhance benefits.

The assessment of individual VSECs is discussed more fully in the Minto Phase V/VI Socio-economic Study, (Section 4 Socio-economic Effects Assessment - Appendix T). The characterization of the effects for each VSEC for operations, decommissioning, and closure is summarized in Table 12-5 and Table 12-6.

Table 12-5: Characterization of Socio-economic Effects during Operations.

Socio-economic Condition	VSEC	Magnitude	Spatial Scale	Duration	Direction	Frequency
Material Well-Being	**Business opportunities**	Medium	RSA	Long-term	Positive	Continuous
		Medium	LSA	Long-term	Positive	Continuous
	Employment opportunities	Medium	RSA	Long-term	Positive	Continuous
		Medium	LSA	Long-term	Positive	Continuous
	Employment income	Medium	RSA	Long-term	Positive	Continuous
		Medium	LSA	Long-term	Positive	Continuous
	Royalties and donations	Low	RSA	Long-term (Donations)	Positive	Low
		Medium	LSA	Short-term (Royalties), Long-term (Donations)	Positive	Continuous (Royalties); Low (Donations)
	Traditional economy	Low	LSA	Long-term	Neutral	Continuous
Population	**Community stability**	Low	RSA	Long-term	Neutral	Intermittent
		Low	LSA	Long-term	Neutral	Intermittent
	Housing	Low	RSA	Long-term	Neutral to positive	Intermittent
		Low	LSA	Long-term	Neutral to positive	Intermittent
Health	**Health status and services**	Low	LSA	Long-term	Neutral or positive	Intermittent
Education and Capacity	**Education and training**	Low	LSA	Long-term	Positive	Intermittent
Community Wellness	**Community well-being**	Medium	LSA	Long-term	Positive	Continuous
	Cultural well-being	Low	LSA	Long-term	Positive	Intermittent
Connections to the Land and Water	**Traditional and current use**	Low	LSA	Long-term	Neutral	Continuous
Sustainability	**Intergenerational equity**	Low	LSA	Long-term	Positive	Continuous
	Minto – SFN relationship	Medium	LSA	Long-term	Positive	Continuous

Table 12-6: Characterization of Socio-economic Effects during Decommissioning and Closure.

Socio-economic Condition	VSEC	Magnitude	Spatial Scale	Duration	Direction	Frequency
Material Well-Being	Business opportunities	Low	RSA	Long-term	Positive	Continuous
		Low	LSA	Long-term	Positive	Continuous
	Employment opportunities	Low	RSA	Long-term	Positive	Continuous
		Low	LSA	Long-term	Positive	Continuous
	Employment income	Low	RSA	Short-term	Positive	Continuous
		Low	LSA	Short-term	Positive	Continuous
	Royalties and donations[15]	Low	RSA	Short-term	Neutral to positive	Low
		Low	LSA	Short-term	Neutral to positive	Low
	Traditional economy	Low	LSA	Long-term	Positive	Continuous
Population	Community stability	Low	RSA	Short-term	Neutral	Intermittent
		Low	LSA	Short-term	Neutral	Intermittent
	Housing	Low	RSA	Short-term	Neutral	Intermittent
			LSA	Short-term	Neutral	Intermittent
Health	Health status and services	Low	LSA	Short-term	Positive	Intermittent
Education and Capacity	Education and training	Low	LSA	Long-term	Positive	Intermittent
Community Wellness	Community well-being	Medium	LSA	Long term	Neutral	Continuous
	Cultural well-being	Low	LSA	Long-term	Positive	Intermittent
Connections to the Land and Water	Traditional and current use	Low	LSA	Long-term	Positive	Continuous
Sustainability	Intergenerational equity	Low	LSA	Long-term	Positive	Continuous
	Minto – SFN relationship	Low	LSA	Short-term	Positive	Continuous

[15] *As royalties will not be paid during decommissioning and closure, this characterization refers to donations only.*

13 Heritage and Historic Resources Effects Assessment and Management

13.1 Existing Conditions

Minto has commissioned several archaeological studies to acquire a thorough understanding of the heritage and historic resources in the Project area. Most recently in 2011, Matrix (Matrix Research Limited) was retained to complete a heritage resource overview assessment (HROA), and subsequent heritage resource impact assessment (HRIA). Please refer to Appendix U for the complete Matrix report.

13.1.1 Previous Heritage Work

In 1994, prior to the construction of Minto Mine, an archaeological impact assessment of the mine site, access road, and barge landing areas was undertaken by Sheila Greer (Permit #94-6ASR). During Greer's study, no archaeological sites were identified at the proposed Mine and mill site located at the headwaters of Minto Creek.

Greer identified heritage site KdVd-1 (aka Trouble Hill) on the north side of the confluence of Minto Creek on the west bank of the Yukon River. The site was visited in 2007 by Thomas Heritage Consulting (Thomas) (2008) under Permit 07-3ASR; however, the location identified by Greer was not found. Two distinct features were identified by Thomas in 2007 on the north side of Minto Creek: a large bedrock outcrop and a terrace feature overlooking the Yukon River. These features were tested for subsurface cultural materials. From the hearth features found, and cultural remains present, the site appears to have been inhabited regularly over the last 4000 years.

Further archaeological testing was undertaken during the 2009 field season (Farnell 2010). A total of 193 lithic artifacts and over 2500 animal bone fragments were recovered from two excavation areas in 2009.

Identified species include caribou, moose, muskrat, hare, ground squirrel, and beaver. Fire-cracked rocks from both excavation areas suggest that hearths are also associated with KdVd-1. Farnell concluded, based on artifact distribution and a complex stratigraphic profile, that the site witnessed recurrent and prolonged pre-contact habitation (2010).

Two archaeological sites have been recorded along the banks of the Yukon River around Minto Landing. Heritage site KdVc-1 is located to the north of Minto Landing. According to the Yukon Archaeological Site Record, this site was initially recorded by S. Van Dyke in 1978. Sheila Greer visited the site in 1994. The site is located along a bench feature on the east side of the Yukon River at the western end of the Minto airstrip. The site record indicates that a midden, hearth, scatters of lithic artifacts, fire cracked rock, and bone were identified.

Heritage site KdVc-2 is located at Minto Landing. According to the Yukon Archaeological Site Record, heritage site KdVc-2 was initially recorded by S. Van Dyke in 1978. Van Dyke recorded the site at the north end of a quarried area along the east side of the Yukon River, northwest of the northernmost structure at Minto Landing. He described the site as including a scatter of lithics and bone, midden, cabin, cache, cellar, and drying rack. In subsequent years, Sheila Greer (1994) and T.J. Hammer of Hammerstone Consulting (1996) visited the site. Cultural material identified by Greer in 1994 included a midden, hearth, lithic scatter, fire cracked rock, and bone. Greer expanded the site extent to include approximately 1 km of riverbank to the north-northwest of the current Minto Mine ice bridge approach. Since Greer's (1994) work, KdVc-2 is now the Borden number designation generally accepted as applying to the entire heritage site at Minto Landing.

In 2005, an archaeological field inventory was conducted by Thomas for Yukon Energy Corporation's proposed Carmacks-Stewart transmission line right-of-way (05-14ASR; Thomas 2006). The archaeological field inventory resulted in the discovery of numerous historical and archaeological sites. Two archaeological sites (KdVc-10, and KdVc-11) associated with Lhutsaw Creek are situated approximately 2.1 km and 2.2 km northeast of Minto Landing, respectively. Both sites comprise scatters of lithic tools and are situated on high terraces.

In 2007, an HRIA was conducted by Matrix for Yukon Energy Corporation proposed Carmacks-Stewart transmission line right-of-way (07-15ASR, Heffner & Burkmar 2009b; see Map 2). The HRIA identified a portion of the heritage site KdVc-2 as being in direct conflict with the proposed transmission line. Mitigative work was conducted in 2008 within portions of KdVc-2 that overlapped with the proposed transmission line. Seven 1 m x 1 m evaluative units and one 0.5 m x 0.5 m unit were excavated during this work (08-03ASR, Heffner & Burkmar 2009a).

In 2009, Matrix conducted a HRIA and systematic data recovery at the portion of KdVc-2 located at the current ice bridge approach (09-16ASR, Davison 2010). During that study ten 1 m x 1 m evaluative units were excavated. Cultural materials found above and below a previously-dated layer of White River Ash (Smith et al. 2004) indicate occupations before and after AD 800. Excavation at KdVc-2 resulted in the recovery of 323 lithic artifacts including stone tools of pre-contact or proto-contact age.

Also found during the 2009 HRIA were 492 bone fragments consisting mostly of small, unidentifiable burned or calcined pieces. A buried hearth with associated lithic material was found below the layer of White River Ash and four possible cultural depressions were identified in the immediate area. Pre- and proto-contact artifact types at the site indicate general-purpose activities such as tool maintenance and use, and subsistence activities (Davison 2010). A post-contact component was also identified at KdVc-2, consisting of late nineteenth- and twentieth-century artifacts (e.g., cans, nails, pottery, wire, glass, and unidentified metal).

13.1.2 2010/2011 Heritage Work

As noted, Matrix was retained to complete a HROA for Minto Mine in 2010. A summary has been provided in this subsection; however, for full results, please refer to the *Heritage Resources Overview Assessment of the Minto Mine Claim Area and Heritage Resources Impact Assessment of the Proposed Minto Mine Phase IV Expansion Conducted under Permit 10-08ASR* (Appendix U). Figure 13-1 provides an overview of the high potential areas noted by Matrix.

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FIGURE 13-1
AREAS OF HIGH HERITAGE RESOURCE POTENTIAL IN THE MINTO AREA

JULY 2013

CAPSTONE MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

- High Potential Areas
- Proposed Roads
- Phase V/VI Tailings
- Phase V/VI Pits
- Phase V/VI Dumps
- Phase V/VI Dam
- Phase IV Features

ACCESS

Aerial imagery obtained from Challenger Geomatics.
Imagery acquired August 14 th 2012.
High Potential areas obtained from Matrix Research Ltd, March 2013

Datum: NAD 83 Projection: UTM Zone 8N

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(*Last edited by: mducharme;02/07/2013/14:33 PM*)

Based on findings from the HROA, the Minto Mine Phase IV Expansion area encompasses areas of high heritage potential. This necessitated the completion of the HRIA component of this study, which was to identify heritage resources and assess potential impacts that may result from the proposed development. The HRIA was completed to address the Phase IV expansion, as well as to manage potential conflicts with heritage resources during future mining-related development in the study area (i.e., Phase V/VI).

The HRIA resulted in the discovery of two heritage sites identified: KdVd-2 (Temporary Site Number M10-Minto-1) and KdVd-3 (Temporary Site Number M10-Minto-2). Please refer to section 5.2.1 of Matrix's report (Appendix U) for details. Please note these sites were located within HPZ1 and HPZ2 noted on Figure 4 in Matrix's *Heritage Resource Impact Assessment* (Appendix U).

13.2 Potential Effects Characterization and Effects Assessment

The Project is an expansion of an existing mine, and requires clearing approximately an additional 82.04 ha. Proposed activities involve the use of heavy equipment to clear land and move earth, and may potentially affect heritage resources. Heritage resources are valued for their physical, material, and symbolic properties. Therefore, adverse effects may arise from the disturbance, destruction, or removal of heritage resources.

Minto is aware of, and intends to comply with, several pieces of legislation related to heritage and historic resources, which include: *Yukon Historic Resources Act*, Archaeological Site Regulation, and the Selkirk First Nation Final Agreements. Furthermore, Minto has a Heritage Protection Plan which outlines the procedures and protocol for employees and contractors to follow in the event a heritage resource is discovered. Minto's Heritage Protection Plan can be found at http://www.emr.gov.yk.ca/mining/pdf/mml_minto_heritage_resource_protection_plan.pdf

13.2.1 Mitigation Measures

In order to prevent adverse effects to heritage and historic resources in the Minto area, the following mitigations will be implemented or continued:

- Adherence to Minto's Heritage Protection Plan
- Minto will conduct a HRIA where Phase V/VI activities overlap with areas identified as having high heritage resources potential, as per Matrix's *Heritage Resource Overview Assessment* (Appendix U);
- Minto commits to ongoing community consultations and communication to ensure awareness of the Project extent and operations, with opportunity for public discussion or raising of concerns; and,
- All discoveries of heritage and paleontological resources will be reported to SFN government's heritage department and YG heritage branch.

13.2.2 Conclusions

As noted above, Minto has a Heritage Protection Plan which outlines the approved protocol and procedures that will be undertaken in the event a discovery is made. With the application of the mitigation measures and compliance with the above noted pieces of legislation, the Project is not anticipated to result in significant adverse effects on heritage and historic resources.

14 First Nation, Stakeholder and Regulator Engagement

14.1 Introduction

Minto and the Selkirk First Nation (SFN) share the desire to minimize adverse environmental and socio-economic impacts resulting from the Mine operation and associated activities. Minto believes this can be accomplished through consultation and open communication with stakeholders that include SFN, project regulators, and others. Accordingly, Minto has increased its focus on stakeholder engagement.

14.2 Engagement with Selkirk First Nation

The Minto Mine is located on the west side of the Yukon River within SFN Category A settlement land. As the landowner, SFN is Minto's primary stakeholder. Minto has therefore engaged SFN in a process of meaningful and significant involvement in the planning and development of the Phase V/VI expansion.

While Minto and SFN have had a collaborative relationship prior to commercial production commencing in 2007, a number of initiatives have recently been established to enhance effective engagement through many channels.

These initiatives include regular meetings between Capstone leadership and SFN Chief and council, as well as with SFN leadership representatives.

For the past several years, Minto and SFN have committed a bi-lateral technical working group (BTWG) to discuss technical issues related to the Minto Mine regularly. The BTWG comprises four teams of Minto and SFN representatives tasked with engagement in the following areas: geotechnical, water quality, consultation, and closure and reclamation, particularly as it relates to the Phase V/VI expansion.

Minto retained Klohn Crippen Berger to conduct both a comprehensive traditional knowledge study and a socio-economic study. In late 2010, community meetings related to the socio-economic study for Phase V began in Pelly Crossing, the scope of which was subsequently revised to include the Phase V/VI expansion. Detailed information about the socio-economic study can be found in Section 12 and Appendix T.

Another initiative saw Minto hiring an SFN citizen to help coordinate meetings, interviews, open houses and conduct research. This person has worked effectively to assist Minto and Klohn Crippen Berger to engage with the community at large.

Minto also created a liaison position, filled by a SFN citizen, to facilitate SFN employment on the project. This person tracks SFN resumes, participates in interviews, posts jobs in the community, liaises with SFN staff on site, and participates, on behalf of Minto, in job fairs, and other related events.

As described in Section 1.6.3.1, Minto and SFN are parties to a confidential Cooperation Agreement.

14.3 Tri-partite Socio-economic Working Group

Another important area of engagement was the creation of a tri-partite socio-economic working group that comprises SFN, YG and is led by Minto. It is responsible for a socio-economic effects monitoring program, as described in the decision document related to Phase IV (YESAB project # 2010-0198). The working group has met several times in order to determine the scope of the monitoring program, discuss availability of data, responsibilities and reporting. Meetings occurred in March and April of 2013 where the working group reviewed the draft Minto Mine project effects monitoring program and the Minto Mine socio-economic monitoring framework. Next steps include having a governance meeting this Spring and launching the monitoring program this summer/fall; with the initial report being issued in summer/fall of 2014.

14.4 Identification of Other Stakeholders

Minto recognizes the role that federal/territorial boards and government departments play in protecting the interests of Yukoners as well as providing advice and expertise related to the Project. Therefore, Minto has taken care to engage these stakeholders throughout the Phase V/VI expansion planning process.

This engagement has included communication through technical working groups, site tours, updates, phone calls, regulator meetings, and reports. Stakeholders and regulators who are frequently engaged by Minto are:

- YESAB
- YWB
- YG EMR
- YG Water Resources
- Environment Canada

14.5 Forms of Engagement

For details regarding specific First Nation, stakeholder, and regulator engagement, please see the SFN, Stakeholder and Regulator Engagement Table (Appendix V). This table provides details of engagement that has occurred since 2011 and includes communication related to earlier phases of the Minto Mine.

15 Decommissioning, Reclamation and Closure

15.1 Scope and Objectives

YESAB requires that information regarding the decommissioning, reclamation and closure of major mining projects be presented as part of any proposal for mining and milling activities. Accordingly, a plan entitled Preliminary Reclamation and Closure Plan, Phase V/VI Expansion – Minto Mine, Yukon has been prepared and is included in Appendix W of this Project Proposal. This Preliminary Reclamation and Closure Plan (PRCP) has been specifically scoped to fulfill the requirements in the Yukon Environmental and Socio-economic Assessment Act (YESAA) for quartz mining projects proposed in the Yukon.

This PRCP builds on the understanding of the site conditions and subsequent closure methods proposed in previously developed (and approved) site closure plans, most recently for the Phase IV mine life. The PRCP is intended to address the long-term physical and chemical stability of the site and closure of the proposed features and disturbances associated with the Phase V/VI Mine Expansion. Closure methods for previously permitted infrastructure components that are not expected to change in the Phase V/VI Expansion are addressed most recently in the approved Minto Mine Decommissioning and Closure Plan (Revision 3.2) and are presented or referenced in the document only to the extent that is required to acknowledge that they will be part of the closure "landscape" at the end of the Phase V/VI mine life.

The PRCP is based on the best information available at the present time, and presents methods and techniques for closure commensurate with environmental and socio-economic assessment requirements to show reasonable and defensible mitigations of potential effects to valued components at closure. A program is presented for site management and monitoring, both during implementation of closure and after decommissioning and reclamation measures are completed. A proposed continuation and expansion of the reclamation research program will provide more site-specific information to optimize closure methods, and it is expected that further detail on the closure methods will be provided in subsequent versions to support project licencing.

Minto is committed to implementation of reclamation methods that will mitigate potential adverse effects to environmental and socio-economic values. The overall goal of closure at the Minto site is to leave the area as a self-sustaining ecosystem, ensuring that land use after closure is compatible with the surrounding lands, and that the site vegetation returns to a state as near as possible to that in existence prior to mining activities. Overall reclamation measures are summarized by site feature in Figure 15-1, and measures are summarized further in Section 15.2 Key Reclamation and Closure Measures

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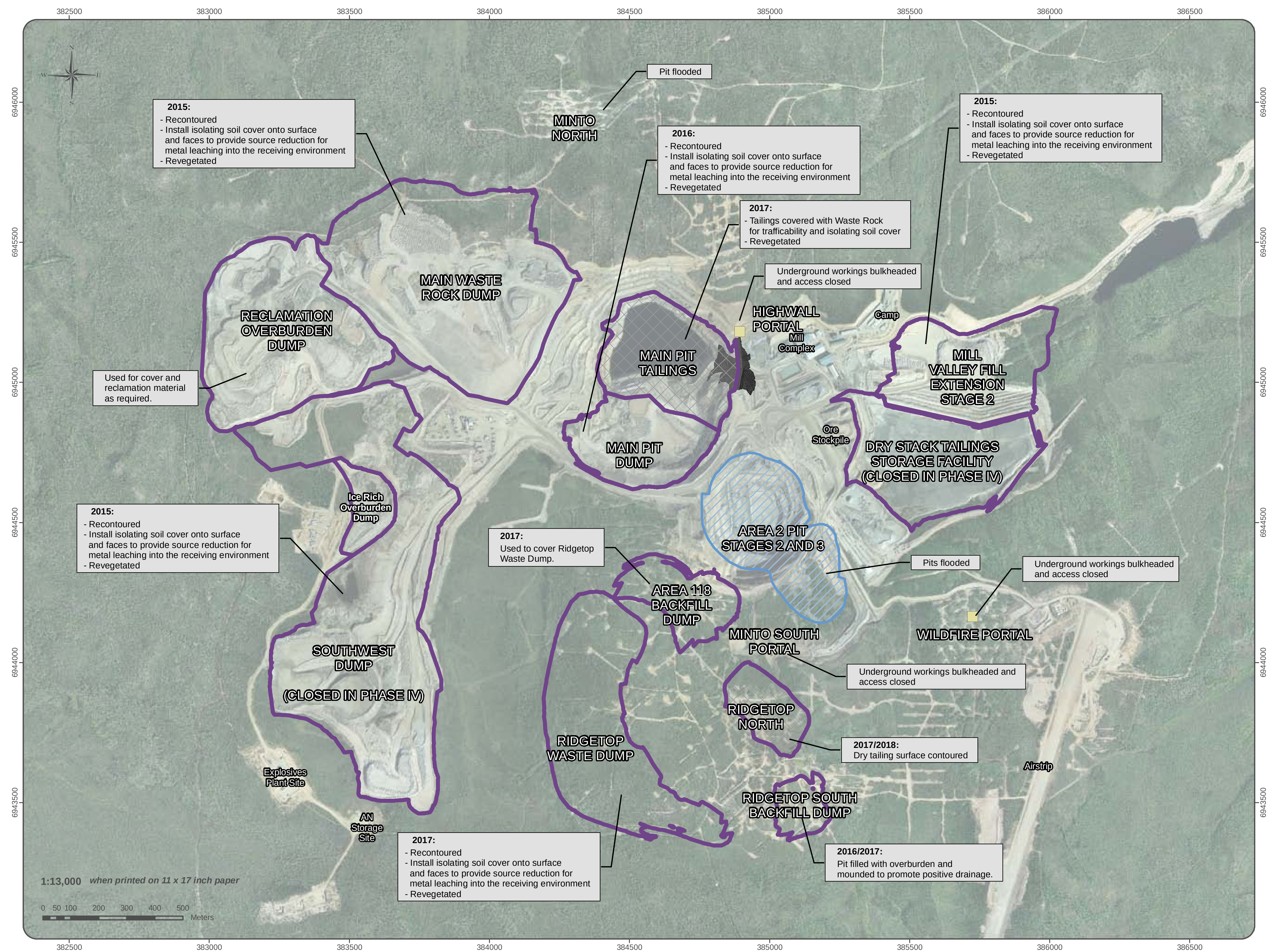

MINTO MINE
PHASE V/VI EXPANSION

PRELIMINARY RECLAMATION AND CLOSURE PLAN

FIGURE 15-1
RECLAMATION MEASURES

JULY 2013

Minto Explorations Ltd.
A SUBSIDIARY OF CAPSTONE MINING LTD.

- Reclamation Feature Outline
- Tailings
- Mine Lakes
- Dumps
- Pits
- Main Dam

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 14th 2012.
Site contours derived from 2012 aerial imagery obtained from Challenger Geomatics.

Hydrology data provided by Minto Explorations Ltd, May 2009.

Datum: NAD 83 Projection: UTM Zone 8N

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15.2 Key Reclamation and Closure Measures

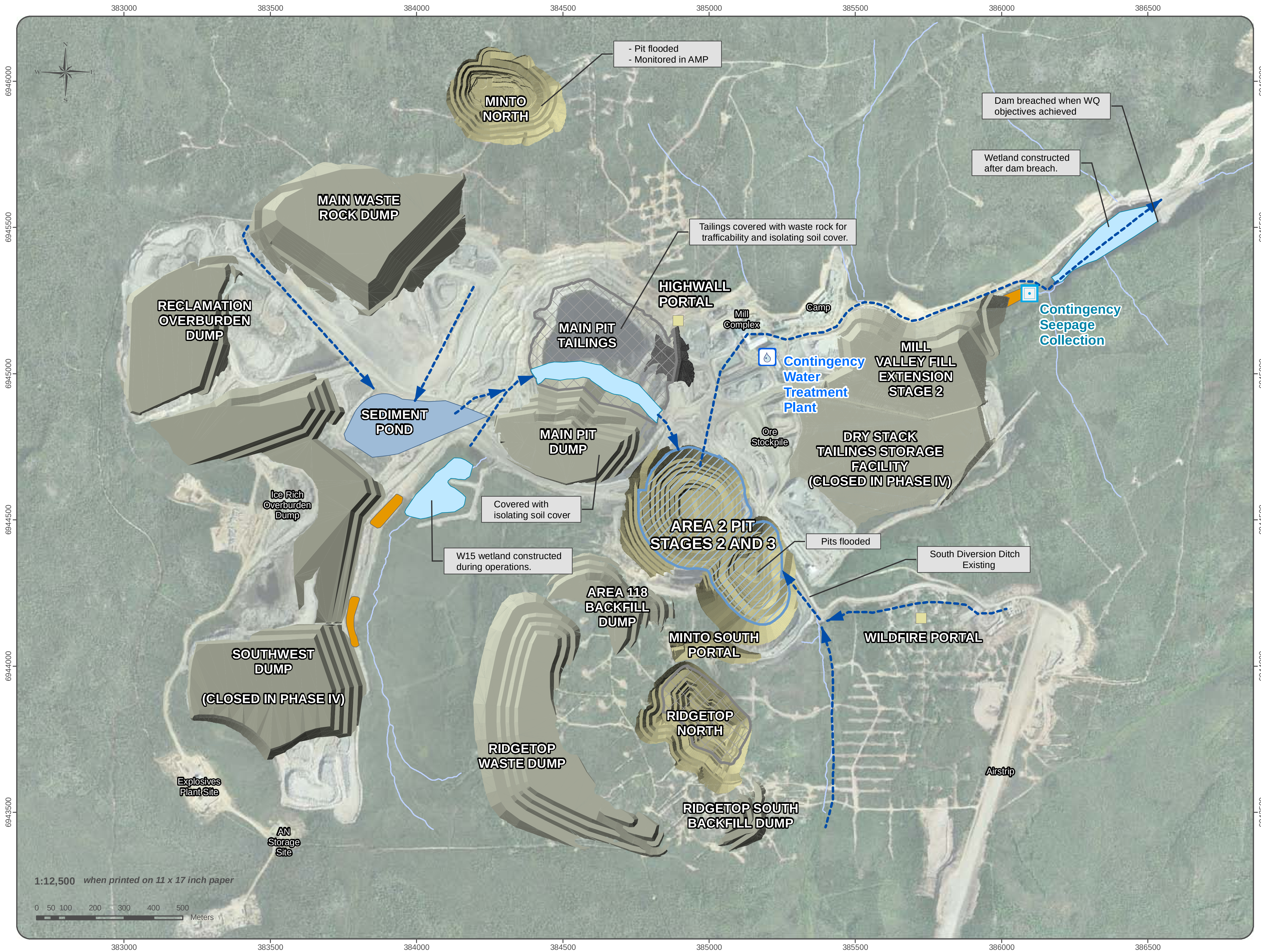
A systematic approach to decommissioning and closure reclamation has been developed for the Minto project. Progressive reclamation measures will be implemented where possible during mine construction and operations. This approach will not only provide valuable reclamation success feedback for use in advanced/final closure, but progressive reclamation will reduce final reclamation liability and costs and shorten the overall reclamation implementation schedule. These progressive efforts will also help reduce slope erosion through physical slope stabilization of revegetation efforts, enhancing ultimate reclamation success.

Through previous closure planning initiatives and ongoing reclamation research, Minto has identified several key reclamation and closure methods that are consistent with meeting the identified reclamation objectives. To this end, the company has considered closure and reclamations measures that are low maintenance, cost effective, and has adopted standard or widely accepted methods where appropriate. Where opportunities exist to reduce active management in closure through the application of more innovative techniques (i.e., application of passive/semi-passive technologies), the company has explored their viability using a combination of the current state of industrial knowledge, plans for furthering proof of concept through site-specific research, and adaptive management planning to mitigate remaining uncertainty.

Most of the methods proposed for employment at Minto are standard practice (e.g. recontouring, seed and fertilizer application, scarification of compacted surfaces) and do not require detailed explanation of their application. The key methods chosen specific to addressing potential project effects on water quality include:

- Source Control methods;
- Passive and Semi-Passive Treatment Systems; and
- Contingency Water Treatment.

These mitigation measures are proposed in the context of an overall water management strategy for the site that is outlined in Appendix J – Water Management Plan. Figure 15-2 below illustrates the overall closure water management strategy including the diversion and constructed channelization of surface water, the flooding of pits, and the passive and semi-passive treatment systems proposed to polish runoff and seepage waters.



MINTO MINE
PHASE V/VI EXPANSION

PRELIMINARY RECLAMATION AND CLOSURE PLAN

FIGURE 15-2
WATER MANAGEMENT

JULY 2013

Minto Explorations Ltd.
A SUBSIDIARY OF CAPSTONE MINING LTD.

- Collection Point
- Water Treatment Plant
- Simplified Watercourses
- Water Conveyance
- Mine Lakes
- Sediment Pond
- Wetland
- Bioreactor
- Dumps
- Pits
- Main Dam
- Tailings

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 14 th 2012.
Site contours derived from 2012 aerial imagery obtained from Challenger Geomatics.

Hydrology data provided by Minto Explorations Ltd, May 2009.

Datum: NAD 83 Projection: UTM Zone 8N

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15.2.1 Source Control

Source control is intended to be the primary control for the reduction of metal loadings to the receiving environment through limiting the access of water to materials known to have metal leaching potential. Source control includes such measures as operational characterization and materials handling programs, sub-aqueous disposal, engineered cover systems and encapsulation. Source control measures that are proposed for Minto Phase V/VI will primarily be a combination of operational characterization and materials handling programs and sub-aqueous disposal (operational strategies detailed in Appendices A – Waste Rock and Overburden Management Plan and D – Tailings Management Plan) and waste covers that reduce infiltration of precipitation and isolate waste materials from atmospheric influences.

A number of candidate waste cover systems have been identified for Minto's waste facilities. SRK Consulting has undertaken a scoping level evaluation of available materials at the Minto site (and commercially available products) to identify types of covers that could be considered for placement on site waste materials at closure. Different cover options have very different performance, installation and maintenance considerations. SRK's report is pending finalization and is entitled: Scoping Level Cover Assessment for Minto Closure Covers.

As summarized and detailed in Sections 7 and 8 of this Project Proposal respectively, the water quality prediction for the closure period returned an acceptable outcome – even under reasonable worst case, upper limit concentration conditions – from the application of a simple isolating soil cover on waste materials. Accordingly, the reclamation strategy for Phase V/VI adopts the application of this cover type to all site waste facilities. This cover type can be constructed from available materials (stockpiled overburden) at the Minto site – either existing or anticipated from Phase V/VI development. Much of this is anticipated to be direct-placed from mining activities, eliminating additional handling requirements involved in stockpiling.

The isolating soil cover is the simplest and least expensive of evaluated cover options. It is expected to provide modest reductions to infiltration (from approximately 30% of mean annual precipitation on native ground to 20% MAP), but not without expected periods of significant breakthrough. The construction materials are expected to be erodible, and revegetation and runoff control will be key to establishing and maintaining their integrity.

15.2.2 Passive and Semi-Passive Treatment Systems

The terms "passive" and "semi-passive" are often used almost interchangeably, with no clearly defined transition between the two terms. In general, the term passive suggests a system that is largely self-sustaining with minimal requirement for ongoing maintenance while semi-passive refers to systems engineered systems that require a higher degree of monitoring and active management to perform optimally.

Passive treatment systems were identified as critical to achieving required closure water quality in previous Minto closure planning efforts. Refinement of expected site geochemistry and drainage at closure by SRK suggests that treatment of any form of site water after cessation of Phase V/VI mining and the application of standard reclamation measures and covering of wastes with isolating soil covers may not be necessary. That being said, the importance of additional load mitigation measures to account for expected periods of soil cover breakthrough and other unexpected site conditions is acknowledged by the closure planning team, as is the importance of applying reasonable mitigation effort to minimize effects to the receiving environment. Passive and semi-passive treatment systems are therefore still proposed as key mitigation measures for the achievement of acceptable water quality from the Minto site in the closure condition.

The incorporation of passive treatment systems to treat mining impacted waters at the Minto mine site has been discussed previously at a fairly conceptual level. The current reclamation plans and reclamation research are now working towards developing specific, detailed, quantifiable designs. In order to confirm the feasibility of passive treatment systems to treat a significant portion of the provide significant reduction of contaminant load generate by the mine it was necessary to confirm that 1) a significant portion of the contaminant load could be passively routed through areas which are amenable to constructing passive treatment systems, and 2) that passive treatment technologies would work at Minto given the anticipated contaminant loads and cold climate.

A technology evaluation and ranking exercise based on key considerations at the Minto Site concluded that biological reactors (bioreactors) and constructed wetland treatment systems (CWTSs) are the two most promising technologies for further, site-specific consideration at Minto. A comprehensive reclamation research program is proposed for this evaluation. It is expected that these technologies will be best applied in a treatment train (sequential) configuration, and Figure 15-2 previously illustrates one example of how this can be achieved.

Areas that have been identified as potential locations for construction of passive treatment wetlands on the Minto Site include the:

- Area up gradient of the W15 Collection Point at the toe of the Southwest Dump;
- Surface of the Main Pit tailings; and
- Existing Water Storage Pond and Dam location (W37).

In the broadest sense, a bioreactor can be defined as permeable treatment zone that uses biochemical processes. Biological reactors use the degradation of organic materials for the purposes of treatment and often involve installation of the treatment materials into lined trenches or pond systems. These systems have been used in mining applications to treat groundwater discharges from underground workings and also for shallow groundwater systems. Because of its northern climate, a bioreactor at the Minto mine site is anticipated to be an in-place (buried) treatment cell. By its location and placement, it is designed to intercept and remediate contaminated (mining impacted) water. The most promising locations for implementation of bioreactors are:

- Toe of waste dumps to treat seepage (if required); and
- Toe of MVFE to treat seepage from DSTSF.

15.2.3 Contingency Water Treatment

The Area 2 open pit will be flooded at closure and will create a large sedimentation pond in the post-closure period. Using the pit for the removal of suspended solids will act to reduce potential total metal loadings to the receiving environment. The flooding of the pit will also allow for some natural attenuation and removal of metals from the water column based on the results of investigations on in-pit lakes at other mine-sites. The potential in-pit treatment of site water has not been included in the current predictive modelling conducted for the closure of the site, but may be used as a pre-treatment technique, if conditions in closure are amenable, to improve water quality leaving the Area 2 Pit.

Completely passive mechanisms for water quality improvements in pit settings may include:

- Particle settling to remove suspended solids in runoff waters.
- Oxygenation of constituents in seepage by exposure of collected water to the atmosphere. Oxygenation of iron or manganese contained in waste rock or tailings seepage can lead to precipitation of iron or manganese oxides, which will provide a sorption-based removal mechanism for some trace metals including copper.

Algal or other photosynthetic microbial sorptive removal of dissolved metals by sorption on organic biomass. Naturally, pit lakes will develop some photosynthetic biomass, which in a low-productivity catchment such as that absorbed at Minto Mine will be low in nutrients; consequently this mechanism will be limited unless enhanced by nutrients. The use of the Area 2 pit as pre-treatment sites for semi-passive treatment vessels could be done especially during the transition from active water treatment to passive closure.

As per the stated reclamation objectives, Minto is committed to trying to close out the Minto Mine in a manner that does not require the long-term use of active water treatment to achieve discharge criteria. The application of the source control mitigation measures described in the preceding sections should be successful in reducing metal loadings from the waste dumps on site; however, it is realized that there will be the need to actively treat water during the immediate post-closure period while revegetation of the cover systems and reclaimed areas becomes established, and while other source load reduction and tertiary water treatment systems stabilize. Minto currently operates a water treatment plant and supporting collection/conveyance system for impacted waters under a management plan which has been approved under Water Use Licence QZ96-006. This system has been shown to be successful in reducing metal loads to a level where it is possible to discharge the treated water directly into the receiving environment. Information on this WTP and supporting water collection/conveyance system is presented in the Minto Mine Phase V/VI Water Management Plan (Appendix J.)

Minto will retain and keep operational the required elements of this active collection/conveyance and treatment system for as long as is required to ensure that appropriate site water quality performance objectives are met. Its use will be guided by the Adaptive Management Plan (see below). It is not expected that any form of longer term active water treatment – if required/implemented – would include reverse-osmosis (RO) treatment for low level nitrogen and selenium concentrations.

15.3 Adaptive Management Planning

There is inherent uncertainty in developing reclamation and closure plans, as mitigations and closure method performance are contingent upon the predictions of future conditions. Minto believes it is critical to acknowledge these areas of uncertainty and to provide for mechanisms in the planning stage that will address unexpected results or conditions in the closure period. The Adaptive Management Planning is widely accepted as an appropriate tool for achieving this objective, and as such, Minto has included an AMP framework with this PRCP (Appendix W – Appendix A) and intends to advance its level of detail in future versions of this plan.

15.4 Conceptual Implementation Schedule

A conceptual implementation schedule of proposed key reclamation and closure activities for Phase V/VI mining is presented below by year, and is based on the development schedule presented in Section 3 of this Project Proposal for mining and waste placement activities. This schedule is intended to illustrate how reclamation activities could be staged relative to development activities, but is subject to changes in the mine plan, development activities and other considerations.

2013

- Reclamation research, on-site data collection, and bench-scale pilot systems begin for constructed wetland treatment systems and biological reactors.
- Greenhouse pilot-scale constructed wetland treatment system starts.

2014

- Commence the Southwest Waste Dump cover placement and revegetation.
- On-site pilot-scale of constructed wetlands treatment systems and biological reactors.

2015

- Commence the Southwest Waste Dump mid-grade waste area, Main Waste Dump expansion, and DSTF/MVFE covers and revegetation.
- W15 wetland construction commences.

2016

- Commence Main Pit dump cover and revegetation.
- W15 wetland transitions to take impacted waters and treatment parameters are established with partial treatment achieved by end of year.
- Commence W37 wetland/bioreactor construction.

2017

- Commence Ridgetop Waste Dump cover and revegetation.
- Main Pit wetland construction commences.
- W15 CWTS treatment parameters are established and any minor adjustments needed are made. Treatment effectiveness monitored.

2018

- Ongoing monitoring of progressive reclamation and passive treatment initiatives.
- W37 wetland construction.
- W15 wetland treatment effectiveness is monitored with outflows now meeting predefined treatment goals. Treatment goals are met and outflows discharged to surface waters.
- Main Pit CWTS treatment parameters are established and any minor adjustments needed are made. Treatment effectiveness monitored.

2019

- Ongoing monitoring of progressive reclamation and passive treatment initiatives.
- W37 wetland transitions to take impacted waters and treatment parameters are established with partial treatment achieved by end of year. Outflows are sent to treatment plant.
- Main Pit wetland transitions to take impacted waters and treatment parameters are established with partial treatment achieved by end of year.

2020

- Ongoing monitoring of progressive reclamation and passive treatment initiatives.
- W37 CWTS treatment parameters are established and any minor adjustments needed are made. Treatment effectiveness monitored. Outflows continue to be sent to treatment plant.
- Main Pit wetland treatment effectiveness is monitored with outflows now meeting predefined treatment goals. Treatment goals are met and outflows discharged to surface waters.

2021

- Milling complete for Phase V/VI.
- W37 treatment effectiveness is monitored with outflows now meeting predefined treatment goals. Treatment goals are met and outflows discharged to surface waters.
- Planned and phased monitoring regimen begins for wetland treatment systems.
- Active decommissioning and closure starts (3-year period).
- Ongoing site reclamation activities where still required.

2022

- Active decommissioning continues (mill decommissioning, recontouring, etc.).

2023

- Final diversion construction.
- Dam deconstruction starts.

2024

- Post-closure monitoring and maintenance commence.

16 Effects of the Environment on the Project

The following sub-sections characterize potential effects of the environment on the Project; including the predicted effects of climate change. Critical site conditions, such as ground stability, that would affect the timing of operations for the Project are also described.

16.1 Approach and Scope

The consideration of potential effects of the environment on the Project included identification of environmental factors deemed to have possible consequences for the Project, and the mitigation measures currently implemented or planned to reduce or eliminate potential effects. The potential effects of the environment on the Project were characterized as ranging from minor (e.g., inconveniences) to major (e.g., causing the operations to cease for some period). Consideration was also given as to whether they could affect one or more components of the Project.

Minto Phase V/VI adds and expands open pits and adds new underground reserves for a planned mining lifetime of 48 months. Active closure and post-closure monitoring are planned for 15 years. The environmental conditions with the potential for negative effects on the operations, closure, reclamation, and post-closure phases of the Project include:

- Terrain instability, including rockfall and permafrost degradation;
- Extreme weather events, including extreme rain, snow, ice, and wind;
- Forest fire risk;
- Seismic activity; and
- Climate change.

Where possible, existing knowledge of these environmental conditions is integrated into the site-specific design. The specific measures that have been considered during Project planning and design addressing these environmental conditions are summarized in the following sections.

16.2 Terrain Instability

Terrain instability can result from human activities or natural phenomena. Naturally-induced terrain instability that could have adverse effects on the Project include rockfall, slope instability and other soil movements which could result from processes such as permafrost degradation. The following subsections describe some of the forms of terrain instability that could potentially have an effect on the Project as well as describing possible mitigations.

16.2.1 Rockfall

Rockfall has the potential to occur within the open pit areas as a result of fracturing of bedrock due to blasting. The effect of rockfall on the Project is considered to be minor as standard operating practices for mining within pits are designed to mitigate any potential effects. These practices include catch benches to collect rockfall debris, identification of areas of potential rockfall by mine engineering and geology personnel and worker safety requirements to minimize exposure to unstable areas.

16.2.2 Avalanches

The potential for avalanches to impact on the project is minimal and primarily is associated with the pit walls. It is only the terrain surrounding the Project that has localized areas of steep slopes of sufficient gradient and size to represent an avalanche hazard. Catch benches within the pits minimize the runout from any localized avalanches that could occur during the winter months. Shallow snow avalanches (sloughing) of snow on steep slopes on the access road may occur from time to time but the short length of the slopes means that only a minimal amount of snow could potentially impact the road. Snow clearing equipment is also kept on site to remove snow on the access road, when required.

16.2.3 Landslides

Landslides in the Project area tend to be slower moving creep features as opposed to debris slides or debris torrents and is often related to permafrost (degradation or failure planes within the permafrost) or removal of toe support by stream erosion. Land sliding related to permafrost conditions has been observed in the main pit and the dry stack tailings storage facility. Further information on permafrost in the Project area is located below in Section 16.2.4. Mitigation of land sliding is conducted through the development of engineering designs to address the specific infrastructure units primarily though buttressing.

16.2.4 Permafrost Degradation

Permafrost is ground remaining at or below 0°C continuously for at least 2 years. The Project is situated in the extensive discontinuous permafrost zone; thus, the areal extent of permafrost ranges from 50-90%. North-facing slopes in the region tend to be underlain by permafrost, while ice-rich horizons are contained in valley-bottom deposits and upland soils. Land preparation, construction and the establishment of infrastructure can result in permafrost disturbance, with effects on vegetation and terrain; however environmental factors such as fires, groundwater interactions, and climate change can also result in permafrost degradation (Shur and Jorgenson, 2007).

Mapping of the distribution of permafrost on the Minto property has been conducted by EBA (2010). Where permafrost has been identified, mitigation measures have been undertaken to reduce the potential for permafrost degradation. For example, one short section of the mine access road underlain by permafrost had geotechnical cloth laid down prior to the placement of fill to minimize any potential degradation.

Several occurrences of permafrost on north facing slopes are being actively monitored while mitigative measures are being developed and implemented. As a result of deformation of a buried permafrost zone, movement of the DSTSF (dry stack tailings storage facility) has been observed and monitored for several years. Mitigation of this movement is ongoing through the construction of the Mill Valley Fill, which is intended to buttress the toe of the DSTSF. Failure of the southwest wall of the Main Pit was also observed in frozen sediments and required buttressing to be constructed within the pit as mitigation. This movement is also believed to have affected the toe of the Southwest Waste Dump, which is experiencing creep thought to be a result of deformation of the permafrost clay layer located near the bedrock contact. Continued monitoring of movement in areas and structures of concern, as part of a physical monitoring program, will ensure that effective and timely mitigative measures can be put into place.

Certain infrastructure developed as part of the Project will undergo a geotechnical stability evaluation, with additional monitoring of ground movement initiated if necessary. In addition, in order to minimize potential permafrost degradation, and the associated risks, generally accepted practices commonly used at Minto include, but are not limited to:

- Ensuring an appropriate level of engineering design for new construction that reflects permafrost characterization of the area;
- When appropriate and feasible, removing overburden and constructing directly on bedrock;
- Preserving permafrost layers that are thick and stable; and
- Designing excavations to ensure that potential thawing or degradation will not pose a stability risk.

Permafrost thaw beyond the Project footprint also has the potential to impact the Project. However, permafrost degradation typically requires a disturbance. Outside of human-induced disturbances (e.g. removing soil cover for construction or excavation), natural disturbances include forest fires, flooding and erosional events, and climate change. These types of events represent environmental conditions with the potential to affect the Project. While the nature of any change cannot always be predicted at a site-specific scale, continued monitoring of flow and water quality at monitoring stations upstream and downstream of the mine site to satisfy licence requirements may allow for the detection of changes and the initiation of necessary mitigation measures.

Permafrost degradation remains an important consideration for the Minto Mine, and efforts will be made to minimize potential permafrost degradation from expansion, to continue monitoring ground movement for structures of concern, and where appropriate to monitor environmental conditions that could indicate natural permafrost disturbances with the potential to affect the Project.

16.3 Extreme Weather Events

Extreme weather conditions and weather events which could potentially impact the Project include heavy rain or snowfall, snow or ice accumulations, and windstorms.

16.3.1 Rainstorms

Climate normals from the Pelly Ranch Meteorological Service of Canada (MSC) station provide information on the historical occurrence of extreme precipitation events in the region; the Minto meteorological station provides rainfall records for the site from 2006 to 2012 (more details on these records is provided in the *Climate Baseline Report* (2012) (Appendix F). The extreme daily rainfall recorded for Pelly Ranch was 34.8 mm on July 20, 1960 (Table 16-1), while June 27 had an extreme of 29.2 mm recorded in 1972 (Environment Canada, Canadian Climate Normals, 1971-2000). Data collected at the Minto meteorological station shows that the most intense one-day rainfall occurred on August 25, 2008 (28.2 mm).

Table 16-1: Rainfall Extremes for Pelly Ranch (Canadian Climate Normals, 1971-2000) and Minto.

Station	Years of Record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pelly Ranch	1971-2000	0	0.3	2.5	17.5	26.4	29.2	34.8	26.4	22.6	20.1	10	5.1
Minto Met. Station	2006-2012	2.4	5.1	2.6	3.0	10.2	16.9	18.0	28.2	13.0	10.0	10.8	4.4

An intense rainfall event resulting in several centimetres of rain in a 24-hour period could result in large additions of water to the Project site. A rain on snow event in spring during freshet might further exacerbate any impacts of an extreme rainfall event. As mitigation for extreme rainfall events, Minto has a water diversion and conveyance network designed to decrease water movement significantly over disturbed areas on the property, and uses best practices for runoff control including swales and tail ditches as described in Section 7. Three main locations at the Project site are capable of storing excess water: the Water Storage Pond, the Mill Pond and the Main Pit as described. These features are described in Section 7 Water Management.

16.3.2 Snowstorms and Snow Accumulation

Mean annual snowfall at Pelly Ranch from Environment Canada's Canadian Climate Normals (1971-2000) is 112.8 cm. The extreme daily snowfall recorded for Pelly Ranch was 20.8 cm on November 27, 1958, while 20 cm was also recorded on March 23, 1993. Extreme snow depth at Pelly Ranch was 57 cm on March 29, 1993, with 55 cm recorded January 3, 1991 and March 1, 1993 (Canadian Climate Normals, 1971-2000).

As a snowfall conversion adapter was only installed at the station in fall 2011, the snowfall record at the Minto meteorological station is not yet long enough to provide meaningful statistics. However, with the assumption that regional precipitation is homogeneous and ignoring any significance of the 400 m elevation difference between Pelly Ranch and Minto's meteorological station site, orographic effects, or valley orientation, the site can be estimated to receive an additional 100 mm of water-equivalent precipitation in the form of snow annually (EBA 2010b).

Annual snow surveys were conducted in 1994, 1995, 1998, and annually from 2006 to 2012 at three locations in the Minto Creek catchment on the first day of February (starting in 2009), March, April, and May (more details on these records is provided in the Climate Baseline Report (2012) (Appendix F)). Based on the ten years of snow surveys, the average water-equivalent snow depth remaining on the first day of March and April is 95.0 mm and 96.8 mm, respectively. May results indicate that the snowpack was either entirely melted or substantially reduced; thus highlighting that the majority of runoff due to snowmelt occurs in April.

Storms producing extreme snowfall could have an impact on Project operations, potentially affecting vehicle and equipment movement on site, affecting airplane traffic to the site and damaging buildings or other infrastructure. As mitigation, snow-clearing equipment is kept on site to remove snow on the access road and on throughout the property as needed, while buildings on site have been designed in accordance with the National Building Code of Canada's (2010) maximum snow loads for the Project area.

Extreme spring snowmelt runoff has presented challenges to the Project in the past. Lessons learned from past peak events continue to be incorporated into site water management. Water storage, conveyance and discharge systems have been optimized to manage peak events like freshet, and are described in Section 7.

In addition, spring snowmelt runoff and intense or prolonged precipitation could potentially result in overbank flooding of Big Creek and/or the Yukon River and impact the access road. Flood control structures at the Big Creek crossing and at points along the Yukon River floodplain have been designed to minimize potential effects on the road. The company continues to optimize control structures for Big Creek under its current type B Water Licence MS95-013. An airstrip provides alternative site access should the road be inundated, until it can be restored.

16.3.3 Windstorms

Historical regional maximum wind speed and maximum gust speed are not available for Pelly Farm from Environment Canada's Canadian Climate Normals (1971-2000). Wind data recorded at the Minto meteorological station were recorded from September 2005 to April 2010 at a height of 3 m, and from October 2010 to July 2012 at a height of 10 m (more details on these records is provided in the Climate Baseline (Appendix F)). Of note, much of the wind record is ice-affected at temperatures below zero because of rime icing; thus, winter wind speeds may be underestimated in the record.

Based on the wind record (excluding periods where the anemometer was iced up), average wind speeds exceeded 4 m/s during the winter months (November through March at temperatures greater than 0°C), compared with spring, summer and early fall wind speeds, which averaged less than 3 m/s. Wind gusts were more intense during the spring months (typically in excess of 11 m/s), with the highest value of 13.0 m/s observed in May. The highest three-second gust recorded was 63.5 m/s on April 24, 2009; although higher wind gusts occurring during the winter may not have been recorded.

High winds may blow down trees or transmission lines, potentially causing damage to buildings and infrastructure. Mitigation measures to reduce potential effects to the Project from windstorms include design of infrastructure to withstand maximum wind loads for the Project area, as set out in the National Building Code of Canada (2010) and the regular inspection of transmission lines.

16.4 Forest Fire Risk

Forest fires represent a risk to the Project in the summer period. The region receives very little summer precipitation and has a high incidence of thunderstorms (Smith et al. 2004). Over the last 40 years, the area around the Minto Mine site has experienced numerous fires, with three major fires occurring in the last 20 years (Figure 3 in the *Vegetation Baseline Report* (2012) (Appendix S)). The most recent wildfire in June 2010 in the Minto Creek catchment burned a total of 6740 ha and came within six kilometres of the mine site, creating a state of emergency.

The protection of life and property are of paramount concern in response to the threat of wildfire. In addition, wildfire could threaten safe operations at the mine site, limit site access, and damage infrastructure, including transmission lines, buildings, and roads. Fire response is included in Minto's Emergency Response Plan, including site evacuation procedures. Firefighting equipment is available throughout the mine site and all staff receives fire extinguisher and fire evacuation training. The emergency response team trains for larger scale response to fires, including the use of an on-site fire truck and other fire suppression methods. Sprinkler systems were purchased and placed on site for the 2010 fire, and have been left in place as mitigation for any future fire threat. The Project is located in the Carmacks fire management district, and during the 2010 fire, YG Community Services Wildland Fire Management responded quickly with dedicated staff and equipment to fight the fire.

Vegetation has been removed around mine infrastructure to eliminate that potential source of fuel, and brushing and clearing is regularly undertaken along transmission lines and the access road. Of the three fireguards created by Wildland Fire Management during the 2010 wildfire, two have been reclaimed, while the southwest fireguard has been left to provide long-term fire protection. Fireguards create a barrier that can be used as a first line of defense against an advancing fire front, and fires burning into them can be more easily controlled. Fireguard construction involves the removal of readily combustible fuels such as trees, shrubs and grasses, and the stripping and stockpiling of woody debris and fine organic matter. Controlled burns were also implemented as part of the fire suppression strategy for the 2010 fire. These have reduced the fuel loading in strategic areas around the mine.

16.5 Seismic Activity

The potential effects of seismic activity on the Project are dependent on the magnitude of any event. Damage to Project infrastructure may range from no major damage/minor interruption in operations to, in the case of a large earthquake (i.e., maximum credible), loss of equipment or major structural damage to Project facilities.

After the January 30, 2008 earthquake, Minto had EBA conduct a review of the engineering design of all major infrastructure units (EBA 2010). EBA evaluated the design standards for the water storage pond dam, main waste dump, dry stack tailings storage facility, ice-rich overburden dump and reclamation overburden dump. Table 16.2 shows the design peak ground accelerations used in the design.

Table 16-2: Design Peak Ground Acceleration of Minto Structures.

Structure	Design Peak Ground Acceleration
Water storage pond dam	0.150 g
Main waste dump	0.150 g
Ice-rich overburden dump	0.055 g
Dry stack tailings storage facility	0.055 g
Reclamation overburden dump	0.055 g

Please note, the difference in the design criteria for the water storage pond dam and main waste dump, as these infrastructure units were designed in the mid-1990s. Subsequent to the design of these two units, the Geological Survey of Canada reduced the peak ground acceleration for the design event (1:475 year earthquake) from 0.150 g to 0.055 g.

To reduce potential effects of seismic activity on the Project, building design considers potential seismic activity in the Project area. Major infrastructure will be designed based on appropriate guidelines, including but not limited to those produced by the National Building Code of Canada (NBCC) for buildings and the Canadian Dam Association for Dam structures.

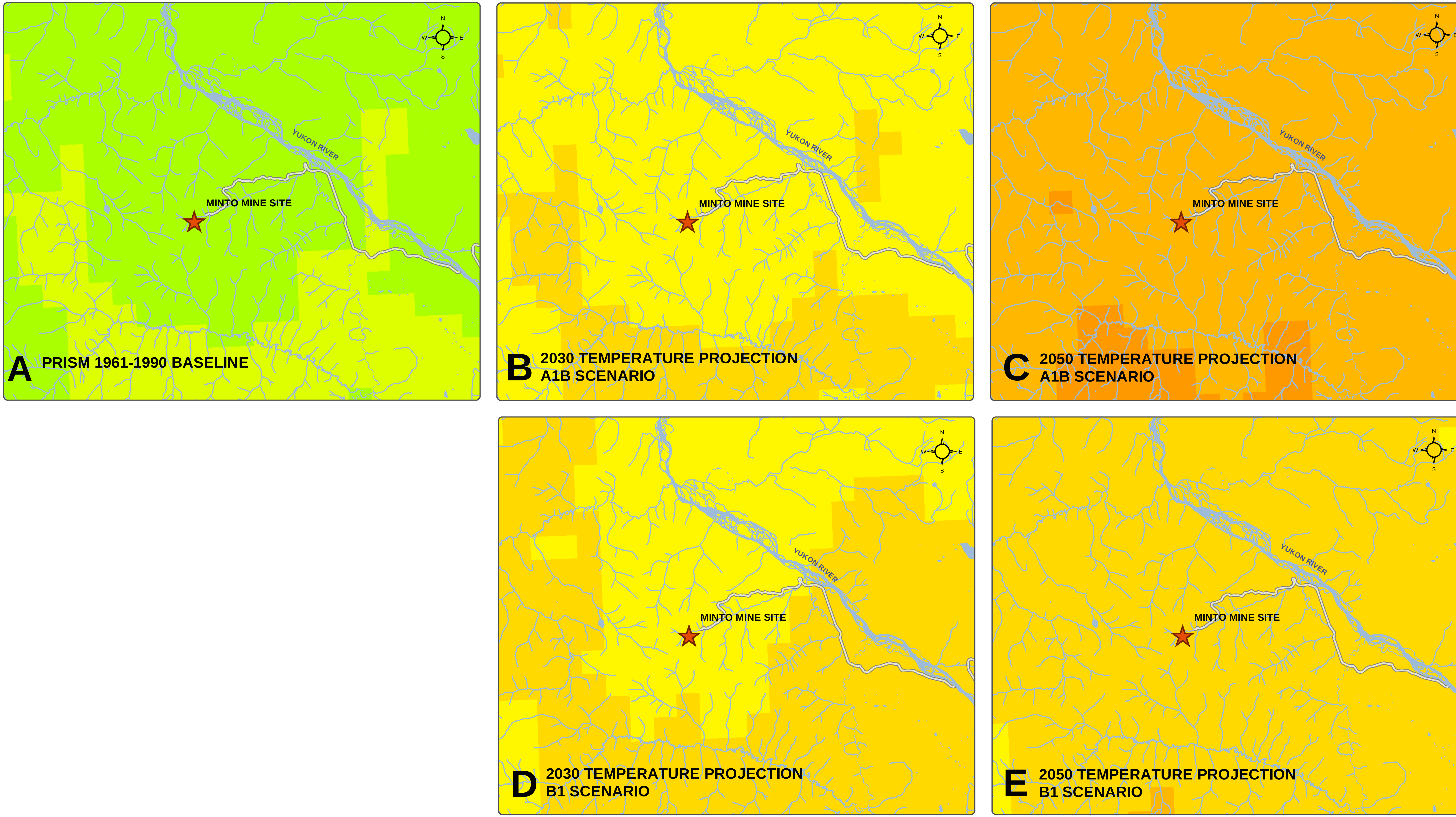
16.6 Climate Change

The Intergovernmental Panel on Climate Change (IPCC) has reported on increasing global average air and ocean temperatures, widespread melting of snow and ice, and sea level rise, with effects on natural systems around the planet; with each assessment report, the certainty for the evidence of climate change has increased (IPCC 2007). Northern latitudes have experienced twice the rate of the global mean increase in surface air temperatures (McBean et al. 2005).

From 1950 to 1998, the Canadian western Arctic experienced warming of 1.5°C to 2.0°C (Zhang et al. 2000). In Yukon, winter and summer temperatures have increased in all regions over the last several decades, with some regional variations. An increase of 0.06°C per year on average in annual mean temperature over a 50-year period has been observed by Environment Canada at Pelly Ranch, corresponding to a total average increase of 3°C between 1957 and 2006. The same increase was observed at Carmacks, corresponding to a total average increase of 3.0°C between 1964 and 2011. The highest rate of increase has been in January for both locations. A similar 50-year trend is also hypothesized for the Minto site, given close correlations between average monthly temperatures at all sites (more detail provided in the *Climate Baseline Report* (2012) (Appendix F).

Projections from global climate models (GCMs) predict continued warming: 0.2°C per decade over the next two decades globally (IPCC 2007). Climate change projections have been obtained from the Northern

Climate ExChange of Yukon Research Centre for an analysis of the range of changes in temperature and precipitation projected for the Project area. The projections, produced by the Scenarios Network for Alaska and Arctic Planning cover two emission scenarios – B1, moderate to low climate change and A1B, medium to high climate change, over 2 time-scales – 2030 and 2050 - using the average of five GCMs that were found to perform best over Alaska and the Arctic, and are statistically downscaled to a 2 km resolution over Yukon using the Parameter-elevation on Independent Slopes Model (PRISM) (SNAP 2011). Averages have been calculated using a 50 km buffer around the Minto Mine site, and suggest an increase in mean annual temperature of 2.0 to 2.2°C by 2030 and 2.6 to 3.8°C by 2050 from the 1961-1990 baseline (Figure 16-1).



National Topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Cadastral data compiled by Natural Resources Canada. Reproduced underlicense from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved. Climate Change Data : Scenarios Network for Alaska & Arctic Planning (SNAP), 2011. Climate Projections for Yukon. Unpublished Data produced for the Northern Climate ExChange, Yukon College

Datum: NAD 83; Map Projection: UTM Zone 8N

1:260,000 (when printed on 11 x17 inch paper)

0 1 2 4 6 8 10

Kilometres

Temperature (Degrees Celcius)

-4.99 - -4	-1.99 - -1
-3.99 - -3	-0.99 - 0
-2.99 - -2	0 - 1

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MINTO PHASE V/VI EXPANSION
EFFECTS OF THE ENVIRONMENT ON THE PROJECT

FIGURE 16-1 CLIMATE BASELINE AND PROJECTIONS: MEAN ANNUAL TEMPERATURE

JUNE 2013

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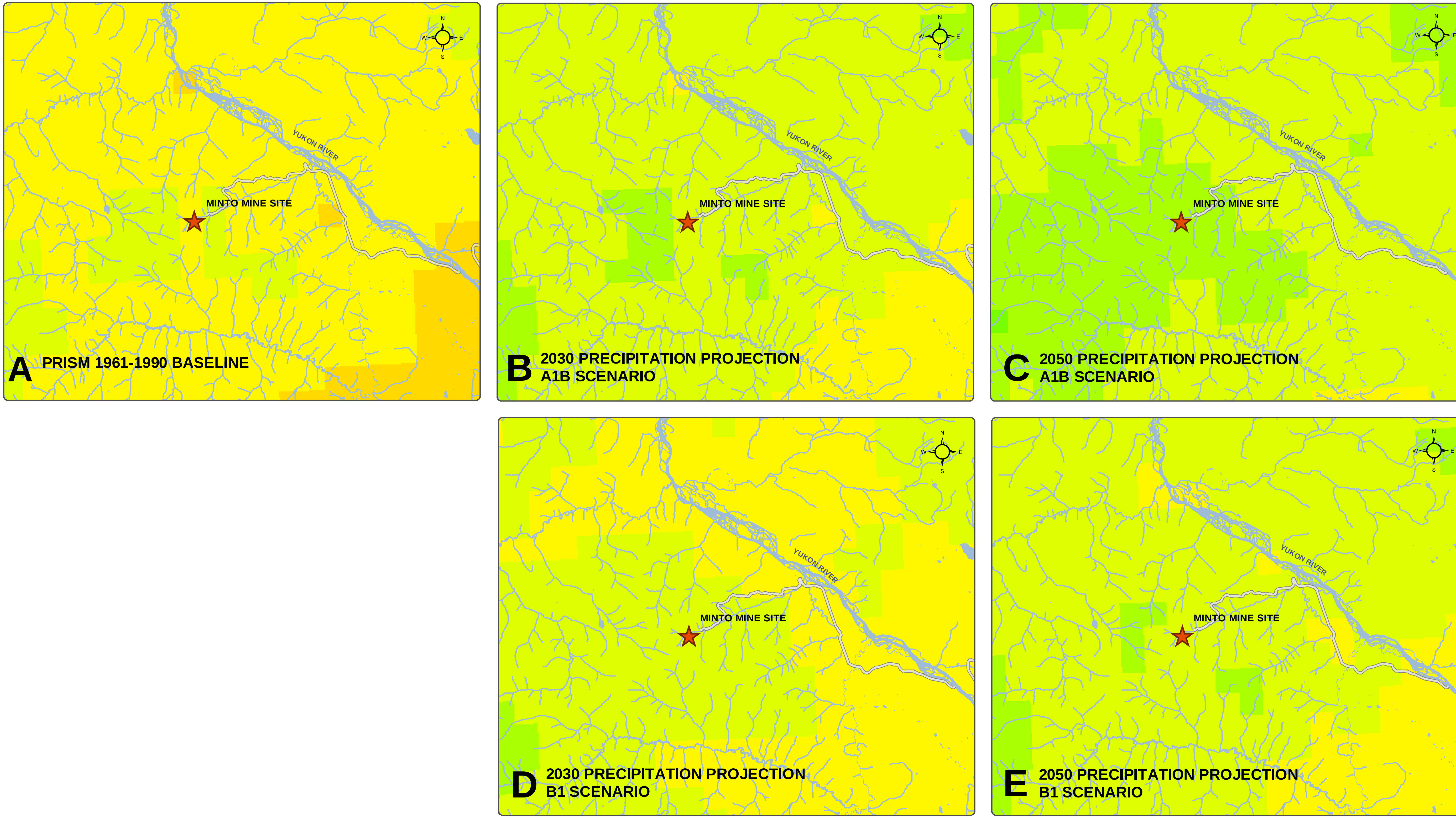
Global precipitation has increased more than 10% at higher latitudes during the 20th century in the Northern Hemisphere (Hengeveld 1997); however, changes to annual precipitation have been variable across Canada and in Yukon over the 1950–1998 period (Zhang et al. 2000). Total annual precipitation has increased by 1.1 mm/year and 1.4 mm/year on average at Pelly Ranch and Carmacks respectively, over the last 60 years, corresponding to an increase in annual precipitation of 60 to 80 mm between 1955 and 2006 (EBA 2010 and Appendix F).

Many GCMs predict increasing annual precipitation at high latitudes of North America (Nohara et al. 2006). The Scenarios Network for Alaska and Arctic Planning projections suggest an increase in annual precipitation ranging from 8 to 13% by 2030 and 12 to 20% by 2050 from the 1961-1990 baseline (Figure 16-2).



1:260,000 (when printed on 11 x17 inch paper)

0 1 2 4 6 8 10 Kilometres

Precipitation (millimetres)

- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 450
- 450 - 500

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Datum: NAD 83; Map Projection: UTM Zone 8N

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MINTO PHASE V/VI EXPANSION

EFFECTS OF THE ENVIRONMENT ON THE PROJECT

FIGURE 16-2 CLIMATE BASELINE AND PROJECTIONS: MEAN ANNUAL PRECIPITATION

MAY 2013

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Changing temperature and precipitation regimes have, and will continue to, alter physical and ecological processes. The effects of climate change on the Project could be felt through changes to the surrounding environment:

- Permafrost warming in the western Arctic associated with increasing air temperatures is anticipated to be greatest in discontinuous and sporadic zones where permafrost is warm (Hinzeman et al. 2005;, thus, heightening concern related to permafrost degradation (16.2.2);

- Trends in precipitation intensity from 1950 to 1995 show that heavy precipitation events have become significantly more frequent in winter and spring in Northwestern Canada (Stone et al. 2000), while increased numbers of high wind events were observed in Barrow, Alaska between 1970–1980 and 1990–2000 (Hinzman et al. 2005). The IPCC predicts that the frequency of heavy precipitation events or the proportion of total rainfall from heavy falls will likely increase in the 21st century over many areas of the globe, particularly in the high latitudes (IPCC 2012). Increases in extreme weather event size and frequency could present a challenge to site operations and affect Project infrastructure (16.3.1 Rainstorms and 16.3.2 Snowstorms and Snow Accumulation);

- A study of the potential alteration of the forest-fire regime in central Yukon suggests that the average annual fire occurrence and area burned may as much as double by 2069, although there may still be years with few fires (McVoy et al. 2005). Such increased potential for wildfires close the Project site could present a threat to life and property (16.4).

Mitigation measures to address these potential effects of climate change on the Project have been addressed in the preceding sections.

16.7 Conclusion

The planning and design of Minto Phase V/VI has taken into account the potential for extreme events and effects of the environment, including climate change. Adverse effects to the Project due to effects of the environment are not anticipated to be significant; however, necessary mitigations have been put in place to minimize any potential effects.

17 Consideration of Cumulative Effects

This section considers first the additive impacts of the Minto Mine on valued components through all its phases of development, and second, potential cumulative effects of the Minto Mine with other surrounding projects. Potential effects on the following valued components have been considered:

- Water Quality/Aquatic Resources[16]
- Wildlife and Wildlife Habitat
- Vegetation
- Air Quality; and
- Heritage and Historic Resources

Please note that consideration in this section has been given to environmental valued components exclusively. Reference to the consideration of cumulative effects on socio-economic values can be found in the *Socio-economic Study Report* (Appendix T).

17.1 Existing Minto Monitoring Programs and Management Plan

Adequate monitoring can aid in identifying changes in indicators and parameters that may translate into the creation of, or an increase in, existing adverse effects. As changes or fluctuations in monitoring results are observed, Minto will respond in a timely manner. Programs and management plans are therefore important for identifying, characterizing, and addressing potential adverse cumulative effects. Table 17-1 outlines Minto's current monitoring and protection plans.

[16] *Combined because values are interrelated in terms of cumulative effects.*

Table 17-1: Summary of Minto Mine Monitoring and Protection Plans.

Plan	Last Update	Content
Heritage Resources Protection Plan	Apr-11	Outlines protocols that ensure protection and proper reporting of any heritage resources identified through the course of operations. These protocols have been developed to ensure compliance with the Historic Resources Act (Yukon Government 2002) and Archaeological Sites Regulations (Yukon Government 2003). In addition, the HRPP was developed in recognition of the intrinsic value that Selkirk First Nation places on its heritage resources. http://www.emr.gov.yk.ca/mining/pdf/mml_minto_heritage_resource_protection_plan.pdf
Erosion and Sediment Control Plan 2011-01	May-11	Outlines controls to minimize local site impacts from erosion and prevent sedimentation to the receiving environment. http://www.emr.gov.yk.ca/mining/pdf/mml_minto_sediment_erosion_control.pdf
Explosives Management Plan	Jun-11	Outlines management practices aimed at minimizing the safety and environmental risks of handling nitrates, which are present in blasting agents. Specifically, methods used to minimize nitrate losses to the environment. http://www.emr.gov.yk.ca/mining/pdf/mml_minto_explosives_management_plan.pdf
Solid Waste Management Plan 2011-02	Jun-11	Describes the handling, collection, storage and disposal of waste for the various waste streams generated at the mine, including both hazardous and non-hazardous solid wastes. Ensures that all wastes are handled, stored and disposed of according to the appropriate regulations and permits, and that the appropriate monitoring is completed. Outlines the management of waste to minimize animal attraction and prevent potential soil and water contamination. http://www.emr.gov.yk.ca/mining/pdf/mml_minto_solid_waste_mgmt_plan.pdf
Environmental Monitoring Plan	Jun-11	Outlines monitoring activities that includes data collection, interpretation, and identification of triggers when there is a potential for an environmental effect, and responsive contingency plans to address potential risks. To the extent possible, a response is anticipated and planned for with an adaptive management strategy. In addition, the EMP includes ongoing monitoring of various environmental conditions such as meteorological conditions which may or may not require an adaptive management approach. Includes physical stability monitoring of various site structures, geochemical monitoring of waste rock storage facilities; water quality surveillance for site and receiving waters; meteorological monitoring, and biological monitoring.
Annual Biological Monitoring Plan	Jul-11	The Annual Biological Monitoring Plan is designed to track spatial and temporal fluctuations in biological fitness as they relate to the Minto Creek watershed. As a component of the overarching Environmental Management Plan, the Annual Biological Monitoring Program includes monitoring for sediment and benthic invertebrates, fisheries and periphyton.
Wildlife Protection Plan (Appendix R)	Sep-11	Describes and outlines a monitoring program that will yield information about wildlife use in the area. This information will feed into closure planning and help refine closure objectives related to ensuring unobstructed passage through the area by wildlife. It also describes the methods to be used at Minto Mine to ensure protection of wildlife, minimize disturbance to animals and minimize adverse impacts on wildlife habitat to the extent possible during the active life of the mine.
Quality Assurance and Quality Control (QA/QC) Plan	Oct-12	Describes and outlines the use of duplicate, field and trip blanks, on-site laboratory and field equipment calibration, overview of external laboratory QA/QC, 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 property. A primary objective of the QA/QC plan is to ensure that data collected, analyzed and evaluated through environmental monitoring programs at Minto Mine is representative and high quality. QA/QC procedures were designed using generally recognized QA/QC protocols.
DSTSF Long term deformation monitoring program	Nov-12	Outlines the monitoring frequency, instrumentation and locations of geotechnical monitoring equipment, specifically addressing potential movement of the dry stack tailings storage facility.
Waste Structures Deformation Monitoring Program	Dec-12	Outlines the monitoring frequency, instrumentation and locations of geotechnical monitoring equipment, specifically addressing potential movement of various waste dumps at the mine.
Seepage Monitoring Plan	Jan-13	The plan outlines the procedures and protocols for seepage monitoring at the mine. The results are used to assess acid rock drainage/ metal leaching conditions at the site by sampling during spring runoff and early fall. The minimum monitoring outlined includes the ore stockpile areas, overburden dumps, waste rock dumps, DSTSF, the mill area, as well as known seepage locations.
MCDS Seepage Monitoring Program	Jan-13	Outlines the seepage monitoring associated with the Minto Creek Detention Structure.
Spill Contingency Plan	Mar-13	The purpose of this plan is to outline a general set of procedures to be followed to assess, prevent, contain and clean-up a spill at the Minto Mine. For that procedure to be effective Minto Mine must ensure that employees and contractors through either their experience or training possess the skills necessary to safely assess, prevent, contain and clean-up a spill or potential spill. http://www.emr.gov.yk.ca/mining/pdf/mml_minto_emergency_spill_response_plan.pdf
Groundwater Monitoring Plan	Apr-13	Outlines the locations, frequency and details of the groundwater monitoring at the mine. This monitoring is largely focused on water quality monitoring from groundwater wells, but contains other monitoring including, but not limited to; seepage water quality and ground temperature monitoring.
Annual Inspections of infrastructure		Annual monitoring requirement by a qualified engineer for inspection of various infrastructures on site. Applies to all waste rocks dumps, water containment areas and other facilities. http://www.emr.gov.yk.ca/mining/pdf/mml_minto_2011_annual_physical_inspection.pdf

17.2 Additive Impacts of Minto Mine

Throughout the life of the Minto Mine, concern surrounding the potential adverse cumulative effects of all Minto phases has been raised, in particular by SFN. As the Project lies within the SFN traditional territory and Category A Settlement Land, Parcel R-6A, SFN is a vital stakeholder in the operation of Minto Mine. In response to stakeholders' concerns, Minto offers the following consideration of the additive impacts of all phases of Minto Mine.

The additive impacts of all phases of development of the mine represent the current state of the valued components. In addition to being outlined in the "Existing Condition" sections within their respective valued component, Table 17-2 summarizes the current state of the Mine (again, based upon individually-valued components).

To date, potential effects to values have been assessed for the individual phases of the Minto Mine development. For the most part, the nature of activities has remained the same over the life of the Minto Mine, with the exception of the introduction of underground mining in Phase IV. The inclusion of underground mining does not directly affect most values that have been considered in this and past assessments. Furthermore, the introduction of underground mining, when compared to surface mining, results in a reduced surface footprint and in fewer potential adverse effects to values such as wildlife and vegetation.

As such, the additive impacts of all phases of the project, rather than just an individual phase or stage, will likely not introduce any new effects. However, the potential exists to result in an increase of magnitude or extent of existing effects and has the potential to extend the duration of effects. For example, as each stage or phase is implemented, the life of the Project is extended. If the area of the Project is for all activities, the extent considered will be larger.

As outlined in Table 17-2, several monitoring programs and plans are in place that aid in understanding the current state of the Minto Mine. To date, and including what is being proposed for the Phase V/VI expansion, the total amount of surface disturbance for Minto operations is approximately 535 ha, including the access road. The milling rate has gone through several incremental increases, from 1,800 to 4,200 tpd. The camp has also expanded over time and is now licenced to house 300 people. With each phase or stage, the life of the Project also extends. Phase V/VI has increased the overall duration of the Project potentially to 2022.

Table 17-2: Summary of Additive Minto Mine Impacts.

Valued Component	Consideration of Additive Impacts
Water quality and aquatic resources	Recent water quality data shows that water in Minto Creek generally meets acceptable standards (CCME/SSWQOs). Specific exceedances are reported and investigated, and measures are taken to address any identified issues/underlying causes. Water quality monitoring of the site is extensive and ongoing. Aquatic resources monitoring of the site is extensive and ongoing (EEM and other programs). Some changes were observed in the aquatic environment since the beginning of mine operations as a result of mining activities as well as natural occurrences (i.e., forest fire and lands subsidence); however, there is no evidence that these changes adversely affect the aquatic resources.
Wildlife and wildlife habitat	Land clearing for the Project will total 535 hectares. No significant adverse trends in populations detected for key species (moose, caribou, sheep). Eight wildlife mortalities directly resulting from project activities between 2010 and 2012 (of which four were bear incidents) Minimal adverse interactions with wildlife. All nuisances/problems with wildlife are reported to local conservation officer. No reports or indications of increased hunting pressure and there is a “no hunting” policy for Minto Mine employees. No reports or indication of impacts on harvest rates. Wildlife Management Plan in place and updated with each project phase.
Heritage and historic resources	No heritage resources have been discovered during mine development. Heritage Resources Protection Plan is in place and updated for each project phase. Heritage potential of the project area has been mapped.
Vegetation	Land clearing for the Project will total 535 hectares. No rare or uncommon plant species/communities have been identified in the Project area. Progressive reclamation implemented throughout LOM ensures the revegetation of disturbed areas.
Air quality	Dust has been generated at site. Effects are still not completely understood; however, increased effort to gain understanding is evident through regular monitoring. Particulate matter monitoring at site shows no exceedances of the ambient air quality guidelines. Dust suppression measures are in place to prevent dust generation. Additional mitigations measure will be implemented with Phase V/VI. Dust sources will be considerably reduced with the completing of surface mining in 2017.

17.3 Cumulative Effects Assessment—Interaction with Other Projects

As noted in Section 1 of this Project Proposal, proposed activities to be undertaken as part of Minto Mine's Phase V/VI trigger an assessment under YESAA at the DO (district office) level. Under YESAA (Section 42), cumulative effects are to be considered by the YESAB assessor within the assessment and subsequently outlined in the evaluation report. Information required from Minto for DO-level proposal submissions is also outlined under YESAA (Section 50) but does not include conducting a cumulative effects assessment (CEA) or consideration. However, as cumulative effects of the Project has been raised as a concern by stakeholders (in particular SFN), Minto offers the following CEA.

This traditional CEA considers the potential cumulative impacts of the residual effects of the Minto project (all phases including Phase V/VI) interacting with the residual effects of other projects within an identified spatial scope (noted within the CEA, depending on the specific value).

17.3.1 Methodology

Table 17-3 summarizes the results from the proposal's effects assessment and notes which values have the potential to result in residual effects. Residual effects are the effects of the Project that remain after the application of mitigation measures. Cumulative effects are the combination of these residual effects with the residual effects of other projects or activities within the spatial or temporal scope of the CEA.

For the most part, the individual valued components considered in past Minto submissions (as well as YESAA assessments) are similar to those outlined throughout this proposal submission. As such, the values (and their associated potential effects) noted in the effect assessments within this submission will be considered for the CEA.

Table 17-3: Summary of Effects Assessment and Determination for CEA Requirement.

Valued Component Considered	Potential Effects	Effects Determined to be Adverse and Significant?	Does the Potential for Residual Effect Exist
Aquatic Resources	Increase in total suspended solids (sediment load).	No	Yes
	Change in Physical Parameters (water temperature and flow).	No	Yes
	Increase of contaminant concentration (metal, metalloids, nutrient loading).	No	Yes
Wildlife	Habitat loss in expansion areas (e.g., waste dumps, pits) that may affect small-ranging species such as birds and small mammals.	No	Yes
	Changes in wildlife movements, wildlife displacement or avoidance of the mine operations area (e.g., by moose) and habitat fragmentation directly in the mine area.	No	Yes
	Direct injury/mortality to wildlife.	No	Yes
Vegetation	Loss of/disturbance to ecosystems and plant species due to infrastructure development and placement.	No	Yes
	Physical and physiological effects related to fugitive dust deposits on plants in the vicinity of mine operations.	No	Yes
	Reduction in ecosystem integrity and displacement of native plant species due to the introduction of invasive plant species.	No	Yes
Air Quality	Increase in airborne dust.	No	Yes
Heritage Resources	The disturbance, destruction or removal of heritage resources.	No	No

The CEA was completed by first noting that residual effects may occur, and further characterizing the types of residual effects that have the potential to occur. If there was no potential for residual effects to occur, the value was no longer considered in the CEA. Secondly, the spatial scope was determined, in consideration of the individual value. The other projects and activities in the area were noted. If no other projects were located within the identified spatial scope, it was determined those cumulative effects could not occur. In situations where other projects were within the identified spatial scope and the potential exists for the residual effects of other projects to interact with the residual effects of the Minto project, the CEA continued and a determination was made with regard to the significance of the potential cumulative effects.

17.4 Water Quality and Aquatic Resources

As outlined in Sections 7 and 8, no significantly adverse effects to water quality are anticipated as a result of the Minto project. Inherently, monitoring water quality over time incorporates cumulative effects consideration.

The spatial extent boundary for the CEA has been determined to be the Minto Creek and McGinty Creek watersheds. In total, this represents an approximate area of 7,600 ha. As well, additional impacts on the Yukon River are considered where possible. The condition of these watersheds has been described within Section 8.

Two major quartz mining operations are located near the Minto Property; the Carmacks Copper Property (Copper North) and Casino Mine (Western Copper) (Figure 17-1). Several Class 3 and 4 Quartz mining operations lie along the Casino Trail (~231 km from the Minto property). Other projects along the Casino Trail, or in the near vicinity, include: Teck Resources Limited (Big Creek and Sonora Gulch properties) and Carmacks Copper–Gold (Figure 17-2).

MINTO MINE
CUMULATIVE EFFECTS ASSESSMENT

FIGURE 17-1 OVERVIEW OF LOCAL MINING AND LAND ACTIVITIES

JUNE 2013

Minto Explorations Ltd.
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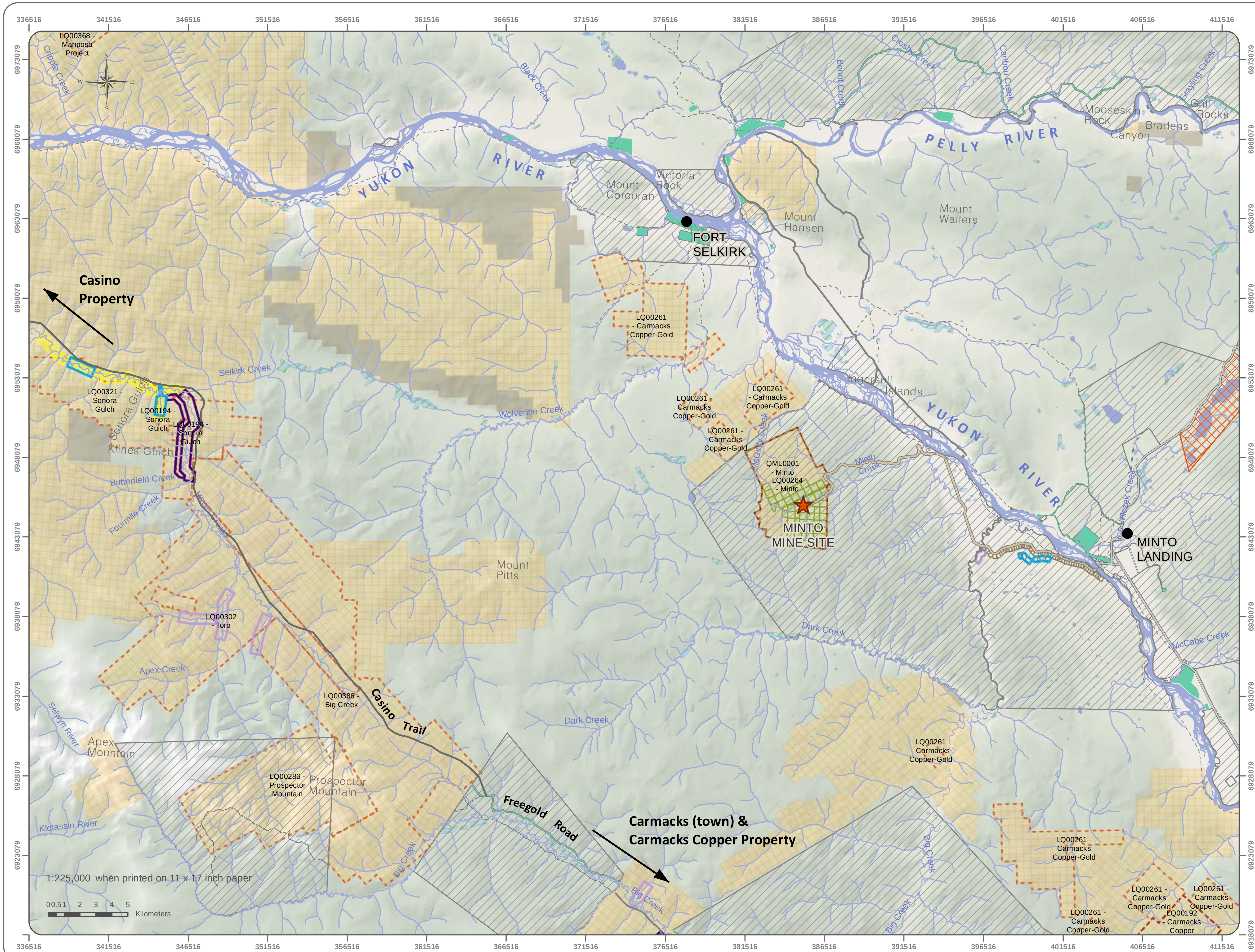

Placer mining land use permit, placer prospecting lease, placer claim, quartz mining land use permit, quartz prospecting lease and quartz claim boundaires and ownership are current as of Aug 7th 2012. Data obtained from Government of Yukon.
Projection: NAD 83 UTM Zone 8N

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MINTO MINE
CUMULATIVE EFFECTS ASSESSMENT

FIGURE 17-2 REGIONAL EXPLORATION ACTIVITIES

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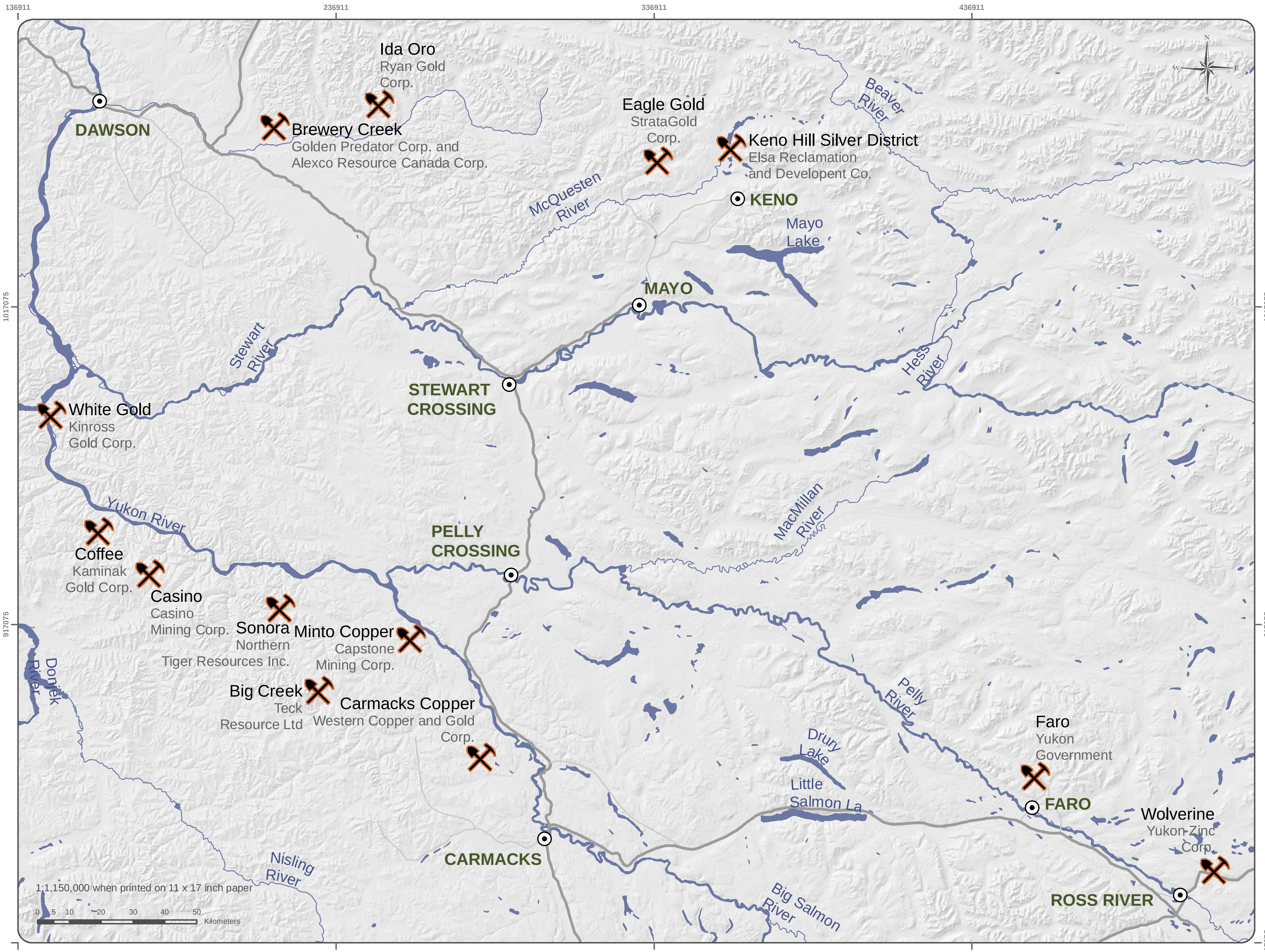

Mining Projects
Towns
Main Road
Secondary Road
Watercourse
Waterbody

Placer mining land use permit, placer prospecting lease, placer claim, quartz mining land use permit, quartz prospecting lease and quartz claim boundaires and ownership are current as of Aug 7th 2012. Data obtained from Government of Yukon.
Projection: NAD 83 UTM Zone 8N

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(*Last edited by: jlindeman;13/06/2013/10:48 AM*)

17.4.1 Cumulative Effects Analysis and Conclusion

On the spatial scope, activities at Minto Mine may have residual effects on aquatic resources, in terms of water quality, physical parameters, and sediment loading. However, none of the other projects noted above are located in the Minto or McGinty Creek watersheds. As such, the residual effects of the Minto Mine will not interact with the effects of other projects, resulting in no cumulative effects.

However, water from the Minto Creek watershed moves into the Yukon River, a highly valued water body, and cumulative effects should also be considered on a larger spatial scale. The Yukon River is a major, fish-bearing system in the territory. Yukon First Nations and commercial fisheries are highly valued, and the water system is integral to many other watersheds. As noted in sections 7 and 8, water discharged to surface water (i.e., Yukon River) will meet water quality objectives, and in consideration of appropriate mixing factor with the Yukon River water, it was determined that potential residual adverse effects of all phases of the Minto Project, in combination with potential residual adverse effects of other projects, are not considered significant. Indeed, once Minto creek water mixes with the Yukon River water, the loading is insignificant relative to the assimilative capacity of the Yukon River, since the average flow at Carmacks is 756 m^3/s [17] (Environment Canada, 2010) while Minto creek average flow (at W1) ranges from 0.03 to 0.33 m^3/s during the summer months, which represents 0.004-0.044% of the Yukon River discharge.

On the temporal scope, cumulative effects on aquatic resources of all phases of the mine development are closely monitored and mitigated through water management, monitoring, and discharge management measures.

Baseline information regarding aquatic resources has been collected at the site since 1994 and is outlined in Appendix L. Monitoring of the site is extensive and ongoing. Any exceedance, or fluctuation observed is recorded and investigated. For example, in accordance with the MMER, Minto has been conducting EEM independently of mine development phases. EEM Cycle 1, carried out in 2008, and EEM Cycle 2, carried out over the 2009-2011 period, consisted of an integrated assessment of effluent sublethal toxicity, water quality, benthic invertebrate community condition, and fish health. Overall, the Minto Mine Cycle 2 EEM documented an influence of the mine on the water quality of Minto Creek even in the absence of discharge. Mine effluent did not cause any sub-lethal toxicity.

Effects to the benthic invertebrate community of Minto Creek indicated some stimulatory responses consistent with an enrichment influence in Minto Creek. The hatchery-based fish survey supported the observed response of benthic invertebrates, indicating that exposure to mine effluent may result in a very slight increase in fish size and body condition, but that a minimum of five to six weeks of constant effluent exposure would be required to elicit this response.

[17] *Obtained from Water Survey of Canada station ID#09AH001 (Yukon River at Carmacks), which operated from 1951 to 1995.*

While some changes were observed in the aquatic environment since the beginning of mine operations, there is no evidence that these changes adversely affect the aquatic resources. Moreover, water quality objectives were developed from premining data in a way that ensures the protection of aquatic life. Also, Minto creek is an erosional system (rather than depositional) and is highly responsive to precipitation events, and therefore mine-related constituents tend to be carried into to Yukon River rather than accumulate in the Minto Creek system over time (see Section 8.1.5.1). When considering the mixing factor mentioned above, the resulting constituent loading in the Yukon River is insignificant.

17.4.2 Conclusions

As noted, no other activities are occurring in the Minto Creek watershed and therefore there are no cumulative effects within the spatial scope. However, water from the Minto Creek and McGinty Creek watersheds moves into the Yukon River, a highly valued water body, and therefore further consideration was given to potential adverse cumulative effects. It was determined that potential residual adverse effects of all phases of the Minto Project, in combination with potential residual adverse effects of other projects, are not significant.

17.5 Wildlife

Activities at Minto Mine may result in residual effects on wildlife and wildlife habitat. The spatial extent boundary for the CEA has been set to a 50 km radius around the mine site, to account for the ranges of key wildlife species adequately.

Two major quartz mining operations are located near the Minto Property; the Carmacks Copper Property (Copper North) and Casino Mine (Western Copper). Several Class 3 and 4 Quartz mining operations lie along the Casino Trail (~231 km from the Minto property). Other projects along the Casino Trail, or in the near vicinity, include: Teck Resources Limited (Big Creek and Sonora Gulch properties) and Carmacks Copper–Gold. Please refer to Figure 17-1 and Figure 17-2 for further detail and location of these activities.

Of the projects noted above, three are located within the 50 km spatial extent established as the spatial boundary extent for wildlife consideration:

- Sonora Gulch – Teck Resources Ltd.
- Big Creek – Teck Resources Ltd.
- Carmacks Copper – Copper North Mining Corp.

Carmacks Copper is located on the outskirts of the spatial extent, approximately 43 km from Minto Mine. According to Copper North’s 2012 Annual Quartz Mining Licence Report, activities at the Carmacks Copper site during the period January 2, 2012 to December 31, 2012 have been limited and consisted of three site visits to monitor water quality and flows and the engineer’s annual inspection. No development activities were undertaken in 2012.

Sonora Gulch and Big Creek are two seasonally operated (May to October) Class 3 quartz mining programs located 41 and 38.5 km from Minto, respectively. Both of these operations are located along the Casino Trail (Figure 17-1) and are helicopter-supported operations. Mobilization of equipment will take place along the Trail during the winter months. Please note that Minto is not connected to these projects, or other projects via the Casino Trail.

Given the nature of other projects in the area, residual effects from their activities may interact with the residual effects of Minto's activities.

17.5.1 Cumulative Effects Analysis

Potential residual effects that relate to wildlife and wildlife habitat include disturbance, injury or mortality (including increased hunting pressure), and loss of habitat. As noted, Minto Mine also has the potential to result in residual effects for all effects noted in the effects assessment in Section 10: Wildlife Effects Assessment and Management (i.e., habitat loss, changes to wildlife movement and direct injury/mortality).

Minto has committed to measures with a dual purpose: to reduce potential effects, and monitor them over time. Updated baseline information is provided in Section 10, and associated Plans and Baseline Reports are provided in the appendices. Wildlife monitoring is ongoing at Minto, with wildlife studies being completed by Minto or other groups (i.e., Yukon Government) on a regular basis. Recent studies have been summarized above in Table 10-1.

In terms of habitat loss, the Project will act cumulatively with all other known projects. However, the overall amount of habitat loss is considered to be relatively small. With the inclusion of Phase V/VI, approximately 535 ha of land have been cleared as a result of the Mine. This represents 0.068% of the identified spatial extent.

The addition of Phase V/VI results in disturbance occurring over a longer time period, and wildlife may continue to avoid the area, while some may be attracted. Over time, some wildlife may become acclimatized to Project activities (i.e., noise level) and become less disturbed by them.

Likewise, injury or direct mortality has the potential to occur over a longer duration. Minto is located on the west side of the Yukon River, while the North Klondike Highway is on the east side. As such, for approximately half the year, the mine is accessible only by a privately-owned and operated barge. Furthermore, road development (i.e., linear density) at the site is limited and does not connect to other access routes.

Regardless, it can be expected that a small number of wildlife will become injured or die as the result of Project activities. However, with the continued application of all mitigations (noted in Section 10.2.3 and in documentation such as the Wildlife Protection Plan), it is not anticipated that effect to wildlife as the result of injury or death, will be significant. Section 10

17.5.2 Conclusions

Minto has proposed mitigations in Section 10 and in the Minto *Wildlife Protection Plan* (2011) (Appendix R), which in combination with non-discretionary legislation, will be adequate to mitigate potential effects to wildlife as a result of the overall Minto project, so they are not significant.

As noted, above in Section 17-1, wildlife monitoring is conducted at the Minto Mine. This will assist with the identification of potential adverse effects in a timely manner. Minto has data of recent and historical wildlife studies; please refer to the Wildlife Baseline Report (2012) in Appendix P.

It was determined that potential residual adverse effects of all phases of the Minto Project, in combination with potential residual adverse effects of other projects are not significant.

17.6 Vegetation

Activities at Minto Mine have the potential to result in residual effects on vegetation. The potential residual effects related to vegetation are the loss of vegetation, physical effects related to dust and the introduction of invasive species. These potential effects may, in turn, impact other values such as wildlife (loss of wildlife habitat) and aquatic resources (change in water temperature and increase in sediment loading).

The spatial extent boundary for the CEA has been set to be the Minto Creek and McGinty Creek watersheds. With the inclusion of Phase V/VI, a total area of 535 ha will be disturbed as the result of the Minto Mine which, for the most part, means the direct loss of vegetation. The approximate size of the Minto Creek and McGinty Creek watersheds combined is 7600 ha. The Minto Mine footprint represents approximately 7% of this area.

Please refer to Section 15.1 for an overview of what reclamation activities have occurred to date. Although newly reclaimed areas will not be identical to their former state, they will become more so over time. Please also see Section 11.2.3 Effects of Invasive Plants regarding Minto’s management practices that will reduce or eliminate the potential of invasive species become part of the vegetative landscape.

Two major quartz mining operations are located near the Minto Property; the Carmacks Copper Property (Copper North) and Casino Mine (Western Copper). Several Class 3 and 4 Quartz mining operations lie along the Casino Trail (~231 km from the Minto property). Other projects along the Casino Trail, or in the near vicinity, include: Teck Resources Limited (Big Creek and Sonora Gulch properties) and Carmacks Copper–Gold.

Activities on other quartz claims noted above also have cleared and altered vegetation, and excavated soils. Although other projects are noted above and in Figure 17-1and Figure 17-2, Minto Mine is the only company operating in the Minto Creek and McGinty Creek watersheds, mining or otherwise.

17.6.1 Cumulative Effects Analysis and Conclusion

As there are no other projects located within the identified spatial extent, the residual effects of Minto Mine will not combine with any other residual effects of other projects. As such, no cumulative effects to vegetation are anticipated.

Surveys and ecosystem mapping has been conducted through past development as will continue as the Project evolves to further understand ecological implication of the Mine.

17.7 Air Quality

Activities at Minto Mine may have residual effects on air quality, mainly due to dust emissions. As such, potential exists that residual effects on air quality may combine with residual effects of other projects, resulting in cumulative effects. Heavier dust particles tend to settle rapidly, near their emission source, while smaller and lighter particles can travel longer distances. Particulate matter travel distance and time are dependent on a number of factors, including wind speed, surface roughness, air moisture, etc. For the purposes of the CEA, the spatial extent boundary was determined to be 30 km.

Two major quartz mining operations are located near the Minto Property; the Carmacks Copper Property (Copper North) and Casino Mine (Western Copper). Several Class 3 and 4 Quartz mining operations lie along the Casino Trail (~231 km from the Minto property). Other projects along the Casino Trail, or in the near vicinity, include: Teck Resources Limited (Big Creek and Sonora Gulch properties) and Carmacks Copper–Gold.

17.7.1 Cumulative Effects Analysis

All the projects mentioned above are located outside the spatial extent boundary of this CEA. Since there are no existing industrial activities near the Project site, existing air quality is only influenced by surrounding natural sources and contributions from long-distance transport of air contaminants. The air quality monitoring conducted at Minto (see section 9.2.1) measures the ambient $PM_{2.5}$ concentration, which inherently accounts for both background and site generated particulate matter. The average 24-hr $PM_{2.5}$ concentration measured at Minto camp is 4.39 $\mu g/m^3$, which is well below Yukon ambient air quality standard of 30 $\mu g/m^3$, and therefore indicates that the cumulative effects are not significant.

On a temporal scope, dust has been generated through all phases of the Minto project, and some of this dust may have deposited on surrounding vegetation. However, rain, wind or snow regularly washes away the deposited dust, and consequently, dust deposition on vegetation doesn't accumulate over time. Minto will also implement additional dust mitigation measures as part of Phase V/VI (see section 9.3), which will further reduce the potential for the generation of airborne dust and its potential deposition on surrounding vegetation.

17.7.2 Conclusion

As noted, no other industrial activities are occurring in the Project area, therefore the only contributions of air contaminants are from natural sources and long-distance transport. Background air quality is generally considered pristine in the Project area, as indicated by the air quality monitoring undertaken at site. In light of these considerations, it was determined that potential residual adverse effects of all phases of the Minto Project on air quality, in combination with potential residual adverse effects of other projects are not significant.

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