Minto Mine Phase IV Reclamation and Closure Plan Revision 4.0

Prepared For:

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MINTO MINE

Minto Explorations Ltd.

September 2013

ACCESS

MINTO MINE PHASE IV RECLAMATION AND CLOSURE PLAN

REVISION 4.0

September 2013

Prepared for:

MINTO EXPLORATIONS LTD.

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CONTEXT OF THIS DOCUMENT

This fourth revision of the Minto Mine Reclamation and Closure Plan (RCP) is presented for review and will be revised to incorporate reviewer comments. This version is an update to the Minto Mine Decommissioning and Reclamation Plan, Revision 3.2 (DRP), submitted to Yukon Government, Energy Mines and Resources in June 2011. This RCP contains additional detail to further refine Phase IV concepts, now that this phase is almost complete. Minto also recently submitted a Preliminary Reclamation and Closure Plan (PRCP) to YESAB presenting proposed closure methods for the mine features and layout anticipated from the proposed Phase V/VI expansion at the preliminary or conceptual level, with the intention of providing a level of detail to support the intended purpose of the Project Proposal submission to YESAB for the Phase V/VI Expansion. Closure planning is a process continuum, and RCP documents accordingly advance in detail as the Project proceeds through its mine life. These two RCP documents—although representing different mine life plans—share key closure concepts and methods, and both plans will be advanced in detail during licencing.

This RCP is now considered to be Revision 4.0. Significant advancements in the RCP over the 2011 DRP include:

- A much improved understanding and analysis of site closure hydrology, which has informed revisions to site runoff conveyance alignments, sizing and design;
- Updated water balance and geochemistry source term evaluation, combined for a revised site water quality prediction (prepared for Phase V/VI, and considered conservative as a planning tool for the Phase IV mine plan);
- Supporting rationale for the selection of isolating soil covers as the primary reclamation measure, based on a further characterization of available construction materials;
- Advanced supporting rationale for the application of semi-passive treatment technologies as contingency water treatment measures for closure, including the framework for a research program aimed at providing proof of concept for these technologies in the Minto site context; and
- An updated closure cost estimate for financial assurance purposes, including all proposed revisions to the closure methodologies and adjustments to the costing based on emergent closure costing guidance from YG EMR.

PROJECT CONTACTS

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EXECUTIVE SUMMARY

This RCP addresses the long-term physical and chemical stability of the site, including reclamation of surface disturbances. A program is presented for site management and monitoring both during implementation of closure and after decommissioning and reclamation measures are completed. Decommissioning and reclamation cost estimates are provided and financial security requirements reviewed.

The RCP has been specifically scoped to fulfill the requirements of closure plan submissions in both of the projects primary regulatory instruments – Quartz Mining Licence QML-0001, and Water Use Licence QZ96-006, and to adhere to guidance documentation on closure plan development from both the Yukon Government and the Yukon Water Board.

A systematic approach to decommissioning and closure reclamation has been developed for the Minto project. Progressive reclamation measures have been implemented where possible during mine construction and operations. This approach has provided valuable reclamation success feedback for use in advanced/final closure, and these progressive efforts will also help reduce slope erosion through physical slope stabilization of revegetation efforts, enhancing ultimate reclamation success.

The closure phase of the Minto mine will commence with the cessation of economic mining of the open pit and the milling of ores and stockpiles from the ore zone. Once all mineable ore reserves have been processed, the mill, concentrator and other facilities will be decommissioned, and waste facilities and disturbed areas will be covered and revegetated. During the active closure phase, which is expected to last approximately 3 years, the number of personnel required will vary depending on site activities; however, it is expected that as major decommissioning and reclamation tasks are completed the number of site personnel required will decline.

Cost estimation for implementation of the proposed closure measures is the basis for establishing the financial security that will be required on the project. The Phase IV closure cost estimate has been prepared based on the final extent of disturbance for each of the infrastructure units described in this report. A closure cost of approximately $35,900,000 is estimated for final closure.

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1 INTRODUCTION

Minto Explorations Ltd. (Minto), a wholly owned subsidiary of Capstone Mining Corporation (Capstone), owns and operates the Minto Project located 240 km (150 miles) northwest of Whitehorse, Yukon. For the purposes of this reclamation and closure plan, the "Minto Project" means the mining of the Minto deposit by both open-pit and underground mining methods and related ancillary facilities.

This reclamation and closure plan (the RCP) addresses the long-term physical and chemical stability of the site, including reclamation of surface disturbances from existing development. A program is presented for site management and monitoring both during implementation of closure and after decommissioning and reclamation measures are completed. Decommissioning and reclamation cost estimates are provided.

The RCP is based on the best information available at the present time. A proposed continuation and expansion of the reclamation research program will provide more site-specific information to optimize closure methods. At the time of this writing, the Yukon Environmental and Socioeconomic Assessment Board's (YESAB's) Mayo Designated Office has received from Minto Explorations Ltd. a proposal for the Phase V/VI expansion of the mining and milling operations. If permitted, this expansion would see a significant extension (approximately 8 years) to the mining activities at the site. As part of that submission, Minto submitted a Preliminary Reclamation and Closure Plan (PRCP) that provided conceptual closure methods and supporting rationale for the Phase V/VI mine plan. These methods and the PRCP were optimizations of the previous 2011 DRP, and benefitted from an updated water quality prediction, an evaluation of the characteristics of soil materials available for closure cover construction at the site and candidate closure cover options, and a more detailed evaluation of the potential for passive water treatment implementation and a corresponding research program. Each of these evaluations – although prepared and presented in the context of Phase V/VI closure planning – is relevant and material to the Phase IV closure condition, and have been relied upon and utilized in this RCP.

The mine site and access road lie within the traditional territory of the SFN and comprises part of land claim settlement parcels R-6A, R-44A (Type A settlement lands) and R-40B. Minto has worked extensively with SFN and their technical advisors towards the development of a mutually agreeable plan for closure of the Minto site for a number of years. This collaborative effort has resulted in numerous improvements to this RCP, but Minto also recognizes that there are still areas of disagreement with respect to the plan for reclamation and closure at the site. Specifically, the parties have not yet come to an agreement on the definition of suitable quality of discharge water from the site in the closure period, and accordingly the required key closure measures to achieve this quality. The parties do have an agreement to continue to work together to develop a mutually agreeable definition and associated closure water quality objectives. In the interim, this RCP has been updated utilizing what Minto sees as responsible and appropriate objectives for closure water quality, founded in the protection of the most sensitive species and life stage of aquatic resources in the receiving environment.

1.1 CLOSURE PHILOSOPHY

In keeping with its high standards for environmental and social responsibility, Minto intends to implement an environmentally sound and technically feasible decommissioning and reclamation plan for the Minto mine. Closure planning and the implementation of this phase at a mine site must be undertaken with appropriate environmental care while respecting local laws, Selkirk First Nation (SFN) agreements, and the public interest and ensuring that Minto's high environmental standards are achieved. Necessary environmental protection measures have been adopted in the development of this Plan to ensure that a healthy environment exists after mine closure. This approach is consistent with Minto's corporate policies.

A principle tenet of the philosophy followed during the development of this Plan was to work towards an eventual passive closure scenario, with minimal management required to achieve long-term chemical and physical stability of reclaimed mine components. This involved an assessment of the key mine components that require mitigation based on the current understanding of materials contained within these components. Mitigation measures have been incorporated into elements of the RCP to address public safety issues and environmental concerns with post-closure monitoring and inspections planned to ensure that this objective is met. Once the effectiveness of each mitigation measure is assured, then management of the site can be safely reduced to a level that is consistent with closure objectives. It is anticipated that final determination of the effectiveness of closure measures for passive and eventual walk-away status will be the subject of review and concurrence with regulatory agencies, SFN and the public. Under the Quartz Mining Act (QMA), Minto would then apply for a certificate of closure from Yukon Government (YG).

Minto has entered into a Cooperation Agreement (the Agreement) with the SFN. All activities at the site including closure measures are guided by this Agreement. Therefore, a strong working relationship with the SFN forms a foundation for this document. To that end, meetings with SFN related to closure issues have been ongoing since the first version of the RCP, and their comments on closure and other issues raised during ongoing dialogue were considered in the ongoing development of this Plan. This dialogue continues, and although there are still outstanding differences of technical opinion on closure objectives and required measures, parties continue to work towards their resolution in the ongoing closure planning discussions.

To ensure that the overall closure philosophy can be achieved, the following objectives were emphasized during the development of this plan:

- Protection of public health and safety;
- Implementation of environmental protection measures that prevent adverse environmental impact;
- Ensuring land use commensurate with surrounding lands;
- Ensuring full consultation with the SFN, so that closure measures are appropriate and supported by the local peoples who are most affected;
- Incorporate long term closure measures;
- Progressive reclamation measures implemented during mine operations;
- Post-closure monitoring of the site to assess effectiveness of closure measures for the long term; and
- Post-closure monitoring and management of the site until performance objectives are consistently met with minimal ongoing management.

1.2 SCOPE OF PLAN

The RCP has been specifically scoped to fulfill the requirements of closure plan submissions in both of the project's primary regulatory instruments – Quartz Mining Licence QML-0001, and Water Use Licence QZ96-006, and to adhere to guidance documentation on closure plan development from both the Yukon Government and the Yukon Water Board.

Specifically, the licenced requirements for closure plan submission under each licence are:

- QML-0001: *Section 9.0 Reclamation and Closure Plan*

  9.1 The Licensee must undertake reclamation at the site in accordance with the approved closure plan.
  9.2 The Licensee must:

  (a) submit to the Chief for approval a reclamation and closure plan within 30 days of the effective date and then on June 1, 2013 [Amended to September 16, 2013] and June 1, 2015; and

  (b) implement the reclamation and closure plan and any conditions of the approval as of the date each plan becomes an approved plan.

  9.3 The Licensee acknowledges that on the date an updated reclamation and closure plan, as described in paragraph 9.2(a) and including any amendments to it and any additional terms and conditions required by the Chief, becomes an approved plan, the previous reclamation and closure plan shall cease to be an approved plan.

- WUL QZ96-006: *Clause 103 Permanent Closure*

  The Licensee shall submit an updated detailed DRP to the Board by September 16, 2013 as an application for amendment of this licence. The detailed DRP shall:

  a) include the results of a Failure Modes and Effects Assessment of the proposed closure measures in the DRP that will examine risks associated with the proposed closure measures and will identify specific contingency plans necessary to manage risks identified in the assessment;

  b) be adequate for an independent assessment of the physical and geochemical stability of the mine wastes and mine workings remaining after application of the proposed closure measures and of the costs of the proposed closure measures and post closure monitoring and maintenance;

  c) the DRP shall include, but not necessarily be limited to, the following components:

     i) preliminary designs for the closure of all major mine facilities , including dams, spillways, diversion ditches, pits, dumps and mill/camp facilities;

     ii) plans to ensure long term stabilization of the DSTSF, including revegetation;

     iii) calculations of the Maximum Credible Earthquake;

     iv) calculations of the inflow design flood proposed for closure and the rationale for the severity or return period of the flood event;

     v) designs for the closure water management structures and conveyance channels to withstand the inflow design flood event;

     vi) an updated Reclamation Research Plan and proposed schedule for implementing the plan;

vii) a detailed Post-Closure Monitoring Program to verify that performance objectives for all facilities are being achieved;

viii) an updated Water Balance and Water Quality Model for the mine site and Minto Creek; and

ix) an updated detailed cost estimate, including clearly defined assumptions and calculations for decommissioning and on-going post closure monitoring and maintenance.

In addition, the EMR guidance document *Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and closure costing guidance* released February 2013, has been very helpful in providing guidance for the appropriate content and costing of the RCP.

The RCP is intended to address closure of currently permitted infrastructure components. These activities and components are addressed in Section 2.2.

- Development, mining and milling of materials from the Area 2 open pit which contains 3,192 Kt of ore plus 25,980 Kt of waste;
- Development, mining and milling of materials from the Area 118 open pit which contains 88 Kt of ore plus 639 Kt of waste;
- Development, mining and milling of materials from the Area 2 and Area 118 underground areas which contain approximately 1,541 Kt of ore and 341 kt of waste;
- Expansion of the Southwest Waste and Reclamation Overburden Dumps;
- In-Pit deposition of tailings from Phase IV ore feeds (Area 2 and Area 118);
- Construction of the South Wall buttress in Main Pit;
- Construction of the Mill Valley Fill Expansion buttress;
- Extension of the camp pad;
- Operational water management; and
- Progressive reclamation of infrastructure components, as and whenever possible to reduce site liability.

The approach taken in the presentation of this Closure Plan is to provide a brief description of each mine component and the closure issues and measures related to that component. Previous work or reports on the project have been referenced without repeating details so that this document is focused on decommissioning and reclamation measures.

1.3 STATUTORY AND REGULATORY RESPONSIBILITIES

Versions 1, 2 and 3 of this Plan were developed to meet the regulatory requirements as stipulated in Minto's Water Use Licence and Quartz Mining Licences. Closure methods and details associated with the Phase IV Expansion were approved most recently by in the DRP version 3.2 Yukon Government, Energy Mines and Resources (YG EMR) in September 2011, and a required re-submission of the closure costing for a security update was provided to YG EMR September 30, 2012. This RCP incorporates site developments undertaken as part of Phase IV, and closure concepts advanced since the approval of the last Plan. It is intended to meet the regulatory requirements from the primary project authorizations as presented above in Section 1.2.

Prior to implementing the closure measures described in this Plan, meetings will be held with the SFN and the local community to ensure that First Nations and community interests and concerns are addressed and included in the closure planning of the Minto mine. Section 1 above describes the current state of closure plan discussions with SFN. Also prior to implementation of the RCP, the YG Water Resources and Mining Land Use Divisions will be informed of Minto's intentions. Meetings will also be held with Environment Canada, Environmental Protection, Department of Fisheries and Oceans, Environmental Health, and Government of Yukon Departments of Environment and Occupational Health and Safety to apprise regulators of planned site activities. These meetings will ensure that regulatory agencies' concerns with closure implementation are met.

1.4 REGULATORY APPROVALS

Several government agencies and SFN are involved in reviewing, assessing, authorizing and monitoring the Minto Mine. The relevant legal, regulatory and guideline-based instruments include:

- Selkirk First Nation Cooperation Agreement;
- Metal Mining Effluent Regulations (MMER) of the federal Fisheries Act; including guidance for:
    - Effluent Characterization; and
    - Environmental Effects Monitoring;
- Type A Water Use Licence QZ96-006 ("WUL QZ96-006"), issued in April 1998 and including subsequent amendments, and valid until June 30, 2016;
- Type B Water Use Licence MS04-227 ("WUL-B") issued in August 1996 and valid until June 30, 2016;
- Quartz Mining Licence QML-0001 ("QML-0001") issued in October 1999 and subsequent amendments and valid until June 30, 2016;
- Mining Land Use Permit;
- Fish Collection Permits;
- Waste Management Facility Permits:
- Multi-Use Land Treatment Facility Permit;
- Special Waste Permit;
- Commercial Dump Permit; and
- Air Emissions Permit.

In accordance with these instruments, Minto has submitted operational and monitoring plans including but not limited to:

- General Site Plan;
- Mine Development & Operations Plan;
- Underground Mine Development & Operating Plan;
- Main Waste Rock Dump Design Plan;
- Southwest Waste Dump Design Plan;
- Reclamation Overburden Dump and Ice-Rich Overburden Dump Design Plans;
- Dry Stack Tailings Storage Facility Design and Management Plans;
- Engineering Plans and a Construction Quality Assurance Manual for the Water Storage Pond dam;
- Mill Water Pond Design;
- Waste Management Plans;
- Waste Rock & Overburden Management Plans;
- Tailings Management Plan;
- Spill Contingency Plan;
- Heritage Resource Protection Plan;
- Sediment & Erosion Protection Plan;
- Explosives Management Plan;
- Wildlife Protection Plan;
- Emergency Response Plan; and
- Decommissioning and Reclamation Plan.

1.5 ACKNOWLEDGEMENTS

This Plan benefited from input by the following companies, many of which have contributed to previous versions of the Minto Mine closure plans:

Access Consulting Group (ACG) – Developed Revision 1 of the site Decommissioning and Reclamation Plan (DRP), provided support to Revision 2, and co-authored Revision 3 with EBA Engineering Consultants Ltd. (EBA).

Contango Strategies Ltd. – Provided specialist expertise related to the evaluation, design, and implementation of constructed wetland treatment systems in cold climates.

EBA Engineering Consultants Ltd. (EBA) – Assisted with development of Revision 2 of this Plan, developed Phase IV conceptual closure plan, and co-authored Revision 3, including the preliminary engineering design.

Selkirk First Nation (SFN) – Longstanding participation in many components of the closure planning process based on current and potential future use of the project area, including the development of closure objectives, reclamation measures and closure cost estimations.

SRK Consulting Ltd. – Provided geochemical characterization and predictive water chemistry modeling, as well as lead support on waste cover evaluation and recommendations.

2 PROJECT DESCRIPTION

2.1 PROJECT LOCATION AND BACKGROUND

The Minto Project is a copper-gold-silver project located on the west side of the Yukon River approximately 75 km (47 miles) north-northwest of Carmacks, Yukon Territory. The mine site and access road lie within the traditional territory of the SFN and comprises part of land claim settlement parcels R-6A, R-44A (Type A settlement lands) and R-40B. Minto concluded a comprehensive Cooperation Agreement with the SFN on September 16, 1997. This agreement is still in effect, however an amended agreement is being negotiated.

The Minto Property is centered at approximately 62°37'N latitude and 137°15'W longitude (NAD 83, UTM Zone 8 coordinates 6945000N, 384000E). The Minto Project consists of 284 claims. There are 120 pending quartz claims, 99 quartz claims and 65 quartz claims under lease. Minto is the 100% registered owner of the claims and leases. The property is accessible by crossing the Yukon River at Minto Landing. Barge landings have been constructed for ice-free crossing and an ice bridge is used upon freeze-up of the Yukon River.

Copper deposits were first discovered in 1970 and claims were staked in 1971. Extensive exploration yielded the first significant drill intersection in July of 1973. The claims and leases cover an area of approximately 10 square miles. Figure 2-1 and Figure 2-2 present visual depictions of the general project location within the Yukon and the project area overview.

Preliminary site development was initiated at the property in 1996 and continued during the following decade with Minto commencing operations in October 2007. 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. The Minto Mine has been conducting operations under the Phase IV Mine Plan since February 2011.

Pre-stripping 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 pre-stripping 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.

The ore deposits are mined using conventional open pit truck and loader operations and processed in a mill plant on site. A 200 person camp is presently near capacity with the mine construction management, contractors and support staff. All existing facilities and development described in Section 2.4 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.

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FIGURE 2-1
PROJECT LOCATION

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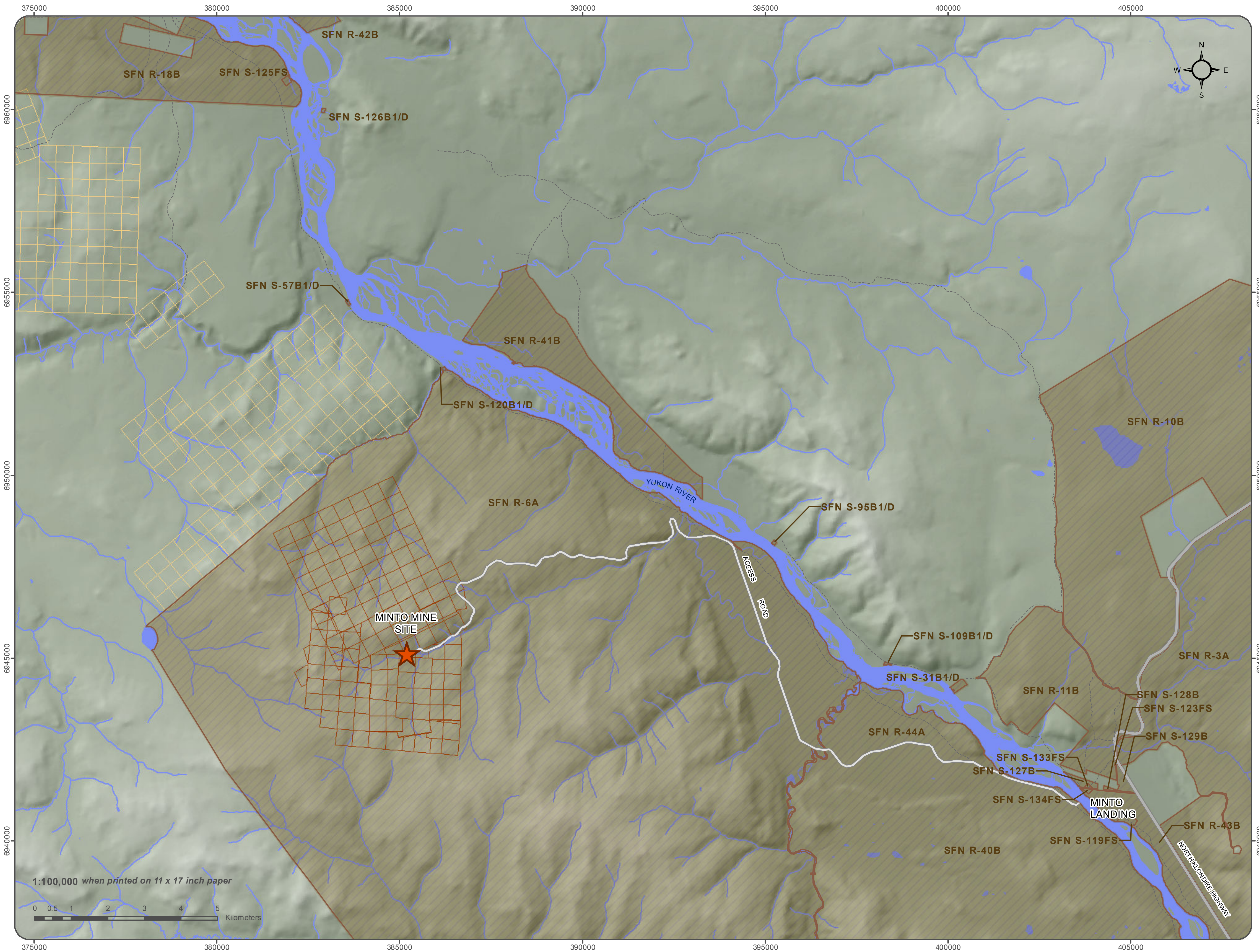

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FIGURE 2-2
AREA OVERVIEW

SEPTEMBER 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

ACCESS

First Nation Settlement land obtained from Natural Resource Canada. Quartz claim boundaires and ownership are current as of Feb 18 th 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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Table 2-1 provides an overview of the project area and environmental setting information for the study area. This table provides physical project location information, geographic reference, access route, watershed drainage, special designations, and key environmental features within the study area. The information has been extracted from a number of documents, including previous Canadian Environmental Assessment Act (CEAA) and Yukon Environmental and Socio-Economic Assessment Act (YESAA) screenings.

Table 2-1 Project Area Overview and Environmental Setting

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, 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. Traditional use 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 metres to 600 metres 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 174 mm.
Vegetation Communities:	Riparian, black spruce, white spruce, paper birch, lodgepole pine, buck brush/willow and ericaceous shrubs, feathermoss, sedge, sagewort grassland, mixed, 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 sharptail 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 sculpins; In Minto Creek and project area watershed (lower reaches only), slimy sculpin, round whitefish, arctic grayling and Chinook salmon.
Known Heritage Resources:	East side of Yukon River in the vicinity of Minto Landing four historic sites designated KdVc-2 (Minto landing), KdVc-3 (Minto Resort), KdVc-4 (Old Tom's Cabin), and KdVD-1 (Minto Creek).

2.2 PHASE IV ACTIVITIES

The following activities are in progress as part of Phase IV:

- Development, mining and milling of materials from the Area 2 open pit which contains 3,192 Kt of ore plus 25,980 Kt of waste;
- Development, mining and milling of materials from the Area 118 open pit which contains 88 Kt of ore plus 639 Kt of waste;
- Development, mining and milling of materials from the Area 2 and Area 118 underground areas which contain approximately 1,541 Kt of ore and 341 kt of waste;
- Expansion of the Southwest Waste Dump and Reclamation Overburden Dump;

- In-Pit deposition of tailings from Phase IV deposits;
- Construction of the South Wall buttress in Main Pit;
- Construction of the Mill Valley Fill Expansion buttress;
- Extension of the camp pad;
- Operational water management; and
- Progressive reclamation of infrastructure components, as and whenever possible to reduce site liability.

The open pit mining is being conducted using standard blast and haul open pit mining practices. Milling is conducted using a conventional crushing, grinding and flotation process plant utilizing standard unit processes and equipment). The plant currently processes a maximum of 4,200 tpd (metric tonnes per day).

Figure 2-3 shows the Phase IV development at End of Mine life (2014). Additional details and information on the project are contained in the Minto Mine Expansion - Phase IV Project Application submitted to YESAA in August 2010.

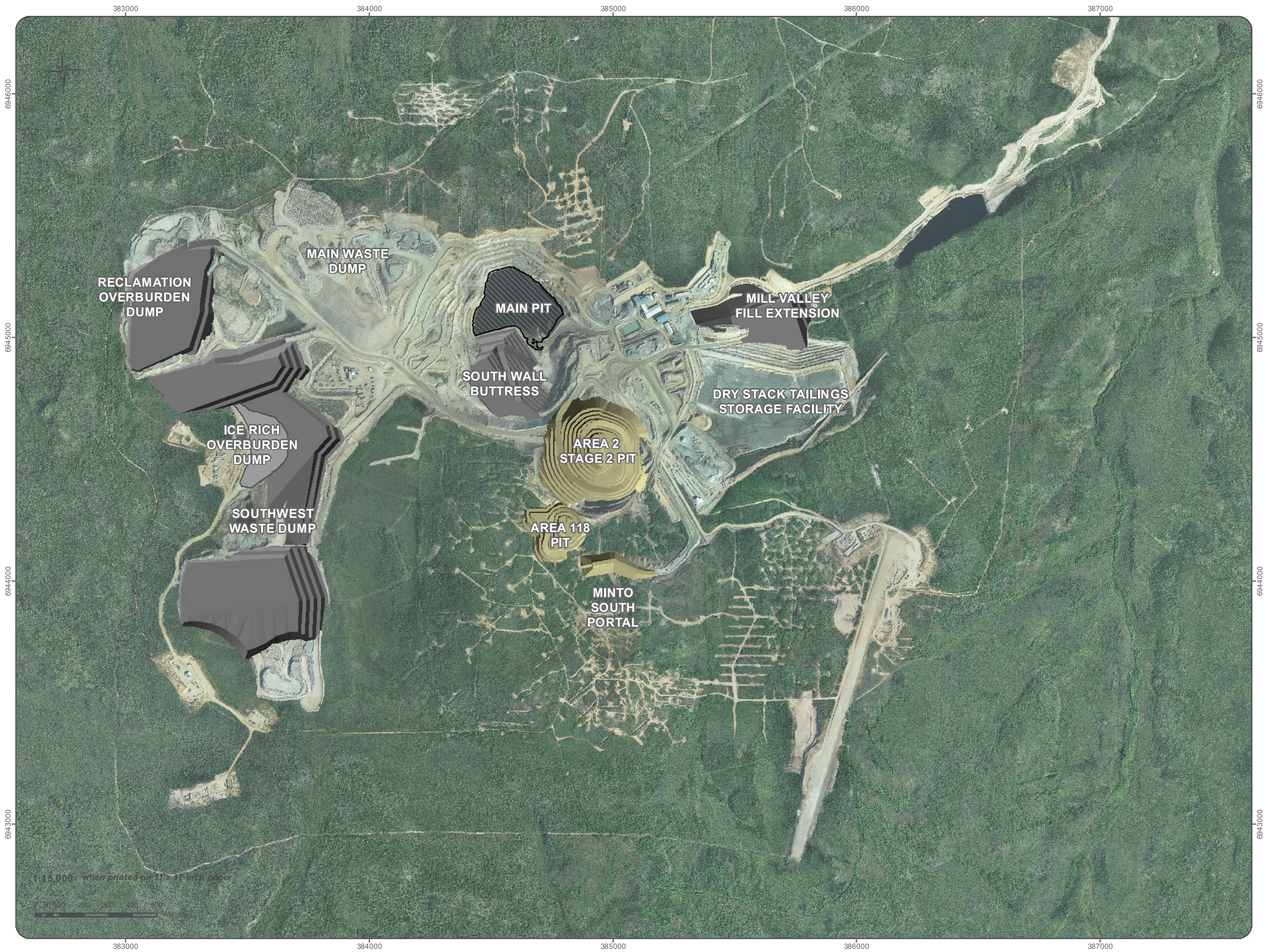

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FIGURE 2-3
END OF PHASE IV SITE LAYOUT

SEPTEMBER 2013

- Phase IV Tailings
- Phase IV Dumps
- Phase IV Pits

ACCESS

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

Datum: NAD 83 Projection: UTM Zone 8N

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2.3 PROPOSED PHASE V/VI EXPANSION

The Phase V/VI expansion of the Minto Mine is currently under in assessment under YESAA. While this RCP does not address Phase V/VI, the progressive reclamation, reclamation research and site-wide water management have been designed to concur with closure goals and objectives for Phase V/VI.

The principal activities associated with Phase V/VI 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;
- Expanded mining of the Minto South Underground using conventional underground mining methods;
- 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 expansion of the current Mill Valley Fill to further stabilize dry stack tailings storage facility;
- 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; and
- Construction of a small dam (Main Dam) to retain tailings within the footprint of the Main Pit.

Additional details and information on the project are contained in the Minto Mine Phase V/VI Expansion Project Proposal.

2.4 EXISTING SITE INFRASTRUCTURE

2.4.1 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.

2.4.2 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 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.

2.4.3 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 **Error! Reference source not found.**2.

Table 2-2: 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

2.4.4 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. 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 a sewage treatment plant. 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.

2.4.4.1 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, with completion expected in the fall of 2013. The new modular units will be constructed on 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.

2.4.5 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-attractant 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.

2.4.6 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.

2.4.7 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.

2.5 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. The Main Pit is further discussed in Section 6.3.1.
- **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. The Area 2 Pit is further discussed in Section 6.3.2.
- **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. The Area 118 Pit is further discussed in Section 6.3.3.
- **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. Minto South Underground is further discussed in Section 6.4.

- **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. The MWD is further discussed in Section 6.1.1.
- **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. The SWD is further discussed in Section 6.1.2.
- **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. The DSTSF is further discussed in Section 6.6.
- **Mill Valley Fill Extension (MVFE)**
  This facility 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. The MVFE is further discussed in Section 6.7.
- **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. The ROD is further discussed in Section 6.1.4.

2.6 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.

2.6.1 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%.

2.6.2 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.

2.6.3 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.

2.6.4 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.

2.7 WATER MANAGEMENT

Management of water at the Minto Mine plays an important part in the mine planning; 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;
- The Water Management Plan (WMP)

2.7.1 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 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 and the Area 2 Pit Tailings Management Facility. 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.

2.7.2 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.

2.7.2.1 Water Balance Model

The water balance model for Phase IV was prepared for the Phase IV Yukon Environmental and Socioeconomic Assessment Board (YESAB) application (SRK Consulting, 2010) and for the Water License Amendment 8 application (SRK Consulting, 2012a). The water balance model has also been updated, most recently for the Phase V/VI Expansion Proposal, which is part of the information provided in Appendix A in SRK's report *Minto Mine Phase V/VI Expansion: Water and Load Balance Model Report*. 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.

The water balance model divides the site and surrounding areas into catchments and sub-catchments within the Upper Minto Creek (Minto Mine site) 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.

2.7.2.2 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 2-3 shows the estimated range of annual precipitation and site-wide runoff,

Table 2-3 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

2.7.3 Water Management Plan

Minto's comprehensive Water Management Plan (WMP) consists of segregation, diversion, conveyance, treatment and discharge of water to effectively manage water at the Minto Mine and meet licensed effluent discharge standards. The main components and features of the operational water management plan are described below. More detail can be found in the WMP.

2.7.3.1 Water Storage

Runoff is the primary source of the water required for mine operation. Water is currently collected during the spring, summer and fall and then used as required during the remainder of the year. Between approximately 170,000 m^3 (in a 10 year return period dry year) and 1,300,000 m^3 (in a 10 year wet year) of excess water is estimated to report annually to the upper Minto Creek watershed (Clearwater Consultants Ltd., 2011). Water balance updates (2011) suggest that the upper end of this range remains appropriate, but that the low end of the range may be underestimated.

Minto Mine currently has three main water storage areas:

- The Water Storage Pond with a water storage capacity of approximately 325,000 m^3;
- The Mill Pond with a water storage capacity of approximately 5,000 m^3;
- The Main pit with a water storage capacity of approximately 3,900,000 m3, decreasing as the life of the mine progresses due to the placement of waste in the Main Pit (waste rock and tailings); and
- The Area 2 pit, which could also be used for short term storage of excess runoff that cannot be immediately treated and/or discharged.

The WSP is formed behind the WSP dam. Storm water and runoff water from the catchment area above the WSP dam currently report to the WSP during spring, summer and fall. The maximum depth of water in the WSP dam is approximately 15 m. The area covered by water at maximum depth is approximately 5 ha and the length of the WSP is approximately 500 m. Minto uses the reclaim water system from the WSP when water from the Mill Pond is insufficient for operations, and in addition to using reclaim water from the main pit tailing supernatant. All runoff collected from the site can be directed to the WSP if warranted, i.e. during base summer flows to recharge the process water supply for the winter. The WSP also receives direct runoff from the slope to the south.

Impacted water is stored in the Mill Pond (approximately 3 m depth) southwest of the mill. Currently the Mill Pond receives discharge from Pit dewatering and excess process water from the plant and is isolated from most surface water flow. Upper catchment flows are piped around the Mill Pond to avoid mixing with impacted water.

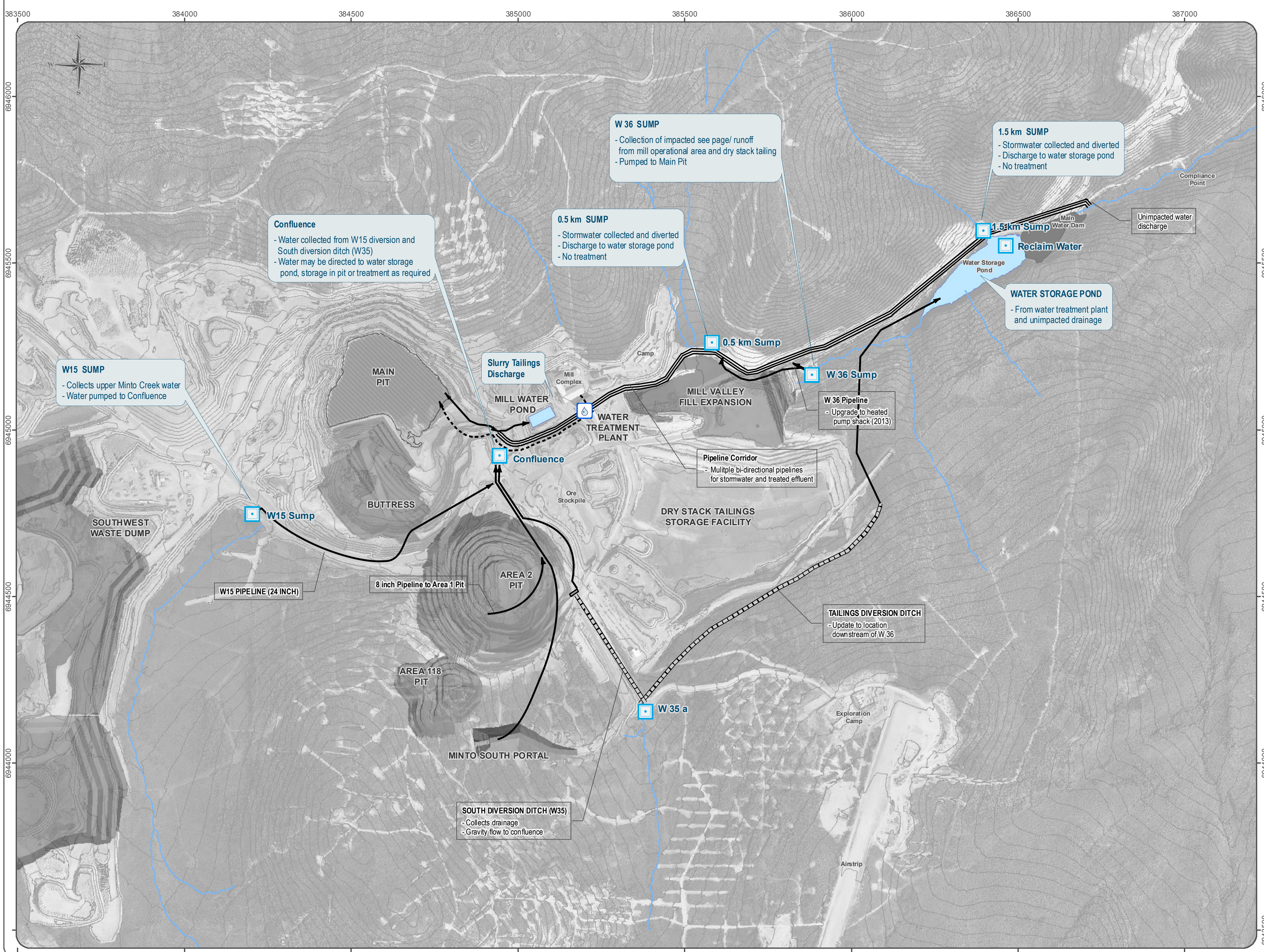
Runoff reporting to the W35 sump (including runoff pumped from the W15 sump and runoff from the South Diversion Ditch) can all be directed if appropriate into the Main Pit for temporary storage if required due to water quality constraints. Storage of water in the Pit is anticipated for short periods during freshet and significant precipitation events.

Stored impacted water will either be used as process water or treated prior to discharge. Undiverted storm water, and possibly some treated water, will report to the WSP, which may provide additional process water. As a contingency, the WSP may serve as a containment area in case of local failure of the impacted water circuit collection systems. If impacted water reports to the WSP, this water can be subsequently treated either directly in the WSP or pumped via the Conveyance Network for treatment in the Water Treatment Plant.

2.7.3.2 Conveyance Network

The Minto site has in place a network of collection points, ditches, berms, culverts, pipes and pumps (the "Conveyance Network" comprised of storm water and impacted water circuits) to divert storm water off site and, depending on observed water quality and operational requirements, discharge impacted water or move it to the WSP, Mill Pond or, if necessary, the Pit. The current locations and alignments of these collection and conveyance features are shown on Figure 2-4.

Pump stations are in place where gravity flow is not possible. Each collection sump is intended to briefly detain water during periods of peak flow until the associated pumping system is able to expel the excess water. Each sump includes a fail-safe consisting of a culvert, French drain or spillway which can release excess water from the collection sump in the event of pump failure or if the pumping capacity is exceeded. The collection sumps are designed to allow the pumps to operate at peak capacity, however Minto does not anticipate the collection sumps will capture all waters. Collection sumps and pump stations are not designed for 100% capture and conveyance of waters during freshet. The design of the Conveyance Network components anticipates that downstream structures (including the WSP) will accommodate overflow.



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MINTO MINE PHASE IV

RECLAMATION AND CLOSURE PLAN REVISION 4.0

FIGURE 2-4
OPERATIONAL WATER MANAGEMENT

SEPTEMBER 2013

- Collection Point
- Water Treatment Plant
- Pipe Alignment
- Piping Corridor
- Tailings Slury Discharge
- Diversion Ditch

0 100 200 300 400 500 Meters

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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(Last edited by: mducharme;16/09/2013/15:43 PM)

2.7.3.2.1 W15 Sump

Runoff reports to the W15 Sump from the upper Minto Creek catchments where the Southwest Dump and Reclamation Overburden Dump are located. Minto has characterized waters from these catchments as impacted water, because they drain an operational area of the mine. However, this runoff is currently less impacted and can be handled separately from the more impacted waters associated with the Pit, the mill/stockpiling area and the Dry-Stack Tailings area. A collection sump and pump station (W15 Sump) pumps water through a nominal 24-inch pipe into the South Diversion Ditch and ultimately to the W35 sump at the confluence area and, depending on measured water quality, subsequently discharged to the receiving environment, diverted and stored in the Water Storage Pond or directed to storage in anticipation of treatment.

2.7.3.2.2 South Diversion Ditch and W35 Sump (Confluence)

The South Diversion Ditch (SDD) intercepts channelized surface water from the south area of the upper watershed, which drains the area west of the airstrip. Since the Phase IV expansion, the SDD has been directing flow to a headwall that directs diverted water into a pipe following the road alignment and ties into the existing diversion pipe network in the confluence area near the mill. The headwall has a spill way that allows excess water to spill into the Area 2 pit if the flow rate exceeds the pipe capacity.

The collected runoff is directed via the South Diversion Ditch to the Confluence area and W35 sump and handled based on the same decision process as described above for the water pumped from the W15 sump.

2.7.3.2.3 Tailings Diversion Ditch

The design for the Dry Stack Tailings Storage Facility includes diversion structures to the south/east of the facility to redirect upslope run-on water away from the tailings and into the Minto Creek valley (ultimately to the WSP). A berm/ditch structure was constructed in 2009 but does not function as required. This structure is being re-constructed and extended to the east of the tailings area.

2.7.3.2.4 Km 0.5 and 1.5 Sumps

Storm water reporting to the Km 0.5 and 1.5 sumps along the site access road is diverted around the Minto Mine infrastructure using a system of collection sumps, pumps and pipes.

2.7.3.2.5 W37 Sump and Pipeline (impacted water)

The W37 Sump in the Minto Creek Valley down-gradient of the Dry Stack Tailings Facility and the mill complex area is a key component of the current and ongoing water management plan. Water quality results to date from the monitoring of the seepage from the tailings facility, as well as runoff from the stockpile and operational areas around the milling complex show high metal loads that require treatment prior to discharge from the site. The sump currently collects impacted water and pumps directly to the open pit and then to the WTP for treatment prior to release, through a dedicated pipeline that follows the pipeline corridor along the access road.

As a result of the Mill Valley Fill Expansion material being placed downgradient of the mill and DSTSF area, the W37 pipeline required realignment to keep it on the surface in this area. The sump and water retention berm were reconstructed to ensure adequate water capture, while the pumping system was upgraded to better handle large seasonal variations in flow rate.

2.7.3.3 Water Treatment Plant

In order to treat water to the required effluent quality standards, a clarifier system to treat impacted water using coagulants, flocculants and sulphide precipitation is used. In addition to the clarifier system, Minto also uses its Water Treatment Plant, constructed with similar technology and commissioned in May 2010. The 3,600 cubic metres per day (m^3/d) capacity WTP is located within a 60-foot by 150-foot building (18-feet in height) adjacent to the tailings filter building. This building enables year-round operation including in winter temperatures if necessary, however Minto's intent under normal conditions is to operate the WTP primarily during freshet and the summer months.

The WTP 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. A majority of the metal loading at Minto Mine is associated with TSS loading, therefore efficient TSS removal is an essential first step in the WTP design. To achieve this, the WTP is designed to accommodate a highly variable TSS concentration in impacted water and will incorporate several treatment steps, including coagulation of suspended solids using Nalco Aluminex 5 and use of organic sulphide TMT to convert dissolved copper to a sulphide that will be precipitated in a ballasted sand clarifier. The next step is addition of a flocculent in another clarifier to aid in the continued precipitation of TSS and sulphides. Treated water decants from the clarifier and undergoes filtration as a polishing step, and final discharge water may also be amended with sodium bicarbonate to maintain an adequate pH and alkalinity.

In 2011, Minto completed an assessment of options for adding a module to the existing WTP for removing these parameters to concentrations below the discharge standards. Treating water for selenium to concentrations less than 3 μg/L is possible but is exceedingly challenging without generating by-products that are far more environmentally hazardous and problematic from a disposal point of view. It was concluded that installation of a reverse osmosis (RO) unit offered the best chance of success of achieving the objective of releasing water from site in 2012. It was recognized, however, that the addition of a RO unit alone would not satisfy long-term water treatment requirements. An assessment of long-term water treatment or water management options is underway.

In 2012, two reverse osmosis (RO) trains capable of handling 2,500 m3/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 pre-treatment 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 is pumped to the Main Pit. 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.

2.7.3.4 Source Control

Since total suspended solids (TSS) can be a significant factor affecting water quality, an important part of the Water Management Plan is source control consisting of erosion prevention and dust suppression. Dust control efforts currently consist of watering roads, the addition of water and a dust-suppression reagent at the crusher, and use of a curtain at the top of the stacker conveyor. Minto continues to monitor dust levels and address any issues.

The primary erosion control initiative at the site is the establishment of the water diversion and conveyance network which significantly decreases water movement over disturbed areas at Minto Mine. On areas where diversion and collection as part of this network is not afforded, or areas upgradient of diversion and collection, protection against the mobilization of significant amounts of sediment is based on runoff, erosion and sediment control best management practices. Successful runoff control will reduce the need for more expensive and difficult erosion and sediment control measures. Ongoing BMPs at the Minto Mine include:

- Swales and tail ditches to limit sediment mobilization on exploration roads;
- Recovering and re-seeding 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.

2.7.3.5 Monitoring Program and Mine Water Discharge

A key component of the current and proposed water management plans is the water quality surveillance program. The water quality (and quantity) monitoring program results provide valuable information that is used on a variety of timescales from instantly to annually to make water management decisions at the site. The water quality surveillance program is reported monthly, quarterly and annually as required by the water use licence.

3 ENVIRONMENTAL SETTING

Table 2-1 provides a summary of the key environmental features near the project area. Baseline environmental reports have been prepared to document and describe the existing environmental setting of the site. These baseline reports are attached as Appendices in the Minto Mine Phase V/VI Expansion Project Proposal. Readers of this document are referred to those reports should additional information be required.

Forest fires have affected large parts of the Minto Creek basin and surrounding areas during the past twenty years, and as recently as the summer of 2010. An earthquake January 30, 2008 resulted in a review of the engineering design of all major infrastructure units, which are have design peak ground accelerations of 0.055 to 0.150 g.

3.1 CLIMATE, HYDROLOGY AND DESIGN EVENTS

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.

Meteorological data are available for the Minto Mine site from two meteorological stations that have been operational since 2005 and 2010, respectively. They provide a continuous but short record of air temperature, wind velocity and direction, pressure, and precipitation. Long-term meteorological data and climate normals are available from the Pelly Ranch (Fort Selkirk – Climate ID#2100880) Meteorological Service of Canada station, 25 km northeast of the Minto Mine, with a continuous record of daily air temperatures and precipitation in the form of rainfall and snowfall from 1956 to present (57 years). Snow surveys have been conducted at Minto Mine in 1994, 1995, 1998, and annually from 2006 to date, at three locations in the Minto Creek catchment area. Hydrometric data have been collected intermittently on Minto Creek since 1993 at two stations: W1, Minto Creek near the mouth, with a catchment area of 42 km^2 and W3, Minto Creek downstream of water storage pond dam, with a catchment of 10.4 km^2.

The mean annual rainfall measured at Minto is 174 mm (EBA 2010; omitting precipitation occurring when air temperatures were below zero due to improper tipping bucket readings). 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).

August is the rainiest month at the Minto site 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). The extreme daily rainfall recorded for Pelly Ranch was 34.8 mm on July 20, 1960, while the extreme daily snowfall recorded for Pelly Ranch was 20.8 cm on November 27, 1958, with 20 cm also recorded on March 23, 1993. 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.

Additional the climate baseline information and precipitation analysis are available in the Minto Climate Baseline Report (ACG, 2013a) and the Precipitation Analysis for the Minto Mine Memorandum (SRK Consulting, 2012b) respectively.

Design flood flows used for the design of water conveyance structures were calculated using the rational method. Given that extreme rainfall events tend to yield the largest instantaneous flows for small watersheds like the Minto Mine site, the rational method provides a methodology to calculate extreme flows from design rainfall events. For ditches located downstream of the pits, flow routing through the pits was also considered given the significant surface area of the pits compared to the calculated flows.

Sub-catchments for the different water conveyance structures was performed in ArcGIS using the end-of-Phase-IV contour data. Rainfall intensities were derived from the Pelly Ranch Intensity-Duration-Frequency. Runoff coefficients were selected for forested areas (0.25) and disturbed lands (0.5) within each catchment. The length of the rainfall event was adjusted to the time of concentration of each sub-catchment. The time of concentration is defined as the theoretical time it would take for water to travel from the headwaters of the basin to the outlet, or the time it would take for the entire catchment to contribute to flow.

The 200-year flood (0.5 % probability of exceedence in any single year) was selected as a baseline value for evaluating preliminary sizing of water conveyance and diversion channels for closure. Detailed explanations of the derivation of design flows and the design of water conveyance ditches are provided in the Closure Hydrology Report (Appendix B).

3.2 CLOSURE WATER QUALITY PREDICTIONS

Minto retained SRK to develop a predictive water chemistry model in order to understand more thoroughly what the potential water quality discharging from the site would be at closure. The predictive water chemistry model is based on site monitoring data and the ongoing geochemical characterization program which includes humidity cells conducted on appropriate material types, and is an update of previous similar work conducted by SRK for both closure and operational periods. A copy of the results of the predictive water quality model for the site can be found in Appendix A.

Previous water quality prediction work in support of the closure planning for Minto (2011 DRP) incorporated the following key elements:

- Hydrology source terms from the site water balance model;
- Areas and locations of waste placement;
- Geochemical source terms based on information available at the time; and
- Mitigation measures required to achieve closure water quality objectives for Phase IV. These included:
    - Soil covers; and
    - Passive/semi-passive treatment of surface waters at key locations.

Most of these key elements have been revisited for the update of the predictive modeling for Phase V/VI, and also utilized for this Phase IV RCP. These predictions, although developed for an expanded mine plan, are appropriate and conservative as planning tools for Phase IV closure planning. The reader is directed to SRK's report entitled *Minto Mine Phase V/VI Expansion: Water and Load Balance Model Report* which is appended to this report as Appendix A.

This predictive modeling work was initially conducted as a screening exercise using isolating soil covers on waste facilities as the sole closure mitigation, and did not incorporate expected load reductions from planned passive treatment systems. This was conducted to inform the closure planning team of the initial mitigative value of isolating soil covers in mitigating expected water quality from site runoff and seepage at closure. A series of scenarios was evaluated in the modeling (typical/upper limit concentrations, expected case/reasonable worst-case) and summary tables for key parameters during the 'open months' (April through October) are provided below in Table 3-1 through Table 3-4 below for Site Effluent (Water Storage Pond) and Lower Minto Creek (W1) locations during the post-closure period.

Table 3-1: 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
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 3-2: 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
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 3-3: 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
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 3-4: 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
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

For the post-closure period, the expected case (typical concentrations) and reasonable worst-case (upper limit concentrations) scenarios were evaluated in an aquatic resource effects assessment, described in Section 8 of Minto's *Phase V/VI Expansion Mining and Milling, Minto Mine* Project Proposal to YESAB (July 2013). The outcomes of the modeling and effects assessment suggest that even in the most conservative of evaluated model scenarios (reasonable worst case, upper limit concentrations), mitigation of potential metal loading from waste facilities using operational source control and closure isolating soil covers constructed from available site materials alone are not expected to result in adverse effects to aquatic resources downstream of Minto mine.

As such, further loading reductions from additional mitigations – namely passive treatment systems – were not integrated further into SRK's modeling work. SRK did provide the closure planning team with estimations for water quality/quantity at key proposed passive treatment areas (W15 below SWD, surface of Main Pit with completed tailings deposition, and W37 area at the toe of the MVFE). These estimations were utilized with additional site information to develop effluent estimations from wetland at these locations. This information is provided in Section 6 as contingency water treatment rationale, along with proposed key reclamation measures for these locations.

The outcomes of the water quality predictions, the effects assessment evaluating the potential effects on aquatic resources from the Minto mine in a reasonably conservative closure scenario, and the feedback from the effects assessment on the proposed closure mitigation measures has led to the refinement of the Minto Mine closure and reclamation strategy. Section 4 introduces this reclamation strategy, and the subsequent sections provide more detailed information on the reclamation and closure plan.

4 RECLAMATION STRATEGY

This section of the RCP provides reclamation objectives and the overall reclamation strategy for the Minto site. Also provided is information regarding planned reclamation, revegetation research programs and details and observations on reclamation and re-vegetation to date. The reclamation strategy proposed by Minto is based on the long-term protection of aquatic resources in the downstream environment of Minto Creek and the Yukon River.

A systematic approach to decommissioning and closure reclamation has been developed for the Minto project. Progressive reclamation measures have been implemented where possible during mine construction and operations. This approach has provided valuable reclamation success feedback for use in advanced/final closure, and these progressive efforts will also help reduce slope erosion through physical slope stabilization of revegetation efforts, enhancing ultimate reclamation success.

An important part of the reclamation planned for the Minto Mine is the safe conveyance of surface water through the site toward Minto Creek. The alignment of major ditches to convey water on the mine site has been established to prevent erosion and to protect site infrastructure. The site layout is presented in Section 6.8, while additional discussion of the design of ditches is presented in subsequent sections.

Minto has received substantial feedback on closure plan submissions – from regulatory bodies, and from Selkirk First Nation, including their respective technical reviewers. This feedback – combined with results from reclamation research and specific evaluations of site conditions – has enabled Minto to refine their reclamation strategy for the Minto Mine site. A key exercise guiding this evaluation and refinement of the Minto reclamation strategy was undertaken in January 2013 in the form of a preliminary Failure Modes and Effects Assessment (FMEA) session. A two day workshop (followed by partial day sessions to complete the exercise with a smaller group was held to identify the risks involved with components of a few different closure option scenarios being considered for the Minto mine. The workshop, facilitated by Dirk van Zyl of the University of British Columbia, was held in Whitehorse from January 15th – 19th, 2013. Technical representatives from the following stakeholders and government agencies participated:

- Capstone Mining Corp.;
- Selkirk First Nation;
- Access Consulting Group;
- SRK Consulting;
- Yukon Government, Energy, Mines, and Resources (Steve Jan Consultants); and
- Yukon Water Board (Gomm Environmental Engineering Company).

Lead up meetings on closure planning strategies with technical representatives from SFN and YG EMR in December 2012 had 'shortlisted' 6 candidate closure scenarios for the Minto Site, each of which had a different key closure measure focus. The FMEA group concurred after reviewing some preliminary water quality estimations for each scenario that there were 3 most likely scenarios that were appropriate to carry forward through the FMEA process. These are presented below with the key assumptions of each:

Scenario1: Source Control Focus

- Highest quality covers on waste rock and tailings
- No treatment

Scenario 2: Hybrid of Source Control and Treatment Focus

- High quality covers on waste rock and tailings
- Use of active and passive treatments on site

Scenario 3: Treatment Focus

- Routine quality covers on waste rock and tailings
- Use of active and passive treatments on site, managing water using reservoirs to optimize treatment plant function and collection systems

The outcomes of the preliminary FMEA process are captured in the tables presented in Appendix C. The group initially identified classes of failure, which were used to identify potential failure mechanisms with associated likelihood and consequence factors. The pre-developed spreadsheet tools then assigned each failure mechanism with a risk ranking, and the team collaborated on considerations and potential risk mitigation measures for failure modes. The session completed with an understanding that once the final closure strategy for the site were determined, that the FMEA exercise should be revisited specific to the proposed closure measures.

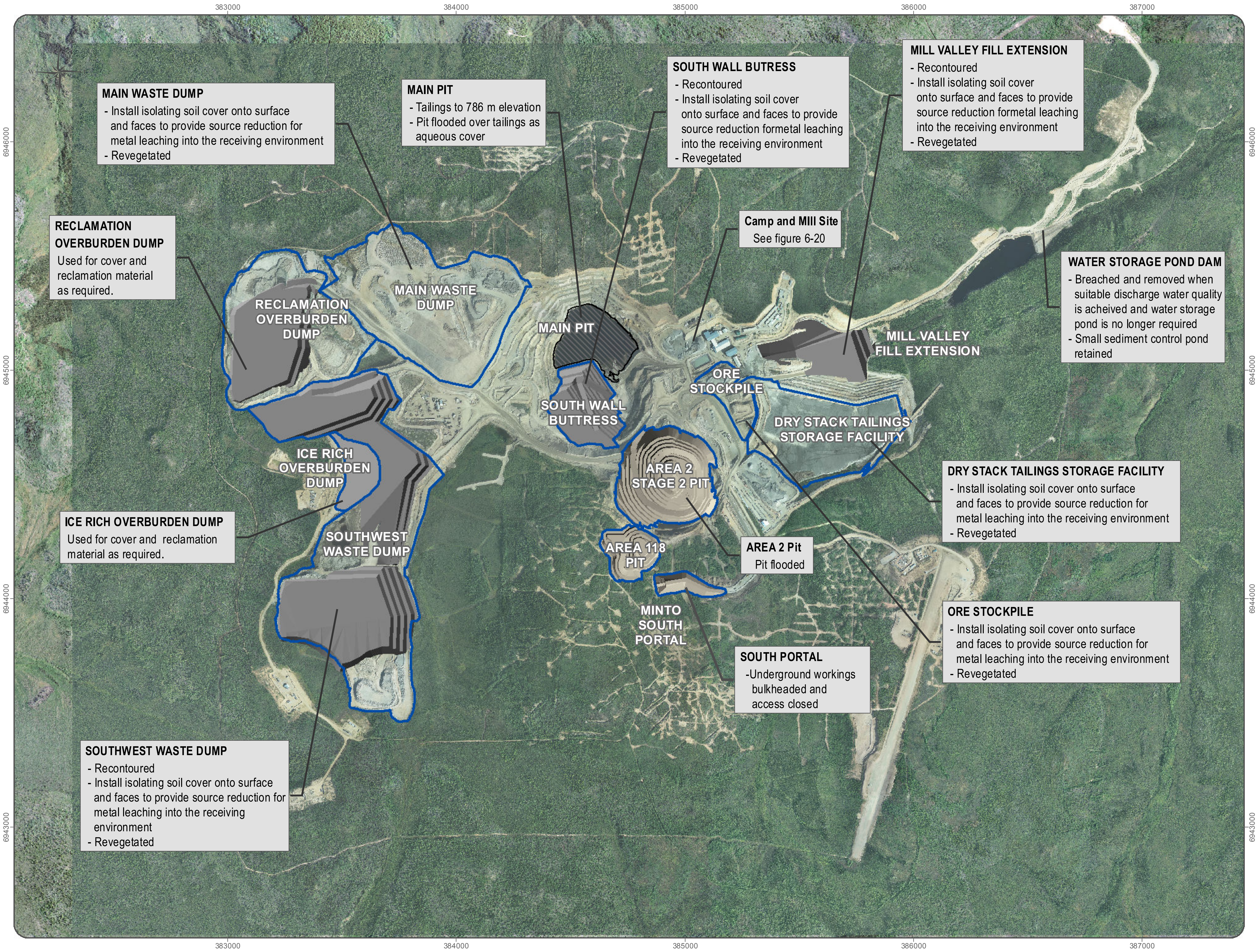
As a result of the review of the preliminary FMEA findings (specifically the potential failure mechanisms assigned the highest risk), and further informed by more recent site evaluations (updated water quality prediction and cover material evaluation), Minto has adopted limited source control of potential contaminants with contingency load reduction through passive and/or active treatment as the principle tenets of the reclamation strategy for the Minto site. This is effectively a variation of Scenario 3, which employs water treatment (either passive or active) as contingency measures, as opposed to 'key' reclamation measures. This shift is predicated on the recent water quality prediction modelling for the site, and the attendant effects assessment submitted for the Phase V/VI Expansion, as outlined above in Section 3.2. This strategy will be employed with a stronger emphasis on Adaptive Management of the closure conditions, a clear outcome of the preliminary FMEA process.

The revisiting of the FMEA in the context of this preferred strategy has not been completed to date, largely due to outstanding uncertainty regarding the required stabilization measures for DSTSF instability (for which internal and 3rd party evaluations are ongoing). Minto recognizes the sensitivity of the participating parties to the application of these preliminary results. Minto also recognizes that SFN may not concur with the adopted closure and reclamation strategy in this RCP, however Minto and SFN continue to work together on both leadership and technical levels to resolve key differences of opinion related to closure of the Minto site. Minto will continue these discussions in the ongoing collaborative closure planning efforts and ultimately attempt to achieve a set of closure objectives and mitigation measures that has the full support of SFN. In the interim, the preliminary FMEA results have been exceedingly useful in guiding the closure planning team towards the preferred closure strategy. Minto suggests that these findings adequately cover potential failure modes for the strategy presented in this RCP, and is confident that the reclamation and closure strategy put forward is a responsible and achievable plan that will effectively achieve the stated closure objectives for the Minto site.

The application of the revised closure and reclamation strategy will be presented in Section 6 and detailed in key reclamation measures outlining the isolation of mining wastes from the environment. The use of passive water treatment technologies at the site has been contemplated as a key in previous site closure plans. Refinement of geochemical source term and water quality predictions suggests that the additional load reduction offered by passive treatment will not be required to meet suitable discharge water quality. Passive treatment systems are now included as contingency closure measures. Active treatment is discussed but is considered mitigation for the active decommissioning and transitional closure period, and beyond that, a worst-case final fallback mitigation to potential water quality impacts from the site if the mitigative measures described in Section 4.2 are not effective in reducing metal loadings to the receiving environment.

Overall reclamation measures are summarized by site feature in Figure 4-1.

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. Adaptive Management Planning is widely accepted as an appropriate tool for achieving this objective, and Minto has included an AMP framework with this RCP (Appendix D) and intends to advance its level of detail in future versions of this plan in collaboration with SFN and their technical advisors.



capstone
MINTO MINE

MINTO MINE PHASE IV

RECLAMATION AND CLOSURE PLAN REVISION 4.0

FIGURE 4-1 SUMMARY OF PROPOSED RECLAMATION MEASURES

SEPTEMBER 2013

Phase IV Tailings
Phase IV Dumps
Phase IV Pits

0 100 200 300 400 500 Meters

ACCESS

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

Datum: NAD 83 Projection: UTM Zone 8N

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4.1 RECLAMATION AND CLOSURE OBJECTIVES

The primary objectives of the closure and reclamation of Minto Mine are:

- To have a closure planning process that seeks input from SFN and incorporates the input into closure planning;
- To protect the health of people pursuing traditional activities including hunting, fishing, trapping, camping and collection of plants for food, medicinal or cultural purposes;
- To protect people from safety risks when they are pursuing traditional activities including hunting, fishing, trapping, camping and collection of plants for food, medicinal or cultural purposes;
- To protect the environment (including land, air, water, plants, animals fish and other environmental components and their interrelationships) from long term effects caused by the mine activities and facilities;
- To return the mine site and affected areas to a state similar to surrounding lands so that people can pursue traditional activities the same as they did before mining, including hunting, fishing, trapping, camping and the collection of plants for food, medicinal or cultural purposes;
- To protect the environment from long-term effects caused by post-closure access to the mine area;
- To protect the environment from effects of earthquakes, floods, climate change and other natural events on related mine structures;
- To have effective management and control structures in place during operation, closure and post-closure to provide:
    - Adequate financial resources to carry out all closure activities including plan implementation and long-term activities;
    - Adequate flexibility during closure and post-closure to allow adaptation of activities in order to address unexpected performance and events; and
    - Consideration of Minto's long-term desire to "walk away" from the site under conditions acceptable to SFN and with adequate resources provided to address long term requirements.
    - To minimize long term activities by ensuring long term chemical and physical stability of mining components and disturbed areas;
    - To confirm the effectiveness of closure measures by monitoring the site after closure, and to respond adaptively if measures are not performing as expected;
- To undertake mine planning incorporating progressive reclamation;
- To provide short and long term slope stabilization and erosion control on linear and non-linear disturbances;
- To ensure the long-term chemical stability of residual mining components and their effects on water quality draining the property;
- To ensuring the long-term physical stability of key structures such as the waste dumps and the diversion and drainage ditches; and
- To work towards a passive closure scenario for most or all mine components.

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. Further information on the key reclamation and closure methods is introduced in Section 4.2, and information regarding the selected methods for specific mine components is presented in Section 6.

These closure objectives are reflective of the closure objectives laid out for the licensee to achieve in Schedule B of the Quartz Mining Licence QML-0001 "Terrestrial Reclamation Standards for the Minto Mine". These standards were derived from the YG's Reclamation and Closure Policy as well from a submission from the SFN Lands and Resources Department which represents the interests of SFN members.

4.1.1 Closure Water Quality Objectives

As identified above, one of Minto's key closure and reclamation objectives for the Minto site is:

> *To protect the environment (including land, air, water, plants, animals fish and other environmental components and their interrelationships) from long term effects caused by the mine activities and facilities;*

Minto considers this goal as the paramount guiding objective to follow in the identification of objectives for runoff and receiving environment water quality from the Minto site at closure. Minto used recent predictive modeling work and subsequent potential environmental effects evaluations related to the proposal for the Phase V/VI Expansion of the Minto Mine as the premise for the closure water quality objectives.

In that proposal (YESAB, Project #2013-0100) Minto evaluated the existing effluent and water quality standards in the Water Use Licence QZ96-006 in terms of their appropriateness, achievability, and effectiveness in ensuring protection of aquatic resources in the Minto Creek and Yukon River receiving environments. Since early 2011 natural variability in the Minto Creek system downstream of the area of the mine's control has resulted in substantial exceedances in water quality standards at station W2 in the absence of any discharge from the mine. Minto cannot, under any scenario, achieve water quality in lower Minto Creek meeting these values.

Minto is proposing a reclamation and closure strategy which defines water quality objectives as:

- the existing *licenced* effluent discharge *limits* as measured at the last point of control for the site in closure (proposed at station W50).

Minto's revised closure water quality prediction for Phase V/VI (considered a reasonable and conservative proxy for Phase IV) suggests that most of the existing licenced effluent limits would be achievable under the proposed Phase IV closure and reclamation strategy. Cadmium and selenium are the sole licenced parameters for which this may not be the case. Minto has however put forward in the Phase V/VI Expansion proposal to YESAB extensive rationale for – and evaluation of potential effects of – the revision of the cadmium and selenium effluent limits. The outcome of that effects assessment supports the revision of the cadmium and selenium limits and does not anticipate any significant adverse effects related to cadmium and selenium concentrations from effluent discharge under proposed closure conditions.

Minto recognizes that monitoring of potential effects to aquatic resources in the receiving environment is a responsibility of the company in both operational and closure conditions. Minto will use the Adaptive Management Plan framework committed to in this RCP to achieve the closure objective of *long-term protection of aquatic resources in lower Minto Creek and Yukon River*. Appropriate monitoring and effects evaluation tools, e.g. the Biotic Ligand Model for aqueous copper, will be employed throughout the proposed closure monitoring period to ensure this objective is achieved.

Closure water quality objectives are the subject of ongoing discussion with SFN, and Minto is committed to continuing the dialogue and technical evaluation of alternative water quality objective definitions going forward. These discussions are currently aimed at finding a mutually agreeable definition of suitable water quality and mechanisms for ensuring its achievement.

4.2 KEY RECLAMATION AND CLOSURE METHODS

Through previous closure planning initiatives and ongoing reclamation research, Minto has identified several key reclamation and closure methods that are consistent with meeting the reclamation objectives identified in the previous section. To this end, Minto has considered closure and reclamation 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), Minto 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 remainder of this section describes the techniques and methods that are specific to addressing higher risk failure mechanisms and to achieving suitable site discharge water quality at closure. These include:

a) Source Control methods; and

b) Contingency Water Treatment.

4.2.1 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 issues. 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 IV will primarily be a combination of operational characterization and materials handling programs, sub-aqueous disposal and soil covers.

4.2.1.1 Operational Materials Characterization and Materials Handling Plans

Materials characterization allows mining companies to understand the different ore and waste material types present at a site and develop special handling plans based on any identified environmental concerns associated with each material type. Minto tests all of its development rock in advance of the materials being removed from the active mining face. For Phase IV, the waste rocks are characterized based on the acid rock drainage potential and the contained copper content.

The use of copper content for the development of the waste rock classification system is supported by the association of increased abundance of copper sulphide mineralization with increasing mineralization of the deposit. A review of the geologic database indicates that over 90% of the total contained metals within the geological materials at this site occur within materials with a copper content of greater than 0.1%. It should be noted that the lack of materials characterization and handling programs during the initial phases of mining at the site resulted in potential metal leaching material being placed into the waste rock dumps which have a larger surface area. Geochemical characterization work conducted by SRK in support of Phase IV identified the need for materials characterization and handling program to ensure that waste materials with the potential for metal leaching could be identified and stockpiled or disposed of in an appropriate manner.

Material handling plans are used to instruct the mining operation crews as to where the different rock classes may be placed. Minto has an established materials handling and classification system in order to identify ore and waste during operations. The current Minto waste materials handling procedure is summarized as follows:

- Drill cuttings from every blasthole are sampled, bagged, tagged, and sent for to the assay lab prior to blasting;
- A representative sample of the cuttings is assayed using atomic absorption (AA) to determine the metal content: The Minto assay lab, under supervision of the Chief Assayer, has the ability to conduct copper, oxide, and silver assays;
- 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;
- After blasting, the aforementioned polygons are laid out in the field by the Mine Surveyor working with the Production Geologist in order to inform Mine Operations of where the materials within a polygon are to be taken;
- Field layout is done with using stakes and flags of various predefined colors for ore bearing materials;
- Ore and waste are loaded out and dispatched to the appropriate locations based on the aforementioned flags;
- These locations are communicated to foremen and operators by the Production Geologist and under the direction of the Mine Foreman.

The current Minto materials handling procedure has been expanded during Phase IV development to include the identified waste categories. Table 4-1 contains the waste rock material classifications and handling plans that were utilized during Phase IV.

Table 4-1 Waste Rock Classifications and Handling Plans

Material	Handling Plan and Closure Measure
Waste rock with no copper content	Material to be used for general construction fill at the site. No neutral metal leaching expected to occur.
Waste rock with contained copper content of less than 0.1%	Material to be placed into the waste rock dump or backfilled into the Area 118 pit. Minor neutral metal leaching may result from this material but is not expected to be significant due to the low metals content
Waste rock with a contained copper content from 0.1% to 0.3%	Medium Grade Waste originally to be stockpiled in the Grade Bin Disposal Area for subsequent disposal at closure. South Wall instability necessitated relocation of this stockpile to SWD, revision of geochemical source terms and water quality prediction suggest rudimentary cover in place is a sufficient closure measure.
Waste rock with a contained copper content from 0.3% to 0.64%	High Grade Waste which could be milled at the end of mining, to be stockpiled. Currently stockpiled at southern extent of SWD, will most likely remain in place at closure given current commodity prices, Minto suggesting high quality cover as precautionary closure measure, although revised geochemical source terms do not suggest this is necessary.
Waste rock classified as Potentially Acid Generating based on geochemical characterization program	Material to be simultaneously disposed with tailings into the Main Pit for subsequent sub-aqueous disposal at closure. This is being conducted currently.

Overburden segregation is required for mine sites where there is a need to ensure that waste materials generated by stripping and other development activities are preserved for future reclamation activities. The implementation of reclamation at the Minto Mine will require a large volume of overburden for isolating soil cover construction. Overburden has been stockpiled separate from waste rock since in the Ice-Rich Overburden Dump and the Reclamation Overburden dump for this purpose. SRK's characterization of available and expected overburden materials in the context of their potential for use in construction of waste covers is included in Appendix E.

4.2.1.2 Sub-aqueous Disposal

Sub-aqueous disposal involves the placement of materials underwater. In the case of potentially acid-generating materials, this method of disposal is done in order to limit exposure to oxygen. This method of source control can be very effective given that the dissolved oxygen content of water is approximately 10,000 times less than for materials that are located above water. In the case of tailings materials for Minto, which are not an acid generating concern, sub-aqueous disposal is conducted to contain the materials and to limit the neutral metal leaching, erosional and runoff concerns associated with surface disposal options. Minto currently employs this method with NP:AP<3 waste material from the Phase IV mining, and disposes of the slurry tailings from milling in this fashion (in the Main Pit currently).

Flooding of waste rock in a pit lake will result in some initial flushing of metals as the materials become wetted but this can be treated either with passive batch treatment or active treatment if required prior to water being discharged from the pit. Once the waste rock and tailings within the pit has become flooded the movement of water through the flooded materials becomes controlled by diffusion which acts to limit metal leaching.

Over time, the development of a fine sediment layer on the surface of flooded materials helps to seal off the materials and further limits their ability to contribute to metal loadings. The period immediately following the placement of soil covers onto waste dumps will potentially contribute to the development of sediment layers until such a time as vegetation becomes well established.

4.2.1.3 Waste Cover Systems

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 material at closure. Different cover options have very different performance, installation and maintenance considerations. SRK has presented a thorough scoping level assessment of waste cover options, and this evaluation is presented in Appendix E.

As identified in Section 3 previously, the water quality at closure is expected to be protective of the most sensitive receiver – even under reasonable worst case, upper limit concentration conditions – from the application of a rudimentary isolating soil cover on waste materials. Accordingly, the reclamation strategy now 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.

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. Figure 4-2 below presents a simple preliminary design of this preferred closure cover type.

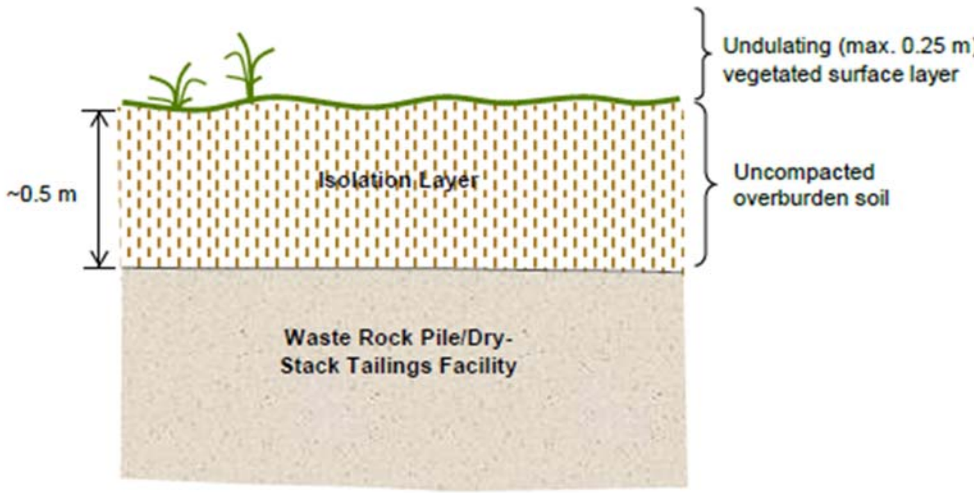


Figure 4-2 Conceptual Isolation Cover (SRK, 2013a)

The following sections detail contingency mitigation measures that are intended to provide additional load reduction capacity from site sources should the isolating soil covers not provide the anticipated mitigation.

4.2.2 Contingency Water Treatment Methods

4.2.2.1 Pit Lake Pre-Treatment

The Main Pit and Area 2 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. 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 Main Pit and/or 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 pits as pre-treatment sites for semi-passive treatment vessels could be done especially during the transition from active water treatment to passive closure. Two practical approaches that could be combined include:
    - Addition of organic reagents and/or alkaline reagents to the pits to create an anaerobic zone in the lake where metal removal in reductive forms, including metal sulphides or reduced metal oxides, is encouraged. Typically a combination of carbon sources is utilized to achieve both rapid formation of reductive conditions (carbon sources such as sugars and alcohols), and sustained maintenance of reductive conditions (carbon sources such as wood chips and other biomass forms).
    - Addition of nutrients including nitrogen and/or phosphate will enhance the development of a photosynthetic algal or microbial population in the lake, which will provide both a direct removal by sorption on biomass, as well as sustaining anaerobic conditions in the deeper part of the lake as the photosynthetic biomass decays, acting as a sustainable mechanism for anaerobic conditions in the lake bottom.
- Examples of the pre-treatment of pit lakes for metals removal include:
    - The Anchor Hill pit at the Gilt Edge Mine in South Dakota, which had ice-covered conditions for more than five months of the year, where alkaline reagents and multiple organic sources including wood chips, alcohols, and sugar syrups were added (Harrington et al., 2004). Greater than 90% removal of metals including copper were achieved and sustained for several years.
    - The pit lake at the Barite Hill Mine in South Carolina, alkaline reagents and multiple organic sources including wood chips, alcohols, and sugar syrups were added (Harrington et al. 2009). Greater than 99% removal of most metals including copper was achieved.

Investigations are currently underway to evaluate the feasibility and effectiveness of batch treating pit-lake water by adding additional carbon sources (e.g., sugars and alcohols) to create reducing conditions that would facilitate the precipitation of metals as sulphides. Initial limnocorral tests have provided promising results for sequestering metals. These evaluations will continue over the next several years to develop “proof of concept” for batch treatment of the pit-lake water. More details of the ongoing pit-lake treatment evaluation are presented in Section 4.5.4.1.

4.2.2.2 Passive and Semi-Passive Treatment Systems

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 the application of standard reclamation measures and covering of wastes with isolating soil covers will be sufficient to achieve suitable discharge water quality without the need for additional treatment. That said, the importance of additional load mitigation measures to account for 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 adaptive management measures for the achievement of acceptable water quality from the Minto site in the closure condition. The use of passive treatment will be guided by the Adaptive Management Plan (Appendix D).

Passive treatment as a remediation method for mine-impacted water can be a sustainable method used during post-closure of a mine, as they generally involve significantly less direct capital costs, as well as lower operations and maintenance costs, when compared to traditional active treatment options (Kilbourn Inc., 1999).

There are numerous definitions of passive treatment that have been used. Gusek (2002) defined passive treatment in terms of the use of each type of treatment that occurs within a system, such that

> *Passive treatment is a process of sequentially removing metals and/or acidity in a natural-looking, man-made bio-system that capitalizes on ecological and geochemical reactions. The process requires no power and no chemicals after construction and lasts for decades with minimal human help.*

While Pulles et al. (2004) defined passive treatment processes in terms of energy:

> *A water treatment system that utilizes naturally available energy sources such as topographical gradient, microbial metabolic energy, photosynthesis and chemical energy and requires regular, but infrequent maintenance to operate successfully over its design life.*

The Global Acid Rock Drainage (GARD) Guide's (INAP, 2010) definition builds from the previous two to describe passive treatment as

> *Processes that do not require regular human intervention, operations, or maintenance and should typically employ natural construction materials, (e.g., soils, clays, and broken rock), natural materials (e.g., plant residues such as straw, wood chips, manure, and compost) and promote the growth of natural vegetation. Passive treatment systems use gravity flow for water movement.*

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.

All of the definitions involve a minimal amount of operations and maintenance, and the use of mimicking natural mechanisms in a controlled environment; however, it is Gusek's definition which includes the concept of sequential that becomes significant for the purposes of remediating mine-closure sites. No single cell or specific type passive treatment system can completely remediate a complicated mine drainage site on its own. The use of numerous systems or groups of systems are designed to target different aspects of the whole to work together to achieve adequate removal. Thus, passive treatment must be seen as a sequence of processes that achieve an end result together, since there is no single system that can be effective in every situation (Gusek, 2009).

With that in mind – and with the assumption that if required, passive treatment systems would be employed in a contingency, adaptive manner – it was recognized at the outset that reclamation research into passive treatment at the Minto site would need to focus not only the individual technologies but also innovative ways in which the various complementary passive treatment technologies can be combined in an optimal manner to create robust, self-sustaining, integrated passive treatment systems which can handle a wide range of conditions, variable flow rates and large fluctuations in water quality.

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 to have available for implementation should the key source control closure measures not perform as anticipated. In order to confirm the feasibility of passive treatment systems to provide significant additional reduction of contaminant load generated 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 detailed review of the site wide water balance confirmed that significant portion of the mining impacted seepage, surface flow and contaminant load could be passively intercepted at a few specific areas which have sufficient space and topography for the incorporation of a wide variety of passive treatment systems (e.g., constructed wetlands).

The various potential passive treatment technologies were evaluated and ranked in order to determine which passive treatment technologies held the greatest promise for incorporation in Minto water management and closure planning. A guidance document to help short list and then select an appropriate method for managing mine waste sites was created by The Interstate Technology and Regulatory Council (ITRC), a body of socio-economic and environmental regulators, industry, federal government, and stakeholders that work towards innovative environmental decision making (ITRC, 2010).

ITRC's "Mining Waste Treatment Technology Selection" guidance document (and associated literature reviews) is an interactive and iterative web-based decision tree which provides a systematic framework that can be used to identify a short list of appropriate technologies (ITRC, 2012). The ITRC decision tree framework was used for identifying the range of potential passive treatment technologies which may be applicable at the Minto Mine because it provides a straightforward and transparent method for selecting treatment technologies. It also provides legitimacy in the selection process by using an internationally recognized method that was created specifically for mining waste sites.

Following the identification of potential passive treatment technologies, a screening level evaluation and ranking of the potential passive treatment technologies was conducted. Some of the key considerations evaluating the various treatment technologies included:

- Work acceptably in cold weather;
- Sustainable in the long-term;
- Minimal/low intensity active maintenance scenario;
- Suitable for addressing Minto's specific CoCs (e.g., Cu, Cd, Se);
- Robust technology with adequate precedent of successful application;

- Amenable to collaboration with SFN and consistent with their aspirations for long-term employment and future land use;
- Cost effective; and
- Amenable to incorporation in an Adaptive Management Plan and modifying/expanding if initial design underperforms.

The technology evaluation and ranking (based on key considerations listed above) concluded that biological reactors (bioreactors) and constructed wetland treatment systems (CWTSs) are the two most promising technologies for further, site-specific consideration at Minto. Permeable reactive barriers (PRBs) also ranked high; however, it was recognized that foundation conditions (in particular discontinuous permafrost) combined with the site layout may limit potential applicability at the Minto site. Research is also ongoing into the potential for in-pit treatment to play a role in addressing site wide water quality issues.

4.2.2.2.1 Constructed Wetland Treatment Systems (CWTS)

Wetlands are areas of transition between uplands and open water, possessing unique biogeochemical cycles that function to transfer and transform materials within the ecosystem (Mitsch and Gosselink 1993). These biogeochemical cycles are influenced by a number of interrelated biological, chemical, and physical processes involving unique hydrologic, vegetation, hydrosoil, and microbial conditions (Mitsch and Gosselink 1993). Because of their inherent ability to transfer and transform materials that flow through them, wetlands have received considerable attention for water treatment (Hammer 1989, Dunbabin and Bowmer 1992, Moshiri 1993, Davies and Cottingham 1994, Kent 1994). Mitsch and Gosselink (1993) listed the following wetland attributes that can affect surface water character:

- A decrease in water velocity, causing sediments and chemical sorbed to sediments to drop out of the water column;
- A variety of anaerobic and aerobic processes in close proximity, promoting de-nitrification, chemical precipitation, and other chemical reactions that remove certain materials from the water column;
- High rates of productivity that can enhance mineral uptake by vegetation and subsequent burial in the sediments when plants senesce;
- A diversity of decomposers and decomposition processes in wetland sediments;
- Significant sediment-water exchange; and
- Accumulation of organic peat, resulting in burial of sediment-bound chemicals.

However, natural wetlands are often not available or appropriate for water treatment purposes. Therefore, wetlands can be constructed with specific design features (vegetation, hydroperiod and hydrosoil) that enhance transfers and transformations of targeted materials (Sinicrope et al. 1992, Hawkins et al. 1997, Gillespie et al. 1999, Gillespie et al. 2000, Huddleston et al. 2000).

Constructed wetlands differ from natural wetlands in that they are typically designed for a specific purpose or purposes, such as wastewater treatment, fish and wildlife habitat, migratory waterfowl usage, flood control, and aesthetic values (Bastian and Hammer, 1993). Wetlands have been designed and constructed for treatment of wastewaters from a variety of sources, including storm water and agricultural runoff (Ferlow 1993, Higgins et al. 1993, Rodgers and Dunn 1992, Moore 2000) municipalities (Bastian et al. 1989) petroleum refineries (Litchfield and Schatz 1989, Hawkins et al. 1997, Gillespie et al. 2000, Huddleston et al. 2000), pulp and paper mills (Sherwood 1992, Boyd et al. 1993, Thut 1993, Moore et al. 1994), and acid mine drainage (Brodie 1993, Eger et al. 1993, Hedin et al. 1994). Wastewater constituents that have been successfully treated (decreased or removed) by constructed wetlands include biochemical oxygen demand, suspended solids, nitrogen and phosphorus compounds, organic chemicals, and metals (Hammer 1989, Moshiri 1993, Kent 1994).

There exists considerable literature (even entire books) that report successes and failures of passive treatment systems in cold climates (e.g. Mander and Jenssen 2002). This literature needs to be winnowed to focus on studies that are applicable to this particular situation and site. Of critical importance will be studies regarding the influence of cold temperatures on:

- removal pathways for constituents requiring a decrease in concentrations;
- the success of decreasing concentrations of specific constituents;
- the effects on reaction rates and removal efficiency;
- designs employing detention basins for equalizing flows and increasing residence times that might equalize concentrations; and
- Other important factors, such as nitrogen-limited CWTSs for sustained treatment.

One of the assessments that must be made when considering the potential for impacts of cold climate on the performance of a CWTS is the determination of whether water will be requiring treatment year-round, or only during warm, free flowing months. Much of the scientific literature on cold climate function of CWTS has focused on treatment of municipal wastewater, which is produced year round and requires treatment year round. In the situation of municipal wastewater, rarely is it possible to use a retention pond to store the volumes of water requiring treatment until the summer months. In contrast, at a northern mine site during post-closure, impacted water is only occurring during the months where water is free flowing and the amounts of water that might flow (typically seepage of ground water) during frozen months would be minimal and can be stored in retention ponds until spring thaw. This difference in periodicity of treatment needs alters the design considerations and applicability of both cold-climate concerns and technologies. In light of these aspects of CWTS design basis, it must be realized that the available literature can form an initial basis for a feasibility study, but information gleaned from the literature alone will need to be supported by and confirmed through more site-specific investigation.

Constructed wetlands are considered to be one of the most established passive treatment methods for remediating mine-impacted water and have been used by the mining industry since the mid-1980s (Eger and Wagner 2003, Gusek, 2000, ITRC 2003). Wetlands have numerous unique characteristics. Anaerobic CWTS can be designed to facilitate microbial metabolism involved in sulphate reduction, achieving treatment of the water through reduction of the valency of elements such as aluminum, antimony, arsenic, cadmium, chromium, copper, lead, mercury, manganese, molybdenum, nickel, silver, selenium, sulphur, thallium, uranium, and zinc. Some elements will be precipitated in their reduced form, for example, selenium will be reduced from Se IV or VI valency to Se 0 which becomes a precipitate. Treatment in an anaerobic CWTS is also achieved through precipitation of metal sulphides, including primary metal sulphides as well as precipitation of iron sulphides such as amorphous FeS and co-precipitation of metals within the FeS matrix. For example, manganese and aluminum are traditionally thought of as elements that are treated aerobically; however, they may be precipitated in mineral form through complexation with FeS matrixes.

There have been many wetland systems that have had long-term success but there have also been failures among improperly designed systems, and these failures have had a negative impact on the perception of wetland effectiveness. Many of the systems that failed or were not effective at remediating the contaminants of concern were either improperly sized or designed, all of which can be corrected through a systematically designed piloting program (INAP 2010).

It must be recognized that it is not the origin (e.g., mining, oil and gas, industrial) of the water requiring treatment that is important in the design and effectiveness of a CWTS, but rather, the characteristics of the water chemistry itself and the elements requiring treatment. There are two main types of constructed wetlands; those that are designed to maintain surface flow conditions, and those that have been designed to encourage sub-surface flow. Surface flow wetlands can be designed to encourage either aerobic or anaerobic conditions, depending on design, while sub-surface flow wetlands typically encourage permeable, anaerobic conditions. (Gammons and Frandsen 2001, Eger and Wagner 2003, ITRC 2003, Kilbourn Inc., 1999).

For long-term removal to continue within constructed wetlands, not only must the mechanisms at work keep pace with the contaminant loadings but must also account for seasonal loadings. To achieve effective water treatment, the CWTS must be designed with the proper characteristics and size. A series of sequential treatment cells, incorporating aerobic and anaerobic treatment can be used in combination with other aspects such as oxygenating waterfalls and sediment collecting riffles. Regular monitoring and maintenance will ensure that clogging or invasive plants have not inhibited the removal processes, also monitoring the flow rate and paths will ensure full use of the wetland (ITRC 2003, Kilbourn Inc. 1999).

One of the main constraints of using a constructed wetland for remediation of mine-impacted water is that it can requires a significant amount of land. The amount of land is proportional to the volume of flow being treated and the removal coefficient for the contaminants of concern. This does not mean that size alone means an effective remediation wetland, and a solid understanding and application of the mechanisms described previously should be considered. Treatment wetlands require a footprint that is dependent on the volume of flow to be treated and loading of constituents of concern. A widely used approach in municipal wastewater treatment is based on volumetric loading, with a treatment volume of 3.28 to 6.57 m^3/day per square meter of wetland (INAP 2010). However, depending upon the targeted constituents, other approaches to determine the footprint including rate coefficients and removal pathways may be more reliable to determine appropriate sizing of a CWTS, especially when metals treatment is of importance.

Areas that have been identified as potential locations for construction of passive treatment wetlands on the Minto Site include the:

- W15 Area – Upgradient of the runoff collection sump at the toe of the Southwest Dump; and
- W37 Area – vicinity of the existing Water Storage Pond and Dam location, below the toe of the MVFE.

More information on how CTWSs could be implemented at these candidate locations is presented below.

4.2.2.2.2 Biological Reactors

Bioreactors are proposed as the complimentary contingency passive treatment technology to CTWSs for Minto closure. 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. Treatment media for biological reactors in the documented studies are often derived from local municipal and industrial waste sources; however, it would be necessary to determine whether these sources exist in the local area or can be sourced and transported to site in a cost effective manner. Wood chips or peat are local products that could be utilized. These systems could also be operated in a semi-passive mode where an alcohol tank can be set up to drip into the influent end of the biological reactor, and only require infrequent refilling.

Because of the northern climate for this location, a bioreactor installation 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, and would be employed if locations monitored in the surveillance program, and comparison with site objectives and thresholds in the AMP, determined that further load reduction from seepages were warranted to meet suitable site water quality discharge.

In general, the bioreactor treatment zones would be created indirectly using materials designed to stimulate secondary processes e.g., adding carbon substrate such as wood chips or soluble carbon sources such as sugars and alcohols to enhance microbial activity which will in turn generate biochemical reducing conditions that will enhance metals removal. The COCs in consideration at the Minto site can be reductively precipitated either as an elemental precipitate (such as Se0) or as a sulphide form (such as CuS). In the same reactor, other mine-related parameters, such as nitrate, will also be removed by the microbial processes. Bioreactors with excess reduced species (elevated sulphide, dissolve organic carbon, or reduced metals such as iron or manganese) will need to be paired with a subsequent oxidation cell, which could be an open water body such as a pit lake, a rock-filled cell, a buried or surface water cascade, or an aerobic wetland) to remove these constituents prior to discharge from site.

In this document the term bioreactor refers to shallow permeable treatment zones which are gravity fed and installed immediately down gradient of the source of contamination (e.g., intercepting shallow seeps along the toe of the waste rock dumps). The term “permeable reactive barrier” (PRB) is a specialized form of bioreactor in which the reactive media is trenched and placed deeper into the subsurface, forming a permeable reactive barrier through which a contaminant plume flows. When a PRB is working according to design, water passes through the PRB but the contaminant is retained and removed in the PRB by precipitation processes. Biochemical PRBs, where the permeable substrate contains a carbon source, operates on the same basic principles described for the bioreactor above. It is anticipated that there is limited potential for the application of PRBs at the Minto Site, with the possible exception of the area down gradient of W37 where the ground is presumed to be thawed by the presence of the reclaim pond.

For a PRB to work, it is essential that the in situ hydrogeology of the flow path is known, and that there is certainty that contaminant plume flow will go through the PRB, and that the flow is reasonably uniform across the plume thickness. Where PRBs fail is typically because of flow around the PRB, or concentrated flow through one section of the PRB exhausting the treatment capacity faster than other sections. PRBs are not currently being considered as contingency passive treatment technology for the Minto site.

As discussed previously, the contingency bioreactors proposed for Minto are not intended to be a stand-alone remedy, but rather an important piece of a passive "treatment train" which would include engineered wetlands and monitored natural attenuation. Research is also ongoing for additional in-pit treatment as mining-impacted waters fill the open pits and runoff is eventually routed through the open pits at the end of mine life.

It is generally recognized that the success or failure of a bioreactor depends on the ability of bioreactor to accomplish the following (adapted from ITRC-PRB Technology Update June 2011) (ITRC 2011):

- Promote hydraulic performance whereby target contaminants are routed through the reactive material with an appropriate residence time;
- Adequately collected and routed through the bioreactor (i.e., seepage is not allowed to flow around the bioreactor without being treated); and
- Promote contaminant treatment within the bioreactor zone whereby target contaminants are reduced to intended concentrations in the outflow through the targeted treatment processes.

The bioreactor treatment process itself is relatively straightforward to evaluate. A primary challenge with the design of bioreactors and PRB systems, which can lead to poor performance, is the inadequate characterization of the in situ flow conditions within the permeable reactive media which results in the bioreactor failing to achieve suitable hydraulic performance and residence time. The nature of potential failures includes improper sizing of the reactor for the flow conditions at the site, and problems with the substrate composition. Examples of flow-related failures are cases where the range flow is too great, causing—at certain times of the year—situations where not all of the flow can be routed through the bioreactor (because of limitations of the media), or where the concentration of seepage varies through the year, and the mass loading exceeds the potential mass removal. Examples of these substrate-related failures includes insufficient inclusion of porous media (typically gravel), layered substrates where one layer becomes a flow barrier, and changes in hydraulic properties of organic substrates as they degrade. Other design considerations that affect the potential for bioreactors to work are the physical configuration of the reactor, with some configurations more susceptible to dead zones where substrate is partially or entirely unused for treatment because flow does not pass through these zones.

4.2.2.3 Candidate Contingency Passive Treatment Locations

4.2.2.3.1 W15 Area (Below SWD)

The area adjacent to the SWD and leading into W15 is expected to offer the greatest potential for addressing the mining impacted surface water and shallow groundwater contaminant load close to the potential sources. This area is also near its final configuration with a minimum potential for future mining disturbance. These factors make the area up gradient of W15 ideal for both detailed characterization work and the construction of field scale pilot passive treatment cells.

It is anticipated that insights gained up gradient of W15 will also provide significant insights into other areas that appear to be amenable to passive treatment—including down gradient of the Main Dump, down gradient of the DSTSF and associated with the outflows of both Area 1 and Area 2 pits, locations which are still active areas of mine operation.

Below is an example of a possible treatment train which may have application at multiple locations on the Minto site, including W15 (Figure 4-33).

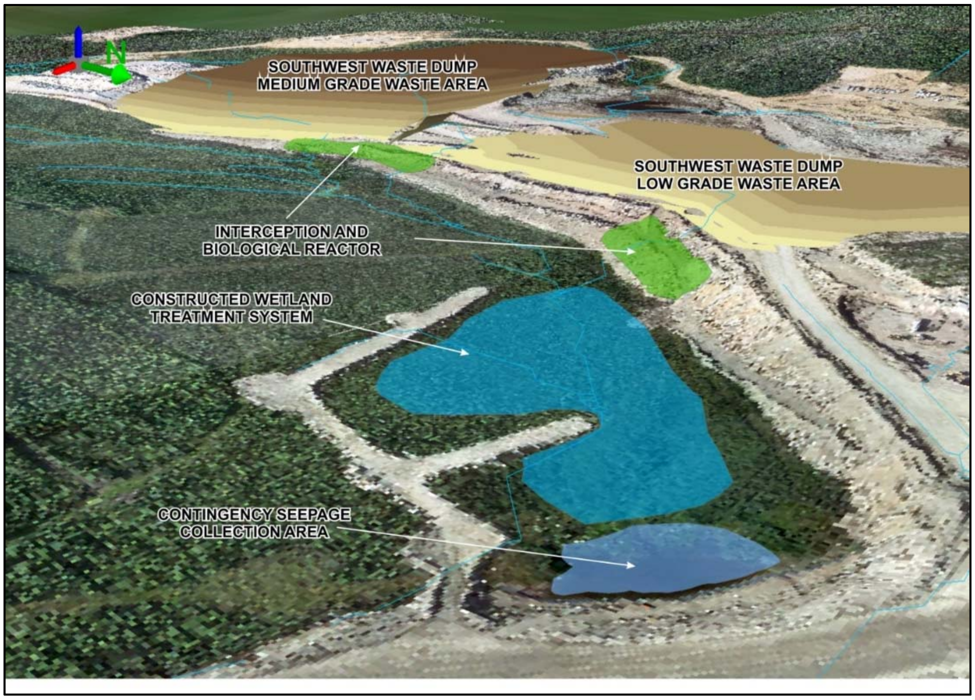


Figure 4-3: Potential Passive Treatment Train Option for W15.

The concept includes the installation of a seepage interception system (i.e., granular filled trenches) along the down gradient toe of the waste rock dumps which would route seepage into shallow bioreactor cells. The bioreactor cells could include both reactive permeable medium and injection ports to enable the introduction of amendments (i.e., additional liquid phase carbon sources to enhance desired biological processes). The bioreactor cell(s) could be designed to overflow into a constructed wetland cell which by its design supports anaerobic processes. This anaerobic wetland cell could, in turn, flow into a constructed aerobic wetland. The Minto site also has significant topographic relief which can be used advantageously to provide aeration and further enhance the removal of metals through precipitation/co-precipitation of metals in an oxidized form.

A treatment train such as the one described above (bioreactor/anaerobic wetland/aerobic wetland) may be suitable for application at multiple locations on the site, including down gradient (east) of the SW Dump, down gradient of the Main Waste Rock Dump, and down gradient of the DSTSF.

While the focus of the early stages of passive treatment characterization work is clearly on the area adjacent to W15 and the SW Dump, additional characterization work will also be completed in subsequent field seasons in the areas down gradient of the DSTSF, adjacent to W37, and within the footprint of the current Water Storage Pond.

Conceptual CWTS Design

As identified above in the treatment train discussion, the CWTS will be made up of multiple treatment steps in a series. Based on the predicted water chemistry, the steps will be a series of anaerobic cells separated by berms to maintain desired depths and reset water flows as needed. Between the three CWTS areas (W15, Main Pit, and W37) small riffles lined with rip-rap will promote reoxygenation of the water and treatment of elements such as aluminum and manganese through oxidative processes.

An anaerobic wetland cell refers to a wetland ecosystem where the microbes in the substrate of the wetland (where the water and soil meet) perform their metabolism without the need for diatomic oxygen. In this case, the wetland is specifically designed so that there is a decreased amount of oxygen in the substrate. This is accomplished by using a deeper water depth, adding organic matter into the soil when the wetland is built, and stimulating microbial activity by growing certain types of plants. Each winter the leaves that fall into the water provide organic material to feed the microbes for the next year.

The anaerobic wetland cells will treat the water for elements such as arsenic, cadmium, cobalt, lead, selenium, uranium, and zinc. Additionally, elements such as aluminum and manganese can be treated in anaerobic wetlands by co-precipitation and sorption. Some of these elements will be removed from the water by microbes that use them as terminal electron acceptors. Other elements will be removed from the water through dissimilatory sulphate reduction. Once the microbes have reduced the sulphur to sulphides, it can then bind to other elements and form minerals that precipitate to the sediment of the wetland.

As an example layout, each CWTS will be built with multiple small cells connected together in a treatment series. The series will be replicated at least in parallel. This design element serves several purposes as described below:

- Water in wetlands can channel over time, causing a faster waterflow through the system. By dividing a water flow into multiple cells separated by spillways, the water can only ever channel through only a single cell at once, thereby maintaining the overall hydraulic retention time and treatment effectiveness.
- Having replicates of the series allows for any alterations needed during demonstration and acclimation phases, as one series can be taken off line and adjusted while the others two will continue to treat water.

Two typical conceptual CWTS schematics have been included in Figure 4-4 and Figure 4-5. Assumptions specific to the conceptual design of the CWTSs include the following:

- Multiple series of flat bottom cells will operate in parallel.
- Cell base and side slopes will be lined.
- Anaerobic cells and have an operating water depth of approximately 0.30 m (using *Carex aquatilis* as the vegetation species, however this could be deeper if other species are used).
- Cells are divided by lined berms with rip-rap armouring along the slopes and at the inlets.
- Perimeter berms will be constructed with a crest width sufficient to accommodate maintenance vehicles or foot traffic, as appropriate.

- The soil to be placed at the bottom of the cells will be sourced on-site, analyzed and amended as needed to achieve the appropriate conditions to treat water and promote plant and microbial growth. The soil will be mixed with amendments such as biochar, slow release fertilizer, wood chips and crushed oyster shells in order to provide enhanced surface area, nutrients, organic carbon, and buffering capacity, respectively, to initiate natural biological cycles for water treatment within the CWTS.
- The CWTS will be densely planted (i.e., about 2-4 plants per cubic meter) by hand with emergent aquatic vegetation obtained from, at, or near the site. These plants are typically dug with a backhoe and then the rhizomes (thick roots that the plants use to spread) are cut into smaller pieces for planting.
- After planting, the cells can be brought on line. During this maturation period, good-quality water will initially be used (i.e., not seepage) so that the plants can have a chance to develop, multiply and mature. This water can be partially recycled through the wetland using a pump.

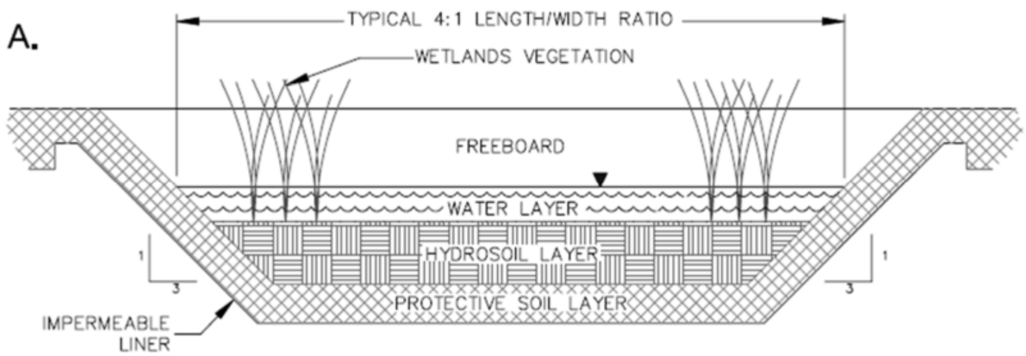


Figure 4-4: Profile of a Typical Surface Flow CWTS (Castle and Rogers 2008).

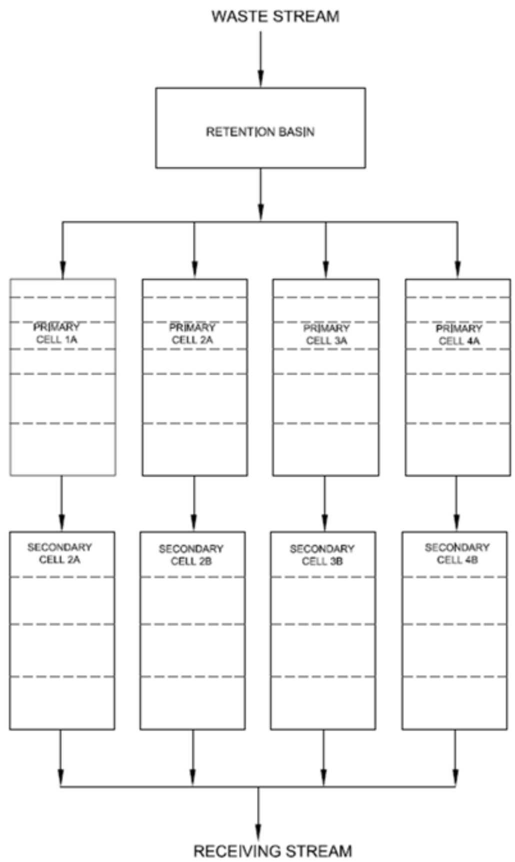


Figure 4-5: Schematic Flow Diagram of a Typical CWTS (Murray-Gulde et al. 2008).

Flows will be allowed to follow seasonal variation, with some equilibration of flows and concentrations of constituents provided by sedimentation ponds upstream of each CWTS.

Minimal ongoing maintenance will be required during operation of the CWTSs. This will include regular inspections to remove debris, examine berms and spillways, adjust rocks or sandbags at the spillways to even flow paths and remove burrowing animals. Monitoring of flow, pH, redox, dissolved oxygen, and alkalinity will be required. Routine water quality sampling begins during maturation to confirm that the explanatory parameters are within desired ranges and monitor their stability. If they are out of range, it is possible to adjust using additional amendments such as those that were originally added to the soil. Access to the CWTSs to allow for this limited maintenance and monitoring will be required

Because sediments and detritus mass has accreted within the CWTSs, it may be necessary to raise the operating water level within the cells during their operation (e.g., after 50+ years). Inter cell flow structures will be constructed to allow for the placement of stop logs (or rocks, sandbags) to raise the water levels and accommodate this build-up of mass.

In the winter, when the wetlands freeze, they may freeze through to the ground or they may have a small amount of liquid water between the ice and soil. Either scenario will allow the treatment to continue. If the wetlands freeze solid, the water will stop flowing and there will be nothing to treat until the spring thaw. If there is a small amount of water flowing, it will be beside the soil where the microbes are and will be treated. There are microbes (called psycrophiles or cold-loving bacteria) that live best at temperatures between +10^{0}C and -15^{0}C. If the water is liquid, these bacteria will be living and actively treating the water. If there is still water between the ice and soil, the water will not flow from one cell to another because the water flows by spillway. Since the water is covered by ice, it cannot spill over.

The riffles will perform an additional function in winter. The riffles are covered in rip-rap to disperse water, decreasing velocities, and aid in freezing in the winter. By spreading out the water in a thin layer over the rip-rap, it is more likely to freeze and stop water flow.

In spring thaw, water that flows over the surface of the wetland will be diluted by snowmelt and ice melt. The ice in the wetland is cleaner than the water because as ice freezes it leaves salts and elements in the liquid water portion. So as the ice cover melts, it is actually cleaner than the water underneath it. When wetlands begin to melt, they melt from the edges in, and also melt starting from each plant stem outwards, forming liquid tubes in the ice surrounding the dead plant stem from the previous year(s). This allows water exchange to the sediment to begin very early in the thawing process, and the decaying plant stems themselves are a very active spot for microbial activity.

Further information regarding how this plan for a CWTS at the W15 location will be scaled up and optimized is presented in Section 4.5.4.2 discussing reclamation research.

Conceptual Design Assumptions

The following site specific information was utilized to assess the feasibility and expected performance of a CWTS in this vicinity:

- The maximum predicted post-closure influent flow rate;
- Estimated area available for CWTS construction, based on a GIS evaluation of available area constrained by mine facilities and slope;
- The aspect ratio of the polygons for available area for CWTS construction were evaluated with a goal of constructing CWTS cells of between 3:1 and 4:1 length:width. This determined the total number of cells in a series and the number of replicates of the series for the site. A conservative 6 meters for internal berms and 3 meters for each side of external berm was then applied; and
- For the CWTS at W15 an exceedance of the target range of aspect ratio is deemed acceptable in this situation for the following reasons:
    - Accomplishes goal of three series at W15, allowing for possibility of demonstration series to be incorporated into final closure designs; and
    - Velocity at peak flow remains low despite decreased width (0.23cm/sec).

For the W15 Area, the following assumptions were made:

- Removal coefficients used in calculations for predicted performance of the CWTS were calculated based on a combination of published (peer-reviewed) data and pilot data. Recognizing that none of these removal coefficients were developed from the actual water from the Minto site, conservative estimates were used for all elements. The actual removal rates and thermodynamic minimums for the CWTS will be established experimentally through site-specific pilot and demonstration-scale testing during the operations of the mine.

- The depth of water in the CWTS was estimated to be 30 cm, based on assessment of characteristics of emergent wetland plant species that have been previously documented on site. Water Sedge (*Carex aquatilis*) have been described as a dominant-emergent wetland plant species on site. While ecovar specificities remain to be determined, literature reviews indicate that this species should able to survive and reproduce in water depths of approximately 30 cm. While *C. aquatilis* will grow in water of less depth (or moist soils), the water depth is maximized to promote anaerobic properties of the CWTS and increase the hydraulic retention time of the system.

- The wetlands were assumed to be planted with *Carex aquatilis* which are known to be present on site. This is a conservative assumption, as other plant species such as *Typha latifolia* (cattail) and *Schoenoplectus acutus* (hardstem bulrush) could potentially be growing in the area but off-site, and be viable candidates for planting of the CWTS. Should *T. latifolia* or *S. acutus* be potential candidates for vegetating the CWTS, the depth, and therefore the hydraulic retention time of the system could be increased as much as three- or four-fold.

- The reasonable worst-case post-closure scenario using maximum expected concentrations were used as the influent inputs.

- The maximum predicted post-closure influent flow rate was used.

The main parameters of the W15 CWTS design are summarized in Table 4-2.

Table 4-2: W15 CWTS Parameters.

Total area for CWTS construction	46,800 m^2
Working area for CWTS water treatment	38,976 m^2
Depth	0.3 m
Dimensions of each cell	174 m length : 37.3 m width
Number of series	3
Number of cells per series	2
Volume of water in CWTS	11,693 m^3
Hydraulic retention time (minimum time, at max flows)	41 hrs
Peak water velocity	0.23 cm/sec

4.2.2.3.2 W37 Area (Toe of MVFE)

Currently, seepage from the toe of the MVFE, which includes seepage from the DSTSF via the finger drain channels beneath the facility, is collected at the Minto Creek Detention Structure and pumped back to the Main Pit prior to treatment for discharge. Figure 4-6 below shows a possible configuration of the treatment cell and contingency seepage collection system in relation to the MVFE (under a conceptual expanded design), with a downstream CTWS in the vicinity of the current water storage pond.

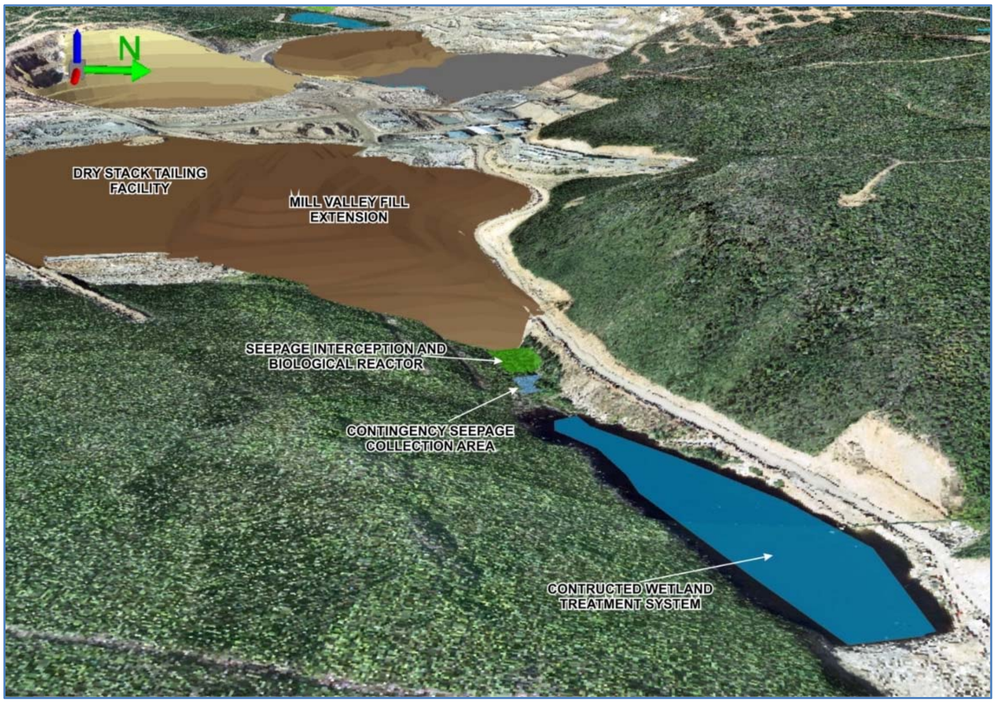


Figure 4-6: Potential Treatment Cell Configuration Downstream of the DSTSF and MVFE.

Expected Biological Treatment System Performance

Ultimate configuration and design of this passive treatment configuration between the toe of the MVFE (W37) and the WSPD (Water Storage Pond Dam) will be determined as the research in this area of the site advances. Although the above configuration contemplates a bioreactor to treat the DSTSF/MVFE seepage, then a CWTS for final polishing of all site drainage prior to discharge from site, final drainage channel configuration will likely determine the possible configurations of passive treatment systems in this area.

For the purposes of comparison with the performance estimations from CWTSs in the W15 area in previous sections, it is possible to use the same process and assumptions as were described in those sections to evaluate the potential performance of a CWTS at the toe of the MVFE (as opposed to the bioreactor proposed above.) A much smaller CWTS was evaluated for this purpose, leaving area along the stream channel for conveyance of higher flow volumes if required (to be determined in final engineering prior to closure).

The main parameters of a conceptual W37 CWTS design are summarized in Table 4-3.

Table 4-3: W37 CWTS parameters.

Total area for CWTS construction	4,375 m^2
Working area for CWTS water treatment	2,869 m^2
Depth	0.3 m
Dimensions of each cell	37.8 m length : 9.5 m width
Number of series	1
Number of cells per series	4
Volume of water in CWTS	860.7 m^3
Hydraulic retention time (minimum time, at max flows)	6.4 hours
Peak water velocity	0.64 cm/sec

A CWTS system at the W37 location could be employed if required and triggered in AMP monitoring to provide valuable additional contaminant load reduction from up gradient sources (SWD, MWD, pit walls, etc.) where that loading may have deviated from expectations. This could include instances where surface water diversion structures up gradient of the DSTSF did not perform as expected (increasing contact with tailings materials and ultimately seepage rates at W37). This treatment would be valuable in mitigating these potential conditions and in further ameliorating the expected seepage from the DSTSF facility, prior to its contribution to the rest of the conveyed flow from the site for discharge.

4.2.2.4 Active Water Treatment

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 Section 2.7 Water Management.

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 (Appendix D). Section 8 presents assumptions and costing related to the use of active treatment in the closure and post-closure period at Minto.

4.3 RECLAMATION TO DATE

To date there has been little opportunity to conduct final reclamation measures at the various infrastructure units on site because of the discovery of several new ore deposits that have given way to the Phase V/VI permit application and uncertainty around the final mine footprint. However, where possible, progressive reclamation has been conducted to address water management and aesthetic objectives.

For example, in 2009 Minto conducted reclamation activities on exploration roads and drill pads, particularly in erosion-sensitive areas that can potentially impact surface run-off water quality. Reclamation of disturbed areas along the access road and at Big Creek in the vicinity of the Big Creek Bridge was completed between May 6 and May 10, 2000.

In 2011/12, Minto recontoured, covered, and revegetated the face of the Main Waste Dump with the intention of scaling up the research findings from smaller revegetation plots. This work is outlined in greater detail in Section 4.5.3 as reclamation research, and along with the other reclamation research findings, this information will be used to assist with planned progressive reclamation measures, reclamation research, and measures for final closure.

As required in Water Use Licence QZ96-006, Minto is also placing a soil cover on the surface of the DSTSF, as placement of tailings in the facility has now ceased. This cover will serve as a temporary surface stabilization measure while the design of soil covers for site facilities is being refined. This activity is discussed further in Section 6.6.

4.4 NATURAL REVEGETATION

Overall reclamation is expected to be successful with seeding and natural revegetation complimenting each other.

The project area was first disturbed by the construction of trails and trenching which was done as part of exploration programs on the property from 1971 to 1976. Natural revegetation has been effective in largely covering these disturbed areas in the 35 years since the area was first disturbed. For example, prior to construction activities in 2006, the airstrip was almost completely revegetated and required extensive clearing in preparation for recommissioning. Other areas that have seen significant natural revegetation on the site (some of which are now re-disturbed by current construction activities) include areas adjacent to the WSPD centerline, old borrow sources, and the cleared right-of-way of the main access road.

The primary colonizing plant species now found around the mine site are willows and graminoids. The extent of recolonization at each location is dependent on local conditions, including soil conditions (type and moisture content) and aspect. Generally, revegetation is occurring more extensively next to undisturbed areas and on linear disturbances.

4.5 RECLAMATION RESEARCH

An important component of the reclamation planning process is ongoing reclamation research with the objective of developing the methods required to implement a successful reclamation program. Reclamation research will focus in certain areas related to the key and contingency closure methods proposed for the site, as well as the proposed adaptive management measures:

- soil cover revegetation and erosion control; and
- semi-passive water treatment technologies.

The relative success of these techniques at the Minto site compared with expectations built on evidence from applications and use in other similar sites will be dependent on a number of site-specific conditions. A comprehensive Reclamation Research Program has been designed and initiated to provide proof of concept for these techniques in the Minto Mine setting. The elements of this program are presented in this section. Other aspects of mine site reclamation including recontouring and erosion stabilization techniques are well established and are less reliant upon site-specific research for success.

Documentation of natural revegetation successes is ongoing during current reclamation research activities as documented in the annual reclamation reports. Information developed on site will be supplemented with information obtained from other mine reclamation programs in the Yukon and other jurisdictions. Considerable research has been carried out into the reclamation and revegetation of disturbed lands in the Yukon, including operating and abandoned mines, and mineral exploration sites. Much of this information is in the public domain and is well presented in the guidance document Mine Reclamation in Northwest Territories and Yukon (INAC, 1992.)

The true benefits of reclamation research will be realized if the information obtained and knowledge gained is incorporated into larger scale reclamation projects as quickly as possible.

4.5.1 Soil Covers

SRK Consulting has produced a Scoping Level Cover Assessment study for the Minto Mine Site Closure, which is presented in Appendix E. Mine waste at Minto Mine includes both waste rock and tailings (dry stack and in-pit tailings). At the end of Phase IV, there will be a total of six distinct waste rock and overburden piles on site. Isolating soil cover systems constructed from locally available stockpiled or mined materials are proposed in order to reduce metal loadings to the receiving environment (Section 4.2.1). Geochemical characterization of the mine waste has confirmed that acid generation potential is low at the site, and performance estimates for these covers are based on considerable relevant experience on similar projects.

Refinement of site-specific performance expectations related to infiltration reduction is not considered to be valuable given the reduced reliance on infiltration reduction and the nature of the available cover construction materials at site. Further research related to cover performance will be conducted in the context of revegetation and erosion control, as discussed in the following sections.

4.5.2 Growth Media and Revegetation

Plants require, as a minimum, a medium that will allow roots to penetrate, that will retain adequate moisture and that contains suitable levels of nutrients for successful growth. The natural vegetation found on undisturbed sites around the mine generally provides information the underlying soil properties, including texture, drainage, and pH, and the level of available nutrients that presently occur at the site. A soil sampling program was initially conducted in the project area during 1994 as described in the original environmental assessment report. The results of this program provide the basic information required for reclamation planning.

Research is being proposed for 2014-2016 to more adequately characterize moisture and nutrient regimes, and will be dovetailed with the soil cover research where possible. This will include three subprojects in partnership with Yukon College, which are identified at a preliminary level below.

The revegetation trials are designed to determine the best methods of restoring the Minto mine site footprint to a functioning and self-sustaining ecosystem. Four important components of a revegetation process that are being examined presently or proposed are briefly described below and other related considerations are further discussed:

1. Practical seed mixes - while it is known what seed types have been used at the site previously and what types of plants have been naturally revegetating the site, further reviews and investigations are necessary to confirm the appropriate seed mixes that should be used in conjunction with different soil covers. The ultimate seed mixtures will be developed using:

    - knowledge of the naturally occurring vegetation and soil conditions;
    - an inventory of naturally occurring seed sources on site;
    - results from revegetation activities to date;
    - existing literature on regional revegetation science; and
    - information gained from revegetation test plot trials on site.

2. Soil covers - different plant varieties and species, waste characteristics, cover designs and other environmental conditions are all factors influencing uptake of metals by plant tissues. Sampling of plant tissues from both background plots and expanded revegetation test plots (i.e. Main Waste Dump) will be conducted to assist in designing the revegetation program, and existing literature and research regarding plant metal uptake and animal foraging patterns will be incorporated into the seed mix design.

3. Transplanting and collection of seeds of local plants that have been noted, during monitoring, to have colonizing potential (especially trees, shrubs and nitrogen fixing legumes). The creation of vegetation islands can also enhance natural succession.

4. Utility of soil amendments - such as biochar, peat, wood fibre or mulches need to be investigated for usefulness in areas where soils are deficient or unstable.

The establishment of an initial ground cover of graminoids (all grasses and grass-like plants, including sedges and rushes) has historically been viewed as a desirable objective on most disturbed areas to stabilize slopes and control soil erosion. Initial test plots were typically small and optimum conditions may have applied. The information obtained from test plots was then applied to larger reclamation efforts in 2011/12 on the face of the Main Waste Dump (see Section 4.5.3 below). Moving forward, vegetation growth will be assessed using standardized methods each summer. The successes from the trial plot program will be transferred to more progressive reclamation efforts that will provide a large-scale opportunity for refinement of reclamation and revegetation techniques and measures.

The revegetation component of the reclamation research program will be expanded in the following ways:

1. Revegetation trial plots will be established in concert with soil cover trials where appropriate. Methodology yet to be determined.

2. Revegetation research will be expanded beyond grasses to larger, later successional shrub/tree species. Establishment of these species in the revegetation program will enhance the natural succession. This will involve a combination of:

   - Local stock collection and transplanting trials;
   - Local seed collection and broadcasting and propagation trials; and
   - Live planting for erosion control
   - Preferred aspect and slope conditions for different plants

3. Identify nearby areas for native vegetation seed and stock collection. Areas slated for clearing need to be inspected so suitable plants can be salvaged. A general inventory of indigenous plant communities in the area was conducted in 2010 as a component to the Minto Mine Ecosystem Mapping program (Access Consulting Group) and the network will be re-surveyed in 2013. This information can be used to locate naturally occurring shrub or tree species that could be used in transplanting /seeding trials.

4. Vegetative erosion control methods will be field tested on site - they can provide a cost effective alternative to synthetic or other manufactured products. Grass seeding of slopes is an immediate step towards stabilizing soils on steep slopes, however live shrub/tree plantings are more effective at reducing soil/cover erosion on steeper slopes and gullies.

5. Nitrogen fixing flora will be included as a critical component of revegetation prescriptions, so soils are not depleted of plant available nitrogen. Native species that are nitrogen-fixing candidates for seed collection are:

   - Arctic lupine (Lupinus arcticus)
   - Yellow locoweed (Oxytropis campestris)
   - Hedysarum alpinum; and
   - Alder (Alnus sp.)
   - Agronomic species include alfalfa and clover.

4.5.3 Main Waste Dump Trials

Previous years' research has provided Minto Mine with information to pursue a large-scale project: the cover trial on the Main Waste Dump (MWD) re-contoured rock surface. Two variables were considered in the trial; the suitability of the major types of overburden found on-site as cover material and amendments such as fertilizer and organic material. These will be compared to simply seeding the overburden, allowing Minto Mine to gauge if these amendments improve seeding success. Re-vegetation success will be monitored and will provide Minto with information to customize site-specific reclamation methods. The cover trial will also stabilize inactive slopes, reduce the amount of reclamation taking place at end of mine life, and improve aesthetics on-site.

Ongoing data collection from the next few growing seasons will provide Minto Mine with additional information, including:

- Assessing success of seed mix on large scale plots;
- Determining if different types of overburden on-site can support vegetation; and
- Gauging benefit of using amendments to overburden (organic matter and/or fertilizers).

Figure 4-7 shows the reclamation work that Minto Mine completed on the Main Waste Dump in 2011. At the beginning of the 2012 summer Minto completed the re-contouring of the slopes (Figure 4-8) and placed 1m of overburden over the re-contoured slopes (Figure 4-8). As sections of the overburden were placed, they were hand seeded and fertilized (depending on plot amendment) (Figure 4-9).

Figure 4-7 Main Waste Dump near the end of construction season 2011 (September)

Figure 4-8 Main Waste Dump as it appeared in July 2012 with final placement of overburden into distinct plots

Figure 4-9 Final plot placement in August 2012. Note seedling emergence in upper right plots

To support SRK's further investigation into available cover construction materials at site, materials were recovered from the site's Reclamation Overburden Dump, characterized, and placed in distinct plots (Figure 4-10). The naming convention of the overburden plots reflects the position the overburden was placed on the Main Waste Dump. There are two benched areas, identified as "Upper and Lower". West facing slopes and east facing slopes are also pointed out in the convention. Table 4-4 below indicates the naming convention for the plots, along with their areas.

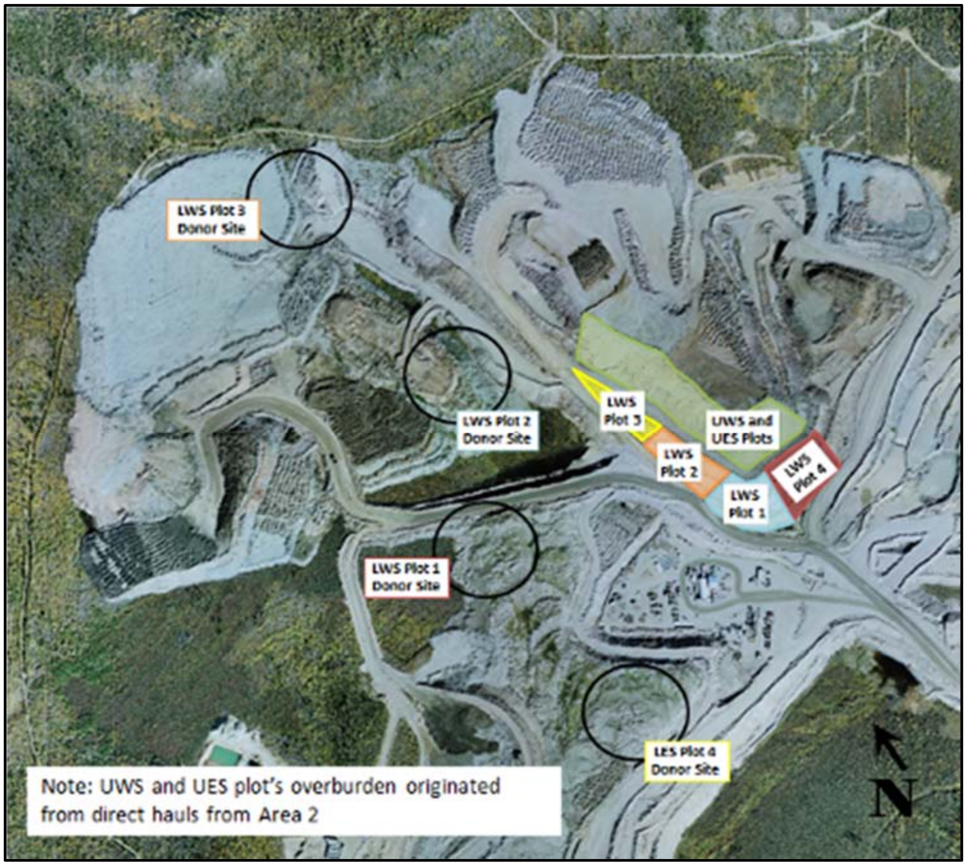


Figure 4-10 Origin of overburden material from ROD placed in distinct plots on the MWD re-contoured rock surface

Table 4-4 Naming convention, areas, volumes and depths of each overburden plot

			Area (m2)	Area (ha)	Depth of OVB cover (mm)	Total volume of material placed (m3)
Plot Name	Upper West Slope (UWS) and Upper East Slope (UES)	**UWS and UES Plots**	17229	1.72	1000	17229
	Lower West Slope (LWS)	**LWS Plot 1**	10309	1.03	1000	10309
		LWS Plot 2	6237	0.62	500	3118
		LWS Plot 3	6219	0.62	1000	6219
	Lower East Slope (LES)	**LES Plot 4**	3970	0.40	1000	3970

Plot size was chosen to balance the minimum area required to gather scientifically sound information, initiating enough diverse treatments to analyze different scenarios, and field fitting the plots for the most efficient use of space. Each overburden plot was chosen to represent materials available from the overburden stripping that occurred in Main and 2 pits. As mentioned in Figure 4-8, the upper slope plots were capped with material directly excavated and hauled from Area 2 pit development indiscreetly, without much segregation. A selection method occurred for the lower slope's plots within the ROD area. Sites were chosen to represent a wide range of materials on site (gravelly and sandy overburden, to loam-textured, to overburden containing high clay content pockets). Stockpiles and pads of materials were surveyed for material types using field cues (hand texturing, colour comparison, visual estimation of coarse to fine material composition).

Minto is currently re-evaluating the reclamation research objectives and structure of these plots, and the ongoing observations and findings from these larger scale efforts will inform revegetation and erosion control measures elsewhere on the site.

4.5.4 Passive/Semi-passive Water Treatment

4.5.4.1 Pit Lake Pre-Treatment

Minto has initiated a preliminary investigation into the effectiveness and viability of pit lake pre-treatment methods. In 2012, four limnocorrals were placed into the Main Pit, filled with pit water, and amended with reagents to encourage microbial reductive treatment of selenium, copper, and nitrate. The treatment method for the removal of these constituents is biochemical reduction, where nitrate is reduced to nitrogen (gas), selenium (as selenite/selenite) is reduced to elemental selenium (solid precipitate). In the higher doses of organic carbon sources, sulphate reduction is also expected; in this case, some metals such as copper may be removed as sulphide precipitates. This limnocorral study is part of an ongoing program to evaluate the feasibility of passive treatment at the Minto Mine site, and the results of this study will be used to design possible larger scale trials in the lake and/or will inform other potential passive treatment studies, including constructed wetlands and bioreactors, at the site.

The limnocorrals were installed in the pit in the fall of 2012, filled with pit lake water, and three of the limnocorrals were used as test vessels, and the fourth was retained as a control without any reagent addition. The rest of the pit began to receive tailings at around the same time; the control limnocorral is used to show how the water chemistry evolves without the effect of tailings addition over time.

The variables being tested in the three test limnocorrals are the addition of both soluble organic carbon sources (alcohol and molasses) and solid phase carbon sources (wood chips) to the pit lake water column. Microbes that are free floating in the water column will react with the dissolved carbon sources, leading to the biochemical reduction and removal of the constituents from the water column. The wood chips provide both an additional carbon substrate for this biochemical reduction process, as well as an attachment site for microbes.

The tests were begun in the fall of 2012 and during initial tailings deposition access to the limnocorrals for sampling was restricted due to safety concerns. Sampling of the limnocorrals has been accomplished during the summer of 2013, and the results are currently being evaluated. An initial assessment of the results is encouraging from an aqueous contaminant reduction perspective, which includes all licence parameters. Biochemical indicators will also be tracked, which will provide information about the nature of the microbiological community in the test limnocorrals. When all of this analytical information is fully interpreted, the next steps in the evaluation of in-pit treatment of mine water will be formulated.

4.5.4.2 Constructed Wetland Treatment Systems

Proposed as contingency load reduction measures, CWTSs have good potential for success at the Minto site, should additional load reduction beyond the proposed source control measures be required. The ability to achieve water quality targets by any type of technology is reliant upon accurate knowledge of input parameters and clearly defined objectives. Many of these have been assessed for the Minto site, and a research program has been designed to obtain additional necessary information for the successful development and implementation of the CWTS. This preliminary site data will then be applied to pilot-scale CWTS on site and in testing in Contango Strategies Ltd.'s (CSL's) year-round greenhouse in order to develop the design basis for the eventual demonstration and full-scale CWTS on site. The phases required to design the constructed wetland systems are as follows:

Information Gathering

The purpose is to gather information about the Minto site in the context of passive water treatment and design of a site-specific CWTS that will achieve predictable treatment of water post-closure. This work will be initiated with meetings between Minto, contractor specialists and other parties of interest, including a site visit as early as possible during the project.

Initially there will be a focus on the W15 area of the site that is receiving seepage and runoff from the Southwest Waste Rock Dump (SWD) as this is anticipated to be the most significant single source of major element loadings on site. A stream and wetland have formed naturally in this area and will provide opportunity to evaluate the natural remediation processes occurring on site as well as the tendencies of local flora and microbial populations.

Water

Rates of removal of constituents of potential concern (CoPCs) and changes in water quality will be estimated as water passes through the natural system along the stream and pond preceding the W15 monitoring station. Characterization of waters for the SWD will be based on data collected from existing water monitoring sites W15, W32, W37, W38, W39, and W40. Additional monitoring sites located in the pond preceding the W15 pump area will be identified during the initial site visit. The pH, Eh, conductivity, temperature and flow rate at each point will monitored weekly, and it is recommended that the monthly monitoring currently being performed as per the Water Use Licence (WUL) be increased to once every two weeks (e.g., total metals by ICP-MS, nutrients). In situ redox probes and thermistors will be installed to monitor sediment Eh and temperature, respectively. Site staff will be trained in how to take measurements of these in situ devices.

Sediments

Sediment samples will be collected seasonally with a coring device near the locations of the thermistors and redox probes. Cores will be collected seasonally, once immediately after spring thaw, during the peak growth period of summer, and finally once before freezing. These sediment samples will be subjected to a panel of tests, including NPK, pH, BOD, COD, TOC, and ICP-MS (metals scan). Additionally, the microbial composition of these sediments will be determined by metagenomic analyses (DNA-based community compositions) for bacteria, eukaryotes and archaea to determine established vs. transient populations that may be important to the biogeochemical activities of the CWTS on site.

Plants

After spring thaw has occurred and plants are actively growing, local plant species will be identified for potential use in the CWTS. Although lists of plant species at or around the site exist, it is important to evaluate ecovars to determine aspects such as water depth preference and record association with redox and pH zones in the water and sediments.

Potential plant species will be identified for use in the CWTS. Plant species will be selected based on a combination of criteria, including observations of explanatory parameters associated with specific plant species (e.g., redox associated with root zones, apparent preference for specific water depths, on-site abundance), socio-cultural importance of the plants (e.g., traditional medicine or food), and consideration of impact on local animal species (e.g., key food source for local animals).

The main components of the information-gathering phase are:

1. Characterization of water for treatment;
2. Identification of targeted constituents and performance goals;
3. Identification of borrow sites for plants and hydrosoil substrate;
4. Evaluation of natural remediation processes occurring on site; and
5. Site assessment for feasibility of implementation of CWTS.

- This information gathering exercise has begun, with CSL's first investigative visit to site completed in August of 2013. Findings from that visit were encouraging, and a follow up visit is pending.

Pilot-scale testing at Laboratory Facilities

Pilot-scale systems will be designed and built in a year-round temperature controlled greenhouse at CSL's laboratories. These pilot systems will be closely monitored by trained technicians and will be used to optimize system performance. In some cases, laboratory "bench top" experiments may precede the pilots to test design assumptions. Plants will be collected from the Minto Mine site, and shipped by courier to CSL's greenhouse in Saskatoon. Potential soils will also be collected at site and shipped to CSL.

A pilot-scale CWTS will be built using approximately 60kg of substrate (hydrosoil) per treatment cell. Typically, there will be two to four treatment cells in a pilot series (one per type of plant being tested), with two replicates of each series. If four plant species were tested, this would result in 16–32 CWTS cells being evaluated. An example of a pilot-scale system is provided in schematic in Figure 4-11, and a photograph of other pilot-scale systems in one of CSL's greenhouses is shown in Figure 4-12.

Simulated water will be designed to mimic the SWD seepage water. This simulated water will be used for the greenhouse pilot-scale experiments. Once the plants are established, as part of the stress testing, the systems can be tested for effectiveness with fluctuations in water chemistry. Each series in the pilot CWTS will treat approximately 300 L of simulated water per week. These pilot CWTS will be run for a minimum of 6 months and maximum of two years, depending on the extent of testing to be performed.

Plant-specific attributes will be evaluated such as suitability for transplanting, effects on water flow (e.g., short circuiting of water), uptake of CoPCs, effects of plant species on soil redox, tolerance to variations in water depth, accretion rates (detritus decomposition rates), and effects of nutrients on plant growth.

These systems will also be used to determine metal loading and sediment accretion rates as well as other factors to help ensure that concentrations within the sediment do not exceed site limits for hazardous materials. Toxicity testing will be completed to confirm the bioavailability of the constituents deposited in the sediments.

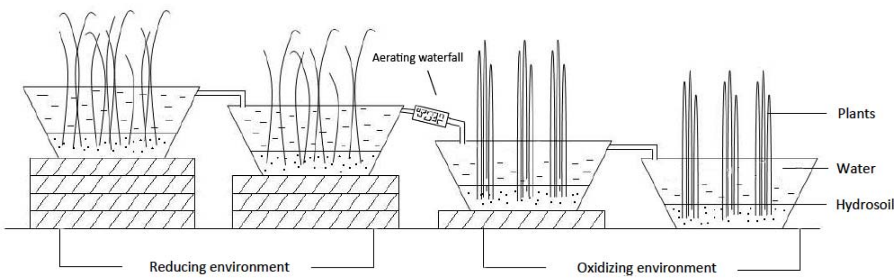


Figure 4-11 Example Layout of Greenhouse Setup for Pilot-scale CWTS.

Figure 4-12 Example Pilot-scale CWTS in Greenhouse

The work to be conducted during the laboratory pilot-scale testing can be summarized as follows:

1. Design of pilot-scale CWTS (one or more designs may be tested for optimization).
2. Assembly of pilot-scale CWTS in greenhouse at CSL.
3. Performance monitoring and stress testing.

On-site Pilot-scale Testing

Pilot-scale systems will be built on site. Water will be diverted before it reaches the natural wetland formed upstream of W15 to the pilot testing CWTS cells. An estimate of size of each cell is 2 m wide by 8 m long, however, the exact dimensions of the system will be determined based on available space and plants. Two to four plant species will be tested with two cells in each series. An example of an on-site pilot-scale system is provided in Figure 4-13.

Amenability to transplanting and plant density over time will be assessed. The timing of plant emergence in the spring as well as any invasion of species not included in the design will be monitored. The relationship of the plants to possible short-circuiting of water flow will also be evaluated during this phase. Once the system is established, local technicians will be trained to monitor explanatory parameters regularly. Additionally, periodicity of water flow, hydraulic retention times, and water depths will be monitored and characteristics of freeze and thaw events in relation to CWTS and water treatment will be evaluated. Thermistors will be used to determine whether year-round flow of water at the sediment interface is plausible. In situ redox probes will be installed to assess biogeochemical parameters throughout the year. Core samples will be collected seasonally and depth intervals sampled for metals content and microbial communities to determine depth of active zones.

Figure 4-13 Example of On-site Pilot-scale CWTS

The purpose of this research program is to identify the combination of conditions in the pilot-scale testing resulting in maximum removal of CoPCs and best outflow water quality possible. Based on the predicted water quality parameters for seepage and runoff water at the Minto site, and local topography, it is likely that more than one CWTS will be used to ensure passive post-closure water treatment. The CWTS may become stand-alone treatment systems, or may be integrated with other technologies such as biochemical reactors to achieve a hybrid approach to water treatment on site.

Once information is gathered through site visits and pilot-scale trials, additional phases may include the following options (as appropriate for the project). These options are outlined in concepts below, and will be refined based on the outcomes of the initial phases of research.

Outdoor pilot-scale design and monitoring at laboratory facility:

- Assembly of outdoor pilot-scale CWTS in outdoor cold climate environment (based on information gathered from indoor pilot-scale findings).
- Performance and seasonal monitoring of the outdoor pilot-scale CWTS.

On-site demonstration-scale design and monitoring:

- Design of on-site demonstration-scale CWTS.
- Construction of demonstration-scale CWTS at the Minto site.
- Performance monitoring of demonstration-scale CWTS at site.

4.5.4.3 Biological Reactors

The bioreactor treatment process is a semi-passive treatment technology, with the primary activity required the replacement or replenishment of the media. The bioreactor process itself is relatively straightforward to evaluate, with the primary evaluation requirements related to site-specific conditions in which the system is designed to operate. A primary challenge with the design of bioreactors (and PRB systems), which can lead to poor performance, is the inadequate characterization of the in situ flow conditions within the permeable reactive media which results in the bioreactor failing to achieve suitable hydraulic performance and residence time. The nature of potential failures includes improper sizing of the reactor for the flow conditions at the site, and problems with the substrate composition. Examples of flow-related failures are cases where the range flow is too great, causing—at certain times of the year—situations where not all of the flow can be routed through the bioreactor (because of physical limitations of the media), or where the concentration of seepage varies through the year, and the mass loading exceeds the potential mass removal. Examples of these substrate-related failures includes insufficient inclusion of porous media (typically gravel), layered substrates where one layer becomes a flow barrier, and changes in hydraulic properties of organic substrates as they degrade. Other design considerations that affect the potential for bioreactors to work are the physical configuration of the reactor, with some configurations more susceptible to dead zones where substrate is partially or entirely unused for treatment because flow does not pass through these zones.

To avoid these potential pitfalls, the scope of work for evaluating the potential application of bioreactor technology at the Minto Site has been divided into several stages—beginning with detailed characterization of the seepage inputs and foundation conditions in the areas where bioreactors are being considered and advancing to laboratory characterization and bench scale testing of substrate mixtures before ultimately advancing to field scale pilot trials.

It is recognized that complementary field studies and monitoring programs are already underway at the Minto site: e.g., seepage monitoring and ongoing water quality monitoring. This will lead to defined flow and mass loading curves for the seepage areas. It is anticipated that it will be possible to incorporate this information directly into the bioreactor evaluation program as it becomes available and refined. It is also anticipated that it may be possible to enhance further the usefulness of the existing/ongoing sampling and monitoring programs in a cost-effective manner by incorporating some additional analysis and/or adjusting the timing and frequency of the sampling/monitoring programs. Additionally, synergies exist between the evaluation of the bioreactor treatment systems, and the constructed wetlands characterization program.

The following sections outline the first three phases of the research program and planned field trials for bioreactor treatment:

Information Gathering

Additional site and contaminant source characterization work is required in order to facilitate effective design of both bioreactors and constructed wetlands, which is as follows:

- Assimilate all available site information and identify information gaps.
- Field characterization program:
- Visual inspection along the toe of SW Dump, Main Dump, DSTSF and area down gradient of W37.
- Document primary seeps and collect basic parameters.
- Identify probable locations for constructed wetlands.
- Determine options for intercepting/routing seepage the bioreactor cell and ultimately into constructed wetlands.
- Evaluate native plants and tree stands for use as a compost/ solid phase organic carbon source for the bioreactor.
- Basic foundation investigation (test pitting / shallow bore holes).
- Install Eh and temperature probes along potential seepage interception.
- Construct field trial of an interception trench adjacent to significant seep, install Eh and temperature probes (with datalogger) and bury a portion of the instrumented trench under 3 m of granular fill to confirm that it is feasible to insulate the seepage interception trench and bioreactor cell to facilitate year round operation.
- Collect shallow soil samples along potential alignment of interception trench(s) and bioreactor sump area for laboratory characterization.
- Install a sampling port into interception trench.
- Collect local organics for use in laboratory/bench scale trials.
- Collect local granular fill materials for detailed characterization.

Laboratory Characterization / Bench Scale Trials

A successful bioreactor requires media that is permeable, to allow through-flow of water, and to maintain that permeability over time even as the organic phase of the media degrades. The media must also supply a carbon source and nutrients to maintain microbial reactions that improve water quality over the time of operation. This phase evaluates potential media with these requirements in mind. The tests and evaluations proposed in this phase include:

- Evaluate potential permeable media and carbon sources (both soluble and slower or faster release-insoluble carbon sources) in flow-through bioreactor test columns, to identify variable sulphate reduction rates based on media composition.
- Detailed characterization of physical properties of on-site granular fill which could be incorporated in the bioreactor.
- Evaluation of potential sources of wood chips and/or mulch that is locally available for their nutrient and carbon source characteristics.
- Evaluate long-term stability of the precipitated contaminants by leaching tests.

Large Scale Field Pilot Trials

As the results of the first two phases become available, a site-specific bioreactor design will become the focus of the research program. The results of this phase will be to place a realistic-scale bioreactor in a site setting that is similar to what would be encountered in closure. This will include flow rates and contaminant loading that is similar to what would be treated in closure. This may best be obtained by placing the reactor near a seep that has flow and loading characteristics that were defined in other investigations, or could instead receive flow from a pumpback/collection system. The work scope for this phase includes the following:

- Scope potential site for bioreactor field trial informed by site-specific investigations, site constraints, and bench scale trials. It is anticipated that the site must have the following characteristics:
  - Secure location for over 2 years;
  - near mill area;
  - water pumped back from W37 or other seepage collection site with consistently available flow; and
  - suitable footprint with respect to foundation conditions.
- Design field trial based on results of laboratory characterization program: flow rates and contaminant loading matched to substrate volumes expected to yield consistent contaminant removal.
- Construct pilot trial of bioreactor and implement monitoring program – the feasibility and timing of this task will depend entirely on the progress and results achieved in all the preceding tasks.

The composition of the media used in the larger scale bioreactor will be determined from the column studies performed during laboratory characterization. A preference will be given to locally available media if the performance is adequate to meet the treatment requirements, and only will be supplemented by media if a cost-benefit analysis of the importing more distant media shows that to be superior to a bioreactor that uses on-site materials only or primarily.

4.6 RECLAMATION KNOWLEDGE TO DATE

Based on the specific reclamation research results to date and on a review of other reclamation and trial projects – the following will guide reclamation activities during progressive and final closure:

- Chemical analysis of soils indicate that the overburden soils are deficient in macronutrients (Nitrogen, Carbon, Phosphate and Potassium), but have adequate micronutrients (Copper, Iron, Manganese, Molybdenum, Zinc). It is recommended that soils be amended with fertilizer and/or mulched to promote grass/plant growth after seeding.
- The nutrient uptake by northern native seed varieties on nutrient deficient soil is usually more effective than nutrient uptake by southern agronomic species. Seeding with agronomic species over most disturbed areas at the Minto mine site may be required because of the high cost and limited availability of northern native revegetation species.
- Where additional areas at the mine may be targeted for progressive reclamation, seed and fertilizer treatments should be formulated based on the monitoring results of the revegetation trials to date. Two seed mixes are recommended below:
    i. a dry area seed mix (Table 4-5), which would be applied to most disturbed sites in the area, and
    ii. a wet area seed mix (Table 4-6) for riparian sites.

Table 4-5 Dry Area Seed Mix

Species	Botanical Name	Application Rate (kg/ha)	Percentage
Violet Wheatgrass	*Agropyron violaceum*	12	40.0
Sheep Fescue	*Festuca ovina*	7	23.3
Rocky Mountain Fescue	*Festuca saximontana*	7	23.3
Glaucous Bluegrass	*Poa glauca*	4	13.4
Total		30	100

Table 4-6 Wet Area Seed Mix

Species	Botanical Name	Application Rate (kg/ha)	Percentage
Violet Wheatgrass	*Agropyron violaceum*	16	53.3
Fowl Bluegrass	*Poa palustris*	8	26.7
Tufted Hairgrass	*Deschampsia caespitosa*	6	20.0
Total		**30**	**100**

In addition to each grass mix, a nitrogen-fixing plant species will be added. If native species Yellow locoweed (Oxytropis campestris) and Arctic lupine (Lupinus arcticus) are available they can be applied at 2kg/ha. Agronomical species Medicago sp. (Rambler or Drylander) and Alsike clover at can also be applied at 2kg/ha. Rhizobium inoculant is needed for these legume seeds.

- Topsoil and logs (coarse woody debris) should be salvaged during stripping and clearing and stockpiled to the side. The topsoil as well as being a seed bank, contains microfauna and fungus necessary for nutrient cycling. The logs are carbon/moisture reservoirs and provide habitat and preferable re-growth microsites. This material is needed to jump start soil-building processes and to accelerate revegetation growth.
- Vegetation islands of shrubs, trees and coarse woody debris act as a seed banks, attract wildlife which transport seeds and nutrients into the grassed area and speed up vegetation succession. Vegetation islands should be incorporated into both the revegetation research program and the larger scale progressive reclamation efforts. Retention of islands of vegetation where possible within the Minto Mine future expansion plans will enhance landscape diversity and accelerate vegetation succession after mine closure.
- Local shrub/tree species can be salvaged and planted on corresponding aspects. Use ecosystem polygons already mapped to assist in finding local plant stock, and in determining species adapted to particular aspects and conditions.

5 IMPLEMENTATION SCHEDULE

As currently permitted, Phase IV surface mining is scheduled to cease early to mid-2014, underground mining in 2016, with milling cessation within 1 year. As stated in previous sections, Minto intends to continue to operate beyond the scope of Phase IV operations. The proposed Phase V/VI mine plan involves surface mining until 2017, underground mining until 2019, and milling until 2022. The phase V/VI proposal entered an evaluation by YESAB in June 2013 and a final decision on the project is not expected until August 2014.

Regardless of the mine plan, reclamation of disturbed areas will occur in a phased approach to match the overall mining schedule and after closure to reflect the reclamation and monitoring effort required. This phased approach to reclamation planning will assist Minto in achieving the overall objectives of progressive and final reclamation at the site.

An implementation schedule of proposed key reclamation and closure activities for Phase IV mining is presented below by year. If Phase V/VI mining activities are approved, the schedule would be adjusted according to a revised Phase V/VI Reclamation and Closure Plan..

2014

- Reclamation of DSTSF. Monitoring of the reclaimed DSTSF will commence to verify effectiveness of closure on reductions in source loadings;
- Reclamation research, on-site data collection, water quality analysis and bench-scale pilot systems begin for constructed wetland treatment systems and biological reactors;
- Commence the Southwest Waste Dump reclamation (cover placement and revegetation);

2015

- Commence Main Waste Dump reclamation, and final DSTSF/MVFE covers and revegetation;
- Reclamation of Main, Area 2 and Area 118 pits

2016 Start of final closure

- Processing of stockpiles is completed and reclamation of ore stockpile footprints begins;
- End of Phase IV milling;
- Active decommissioning and closure starts (3-year period);
- Continued reclamation of the Area 118 Pit, main waste dump, and southwest waste dump;
- Flooding of the Main Pit and Area 2 Pit;
- Commence Main Pit dump cover and revegetation;
- Ongoing monitoring of progressive reclamation.

2017

- Active decommissioning continues (mill decommissioning, recontouring, etc.);
- Ongoing site reclamation activities where still required;

- Initial diversion and conveyance channel construction
- Ongoing monitoring of progressive reclamation.

2018

- Final diversion channel construction;
- Dam deconstruction;
- Reclamation of the Mill Valley Fill Expansion;
- Completion of site reclamation activities;
- Beginning of post-closure period monitoring program.

2033

- Scheduled end of post-closure period monitoring program.

6 CLOSURE MEASURES FOR SITE RECLAMATION UNITS

This section outlines the proposed reclamation methodologies that will be applied to the different reclamation units present at the site. Each sub-section contains a description of the area in addition to discussion of the closure issues that help govern the closure methodologies chosen for that unit. References to previous reports or supporting documentation are also contained in each sub-section.

Figure 2-3 presents the overall site plan at the end of the Phase IV expansion project, in addition to a general summary of the various closure measures proposed for the reclamation units that will be present at the end of mining under the Phase IV application. This figure also identifies the currently proposed timeline for conducting the reclamation works at the site. Figure 6-2 in Section 6.8 shows the final site water management layout for the site based on the currently proposed closure plan, including proposed major diversion alignments, and pit flooding projections.

The disturbed area has been divided into reclamation units as follows:

- Waste Rock And Overburden Dumps;
- Ore stockpiles;
- Open Pits;
- Underground Workings;
- Dry Stack Tailings Storage Facility and Diversion Structures;
- Mill Valley Fill Extension;
- Haul Roads;
- Water Storage Pond Dam;
- Mill and Ancillary Facilities;
- Mill Pond;
- Access Road; and
- Miscellaneous Components.

Table 6-1 contains a summary of the expected site disturbance associated with each reclamation unit at the end of Phase IV mine life. This table lists the reclamation components and sub-components, the total area expected to be disturbed by each unit during the construction and operations phases and the final surface area of the reclamation unit that will require reclamation. The areas to be reclaimed contained in the table are based on three dimensional models of the facilities and as such reflect the actual areas as opposed to the disturbed footprint which does not account for slope.

It is estimated that a total of 316 hectares will be disturbed by the end of Phase IV mine development. Table 6-1 below presents calculated areas of disturbance requiring reclamation.

Table 6-1 Estimated Area of Disturbance Requiring Reclamation

Reclamation Component	Surface Area Requiring Reclamation (ha)
Main Waste Dump	43.5
South West Dump	74.0
Ice-Rich Overburden Dump	34.5
Reclamation Overburden Dump	30.0
Ore Stockpile Areas	15.7
Open Pits	n/a
Haul Roads	13.0
Portal Area	2.0
Tailings Area	41.3
Water Storage Pond Dam (including 4.7 ha impacted by impounded water)	6.0
Mill and Ancillary Facilities (Including MVFE surface)	10.5
Access Road (assuming full extent of access road reclamation)	26.2
Explosives Plant site	2.6
Mine Camp	2.2
Air Strip	n/a
Mine Contractor Laydown	2.5
Exploration Sites and Trails	n/a
Land Treatment & Solid Waste Facilities	1.0
Miscellaneous Components Subtotal	8.3
Total	**313.3**

6.1 WASTE ROCK AND OVERBURDEN DUMPS

This section addresses the reclamation of the waste rock and overburden dumps at the site which include the following reclamation units:

- Main Waste Dump;
- Southwest Waste Dump;
- Ice-Rich Overburden Dump; and
- Reclamation Overburden Dump.

The MWD and SWD are existing mine infrastructure that contain unclassified waste rock generated during earlier mine development. This material was not segregated by copper content and as a result contains some higher copper content materials. Updated geochemical modelling and water quality predictions indicate that, for most waste rock dump areas, rudimentary revegetated soil covers will be appropriate for mitigating the potential for contaminant migration from the waste rock dumps. However, as a precautionary measure, costing allowances have been made for the incorporation of a low permeability, engineered cover system to further reduce metal loadings from the High Grade Waste area of the SWD (located at the very southwest corner of the SWD.)

6.1.1 Main Waste Dump

The Main Waste Dump (MWD) is located immediately northwest of the Main Pit, and has been constructed in sequential lifts as materials are extracted from the Main Pit. The MWD has been constructed according to EBA's Geotechnical Evaluation – Proposed Main Waste Dump, Minto Project, Yukon (EBA, 1998) which addresses physical stability design considerations such as maximum credible earthquake criteria so the likelihood of major failure of the facility is deemed to be low. Annual inspections of the MWD have taken place as per Section 9.3.2 of the Quartz Mining Licence QML-0001 and no physical stability issues have been identified to date. The MWD has not and will not receive any additional waste material from Phase IV; however, additional waste rock disposal is scheduled for the MWD in connection with Phase V/VI mine development of the Minto North Pit.

Waste materials placed in the facility contain copper concentrations ranging from 0–0.64% since the majority of the MWD was constructed prior to the development of specific material handling plans based on the copper content. Geochemical characterization of the materials as part of permit requirements has shown that the materials do not present an acid rock drainage concern. The average NP/AP ratio of materials placed into the MWD is 48.5 with an average paste pH of 8.61 (Minto, 2009). Neutral metal leaching has been identified as being a potential chemical concern associated with closure of this reclamation unit based on the ongoing geochemical characterization program (SRK, 2010) for the mine.

The proposed reclamation of the MWD will involve addressing physical stability concerns with geochemical concerns being addressed as part of the site-wide source control program described in Section 4 of this report. The slope of each lift will be reclaimed as per Figure 6-1, which shows typical standard reclamation measures of a dump slope. Slope crests will be rolled over using a tracked dozer with recontouring conducted in areas where the dump faces are greater than the long term angle of repose. This has been completed for a significant portion of the dump face already in progressive reclamation activities – see Section 4.3 Reclamation to Date.

Geochemical characterization of the waste materials previously disposed of in the MWD has shown that the materials do not present an acid rock drainage concern. Neutral pH metal leaching has been identified as being a potential geochemical concern associated with closure of the dump based on the ongoing geochemical characterization program (SRK, 2010) for the mine.

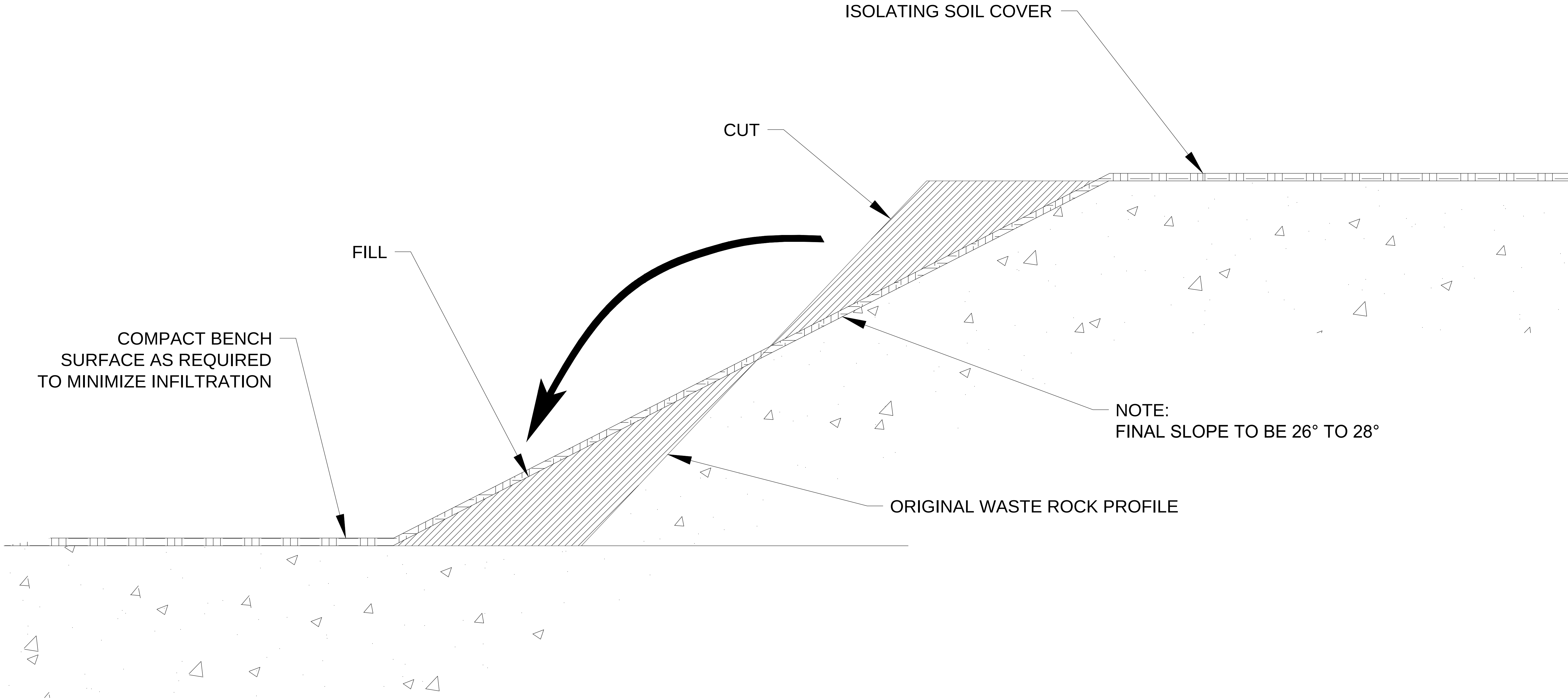
Both benched (i.e., relatively flat) and sloped surfaces of the MWD will be covered with a soil cover. Prior closure plans for this unit had proposed a soil cover thicknesses of 0.25 m for placement onto the MWD. The 0.25 m thickness is being re-evaluated based on the results of the predictive closure water quality model and the identified need for implementing source control. Research into optimal cover thickness is ongoing; however, based on our current understanding of cover material properties, the following assumptions have been made regarding the anticipated cover configuration. Bench areas will be covered with a minimum 0.5m thickness of soil cover with 20% of the bench areas to be covered with an average 2.0m cover thickness to facilitate the incorporation of deeper rooting vegetative cover. For costing purposes, all bench areas will be covered with an average 0.8m thickness of soil cover. All perimeter slopes are to be covered with a minimum 1.0m of soil cover.

The surface of the SWD shall not be scarified prior to placement of the cover as infiltration into the dump materials is not considered desirable based on the potential for neutral metal leaching of the waste materials. Compaction of the surface of the dump is considered to be favourable towards the intent of reducing infiltration.

Reclamation overburden will be loaded with an excavator and hauled by trucks from the reclamation overburden dump. Overburden will be placed with the trucks and further spread with a low ground pressure dozer. Compaction of the cover during spreading will be minimized by the use of low ground pressure equipment, however, areas observed to have compaction will be ripped to reduce compaction effects prior to seed and fertilizer application.

The current reclamation seed mixture and fertilizer application rates contained in the 2011 DRP for the Minto mine will be followed unless ongoing reclamation research programs show that changes to these are warranted.

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION



NOTES:

FIGURE REPRODUCED IN PART FROM FIGURE 6-4 OF MINTO MINE DECOMMISSIONING AND RECLAMATION PLAN ver. 3.2

DATE	ISSUE/REVISION	REV No.	DRW.	APP.
2013-09-13	ISSUED FOR REVIEW	00	KB	JT

ACCESS

capstone MINTO MINE

PROJECT NAME: Minto Mine Phase IV Reclamation and Closure Plan Revision 4.0	DESIGNED BY: EBA	ACCESS PROJECT NO: MIN-11-01	CLIENT REF.:
	DRAWN BY: K. Boldt	SCALE: NOT TO SCALE	
TITLE: TYPICAL SLOPE RECLAMATION MEASURES	CHECKED BY: J. Theriault	FIGURE: 6-1	REV.: 00

C:\Users\kboldt\Projects\Minto\CAD\Drawings\MIN-11-01-F6-1.dwg

6.1.2 Southwest Waste Dump

The southwest waste dump (SWD) is located to the south of the MWD and was designed by EBA in 2008 in order to optimize operations and provide additional storage areas for waste rock and non-ice-rich overburden material. Construction began shortly after the design approval in October 2008 and is currently being developed as per the EBA report entitled Geotechnical Design, Proposed Southwest Waste Dump (EBA, 2008a). The Phase IV expansion of the SWD has been constructed in accordance with the Waste Management Plan (EBA, 2010a) which outlines the design criteria for this unit. The dump has been constructed in progressive lifts with ongoing monitoring of the stability of the SWD being conducted as recommended in the design report through a combination of visual inspections, deformation surveys and monitoring instrumentation (piezometers, ground temperature cables and survey hubs).

The majority of waste rock scheduled for surface disposal as a result of Phase IV was placed into the SWD. Segregation of waste on the basis of copper content was conducted, and the highest grade waste (HGW) which was originally destined for a Grade Bin Disposal Area (GBDA) south of the Main Pit was instead stockpiled in a segregated area in the southern-most extent of the SWD area. This was due to the instability and south wall failure of the Main Pit in the GBDA area. Medium grade waste (MGW) was also placed in an area separate from the rest of the waste in the dump. Some of the original portions of the SWD constructed as part of past mine workings have been covered as a result of the expansion of this unit. The covering of the older portions of the SWD, which are suspected to contain higher copper content waste rock materials, will help to reduce potential metal loadings from these materials.

The SWD is estimated to receive approximately 6.44 Mm^3 of waste materials with copper content less than 0.1% from the Phase IV development. Initial geochemical characterization of the waste materials scheduled for placement in the SWD has shown that the materials do not present an acid rock drainage concern. Neutral pH metal leaching has been identified as being a potential geochemical concern associated with closure of the dump based on the ongoing geochemical characterization program (SRK, 2010).

It is anticipated that the entire surface of the SWD, with the possible exception of the isolated area of high grade waste, will be covered with a rudimentary, revegetated isolation soil cover similar to that proposed for the MWD. Research into optimal cover thickness is ongoing; however, based on our current understanding of cover material properties, the following assumptions have been made regarding the anticipated cover configuration. Bench areas will be covered with a minimum 0.5m thickness of soil cover with 20% of the bench areas to be covered with an average 2.0m cover thickness to facilitate the incorporation of deeper rooting vegetative cover. For costing purposes, all bench areas will be covered with an average 0.8m thickness of soil cover. All perimeter slopes are to be covered with a minimum 1.0m of soil cover. A ‘rough and loose’ surface will be encouraged for erosion control, moisture retention and promotion of seed and propagule capturing.

While updated water quality predictions indicate that rudimentary soil cover is appropriate for the entire SWD surface, Minto has conservatively allowed for the placement of an engineered very low permeability cover over the area containing high grade waste. The closure costing has allowed for the installation of a bituminous geomembrane over the area of HGW.

Reclamation overburden will be loaded with an excavator and hauled by trucks from the reclamation overburden dump. Overburden will be placed with the trucks and further spread with a low ground pressure dozer. Compaction of the overburden during spreading will be minimized by the use of low ground pressure equipment, however, areas observed to have compaction will be ripped to reduce compaction effects prior to seed and fertilizer application.

The current reclamation seed mixture and fertilizer application rates presented in Section 4.6 will be followed unless ongoing reclamation research programs show that changes to these are warranted.

6.1.3 Ice-Rich Overburden Dump

The ice-rich overburden dump (IROD) is the furthest west reclamation unit on the site and has been constructed immediately upgradient of the SWD. A toe berm has been constructed from waste rock to retain the ice-rich overburden and prevent migration of the material downslope as ice in the stockpiled materials melt. The IROD has been constructed according to EBA's Geotechnical Design, Ice-Rich Overburden Dump, Minto Mine, Minto YT (EBA, 2006) and has been inspected since as per the Quartz Mining Licence (QML-0001, Section 9.3.2) with no stability issues identified to date. Construction of the SWD around the margins of the IROD have significantly reduced the likelihood and potential consequences of IROD instability.

Materials from the IROD will be used as a source for growth media during reclamation of the SWD. Reclamation of the IROD will involve the placement of a 0.25 m layer of overburden on the toe berm as this unit is not deemed to require source control.

Any overburden remaining in the dump after closure and reclamation has been completed will be resloped to less than 2.5H:1V and revegetated. Revegetation test plots were established on the toe berm in 2007. Final revegetation seed mixtures and fertilization requirements for the IROD will be similar to those applied elsewhere on the site.

6.1.4 Reclamation Overburden Dump

The reclamation overburden dump (ROD) is located to the west of the MWD and north of the SWD. The ROD will be expanded as a result of Phase IV in order to stockpile reclamation materials stripped during construction and development of site infrastructure (eg. Area 2 and 118 open pits, Mill Valley Fill). The existing portions of the ROD have been constructed in accordance with EBA's Geotechnical Design, Proposed Reclamation Overburden Dump, Minto Mine, Yukon (EBA, 2008b). The proposed expansion of the ROD will be constructed in accordance with EBA's Phase IV Waste Management Plan (EBA, 2010a) which outlines the design criteria for this unit. Currently, the ROD contains 4.43 Mm^3 of overburden that would be available for soil cover construction at the end of Phase IV.

The overburden materials stockpiled in the ROD will be used as a source for growth media during reclamation of other units at the site. Any overburden remaining in the ROD after closure and reclamation has been completed will be resloped to less than 2.5H:1V and revegetated.

6.2 ORE STOCKPILES AND PADS

The Phase IV mine plan includes the milling of all stockpiled ore prior to final closure. The following stockpiles at the site will be treated in this fashion and therefore are not deemed to be an issue at closure:

- high grade sulphide ore stockpile and pad (located south of the mill); and
- low grade sulphide ore stockpile and oxide ore pad (located between the pit and the MWD).

Both the high and low grade sulphide stockpile pads were constructed from waste rock according to design criteria set out in EBA's Waste Rock Stability Evaluation, Minto Project, Yukon (EBA, 1996). The stockpile pads on site are designed in accordance with the recommendations in "Mined Rock and Overburden Piles Investigation and Design Manual" published by the BC Mine Waste Rock Pile Research Committee. In accordance with the above mentioned manual, all stockpile pads on site are designed to be stable up to a seismic event which results in peak ground accelerations which have a 10% probability of exceedance in 50 years (EBA and Access, 2011). The ore stockpiles have been inspected annually as per the Quartz Mining Licence (QML-0001) and there are no issues identified to date that suggest long term stability concerns for these units).

Reclamation of the stockpile pads will be conducted following the completion of milling of stockpiled ore materials. Compacted portions of the pads will not be scarified to promote drainage as the geochemical characterization program indicates that there is potential for neutral metal leaching from these materials. The pads will have a minimum of a 0.5 m soil layer of growth material applied followed by application of seed and fertilizer.

6.3 OPEN PITS

Phase IV involves the development of the Area 2 and Area 118 open pits. The Main Pit mining was completed in April 2011 and has been included in this plan based on the planned deposition of tailings and NP:AP>3 waste rock into this unit.

6.3.1 Main Pit

The Main Pit encompasses the original drainage channel for Minto Creek. The Main Pit was excavated according to Minto's Open Pit Design Plans (MintoEx, 2006). The north wall of the pit is benched in competent bedrock while the south wall is composed of bedrock and ice-rich overburden. Acid-base accounting indicates that the open pit wall rocks are net neutral to slightly acid consuming (non-acid generating). Results to date (SRK, Appendix A) indicate that the open pit wall geochemistry is consistent with the initial geochemical predictions put forward in the original geochemical characterization report (Mills, 1997).

The open pit was exhausted of ore during April 2011. An area of instability in the south wall of the pit failed shortly after completion of mining activities, and a stabilization buttress (South Wall Buttress) for the area is nearing completion.

During the operations period the storage capacity of the flooded pit will be sufficient to accommodate a storm volume of 975,000 m^3 which is required by the current water licence to be available at the end of each season of operation. According to the Phase IV Tailings Management Plan (EBA, 2010b), slurry tailings are being placed in the pit and will be placed to an elevation of approximately 8 m below the final spillway invert elevation.

The completion of tailings deposition into the Main Pit occurs while the mine is still in operations and construction of a final discharge channel from the pit to Minto Creek will not be possible until the end of milling activities currently scheduled for early 2016. Excess water accumulated in the Main Pit prior to the construction of the discharge channel will be either:

- Subject to treatment in the water treatment plant and discharged to the receiving environment; or
- Pumped into the Area 2 pit to accelerate flooding of that unit.

The pit will then be allowed to flood in order to cover the deposited tailings and waste rock. Water quality in the Main Pit will be monitored during flooding and the water treatment plant will be in place so that water can be treated prior to release off-site if required.

At closure, approximately 55% (10.6 ha) of the open pit walls will remain exposed above water following flooding of the Main Pit. Prior to flooding, any accessible benches in the pit excavated in overburden will be scarified to encourage natural revegetation, but no additional reclamation work will be done on the open pit high walls. Boulders, up to 1 m in size, will be placed on all potential access routes to prevent uncontrolled human access to the pit.

The Main Pit will be flooded until it overflows into the engineered drainage channel (ditch 400). It is expected that it will have an approximate final water elevation of 785 m. The proposed Main Pit lake will spill to the east at approximately the same elevation at the low point on the pit rim into a designed intake structure and drainage channel that will convey the flow from the pit. The discharge channel (ditch 400) from the Main Pit is discussed in Section 6.8.

6.3.2 Area 2 Pit

The Area 2 Pit is located to the west of the Dry Stack Tailings Storage Facility. The Area 2 open pit has been constructed using standard drill and blast mining techniques with the proposed excavation occurring primarily in competent bedrock. The Area 2 pit will be used to store tailings once the Main Pit has been filled to its design capacity.

Some of the upper benches will be excavated into overburden and there is the potential for shallow surficial instability to occur in the overburden unit. Any areas of instability noted during operations will be addressed during subsequent updates of this document. Acid-base accounting indicates that the open pit wall rocks are net neutral to slightly acid consuming (non-acid generating).

Following the cessation of operations, the Area 2 pit will be flooded until it overflows into the engineered drainage channel. To facilitate this, the existing Southwest Diversion Ditch (referred to as Ditch 100 in this RCP) will be diverted into the Area 2 Pit at closure. Minto will evaluate whether pumping water into the Area 2 pit is required in order to accelerate flooding at closure. Pumping into the Area 2 pit is currently considered a favourable measure to submerge non-acid generating sulphide materials that are exposed as a result of the mining operations in this area. Accelerated flooding of the pit will act to reduce the oxidation of any exposed materials in the pit walls resulting in lower overall metal loadings due to less soluble secondary weathering products being produced from sulphide oxidation. The Area 2 pit lake will have an approximate depth of 35 m following flooding.

Due to the limited topography in Area 2 pit it is estimated that approximately 20% of the open pit walls will be exposed following flooding of this unit. The proposed Area 2 pit lake will spill to the north at an elevation of approximately 802 m into a designed intake structure and drainage channel that will convey the flow out of the pit. The conceptual intake structure invert elevation is estimated to be at approximately the same elevation as the low point on the pit rim, but the final invert elevation will be determined following development of that portion of the pit. The discharge channel (ditch 450) from the Area 2 pit is discussed in Section 6.8.

Prior to flooding, any accessible benches in the pit excavated in overburden will be scarified to encourage natural revegetation, but no additional reclamation work will be done on the open pit high walls. Boulders, up to 1 m in size, will be placed on all potential access routes to prevent uncontrolled human access to the pit

6.3.3 Area 118 Pit

The Area 118 pit is located upslope and to the west of the Area 2 pit and will be mined during 2014. The Area 118 open pit will be constructed using standard drill and blast mining techniques with the proposed excavation occurring mostly in competent bedrock. The upper benches will be excavated into overburden and there is the potential for shallow surficial instability to occur in the overburden unit. Any areas of instability noted during operations will be addressed during subsequent updates of this document. Acid-base accounting indicates that the open pit wall rocks are net neutral to slightly acid consuming (non-acid generating). The Area 118 Pit will be left in its final mined-out state at closure.

6.4 UNDERGROUND WORKINGS

The Phase IV mine plan includes underground mining below the Area 2 and Area 118 open pits. Development includes a portal (construction complete) and decline for underground access which required surface overburden excavation to expose bedrock prior to drilling and blasting of the portal. It is estimated that approximately 1,541 kt of ore and 341 kt of waste will be excavated from underground mining, which is commencing shortly.

The proposed mine plan includes disposal of waste materials by backfilling into the underground workings. The waste rock from the underground will follow the approved Waste Rock and Overburden Management Plan for phase IV.

To date, geochemical characterization for the underground waste rock recovered from core samples show that underground waste rocks are similar in geochemical properties to waste rock from Area 2 and Area 118 open pits.

Upon completion of underground mining, the underground workings will be allowed to flood. Recently updated hydrogeologic investigations indicate that in the post-closure period the groundwater table will not rise sufficiently to result in water discharging at the surface. In Accordance with the Yukon Quartz Mining

Act, at the completion of mining the portal to the underground workings will be sealed, preventing access by people and wildlife. The ventilation raise will also be sealed to prevent access.

The portal area will be backfilled and recontoured to a stable and natural slope. This will be followed by the application of appropriate seed and fertilizer to restore vegetation to the area.

6.5 HAUL ROADS

The haul roads on the site radiate out from the open pit to the mill, the ore stockpiles, the waste rock dumps and the ice-rich overburden dump. Haul roads, site roads and the main access road will be subject to standard road decommissioning and reclamation measures at closure, including culvert excavation, drainage recontouring, slope stabilization and surface scarification. Regrading/contouring of the roads will ensure that runoff sheds off the road surface and does not become ponded. Site reclamation experience indicates that road surfaces are not expected to require seeding, only surface scarification in order to encourage natural revegetation. Sediment management measures will be installed where drainage channels have been re-established in order to prevent sediment from entering streams while revegetation occurs. Short term sediment management measures may include installation of silt fencing and enviro-matting at select sites until vegetation becomes established.

6.6 DRY STACK TAILINGS STORAGE AREA AND DIVERSION STRUCTURES

All tailings placed in the DSTSF were dewatered using ceramic filters before being conveyed by truck for spreading and compaction in the Dry Stack Tailings Storage Facility (DSTSF). Construction of the facility was in accordance with EBA's Geotechnical Design Report, Dry Stack Tailings Storage Facility, Minto Mine, Yukon (EBA, 2007). Further details on the tailings handling procedures are available in Minto's Tailings Management Plan (TMP) and the related Operations, Maintenance and Surveillance Plan (OMS) for the DSTSF.

The DSTSF is located on a bench to the south of the mill and upslope from the Minto Creek channel. The facility has been constructed as per the specifications provided in the TMP and overseen by the Engineer of Record (EBA). Field compaction of placed dewatered tailings was regularly verified using a nuclear densometer, as per the quality control program. The last tailings placement in the DSTSF occurred in November of 2012, at which point issuance of the water licence amendment for Phase IV operations allowed for the switch to the placement of slurry tailings in the Main Pit. Monitoring of the stability of the tailings stack has been conducted through daily visual inspections and through monitoring the installed instrumentation (piezometers, ground temperature cables and settlement monuments). Regular field visits and an annual geotechnical inspection are conducted by the Engineer of Record as required under the Quartz Mining Licence QML-0001 (Section 9.3.2).

The Mill Valley Fill Extension which is described in the next section was designed to buttress the DSTSF and eliminate its movement, and although the MVFE is now built to design completion and movement is slowed, there is still some facility movement identified through the monitoring program.

The rate of movement varies across the dry stack; along the centerline of the facility, where tailings fill is thickest, it is approximately 3.0 mm/d (DSSH12), while the rate at the eastern edge measures 1.5 mm/d (DSSH17). The movement rates of these survey hubs peaked at 8.6 mm/d and 2.5 mm/d, respectively, suggesting that the MVFE has had a significant effect. In April 2013, nine new inclinometer holes were installed in and around the DSTSF to better characterize the rate of movement and the depths at which it is occurring. This geotechnical drilling program provides additional data for an assessment of what, if any, further measures will be required to stop movement of the facility.

Minto submitted a risk assessment report on the DSTSF to the Department of Energy Mines and Resources (EMR) in March 2009 (SRK, 2009b). The report evaluated all conceivable failure modes for the facility using the Failure Modes and Effects Analysis (FMEA) method. The report recognizes the lowered physical risks associated with the DSTSF versus a conventional slurried tailings impoundment and noted that the regulatory requirements necessary to mitigate risks are currently in place. The preliminary FMEA exercise for the Minto Closure Planning conducted in January 2013 (Appendix C) acknowledged the ongoing uncertainty regarding the mechanism of instability and the potential need for further mitigation measures. Minto has engaged SRK to conduct a targeted investigation into the extent of continued movement at the site with a view towards the development of ultimate mitigation measures for the DSTSF instability. Minto and SFN have also engaged a 3rd party expert on geotechnical stability under mutually agreed upon terms of reference to assist in the evaluation of the facility movement and the development of appropriate mitigation. This evaluation is ongoing, and the results of this are not available for inclusion in this RCP, as stipulated in WUL QZ96-006 clause 103 c) ii). Minto will include the Yukon Water Board and YG EMR in the distribution of findings and final mitigation recommendations and designs as they are developed.

Geochemical characterization of the tailings has indicated there is no acid-rock drainage potential in this reclamation unit, however neutral metal leaching of copper and other elements has been identified. Closure measures for the DSTSF will focus on reduction of source loadings from the facility in addition to ensuring the physical stability of the facility. Managing water movement in and around the DSTF is seen as the key factor in the design of closures measures. The compacted tailings have a low permeability due to the mechanical compaction of the tailings following placement and spreading in the facility. Infiltration of precipitation and run-on water is not expected to have a significant influence on the DSTSF and surface grading will be utilized during the closure phase to assist in the shedding of water from the surface.

Progressive reclamation of the DSTSF is currently underway and a thick layer of overburden, ranging in thickness is in the process of being placed over the tailings surface, as released from Area 2 stripping activities. This thick overburden layer will obviate the risk of surficial erosion exposing the underlying tailings. The tailings surface will be recontoured to divert surface runoff efficiently off the tailings stack. The closure costing allows for an additional 0.5m of select overburden to ensure that the cover is suitable for revegetation. The current reclamation seed mixture and fertilizer application rates outlined in Section 4 will be followed unless ongoing reclamation research programs show that changes to these are warranted.

6.6.1 DSTSF Diversion Structures

Existing design components (upstream diversion ditches, finger drains and a toe berm) are currently intercepting and diverting some portion of surface runoff from upslope and filtering seepage from below the area. The south diversion ditch (SDD) is the primary diversion structure and is used to convey flow from the original tributary channel that previously ran through the DSTSF into the mill water pond. It is referred to as ditch 100 in the closure plan layout. It has an estimated discharge capacity of 13.3 m^3/s (SRK, 2013b). Such a discharge capacity is more than 4 times larger than the calculated 200-year design flood for ditch 100 of 3.5 m^3/s. The current dimensions of the SDD are more than adequate for closure. During closure the SDD will be consolidated if necessary (adequate size of riprap, proper grading of materials, longitudinal slope and ditch depth) to ensure its long term efficiency for the post-closure period. The operations Water

Management Plan bypass of the SDD around the Area 2 pit will be decommissioned at closure, allowing the SDD (ditch 100) to spill into the Area 2 pit.

Field observations have shown that the Tailings Diversion Ditch to the south of the facility required reconstruction to ensure that water is successfully captured and routed around the facility. This work is being conducted currently according to EBA's design document from October 2011 *Upstream Water Management for the Mill Valley Fill Expansion and Dry Stack Tailings Storage Facility* (EBA, 2011).

Secondary and tertiary ditches will direct any excessive direct precipitation from the DSTSF surface to the Ditch 400 for discharge off site.

6.7 MILL VALLEY FILL EXTENSION

The Mill Valley Fill Extension (MVFE) is located immediately downslope of the DSTSF and was designed to buttress the DSTSF due to stability concerns identified through the instrumentation monitoring program at the site. The MVFE has allowed for expansion of the camp pad and establishment of surface laydown areas during the operations phase. The MVFE construction is complete in accordance with the original (Stage 1) design, and was constructed from 1.3 M-m^3 of low copper content run-of-mine rock in order to limit the potential for neutral metal leaching into the receiving environment.

As indicated above in Section 6.6, a geotechnical evaluation is currently underway to further understand the creep movement potential of the DSTSF with a view towards evaluating if further buttressing of the facility is required. The results of that evaluation and associated recommendations are anticipated in late 2013.

Closure of the MVFE will be conducted at the end of Phase IV milling and will involve the removal of any temporary buildings and materials stored in the laydown areas. The location of the MVF in the main valley of Minto Creek means that it will be necessary to route the main site discharge channel alongside the MVF and a spillway down the face of the MVF. The main site discharge channel (called ditch 400 in the closure water management layout) will be designed to accommodate the 200-year event for the entire upstream catchment area including the routing provided by the two pits. Evaluation of the potential for the main site discharge channel to influence the geotechnical stability of the DSTSF will be evaluated during detailed design. The cost of the spillway design and associated geotechnical stability evaluation has been included in the closure costing for this unit. It is important to understand that the detailed design and associated geotechnical evaluations for this channel are not able to be finalized until after the ultimate configuration of the MVFE facility has been determined, so that final designs can be used.

Recontouring of areas of the MVFE not required for channel construction will be conducted in order to establish final drainage runoff patterns. The surface of the MVF is currently not expected to require source control so it will be covered with 0.25 metres of growth media prior to application of seed and fertilizer.

6.7.1 Seepage at Toe of MVFE

Currently, seepage from the toe of the MVFE, which includes seepage from the DSTSF via the finger drain channels beneath the facility, is collected at the Minto Creek Detention Structure and pumped back to the Main Pit prior to treatment for discharge. This will be continued through the active decommissioning stage as required until upstream and local reclamation works are completed to a stage that allows release of this water without compromising the suitability of site discharge as measured by the existing site effluent discharge standards and MMER Schedule 4 criteria. Accordingly, water quality in this area will be monitored and any adverse trends in water quality will be addressed as per the AMP.

6.8 WATER MANAGEMENT STRUCTURES AND SYSTEMS

One main objective of the closure water management plan is to produce a preliminary design for the water conveyance structures, including sizing and protection against erosion, to safely route flow downstream of the mine site towards Minto Creek.

The design considerations and criteria, methodologies and results of the hydrological analysis and hydraulic design completed for Minto Mine closure are presented in the Minto Mine Phase IV Closure Hydrology Report, presented in Appendix B. A summary of the report is presented in the next sub-sections.

6.8.1 Site layout

The proposed site layout of water conveyance channels has been determined based on the layout proposed in the 2011 DRP, and the mine site topographical constraints at closure. The main objective is to safely convey water downstream of the site, avoiding erosion of waste rock dump covers, tailings and other remaining works at closure.

The proposed water conveyance ditch alignments are presented in Figure 6-2. These alignments will be refined at closure to adapt to site conditions and provide safe routing of surface water over and around waste dumps and the DSTSF.

A combination of primary, secondary and tertiary ditches are proposed. Primary water conveyance channels are the main channels that will route the accumulated overland flow through the mine site. Erosion protection measures will be incorporated to ensure the stability of the channels. Energy dissipation measures will be required to ensure that flow across steep slopes is managed safely and energy is dissipated in controlled locations. Five primary ditches have been incorporated into the water conveyance design, and are described below.

- The South Diversion Ditch (labelled Ditch 100) has been constructed as part of mine operations to intercept flow to protect the DSTSF from run-on flow. This ditch will be upgraded for closure, and will route flows into the Area 2 Pit. The ditch currently has the capacity to carry up to 13.3 m^3/s (SRK, 2013b). Regular flow is diverted around Area 2 pit by a pipe which has an estimated capacity of 1.1 m^3/s, while any additional flows enters the pit through a recently constructed spillway.

- Flows from the Main Waste Dump and the Reclamation Overburden Dump will be captured in Ditch 300. Ditch 350 will control flow predominantly originating from the Southwest Dump, out of the W15 area. Ditch 300 will discharge its flow into Ditch 350, routing flows into the Main Pit. The alignments of these ditches have been located to minimize flow over erodible buttress soils.

- The Main Pit and Area 2 Pit will provide detention for upper catchment flows in the form of pit lakes at closure. The outlets of these pits will direct flow into Ditch 400 and 450, respectively. Ditch 450 will discharge to Ditch 400 in the mill area. Thus, Ditch 400 will convey the majority of on-site flows. The Ditch 400 alignment will stay as far north as possible when crossing the MVFE, hugging the existing hillside, and will be routed down the MVFE NE slope and continuing in the valley bottom.

Secondary water conveyance channels are ditches that will route runoff water from elevated catchments (i.e. from the top of waste rock dumps and the DSTSF) into the primary ditches and/or energy dissipation and sediment control ponds. These will convey flow from much smaller catchment areas than primary ditches, but will route water down potentially steep slopes, up to 1.5H:1V. The design of secondary ditches will incorporate structures to drop water along the waste rock dump steep faces if required (i.e spillways, drop structure, baffles) in addition to energy dissipation/sediment control ponds at the base of steep slopes, to protect the channels against high flow velocities. The final alignment of secondary ditches will be determined at closure.

The Dry Stack Tailings Diversion Ditch is being upgraded in fall 2013 as part of operations, and has also been retained to assist in preventing run-on flows from entering the DSTSF. It is treated as a secondary ditch, and routes flows to the water storage pond. It will be upgraded as required for closure.

Tertiary water conveyance channels are relatively minor ditches and swales that will direct overland flow on the elevated catchment areas towards secondary ditches, protecting the steep slopes from concentrated surface flow. They will be designed to intercept flow before it can concentrate and potentially erode cover materials. These ditches will route small flows with low flow velocities due to the very small areas of surface runoff being managed.

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FIGURE 6-2 CLOSURE WATER MANAGEMENT LAYOUT

SEPTEMBER 2013

- Proposed Diversion Structure (Primary Ditch)
- Proposed Diversion Structure (Secondary Ditch)
- Proposed Diversion Structure (Tertiary Ditch)
- Existing (Primary) Diversion Ditch (to be consolidated at closure)
- Existing Diversion Ditch
- Pit Lake
- Sediment Pond

THE LAYOUT OF THE DITCHES IS CONCEPTUAL AND WILL BE FINALIZED IN CONJUNCTION WITH THE DETAILED CLOSURE DESIGN. THE MAIN WASTE DUMP DITCHES ARE NOT SHOWN ON THIS FIGURE AND WILL BE DESIGNED AT CLOSURE

0 100 200 300 400 500 Meters

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

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6.8.2 Hydrological Study

A hydrological study (Appendix B) was undertaken to determine floods of various return periods for each sub-catchment within the Minto Mine site. Catchments were delineated for each proposed primary ditch to determine their surface area.

Three primary ditches (100, 300 and 350) will be located upstream from the Main Pit and Area 2 Pits and will flow into them. The surface area of the catchments for those three ditches vary between 1.7 and 3.9 km^2. The flood flows for those catchments have been determined using the Rational Method applied for the calculated time of concentration (varying between 45 and 75 minutes depending on the catchment). The time of concentration is a theoretical parameter that can be defined as the time required for all areas in the catchment to contribute to the flow at the outlet. Precipitation data (Intensity Duration Frequency curves) have been obtained from Environment Canada for the Pelly Ranch weather station, located in proximity to the mine site. Figure 6-3 shows the catchments of each of these three ditches.

Two primary ditches (ditch 400 and 450) will act as outflows from the Main Pit and Area 2 Pit and thus will experience significant routing of floods through pit lakes. Ditch 400 has a catchment area of 8.8 km^2, encompassing most of the mine site, while ditch 450 had a catchment area of 2.4 km^2. Flood flows were determined from the freshet period, since it is expected that the largest volume of runoff will yield the largest flows for both ditches. A constant base flow resulting from snowmelt was estimated and superimposed on a 24-hour rainfall event with a 200-year recurrence. Using this method, it is assumed that the inflows to the pits will be constant over a period of time and lead to a balance between inflows and outflows. Figure 6-4 shows the catchments of these two ditches.

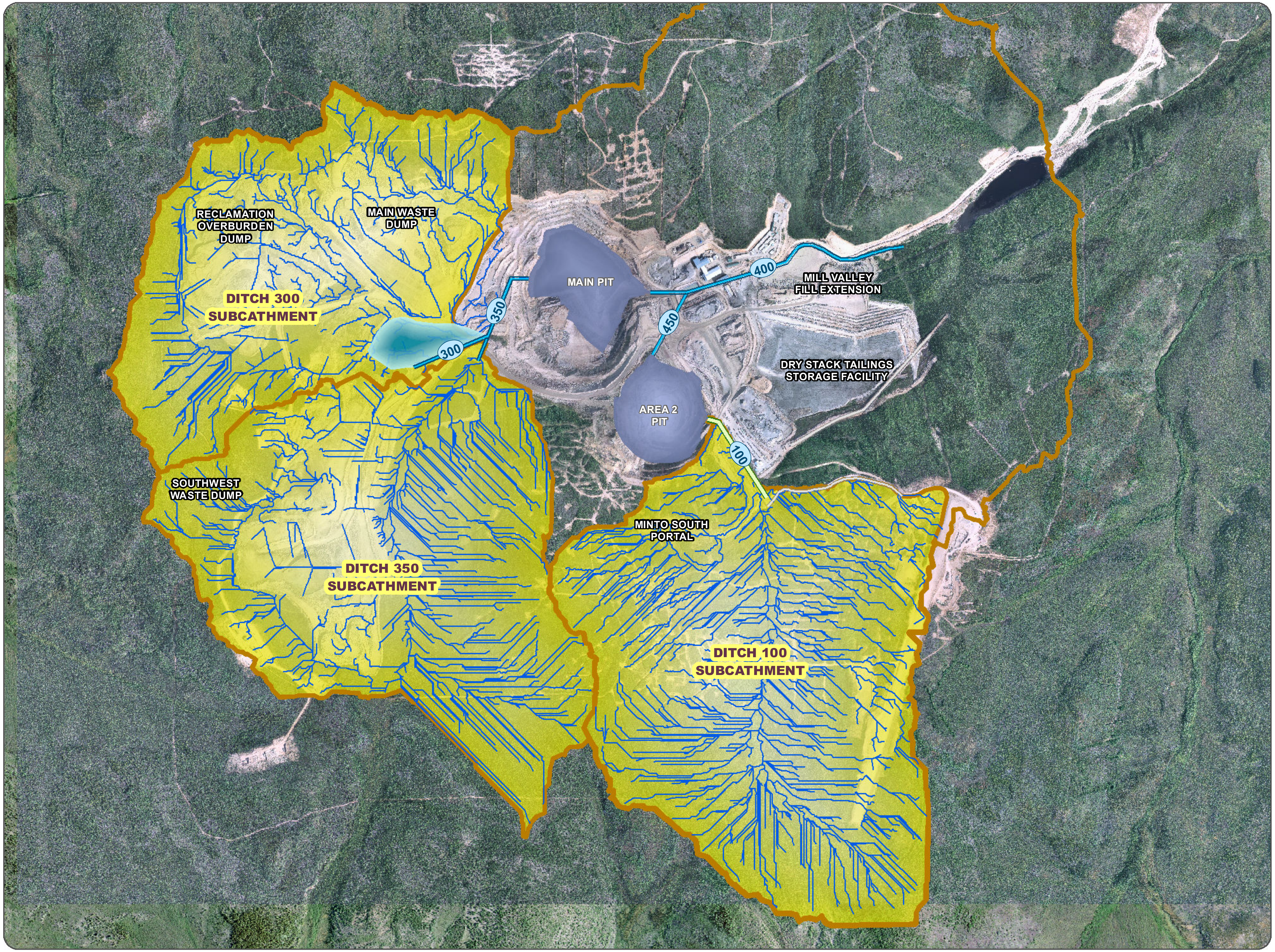

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FIGURE 6-3

UPPER PRIMARY DITCH CATCHMENTS

SEPTEMBER 2013

- Proposed Diversion Structure (Primary Ditch)
- Existing Primary Ditch
- Existing Secondary Ditches
- Modelled Water Flow
- SubCatchment
- Pit Lake
- Sediment Pond

THE LAYOUT OF THE DITCHES IS CONCEPTUAL AND WILL BE FINALIZED IN CONJUNCTION WITH THE DETAILED CLOSURE DESIGN.

0 100 200 300 400 500 Meters

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

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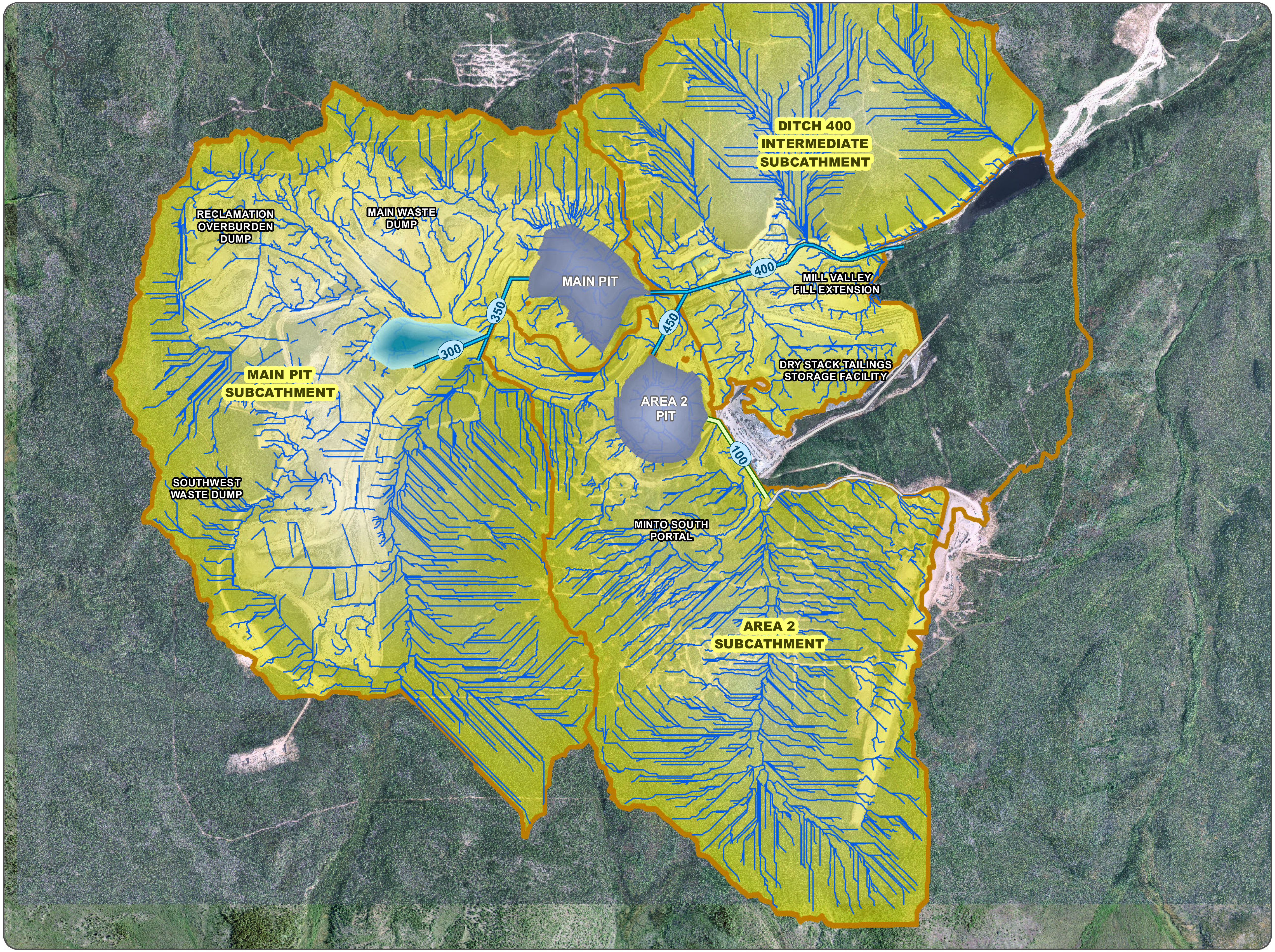

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FIGURE 6-4
LOWER PRIMARY DITCH CATCHMENTS

SEPTEMBER 2013

- Proposed Diversion Structure (Primary Ditch)
- Existing Primary Ditch
- Existing Secondary Ditches
- Modelled Water Flow
- Sediment Pond
- Pit Lake
- Subcatchment

THE LAYOUT OF THE DITCHES IS CONCEPTUAL AND WILL BE FINALIZED IN CONJUNCTION WITH THE DETAILED CLOSURE DESIGN.

0 50 100 200 300 400 500 Meters

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

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The 200-year flood was used as the inflow design flood and the main design criteria to for ditch sizing. This design flow provides a reasonably conservative design flood for mine closure that is based on reliable site specific data. A larger flood recurrence would be highly hypothetical for small watersheds like for the Minto Mine Site and thus unreliable. The selected design criteria for the ditch sizing will provide a significant allowance for additional hydraulic capacity. Table 6-2 presents the selected design flows that will be used for each ditch, and for the two pit outlets.

Table 6-2 Design flows for primary ditches

Component	Drainage area (km²)	Design flow (m³/s)
Ditch 100	2.2	3.5
Ditch 300	1.7	5.0
Ditch 350	3.9	8.0
Ditch 400	8.8	6.6
Ditch 450	2.4	1.8
Main Pit outlet structure	5.0	3.4
Area 2 Pit outlet structure	2.4	1.8

The rational method was also applied to secondary ditches to determine a 200-year flood flow, based on an approximate catchment area for each waste rock dump and the DSTSF. Due to the very small catchment areas for secondary ditches and the associated uncertainty in calculated values, flows were rounded to the upper round number and grouped into categories. Table 6-3 presents the design flows for the secondary and tertiary ditches.

Table 6-3 Design flows for secondary and tertiary ditches

		Design flow (m³/s)
	- DSTSF	3.0
Secondary ditches	- Main Overburden Dump - Southwest Dump (South section)	2.0
	- Southwest Dump (Middle and North sections) - South Overburden Dump - Main Waste Dump - Tailings Diversion Ditch	1.0
Tertiary ditches		0.5

6.8.3 Design criteria for ditch sizing

The sizing of drainage ditches was based on additional design criteria and assumptions. They are outlined below.

Flow Velocity

A maximum flow velocity was set for ditches to limit the size of rip rap required. A maximum D_{50} of 300 and 150 mm was selected for primary and secondary ditches, respectively. The following maximum flow velocities were targeted:

- Primary ditches: 3.5 m/s
- Secondary ditches: 2.5 m/s

Channel geometry

- Side slopes of all drainage ditches set at 2.5H:1V;
- A minimum channel slope of 0.5 % selected for all ditches;
- A target ratio of 2 selected as the maximum ratio of base width over maximum water depth. It is deemed to provide an optimal ratio for functionality and cost efficiency.

Freeboard allowance

- Freeboard allowance will provide ditches with an additional margin of safety for calculated flows that present uncertainty due to the small catchment areas and the lack of local data. The following values are selected.
- Primary ditches: 0.5 m
- Secondary ditches: 0.3 m

The above design criteria are assumed to be optimal and economical to minimize cut and fill volumes, to limit the size of channels and of riprap elements required for erosion protection and to provide an adequate safety margin to the hydraulic capacity of ditches. Further optimization studies would be required when the closure plan is implemented to determine the optimal channel size and alignments. Design criteria could also be revisited if necessary.

The details of the ditch design if presented in the following section.

6.8.4 Channel sizing

6.8.4.1 Primary ditches

Preliminary sizing of primary ditches has been done using the Manning's equation, using a trapezoidal cross-section. The natural ground longitudinal profile for each primary ditch alignment has been extracted from the most recent topography. The proposed alignments generally travel through slopes that vary between 0 and 10%, with a few exceptions where slopes as steep as 40% are observed. A Manning's roughness coefficient of 0.035 was selected as it applies to engineered channels with rockfill elements.

The design work involved a two-step process that is as follows:

1) The minimum channel slope leads to the largest water depth in the channel. The depth of each ditch is sized based on the minimum slope.

2) The maximum channel slope leads to the fastest velocities. The maximum channel slope was defined based on the maximum allowable velocity of 3.5 m/s that was selected as the design criteria. The Isbash equation was used to relate the flow velocity to the required rip rap size.

Table 6-4 presents the selected base widths, slopes and the required rip rap mean diameters (D_{50}) for each primary ditch. The minimum channel depth should be equal to the maximum flow depth with an additional 0.5 m of freeboard.

Table 6-4 Design parameters for primary ditches

Ditch	Design flow (m^3/s)	Base width (m)	Minimum slope (%)	Maximum slope (%)	Maximum flow depth (m)	Maximum flow velocity (m/s)	Maximum rip rap size – D_{50} (mm)	Steep slopes/stilling basin
100	3.5	1	0.8	1.5	0.8	1.9	100	No*
300	5.0	1.5	2	6.5	0.7	3.5	300	Yes (at outlet)
350	8.0	2	1	4.5	0.9	3.4	300	No*
400	6.6	1.5	1	5	1.0	3.4	300	Yes (MVF)
450	1.8	1	1	10	0.6	3.2	250	No

Ditch 100

Ditch 100 already exists on the Minto site and is known as the South Diversion Ditch. This ditch will be upgraded and consolidated as needed at closure, but will remain the same dimensions. The current ditch has an estimated total capacity of 13.3 m^3/s (SRK, 2013b) which is nearly 4 times the calculated 200-year design flow of 3.5 m^3/s. The ditch can be constructed on a slope between 0.8 and 1.5%, which easily follows the current topography with only grading required and no significant excavation or fill.

Ditch 100 empties into the Area 2 Pit through an overflow spillway. Such a spillway is already constructed and should only be consolidated if required at closure. The spillway will empty into Area 2 pit which will act as an energy dissipation basin.

Ditch 300

Ditch 300 will collect water from the northwest corner of the mine site, i.e. from the Reclamation Overburden Dump and the Main Waste Dump. It will connect with Ditch 350 which flows into the Main Pit. A minimum base width of 1.5 m is required to convey the 5 m^3/s design flow. The depth of the ditch should be at least 1.2 m (0.7 m maximum flow depth and a 0.5 m freeboard allowance). Such a cross-section can be constructed on a slope varying between 2 and 6.5% to safely convey the flow. A minimum D_{50} of 300 mm is required for the rip rap.

Ditch 300 will require a steeper section at its outlet to join ditch 350. Larger riprap or another means of protection will be required in this location. An energy dissipation basin will also be required at the junction of the two ditches, and will be designed at closure.

Ditch 350

Ditch 350 is the primary ditch with the highest design flow at 8 m^3/s. It will convey water from the western half of the mine site, where the waste rock dumps are located. It captures flow from the southwest corner of the mine site (Overburden Dump and Southwest Waste Rock Dump), and also intercepts flow coming from Ditch 300. A minimum base width of 2 m is required along with a minimum depth of 1.4 m (0.9 m maximum flow depth and 0.5 m freeboard allowance). Such a cross-section can be constructed on a slope varying between 1 and 4.5 %. A minimum D_{50} of 300 mm is required for the rip rap.

Ditch 350 will empty into Main Pit through an overflow spillway. Such a spillway will be designed and constructed at closure. Main Pit will act as an energy dissipation pond for the flow coming from Ditch 350.

Ditch 400

Ditch 400 will convey most of the surface water out of the mine site. It acts as the outflow from Main Pit which captures the flow from Ditch 350. It also captures the outflows from Area 2 Pit (through Ditch 450) and flows coming from its intermediate watershed downstream of the Main Pit. It will run adjacent to the main access road downstream from Main Pit, to the north of the Mill Valley Fill Extension (MVFE). It will then drop on the MVF east face to reach the bottom of the main valley that leads to the water storage pond at the downstream end of the mine site.

A minimum base width of 1.5 m and a minimum depth of 1.5 m (1.0 m flow depth and 0.5 m freeboard allowance) is required for Ditch 400. The longitudinal slope of the constructed ditch can vary between 1 and 5%. A minimum D_{50} of 300 mm is required for the rip rap.

Ditch 400 will require the construction of an intake structure at the outlet of Main Pit. The invert elevation of the intake structure should be at approximately elevation 785 m, and provide a smooth transition from the pit lake to the shallow fast flowing channel. The confluence with Ditch 450 will also require another structure to properly merge the flows. If possible, those two structures could be combined in a single larger energy dissipation and intake basin for ditch 400. A spillway will also need to be designed along the MVFE east slope. A stilling basin will be constructed at its toe to dissipate energy coming from the spillway. All of these structures will be designed at closure.

Ditch 450

Ditch 450 will convey the routed outflows from Area 2 Pit. Area 2 Pit will only receive inflows from Ditch 100, such that the design flow of Ditch 450 is of 1.8 m^3/s. Ditch 450 will connect with Ditch 400 after 300 m. A minimum base width of 1 m and a minimum depth of 1.1 m is required (0.6 m maximum flow depth and 0.5 m freeboard). Such a cross-section is adequate for a longitudinal slope varying between 1 and 10%. A minimum D_{50} of 250 mm is required for the rip rap.

Ditch 450 will require the construction of an intake structure at the outlet of the Area 2 Pit. The invert elevation of the intake structure should be at approximately elevation 802 m, and provide a smooth transition from the pit lake to the shallow fast flowing channel. It will empty into Ditch 400 in an energy dissipation basin. These structure will be designed in detail at closure.

6.8.4.2 Secondary ditches

Secondary ditches will flow on top of covers and convey water from high flat ground down on the steep faces towards the primary ditches. Their design includes two parts:

- a typical channel cross-section on mild slopes (less than 10%)
- a steep section down the waste rock dump and DSTSF faces, with a slope up to 65% (1.5H:1V)

Secondary ditches will be laid out as a single main channel on the top of covers, but will be required in certain locations to be divided into numerous smaller parallel channels to drop from the steep faces to the primary ditches. Smaller channels will allow a reduction in discharge and flow velocities in each channel, and thus reduce the importance of the erosion protection measures required. Stilling basins at the toe of the steep faces will be required to dissipate the energy of the flow coming from higher ground, before it enters the primary ditches.

A single minimal cross-section was developed for all secondary ditches to meet the design criteria and safely convey the 200-year flood at a minimum. This cross-section is applicable to the reaches of secondary ditches flowing on top of covers, or on mild slopes. Water conveyance for secondary ditches down steep slopes will be designed at closure (for costing purposes it has been assumed that steep portions will be reinforced with channel lining of concrete in a flexible geosynthetic layer).

Since three different design flows were determined for secondary ditches (1, 2 and 3 m³/s, see Section 6.8.2), the maximum slope limitation varies for each secondary ditch. Table 6-5 presents the calculated values.

Table 6-5 Design parameters for secondary ditches

Ditch	Design flow (m³/s)	Base width (m)	Minimum slope (%)	Maximum slope (%)	Maximum flow depth (m)	Maximum flow velocity (m/s)	Maximum rip rap size – D_{50} (mm)
Secondary ditches	1	1	0.5	9	0.5	2.5	150
	2	1	0.5	5	0.7	2.5	150
	3	1	0.5	3.5	0.8	2.5	150

A cross-section with a minimum base width of 1 m and a minimum depth of 1.1 m (0.8 m maximum flow depth for 3 m³/s and 0.3 m freeboard allowance) will work properly for all reaches of secondary ditches within the define slopes. This design will be finalized at closure,

6.8.4.3 Proposed ditch cross-sections and profiles

Conceptual drawings have been prepared for each primary ditch.

The natural ground profile and a potential proposed longitudinal profile for each ditch that optimizes the cut and fill volumes is presented. The proposed longitudinal ditch profile is based on the range of slopes that were defined above. The optimal profile should be determined at closure, based on the final topography along the proposed alignments.

The cross-sections for each primary ditch were determined based on the results presented in Table 6-3. Each cross-section was made 0.5 m wider than the calculated minimum based with to provide an additional safety margin against potential obstruction with debris or ice. The depth of all primary ditches was set at 1.5 m, which matches the largest minimum depth required for all primary ditches. Ditch 400 has a calculated maximum water depth of 1.0 m, which leads to a 1.5 m channel depth with the 0.5 m freeboard design criteria. The selected cross-sections are shown in the conceptual design drawings.

The following conceptual design drawings were produced as part of the RCP and are presented in Appendix F.

- Drawing No. 00: Site Plan
- Drawing No. 01: Ditch 300 – Plan and Profile
- Drawing No. 02: Ditch 350 – Plan and Profile
- Drawing No. 03: Ditch 400 – Plan and Profile
- Drawing No. 04: Ditch 450 – Plan and Profile

Various areas of optimization and conservatism could be studied for the proposed ditch alignment and profiles if required later in the closure phase. The main ones include:

1) **Ditch alignment**: ditch alignments could be modified to better accommodate the topography at closure. If in certain locations longitudinal slopes are too steep to properly manage the design flows, alignments could be routed over a longer path to provide for milder slope.
2) **Ditch cross-section**: cross-sections could be widened or deepened if it is anticipated that they could be partially blocked either due to debris, ice jams, sediment deposition or settlement of foundations. The current freeboard does provide primary ditches with up to double the hydraulic capacity of a given cross-section at the calculated water level.
3) **Geosynthetic liner**: in steeper reaches with high flow velocities, synthetic liners could be used to reduce the risk of erosion. Larger riprap is another option although it may prove to be less economically attractive.
4) **Longitudinal slope**: longitudinal slopes should be kept to a minimum to limit flow velocities and the risk of erosion. The calculated maximum allowable slope for each ditch could be reduced by increasing cut and fill volumes, or adding drop structures (and stilling basin at their toe to dissipate energy).
5) **Drop structures/spillways**: in steep reaches, drop structures and/or spillways could be added to the design to limit high flow velocity in short reaches and ensure energy dissipation in controlled locations (stilling basin).

6.8.5 Water Storage Pond and Dam

The location of the Water Storage Pond Dam relative to other site developments is shown in Figure 2-3. The water dam on Minto Creek provides water retention for mill processes and various site uses during operations and is considered to be the furthest downstream point for discharge control at the site. The original project proposal initially predicted that excess water would meet the Water Use Licence (WUL) effluent criteria and be discharged passively to Lower Minto Creek over the dam spillway. Operational experience based on heavy precipitation and snowpack years has shown that a water treatment plant, as per the current site Water Management Plan, is required. The treatment plant was installed and operational during the second quarter of 2010 and will remain in operation until WUL criteria can be achieved.

The dam will remain in place until such time that the water quality at the site has stabilized relative to water quality objectives. In the interim it will act as a settling pond where turbid runoff waters will undergo retention, monitoring and treatment if required. Physical stability of the Water Storage Pond Dam will be ensured during post closure by regular geotechnical inspections.

Once the water quality in Minto Creek reaches the acceptable effluent criteria, water will be allowed to move into the creek over the dam spillway for the remainder of the open flow season. The dam would then be decommissioned with any sediment in the facility being excavated and hauled to a suitable waste rock dump for disposal.

As a final treatment measure, this area will then be converted into a constructed passive treatment system that will accommodate a design flow consistent with the available area in the vicinity. During certain peak flow events, an overflow system may be required that routes excess runoff below the CWTS to avoid overwhelming and/or destruction of the system. This would most likely follow the current alignment of the access road along the Water Storage Pond. The design and construction of this CWTS will be advised by the pilot CWTSs in the W15 vicinity. By the time this final CWTS is constructed, there will be many years of site-specific operational performance data with which to optimize the design of this and other site CWTSs.

Drawing No. 05 in Appendix F shows the proposed dam removal layout.

6.9 MILL AND ANCILLARY FACILITIES

This section addresses the decommissioning measures for the mill and the ancillary facilities in the immediate vicinity that support the milling activities. The facilities addressed in this section include:

- Mill building;
- Generator building;
- Concentrate shed;
- Tailings filter building;
- Mill water pond;
- Mill reagents and chemicals; and
- Contractor’s shop and work area.

Figure 6-5 shows details on the closure measures for these facilities.

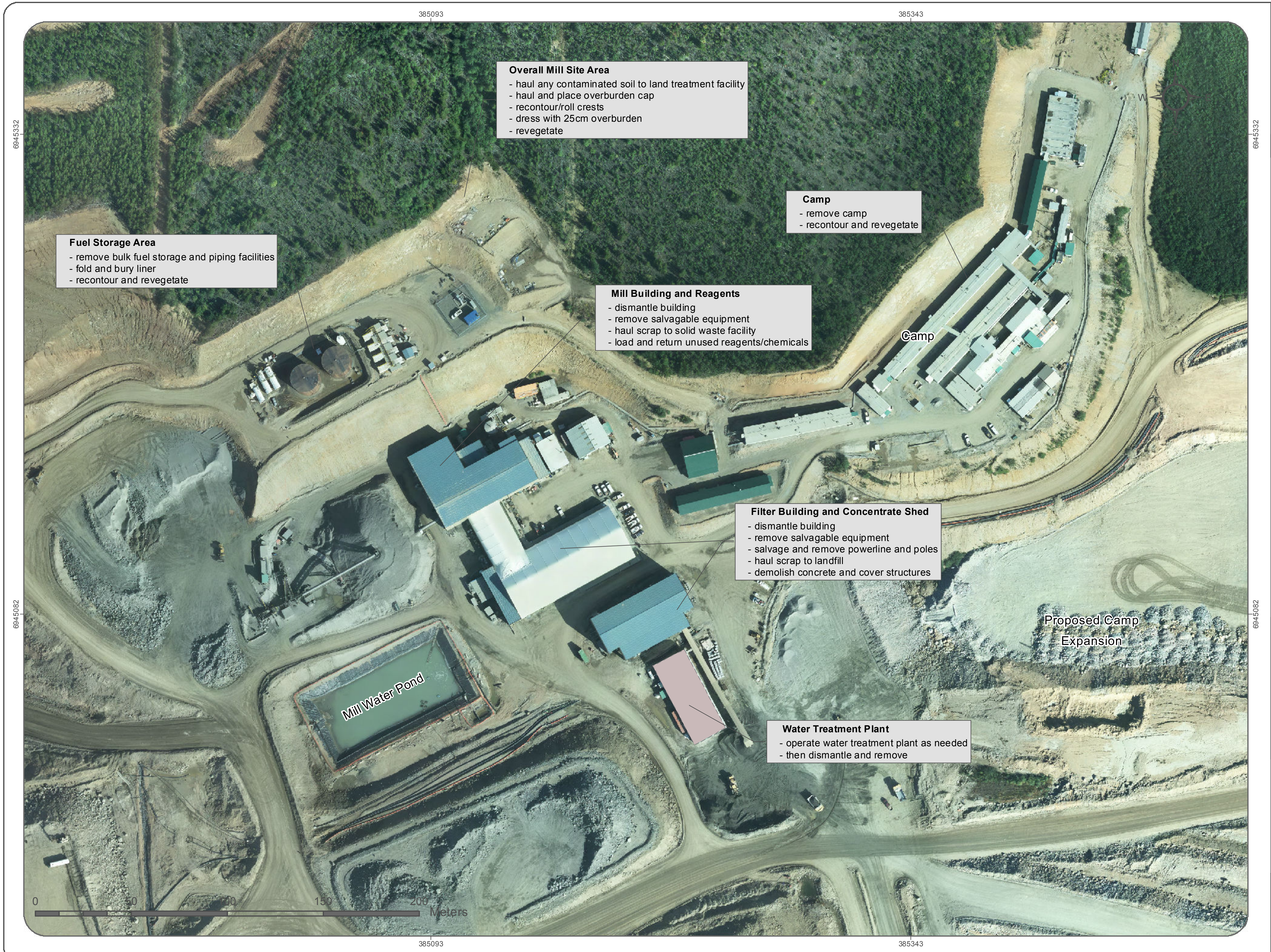

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FIGURE 6-5

MILL AND ANCILLARY FACILITIES RECLAMATION MEASURES

SEPTEMBER 2013

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

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Physical stability concerns for these structures at closure will be mitigated by their disassembly and removal from the site with the exception of the mill water pond which will require earthworks to mitigate physical stability issues. Environmental concerns for these areas will arise primarily from contamination of surrounding soils by fuel, chemicals or other wastes. Such instances will be documented through an environmental audit, conducted upon the completion of milling activities. Any contaminated soils identified will be remediated on site at the site's approved land treatment facility, and any recyclables and/or special wastes will be removed from the solid waste facility. Closure plans will be submitted to YG Environment prior to the final decommissioning of the land treatment facility and the solid waste facility.

A salvage program will be conducted towards the end of mine life to minimize the volume of scrap generated by the decommissioning of these facilities that will require in-situ disposal. It is expected that removal of these facilities, namely the camp and explosives plant site, will be done by auction or contractor for salvage value.

The reclaim line and all above ground power cables and overhead power line gear will be salvaged. Any buried services such as piping and wiring will remain buried. Concrete footings will be broken down to slightly below grade as required and covered with fill. Recontouring of areas will also be conducted as required in order to establish final drainage runoff patterns. Culverts will be removed and pertinent areas will be covered in approximately 0.5 metres (unless otherwise noted) of growth media prior to application of seed and fertilizer.

6.9.1 Mill Building

Closure measures for this reclamation unit will include the removal of salvageable mill components, such as the ball and SAG mills and other milling-related equipment within the structure. It is anticipated that the building and steel framework will also be salvageable and that there will be minimal materials requiring disposal onsite. Any recyclable materials will be shipped to an appropriate recycling facility and all wastes will be disposed of either in the site solid waste management facility or an approved offsite disposal facility.

The concrete foundations and building footprint will be reclaimed in the manner described at the start of this section. The toe slopes of the fill at both the mill and the campsite pads will be recontoured to assume a more rounded slope, limiting erosion as much as possible. The angle and subsequent stabilization/revegetation measures will be contingent upon reclamation research findings from variable slope trial plots.

6.9.2 Generator Buildings

The generator buildings will be removed from the site after the power hook-ups are disassembled. Site reclamation of the area occupied by the generator buildings will be conducted in the same manner described for the camp area.

6.9.3 Concentrate Shed

The concentrate shed will be dismantled and removed for sale or salvage at the end of mine life. The remaining concrete footings will be broken down to slightly below grade and covered in fill material.

Recontouring will also be conducted as required in order to establish final drainage runoff patterns and areas being reclaimed will be covered in 0.25 metres of growth media and revegetated using the approved reclamation seed mixture.

The southwest corner of the foundation may require complete removal to facilitate the excavation of the reclaimed drainage channel for Minto Creek in the vicinity of the mill water pond. This section of the foundation would be broken down and pushed into the interior of the remaining footings area, and all footings will be collapsed inward and buried with fill prior to surface reclamation.

6.9.4 Tailings Filter Building

The tailings filter building and associated tailings handling infrastructure (conveyors, etc.) will be dismantled and removed for sale or salvage at the end of mine life. Any recyclable materials will be shipped to an appropriate recycling facility and all wastes will be disposed of in an appropriate disposal area, either the site solid waste management facility or an approved off-site disposal facility.

Concrete footings will be broken down to slightly below grade and covered in fill material. Recontouring will also be conducted as required in order to establish final drainage runoff patterns and areas being reclaimed will be covered in 0.25 metres of growth media prior to application of seed and fertilizer.

6.9.5 Mill Water Pond

The mill water pond is a geosynthetic lined pond, constructed according to EBA's Final Preliminary Design – Mill Water Pond, Minto Property, Yukon Territory (EBA, 1997). Together, the mill water pond and the Water Storage Pond Dam contain enough water to make process water for milling activities, supplementing water from the pit dewatering wells and mill groundwater well.

The mill pond will be left in place as an interim holding area for water entering the water treatment plant during the initial closure period. Some clean-up of the mill pond may be necessary in order to prevent degradation of storm water entering the mill pond from the pit. Current water quality in the mill pond is within federal Metal Mine Effluent Regulations criteria but does not meet the WUL QZ96-006 effluent criteria for discharge.

The area of the mill pond will be evaluated to determine whether there is potential for construction of a passive treatment wetland to reduce the potential for water quality effects in the post-closure period. The requirement for the passive treatment wetland will be determined based on the results of reclamation research on source control to reduce metal loadings from site infrastructure. Progressive reclamation and post-closure monitoring of the DSTSF during Phase IV operations will also be used to help evaluate the need for a passive water treatment facility in this area.

6.9.6 Mill Reagents and Chemicals

Following the end of milling operations any unused mill reagent supplies will be returned to the supplier for credit. It is anticipated that all reagent product at the site will be properly contained/stored so that no product will be considered as special waste. A closure inventory/investigation of reagents and hazardous materials on site will be conducted upon the cessation of milling activities. Should some product's containment be deemed suspect upon the closure inspection, that volume of materials will be added to an inventory of special wastes. As such, the material will be stored under Minto's Special Waste Permit # 43-040, and removed from the site for disposal in a permitted facility by a licenced contractor with other special wastes on site.

It is expected that the mine's inventory of hydrocarbon products will be consumed during the closure activities. Fuels and lubricants will be required during the implementation period of the closure plan following the end of milling activities. The inventory remaining on site once all activity has ceased will be removed from the site by one of three methods:

- returned to the original supplier for credit wherever possible;
- sold to a third party user; or
- trucked to an authorized disposal agency to be recycled or destroyed.

It should be noted that the operation of diesel powered vehicles and any electrical generators used on site will provide Minto with a method of reducing remaining inventory of diesel fuel as the mining operations cease. Gasoline will be similarly removed, and any remaining inventories of diesel and gasoline will be returned to suppliers or sold based on wide spread local use.

The propane supplier will remove the propane tanks. Associated propane delivery lines at the camp will be removed and disposed of in a manner similar to that of the gasoline and diesel fuels.

Other hydrocarbon products that are present at the mine site are primarily hydraulic fluids, lubricating oils, greases, antifreeze, and solvents packaged in either 1000 litre bulk containers, 205 litre drums or smaller packaging. In most cases the remaining inventory of these materials will be returned to the original suppliers for reuse or sold to other third party users in the local area. In certain circumstances, specialized products may have to be disposed of through a licenced waste disposal firm. It is anticipated that the volume of materials requiring disposal as special waste will be limited.

Any fuel storage areas and refueling stations, once decommissioned, will be assessed for hydrocarbon contamination of the underlying soils. A formal site assessment to identify hydrocarbon contaminated soils in other portions of the site will be conducted as part of the closure program and any soils identified by this assessment will be excavated and transported to Minto's permitted Land Treatment Facility (LTF).

It is anticipated that landfarming of soils in the LTF will be required for a period of several years following the completion of closure activities at the site.

6.9.7 Contractor's Shop and Work Area

The mining contractor's area, constructed on site adjacent to the toe of the MWD, serves as the base of operations for the mining contractor during active mining activities. At closure, the buildings in this area will be dismantled and removed, and any scrap will be recycled or hauled to the onsite permitted Solid Waste Facility.

Physical stability will not be a concern at closure for this area. This is a low elevation pad and will only require proper erosion control at closure. Environmental concerns for the contractor's shop and work area will arise primarily from contamination of surrounding soils by fuel, chemicals or other wastes. Such incidents will be documented through an environmental audit, conducted upon the completion of milling activities. Any contaminated soils identified will be remediated on site at the site's approved land treatment facility, and any recyclables and/or special wastes will be removed from the solid waste facility. Closure plans will be submitted to YG Environment prior to the final decommissioning of the land treatment facility and the solid waste facility.

6.10 MAIN ACCESS ROAD

The main access road to the property was constructed in 1996 and 1997. This road was constructed to facilitate 26-ton ore concentrate truck traffic. The road was constructed by cut and fill methods with a road width of 8 meters and associated ditch drainage and culvert installations. Figure 2-2 shows the alignment of the main access road. Minto expects that the determination of the extent to which the main access road is deactivated will be made in consultation primarily with SFN and secondarily with local trappers, the community, and government regulators. This closure plan recognizes three potential outcomes for road reclamation:

1. No road deactivation;
2. Road deactivation from Minto Creek to the mine site; or
3. Deactivation of the entire road.

In making a final decision about closing the main access road, consideration will also be given to the potential requirement for equipment access. Despite the identified closure timing and schedule, final access road removal (if selected) would only be undertaken once it is concluded that the site is stable and there is no need for heavy equipment access to the site.

The primary consideration for the physical stability of the main access road at closure will be slope stability where culverts have been removed and drainage channels have been established through the road alignments. Siltation of streams could occur during culvert removal and slope stability work. The road will be inspected during an environmental audit to take place at the end of mine life to identify any spills or contamination that was not addressed during operations. The results of the audit would be shared with and/or conducted by SFN Lands and Resources Department so that a scope of work for closure could be jointly developed.

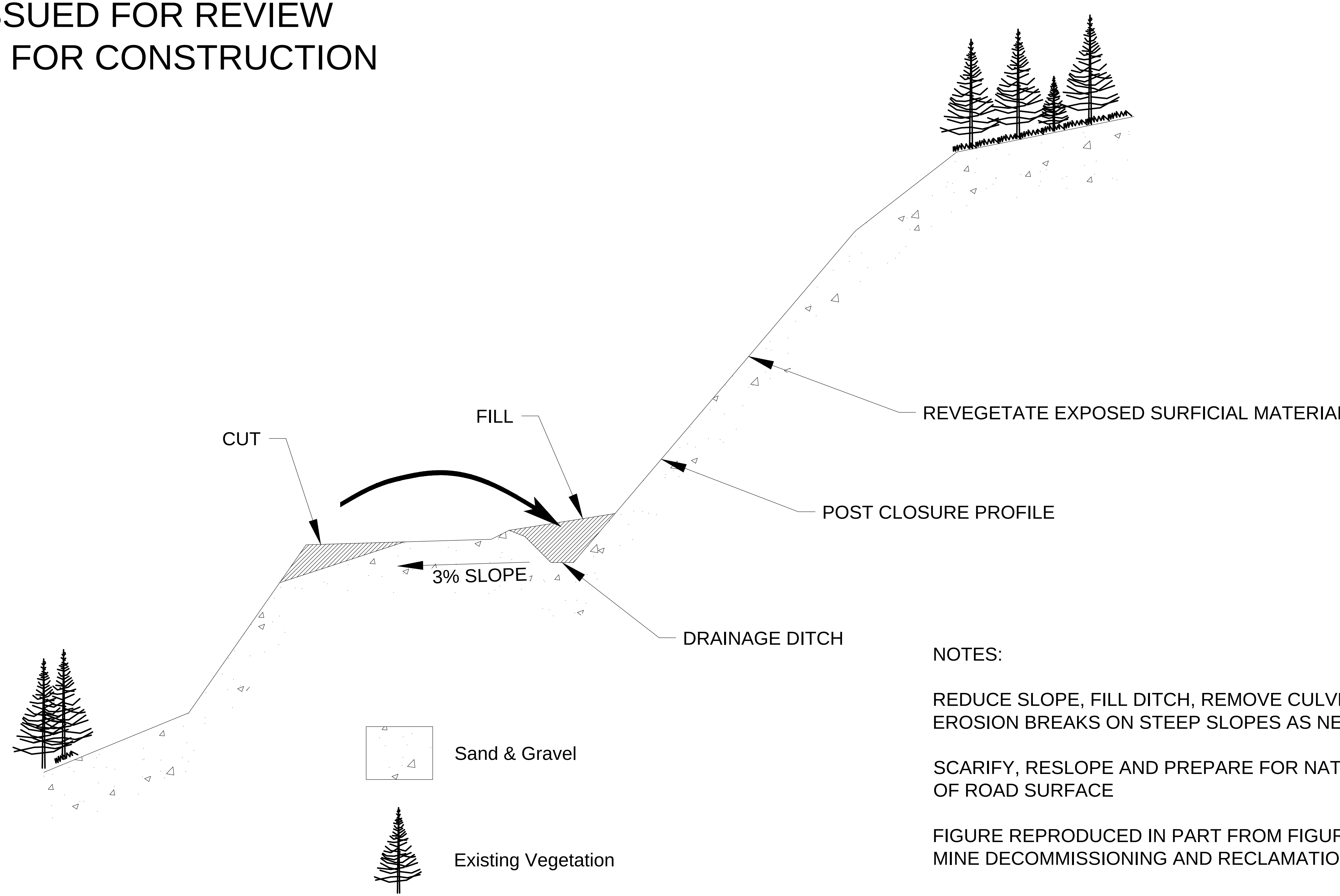
Should one of the two options involving deactivation of the road be chosen, then standard road decommissioning and reclamation measures at closure, including culvert excavation, drainage recontouring, slope stabilization and surface scarification will be applied.

Culvert removal work will be conducted in the late summer/early fall when flows are low or non-existent. Culvert removals and bank recontouring works at locations where there is still flow will include pump around or flow diversions to ensure that work is done in the dry and silt loads are not added to stream systems. Regrading/contouring the roads will ensure that runoff sheds off the road surface. The road surfaces are not expected to require seeding, only surface scarification to encourage natural revegetation.

The removal of culverts at stream crossings which are fish bearing is of primary concern. At these stream crossings, the roadbed would be cut down to the culvert and original streambed elevation with side slopes brought back to 2H:1V. Material removed during culvert removal will be spread loosely on adjacent road surface to promote revegetation. The stream channel would be stabilized as required and slopes revegetated. The Big Creek Bridge and all culverts will be removed once all heavy equipment has been removed from the mine and closure activities have been completed in the upper Minto Creek basin.

The disturbed footprint of the access road occupies only a portion of the cleared right-of way. Site experience shows that vegetation should re-establish itself in the 30 m wide right-of-way during the life of mine and only remedial revegetation work will likely be required. The preferred methodology is to encourage natural revegetation to occur, after first preparing the road surface by recontouring and scarifying. Temporary sediment management measures such as silt fencing will be installed as required in order to minimize sediment transport during establishment of a vegetative cover. Figure 6-6 shows the reclamation measures for the access road.

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION



NOTES:

REDUCE SLOPE, FILL DITCH, REMOVE CULVERTS AND INSTALL EROSION BREAKS ON STEEP SLOPES AS NECESSARY

SCARIFY, RESLOPE AND PREPARE FOR NATURAL REVEGETATION OF ROAD SURFACE

FIGURE REPRODUCED IN PART FROM FIGURE 6-21 OF MINTO MINE DECOMMISSIONING AND RECLAMATION PLAN ver. 3.2

DATE	ISSUE/REVISION	REV No.	DRW.	APP.
2013-09-13	ISSUED FOR REVIEW	00	KB	JT

ACCESS

capstone
MINTO MINE

PROJECT NAME:
Minto Mine Phase IV
Reclamation and Closure Plan
Revision 4.0

TITLE:
Haul Road and Site Road
Typical Reclamation
Cross-Section

DESIGNED BY:	ACCESS PROJECT NO:	CLIENT REF.:
EBA	MIN-11-01	
DRAWN BY: K. Boldt	SCALE: NOT TO SCALE	
CHECKED BY: J. Theriault	FIGURE: 6-6	REV.: 00

C:\Users\kboldt\Projects\Minto\CAD\Drawings\MIN-11-01-F6-6.dwg

6.11 MISCELLANEOUS SITES AND FACILITIES

This section addresses the decommissioning measures for miscellaneous facilities and sites around the property. These facilities include:

- Mine camp and related infrastructure;
- Airstrip;
- Exploration sites and trails;
- Land treatment facility;
- Solid waste facility
- Explosives plant site; and
- Site roads.

Figure 6-5 shows details on the closure measures for the camp area. Closure measures will focus on long term physical stability of these areas following closure and ensuring that any areas of contamination are identified and remediated in an appropriate manner. The physical stability of these structures/areas at closure will be mitigated for the most part by either:

- Disassembly and removal from the site; and/or
- Recontouring and revegetation of the area.

Environmental concerns for these areas will arise primarily from contamination of surrounding soils by fuel, chemicals or other wastes. Such incidents will be documented through an environmental audit, conducted upon the completion of milling activities. Any contaminated soils identified will be remediated on site at the site's approved land treatment facility, and any recyclables and/or special wastes will be removed from the solid waste facility. Closure plans will be submitted to YG Environment prior to the final decommissioning of the land treatment facility and the solid waste facility.

A salvage program will be conducted towards the end of mine life to minimize the volume of scrap that will require in-situ disposal. It is expected that removal of these facilities, namely the camp and explosives plant site, will be done by auction or contractor for salvage value.

Buried services such as piping and wiring will remain buried. Concrete footings will be broken down to slightly below grade, where required, and covered with fill. Recontouring of areas will also be conducted as required in order to establish final drainage runoff patterns. Culverts will be removed and pertinent areas will be covered in 0.25 metres of growth media prior to application of seed and fertilizer.

6.11.1 Mine Camp and Related Infrastructure

In 1999 Minto completed construction of a camp for mine staff that included living quarters for 42 persons – a seven-unit accommodation/kitchen/diner/change room complex. In 2006, the camp was expanded by the addition of trailers and other construction to provide capacity for 140 persons, including an office complex. The facility provides a potable water supply (drilled groundwater well, 1998), gas-fired heat, a local power supply, and sewage disposal to two adjacent septic fields. The septic system has now been converted to a packaged treatment plant, and the camp is being reconstructed again to allow for greater occupancy. Several structures behind the facility house the fuel supply to the furnaces, relay power from a diesel electrical generator, and pump fresh water.

Closure measures for the campsite include disassembly of the camp trailers and related infrastructure. All salvageable material will then be removed from the site. The remaining campsite landing will be scarified and recontoured, as required, to establish drainage patterns and then covered with 0.25 m of growth media and revegetated. Seed mixtures and fertilization specifications will be based on both revegetation trials and natural revegetation observations and success.

6.11.2 Airstrip

The airstrip area was noted to be subject to colonization by natural vegetation during a period of project inactivity from 1997 to 2005. Based on these observations, reclamation of the airstrip will focus on scarification of compacted surfaces. Natural revegetation will be allowed to occur in order to minimize the introduction of non-native species. Seeding of this reclamation unit is not deemed to be required as there is minimal erosion potential of the airstrip.

6.11.3 Exploration Sites and Trails

Current exploration activities being conducted on the site operate under a Class III Mining Land Use Authorization are subject to specific closure measures as identified in the Class III Authorization. These measures will be implemented as required by the exploration crew, and are not subject to closure planning in this plan.

6.11.4 Land Treatment Facility

The Minto land treatment facility (LTF) is located near the airstrip in an area originally excavated on bedrock for an equipment laydown area. This facility is permitted by YG, Department of Environment, Environmental Programs Branch under Permit #24-204 to treat a maximum volume of 700 m^3 of hydrocarbon contaminated soil. Contaminated soils from fuel/oil spills during operations will be treated in this facility to appropriate levels of remediation before being used as industrial fill as per permit requirements.

The closure of this facility is subject to the submission of a formal Closure Plan to YG, along with sampling results which demonstrate the final concentrations of contaminants in the soil being treated. It is expected that upon final closure of the entire site, dismantling and decommissioning activities may reveal or result in soil contamination requiring the relocation of contaminated soil to the LTF and an undetermined number of months of treatment to achieve desired remediation levels. As such, the LTF Closure Plan and final sampling results will be prepared and submitted sometime after final closure of the mine site has begun.

Generally, once the desired contaminant levels have been reached in the final volumes of treated soil, and the Closure Plan has been approved by YG, the soils will be spread at approved locations at the site, recontoured in place and revegetated. If required, additional overburden may be hauled and used as cover material and growth media for revegetation.

6.11.5 Solid Waste Facility

Under Commercial Dump Permit # 81-005, issued to Minto Explorations Ltd. by YG, Department of Environment, Environmental Programs Branch, Minto has established a Solid Waste Facility adjacent to the Land Treatment Facility near the airport that includes:

- A burning pit for wood and paper waste;
- Construction waste disposal area;
- Metal and rubber tire disposal areas; and
- Incinerator ash disposal in old exploration trenches.

The solid waste facility will receive construction and operational waste throughout the operation of the mine, as permitted. At closure the area will be covered by fill and compacted in 'lifts' as per common landfill practice.

Scrap equipment will be stored in various lay down areas located on site and along the access road, including primarily scrapped equipment stored to be utilized on the mine site as a source of spare parts or good recyclable scrap material. Salvageable material from these sites will be sold as scrap and removed from the site at closure. Material that has no scrap value will be disposed of in the solid waste facility. Prior to disposal in the landfill, all of this material will be examined to ensure that all hazardous materials are removed.

Any hazardous materials identified in these areas will be removed and shipped off site to a licenced waste disposal site, along with other stored hazardous or special wastes, as permitted under Minto's Special Waste Permit # 43-040.

The submission of a formal Closure Plan to YG for the solid waste facility will be required at final closure. The formal closure plan will document the conditions and materials at final closure. Preceding the final reclamation of this facility, tires and salvageable scrap metal will be hauled off site for salvage/recycling. Once the closure plan is approved by YG, the facility will be covered by two compacted lifts of 200 mm thick compactable soil material obtained from local borrow sources. The cover material will be graded to prevent pooling of precipitation runoff and to encourage the shedding of water. The site will then be revegetated using a suitable seed mixture.

6.11.6 Explosives Plant Site

The ANFO explosives (ammonium nitrate – fuel oil) production area is comprised of the production plant and AN bag storage and powder magazine storage areas, located near the drainage boundary southwest of the mine site.

At closure, unused explosives that remain on site will be returned for credit and the explosives magazines and other equipment will be returned to the explosives supplier. The septic system at the site will be pumped of contents, broken down and backfilled. Fuel-contaminated soils will be excavated and hauled to the land treatment facility for remediation. Disturbed areas will be recontoured as required and covered with 0.25 m of overburden or growth media prior to application of seed and fertilizer. Seed mixtures and fertilization specifications will be based on both revegetation trials and natural revegetation observations and success.

6.12 MINE ROADS

All mine roads will be subject to standard road reclamation measures previously described in the haul roads and main access road sections of this report.

6.13 ADAPTIVE MANAGEMENT PLANNING

Minto is committed to an adaptive management plan (AMP) in the context of the Phase IV closure plan for the components which are deemed to have some uncertainty associated with their performance. These "uncertain" components were determined in part by the preliminary failure modes and effects analysis (FMEA) which was conducted in January 2013, with a focus on the closure and reclamation components of both Phases IV and V/VI. The preliminary FMEA analyzed site closure using a number of closure and reclamation mitigation options to determine the potential risks associated with these methods.

An AMP is an iterative process. This implies that an AMP is never complete in nature, but in a continuous state of refinement in response to feedback from monitoring, analysis of data, and changing conditions. The ideas presented within this document build on information gathered through the operations and environmental monitoring at Minto. Phase IV is part of a sequence of stages in the evolution of the life cycle of the Minto mine site. Until final closure, the project is anticipated to continue to evolve and change. The various components and activities related to the phases do not occur in isolation, and plans such as this AMP must be dynamic in order to effectively deal with change. As a result, any future developments that occur at the Minto mine site will necessitate updates to the AMP. Thus the AMP is considered a "living document". Subsequent iterations of the closure AMP will take these changes into account.

Since it is difficult to predict the specific environmental condition that may arise which requires a response from management, the AMP does not necessarily provide specific detailed descriptions of responses to a situation. The AMP provides a range of possible responses to use as a guide to respond to specific environmental conditions encountered. Management should use the information provided in the AMP and adapt the appropriate response from this guide.

The AMP aims to identify areas of uncertainty within the proposed Phase IV closure. This AMP, or subsequent iterations, will develop monitoring commitments, thresholds, triggers, and responses to underperforming elements or emerging risks within the Phase IV reclamation and closure process.

The primary objective of this AMP is to protect the quality of off-site water by isolating and controlling the on-site water, if necessary. A commitment to passive and active water treatment as a contingency is a major component of the Phase IV preliminary closure plan, and is also a significant response measure within the Phase IV AMP.

The approach presented in this AMP follows the Environmental Code of Practice for Metal Mines from Environment Canada. The preliminary AMP framework can be found in Appendix D.

The Minto project is subject to a number of operational monitoring programs, including but not limited to:

- Water Quality Surveillance for site and receiving waters;
- Physical Stability Monitoring of various site structures;
- ABA Testing;
- Water Monitoring;
- Tailings Stability Monitoring; and
- Geotechnical Inspections.

Data from these programs has been and will continue to be collected under these programs during the closure period with similar requirements to those in effect during the operational life of the mine. Section 7.0 of this report proposes the continuation (and progressive scaling back) of the majority of these monitoring initiatives during the period of active reclamation and through the post-closure period when there is minimal site presence.

The closure measures in the previous sections have been developed and proposed based on the most up to date information collected at the site, and on the best interpretations of this data, with respect to the projected conditions on site at final closure. Changes to the RCP will be required as conditions continue to change as the site progresses through operations and closure. The periodic revisions to this Plan as per the QML schedule will address these changing conditions moving through operations, but as closure activities progress and monitoring on the site continues, planning mechanisms that can account for and react to changes to the expected conditions governing the closure measures need to be in place.

Adaptive management planning (AMP) is a recognized and effective way to ensure that changing conditions during closure are not subject to static reclamation initiatives, and that closure programs can be adapted to these conditions to achieve desired performance. Minto is committed to AMP in the context of closure of some of the higher risk features on the site.

The Adaptive Management Plan will be refined over the remaining operational life of the mine with the goal of having them finalized for implementation at closure. They are modeled on accepted AMP features, such as performance monitoring programs, threshold levels for data from the monitoring programs and associated triggers for action items, and response actions for expanding or refining the monitoring initiatives, implementing extended closure measures, and/or conducting further studies to develop mitigation measures for conditions that are divergent from those expected.

7 POST-CLOSURE SITE MANAGEMENT

The closure phase of the Minto mine will commence with the cessation of economic mining of the open pit and the milling of ores and stockpiles. Once all mineable ore reserves have been processed, the mill and concentrator will be flushed and the tailings management facility (TMF) will be decommissioned. During the active decommissioning phase which is expected to last approximately 3 years, the number of personnel required will vary depending on site activities; however it is expected that as major decommissioning and reclamation tasks are completed the number of site personnel required will decline.

It is expected that a Water Use Licence or amendment will be required for the decommissioning phase of the operation as water use will continue on a limited basis and wastewater will be released from the WSPD in a controlled fashion, either treated or passively depending on the monitoring results. Decommissioning of the Big Creek Bridge along the main access road will be subject to community consultation and this activity may also require a Water Use Licence. The continued need for a Water Use Licence following the decommissioning phase will be dependent on site conditions, performance of closure measures in achieving stated objectives and legislated requirements. Post-closure management and monitoring of the site will be guided to some extent by the Water Use Licence, quartz mining licence or other permit requirements, the performance of physical structures remaining on site and the ability of achieving and demonstrating long term compliance with existing waste discharge standards.

Once overall closure performance has been demonstrated for all aspects of decommissioning, the necessity of maintaining licences or permits will be re-examined. At that point a Certificate of Closure, under the Quartz Mining Act would be requested. The following section provides a general outline of the site management approach that will be taken at the Minto mine during the closure phase.

7.1 ORGANIZATION, SITE ACCESS & SECURITY

A number of personnel will be required on site to implement the various decommissioning and closure tasks. Generally these tasks entail closure of mine workings, regrading of waste rock and overburden piles, decommissioning of the TMF, removal of the Water Storage Pond Dam, salvage and removal of infrastructure, equipment and reagents, decommissioning of access roads and reclamation and revegetation of disturbed lands. These activities would be undertaken on a seasonal basis and directed by an onsite manager responsible for decommissioning and reclamation of the Minto mine.

During site decommissioning, it is anticipated that at least a portion of the existing camp accommodations would remain on site to support site personnel. It is anticipated that during the initial post-closure phase, site security requirements will continue with a caretaker remaining on site following seasonal closure of the site. A site inspection schedule will continue for the period of closure implementation (3 years) and then move into a post-closure monitoring period (12 years) for a total of 15 years. Security personnel will no longer be required once decommissioning and reclamation activities are completed on the property. Once the majority of physical reclamation works are performed on the site, the number of employees or contractors required will be reduced. Minto is committed to having SFN members employed during implementation of the RCP and will continue to work with SFN to optimize long term closure monitoring requirements.

The main access road, barge landings and property security gate will be maintained during implementation of the post-closure phase. Site access along the main road, barge support and Big Creek Bridge will be required for personnel and truck haulage requirements to and from the site. The security gate and fencing will be maintained while the main access road is in use. Decommissioning and reclamation of various haul and site access roads will be completed once closure measures have been completed at each facility and site access is no longer required.

Once decommissioning activities are completed onsite, and following a period of post-closure monitoring, a determination will be made about whether to permanently close the main site access road. This decision will be made in conjunction with SFN as the access road lays within SFN Category "A" settlement lands. Closure of the main access road is expected to be consistent with the RCP's closure philosophy; however, it is recognized that the performance of physical reclamation of the site must be assured before a final determination of the main access road closure is made. Government regulators and the local trapper will also be consulted regarding decommissioning plans for the road.

7.2 SUPERVISION AND DOCUMENTATION OF WORK

All decommissioning and reclamation works shall be supervised to ensure that works are constructed according to their design and that the work is properly carried out and documented. The project manager or the construction supervisor will be responsible for supervising all closure works. Daily inspection procedures would be completed to document work progress, deficiencies and completion. Existing plans for spill response or other site internal procedures for fuel handling, waste disposal, fire control and suppression, health and safety and environmental management systems would be used, developed and followed as necessary.

Environmental inspections and tests conducted prior to the implementation of closure measures would be used to confirm areas requiring clean up.

For the WRD and TMF, plans for all earth works and inspections would be prepared and submitted to the YWB and EMR for review prior to construction. These plans would be submitted in a timely manner to facilitate agency review and Board approval prior to implementation. A competent engineer following standard quality control and assurance procedures would inspect and document this construction work. As-built plans and drawings would be completed and the results of the closure work completed on the removed water dam and tailings management facility documented in a final RCP report. This report would then be submitted to the YWB and regulatory agencies upon completion of closure activities.

A competent environmental practitioner following standard quality control and assurance procedures would design, direct and document the following restoration work. For the Big Creek Bridge removal and Minto Creek culverts, plans for all restorative works would be prepared and submitted to the YWB prior to decommissioning. A summary report of the works would then be prepared and submitted to the YWB and regulatory agencies upon completion of closure activities.

Upon completion of the decommissioning and reclamation works, a final site plan report (summary text and drawings) would be prepared to outline the facilities or works remaining on the site following closure. This plan would identify the location of buried concrete structures or scrap and landfill disposal areas. It is expected that this plan would accompany an Application for a Certificate of Closure under the *Yukon Quartz Mining Act*.

7.3 MINE RECORDS

As noted in the previous section, all decommissioning and reclamation works would be documented. Active Mining period records showing the extent of open pit workings would be retained by Minto. Other site records, files and plans would also be archived at the site. Where plans or drawings are required for mine safety reasons, these plans would also be submitted to government mine safety offices. As-built reports for structures completed for closure and the final site closure report would be retained for record by Minto and submitted to government agencies and boards.

7.4 COMPLIANCE MONITORING AND REPORTING

Environmental compliance monitoring, internal monitoring of earthworks and independent geotechnical inspections are presently ongoing at the property. The environmental monitoring at the Minto mine employs several types of scheduled periodic inspections to ensure that the facility is meeting environmental performance objectives and complying with appropriate regulatory standards. These inspections entail:

- Scheduled inspections of the waste rock and overburden storage areas, tailings management facility, water retaining structures and mine components to monitor environmental performance;
- Scheduled water quality sampling and flow measurements of effluent streams and local receiving water streams;
- Scheduled receiving water programs for benthic invertebrates, stream sediments and fish to monitor downstream environmental quality;
- Scheduled piezometric monitoring of water levels in wells and the spillway structure at the Main Water Pond Dam (if still in place);
- Monitoring of other instrumentation installed in the DSTSF as per the Tailings Management Plan (thermistors, survey hubs, etc.);
- Annual inspections of the TMF by a qualified geotechnical engineer, diversion channel, waste rock and overburden storage areas, and Main Water Pond Dam for structural stability; and
- Scheduled environmental tours and audits of the property by Minto staff to look for environmental hazards and site stability. Minto will endeavour to invite various Government agencies' representatives as part of the environmental inspections.

At present, site personnel undertake the scheduled environmental monitoring and inspection programs with the exception of annual geotechnical inspections and the benthic invertebrates, stream sediment and fish monitoring programs, which are conducted by qualified professionals. All results are reported to the YWB, and YG EMR as monthly or annual reports.

During the active closure phase environmental and physical compliance monitoring and inspections will continue as required by the present Water Use Licence or Quartz Mining Licence monitoring programs utilizing site-based personnel. It is expected that the amount of environmental and physical monitoring and inspection (frequency and quantity) will decline once all closure measures are implemented. The approach to closure monitoring will be to continue with the present licence monitoring and inspection programs until decommissioning and reclamation measures have been completed and then reduce the frequency of site monitoring and the number of monitoring stations over time as satisfactory closure performance is confirmed. Revisions to the current Water Use Licence requirements will be required upon closure to authorize the proposed monitoring programs.

The schedule for monitoring programs planned for the 15-year period immediately following cessation of active mining and milling operations are presented in Table 7-1. For the first 5 years following the cessation of mining, routine environmental monitoring will be completed to demonstrate the effectiveness of closure measures and their performance. Year 6 to 10 monitoring frequencies would be reduced to periodic inspections, with a further reduction of frequency for years 11 to 15. The purpose of these periodic inspections would be to ensure that waste discharges remain compliant, downstream receiving waters meet current Canadian Council of Ministers' of the Environment (CCME) Guidelines for the Protection of Freshwater Aquatic Life, and physical structures are performing as designed. Should these inspections identify issues of concern, then plans would be developed to address the concerns.

Based on the results of site monitoring for the 15-year post-closure monitoring period and discussion with the SFN and the appropriate regulators the need for and the frequency of additional site monitoring will be determined. If the results from monitoring indicate that the site is stable with acceptable geotechnical and environmental performance, then Minto would propose to decrease the frequency of monitoring further. If the results from monitoring indicate there are concerns with either geotechnical conditions or environmental issues, then the site would continue to require more frequent monitoring than otherwise proposed and possibly additional remedial work would be proposed.

As previously mentioned, Minto is interested in having the SFN participate actively in both the closure activities and in post-closure monitoring. Minto will work directly with SFN in this regard.

Environmental monitoring and inspections conducted during the post-closure period (years 4-15 after cessation of mining) will be undertaken by periodic visits to the site. Access to the property for post-closure monitoring would be via ATV, snowmobile, and/or helicopter if the road is decommissioned.

Table 7-1 Post-Closure Monitoring Program

		UTM LOCATION (m) ZONE 8		YEAR 1-5 FREQUENCY						YEAR 6-10 FREQUENCY					YEAR 11-15 FREQUENCY				
SITE	**DESCRIPTION**	**Easting**	**Northing**	**Surface Water**	**Ground water**	**Sediment**	**Benthos**	**Flows**	**Other**	**Surface Water**	**Ground water**	**Sediment**	**Benthos**	**Other**	**Surface Water**	**Ground water**	**Sediment**	**Benthos**	**Other**
	Receving Water Stations																		
W-2	Mainstem Minto Creek directly u/s Access Road Crossing	392616	6948477	W		A	BA	DCR, W		Q		BA	BA		A		A	BA	
W-3	Mainstem Minto Creek 50 m d/s toe of Dam (Final Point of Discharge)	386747	6945682	W		A	BA	DCR, W		M		BA	BA		Q		A	BA	
W-6	Tributary to Minto Creek	387544	6946420	Q		A	BA	Q		Q		BA	BA		A		A	BA	
W-7	Tributary to Minto Creek	387504	6946069	Q		A	BA	W		Q		BA	BA		A		A	BA	
W-10	Mainstem Minto Creek (south fork at headwaters)	383348	6943654	M				M		Q					A				
	Mine Site Stations																		
W-12	Discharge from Open Pit	384819	6944991	M						SA					A				
W-15	Minto Creek, downstream of the SWD	384286	6944754	M						SA					A				
W-16	Main Water Storage Pond Discharge (or Main Water Storage Pond if not discharging)	386538	6945573	W*							NLA					NLA			
W-17	Main Water Storage Pond Dam Seepage	386615	6945645	M*							NLA					NLA			
W-37	Seepage from toe of MVFE			M						SA					A				
W-8	Alternate Tailings Area Seepage/Runoff	385620	6945067	M						SA					A				
W-8A	Tailings Seepage/Runoff	385707	6945071	M						SA					A				
	Physical Inspection Elements																		
	Water Dam	-	-						A*					NLA					NLA
	DSTSF and MFFE	-	-						A					A					A
	Diversion Ditches	-	-						A					A					A
	Waste Rock Dumps	-	-						A					A					A
	Ice-Rich Overburden Dump	-	-						A					A					A
	Environmental Inspection Elements																		
	Revegetation Inspection	-	-						A					A					A
	Wildlife Use Survey	-	-						A					A					A

*** Unless structure has been decommissioned/reclaimed**

Frequency Description

W	Weekly
W2	Every 2 Weeks
M	Monthly
Q	Quarterly
SA	Semi-annually
A	Annually
BA	Bi-annually
NLA	No longer active
DCR	Daily Continuous Record during open season

During the post-closure period, reporting on all environmental and inspection programs carried out on the property will continue. These reports will be filed with the YWB, and EMR in accordance with conditions contained in the Water Use Licence, Quartz Mining Licence and other operating permits and approvals as they are.

Company personnel responsible for the management of the Minto mine would continue to meet with regulatory agencies, SFN, and the community (Pelly Crossing) on an as-needed basis to keep interested parties appraised of decommissioning activities and the results of post-closure monitoring.

It is expected that a review of the environmental performance of the mine following closure would be made with EMR and other interested parties. Once this review is completed, Minto would apply to the Minister of EMR for a Certificate of Closure for the Minto mine under the Yukon Quartz Mining Act Mine Production Regulations. The Certificate of Closure will confirm that Minto has fulfilled its closure obligations for the site.

7.5 LONG TERM MAINTENANCE

Provisions for maintenance of reclamation tasks such as erosion control and maintenance seeding have been included as part of the long-term closure requirements. Based on physical inspections and monitoring, maintenance works will be planned for and conducted as required to meet closure performance standards and objectives.

7.6 TEMPORARY CLOSURE

Temporary closure is defined in both the Quartz Mining License QML-0001 and the Water Use License QZ96-006 as the status of the project if no ore is processed through the mill for six consecutive months following start-up.

Minto's priority during any temporary closure scenario is to ensure that the site remain geochemically and physically stable, and monitored in compliance with applicable licenses and legislation. Generally, this will include both initial stabilization and then ongoing routine monitoring and maintenance of the site infrastructure and facilities. The current Water Use Licence QZ96-006 contains a temporary closure monitoring schedule (Part H – Interim Closure) that forms the basis for the proposed temporary closure monitoring plan. It has been augmented to include planning for project elements that were not in place and therefore not subject to the interim closure period monitoring, such as the mill, WSPD, water treatment plant, mill water pond, waste dumps, tailings storage area, and the explosives storage facility.

Table 7-2 provides a summary of the various project components and the inspection and maintenance activities for use during any temporary cessation of mining activities.

Table 7-2. Summary of Care and Maintenance Activities and Surveillance Program during Temporary Cessation of Mining Operations

Project Component	Area of Interest	Care/Maintenance Activities	Monitoring Activities	Monitoring Responsibility	Monitoring Timing/Frequency
Open Pits	Water Management/Treatment Physical Stability	Maintain creek diversions around pits Treat excess pit water and transfer to WSP if required Restrict access to hazardous areas with physical barriers	WUL Physical Monitoring Program	Caretaker	As per WUL
			Water Quality Monitoring for Treatment	Water Treatment Technician	As required
			Geotechnical Inspection of Creek diversion	Engineer	Annual
Ore Stockpiles – **High Grade**	Physical Stability	Reduce High Grade Stockpile Inventory	n/a	n/a	n/a
	Geochemical Stability	Monitor for seepage	WUL Water Quality Surveillance Program	Caretaker	As per WUL
Ore Stockpiles – **Low Grade**	Physical Stability	Monitor for stability	WUL Physical Monitoring Program and Annual Geotechnical Inspection	Caretaker	As per WUL
	Geochemical Stability	Monitor for seepage	WUL Water Quality Surveillance Program	Caretaker	As per WUL
Waste Rock and Overburden Dumps	Physical stability	Runoff/Erosion/Sediment control, as required.	WUL Physical Monitoring Program	Caretaker	As per WUL
			Geotechnical Inspection	Engineer	Annual
	Geochemical Stability	Monitor for seepage	WUL Water Quality Surveillance Program	Caretaker	As per WUL
Dry Stack Tailings Storage Facility	Physical stability	Surface water diversion structure repair/maintenance, as required Runoff/Erosion/Sediment control, as required. Stability Monitoring as required	Visual inspection elements of Monitoring Program from Tailings Management Plan (TMP) WUL Physical Monitoring Program	Caretaker	As per TMP
			Geotechnical Inspection from WUL and TMP	Engineer	Annual
	Geochemical Stability	Monitor for seepage and water quality	WUL Water Quality Surveillance Program and TMP Monitoring Elements	Caretaker	As per WUL
Mill and Camp Site	Buildings, Equipment, and Infrastructure Physical Stability	Concentrate removed from site Secure buildings and maintain necessary equipment onsite for resumption of milling Inspect for site stability	Visual inspection periodically for signs of instability	Caretaker	Monthly
			Structural Inspection	Engineer	Twice Annually
	Mill Pond Physical Stability	Maintain pond liner, repair as required. Maintain culverts.	WUL Physical Monitoring Program	Caretaker	As per WUL
Water Storage Pond Dam	Water Management Physical stability	Maintain spillway and structure as required based on geotechnical inspections. Monitor pond levels and water quality. Maintain spring/early summer pumping drawdown equipment.	WUL Physical Monitoring Program	Caretaker	As per WUL
			Geotechnical Inspection	Engineer	Annual
	Geochemical Stability	Monitor for seepage water quality	WUL Water Quality Surveillance Program	Caretaker	As per WUL
Explosives Facility	Physical stability	Remove bulk explosives from site. As required, repair and replace infrastructure	Visual inspection periodically for signs of instability.	Caretaker	Monthly
Barge Landing	Access to Yukon River	As required, granular upgrade to landing site.	Visual inspection periodically for signs of instability.	Caretaker	Weekly
Access Road and Surface Drainage	Entire Route	As required, surface grading and granular amendments, ditch and culvert maintenance.	Visual inspection periodically for signs of instability/erosion	Caretaker	Weekly and after heavy precipitation events
Entire Site	Physical stability	Runoff/Erosion/Sediment control, as required. Road/culvert maintenance as required.	WUL Physical Monitoring Program	Caretaker	As per WUL
			Geotechnical Inspection	Engineer	Annual
	Water Quality/Management	Retain Water Treatment Plant and Operators Maintain storm water diversion systems Continue seasonal water treatment as required for excess pit and site water	Undertake expanded temporary closure monitoring and submit to the YWB pursuant to Water Use Licence QZ96-006 (see Tables 7-4 and 7-5 for expanded monitoring program sites and schedule.) Continue required monitoring under Metal Mining Effluent Regulations (MMER)	Caretaker	As per WUL and MMER
	Security	Full time site caretaker will check, repair and replace as required: • precautionary signage • security gate – installed on Access Road at Main Dam	Site Inspection and Security Monitoring of all infrastructure and site elements	Caretaker	Daily: Inspection Sheets included in Annual Reporting
	Miscellaneous Infrastructure	Shut down and winterize camp, except for caretaker facilities Inspect power line	Site Inspection and Security Monitoring of all infrastructure and site elements – report any changes to stability/condition of miscellaneous infrastructure.	Caretaker	Daily: Inspection Sheets included in Annual Reporting
	Reporting	Prepare and submit annual report to the Yukon Water Board pursuant to Water Use Licence QZ96-006, including details of temporary closure activities and monitoring. Prepare and submit annual report to YG Mineral Resources Branch pursuant to the Quartz Mining License QML-0001, including details of temporary closure activities and monitoring. Prepare and submit quarterly monitoring reports to Environment Canada under MMER.		Minto Explorations Ltd.	Annually, by July 30 Quarterly, Online RISS Registry

7.6.1 Physical Stability and Geochemical Stability

Stabilization of site works during any temporary closure will be based on a continuation of efforts during operations to ensure construction and performance of facilities in accordance with their engineered designs. At this stage in the mine's life, many operational monitoring and research programs are underway to better understand the site and achieve physical and geochemical stabilization through such measures as:

- Resloping and crest rolling to reduce slope angles on the waste dumps;
- Grading and contouring to direct surface water away from steeper slopes to reduce erosional impacts;
- Planting live willows in appropriate places throughout the site to help control erosion and reduce sediment in surface runoff water;
- Covering potentially unstable areas with overburden and revegetating to establish a stable cover, again reducing erosional impacts; and
- Augmenting revegetation efforts with bioengineering (planting of live cuttings/seedlings) efforts.

Site infrastructure, including buildings and process machinery, will be emptied/drained of hazardous reagents and process fluids where appropriate and stabilized for temporary closure based on recommendations from mechanical and chemical suppliers, contractors and engineers. This includes the removal of all hazardous wastes, including waste hydrocarbons, coolants, lubricants, mill reagents, and process chemicals. The bulk explosives inventory will be removed from site and explosives storage containers and facilities will be inspected regularly.

The significant exception to these activities will be water management and treatment infrastructure and reagents, which will remain in place and operational as required to maintain effluent quality compliance during any temporary closure. Water management and treatment activities will be continued in accordance with the existing Water Management Plan (MintoEx, 2009).

Temporary decommissioning of the rest of the infrastructure will only be conducted to a level whereby the infrastructure and systems are ensured to be stable in the short term (3 years) and such that mining and milling operations can be resumed in a timely manner should the decision be made to emerge from temporary closure to transition back into operations. The temporary decommissioning measures will include the following:

- The retention of essential equipment/assets onsite to maintain infrastructure; and
- The storage of reagents and other hazardous materials (not waste) in competent primary and secondary containment, to ensure compliance with applicable legislation.

7.6.2 Security and Monitoring

Uncontrolled access to the mine site could pose a risk to the public and to the site assets. As such, a full-time caretaker/monitor (at least 2 individuals trained for cross-shift) will be housed onsite in a serviced portion of the existing camp. Site equipment (grader/loader) and vehicles will be kept onsite for caretaker use in care and maintenance activities. Contingency equipment will also be kept onsite should more intensive earthworks be required during the temporary closure period.

A security gate shall be installed on the main access road adjacent to site in the event of the site being placed in temporary closure. This is a steep cut and fill location that will prohibit vehicle access around the gate. Snowmobile/ATV access cannot always be controlled, but warning signs will be erected indicating the risk of entry to the site at the main gate and at key locations around the site. Site buildings will be locked and secured.

The main access road will be maintained for caretaker and emergency access with equipment retained on site. Previous periods of inactivity at the site have shown that the access road remains relatively stable and allows access to site with little maintenance requirements. In winter, contractors will establish the ice road across the Yukon River at Minto Landing. In the summer the barge will be used only on an as needed basis during temporary closure, with a smaller boat being used when required for ferrying caretakers. Caretakers will remain at the site during periods when the ice bridge is not accessible.

The caretaker(s) will be responsible for:

- Regular inspections (Table 7.2) of the site to observe and document the condition of and note any changes in site security and public safety measures, infrastructure, mine works, etc., and to document any newly emerging environmental or public health and safety issues.
- Conducting routine physical monitoring activities;
- Regular water quality and flow monitoring and treatment if necessary (a skilled operator may be necessary to operate water treatment plant);
- Submitting of inspection and monitoring reports to managers on a regular basis;
- Responding to any security/safety issues as required; and
- Conducting routine site maintenance and basic repairs to infrastructure and works as required (snow removal, culvert and road maintenance, building maintenance).

Site inspections and monitoring will be conducted by vehicle when seasonally possible. During winter, some sites may only be accessible by snowmobile as snow removal will not be reasonable at all locations. Inspection results will be documented in an approved format. Any reports of changes in the physical status of any part of the site may warrant a follow-up investigation by managers and/or professional personnel.

Minto's Water Use Licence contains a comprehensive Physical Monitoring Program which the licensee must conduct and report upon on a regular basis. This program includes regular visual inspections (Table 7.2) of the following structures at different frequencies, varying from daily to annually:

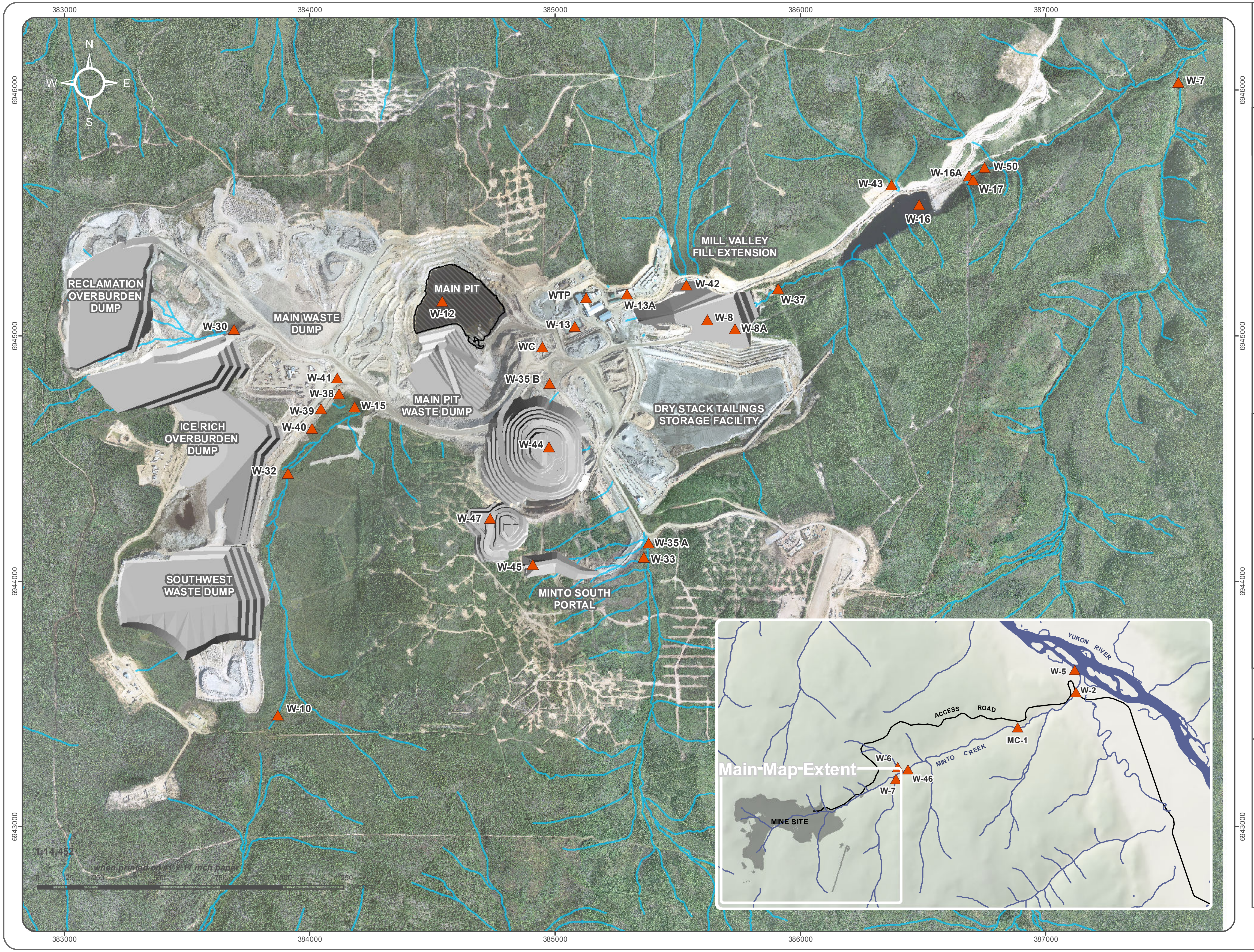
- Water Storage Pond Dam;
- Mill Water Pond;
- Waste Rock and Overburden Dumps; and
- Diversion Ditching.

In addition, Minto's Environmental Monitoring Plan further commits to structural monitoring of the elements listed above. These programs will continue in the event of any temporary closure, with results to be included in annual reporting under the water license.

Should temporary closure occur prior to the reclamation of the dry stack tailings facility then the monitoring program for the physical stability of the tailings pile as presented in Minto's Tailings Management Plan will be followed. Without ongoing tailings placement, the visual inspection elements of the stack stability monitoring will be conducted by the site caretaker, with any stability-related issues reported to the engineer immediately.

Some elements of the monitoring program (geotechnical and structural inspections and non-routine water quality and biological monitoring) will be conducted by appropriate professional personnel, and results of these inspections will be included in the annual reports and other required submissions.

Monitoring stations for the water quality surveillance program during any temporary closure are the same as those required during operations, as shown in Figure 7-1.



capstone
MINTO MINE

MINTO MINE PHASE IV

RECLAMATION AND CLOSURE PLAN REVISION 4.0

FIGURE 7-1

WATER QUALITY MONITORING STATIONS LOCATIONS

SEPTEMBER 2013

Surface Water Quality Monitoring Station

Watercourse

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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(*Last edited by: mducharme;13/09/2013/14:28 PM*)

7.6.3 Reporting

All monitoring and inspection data collected during a temporary site closure will be compiled and submitted according to the required annual reporting timeframes for both the Water Use Licence and the Quartz Mining Licence.

8 CLOSURE COSTS

Cost estimation for implementation of the proposed closure measures is the basis for establishing the financial security that will be required on the project. The Phase IV closure cost estimate has been prepared in accordance with recent costing guidance from YG EMR in the document *Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and closure costing guidance*. This estimation is based on the final extent of disturbance for each of the infrastructure units described in this report using a Net Present Value (NPV) approach for costs beyond 5 years post-closure.

The tables of estimated costs to implement the decommissioning and reclamation measures described in this report are presented Tables 8-1 through 8-14 below. The costing has been prepared to provide an estimate of closure plan implementation for End of Mine Life, as the Phase IV mine life is scheduled to be complete before a scheduled 2-year RCP and security update.

The costs have been developed using a combination of current unit rates for available Yukon contractors' equipment, and custom unit rates specific to the project. These custom rates were updated in September of 2013 with input from the mine construction heavy equipment contractor and based on their experience on site during the construction activities, considering such factors as:

- Actual haul distance;
- Road grade (vertical rise and drop); and
- Material handling and volumes required.

The unit costs have been applied to levels of effort in sufficient detail to allow thorough scrutiny by the reader. As such, equipment rates have been used where the level of effort is well understood, and in other cases, unit area or volume rates have been employed.

- Table 8-1 provides a summary of cost estimates prepared for End of Mine;
- Table 8-2 contains a summary of the unit rates used in the calculations;
- Table 8-3 to Table 8-11 provide closure cost estimates for the specific site development reclamation components;
- Table 8-12 provides closure cost estimates reclamation research and revegetation activities;
- Table 8-13 outlines costs associated with the site management during closure implementation and presents post-closure costs for compliance monitoring and maintenance for the entire projected 15 year active closure and post-closure monitoring life; and
- Table 8-14 presents costs for various supporting studies as outlined in the closure measures Section 6.

The closure measures presented in this plan have been prepared at a preliminary level of engineering design. It is recognized that a certain level of detailed engineering will be required for major closure activities including, dam removal, and conveyance or diversion ditches. The approach is to ensure that closure measures are sound and have undergone review before detailed engineering is undertaken. Detailed engineering is planned for major works prior to implementation, and where required the estimate costs for the development of these designs is included in the financial assurance costing estimation.

The closure plan costing allows for 10-years of Active Treatment during the transitional post-closure period after which time it is anticipated that all source control closure measures will be fully in place and the site conditions will have stabilized such that mine water will be suitable for discharge without the need for additional treatment. The closure costing also funds the ongoing reclamation research into passive/semi-passive supplemental treatment technologies (i.e., CWTS, bioreactors and batch treatment of open-pits) such that these technologies will be developed to the "proof of concept" level of design and therefore ready to implement as a contingency measure in the event that supplementary water treatment is required.

Long-term costs have been developed to 100 years as the closure planning has moved away from a "walk away" closure scenario. Additionally, the discount rate has been from 3% in the previous version of the RCP to 2.5% to be consistent with some recent BC examples.

For the purposes of closure costing an estimate of 7% of the capital cost of each closure measure was used for typical project management and engineering costs. An additional 18% Indirect Costs was added to the final calculated costs. The indirect costs have been revised upwards from 12% Indirect Costs allowed for in the previous version of the RCP. This increased allowance for indirect costs is consistent with recent guidance from EMR.

The short term (years 0-5) closure costs are estimated at $28,612,520. The long term closure costs (years 6+) are estimated with an NPV of $7,239,419, for a total financial security of $35,851,940 which assumes 10 years of active water treatment post-closure.

8.1 FINANCIAL SECURITY UPDATES

YG has developed a policy respecting mine site reclamation and closure with one of the stated principles being "adequate security must be provided by the project proponent at each stage of mine development reclamation and closure consistent with the requirements of relevant legislation and Yukon financial security guidelines" (YG, 2006). Typically requirements for mine security bonding are conditions of the Type A Water Use Licence or Yukon Quartz Mining Production Licence. Minto intends to adhere to the principles for mine reclamation and closure and security requirements in accordance with YG's policy which identifies that the security estimate be updated every second year.

Minto and YG will jointly determine a schedule for security payment scheduling.

Minto will discuss road decommissioning requirements with SFN, which will ultimately refine the final closure costs associated with the access road decommissioning.

Table 8-1

Summary Table of Estimated Closure Costs - 2013

Description of Cost	Estimated Cost Existing Security (September 2012)	Estimated Cost Proposed 2013
Short-Term Reclamation and Closure Costs (years 1-5)		
Waste Dumps	$8,286,594	$6,332,223
Pit and Haul Roads	$460,668	$271,268
Primary Water Conveyance Structures		$741,863
Tailings & MVFE	$2,615,559	$1,481,569
Main Dam	$615,033	$590,958
Mill and Facilities	$801,633	$802,356
Mill Pond	$177,524	$177,524
Access Road	$253,906	$253,906
Miscellaneous	$307,385	$383,373
Revegetation	$1,557,900	$1,557,900
Site Management	$1,234,660	$1,626,160
Supporting Studies	$510,500	$510,500
Reclamation and Closure Research Program		$1,450,000
Capital Costs		
Active Treatment		$2,000,000
Active Treatment Capital Replacement		$240,000
Passive Treatment	$202,658	$0
Passive Treatment Capital Replacement		$0
Operating Costs (total years 1-5)		
Active Treatment	$3,115,680	$3,115,680
Passive Treatment		$0
Site Access and Maintenance[1,2]	$391,500	$0
Monitoring[1]	$790,500	$710,500
Sub-total	$21,321,701	$22,245,778
Indirect Costs (%)	12%	18%
Indirect Costs	$2,607,204.06	$4,004,240.12
Cost Inflation (3%/year)	$0	$2,362,502
Total Short Term Costs	**$23,928,905**	**$28,612,520**
Long-Term Reclamation and Closure Costs		
Reclamation and Closure Research Program		$750,000
Capital Costs		
Active Treatment		$0
Active Treatment Capital Replacement		$300,000
Passive Treatment		$0
Passive Treatment Capital Replacement		$0
Operating Costs		
Active Treatment		$3,750,000
Passive Treatment		$0
Site Access and Maintenance		$2,400,000
Monitoring		$120,000
Sub-Total		$7,320,000
Sub-Total NPV (2.5% DROR)		$6,135,101
Indirect Costs (%)		18%
Indirect Costs		$1,104,318
Total (NPV)		$7,239,419
Total Financial Security (18% Indirect Costs)	**$23,928,905**	**$35,851,940**

[1] Existing FS includes maintenance and monitoring costs for years 6-15

[2] Site Access and Maintenance costs for years 1-5 are included in the Site Management line item

Table 8-2
Minto Mine Closure Unit Rates for 2013

Equipment Rates		
Equipment	**Unit Rates**	**Per Unit**
D9H Dozer	$350	per hr
D6D Dozer	$160	per hr
Haul Truck D250E	$250	per hr
Tandem Haul Truck	$150	per hr
Cat 235 Excavator	$250	per hr
Cat 235 Excavator w hammer	$275	per hr
Cat 16H grader	$250	per hr
988B Loader	$190	per hr
Tractor Trailer (lowbed)	$160	per hr
30 ton Crane	$190	per hr
Hiab Flatdeck truck	$160	per hr
Cat 950 loader	$140	per hr
Vibratory Roller	$150	per hr
Crane support	$190	per hr
Pickup Truck	$2,500	per mo
Personnel Rates		
Personnel	**Unit Rates**	**Per Unit**
Blaster	$62	per hr
General Labourer	$47	per hr
Trades Labourer	$83	per hr
Site Supervisor	$100	per hr
Design Engineer	$135	per hr
Environmental Scientist	$100	per hr
Project Manager	$9,700	per mo
Camp Labourer	$4,000	per mo
Site Caretaker	$6,100	per mo
Environmental Monitor	$5,000	per mo
Revegetation Rates	**Unit Rates**	**Per Unit**
Revegetation Seed Mix	$15	per kg
Revegetation Seed Mix - 50kg/ha	$750	per ha
Fertilizer	$1	per kg
Fertilizer - 250kg/ha	$250	per ha
Tree Seedlings (1,000 seedlings per ha)	$1,750	per ha
Seed/Fertilizer Application	$1,500	per ha
Erosion Barrier	$3	per sq.m
Revegetation cost per ha. Including application cost	**$2,500.00**	**per ha**
Contractor Unit Rates & Camp Costs	**Unit Rates**	**Per Unit**
Custom Rate A (Load, haul, place soil cover ROD-MWD)	$3.75	per cu.m
Custom Rate B (Load, haul, place soil cover ROD-SWD)	$4.25	per cu.m
Custom Rate C (Load, haul, place soil cover ROD-MWD / LGO)	$4.00	per cu.m
Custom Rate D (Load, haul, place soil cover ROD-MWD / HGO)	$4.00	per cu.m
Custom Rate E (Load, haul, place soil cover ROD-CSA)	$3.75	per cu.m
Custom Rate F (Load, haul, place soil cover ROD-MVFE)	$4.25	per cu.m
Custom Rate G (Load, haul, place soil cover ROD-DSTF)	$4.25	per cu.m
Custom Rate H (Load, haul, place fill SWD - MVFE)	$4.25	per cu.m
Custom Rate I (Load, haul, place soil cover ROD-WSP Dam)	$4.50	per cu.m
Custom Rate J (Push from WSP Dam - U/S WSP Dam)	$2.20	per cu.m
Load, haul & place mat'l underground	$7.00	per cu.m
Produce rip-rap	$13.00	per cu.m
Load, haul and place rip-rap	$13.00	per cu.m
Deliver and install geosynthetic membrane on prepared foundation	$20.00	per sq.m
Unit Basis (footing burial)	$5.00	each
GeoWeb - GW30V3	$5.60	per sq.m
GeoWeb - GW30V4	$7.10	per sq.m
GeoWeb - GW30V6	$10.60	per sq.m
Freight run to Whitehorse	$1,000.00	per load
Camp Cost	$70.00	per day per person
Power and Heat	$5,500.00	per month
Employee Transport Costs	$3,000.00	per month
Barge Operating Cost	$10,000.00	per month

Notes:
1) Custom Rates A through E previously developed specifically for Minto Mine, taking into account such factors as haul
2) Custom Rate F is new to this costing iteration and is based on experience and extrapolotion of other custom rates.

Table 8-3

Waste Rock and Overburden Dumps, Estimated Closure Costs - 2013

Item No.	Work Item Description	Equipment / Labour	Units	Quantity	Unit Rates	Cost	Total
	WASTE ROCK AND OVERBURDEN DUMPS						
3.1	**Main Waste Dump (s 6.1.1)**						
	Roll crest and recontour	D9H Dozer	hrs	500	$350	$175,000	$175,000
	Additional compaction, as req'd	Vibratory Roller	hrs	60	$150	$9,000	$9,000
	Haul & place overburden for revegetation - Bench area (0.8 m thickness) (23.7 ha)	Custom Rate A (Load, haul, place soil cover ROD-MWD)	cu.m.	189,600	$3.75	$711,000	$711,000
	Haul & place overburden for revegetation - Slope area (1.0 m thickness) (13.4 ha)	Custom Rate A (Load, Haul, place soil cover ROD-MWD)	cu.m.	134,000	$3.75	$502,500	$502,500
	Project Management & Engineering	7% of Total Cost	%		7.00%	$97,825	$97,825
	Sub-Total						**$1,495,325**
3.1.1	**Main Waste Dump - Ditching Option 1 - Rip-rap**						
	Contour secondary ditching (1840 m)	Cat 235 Excavator	hrs	92	$250.00	$23,000	$23,000
	Provision for ditching rip-rap	Produce rip-rap	cu.m.	6,510	$13.00	$84,630	$84,630
		Load, haul and place rip-rap	cu.m.	6,510	$13.00	$84,630	$84,630
	Contour tertiary ditching (490 m)	Cat 235 Excavator	hrs	25	$250.00	$6,125	$6,125
	Sedimentation Pond	Misc.	l.s.	1	$100,000.00	$100,000	$100,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$20,887	$20,887
	Sub-Total						**$319,272**
3.1.2	**Main Waste Dump - Ditching Option 2 - GeoWeb**						
	Contour secondary ditching (1840 m)	Cat 235 Excavator	hrs	92	$250.00	$23,000	$23,000
	Provision for ditching erosion protection	Produce rip-rap	cu.m.	1,870	$13.00	$24,310	$24,310
		Load, haul and place rip-rap	cu.m.	1,870	$13.00	$24,310	$24,310
	GeoWeb	GeoWeb - GW30V4	sq.m	18,400	$7.10	$130,640	$130,640
	Contour tertiary ditching (490 m)	Cat 235 Excavator	hrs	25	$250.00	$6,125	$6,125
	Sedimentation Pond	Misc.	l.s.	1	$100,000.00	$100,000	$100,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$21,587	$21,587
	Sub-Total						**$329,972**
3.2	**Southwest Dump**						
	Roll crest and recontour	D9H Dozer	hrs	220	$350	$77,000	$77,000
	Additional compaction, as req'd	Vibratory Roller	hrs	160	$150	$24,000	$24,000
	Haul & place overburden for revegetation - Bench area (0.8 m thickness) (61.9 ha)	Custom Rate B (Load, haul, place soil cover ROD-SWD)	cu.m.	495,200	$4.25	$2,104,600	$2,104,600
	Haul & place overburden for revegetation - Slope area (1.0 m thickness) (8.3 ha)	Custom Rate B (Load, haul, place soil cover ROD-SWD)	cu.m.	83,000	$4.25	$352,750	$352,750
	Project Management & Engineering	7% of Total Cost	%		7.00%	$179,085	$179,085
	Sub-Total						**$2,737,435**
3.2.1	**Southwest Dump - Ditching Option 1 - Rip-rap**						
	Contour secondary ditching (1980 m)	Cat 235 Excavator	hrs	99	$250.00	$24,750	$24,750
	Provision for ditching rip-rap	Produce rip-rap	cu.m.	6,990	$13.00	$90,870	$90,870
		Load, haul and place rip-rap	cu.m.	6,990	$13.00	$90,870	$90,870
	Contour tertiary ditching (1830 m)	Cat 235 Excavator	hrs	92	$250.00	$22,875	$22,875
	Sedimentation Pond	Misc.	l.s.	1	$100,000.00	$100,000	$100,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$23,056	$23,056
	Sub-Total						**$352,421**
3.2.2	**Southwest Dump - Ditching Option 2 - GeoWeb**						
	Contour secondary ditching (1980 m)	Cat 235 Excavator	hrs	99	$250.00	$24,750	$24,750
	Provision for ditching erosion protection	Produce rip-rap	cu.m.	2,010	$13.00	$26,130	$26,130
		Load, haul and place rip-rap	cu.m.	2,010	$13.00	$26,130	$26,130
	GeoWeb	GeoWeb - GW30V4	sq.m	19,800	$7.10	$140,580	$140,580
	Contour tertiary ditching (1830 m)	Cat 235 Excavator	hrs	92	$250.00	$22,875	$22,875
	Sedimentation Pond	Misc.	l.s.	1	$100,000.00	$100,000	$100,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$23,833	$23,833
	Sub-Total						**$364,298**
3.3	**Ice-Rich Overburden Dump (s 6.1.3)**						
	Roll crest of berm and recontour	D9H Dozer	hrs	16	$350	$5,600	$5,600
	Excavate material for placement on berm	Cat 235 Excavator	hrs	40	$250	$10,000	$10,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$1,092	$1,092
	Sub-Total						**$16,692**
3.4	**Reclamation Overburden Dump (s 6.1.4)**						
	Blade pad after removal of material during reclamation	D6D Dozer	hrs	90	$160	$14,400	$14,400
	Project Management & Engineering	7% of Total Cost	%		7.00%	$1,008	$1,008
	Sub-Total						**$15,408**
3.2.1	**Reclamation Overburden Dump - Ditching Option 1 - Rip-rap**						
	Contour secondary ditching (3480 m)	Cat 235 Excavator	hrs	174	$250.00	$43,500	$43,500
	Provision for ditching rip-rap	Produce rip-rap	cu.m.	12,290	$13.00	$159,770	$159,770
		Load, haul and place rip-rap	cu.m.	12,290	$13.00	$159,770	$159,770
	Contour tertiary ditching (1900 m)	Cat 235 Excavator	hrs	95	$250.00	$23,750	$23,750
	Sedimentation Pond	Misc.	l.s.	1	$100,000.00	$100,000	$100,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$34,075	$34,075
	Sub-Total						**$520,865**
3.2.2	**Reclamation Overburden Dump - Ditching Option 2 - GeoWeb**						
	Contour secondary ditching (3480 m)	Cat 235 Excavator	hrs	174	$250.00	$43,500	$43,500
	Provision for ditching erosion protection	Produce rip-rap	cu.m.	3,510	$13.00	$45,630	$45,630
		Load, haul and place rip-rap	cu.m.	3,510	$13.00	$45,630	$45,630
	GeoWeb	GeoWeb - GW30V4	sq.m	34,800	$7.10	$247,080	$247,080
	Contour tertiary ditching (1900 m)	Cat 235 Excavator	hrs	95	$250.00	$23,750	$23,750
	Sedimentation Pond	Misc.	l.s.	1	$100,000.00	$100,000	$100,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$35,391	$35,391
	Sub-Total						**$540,981**
3.5	**Low Grade Ore Stockpile and Pad (s 6.2)**						
	Recontour Stockpile and Pad	D9H Dozer	hrs	40	$350	$13,825	$13,825
	Haul and place overburden for revegetation	Custom Rate C (Load, haul, place soil cover ROD-MWD / LGO)	cu.m.	16,250	$4.00	$65,000	$65,000
	Removal of bottom layer of material, move to pit.	Misc.	l.s.	1	$5,000	$5,000	$5,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$5,868	$5,868
	Sub-Total						**$89,693**
3.6	**High Grade Ore Stockpile Pad (s 6.2)**						
	Recontour stockpile and pad	D9H Dozer	hrs	54	$350	$18,900	$18,900
	Haul and place overburden for revegetation	Custom Rate D (Load, haul, place soil cover ROD-MWD / HGO)	cu.m.	24,000	$4.00	$96,000	$96,000
	Installation of geosynthetic membrane (e.g. BGM)	Price is delivered and installed on prepared foundation	sq.m	24,000	$20.00	$480,000	$480,000
	Removal of bottom layer of material, move to pit	Misc.	l.s.	1	$7,500	$7,500	$7,500
	Project Management & Engineering	7% of Total Cost			7.00%	$42,168	$42,168
	Sub-Total						**$644,568**
3.7	**Grade Bin Disposal Area**						
	Move material to Area 1 Pit	988B Loader	hrs	3,500	$190	$0	$0
		D9H Dozer	hrs	360	$350	$0	$0
		Haul Truck D250E	hrs	5,500	$250	$0	$0
	Project Management & Engineering	7% of Total Cost	%		7.00%	$0	$0
	Sub-Total						**$0**
3.8	**Contractor's Shop and Work Area (s 6.9.7)**						
	Remove salvageable equipment	General Labourer	hrs	75	$47	$3,525	$3,525
		Haul Truck D250E	hrs	25	$250	$6,250	$6,250
		Trades Labourer	hrs	60	$83	$4,980	$4,980
	Dismantle buildings	General Labourer	hrs	60	$47	$2,820	$2,820
		30 ton Crane	hrs	13	$190	$2,375	$2,375
		Cat 235 Excavator	hrs	38	$250	$9,375	$9,375
	Haul building pieces off site - equipment	Tractor Trailer (lowbed)	hrs	25	$160	$4,000	$4,000
	Scrap haul to site landfill	Haul Truck D250E	hrs	25	$250	$6,250	$6,250
	Excavate & haul contaminated materials to site LTF	Misc.	l.s.	1	$6,250	$6,250	$6,250
	Bury footings - haul and place fill, locally sourced	Unit Basis (footing burial)	each	3,125	$5	$15,625	$15,625
	Recontour	D9H Dozer	hrs	19	$350	$6,563	$6,563
	Haul and place overburden for revegetation	Custom Rate E (Load, haul, place soil cover ROD-CSA)	cu.m.	6,250	$4	$23,438	$23,438
	Project Management & Engineering	7% of Total Cost	%		7.00%	$6,402	$6,402
	Sub-Total						**$97,852**
Total Estimated Cost in Reclaiming Overburden and Waste Rock Dumps							
	Option 1 - assuming use of rip-rap lined ditches						**$6,289,530**
	Option 2 - assuming use of GeoWeb lined ditches						**$6,332,223**

Note:

Table 8-4
Open Pit and Haul Roads, Estimated Closure Costs - 2013

Item No.	Work Item Description	Equipment / Labour	Units	Quantity	Unit Rates	Cost	Total
	OPEN PIT, UNDERGROUND AND HAUL ROADS						
4.1	**Main Pit**						
	Remove pit pumps and pipe column/general cleanup	General Labourer	hrs	80	$47	$3,760	
		Trades Labourer	hrs	20	$83	$1,660	
		Support equipment	l.s.	1	$1,000	$1,000	$6,420
	Secure pit access - boulder placement	Cat 235 Excavator	hrs	20	$250	$5,000	
		Haul Truck D250E	hrs	20	$250	$5,000	
	Highwall perimeter safety berm/trench (~1km)	Cat 235 Excavator	hrs	40	$250	$10,000	$20,000
	Construct inflow spillway from upgradient of pit	Cat 235 Excavator	hrs	40	$250	$10,000	
		Haul Truck D250E	hrs	20	$250	$5,000	
		Produce rip-rap	cu.m	200	$13	$2,600	
		Load, haul and place rip-rap	cu.m	200	$13	$2,600	$20,200
	Construct exit channel into Mill Pond system	Cat 235 Excavator	hrs	20	$250	$5,000	
		Produce rip-rap	cu.m	200	$13	$2,600	
	rip-rap shoulder exiting pit-spillway	Load, haul and place rip-rap	cu.m	200	$13	$2,600	
		General Labourer	hrs	10	$47	$470	$10,670
	Project Management & Engineering	7% of Total Cost	%		7.00%	$17,268	$17,268
	Sub-Total						**$74,558**
4.2	**Area 2 Pit**						
	Remove pit pumps and pipe column/general cleanup	General Labourer	hrs	40	$47	$1,880	
		Trades Labourer	hrs	10	$83	$830	
		Support equipment	l.s.		$1,000	$1,000	$3,710
	Secure pit access - boulder placement	Cat 235 Excavator	hrs	20	$250	$5,000	
		Haul Truck D250E	hrs	20	$250	$5,000	$10,000
	Construct exit channel into Mill Pond system	Cat 235 Excavator	hrs	40	$250	$10,000	
	rip-rap shoulder exiting pit	Load, haul and place rip-rap	cu.m	50	$13	$650	
	Exit Spillway construction	General Labourer	hrs	40	$47	$1,880	
		Produce rip-rap	cu.m	250	$13	$3,250	
		Load, haul and place rip-rap	cu.m	250	$13	$3,250	$19,030
	Project Management & Engineering	7% of Total Cost	%		7.00%	$2,292	$2,292
	Sub-Total						**$35,032**
4.3	**Area 118 Pit**						
	Remove pit pumps and pipe column/general cleanup	General Labourer	hrs	30	$47	$0	
		Trades Labourer	hrs	7.5	$83	$0	
		Support equipment	l.s.		$750	$0	$0
	Secure pit access - boulder placement	Cat 235 Excavator	hrs	15	$250	$0	
		Haul Truck D250E	hrs	15	$250	$0	$0
	Construct exit channel into Mill Pond system	Cat 235 Excavator	hrs	30	$250	$0	
		Produce rip-rap	cu.m	30	$13	$0	
	rip-rap shoulder exiting pit	Load, haul and place rip-rap	cu.m	37.5	$13	$0	
	Exit Spillway construction	General Labourer	hrs	30	$47	$0	
		Produce rip-rap	cu.m	188	$13	$0	
		Load, haul and place rip-rap	cu.m	187.5	$13	$0	$0
	Haul and place overburden for revegetation	Load, Haul and place soil cover	cu.m.	7500	$4.25	$0	$0
	Project Management & Engineering	7% of Total Cost	%		7.00%	$0	$0
	Sub-Total						**$0**
4.4	**Haul Roads (s 6.5) (15 ha)**						
	Remove culverts and haul away	General Labourer	hrs	55	$47	$2,585	
		Cat 235 Excavator	hrs	28	$250	$7,000	
		Haul Truck D250E	hrs	28	$250	$7,000	$16,585
	Recontour slopes	D9H Dozer	hrs	208	$350	$72,800	$72,800
	Scarify surfaces	Cat 16H grader	hrs	208	$250	$52,000	
		General Labourer	hrs	28	$47	$1,316	$53,316
	Stabilize slopes - erosion barriers - material	Unit Cost Basis	sq.m	2,800	$3	$8,400	$8,400
	Project Management & Engineering	7% of Total Cost	%		7.00%	$10,577	$10,577
	Sub-Total						**$161,678**
4.5	**Underground**						
	Backfill underground waste	Load, haul & place mat'l underground	cu.m	70000	$7	$0	$0
	Recontour slopes	D9H Dozer	hrs	20	$350	$0	$0
	Seal off underground portal		l.s.	1	$10,000	$0	$0
	Seal off ventilation raise		l.s.	1	$5,000	$0	$0
	Scarify road	Cat 16H grader	hrs	8	$250	$0	$0
	Project Management & Engineering	7% of Total Cost	%		7.00%	$0	$0
	Sub-Total						**$0**
Total Estimated Cost in Reclaiming Open Pit and Haul Roads							**$271,268**

Note:
Linear disturbances to be scarified / decompacted and allowed to naturally revegetate

Table 8-5

Primary Water Conveyance Structures, Estimated Closure Costs - 2013

Item No.	Work Item Description	Equipment / Labour	Units	Quantity	Unit Rates	Cost	Total
5.1	**Decomission 100 Surface Drainage Channel**						
	Remove redundant infrastructure	Misc.	l.s.	1	$25,000	$25,000	$25,000
	Upgrade for final closure	Misc.	l.s.	1	$50,000	$50,000	$50,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$5,250	$5,250
	Sub-Total						**$80,250**
5.2.1	**200 Surface Drainage Channel (1120 m length) - Ditching Option 1 - Rip-rap**						
	Contour ditching (1120 m)	Cat 235 Excavator	hrs	56	$250.00	$14,000	$14,000
	Provision for ditching rip-rap	Produce rip-rap	cu.m.	3,960	$13.00	$51,480	$51,480
		Load, haul and place rip-rap	cu.m.	3,960	$13.00	$51,480	$51,480
	Project Management & Engineering	7% of Total Cost	%		7.00%	$8,187	$8,187
	Sub-Total						**$125,147**
5.2.2	**200 Surface Drainage Channel (1120 m length) - Ditching Option 2 - GeoWeb**						
	Contour secondary ditching (1120 m)	Cat 235 Excavator	hrs	56	$250.00	$14,000	$14,000
	Provision for ditching erosion protection	Produce rip-rap	cu.m.	1,700	$13.00	$22,100	$22,100
		Load, haul and place rip-rap	cu.m.	1,700	$13.00	$22,100	$22,100
	GeoWeb	GeoWeb - GW30V6	sq.m	11,200	$10.60	$118,720	$118,720
	Project Management & Engineering	7% of Total Cost	%		7.00%	$12,384	$12,384
	Sub-Total						**$189,304**
5.3.1	**300 Surface Drainage Channel (370 m length) - Ditching Option 1 - Rip-rap**						
	Contour ditching (370 m)	Cat 235 Excavator	hrs	19	$250.00	$4,625	$4,625
	Provision for ditching rip-rap	Produce rip-rap	cu.m.	1,310	$13.00	$17,030	$17,030
		Load, haul and place rip-rap	cu.m.	1,310	$13.00	$17,030	$17,030
	Project Management & Engineering	7% of Total Cost	%		7.00%	$2,708	$2,708
	Sub-Total						**$41,393**
5.3.2	**300 Surface Drainage Channel (370 m length) - Ditching Option 2 - GeoWeb**						
	Contour secondary ditching (370 m)	Cat 235 Excavator	hrs	56	$250.00	$14,000	$14,000
	Provision for ditching erosion protection	Produce rip-rap	cu.m.	560	$13.00	$7,280	$7,280
		Load, haul and place rip-rap	cu.m.	560	$13.00	$7,280	$7,280
	GeoWeb	GeoWeb - GW30V6	sq.m	3,700	$10.60	$39,220	$39,220
	Project Management & Engineering	7% of Total Cost	%		7.00%	$4,745	$4,745
	Sub-Total						**$72,525**
5.4.1	**350 Surface Drainage Channel (510 m length) - Ditching Option 1 - Rip-rap**						
	Contour ditching (510 m)	Cat 235 Excavator	hrs	26	$250.00	$6,375	$6,375
	Provision for ditching rip-rap	Produce rip-rap	cu.m.	1,800	$13.00	$23,400	$23,400
		Load, haul and place rip-rap	cu.m.	1,800	$13.00	$23,400	$23,400
	Project Management & Engineering	7% of Total Cost	%		7.00%	$3,722	$3,722
	Sub-Total						**$56,897**
5.4.2	**350 Surface Drainage Channel (510 m length) - Ditching Option 2 - GeoWeb**						
	Contour secondary ditching (510 m)	Cat 235 Excavator	hrs	26	$250.00	$6,375	$6,375
	Provision for ditching erosion protection	Produce rip-rap	cu.m.	780	$13.00	$10,140	$10,140
		Load, haul and place rip-rap	cu.m.	780	$13.00	$10,140	$10,140
	GeoWeb	GeoWeb - GW30V6	sq.m	5,100	$10.60	$54,060	$54,060
	Project Management & Engineering	7% of Total Cost	%		7.00%	$5,650	$5,650
	Sub-Total						**$86,365**
5.5	**400 - Surface Drainage Channel Over MVFE (1380 m length)**						
	Contour secondary ditching (1380 m)	Cat 235 Excavator	hrs	69	$250.00	$17,250	$17,250
	Provision for ditching rip-rap (1060 m)	Produce rip-rap	cu.m.	1,610	$13.00	$20,930	$20,930
		Load, haul and place rip-rap	cu.m.	1,610	$13.00	$20,930	$20,930
	Concrete	Poured concrete	cu.m.	120	$500.00	$60,000	$60,000
	Insertion of baffles	General Labourer	hrs	20	$47.00	$940	$940
	GeoWeb	GeoWeb - GW30V6	sq.m	10,600	$10.60	$112,360	$112,360
		GeoWeb - GW30V3	sq.m	1,500	$5.60	$8,400	$8,400
	Project Management & Engineering	7% of Total Cost	%		7.00%	$16,857	$16,857
	Sub-Total						**$257,667**
5.6.1	**450 Surface Drainage Channel (330 m length) - Ditching Option 1 - Rip-rap**						
	Contour ditching (330 m)	Cat 235 Excavator	hrs	17	$250.00	$4,125	$4,125
	Provision for ditching rip-rap	Produce rip-rap	cu.m.	1,170	$13.00	$15,210	$15,210
		Load, haul and place rip-rap	cu.m.	1,170	$13.00	$15,210	$15,210
	Project Management & Engineering	7% of Total Cost	%		7.00%	$2,418	$2,418
	Sub-Total						**$36,963**
5.6.2	**450 Surface Drainage Channel (330 m length) - Ditching Option 2 - GeoWeb**						
	Contour secondary ditching (330 m)	Cat 235 Excavator	hrs	17	$250.00	$4,125	$4,125
	Provision for ditching erosion protection	Produce rip-rap	cu.m.	500	$13.00	$6,500	$6,500
		Load, haul and place rip-rap	cu.m.	500	$13.00	$6,500	$6,500
	GeoWeb	GeoWeb - GW30V6	sq.m	3,300	$10.60	$34,980	$34,980
	Project Management & Engineering	7% of Total Cost	%		7.00%	$3,647	$3,647
	Sub-Total						**$55,752**
Total Estimated Cost in Constructing Primary Drainage Ditches							
	Option 1 - assuming use of rip-rap lined ditches						**$598,317**
	Option 2 - assuming use of GeoWeb lined ditches						**$741,863**

Note:

Table 8-6
DSTSF and MVFE, Estimated Closure Costs - 2013

Item No.	Work Item Description	Equipment / Labour	Units	Quantity	Unit Rates	Cost	Total
	DSTSF						
6.1	**Tailings Deposit - Entire Area (41.3 ha)**						
	Roll crest of starter bench and recontour	D9H Dozer	hrs	50	$350	$17,500	$17,500
	Haul overburden ROD - DSTF (0.5 m)	Custom Rate G (Load, haul, place soil cover ROD-DSTF)	cu.m	224,000	$4	$952,000	$952,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$67,865	$67,865
	Sub-Total						**$1,037,365**
6.2.1	**Dry Stacked Tailings - Ditching Option 1 - Rip-rap**						
	Contour secondary ditching (720 m)	Cat 235 Excavator	hrs	36	$250.00	$9,000	$9,000
	Provision for ditching rip-rap	Produce rip-rap	cu.m.	2,540	$13.00	$33,020	$33,020
		Load, haul and place rip-rap	cu.m.	2,540	$13.00	$33,020	$33,020
	Impervious barrier	Impervious liner	sq.m	4,320	$20.00	$86,400	$86,400
	Contour tertiary ditching (780 m)	Cat 235 Excavator	hrs	39	$250.00	$9,750	$9,750
	Project Management & Engineering	7% of Total Cost	%		7.00%	$11,983	$11,983
	Sub-Total						**$183,173**
6.2.2	**Dry Stacked Tailings - Ditching Option 2 - GeoWeb**						
	Contour secondary ditching (720 m)	Cat 235 Excavator	hrs	36	$250.00	$9,000	$9,000
	Provision for ditching erosion protection	Produce rip-rap	cu.m.	730	$13.00	$9,490	$9,490
		Load, haul and place rip-rap	cu.m.	730	$13.00	$9,490	$9,490
	GeoWeb	GeoWeb - GW30V4	sq.m	7,200	$7.10	$51,120	$51,120
	Impervious barrier	Impervious liner	sq.m	4,320	$20.00	$86,400	$86,400
	Contour tertiary ditching (780 m)	Cat 235 Excavator	hrs	39	$250.00	$9,750	$9,750
	Project Management & Engineering	7% of Total Cost	%		7.00%	$12,268	$12,268
	Sub-Total						**$187,518**
6.3	**South Diversion Ditch (length cut by 50%)**						
	Widen south diversion ditch	D9H Dozer	hrs	50	$350	$17,500	$17,500
		Cat 235 Excavator	hrs	20	$250	$5,000	$22,500
		Produce rip-rap	cu.m	1,200	$13	$15,600	$15,600
	Haul and place rip-rap	Load, haul and place rip-rap	cu.m	1,200	$13	$15,600	$15,600
	Construct spillway into Area 2 Pit	Cat 235 Excavator	hrs	40	$250	$10,000	$10,000
		Haul Truck D250E	hrs	20	$250	$5,000	$5,000
		Produce rip-rap	cu.m	200	$13	$2,600	$2,600
		Load, haul and place rip-rap	cu.m	200	$13	$2,600	$20,200
	HDPE liner	Unit rate	sq.m	2,400	$10	$24,000	$24,000
		General Labourer	hrs	80	$47	$3,760	$3,760
	Project Management & Engineering	7% of Total Cost	%		7.00%	$7,116	$7,116
	Sub-Total						**$143,876**
6.4	**Mill Valley Fill Facility (s. 6.7)**						
	Roll crest and recontour	D9H Dozer	hrs	30	$350	$10,500	$10,500
	Haul and place overburden for revegetation	Custom Rate F (Load, haul, place soil cover ROD-MVFE)	cu.m.	23,900	$4	$101,575	$101,575
	Project Management & Engineering	7% of Total Cost			7.00%	$735	$735
	Sub-Total						**$112,810**
Total Estimated Cost in Reclaiming Tailings Area							

Option 1 - assuming use of rip-rap lined ditches	**$1,477,225**
Option 2 - assuming use of GeoWeb lined ditches	**$1,481,569**

Note:

Table 8-7
Water Storage Pond Dam, Estimated Closure Costs - 2013

Item No.	Work Item Description	Equipment / Labour	Units	Quantity	Unit Rates	Cost	Total
	WATER STORAGE POND DAM						
7.1	**Reclaim System**						
	Remove salvageable equipment - pipeline/pumps	General Labourer	hrs	48	$47	$2,256	
		Trades Labourer	hrs	98	$83	$8,134	$10,390
	Remove pipeline	Haul Truck D250E	hrs	100	$250	$25,000	
		Cat 235 Excavator	hrs	100	$250	$25,000	
		General Labourer	hrs	200	$47	$9,400	$59,400
	Dismantle Building	Cat 235 Excavator	hrs	16	$250	$4,000	
		Trades Labourer	hrs	10	$83	$830	
		General Labourer	hrs	20	$47	$940	$5,770
	Misc. Supplies & Tools	Misc.	l.s.	1	$1,000	$1,000	$1,000
	Recontour alignment	D9H Dozer	hrs	16	$350	$5,600	$5,600
	Project Management & Engineering	7% of Total Cost	%		7.00%	$5,751	$5,751
	Sub-Total						**$87,911**
7.2	**Water Storage Pond Dam**						
	Pump down impounded water, over spillway (using reclaim pumps)	General Labourer	hrs	96	$47	$4,512	$4,512
	Misc. Supplies & Tools	Misc.	l.s.	1	$5,000	$5,000	$5,000
	Engineering design for final structure include appropriate flow determination, channel designs, etc.	Misc.	l.s.	1	$20,000	$20,000	$20,000
	Build coffer dam and install pump-around system Operate system until new structure is ready	Misc.	l.s.	1	$10,000	$10,000	$10,000
	Stockpile rip-rap from downstream shell	Unit Cost Basis	cu.m	10,000	$10	$100,000	$100,000
	Breach Dam: push material using dozer into new areas	Custom Rate J (Push from WSP Dam - U/S WSP Dam)	cu.m	25,000	$2.20	$55,000	
	and load, haul & dump and contour material in new area	Custom Rate I (Load, haul, place soil cover ROD-WSP Dam)	cu.m	31,000	$4.50	$139,500	
		Environmental Scientist	hrs	60	$100.00	$6,000	$200,500
	Construct stream channel at original grade - load, haul & place rip-rap (salvage from old WSP Dam stockpile)	Load, Haul and Place rip-rap	cu.m	1,125	$13.00	$14,625	$14,625
	Load, haul, place & contour overburden on slopes of new area u/s of WSP Dam	Custom Rate I (Load, haul, place soil cover ROD-WSP Dam)	cu.m	15,000	$4.50	$67,500	$67,500
	Stabilize slopes with erosion barriers	Unit Rates	sq. m	15,000	$3	$45,000	$45,000
	Misc. Supplies & Tools	Misc.	l.s.		$3,000	$3,000	$3,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$32,910	$32,910
	Sub-Total						**$503,047**
Total Estimated Cost in Reclaiming Water Dam							**$590,958**

NOTES:

Table 8-8
Mill & Ancillary Facilities, Estimated Closure Costs - 2013

Item No.	Work Item Description	Equipment / Labour	Units	Quantity	Unit Rates	Cost	Total
	MILL AND ANCILLARY FACILITIES						
7.1	**Mill Building**						
	Remove salvageable equipment	General Labourer	hrs	550	$47	$25,850	
		Trades Labourer	hrs	600	$83	$49,800	
		Crane Support	hrs	40	$190	$7,600	$83,250
	Decontaminate Building-hosing and clean-up	Trades Labourer	hrs	160	$83	$13,280	$13,280
	Dismantle Building	General Labourer	hrs	1000	$47	$47,000	
		Trades Labourer	hrs	600	$83	$49,800	
		Cat 235 Excavator w hammer	hrs	120	$275	$33,000	
		Crane Support	hrs	60	$190	$11,400	$141,200
	Concrete Demolition	Blaster	hrs	40	$62	$2,480	
		Cat 235 Excavator	hrs	20	$250	$5,000	
		D9H Dozer	hrs	30	$350	$10,500	$17,980
	Misc. Supplies & Tools	Misc.	l.s.	1	$11,000	$11,000	$11,000
	Scrap haul to solid waste facility	Cat 235 Excavator	hrs	50	$250	$12,500	
		Haul Truck D250E	hrs	100	$250	$25,000	$37,500
	Project Management & Engineering	7% of Total Cost	%		7.00%	$21,295	$21,295
	Subtotal:						**$325,505**
		Subtract 50% for Salvage Value					**$162,752**
8.2	**Generator & Filter Buildings & Concentrate Shed**						
	Remove salvageable equipment	General Labourer	hrs	240	$47	$11,280	
		Trades Labourer	hrs	240	$83	$19,920	$31,200
		Crane Support	hrs	24	$190	$4,560	
	Salvage and remove powerline and poles		l.s.	1	$27,500	$27,500	$32,060
	Dismantle Buildings	General Labourer	hrs	160	$47	$7,520	
		Trades Labourer	hrs	80	$83	$6,640	
		Cat 235 Excavator w hammer	hrs	40	$275	$11,000	
		Crane Support	hrs	30	$190	$5,700	$30,860
	Concrete Demolition	Blaster	hrs	40	$62	$2,480	
		Cat 235 Excavator	hrs	20	$250	$5,000	
		D9H Dozer	hrs	20	$350	$7,000	$14,480
	Misc. Supplies & Tools	Misc.	l.s.	1	$10,000	$10,000	$10,000
	Scrap haul to solid waste facility	Cat 235 Excavator	hrs	10	$250	$2,500	
		Haul Truck D250E	hrs	20	$250	$5,000	$7,500
	Project Management & Engineering	7% of Total Cost	%		7.00%	$8,827	$8,827
	Subtotal:						**$134,927**
		Subtract 50% for Salvage Value					**$67,464**
8.3	**Fuel Storage Area**						
	Cleanout tanks-remove sludge, pressure wash	General Labourer	hrs	60	$47	$2,820	
		Removal to Licensed facility	l.s.	1	$10,000	$10,000	$12,820
	Remove bulk fuel storage and piping facilities	General Labourer	hrs	100	$47	$4,700	
		Trades Labourer	hrs	120	$83	$9,960	
		Crane Support	hrs	30	$190	$5,700	
		Support Equipment	l.s.	1	$2,500	$2,500	
		Cat 235 Excavator	hrs	40	$250	$10,000	
		General Labourer	hrs	40	$47	$1,880	
		Tractor Trailer (lowbed)	hrs	30	$160	$4,800	$39,540
	Fold and Bury Liner	Cat 235 Excavator	hrs	20	$250	$5,000	
		D9H Dozer	hrs	100	$350	$35,000	$40,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$6,465	$6,465
	Subtotal:						**$98,825**
8.4	**Mill Reagents**						
	Load and return extra reagents/chemicals	General Labourer	hrs	100	$47	$4,700	
		Support Equipment	l.s.	1	$2,500	$2,500	
		Disposal Cost-bulk materials	l.s.	1	$5,000	$5,000	
		Disposal Cost-lab pacs	pallets	2	$2,000	$4,000	$16,200
	Removal of drums, steel, oils, glycol & batteries, as per 09July quote from General Waste Management to MEL	Contractor quote	l.s.		$50,900	$50,900	$50,900
	Project Management & Engineering	7% of Total Cost	%		7.00%	$4,697	$4,697
	Subtotal:						**$71,797**
8.5	**Reclaim Entire Mill Site Area**						
	Test soils for contamination	Environmental Scientist	hrs	35	$100	$3,500	
		Analytical Costs	l.s.	1	$6,000	$6,000	$9,500
	Haul any contaminated soils to Land Treatment Facility	Cat 235 Excavator	hrs	15	$250	$3,750	
		Haul Truck D250E	hrs	15	$250	$3,750	$7,500
	Re-contour area and slopes to bury footings and establish drainage	D9H Dozer	hrs	175	$350	$61,250	$61,250
	Haul and place overburden cap **(0.5m thickness)**	Unit Rate	cu.m	54000	$5.50	$297,000	$297,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$26,268	$26,268
	Subtotal:						**$401,518**
Total Estimated Cost in Reclaiming Mill and Ancillary Facilities							**$802,356**

Table 8-9

Mill Water Pond, Estimated Closure Costs - 2013

Item No.	Work Item Description	Equipment / Labour	Units	Quantity	Unit Rates	Cost	Total
	MILL POND						
9.1	**Reclaim Mill Pond**						
	Remove upstream culvert	General Labourer	hrs	10	$47	$470	
		Cat 235 Excavator	hrs	10	$250	$2,500	$2,970
	Construct channel	Cat 235 Excavator	hrs	100	$250	$25,000	
		D9H Dozer	hrs	20	$350	$7,000	$32,000
		Produce rip-rap	cu.m	5,000	$13	$65,000	$65,000
		Load, haul and place rip-rap	cu.m	5,000	$13	$65,000	$65,000
		General Labourer	hrs	20	$47	$940	$940
	Project Management & Engineering	7% of Total Cost	%		7.00%	$11,614	$11,614
	Subtotal:						**$177,524**
Total Estimated Cost in Reclaiming Mill Pond							**$177,524**

Note:

Table 8-10

Main Access Road, Estimated Closure Costs - 2013

Scenario 1 - No Road Deactivation

Item No.	Work Item Description	Equipment / Labour	Units	Quantity	Unit Rates	Cost	Total
10.1	**NO ROAD DECOMMISSIONING REQUIRED**						
10.1.1	**Road Surface**						
	Install road barrier at west side of Minto Creek	Misc	l.s.	1	$2,000	$2,000	$2,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$140	$140
	Subtotal:						
Total Estimated Cost for Access Road Closure (Scenario 1)							**$2,140**

Scenario 2 - Decommission Access Road From Minto Creek to Mine Site (11 KM)

Item No.	Work Item Description	Equipment / Labour	Units	Quantity	Unit Rates	Cost	Total Adjusted
10.2	**ACCESS ROAD - 11 KM SECTION**						
10.2.1	**Road Surface**						
	Scarify - 11 km	Cat 16H grader	hrs	70	$250	$17,500	$17,500
	Recontour slopes and drainages	D9H Dozer	hrs	25	$350	$8,750	$8,750
	Project Management & Engineering		%		7.00%	$1,838	$1,838
	Subtotal:						**$28,088**
10.2.2	**Culverts**						
	Culvert excavation (40 small culverts)	Cat 235 Excavator	hrs	100	$250	$25,000	$25,000
	Culvert removal	General Labourer	hrs	140	$47	$6,580	
		Haul Truck D250E	hrs	100	$250	$25,000	$31,580
	Minto Creek Culvert Removal & Streambank Restoration	Trades Labourer	hrs	40	$83	$3,320	
		General Labourer	hrs	75	$47	$3,525	
		Cat 235 Excavator	hrs	40	$250	$10,000	$16,845
	Recontour slopes and drainage	D9H Dozer	hrs	70	$350	$24,500	$24,500
	Stabilize slopes	General Labourer	hrs	200	$47	$9,400	
	Erosion barriers	Erosion Barrier	per sq. m	500	$3	$1,500	$10,900
	Project Management & Engineering	7% of Total Cost	%		7.00%	$7,618	$7,618
	Subtotal:						**$116,443**
Total Estimated Cost for Access Road Closure (Scenario 2)							**$144,530**

Scenario 3 - Decommission Entire Access Road (27 KM)

Item No.	Work Item Description	Equipment / Labour	Units	Quantity	Unit Rates	Cost	Total Adjusted
10.3	**ACCESS ROAD - 27 KM SECTION**						
10.3.1	**Road Surface**						
	Scarify - 27 km	Cat 16H grader	hrs	150	$250	$37,500	$37,500
	Recontour slopes and drainage	D9H Dozer	hrs	50	$350	$17,500	$17,500
	Project Management & Engineering	7% of Total Cost	%		7.00%	$3,850	$3,850
	Subtotal:						**$58,850**
10.3.2	**Big Creek Bridge**						
	Remove bridge decking and span	General Labourer	hrs	50	$47	$2,350	
		Crane support	hrs	40	$190	$7,600	
		Cat 235 Excavator	hrs	40	$250	$10,000	
		Tractor Trailer (lowbed)	hrs	20	$160	$3,200	$23,150
	Cut off piles	General Labourer	hrs	50	$47	$2,350	$2,350
	Re-contour	Cat 235 Excavator	hrs	30	$250	$7,500	
		D9H Dozer	hrs	30	$350	$10,500	$18,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$3,045	$3,045
	Subtotal:						**$46,545**
10.3.3	**Barge Ramps**						
	Remove all gravel	Cat 235 Excavator	hrs	20	$250	$5,000	$5,000
	Re-countour areas and scarify	D9H Dozer	hrs	30	$350	$10,500	$10,500
	Shoreline restoration	Misc.	l.s.		$5,000	$5,000	$5,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$1,435	$1,435
	Subtotal:						**$21,935**
10.3.4	**Culverts**						
	Culvert excavation (45 small culverts)	Cat 235 Excavator	hrs	115	$250	$28,750	$28,750
	Culvert removal	General Labourer	hrs	150	$47	$7,050	
		Haul Truck D250E	hrs	115	$250	$28,750	$35,800
	Minto Creek Culvert Removal & Streambank Restoration	Trades Labourer	hrs	40	$83	$3,320	
		General Labourer	hrs	75	$47	$3,525	
		Cat 235 Excavator	hrs	40	$250	$10,000	$16,845
	Recontour slopes and drainage	D9H Dozer	hrs	70	$350	$24,500	$24,500
	Stabilize slopes	General Labourer	hrs	200	$47	$9,400	
	Erosion barriers	Erosion Barrier	per sq. m	1,000	$3	$3,000	$12,400
	Project Management & Engineering	7% of Total Cost	%		7.00%	$8,281	$8,281
	Subtotal:						**$126,576**
Total Estimated Cost for Access Road Closure (Scenario 3)							**$253,906**

Note:

MINTO MINE CLOSURE COSTING-REVISED BY SJCI

Table 8-11
Miscellaneous Sites and Facilities, Estimated Closure Costs - 2013

Item No.	Work Item Description	Equipment / Labour	Units	Quantity	Unit Rates	Cost	Total
	MISCELLANEOUS SITES AND FACILITIES						
11.1	**Airstrip**						
	Scarify airstrip and adjacent laydown areas	Cat 16H Grader	hrs	40	$250	$10,000	$10,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$700	$700
	Subtotal:						**$10,700**
11.2	**Mine Camp and Related Infrastructure (Expanded)**						
	Disconnect Services	Trades Labourer	hrs	120	$83	$9,960	$9,960
	Remove salvageable equipment	General Labourer	hrs	1056	$47	$49,632	$49,632
	Dismantle buildings	General Labourer	hrs	1800	$47	$84,600	
		Cat 235 Excavator	hrs	180	$250	$45,000	$129,600
	Haul scrap to Solid Waste Facility	Haul Truck D250E	hrs	30	$250	$7,500	
		Cat 235 Excavator	hrs	15	$250	$3,750	$11,250
	Reclaim Septic System	General Labourer	hrs	15	$47	$705	
		Cat 235 Excavator	hrs	3	$250	$750	$1,455
	Site Clean-Up	General Labourer	hrs	750	$47	$35,250	$35,250
	Project Management & Engineering	7% of Total Cost	%		7.00%	$16,600	$16,600
	Subtotal:						**$253,747**
11.3	**Explosives Plant Site**						
	Remove salvageable equipment	General Labourer	hrs	100	$47	$4,700	
		Trades Labourer	hrs	50	$83	$4,150	$8,850
	Dismantle buildings	General Labourer	hrs	200	$47	$9,400	
		Cat 235 Excavator	hrs	30	$250	$7,500	$16,900
	Disconnect Services	Trades Labourer	hrs	20	$83	$1,660	$9,160
	Crane services	30 ton Crane	hrs	5	$190	$950	$2,610
	Haul scrap to Solid Waste Facility	Haul Truck D250E	hrs	30	$250	$7,500	
		Cat 235 Excavator	hrs	10	$250	$2,500	$10,000
	Project Management & Engineering	7% of Total Cost	%		7.00%	$2,685	$2,685
	Subtotal:						**$50,205**
11.4	**Exploration Sites and Trails**						
	Natural revegetation	n/a	n/a				
	Subtotal:						**$0**
11.5	**Land Treatment Facility**						
	Prepare and submit closure plan	Misc	l.s.		$2,000	$2,000	$2,000
	Characterize final soil hydrocarbon concentrations	Misc	l.s.		$4,000	$4,000	$4,000
	Recontour	D9H Dozer	hrs	3	$350	$1,050	$1,050
	Haul and place coverburden cover from nearby	Cat 235 Excavator	hrs	20	$250	$5,000	
		Haul Truck D250E	hrs	20	$250	$5,000	
		D9H Dozer	hrs	6	$350	$2,100	$12,100
	Project Management & Engineering	7% of Total Cost	%		7.00%	$1,341	$1,341
	Subtotal:						**$20,491**
11.6	**Solid Waste Facility**						
	Prepare detailed closure plan	Misc	l.s.		$2,000	$2,000	$2,000
	Characterize final waste area	Misc	l.s.		$2,000	$2,000	$2,000
	Remove recyclables and special waste materials	Tractor Trailer (lowbed)	hrs	40	$160	$6,400	$6,400
	Recontour	D9H Dozer	hrs	2	$350	$700	$700
	Haul and cover with adjacent fill and place overburden cap	Cat 235 Excavator	hrs	20	$250	$5,000	
		Haul Truck D250E	hrs	20	$250	$5,000	
	Compaction of cover	D9H Dozer	hrs	6	$350	$2,100	$12,100
	Project Management & Engineering	7% of Total Cost	%		7.00%	$1,624	$1,624
	Subtotal:						**$24,824**
11.7	**Site Roads**						
	Recontour	Cat 235 Excavator	hrs	**37.5**	$250	$9,375	$9,375
	Scarify	Cat 16H Grader	hrs	**50**	$250	$12,500	$12,500
	Project Management & Engineering	7% of Total Cost	%		7.00%	$1,531	$1,531
	Subtotal:						**$23,406**
Total Estimated Cost in Reclaiming Miscellaneous Sites and Facilities							**$383,373**
Note:							

Table 8-12

Reclamation Research and Revegetation, Estimated Closure Costs - 2013

Item No.	Work Item Description	Units	Quantity	Unit Rates	Cost	Total
12.1	**REVEGETATION ACTIVITIES**					
12.1.0	**Determination of Revegetation Plan for Current Site**					
	Issuance of a plan for all site areas for regulatory review and approval	Misc	1		$20,000	$20,000
	Sub-Total					**$20,000**
12.1.1	**Main and Southwest Dumps (total surface area of 102.1 ha)**					
	Seed and fertilize w/ labour	ha	107.3	$2,500	$268,250	
	Re-seed and fertilize (1/2 of total area)	ha	53.7	$2,500	$134,125	
	Re-forest	ha	107.3	$1,750	$187,775	$590,150
	Sub-Total					**$590,150**
12.1.2	**Ice-Rich Overburden Dump (toe berm surface area of 6.1ha)**					
	Seed and fertilize w/ labour	ha	6.1	$2,500	$15,250	
	Re-seed and fertilize (1/2 of total area)	ha	3.1	$2,500	$7,625	
	Re-forest	ha	6.1	$1,750	$10,675	$33,550
	Sub-Total					**$33,550**
12.1.3	**Reclamation Overburden Dump (total surface area of 31.8 ha)**					
	Seed and fertilize w/ labour	ha	31.8	$2,500	$79,500	
	Re-seed and fertilize (1/2 of total area)	ha	15.9	$2,500	$39,750	
	Re-forest	ha	31.8	$1,750	$55,650	$174,900
	Sub-Total					**$174,900**
12.1.4	**Ore Stockpiles and Pads (final total surface area of 31.6 ha)**					
	Seed and fertilize w/ labour	ha	31.6	$2,500	$79,000	
	Re-seed and fertilize (1/2 of total area)	ha	15.8	$2,500	$39,500	
	Re-forest	ha	31.6	$1,750	$55,300	$173,800
	Sub-Total					**$173,800**
12.1.5	**Mill Valley Fill and DSTF Front Face (disturbed area of 23.9 ha)**					
	Seed and fertilize w/ labour	ha	23.9	$2,500	$59,750	
	Re-seed and fertilize (1/2 of total area)	ha	12.0	$2,500	$29,875	
	Re-forest	ha	23.9	$1,750	$41,825	$131,450
	Sub-Total					**$131,450**
12.1.6	**Contractor's Shop and Office Area (disturbed area of 2.5 ha)**					
	Seed and fertilize w/ labour	ha	2.5	$2,500	$6,250	
	Re-seed and fertilize (1/2 of total area)	ha	1.3	$2,500	$3,125	
	Re-forest	ha	2.5	$1,750	$4,375	$13,750
	Sub-Total					**$13,750**
12.1.7	**Tailings Surface Area (current disturbed area of 20.9 ha)**					
	Seed and fertilize w/ labour	ha	30.2	$2,500	$75,500	
	Re-seed and fertilize (1/2 of total area)	ha	15.1	$2,500	$37,750	
	Re-forest	ha	30.2	$1,750	$52,850	$166,100
	Sub-Total					**$166,100**
12.1.8	**Water Storage Pond Dam (total dam surface area 3.3 ha)**					
	Seed and fertilize w/ labour	ha	3.3	$2,500	$8,250	
	Re-seed and fertilize (1/2 of total area)	ha	1.7	$2,500	$4,125	
	Re-forest	ha	3.3	$1,750	$5,775	$18,150
	Sub-Total					**$18,150**
12.1.9	**Mill Area (total surface area of 7.6 ha)**					
	Seed and Fertilize w/ labour	ha	10.8	$2,500	$27,000	
	Re-seed and fertilize (1/2 of total area)	ha	5.4	$2,500	$13,500	
	Re-forest	ha	10.8	$1,750	$18,900	$59,400
	Subtotal:					**$59,400**
12.1.10	**Haul Road (total surface area of 15 ha)**					
		ha	15.0	$2,500	$37,500	**$37,500**
12.1.11	**Underground Portal Excavation (total surface area of 6.1 ha)**					
	Seed and Fertilize w/ labour	ha	6.1	$2,500	$15,250	
	Re-seed and fertilize (1/2 of total area)	ha	3.1	$2,500	$7,625	
	Re-forest	ha	6.1	$1,750	$10,675	$33,550
	Subtotal:					**$33,550**
12.1.12	**Miscellaneous Sites - Camp, Airstrip, Waste Facilities, Explosives Site (area for reclamation of 14 ha)**					
	Seed and fertilize w/ labour	ha	14.0	$2,500	$35,000	
	Re-seed and fertilize (1/2 of total area)	ha	7.0	$2,500	$17,500	
	Re-forest	ha	14.0	$1,750	$24,500	$77,000
	Subtotal:					**$77,000**
12.1.13	**Access Road**					
	Scenario 1 - No Deactivation					
	No revegetation					
	Subtotal:					**$0**
	Scenario 2 - Deactivate from Minto Creek to Mine Site (11 km)					
	Revegetate and fertilize banks at culvert excavations, including labour	ha	2.0	$2,500	$5,000	$5,000
	Subtotal:					**$5,000**
	Scenario 3 - Deactivate Entire Road (27 km)					
	Hydroseed roadside banks & slopes (~0.25ha per km of road, along 50% of its length)	ha	3.4	$4,000	$13,600	$13,600
	Revegetate and fertilize banks at culvert excavations, including labour	ha	6.0	$2,500	$15,000	$15,000
	Subtotal:					**$28,600**

Total Estimated Cost for Reclamation Research and Revegetation		
	Scenario 1 - No Access Road Deactivation	**$1,529,300**
	Scenario 2 - Deactivate Access Road from Minto Creek to Mine Site	**$1,534,300**
	Scenario 3 - Deactivate Entire Access Road	**$1,557,900**

Note:

Table 8-13

Site Management and Monitoring, Estimated Closure Costs - 2013

Item No.	Work Item Description	Equipment / Labour	Units	Quantity	Unit Rates	Cost	Total
	SITE MANAGEMENT						
13.1	**Onsite Management**						
	Project Management and Engineering - Included in PME Costs in each Closure Component						
	Pickup truck	Light truck	monthly	50	$2,500	$125,000	$125,000
	Sundry equipment maintenance	Unit Cost Basis	yearly	10	$5,000	$50,000	$50,000
	Power and heat	Unit Cost Basis	monthly	30	$5,500	$165,000	$165,000
	General Administrative expenses	Unit Cost Basis	monthly	50	$2,000	$100,000	$100,000
	Camp Costs (5 year period)	Unit Cost Basis	man-day	6,138	$70	$429,660	$429,660
	Subtotal:						**$869,660**
13.2	**Transport Costs**						
	Employee transport costs	Unit Cost Basis	monthly	50	$3,000	$150,000	$150,000
	Barge operating costs	Unit Cost Basis	monthly	20	$10,000	$200,000	$200,000
	Subtotal:						**$350,000**
13.3	**Water Treatment**						
	Labour - Water Treatment Operators (5 years @ 4 mo/yr)	Unit Cost Basis	monthly	20	$31,584	$631,680	$631,680
	Cost per cubic metre of compliant water (5 years @ 360,000 m3/yr)		cu.m	1,800,000	$1.38	$2,484,000	$2,484,000
	Subtotal:						**$3,115,680**
13.4	**Water Quality Monitoring (Post Mine Closure) (50:50 sampling labour/analyses costs split) & Reporting**						
	Years 1-5 (monthly during open season)	Misc.	monthly	30	$4,000	$120,000	
	Years 6-10 (quarterly - spring/summer/fall)	Misc.	quarterly	15	$4,000	$60,000	
	Years 11-15 (once annually - post spring freshet)	Misc.	yearly	5	$4,000	$20,000	$200,000
	Disbursements (non-labour/non-analytical)	Misc.	yearly	15	$4,000	$60,000	$60,000
	LTF Monitoring and Maintenance (years 1-5)	Misc.	yearly	5	$4,000	$20,000	$20,000
	Enhanced Groundwater/Foundation monitoring below DSTF and Waste Rock Dumps	Misc.	yearly	15	$15,000	$225,000	$225,000
	Geo-technical Inspections (annually yrs 1-5, bi-annual yrs 6-15)	Misc.	each	10	$15,000	$150,000	$150,000
	Reclamation Inspections (annually yrs 1-5, bi-annual yrs 6-15)	Misc.	each	10	$7,500	$75,000	$75,000
	Biological Monitoring - Closure implementation	Misc.	l.s.	1	$10,000	$10,000	
	Years 1-5 (Annually)	Misc.	yearly	5	$4,000	$20,000	
	Years 6-10 (Annually)	Misc.	yearly	5	$4,000	$20,000	
	Years 11-15 (Every two years)	Misc.	bi-annual	3	$3,500	$10,500	$60,500
	Subtotal:						**$790,500**
13.5	**Post Closure Maintenance - Water Storage Pond Dam**						
	Monitoring of piezometers, thermistors						
	Years 1-5 (quarterly)	Misc.	quarterly	20	$3,000	$60,000	
	Years 6-10 (bi-annually)	Misc.	bi-annually	8	$3,000	$24,000	
	Years 11-15 (annually)	Misc.	annual	5	$2,500	$12,500	
	Annual Inspection + report	Misc.	annual	15	$3,000	$45,000	
	Carry out inspection recommendations/maintenance	Misc.	annual	15	$10,000	$150,000	$291,500
	Misc. maintenance work related to the site after closure (Yr1-5)	Misc.	yearly	5	$10,000	$50,000	$50,000
	Misc. maintenance work related to the site after closure (Yr6-15)	Misc.	per year	10	$5,000	$50,000	$50,000
	Subtotal:						**$391,500**
13.6	**Ultimate Removal of wells and instrumentation**	Misc.	unit basis		$15,000		**$15,000**
Total Estimated Cost for Post Closure Site Management							**$1,626,160**

Note:
Itemss13.3 and 13.4 are used under scenarios with no long term operations and are therefore not included in the Total cost calculation on this woorksheet. In scenarios where long term operations are to be included, costs for water treatment and monitoring are calculated seperately with a NPV. This calculation is found on a separate worksheet.

Table 8-14

Supporting Studies - 2013

Item No.	Work Item Description	Equipment / Labour	Units	Quantity	Unit Rates	Cost	Total
14.1	**Permafrost Foundation Monitoring**						
14.1.1	Enhanced subsurface monitoring program in and below waste rock dumps (WRD)						
	Preparing detailed monitoring program	Misc.	l.s.	1	$8,000	$8,000	
	Enhanced Adaptive Management Plan for WRD	Misc.	l.s.	1	$8,000	$8,000	$8,000
14.1.2	Enhanced subsurface monitoring program in and below DSTSF						
	Preparing detailed monitoring program	Misc.	l.s.	1	$4,000	$4,000	
	Enhanced Adaptive Management Plan for DSTSF	Misc.	l.s.	1	$4,000	$4,000	$4,000
	Sub-Total						**$12,000**
14.2	**Kinetic Tailings and Waste Rock Materials Testing**						
14.2.1	Monitoring program and field test to enhance long term water quality prediction related to drystack tailings facility and materials in WRDs						
	preparing composite sample over several months of production	Misc.	l.s.	1	$5,000	$5,000	
	undertaking field test	Misc.	l.s.	1	$12,000	$12,000	
	initiate parallel laboratory analysis	Misc.	l.s.	1	$10,000	$10,000	
	monitoring field apparatus (columns)	Misc.	l.s.	1	$4,000	$4,000	
	reporting	Misc.	l.s.	1	$5,000	$5,000	$36,000
	Sub-Total						**$36,000**
14.3	**Other Adaptive Management Plans Required**						
	Changes in WTP input water quality or quantity	Misc.	l.s.	1	$22,500	$22,500	$22,500
	Sludge Management Plan - for material from WTP	Misc.	l.s.	1	$15,000	$15,000	$15,000
	Site testing ML ARD	Misc.	l.s.	1	$45,000	$45,000	$45,000
	Groundwater Management Plan	Misc.	l.s.	1	$15,000	$15,000	$15,000
	Long term reclamation of contaminated soils	Misc.	l.s.	1	$22,500	$22,500	$22,500
	Physical Monitoring program - prior to closure	Misc.	l.s.	1	$60,000	$60,000	$60,000
	Modeling of pit lake water qualities prior to flooding	Misc.	l.s.	1	$22,500	$22,500	$22,500
	Sub-Total						**$202,500**
14.4	**Closure Specific Studies and Field Trials**						
	Main Site Discharge Channel Geotechnical Design and Stability Evaluation	Engineering/Design	l.s.	1	$30,000	$30,000	$30,000
	Passive Treatment Evaluations	Engineering/Design	l.s.	1	$100,000	$100,000	$100,000
	Engineered Cover Evaluations	Engineering/Design	l.s.	1	$75,000	$75,000	$75,000
	Site contamination surveys (pre $35K, post $20K)		l.s.	1	$55,000	$55,000	$55,000
	Sub-Total						**$260,000**
Total Estimated Cost for Supporting Studies							**$510,500**
Note:							

9 LIMITATIONS OF REPORT

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10 REFERENCES

Access Consulting Group, 2013. Minto Ecosystem and Vegetation Baseline Report. Prepared for Minto Explorations Ltd, Vancouver, BC.

Access Consulting Group (ACG), 2013a. Minto Climate Baseline Report.

Bastian, R.K. and D.A. Hammer. 1993. The use of constructed wetlands for wastewater treatment and recycling. In: G.A. Moshiri (Ed.), Constructed Wetlands for Water Quality Improvement, Lewis Publishers, Boca Raton, FL, pp. 59-68.

Bastian, R.K., P.E. Shanaghan, and B.P. Thompson. 1989. Use of wetlands for municipal wastewater treatment disposal – regulatory issues and EPA policies. In: D.A. Hammer (Ed.), Constructed Wetlands for Wastewater Treatment. Lewis Publishers, Chelsea, MI, pp. 265-278.

Boyd, J., O. McDonald, D. Hatcher, R.J. Portier, and R.B. Conway. 1993. Interfacing constructed wetlands with traditional wastewater biotreatment systems. In: G.A. Moshiri (Ed.), Constructed Wetlands for Water Quality Improvement, Lewis Publishers, Boca Raton, FL, pp. 453-459.

Brodie, G.A. 1993. Staged, aerobic constructed wetlands to treat acid drainage: Case history of Fabius Impoundment 1 and overview of the Tennessee Valley Authority's program. In: G.A. Moshiri (Ed.), Constructed Wetlands for Water Quality Improvement, Lewis Publishers, Boca Raton, FL, pp. 157-165.

Clearwater Consultants Ltd, 2010. Minto Mine – Site Water Balance Update 2010. Prepared for Minto Explorations Ltd, Vancouver, BC.

Davies, T.H. and P.D. Cottingham. 1994. The use of constructed wetlands for treating industrial effluent (textile dyes). Water Sci. Technol. 29(4):227-232.

Dunbabin, J.R. and K.H. Browmer. 1992. Potential use of constructed wetlands for treatment of industrial wastewaters containing metals. Sci. Total Environ. 111:151-168.

Eger, F. G. Melchert, D. Antonson, and J. Wagner. 1993. The use of wetland treatment to remove trace metals from mine drainage In: G.A. Moshiri (Ed.), Constructed Wetlands for Water Quality Improvement, Lewis Publishers, Boca Raton, FL, pp. 171-178.

Eger, P., & J. Wagner. 2003. *Wetland Treatment Systems: How long will they really work?* Minnesota Department of Natural Resources.

EBA Engineering Consultants Ltd, 2011. Upstream Water Management for the Mill Valley Fill Expansion and Dry Stack Tailings Storage Facility – Minto Mine, YT. Prepared for Minto Explorations Ltd, Vancouver, BC.

EBA Engineering Consultants Ltd, 2010a. Phase IV Waste Management Plan – Minto Mine, YT. Prepared for Minto Explorations Ltd, Vancouver, BC.

EBA Engineering Consultants Ltd, 2010b. Phase IV Tailings Management Plan – Minto Mine, YT. Prepared for Minto Explorations Ltd, Vancouver, BC.

EBA Engineering Consultants Ltd, 2010c. Minto Mine 2010 Climate Baseline Report. Report prepared for Minto Exploration Inc. 14pp.

EBA Engineering Consultants Ltd, 2008a. Geotechnical Design, Proposed Southwest Waste Dump, Minto Mine, Yukon. Prepared for Minto Explorations Ltd, Vancouver, BC.

EBA Engineering Consultants Ltd, 2008b. Geotechnical Design, Proposed Reclamation Overburden Dump, Minto Mine, Yukon. Prepared for Minto Explorations Ltd, Vancouver, BC.

EBA Engineering Consultants Ltd, 2007. Geotechnical Design Report, Dry Stack Tailings Storage Facility, Minto Mine, Yukon. Prepared for Minto Explorations Ltd, Vancouver, BC.

EBA Engineering Consultants Ltd, 2006. Geotechnical Design, Ice-Rich Overburden Dump, Minto Mine, Yukon. Prepared for Sherwood Mining Corporation, Vancouver, BC.

EBA Engineering Consultants Ltd, 1998. Geotechnical Evaluation, Proposed Main Waste Dump, Minto Project, Yukon Territory. Prepared for Sherwood Mining Corporation, Vancouver, BC.

EBA Engineering Consultants Ltd, 1997. Final Preliminary Design – Mill Water Pond, Minto Property, Yukon Territory. Prepared for Sherwood Mining Corporation, Vancouver, BC.

EBA Engineering Consultants Ltd, 1996. Waste Rock Stability Evaluation, Minto Project, Yukon Territory. Prepared for Sherwood Mining Corporation, Vancouver, BC.

[EBA/ACG] EBA Engineering Consultants Ltd. and Access Consulting Group, 2011. Minto Mine Decommissioning and Reclamation Plan Rev.3.2. Prepared for Minto Explorations Ltd.

Ferlow, D.L. 1993. Stormwater runoff retention and renovation: A black lot function or integral part of the landscape? In: G.A. Moshiri (Ed.), Constructed Wetlands for Water Quality Improvement, Lewis Publishers, Boca Raton, FL. pp 373-379.

Gammons, C., & Frandsen, A. 2001. Fate and Transport of metals in H2S-rich waters at a treatment wetland. *Geochemical Transactions. 2*(1):1-15.

Gillespie, W.B. Jr., W.B. Hawkins, J.H. Rodgers, Jr., M.L. Cano, and P.B. Dorn. 2000. Transfer and transformations of zinc in constructed wetlands: Mitigation of a refinery effluent. Ecol. Eng. 14:279-292.

Gillespie, W.B. Jr., W.B. Hawkins, J.H. Rodgers, Jr., M.L. Cano, and P.B. Dorn. 1999. Transfer and transformations of zinc in flow-through wetland microcosms. Ecotoxicol. Environ. Saf. 43:126-132.

Gusek, J. 2000. Reality Check: Passive Treatment of Mine Drainage an Emerging Technolgy or Proven Methodology? *SME Annual Meeting 28 February–1 March.* Preprint 00-43.

Hammer, D.A. 1989. Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Inc., Chelsea, MI.

Harrington, J., Gobla, M., Francendese, L., and Bates, E. 2009. Low Cost Treatment of a Highly Contaminated Pit Lake Using Innovative Technology, Barite Hill Mine McCormick, SC.

Hawkins, W.B., J.H. Rodgers, Jr., A.W. Dunn, P.B. Dorn, and M.L. Cano. 1997. Design and construction of wetlands for aqueous transfers and transformations of selected metals. Ecotoxicology and Environment Safety. 36:238-248.

Hedin, R.S., R.W. Nairn, and R.L.P. Kleinmann. 1994. Passive treatment of coal mine drainage. Information Circular 9389, U.S. Bureau of Mines, Pittsburgh, PA. p. 35

Higgins, M.J., C.A. Rock, R. Bouchard, and B. Wengrezynek. 1993. Controlling agricultural runoff by use of constructed wetlands. In: G.A. Moshiri (Ed.), Constructed Wetlands for Water Quality Improvement, Lewis Publishers, Boca Raton, FL, pp 359-367.

Huddleston, G.M., W.B. Gillespie, and J.H. Rodgers, Jr. 2000. Using constructed wetlands to treat biochemical oxygen demand and ammonia associated with a refinery effluent. Ecotoxicology and Environmental Safety. 45:188-193.

[INAP] International Network for Acid Prevention. 2010. Passive treatment technologies. In Global Acid Rock Drainage Guide (GARD Guide) (p. Section 7.5.2). http://www.gardguide.com/.

[INAC] Indian and Northern Affairs Canada. 1992. Mine Reclamation in Northwest Territories and Yukon. Northern Water Resources Studies, Indian and Northern Affairs Canada.

[ITRC] Interstate Technology and Regulatory Council. 2003. Technical and Regulatory Guidance Document for Constructed Treatment Wetlands.

[ITRC] Interstate Technology and Regulatory Council. 2010. Technology Overviews. Retrieved October 24, 2012, from Mining Waste Treatment Technology Selection: http://www.itrcweb.org/miningwaste-guidance/technology_overviews.htm

[ITRC] Interstate Technology and Regulatory Council. 2011. Technical/Regulatory Guidance: Permeable Reactive Barrier: Techniology Update.

[ITRC] Interstate Technology and Regulatory Council. 2012. Mining Waste Treatment Technology Selection: An ITRC Web-based Technical and Regulatory Guidance Document. US EPA Clean Up Information Network.

Kent, D.M. 1994. Applied Wetlands Science and Technology. CRC Press, Inc., Boca Raton, FL.

Kilbourn Inc. 1999. MEND Report 3.14.1: Review of Passive Systems for the Treatment of Acid Mine Drainage. Prepared for Mine Environmental Neutral Drainage (MEND) program.

Litchfield, D.K. and D.D. Schatz. 1989. Constructed wetlands for wastewater treatment at Amoco Oil Company's Mandan, North Dakota Refinery. In: D.A. Hammer (Ed.), Constructed wetlands for wastewater treatment. Lewis Publishers, Chelsea, MI, pp. 233-238.

Mander, U. and P.D. Jenssen, eds. 2002. Constructed wetlands for wastewater treatment in cold climates. WIT Press/ Computational Mechanics, Advances in Ecological Sciences. 11: 344

Mills, C. 1997. An Assessment of the Acid Base Accounting (ABA) and Mineralogical Test Work on Eight Samples from the Proposed Minto Project, Yukon Territory. Vancouver, BC.Minto Explorations Ltd. 2009. Minto Mine - Detailed Decommissioning and Closure Plan Revision 2.

Minto Explorations Ltd., 2006. Minto Mine – Open Pit Design Plan.

Mitsch, W.J. and J.G. Gosslink. 1993. Wetlands, 2nd edition. Van Nostrand Reinhold, New York, NY.

Moore, J.A., S.M. Skarda, and R. Sherwood. 1994. Wetland treatment of pulp mill wastewater. Water Science and Technology. 29(4):241-247.

Moore, M.T., J.H. Rodgers, Jr., C.M. Cooper, and S. Smith. 2000. Constructed wetlands for mitigation of atrazine-associated agricultural runoff. Environmental Pollution 110:393:399.

Moshiri, G.A. (Ed.). 1993. Constructed Wetlands for Water Quality Improvement. Lewis Publishers, Boca Raton, FL.

Pulles, W., & et al. 2004. Development of a high-rate passive sulphate reduction technology for mine waters. Proceedings of IMWA Conference, September 19-23, Newcastle, UK. pp. 253-265.

Rodgers, J.H. Jr., and A. Dunn. 1992. Developing design guidelines for constructed wetlands to remove pesticides from agricultural runoff. Ecol. Eng. 1:88-95.

Sherwood, R. 1992. Wetland treatment. TAPPI Environ. Conf. Proc., Richmond, Va., Book 2, pp. 705-720.

Sinicrope, T.L., R. Langis, R.M. Gersberg, M.J. Busnardo, and J.B. Zedler. 1992. Metal removal by wetland mesocosms subjected to different hydroperiods. Ecol. Eng. 1:309-322.

SRK Consulting Inc. 2009a. Pre-feasibility Geotechnical Evaluation, Phase IV, Minto Mine. Prepared for Minto Explorations Ltd, Vancouver, BC.

SRK Consulting Inc. 2009b. Tailings Risk Assessment - Minto Project, Yukon Territory. Prepared for Minto Explorations Ltd, Vancouver, BC.

SRK Consulting Inc. 2010. Minto Mine Expansion – Phase IV, ML/ARD Assessment and Post-closure Water Quality Prediction. Prepared for Minto Explorations Ltd, Vancouver, BC.

SRK Consulting Inc. 2012a. Memo: Component of Information Request Response #1 to Yukon Water Board, January 2012.

SRK Consulting Inc. 2012b. Memo: Precipitation Analysis for the Minto Mine.

SRK Consulting Inc. 2013a. Scoping Level Cover Assessment for Minto Closure Covers. Prepared for Minto Explorations Lrd, Vancouver, BC.

SRK Consulting Inc. 2013b. Memo: South Diversion Ditch Realignment and Overflow Spillway.

Thut, R.N., 1993. Feasibility of treating pulp mill effluent with a constructed wetland. In: G.A. Moshiri (Ed.), Constructed Wetlands for Water Quality Improvement, Lewis Publishers, Boca Raton, FL, pp. 441-447.

YG, 2006. Yukon Mine Site Reclamation and Closure Policy.