Minto Mine
Reclamation and Closure Plan
2020-01

Prepared by:
Minto Explorations Ltd.
Minto Mine
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Context of this Document

This seventh version of the Minto Mine Reclamation and Closure Plan (RCP) is presented for review and will be revised to incorporate reviewer comments as appropriate. This version is a new RCP including future mining already licenced but also identifies measures for decommissioning and reclaiming site developments from past mining. Closure planning is a process continuum, and RCP documents accordingly advance in detail as the Project proceeds through its mine life.

This RCP is considered to be Version 2020-01. Significant advances in the RCP over version 2018-01 include:

- Project schedule adjustments for current operational mine-plan and best estimate at timing for reclamation and closure activities and phases;
- Reclamation Research Program updates based on work completed in the last two years;
- A substantially updated Closure AMP, with revisions and improvements based on regulatory review and engagement with SFN through the Bilateral Technical Working Group;
- Refinement of the definitions and application of attainment of closure water quality objectives; and
- Updating of the Closure Security Costing

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RCP Versions

RCP Version	Issue Date	Description of Version
5.0	June 2014	RCP developed to include all Phase V/VI facilities and submitted with Phase V/VI licence application. Closure cost estimates were not included.
5.1	August 2014	Same plan as 5.0 with closure costing estimates.
2016-01	August 2016	Updated RCP incorporating changes identified as per the WUL and QML. Advancement of closure designs from conceptual to preliminary. Updated water and load balance model. Plan focus on a narrow scope (current mine plan) compared to 5.0 and 5.1. Revised costing estimates.
2017-01	February 2017	Updated to incorporate final Post Closure Water Quality Objectives.
2018-01	February 2018	Updated based revisions to the mine plan, and on YWB IR(2) and IR(3).
2020-01	2020	Updated based revisions to the mine plan, and on YWB IR(2), IR(3) and IR(6) and engagement with SFN.

2020 Revisions

RCP Section	Description of Revision
1.4	Updates to project schedule based on revisions to mine plan and adjustments for work completed
Throughout	Minor terminology and editorial updates
2.2	Updates to the Reclamation Research Program to reflect work to date and findings. In pit treatment research based on IR#2-7.
2.3	Updates to stakeholder engagement initiatives
3.1.3.1.4	Section added for refinement of post-closure water quality objective attainment, based on engagement with SFN through the BTWG. This information was based on Closure AMP changes.
3.2.1.5	Section added to include design criteria for CTWS construction
3.2.4	Seed mix species for revegetation added, based on IR#5-88.
5.1	Minor update for mining areas and activities completed/planned
5.2	Updated for current volumes and configurations, and reclamation work completed to date
5.3	Updated for current volumes and configurations, and operational activities
5.4.3.1	Statement included on viability of water quality modeling work
5.5.2	Operational geochemical monitoring program updated to reflect current focus on underground operations
5.5.4	Table 5-17 updated mine structures and instrumentation
7.1	Underground working and mining methods updated
7.2.1	Updated to reflect reclamation work to date
7.3.2	Updated to reflect mining and tailings deposition to date

RCP Section	Description of Revision
7.4.4	Updated to reflect reclamation work to date
7.6.1	Closure water management summary points updated to reflect refinement of phase transition triggers and wetland commissioning criteria, based on changes to the Closure AMP.
7.6.5.1	Updated with refined wetland commissioning criteria, based on changes to the Closure AMP.
7.11.1	Table 7.1 updated with revised monitoring frequency for mine site stations in PCI, based on discussions with SFN via BTWG
7.12.1.1	Minor updates to reflect revised Closure AMP
8.1	Figure 8-1 updated for new closure and reclamation schedule
9	Updated for revised security calculations and context, and Figure 9-1 updated
Appendices	Added Appendices A7 and A8

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.

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 (December 2014), and Water Use Licence QZ14-031-1, and to adhere to guidance documentation on closure plan development from both the Yukon Government and the Yukon Water Board.

Research carried out on proposed closure measures intend to cover gaps in knowledge which provides feedback to site specific development of robust closure measures. 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 and will continue to provide valuable reclamation success feedback for use in advanced/final closure, enhancing ultimate reclamation success.

The temporary closure period of the Minto mine will commence with the cessation of economic mining of known ore deposits and the milling of ore stockpiles with the expectation of recommencing of mining and milling activities with improved economics. During this period the mine site would be actively cared for with full time site personnel, although significantly reduced compared to operational periods. Temporary closure is expected to last no longer than 5 years.

Final closure of the Minto mine will commence with the depletion of known ore deposits or an unfavorable long term outlook which causes cessation of economic mining of known ore deposits and the milling of ores stockpiles. Once permanent closure commences, the mill and other facilities will be decommissioned, closure water conveyance constructed and waste facilities and disturbed areas will be contoured, covered and revegetated. During the active closure period, 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 reclamation and closure cost estimate has been prepared based on the final extent of disturbance for each of the infrastructure units described in this report. Decommissioning and reclamation cost estimates have been completed for Year 0, Peak liability and end of mine life (EOM). The estimated closure costs associated with implementing the current RCP for Year 0, Peak and EOM are: $66.7M, $72.7 and $57.1M, respectively.

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1 Introduction

Minto Explorations Ltd. (Minto) owns and operates the Minto Project located 240 km northwest of Whitehorse, Yukon. For the purposes of this reclamation and closure plan, the "Minto Project" means mining by both open-pit and underground mining methods and related ancillary facilities.

This reclamation and closure plan (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.

1.1 Closure Philosphy and Guiding Principles

In keeping with its high standards for environmental and social responsibility, Minto intends to implement an environmentally sound and technically feasible reclamation and closure 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, agreements with Selkirk First Nation (SFN), 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 health and 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 will be the subject of review and concurrence with regulatory agencies, SFN and the public.

Minto has entered into a Cooperation Agreement (the Cooperation 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 parties continue to work towards refinement of reclamation issues in the ongoing closure planning discussions.

To ensure that the overall closure philosophy and goal can be achieved, Minto has taken an objectives-based approach to the reclamation and closure planning for the site. Section 3 provides information on this approach and the fundamental and site-specific closure objectives.

1.2 Scope of Plan

The RCP has been specifically scoped to fulfill the requirements of the EMR and YWB guidance document Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and Closure Costing Guidance released August 2013. In addition, Minto has taken into consideration requirements concerning closure plan submissions in both of the project's primary regulatory instruments – Quartz Mining Licence QML-0001, and Water Use Licence QZ14-031.

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

QML-0001: Section 7.0 Required Plans

7.2 The Licensee must:

a) submit to the Director and updated reclamation and closure plan within one (1) year of the effective date of this License[1]; and
b) Submit to the Director an updated reclamation and closure plan every two years commencing on the anniversary date of this License.

Section 8.0 Implementation of Plans

8.2 The Licensee must undertake reclamation at the site in accordance with the approved closure plan.

WUL QZ14-031: Section 6 Reclamation and Closure Plan

Clause 110 – The Licensee shall submit an updated, detailed RCP to the Board by August 5, 2016 as an application for amendment to this Licence, and every two years thereafter in the operations phase for Review and Approval. The updated RCP shall include, but not necessarily be limited to, the following:

a) a preliminary Closure Failure Modes Effects Assessment and the Main Pit Dam Failure Modes Effects Assessment;
b) plans detailing cover and re-vegetation strategies for the Dry Stack Tailings Storage Facility (DSTSF);
c) an updated Closure Water Balance and Water Quality Model for the mine site and for Minto and McGinty Creeks, along with the corresponding complete datasets and complete lists of assumption used for the modelling;
d) a detailed Post-Closure Monitoring Program to verify that performance objectives for the all facilities are being achieved;
e) an updated Closure AMP including, but not necessarily be limited to, the following:

[1] On receipt of the WUL amendment QZ14-031-01, submission of an updated RCP was required on August 5th, 2016. An extension of the RCP deadline under the QML was granted to harmonize the dates.

i. numerical values of thresholds for each parameter for each specific threshold for each AMP component;
ii. consideration of statistical trend analysis to provide future forecasting of potential exceedances;
iii. threshold for action and responses related to potential poor performance of the Main Pit Dam, and
iv. management measures to respond to changing conditions in McGinty Creek, water quality at internal monitoring locations, pit water levels in open pits.

f) updated detailed closure cost estimates for all existing and proposed work including, but not be limited to, the following:

i. all changes required as per this Licence;
ii. a MS Excel security costing workbook, with all supporting spreadsheets including and describing all formulas and assumptions;
iii. the plan and cost to move all PAG Waste Rock material to a location which is permanently saturated;
iv. costing for monitoring of the DSTSF and MVFE1 and MVFE2 until such time as their movement has proven to be decelerated;
v. separate costing for the works completed between the issuance of this Licence and August 5, 2016, and
vi. separate costing for works planned between August 5, 2016 and August 5, 2018.

Clause 111 – The updated RCP shall include preliminary designs for the closure of all major mine facilities, including but not limited to dams, spillways, diversion ditches, pits, dumps, mill, and camp facilities based on:

a) Maximum Credible Earthquake;
b) calculations of the inflow design flood proposed for closure and the rationale for the severity or return period of that flood event;
c) risk and consequence of inflows greater than the proposed inflow design flood (including comparison to Probable Maximum Flood (PMF) size event), and
d) designs for the closure water management structures and conveyance channels to withstand the inflow design flood event.

Subsection 6.1 – Application of Water Quality Objectives

Clause 113 – The updated RCP, required by clause 110 shall include Post-Closure (Phases I-II) WQOs that meet the criteria for Non-Degradation of Background Concentrations in Minto and McGinty creeks.

If Non-Degradation of water quality is not achievable, then WQOs shall be set at no more than 50% of the assimilative capacity of Minto Creek, as calculated using the following formula:

Closure and Post Closure WQO = Background Concentrations + (0.5*(WQO Operations – Background Concentrations)

Subsection 6.2 – Reclamation Research Plan

Clause 114 – The Licensee shall submit to the Board for Review and Approval an updated Reclamation Research Plan with the RCP updates described in Clause 110. This plan shall be implemented once approved, and shall specify the following:

a) annual reporting on research activities;
b) phase V and VI research activities;
c) a schedule for implementing the plan, and
d) information on the reclamation research program for both passive and semi-passive water treatment systems and cover systems, including
    i. performance evaluation;
    ii. implementation schedule, and
    iii. specific timelines for completing tasks as soon as practical

Subsection 6.5 Permanent Closure

Clause 121 – The Licensee shall immediately implement the most recently approved RCP upon Permanent Closure.

Clause 122 – The Licensee shall maintain a functioning water treatment plant on site as a contingency until such time as it can demonstrate through the Board's Review and Approval process that the closure WQOs (as defined in clause 113 for the receiving environment) are being and will continue to be met.

Clause 123 – The Licensee shall submit to the Board for Review and Approval, a report demonstrating that the water quality onsite has stabilized prior to the decommissioning of the Water Storage Pond.

YG's Decision Document issued on June 4, 2014 has specific guidance for RCP development for the Minto Site. Specifically, these are:

> ***Clause #25.*** *The Proponent shall provide an updated Reclamation and Closure Plan to Regulators as a part of License applications. This Plan shall include a reclamation research program, performance evaluation, and implementation schedule, for both passive and semi-passive water treatment systems and cover systems that may be implemented during the closure period. When preparing the Plan, the Proponent shall seek and consider input from the advisory committee (referred to in mitigation #13 of Decision Document 2010-0198) prior to submission of documents to regulatory bodies. Regulatory approvals for the Phase V/I project shall include specific time lines for completion of the tasks described in this condition. Those time lines should focus on completing the tasks as soon as practical; and*

Clause #33. *Non-degradation (compared to historical background quality) of Minto Creek water quality shall provide the basis for the development of water quality objectives for the closure period. However, if non-degradation cannot be achieved using reasonable and practical passive treatment mitigations, then the closure objective shall be guided by what can be practically achieved (as long as the objectives are below the effects levels for aquatic resources with sufficient contingency). Determination of "reasonable" and "practical" mitigations must take into account the expected or actual site performance of a given mitigation, and the cost of the mitigation (both initial cost and long-term maintenance cost) compared to the expected contaminant reductions.*

The YWB adequacy review information requests (IR 2 and 3) issued on May 26, 2017 and September 20, 2017 are addressed were practical. EMR's costing review has also been considered in this update.

1.3 Regulatory Requirements

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 QZ14-031 ("WUL QZ14-031"), issued in August 2015 and including subsequent amendments, and valid until June 12, 2040;
- Type B Water Use Licence MS15-094 ("WUL-B") issued in July 2016 and valid until June 30, 2041;
- Quartz Mining Licence QML-0001 ("QML-0001") issued in October 1999 and subsequent amendments and renewals and valid until December 31, 2030;
- 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:

- Site Characterization Plan;
- Mine Development and Operations Plan;
- Underground Mine Development and 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 Dam;
- Mill Water Pond Design;
- Waste Management Plans;
- Waste Rock and Overburden Management Plans;
- Tailings Management Plan;
- Spill Contingency Plan;
- Heritage Resource Protection Plan;
- Sediment and Erosion Protection Plan;
- Explosives Management Plan;
- Wildlife Protection Plan;
- Emergency Response Plan; and
- Reclamation and Closure Plan.

1.4 Project Schedule

The Minto Mine is currently an open pit and underground mining operation with conventional crushing, grinding, and flotation to produce copper concentrates with significant gold and silver credits. Concentrates are exported internationally via the Port of Skagway, Alaska for smelting and sale. Closure and reclamation of all mine components follows completion of mining and milling.

Table 1-1 below outlines the Project development schedule from current status through to the completion of post closure two (PCII).

Table 1-1: Project Schedule

Year	Summary of Mining Activities
2020	Underground mining from, the Minto East deposit is completed while mining commences in Copper Keep deposit. Milling continues throughout the year.
2021	Underground mining from Copper Keel continues throughout the year. Minto East underground mining is completed. Minto North underground development and Minto East 2 underground deposit begins later in the year. Milling continues throughout the year.
2022 to 2024	Underground mining from Copper Keel, Minto East 2 and Minto North deposits is continues. Milling continues throughout the year.
	Summary of Closure Activities (Projections only)
Year 0	Milling continues until mid year. Active closure begins.
Year 1 to 3	Active closure period continues (total duration expected three years) with Post-Closure I beginning mid-Year 3.

Year	Summary of Mining Activities
Year 3 to 8	Post-Closure I period continues (total duration expected five years but will be performance based).
Year 8 to 18	Post-Closure II period continues (total duration of Post-Closure II is ten years).

As shown in Table 1-1 above, closure at the Minto Mine has been categorized into three primary closure periods which are Active Closure (AC; Years 1 to 3), Post Closure I (PCI; Years 3 to 8) and Post Closure II (PCII; Years 8 to 18). It should be noted that dates are only estimates as the criteria for moving from phase to phase is based on specific thresholds, not dates.

The AC period includes the implementation and construction of the large majority of the selected closure measures. Closure measures completed during this period include, but are not limited to recontouring, soil placement, closure water conveyance construction, revegetation, construction of passive water treatment facilities and partial decommissioning of the Water Storage Dam, demobilization and demolition. Further details regarding the planned closure measures can be found in Section 7. During the AC period, operational water quality objectives/effluent standards will still apply and active treatment is expected to be the primary means of water treatment. The AC period is expected to span three years but may be completed sooner as is dependent on closure measures being completed.

The PCI period is intended to provide time for the closure measures to establish and assessments to be completed on the performance of the chosen closure measure(s). During this period, maintenance of soil covers will be ongoing as vegetation begins to establish (beyond the progressive reclamation efforts). Water conveyance features will be commissioned along with the passive treatment system. The passive treatment system is expected to take two years to reach design performance. A pump back system will be established from the passive treatment system to the water treatment plant as there is potential that water quality will not meet effluent standards without active treatment in the initial stages. During PCI, operational water quality objectives/effluent standards will still apply. Passive treatment will be commissioned over the first two years of PCI and will become the primary water treatment system utilizing active treatment as required to meet operational water quality objectives and manage site water inventory. During PCI, the site will be occupied by a small contingent of staff for a five month period during open water season. For purposes of costing for this plan, the PCI period spans five years but facilities may advance into PCII as closure criteria/expected performance of the closure measures are met. This may result in a reduced or extended PCI duration. Water quality has been identified as a key indicator of reclamation performance and therefore water quality must meet the Post Closure Water Quality Objective attainment criteria (see Section 3.1.3.1) for a period of three consecutive years prior to advancing from PCI to PCII.

The PCII period is intended as a confirmatory period which will monitor that the closure measures continue to perform as expected. PCII is primarily a monitoring phase with maintenance activities as required. During PCII the closure water quality objectives will apply and passive treatment will be the primary water treatment onsite. During PCII, the site will be monitored a minimum three times per year and will be occupied once every five years for two weeks per visit by a small number of staff. The two week visit is intended to complete any maintenance as required based on findings of site inspections. The PCII period spans ten years after which Minto has costed for a visit once every ten years over ninety years.

2 Reclamation and Closure Planning

This RCP is an advancement of the measures and methods previously approved or presented in preceding closure plan iterations for the Minto Mine. Section 3.1 outlines the objectives-based approach used to refine this version of Minto's RCP.

Minto has worked with stakeholders (SFN, YG) over the years to refine the proposed closure methods for the Minto site, and this dialogue is ongoing in the context of further refinement of closure objectives (end land use) and reclamation research programs.

Section 2.1 below presents a brief outline of the current status of reclamation and research planning for the Minto site, and Section 2.2 outlines the ongoing and planned reclamation research for Minto's closure planning.

2.1 Status of Reclamation and Closure Planning

Closure planning for mining projects is best understood as a continuum that evolves from a basic conceptual level during pre-production stages towards detailed designs as facilities are completed and as-built details are available for consideration in closure designs. Figure 2-1 illustrates a simplified conceptual model of this type of continuum, in which the level of detail in closure plans and the related implementation strategy for particular closure measures increases as a mine moves through the mine life cycle.

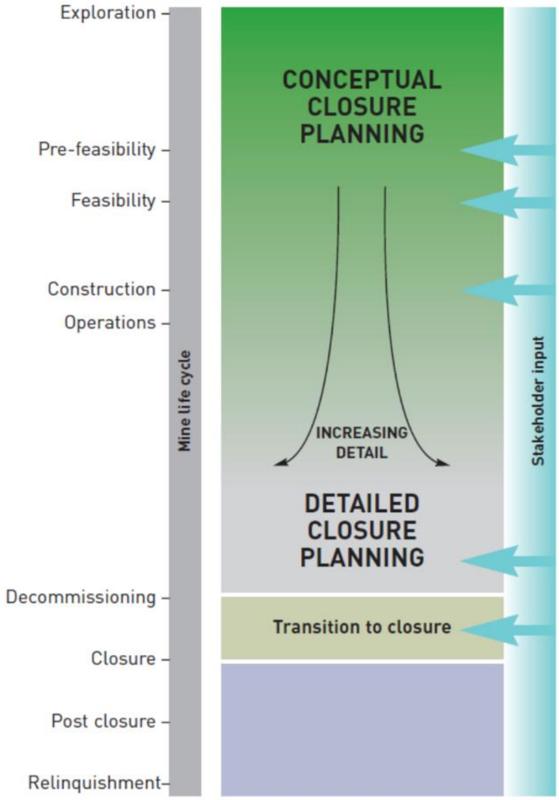


Figure 2-1: Continuum of Closure Planning Relative to Mine Life Cycle

Figure 2-1 presents a useful conceptual model, but it represents a scenario where implementation of closure measures occurs only after operations are complete, and as such this conceptual does not fully reflect the present situation at Minto Mine. At Minto, the various facilities are themselves at different stages within the continuum- for some substantial progressive reclamation is underway (e.g. Mill Valley Fill Expansion) while other facilities are still being planned (Minto North underground). As such, the level of closure planning detail varies with the different facilities across the site, and a general statement about where site-wide closure planning is within the conceptual model of the continuum would be an oversimplification.

From a practical perspective, this RCP incorporates as-built survey detail into the designs for the proposed closure measures for facilities that are already built. Alone, the use of as-built details in designs puts closure planning at a more advanced stage in the continuum illustrated in Figure 2-1. However, because final detailed closure planning has not yet been completed, Minto has included cost allowance for additional closure planning in the liability estimates that are presented in Section 9. Some examples of additional concepts or design details to be considered in future stages of closure include, but are not limited to, the following:

- Secondary and tertiary closure water conveyance on waste dump facilities including site drainage
    - this has been addressed in preliminary detail, but development of a detailed layout for alignments for secondary and tertiary channels is required for each waste storage facility and for the general disturbed areas.
- Additional information is being collected through the Reclamation Research Program (see Section 2.2), and will inform closure measures and implementation strategies for final closure of the additional level of detail is reasonably expected later in the mine life once final closure is approaching. This will specifically include passive treatment measures. Areas of additional information collection includes:,
    - Pit Lake Treatment
        - Refine treatment approach for site-specific pit water quality.
    - Lysimeters;
        - Further refine expected performance of closure covers.
    - Vegetation
        - Further refine the development of a sustainable re-vegetation strategy.
- Further design and execution planning needs to be given to tailings in the Main Pit that are currently above the final closure water elevation. Consideration will be given to undertaking subaerial placement during late winter conditions to reduce execution risks related to trafficability.
- Further consideration to be given to optimizing the cover design (primarily thickness) that should be used on non-waste rock dump facilities such laydowns, yards, stockpile pads, mill and camp pad areas. The merits of placing residuum instead of fine-grained soils in areas where disturbance has been limited to stripping of residuum (such as the camp and fuel farm areas) will be considered.

Reclamation and closure planning has been a primary consideration in mine planning and operational decision making. Planning new dumps has been guided by long term closure design criteria (i.e. final slopes, water conveyance requirements), and the completion of dump facilities provides an opportunity for the economical direct placement of overburden as waste dump closure covers during pit stripping activities. Construction of the Main Waste Dump Expansion was completed with closure considerations regarding landform design and facility drainage. The design for the Mill Valley Fill Expansion Stage 2 has incorporated a design-for-closure access road realignment.

Rock materials specifications and quantities for closure water conveyance structures (riprap, bedding materials, and crush rock) have been identified (Section 7) and will be produced and stockpiled during active mining activities to the extent practical. This will reduce requirements to produce or source the materials at closure.

End land use objectives will be a topic of discussion moving forward with SFN and YG. Areas that require further consideration and guidance are what SFN's preferences are regarding the closure measures for the access road, air strip, site access and signage. YG has indicated further consideration will need to be given to the contaminated sites closure objectives and land use. YG has indicated that they will be providing guidance contaminated sites and that future discussions with SFN and Minto will be required.

2.2 Reclamation Research

Reclamation research will be an ongoing component of Minto's closure planning process. Minto is committed to continuing our collaboration with SFN regarding reclamation research initiatives especially as they relate to end land use (revegetation) and long term passive water treatment technology development. This will primarily be completed through the ongoing dialog in the Bilateral Technical Working Group and engagement associated with research done by Yukon University's Northern Mine Remediation program.

Reclamation research will focus primarily on the key closure measures proposed for the site:

- Soil covers;
- Revegetation; and
- Passive water treatment.

This section provides an overview of in-progress or planned reclamation research initiatives at the Minto Mine.

2.2.1 Soil Covers

Water Licence QZ14-031 Clause 90-b calls for at least one lysimeter to be installed in each waste rock pile. To respond to this license requirement, lysimeters were installed in October 2017. One lysimeter each was installed in the MWD, the SWD, and the MVFE. One additional lysimeter was installed in the DSTSF. A fifth lysimeter was purchased for the MPD, and the installation was delayed pending completion of the dump development.

The lysimeters are of the passive wick-type, coupled with appropriate monitoring instrumentation and an automated data acquisition system. Three of the lysimeters (MWD, MVFE, and DSTSF) are coupled with ground temperature probes monitoring the near-surface temperature profile up to 3 m depth. The lysimeters were installed immediately below the interface between the mine waste and the overlying cover material, and the divergence control tube (the "body" of the lysimeter) was filled with the waste material surrounding the instruments.

Monitoring is based on measurements at 6-hour intervals, with results stored in dedicated data loggers and downloaded intermittently. Results to date have been highly variable and meaningful conclusions cannot yet be drawn from the study. Further monitoring over subsequent years may or may reveal insights that can be used to refine expectations of cover performance.

Table 2-1 provides a summary of the installed instrumentations, while complete details of the instrumentation and the installation methods are provided in SRK 2018.

Table 2-1: Summary table of instrumentation monitoring infiltration through dry covers.

Instrument ID	Status	Instruments type	Location	Monitoring
LYS17-01	Active	Lysimeter, Ground Temperature Probe	Main Waste Dump	every 6 hours
LYS17-02	Active	Lysimeter	Southwest Dump	every 6 hours
LYS17-03	Not installed	n/a	Main Pit Dump	n/a
LYS17-04	Active	Lysimeter, Ground Temperature Probe	Mill Valley Fill Extension	every 6 hours
LYS17-05	Active	Lysimeter, Ground Temperature Probe	Dry Stack Tailings Storage Facility	every 6 hours

2.2.2 Revegetation

Research to Date

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

- Chemical analysis of soils indicate that the overburden soils are deficient in macronutrients (nitrogen, carbon, phosphorus and potassium), but have adequate micronutrients (copper, iron, manganese, molybdenum, zinc). It is recommended that soils be amended with fertilizer 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, and because of the need to limit erosion of soil through rapid establishment of adequate vegetation cover;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 preferred regrowth 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.

- 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.

2.2.2.1 Main Waste Dump Trials

Previous years' research has provided Minto Mine with information to pursue a large-scale cover 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.

Findings from the Main Waste Dump revegetation trial indicate:

- The herbaceous species seeded have established well, and are candidates for incorporation in future seed mixes;
- The trials tested low and high seeding and fertilizing rates – results show that the lower rates of application for both seed and fertilizer (34 kg/ha and 125 kg/ha, respectively) are sufficient for successful vegetation establishment, and that higher application rates are unnecessary; and
- The seeded mix on the Main Waste Dump trial has if anything been too successful in its establishment, in that it has established a thick ground cover that appears to limit colonization by local native species and slow transition to a native ecosystem. This observation suggests that seed mixes in the future, and their application rates, should be balanced to provide the benefits of rapid revegetation (where required) while avoiding over-occupying the site and limiting subsequent colonization by native species.

Research Going Forward

The sloped areas of the Dry Stack Tailings Storage Facility were seeded at 35kg/ha with the following seed mix in October 2018. The following spring, erosional areas were over-seeded. Species from this mix have successfully established on the cover, and future monitoring will indicate the longer-term success of this treatment and how modifications might be made for future work at Minto. Potential modifications include the use of annual or biennial agronomic grasses such as oats or fall rye to provide initial ground cover but then to senesce and leave space for natural establishment of local native vegetation species.

Slope Waste-Rock Mix	% by Weight	Seeds/ lb	% by Seed Count
Agrostis scabra, **Ticklegrass**	0.50	4,000,000	7.45
Elymus glaucus, **Blue Wildrye (Smooth)**	15.00	131,000	7.32
Elymus lanceolatus, **Northern Wheatgrass**	15.00	167,000	9.33
Elymus trachycaulus, **Slender Wheatgrass**	25.00	145,000	13.50
Festuca saximontana, **Rocky Mountain Fescue**	10.00	679,000	25.29
Lolium multiflorum, **Annual Ryegrass (Diploid)**	20.00	217,000	16.17
Medicago sativa, **Alfalfa, Creeping Rooted**	12	226,798	10.14
Poa alpina, **Alpine Bluegrass**	2.00	1,000,000	7.45
Trisetum spicatum, **Spike Trisetum**	0.50	1,800,000	3.35
	100.000		100.00

In addition, Minto has ordered approximately 20,000 seedlings each of lodgepole pine and white spruce from seed from an appropriate seedlot donated by the Yukon Government Forest Management Branch. An additional small number of aspen (~5,000) may be available from a seedlot from northern B.C. These seedlings are scheduled for planting in June 2021, with results from this planting program informing future revegetation efforts.

Minto is participating, as part of Yukon Mining Research Consortium, in a Yukon University Northern Mine Remediation revegetation research project. The lead researcher is PhD candidate Kystral Isbister. The project is working with SFN and three other First Nations (Tr'ondëk Hwëch'in, First Nation of Na-cho Nyàk Dun and White River First Nation). The general areas of inquiry are:

- Study 1: How do potentially affected communities describe revegetation "success"?
- Study 2: Can greater aboveground structure (shelter) facilitate the establishment, survival and growth of target species on northern mine reclamation sites?

While this research is being conducted at Coffee Gold Mine, the research is designed to be applicable to Minto Mine and the broader region. Furthermore, it is anticipated that after preliminary results are available that a site-specific research project will be conducted at Minto Mine in collaboration with SFN.

2.2.3 Passive Water Treatment

Section 2.4.1 ITRC Mining Waste Treatment Technology Selection summarizes the process undertaken to identify candidate passive water treatment technologies for post-closure contaminant load reduction at the Minto Site. For the Minto Mine, closure water treatment planning is being approached in a site-specific manner, applying evidence-based goals and assumptions. The evidence is being gathered through the reclamation research plan (RRP). This section outlines the research undertaken to date (and ongoing) is support of the primary technology selected for Minto (Constructed Wetland Treatment System (CWTS)) and secondary contingency measures (bioreactors and in-pit treatment).

As part of the Northern Mine Remediation NSERC Industrial Research Chair program, Dr. Guillaume Nielsen is screening potential inoculum sources at Minto site and characterizes site conditions by sampling discharge water from both mines and surface soils (including peat or wood chips that may be used as carbon source). The project includes laboratory tests, representing site conditions to assess the efficiency of inoculum sampled from different locations from Minto Mine, to compare results with similar laboratory tests conducted with cold adapted bacterial population developed by the Centre National en Électrochimie et en Technologies Environnementales (CNETE) to treat ammonia, nitrates, nitrites. As part of the project, Dr. Nielsen has worked with SFN and Eliza Van Bibber School to obtain water samples with potential inoculum. The collaboration with SFN will continue throughout the project. This project will be supported by a Masters student.

2.2.3.1 Constructed Wetland Treatment System

Passive and semi-passive treatment has been successfully used for removal of metals and metalloids from water for many decades. There are many examples globally of mine contaminant treatment by CWTS from which scientific principals can be borrowed for application in new systems along with more recent advances in technology and application (Ness et al., 2014). A phased approach to testing the potential of CWTS for post-closure treatment at Minto has been implemented, consisting of (1) site assessment and information gathering, (2) technology selection and conceptual design, (3) pilot-scale testing and optimization (controlled environment), (4) onsite demonstration-scale confirmation and optimization and (5) full-scale implementation. The first three phases have been completed successfully, along with five years of testing on site for Phase 4. The following sections outline activities associated with the phased development to date (2020) and the conclusions from these studies that support contaminant removal in a CWTS. Conclusions from completed research of each phase are discussed in the context of contaminant removal and refining the full-scale design.

Phase 1 and 2: Site Assessment, Information Gathering, Technology Selection and Conceptual Design

A site assessment was conducted in 2013 to evaluate feasibility of a CWTS, including identification of possible CWTS locations and borrow sources for substrates and plants (Appendix A1). The geochemical data collected indicated that substantial treatment of seepage water was occurring on site within the natural wetland validating the concept that a CWTS with optimized performance could be designed to function in the long-term closure conditions at the Mine. Potential substrate and vegetation sources for the CWTS were identified as well as probable locations for a CWTS.

Based on the site evaluation and site-specific considerations in the post-closure period, an anaerobic CWTS technology was identified and conceptually designed for treatment of constituents (Appendix A2).

Phase 3: Controlled environment pilot-scale testing and optimization

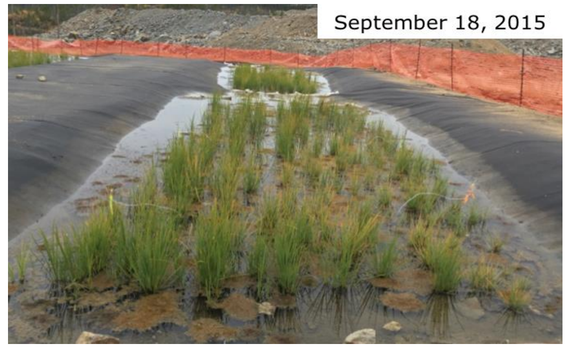
The CWTS was tested off-site at a pilot scale to refine the design for passive treatment in closure (Appendix A2). Three anaerobic CWTS designs were tested to evaluate plants and substrate for the system and corresponding performance with water that mimicked the worst-case post-closure water chemistry during early and long-term closure as predicted at the time (i.e., high and low nitrogen, respectively). Based on performance through pilot-scale testing, expected longevity, and cost effectiveness, the recommended CWTS design for long-term passive treatment of copper and selenium at the Mine was identified as a combination of *C. aquatilis* and moss planted in a sand substrate supplemented with 2-7% by volume as organic material (Appendix A2). This recommendation was used to guide the design and implementation of the demonstration-scale CWTS (Phase 4) at the Mine.

Phase 4: On-site demonstration-scale testing and optimization

Upon completion the off-site pilot-scale CWTS study, Minto constructed a demonstration-scale CWTS on site in August 2014 which was planted with *C. aquatilis* and aquatic moss. The demonstration-scale CWTS was built with two systems in parallel, each with two cells in a series and a final catchment basin that both systems flow into. The demonstration-scale CWTS has now operated on-site from 2015-2020 (Figure 2-2:) and has undergone testing under a range of hydraulic retention times, including stress testing. Detailed study design and construction reports for the Demonstration Scale CWTS are included in Appendix A3 with an annual update report for 2015 through to 2019 provided in Appendix A4 to A8, respectively.

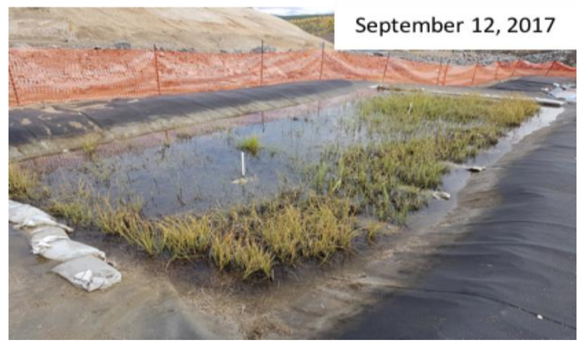
May 2015

September 2015

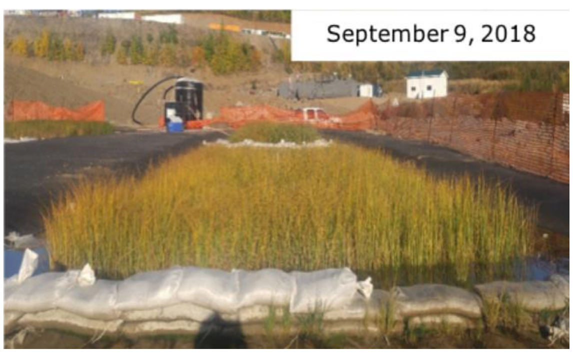


September 2016

September 2017



September 2018



September 2019

Figure 2-2: Maturation of the CWTS from construction in August, 2014 and through operations (2015-2019).
2015 pictures show cell 2A. 2016 to 2019 pictures show cell 1B.

The overriding objective of the Minto Mine demonstration-scale CWTS program is to advance testing under site conditions and guide site design of a full-scale CWTS for the Minto Mine. CWTS were selected for evaluation as a method to improve the quality of site runoff water in the post-closure period. Sections 3.1.3.1.2 and 2.4.1 identify the process of selecting viable and reasonable passive treatment technologies for further consideration and research. The key findings presented below support that a CWTS is capable of improving the quality of site runoff water and that the CWTS technology is performing as expected. Additionally, the key findings below confirm the original basis of the CWTS design documents and criteria (Appendix G1).

Key findings from the demonstration-scale CWTS (2014-2019) that refine the site-design of the full-scale CWTS are discussed herein.

Soils

- Soils used in construction of the demonstration-scale system had high leachable copper which extended the commissioning period of the CWTS (Appendix A4 to A6). Soil for the full-scale system will be different than what was used in the demonstration-scale system, where a different borrow source was available upon construction of the system (Appendix A4). The soil for the full-scale CWTS will be pre-screened to ensure a low leachable metal content), ideally in the range of copper content of the originally tested demonstration-scale soil (Appendix A3).
- Higher sand content would improve hydrology, constructability, and accessibility for sampling. The recommended soil for the CWTS is sand of 1 mm particle size with 2-7% by volume as organic material woodchips or straw.
- Depending on the iron content in the soil, iron could be incorporated into the soils during construction to encourage AVS production in the full-scale CWTS.

Plants

- *C. aquatilis* and moss transplanted well during construction (>95% survival) and are suitable for the full-scale system (Appendix A4).
- The full-scale CWTS is designed to be constructed with *C. aquatilis* at a density of 3-5 plants per meter square. The full-scale system could be planted more densely to bring online faster, or less densely if time is less of an issue than sourcing plants. The density of moss stakes in the full-scale CWTS should be greater than the density of the demonstration-scale CWTS which was one stake per meter square (Appendix G1).
- The monoculture of *C. aquatilis* in the demonstration-scale CWTS was prone to aphid infestation, due to the isolated nature of the demonstration-scale CWTS and not expected to affect the full-scale CWTS (Appendix A6). The treatment of constituents was not impacted when aphids caused damage to the above water vegetation (Appendix A6). Furthermore, preventative pesticide application was proven to control aphid populations (Appendix A7).
- The annual supply of organic carbon from *C. aquatilis* biomass may be insufficient for treatment of high nitrate loads (Appendix A8). Additional carbon could be incorporated through a forebay and/or nitrate loads could be decreased with *in situ* treatment in a pit lake (testing in 2021).

Commissioning timelines of the demonstration-scale system were assessed to allow for proper phasing of full-scale system implementation for closure. The key findings from the assessment of commissioning timelines are:

- CWTS performance improved as plants matured, reducing conditions and microbial populations established (Appendix A4 toA6)
- Commissioning criteria have been developed for the full-scale CWTS based on the demonstration-scale system, with commissioning of the full-scale system anticipated approximately 2 years after construction (Appendix J2).

Site-specific contaminant removal rates (RRCs) from the pilot-scale studies were refined through the on site testing. RRCs were assessed annually in the demonstration-scale system once the CWTS has entered the operational period. The key findings from the demonstration-scale program are below:

- Tracer study data was incorporated to increase the accuracy of RRCs (Appendix A5)
- RRCs for dissolved cadmium, copper and selenium have been refined to 0.70, 0.64, and 0.26 day^{-1} according to first-order rate kinetics with the current state of knowledge (Appendix J2).
- The RRCs for cadmium, copper, and zinc were unaffected by less reducing conditions experienced in the CWTS when there were high nitrate loads (Appendix A8).
- In contrast, molybdenum and selenium (somewhat) treatment rate was impacted by high nitrate loads, as anticipated (Appendix A8).
- Partial decomposition of above water *C. aquatilis* biomass year after year results in accumulation of organic matter over time (accretion) which will bury treated constituents. The full-scale CWTS will require free-board to account for the amount of accretion created annually.
- Constituents are being treated and sequestered to the soils with minimal plant uptake. Constituents have shifted primarily into stable reduced and residual mineral fractions in the soils (Appendix A8).
- Evapotranspiration rates have been determined for the system (Appendix A6).

The CWTS was unintentionally exposed to a double stress test which included drying out the CWTS and exposing the wetland soils to air, as well as elevated nitrate concentrations in the water (Appendix A7). The key findings of the double stress test are:

- Drought and high nitrate concentrations interfered with CWTS reducing conditions. Recovery periods were identified for each constituent, alongside recovery strategies which are applicable to full-scale operation (Appendix A7).

Research Going Forward

The removal rate coefficients evaluated to date in the demonstration-scale system have been in the presence of high nitrate concentrations. Nitrate concentrations are expected to decrease substantially over 18 years after closure. While nitrate is not a primary constituent for CWTS treatment at the Mine, removal is targeted to subsequently achieve treatment of constituents such as selenium. The CWTS research program will therefore include a test program to evaluate treatment rates in the presence of lower nitrate loads. Furthermore, the reduction of nitrate is being evaluated through pit lake treatment trials as discussed in Section 2.2.3.3.

W15 Area Reclamation Research Plan

A monitoring program of the SWD seepage, the associated 'volunteered'/natural wetland and the W15 pond area was undertaken from 2016-2017. This monitoring program was initiated to further investigate the findings of the 2013 assessment completed by Contango between W10-W15 and determine if the proposed future terraced wetland (FTW) is practicable for improving water quality at the W15 pond (collection point for the watershed).

The 2013 assessment suggested the natural wetland in the area is possibly treating the seepage from the SWD, and the proposed terraced wetland was designed to enhance the existing wetland performance. The 2013 assessment also suggested that road runoff from a culvert was contributing impacted water to the W15 area. However, there was only one set of data from 2013 to support this inference. Therefore, in June 2016, a monitoring program was developed and initiated on the components of the SWD drainage area. Initial samples collected in 2016 included water, soil, microbial, and plant. The monitoring program selected five additional sampling sites (FTW-A, -B, -B1, -C, and –D) that intercepted locations where water was entering the W15 pond (Figure 2-3). FTW-A, -B, and -B1 were branches of the main creek that feed the W15 pond from the southwest, and FTW-C and -D were receiving seepage water from W38 (FTW-D had higher flows than FTW-C, and corresponded to the area identified in 2013 that also had culvert runoff). Sampling occurred at these sites (or a subset thereof) and at W15 twice monthly. However, when discharging and W15 was being sampled daily, samples were collected weekly for internal analysis of total and dissolved copper. Figure 2-3). FTW-A, -B, and -B1 were branches of the main creek that feed the W15 pond from the southwest, and FTW-C and -D were receiving seepage water from W38 (FTW-D had higher flows than FTW-C, and corresponded to the area identified in 2013 that also had culvert runoff).

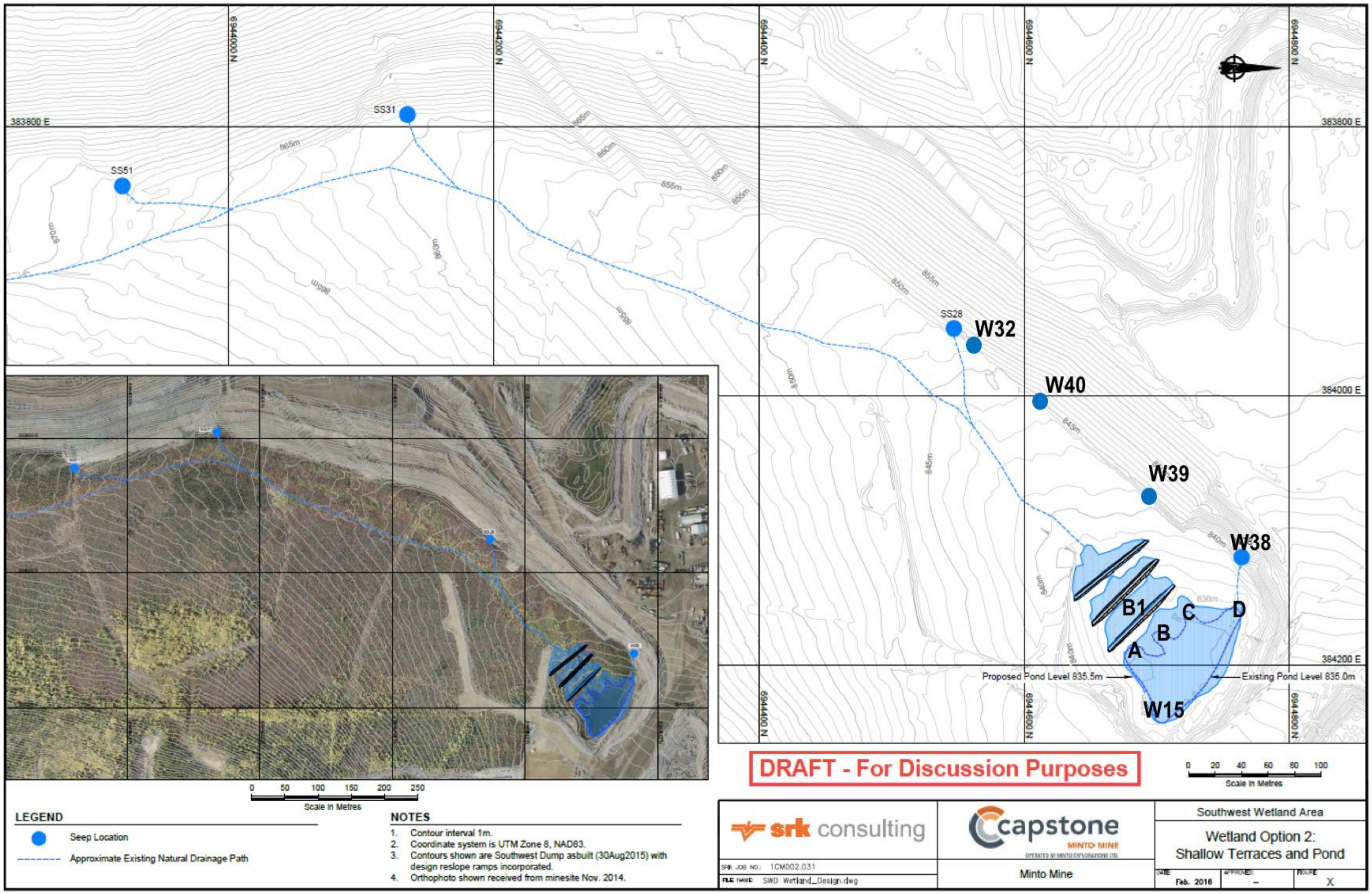


Figure 2-3 - Proposed terraced wetlands and sampling locations.

Estimated location of W32, W39, and W40 seeps shown on map. W39 is approximately 80 m southwest of W38 on the same toe of the SWD. Sites A, B, B1, C and D are equivalent to sites FTW-A, FTW-B, FTW-B1, FTW-C, FTW-D discussed in this report. W10 sampling location is approximately 1.5 km Southwest of W15.

The terraced wetland area monitoring program continued in 2017 with twice montly water sampling, and the sampling sites were refined to include FTW-B, FTW-D, W15, and surrounding seeps (i.e., removing FTW-A, -B1, and -C). In 2017 reclamation activities and lower precipitation appeared to be the major contributing factors in decreased visible seepage water flows along the toe of the SWD. Reclamation activities over the past two years include re-contouring and overburden placement in the SWD.

The results of the 2016 and 2017 monitoring programs (Appendix A5 and Appendix A6) suggest that the location of the conceptual terraced wetland layout design proposed in 2015 should be reconsidered as the seeps contributing impacted water to the W15 area would not be intercepted by the current layout (since they are downstream). Therefore, treatment by terraced wetland is not recommended between W10 and FTW-B. The monitoring program in 2016 and 2017 has indicated that the creek is not the source of elevated metals. Rather, the source of constituents appears to be seeps reporting directly from the SWD to the west side of the W15 pond (i.e., W38 seep, via FTW-D monitoring point or subsurface flow). Additionally, since water from the creek (FTW-B) does not contribute to elevated constituents at W15, it will not require treatment. For these reasons, a terraced wetland in this location is neither being pursued in further research nor incorporated into the closure water management strategy.

2.2.3.2 Bioreactors

Research to Date

Four pilot anaerobic bioreactors were commissioned at the Minto mine site in the summer of 2014 (Figure 2-4). Installation was completed on August 7th, 2014 and operation started on August 20th 2014. Bioreactor substrate composition varied among the bioreactors and included mixtures of creek sediments, low-grade or river gravel, wood chips or biochar (a coal made out of wood). During the first year the bioreactors were monitored until September 23rd 2014, after which they were dismantled and stored for the winter. In the following year, the bioreactors resumed operation on June 2nd and were monitored between June 20th 2015 and September 26th 2015.

Results during the four months of operation in the succeeding summer and fall in 2015 suggested that:

- Bioreactors continued to reduce selenium from the influent which had a concentration close to Minto Mine's selenium effluent discharge limit, decreasing to below the discharge limit of 0.003 mg/L as set by Minto's Water Use License;
- Steady copper removal was observed in all bioreactors regardless of temperature drop during the fall months;
- Chipped wood seemed to release organic acid in the effluent (lower pH, higher Total Organic Content) in the first month of operation but not in the second year of operation;
- All bioreactors including two that contained wood chips met pH requirement of mine discharge limit throughout the second year of operation;
- Large amount of organic carbon released from wood chips in the first year seemed to be consumed by bacteria and the concentration settled to the same level as other bioreactors without wood chips by the middle of the operation period;
- Bioreactors amended with wood chips efficiently lowered SO_4; and

- Bioreactors helped to reduce NO_3 concentrations to below discharge limits of 7.65 µg/L.
- No exceedance of the mine effluent discharge limits were observed for NO_2 and NH_3, although high PO_4 (not regulated) was observed in the effluent of the biochar amended reactor.

Figure 2-4: Pilot-Scale Bioreactors at Minto Mine (Picture taken in August 2014)

Research Going Forward

At this time, Minto is not proceeding with further trials of pilot anaerobic bioreactors at site. Minto is participating in Yukon University Northern Mine Remediation Program research projects that include bioreactors.

2.2.3.3 Pit Lake Treatment

Batch treatment of pit lakes in the operations or early closure period has potential to lower contaminant inventories in pit lake water and therefore reduce loadings when pit lakes ultimately fill and discharge to the CWTS and ultimately to Minto Creek. The Area 2 and Main Pits will be flooded at closure and will create large sedimentation ponds in the post-closure period. Flooding of the pit will 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.

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 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 present 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 approaches that make sense and could be combined include:
    - Addition of organic reagents to the pits to create an anaerobic zone in the lake where metal removal is enhanced via metal sulphide precipitation or formation of low solubility reduced phases (e.g., elemental selenium). This also encourages removal of nitrogen forms such as nitrate and nitrite via denitrification. Typically, a combination of carbon sources is utilized to achieve both rapid formation of reducing conditions (carbon sources such as sugars and alcohols), and sustained maintenance of reducing 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.

Historically, passive in-situ water treatment in pits has been considered as a contingency mitigation measure in closure planning for the Minto site, and the potential in-pit treatment of site water has not been included in the current predictive modelling conducted for the closure of the site. Recently, Minto has initiated a more systematic evaluation of the potential for in-pit passive treatment techniques to be used as a pre-treatment technique, if conditions in closure are amenable, to improve water quality leaving the Area 2 and Main Pits. This includes examination of case studies and literature review, and most recently the initiation of a phased treatment trial program.

In-Pit Treatment Process and Case Studies

The use of soluble organic carbon injections to significantly lower contaminant concentrations in pit lakes, underground mine workings, and shallow groundwater has been described in detail in numerous reports at locations across North America (e.g., Lindsay, 2009; Murphy et al., 2008; Houston et al., 2005; Addison et al., 2005; Harrington, 2002; Harrington et al., 1999, 2004, 2009, 2015; ITRC, 2010a; Morie et al., 2004; Paulson et al., 2004; Saunders et al., 2004) including northern Canada (Gault et al., 2018). In particular, in situ treatment has been successfully implemented at numerous flooded open pits (Harrington, 2002; Harrington et al., 2004, 2009; ITRC, 2010a; Paulson et al., 2004). In situ pit lake treatment uses the flooded open pit (or a portion thereof) as the reaction vessel for biologically reductive processes, treating water directly at the source of contamination. In situ treatment is performed through injection or placement of reagents into the flooded pit (e.g., organic carbon and nutrients) with pumping to circulate the reagents through the desired water volume. This results in the formation of a reductive zone within the flooded pit, creating the conditions necessary for microbial denitrification and dissimilatory sulphate reduction conducted by denitrifying and sulphide producing bacteria (SPB), respectively. Denitrifying bacteria facilitate the transfer of electrons from the organic carbon supplied to the system (e.g., alcohol, molasses) to nitrate and nitrite, converting these nitrogen species to nitrogen gas. Similarly, SPB facilitate the transfer of electrons from the organic carbon to reduce sulphate to sulphide. The sulphide then binds to the dissolved fraction of chalcophile metals and metalloids such as arsenic, cadmium, copper, lead, molybdenum, nickel, and zinc, removing them from solution via precipitation as insoluble metal sulphide phases. Under such reducing conditions, elements such as selenium and uranium are largely transformed to less soluble forms (e.g., elemental selenium and uraninite phases). Such phases form particulates that settle to the base of the pit and will become buried over time as sediment naturally accumulates. The stability of these phases become enhanced by burial, or co-deposition of bulk iron sulphide phases in the sediment.

In situ treatment systems require minimal construction and have low capital and operational costs. Treatment occurs quickly (within months) and is suitable for batch or periodic treatment of large volumes of mine-impacted water and high concentrations of metals. Treatment effects continue year-round and associated maintenance is minimal; however, periodic addition of reagents (e.g., alcohol, molasses) may be needed to sustain treatment.

By treating water at the source in the flooded pit, potential contaminants of concern are retained in the pit lake sediment rather than being exposed to the surface environment. In situ treatment also provides an ancillary benefit of improving groundwater and seepage chemistry in the receiving environment should the flooded pit be a major source of such loading. Pit walls or waste materials placed in the pit can also be stabilized by the creation of saturated biochemically reducing conditions where oxidative leaching is avoided or minimized.

The following three case studies illustrate successfully implemented in situ pit lake treatment that is relevant pit lake treatment that may be performed at Minto Mine.

Case Study #1 Sweetwater Pit Lake (Wyoming, USA)

In situ treatment was employed to treat elevated selenium and uranium concentrations in the circumneutral pH pit lake at the Sweetwater uranium mine (Wyoming, USA). Addition of soluble organic carbon resulted in the decrease of nitrate-N concentrations from 1.1 mg/L to below detection within the first two weeks of treatment (Harrington, 2002). Within four months, uranium and selenium concentrations decreased from 8.1 mg/L to approximately 4.2 mg/L (target 5.0 mg/L) and 0.46 mg/L to approximately 0.004 mg/L (target 0.05 mg/L), respectively. The treated concentrations remained at those levels for four years following in situ treatment (Paulson et al., 2004), with follow up sampling indicating that such levels have continued to be maintained beyond ten years of monitoring.

Case Study #2 Barite Hill Pit Lake (South Carolina, USA)

The pit lake at the Barite Hill gold mine (South Carolina, USA) was the location of an emergency response that included in situ treatment using a phased chemical and microbiological treatment. Prior to treatment, this pit lake was acidic (pH 1.5 to 2) and had high trace element concentrations (**Table 2-2**). Carbide lime was used to raise the pit lake pH closer to circumneutral conditions while injection of soluble organic carbon created sulphate-reducing conditions that sequestered metals as metal sulphides and/or less soluble reduced phases. Comparison of constituent concentrations before and after in situ treatment indicated greater than 70% removal of antimony from the pit lake water column and greater than 90% removal was achieved for other metal(loid)s of concern (**Table 2-2**; Harrington et al., 2009).

Table 2-2: **Barite Hill Pit Lake Constituent Concentrations Before and After In Situ Treatment (Harrington et al., 2009).**

Parameter	Concentration Before In Situ Treatment	Concentration After In Situ Treatment	Percent Reduction
	mg/L	mg/L	%
Antimony	0.02	<0.006	>70%
Arsenic	0.968	<0.01	>99%
Cadmium	1.57	<0.005	>99%
Chromium	0.141	<0.01	>92%
Copper	287	<0.01	>99%
Lead	0.161	<0.01	>93%
Nickel	0.404	<0.02	>95%
Selenium	0.23	0.01	96%
Zinc	40.2	<0.02	>99%

Case Study #3 Anchor Hill Pit Lake (South Dakota, USA)

The Anchor Hill pit lake at the Gilt Edge Mine Superfund Site (South Dakota, USA) was also the location of in situ treatment to significantly lower elevated metal and nitrate concentrations prior to a batch discharge of treated water. The acidic pit (pH 3) was treated with lime and sodium hydroxide initially to raise the pH before methanol and molasses were added to stimulate the development of sulphate-reducing conditions and associated metals removal. This resulted in near complete nitrate removal (from 55 mg/L to 0.01 mg/L) and reductions in pit lake trace element concentrations of between 86% and greater than 99% (Table 2-3; Harrington et al., 2004).

Table 2-3: Anchor Hill Pit Lake Constituent Concentrations Before and After In Situ Treatment (Harrington et al., 2004).

Parameter	Concentration Before In Situ Treatment	Concentration After In Situ Treatment	Percent Reduction
	mg/L	mg/L	%
Nitrate-N	55	0.013	>99%
Arsenic	0.017	Below detection [a]	-
Cadmium	0.284	0.007	98%
Copper	13.6	0.028	>99%
Lead	0.0281	Below detection [a]	-
Nickel	0.348	0.048	86%
Selenium	0.0222	<0.0009	>96%
Zinc	6.66	0.15	98%

[a] Detection limit not reported.

In Pit Treatment at Minto Mine

The Minto Mine site is located Yukon; therefore, any proposed in situ pit lake technology must take into consideration the cold climate challenges associated with this location and allow for continued treatment over the cold winter months. Longer-term data are available for organic carbon injections to pit lakes, where treatment has extended over winter (e.g., Sweetwater and Barite Hill pit lakes; Paulson et al., 2004; Harrington et al., 2009; Park et al., 2009), and in some instances many years after the last carbon injection event (e.g., Sweetwater; Paulson et al., 2004). It is important to note that both the Anchor Hill and Sweetwater pit lake locations experience cold winters, with the Sweetwater pit lake frozen/ice covered from early December until March. The pit lakes both freeze over during winter, but this has not impeded the constituent removal obtained by in situ treatment. Indeed, the ice cover may be viewed as beneficial in that it acts as a barrier to the mixing and diffusion of oxygen from the atmosphere into the lake. As such, carbon additions at both Anchor Hill and Sweetwater pit lakes were typically performed in the late summer or fall to prolong the period that the lake would remain reducing and therefore maximize constituent removal. Carbon injection has also been employed for in situ treatment of the flooded mine workings at the Silver King mine (Keno Hill, central Yukon) since 2015. The water temperature in this mine typically varies between 2 and 5°C year-round and has demonstrated prolonged treatment (cadmium and zinc; ≥75% removal over long term; Gault et al., 2018). This indicates that treatment of cold waters is feasible using this technology, likely due to the presence of psychrophilic (i.e., adapted to cold conditions) bacteria in the mine workings, which are also expected to be present in the flooded pits of the Minto Mine site.

Off-Site Bench-Scale Trials

A phased approach is underway to evaluate in situ pit lake treatment for the site. This work was based around treatment in the Main Pit, although the results will also have application to the Area 2 Pit. Phase 1, initiated in summer 2020, includes bench-scale trials to evaluate different carbon amendments to treat constituents of concern (nitrate, nitrite, ammonia, copper, selenium), to refine amendment dosing requirements, and potential for leaching from the waste rock tailings in the Main Pit under strongly reducing conditions (e.g., sulphate-reducing). The results from the bench-scale trials will inform Phase 2 in situ, on-site limnocorral trials within the Main Pit lake that are planned in 2021, to further evaluate insitu pit lake treatment under field conditions.

The Phase 1 trials use water from the Minto Mine Main Pit, waste rock, and tailings, to mimic site conditions. The ratio of water to rock/tailings largely reflects the estimated amounts of waste rock and water currently in the Main Pit, although a relatively higher water volume was used to allow for sampling throughout each trial.

Four barrel trials are currently operating at Ensero Solutions' Saskatoon laboratory (Table 2-4). Each barrel comprises:

- 67.5 L of Main Pit water collected at Site;
- 7 L of waste rock collected at Site; and
- 15.5 L of tailings obtained from Site.

Different carbon amendments were examined (glycerol, ethanol, and molasses) in three of the trials, with no soluble carbon added to the fourth trial, which acted as a control (Table 2-4). All four trials also received a shallow layer of woodchips to provide a slower-release source of carbon and an anchor for microbial attachment. All trials are maintained at 10°C to simulate average Main Pit water temperatures at the Site.

Table 2-4: Phase 1 Off-Site Bench-Scale In Pit Trials

Trial	Amendment	Temperature (°C)	Trial Name
1	Ethanol	~10°C	Trial E1
2	Glycerol	~10°C	Trial G2
3	Molasses	~10°C	Trial M3
4	Control	~10°C	Trial C4

An important aspect of this work is to evaluate nitrogen species treatment in the Main Pit. It is recognized that during operations and into early post-closure, nitrogen species will be continually supplied to the pit water as waste rock deposited both within the pit and in subaerial piles located within the pit catchment is flushed, releasing nitrogen present from blast residues. To approximate this, nitrogen species in all four trials were topped up at weeks 2, 4, and 6 following the initial carbon amendment at week 0. The cumulative nitrogen species concentration added over these three top-up events was equivalent to the 90th percentile concentration present in the Min Pit between 2016 and 2018 (i.e., during operations, when nitrogen species concentrations were elevated), and therefore presents a conservative basis for evaluating nitrogen removal through the trials. Once the entire three-month trial program is completed, analysis of the weekly monitoring events will be completed and a report prepared to determine next steps.

2.3 First Nation Consultation and Community Engagement

Summary of community engagement activities (e.g. governments, local communities, regulatory agencies and non-government agencies) undertaken to support the development of the RCP.

Minto and the SFN share the desire to minimize adverse environmental and socio-economic impacts resulting from the Mine operation and during closure. Minto believes this can be accomplished through consultation and open communication with stakeholders that include SFN, project regulators, and others. Accordingly, Minto has continued to focus on stakeholder engagement.

2.3.1 Engagement with Selkirk First Nation

The Minto Mine is located on the west side of the Yukon River within SFN Category A settlement land. As the landowner, SFN is Minto's primary stakeholder. Minto has therefore engaged SFN in a process of meaningful and significant involvement in the planning and development of the Reclamation and Closure Plan.

While Minto and SFN have had a collaborative relationship prior to commercial production commencing in 2007, a number of initiatives have been established to enhance effective engagement through many channels.

These initiatives include regular meetings between Minto leadership and SFN Chief and council, as well as with SFN leadership representatives.

Minto and SFN have committed a bi-lateral technical working group (BTWG) to discuss technical issues related to the Minto Mine regularly. The BTWG is comprised of Minto and SFN representatives tasked with engagement in the following areas: geotechnical, water quality, consultation, and closure and reclamation. Most recently, SFN and Minto have collaborated on the latest evolution of the Closure AMP.

Minto and SFN are parties to a confidential Cooperation Agreement.

2.3.2 Tri-Partite Socio-economic Working Group

Another important area of engagement is the tri-partite socio-economic working group that is comprised of SFN, YG and Minto. It is responsible for a socio-economic effects monitoring program, as described in the decision document related to Phase IV (YESAB project # 2010-0198). The scope of the monitoring and report program was agreed upon in 2013 and updated in 2018. The working group meets regularly and discusses availability of data, responsibilities and reporting. The first report was published for 2014 data..

In 2015, a housing surveyor was undertaken in Pelly Crossing and the results of that survey was published in the 2015 report (second report). The 2016 to 2018 Report is being finalized with a pilot project on digitizing the report for 2019 underway.

2.3.3 Tri-Partite Reclamation and Closure Working Group

A tri-partite reclamation and closure group that is comprised of SFN, YG and Minto was developed to provide an opportunity for Minto to update SFN and YG on the progress of the reclamation and planning process. The group met in November 2015, as well as May and July 2016. The group's discussions included, but was not limited to, submission extension request, scope of upcoming Reclamation and Closure Plan, operations updates, and areas of engagement with SFN. The final meeting was held at Minto and included a tour of the site with a focus on the proposed reclamation and closure measures.

2.3.4 Identification of Other Stakeholders

Minto recognizes the role that federal/territorial boards and government departments play in protecting the interests of Yukoners as well as providing advice and expertise related to the Project. Therefore, Minto has taken care to engage these stakeholders throughout the reclamation and closure planning process.

This engagement has included communication through technical working groups, site tours, updates, phone calls, regulator meetings, and reports. Stakeholders and regulators who are frequently engaged by Minto are:

- YWB,
- YG EMR,
- YG Water Resources Branch,
- Environment and Climate Change Canada, and
- Fisheries and Oceans Canada.

2.3.5 Forms of Engagements

For details regarding specific First Nation, stakeholder, and regulator engagement, please see the SFN, Stakeholder and Regulator Engagement Table (Appendix B). Information from the Temporary Closure period (Oct 2018 – Oct 2019) is unavailable at this time. This table provides details of engagement that has occurred since 2011 and includes communication related to earlier phases of the Minto Mine. Forms of engagement include:

- Bilateral Technical Working Group Meetings,
- Community sessions,
- Meetings between SFN leadership and company senior management,
- Bilateral meetings with regulators, and
- Technical meetings involving multiple stakeholders.

2.4 Closure Alternatives

In the process of planning the closure strategies for the Minto Mine site, several tools, techniques, and methodologies were utilized in order to examine the various possible alternatives for closure, and which were best suited to the site, the desired closure goals, objectives, and end land use. This included Interstate Technology and Regulatory Council (ITRC) mine waste treatment technology selection process, Failure Modes and Effects Assessment (FMEA), Scoping level cover assessment, and First Nations consultation on closure alternatives. These are discussed further in the following sections.

2.4.1 ITRC Mining Waste Treatment Technology Selection

The ITRC mine waste treatment technology selection process is recognized as a world class resource on the topic of innovative mine reclamation and treatment technologies. As such, it was selected to use as the primary tool for identifying and evaluating potential treatment technologies for the RCP v4.0.

The process uses a series of questions and decision trees to guide users to a set of treatment technologies that may be applicable to a particular site situation. The decision framework currently includes a total of 22 potential technologies (prevention and treatment) that could be applied to mitigate and/or treat mining impacted surface and groundwater. The list of technologies is reviewed and updated frequently by the ITRC and is comprehensive, spanning operational life and mine closure.

The various stages of closure planning have identified potential risks associated with closure water quality and as well as a need to address the topic of defining “reasonable and practical” passive treatment technologies to assist with the development of closure WQOs.

A complete reassessment of the full range of potential passive treatment technologies was performed to ensure that any changing site conditions and/or emergent technologies were factored into potential passive water treatment technology selection. A re-visiting of relevant site conditions was undertaken and the ITRC Process was then re-applied.

Using the ITRC framework, five (5) passive treatment technologies were short-listed as being considered relevant to the Minto site, and in the context of identifying “reasonable and practical passive treatment” as defined in the decision document. These are:

- Constructed wetland treatment systems (CWTS);
- Biochemical reactors (BCR);
- Permeable reactive barriers (PRB);
- In situ treatment of open pits (chemical precipitation through sulphate reduction); and
- In situ treatment of open pits (enhanced biological treatment using algae to sequester metals).

Of the five (5) technologies that made the short-list, only one (1) has been identified as a primary passive treatment technology in the Minto Mine closure context – CWTSs. This is primarily based on CWTSs being the most passive to operate of all of the shortlisted technologies. The level of site-specific research that has been conducted at the Minto site, and the technologies' 'readiness' for advanced design-level integration into the current closure planning was also taken into consideration.

Four (4) additional technologies are presented as candidate contingency passive treatment technologies – BCRs, PRBs, and two variations of in-situ batch treatment in open pits. Batch treatment of open-pits is subdivided into sulphate reducing batch treatment (which removes metals by precipitation as sulphides) and enhanced biological treatment (which removes metal by algae sequestration which then sinks to the base of the pit). These measures can be considered at a 'contingency' plan level of integration into current closure planning at the Minto site, and some site-specific experimentation has already been completed to date. The full ITRC memo for Minto can be found in Appendix C.

2.4.2 Failure Modes and Effects Assessment

Failure Modes and Effects Assessments (FMEA) have been utilized in Minto Mine closure planning initiatives since 2013. This section summarizes these efforts, and the full reports are included in Appendices D-1 through D-3.

2.4.2.1 2013 FMEA

In advance of the submission the Phase IV RCP, Minto conducted a multi-stakeholder FMEA as a key exercise guiding the evaluation and refinement of the Minto reclamation strategy. The two-day workshop (followed by partial day sessions to complete the exercise with a smaller group) was held in Whitehorse in January of 2013, and involved participants representing Capstone Mining Corp., Selkirk First Nation (SFN), Yukon Government- Energy Mines and Resources (YG-EMR) (represented by Steve Jan Consultants), and the Yukon Water Board (YWB), and was facilitated by Dirk van Zyl of the University of British Columbia.

The goal of the FMEA was to identify the risks involved with components of several different closure option scenarios being considered for the Minto mine. Previous meetings in December 2012 with technical representatives from SFN and YG EMR on closure planning strategies had 'shortlisted' 6 candidate closure scenarios for the Minto Site. Each scenario had a different key closure measure focus. After reviewing some preliminary water quality estimations for each scenario, the FMEA group concurred there were three scenarios most appropriate to carry forward through the FMEA process. These are presented below with the key assumptions of each:

Scenario: Source Control Focus

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

Scenario 2: Hybrid of Source Control and Treatment Focus

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

Scenario 3: Treatment Focus

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

The group initially identified classes of failure, which were then used to identify potential failure mechanisms with associated likelihood and consequence factors. The pre-developed spreadsheet tools then assigned each failure mechanism a risk ranking, and the team collaborated on considerations and potential risk mitigation measures for failure modes. The session finished with an understanding that once the final closure strategy for the site was determined, the FMEA exercise should be revisited specific to the proposed closure measures. The outcomes of the preliminary FMEA process were included in the Phase IV RCP v4 (September 2013), and are captured in the tables presented in Appendix D1 to this plan.

As a result of the review of the preliminary FMEA findings (specifically, the potential failure mechanisms assigned the highest risk), and further informed by further site evaluations (updated water quality prediction and cover material evaluation), Minto adopted limited source control of potential contaminants as the principle tenets of the reclamation strategy for the site. In addition, Minto committed to implement reasonable and practical passive and/or semi-passive treatment options.

2.4.2.2 2014 FMEA

Following the submission of an updated Phase V/VI Reclamation and Closure Plan (RCP v5.1, August 2014) in support of permit amendment applications for the Phase V/VI Expansion mine plan Minto hosted a multi-stakeholder FMEA workshop (in two parts). The first session was held in Vancouver on August 27 and 28, 2014. A second, supplementary FMEA workshop was held in Whitehorse on October 9 and 10 with a smaller subset of the original workshop group to address outstanding mine components and closure aspects that had not been addressed in the first workshop.

As with the January 2013 workshop, the 2014 FMEA used predefined consequence categories, severity descriptors and likelihood terminology to determine where the residual risk associated with the various mine components ranked on a risk matrix (from Low to Very High). The risk rating tools used in the FMEA workshops are presented within the Final Report and Risk Register in Appendix D2. The overall objective of the FMEA workshop was to evaluate the residual risks that would remain after implementation of the RCP v5.1.

A pre-workshop teleconference attended by participants from Minto, SRK, SFN, and AEG was held to discuss and refine the methodology to be utilized, so as to maximize the time for risk ratings during the workshop. During this call it was determined that the results of the January 2013 FMEA workshop would be incorporated so as to not lose the information gained from that process.

The 2014 FMEA covered the entire Minto mine site and mainly focused on a time frame during Post Closure II as it is described in the RCP v5.1, when all reclamation activities are completed and the site has entered into a phase of primarily monitoring and maintenance. The Closure FMEA used an approach in which specific combinations of failure modes and resulting effects were rated by participants. For each scenario that was rated, potential risks were identified, recorded, and taken through a facilitated procedure using the consequence-severity and likelihood tools to reach a consensus risk rating. The risk ratings were recorded in a risk register spreadsheet that was projected on a screen for participants to refer to and provide feedback on during the meeting, and the resultant risk IDs were placed on a wall matrix and photographed once the topic was complete.

The first 2014 FMEA workshop was held at SRK's office in Vancouver, BC on August 27 and 28, 2014. The workshop was facilitated by Dr. Dirk Van Zyl (Chair of Mining and the Environment at the Norman B. Keevil Institute of Mining Engineering, University of British Columbia). The two-day workshop included participation by representatives of Minto, SFN, and YG-EMR. Representatives from Norwest Corporation (in its third-party review capacity on geotechnical subjects at Minto Mine, on behalf of Minto and SFN jointly) participated on the second day only (August 28).

The topics rated in the August workshop included:

August 27:

1. Area 2 Pit
9. Source Control – Waste Covers
10. Water Conveyance

August 28:

2/3/6. Main Pit/Main Pit Dump/Main Dam and Spillway
7/8. Dry Stack Tailings Storage Facility and Mill Valley Fill Extension

The August 2014 workshop rated breach of the Main Dam due to permafrost thaw, settling of the dam leading to tailings release, and general failure to conduct preventative maintenance and corrective actions leading to system failures, as the largest perceived residual risks to the site at closure. The lack of inclusion of long-term operation and maintenance of the site was identified as an important issue to be addressed, as was further assessment of permafrost thaw as it pertains to the closure design, in particular for the Main Dam and associated structures.

The supplementary FMEA workshop was conducted over two half-day sessions in October 2014. The workshop was jointly facilitated by Dylan MacGregor and Scott Keesey and the same FMEA protocols and risk rating tools that were used in the August workshop were used once again.

The topics rated in the October workshop included:

October 9:

6. The remaining WRDs (Main Waste Dump, Southwest Waste Dump and Ridgetop Waste Dump)
7. Backfill dumps

October 10:

2. The remaining open pits (Minto North, Ridgetop North)
11. Water Treatment
14. Administration
15. “Domino Effect”

The October workshop found the risk scenarios evaluated to contain relatively low residual risk (i.e., Low to Moderate) and primary mitigative actions identified included implementation of an effective AMP and minor modifications to closure configuration (e.g. regrading to maintain ponds away from spill points). It was agreed that the Reclamation Research Plan needed to advance further in order to better evaluate reasonable and practicably treatment technologies and there is a need to better define water quality objectives before Water Treatment can be properly evaluated by the FMEA process. The group ultimately decided to not rank Water Treatment scenarios but rather flag this topic as significant and consider addressing residual risks associated with Water Treatment using a different process in the future.

The workshop participants also identified a number of “parking lot” issues/concerns that could not be addressed by the FMEA process but which require further consideration. The key issues/concerns raised included:

- Current closure plan was deficient with respect to showing final reclaimed facilities, toes of re-graded slopes and location of secondary and tertiary water conveyance;
- More information requested regarding the status of the Reclamation Research Plan and the Main Waste Dump revegetation trials;
- Trafficability layer is required over the Ridgetop North Pit tailings backfill whereas costing only allows for 0.5m of overburden;
- Need to advance the discussion/determination of what constitutes “reasonable and practicable” passive treatment, establish protocols and revisit the options evaluation;
- SFN reiterated their concern that the consequence category of “Community/Media/Reputation” is biased because SFN are lumped together with groups having other interests and perspective; and
- The current closure plan does not sufficiently address signage and access control. There is a need to retain institutional controls and maintain signage in perpetuity.

The highest overall risks (i.e., High and Very High) identified during the FMEA workshops were associated with Administration, Water Conveyance, and Waste Rock Dumps. Administrative Failures represented the largest perceived residual closure risk. A recurring theme for mitigating residual risk included the implementation of an effective AMP and long-term care and maintenance program.

Table 2-5 contains a list of action items identified by FMEA scenarios that were flagged with high to very high risk ratings, along with how, and where, they are addressed in the RCP.

Table 2-5: 2014 FMEA Results for Scenarios with High to Very High Risk based on the 2014 FMEA Risk Registry

Code	Area/Facility	Failure Mode & Effect	Addressed in RCP 2016-01 Section	Action Taken
6.1	Main dam	Blockage or settlement of Ditch 300 leads to water in Main Pit and the Main dam has settled, leading to overtopping of the Main Dam resulting in breach, release of tailings and water to lower Minto Creek [environmental impact]	NA	No longer applicable, dam has been removed from mine plan.
6.2	Main dam	Blockage or settlement of Ditch 300 leads to water in Main Pit and the Main dam has settled, leading to overtopping of the Main Dam resulting in breach, release of tailings and water to lower Minto Creek [comm/Media/Rep]	NA	No longer applicable, dam has been removed from mine plan.
14.1	Administrative	General failure to conduct preventative maintenance and corrective actions leading to system failures (passive treatment, covers, etc.) resulting in impacts on ecosystems components.	Section 7.12 and Section 9.0	Adequate monitoring and maintenance in place as well as sufficient costing.
14.2	Administrative	General failure to conduct preventative maintenance and corrective actions leading to system failures (passive treatment, covers, etc.) resulting in negative traditional use.	Section 7.12 and Section 9.0	Adequate monitoring and maintenance in place as well as sufficient costing.
14.3	Administrative	General failure to conduct preventative maintenance and corrective actions leading to system failures (passive treatment, covers, etc.) resulting in regulatory/ legal action.	Section 7.12 and Section 9.0	Adequate monitoring and maintenance in place as well as sufficient costing.
14.5	Administrative	General failure to conduct preventative maintenance and corrective actions leading to system failures (passive treatment, covers, etc.) resulting in community/media/reputation impacts.	Section 7.12 and Section 9.0	Adequate monitoring and maintenance in place as well as sufficient costing.
14.8	Administrative	Departure from design of engineered structures, resulting in need for upgrades/ repairs/ redesign	Section 7.12	Monitoring to confirm.
14.9	Administrative	Bankruptcy/ dissolution of the company and inadequate financial security leads to requirement for public government to fund and conduct preventative maintenance and corrective actions to avoid system failures and impacts on ecosystem components.	Section 9.0	Adequate costing currently in place.
12-P5	Primary Channels	SWD toe seepage collection systems inadequate, leading to unacceptable WQ downstream	Section 7.12 and Section 7.7	Monitoring to confirm and enhanced natural wetland conceptual design.

2.4.2.3 2017 FMEA Update

In response to Minto's submission of RCP v2017-01 on March 2017, YWB issued their Technical Information Request #2 on May 26, 2017, which included the following related to the FMEA:

> ***IR2-15. Please provide an updated closure FMEA that includes all components of the proposed RCO, including water treatment, and deals wit the "parking lot" issues identified on Page 4 of exhibit 1.2 [the FMEA summary report].***

A series of FMEA workshops were undertaken in 2017 to meet this YWB information requests, and to inform ongoing planning for this version of the Minto RCP. The full report is included in Appendix D3. This was an internal exercise, and is effectively a re-evaluation of the 2014 risk register in the context of any new information. The first (of two) workshop covered site components for which a sufficient level of design currently exists to facilitate this risk assessment. It was focused on site infrastructure (pits, waste rock dumps, dry stack tailings storage facility, water conveyance, covers) and administrative topics. The second workshop covered water quality/water treatment topics.

The primary objective of the FMEA workshops was to characterize the residual risks that would remain after implementation of the RCP v2017-01, particularly in the context of higher identified risks in 2014 and through a more in depth look at items that were included in the Parking Lot in 2014. The secondary objective of the workshop was to, for any unacceptable residual risks identified in the ranking exercise, identify potential mitigation measures that would further reduce the overall risk ranking and bring the residual risks into a more acceptable location in the risk matrix. These potential mitigations were then further evaluated and have been incorporated into this RCP v2018-01.

Overall, the exercise returned mostly 'low' and 'moderate' risks associated with the v2017-01 plan. The unacceptable risk areas (high and very-high) contained only three entries. Two of the three were Administrative risk/consequence statements that were not changed from 2014 (although the 2017 workshop team strongly disagrees with the previous risk rating). Further, the 2017 team suggests that the risk has either been mitigated since 2014 (with additional financial security posted with YG) or there is no conceivable way to mitigate the risk, as it assumes violation of future licence conditions. Both entries are of the Cost Consequence category.

The third unacceptable risk statement regarding a failure to relocate SAT material prior to completion of the Main Pit Dump (as with some others) was subject to a 're-ranking' after the identification of additional mitigation measures, which reduced the risk classification from 'very high' to 'low'.

Some 2014 register entries were not re-evaluated in the 2017 workshops. 2014 comments regarding the risk statements were retained, and rationale for the entry not being re-evaluated in 2017 is included in Section 3.3 and Table D-1 in Appendix D3. The most common reasons for not re-evaluating entries were:

- The consequence category was not utilized in the 2017 workshop;
- The entry was expanded into a number of more detailed risk statements;
- The entry was a carry over from 2013 and/or is addressed elsewhere and is redundant; and

- The entry pertained to an element of the mine plan or RCP that is no longer relevant (e.g. Main Dam).

The 2017 FMEA team acknowledges that some of these risks are still worthy of re-evaluation, yet is confident that the 2017 RCP addresses most of the remaining higher classified risk statements, particularly from categories that were not evaluated in the 2017 workshop. For example, the highest classified risks in this table relate to consequences from a general failure to conduct preventative maintenance and corrective actions leading to system failures. The likelihood of these failures was rated as 'LIKELY' in 2014 on the basis of the duration of post-closure monitoring and maintenance in RCP 2014-01. RCP v2017-01 includes a plan and a closure (security) cost allowance for a much longer PCMM duration.

The 2014 issues raised that were recorded in the Parking Lot are summarized below with an indication of how each item was addressed in RCP v2017-01, RCP v2018-01, and/or the 2017 FMEA.

- **Current closure plan is deficient with respect to showing final reclaimed facilities, toes of re-graded slopes and location of secondary and tertiary water conveyance;**

  The designs for final reclaimed facilities have been advanced substantially in RCP v2017-01, and the final re-grading plans for the waste facilities were also available for the 2017 FMEA and will be included in RCP v2018-01.

- **More information requested regarding the status of the Reclamation Research Plan and the Main Waste Dump revegetation trials;**

  RCP v2017-01 included additional information regarding the RRP, particularly related to the Constructed Wetland Treatment System research. RCP v2018-01 further updates work on this research component, and the accompanying cover design report (Updated Closure Cover Design for the Minto Mine 2018 Reclamation and Closure Plan (SRK Consulting, January 2018)) incorporates recommendations based on observations of the Main Waste Dump revegetation trials during inspections carried out during July 2017.

- **Trafficability layer is required over the Ridgetop North Pit tailings backfill whereas costing only allows for 0.5m of overburden;**

  The Ridgetop Pits were not a part of the mine plan that underpinned RCP v2017-01. Now that the Ridgetop pits have been re-integrated into the mine plan, a trafficability layer over the Ridgetop North Pit tailings backfill has been added to the mitigative measures for that facility in RCP v2018-01.

- **Need to advance the discussion/determination of what constitutes "reasonable and practicable" passive treatment, establish protocols and revisit the options evaluation;**

  RCP v2017-01 presented the documentation of the systematic process that was undertaken to identify and select appropriate passive treatment technologies for the Minto Site. The RCP also presented a detailed design for the installation of a constructed wetland treatment system as part of the closure configuration, with associated monitoring, maintenance and adaptive management plans to ensure its efficacy in the post-closure period. The system was evaluated in depth in the Water Treatment topic in the 2017 FMEA workshop, which included a select group of technical experts who were responsible for the treatment system design.

- **SFN reiterated their concern that the consequence category of "Community/Media/Reputation" is biased because SFN are lumped together with groups having other interests and perspective; and**

  This consequence category was not included in the 2017 workshop exercise.

- **The current closure plan does not sufficiently address signage and access control. There is a need to retain institutional controls and maintain signage in perpetuity.**

  This issue has not been addressed in any RCP updates. It continues to be a future land use management decision requiring resolution with SFN.

2.4.3 Scoping Level Cover Assessment and Performance Modeling

In August 2013 SRK Consulting completed a scoping level evaluation (Scoping Level Cover Assessment for Minto Closure Covers) of available materials at the Minto site (and commercially available products) to identify types of covers that could be considered for placement on site waste materials at closure. The assessment took into account site specific conditions and overall site wide closure objectives. The full report can be found in Appendix E1.

Site specific conditions such as design life, climate, material availability, waste characterization, seismicity, slope stability, and erosion resistance were carefully evaluated to determine what cover concepts would be most likely to be successful at Minto, and how they could be implemented. Once the cover concepts that are most likely to be successful at Minto were identified, appropriate cover functions were defined to specifically ensure overall site wide closure objectives would be met. Additionally, conceptual cover designs were presented to demonstrate actual implementation plans for each of the concepts.

SRK utilized regional climate data from Environment Canada, as well as previous site studies to determine the mean annual total precipitation for the site, as well as the mean annual evaporation, and concluded that between March and September, the mean monthly climatic water balance is net negative, i.e. evaporation exceeds precipitation. Additionally, the site was classified as Dry Subhumid. Based on these factors, the site is best suited towards either water covers or infiltration controlling covers. Annual average ambient air temperatures, the presence of discontinuous permafrost in the region, and empirical methods were used to determine the annual depth of frost penetration. Based on this it was determined that any low permeability barrier cover that could be damaged through freeze-thaw action would have to be constructed with a protection cover of at least 3 m.

Locally available soils were characterized over numerous programs and the overburden soils can generally be classified as silty sands. Three existing primary candidate cover soil sources were identified; (1) overburden stockpiled on the Main Waste Dump (MWD); (2) the Reclamation Overburden Dump (ROD); and (3) the Ice-Rich Reclamation Overburden Dump (IROD). In total it was estimated that about 2.8 Mt of these soils were available for use as cover material. In addition, the overburden soils that will be produced during mining of the Area 2 Stage 3 Pit have been characterized and found to be similar to the soil in the existing stockpiles, and are therefore suitable for use as cover material.

Indicator property characterization testing and hydraulic testing (i.e., porosity, saturated hydraulic conductivity and Soil Water Characteristic Curves (SWCC)) was carried out on soil samples to further characterize the soils. It was determined that the locally available soils would require amendments in order to be used for construction of low infiltration covers, and could be workable for use as store-and-release materials.

Waste settlement was also considered. The waste rock dumps and dry stack tailings at Minto were not expected to undergo significant settlement; however, the tailings in Main Pit will undergo settlement as a result of self-weight consolidation, as well as the surcharge from cover placement. As such, it was noted that cover design should either allow or compensate for potential settlement, or construction should only be done once settlement is largely complete.

The Minto site is not considered to be particularly seismically active (see Section 4.11). Cover placed on steep side slopes not subject to liquefaction would be subject to classic failure mechanisms such as increased pore water pressures induced by ground shaking. At the Minto site this failure mechanism would only apply to covers constructed on the waste rock piles and the Dry Stack Tailings Storage Facility.

In October 2015 SRK completed a modeling exercise on various soil cover designs being proposed for use at Minto. The model used was a surface flux boundary model that further defines and brackets the likely range of percolation for the proposed soil covers at Minto. The cover modeling methods, scenarios evaluated, as well as results and discussion are summarized in this section below. Additional detail on the soil cover modeling can be found in the Minto Mine Closure Covers: results of Numerical Modelling to Bracket Percolation Predictions Memo in Appendix E2.

The cover modeling methods primarily focused on the model inputs. There were a total of five primary model inputs used, including meteorological data, soil cover material properties, boundary conditions, initial conditions and vegetation. Model input data included meteorological data (daily precipitation and evaporation) from Environment Canada's Pelly Ranch weather station. Evapotranspiration, snowmelt and sublimation were also utilized. Data from field investigations (test pits – particle size distribution) was used to inform the material properties inputs. Top and bottom boundary conditions were considered and being a one-dimensional model no side boundaries were required. Initial soil conditions were expressed in terms of gravimetric moisture content and were set at 7% for waste rock, 18% for tailings and 11% for the soil cover materials, respectively. The final model input was vegetation, which used conservative pasture-type vegetation assumptions and a constant rooting depth of 10cm.

The base case scenario assumed a simple 0.5 m thick soil cover overlying waste rock. The surface is assumed to have no vegetation. Normal precipitation was applied as a 20 year long daily sequence while the snow water equivalent was released over 14 days to simulate freshet. Potential evaporation was equal to 400 mm annually and was distributed monthly in equal daily increments. Sensitivity analysis scenarios were run to evaluate which parameters have the greatest influence on the percolation predictions. The following sensitivity analysis scenarios were completed; a delayed freshet, finer and coarser cover material, finer and coarser underlying waste rock, no sublimation and increased sublimation, increased cover thickness, upset climatic condition and presence of vegetation.

The results of the modeling exercise showed that even the base case had a considerable reduction in percolation. When comparing waste rock and tailings it was predicted that tailings percolation is less due to the finer grained nature of the material, however tailings with a simple soil cover preformed similar to that of the base case. Based on the cover material information modeled there is no preferred material type with which lower percolating covers could be constructed. Increasing cover thickness to 1 m predicted a slightly better percolation rate whereas increasing cover thickness to 2 m had negligible effects on percolation rates. Changing the underlying waste rock characteristics predicted that coarser waste rock would result in higher percolation rates while finer waste rock material resulted in no effects in percolation rates. A delayed freshet timing had a significant effect on the model outcome as the model allowed for some of the freshet water to be evaporated. The model was found to be very sensitive towards sublimation assumptions. The effect of wetter or dryer climatic years was found to have little effects. The final result was on the vegetation where it was determined that only modest increase in cover performance was predicted.

2.4.4 First Nations Consultation on Closure Alternatives

As briefly described in Section 2.3.1, bilateral discussions with SFN and their technical advisors were held during the reclamation and closure planning process. In an effort to have meaningful collaboration in regard to reclamation and closure planning Minto and SFN focused some of the discussions on closure measures alternatives. The primary subjects of focus regarding closure measures alternative were closure water conveyance alignments and constructed wetland configurations/design. The focused alternative measures discussions were held over four separate meetings from January 11th, 2016 to May 3rd, 2016.

As noted in Appendix B a teleconference meeting was held on January 11th, 2016, the subjects discussed at that meeting was different options for closure water conveyance alignments and potential locations for treatment wetlands. Similarly, before proceeding with advancing closure water conveyance design, another teleconference was held on April 5th, 2016 to discuss the effects of closure conveyance routing through the Area 2 pit and the effect on downstream hydrology.

Alternative options for wetland configuration and design were held in Whitehorse on March 1st, 2016 and via teleconference on May 3rd, 2016. Subjects discussed included potential wetland design configurations and water conveyance options within the wetland area.

3 Closure Objectives and Design Criteria

3.1 Objectives-Based Planning

Principles and approaches for reclamation planning from the published Reclamation and Closure Planning for Quartz Mining Projects guidance document (Yukon Government 2013) have been considered in the closure planning approach for the Minto Mine (Figure 3-1). This guidance document provides direction on the level of detail, information required and processes necessary for developing reclamation and closure plans in Yukon. To achieve its purpose, the guide has the following objectives:

- Describing the context for mine closure planning in the Yukon, and the rationale for requirements to submit RCPs and liability estimates;
- Describe the principles, philosophy and broad objectives for closure planning for Yukon mining projects;
- Describe the information expectations for RCPs and liability estimates; and
- Identify key sources of additional guidance for preparing RCPs and liability estimates.

Principles and approaches presented by Yukon Government (2013) include fundamental reclamation and closure objectives, community and regulatory engagement, reclamation and closure principles and principles for estimating liability. The intent of this section is to present the closure goal, principles, objectives, options, measures and criteria specifically for reclamation and closure of the Minto Mine, while following the guidance outlined by the Yukon Government (2013).

In an objectives-based approach, the closure goal is supported by closure principles which guide the selection of clear and measurable closure objectives for all project components. For each closure objective, proponents propose a set of closure options that could achieve the objective, and a selected closure activity is chosen from these options. Closure criteria measure whether the selected closure activity achieves the specific closure objective.

The closure goals, principles and objectives below, have also been guided by input from SFN. Engagement on closure objectives and end land use will continue in the future, however, Minto is using information regarding closure objectives that originated from SFN review of a Decommissioning and Reclamation Plan in 2007. Minto understands that these objectives potentially will be updated, however, are still appropriate for guiding the development of this plan and as such have been utilized during this planning process.

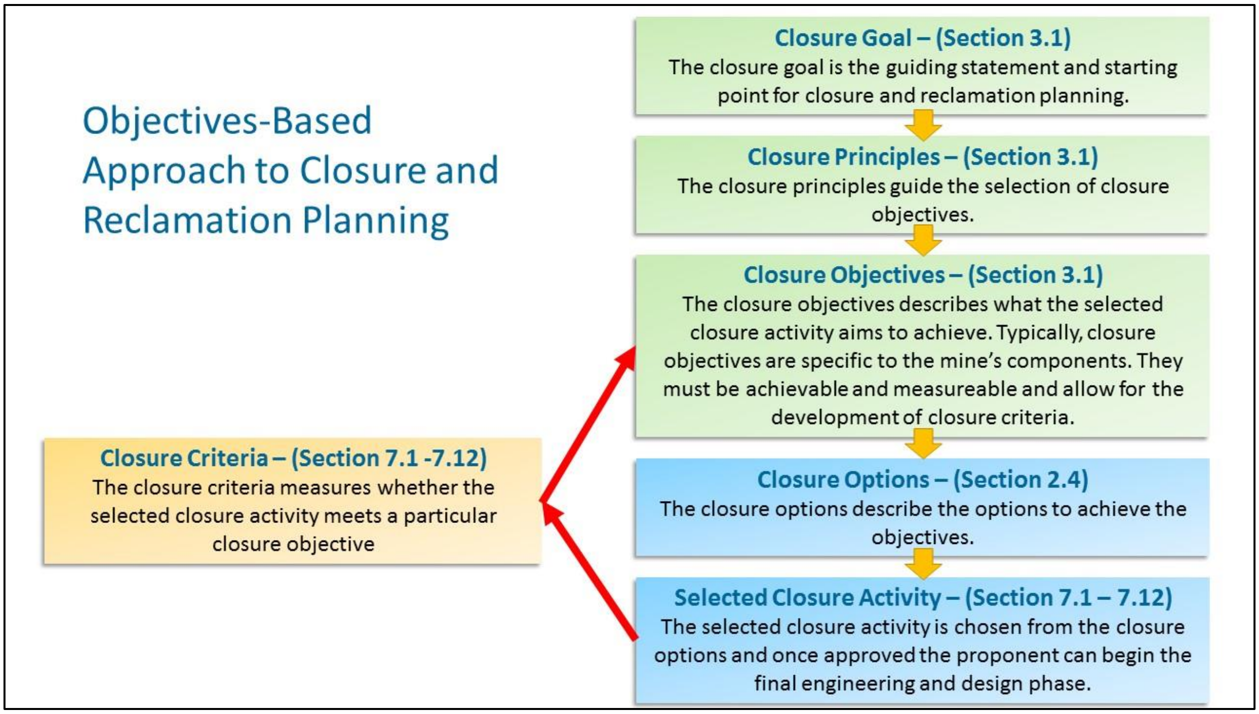


Figure 3-1: Objectives Based Approach to Closure and Reclamation Planning (adapted from MVLWB/AANDC, 2013)

3.1.1 Closure Goal

The closure goal is the guiding statement and starting point for closure and reclamation planning. Establishment of goals are meant to ensure the long-term success of the program by developing a clear and executional plan. The closure goal is met when the reclamation and closure measures satisfied all closure objectives.

For the Minto Project, the closure goal is to return the mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment over the long term, protective of human health and safety and support traditional activities.

3.1.2 Closure Principles

Closure principles guide the selection of closure objectives. Four core closure principles are applicable to the Minto Project include:

- physical stability;
- chemical stability;
- no long-term active care requirements; and
- future land use (including aesthetics, values, human health and safety).

3.1.3 Closure Objectives

Closure objectives are statements that clearly describe what the selected closure activities aim to achieve. They must be measurable, achievable, and allow for the development of closure criteria. Objectives are short-term concrete stepping stones toward achieving a goal and should be specific, appropriate and realistic (Huggard and Nadeau 2013). Table 3-1 below includes Yukon Government's (2013) fundamental reclamation and closure objectives to be achieved during all stages of reclamation and closure projects in the Yukon and their accompanying value.

Component-specific closure objectives (Table 3-2), categorized under the fundamental closure objectives presented in Table 3-1, are intended to be objectives-based and non-prescriptive. The purpose of implementing performance-based objectives is to encourage research and innovation resulting in cost-effective applications while ensuring public health and safety and environmental protection are met (YG 2008).

Fundamental closure objectives developed by Yukon Government (2013) in the Reclamation and Closure Planning for Quartz Mining Projects along with closure objectives identified by SFN have been used to guide the development of detailed objectives that are site-specific, defined by factors that include environmental conditions, site conditions and community expectations. Minto specific closure objectives are presented in Table 3-2.

Table 3-1: Fundamental Mine Reclamation and Closure Objectives (YG 2013)

Value	Reclamation and Closure Objectives
Physical Stability	All mine-related structures and facilities are physically stable and performing in accordance with designs. All mine-related structures, facilities and processes can withstand severe climatic and seismic events.
Chemical Stability	Release of contaminants from mine related waste materials occurs at rates that do not cause unacceptable exposure in the receiving environment.
Health and Safety	Reclamation eliminates or minimizes existing hazards to the health and safety of the public, workers and area wildlife by achieving conditions similar to local area features. Reclamation and closure implementation avoids or minimizes adverse health and safety effects on the public, workers and wildlife.
Ecological Conditions and Sustainability	Reclamation and closure activities protect the aquatic, terrestrial and atmospheric environments from mine-related degradation and restore environments that have been degraded by mine-related activities. The mine site supports a self-sustaining biological community that achieves land use objectives.
Land Use	Lands affected by mine-related activities (e.g., building sites, chemical and fuel storage sites, roads, sediment ponds, tailings storage facilities, waste rock storage areas, underground workings, etc.) are restored to conditions that enable and optimize productive long-term use of land. Conditions are typical of surrounding areas or provide for other land uses that meet community expectations.
Aesthetics	Restoration outcomes are visually acceptable.
Socio-economic Expectations	Reclamation and closure implementation avoids or minimizes adverse socio-economic effects on local and Yukon communities, while maximizing socio-economic benefits. Reclamation and closure activities achieve outcomes that meet community and regulatory expectations.
Long-term Certainty	Minimize the need for long-term operations, maintenance and monitoring after reclamation activities are complete.
Financial Considerations	Minimize outstanding liability and risks after reclamation activities are complete.

Table 3-2: Minto Mine Specific Closure Objectives

Mine Components	**Water Retention and Water Conveyance Structures**	**Open Pits**	**Waste Rock Storage Facilities**	**Tailings Storage Facilities**	**Mine Infrastructure**	**Roads and Other Access**
Components Breakdown	Constructed wetland areas, Closure conveyance channels, Water storage pond	Main Pit, Area 2 Pits, Area 118 Pit, Minto North Pit	Main Waste Dump/Expansion, Southwest Waste Dump, Mill Valley Fill Extension, Main Pit	Dry Stack Tailings Storage Facility, Main Pit Tailings Management Facility, Area 2 Pit Tailings Management Facility	Milling Complex, Camp, Laydowns, Fuel Farms, Solid Waste Facility	All roads, Airstrip, laydowns, general areas of disturbance
YG Fundamental Closure Objectives	Physical Stability Chemical Stability Long-term Certainty	Health and Safety Physical Stability Chemical Stability	Physical Stability Chemical Stability Long-term Certainty Aesthetics Land Use Ecological Conditions and Sustainability Socio-economic Expectations	Physical Stability Chemical Stability Long-term Certainty Aesthetics Land Use Ecological Conditions and Sustainability Socio-economic Expectations	Health and Safety Land Use Aesthetics Socio-economic Expectations	Land Use Health and Safety Socio-economic Expectations
SFN Fundamental Closure Objectives	• Work towards a passive closure scenario for most mine components. • Ensure long term chemical and physical stability of mine components and disturbed areas. • Reclaim the mine site and affected areas to a state similar to surrounding lands so that people can pursue traditional activities in the manner they did before mining. • To protect the environment from effects of earthquakes, floods, climate change and other natural events.	• Protecting the health and safety of people pursuing traditional activities. • Work towards a passive closure scenario for most mine components. • Ensure long term chemical and physical stability of mine components and disturbed areas.	• Protecting the health and safety of people pursuing traditional activities. • To protect the environment from long-term effects caused by the mine activities and facilities. • Work towards a passive closure scenario for most mine components. • Ensure long term chemical and physical stability of mine components and disturbed areas. • Reclaim the mine site and affected areas to a state similar to surrounding lands so that people can pursue traditional activities in the manner they did before mining. • To protect the environment from effects of earthquakes, floods, climate change and other natural events. • To confirm the effectiveness of closure measure by monitoring the site after closure. • To have a long-term benefit legacy for SFN people and businesses resulting from participation in closure and post-closure activities.	• Protecting the health and safety of people pursuing traditional activities. • To protect the environment from long-term effects caused by the mine activities and facilities. • Work towards a passive closure scenario for most mine components. • Ensure long term chemical and physical stability of mine components and disturbed areas. • Reclaim the mine site and affected areas to a state similar to surrounding lands so that people can pursue traditional activities in the manner they did before mining. • To protect the environment from effects of earthquakes, floods, climate change and other natural events. • To confirm the effectiveness of closure measure by monitoring the site after closure. • To have a long-term benefit legacy for SFN people and businesses resulting from participation in closure and post-closure activities.	• Protecting the health and safety of people pursuing traditional activities. • Reclaim the mine site and affected areas to a state similar to surrounding lands so that people can pursue traditional activities in the manner they did before mining. • To have a long-term benefit legacy for SFN people and businesses resulting from participation in closure and post-closure activities.	• Protecting the health and safety of people pursuing traditional activities. • Reclaim the mine site and affected areas to a state similar to surrounding lands so that people can pursue traditional activities in the manner they did before mining. • To have a long-term benefit legacy for SFN people and businesses resulting from participation in closure and post-closure activities.
Minto Specific Closure Objectives	• Ensure decommissioning of, or upgrades to, water retention and sediment control structures, and appurtenances, in such a way that drainage at, and the site is stable in the long term • Convey flows into and throughout the mine footprint, and off of the site in a controlled, stable fashion under a reasonable range of anticipated conditions • Develop practical designs for structures while considering unforeseen circumstances and events over a long period of time. • Where practical and required include deterrents to limit wildlife usage.	• Ensure physical and chemical stability of decommissioned pit • Able to withstand severe climatic events • Protect humans and wildlife from topographic hazards associated with pit and pit lake	• Ensure long-term physical stability to minimize erosion, subsidence or slope failure • Able to withstand severe climactic and seismic events • Ensure long-term chemical stability such that runoff and seepage do not increase loading and degrade water quality • Where practical incorporate into landform designs, natural topography • Where practical incorporate ascetics and wildlife habitat into closure measures	• Ensure facilities are designed for closure conditions, so as to ensure physical and chemical stability when decommissioned • Minimize potential of mobilization (Aeolian or aqueous) of tailings or contaminants • Able to withstand severe climactic and seismic events • Ensure long-term chemical stability such that runoff and seepage do not increase loading and degrade water quality is considered in closure measures • Where practical incorporate into landform designs, natural topography • Where practical incorporate ascetics and wildlife habitat into closure measures	• Where practical remove potential threats to public health and safety • Decommission facilities in a safe manner • Ensure physical stability of any remaining structures • Consider the site aesthetics and local opportunities during component reclamation.	• Minimize, eliminate or manage invasive species colonization at linear features in closure • Minimize where feasible the risk to public safety • Where practical incorporate local perspective in closure measure

3.1.3.1 Closure Water Quality Objectives

This section presents information related to the establishment of water quality objectives (WQOs) for the closure and post-closure periods. It includes background and guiding language in current project authorizations, a summary of work completed to date with SFN under a framework for post-closure WQO development, WQOs for evaluating project performance related to receiving water quality, and a discussion of how attainment of the objectives drives the closure phases.

3.1.3.1.1 Background

Section 3.1 above discusses the selection and application of closure objectives in a general sense, and also specific to mine components for closure of the Minto Mine. One of the key closure objectives is 'chemical stability' of mine components, and this can be extended to the aquatic receiving environment as well. A key mine closure performance indicator will be maintenance of functioning and healthy aquatic ecosystems in the receiving environment, and SFN also maintains Final Agreement rights as the landowner in the mine receiving area.

Water quality objectives, as a term, has been utilized to refer to 'targets' for water quality at certain locations. They can be narrative, but are more typically numerical. In the closure context as outlined in Section 3.1 above, numerical WQOs are a closure criterion – a measurable condition against which achievement of the closure objectives can be evaluated/confirmed. There are a range of methods available for the development of WQOs, and they are specific to an end-member condition (e.g. protection of aquatic life, non-degradation from background conditions). As a jurisdiction, Yukon does not have formalized guidance on preferred methods for the development of WQOs.

QZ14-031 includes numerical WQOs for the operational period, applied in lower Minto Creek. These operational WQOs are the basis of the operational effluent quality standards (EQSs) and are also key values utilized as specific performance thresholds in the operational Adaptive Management Plan. As noted in Section 1.4, post-closure WQOs will be applied to the Post-Closure II period only. In the Phase V/VI application, Minto had proposed to use the operational WQOs for the closure and post-closure periods. On review, the Yukon Water Board elected an alternative approach in QZ14-031, as follows:

> *113) The updated RCP, required by clause 110 shall include Post-Closure (Phases I-II) WQOs that meet the criteria for Non-Degradation of Background Concentrations in Minto and McGinty creeks. If Non-Degradation of water quality is not achievable, then WQOs shall be set at no more than 50% of the assimilative capacity of Minto Creek, as calculated using the following formula:*
>
> ***Closure and Post-Closure WQOs = Background Concentrations + (0.5 * ((WQO Operations) – (Background Concentrations))***

where *WQO Operations* refers to the Operational period WQOs listed in Table 2- Water Quality Objectives in QZ14-031. The licence further defines Non-Degradation and Background Concentrations as follows:

> *"Background Concentrations" means the datasets presented in the Application:*
> *- Exhibit 1.11.1.6, Section 3.3, Table 3-13 - Access Consulting Group. 2014. Minto Creek*

Water Quality Characterization (Revision 1). Prepared for Minto Explorations Ltd. (MEL); and - Exhibit 1.11.1.10, Section 4.3, Table 4-11 - Access Consulting Group and Minnow Environmental Ltd. 2014. McGinty Creek Water Quality Characterization May 2009- July 2012. Prepared for MEL.

"Non-Degradation" refers to water quality that is not statistically significantly different from the Background Concentrations.

QZ14-031 defines the above-referenced data set for use in defining Background Concentrations in Minto Creek and McGinty Creek, but it does not define how that data set will be used to develop the background definition. The sections that follow outline how Minto has worked with SFN to develop post-closure water quality objectives that are achievable, acceptable to Minto and SFN, and reflect the application of reasonable and practical passive treatment.

3.1.3.1.2 Post-closure WQO Development

A six-step process for the development of post-closure WQOs for Minto Creek was collaboratively developed by Minto and SFN. The framework for the development of these WQOs was a component of the RCP v5.1 (Capstone, 2016), and the process has been completed. This section outlines the process undertaken to develop numerical post-closure WQOs for Minto Creek and how they are applied.

Minto drafted the initial framework in early 2015, prior to the Yukon Water Board's deliberations and issuance of QZ14-031. The framework was therefore based on language in the Phase V/VI Decision Document, which provided clear guidance for the development of post-closure water quality objectives:

33. Non-degradation (compared to historical background quality) of Minto Creek water quality shall provide the basis for the development of water quality objectives for the closure period. However, if non-degradation cannot be achieved using reasonable and practical passive treatment mitigations, then the closure objective shall be guided by what can be practically achieved (as long as the objectives are below the effects levels for aquatic resources with sufficient contingency). Determination of "reasonable" and "practical" mitigations must take into account the expected or actual site performance of a given mitigation, and the cost of the mitigation (both initial cost and long-term maintenance cost) compared to the expected contaminant reductions.

The framework consisted of six steps, intended to parallel the development of a plan for the implementation of passive treatment of mine impacted water at the site, in a manner that is both reasonable and practical. The steps, including a description of work undertaken, include:

Step 1: Confirm technologies - Selection of viable and reasonable passive treatment technologies for further consideration/research was conducted, and was presented in RCP v5.1 Section 2.2. The technologies were further reviewed to define which technologies are reasonable and practical. This work is further summarized in Section 2.4.1 and the full memorandum is included in Appendix C. This work also established a working definition of 'reasonable and practical', in the context of passive water treatment options. For the purposes of evaluating and refining technology selections for passive water treatment and the Minto site, 'reasonable and practical' was defined as having the following criteria:

- Operationally passive:
    - Self-sustaining in the long-term (e.g. minimal need for electricity or chemical addition)
    - Minimal ongoing operational oversight required
    - Does not require active decommissioning activities
- Minimizes long-term maintenance:
    - Able to naturalize, with only periodic and limited maintenance requirements
    - Most maintenance can be performed manually (i.e., does not require heavy equipment)
    - No routine addition of substrates or organics

The Sections 3.1 through 3.5 in the same document identifiy how this definition was then applied for the selection of candidate closure treatment options.

Step 2: Develop Configuration Options – Minto elected to move forward in the planning process with SFN utilizing the most passive of the options identified in Step 1 (Constructed Wetland Treatment Systems) as being reasonable and practical technologies for consideration going forward. The remaining technologies shortlisted can be viewed as contingency options for consideration should the Closure AMP be triggered to re-evaluate the treatment systems installed.

In early 2016, Minto developed a set of options for the location of potential treatment system installations. These were evaluated by the BTWG in consideration of spatial and temporal constraints (where and when would treatment installations be needed). This discussion focussed on areas with a contaminant load, and where actual wetland construction could be achieved:

- An area to the east of the Southwest Dump (around W15 monitoring location); and
- The Water Storage Pond footprint.

Other areas considered but not pursued further, (with rationale for not pursuing further) include:

- Between the WSP and the toe of the MVFE
    - limited available area and an important water conveyance infastructure location, so more value was placed on retaining this area for water conveyance requirements.
- The area around the former Mill Water Pond
    - This is the location of WTP, which needs to remain onsite and operational as a closure contingency, so timing/implementation of a passive treament installation here was not practical.
- Locations off the mine footprint
    - Lease and topography issues were identified, and team did not see value in further disturbances, road construction, etc.
- The outlet of the Main Pit
    - This has also been retained as a contingency option, but the initial evaluations were unclear as to if a meaningful load reduction could be achieved in this location.

In the process of this discussion, it was recognized that primary closure water conveyance considerations needed to be considered at the same time, so Minto included options and conveyance variants in different areas in the presentations and disucssions with SFN. The group determined that the original Phase V/VI conveyance routing was still the preferred alignment.

Minto then advanced these options into a set of possible layouts, which were again informed by spatial constraints at site as well as temporal considerations. These were presented in a workshop setting with considerations regarding timing of construction/implementation, and a transition strategy for passive treatment installations.

Step 3: Select Configuration and Implementation Strategy – Minto and SFN reviewed the options for configurations of passive treatment installations developed in Step 2 in a series of workshops in spring 2016. Minto presented some preliminary options with associated considerations related to constructability, treatment cell shape and alignment, elevation/fill, and conveyance. It was during these sessions that the importance of a high flow bypass channel was raised and incorporated into the planning for the WSP CWTS installation.

The group selected the most appropriate configuration and implementation strategy. This is the basis of *where and when* passive treatment will be reasonable and practical. This initially inlcuded both a CWTS at the WSP and a terraced wetland installation in the area of W15. However, based on the current evaluation a terraced wetland in the W15 area is not expected to have a significant impact on the reduction of load and therefore is deemed not reasonable or practical.

The configuration of the proposed CWTS installation is presented in Section 7.7.5, and the implementation strategy is outlined in Section 8.2.

Step 4: Refine Performance Expectations – Minto refined existing performance expectations for the proposed CWTS based on the configuration and implementation strategy selected in Step 3 and the best available information, including results of site specific investigations. These have since been reviewed and refined further based on the ongoing findings of research work outlined in section 2.2.3.1. This review and refinement of the CWTS performance expectations will continue as appropriate under the reclamation research program.

Step 5: Updated Water Quality Estimates – Minto incorporated the performance expectations from Step 4 into updated Load Balance and Water Quality Predictions for an appropriate range of closure conditions/scenarios. This work was presented in Section 5.4.3 of RCP v2017-01, and has been updated again with monitoring and research program data in Appendix I.

Step 6: Define Closure Period WQOs – Minto and SFN worked together to evaluate the outcomes of the previous steps to develop closure period WQOs. It was acknowledged in this step that objectives should be developed for both short and long-term condition evaluation, so Minto and SFN developed numerical *individual data point evaluator* and *central tendency evaluator* WQOs for each of the required non-degradation and upper threshold (50% of assimilative capacity) concepts. Minto and SFN were able to achieve agreement of this set of closure WQOs, and Minto considers this a substantial achievement of the collaborative technical process.

The process of developing the WQOs helped the technical teams identify associated considerations. The application of the WQOs (how will they be utilized) and the definition of attainment (how will we know when we have met the objectives) were identified as key considerations that were discussed at length both as the numerical WQOs were being developed, and after the agreement on the WQOs had been reached. Minto and SFN are in agreement that the Closure AMP is the primary management framework within which the application of the WQOs should be outlined, and the revised Closure AMP outlined in Section 7.12.1 and in Appendix J2 has been updated considerably. The Minto Creek Water Quality section is built exclusively around managing the Minto site in post closure to achieve the post closure WQOs. SFN has reviewed revision 2017-01 of the Closure AMP, and revision 2018-01 has incorporated SFN's feedback in a number of areas, including the inclusion of a continous improvement plan for passive water treatment, and utiziling attainment of post closure objectives to trigger the transition from PCI to PCII. Some details of the AMP around specific thresholds and responses are still under discussion with SFN.

The details of the process undertaken to arrive at agreed-upon closure WQOs is presented below, and the outcomes of this step are discussed in detail in Section 3.1.3.1.3.

Development of Background Water Quality Characterization

Both approaches (non-degradation and 50% of assimilative capacity) for the development of closure WQOs required a clearly-defined background water quality condition. Definition of the background water quality of Minto Creek (applicable at lower Minto Creek) was discussed in detail among Minto, SFN, and technical consultants in June 2016. Although WUL QZ14-031 (Clause 113) refers to Access 2014 as the statistical basis for background water quality, Minto and SFN put forth *Background Water Quality of Lower Minto Creek for Application in the Derivation of Post-Closure Water Quality Objectives* (Minnow, 2016) in Appendix H as a more appropriate and robust background water quality evaluation for Minto Creek. These discussions and the report in Appendix H covered a number of factors critical to the clear definition of background water quality, including representative sampling stations, contaminants of potential concern (COPCs), dealing with less than method detection limit (MDL) results, dealing with replicate results, identifying outliers, evaluation of possible data groupings, and the designation of summary statistics to be used as non-degradation WQOs or for the development of higher threshold WQOs. Following the process below, SFN and Minto are in agreement on the statistical representation of background water quality that is the foundation of the non-degradation WQOs.

Following the application of the rationalized rules for developing the representative background water quality dataset, the dataset was used to calculate two key summary statistics for each COPC to represent background water quality of lower Minto Creek and for potential application as WQOs or for the development of WQOs. Specifically, the two key summary statistics were:

1. the 95^{th} percentile of the background dataset (Appendix F); and
2. the 95^{th} percentile of the annual medians of the background dataset (Appendix F).

The intended use of the 95^{th} percentile of the background dataset is as an "individual data point evaluator" to assess short-term maximum contaminant concentrations in the receiving environment. The intended use of the 95^{th} percentile of the annual medians is as a "central tendency evaluator" to assess long-term average contaminant concentrations in the receiving environment. The 95^{th} percentile of the background dataset was adopted as the individual data point evaluator non-degradation WQO while the 95^{th} percentile of the annual medians was adopted as the central tendency evaluator non-degradation WQO. In addition, and in accordance with the WUL, associated "50% Assimilative Capacity" concentrations were calculated (Table 3-3). These concentrations were calculated from the agreed upon background concentrations and operational stage WQOs according to the formula provided in the Minto WUL.

As mentioned above, Minto and SFN do agree that a well-designed AMP provides a reasonable mechanism for evaluating attainment, and implementing appropriate responses. A fundamental guiding principle is that, because the non-degradation WQOs are based on the 95th percentiles, they will be exceeded at an average rate of 5% in the absence of any mine influence on water quality. Exceedences are expected. Exceedances of the 50% of assimilative capacity objectives were also observed in historical background water quality monitoring results. Thus, definition of attainment must consider natural exceedance rate, and initial response to any observed exceedance must be focussed on distinguishing a mine related influence from natural variability. Attainment of the non-degradation and 50% of assimilative capacity WQOs are discussed in the following section.

Through discussions with SFN, Minto has adopted the same methodology for the development of non-degradation WQOs for McGinty Creek. The only difference with the methodologies is that background water quality data up to July 2015[2] has been included in the dataset evaluated for the summary statistics. McGinty Creek will not be subject to 50% of assimilative capacity WQOs, as non-degradation from background conditions will be the narrative objective for water quality in the receiving environment of that catchment (Table 3-4). Both sets of WQOs are presented in the following section.

3.1.3.1.3 Numerical Water Quality Objectives

Minto Creek

The bilateral process for defining numerical post-closure WQOs (outlined above) has concluded. Based on discussions held in the bilateral forum, agreement on the numerical water quality objectives was achieved in principle. The outcome of that agreement is a set of WQOs based on non- degradation and a second set of 50% of assimilative capacity WQOs. Each WQO concept has an individual data point evaluator objective and a central tendency evaluator as shown in Table 3-3 below.

The 95th percentile of the background water quality dataset was adopted for each contaminant of concern as the individual data point evaluator for the non-degradation WQOs, as described in more detail in Appendix F. The central tendency evaluator for the non-degradation WQOs were derived utilizing the 95th percentile of annual medians and is described in more detail in Appendix F.

The 50% of assimilative capacity WQOs were calculated using the formula outlined in QZ-14-031 and shown above in Section 3.1.3.1.1. The non-degradation individual data point evaluators were used for the background value in the 50% of assimilative capacity calculation for the individual data point evaluator WQOs. The non-degradation central tendency evaluators were used for the background value in the 50% of assimilative capacity calculation for the central tendency evaluator WQOs. In both cases, the operational WQOs as defined in water licence QZ-14-031 were used as the “WQO Operations” variable in the calculation.

[2] Mining at Minto North pit started on August 5th, 2015.

As noted previously, through this amendment application Minto is proposing to apply the post-closure WQOs to the Post-Closure II period only, and to have operational WQOs apply through the end of the Post-Closure I period (for Minto Creek only - see Section 1.4 and 7.6 for additional details on closure periods). The proposed WQOs for McGinty Creek below would apply to all mine closure periods.

Table 3-3: Non-Degradation and Associated 50% of Assimilative Capacity Water Quality Objectives for Minto Creek, to be applied at Station W2.

Analytes	Non-Degradation		50% Assimilative Capacity	
	Individual Data Point Evaluator (95th percentile)	Central Tendency Evaluator (95th percentile of annual medians)	Individual Data Point Evaluator (95th percentile)	Central Tendency Evaluator (95th percentile of annual medians)
Ammonia (mg/L)	0.12	0.063	0.18	0.13
Nitrite (mg/L)	0.04	0.028	0.05	0.04
Nitrate (mg/L)	0.22	0.15	4.7	4.6
Dissolved Al (mg/L)	0.053	0.032	0.077	0.066
Dissolved As (mg/L)	0.0011	0.00086	0.0031	0.0029
Dissolved Cd[1] (mg/L)	0.00005	0.000044	0.000221	0.00019
Dissolved Cr (mg/L)	0.0011	0.001	0.0011	0.001
Dissolved Cu (mg/L) (when DOC @ W2 > 10 mg/L)	0.0054	0.0029	0.013	0.011
Dissolved Cu (mg/L) (when DOC @ W2 ≤ 10 mg/L)	0.0054	0.0029	0.0092	0.0079
Dissolved Fe (mg/L)	0.91	0.57	1	0.84
Dissolved Pb (mg/L)	0.00025	0.00014	0.0021	0.0021
Dissolved Mo (mg/L)	0.0015	0.0011	0.037	0.037
Dissolved Ni (mg/L)	0.002	0.0016	0.056	0.056
Dissolved Se (mg/L)	0.0005	0.00046	0.0013	0.0012
Dissolved Ag (mg/L)	0.00001	0.00001	0.000055	0.000055
Dissolved Zn (mg/L)	0.0084	0.0046	0.019	0.017

[1]Cadmium value calculated using 95th percentile hardness (225.2 mg/L) in Operational Stage WQO calculation. Actual objective for comparison with monitoring results will be calculated with observed hardness.

Table 3-4: Background Concentrations (PC WQOs) for McGinty Creek, to be applied at Station MN-4.5.

Analytes	Background Concentrations	
	Individual Data Point Evaluator (95th percentile)	Central Tendency Evaluator (95th percentile of annual medians)
Ammonia (mg/L)	0.118	0.046
Nitrite (mg/L)	0.050	0.005
Nitrate (mg/L)	0.232	0.083
Dissolved Al (mg/L)	0.135	0.047
Dissolved As (mg/L)	0.00061	0.00054
Dissolved Cd (mg/L)	0.000041	0.000015
Dissolved Cr (mg/L)	0.0010	0.0010
Dissolved Cu (mg/L)	0.0035	0.0028
Dissolved Fe (mg/L)	0.403	0.358
Dissolved Pb (mg/L)	0.00020	0.00020
Dissolved Mo (mg/L)	0.0010	0.0010
Dissolved Ni (mg/L)	0.0018	0.0016
Dissolved Se (mg/L)	0.00019	0.00016
Dissolved Ag (mg/L)	0.000020	0.000020
Dissolved Zn (mg/L)	0.0052	0.0050

3.1.3.1.4 Post-closure WQO Attainment

Attainment of the different post-closure WQOs are defined and applied differently in application – specifically in the Closure AMP and in determining the transition timing between Closure Phases PCI and PCII.

Attainment of the Non-degradation WQOs is an important target in closure planning and adaptive management planning. The closure measures have been developed and designed to reduce contaminant loading to Minto and McGinty Creeks to the degree that they are reasonable and practical. The Closure AMP has been designed (specifically for Minto Creek) to promote continuous improvement of runoff water quality through the PCI closure phase (Closure AMP section 2.1.3.3) but extends that commitment beyond PCI with considerations to improve water quality mitigation measures in PCII, with the goal of attaining non-degradation objectives. The Closure AMP outlines how this is approached, and the mechanisms for transitioning to the 50%AC objectives. Progress towards attainment of these objectives will be evaluted through a trend assessment methodology, and a fixed duration 'cap' of five (5) years will be placed on the continuous improvement expectations for the application of this non-degradation framework. In other words, efforts will continue to attempt to achieve non-degradation objectives for a maximum of five years in PCII. This balance has been struck with SFN to ensure efforts continue towards non-degradation objectives, but that a reasonable timeline is established for transition to the 50%AC objectives if non-degradation is not being achieved.

In the case of the non-degradation condition being declared unattainable for any given specific indicator, that parameter will be subject only to the 50% of assimilative capacity water quality objectives. Until such time, the specific indicators will be subject to both AMP frameworks to ensure that actions are implemented in the case where 50% assimilative capacity WQOs are approached or exceeded early in the post closure period.

As briefly discussed above in section 3.1.3.1.2, the 50% of assimilative capacity post closure WQOs have been exceeded from time to time in the historical background monitoring results (i.e. at stations without any mine-related influence), and there is no reason to expect any different in the future and therefore the definition of attainment is an important concept. Minto's proposed criteria for attainment of the 50%AC post-closure WQOs are that, for each COPC:

1) the "individual data point evaluator" WQO is not exceeded in two consecutive samples;
2) not more than two exceedances of the "individual data point evaluator" WQO occur per year; and
3) there are no exceedances of the "central tendency evaluator" based on water quality results on three year rolling average.

This definition aligns with there being no exceedance of Specific Threshold 4 in Table 2-11 in the Closure AMP (Appendix J2).

In advance of their application in PCII, attainment of a key subset of the 50%AC WQOs will be used in PCI to trigger the transition between these closure phases. These key parameters include Cu, Se (design basis elements of CWTS), NO_3 and As.

3.2 Design Criteria

Design criteria are presented in the relevant design documents. The information in this section is provided for summary purposes only- the design documents stand alone and take precedence.

3.2.1 Water Management Structure and Systems

The post-closure water management system at Minto mine will consist of the following:

- Water conveyance system (primary, secondary, and tertiary channels);
- Water reservoirs (Main Pit and Area 2 Pit); and
- Passive treatment facilities (wetlands) (Appendix G1).

Design criteria and preliminary design specifications for the water conveyance system are provided in the Minto Mine – Closure Water Conveyance System Design Update Report (Appendix G2). The closure conveyance structures are a network of channels, erosion protection features, and energy dissipation structures that convey surface water from the mine area to lower Minto Creek.

The conveyance design report focuses on the primary arterial network of conveyance structures within the mine footprint. Secondary and tertiary drainage features and swales are not included in the preliminary engineering design for the conveyance channels, however the engineering designs for the closure covers (Appendix E3) do take account of drainage from the various covered facilities. It is anticipated that the design of the secondary and tertiary drainage features will not have a significant influence on the design of the primary conveyance network.

No specific design criteria were considered for the reservoirs (the Main Pit lake and the Area 2 Pit lake) formed by the mined-out pits.

3.2.1.1 Water Conveyance System

Hydrology: Primary conveyance channels are designed to convey all flows up to the 24-hour duration, 1:200 year return period event without significant damage to the channel protection. All primary channels are topographically located such that flows up to the Probable Maximum Flood will be contained by topography and post-flood flows will recede to the primary conveyance channels.

Channel Alignment: Conveyance channel alignments were selected based on four main criteria: 1) Conveyance of runoff generated from catchment areas, 2) Minimization of channel slopes to the extent practical, 3) Utilization of end pit lakes to attenuate flow and settle sediment, and 4) Ultimately convey flows to Minto Creek upstream of the W3 monitoring station. In addition, the potential for long term thaw consolidation of ice-rich permafrost overburden soil to cause changes in conveyance alignments was considered, and alignments were selected to limit channel length over deeper permafrost overburden where possible.

Concept of Low Maintenance: Closure conveyance channels must be designed in a manner that their constructed features are robust and durable. Key design criterial should consider:

- Rock riprap erosion protection;
- Robust geometry that reduces the risk of overtopping and erosion;
- Accounts for future climate change conditions and discharge requirements; and
- Utilizes the end pit lakes for mixing, energy dissipation, and sediment deposition.

3.2.1.2 Energy Dissipation Basins and Aprons

The energy dissipation apron for Channel A is intended to transition high energy channel flow into the Main Pit and minimize erosion. The apron riprap specification will be defined in a later design stage once as-built surface details are available- at a minimum, the apron riprap will sized to withstand the 1:200 year design flows.

The stilling basin for Channel E Segment 3 is designed to dissipate the energy from the design flows exiting the channel and entering the Primary Head Pond. The stilling basin (including the riprap component) has been designed to handle the Probable Maximum Flood.

3.2.1.3 Riprap Protection and Seepage Management

All primary closure conveyance channels are designed to be lined with rock riprap for erosion protection. Each channel is divided into segments that relate to a typical riprap classification.

Seepage loss through the conveyance channels likely to be limited and is considered to pose a minimal risk to the environment. At later stages of closure design the need for a geomembrane or low conductivity layer will be further evaluated to determine whether segments of the conveyance channels require additional seepage control.

3.2.1.4 Water Reservoirs

The Main Pit water reservoir is planned to have a nominal water elevation of 786 masl.

The Area 2 Pit water reservoir is planned to have a nominal water surface elevation of 799 masl.

The Water Storage Dam currently impounds the Water Storage Pond. The Water Storage Pond will be converted to a constructed wetland treatment system during the Active Closure Period, and the Water Storage Dam will be decommissioned over the same period. The Water Storage Dam design stability exceeded the minimum Factor of Safety (FoS) for the following conditions: FoS ≥1.5 for the steady state seepage condition, FoS ≥1.2 for the stability of the upstream face in a submerged condition, and FoS ≥1.2 for seismic loading conditions using a peak ground acceleration of 0.083g (EBA 1995).

3.2.1.5 Constructed Wetland Treatment System

Design criteria for the CWTS are provided in Appendix G1 (CWTS Design Document) and are also provided in the key findings in Section 2.2.3.1.

3.2.2 Overburden and Waste Rock Dumps

Per Yukon requirements, design criteria for overburden and waste rock dumps are based on the recommended Factors of Safety (FOS) listed in the "Mined Rock and Overburden Piles Investigation and Design Manual" (BC Mine Waste Rock Pile Research Committee 1991); these are provided in Table 3-5.

Table 3-5: BC Mined Rock and Overburden Pile Minimum Factor of Safety Guidelines

Stability Condition	**Suggested Minimum Design Values for FOS**	
	Case A	**Case B**
Stability of Dump Surface		
Short-term (during construction)	1.0	1.0
Long-term (reclamation – abandonment)	1.2	1.1
Overall Stability (Deep Seated Stability)		
Short-term (static)	1.3 – 1.5	1.1 – 1.3
Long-term (static)	1.5	1.3
Pseudo-static (earthquake)	1.1 – 1.3	1.0
Case A Low level of confidence in critical analysis parameters Possibly unconservative interpretation of conditions or assumptions Severe consequence of failure Simplified stability analysis method (charts, simplified method of slices, etc...) Stability analysis method poorly simulates physical conditions Poor understanding of potential failure mechanism(s)		
Case B High level of confidence in critical analysis parameters Conservative interpretation of conditions, assumptions		

Minimal consequence of failure
Rigorous stability analysis method
Stability analysis method simulates physical conditions well
High level of confidence in critical failure mechanism(s)

The waste dump seismic design criteria based on BC Mine Waste Rock Pile Research Committee 1991 guidance that outlines that a 10% probability of exceedance in 50 years or the 1:475 event is appropriate for dump design. The peak ground acceleration in the Minto project area is approximately 0.05 g (per the 2015 National Building Code). Table 3-6 lists the design peak ground acceleration utilized in design of waste dumps and other structures at Minto. It should be noted that the range in the design criteria listed in the above table is a function of updates to the National Building Code Seismic Hazard models over time. For example, the Main Waste Dump was designed in the mid-1990s and subsequent to its design, the Geological Survey of Canada revised the seismic hazard model which reduced the peak ground acceleration at Minto for the design event (1:475 year earthquake) from 0.150 g to 0.057 g. The 2015 revision to the seismic hazard model further reduced the peak ground acceleration for the 1:475 year earthquake at Minto to 0.05 g from 0.057 g (see Minto Mine Site Characterization Report (Appendix H)).

Table 3-6: Design Peak Ground Acceleration of Minto Structures

Structure	Design Peak Ground Acceleration	Reference
Water Storage Dam	0.083	EBA 1995
Main Waste Dump	0.15 g	EBA 1998
Ice Rich Overburden Dump	0.055 g	EBA 2006
Dry Stack Tailings Storage Facility	0.055 g	EBA 2007
Southwest Waste Dump	0.055 g	EBA 2008
Main Waste Dump Expansion	0.057 g	SRK 2013a
Area 118 Backfill Dump	0.057 g	SRK 2013c
Main Pit Dump	0.057 g	SRK 2013a
Mill Valley Fill Extension Stage 2	0.057 g	SRK 2015a

The potential for liquefaction of saturated zones of sand and silt (colluvium) layers to liquefy under earthquake loading and long-term closure conditions (thawed) was assessed as part of the MVFE Stage 2 perofrmance monitoring plan (SRK 2017) and concluded that the thawed overburden is unlikely to liquefy under the design earthquake event.

3.2.3 Tailings Storage Facilities

The Main Pit TMF, the Area 2 Pit TMF, and the Ridgetop North TMF are all in-pit tailings storage facilities and none are subject to rigorous design criteria. The Main Pit TMF is expected to have a combination of subaerial and subaqueous tailings, the Area 2 Pit TMF is expected to have only subaqueous tailings, and the Ridgetop North Pit TMF is expected to have only subaerial tailings at the start of Active Closure.

As noted in Table 3-6, the DSTSF design criteria were: Factor of Safety (FoS) ≥1.3 for long term stability, and FoS ≥1.1 for seismic stability (using a peak ground acceleration of 0.055 g.

3.2.4 Cover Systems (Soil and Vegetation)

Design criteria for soil covers are presented in the cover design report (Appendix E3) and can be summarized as follows:

- Design life: 100 years
- Slope stability of dump surface (long term- Table 3-5): Factor of Safety ≥ 1.1
    - Erosion resistance:
    - Soil loss of <6 t/ha/year after implementation of erosion control measures (e.g. vegetation establishment) are fully implemented
    - No damage following 1:200 year, 24 hour duration storm during peak freshet conditions

Additional qualitative design performance considerations are discussed in the cover design report.

In general, reclamation cover systems will be seeded with a blend of native grasses – in conjunction with agronomic ryegrass (and or oats) and alfalfa on slopes where erosion is a concern and rapid establishment of vegetation cover is an objective – and planted with native woody species. A list of candidate species for seeding is provided in Table 3-7 below. Actual seed mixes will depend on characteristics of the sites to be seeded and commercial availability of species at the time of seeding; for example, violet wheatgrass is a potential grass for inclusion in reclamation seed mixes, but is often not available commercially. Native woody species for planting will generally include lodgepole pine, white spruce, aspen, and birch, when seedlots are available for propagation.

Seed mixes will generally be applied at rates of roughly 25 kg/ha on plateaus (where used) and 35 kg/ha on slopes, and fertilized with N-P-K formulations at roughly 125 kg/ha. Seed mixes with various combinations of the species below have been successfully used on the Main Waste Dump (2012) and Dry Stack Tailings Storage Facility (2018) at Minto, and at other sites in Yukon such as Faro.

Table 3-7: Candidate seed-mix species for revegetation.

Common name	Latin name
Ticklegrass	*Agrostis scabra*
Blue wildrye (smooth)	*Elymus glaucus*
Northern wheatgrass	*Elymus lanceolatus*
Slender wheatgrass	*Elymus trachycaulus*
Northern fescue	*Festuca saximontana*
Annual ryegrass (diploid)	*Lolium multiflorum*
Alfalfa, creeping rooted	*Medicago sativa*
Alpine bluegrass	*Poa alpina*
Spike trisetum	*Trisetum spicatum*
Violet wheatgrass	*Agropyron violaceum*
Sheep fescue	*Festuca ovina*
Glaucous bluegrass	*Poa glauca*
Fowl bluegrass	*Poa palustris*
Tufted hairgrass	*Deschampsia caespitosa*

4 Environment Description

4.1 Site Overview

The Minto Mine is located on the west side of the Yukon River, approximately 240 km northwest of Whitehorse, Yukon (Figure 4-1) and is centered at 62°36'N latitude and 137°15'W longitude (NAD 83, UTM Zone 8 coordinates 6945000N, 384000E). Highway 2 (North Klondike Highway) is located on the east side of the Yukon River; the mine can be accessed by road in the summer by barge crossing or in winter by the ice bridge crossing at Minto Landing. The airstrip at the mine allows access by fixed-wing aircraft year-round.

A summary the environmental conditions are summarized in Table 4-1 below:

Table 4-1: Summary of Environmental Conditions

Project Area Attribute Description	Project Area Attribute Description
Region:	Yukon
Topographic map sheet:	NTS 115 I/10, 115 I/11
Geographic location name code:	Minto Project
Latitude:	62° 36' N
Longitude:	137° 15' W
Drainage region:	Yukon River
Watersheds:	Yukon River, Big Creek, Wolverine Creek, Dark Creek, McGinty Creek, and Minto Creek.
Ecoregion:	Yukon Plateau (Central) - Pelly River ecoregion.
Study area elevation:	Rolling hills above mine site at 1131 to 600 m at the Yukon River Valley bottom.
Site climate:	Temperature ranges from –43.2°C (November 2006) to 30.3°C (July 2009). Mean annual temperature of –1.8°C. Mean annual rainfall is 174mm.

Project Area Attribute Description	Project Area Attribute Description
Vegetation communities:	Riparian, black spruce, white spruce, paper birch, lodgepole pine, buck brush/willow and ericaceous shrubs, feather moss, sedge, sagewort, grassland, mixed forest (aspen, balsam, and sub-alpine). Discontinuous permafrost is present on site. Site has been subject to recent forest fires.
Wildlife species:	Moose, caribou, Dall sheep, mule deer, grizzly and black bear, varying hare, beaver, lynx, marten, ermine, deer mouse, fox, mink, wolverine, least weasel, wolf, squirrel, porcupine coyote, muskrat, otter and wood frog. Bird species include: spruce, blue, ruffed, and sharp-tail grouse; waterfowl, raptors, and a variety of smaller birds.
Fish species:	In the Yukon River: Chinook, Coho, and chum salmon, rainbow trout, lake trout, least cisco, Bering cisco, round whitefish, lake whitefish, inconnu, Arctic grayling, northern pike, burbot, longnose sucker and slimy sculpin. In Big Creek: Chinook and chum salmon, Arctic grayling and whitefish species. In Wolverine Creek: Chinook salmon, Arctic grayling, and slimy sculpin. In Minto Creek (lower reaches only): Chinook salmon, slimy sculpin, round whitefish, Arctic grayling, longnose sucker, burbot. In McGinty Creek (lower reaches only): slimy sculpin, Arctic grayling.

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

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

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

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

The climate of the region is continental with short, warm summers and very cold winters. The summer period is characterized by temperatures in the range of 10 to 20°C. The winter period is characterized by a much larger day-to-day variation in air temperatures, typically between -10 and -30°C. Annual precipitation ranges from 300 to 500 mm. Diurnal variation in air temperatures tends to be less during the winter period than during the summer. The transitions between winter and summer are characterized by a quick rise or fall in air temperatures. July has been the warmest month on average (14.6°C) while the coldest has been January (−19.1°C). The mean annual air temperature at the site is −1.8°C. The maximum air temperature ever recorded was 30.3°C. The minimum air temperature ever recorded was −43.2°C.

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

Topography in the Dawson Range is moderate and the active geomorphological processes in the study area are typically limited to include slow mass movement (solifluction) and some minor gully erosion. Although there are no reports of large-scale active natural landslides in the Minto Project area, smaller scale instabilities have recently been documented in the Minto Creek catchment area, downstream of the mine site.

A full characterization of the existing environmental conditions for the Minto Site area is included in the Minto Mine Site Characterization Report, in Appendix H.

MINTO MINE

FIGURE 4-1
PROJECT LOCATION

NOVEMBER 2020

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5 Project Description

5.1 Project Location and Background

Minto Mine is a copper-gold-silver project located on the west side of the Yukon River approximately 75 km north-northwest of Carmacks, Yukon Territory. The mine site and access road lie within the traditional territory of the Selkirk First Nation (SFN) and comprise part of land claim settlement parcels R6A, 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 was executed on November 5, 2009.

The Minto Project consists of 364 claims. There are 299 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. The claims and leases cover an area of approximately 10 square miles. Extensive exploration yielded the first significant drill intersection in July of 1973. Figure 5-1 and Figure 5-2 present visual depictions of the general project location within the Yukon and the current project area overview respectively.

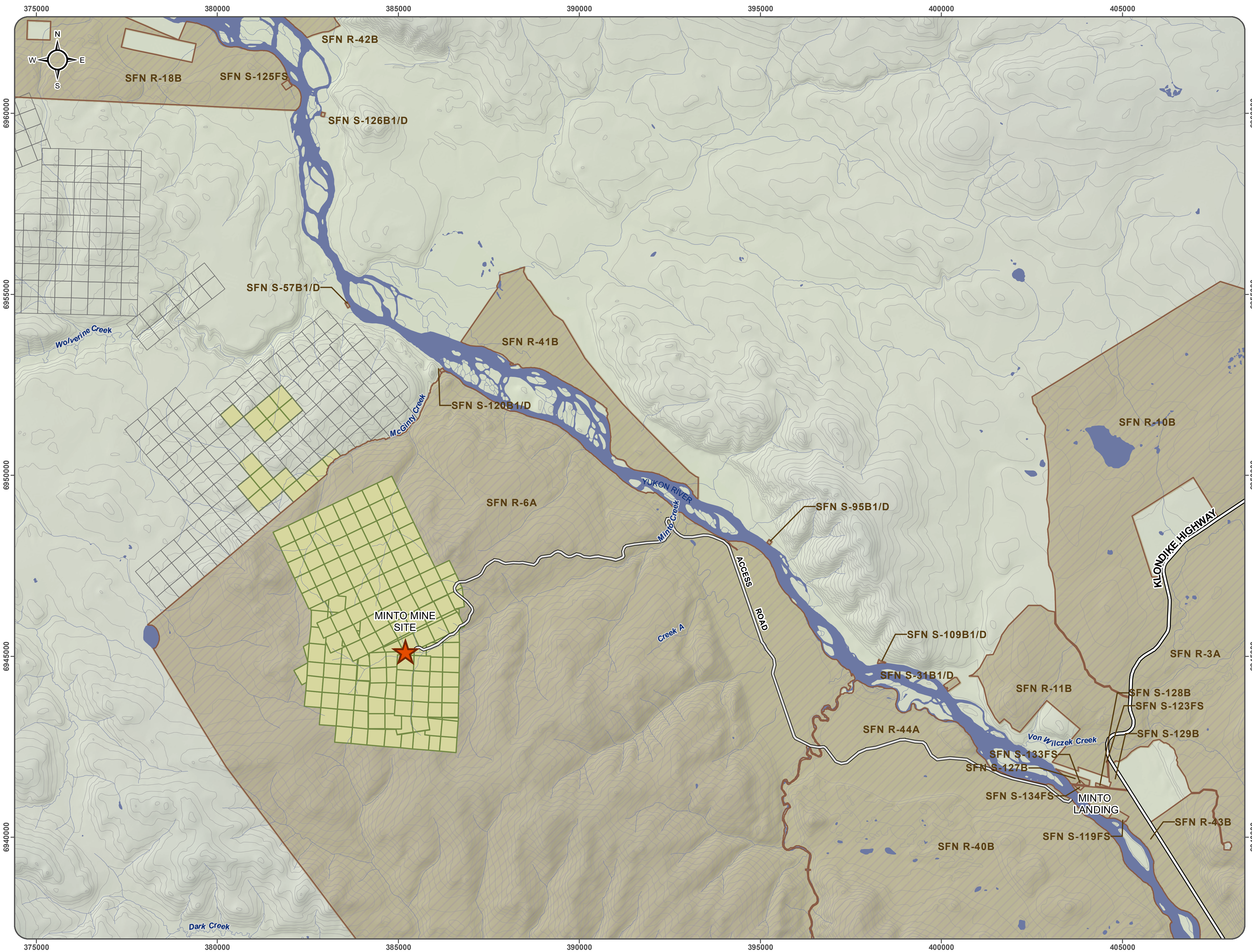
Preliminary site development was initiated at the property in 1996 and continued during the following decade with Minto commencing operations in October 2007. From 2007 through April 2011, mining at Minto took place in what is known as the Main Pit. Exploration during those years identified several other 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). Decision documents approving the application were issued in March 2011. Subsequent amendments to the mine's Quartz Mining License and Water Use License authorized the mining and ancillary activities associated with the Phase IV Project Proposal.

Another application (2010-0100) was submitted to YESAB in July 2013, aimed primarily at assessing further increases in reserves (the Phase V/VI Project Proposal). Decision documents were issued in June 2014, after which amendments to the mine's Quartz Mining License and a renewal of its Water Use License authorized the additional mining proposed in the application.

Operations consisted solely of open pit mining from 2007 until August 2012, at which time development of the Minto South Underground commenced with stripping of overburden around the portal access. To date, Minto South ore zones have been mined out while mining is underway in Minto East and Copper Keel.

The open pits at Minto were mined via a conventional truck/shovel process, while the underground mine uses primarily longhole open stoping. Mineral separation is via an on-site crushing, grinding, and flotation plant. A 256- person camp houses mine personnel.



MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 5-1
AREA OVERVIEW

NOVEMBER 2020

MINTO

- Minto Mine Site
- Mine Access Road
- Selkirk First Nation Settlement Lands
- MInto Exploration Ltd. Claims
- Other Claims

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kelometres

ENSERO solutions

First Nation Settlement land obtained from Natural Resource Canada. Quartz claim boundaires and ownership are current as of 12 November 2020.

Datum: NAD 83 Projection: UTM Zone 8N

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5.1.1 Current Activities

The following activities are currently in progress at Minto Mine:

- Deposition of SAT waste rock within the TMFs;
- Milling of the ore released from active mining areas and stockpiles;
- Deposition of tailings into both the Main and Area 2 open pits;
- Mining of Minto East is in progress;
- Mining of Copper Keel (underground) is in progress;
- Regrading of waste dumps as part of progressive reclamation work;
- Operational water management; and
- Progressive reclamation of infrastructure components whenever possible to reduce closure responsibilities.

Figure 5-2 shows the current (Year 0) site layout. This site configuration is the basis of the Year 0 closure cost liability calculation in Section 9.

MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 5-2

SITE CONFIGURATION - YEAR 0 (AUGUST 2020)

NOVEMBER 2020

MINTO

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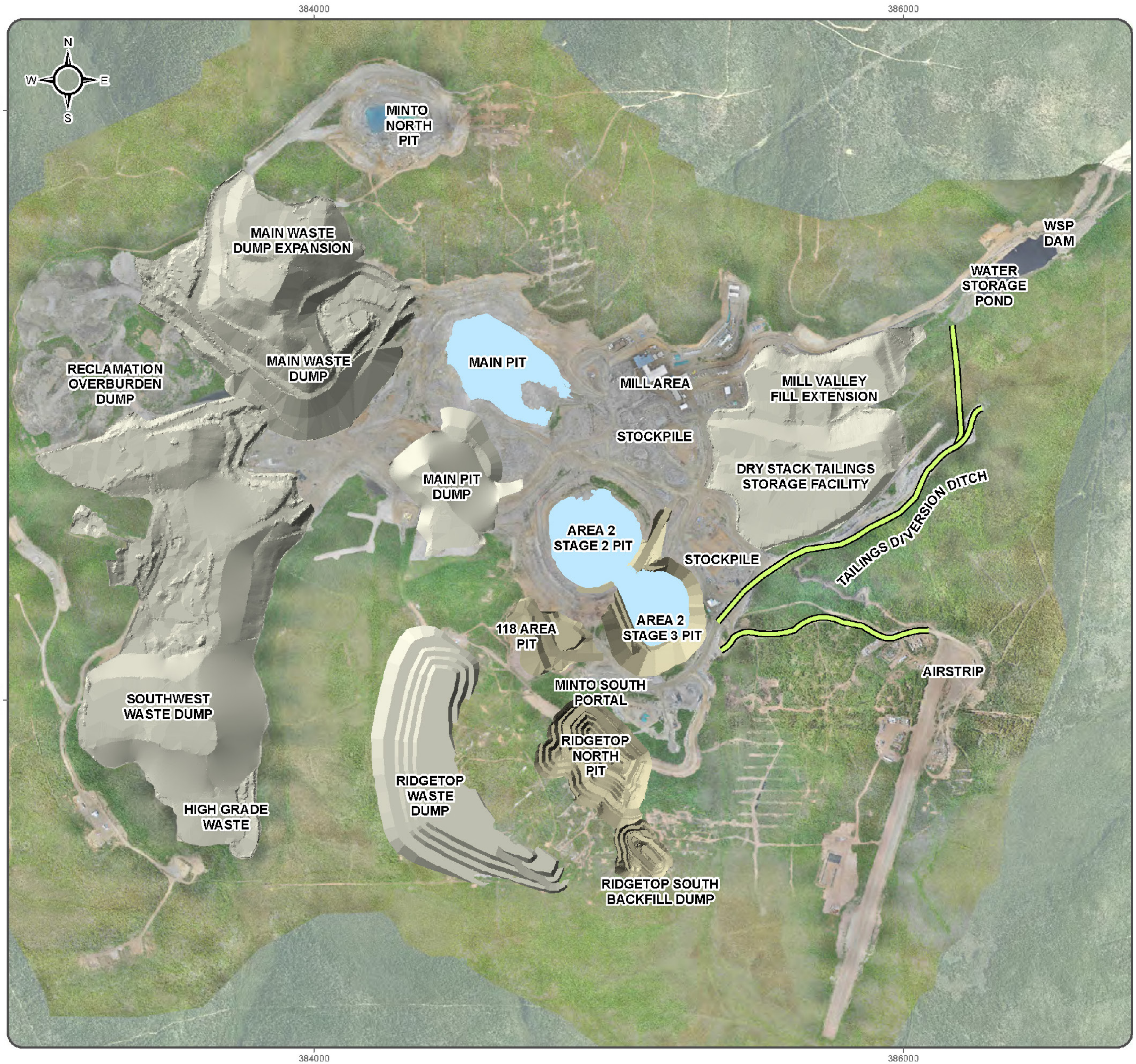
5.1.2 Future Activities

The following activities are planned between Year 0 and the completion of the mine life in:

- Mining of the Ridgetop North Pit, and the Ridgetop South Pit using conventional surface mining methods, including an expanded network of haul roads to accommodate the mining activities;
- Continued mining of the Minto East Underground and Copper Keel using conventional underground mining methods, all accessed via the Minto South Portal;
- Commencement of underground mining in the Minto East 2 and Minto North Underground mining areas;
- An increase in underground mine life and milling to Q4-2024 and Q2 2025, respectively;
- Continued construction of a new waste rock dump (Main Pit Dump) ;
- Continued placement of waste rock on the Main Waste Dump Wrap;
- Construction of a new waste rock dump (Ridgetop Waste Dump);
- Backfilling and cover placement of the completed Area 118 pit, ; Regrading and cover placement at Main and Southwest waste dumps;
- Operational water management; and
- Progressive revegetation of infrastructure components whenever possible.
- Backfilling of the completed Ridgetop South Pit, and the creation of the Ridgetop South Backfill Dump, using waste rock from the mining of the Ridgetop North Pit and underground deposits.

Additional details and information on the project are presented in the following sections, and Figure 5-3 shows the expected site layout at the completion of mining activities. This site configuration is the basis of the end of mine life closure cost liability calculation in Section 9.



MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 5-3
SITE CONFIGURATION - END OF MINING (AUGUST 2025)

NOVEMBER 2020

MINTO

Tailings Diversion Ditch

Pit Lake

Dump

PIt

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0 100 200 300 400 500 Meters

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Datum: NAD 83 Projection: UTM Zone 8N

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Development\Letter

5.2 Mine Features, Facilities, and Equipment

5.2.1 Open Pits

Since stripping began in 2006, four pits have been mined at Minto. Their development histories are summarized in this section.

The configuration of the open pits are shown in Figure 5-4.

5.2.1.1 Main Pit

The Main Pit was mined in five stages between 2006, when stripping first began, and April 2011.

The Main Pit cuts through the original drainage channel for Minto Creek. The north wall of the pit is benched in competent bedrock. The south wall is composed of a thick layer of overburden soil underlain by weathered bedrock hosting oxidized copper mineralization, transitioning into un-weathered bedrock that hosts sulfide ore.

The south wall was mined to a 30° angle, and a large volume of overburden was excavated to a shallower slope near the rim of the pit; despite this, a slope failure occurred shortly after the completion of the pit in April 2011. Movement had been observed in the pit for several months prior to the failure, and extensive monitoring provided warning of the impending failure. Analysis showed that the bulk of a 50m-thick silty / sandy overburden layer had slid into the pit along a thin layer of ice-rich permafrost clay.

A buttress was originally planned for the south wall to guard against sloughing, thawing, and small-scale failures. The slope failure necessitated a redesign of the buttress, which was completed in July 2011. Construction of the buttress has been completed. Additional fill was also placed around the rim of the pit to provide a new haul road bypassing the one mined out by Area 2 pit. Finally, SAT waste was deposited both on top of the buttress and in front of it, effectively increasing its size while storing this waste within the footprint of the pit.

Tailings deposition into the Main Pit began in November 2012. The Main Pit Tailings Management Facility has since received 3.3 Mt of slurry tailings. The Main Pit also hosts the infrastructure that supplies the mill with process water. The current Main Pit configuration with South Wall Buttress and SAT dump are shown in Figure 5-5.

5.2.1.2 Area 2 Pit

Area 2 Pit is located south of the mill area and southeast of the Main Pit. It was initially mined in two stages to provide timely ore release, the first starting in April 2011 and finishing in April 2013, and the second finishing in January 2014.

Upon completion of the Stage 2 pit, an underground portal was created in the highwall. The ore lens, referred to as the M-zone, at the bottom of the pit extended into the highwall another 120m at a plunge angle of approximately 10°, but the large amount of overlying waste rock rendered surface mining impractical.

Between February and November 2014, underground mining methods were used to extract this ore via the portal at the bottom of the pit.

Upon completion of M-zone underground mining and remnant ore recovery from the pit's access ramp, tailings deposition began. As of December 31, 2019, the Area 2 Pit Tailings Management Facility has received approximately 4.73 Mt of tailings. A pump system sends excess supernatant water to the Main pit via a pipeline, where the mill's water reclaim infrastructure is located.

The Area 2 Stage 3 Pit was completed in March of 2018, and Stage 4 Pit completed in August of 2018.The Area 2 Pit (including Area 2 Stage 3 and 4) configuration are shown in Figure 5-6.

5.2.1.3 Area 118 Pit

Area 118 is a relatively small pit that was mined between January and October 2014. It is located to the southwest of the Area 2 pit and partly overlaps it. As a small shallow pit, most of the ore it released was partially oxidized.

Mining took place at a reduced rate (approximately 5,000 BCM/d vs. typical production rates >10,000 BCM/d) in an effort to extend the duration of mining activity to cover the licensing timeline for subsequent surface deposits. The current Area 118 Pit configuration is shown in Figure 5-6.

The pit has been partially backfilled with overburden from Area 2 Stage 3 mining. The pit will be entirely backfilled before closure.

5.2.1.4 Minto North Pit

The Minto North Pit is located northeast of the Main Waste Dump in the McGinty Creek drainage. Minto North mining began upon receipt of the necessary licenses in August 2015 and was completed in October 2016.

This pit is characterized by a single continuous zone of high-grade ore, plunging from east to west. The shallower and lower-grade parts of the ore zone were expected to be partially oxidized, but minimal alteration was seen and nearly all of the pit's ore release is un-weathered sulfide ore.

The pit's south highwall hosted several continuous multi-bench wedge structures that were shown by analysis to be unstable. Although, these wedge structures were pre-emptively excavated out of the highwall, a 77,000 m^3 portion of the south wall let go shortly after mining was completed. The Minto North Pit configuration is shown in Figure 5-7.

5.2.1.5 Ridgetop North/South Pits

The Ridgetop Pits have not been mined at the time of writing this plan. The Ridgetop pits share common wall design parameters: a 53° interramp angle with a 72° bench face angle.

Ridgetop South is designed with a single-lane ramp where as the Ridgetop North features double-lane haulage until the 837m elevation, by which point 82% of the pit's total volume will have been mined. The ramp is routed along the north highwall; the high entry point is less efficient in terms of haulage, but this ramp alignment serves to push back the wall such that more ore is recovered and the stripping ratio is reduced.

The bottom of the Ridgetop South pit is at the 841m elevation, while Ridgetop North reaches 784m. The maximum highwall heights are 77m and 148m, respectively.

The Ridgetop South Pit is expected to be backfilled with waste rock after completion. The Ridgetop North Pit is expected to be used for tailings storage after completion. The Ridgetop Noth pit is design to have 1.9 Mm^3 of tailings storage capacity.

5.2.2 Overburden and Waste Rock Dumps

Several waste rock and overburden dumps were constructed during operations, as illustrated in Figure 5-2. A summary of the quantities placed in each dump by the end of 2018 are provided Table 5-1. As the mine was in closure for most of 2019, no material was placed in any dumps in 2019. Although these are not the final volumes for some of the facilities, it provides an indication of the relative magnitude of each facility. The final volumes will be updated in subsequent revision of this Plan, or at time that operations are complete and transition into closure begins.

Table 5-1: Waste Dump Footprint and Storage Volumes

Dump Location	Quantity Stored as of December 31, 2018 (m^3)
Main Pit Buttress	4,230,000
A2S2 In-Pit	70,000
Main Pit Dump	1,480,000
Southwest Dump	12,120,000
Mill Valley Fill Extension	1,440,000
Reclamation Overburden Dump	4,300,000
Main Waste Dump	8,360,000
Main Waste Dump Expansion	3,810,000
Mill Valley Fill Extension 2	1,360,000
Total Waste Dumped	37,170,000

**Includes volume of Ice-rich Overburden Dump*

5.2.2.1 Main Waste Dump / Main Waste Dump Expansion

The Main Waste Dump (MWD) was Minto's first rock dump and initially held most of the material from the mining of the Main Pit between startup in 2006 and the start of SWD development in early 2009. Dumping on the Main Waste Dump finished in September 2009 and was not resumed until the approval of an expansion in 2015.

The MWD is located west of the Main Pit. It is sitting on a foundation of solid bedrock and its close proximity to Minto North Pit made an expansion of the dump an attractive option for disposal of Minto North waste rock and overburden; the Main Waste Dump Expansion was approved as part of Phase V/VI licensing, increasing the dump height by approximately 30m.

To date, no physical stability issues have been observed.

5.2.2.2 Reclamation Overburden Dump

The Reclamation Overburden Dump (ROD) was developed in two stages, first to a design for overburden from stages 1 through 4 of the Main Pit's development, and then to a significantly larger design that would hold overburden from Stage 5, Area 2, and Area 118.

The ROD is designed with a low fill thickness and a shallow slope to allow for long-term storage of excess overburden; however, the contents of the dump may be partly mined out for use in reclamation.

5.2.2.3 Ice-Rich Overburden Dump

The Ice-Rich Overburden Dump (IROD) was initially a free-standing dump consisting of a rockfill berm structure behind which ice-rich overburden would be placed so that this material would not impact the stability of the larger overburden dumps on site.

As the SWD grew around it, the IROD berm ceased to be identifiable as a distinct structure: the dump is now identifiable only as a small area of exposed overburden along the west side of the SWD. The dump received mud and ice-rich overburden during Main Pit mining, mostly from Stage 5 in 2010 / 2011.

For reclamation purposes, the IROD is treated as a part of the SWD, and has been recontoured as part of the overall SWD regrading. In practical terms, the IROD is no longer a discrete facility.

5.2.2.4 Southwest Waste Dump

The SWD was initially designed to contain waste rock from the Stage 4 and Stage 5 expansions of the Main Pit. The original Main Waste Dump had reached its capacity with the completion of Stage 3, and the high cost of haulage precluded an expansion of the MWD's height. Construction of the SWD began in March 2009.

The SWD was designed to hold both waste rock and thaw-stable overburden, provided that the latter was not dumped within 30m of the ultimate crest. It received a significant quantity of overburden from the mining of Stage 5 of the Main Pit in 2010/2011.

The height and extents of the dump were increased as part of Phase IV licensing, allowing for the deposition of waste rock from the Area 2 and Area 118 pits. Phase IV also introduced changes to waste rock management practices; specifically, segregation of waste rock into classes on the basis of copper content. Waste rock grading more than 0.10% Cu was originally slated for disposal within the footprint of the Main Pit, both within a buttress and on top of the overburden slope at the 810 bench, but the failure of the pit's south wall and the greater-than-expected quantity of this waste rock rendered that plan unworkable. Instead, separate areas within the SWD for waste rock of low, medium, and high grades were designated, with the intention that each portion of the dump would be receive a cover appropriate to its contents.

With the exception of the high grade waste portion of the dump, the SWD has been largely re-contoured. The high grade waste portion of the dump will be relocated to subaqueous storage for closure.

The dump's location above the Minto Creek valley, on a foundation of overburden, has resulted in some down-slope movement, particularly at the south end of the dump where the fill thickness is greatest. Current movement rates are between 0 mm/d and 0.8 mm/d, having decreased from the rates seen during active construction of the dump; these are evaluated annually and reported in the Annual Geotechnical Inspection Reports.

5.2.2.5 Mill Valley Fill

The Mill Valley Fill is located in the Minto Creek valley near the mill. It was constructed early in the life of Minto Mine to provide space for milling and related activities. The first stage of expansion (Mill Valley Fill Extension Stage 1) was constructed in previous phases of mining. The Mill Valley Fill Extension Stage 2 began construction in December 2015 and was constructed with waste rock from Minto North. There will be no significant change between the Mill Valley Fill Extension Stage 2 condition at Year 0 and the end of mine life.

In September 2010, EBA Engineering Consultants Ltd. recommended the construction of a valley-fill buttress, called the Mill Valley Fill Extension (MVFE), downslope (north) of the DSTSF as a measure to arrest the movement of the DSTSF. The construction of the MVFE (later referred to as the MVFE Stage 1) began in January 2012 and was completed by late 2013 (Minto 2013). The survey hubs that are being used to monitor rates of DSTSF movement have shown a significant deceleration (see Section 5.2.5 (DSTSF) for details). A subsequent SRK study in 2012 and the independent third party review that followed recommended an approach to increase the stability Factor of Safety by 50%, resulting in the design and construction of an enlargement of the existing buttress, i.e. MVFE Stage 2. The design of the MVFE Stage 2 is presented in Figure 7-3. The total volume of the Stage 2 extension is 1.4 Mm^3 and was made entirely of waste rock.

The MVFE Stage 2 was constructed by raising the existing MVFE Stage 1 and expanding the footprint to the east. It consists of three tiers at approximate elevations of 766 m, 776 m, and 781 m. The faces of each of the tiers are at an overall 3H:1V. The eastern limit of the Stage 2 extension was designed such that the toe is 75 m upstream from the Water Storage Pond at the maximum operational pond elevation of 716.3 m. The resulting toe is approximately five meters above the maximum pond elevation and two meters above the crest of the Water Storage Dam.

The initial toe blanket layer of coarse waste rock was constructed over previously undisturbed areas using run of mine construction grade waste rock. This lift was end dumped from a height of 10 m to create a coarse toe blanket layer along the valley floor. Vegetation and topsoil from previously undisturbed areas were stripped prior to fill placement.

Mill Valley Fill Extension Stage 2 was substantially completed in August 2016. Monitoring data has shown the MVFE Stage 2 has been successful in further reducing the movement rates of the DSTSF, with all rates now less than 1.0mm/day at all survey hub locations as of July 2017 and continuing to show a decelerating trend.

5.2.2.6 South Wall Buttress and Main Pit Dump

Construction on the South Wall Buttress began in May 2011 after a failure of the south wall of the Main Pit was observed. The South Wall Buttress is a rock fill structure designed to buttress the south wall of the Main Pit and preserve the remainder of the pit volume for tailings deposition. The South Wall Buttress was receiving waste rock from Area 2 Pit and was completed in 2013.

The Main Pit Dump has been redesigned relative to Phase V/VI so that it does not encroach on the area where NP:AP<3 rock was previously placed. As of December 31, 2019, 1,480,000m^3 of material was placed at the Main Pit Dump The dump was designed to be resloped at a 3H:1V slope (or shallower) along all faces. A 26 m-wide access road along the front face of the dump is used to link the east and west sides of the mine. The entirety of the Main Pit Dump is above the Main Pit Tailings Management Facility spill elevation, thus maximizing volume available for tailings and NP:AP<3 waste in the Main Pit.

5.2.2.7 SAT Dump

The Phase IV quartz mining and water licences required Minto to segregate waste rock from open pits on the basis of acid-base accounting (ABA) characteristics, with material having NP:AP[3]≥3 being suitable for bulk disposal in upland waste dumps and material having NP:AP<3 to be stored in a location that would ultimately be saturated over the long term. Since the material with NP:AP<3 was planned to stored in a saturated closure condition, this material has been categorized as 'SAT' for communications related to on-site materials handling during routine mining operations. Bulk waste is simply called 'waste' for on-site communication.

SAT was used in the initial construction of the South Wall Buttress, together with bulk waste to expedite construction. Later, SAT was placed on top and to the west of the buttress, and in 2016 in a discrete dump ramping down to the 786m level northwest of the buttress was commenced. Together, all of the SAT waste that has been placed outside of the design shell of the South Wall Buttress has been referred to as the SAT Dump. As of July 2016, about 576k m^3 of SAT is stored in the dump below the 786 masl elevation (i.e. the expected elevation of the final pit lake surface) while 1,040k m^3 of SAT is stored above the 786 masl elevation. There was no SAT storage during temporary closure. In the first 10 months of 2020, 19,565 t were stored below the 786 masl elevation.

5.2.2.8 Area 118 Backfill Dump

Construction of the Area 118 Backfill Dump began with by backfilling of Area 118 Pit during mining of Area 2 Stage 3 Pit beginning in late 2016. While the dump design allowed for a mix of thaw stable and ice rich overburden to be dumped below the pit rim, minimal ice rich overburden was encountered during mining and as such the backfill placed to date consists almost entirely of thaw stable overburden. Construction of Area 118 Backfill Dump will be completed during mining of the Ridgetop North and Ridgetop South pits.

5.2.2.9 Ridgetop Waste Dump

The proposed RWD is located west of, and on the opposite side of the ridge from, the Ridgetop North Pit. The RWD design was developed to take advantage of good foundation conditions (i.e. weathered bedrock and residual soils over a large area of the proposed dump footprint) and to avoid areas underlain by ice-rich overburden. A secondary design consideration was to locate the footprint of the RWD primarily on the west side of the north-south drainage divide located west of (and at higher elevation from) the Ridgetop pits; this would ensure that most of the RWD drainage would report to the western catchment (the W15 catchment)

[3] ratio of neutralization potential (NP) to acid potential (AP), as determined through laboratory ABA testing

that already contains the SWD and the MWD, and would minimize the waste dump seepage reporting eastward to the eastern catchment (the W35 catchment).

5.2.3 Ore Stockpiles

Milling of all stockpiled ore will be completed before final closure. No stability issues have been identified to date with any of the ore stockpiling areas

Eight ore stockpile exist on the property in the vicinity of the mill. Within the run of mine pad boundaries; four (4) run of mine stockpiles exist:

- Mill Pond Pad – also known as the Live Pile. Crushed material actively being fed into the mill, dominantly underground material.
- East Stockpile – Sulphide and partially oxidized run of pit (ROP) stockpile.
- South Stockpile – Partially oxidized run of pit (ROP) stockpile.
- UG Stockpile – active ore stockpile holding Underground material transported from the Portal Ore Pad (POP).

Additional stockpiles include the Portal Ore Pad, West of the Main Pit (ROP), adjacent to the Main Waste Dump (ROP) and the Top of the World stockpiles (ROP) consisting of partially oxidized run of pit (ROP).

Historically the ore pads were categorized by copper grades. This material was assigned to colour coded material bins described by the solubility of the contained copper.

Table 5-2: Ore stockpiles

Material Type	Copper Grade Range (%)	Soluble Copper (%)
Blue Sulphide	0.5 to 1% Cu	< 15%
Green Sulphide	1 to 2% Cu	< 15%
Yellow Sulphide	> 2% Cu	< 15 %
Partially Oxidized Ore (POX)	> 1.5 % Cu	> 15 %
Low Grade Partially Oxidized Ore (LG POX)	0.8 to 1.5 % Cu	> 15 %

The Blue, Green and Yellow ore categories are typically boulders of open pit and underground material too large for the crushers on site. The large material is set to the side, and gradually broken into manageable sized fragments that can be fed into the crushers with a rock breaker. The partially oxidized (POX) and low grade oxidized(LG POX) material of the open pits was set aside to help maintain mill recovery and the higher grade pit ores were fed into the mill as they were mined to maintain the highest possible head grades. The lower grade and partially oxidized stockpiles were depleted gradually and are used to supplement mill feed during periods of open pit waste stripping or low underground production.

Table 5-3: Stockpile Inventory

	Dec 31, 2018			Dec 31, 2019	
Material Category	**Tonnes**	**Cu %**		**Tonnes**	**Cu %**
Yellow	-	-		-	-
Green	14, 173	1.38		10, 384	1.38
Blue	28, 556	0.61		10, 142	0.61
POX	217, 792	1.57		227, 608	1.57
LG POX	140, 021	0.66		126, 729	0.66
Portal Ore Pad	4, 430	2.84		-	-
Live Pile				366	2.56
Total Ore					

Table 5-4: 2019 Ore Stockpiles by Geographic Location

Location	Tonnes	Cu (%)	Dominant Material
ROM OS	33, 804	1.13	Blue, Green, Yellow, POX
ROM A2S3	139, 976	0.66	POX >> Yellow
ROM UG ore	20, 064	2.31	Yellow
South	181, 106	0.93	POX < LG POX
TOTW	25, 986	0.81	Blue, Green, Yellow, POX
Live	366	2.56	Yellow

MINTO MINE
RECLAMATION AND CLOSURE PLAN

FIGURE 5-4

OVERVIEW OF OPEN PITS

NOVEMBER 2020

MINTO

1:12,500 *when printed on 11 x 17 inch paper*

0 50 100 200 300 400 500 Meters

ENSERO solutions

Aerial Imagery aquired in August 2020

Datum: NAD 83 Projection: UTM Zone 8N

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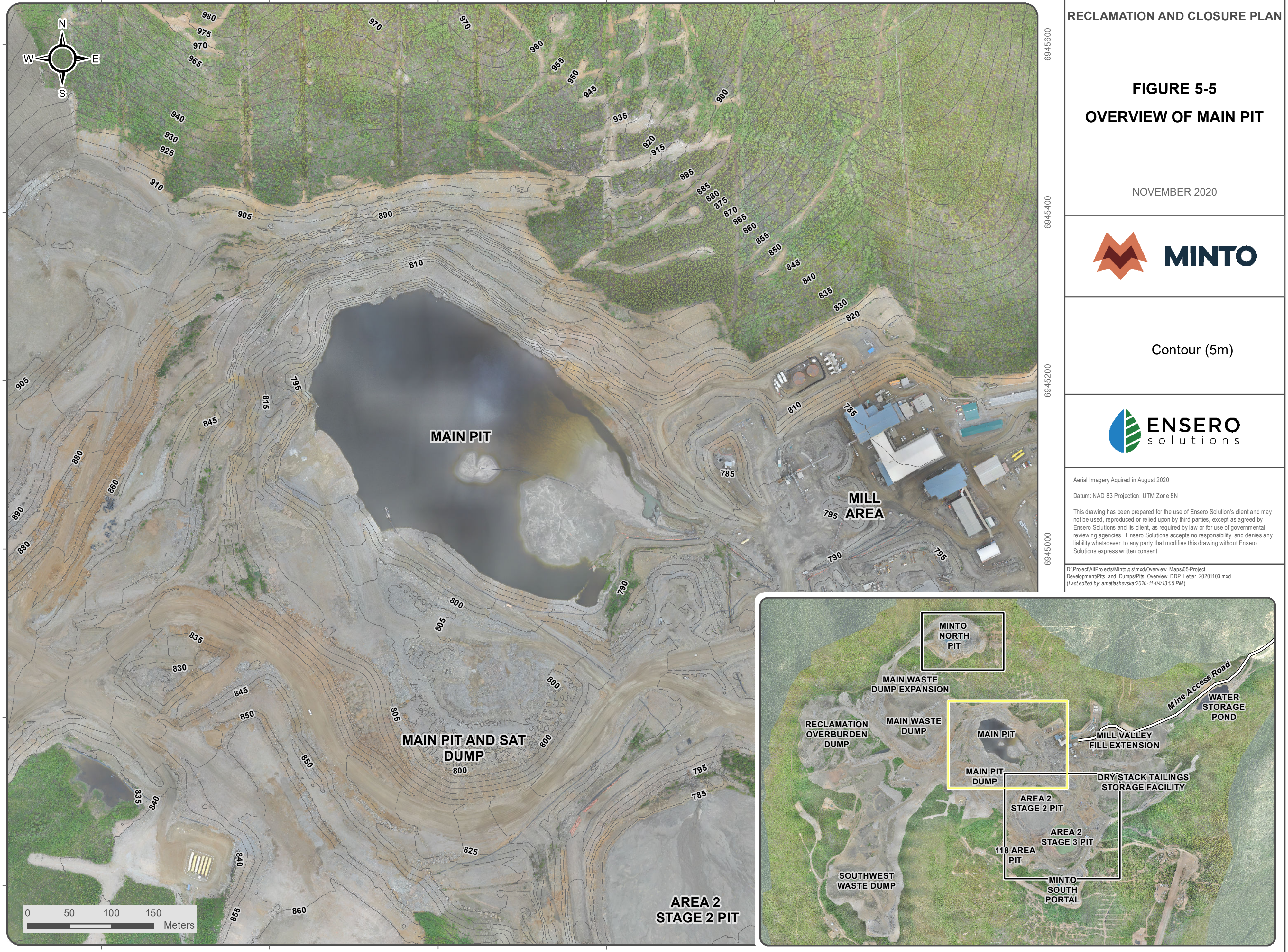
MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 5-5
OVERVIEW OF MAIN PIT

NOVEMBER 2020



Contour (5m)

Aerial Imagery Aquired in August 2020

Datum: NAD 83 Projection: UTM Zone 8N

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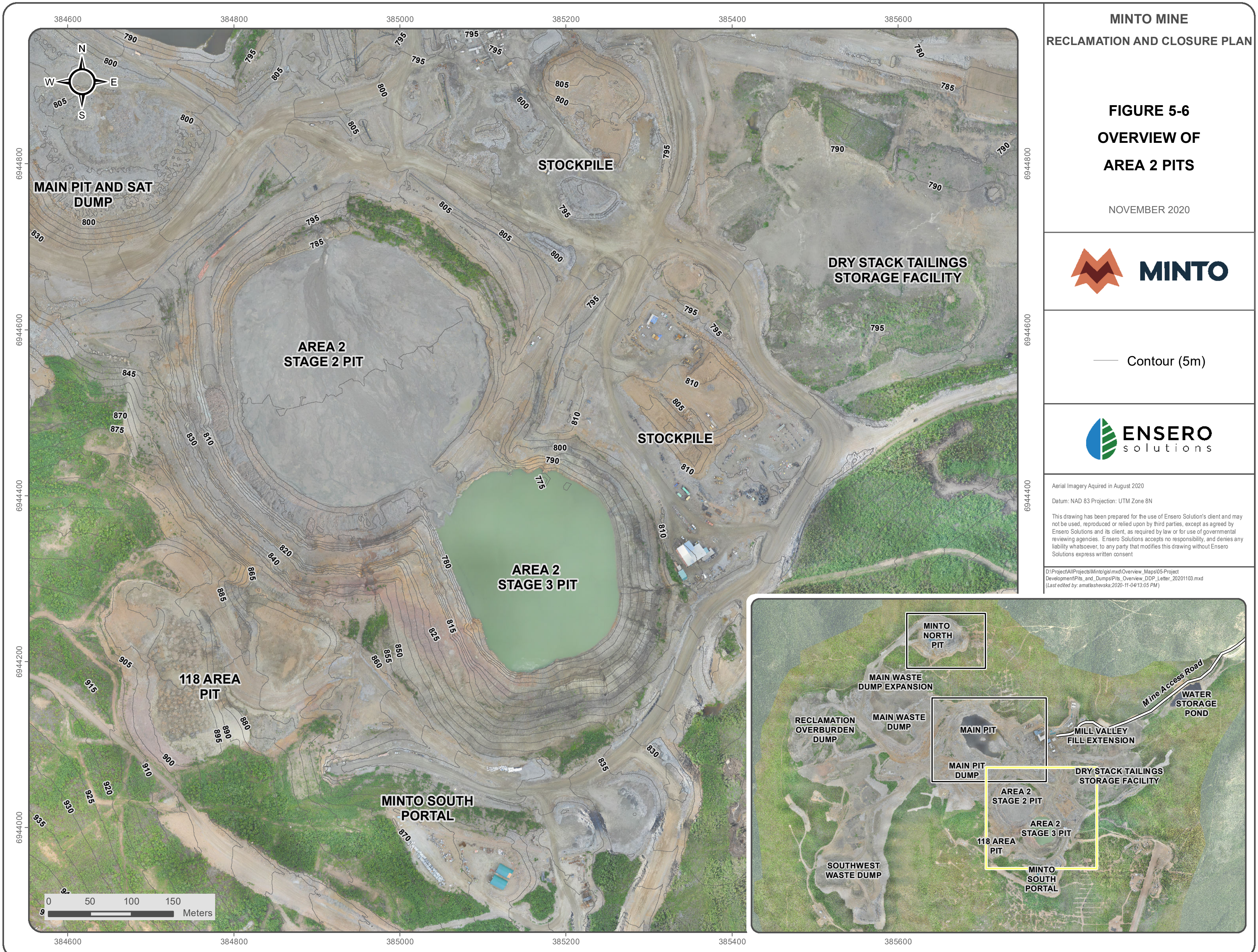
(*Last edited by: amatlashevska;2020-11-04/13:05 PM*)

MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 5-6
OVERVIEW OF AREA 2 PITS

NOVEMBER 2020



Contour (5m)

Aerial Imagery Aquired in August 2020

Datum: NAD 83 Projection: UTM Zone 8N

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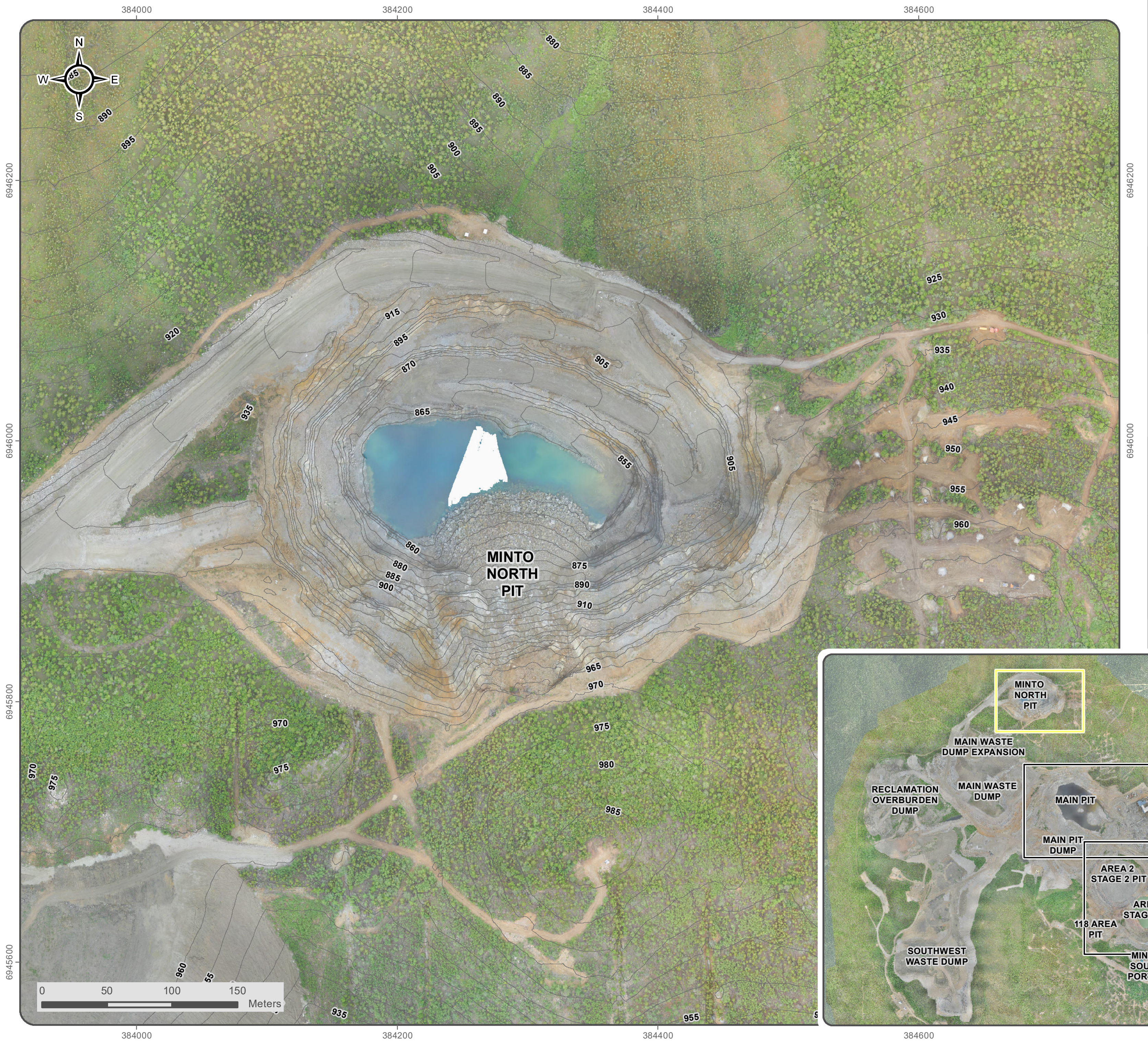

MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 5-7
OVERVIEW OF MINTO NORTH PIT

NOVEMBER 2020

MINTO

ENSERO solutions

Contour (5m)

Aerial Imagery Aquired in August 2020

Datum: NAD 83 Projection: UTM Zone 8N

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5.2.4 Mine Infrastructure and Ancillary Facilities

The following sections describe major mine infrastructure that requires consideration at closure. Other infrastructure items that will require general closure measures include: access road, barge landing, Pelly laydown, Pelly camp, warehouse, warehouse laydown, underground shop, airstrip and explosives plant site.

5.2.4.1 Mill Complex

The mill is located adjacent to the Main Pit. It processes ore via conventional crushing, grinding, flotation, and dewatering to produce copper concentrates with significant gold and silver credits, and a slurry tailings stream that is pumped to one of the mine's tailings management facilities.

The mill facilities include:

- Two-stage grinding circuit composed of a single semi-autogenous grinding (SAG) 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;
- Tailings thickening and pumps;
- Adjacent to the mill is a concentrate storage building, which is a large tent structure with a concrete foundation;
- South of the mill and concentrate storage building is tailings filtration plant, which was formerly used to dewater tailings for deposition on the Dry Stack Tailings Storage Facility; and
- Surface Area: 11.12ha (Mill, Camp, Fuel Storage and Crusher)

5.2.4.2 Mine Camp and Related Infrastruture

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 been converted to a packaged treatment plant, and the camp was expanded again to allow for greater occupancy (up to 256 persons). Several structures behind the facility house the fuel supply to the furnaces, relay power from a diesel electrical generator, and pump fresh water. Several structures behind the main camp buildings house the fuel supply to the furnaces, relay power from a diesel electrical generator, and pump fresh water.

5.2.4.3 Solid Waste Facility

Minto Mine operates a solid waste facility under Commercial Dump Permit # 81-005 issued by YG, Department of Environment, Environmental Programs Branch. The facility includes a burning pit for untreated wood and paper waste, a construction waste disposal area, metal and rubber tire disposal areas and an incinerator for food waste and other wastes. No material is placed in the landfill that could potentially be an animal attractant. The burn pit and incinerator are surrounded by an exclusion (bear) fence. Figure 5-8 below shows the current locations of all the waste management facilities on site.

MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 5-8

SOLID WASTE MANAGEMENT INFRASTRUCTURE

NOVEMBER 2020

MINTO

1:8,000 *when printed on 8x11 inch paper*

0 50 100 150 200 250 Meters

ENSERO solutions

National Topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Cadastral data compiled by Natural Resources Canada. Reproduced underlicense from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada.

Datum: NAD 83 Projection: UTM Zone 8N

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5.2.4.4 Water Storage Pond and Water Treatment Plant

The Water Storage Pond is currently being used as a clean water storage reservoir. Water from un-impacted or minimally impacted areas of the mine site are diverted to the WSP for storage until discharge to Minto Creek. The water treatment plant can also discharge treated water to the pond for storage prior to discharge. The pond has a total capacity of approximately 320,000 m^3 and retention is provided by the Water Storage Dam. Further details on the WSP can be found in the Water Management Section 5.4.

Water used for grinding and flotation is currently sourced from the Main Pit or Area 2 Pit. After cycling through the mill complex, water is disposed of in either the Area 2 Pit or the Main Pit as tailings slurry.

The Water Treatment Plant accepts water from the Main Pit, Area 2 Pit or the Water Storage Pond and discharges treated water to the Main Pit, the Water Storage Pond or Minto Creek. The Water Treatment Plant discharges sludge and reverse osmosis concentrate to the Main Pit. The Water Treatment Plant consists of:

- Ballasted lamellae clarifier unit (Actiflo) for removal of TSS and total metals;
- Multiple stages of filtration; and
- Two reverse osmosis trains to remove dissolved solids (including nitrate and selenium).

The reverse osmosis (RO) process removes 95-99% of all constituents in the feed water. The process produces two streams: 75% of the water is a clean water stream (with 95-99 % removal of dissolved solids) which is discharged to the WSP (or directly to Minto Creek), and 25% is a concentrated reject stream that is added to the tailings slurry and co-disposed with the tailings. Further details regarding water treatment can be found in the Water Treatment Section 5.4.4.

5.2.5 Tailings Storage Facilities

5.2.5.1 Dry Stack Tailings Storage Facility

The DSTSF is located southeast of the mill and on the south slope of the Minto Creek Valley. The DSTSF was designed by EBA in 2006 (EBA, 2007), with construction and operation of the DSTSF occurring between 2007 and 2012. The tailings were dewatered in a filtration plant to a target water content of 15% (by weight), hauled to the DSTSF, spread into 1m lifts, and compacted to a target density of 95% of standard proctor maximum dry density. Tailings deposition was completed in October 2012, at which point slurry tailings deposition commenced in the Main Pit. A total of 5.1 million m^3 of tailings were placed in the DSTSF over the six years of active operations. An interim soil cover was placed over the tailings during stripping of the Area 2 and Area 118 pits between November 2012 and June 2013. The interim cover serves to limit water erosion of tailings and prevent wind erosion and dispersion of tailings dust until the final engineered cover system for the DSTSF is in place. Final cover was placed on the slopes of the Waste Rock Shell on the DSTSF, as well as much of the surface, as per the final cover design. The slopes have been seeded, while the plateau is scheduled for final contouring (to complete the surface drainage network) and seeding in 2021 -2022.

Movements in the DSTSF were identified in early 2009. Following drilling and instrumentation campaigns in 2009, 2010 and 2011, a valley-fill buttress, called the Mill Valley Fill Extension (MVFE Stage 1) was recommended by EBA. Construction of the buttress occurred between May 2011 and March 2013 with 1.4

million cubic meters of waste rock. At the time of the initial buttress design, it was recognized that a larger buttress might be necessary to sufficiently arrest the DSTSF movements, particularly in the northeast corner.

Geotechnical instrumentation installed to monitor movement rates of the DSTSF showed deceleration ranging between 20 and 60 percent within the first two years since the completion of the MVFE Stage 1. In 2013, a geotechnical drilling investigation was completed that included installation of inclinometers, survey hubs, thermistors, and piezometers. The objective of the 2013 investigation was to gain further understanding of the movement and foundation soils to support the design of an additional extension of the MVFE (referred to as the MVFE Stage 2) to incrementally slow and ultimately arrest the movement. The conceptual design of the MVFE Stage 2 was completed in 2014, with the final design completed in 2015.

In parallel to the MVFE Stage 2 design development, Minto and SFN appointed an independent third party reviewer to review geotechnical conditions at the mine and provide recommendations, including the design of MVFE Stage 2. The resulting final design incorporated all design and construction recommendations provided by the third party reviewer.

Construction of the MVFE Stage 2 occurred between October 2015 and August 2016 using approximately 1.4 million cubic meters of waste rock. Since completion of the bulk material placement, the monitoring data has shown a significant decrease in movement rates as a response to the MVFE Stage 2, with all rates now less than 0.25 mm/day at all survey hub locations as of July 2020, and with the hubs continuing to show a decelerating trend. For comparison, peak movement rates of the DSTSF were up to 8.6 mm/day prior to the MVFE Stage 1 construction and up to 1.4 mm/day prior to MVFE Stage 2 construction.

5.2.5.2 In-Pit Tailings Management Facilities

From November 1, 2012, when dry-stacking operations ceased, through the completion of the life-of-mine (LOM) plan, tailings would be deposited into pits as per the Tailings Management Plan. Tailings is sent through pipeline into the pits where it is able to settle to the bottom of the pit. The large surface areas of the pit bottoms result in the bottom of the pit having a variable depth of tailings. For example, the current elevation of tailings in the Main Pit varies by several meters depending on where the deposition point was into the pit.

5.3 Mining Operations

5.3.1 Open Pit Mining

The Ridgetop pits are the final open pits included in the current licence. It is expected that the overburden would be placed directly as cover material on completed waste rock and tailings storage facilities during the mining operation as part of progressive reclamation.

5.3.1.1 Mine Equipment

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

The following Table 5-5 lists a possible fleet to be used for mining the pits. This equipment is not currently on site and would be contractor-owned.

Table 5-5: Open Pit Equipment Fleet

Equipment Type	No. of units
Hitachi 2500 Shovel	1
Hydraulic Excavators, Hitachi EX1200 or similar	3
100-ton Haul Trucks, Cat 777 or similar	9
Front-end loaders, Cat 990 or similar	2
Small Hydraulic Excavators, Cat 330 or similar	2
D11-class dozer	2
D10-class dozers	2
Graders, 16' blade	2
Blast hole drills	3

5.3.1.2 Grade Control and Material Segregation Practices

Accurate in-pit separation of ore from waste, as well as segregation of various types of waste, will continue to be essential to the successful operation of the mine. Grade control practices for waste rock and ore can be summarized as follows:

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

Further detail on waste handling and placement can be found in the Waste Rock and Overburden Management Plan (Minto 2018b).

5.3.1.3 Underground Mining Operations

Underground mining started in 2012 with the collaring of the Minto South Portal. Development of the Minto South Underground continued through late 2013.

In January 2014, through continued consultation with Yukon Government Department of Energy, Mines and Resources, Minto sought approval for changing the mining sequence such that the “M-zone,” originally the final ore zone to be mined in the Phase IV plan, could be brought ahead in the schedule and accessed from a portal at the bottom of the completed Area 2 Stage 2 pit. Approval to proceed was granted on January 10, 2014.

The M-zone was completed in October 2014, at which time mining resumed in the Minto South Underground, specifically the Area 118 zone. The Area 118 zone was completed in April 2016. The Area 2 underground ore zone was mined after the completion of Area 118 underground and was completed in 2018.

Development of a decline to the Minto East zone began in 2017and the ore zone is scheduled to be complete in 2021. Mining was suspended in October 2018 when the mine went into care and maintenance. In 2019 the Minto mine was restarted with new ownership and resumed mining with development to the Copper Keel ore body. Production mining in Copper Keel started in July 2020 and will continue through 2023.

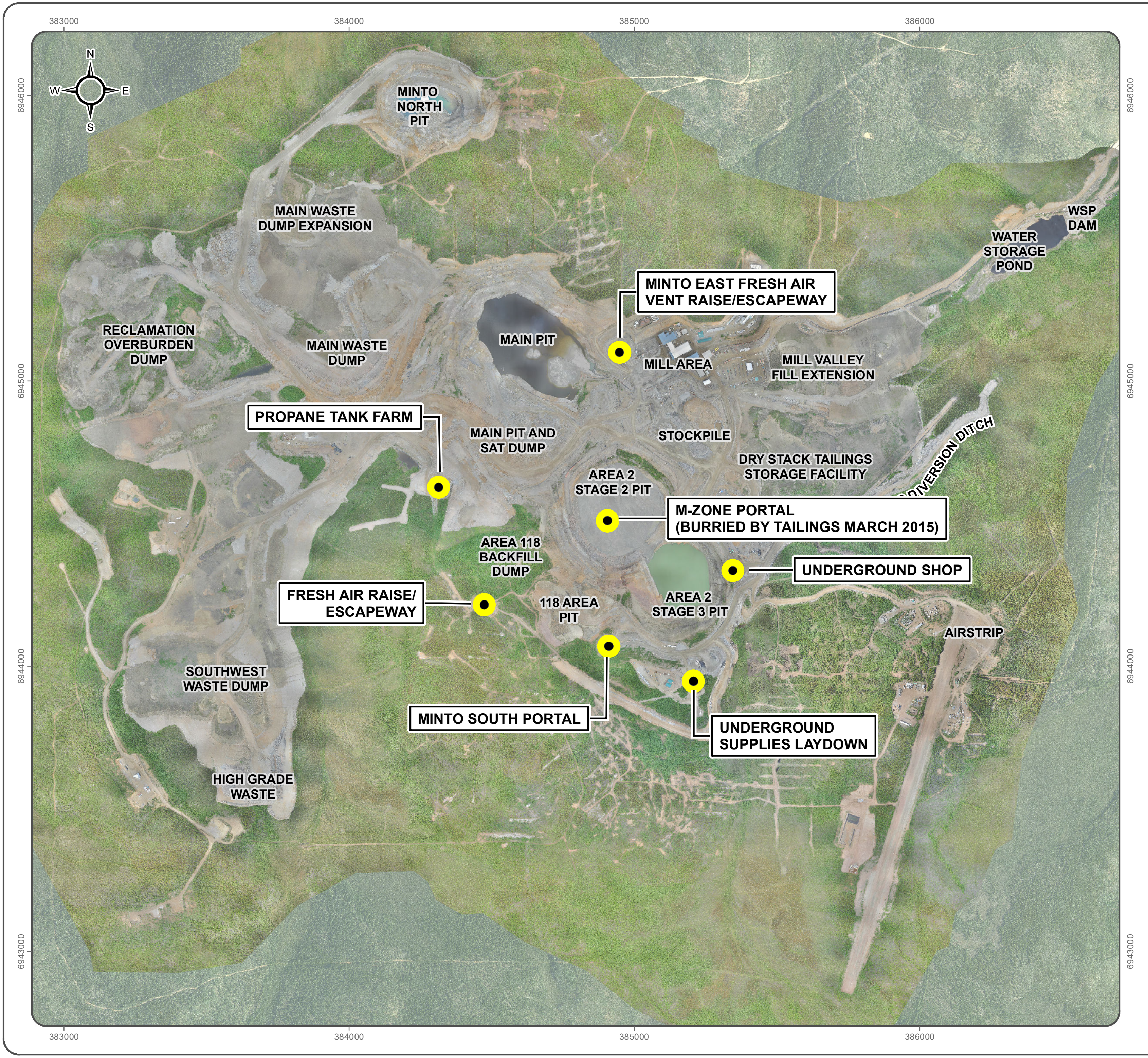
Future mining zones include the Minto East 2 deposit which will start development in 2021 (or whenever approval is granted) from the Minto East Ramp and the Minto North 2 Underground which is a stand alone portal mine that will begin construction and development in 2021 (or whenever approval is granted) from within the Minto North Open pit.

The M-zone portal and completed underground workings, located at the bottom of Area 2 pit, have been flooded by tailings and water.

The waste rock from the underground is handled following the approved Waste Rock and Overburden Management Plan. 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.

5.3.1.4 Supporting Surface Infrastructure

Figure 5-9 shows underground supporting surface infrastructure.



MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 5-9

UNDERGROUND SUPPORTING SURFACE INFRASTRUCTURE

NOVEMBER 2020

MINTO

1:18,000 *when printed on 8x11 inch paper*

0 100 200 300 400 500 Meters

ENSERO solutions

Datum: NAD 83 Projection: UTM Zone 8N

D:\Project\AllProjects\Minto\gis\mxd\Overview_Maps\03-

5.3.1.5 Ore Zones and Portals

The following Table 5-6 summarizes the nomenclature associated with Minto's ore zones:

Table 5-6: Nomenclature for Underground Complexes, Portals, and Zones at Minto.

Underground Complex	Access	Zones
Minto South Underground	Minto South Portal	Area 118
		Area 2
		Minto East
		Copper Keel
		Wildfire
		Minto East 2
M-zone	M-zone Portal	M-zone
Minto North	Minto North Portal	Minto North Underground

A separate underground complex, known as the Wildfire Underground, was presented during the environmental assessment process. This would mine relatively shallow ore zones from a separate portal with its own dedicated infrastructure. Originally planned to be mined after the completion of the Minto South Underground, this area is now part of Copper Keel South and accessed via the Minto South Portal .

In the YESAA environmental assessment, Minto proposed that the Copper Keel and Minto East zones be accessed via their own portal. The current mine plan has been revised to access them from the Minto South Portal, reducing development expense, surface disturbance, and the number of mine openings to be secured as part of closure activities.

Figure 5-10 shows preliminary development and stoping designs for the aforementioned ore zones.

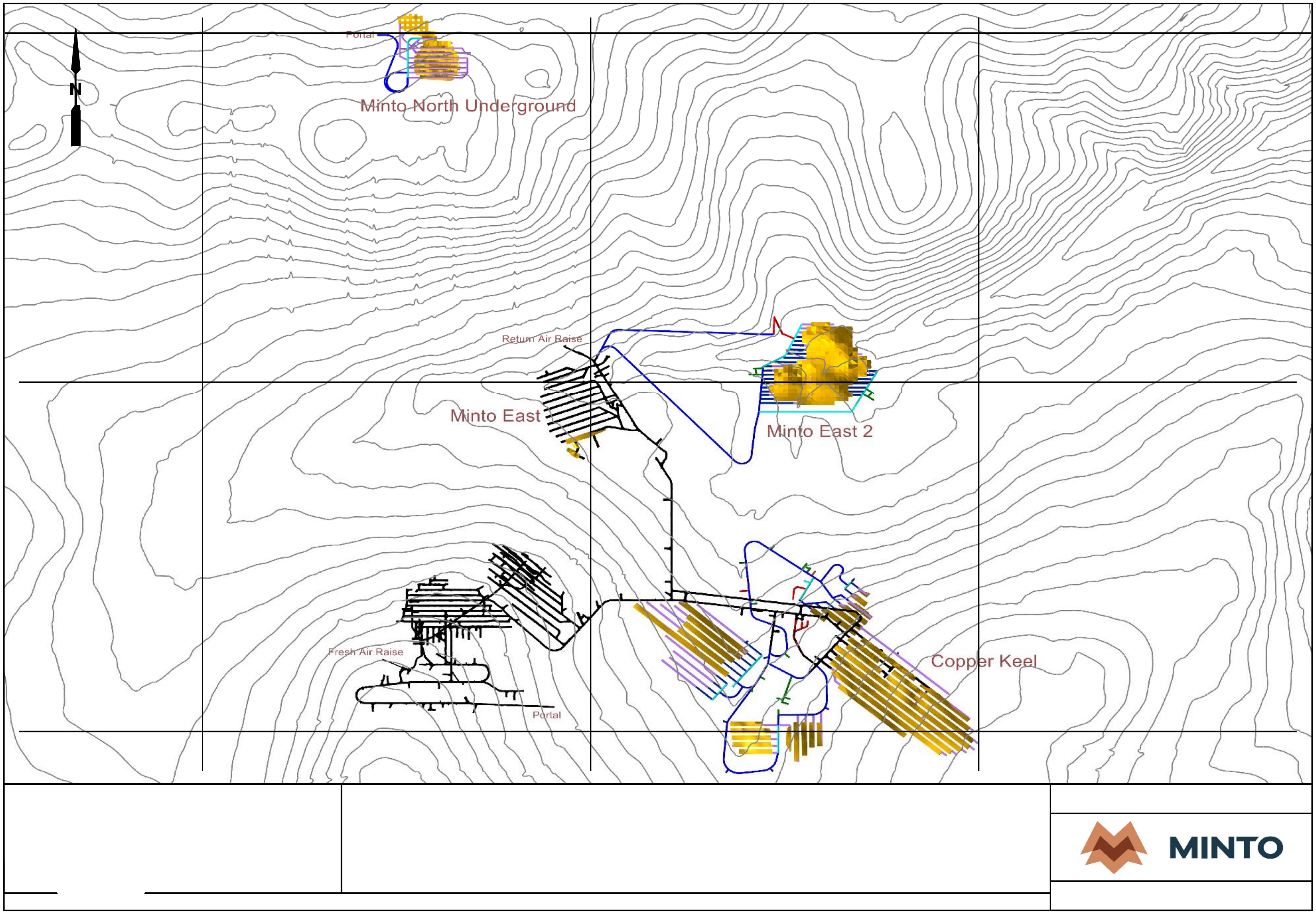


Figure 5-10: Plan View of Underground Development and Ore Zones

5.3.1.6 Mining Methods

Each of the areas summarized in Table 5-6 consists of many separated lenses of ore, varying considerably in size and thickness. The physical characteristics and grades of each ore zone determine which mining methods can be applied. A variant of longhole open stoping, described below, has found wide applicability at Minto, having been successfully used to mine the M-Zone and Area 118, Area 2, and Minto East.

All of these ore zones can be described as lenses of foliated granodiorite (fG), bounded at their hanging wall and footwall contacts by equigranular granodiorite (eG) host rock. The fG zones are typically 5-30 m thick, and the grade within them varies from 0% to approximately 6% copper. The fG zone typically dips at 20° to 35°.

To mine these zones, a series of parallel sill drifts are driven along the strike of the deposit, following the footwall contact. From these sill drifts, generally driven 6m wide and 4.5m high, a top-hammer longhole rig drills rings of 3” up-holes into the deposit above, stopping at the hanging-wall contact.

After drilling is complete, the rings are loaded, blasted, and then mucked out from the sill drift, which serves as a drawpoint. The average blast size is 9,000 tonnes. Mucking is via remote-controlled LHD; all stopes are non-entry, so no workers are exposed to the open stope. Ore is trucked to surface along the main ramp that accesses the deposit.

For the Minto East and Copper Keel zones, production drift centerlines are 20 m apart. Geotechnical analysis supports the use of 15 m-wide stopes and 5m-wide pillars in Area 2. The pillar thickness is increased where stope height necessitates it. This method of varying stope and pillar widths based on the height of the deposit will also be applied to subsequent ore zones (e.g. Minto East 2). This mining method does not use backfill; however, small quantities of development waste are sometimes placed in completed stopes to reduce haulage requirements.

Minto North Underground will also be mined as longhole stopes but will involve cemented rockfill to backfill the primary stopes. The backfill will consist of waste rock mixed with cement to a design recipe underground. The backfill will cure with enough strength to act as engineered pillars. Once the primary stopes are mined and backfilled the rock pillars between primary stopes will be extracted as secondary stopes. The stope sill development will be on 14m centres and primary and secondary stopes will both be 14m wide. In order to fill the primary stopes with backfill, there will be additional development top cuts above the primary stopes to provide a backfill dumping point. The entrance to Minto North Underground will be a haulage portal from the Minto North Pit. An alimak ventilation raise will be excavated to surface to provide secondary egress and flow through ventilation for the mine.Significant variability in copper grades is seen within each ore zone; therefore, diamond drilling completed as part of earlier exploration is supplemented by infill drilling done from each sill using the production drilling equipment. Where additional information is needed prior to the completion of sill drifts, diamond drilling is also done from the underground workings.

For an example of mine development, Figure 5-11 provides a perspective view of the Area 118 zone in a nearly completed state (some stopes and development are omitted for clarity).

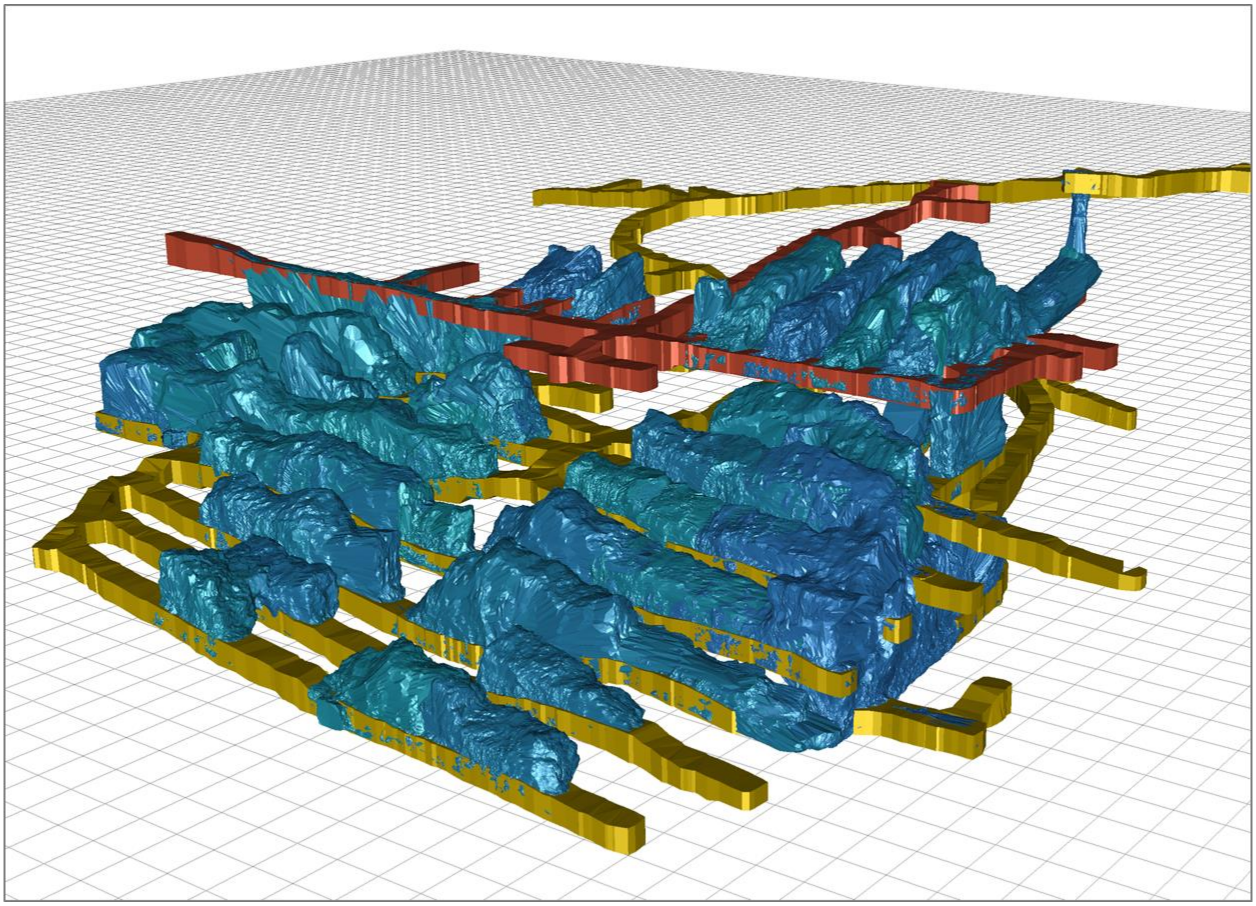


Figure 5-11: Perspective View of Area 118 Zone Looking Southeast. 740 Level Development Shown in Red. Some Development and Stoping Omitted for Clarity.

5.3.1.7 Ground Support

Ground support originally comprised of 2.4 m-long fully grouted resin rebar bolts on a 1.5 m x 1.5 m pattern with a 1.8 m bolt in the center for the back and all 1.8m bolts for the walls. Mesh is installed to within 1.5 m from the floor. Additional support is installed in intersections. In 2020 the mine switched ground support styles to inflatable bolts. The bolts are still 2.4m long and maintain a tensile strength of 12 tonnes like the resin bolts.

5.3.1.8 Ventilation

Air is supplied to the mine by a fresh air raise installed in March 2015. Air is supplied to the mine with a 400 HP fan and enters the main ramp at the 760 level.

The fan is equipped with a variable frequency drive, which is used to balance the quantity of air delivered with the requirements of the diesel equipment in use at each stage of the mine life. Maximum fan power is 344hp; testing the fan at full speed during commissioning, airflow was measured at 350,000 cubic feet per minute (cfm).

Air is heated to maintain above-freezing temperatures year-round. The system comprises four burners totalling 32 million BTU/h and their ancillary infrastructure (blower motors, CO and temperature sensors, electronic controls).

Four 30,000 gallon propane tanks supply the burner with fuel. Two additional tanks will be installed in prior to the 2016 / 2017 heating season. Propane consumption averaged 4,400 L/d in December 2015.

In 2017, Minto completed a raise bore vertical vent raise for the Minto East deposit from the old mill crusher pad. This raise is a return air raise for the mine air and contains two 150 HP fans in a bulkhead at the bottom to assist the surface fan on the fresh air raise. Air entering the fresh air raise sweeps through the main ramp, Copper Keel deposit, and down the Minto East ramp before exiting out the return air raise. A small amount of excess air splits off at the bottom of the fresh air raise and exits out the haulage portal.

5.3.1.9 Water Supply

Inflow to the mine through faults and un-grouted diamond drill holes is generally sufficient to supply the mine with water for drilling and dust control. The mine recirculates water through a network of sumps designed to remove suspended sediment, which is dug out and hauled to surface and disposed in either the Main Pit or Area 2 Tailings Management Facilities. Occasional deliveries of water from surface have been required in the past as mining retreated out of wet areas.

5.3.1.10 Dewatering

Water currently collects into six sumps (690L, 655L, 620L, 580L, 520L and 475L), from which pumps send water to the main water sump at 760L. This is a two-stage clean/dirty sump that removes most suspended solids before water is pumped to a final settling sump near the portal. This portal sump either discharges out to the permanent heat traced line on surface and on to the Area 2 Pit or returns water underground to supply the mine feed storage tank.

5.3.1.11 Explosives

Emulsion is used for both longhole production and development. A bulk emulsion product known as Dyno Titan RU, formulated for underground use and having high viscosity, is used to load most blasts. This product is delivered via one of two dedicated mobile loading units – one for development rounds and a larger unit for longhole stope blasts.

To provide a backup in the event that the mobile loading unit is out of service, Minto stocks a product known as Dyno SL, which is a cartridge emulsion designed to be manually loaded using a portable pneumatic unit.

In development, a perimeter blasting product (Dynosplit D) is used to reduce overbreak in the back, and Dyno AP (a cartridge emulsion) is used in wet lifter holes.

The following Table 5-7 lists the magazines on site:

Table 5-7: Explosives Magazines

License No.	Location	Magazine Contents
YT-535	Surface	Surface detonators
YT-533	Surface	Surface explosives
YT-541	Surface	Underground detonators
YT-534	Surface	Underground explosives (perimeter control and boosters)
YT-542	Surface	Surface explosives (pre-shear)
YT-551	Surface	Underground explosives (packaged emulsion)
YT-553	Underground	Underground detonators
YT-550	Underground	Underground explosives

The Minto South Underground has three magazines, one for detonator caps, one for bulk emulsion, and one for boosters and packaged explosives. All are equipped with concrete floors and lockable gates. The powder magazine is large enough to store and handle 1.5 tonne totes of emulsion used by the development loader. The larger longhole loading unit is parked on surface at Dyno Nobel's office / shop / silo complex.

Non-electric caps are used to time and sequence blast holes in both production and development blasts. A single electric cap is used for each blast to tie the first non-electric cap into the mine's electric central blasting system.

5.4 Water Management

Management of water at the Minto Mine plays an important part in the mine planning; strategies and systems for managing water are in place for the current mining operations. The site water management plan (WMP) 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.

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 includes the following aspects of the operational Water Management Plan at the Minto Mine:

- The operational water management plan (WMP);
- The site water balance;
- The Water Quality Modelling; and
- The water treatment system.

The Minto Mine Site has a positive water balance. Therefore, it is necessary to release water from site from time to time to prevent accumulation of excess water. The primary objective of the water management strategy is to control the release of water from site in a way that eliminates or minimizes potential effects to the water quality in Minto Creek.

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

- The site water balance is used to define mine water inventory targets and targets for volumes to be released to Minto Creek. Regular tracking of the mine water inventory allows the mine operations to determine if the inventory is on target and if and when water must be released from site.
- Runoff from developed mine areas (mine water) is collected and stored in the Main Pit Tailings Management Facility (MPTMF) and the Area 2 Pit Tailings Management Facility (A2PTMF). Mine water is used for ore processing and tailings deposition.
- The preferred method for controlling and limiting the inventory of mine water on site is to collect and divert discharge-compliant (clean) runoff to the water storage pond (WSP) and from there to Minto Creek as natural creek flow allows.
- If collection, diversion and release of clean water is not sufficient for meeting mine water inventory targets then Minto has the option of treating and releasing mine water.

The following sections will describe details of the operational water management plan, site water balance and description of operational water treatment. Planned water management for temporary closure and for the final reclamation and closure plan are described in Section 6.3.7 and 7.6, respectively.

5.4.1 Operational Water Management

The primary objective of the water management plan is to manage the release of water from site and, by extension, manage the inventory of mine water stored in the MPTMF and the A2PTMF. The mine operation must have sufficient water to operate but must avoid storing excess of mine water that does not meet the WL effluent quality limits.

During operations, water collected at the Minto Mine will be segregated on the basis of clean runoff and mine water. Clean runoff will be diverted around the active mining areas to the Water Storage Pond, and mine water will be contained in the MPTMF and A2PTMF. Runoff is classified as ‘clean’ if the water meets the water quality limits defined in the water licence. Runoff that does not meet water quality limits is categorized as ‘mine water’. During operations, clean runoff is intended to be released to Minto Creek as natural creek flow allows, from the WSP while mine water will be used for processing of ore and for sub-aqueous deposition of tailings and waste rock.

Diversion and release of clean runoff is intended to be the main method for managing the mine water inventory. However, release of treated mine water may be required if diversion of clean water is insufficient for managing the inventory of mine water.

Figure 5-12 shows a diagram of the work flow for the water management plan. The work flow includes the following steps:

Step 1. Define a mine water inventory target. The target will be set based on the available storage capacity, operational water demand, and runoff estimates. The water balance model will be used as a tool to evaluate the potential range of precipitation and runoff events that will have to be planned for.

Step 2. Track the site's mine water inventory. The inventory of mine water stored in the MPTMF and A2PTMF will be tracked on a weekly or monthly basis or as required, by surveying the water levels in the two reservoirs and by tracking the volume of waste rock and tailings solids deposited sub-aqueously in the two tailings management facilities. If the mine water inventory is increasing at a rate that would result in an exceedance of the inventory target, then steps would be taken to release additional water from site. Discharge management is described in Section 5.4.15.

Step 3. Update the water inventory target every 6 months, or as required and repeat Step 2. Operational, physical or water quality changes may change the water demand, storage requirement, availability of reservoirs or other elements that was used as a basis for defining the water inventory target. Therefore, the inventory target will be updated regularly.

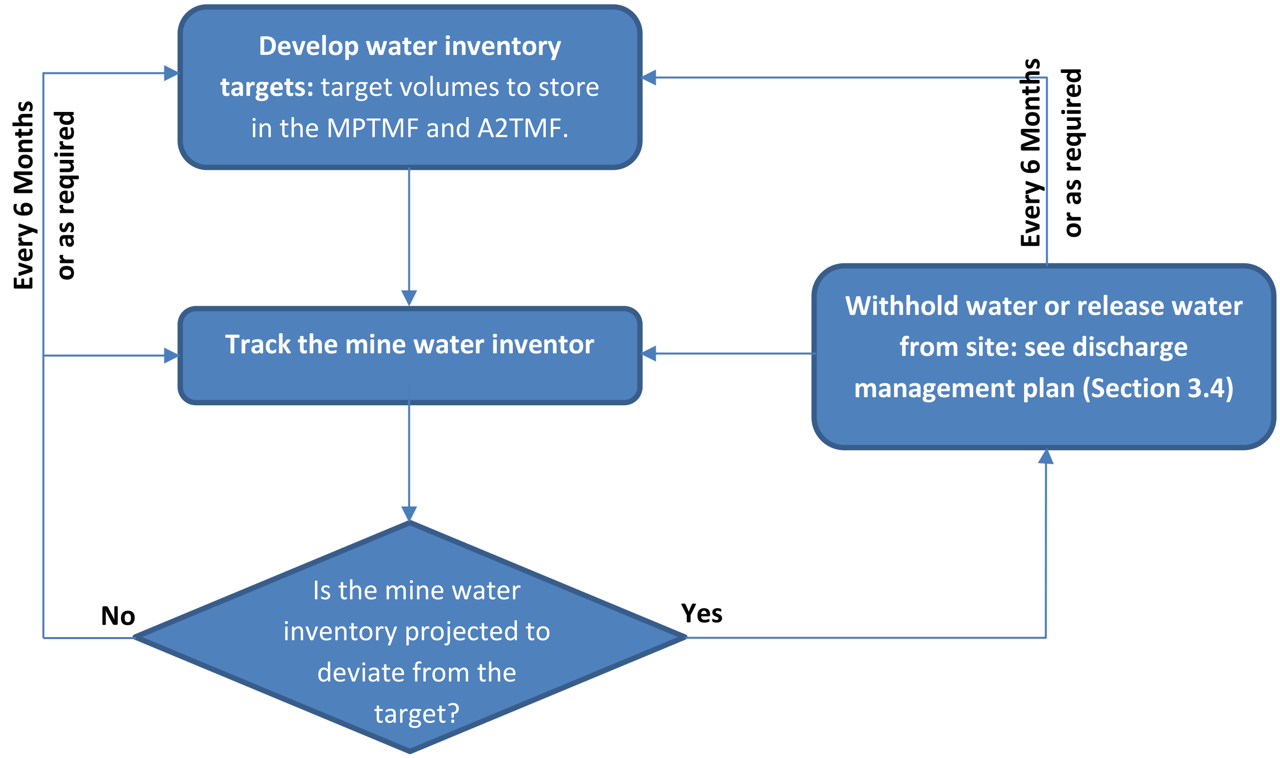


Figure 5-12: Water Management Plan Workflow

5.4.1.1 Defining Mine Water Inventory Target

The mine water inventory target will be defined based on the following considerations:

- As a guiding principle, a minimum of 600,000 m3 of free water, or one year of operational water demand, should be stored on site at all times. This water inventory will ensure that the operation has adequate supply of water and that the mine water reservoir has sufficient residence time to allow for proper settling and management of suspended solids.
- Storage capacity to hold a minimum of 1,000,000 m3 of mine water runoff must be available on October 31 each year. This storage capacity is estimated to represent water that would report to the MPTMF or the A2PTMF in a 1 in 200 wet year (approximately 1,400,000 m3 of site-wide runoff minus approximately 400,000 m3 diverted).
- Climatic variability. The water and load balance model developed for the Minto site will be used to evaluate the mine water inventory targets against a range of precipitation and runoff events (dry and wet years).

The inventory targets will be used by water operators as a basis for deciding whether to release additional water from site or to scale back water release. Inventory targets will be updated every 6 months or as required.

5.4.1.2 Mine Water Inventory Tracking

Water operators at the Minto Mine will track the mine water inventory on a weekly or monthly basis or as required. The following data will be collected and used for inventory tracking:

- Surveys of water levels in:
    - The Main Pit Tailings Management Facility (MPTMF);
    - The Area 2 Pit Tailings Management Facility (A2PTMF); and
    - The Water Storage Pond (WSP).
- Volumes of tailings solids and waste rock deposited sub-aqueously in the MPTMF and A2PTMF
- Pumped flows on site
- Precipitation and snow accumulation
- Runoff at hydrometric stations

Surveyed water levels will be converted to volumes using level-volume curves for the MPTMF and A2PTMF. The frequency of updates to the water inventory will depend on the season and operational factors. During winter months when flows are low, inventory updates may only be required every 4 to 8 weeks. However, before freshet and during periods with heavy precipitation in the summer and fall months, it may be necessary to update the inventory every 1 to 3 weeks.

5.4.1.3 Reservoirs

The water management plan was developed in conjunction with Minto Mine's Waste Rock and Overburden Management Plan and Tailings Management Plan. The Tailings Management plan (TMP) was developed to make use of three planned tailings management facilities planned, namely the MPTMF, A2PTMF and the Ridgetop North Pit TMF (RNPTMF). The water management plan will primarily rely on the water storage capacity available in the MPTMF, the A2PTMF, and the WSP. The capacity of the Ridgetop North Pit will not be included in available capacity until after the pit is developed.

Main Pit Tailings Management Facility

The MPTMF currently (December 2017) holds 3.35 Mt of tailings deposited from November 2012 to July 2015. A bathymetry survey conducted in October 2016 showed a deposited dry tailings density of 1.35 t/m^3. As of that survey, the remaining storage capacity of the MPTMF up to 786 masl is 920,000 m^3.

Area 2 Pit Tailings Management Facility

The final A2PTMF will consist of two intersecting pits separated by a saddle. The larger and more northerly of the intersecting pits is called Area 2 Stage 2 Pit, while the smaller and more southerly pit is referred to as Area 2 Stage 3 Pit. Tailings have been deposited in the A2PTMF since March 2015. As of November 1, 2017, it holds 3.53 Mt of tailings. A bathymetry survey conducted in October 2016 showed a deposited dry tailings density of 1.33 t/m^3. As of that survey, the remaining tailings storage capacity of the A2PTMF, up to 799 masl, is 6.1 Mm^3.

It is important to note that of the total 7.02 Mm^3 remaining storage capacity (0.92 Mm^3 MPTMF and 6.1 Mm^3 A2PTMF) an estimated 705,000 m^3 was occupied by free water as of November 1, 2017.

Ridgetop North Pit TMF

Ridgetop North Pit was scheduled to be the final pit mined as part of the Phase V/VI mine plan.

Ridgetop North Pit TMF is projected to have a total storage volume of 1.9 Mm^3 below the natural spill elevation of 862 m.

The Ridgetop North Pit TMF will only receive tailings slurry; no NP:AP<3 rock will be stored in this facility. During operations, Minto anticipates pumping excess water from the Ridgetop North Pit TMF to the adjacent A2PTMF for purposes of water management. There will be no surface discharge from the TMF and no spillway.

Minto North

During active development and mining of the Minto North pit (2014 through 2017), mine water was trucked to the MPTMF. There will be no surface discharge from the Minto North Pit and no spillway during operations. During mining, the Minto North underground deposit will be dewatered into the Minto North Pit. After completion of underground mining the Minto North pit water will be pumped into the Minto North Underground workings.

Underground Workings

Upon completion of mining each zone in the Minto South Underground, it becomes available for the storage of tailings and/or water.

Table 5-8: Storage Capacities of Underground Ore Zones

Facility	Volume (m^3)
Area 118 Zone	262,000
Area 2 Zone	110,000
Minto East Zone	197,000
Copper Keel Zone	800,000
Minto East 2 Zone	460,000
Total Underground Storage Capacity	**1,829,000**

5.4.1.4 Water Conveyance and Diversions

Infrastructure for conveyance of water is an important element of the water management plan. Existing and planned water management infrastructure is discussed in Section 5.4.1.8.

5.4.1.5 Discharge Management

The discharge management actions described here provide a framework and specific procedures for diverting and releasing water from site.

Licence Effluent Quality Standards

Effluent quality limits as outlined in the proposed Water Licence QZ14-031 are included in this section. The water licence will always be referred to in conjunction with the Minto Water Management Plan when making water management decisions to ensure a complete understanding and maintain compliance with the licence.

From QZ14-031-2:

9. All effluent discharged to Minto Creek must meet the following limits at all Effluent Points (including W16a, W17, W50 and WTP):

a)

Table 1 Effluent Standards

Parameter	Effluent Standards
pH, pH Units	6.0 – 9.0
Ammonia - N, mg/L	0.75
Nitrite - N, mg/L	0.18
Nitrate - N, mg/L	27.3
Aluminum (dissolved), mg/L	0.3
Arsenic (dissolved), mg/L	0.015
Cadmium[1] (dissolved), µg/L	$3*e^{(0.736(\ln(hardness)-4.943)}$
Chromium (dissolved), mg/L	0.003
Copper (dissolved), mg/L (when [DOC] @ W2 >10 mg/L)	0.06
Copper (dissolved), mg/L (when [DOC] @ W2 ≤10 mg/L)	0.039
Iron (dissolved), mg/L	3.3
Lead (dissolved), mg/L	0.012
Molybdenum (dissolved), mg/L	0.219
Nickel (dissolved), mg/L	0.33
Silver (dissolved), mg/L	0.0003
Selenium (dissolved), mg/L	0.006
Zinc (dissolved), mg/L	0.09
Oil and Grease	None Visible

[1] Hardness measurement at WQO Station

b) *Total Suspended Solids (TSS) of 15 mg/L except during March, April and May when the TSS limit is a maximum grab concentration of 30 mg/L and a monthly mean concentration of 15 mg/L.*

c) *A bioassay standard of a 96-hour at 100% LT50 bioassay using rainbow trout (EPS1/RM/13), pH non-adjusted and a 48-hour at 100% LT50 bioassay using Daphnia magna, pH non-adjusted (EPS 1/RM/14); and*

d) *The effluent limits set out in Schedule 4 of the MMER.*

3.4 Water Quality Objectives

11. The table below lists Water Quality Objectives. Any exceedances of these at the defined WQO[*] Station shall trigger the Operations Adaptive Management Plan.

Table 2- Water Quality Objectives

Parameter	Water Quality Objectives
pH, pH Units	6.0 - 9.0
Ammonia - N, mg/L	0.25
Nitrite - N, mg/L	0.06
Nitrate - N, mg/L	9.1
Aluminum (dissolved), mg/L	0.1
Arsenic (dissolved), mg/L	0.005
Cadmium[1] (dissolved), µg/L	$e^{(0.736(\ln(hardness)-4.943)}$
Chromium (dissolved), mg/L	0.001
Copper (dissolved), mg/L (when [DOC] @ W2 >10 mg/L)	0.02
Copper (dissolved), mg/L (when [DOC] @ W2 ≤10 mg/L)	0.013
Iron (dissolved), mg/L	1.1
Lead (dissolved), mg/L	0.004
Molybdenum (dissolved), mg/L	0.073
Nickel (dissolved), mg/L	0.11
Silver (dissolved), mg/L	0.0001
Selenium (dissolved), mg/L	0.002
Zinc (dissolved), mg/L	0.03
Bioassay (Quarterly Analyses)	30-day Early Life Stage Toxicity for rainbow trout (EPS 1/RM/28), 7-day for *Ceriodaphnia dubia* (EPS 1/RM/21), and 72-hour for algae (*Pseudokirchneriella subcapitata)* (EPS 1/RM/25).

[1] Hardness measurement at WQO Station

* WQO Station definition from QZ14-031:

"WQO Station" for the purposes of this Licence means:

- *station W2 during the period when flow is encountered at stations W15 and W35; or*
- *station W50 during the period when flow is not encountered at stations W35 and W15.*

Discharge Flow Restrictions

Flow restrictions on discharge from the Minto Mine as outlined in Water Licence QZ14-031 are included in this section. The water licence will always be referred to in conjunction with this document when making water management decisions to ensure a complete understanding and maintain compliance with the licence.

From Water Licence QZ14-031:

3.2. Discharge Rates

3) The Licensee shall cease discharging and take remedial action if there is erosion and/or alteration to the bed or bank of the water channel.

4) All discharge from the Reverse Osmosis Plant (RO) shall meet the WQOs in Table 2.

5) When W35 and W15 are frozen, discharge from the Effluent Points and/or the RO shall meet the WQOs in Table 2 at W50.

6) When W35 and W15 are not frozen, discharge from Effluent Points shall meet either:

a. The WQOs in Table 2

or

b. the EQSs in Table 1 and be discharged at a rate (Q_{EFF}) that shall be determined as follows:

a) Initial discharge rate: 1/3 (Q_{MC}+Q_{RO})≥Q_{EFF-C}

b) Rate after discharge has commenced: 1/3 (Q_{MC}+Q_{RO}-Q_{EFF}-M)≥Q_{EFF-C}

Where:

Q_{MC} = daily flow rate in Lower Minto Creek (represented by either W1 or MC1), Q_{RO} = daily flow rate of discharged from the RO; Q_{EFF}-M = measured daily rate of discharge from mine site Q_{EFF-C} = calculated rate of water discharge from mine site

7) There shall be no surface discharge to McGinty Creek without revision of licence conditions.

8) The flow in McGinty Creek shall remain statistically unaltered from baseline flow.

Maximum discharge flow will be calculated daily based on a manual or automated flow measurement. Automated flow measurements will consist of remote water level transmission converted to flow using a rating curve or an in-stream flow sensor that transmits a flow value to the mine.

5.4.1.6 Water Management Decisions and Actions

Operational water management decisions can be summarized as follows:

1) The first water management decision is whether or not water (clean runoff or treated mine water) must be released from site.
2) Secondary decisions include:
   a) The quantity of water,
   b) The preferred water source, and
   c) Timing of the release.

Water must be released from site when the mine water inventory exceeds, or is projected to exceed, the inventory target. The inventory target will regularly be compared to the mine water-tracking log to determine whether the mine is operating at a water deficit or surplus or is on target. Actions to be taken in the event of a surplus when water must be released from site are described in Section 5.4.1.7.

Water released from site must always meet effluent quality standards and flow restrictions as prescribed in the water licence. Water treatment will be required if water destined for release does not meet these limits. Options for treating water are discussed in Section 5.4.4.

5.4.1.7 Surplus Water Inventory Actions

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

1. **Divert water from W35 to WSP:** water will be diverted from the south-west catchment (collected at station W35) to the WSP. Historically, the water at W35 has been of a similar quality to clean runoff measured in lower Minto Creek. On-going water quality monitoring will ensure that water in the WSP remains in compliance with the water licence water quality limits. The mine will maintain procedures, checklists, sample collection, and analysis that must be completed prior to diverting water from W35 to the WSP.

2. **Divert water from W15 to WSP:** if diversion of water from W35 in insufficient to meet water inventory and release targets then water collected at W15 can be diverted to the WSP. Water collection point W15 collects runoff from undisturbed areas and from waste rock. The water quality parameter concentrations have historically been elevated compared to undisturbed catchments but have generally met water quality limits in the months of May, June, July and August. On-going water quality monitoring will ensure that water diverted from W15 and water in the WSP remains in compliance with water quality limits in effect. The mine will maintain procedures, checklists, sample collection, and analysis that must be completed prior to diverting water from W15 to the WSP.

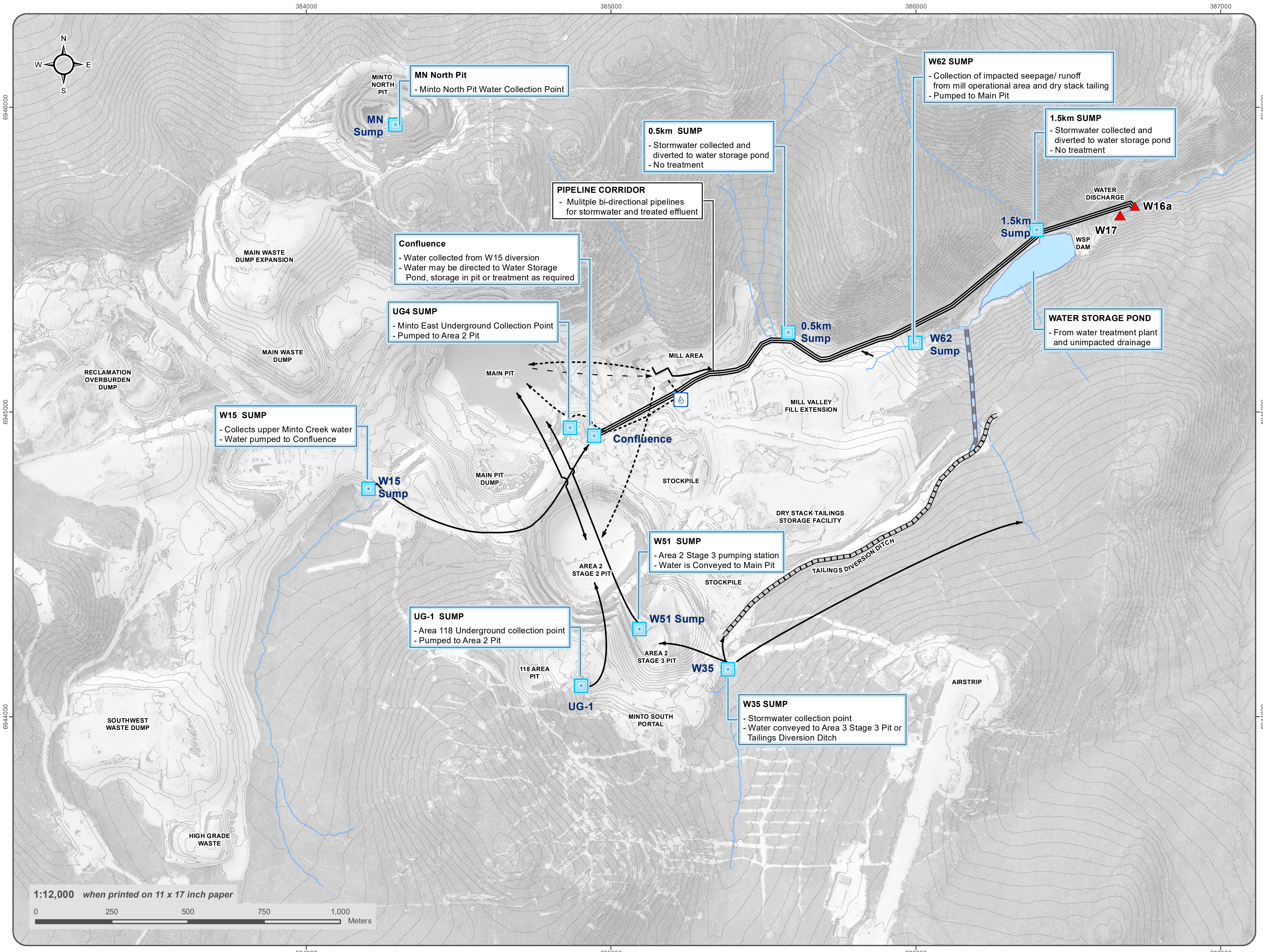
3. **Release mine water stored in the MPTMF or A2PTMF to WSP.** The mine water stored on site will likely require water treatment before it can be released. Water treatment considerations are discussed in Section 5.4.4. The mine will maintain procedures, checklists, sample collection, and analysis that must be completed prior to releasing water from the MPTMF or A2PTMF. Water will only be released from the WSP to Minto Creek when the water quality complies with limits prescribed in the water licence and only in quantities that meet the limitation in Section 5.4.1.5. In addition, the water quality, flow, and channel conditions of lower Minto Creek will be considered before a decision is made to release water from the WSP to Minto Creek.

5.4.1.8 Water Conveyance Network

The Minto Mine water conveyance network consists of diversion ditches, culverts, sumps, pumps, and pipelines installed throughout the mine site. The system is designed to segregate clean runoff and mine water. Clean water is conveyed to the WSP while mine water is conveyed to the mine water storage reservoirs, which includes the MPTMF and A2PTMF.

Figure 5-13 shows the location of water conveyance infrastructure that are currently in place. Table 5-9 summarizes the current mine water infrastructure, and also includes authorized (by QZ14-031) changes that have yet to be implemented.

The conveyance network is intended to provide a high degree of operational flexibility such that appropriate water management actions can be taken based on informed management decisions.



MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 5-13

MINTO MINE WATER CONVEYANCE NETWORK

NOVEMBER 2020

MINTO

- Water Treatment Plant
- Collection Point
- Monitoring Location
- Mill Water Reclaim Line
- Pipe Alignment
- Piping Corridor
- Tailings Slury Discharge
- Tailings Diversion Ditch
- Tailings Diversion Ditch Extension, To Be Constructed
- Contour (5m)

ENSERO solutions

Aerial imagery obtained from Challenger Geomatics. Imagery acquired Sept 9th 2014.
Site contours derived from 2014 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: amatlashevska;2020-11-05/09:06 AM)

Table 5-9: Minto Mine Water Management Infrastructure

Infrastructure Name	Description of Current Use
Main Pit Tailings Management Facility (MPTMF)	Tailings management facility and water reservoir. Total capacity to the natural spill elevation is approximately 4.9 Mm3.
Area 2 Pit Tailings Management Facility (A2PTMF)	Tailings management facility and water reservoir.
Water Storage Pond (WSP)	Stores clean water destined for release to Minto Creek, or available for mill use. Total capacity is approximately 320,000 m3.
Ridgetop North Pit	Undisturbed footprint
W15 sump	Collects runoff and seepage from the western sub-catchments on the Minto Site and conveys the water via a pipeline to the Main Pit or WSP.
W35 sump	Collects runoff and seepage from the southern undisturbed sub-catchments on the Minto Site and conveys the water to the Tailings Diversion Ditch and the WSP or the spillway into A2S3 pit.
0.5 km and 1.5 km sumps and ditches	Collects runoff from sub-catchments north of the Minto Mine access road. Runoff collected is diverted to the WSP.
Tailings diversion ditch	Diverts water from small catchment upslope of ditch and conveys W35 catchment water to WSP.
Underground dewatering (Minto South Portal)	Water collected from underground dewatering will be conveyed by pipe or trucked to the MPTMF or A2PTMF.
Confluence	Hub located between the Main Pit and Area 2 pit where water from W15 may be directed to the Main Pit or to the WSP.
WSP discharge	Pumps and pipes for releasing water from the WSP to Minto Creek.
Ridgetop North sump	Undisturbed footprint
Ridgetop South sump	Undisturbed footprint
Minto North pit	Local runoff collected in the Minto North Pit may be transported to the MPTMF or A2PTMF.
MVFES2 Collection sump	Collects and pumps Mill Valley seepage to the Main Pit.
Reclaim water line from the WSP to the mill	Conveys water from the WSP to the mill, if required
Reclaim water line from the MPTMF to the mill	Conveys water from the MPTMF to the mill or A2PTMF.
Reclaim water line from the A2PTMF to the mill	Conveys water from the A2PTMF to the mill or MPTMF.
Tailings line from the mill	Conveys slurried tailings and water from the mill to the MPTMF, A2PTMF.
Water treatment plant	Accepts feed water from the MPTMF, the A2PTMF or the WSP and discharges treated water to the MPTMF, A2PTMF, WSP or Minto Creek. Sludge and brine produced in the treatment process is pumped to the MPTMF or A2PTMF.

5.4.2 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.

5.4.2.1 Water Balance Model

Site water management is informed by a stochastic water balance model that incorporates frequency distributions for total annual precipitation to estimate the range and probability of runoff events for the proposed development through to post-closure. The model generates a range of forecasts which contribute to the refinement of options for managing both discharge to the environment and water inventory at the mine site. Table 5-10 shows the estimated range of total site precipitation and run-off estimates.

Table 5-10: 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	m3/year	290,000	950,000	1,480,000

The water balance model divides the site and surrounding areas into catchments and sub-catchments within the Upper Minto Creek (Minto Mine site) catchment as well as the sub-catchment for the Minto North Pit, which is located within the adjacent McGinty Creek catchment. The area of the sub- catchments are calculated and classified as undisturbed, developed, or partially developed. Undisturbed catchments typically produce clean runoff that is of similar quality as background water quality in lower Minto Creek. Developed catchments produce mine water runoff. The mine water runoff is generally of poorer quality than the clean runoff but the quality varies over a wide range depending on season and degree and type of material contacted. Catchment delineations and classifications are described in the Water and Load Balance Model Update Report 2018 (included in this RCP as Appendix I).

5.4.2.2 Groundwater

Groundwater represents a minor component of the site's water balance. The mine is located at the headwaters of Minto Creek and therefore has limited input of regional groundwater. The tight bedrock and discontinuous permafrost limit the sub-surface movement of ground water. Some groundwater is encountered during active mining of the pits and underground. However,dewatering volumes are relatively low. An evaluation of groundwater for the Minto Site is available in the Site Characterization Plan in Appendix H.

5.4.2.3 Annual Operational Water Balance

Table 5-11 shows a summary of the annual operational water balance for Minto Mine. The annual water balance shows that runoff yields approximately 950,000 m^3 of water in a year with average precipitation. Operational demand account for approximately 590,000 m^3. This leaves an excess volume of about 360,000 m^3, which must be stored on site or be released to Minto Creek as natural creek flow rates allow.

In a 1-in-100 dry year, the runoff volume would not be sufficient to cover the operational water demand, while a 1-in-200 wet year would yield approximately 890,000 m^3 of excess runoff. The strategy for managing the excess surface runoff and mine water inventory is to divert and release clean runoff to Minto Creek to the greatest extent possible.

Table 5-11: Annual Operational Water Balance Summary for Minto Mine

Water Balance Component	Unit	1:100 Dry Year	Average Annual Precipitation	1:200 Wet Year
Water Input				
Annual site-wide runoff	m^3/year	290,000	950,000	1,480,000
Operational Water Demand				
Water to tailings pores	m^3/year	530,000	530,000	530,000
Water to waste rock pores	m^3/year	60,000	60,000	60,000
Water in Excess of Operational Demands				
Water to store on site or Released to Minto Creek	m^3/year	-300,000	360,000	890,000

5.4.2.4 Diversion of Clean Runoff

Table 5-12 shows a summary of sub-catchments for Minto Mine. Sub-catchments that can be considered to be largely undisturbed (i.e. consistently produce clean/discharge-compliant runoff) include the WSP and W35 catchments.

The WSP catchment accounts for approximately 22% of the total catchment area of the Minto Mine site. Runoff from the northeastern WSP catchment is collected in a ditch along the mine access road and flows through a culvert to the WSP. The eastern portion of the southern WSP catchment reports to the south diversion ditch that follows the southern boundary of the dry-stack tailings facility. From there it flows to the WSP. Runoff from westernmost portion of the southern catchment reports directly to the WSP. The WSP is the primary clean water reservoir at the site and existing pumping infrastructure allows for transfer of water either to Minto Creek or the Water Treatment Plant.

Two other catchments present material opportunities for diversion of clean runoff.

- The W35 catchments represent approximately 16% of the total upper Minto Creek catchment area of the Minto Mine site. As the footprint for the Area 2 Stage 3 pit has necessitated, water collected at W35 is conveyed to the Tailings Diversion Ditch and from there flows to the WSP.
- The W15 catchment represents 36% of the total upper Minto Creek catchment area of the Minto Mine site. W15 receives runoff from both undisturbed catchments and developed mine areas. However, runoff that historically has reported to W15 has generally met water quality limits listed in WL QZ14-031 for the months of May, June, July, and August. Existing pumping and piping infrastructure allows for transfer of W15 water to the Main Pit or WSP.

The WSP reservoir and related infrastructure, the tailings diversion ditch, and the W15 infrastructure together permit water from the respective catchments to be managed as clean runoff when water quality allows.

If clean surface diverted to the WSP does not meet the WL QZ14-031 effluent quality limits then water treatment may be required. Operational use of water treatment is discussed in Section 5.4.1.5 (Water Inventory and Discharge Management).

Table 5-12: Minto Mine Sub-Catchments and Potential Runoff Volumes Diverted, Average Year

Sub-Catchment	Area	% of Minto Mine Site-Wide Catchment	Diverted Runoff, 60% Diversion Efficiency		Diverted Runoff, 80% Diversion Efficiency	
	Ha	%	m^3/year	% of Site-Wide Runoff	m^3/year	% of Site-Wide Runoff
W35a	172	16	120,000	14	160,000	19
WSP	235	22	90,000	11	120,000	14
W15	374	36	150,000	18	200,000	24
Diversion Options						
W35a + WSP	407	39	210,000	25	280,000	33
W35a + WSP + W15	781	75	360,000	42	480,000	56

5.4.3 Water Quality Modelling

Water quality predictions for the Minto site have not been revised to support this version of the RCP, as explained in Section 5.4.3.1. Methods and results are presented in the Water and Load Balance Model Report 2018 (Appendix I)). This section provides a brief summary of the approach and presents selected key results.

5.4.3.1 Approach to Water Quality Modelling

The 2018 water quality predictions were developed using the GoldSim modeling software package, using Minto’s prior model as a starting point. The prior version of the model was most recently updated in March 2017 for the water and load balance update included in the 2016 annual report (Minto 2017). The model combines water balance inputs (summarized in the preceding section (Section 5.4.2) with geochemical loading inputs (derived largely from full-scale operational monitoring results) to produce a combined water and load balance that yields estimates of aqueous concentrations of modelled parameters at discrete points of interest relative to the mine site. The water and load balance is primarily a conservative mass balance, with no modelled removal of geochemical load except in model scenarios incorporating passive wetland treatment elements. The effect of placement of soil covers on waste rock and tailings is modelled by decreasing the rate of net percolation of water and flushing of load through those materials after placement of covers in the model scenario. As part of this 2020 RCP update, key site water quality monitoring inputs to model source terms were reviewed and were found to be similar to the previously observed levels that were used as inputs to the existing 2018 RCP model version. On that basis (and given the lack of substantial fundamental changes to the RCP) the water quality model was not updated for the 2020 RCP update.

5.4.3.2 Water Quality Model Results

Minto Creek catchment water quality model results summaries for dissolved copper, dissolved selenium, and dissolved cadmium are presented for the pit lakes (Figure 5-14), Minto Creek downstream of mine-related disturbances (Figure 5-15), and Minto Creek near the mouth (Figure 5-16). These three parameters have been of primary interest and provide a general representation of the overall model results (which are provided in full in Appendix I, along with discussion). Major aspects of the results at each location are noted in the following bullets.

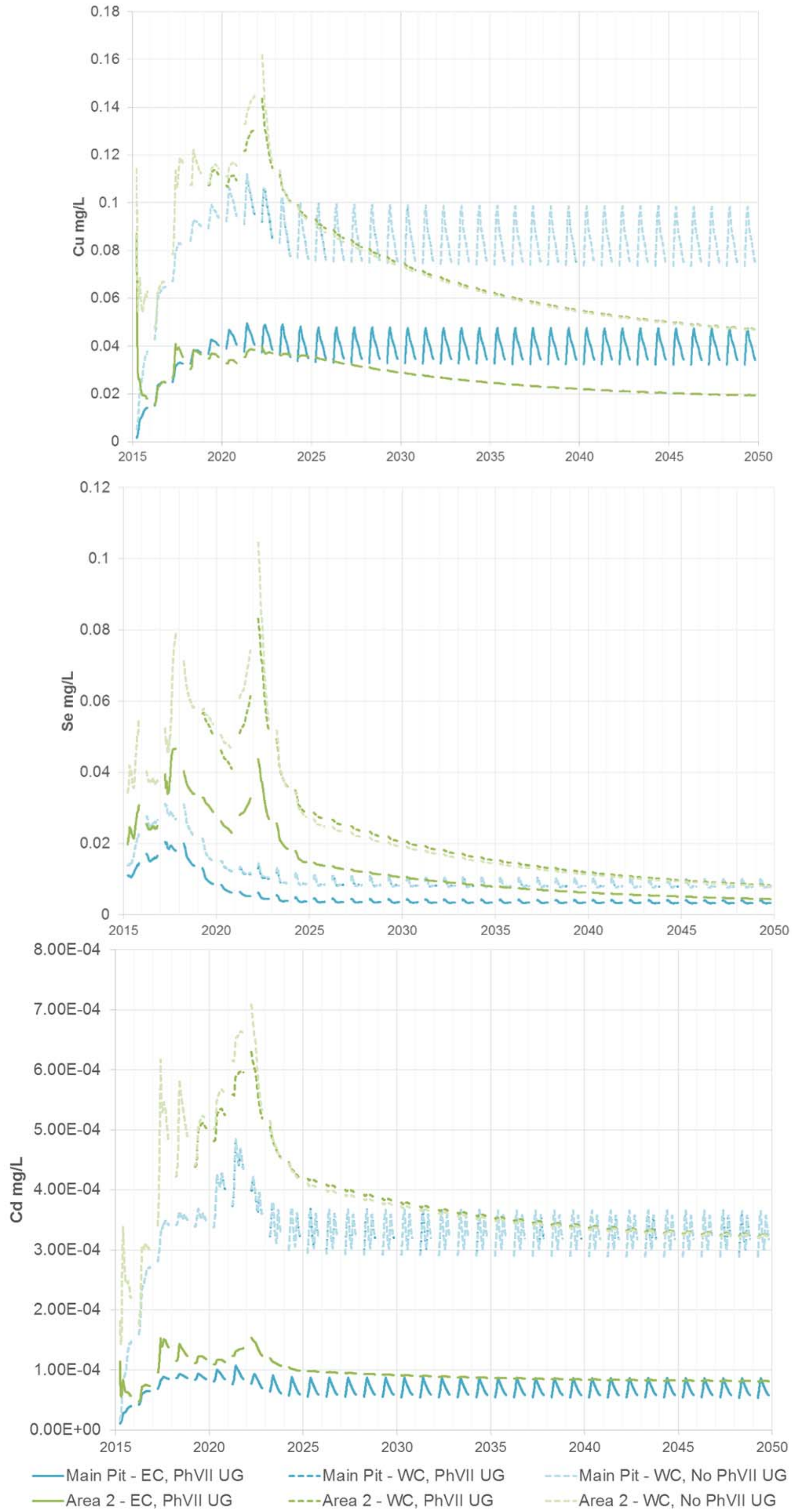
- Open pits (Figure 5-14):
    - Concentrations in the Area 2 Pit are expected to increase during the operational stage when waste rock and tailings are placed in the Area 2 Pit. Selenium concentrations increase markedly during periods when tailings are deposited to the pit. After closure, copper, selenium, and cadmium concentrations are expected to eventually decline to steady-state levels that are representative of long-term post-mining geochemical loading rates.
    - Concentrations in the Main Pit remain relatively constant, again reflecting geochemical loading rates.
    - Scenarios were run with and without Phase VII mine components included, and the results showed that including Phase VII had little to no perceptible effect on model outcomes.

- Minto Creek downstream of mine-related disturbances (at station W3) (Figure 5-15):
    - Model results for W3 show relatively low concentrations during the operational period followed by a modest increase in concentrations at closure. This is due to the fact that residual mine water stored in the Area 2 Pit begins reporting to Minto Creek at that time.
    - Model results show a wide range of seasonal variability that reflects the proportion of pit discharge water to total model flows at W3.

- Minto Creek near the mouth (at station W1) (Figure 5-16):
    - Model results for W1 show relatively low concentrations during the operational period followed by a modest increase in concentrations at closure. The pattern is similar to that modelled for W3, which reflects the influence of discharge from the open pits after discharge begins, and it is similar for scenarios with and without the Phase VII mine components.
    - Model results for dissolved copper, dissolved selenium, and dissolved cadmium for the high-flow period are near or above values determined to represent a concentration that has been defined as 50% assimilative capacity during the freshet period for all model scenarios.
    - During the lower flow periods of summer and fall, model results for these same parameters (dissolved copper and dissolved selenium) are near or below the concentrations defined as 50% assimilative capacity values for both Expected Case (EC) scenarios (i.e. with and without wetland treatment (WT and No WT) and for the Worst Case (WC) with Wetland Treatment (WT) scenario for dissolved copper. For dissolved selenium over this same period, the Worst Case (WC) scenarios (with and without wetland treatment (WT and No WT) are near or above the 50% assimilative capacity concentrations.

- Scenarios were run with and without Phase VII mine components included (PhVII UG and No PhVII UG), and the results showed that including Phase VII had little to no perceptible effect on model outcomes for lower Minto Creek.

McGinty Creek catchment water quality model results for dissolved copper, dissolved selenium, and dissolved cadmium are presented for McGinty Creek near the mouth (Figure 5-17). The results are very similar to those presented in the Phase V/VI expansion application (Minto 2014) and are different only due to changes in modelling method (previously a spreadsheet model, now a GoldSim model) and characterization of the dominant source term that represents undisturbed catchment runoff. The McGinty Creek results show that there is expected to be minimal, if any, measurable effect on the water quality in McGinty Creek from mining of the Minto North deposits (both open pit and underground). Complete modelling results for McGinty Creek are provided in Appendix I.



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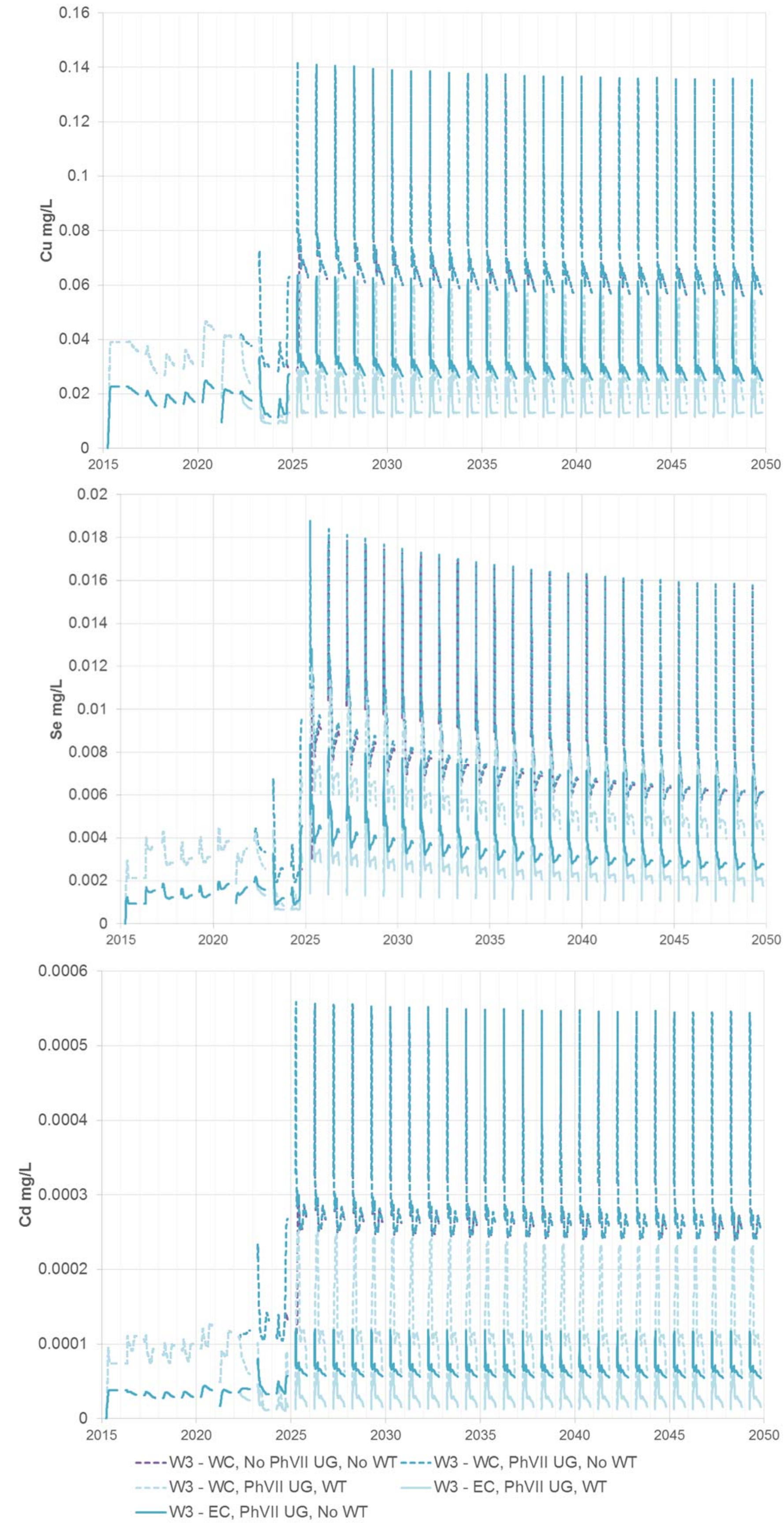
		Selected water quality modelling results for Main Pit and Area 2 Pit lakes		
Job No: 1CM002.044 Filename: Fig_5-14_MP+A2Plake_WQ.pptx	Minto Mine	Date: Feb 2018	Approved: DBM	Figure: **5-14**



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		Selected water quality modelling results for Minto Creek below the mine site (Station W3)		
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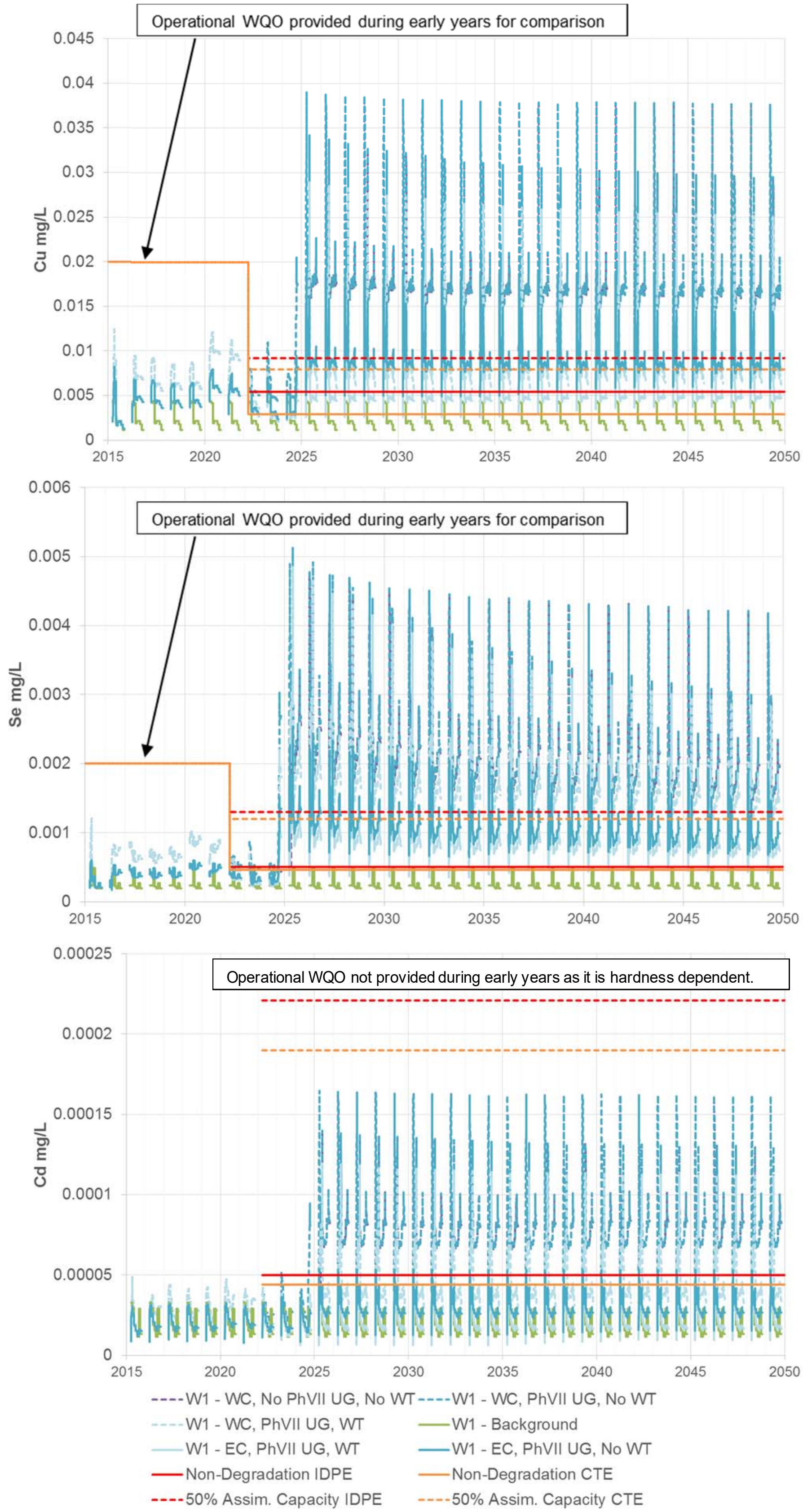

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Minto Mine RCP 2018-1

Selected water quality modelling results for Minto Creek near the mouth (Station W1)

Job No: 1CM002.044

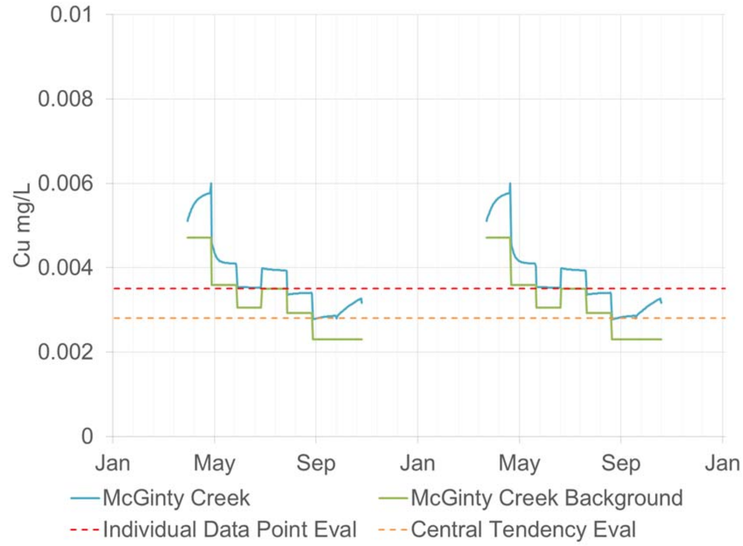
Filename: Fig_5-16_W1_WQ_2018.pptx

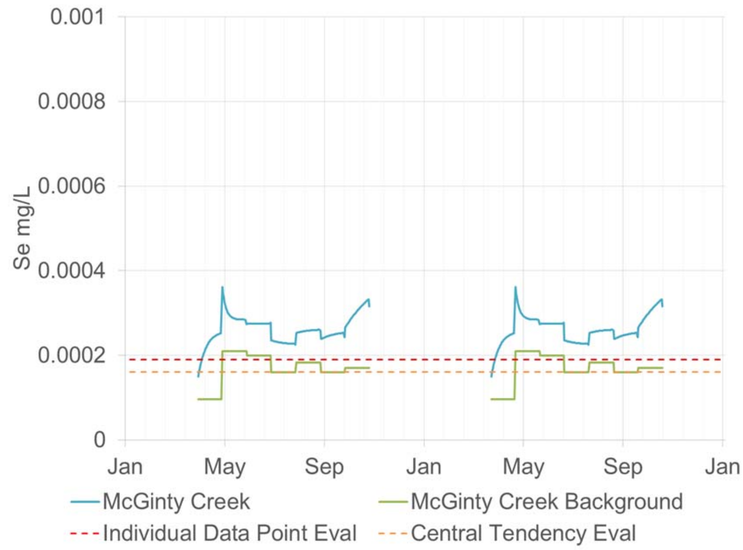
Minto Mine

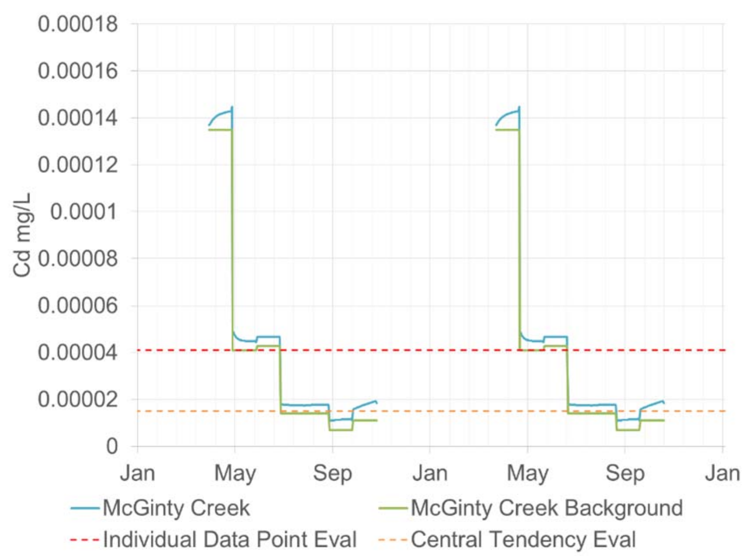
Date: Feb 2018

Approved: DBM

Figure: **5-16**







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Minto Mine RCP 2018-1

Selected water quality modelling results for McGinty Creek near the mouth (Station MN4.5)

Job No: 1CM002.044

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Minto Mine

Date: Feb 2018

Approved: DBM

Figure: **5-17**

5.4.4 Water Treatment

Water treatment may be required if:

- Water stored in the WSP does not meet water quality limits prescribed in the water licence or natural creek flow is too low to efficiently release water from the WSP.
- Mine water stored in the MPTMF or the A2PTMF is to be released to Minto Creek and the water does not meet water quality limits prescribed in the water licence.

The WSP is intended as a clean water reservoir where discharge compliant water is stored and monitored prior to release to Minto Creek. However, storm events, seepage losses from the mill valley or other events may cause certain water quality parameter concentrations to exceed water licence water quality limits. Minto will maintain procedures that must be followed prior to treating and releasing water stored in the WSP. When treating WSP water, it may be necessary to release the treated water directly to Minto Creek from the water treatment plant rather than returning the water to the WSP.

During the operations phase, mine water stored in the MPTMF or the A2PTMF will likely require treatment before it can be released to the WSP.

The first stage of the water treatment plant at Minto was constructed in 2010. The water treatment process included a ballasted lamella clarifier unit (Actiflo®) system for removal of TSS, total metals and dissolved copper. The process relies on the addition of alumina-based coagulant (Aluminex-5), flocculant and organo-sulphide (TMT-15) reagents to facilitate removal of TSS and to precipitate dissolved copper and other metals. Yardney sand filters and Cuno polypropylene filters were installed downstream of the clarifier unit to reduce concentrations of fine particulate matter carried over with the clarifier overflow. The plant was designed for a maximum capacity of 3,600 m^3/day.

In 2012, two Reverse Osmosis (RO) trains capable of handling 2,500 m^3/day per train were added to the treatment process downstream of the existing clarification and filtration units. Treated effluent (permeate) from the RO units is also amended, when necessary, with sodium bicarbonate to adjust the pH and add salinity and alkalinity.

Feed water for the plant has historically been sourced from the MPTMF or from the WSP. A feed water line from the A2PTMF may be added in the future if required. Treated effluent can be directed to the Main Pit, the WSP or directly to Minto Creek. Sludge or RO brine can be pumped to the MPTMF for disposal.

Minto's water treatment plant can be operated in three general configurations:

1. **Clarification and filtration:** this process configuration removes suspended solids (TSS). Coagulant and flocculant solutions are added to the feed water, which is pumped to a ballasted lamella clarifier and a filter. Dissolved constituents are generally not removed. The by-product of the process is a sludge that is pumped to the MPTMF or A2PTMF. The maximum treatment capacity is approximately 4,000 m^3/day.

2. **Sulphide precipitation, clarification, and filtration:** this process configuration can remove dissolved copper, cadmium, zinc, nickel, cobalt, and lead, in addition to TSS. Dissolved metals are removed by adding

an organo-sulphide reagent that binds to dissolved metals and forms precipitates. The by-product of the process is a sludge that is pumped to the MPTMF or A2PTMF. The maximum treatment capacity is approximately 4,000 m^3/day.

3. **Reverse osmosis (RO):** this process removes 95 to 99% of all constituents in the feed water. The feed water for the RO unit is the effluent from the 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 to 99% of constituent loadings. The brine stream is pumped to the MPTFM or A2PTMF. Because of this brine by-product, RO cannot be considered a true water treatment process but is rather a process that concentrates mine water into a smaller volume with higher constituent concentrations. The maximum treatment capacity is approximately 2,500 m^3/day.

Table 5-12 shows a summary of water treatment options and parameters that can be removed.

Table 5-12: Summary of Water Treatment Options and Applicability

Water Treatment Process Configuration	Applicable for Removal of
Clarification and Filtration	TSS Total Metals (not dissolved metals)
Sulphide precipitation, Clarification and Filtration	TSS Total Metals Dissolved Metals, including Cu, Cd, Co, Hg, Ni, Zn
Reverse Osmosis	All other parameters, including Se, nitrate and nitrite.

Figure 5-18 shows a decision chart to guide the selection of water treatment process options when water treatment is required. The analysis of feed water quality can be based on on-site assays or off-site laboratory analysis, depending on the parameter of concern and the relative confidence in the analytical results. Discharge will not commence unless Minto has confidence in the analytical results.

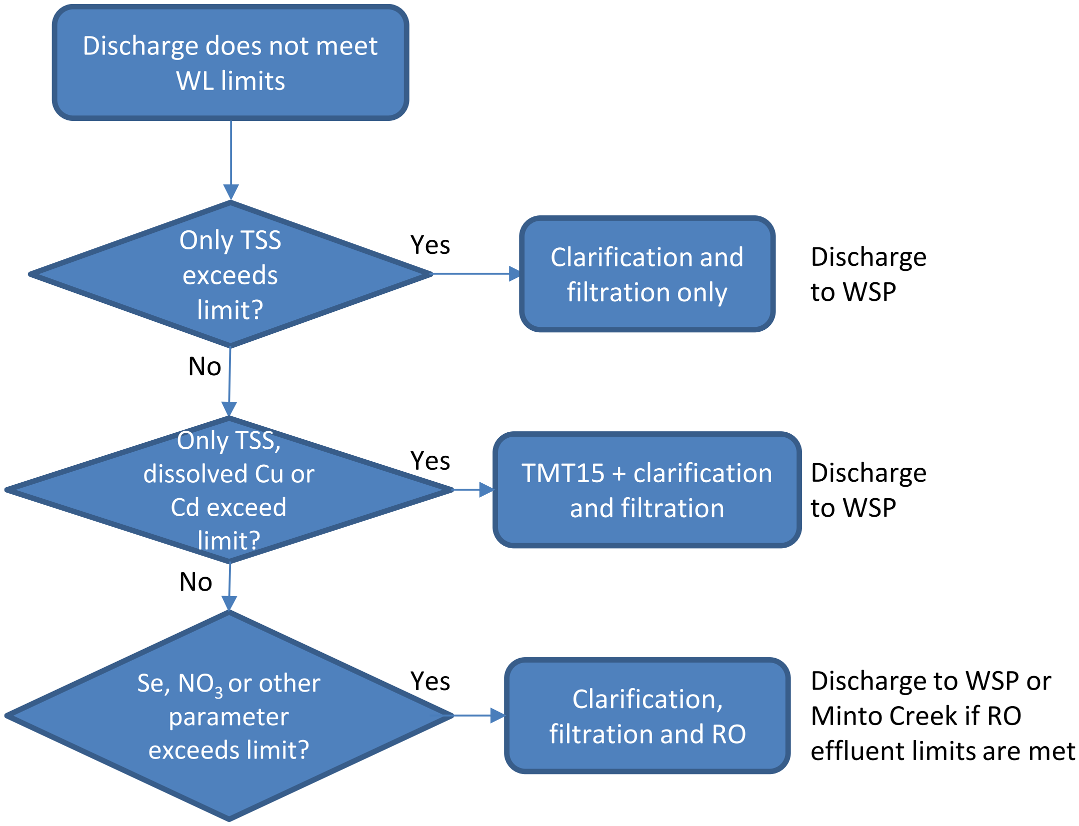

Figure 5-18: Water Treatment Selection Chart

5.4.4.1 Water Treatment Limitations

Minto's water treatment plant was originally designed to remove TSS, total metals and dissolved copper from mine water. In 2011, the mine received an amended water licence that included water quality limits for nitrate and selenium, which the existing water inventory at the mine exceeded. As there was a potential need to treat and release mine water stored in the Main Pit, alternative or supplemental water treatment was identified as being required.

A review of conventional water treatment methods for removal of nitrate and selenium concluded that nitrate could likely be removed using anaerobic biological treatment but removal of selenium to concentrations below the water quality limit of 2.0 µg/L would not be possible/reliable using biological treatment alone. Rather, TSS removal and RO would be required as pre-treatment steps ahead of anaerobic biological treatment. In this treatment process, RO brine would be pumped to an anaerobic biological treatment process and the clean RO permeate would be released to the environment. Selenium present in the RO brine would be removed as sludge in the anaerobic water treatment process. The anaerobic process would be followed by an aerobic biological treatment process that would remove residual dissolved carbon and other nutrients carried over from the anaerobic treatment. Finally, effluent from the aerobic biological water treatment would be settled and filtered prior to release.

Although RO is considered to be a conventional technology, the treatment process described above for removal of selenium to ultra-low concentrations of 2.0 µg/L is outside the realm of conventional technology. However, the use of RO alone for removal of selenium or any other constituents is, in effect, a mine water concentration process than a true water treatment process. As described, 95 to 98% of water quality parameter loadings in the mine water report to the RO brine. If RO alone is used for “treatment” of mine water, the brine would be pumped back to the MPTMF or the A2PTFM where the loadings removed would mix with the untreated mine water. This would result in a gradual increase in all parameter concentrations over time. If RO is used for an extended period of time, the parameter concentrations in the mine water reservoir may increase to a point where RO is no longer effective. In other words, long-term use of RO alone simply causes a gradual worsening of the mine water quality and therefore is not a sustainable water treatment method, particularly in the transition to closure and in the post-closure period.

5.5 Operational Monitoring

Environmental monitoring at the Minto mine is key to confirming that the operational plans implemented on site are protective of the environment and remain in compliance with applicable licences and permits. The monitoring on site is guided by Minto’s Environmental Monitoring, Surveillance and Reporting Plan (EMSRP). The EMSRP includes numerous monitoring programs that cover a wide variety of environmental topics. The programs included in the EMSRP are the Water Monitoring Program, Geochemical Monitoring Program, Meteorological Monitoring Program, Physical Monitoring Program, Aquatic Environmental Monitoring Program, Terrestrial Environment Monitoring Program and the Progressive Reclamation Effectiveness Monitoring Program. This section is intended to provide a brief summary of the operational monitoring programs- refer to the EMSRP (Minto, 2018d) if more detail is required.

5.5.1 Operational Water Monitoring Program

The Water Monitoring Program is made up of three components, Surface Water Surveillance Program, Groundwater Monitoring Program and the Seepage Monitoring Program.

The objective of the Surface Water Surveillance Program is to monitor surface water quality and hydrological conditions at stations within the operational mine area, downstream stations which are influenced by mine effluent discharge, and downstream reference stations which are not exposed to effluent. Water quality and hydrology monitoring is conducted in accordance with the requirements outlined in the WUL and reflected in Table 5-13. Monitoring areas can generally be characterized as sites at or near the active mine site and associated facilities, and on Minto Creek, the Yukon River, McGinty Creek and non-impacted drainages.

Table 5-13: EMSRP 2018-01 Proposed Water Quality and Hydrology Monitoring Program Requirements

Station	Flow	Water Level	Field Parameters Frequency	External Analytical Suite		Internal Suite	96-Hr Pass/ Fail	48-Hr Pass/ Fail	Chronic Toxicity Testing	
				Frequency	Analytical Suite	Frequency			Frequency	Test
W1	C	-	-	-	-	-	-	-		
W2	-	-	W/Wd	W/Wd	A,N,DOC	Wd	-	-	Md	CD-7d
W3	C	-	W/Wd	W/Wd	A,N,DOC	Wd	Md	Md	-	-
W4	-	-	Q	Q	A,N, DOC	-	-	-	-	-
W5	-	-	Q	Q	A,N, DOC	-	-	-	-	-
W6	M	-	M	M	A,N, DOC	-	-	-	-	-
W7	C	-	M	M	A,N,DOC	-	-	-	-	-
W8A	-	-	W	W	A,N	W	-	-	-	-
W10	-	-	M	M	A,N	-	-	-	-	-
W12	-	W-WL, TV	M	M	A,N	-	-	-	-	-
W12A	Wd		Wd	Wd	A,N					
W14	-	-	M	M	B	-	-	-	-	-
W15	C	-	M	M	A,N, DOC	Wd	-	-	-	-
W16	-	W-WL	Mnf/Wd	Mnf/Wd	A,N, DOC	Wnf	-	-	-	-
W16A	Wd	-	Wd	Wd	A,N,DOC	Wd	Md	Md	-	-
W17	C	-	W/Wd	W/Wd	A,N, DOC	Wd	-	-	-	-
W35	C	-	M	M	A,N, DOC	Wd			-	-
W45	Cdw	W-WL, TV	M	M	A,N	-	-	-	-	-
W46	M	-	M	M	A,N,DOC	-	-	-	-	-
W50	M/Wd	-	M/Wd	M/Wd	A,N,DOC	Wd	M	M	M	CD-7d
MC-1	C	-	M/Wd	M/Wd	A,N,DOC	-	-	-	-	-
WTP	Wd	-	Wd	Wd	A,N,DOC	Wd	-	-	-	-
RO	Wd	-	Wd	Wd	A,N,DOC	Wd	-	-	-	-
W51	Cdw	W-WL	M	M	A,N	-	-	-	-	-
W52	Cdw	W-WL, TV	M	M	A,N	-	-	-	-	-
W53	Cdw	W-WL	M	M	A,N	-	-	-	-	-
W54	C	-	M	M	A,N	-	-	-	-	-
W55	M	-	M	M	A,N	-	-	-	-	-
W62	C		M	M	A,N					
C4	M	-	M	M	A,N,DOC	-	-	-	-	-
C10	M	-	M	M	A,N,DOC	-	-	-	-	-
MN	Cdw	W-WL	M	M	A,N	-	-	-	-	-
MN-0.2	M	-	M	M	A,N,DOC	-	-	-	-	-

Station	Flow	Water Level	Field Parameters Frequency	External Analytical Suite		Internal Suite	96-Hr Pass/ Fail	48-Hr Pass/ Fail	Chronic Toxicity Testing	
				Frequency	Analytical Suite	Frequency			Frequency	Test
MN-0.5	M	-	M	M	A,N,DOC	-	-	-	-	-
MN-1.5	C	-	M	M	A,N,DOC	-	-	-	-	-
MN-2.5	C	-	M	M	A,N,DOC	-	-	-	-	-
MN-4.5	C	-	M	M	A,N,DOC	-	-	-	-	-
UG 1*	Cdw	-	M	M	A,N	-	-	-	-	-
UG 2*	Cdw	-	M	M	A,N	-	-	-	-	-
UG 3*	Cdw	-	M	M	A,N	-	-	-	-	-
UG 4*	Cdw	-	M	M	A,N	-	-	-	-	-
UG 5*	Cdw	-	M	M	A,N	-	-	-	-	-
UG 6*	Cdw	-	M	M	A,N	-	-	-	-	-

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

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

Monitoring areas are both up-gradient and down-gradient of mine activities and include, but are not limited to, the DSTSF, mill area, Main Pit Tailings Management Facility, Area 2 Pit Tailings Management Facility, Minto North Pit, mill valley fill, waste rock dumps, water storage pond (WSP), and areas where future mine components are planned. The purpose of the monitoring wells is to provide information to better understand the potential for off-site migration of contamination and to better understand and define source terms and conditions of waste emplacement, for comparison to source terms used in the Water Balance and Water Quality model. All wells are monitored as presented in Table 5-14.

Table 5-14: Operational Groundwater Monitoring

Mine Project Component	Monitoring Well ID	Westbay Zone Depth or description	Quality	Level	Rationale
Up-gradient of Mine Activities	MW17-08	Zone 1 (44.7 mbgs)	B	B	Background well; higher frequency not warranted
		Zone 2 (34.1 mbgs)	B	B	Background well; higher frequency not warranted
		Zone 3 (23.4 mbgs)	B	B	Background well; higher frequency not warranted
		Zone 4 (8.2 mbgs)	B	B	Background well; higher frequency not warranted
Southwest Waste Dump	MW12-DP1	NA	Stop monitoring		Dry or frozen - little record
	MW12-DP2	NA	Stop monitoring		Dry or frozen - little record
	MW12-DP3	NA	Stop monitoring		Dry or frozen - little record
	MW17-09	Zone 1 (57.2 mbgs)	S	S	Seasonal variability sufficient
Main Waste Dump	MW09-01	Zone 1 (44 mbgs)	Stop monitoring		Repeatedly dry; replaced by MW17-10
		Zone 2 (34 mbgs)	Stop monitoring		Repeatedly dry; replaced by MW17-10
		Zone 3 (26 mbgs)	Stop monitoring		Repeatedly dry; replaced by MW17-10
	MW17-10	Zone 1 (85.5 mbgs)	S	S	Seasonal variability sufficient
		Zone 2 (75 mbgs)	S	S	Seasonal variability sufficient
		Zone 3 (61 mbgs)	S	S	Seasonal variability sufficient
		Zone 4 (53.5 mbgs)	A	S	Likely to be dry often – freshet monitoring only
Dry Stack Tailings Storage Facility and Mill Valley Fill Expansion	MW12-06	Zone 1 (142 mbgs)	S	S	Seasonal variability sufficient
		Zone 2 (123 mbgs)	S	S	Seasonal variability sufficient
		Zone 3 (93 mbgs)		S	Currently not sampled with no immediate need to change
		Zone 4 (66 mbgs)	S	S	Seasonal variability sufficient
		Zone 5 (35 mbgs)		S	Currently not sampled with no immediate need to change
		Zone 6 (18 mbgs)	S	S	Seasonal variability sufficient
Main Pit	MW12-07	Zone 1 (115 mbgs)	S	S	Seasonal variability sufficient
		Zone 2 (88 mbgs)	S	S	Seasonal variability sufficient
		Zone 3 (66 mbgs)		S	Currently not sampled with no immediate need to change
Minto North Pit	MW09-03	Zone 1 (38 mbgs)	S	S	Seasonal variability sufficient
		Zone 2 (24 mbgs)	S	S	Seasonal variability sufficient
		Zone 3 (11 mbgs)		S	Currently not sampled with no immediate need to change
	MW17-11	Zone 1 (96.9 mbgs)	S	S	Seasonal variability sufficient
		Zone 2 (75.5 mbgs)		S	Currently not sampled with no immediate need to change
		Zone 3 (58.8 mbgs)	S	S	Seasonal variability sufficient
		Zone 4 (40.5 mbgs)	S	S	Seasonal variability sufficient
		Zone 5 (16.1 mbgs)		S	Dry
Water Storage Pond	MW12-05	Zone 1 (132 mbgs)	S	S	Seasonal variability sufficient
		Zone 2 (110 mbgs)	S	S	Seasonal variability sufficient
		Zone 3 (94 mbgs)	S	S	Seasonal variability sufficient
		Zone 4 (69 mbgs)	S	S	Seasonal variability sufficient
		Zone 5 (52 mbgs)	S	S	Seasonal variability sufficient
		Zone 6 (26 mbgs)		S	Currently not sampled with no immediate need to change
		Zone 7 (15 mbgs)	S	S	Seasonal variability sufficient
	MW17-12	Zone 1 (143.4 mbgs)	S	S	Seasonal variability sufficient
		Zone 2 (129.6 mbgs)	S	S	Seasonal variability sufficient
		Zone 3 (111.4 mbgs)	S	S	Seasonal variability sufficient

Mine Project Component	Monitoring Well ID	Westbay Zone Depth or description	Quality	Level	Rationale
		Zone 4 (91.5 mbgs)	S	S	Review after one year and decrease frequency if stable
		Zone 5 (80.9 mbgs)	S	S	Seasonal variability sufficient
		Zone 6 (70.2 mbgs)	S	S	Review after one year and decrease frequency if stable
		Zone 7 (50.4 mbgs)	S	S	Review after one year and decrease frequency if stable
		Zone 8 (35.2 mbgs)	S	S	Seasonal variability sufficient

The objective of the Seepage Monitoring Program is to assess and monitor potential acid rock drainage and metal leaching conditions at the Minto Mine. The program includes a survey for seepage of all project components including pit wall seepage; ore stockpile areas; overburden dumps; waste rock dumps including low grade, medium grade and high grade waste storage areas; DSTSF; mill valley fill (MVF) area (extension 1 and 2); mill area; and other known seepage locations. The monitoring locations and monitoring frequency are summarized in Table 5-15, along with the analytical parameters required for seepage samples.

Table 5-15: Seepage Monitoring Survey Locations and Sampling Frequency

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

5.5.2 Operational Geochemical Monitoring Program

The Geochemical Monitoring Program is made up of three components; Acid Base Accounting (ABA) Monitoring Program, Waste Rock Verification Program and the Low Grade – Oxide Ore Metal Leaching Characterization Program.

The ABA program is comprised of two parts; one is the internal monitoring which is completed on-site and the other external verification which is completed offsite by an external laboratory.

During open pit mining, on-site ABA monitoring is carried out on drill cuttings from every blast hole. On-site ABA monitoring for the active underground mine is carried out on all development rounds. Multiple samples are collected from each round for grade control purposes. One of these is oven-dried and analyzed for total sulphur (S(T)) and total carbon (C(T)) by the on-site lab. A second sample is air dried and held to build composites for external verification and ABA analyses.

Preliminary waste rock classifications are generated from the on – site laboratory S(T) and C(T) results. Values are converted equivalent acid potential (AP-S(T)) and neutralization potential (NP-C(T)) values, and subsequent NP:AP ratios. The NP:AP ratio is plotted in plan view on the drift maps used for grade control, and material is segregated into the different waste storage facilities based on the ratio.

Composite samples are built for external verification from air dried samples, that correspond to the on-site samples used for preliminary segregation. Underground samples are 50m length composites or approximates of the development headings for each waste class. Equal coarse crush weights of individual samples are used to build a length weighted composite. A split of this sample is re-assayed on site, and then submitted to external laboratories for quality control purposes and additional testing. Additional testing conducted at the external laboratory includes; paste pH, total sulphur, sulphate sulphur, total inorganic carbon, modified neutralization potential (Modified NP) and metals by aqua regia digestion with ICP finish. The modified NP will be analysed using the MEND (1991) method to allow direct comparison with pre-production characterization.

ABA sample frequency, sample type and analysis requirements are summarized in Table 5-16

Table 5-16: Acid Base Accounting Monitoring Program Requirements

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

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

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

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

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

1. Frequency
    a) For open pit waste rock: at monthly intervals, mine personnel will visit every dump crest that was active over the preceding month, as determined by an analysis of the production tracking database system.
    b) For underground waste rock: for each lift of underground waste rock (~30,000 LCM), mine personnel will sample the active dump crest.
2. Sampling and compositing
    a) For open pit waste rock: at 25 m intervals along each active dump crest, the waste rock will be manually sampled. For each sample, one shovel-full of material will be collected and labelled. Particles greater than fist size will be manually rejected at the time of sampling.
    b) For underground waste rock: at 100 m intervals along each active dump crest, the waste rock will be manually sampled. For each sample, one shovel-full of material will be collected and labelled. Particles greater than fist size will be manually rejected at the time of sampling.
3. The resulting samples will be crushed, pulverized, and split in Minto's assay lab such that a representative sample is obtained.
4. Each sample will be analyzed at site for copper, total sulphur (S(T)), and total carbon (C(T)) content using an Eltra CS-800 induction furnace with infrared detectors.
5. S(T) and C(T) values are converted into equivalent acid potential (AP-S(T)) and neutralization potential (NP-C(T)) values, and NP-C(T):AP-S(T) ratios are calculated for each sample.
6. Resulting NP-C(T):AP-S(T) ratio values are compared to the segregation criteria and assigned 'Pass' or 'Fail' verification designations.
7. Response if verification fails

    a) For open pit dumps: If two or more adjacent failures occur, the crest will be resampled at 5 m intervals over each 25 m crest section represented by the failed samples.
    b) For underground dumps: If a failure occurs, the crest will be resampled at 25 m intervals over each 100 m crest section represented by the failed sample.

    Sampling and analysis will follow steps 3 through 6 in the procedure described above. The average copper grade and NP-C(T) and AP-S(T) for the suspect zone will be calculated, and then the (Average NP-C(T)) : (Average AP-S(T)) ratio value for the zone will be calculated. Isolated failures will be accepted with no further action.

Low Grade and Oxide Ore Metal Leaching Characterization Program consists of a large scale on-site leaching test for each material type (Blue Ore and POX), paired with static laboratory tests to define the geochemical characteristics of the materials being tested.

The on-site leaching tests consists of large leach pads (estimated nominally 5m x 5m) lined with a geosynthetic liner and loaded to a depth of 1 to 2 m with run-of-stockpile test material (POX or Blue Ore). The leach pads are subject to ambient site temperature and precipitation conditions, with collection of leachate accomplished by appropriate grading of the leach pad base and installation of a drain pipe through the liner to allow collection of leachate samples.

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

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

5.5.3 Meteorological Monitoring Program

The Water Monitoring Program is made up of two components, Climate Monitoring Program and Snow Survey Program.

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

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

The objective of the Snow Survey Program is to collect snow data used for calculating the snow water equivalent specifically at the Minto Mine. Snow water equivalents are inputs to the Minto Mine Site Water Balance models. Three courses are surveyed during the first week of February, March & April each year. If conditions permit, Minto will additionally survey the snow courses in May. These courses are East-facing (near the Dyno compound), North-facing (near the airstrip) and South-facing (above the Tank Farm).

5.5.4 Operational Physical Monitoring Program

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

- Survey hubs;
- Inclinometers;
- Thermistors; and
- Vibrating Wire Piezometers.

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

The objective of the Physical Monitoring Program is to monitor the performance of key mine infrastructure and workings. Outlined in Table 5-17 is the mine infrastructure that requires monitoring under the Physical Monitoring Program; the table also includes the infrastructure descriptions and instrumentation that is in place.

Table 5-17: Physical Monitoring Program: Mine Structures and Instrumentation

Structure	Description	Instrumentation
Area 2 Pit and Area 2 Pit Tailings Management Facility (A2PTMF)	The Area 2 Pit was completed in 2015 to the extents licensed under Phase IV (Stages 1 and 2); the pit was extended to the south as part of Phase V/VI (Stage 3 and Stage 3 Expansion) and was completd in 2018. Tailings deposition into Area 2 Stage 2 pit (A2S2) began in March, 2015 and the pit is now maintained as a tailings management facility. Dumping of NP:AP<3 waste rock (SAT), intended to be below the final water table at closure, has commenced into the pit.	• Survey hubs • Inclinometer
Area 2 Underground	The Area 2 underground began development in 2016 and was completed in August 2018. The area was accessed by the Minto South portal and decline south of the Area 2 and Area 118 Pits.	None
Area 118 Pit	Mining of the Area 118 Pit was carried out in 2014. As part of Area 2 Stage 3 pit mining, overburden is being dispatched to the Area 118 pit, referred to as the Area 118 Backfill Dump.	• Survey hubs
Area 118 Backfill Dump	The Area 118 Backfill Dump is included in the Phase V/VI licence and commenced in 2017. Construction will continue for the duration of the Area 2 Stage 3 Pit. The dump will fill in the Area 118 Pit.	None
Area 118 Underground	The Area 118 underground began development in 2013 and was completed in 2016. It is accessed by a portal and decline south of the Area 2 and Area 118 Pits. Production mining took place using a longhole stoping method.	None
Big Creek Bridge	Bridge on the Minto access road crossing Big Creek, located at Km 19. Licenced under Type B water licence MS15-094.	None
Barge Landings	Barge landings on the Minto access road at the Yukon river. Licensed under Type B water license MS15-094.	None
Camp	The camp consists of several connected bunkhouse buildings (Sherwood, Minto, Selkirk), a kitchen building, and several separate buildings including the gym and Site Services offices.	None
Copper Keel and Wildfire Underground	The Copper Keel and Wildfire underground are in the phase V/VI mining plan that commenced in 2020. Access is via the Minto South portal..	N/A
Dry Stack Tailings Storage Facility (DSTSF)	Construction of the DSTSF with filtered tailings placement was carried out from 2007 to November 2011. As part of progressive reclamation activities in 2012-2013, the DSTSF was covered with a layer of overburden approximately one to four meters thick. The DSTSF began showing deformation in 2009, interpreted as primarily horizontal sliding towards the north/northeast on an ice-rich layer in the underlying overburden, several meters above bedrock. The movement has continued since then but at a decreasing rate in response to construction of both the Mill Valley Fill waste rock buttress and the Mill Valley Fill Extension 2 waste rock buttress.	• Survey hubs • Thermistors • Inclinometers • Piezometers
Ice Rich Overburden Dump (IROD)	Originally constructed as a free-standing rockfill structure to contain ice-rich overburden. The IROD is no longer active and is now entirely surrounded by the Southwest Waste Dump rockfill. The area has been reclaimed with the Southwest Waste Dump in 2017.	None

Structure	Description	Instrumentation
Main Pit (Area 1 Pit) and Main Pit Tailings Management Facility (MPTMF)	Mining in the Main Pit was completed in 2011. Instability in the south wall of the pit occurred in 2009 during mining of Stage 3 of the pit, and subsequently a larger failure occurred in 2011 after completion of Stage 5. Continued sloughing and creep movement of the south wall led to the design and construction of a waste rock buttress, known as the South Wall Buttress, completed in 2013. Slurry tailings deposition into the pit began in 2012 and the pit is now maintained as a tailings management facility. Dumping of NP:AP<3 waste rock (SAT) below the final water table at closure, is not currently active but remains an alternate dispatch location to the Area 2 Pit Tailings Management Facility.	• Survey hubs • Inclinometer
Main Pit Dump	The Main Pit Dump is included in the Phase V/VI licence. Construction commenced in 2017. The dump is located on the southwest side of the Main Pit.	• Survey hubs
Main Waste Dump (MWD)	The Main Waste Dump stores waste rock released during the mining of the first three stages of the Main Pit. The dump is no longer active.	• Inclinometer
Main Waste Dump Expansion (MWDE)	This dump is an extension of the MWD that stores waste rock released from the Minto North Pit. The dump is no longer active. Reclamation re-sloping began in 2016.	None
Main Waste Dump Wrap (MWDW)	This dump is a reclamation feature to shallow the slopes of the Main Waste Dump for reclamation purposes.	• Survey hubs
Mill Site	The mill site consists of the mill building, crusher and crusher stockpile pad.	None
Mill Valley Fill Extension (MFVE)	A waste rock buttress to the north of the DSTSF, constructed from January 2012 to March 2013 to prevent or decrease movement of the DSTSF.	• Survey hubs
Mill Valley Fill Extension 2 (MVFE2)	An extension of the MVFE waste rock buttress to the northeast, constructed from November 2015 to August 2016 to further decrease movement of the DSTSF.	• Piezometers • Survey hubs • Inclinometers
Mill Valley Fill Extension 2 Collection Sump	A replacement sump for the Minto Creek Detention Structure (MCDS), constructed in 2016. It detains surface water considered impacted from upstream sub-catchment areas and directs it to the MPTMF or water treatment plant.	None
Minto Access Road	Road from the Yukon River barge crossing to the mine site. Licenced under Type B water licence MS15-094.	None
Minto East Underground	Ramping to the Minto East underground began development in 2017 and is accessed by the Minto South portal and decline south of the Area 2 and Area 118 Pits. Production began in 2018 and is scheduled to be completed in early 2021. This area was mined with long hole stoping	None
Minto North Pit	Mining of the North Pit was completed in September 2016. The pit is currently inactive and the access is barricaded.	None
Ore Stockpiles	There are two primary ore stockpiles on site – North and South stockpile. These are located south of the crusher and east of the Area 2 pit.	None

Structure	Description	Instrumentation
Reclamation Overburden Dump (ROD)	Received the bulk of the overburden released as part of Phase IV and earlier mining of the Main Pit. The material in the ROD is available for use in reclamation of the mine at closure.	None
Ridgetop Pit (Ridgetop North Pit, Ridgetop South Pit)	The Ridgetop Pits are included in the Phase V/VI licence and has not commenced yet.	GroundProbe radar (during mining)
Ridgetop Waste Dump	The Ridgetop Waste Dump is included in the Phase V/VI licence and has not commenced yet.	N/A
South Diversion Ditch	This structure was decommissioned in 2017 to allow for Area 2 Stage 3 Expansion mining activities.	None
South Wall Buttress (SWB)	Waste rock buttress constructed against the Main Pit south wall from 2009-2011 as a result of instability in the south wall of the pit.	• Survey hubs
Southwest Waste Dump (SWD)	The Southwest Waste Dump (SWD) stores waste rock released during phase IV mining. Dumping at the SWD is now complete and reclamation re-sloping began in 2015. Re-sloping was substantially completed in 2018.	• Survey hubs • Inclinometers • Thermistors • Piezometers
Tailings Diversion Ditch (TDD)	A diversion ditch located south of the DSTSF to divert unimpacted water around the tailings facility. The intake structure was extended in 2017 to allow for the decommissioning of the South Diversion Ditch with A2S3 Expansion mining.	None
Water Storage Pond Dam (WSP)	The Water Storage Pond and Dam are located east of the mine along Minto Creek. The dam was constructed in 2006 as a clay-core water retention dam for collecting precipitation and surface water runoff at the site. Maximum depth of water at the face of the dam is approximately 15 m.	• Survey hubs • Thermistors • Piezometers

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

5.5.5 Aquatic Environmental Monitoring Program

The Aquatic Environmental Monitoring Program is made up of four components, Metal and Diamond Mine Effluent Regulations (MDMER) Monitoring Program, Sediment Quality and Toxicity Monitoring, Periphyton and Benthic Invertebrate Tissue Monitoring and the Fish Monitoring Program.

The Metal and Diamond Mine Effluent Regulations (MDMER) outline requirements for monitoring and reporting of discharged effluent volume and quality under the MDMER to Environment and Climate Change Canada. The Metal Mine Effluent Program aims to maintain compliance with the MDMER and the program will be revised should regulation amendments occur. Specifically, the Metal Mine Effluent Program requires effluent monitoring with sampling at station W3, downstream of the end of pipe discharge. Effluent monitoring requirements are outlined in Table 5-18. Effluent monitoring samples are collected when there is a deposit of water at W3; testing occurs weekly for deleterious substances. Radium 226 and acute lethality tests are conducted quarterly due to the reduced frequency guidelines outlined in the MDMER. The MDMER specifies requirements for increased testing frequencies if the Radium 226 or acute lethality tests do not meet the prescribed standards as detailed in the MDMER.

Weekly effluent monitoring samples are tested for the deleterious substances as described in the MDMER including the total metals arsenic, copper, lead, nickel and zinc; total suspended solids (TSS) and pH. As a general practice, weekly samples are collected on the same day each week.

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

Environmental Effects Monitoring under the MDMER includes four components: Site Characterization, Effluent Characterization, Effluent Sublethal Toxicity and Supporting Water Quality Monitoring.

Table 5-18: Metal Mine Effluent Monitoring Program Requirements and Frequency

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

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

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

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

5.5.6 Terrestrial Environment Monitoring Program

The Terrestrial Environment Monitoring Program is made up of four components, Invasive Plant Species Monitoring Program, Wildlife Monitoring Program, Erosion and Sedimentation Monitoring Program and Vegetation Metal Uptake Program.

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

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

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

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

High priority plant species in the Yukon, as defined by YISC, are summarized in Table 5-19.

Table 5-19: Common and Scientific Names of High Priority Yukon Invasive Plant Species, as defined by YISC

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

The activities under the Wildlife Monitoring Program are summarized in Table 5-20, including the area monitored and the frequency of monitoring. Wildlife sightings around site are entered into a *Wildlife and Hazing Tracking*

Form. Wildlife sightings from site personnel are collected either via a *Wildlife Sighting Log* form or through communication with the Environmental and Safety Departments. Any direct sighting by the Environmental Department are additionally entered into the *Wildlife and Hazing Tracking Form*.

Table 5-20: Wildlife Monitoring Activities

Area Monitored	Monitoring Activities	Frequency
Wildlife Monitoring	Wildlife monitoring consists of maintaining a wildlife observation log onsite and reporting wildlife encounters as per the Wildlife Act. Environmental personnel on site will monitor project activities and modify operations to address wildlife concerns.	Ongoing
Migratory Birds	Monitoring to determine if waterfowl and shorebirds settle on impacted water bodies, such as the Main or Area 2 Pits. Environmental personnel on site will monitor project activities and modify operations to address wildlife concerns.	Seasonal during migratory periods
Species at Risk/of Concern	Any caribou observations will be reported to the Conservation Officer in Carmacks. Bank swallows have been observed to nest in residuum piles in the summer months, in which case these piles are cordoned off and left undisturbed until after the late summer migration, or resloped prior to nesting season to deter nesting.	As necessary

The Erosion and Sedimentation Monitoring Program monitoring activities are summarized in Table 5-21.

Table 5-21: Erosion and Sediment Monitoring Schedule

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

The main objective of the Vegetation Metal Uptake Program is to monitor and measure metal uptake in vegetation on the mine site and surrounding areas.

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

The following procedures are performed at each monitoring network site:

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

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

5.5.7 Progressive Reclamation Effectiveness Monitoring Program

The Progressive Reclamation Effectiveness Monitoring Program is used to support the progressive reclamation activities that occur during mine operation; while post-closure monitoring is described in the RCP. The objective of the Progressive Reclamation Effectiveness Monitoring Program is to identify and evaluate reclamation and remediation technologies that are considered both promising and feasible for incorporation into the evolving mine RCP.

5.6 Operational Risk Assessment, Contingency Planning and Adaptive Management

Minto uses adaptive management to address uncertainty or conditions beyond those anticipated in mining operations. Mining activities are highly managed operations, with very prescriptive and detailed management plans required for both operational control and regulatory approval. More mature mines such as Minto have management plans which benefit from the operational experience at the site, and uncertainty in the range of conditions expected is reduced through this operational experience. The operational AMP is intended to provide a framework for responses to conditions beyond those expected and identified in their decision-based management plans. Consequently, this AMP addresses a limited range of components.

The following AMP components have been identified as having the potential for unexpected conditions during the operational period for which the Operational Management Plans may not provide adequate mitigation against potential effects to the environment or human health and safety:

- Surface water quality;
- Groundwater quality;
- Water Management, and
- Physical Stability

5.6.1 Operational Adaptive Management Plan Framework

The AMPs for each component are laid out using a common element approach to create consistency in implementation of the AMP protocol for all components as illustrated in Figure 5-19. The common elements are:

1. Description of the component

- *Description* - description and understanding of the component leads to risk narrative and specific performance thresholds.
- *Risk Narrative* describe the possible environmental impacts and environmental conditions that implementation of the AMP will prevent.

2. Monitoring the component

- *Specific Indicators* are the environmental or physical parameters to be monitored and assessed. Specific indicators are measurable or observable, and are indicative of changes from the designed or expected condition.
- *Monitoring Requirements* describes the monitoring regime for the component including frequency, type of data required and interpretation of results.
- *Specific Performance Thresholds* define the conditions, in terms of specific indicators, when action is triggered. Performance thresholds are staged to accommodate levels of concern and a diversity of actions. To the extent possible, specific performance thresholds will include early warning thresholds.

3. Responding to unexpected conditions of the component

Specific Responses are staged according to specific performance thresholds describes the actions to be implemented if specific performance thresholds are crossed. They are provided in the following categories:

a) Notification
b) Review
c) Evaluation
d) Action

4. Annual Reporting and Review

Annual Reporting reflects annual changes made to the AMP as the site conditions change. The AMP should be modified whenever unexpected circumstances are encountered and the protocol is implemented or when additional proven science or technology becomes available. The annual review will include a review of the relevant monitored data and AMP elements. Updates, amendments, performance thresholds crossed, and trigger(s) activated will be provided to the appropriate governmental (including SFN) organizations as required and will be part of the annual report.

Additional reporting is described further in Appendix J1 (Operational AMP).

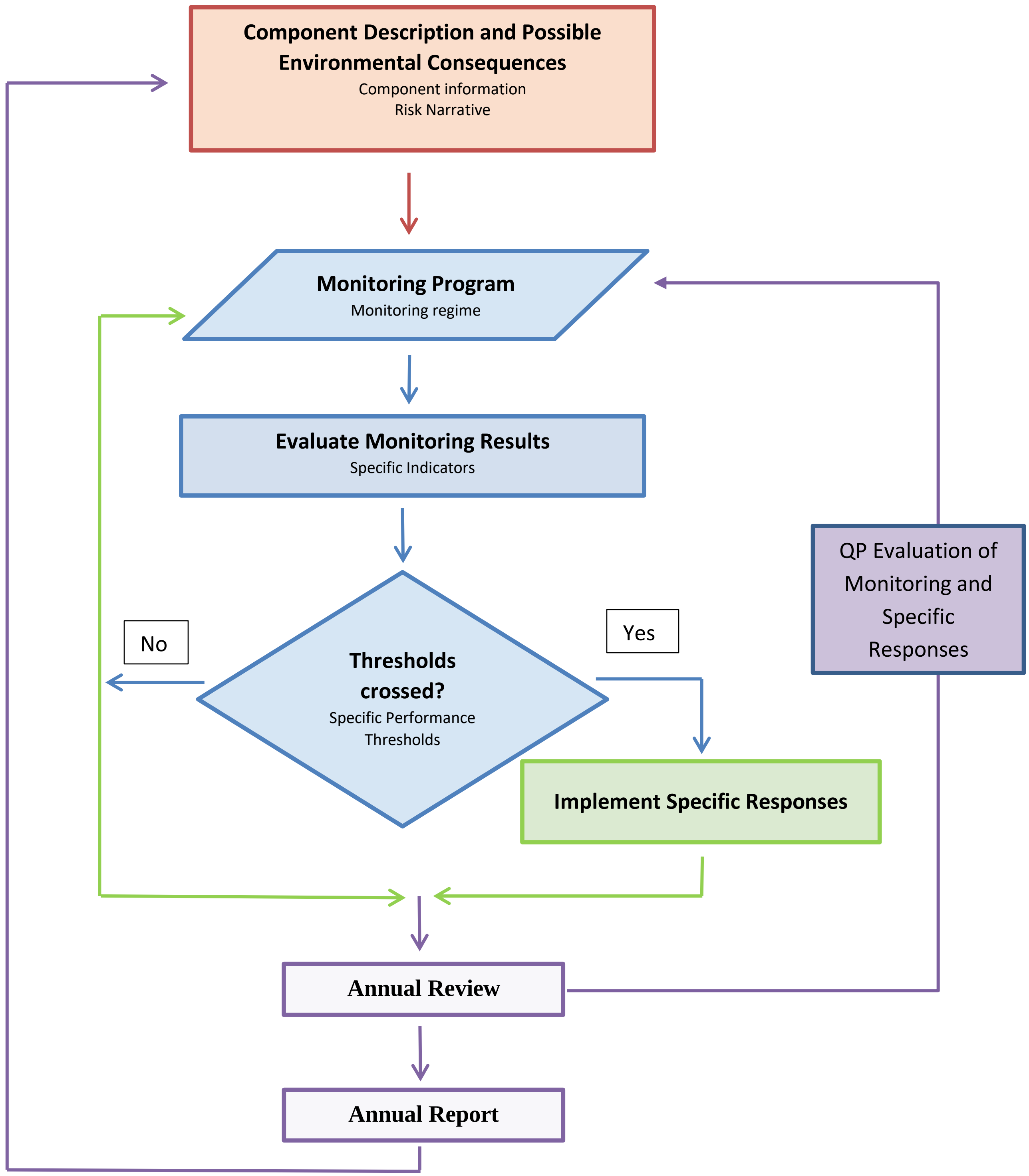

Figure 5-19: Sequential Components of the AMP (Adapted from AECOM 2010)

5.6.2 Adaptive Management Plans for Mine Components

There are a total of 6 mine components included in the operational adaptive management plan and they include:

- Minto Creek Surface Water Quality
- McGinty Creek Surface Water Quality
- Groundwater Quality in Minto Creek Watershed
- Groundwater Quality in McGinty Creek Watershed
- Water Management
- Physical Stability

A detailed adaptive management plan for each of the above mine components can be found in Section 2 of Appendix J1 (Operational AMP).

6 Temporary Closure

This section intends to describe the following aspects of Temporary Closure at the Minto Mine:

- Temporary closure objectives (Section 6.1)
- Temporary closure preparations (Section 6.2) and;
- Temporary closure activities, including (Section 6.3);
    - Site security;
    - Physical and geochemical stability;
    - Water management;
    - Monitoring and reporting;
    - Maintenance and
    - Resources.

The temporary closure approach at the Minto Mine is to maintain the site in a state such that it can resume operations in a timely manner, while continuing to monitor and protect the environment, physical assets and human health and safety.

6.1 Temporary Closure Objectives

The primary temporary closure objectives at Minto include the following:

- Protection of public health and safety;
- Environmental protection; and
- Management of company assets.

This section describes the objectives that will guide the activities undertaken at Minto in the event of a temporary closure. The specific measures regarding protection of public health and safety, environment and company assets are detailed in Sections 6.2 and 6.3. For purposes of this temporary closure plan, temporary closure refers to a suspension of mining and/or milling activities for more than two consecutive months but less than five years.

The primary objective of temporary closure preparations are to secure company assets, and reduce environmental, public health and safety risks. Additionally, temporary closure preparations will be completed to reduce the resources required to maintain the site during temporary closure. The primary activities with regards to preparation for temporary closure are protection of physical assets, securing infrastructure and unused facilities, and potential demobilization of major contractors. Initial preparation will include securing all facilities not required during temporary closure.

The majority of activities that occur during temporary closure will be driven by approved operating plans which include, but are not limited to, the following: managing water as per the approved Water Management Plan (WMP); monitoring and reporting as per the approved Environmental Monitoring, Surveillance and Reporting Plan (EMSRP); managing solid waste as per the approved Waste Management Plan; and adhering to the Adaptive Management Plan (AMP) as required.

Maintenance of site components will also be a key activity to meeting temporary closure objectives and will include, but not be limited to, maintaining access to site, security, water conveyance infrastructure and any facilities required in the event of a temporary closure as per this plan, applicable licences, permits and regulations. Temporary closure will continue until production recommences or full closure is implemented.

6.2 Temporary Closure Preparations

At the beginning of the temporary closure period, preparations will be undertaken to; secure assets not required in temporary closure; reduce environmental liability and demobilize major contractors. During this phase of temporary closure, mining, camp and process facilities not required for temporary closure will be temporarily decommissioned; hazardous material not required for temporary closure will be removed from site and equipment and facilities belonging to contractors not required for temporary closure may be removed.

Mining facilities not utilized will be de-energized, winterized and secured to ensure entry by authorized personnel only. Camp facilities that will not be utilized during temporary closure will be de-energized, winterized and secured to ensure entry by authorized personnel only. Components of processing facilities not utilized in temporary closure will be drained/emptied, cleaned and secured while the overall facilities will be de-energized, winterized and secured to ensure entry by authorized personnel only.

Hazardous materials including, but not limited to, remaining processing reagents, oils, and glycols that are not required for activities in temporary closure will be removed from site. All hazardous wastes, including waste hydrocarbons, glycols, lubricants, mill reagents, and process chemicals will be removed from site. All explosives inventories will be removed and any remaining explosives facilities will be secured to ensure entry by authorized personnel only.

Depending on the expected length of temporary closure, all major contractors may be required to demobilize from site. This demobilization may include all equipment and facilities belonging to contractors that are not required in the event of a temporary closure.

During temporary closure preparations all environmental monitoring will continue in accordance to all applicable licences, permits and approved environmental protection plans. The environmental monitoring will be parallel to that of the operational period. During temporary closure preparation it is expected that the underground workings will remain dewatered and the underground infrastructure will remain intact. Preparations for temporary closure are expected to take up to three months. Routine care and maintenance activities will take place after the initial preparations have been completed.

6.3 Temporary Closure

Site security, stability, water management, monitoring and maintenance are key to meeting the critical temporary closure objectives of protecting public health and safety, the environment and company assets. Full-time staff will be housed onsite in the main camp throughout the entire temporary closure period to provide security, control site access, monitor site activities, manage water and perform maintenance as required. This section details the specific measures regarding: site security, physical and geochemical stability, water management, monitoring and reporting, maintenance and resources as they pertain to meeting the objectives of temporary closure.

6.3.1 Site Security

Access to the site will be restricted and enforced on a 24 hour per day, year round basis. Site security is expected to be comparable to the operational period with access to the site controlled by the tug and barge crew in the summer and ice bridge attendants in winter. In the event that an attendant or tug and barge is not required, a gate will be installed along the access road that will not allow passage. During the spring thaw and fall freeze-up or other river access limiting circumstances, the site will only be accessible from the maintained air strip. Personnel accessing the site will be required to be on an approved site manifest which will ensure that site management has oversight over the personnel accessing the mine site. All visitors will be required to check in with the camp administrator upon arrival. Similar to the operational period, Selkirk First Nation will be provided access to their land during the barge and ice bridge seasons.

In addition to site access restrictions, further security measures may be implemented for mine workings, mine and processing facilities not required during temporary closure, equipment and hazardous material. These additional security measures are discussed in Sections 6.3.1.1 to 6.3.1.3.

6.3.2 Mine Workings

Open pit mining operations will be ceased in the event of a temporary closure and therefore access control is a key temporary closure measure to protect public health and safety. Pit ramp entrances will be barricaded and signage will be posted warning of potential hazards related to entering a closed facility. While access to open pits will be restricted they will remain accessible as authorized personnel will require access on a regular basis to complete tasks related to water management activities.

Underground mining operations will be ceased in the event of a temporary closure and therefore access control is a key temporary closure measure to protect public health and safety. Similar to the open pits, portal entrances and vent raise shafts will be barricaded and signage will be posted warning of potential hazards related to entering a closed facility. Also comparable to the open pits, the portals will have to remain accessible as authorized personnel will require access on a regular basis to maintain equipment involved in dewatering the underground workings.

6.3.3 Mine and Processing Facilities

Not all mine and processing facilities will be required in the event of a temporary closure and therefore access control is a key temporary closure measure to protect public health and safety as well as company assets. As such, all facilities not required to operate in the event of a temporary closure will be secured and locked. Regular visual inspection will be conducted to ensure that all closed facilities remain secured.

6.3.4 Equipment

In the event of a temporary closure, Minto will maintain the equipment necessary to complete maintenance of onsite facilities and infrastructure. However, not all remaining equipment may be required for temporary closure activities and therefore security of that equipment is a key temporary closure measures to protect public health and safety, the environment and company assets. As such, equipment that is on site and not utilized during temporary closure will be stored and secured on lined areas, inside shops or underground as shown in Figure 6-1.

6.3.5 Hazardous Materials

Removal of all hazardous materials not required in the event of a temporary closure is a key temporary closure measure to protect public health and safety and the environment. All hazardous materials that remain onsite in the event of a temporary closure will be stored in the Reagent Storage Tent, Water Treatment Plant, Fuel Farm, Propane Tank Farm, and Waste Management Area as shown in Figure 6-1.

Reagents required for the treatment of water will be secured in the Reagent Storage Tent and/or Water Treatment Plant. The Fuel Farm will be utilized in a reduced capacity during temporary closure and therefore will be secured and serviced by care and maintenance staff. The Propane Tank Farm will be utilized during the winter months while dewatering activities are ongoing underground and will be secured and serviced by care and maintenance staff. Special waste will be stored in the lined special waste pole barn in the Waste Management Area as per the Waste Management Plan.

MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 6-1

EQUIPMENT AND HAZARDOUS MATERIALS STORAGE AREAS

NOVEMBER 2020

MINTO

Equipment Laydown/Storage Area

Hazardous Material Storage Area

1:18,000 ***when printed on 8x11 inch paper***

0 200 400 600 Meters

ENSERO solutions

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Datum: NAD 83 Projection: UTM Zone 8N

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6.3.6 Physical and Geochemical Stability

Physical and geochemical stability are key to meeting the critical temporary closure objectives of protecting public health and safety and the environment. This section will address the approach taken to managing physical and geochemical stability of various components on site in the event of a temporary closure. Components discussed in this section include landfill and waste management areas, tailings facilities, ore stockpiles, Water Storage Pond (WSP) and waste rock facilities.

As per the Minto Mine Waste Management Plan, only inert waste is placed into the landfill. Given the chemical nature of the landfill materials, there is no need to take additional measures beyond continuing the activities as described in the Waste Management Plan. Similarly, given the physical nature of the materials stored on site and the nature of the designs for the hazardous storage areas and landfills, the continued adherence to the site’s management plans will ensure these materials remain stable and protected.

Tailings at Minto are currently located in the covered Dry Stack Tailings Storage Facility and within the Main Pit and Area 2 Pit Tailings Management Facilities. During temporary closure, monitoring of the tailings facilities will continue to take place as per the site’s management plans. Given the physical and chemical nature of the tailings facilities and the contained tailings at Minto, there is no need to take additional measures beyond the monitoring programs and adaptive management protocols already in place.

As for the tailings at Minto (given the physical and chemical nature of the ore stockpiles at Minto), there is no need to take additional measures beyond the monitoring programs and adaptive management protocols already in place.

The Water Storage Pond is part of the mine’s water management system. As such, it will be required for use in the event of temporary closure. The site Water Management Plan, Adaptive Management Plan and Operation, Maintenance and Surveillance (OMS) manual includes routine operations and adaptive management of the Water Storage Pond and the Water Storage Dam. It is noted that there is nothing related to the impoundment that requires chemical stabilization.

Acid Rock Drainage /Metal Leaching (ARD/ML) predictions for ore and waste materials will not be subjected to modification due to increased durations of exposure possible under temporary closure. The great majority of mined materials at Minto are not potentially acid generating, and those that have uncertain potential to generate acidic weathering conditions are not expected to do so for several decades (if at all). As such, there are no materials that require exposure to be minimized.

6.3.7 Temporary Closure Water Management

The appropriate management of site water is critical to meeting the objective of environmental protection in the event of a temporary closure. All water management facilities, including the use of the Water

Treatment Plant, will be managed as if operations were continuing. Specifically, the facilities will be maintained and operated according to the approved Water Management Plan.

This section will summarize the details of the approved Water Management Plan as it pertains to temporary closure. Areas of focus for water management in temporary closure include the following: water management strategy, water treatment and water management infrastructure.

6.3.8 Temporary Closure Water Management Strategy

The current Water Management Plan utilizes a water management strategy and it is expected that this strategy will carry forward in the event of temporary closure. The current water management strategy includes the following key principles:

- The site water balance is used to define mine water inventory targets and targets for volumes to be released to Minto Creek. Regular tracking of the mine water inventory allows the mine operations to determine if the inventory is on target and if, and when, water must be released from site. Consideration will be given to the likely duration of temporary closure as well as required and available water storage capacity for operation restart when defining water inventory targets.
- Runoff from developed mine areas (mine water) is collected and stored in the Main Pit Tailings Management Facility (MPTMF) and the Area 2 Pit Tailings Management Facility (A2PTMF).
- The preferred method for controlling and limiting the inventory of mine water on site is to collect and divert discharge-compliant (clean) runoff to the WSP which then can be discharged to Minto Creek, as required.
- If collection, diversion and release of clean water is not sufficient for meeting mine water inventory targets, then Minto has the option of treating and discharging compliant (clean) water that originated as mine water.

In order to fulfill the water management strategy, the water balance will be updated every 6 months or more often as required. The annual water balance update will help inform the mine water inventory targets and targets for volumes to be released to Minto Creek. In the event of a temporary closure there will be limited, if any, consumption of water and therefore it is expected that the site will have a surplus in water inventory. Due to the expectation of surplus water, the following actions will be undertaken in temporary closure to ensure sufficient storage volumes for water remains in the tailings management facilities:

1. **Divert water from W35 to WSP:** water will be diverted from the south-west catchment of site (collected at station W35) to the WSP. Historically, the water at W35 has been of a similar quality to discharge-compliant (clean) runoff measured in lower Minto Creek. On-going water quality monitoring will ensure that water in the WSP remains in compliance with the water licence effluent quality standards. Minto will maintain procedures, checklists, sample collection, and analysis that must be completed prior to diverting water from W35 to the WSP.

2. **Divert water from W15 to WSP:** if diversion of water from W35 is insufficient to meet water inventory and release targets then water collected at W15 can be diverted to the WSP. Water collection point W15 collects runoff from undisturbed areas and from waste rock. The water quality parameter concentrations have historically been elevated compared to undisturbed catchments but have generally met effluent quality standards in the months of May, June, July and August. On-going water quality monitoring will ensure that water diverted from W15 and water in the WSP remains in compliance with effluent quality standards in effect. Minto will maintain procedures, checklists, sample collection, and analysis that must be completed prior to diverting water from W15 to the WSP.
3. **Release mine water stored in the MPTMF or A2PTMF to WSP.** The mine water stored on site will likely require water treatment before it can be released. Water treatment considerations are discussed in Section 6.3.4.1 of this plan including the water treatment plant configuration to use for specific water conditions that may be present in temporary closure. Minto will maintain procedures, checklists, sample collection, and analysis that must be completed prior to releasing water from the MPTMF or A2PTMF.

In temporary closure, water inventory targets will be updated every 6 months, or more often as required. Water inventory in the tailings management facilities and licensed water storage facilities will be tracked through routine monitoring.

The Minto South underground workings will initially remain dewatered during temporary closure; however, as temporary closure proceeds other options may be considered. Underground dewatering will utilize operational dewatering infrastructure. Minto North will remain dewatered for the duration of temporary closure utilizing methods described in the Water Management Plan.

6.3.8.1 Water Treatment

Water treatment will be a key component to maintaining safe water storage capacity onsite in the event of a temporary closure. The Water Treatment Plant can be operated in three general configurations depending on the constituents that require treatment. The three general configurations are as follows:

1. **Clarification and filtration:** this process configuration removes suspended solids (TSS). Coagulant and flocculant solutions are added to the feed water, which is pumped to a ballasted lamella clarifier and a filter. Dissolved constituents are generally not removed. The by-product of the process is a sludge that is pumped to the MPTMF or A2PTMF. The maximum treatment capacity is approximately 4,000 m^3/day.
2. **Sulphide precipitation, clarification, and filtration:** this process configuration can remove dissolved copper, cadmium, zinc, nickel, cobalt, and lead, in addition to TSS. Dissolved metals are removed by adding an organo-sulphide reagent that binds to dissolved metals and forms precipitates. The by-product of the process is a sludge that is pumped to the MPTMF or A2PTMF. The maximum treatment capacity is approximately 4,000 m^3/day.
3. **Reverse osmosis (RO):** this process removes 95 to 99% of all constituents in the feed water. The feed water for the RO unit is the effluent from the 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 to 99% of constituent loadings. The brine stream is pumped to the MPTMF or A2PTMF. Because of this brine by-product, RO cannot be considered a true water treatment process but is rather a process that concentrates mine water into a smaller volume with higher constituent concentrations. The maximum treatment capacity is approximately 2,500 m^3/day.

As stated in the WUL, a capacity of 1,000,000 m^3 is required to ensure enough storage capacity for freshet and therefore a bypass protocol is not required in the event that the Water Treatment Plant is damaged or unable to keep up with demand for a short to intermediate time period. It is expected that the Water Treatment Plant could be run throughout the year if necessary to maintain the 1,000,000 m^3 capacity.

6.3.8.2 Water Management Infrastructure

The Minto Mine water conveyance network consists of diversion ditches, culverts, sumps, pumps, and pipelines installed throughout the mine site. The system is designed to segregate clean runoff and mine water. Clean water is conveyed to the WSP while mine water is conveyed to the mine water storage reservoirs, which include the MPTMF and A2PTMF.

Figure 6-2 shows the location of water conveyance infrastructure that is currently installed onsite. Table 6-1, below, lists the equipment that is currently utilized at Minto for dewatering and water conveyance. Table 6-2 summarizes the current mine water infrastructure, and further includes the expected status of the infrastructure in the event of temporary closure.

The conveyance network is intended to provide a high degree of operational flexibility such that appropriate water management actions can be taken based on informed management decisions.

Table 6-1: Water Conveyance Equipment Inventory

Pump Size	Pump Type	Quantity	Power Type
150hp	Tsurumi	5	Electrical
140hp	Flyght	1	Electrical
100hp	Tsurumi	2	Electrical
60hp	Tsurumi	4	Electrical
HL250M	Godwin	2	Diesel
HL4M	Godwin	2	Diesel
Pipe Size	**Pipe Type**	**Quantity (m)**	**Additional Information**
24"	HDPE	885	
16"	HDPE	1500	
10"	Steel	240	Heat traced
8"	HDPE	1400	
8"	HDPE	2600	Insulated
4"	HDPE	2800	
4"	HDPE	1400	Insulated
4"	Steel	450	Heat traced
3"	HDPE	600	

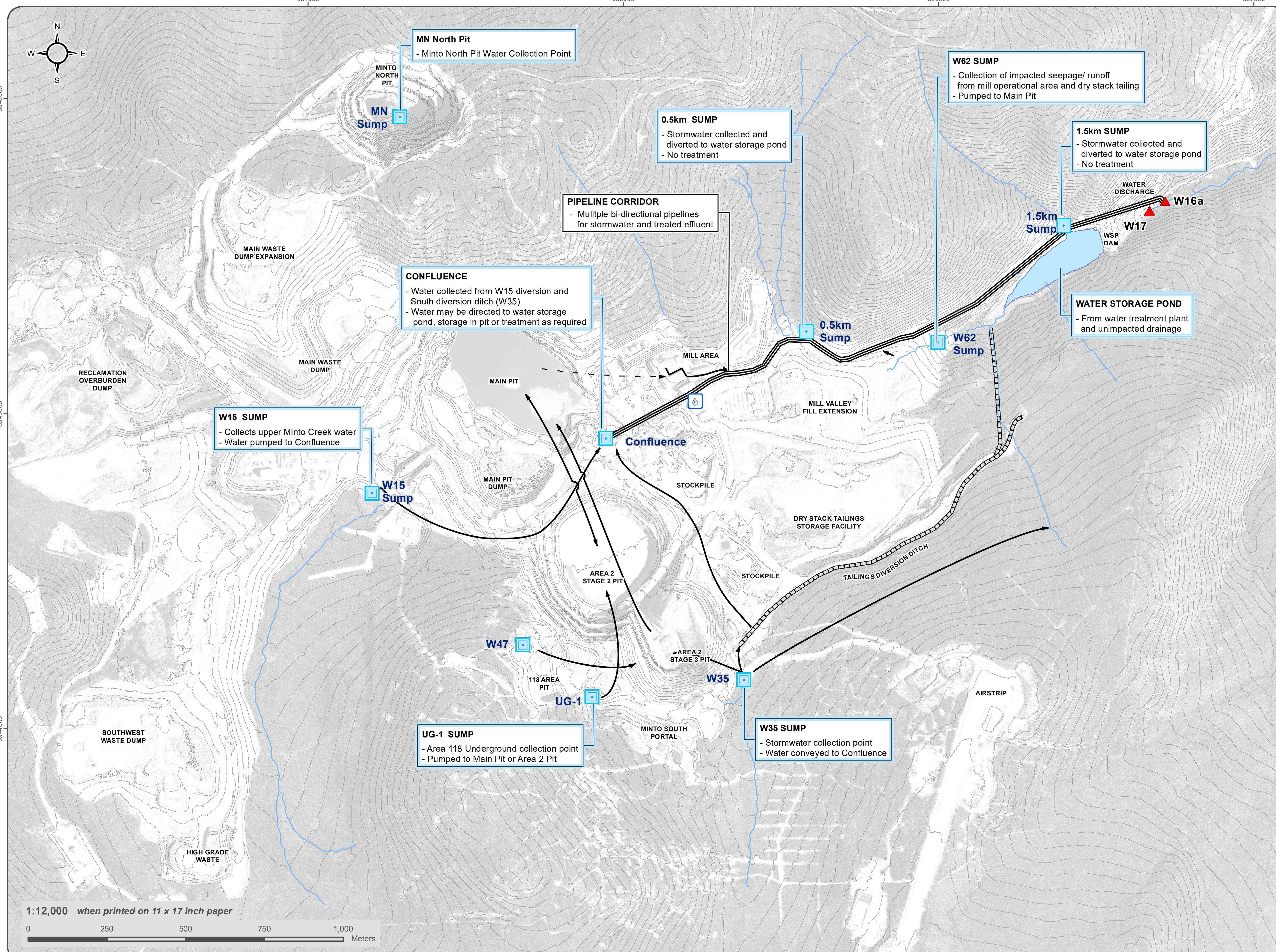
MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 6-2
TEMPORARY CLOSURE WATER CONVEYANCE SYSTEM

NOVEMBER 2020

MINTO



Water Treatment Plant

Collection Point

Monitoring Location

Mill Water Reclaim Line

Pipe Alignment

Piping Corridor

Contour (5m)

ENSERO solutions

Aerial imagery aquired in August 2020

Datum: NAD 83 Projection: UTM Zone 8N

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(*Last edited by: amatlashevska;2020-11-12/12:33 PM*)

Table 6-2: Water Conveyance System Details

Infrastructure Name	Description of Current Use	Temporary Closure Use
Reservoirs		
Main Pit Tailings Management Facility (MPTMF)	Tailings management facility and water reservoir. Total capacity to the natural spill elevation is approximately 4.9 Mm3.	Ongoing use.
Area 2 Pit Tailings Management Facility (A2PTMF)	Tailings management facility and water reservoir.	Ongoing use.
Mill Pond	Facility has been decommissioned	N/A
Water Storage Pond (WSP)	Stores clean water destined for release to Minto Creek, or available for mill use. Total capacity is approximately 320,000 m3.	Ongoing use.
Water Conveyance		
W15 sump	Collects runoff and seepage from the western sub-catchments on the Minto Site and conveys the water via a pipeline to the Main Pit or WSP.	Ongoing use.
W35 sump	Collects runoff and seepage from the southern undisturbed sub-catchments on the Minto Site and conveys the water to the Main Pit or WSP.	Ongoing use.
Minto Creek Detention Structure	Decommissioned and functionally replaced by MVFES2 Collection sump (W62)	N/A
0.5 km and 1.5 km sumps and ditches	Collects runoff from sub-catchments north of the Minto Mine access road. Runoff collected is diverted to the WSP.	Ongoing use.
Tailings diversion ditch	Diverts water from small catchment upslope of ditch as well as the W35 catchment.	This ditch will be modified to lengthen the ditch at the eastern end to convey water from the south diversion ditch to the WSP or A2PTMF or MPTMF.
Area 2 Pit sump	No longer applicable.	
Minto South underground dewatering	Water collected from Minto South underground dewatering will be conveyed by pipe or trucked to the MPTMF or A2PTMF.	Expected ongoing use.
Confluence	Hub located between the Main Pit and Area 2 Pit where water from W15 and W35 may be directed to the Main Pit or to the WSP.	Ongoing use.
WSP discharge	Pumps and pipes for releasing water from the WSP to Minto Creek.	Ongoing use.
Minto North sump	Runoff collected in the Minto North Pit will be transported to the MPTMF or A2PTMF.	Ongoing use.
MVFES2 Collection sump	Collects and pumps Mill Valley seepage to the Main Pit.	Collects and pumps Mill Valley seepage to the Main Pit.
Reclaim Water		
Reclaim water line from the WSP to the mill	Conveys water from the WSP to the mill, if required.	Ongoing use.
Reclaim water line from the MPTMF to the mill	Conveys water from the MPTMF to the mill or A2PTMF.	Ongoing use.
Reclaim water line from the A2PTMF to the mill	Conveys water from the A2PTMF to the mill or MPTMF.	Ongoing use.
Tailings		
Tailings line from the mill	Conveys slurried tailings and water from the mill to the MPTMF and A2PTMF.	Temporarily decommissioned.
Water Treatment		
Water treatment plant	Accepts feed water from the MPTMF, the A2PTMF or the WSP and discharges treated water to the MPTMF, A2PTMF, WSP or Minto Creek. Sludge and brine produced in the treatment process is pumped to the MPTMF or A2PTMF.	Ongoing use.

6.3.9 Monitoring and Reporting

In the event of a temporary closure, monitoring and reporting will be critical to determining the success of the implemented temporary closure measures. In general, the monitoring strategy for environmental protection monitoring will be to monitor as per an approved EMSRP. The EMSRP commits Minto to all regulatory required monitoring and reporting under the approved WUL and Quartz Mining License. It is expected that Minto will develop and submit an updated EMSRP for review and approval as it pertains to temporary closure. The temporary closure EMSRP will focus on reduced frequency of monitoring as appropriate from the operational EMSRP. For clarity, the EMSRP that is referenced in this plan will be whichever approved EMSRP is current at the time (Operational or Temporary Closure EMSRP).

Monitoring and reporting requirements from other regulations, permits and licences that do not fall under the requirements of the EMSRP will be adhered to and followed as required.

Site components and infrastructure will be visually inspected on a regular basis. The visual inspections will document unexpected conditions as they relate to protection of public health and safety, the environment, physical stability and security. Management will be notified of all unexpected conditions and the conditions will be investigated and addressed as required.

In general the monitoring activities will include but not be limited to the following:

- All environmental protection monitoring and reporting will be completed as per approved EMSRP.
- Regular inspections of mine and processing facilities will be completed to ensure the facilities remain in good repair.
- Regular inspections of the water conveyance systems will be completed to ensure the facilities remain in good repair.
- Reports of changes to the physical status of any part of the site may warrant a follow-up investigation by the appropriate personnel.
- Subject matter experts will be utilized as required to remain in compliance with approved plans.
- Water storage capacity in licensed facilities will be monitored regularly and data analyzed to ensure compliance with water storage capacity.
- All monitoring, reporting and inspections not covered by the EMSRP and required by the environment act permits will be adhered to.
- All inspections and monitoring activities will be recorded and filed onsite.

Reporting will be completed as per the EMSRP or as required by applicable permits and licences.

If a temporary closure is triggered, a notice will be provided within seven days (or as the authorizations dictate) to the appropriate authorities stating the following:

- The nature and reason for the temporary closure;
- The anticipated duration of the temporary closure;
- Actions planned to maintain compliance with project permits and plan approvals; and

- Any event which would reasonably be anticipated to result in the resumption of mining or the permanent closure of the mine.

Table 6-3 presents a summary of the temporary closure activities and applicable monitoring of the various project components which would occur in temporary closure.

6.3.10 Maintenance

In the event of temporary closure, site components such as infrastructure and facilities will require maintenance to successfully meet the temporary closure objectives of protecting public health and safety, the environment and company assets. During the temporary closure preparation phase, the facilities not required will be temporarily decommissioned and secured. For facilities that are required in the event of temporary closure, they will be maintained on a preventative maintenance program similar to the program administered during the operational phase. The current preventative maintenance program relies on the outcomes of routine inspections; monitoring; and adherence to site management plans and facility operations, maintenance and surveillance manuals. In temporary closure, it is expected that the same outcomes will be the driving factors for maintenance of site infrastructure and facilities. In general, all facilities, equipment and infrastructure necessary in the event of a temporary closure will require ongoing maintenance; further discussion on this maintenance is provided in this section

In the event of temporary closure it will be critical to maintain the physical stability and functionality of the diversion channels. Water conveyance equipment will require regular maintenance to ensure reliable operation and performance of the water conveyance system. Monitoring, repairs and maintenance will be carried out by the care and maintenance crew.

The access road system will require periodic visual inspections. The care and maintenance crew will be responsible to complete maintenance of surface drainage infrastructure, culvert repair or road grading as required.

In the event of a temporary closure, maintaining the waste rock dumps will be critical to reduce the risk of physical instability. The care and maintenance crew will maintain the sloped grading of bench surfaces to minimize surface water infiltration and erosion of downstream slopes. Furthermore, the crew will maintain the surface water collection ditches to control surface drainage. Any repairs or maintenance of the facility; or improvements to runoff, erosion and sediment control will be undertaken as required.

Equipment that will be utilized in the event of temporary closure will be maintained as required and will be included as part of the preventative maintenance system. Preventative maintenance will aid in the reduction of environmental contamination by preventing spills. Additionally, preventative maintenance will benefit Minto by maintaining the company assets. Maintenance crews will be responsible for the maintenance of equipment similar to the operational period.

Actively managing and maintaining the Waste Management Area will be important to securing the facility in the event of temporary closure. The Waste Management Area will be maintained as per the Waste

Management Plan and associated permits, including but not limited to segregation of waste based on waste type.

The reduced inventory of special waste associated with the limited site activities as well as, the structure and management of the Waste Management Area will ensure hazards contained within the facility are stable and secured.

The physical stability of the fuel and propane tank farms will be maintained by the maintenance crew similar to the operational period. Regular inspections and preventative maintenance will drive the requirement for maintenance of these facilities.

The water treatment plant will be maintained as required including preventative maintenance. To preserve physical stability of the all facilities the care and maintenance crew will conduct quarterly structural inspections of the facilities and will complete proactive repairs as required.

6.3.11 Resources

In temporary closure a care and maintenance crew will be onsite at all times. The staffing numbers onsite at a given time will fluctuate from six to ten people. Two to three environmental personnel will be onsite at all times to complete all of the environmental monitoring and inspection requirements. Appropriate trades personnel will be retained for routine maintenance of components required in temporary closure. Water Treatment Plant operators will be employed part time, as required, to meet the expectations of managing water onsite.

The equipment expected to be utilized during care and maintenance will include, but not be limited to, the following: a front end loader, excavator, rock truck, water truck, vacuum truck, grader, forklift, flat deck truck, fuel truck, tug, barge and necessary light duty trucks.

The care and maintenance staff will consist of a variety of expertise, and roles and responsibilities will include, but not be limited to the following:

- Site management for continued direction and management of all activities;
- Safety personnel to support site inspections, security controls, first aid, emergency response and overall administration of the health and safety management systems;
- Water Treatment Plant Operators to support water management including WTP operations;
- Environmental personnel to coordinate site and environmental monitoring and ensure compliance to ongoing regulatory requirements;
- Adequate maintenance staff to ensure critical process equipment such as pumps and generators, and mobile equipment are maintained in operating condition;
- Equipment operators to support required maintenance, provide site access and maintain infrastructure;
- Some care and maintenance personnel may be trained in operating equipment required for snow removal and road access; and
- Additional support from Capstone’s corporate office for IT and administration.

In temporary closure energy consumption will be significantly reduced. The estimated amount of electric power required in temporary closure is approximately 5,640 kilovolt ampere per month. The estimated diesel required in temporary closure is approximately 40,000 litres while gasoline is estimated at 2,500 litres per month. Propane will fluctuate depending on the season and underground activity and is expected to range from 1,200 to 12,000 litres per month.

Table 6-3: Summary of Care and Maintenance Activities and Monitoring during Temporary Closure

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	Physical Monitoring Program	Environment Monitor/ Coordinator	As per EMSRP
			-Treat excess pit water and transfer to WSP if required	Water Quality Monitoring for Treatment	Water Treatment Plant Operator	As per EMSRP when treating water
			-Restrict access to hazardous areas with physical barriers	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	Water Quality Surveillance Program, Seepage Monitoring Program	Environment Monitor/ Coordinator	As per EMSRP
	Low Grade	Physical Stability	Monitor for stability	Physical Monitoring Program and Annual Geotechnical Inspection	Engineer, Environment Monitor/ Coordinator	Annual, As per EMSRP
		Geochemical Stability	Monitor for seepage	Water Quality Surveillance Program, Seepage Monitoring Program	Environment Monitor / Coordinator	As per EMSRP
Waste Rock and Overburden Dumps		Physical stability	Runoff/Erosion/Sediment control, as required.	Physical Monitoring Program	Environment Monitor/ Coordinator	As per EMSRP
				Geotechnical Inspection	Engineer	Annual
		Geochemical Stability	Monitor for seepage	Water Quality Surveillance Program, Seepage Monitoring Program	Environment Monitor/ Coordinator	As per EMSRP
Dry Stack Tailings Storage Facility		Physical stability	-Surface water diversion structure repair/maintenance, as required -Runoff/Erosion/Sediment control, as required.	Visual inspection elements of Monitoring Program from Tailings Management Plan (TMP) Physical Monitoring Program	Environment Monitor/ Coordinator	As per TMP and EMSRP
			-Stability Monitoring as required	Geotechnical Inspection from WUL and TMP	Engineer	Annual
		Geochemical Stability	Monitor for seepage and water quality	Water Quality Surveillance Program and TMP Monitoring Elements	Environment Monitor/ Coordinator	As per EMSRP

Project Component	Area of Interest	Care/Maintenance Activities	Monitoring Activities	Monitoring Responsibility	Monitoring Timing / Frequency
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	Maintenance	Monthly
			Structural and Physical Inspection	Engineer	As required
	-Physical Stability	-Maintain culverts.	Physical Monitoring Program	Environment Monitor/ Coordinator	As per EMSRP
Water Storage Dam	-Water Management -Physical Stability	-Maintain spillway and structure as required based on geotechnical inspections. -Monitor pond levels and water quality, where applicable. -Maintain spring/early summer pumping drawdown equipment.	Physical Monitoring Program	Environment Monitor/ Coordinator	As per EMSRP and WSPD OMS Manual
			Geotechnical Inspection	Engineer	Annual
	Geochemical Stability	Monitor for seepage water quality	Water Quality Surveillance Program	Environment Monitor/ Coordinator	As per EMSRP
Explosives Facility	Physical stability	-Remove bulk explosives from site. -As required, repair and replace infrastructure	Visual inspection periodically for signs of instability.	Maintenance	Monthly
Barge Landing	Access to Yukon River	As required, granular upgrade to landing site.	Visual inspection periodically for signs of instability.	Environment Monitor/ Coordinator	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	Environment Monitor/ Coordinator, Maintenance	Weekly and after heavy precipitation events
Entire Site	Physical stability	-Runoff / Erosion / Sediment control, as required -Road/culvert maintenance as required.	Physical Monitoring Program	Environment Monitor/ Coordinator	As per EMSRP
			Geotechnical Inspection	Engineer	Annual
	Water Quality / Management	-Retain Water Treatment Plant and Operators -Maintain storm water diversion systems	-Complete required monitoring as per the company's Environment Monitoring, Surveillance and Reporting Plan	Environment Monitor/ Coordinator	As per EMSRP and MMER

Project Component	Area of Interest	Care/Maintenance Activities	Monitoring Activities	Monitoring Responsibility	Monitoring Timing / Frequency
		-Continue seasonal water treatment as required for excess pit and site water	-Continue required monitoring under Metal Mining Effluent Regulations (MMER)		
	Security	Full time site staff will check, repair and replace as required: • precautionary signage • barricades at mine entry ways • secured door ways of temporarily closure facilities	Site Inspection and Security Monitoring of all infrastructure and site elements	Care and Maintenance Staff	Regularly
	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.	Care and Maintenance Staff	Regularly
	Reporting	-Prepare and submit reports to the Yukon Water Board pursuant to the approved Environment Monitoring, Surveillance and Reporting Plan, including details of temporary closure activities and monitoring. - Prepare and submit reports to the Energy Mines and Resources branch of the Yukon Government pursuant to the approved Environment Monitoring, Surveillance and Reporting Plan, including details of temporary closure activities and monitoring. -Prepare and submit quarterly monitoring reports to Environment Canada under MMER. -Prepare and submit reports to other regulatory bodies as required by permits and licences not included in the Company's Environment Monitoring, Surveillance and Reporting Plan.		Environment Coordinator, Site Management	As per the EMSRP Quarterly, Online RISS Registry As per applicable permits and licences

7 Final Reclamation and Closure Measures

The site configuration at the end of mining (and beginning of the Active Closure period) is shown in Figure 7-1, and the site configuration after completion of construction of the final reclamation and closure measures (at the end of the Active Closure period) is shown in Figure 7-2. The following subsections describe the final reclamation and closure measures that are planned for the various components of the Minto Mine site.

7.1 Underground Workings and Openings to Surface

Underground mining schematics and plans are presented in Minto's Underground Mine Development and Operations Plan (Minto 2020). An updated mine plan showing the final layouts and extents of the workings will be completed at time of final closure. An overview of the underground deposits under consideration for this plan are shown in Figure 5-10.

Two portals have been completed to date (the Minto South and the M-Zone Portal). The M-Zone portal was collared from the bottom of the Area 2 Stage 2 pit. The two underground mining areas accessed through these portals were the Minto South and the M-Zone respectively.

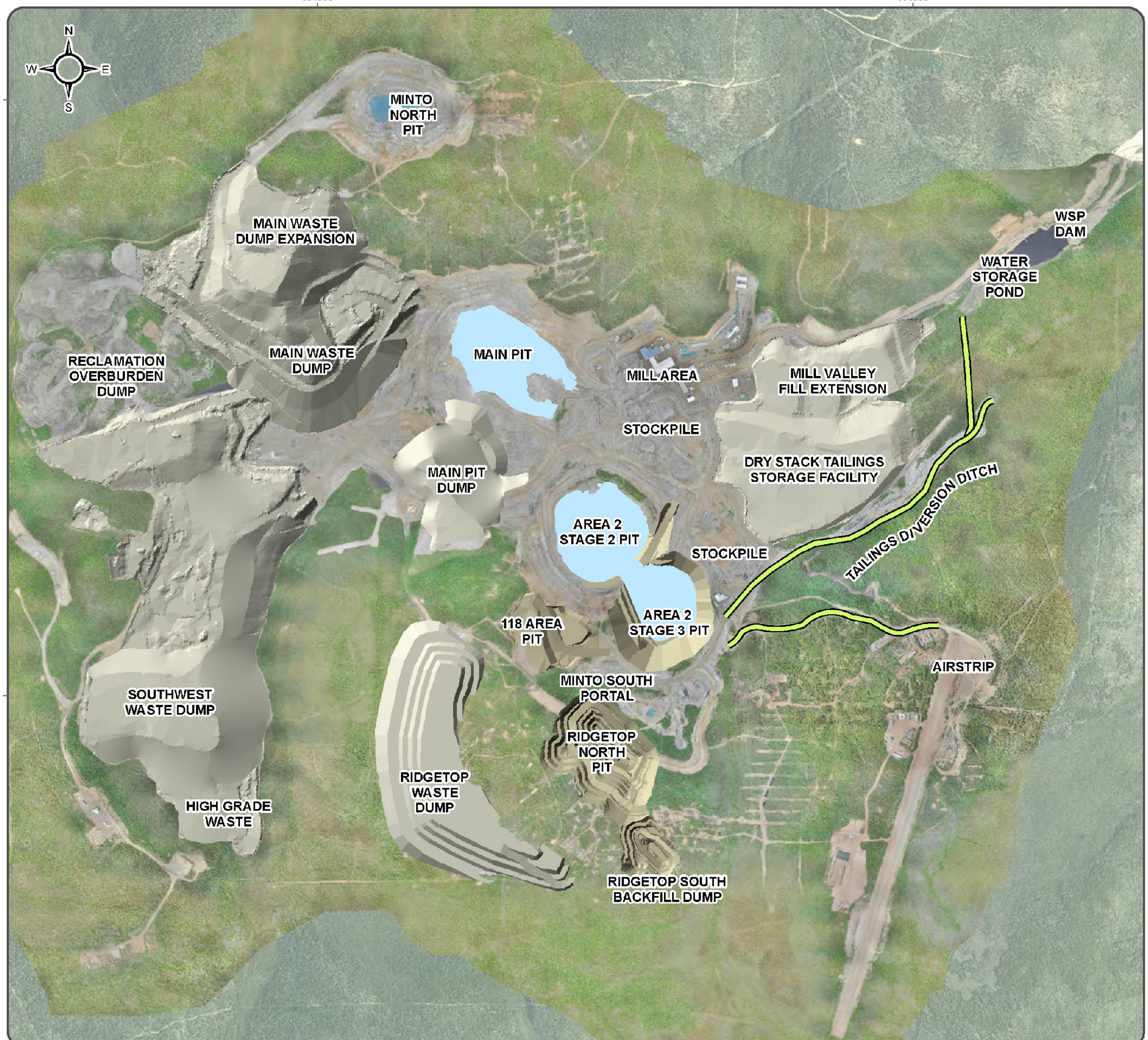
An additional portal is currently being proposed under the Phase VII licence amendment. The additional portal will be within the Minto North Pit and will access the Minto North Underground deposit.

Minto North Underground will also be mined as longhole stopes but will involve cemented rockfill to backfill the primary stopes. The backfill will consist of waste rock mixed with cement to a design recipe underground. The backfill will cure with enough strength to act as engineered pillars. Once the primary stopes are mined and backfilled the rock pillars between primary stopes will be extracted as secondary stopes. The stope sill development will be on 14m centres and primary and secondary stopes will both be 14m wide. In order to fill the primary stopes with backfill, there will be additional development top cuts above the primary stopes to provide a backfill dumping point. An alimak ventilation raise will be excavated to surface to provide secondary egress and flow through ventilation for the mine.

Given the dimensions and the general high strength of rock at Minto, surface expression of subsidence due to mine workings collapse is not expected.

7.1.1 Minto South

Upon completion of underground mining, underground workings will be allowed to flood. Hydrogeological investigations indicate that in the post-closure period the groundwater table will not rise sufficiently to result in water discharging at the surface. The Minto South Portal (elevation 851 m) is about 52 m above the final level of the Area 2 Pit lake (elevation 799 m), representing a significant groundwater gradient that would have to be overcome for water to discharge through the portal opening. In the unlikely event that groundwater would be discharging through the Minto South Portal, it would be confined within the catchment of the Area 2 Pit and would be captured under the general closure water management system.



MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 7-1 SITE CONFIGURATION - BEGINNING OF ACTIVE CLOSURE

NOVEMBER 2020

MINTO

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Datum: NAD 83 Projection: UTM Zone 8N

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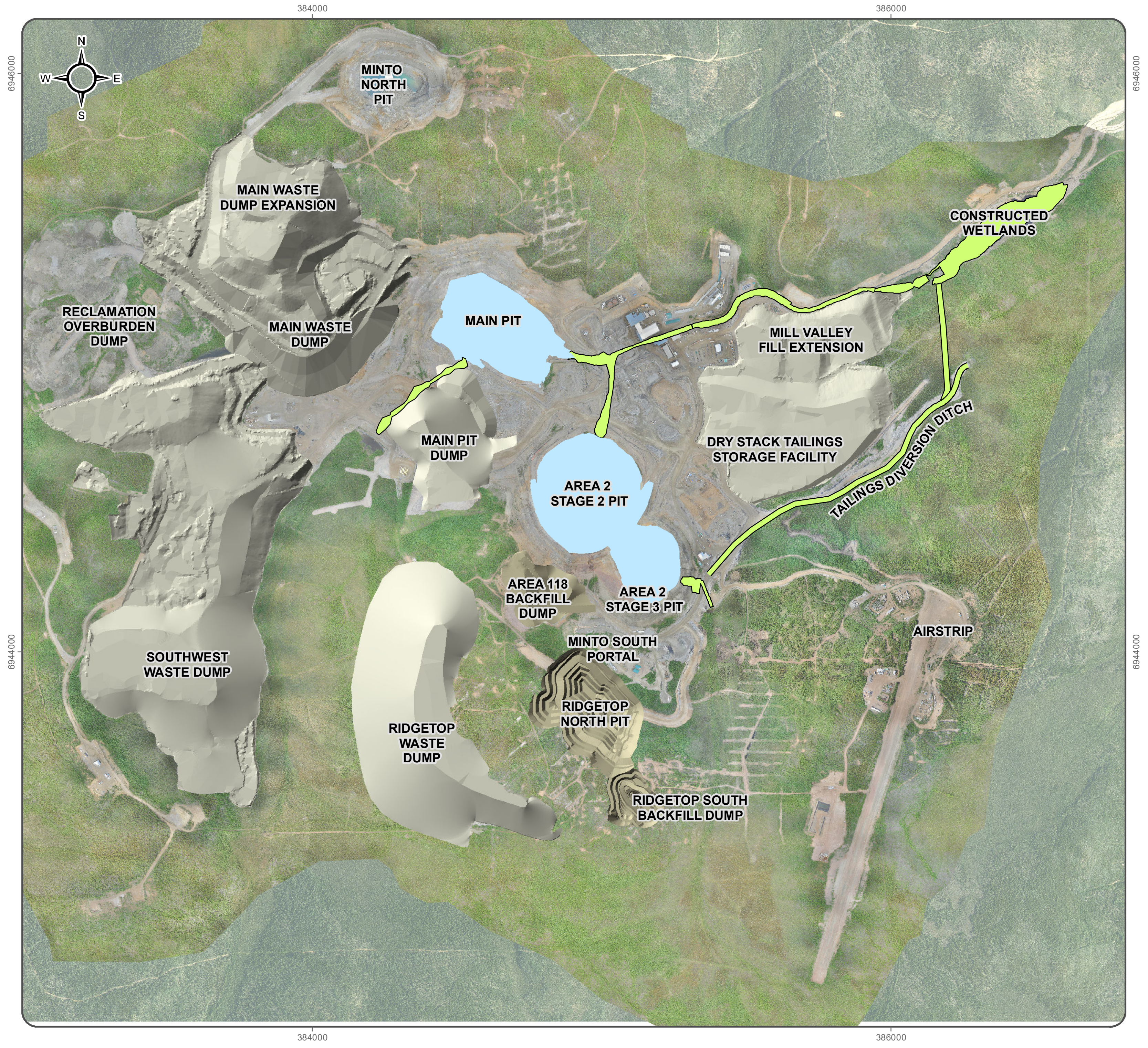

MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 7-2
SITE CONFIGURATION -END OF ACTIVE CLOSURE

NOVEMBER 2020

MINTO

- Tailings Diversion Ditch
- Pit Lake
- Dump
- Pit
- Covered Tailings
- Water Conveyance System

1:18,000 *when printed on 8x11 inch paper*

0 100 200 300 400 500 Meters

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Datum: NAD 83 Projection: UTM Zone 8N

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Underground fixtures, equipment, and systems (compressed air pipes, ventilation ducts, electrical cables, etc.) will be decommissioned, decontaminated of hydrocarbons and other hazardous waste, and disposed of as appropriate. All fuels, lubricants, and hydraulic fluids will be drained and disposed of as appropriate. Mobile equipment will be removed from underground and disposed of as described in Section 7.8.10.

The portals to the underground workings will be blocked to eliminate access by people and wildlife. The blockage will be achieved by placing rockfill to at least 2 m above the top of the opening and will occupy the entire section of the portal. Side slopes of the rockfill will be graded adequately to allow overburden to be placed as a growth medium. This will be followed by revegetation using techniques applied elsewhere on site.

7.1.2 M-Zone

The M-zone portal was excavated from the bottom of the Area 2 Pit. This portal is currently completely flooded with tailings slurry and water and no further closure measures will be required.

7.1.3 Minto North Underground

The Minto North underground portal will be excavated from within the Minto North Pit. The portal entrance will be buried similar to the Minto South Portal.

7.1.4 Vent Raises

All ventilation raises will be sealed to prevent access by construction of a reinforced concrete cap capable of supporting a minimum uniformly distributed load of 12kPa, as per the requirements of the Occupational Health and Safety Regulations. Loose overburden will be excavated from around the vent raise collar and the cap will be anchored in competent bedrock to prevent subsidence or any other movement.

7.2 Open Pits

7.2.1 Restricting Access

Inadvertent access to all pits will be prevented by constructing berm structures along pit perimeters (including across haul roads and other access points), offset from the pit crest by 5 to 10 m. The berm structure will incorporate regular breaks to prevent any significant impoundment or diversion of surface water. Nominally the berm structures will consist of 1.5m high and 4 to 7 m long sections with angle of repose side slopes and 1 m gaps between adjacent sections. Construction of the berm structures will be done by pushing local material into the berm sections using a dozer or equivalent, with the 4 to 7 m dimension corresponding to common dozer blade widths. The gaps will be planted with trees to discourage their use as passage points. Although placement of signage around pit rims is a common feature of closure plans for open pit mines, in practice signs commonly deteriorate over the course of time under exposure to site conditions and are thereafter ineffective. Although a program of sign replacement could be undertaken, Minto proposes to rely on berms alone to prevent inadvertent access.

7.2.2 Main Pit

The Main Pit was exhausted in April 2011. A description of the pit layout and operations is provided in Section 5 (Figure 5-4, Figure 5-5). Details of the pit design, including the slope and bench stability assessment, can be found in the SRK report "Pit Slope Evaluation for Area 1 Open Pit, Minto Mine, YT" dated July 2007.

An area of instability in the ice-rich overburden in the south wall of the pit failed in 2011, and a stabilization buttress (South Wall Buttress) for the area was constructed between 2011 and 2013. Stability monitoring conducted since 2013 observed that the buttress has largely stabilized by 2015, with average movement of about of 0.2 mm/day.

A significant proportion of the highwall will remain exposed after flooding the pit, however acid-base accounting indicates that the rock is not potentially acid generating. No reclamation work is required on the high walls. Perimeter berms will be constructed as described in Section 7.2.1.

The mined-out pit is used for tailings and waste rock deposition. Currently the pit lake is also used as a source of processing water for the mill, as well as a surge reservoir in the overall mine (contact) water management system. The final pit lake elevation is expected be 786 masl. An engineered spillway will be constructed to connect the pit lake to Conveyance Channel C (Section 7.6).

Surface runoff from up-gradient of the Main Pit will be routed through the Main Pit via Conveyance Channel A. The pit also collects water from local catchment and highwall runoff. As a component of closure conveyance system flows, the Main Pit discharge will be routed through the Constructed Wetland Treatment System that is planned for the Water Storage Pond area. See Section 7.6 for discussion on how Main Pit lake discharge will be managed along with other site flows.

7.2.3 Area 2 Pit

The Area 2 Pit is located south of the Main Pit and west of the Dry Stack Tailings Storage Facility as described in Section 5 (Figure 5-6). The final pit will be the product of merging of the Area 2 Stage 2 and Area 2 Stage 3 pits (Section 5.2.1).

The mined-out Area 2 Pit is used for tailings, waste rock and water storage. Following the cessation of operations it will be flooded until it overflows into the engineered drainage channel exiting the pit to the north at elevation 799 m. An engineered spillway will be constructed to connect the pit lake to Conveyance Channel D (Section 7.7) and onward to the post-closure water conveyance system.

Pit flooding will occur over a period of 1 to 4 years following cessation of milling, with inflows from local catchment and highwall runoff as well as from the larger catchment area to the south via the construction of Conveyance Channel B. As a component of post-closure water conveyance system flows, the Area 2 Pit discharge will be routed through the Constructed Wetland Treatment System that is planned for the Water Storage Pond area. See Section 7.6 for discussion on how Area 2 Pit lake discharge will be managed along with other site flows.

The Area 2 Pit was mined using standard drill and blast techniques with the excavation occurring primarily in competent bedrock. Due to the steep topography it is estimated that approximately 20% of the open pit walls will remain exposed following flooding of the pit; however acid-base accounting indicates that the open pit wall rocks are not potentially acid generating. No reclamation activity is required for these high walls.

Some of the upper benches excavated in overburden have experienced slumping (likely due to thawing of permafrost), particularly along the eastern and northern portions of the pit perimeter where overburden exposures are thickest. These areas are naturally revegetating and no additional work will be done to avoid disturbing the vegetation that has established. Prior to flooding, any safely accessible overburden benches that have not slumped or naturally begun to revegetate will be scarified to encourage natural revegetation.

Inadvertent access to the pit will be prevented by construction of perimeter berms (Section 7.2.1).

7.2.4 Area 118 Pit

The Area 118 Pit was excavated to the southwest of the Area 2 Pit (Figure 5-6) and has been partially backfilled during stripping of Area 2 Stage 3 Pit. At closure the pit will be completely buried by the Area 118 Backfill Dump, and no further closure measures related to the Area 118 Pit itself will be required. Closure of Area 118 Backfill Dump is outlined in Section 7.4.9.

7.2.5 Minto North Pit

The Minto North Pit is located in the extreme upper elevation of the McGinty Creek catchment area, directly north of the Main Pit. Pit layout and operations were described in Section 5 (Figure 5-7).

At closure, the pit will be allowed to flood; however, pre-mining groundwater level observations and preliminary water balance modeling under most scenarios indicate that the Minto North Pit is not likely to fill to the point where it would spill. Monitoring of pit water levels and quality has been included in the post-closure monitoring program along with down-gradient groundwater quality, and an allowance for an engineered spillway has been included in the RCP 2018-01 closure cost estimate. Whether the Minto North pit discharges via surface or groundwater, water quality modelling indicates that no negative downstream effects are anticipated and therefore no treatment will be necessary.

The Minto North Pit was mined using standard drill and blast techniques with the excavation occurring primarily in competent bedrock. At closure some or all of the highwalls will remain exposed; however acid-base accounting indicates that the open pit wall rocks are not potentially acid generating. No reclamation activity is required for these high walls. Inadvertent access to the pit will be prevented by construction of perimeter berms (Section 7.2.1).

7.2.6 Ridgetop North Pit

The closure measure for the Ridgetop North Pit is described under the Ridgetop North Tailings Mangement Facility (Section 7.3.2).

7.2.7 Ridgetop South Pit

The closure measure for the Ridgetop South Pit is described under the Ridgetop South Backfill Dump (Section 7.4.7).

7.3 Tailings Facility Areas

Tailings management at Minto initially relied on filtered tailings placed in a dry stack facility until the first pit became available for slurry deposition. Tailings were therefore placed on the DSTSF until the end of October 2012, after which the tailings management strategy was changed to slurry deposition in the Main Pit and in the Area 2 Pit. Facilities layout is shown in Figure 7-3.

Two physical tailings laboratory programs have been previously completed to characterize the tailings performance as it relates to tailings deposition at the site (EBA 2007 and Klohn Crippen Berger 2013). The available test data included indicator properties (grain size distributions and Atterberg Limits), consolidation tests, settling tests, specific gravity, direct shear tests, and hydraulic conductivity tests.

Tailings density achieved in the DSTSF was about 1.8 to 2.2 tonnes/m^3, confirmed by sampling during a post-DSTSF construction subsurface investigation program conducted in 2013 (SRK 2014a). Slurry-deposited tailings density in the Main Pit was estimated to be 1.35 tonnes/m^3, based on bathymetry and tailings production data collected by Minto (Minto 2018a).

The tailings are typically a well graded sand and silt (59% sand, 35% silt and 6% clay) with a Specific Gravity of 2.72. The coefficient of consolidation for a change in effective stresses between 50 kPa and 100 kPa was estimated to be 5.6x10-6 m^2/s. The compression index of 0.1 (in log scale) indicates stiffness behavior typical of sands. An exhaustive summary of physical and mechanical properties of the tailings can be found in an SRK memo - SAT Dump on Tailings (SRK 2016b).

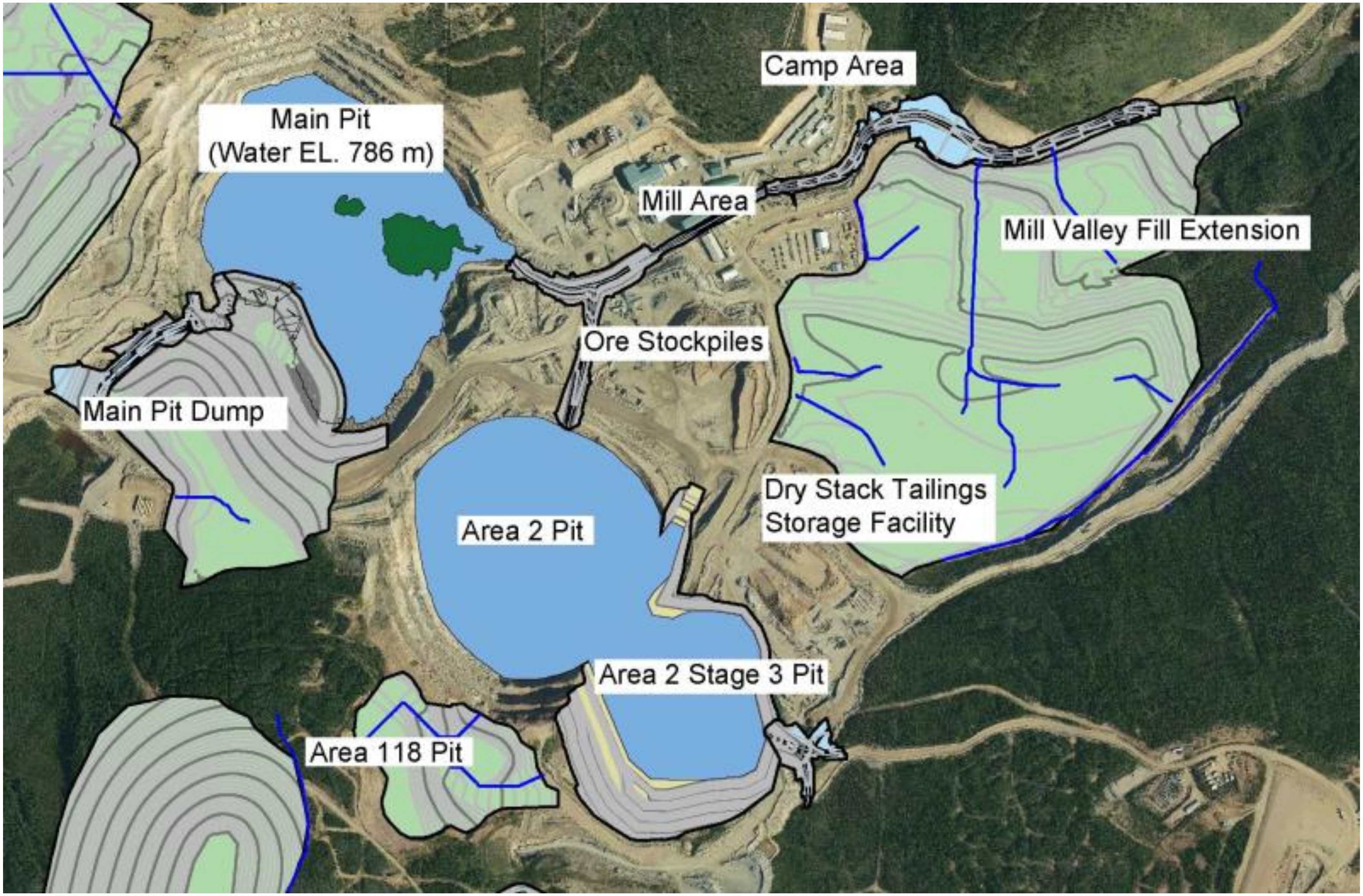


Figure 7-3: Plan View of Post-closure Arrangement of Main Pit, Area 2 Pit, DSTSF and MVFE Stage 2

7.3.1 Dry Stack Tailings Storage Facility

Placement of tailings on the DSTSF was completed between 2007 and 2012 and progressive reclamation activities (in the form of interim cover placement) were carried out. The maximum thickness of tailings is about 25 m. The north and east sides were constructed at an overall slope of approximately 2H:1V and clad with not potentially acid generating waste rock to an overall slope of approximately 4H:1V. This rock shell provides erosion protection to the stacked tailings.

Instability of the DSTSF was first observed in 2009. A detailed study of the causes of instability (SRK 2012) indicated that the area of movement appears to be limited to within or near the edges of the DSTSF itself. The movement was occurring at depth within the relatively deep permafrost soil foundation. The available data indicates that a deep shear zone acting as a sliding surface is relatively well defined at depths of 28 to 64 m below the original ground surface and approximately 7 m above the bedrock contact (SRK 2012). Monitoring of the movement will continue in the closure and post-closure periods as described in Section 7.12.

Clean run-off water from upstream of the DSTSF will be diverted by the Tailings Diversion Ditch (initially completed in 2008 and upgraded in 2014, with a future addition remaining to be constructed), conveyed to east into the High Flow Discharge Bypass Channel. The top surface of the DSTSF will be graded to shed run-off toward the north, south, and west, where secondary channels and swales will direct the water to the primary conveyance network (Conveyance Channel C and Channel E).

The low permeability and partially frozen nature of the compacted tailings results in little seepage being expected, and operational seepage monitoring results support this prediction. The low volumes of seepage that do occur mix with other seepage water before reporting to the operational sump. After sump decommissioning, seepage water will report to the closure water conveyance system at or upgradient of the Primary Head Pond (itself upstream of the Constructed Wetland Treatment System) where it will mix with the water from Conveyance Channel E and be directed to treatment in the wetlands or to the High Flow Bypass Channel, according to flow conditions. During bypass conditions, seepage flows will be a very small proportion of the overall total volume.

An interim overburden cover was completed on the DSTSF in 2014, with overburden thickness up to 5 m (SRK 2016a) consisting of zones of residuum, fine grained soils, and mixed residuum and fine-grained soils. A final cover was placed in 2018 on all faces of the DSTSF that meets the final cover design. Seeding of slopes was completed in 2018.Final cover was placed on the slopes of the Waste Rock Shell on the DSTSF, as well as much of the surface in 2017-2018, as per the final cover design. The slopes have been seeded, while the surface is scheduled for final contouring and water management configuration and seeding (including tree seedings) in 2021 -2022. The surface will be revegetated using appropriate revegetation techniques (Appendix E3) as refined through the ongoing reclamation research program.

7.3.2 In-Pit Tailings Management Facilities

The tailings management system for the in-pit tailings disposal integrated disposal of slurry tailings within the Main Pit and the Area 2 Pit (Figure 7-3) on a schedule that benefited operations and the immediate mine water management needs. As a result, tailings volumes disposed of in each of the pits are approximate. Detailed descriptions of the in-pit tailings disposal operations were provided in Section 5 and the Tailings Management Plan (Minto 2014b).

Main Pit Tailings Management Facility

Tailings deposition into the Main Pit TMF resulted in the east portion of the tailings being beached, while the west portion remaining permanently submerged under the Main Pit lake.

An engineered spillway will be created at the east side of the facility, with an invert at elevation 786 masl, to connect the pit lake with Conveyance Channel C (Appendix G2 – closure conveyance design) and from there to Minto Creek via the post-closure water conveyance system. During low flow periods all flow will undergo passive treatment through the Constructed Wetland Treatment System to be constructed in the Water Storage Pond area, while during high flow a portion will report to the High Flow Bypass Channel (along with other site flows). Water quality will be monitored in the closure and post-closure period as part of the site-wide water monitoring program (Section 7.12).

The tailings lines and the water reclaim system (barge, pumps, reclaim lines) will be decommissioned and removed. Equipment will be salvaged or disposed of, as appropriate. HDPE pipe will be cut into manageable pieces and disposed of in the site landfill.

The area of tailings permanently submerged will not require any further closure activity. Exposed beach areas will be reclaimed with a cover system including a waste rock traffic layer and an isolation/vegetation supporting layer (Figure 7-4; Appendix E1; Appendix E3).

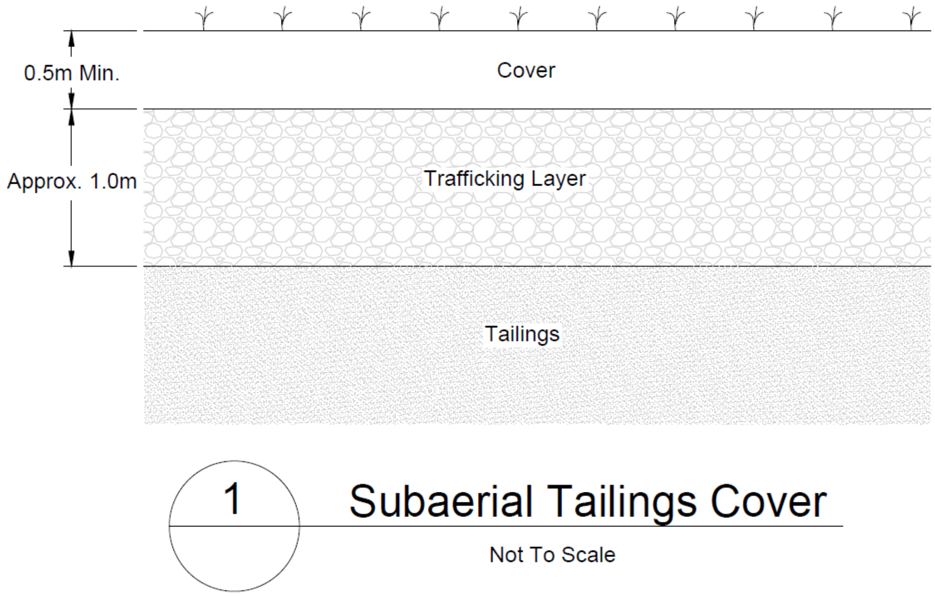


Figure 7-4: Conceptual Isolation Cover for Main Pit and Ridgetop North Tailings

Area 2 Pit Tailings Management Facility

Tailings have been deposited in the Area 2 Pit in accordance with the Tailings Management Plan (Minto 2018a and earlier versions). Area 2 Stage 3 and 4 mining was completed in 2018. Since then, tailings and water have exceeded the saddle elevation.

Tailings in this facility will be permanently flooded and will require no further reclamation activities. An engineered spillway with the invert elevation of 799 masl will be built to connect the pit lake to Conveyance Channel D (Appendix G2).

During low flow periods all flow will undergo passive treatment through the Constructed Wetland Treatment System to be constructed in the Water Storage Pond area, while during high flow a portion will report to the High Flow Bypass Channel (along with other site flows). Water quality will be monitored in the closure and post-closure period as part of the site-wide water monitoring program (Section 0).

Ridgetop North Pit Tailings Management Facility

Tailings will be deposited into the Ridgetop North Pit TMF as soon as practical after the pit has been mined out. The Ridgetop North Pit was not yet mined at the time of this update.

Tailings in this facility will be covered at closure with a similar cover design concept as what is proposed for the subaerial Main Pit tailings. The cover system will include a waste rock traffic layer and an isolation/vegetation supporting layer (Figure 7-4; Appendix E1).

7.4 Waste Rock and Overburden and 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 and Main Waste Dump Expansion;
- Southwest Waste Dump;
- Main Pit Dump;
- Mill Valley Fill Extension;
- Reclamation Overburden Dump;
- Ice-Rich Overburden Dump;
- Ridgetop South Backfill Dump;
- Ridgetop Waste Rock Dump; and
- Area 118 Backfill Dump.

7.4.1 Main Waste Dump and Main Waste Dump Expansion

The Main Waste Dump (MWD) is located immediately northwest of the open pit as described in Section 5 (Figure 7-5). The dump was expanded uphill and to the northwest in 2015/2016 with waste materials excavated from the Minto North Pit- this latest construction forms the Main Waste Dump Expansion (MWDE). The design of the MWDE was developed with closure in mind, through incorporation of landform design concepts that grade the flatter top portion of the dump away from the crest and develop broad drainage paths that, when covered, will direct surface runoff to the ultimate water conveyance system while limiting the potential for erosion.

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. The stability of the expansion was analysed in a report completed in 2013 - Phase V/VI Main Pit Dump Physical Stability Assessment (SRK 2013d).

Annual inspections of the MWD have taken place and no physical stability issues have been identified to date.

Waste materials placed in the facility contained copper concentrations ranging from 0 to 0.64%. Operational geochemical characterization of the materials, as part of licence requirements, has shown that the materials currently in the facility are not potentially acid generating (SRK 2010). Neutral pH metal leaching has been identified as being a potential chemical concern associated with closure of this facility based on operational monitoring for the mine (e.g. seepage monitoring results in Minto 2016b).

Section 2.2.2 discusses reclamation that has been conducted on the south face of the Main Waste Dump as part of the Reclamation Research Program. Results from this program will assist in optimizing dump face reclamation strategies for site waste dumps. Observations of plant abundance and little to no evidence of erosion on revegetated slopes in recent years (including 2017) have shown that establishing vegetation is an effective erosion-limiting measure for the combination of final slope grades and the available cover materials at Minto.

Notwithstanding the results of the research trials showing vegetation can effectively control erosion, the lower edge of the trial reclamation plot has experienced widespread development of erosion gullies around the southern extent of the MWD. These gullies likely initiated at the edge of the trial plot (where initial slope grading and later trial cover placement resulted in over-steepened slopes) and propagated upslope thereafter. To flatten the overall slope around the southern perimeter of the MWD, a grading fill known as the Main Waste Dump Wrap was designed and has been partially constructed (as of February 2018). This grading fill will provide a more gradual transition from the steeper MWD slopes to the adjacent surfaces, and will have overall slopes of 3H:1V or flatter.

The grading fill that is the Main Waste Dump Wrap is a component of an overall approach to limiting erosion of the final reclaimed surfaces through careful design of the final landforms. Other aspects of the landform design approach include grading designs and subsequent implementation that have: produced final graded dump surfaces that avoid routing flows over dump crests wherever possible; limited lengths of secondary conveyance channels by shaping final surfaces to include more tertiary drainage channel; and grading large flatter areas to direct surface runoff to lower gradient routes (e.g. shaping the top of the Main Waste Dump Expansion to drain to the west towards the haul road).

At closure, the final graded surface will be reclaimed as described in the cover design report (Appendix E3). In general, the entire dump will be capped with a minimum 0.5 m thick isolation soil cover constructed from reclamation soil materials available on-site. The preliminary cover design details the cover design criteria and performance expectations, including broad revegetation strategies. Those revegetation strategies include rapid development of extensive ground cover through seeding on slopes where erosion could otherwise be unacceptable, and less intensive seeding effort on level areas to provide some ground cover that would prevent extensive colonization by foxtail barley while at the same time level space for colonization by natural regeneration (which has shown to be extensive in several areas of the site). The active revegetation efforts will rely on seed mixes that include only species listed as acceptable in the Yukon Revegetation Manual (Matheus and Omtzigt 2013).

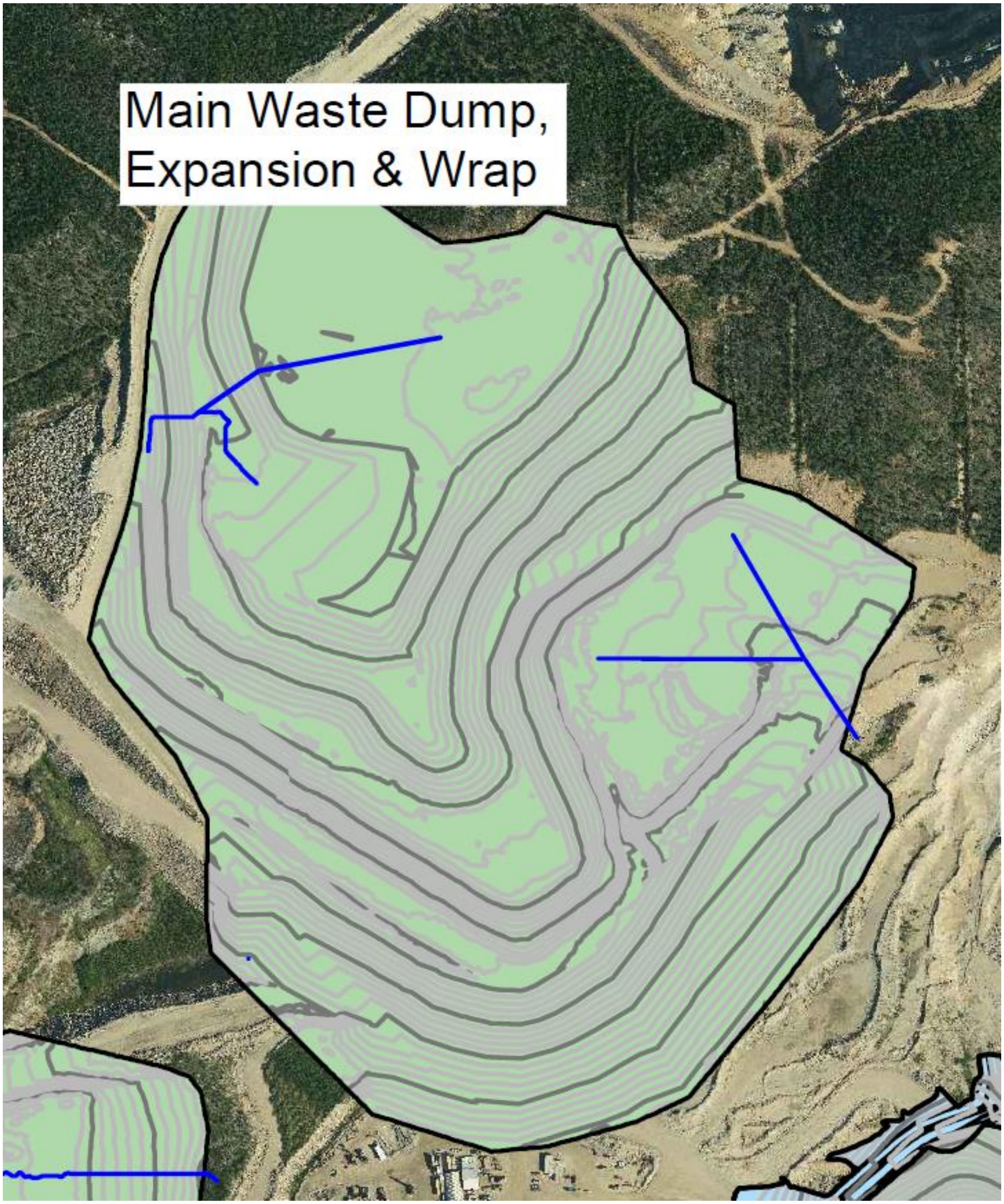


Figure 7-5: Main Waste Dump Plan View of Closure Configuration

7.4.2 Southwest Waste Dump

The SWD is located to the south of the MWD (Figure 7-6). It was started in 2008 in order to optimize operations and provide additional storage areas for waste rock and thaw stable overburden material, in accordance with the Waste Management Plan (EBA, 2010a). Details of the design can be found in a report entitled Geotechnical Design, Proposed SWD (EBA, 2008a).

The SWD is estimated to contain a total of approximately 6.44 Mm^3 of waste materials with copper content ranging from less than 0.1% to 0.5% from the Phase IV development. 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 however identified as being a potential geochemical concern (SRK, 2010).

Waste rock placed in the SWD was segregated based on copper content and the high grade waste (HGW-0.36 to 0.5% copper) was placed in the southern-most zone of the dump. The HGW was originally destined for a Grade Bin Disposal Area (GBDA) south of the Main Pit but due to the instability and south wall failure of the Main Pit it was necessary to place it in the SWD instead. Medium grade waste (MGW- 0.1 to 0.36% copper) was also placed in an area separate from the rest of the low grade waste (LGW- up to 0.1% copper) in the dump. Some of the original portions of the SWD constructed from Main Pit waste rock were overdumped as a result of the continued construction with Phase IV waste rock. The portions of the SWD that were built from Main Pit waste rock were constructed of bulk waste with copper content ranging from <0.01% up to 0.64% copper. The proposed closure covers will help reduce the potential metal loadings from the SWD materials. The SWD was constructed in progressive lifts and ongoing geotechnical monitoring indicate slow foundation movement (average of 0.4 mm/day in 2020) observed in east direction. This movement however was not deemed as being a safety hazard and no remediation is proposed at this time. Monitoring of the movement will continue in the closure and post-closure period.

Significant regrading and recontouring work was completed on the SWD starting in 2014, based on a collaborative and interactive design-build workflow between Minto and SRK engineers and implemented using the mining contractor’s equipment and staff. The SWD will be covered with a 0.5 m thick single layer soil cover constructed of locally available soils sourced from mining of Area 2 Stage 3 Pit or from overburden stockpiles. This includes the HGW area- a portion of the High Grade Waste stockpile was milled in 2017, and the remainder of the HGW stockpile is planned to be milled as part of regular operations. If it is not milled, the remaining HGW will be relocated to a location that is saturated over the long term (either Main Pit or Area 2 Pit). The RCP 2020-01 closure cost estimate makes allowance for HGW relocation to Main Pit as part of closure works. Alternative closure measures for HGW are no longer being considered.

At closure, the final graded surface will be reclaimed as described in the cover design report (Appendix E3). In general, the entire dump will be capped with a minimum 0.5 m thick isolation soil cover constructed from reclamation soil materials available on-site. The preliminary cover design details the cover design criteria and performance expectations, including the broad revegetation strategies noted for MWD in Section 7.4.1. Those revegetation strategies include rapid development of extensive ground cover through seeding on slopes where erosion could otherwise be unacceptable, and less intensive seeding effort on level areas to provide some ground cover that would prevent extensive colonization by foxtail barley while at the same time level space for colonization by natural regeneration (which has shown to be extensive in several areas of the site). The active revegetation efforts will rely on seed mixes that include only species listed as acceptable in the Yukon Revegetation Manual (Matheus and Omtzigt 2013).

Progressive reclamation of the Southwest Waste Dump to date has been extensive. Minto re-sloped the face of the dumps to slopes ranging roughly between 12H:1V and 4H:1V and has hauled and stockpiled overburden necessary to cover and revegetate the top of the dump, and the dump slopes. Remaining work to be completed includes:

- Spreading and grading of the overburden at the top of the dump, and the slopes;
- Grading on the top surface to shed water into swales designed to carry the flow down the face of the dump without causing significant erosion;
- Excavation of the remaining high-grade waste stockpile (for either milling or relocation);
- Additional design work;
- Construction of swales;
- Cover placement; and
- Detailed planning and implementation of revegetation plans.

A minimum cover thickness of 0.5 m is proposed for the Southwest Waste Dump across the facility, including the footprint of the high-grade waste stockpile. Localized areas may require additional grading to meet design grades, and it is proposed that final grades will be achieved through the placement of overburden, subject to Minto’s scheduling plans.

To shed water, the top of the Medium Grade Waste area is proposed to be split into six catchment areas while the bulk waste area is proposed to be split into three small catchment areas. These catchment areas are illustrated in the detailed hydraulic analysis information contained in Appendix E3. The intent is to minimize the amount of water that flows directly over the slope as sheet flow. Each of these small catchments would be constructed to direct water into a broad swale, currently considered to be 2 m wide at the base, and have side slopes of 10H:1V. The swales were designed based on contributing watershed area, and flow depths are anticipated to range between 0.13 m and 0.37 m during a 1:200 year 24-hour flood event. The reported depths are double that of the calculated depths to allow for ice accumulation; however, this is a conservative element, as no significant ice accumulation is anticipated given the expected unsaturated nature of the underlying waste rock and the lack of winter groundwater discharge to the channels.

The swales have been designed to flow over and maintain the same base with the slope, but transition to 3H:1V side slopes along the slopes. The swales on the top are proposed to be protected with vegetation, while the slopes are proposed to be armoured with a gravel to cobble sized rip rap. Rip rap thickness and final dimensions are yet to be determined. Details regarding the hydraulic designs of these swales are provided in Appendix E3.

The proposed re-grading and swale locations are illustrated on Figure 7-6. The Southwest Waste Dump is expected to require approximately 322,200 m3 of cover material. Of this, sufficient overburden has been hauled to the top of the mid-grade pile and stockpiled to achieve final grades, and to apply along the slope. It is estimated that over 60% of the material necessary to cover the Southwest Waste Dump has been hauled and stockpiled. The proposed final slopes are 3H:1V or shallower, and therefore physical stability of the cover is not anticipated to be problematic.

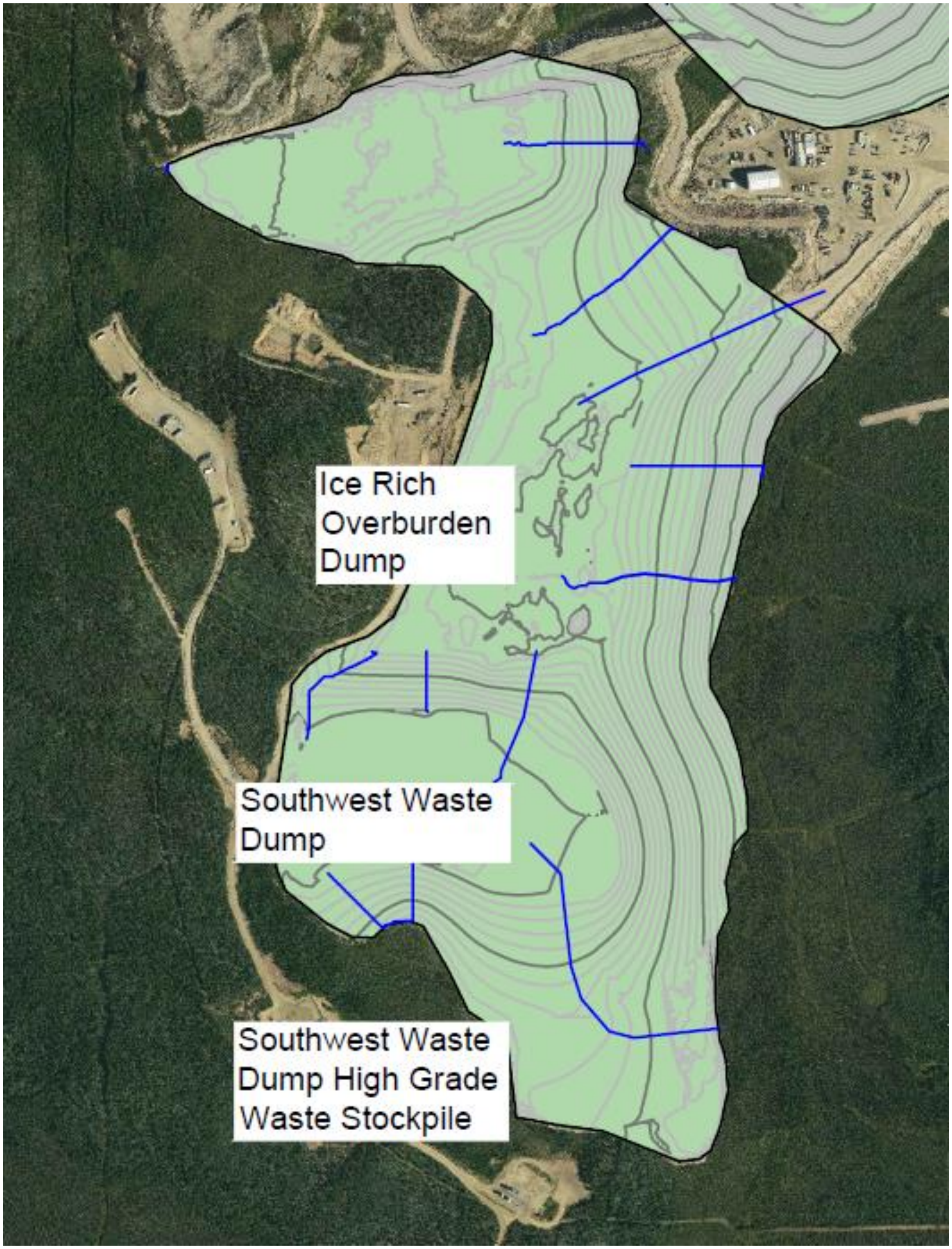


Figure 7-6: Plan View of Southwest Waste Dump

7.4.3 Main Pit Dump and South Wall Buttress

The South Wall Buttress construction started in June 2011 and was essentially complete by November 2013. The purpose of the buttress was to contain the slide debris and stabilize the South Wall against further instability. The Main Pit Dump is an upwards expansion of the South Wall Buttress, and it will be built wholly within the Main Pit footprint.

The Main Pit Dump is currently under construction and the final configuration of the dump has yet to be finalized. SAT material above elevation 786m (the planned final water level of the pit) is currently proposed to be relocated to areas within the pit where it can be covered with water (i.e. below elevation 786 m). A total of 1.04 Mm^3 of SAT will be relocated (Appendix K- RCP 2018-01 Closure Cost Estimate).

A minimum cover thickness of 0.5 m is proposed over the Main Pit Dump. To shed water, the top of the Main Pit Dump has been designed to shed water towards the south-west. The catchment area anticipated to capture the flow is illustrated in the detailed hydraulic analysis information contained in Appendix E3. A broad swale, with dimensions of 2.0 m wide at the base and side slopes of 10H:1V is currently proposed. The swale was designed based on contributing watershed area and the flow depth has been estimated to be 0.22 m during a 1:200 year 24-hour flood event, accounting for ice accumulation within the swale; this is conservative, as explained in Section 5.1 of Appendix E3 for the Southwest Waste Dump. A swale is also proposed to carry the water collected on the top surface down the slope. This swale has been designed to flow over the slope and transition to a channel with the same base width, but with 3H:1V side slopes. The swale on the top are proposed to be protected with vegetation, while the slopes are proposed to be armoured with a gravel to cobble sized rip rap. Rip rap thickness and final dimensions are yet to be determined.

The Main Pit Dump will be covered with a 0.5 m thick single layer soil cover constructed from reclamation soil materials from the Reclamation Overburden Dump or other local sources, and revegetated using appropriate revegetation techniques as described in Section 7.4.1 for the MWD.

7.4.3.1 SAT Dump

The SAT dump is located in the southwest corner of the Main Pit and was designed to receive the SAT waste rock (NP:AP <3) from mining of Minto North Pit- construction began in Q1 2016 and ended in 2017 with completion of mining in Minto North Pit. The storage of this type of waste in an environment that is eventually saturated is a condition of the WUL. The concept was to dump the SAT waste as a single lift (about 16 m thick) in the southwest corner of the Main Pit, on top of the existing tailings and lapping onto the existing in-pit dump. A detailed stability assessment was completed, confirming the feasibility of this concept (SRK 2016b). The crest of this dump will have a target elevation of 786 masl, which coincides with the spill elevation of the Main Pit lake. To comply with the requirement for saturated deposition the SAT waste stored above the 786 m elevation will need to be relocated to a final saturated location.

Other than for safety reasons during construction, failure of the SAT dump foundation or slopes is not a concern, it being entirely below the water level of the Main Pit lake. No additional reclamation activities are required for this dump.

7.4.4 Mill Valley Fill Extension

The Mill Valley Fill is located east of the Main Pit and north of the DSTSF, with its extension occupying the Minto Creek valley downstream further to the east, as described in Section 5 (Figure 7-3). The MVFE was constructed in two stages, for the purpose of buttressing the DSTSF. Monitoring of the DSTSF had shown rates of movement slowing down since the Mill Valley Fill Extension Stage 1 but the movement had not ceased completely, and in 2013 additional investigations and engineering design was undertaken to support the design of an additional stage of buttress construction. The Mill Valley Fill Extension Stage 2 (MVFES2) added more rockfill to the existing buttress both vertically and to the east, and is expected to improve the long-term stability of the DSTSF. Construction of the bulk material placement of the MVFES2 was completed in July 2016 and grading of the final surface has begun.

The top surface of each tier will be graded in roughly a north-south direction to create roughly a 2% grade toward the north (towards Conveyance Channel E). An access road will be built into the final surface of the MVFE Stage 2 to allow for site access post-closure.

Stability monitoring of this dump is ongoing and results reported in the Annual Reports. Monitoring will continue in the closure and post-closure stages (Section 7.12), until a risk assessment or some other approach determines that monitoring is no longer required.

The entire surface of the MVFE will be covered with a 0.5 m thick single layer soil cover. Surface runoff will be directed primarily to the west and north and will report in Conveyance Channel E.

The Mill Valley Fill Extension Stage 1 and 2 were designed with closure in mind. The top surfaces were generally graded to shed water towards the north.

There are three main terraces to the waste dump. The first westernmost terrace will require some effort to re-grade so that water is directed to the west, rather than to the north. The middle terrace is proposed to be graded north and will also convey water shed off the DSTSF (through constructed swales). The eastern terrace is proposed to be graded to shed water off to the north-west. The downstream slopes of the Mill Valley Fill Extension have been completed and closure cover placement has already begun. Closure cover placement and spreading has also begun on the top surfaces of the dumps.

Closure cover placement on the MVFE is mostly complete, with final grading and cover placement confirmed at 0.5 m thick placed along all slopes as well as all surfaces. Slopes have been revegetated as of 2018, however the final grading of surface cover has yet to be completed.

There are three main terraces to the MVFE. The first westernmost terrace will be graded so that water is directed to the west, rather than to the north. The middle terrace is proposed to be graded north and will also convey water shed off the DSTSF (through constructed swales). The eastern terrace is proposed to be graded to shed water off to the north-west. Remaining work to be completed includes:

- additional design work related to final local drainage network details;
- swale construction; and
- ongoing monitoring and implementation of revegetation plans on surface structures (including tree seedling planting).

Consistent with other facilities, a minimum cover thickness of 0.5 m is proposed and localized areas may require additional grading to meet design grades. Design grades may be achieved through the placement of either waste rock, or overburden based on Minto's scheduling plans.

To shed water, the top of this facility was separated into three small catchment areas, controlled by the surface area of each dump terrace. These catchment areas are illustrated in the detailed hydraulic analysis information contained in Appendix E3. Consistent with the other facilities, the intent is to minimize the amount of water that flows directly over the slope as sheet flow. All three of these small catchments would be constructed to direct water into a broad swale, currently considered to be 2 m wide at the base, and have side slopes of 10H:1V. The swales were designed based on contributing watershed area, and flow depths of approximately 0.19 m to 0.39 m during a 1:200 year 24-hour flood event. The reported depths are double that of the calculated depths to allow for ice accumulation; this is conservative, as explained in Section 5.1 of Appendix E3 for the Southwest Waste Dump.

Consistent with the design philosophy employed with the other facilities, the swales have been designed to flow over the slope and transition to a channel base width equal to that of the swale on the top surface with 3H:1V side slopes. The swales on the top are proposed to be protected with vegetation, while the slopes are proposed to be armoured with a gravel to cobble sized rip rap. Rip rap thickness and final dimensions are yet to be determined. The proposed re-grading and swale locations are illustrated in Figure 7-3.

As discussed in Appendix E3, soil loss due to erosion caused by overland sheet flow can impact the integrity of the cover. However, it is proposed that the revegetation concepts described in Appendix E3 be implemented on the slopes to minimize erosion, and increase the rate of success for revegetation. The proposed slopes are 3H:1V or shallower, and therefore physical stability of the cover is not anticipated to be problematic.

The proposed plan includes approximately 71,300 m3 of cover material, all of which has already been hauled to the dump.

The regraded MVFE will be covered with a 0.5 m thick single layer soil cover constructed from reclamation soil materials from the Reclamation Overburden Dump or other local sources, and revegetated using appropriate revegetation techniques as described in Section 7.4.1 for the MWD.

7.4.5 Reclamation Overburden Dump

The reclamation overburden dump (ROD) is located to the west of the MWD and north of the SWD. The ROD is not expected to be expanded during the Phase V/VI Expansion activities. The existing portions of the ROD have been constructed in accordance with EBA's Geotechnical Design, Proposed Reclamation Overburden Dump, Minto Mine, Yukon (EBA 2008a), and subsequent revisions.

The overburden materials stockpiled in the ROD will be used as a source for growth media during reclamation of other facilities at the site. Any overburden remaining in the ROD after closure and reclamation has been completed will be resloped to minimize erosion and revegetated using appropriate revegetation techniques as described in Appendix E3.

7.4.6 Ice-Rich Overburden Dump

The ice-rich overburden dump (IROD) was located south of the ROD and has been constructed immediately upgradient of the SWD. Grading of the IROD and adjacent areas of the SWD has resulted in a single landform, and for practical purposes the IROD no longer exists. Reclamation of the graded IROD footprint is nearly complete and will be finished as described in Section 7.4.2.

7.4.7 Ridgetop South Backfill Dump

The design of the Ridgetop South Pit Backfill Dump final grading is based on the permitted design of the dump. As excavation of the pit, and construction of the dump has not yet started, the configuration of the as-constructed dump is not yet known. Remaining work to be completed includes:

- Additional planning and design work, using as-built dump surface details;
- Cover placement; and
- Detailed planning and implementation of revegetation plans.

Consistent with the other waste dump designs, a minimum cover thickness of 0.5 m is proposed across this facility. Localized areas may require additional grading to meet design grades, and the decision to achieve final grades by grading waste rock or off-spec overburden, or by using suitable cover material will be determined based on Minto's scheduling plans. It may be determined that suitable cover material for this dump will be residuum, which is consistent with the natural soils surrounding the dump.

To shed water, the top of the Ridgetop South Pit Backfill Dump is anticipated to shed away from the dump, to the west. An estimate of the catchment areas and swale sizing is provided in the hydraulic analysis information contained in Appendix E3. Consistent with the designs for the other waste structure, the catchment would be constructed to direct water into a broad swale, currently considered to be 2 m wide at the base, and have side slopes of 10H:1V. The swale was designed based on contributing watershed area, and the flow depth was estimated to be 0.22 m during a 1:200 year 24-hour flood event. The reported depth is double that of the calculated depths to allow for ice accumulation; this is conservative, as explained in Appendix E3 for the Southwest Waste Dump. The swales on the top are proposed to be protected with vegetation. Details regarding the hydraulic designs of these swales are provided in Appendix E3.

The Ridgetop South Pit Backfill Dump design has not been finalized. However, to ensure that here is appropriate cover material allocated for scheduling purposes, the proposed re-grading design was used to estimate the volume of cover material that may be required. The Ridgetop South Pit Backfill Dump p is estimated to require approximately 16,500 m3 of cover material. Grading and cover placement would be followed by revegetation using appropriate revegetation techniques as described in Section 7.4.1 for the MWD.

7.4.8 Ridgetop Waste Dump

The design of the Ridgetop Waste Dump final grading is based on the permitted design of the dump. As construction of the dump has not yet started, the configuration of the as-constructed dump is not yet known. Remaining work to be completed includes:

- Additional planning and design work, using as-built dump surface details;
- Cover placement; and
- Detailed planning and implementation of revegetation plans.

Consistent with the Southwest Waste Dump cover design, a minimum cover thickness of 0.5 m is proposed across the facility. Localized areas may require additional grading to meet design grades, and the decision to achieve final grades by grading waste rock, or using overburden will be determined based on Minto's scheduling plans.

To shed water, the top of the Ridgetop Waste Dump is proposed to be split into three small catchment areas that direct water away from the slopes of the dump towards natural ground at the eastern side of the dump. These catchment areas are illustrated in the detailed hydraulic analysis information contained in Appendix E3. The intent is to minimize the amount of water that flows directly over the slope as sheet flow. Each of these small catchments would be constructed to direct water into a broad swale, currently considered to be 2 m wide at the base, and have side slopes of 10H:1V. The swales were designed based on contributing watershed area, and flow depths are anticipated to range between 0.18 m and 0.37 m during a 1:200 year 24-hour flood event. The reported depths are double that of the calculated depths to allow for ice accumulation; this is conservative, as explained in Section 5.1 of Appendix E3 for the Southwest Waste Dump. The swales on the top are proposed to be protected with vegetation. Details regarding the hydraulic designs of these swales are provided in Appendix E3.

No swales have been designed along the slopes of the dumps as there is no designed catchment to route along the slopes of the dump.

The proposed re-graded facility is illustrated on Figure 2 of Appendix E3. The Ridgetop Waste Dump is estimated to require approximately 194,500 m^3 of cover material. The proposed slopes are 3H:1V or shallower, and therefore physical stability of the cover is not anticipated to be problematic.

Grading and cover placement would be followed by revegetation using appropriate revegetation techniques as described in Section 7.4.1 for the MWD.

7.4.9 Area 118 Backfill Dump

Construction of the Area 118 Backfill Dump began with backfilling of Area 118 Pit with overburden during mining of Area 2 Stage 3 Pit beginning in early 2017 (Figure 7-3). As noted in Section 5.2.2.8, all backfill to date has consisted of thaw-stable overburden. The facility will receive additional overburden from mining of Ridgetop North and Ridgetop South pits.

The Area 118 Backfill Dump may be used as a source for overburden for cover materials during reclamation if needed. Reclamation of the Area 118 Backfill Dump itself after completion of any closure borrow activities will include grading of the remaining overburden to leave final slopes flatter than 3H:1V, followed by revegetation using appropriate revegetation techniques as described in Section 7.4.1 for the MWD.

7.5 Ore Stockpiles and Pads

The Phase V/VI mine plan includes the milling of all stockpiled ore prior to final closure. The following stockpiles at the site (Figure 5-2) will be treated in this fashion and therefore are not deemed to be an issue at closure:

- High and medium grade sulphide ore stockpiles and pads (located south of the mill); and
- Low grade sulphide ore stockpile and partially-oxidized ore pad (located between the Main 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 ore stockpiles have been inspected annually 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 after removal and milling of all stockpiled ore materials. Geochemical characterization will be conducted to determine the need for removal of stockpile base materials to limit long term metal leaching. If indicated by the geochemical characterization results, material will be removed and disposed of in pits or in waste dumps prior to cover placement. The remaining footprint would be graded as required to fit in to the closure surface water management system. Revegetation of the remaining footprint will be carried out through placement of appropriate overburden material as growth medium and seeding or direct planting as per similar reclamation land units on site.

For costing purposes, we have assumed that the following reclamation activities will be done in areas of existing and former ore stockpiles:

- Relocation of all existing ore inventory to the in-pit tailings management facilities;
- Characterization of stockpile base material through test pitting and laboratory analyses;
- Assume removal of 0.5 m of material from the entire footprint, and disposal of this material in the Main Pit as a traffic surface on subaerial tailings prior to cover placement;
- Grading of stockpile area footprints to achieve surface water management objectives;
- Placement of 0.5m of overburden material to support revegetation;
- Revegetate using the same techniques as used for other reclaimed areas of the site.

7.6 Water Management Structures and Systems

7.6.1 Closure Water Management Concept

The closure water management concept is based on developing a post-closure conveyance network that routes water from the mine site to lower Minto Creek (**Figure 7-7**) for the range of possible flow conditions, with passive wetland water treatment for flows below a volume limit of 3,000 m^3/day.

In addition to the conveyance system, three reservoirs will be present in active closure and post closure periods. Two of the reservoirs, the Main Pit Lake and the Area 2 Pit Lake will remain in perpetuity while the third one, the Water Storage Pond, will be decommissioned and the dam deconstructed in the post-closure period.

The following points summarize the planned sequence of management activities beginning with the end of the operational period and extending to Post-Closure II.

- Active Closure (Closure years 1 through 3): construction of closure conveyance network and wetland treatment systems, and filling of open pits as water reservoirs. The Water Storage Dam will be lowered, with excavated materials used in construction of the Minto Creek Constructed Wetland Treatment System (CWTS). A reservoir will be retained behind the lowered Water Storage Dam for control of water during commissioning of the CWTS. Operational Water Quality Objectives and Effluent Standards will apply and active water treatment capability will be retained and is expected to be the primary source of discharge.
- Post-Closure I (Closure years 4 through 8): According to the water balance active water management will be required during a period of commissioning of the water conveyance network and the CWTS. The CWTS will treat typical summer flows (up to 3,000 m^3/day) with discharge of the CWTS effluent monitored and managed by pumping, either as pumped discharge if effluent standards are met or as pumped water return to the inlet to the wetland or to water storage in pits if effluent standards are not met. High flows in excess of 3,000 m^3/day will report to a High Flow Bypass Channel that reports to Minto Creek below the lowered Water Storage Dam. Operational Water Quality Objectives and Effluent Standards will apply during the Post-Closure I commissioning period, and active water treatment capability will be retained and is expected to

be available for use as required to manage on-site water inventory. Transition to Post-Closure II will occur when:

- commissioning monitoring shows that the conveyance system and the CWTS are performing as expected (see Section 7.6.5.1); and
- Key water quality objectives are attained (see Section 3.1.3.1.4)..

It should be noted that the estimated schedule for filling the Area 2 Pit Lake does not define the end of the Post-Closure I. If the water quality and water balance reviews during Active Closure or Post-Closure I determines that it is prudent or useful to delay the filling of the Area 2 Pit then diversions (or treatment) and discharge of water that meets water quality licence limits will be considered.

- Post-Closure II (Closure years 9 through 18): passive water management with verification monitoring of the water conveyance network and the CWTS. Post-closure Water Quality Objectives and operational Effluent Standards will apply during the Post-Closure II verification monitoring period, and active water treatment capability will be retained as a contingency.

The Area 2 and Main Pit Lake water levels are both expected to have reach the spillway invert levels around the time of transition from Active Closure to Post-Closure I. In Post-Closure II, water from the two reservoirs will be allowed to flow freely via the water conveyance network.

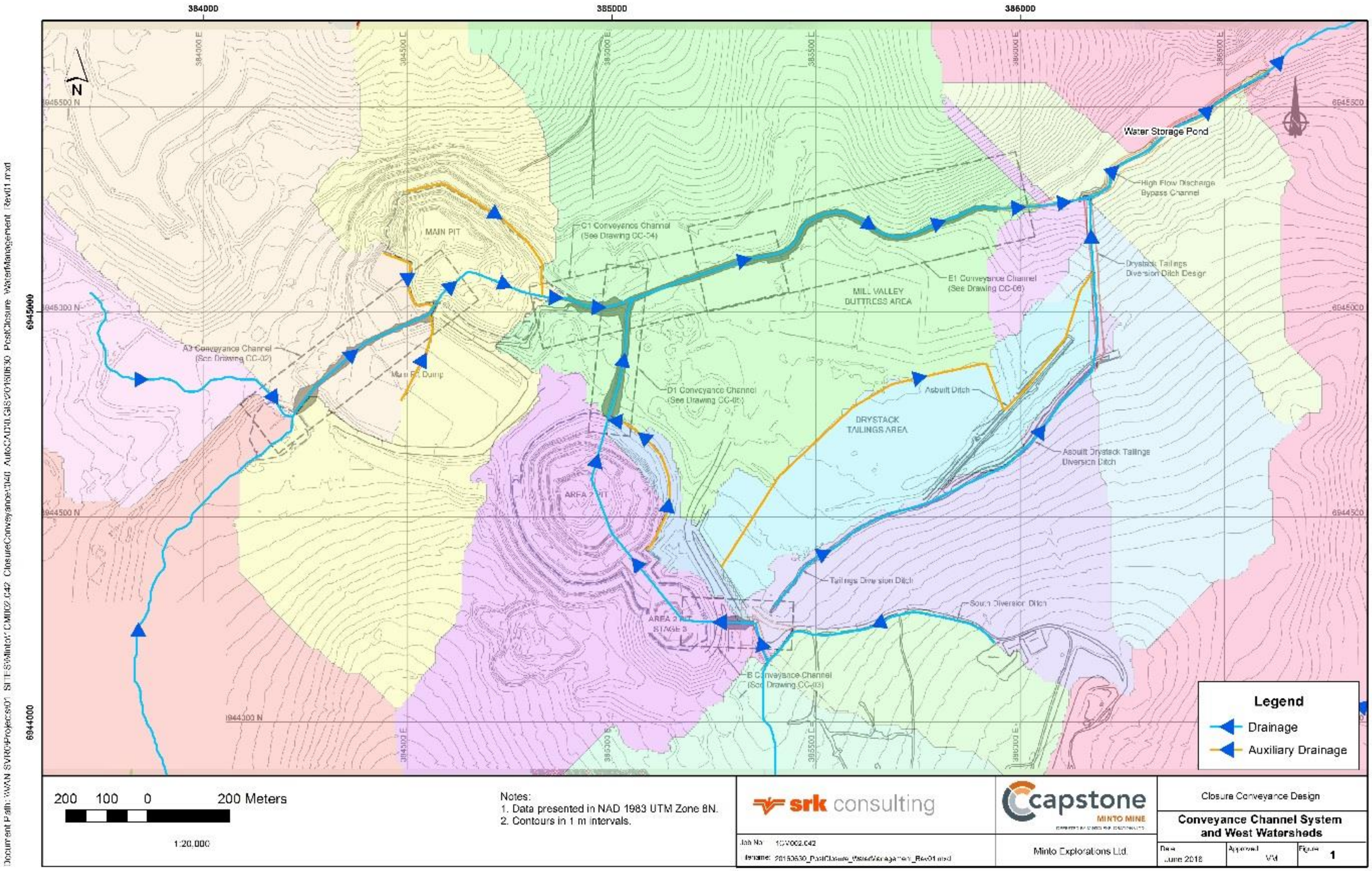


Figure 7-7: Water Management Catchments and Layout

7.6.2 Water Conveyance Channels

The general arrangement of the network of primary closure conveyance channels and respective watersheds are shown on **Figure 7-8**. The network comprises the following:

- Conveyance Channel A: located Southwest of the Main Pit, between the Main Pit Waste Dump and the SWD. This channel conveys surface water from the W15 tributary over the South Wall Buttress to the Main Pit.
- Conveyance Channel B: located East of the Area 2 Stage 3 Pit (A2S3). This channel collects surface water that reports to the W35 tributary and conveys the flow to the A2S3 pit.
- Conveyance Channel C: begins at the discharge of the Main Pit. Channel C conveys the discharge from the Main Pit, and is combined with flow from Channel D, to form Channel E1.
- Conveyance Channel D: begins at the spill point of Area 2 Pit and conveys the discharge water to the confluence with Channel C.
- Conveyance Channel E: commences at the confluence between channel C and D and is essentially a realignment of the former Minto Creek; it consists of three sequential channels: E1, E2, and E3 (from upstream to downstream). Channel E ultimately conveys water from the Main Pit and the Area 2 Pit to the Constructed Wetland Treatment System in the current Water Storage Pond area.
- High Flow Bypass Channel: commences at the north end of the Tailings Diversion Ditch and runs east-northeast along the south side of the Minto Creek valley, through the footprint of the Water Storage Dam, and discharges to lower Minto Creek. During high flow events, it will receive bypass water from Conveyance Channel E to the extent that flows exceed the inlet controls for the Constructed Wetland Treatment System.
- South Diversion Ditch (SDD): this structure has now been mined out through Area 2 Stage 3 mine development. Former SDD flows now report to the TDD.
- Tailings Diversion Ditch (TDD): was constructed in 2008 and upgraded in 2014 to divert surface water south of the DSTSF to a wooded area east of the facility (SRK 2014b). A further extension has been designed to convey water from the end of the current ditch down to the High Flow Bypass Channel and subsequently to lower Minto Creek, and it will be constructed during Active Closure.

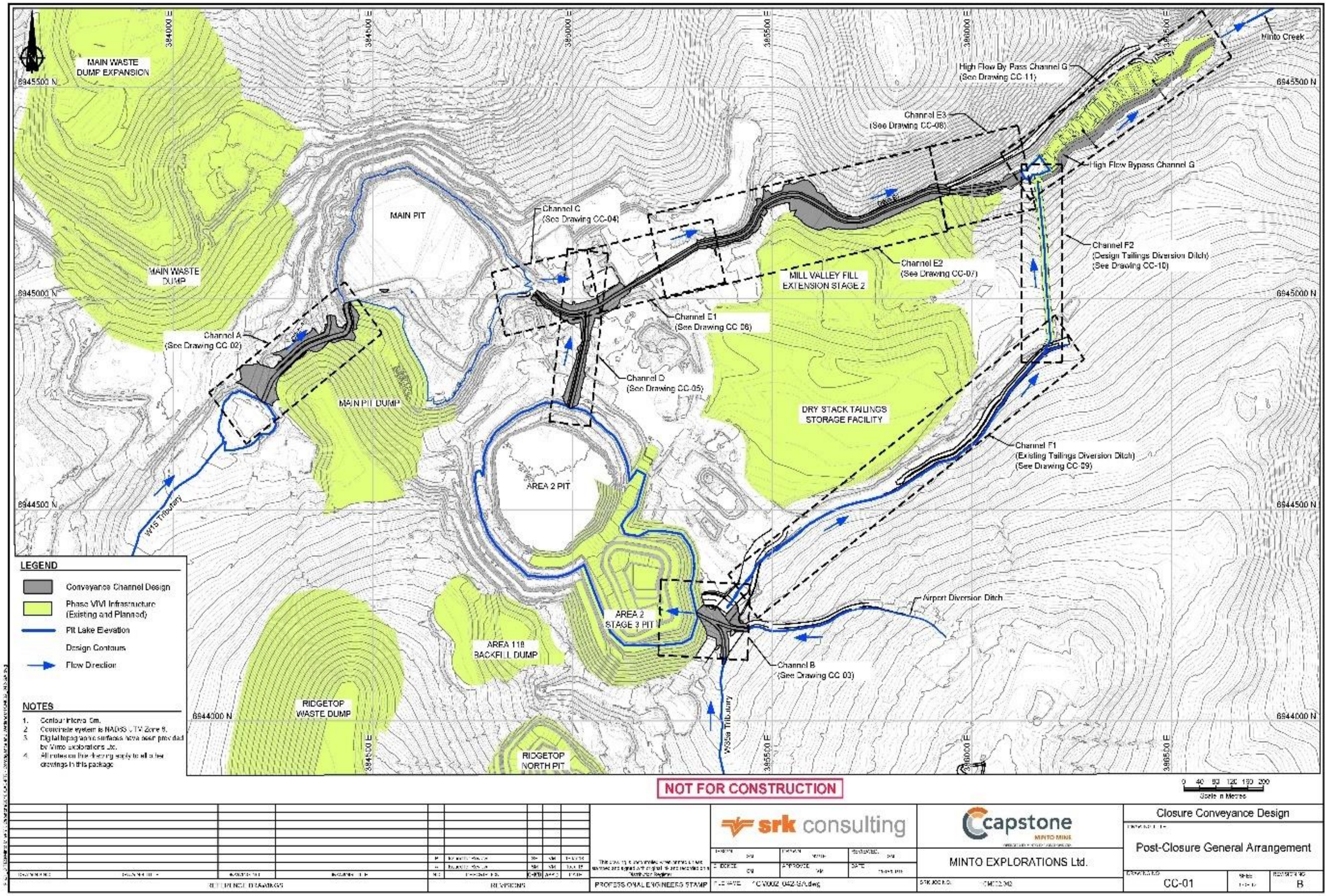


Figure 7-8: Post-closure Primary Water Conveyance System

7.6.3 Water Reservoirs

Three water reservoirs will exist on site at closure: the Main Pit Lake, the Area 2 Pit Lake, and the Water Storage Pond. The two pit lakes will remain in perpetuity and will act as flow-through systems, providing sediment settling and retention capacity. During Active Closure and Post-Closure I, water flowing from the Min Pit Lake will be pumped to the Area 2 Pit Lake or conveyed to the CWTS via channels C and E. No further closure activities are anticipated in relation to these reservoirs.

The location of the Water Storage Pond relative to other site developments is shown in Figure 5-2. The dam on Minto Creek provides water retention for site-wide contact water and is considered to be the furthest downstream point for discharge control at the site. During Active Closure, the dam will be lowered to allow construction of the Constructed Wetland Treatment System and the High Flow Bypass Channel, but will continue to store a limited volume of water to facilitate the Post-Closure I water management strategy described in Section 7.6.1. At the end of Post-Closure I, the dam will be fully decommissioned. Physical stability of the Water Storage Dam will be ensured during post closure by regular geotechnical inspections until such time as the dam is declassified.

7.6.4 Closure of Water Retention and Conveyance Structures

The long term water retention structures are limited to the two former pits, i.e. MPTMF and A2PTMF. As such, no additional closure activities are required in relation to the closure of these facilities. The conveyance channels were designed with robustness and low maintenance in mind, so it is expected they will function as intended into the post-closure period. Regular inspection after construction and throughout the closure period will be completed, with maintenance completed on an as-needed basis following the recommendations of the qualified inspector. Once stable conditions were achieved, time between inspections will be gradually extended and eventually inspections will be suspended.

7.6.5 Wetland Treatment Systems

7.6.5.1 Minto Creek Constructed Wetland Treatment System

Passive water treatment is planned for post-closure at the Minto Mine, with a focus on the constituents of cadmium (Cd), copper (Cu), and selenium (Se). Minto has commissioned the development of a constructed wetland treatment system (CWTS), which is being designed through a phased approach.

The Preliminary Design Report for Treatment Wetlands (Appendix G1) outlines the basis for the technology selection and conceptual design, and presents preliminary design of the CWTS based on findings from information gathering, site assessment, off-site pilot-scale, and on-site demonstration-scale phases.

The design report (Appendix G1) specifically considers water treatment by a CWTS within the footprint of the water storage pond. The preliminary design of the CWTS described in the design report is a surface flow wetland, designed to maintain anaerobic conditions in the sediment to sequester cadmium and copper in sulphide mineral form, and selenium in a low bioavailable elemental form. The phased plan for site-specific design and optimization has demonstrated that these elements can be successfully and sustainably treated using this apporach at the Minto Mine. Rigorous monitoring and adjustments to the operation of the CWTS is expected during an initial commissioning period. The commissioning period will be considered complete when:

- Plant establishment and maturation such that the plants have grown into **densities that provide > 80% coverage with plants in a monoculture**;
- Establishment of reducing conditions within the CWTS (i.e., average soil redox is below -100 mV); and
- Microbial population establishment and maturation to levels similar or better to the demonstration-scale test system **based on genetic testing**.

Requirement for monitoring and maintenance are expected to diminish as the CWTS matures through early- and long-term operation.

Figure 7-9 shows the treatment wetland configuration and preliminary design. Further information on the engineering design for the treatment wetland can be found in Appendix G1.

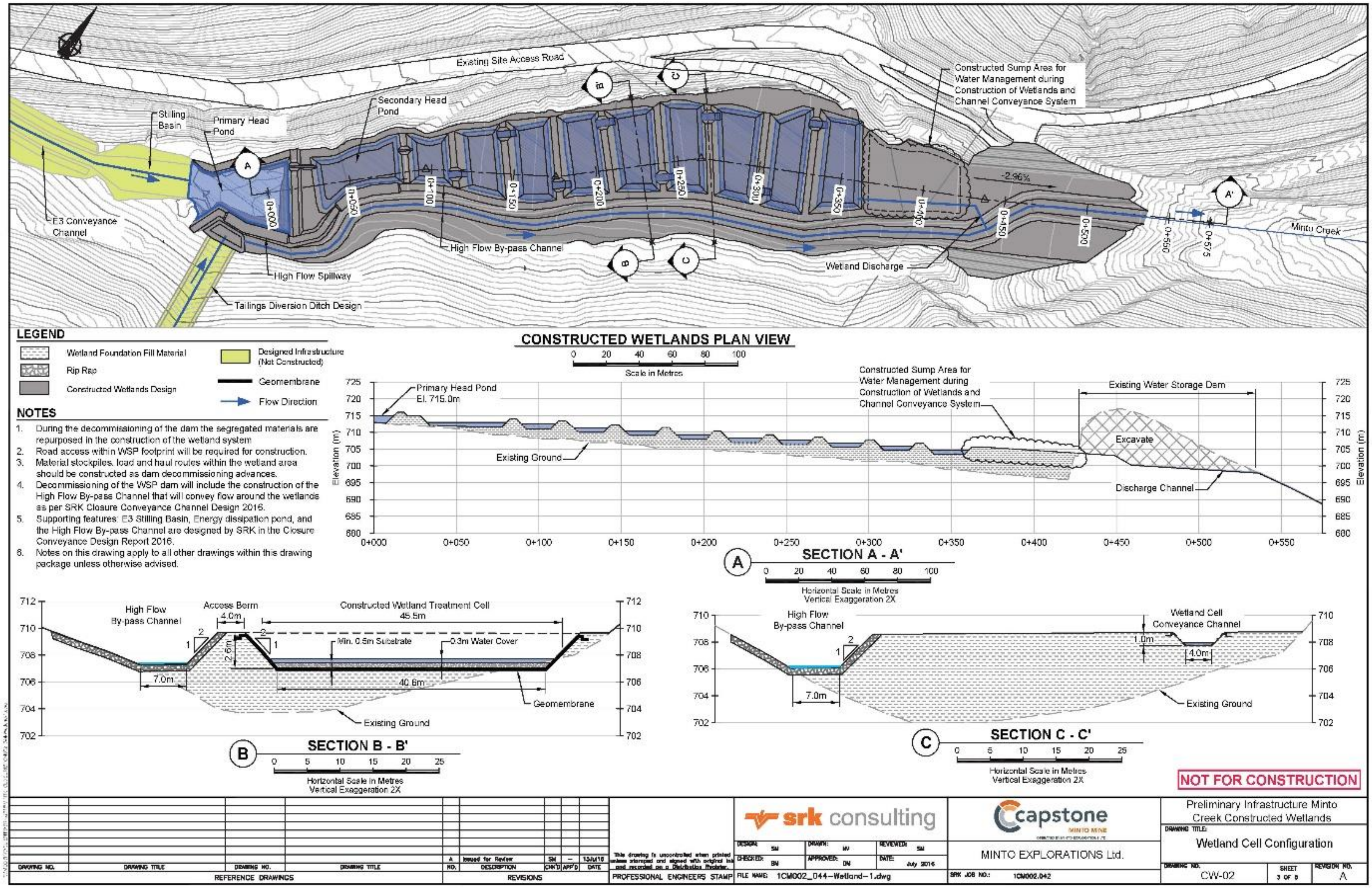


Figure 7-9: Minto Creek Constructed Wetland Configuration

7.7 Mine Infrastructure and Equipment

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

- Mine camp and related infrastructure;
- Mill building and related infrastructure;
- Fuel Farm area;
- Sewage treatment plant;
- Water treatment plant;
- Exploration sites and trails;
- Land treatment facility;
- Solid waste facility;
- Explosives plant site; and
- Mobile equipment.

Environmental concerns for these areas will arise primarily from contamination of surrounding soils by fuel, chemicals or other wastes. Such occurrences 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. Decommissioning 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 has been implemented onsite to reduce the volume of scrap that will require disposal in the on-site landfill. The salvage program will continue until the mine end of mine life.

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 and blending the area in with the natural topography as much as possible. Culverts will be removed and natural drainage will be restored where appropriate. Pertinent areas will be covered in a nominal 0.25 metres of overburden as growth media prior to application of seed and fertilizer.

All equipment, furnishings, materials, and residual supplies will be divided into three categories to be treated as follows:

- Salvage: reusable items that retain a value equal to or higher than the cost of decommissioning and delivery to the point of sale;
- Recycle: items that can be disposed of at recycling depos at no costs related to the disposal, but hauling costs must be borne by Minto; and
- Landfill: non-hazardous waste items that require a tipping fee for disposal and it is more practical to dispose of in the on-site landfill;

All controlled substances and hazardous waste are excluded from these categories and will be disposed of in licensed facilities as appropriate (Section 7.8). An overview of the Mill and Camp area are shown in Figure 7-10 below.

7.7.1 Mine Camp and Related Infrastructure

Closure measures for the camp include disassembly of the camp trailers and related infrastructure. All materials will be salvaged, recycled, or landfilled, as appropriate. The remaining camp pad will be scarified and recontoured, as required, to establish drainage patterns and then covered with a nominal 0.25 m of growth media (if required, pending outcome of revegetation studies) and revegetated. Seed mixtures and fertilization specifications will be based on both revegetation trials and natural revegetation observations and success, similar to the approach described in Appendix E3 for waste rock soil covers.

7.7.2 Mill Building and Related Infrastructure

The Mill Complex is located east of the Main Pit and is comprised of several buildings and facilities, including:

- Mill Building;
- Process Building;
- Filter Plant building;
- Concentrate storage shed;
- Crusher and crusher conveyor;
- Mill warehouse;
- Assay lab;
- Mechanics shop; and
- Electricians shop;

Each of these facilities and buildings will be decommissioned and any hazardous waste removed and handled as described in Section 7.8. Equipment will be removed and separated for salvage, recycling, or landfilling. The buildings and structures will be demolished with the resulting scrap steel being recycled or landfilled (depending on market conditions) while the other non-hazardous demolition debris being placed into the on-site landfill. Concrete foundations will be demolished to just below ground level while concrete pads will be broken up to allow water infiltration but otherwise will be left in place. Any sumps or below-grade voids will be backfilled with waste rock or other suitable fill. The footprint of each building will be covered with suitable fill or overburden soils and revegetated as part of the larger disturbed area.

7.7.3 Fuel Farm Area

The fuel farm area was constructed on a bench above the mill complex. The tanks will be decommissioned, drained of any residual fuel and removed from site for salvage or recycling, as appropriate. The liner will be pressure washed, and then cut into manageable pieces and disposed of in the permitted landfill area. A field sampling program will be conducted to determine if any residual fuel contamination areas and estimate the extent of contamination. Affected soils will be excavated and taken to the Land Treatment

Facility for treatment. The area will be regraded to conform to the original topography as much as possible and limit permanent ponding and then it will be revegetated.

7.7.4 Sewage Treatment Plant

The Sewage Treatment Plant will be decommissioned, and the treatment tanks and piping will be flushed with clean water to remove residual treatment sludge. The residual sludge and treated effluent will be disposed of in the Main Pit. The plant will be disassembled and removed from site for salvage.

7.7.5 Water Treatment Plant

The Water Treatment Plant is an integral part of the environmental compliance system with respect to water quality. It will remain operational throughout the Active Closure and Post-Closure I periods, until it is demonstrated that water quality objectives can be generally achieved without the need for active water treatment.

The Water Treatment Plant will eventually be decommissioned, the modules disconnected, and removed from site for salvage or recycling. The WTP building will be demolished- if the permitted site landfill is capped and reclaimed at that time, the resulting demolition debris will be shipped off-site for disposal into a permitted landfill.

7.7.6 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 this plan.

7.7.7 Land Treatment Facility

Minto currently has two permitted land treatment facilities, the first 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 #24-024 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. This facility is currently slated for decommissioning in 2018. See Figure 7-11 for additional detail.

The second LTF was constructed in 2014 near the landfill area and was built using a cut/fill technique and is lined with a plastic geosynthetic liner. This facility is permitted by YG, Department of Environment, Environmental Programs Brach under Permit #24-041 to treat a maximum volume of approximately 1,800 m^3 of hydrocarbon contaminated soil. Contaminated soils from fuel/oil spills during operation will be treated in this facility to appropriate levels of remediation before being used as industrial fill as per permit requirements.

The closure of both of these facilities is subject to the submission of a formal Decommissioning Plan to YG, along with sampling results which demonstrate the final concentrations of contaminants in the soil being treated.

LTF #24-041 is expected to be required through the Active Closure period as 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 Decommission Plan and final sampling results will be prepared and submitted in due time 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 Decommissioning Plan has been approved by YG, the soils will be spread at approved locations at the site and revegetated. If required, additional overburden may be hauled and be used as cover material and growth media for revegetation. The liner will be cleaned by pressure washing, cut into manageable pieces, and disposed of in the on-site landfill (if still operational) or shipped off-site for disposal in a permitted landfill. The LTF footprint will be regraded and the area will be revegetated using appropriate revegetation techniques refined through the ongoing reclamation research program.

7.7.8 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 near the airstrip that includes:

- A burning pit for wood and paper waste;
- Construction waste disposal area (landfill);
- Special Waste storage;
- Metal and rubber tire disposal areas; and
- Incinerator for camp waste.

The solid waste facility will receive construction debris 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.

Following site closure the equipment and materials that have no scrap value will be disposed of in the solid waste facility. Rubber tires and recyclable scrap metal will be hauled off site for salvage/recycling. All special waste and hazardous material will be removed from site and disposed of at licensed facility.

Prior to disposal in the landfill, all equipment will be examined to ensure that all hazardous materials are removed. Any hazardous materials identified will be collected in suitable containers and shipped off site to a licenced waste disposal facility.

The submission of a formal Decommissioning Plan to YG for the solid waste facility will be required at final closure. The formal Decommissioning Plan will document the conditions and materials at final closure.

Once the Decommissioning Plan is approved by YG, the facility will be covered by a soil cover system. The cover will be graded to prevent pooling of precipitation runoff and to encourage the shedding of water.

The entire site will then be revegetated using appropriate revegetation techniques refined through the ongoing reclamation research program. See Figure 7-11 for additional information.

7.7.9 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 all unused explosives, the explosives magazines, and other equipment will be returned to the explosives supplier. The septic system at the site will be emptied, broken down, and backfilled. Any fuel-contaminated soils will be excavated and hauled to the land treatment facility for remediation. Disturbed areas will be recontoured to blend in with local topography and scarified or covered with 0.25 m of overburden, where required. The entire area will be revegetated using appropriate revegetation techniques refined through the ongoing reclamation research program, including determination appropriate measures to establish vegetation directly on the residual soils found in this area. See Figure 7-12 for additional information.

7.7.10 Mobile Equipment

Mobile equipment includes vehicles, production equipment, light plants, compressors, mobile electricity generators, self-contained storage tanks, etc.

All contractor-owned equipment will be removed by the owners. The remaining equipment will be decommissioned and removed from site for salvage or recycling, as appropriate.

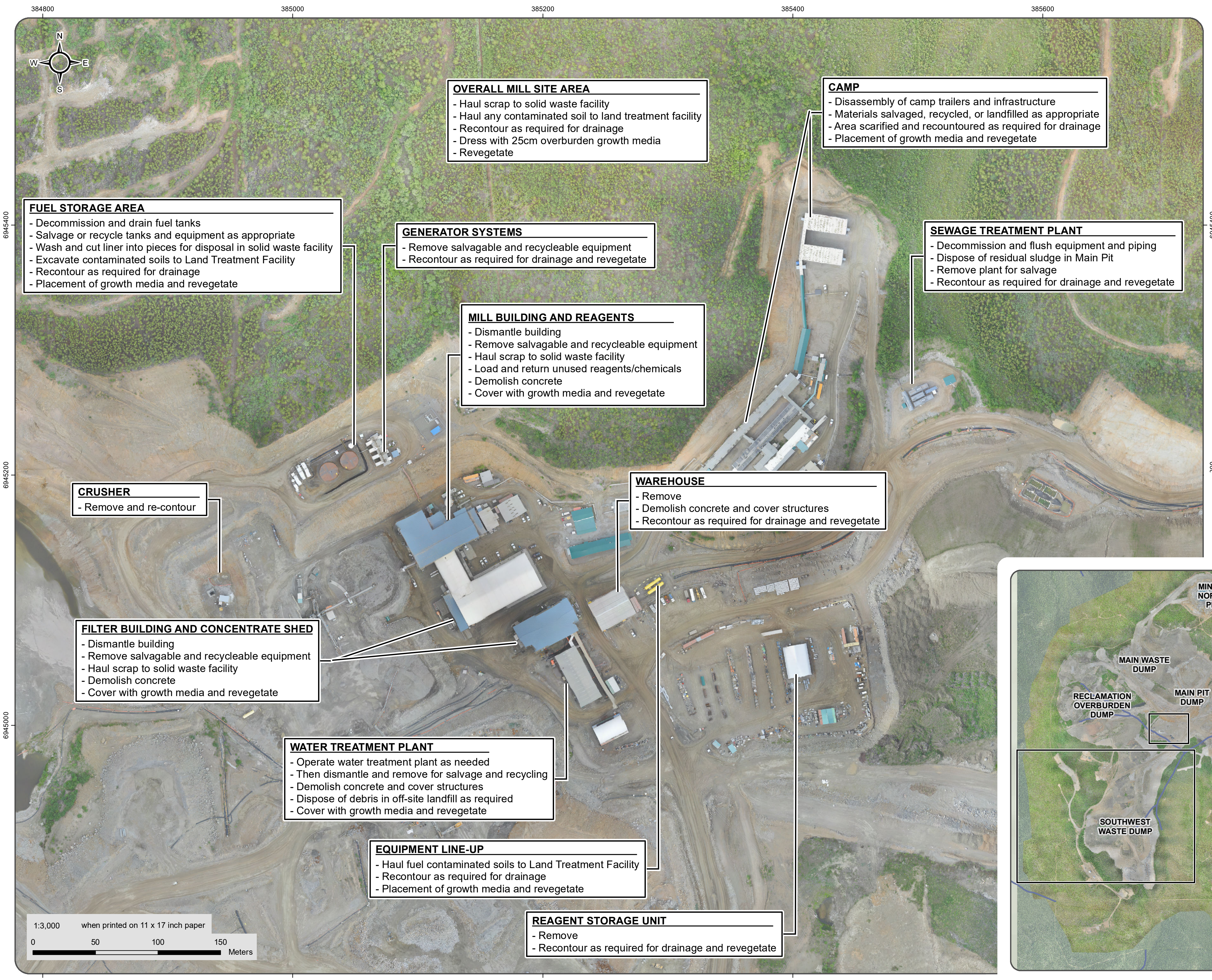
Storage tanks will be decommissioned and the residual fuel or other stored liquids will be drained and placed into suitable drums. The tanks will then be removed from site for salvage or recycling, while the drums will be shipped off-site for salvage or disposal. See Figure 7-13 for overview of Minto South Portal Laydown; see Figure 7-14 for overview of underground shop and laydown area.

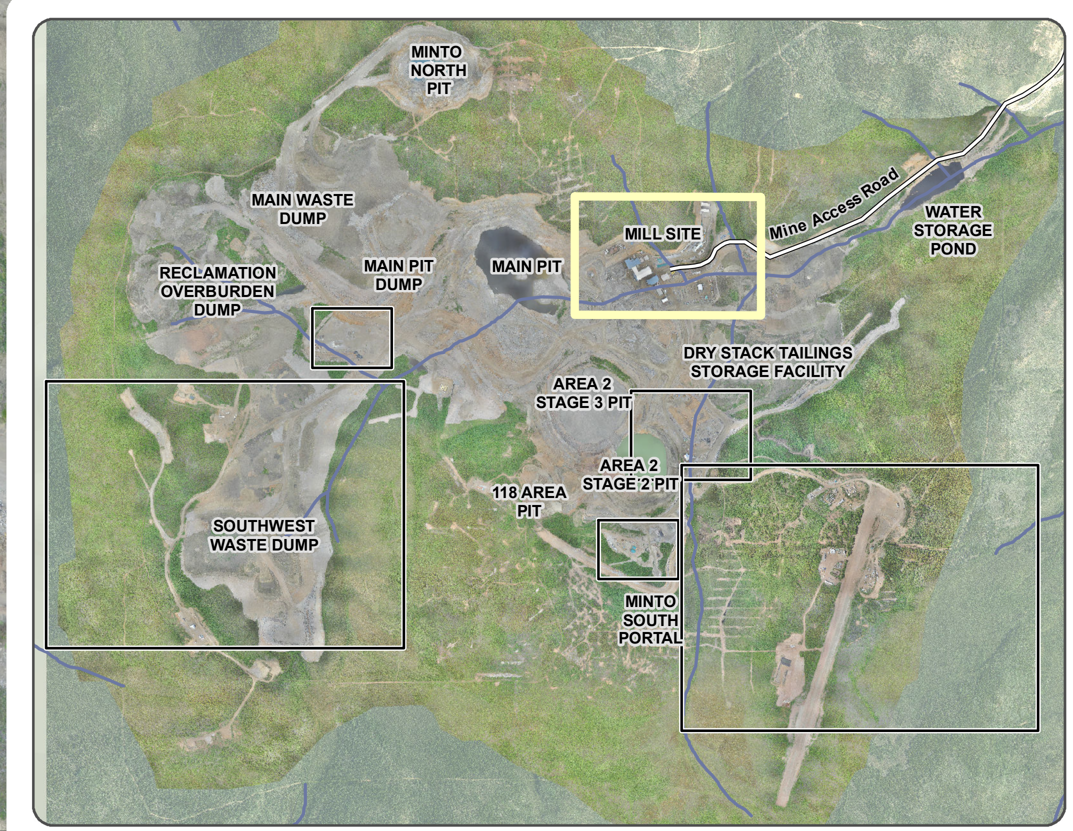
MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 7-10
MILL AND ANCILLARY FACILITIES RECLAMATION MEASURES

NOVEMBER 2020





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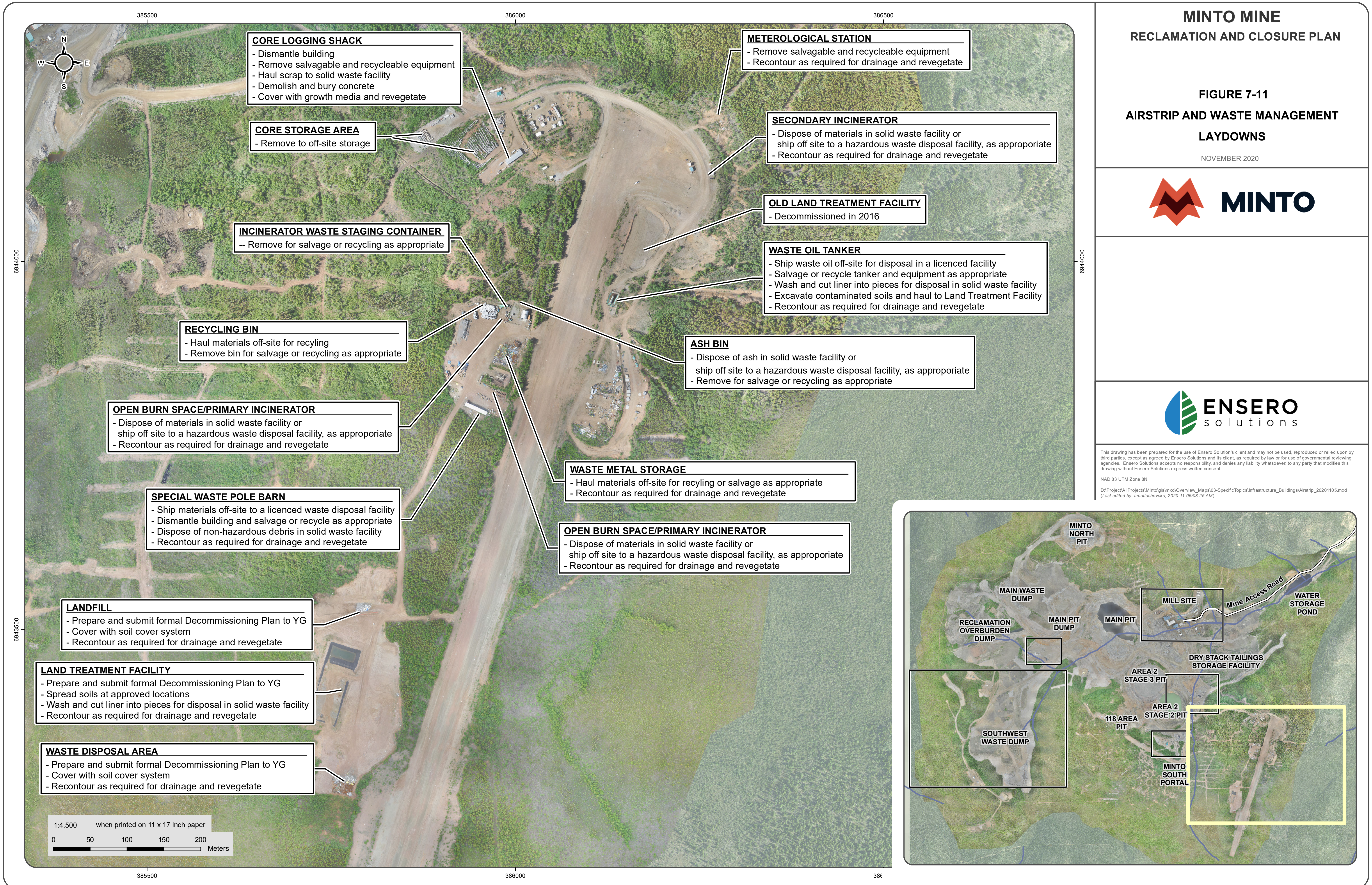

MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 7-11

AIRSTRIP AND WASTE MANAGEMENT LAYDOWNS

NOVEMBER 2020

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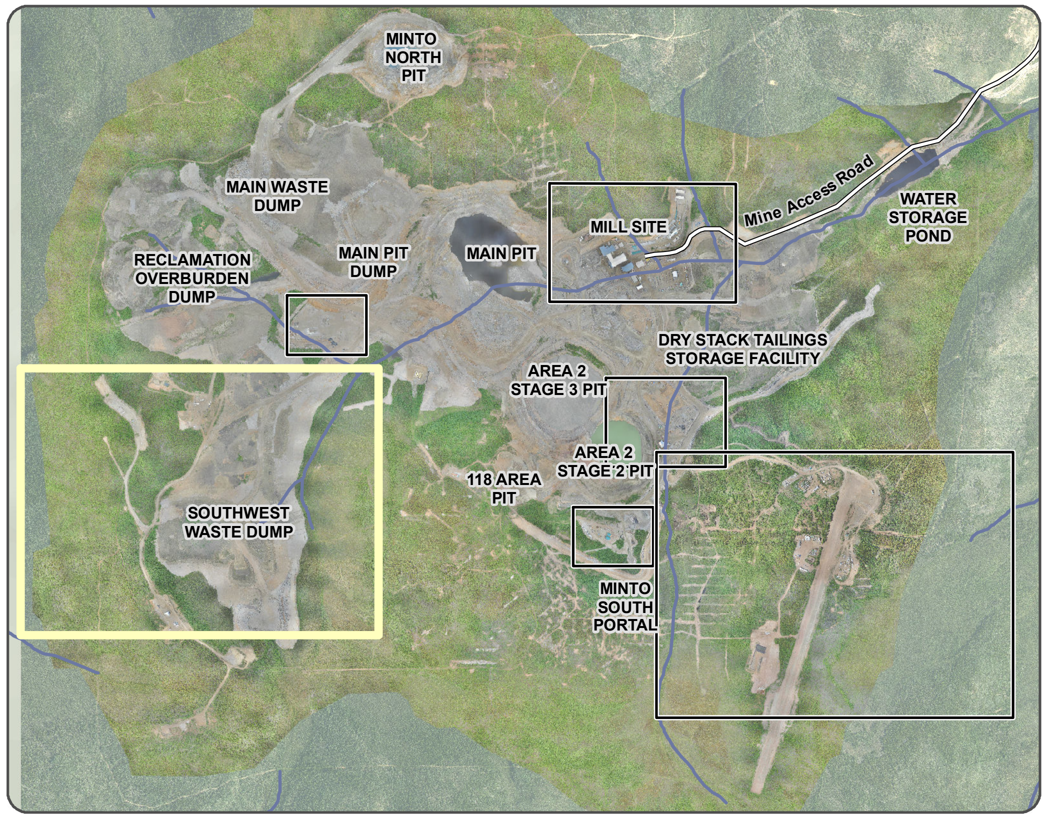
MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 7-12

OVERVIEW OF EXPLOSIVE CONTRACTORS FACILITIES AND LAYDOWNS

NOVEMBER 2020



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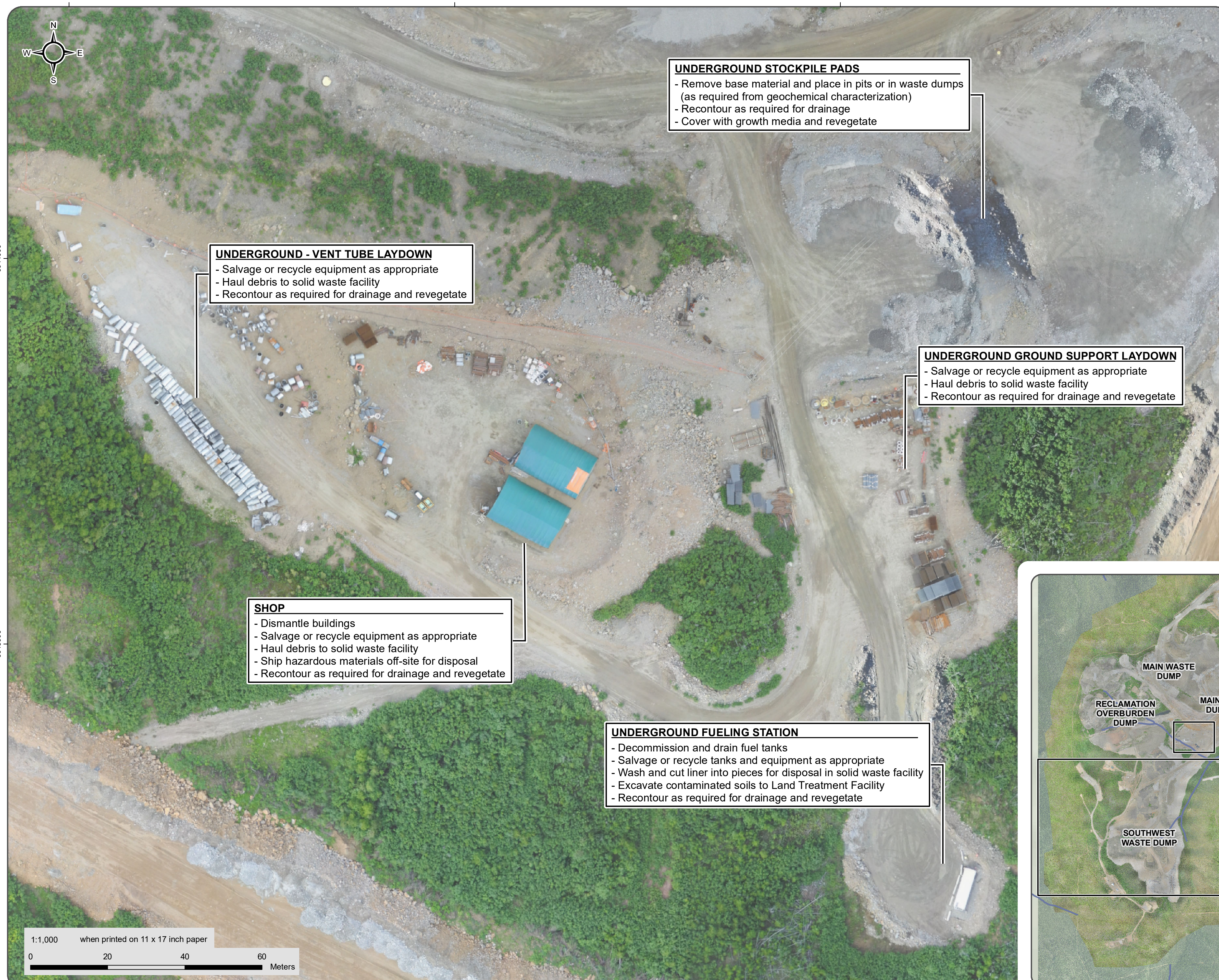

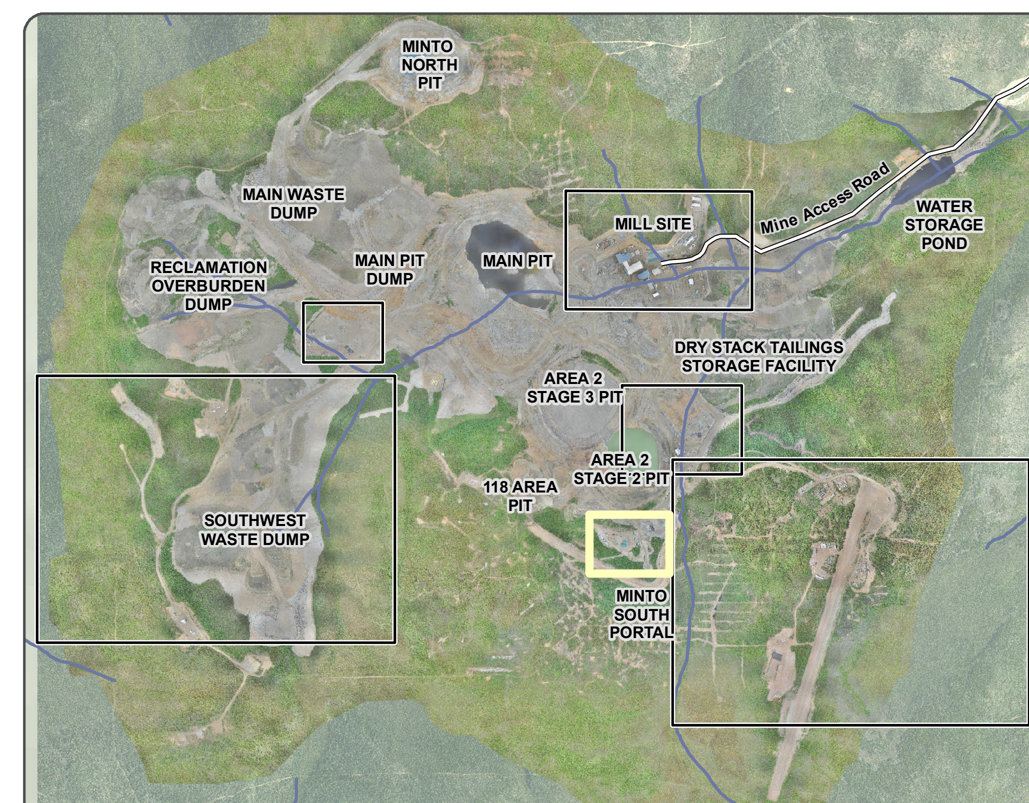

MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 7-13
OVERVIEW OF MINTO SOUTH PORTAL LAYDOWNS

NOVEMBER 2020

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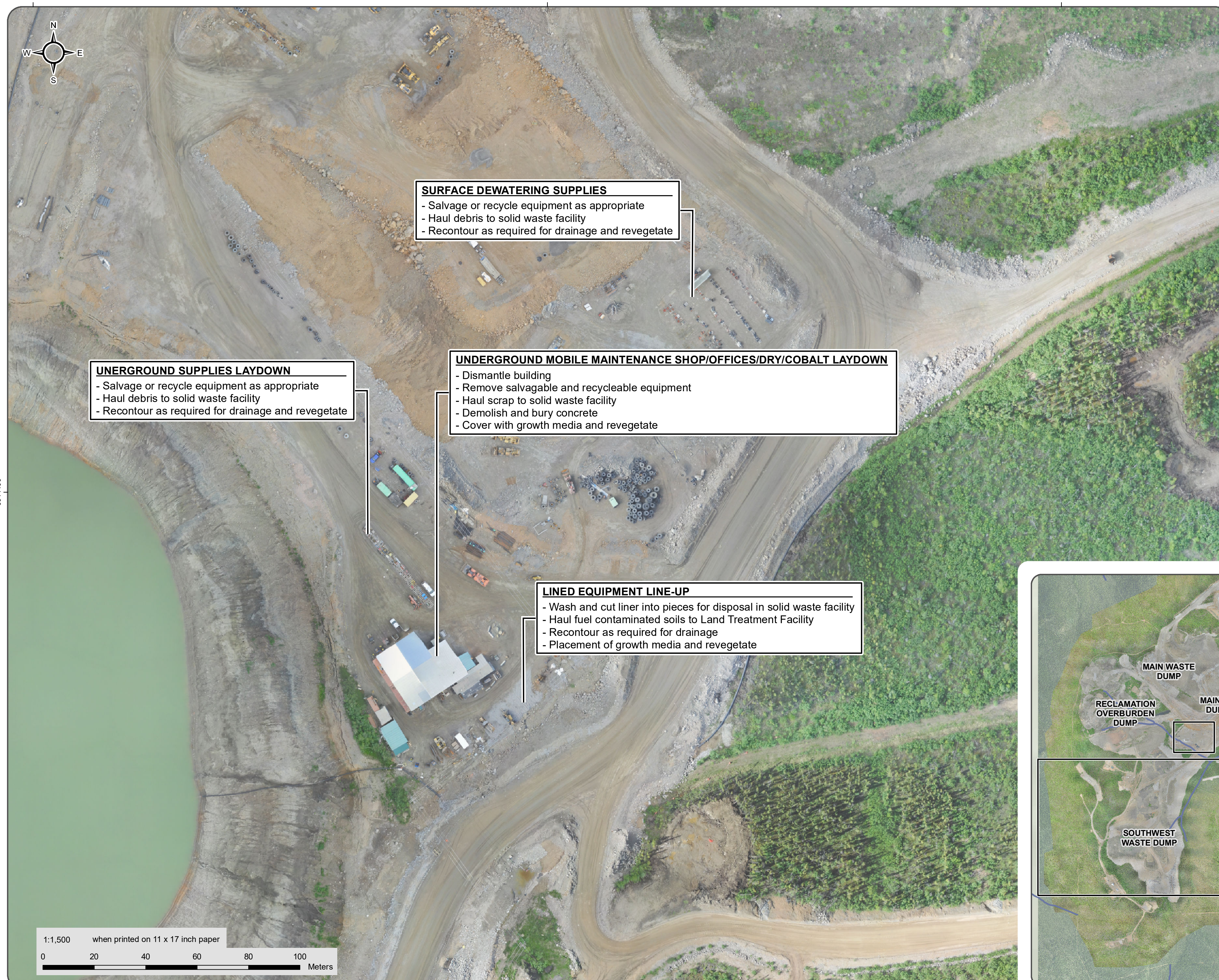

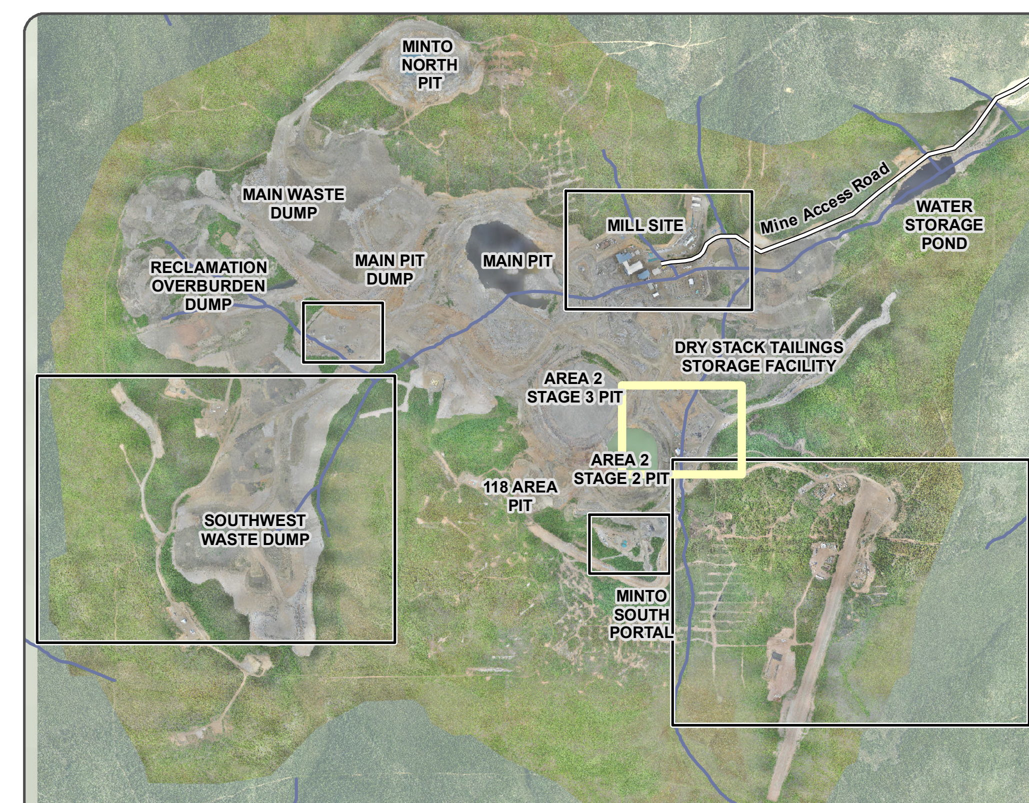

MINTO MINE

RECLAMATION AND CLOSURE PLAN

FIGURE 7-14

OVERVIEW OF UNDERGROUND SHOP AND LAYDOWN

NOVEMBER 2020

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7.8 Hazardous Materials

Hazardous materials will be removed from all buildings and facilities as part of the decommissioning. A comprehensive list of hazardous materials present on site will be compiled based on a review of operating procedures for the various areas and facilities, as well as warehouse inventory sheets. Such wastes may include mill reagents, hydrocarbons, cleaning and household products, automotive fluids, etc. Explosives are discussed in Section 7.7.9 and will be treated as a separate stream.

An estimate of quantities of hazardous materials would be irrelevant at this time as stocks change continuously based on operational requirements; this estimate will be completed once the site begins transition to closure. For closure cost estimate purposes however a total of 27,000 kg was allowed for.

All hazardous materials will be collected and stored in appropriately labeled containers suitable for each type of waste, as recommended by the manufacturers and suppliers of these materials. These containers will then be transported to commercial facilities licensed to dispose of such waste materials. Strict adherence to the specifications of the material safety data sheets (MSDS) will be imposed when handling and transporting these materials.

7.9 Roads and Other Access

7.9.1 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 5-1 shows the alignment of the main access road.

The Main Access Road will remain open throughout the active closure and into post-closure period to provide access for inspections, sampling, and maintenance and repair work. The schedule for the road decommissioning will be determined once the final closure criteria have been achieved. This decision will also 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 the reclamation and closure 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.

7.9.2 Haul Roads

The haul roads on the site connect the open pits 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 that are not needed to support long term monitoring and maintenance will be subject to standard road decommissioning and reclamation measures at closure, including culvert excavation, drainage recontouring, slope stabilization and surface scarification. 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. In the long term establishment of vegetation will provide the primary sediment control.

7.9.3 Airstrip

The airstrip will remain operational into the Active Closure and Post-Closure periods as part of the Yukon emergency landing aerodromes network. No closure activities are required.

7.10 Borrow Materials Planning

7.10.1 Overburden

Overburden for the isolation covers will be obtained from the Reclamation Overburden Dump (Figure 5-2) and from overburden stripped during the development of Ridgetop North and Ridgetop South pit mining operations (Figure 5-6). Overburden from the ROD has been extensively characterized (Appendix E3) and demonstrated to be suitable for use in revegetated isolating soil covers. The site has significantly more overburden available for reclamation than required, with the ROD alone estimated to contain on the order of 4.3 Mm3, available for soil cover construction (refer to Section 5.2.2).

7.10.2 Rip-Rap

The reclamation planning calls for about 50,000 m^3 of durable, geochemically benign rip-rap for lining water conveyance ditches and protecting slopes from erosion due to surface runoff. Rip-rap material will be required at closure ranging in size from D50 of 200mm to D50 >1000 mm.

Geochemically acceptable rock will be sourced from suitable waste rock areas and operations will be set up for screening. Large boulders for use in energy dissipation structures have been opportunistically sourced during operations from the MWDE and Minto North Pit and are stockpiled for later use.

7.10.3 Organics

There are limited readily available sources of organics on-site. Potential sources for incorporation in passive treatment systems are currently being evaluated in connection with ongoing reclamation research. One option currently under consideration includes mulching of locally available trees for incorporation into CWTSs.

7.11 Monitoring and Maintenance

7.11.1 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 includes several types of scheduled periodic inspections to ensure that the facility is meeting environmental performance objectives and is 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 and physical stability 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 monitoring of water levels in wells, the spillway structures at the Main Water Pond Dam (if still in place) and the Minto North Pit;
- Monitoring of other instrumentation installed in the DSTSF as per the Physical Monitoring Plan (thermistors, survey hubs, etc.);
- Annual inspections of the TMF, diversion channel, waste rock and overburden storage areas, and Main Water Pond Dam for structural stability by a qualified geotechnical engineer; 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 Selkirk First Nations and 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, and stream sediment, which are conducted by external qualified specialists. All results are reported to the YWB and YG EMR as monthly or annual reports.

During the active closure period environmental and physical compliance monitoring and inspections will continue as required by the approved EMSRP at the time, utilizing site-based personnel. Prior to entering into Active Closure, Minto intends to refine the monitoring requirements which could include a reduction of monitoring. Also, 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 monitoring and inspection programs detailed in an approved EMSRP 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.

The schedule for monitoring programs planned for the 18-year period (20 years including a 2 year interim period) immediately following cessation of active mining and milling operations are presented in Table 7-1 through Table 7-4. For the first 3 years following the cessation of mining/milling, and during active closure and decommissioning, routine operational environmental monitoring will be completed. As noted in the Yukon Government Reclamation and Closure Guidance document an interim period for monitoring, maintenance, permitting and closure planning must be costed. An additional 2 years was added to the active closure period for monitoring to account for the interim period. The Year 4 to 8 period (Post-Closure I) is expected to demonstrate the effectiveness of closure measures and includes monitoring of their performance, but monitoring frequencies would be reduced to periodic inspections. The period spanning years 9 to 18 (Post-Closure II) is considered as the confirmatory period, during which performance monitoring on a further reduced frequency will confirm that closure measures are performing as intended and that closure objectives were successfully achieved (Table 7-1).

During the Post-Closure I period monitoring data from the geotechnical instrumentation will be collected semi-annually, as allowed by site presence for water monitoring activities, while visual inspections by a qualified geotechnical engineer will be completed on an yearly basis. In the Post Closure II period monitoring data collection and visual inspections will coincide, on a 5 year frequency. Transition from Post-Closure I to Post-Closure II is contingent on the facilities performance, as determine by a qualified professional.

The purpose of these periodic inspections would be to ensure that water discharging from site remain compliant, closure and water quality objectives are being consistently met, and physical structures are performing as designed. Should these inspections or monitoring initiatives identify issues of concern, then plans would be developed to address the concerns, as per the AMP. For each element of concern threshold values will be developed to trigger increased monitoring if performance is not satisfactory or to decrease data collection and inspection frequency if closure objectives have been achieved. These threshold values will be determined in consultation with SFN and regulatory stakeholders following completion of the planned closure activities and prior to the post-closure period.

Based on the results of site monitoring for the 18-year post-closure monitoring period and discussions with 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 and geotechnical monitoring, inspections and treatment wetland monitoring conducted during the post-closure periods (years 4-18 after cessation of mining) will be undertaken by site-based staff or during periodic visits to the site. Water sample collection and data downloads from geotechnical monitoring instrumentation will be completed as per Table 7-1 and Table 7-2, while geotechnical inspections and reporting will be completed as per Table 7-3. Treatment wetland monitoring will be completed as per Table 7-4. Access to the property for post-closure monitoring would be by road while the Main Access Road is maintained or via ATV, snowmobile, and/or helicopter after the road is decommissioned.

During the post-closure period, reporting on all environmental and inspection programs carried out on the property will continue (Table 7-3). 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.

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 consider applying 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.

Table 7-1: Post Closure Water Monitoring Program

		YEAR 1-3 FREQUENCY (Active Closure)				YEAR 4 - 8 FREQUENCY (Post Closure I)				YEAR 9 -18 FREQUENCY (Post Closure II)		
SITE	**DESCRIPTION**	**Water Quality**	**Sediment[4]**	**Benthos[4]**	**Flows**	**Water Quality**	**Sediment[4]**	**Benthos[4]**	**Flows**	**Water Quality**	**Sediment[4]**	**Benthos[4]**
	Receiving/Background Water Stations											
W-2	Mainstem Minto Creek directly u/s Access Road Crossing	Monitoring to be carried as per an approved Environmental Surveillance and Reporting Plan				Wd*/M	A2	A2	Wd/M	SSF	A2	A2
W-3	Mainstem Minto Creek - MMER Compliance Point					M	A2	A2	M	SSF	A2	A2
W-7	Tributary to Minto Creek					SSF			SSF	A		
MN-0.5	Lower west arm of McGinty Creek - Reference Station					SSF			SSF	A		
MN-1.5	Upper east are of McGinty Creek - downstream of Minto North Pit					SSF			SSF	SSF		
MN-4.5	McGinty Creek at confluence with Yukon River					SSF			SSF	SSF		
W-50	50m downstream of end of pipe discharge (WUL Compliance Point)					Wd*/M			Wd	A		
	Mine Site Stations											
W-12	Discharge from Main Pit	Monitoring to be carried as per an approved Environmental Surveillance and Reporting Plan				Mow			SA	SSF		
W-45	Discharge from Area 2 Pit					Mow			SA	SSF		
MN	Minto North Pit[5]					SSF			SA	SSF		
W-15	Minto Creek, downstream of the SWD					Mow			SA	A		
W-16	Main Water Storage Pond Discharge (or Main Water Storage Pond if not discharging)					NLA			NLA	NLA		
W-17	Main Water Storage Dam Seepage					NLA			NLA	NLA		
W-62	Seepage from toe of MVFES2					Mow				A		
HFBP	CWTS High Flow By-Pass					Mwf			Mwf	SSF		

[4] Results of sediment and benthos monitoring will be included in the required annual reporting and will include, as required, recommendations based on study findings conducted by a qualified specialist. It should be noted that some benthic invertebrate community response to reduced nutrient concentrations in Minto Creek may occur.
[5] Monitoring to include recording of water level within the pit.

Table 7-1: Continued.

		YEAR 1-3 FREQUENCY (Active Closure)				YEAR 4 - 8 FREQUENCY (Post Closure I)				YEAR 9 -18 FREQUENCY (Post Closure II)		
SITE	**DESCRIPTION**	**Water Quality**	**Sediment**	**Benthos**	**Flows**	**Water Quality**	**Sediment**	**Benthos**	**Flows**	**Water Quality**	**Sediment**	**Benthos**
	Groundwater Wells											
MW17-08	Upgradient of Mine Activities – TBD (Select zones as recommended by a qualified professional)	A - F				NRM				NRM		
MW17-09	Down gradient of SWD – TBD (Select zones as recommended by a qualified professional)	SA - SF				A - F				A2 - F		
MW12-05	Down gradient of –all mine workings TBD (Select zones as recommended by a qualified professional)	SA - SF				A - F				A2 - F		
MW17-10	Down gradient of MWD – TBD (Select zones as recommended by a qualified professional)	SA - SF				A - F				A2 - F		
MW12-06	Down gradient of DSTSF – TBD (Select zones as recommended by a qualified professional)	SA - SF				A - F				A2 - F		
MW12-07	Down gradient of Main Pit - TBD (Select zones as recommended by a qualified professional)	SA - SF				A - F				A2 - F		
MW09-03	Down gradient of Minto North Pit - TBD (Select zones as recommended by a qualified professional)	SA - SF				NRM						
MW17-11	Down gradient of Minto North Pit - TBD (Select zones as recommended by a qualified professional)	SA - SF				A - F				A2 - F		
MW17-12	Down gradient of Water Storage Pond - TBD (Select zones as recommended by a qualified professional)	SA - SF				A - F				A2 - F		

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

Frequency Description

W	Weekly	A2	Every 2 Years
Wd	Weekly when discharging (*active treatment only)	NLA	No longer active
W2	Every 2 Weeks	DCR	Daily Continuous Record during open season
M	Monthly	SSF	Spring, Summer, Fall (May, July/August, September)
Md	Monthly when discharging	SF	Spring and Fall
Q	Quarterly	F	Fall
SA	Semi-annually	Mwf	Monthly when flowing
A	Annually	NRM	No routine monitoirng
		Mow	Monthly during open water (May-Oct)

Table 7-2: Geotechnical Monitoring and Instrumentation Download Frequency

		YEAR 1-3 FREQUENCY (Active Closure)		YEAR 4-8 FREQUENCY (Post Closure I)		YEAR 9-18 FREQUENCY (Post Closure II)	
AREA	STURCTURE	Instrumentation	Data Download Frequency	Description	Data Download Frequency	Description	Data Download Frequency
UNDERGROUND	Vent Raises	Visual Inspection	Semi-annually	Visual Inspection	Annually	Visual Inspection	Every 5 years
OPEN PITS	Area 118 Pit	SH	Semi-annually	SH	Annually	SH	Every 5 years
	Area 2 Pit	SH	Weekly during mining, quarterly thereafter	SH	Annually	SH	Every 5 years
	Main Pit	SH I	Quarterly Quarterly	SH I	Annually	SH I	Every 5 years
	Minto North Pit	NA	NA	NA	NA	NA	NA
TAILINGS FACILITIES	Area 2 Pit Tailings Management Facility	Visual Inspection	Quarterly	Visual Inspection	Annually	Visual Inspection	Every 5 years
	Dry Stack Tailings Storage Facility	I P SH T	Quarterly Monthly Monthly/Weekly Quarterly	I P SH T	Semi-annually	I P SH T	Annually
	Main Pit Tailings Management Facility	Visual Inspection	Quarterly	Visual Inspection	Annually	Visual Inspection	Every 5 years
WASTE ROCK AND OVERBURDEN DUMPS	Area 118 Backfill Dump	Visual Inspection	Semi-annually	Visual Inspection	Annually	Visual Inspection	Every 5 years
	Ice-rich Overburden Dump	Visual Inspection	Semi-annually	Visual Inspection	Annually	Visual Inspection	Every 5 years
	Main Pit Dump / South Wall Buttress	SH	Semi-annually	SH	Annually	SH	Every 5 years
	Main Waste Dump Main Waste Dump Expansion	I	NA	I	NA	I	NA
	Mill Valley Fill Extension	P SH	Monthly Weekly	P SH	Semi-annually	P SH	Annually
	Reclamation Overburden Dump	Visual Inspection	Semi-annually	Visual Inspection	Annually	Visual Inspection	Every 5 years
	Southwest Waste Dump	I P SH T	Quarterly Monthly Monthly Quarterly	I P SH T	Semi-annually	I P SH T	Every 5 years
MINE INFRASTRUCTURE	Includes all reclaimed camp, mill, warehousing and fuel storage facilities	Visual Inspection	Annually	Visual Inspection	Biannually	Visual Inspection	Every 5 years
ROADS AND ACCESS	Includes main access road, site access roads, and airstrip	Visual Inspection	Annually	Visual Inspection	Biannually	Visual Inspection	Every 5 years
WATER MANAGEMENT	Conveyance Channels	Visual Inspection	Semi-annually	Visual Inspection	Annually	Visual Inspection	Every 5 years
	Water Storage Dam	P SH T	Monthly Monthly Monthly	P SH T	Semi-annually	Visual Inspection	Every 5 years

I Inclinometers
P Piezometers
T Thermistors
SH Survey Hubs
NA Not Applicable

Table 7-3: Post Closure Geotechnical Inspection Program

		YEAR 1-3 FREQUENCY (Active Closure)		YEAR 4-8 FREQUENCY (Post Closure I)		YEAR 9-18 FREQUENCY (Post Closure II)	
AREA	**STURCTURE**	**Description**	**Inspection Frequency**	**Description**	**Inspection Frequency**	**Description**	**Inspection Frequency**
UNDERGROUND	Vent Raises	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year	Semi-Annually –May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years
OPEN PITS	Area 118 Pit	Backfilled; inspection no longer required and not possible	N/A		N/A		N/A
	Area 2 Pit	Visual inspection by Geotechnical Engineer and review of monitoring data	Quarterly	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years
	Main Pit	Visual inspection by Geotechnical Engineer and review of monitoring data	Quarterly	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years
	Minto North Pit	Visual inspection by Geotechnical Engineer and review of monitoring data	Quarterly	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years
TAILINGS FACILITIES	Area 2 Pit Tailings Management Facility	Visual inspection by Geotechnical Engineer as per OMS manual	Quarterly; in conjunction with pit inspection	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years
	Dry Stack Tailings Storage Facility	Visual inspection by Geotechnical Engineer and review of monitoring data as per OMS Manual	Monthly	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years
	Main Pit Tailings Management Facility	Visual inspection by Geotechnical Engineer as per OMS Manual	Quarterly; in conjunction with pit inspection	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years
WASTE ROCK AND OVERBURDEN DUMPS	Area 118 Backfill Dump	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year	Semi-Annually –May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years
	Ice-rich Overburden Dump	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year	Semi-Annually –May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years
	Main Pit Dump / South Wall Buttress	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year	Semi-Annually –May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years
	Main Waste Dump Main Waste Dump Expansion	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year	Semi-Annually –May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years
	Mill Valley Fill Extension	Visual inspection by Geotechnical Engineer and review of monitoring data	Monthly; in conjunction with the DSTSF inspection	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years
	Reclamation Overburden Dump	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year	Semi-Annually –May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years
	Southwest Waste Dump	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year	Semi-Annually –May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years

		YEAR 1-3 FREQUENCY (Active Closure)		YEAR 4-8 FREQUENCY (Post Closure I)		YEAR 9-18 FREQUENCY (Post Closure II)	
AREA	STURCTURE	Description	Inspection Frequency	Description	Inspection Frequency	Description	Inspection Frequency
MINE INFRASTRUCTURE	Includes all reclaimed camp, mill, warehousing and fuel storage facilities	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year	Annually	Included in site-wide geotechnical inspection	Biannually	Included in site-wide geotechnical inspection	Every 5 years
ROADS AND ACCESS	Includes main access road, site access roads, and airstrip	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year	Annually	Included in site-wide geotechnical inspection	Biannually	Included in site-wide geotechnical inspection	Every 5 years
WATER MANAGEMENT	Conveyance Channels	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year	Semi-Annually –May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection	Annually	Included in site-wide geotechnical inspection	Every 5 years
	Water Storage Dam	Visual inspection by Geotechnical Engineer as per OMS Manual. Dam Safety Reviews (DSR) to be completed by an independent engineer as per CDA requirements for a dam with a 'Significant' dam hazard classification.	Monthly Visual inspection; next DSR required in 2020	Visual inspection by Geotechnical Engineer as per OMS Manual	Monthly	No longer required; Dam decommissioned	N/A

Table 7-4: Wetland Monitoring Schedule and Frequency

		YEAR 1 - 3 FREQUENCY (Active Closure)	YEAR 4 - 8 FREQUENCY (Post Closure I)								YEAR 9 -18 FREQUENCY (Post Closure II)			
		Construction	Commissioning (year 4-5)				Early Operation (year 6-8)				Long-term Operation (year 9-18)			
SITE	DESCRIPTION	No Monitoring Required	Water Quality	Substrate/Sediment	Flows	Vegetation	Water Quality	Substrate/Sediment	Flows	Vegetation	Water Quality	Substrate/ Sediment	Flows	Vegetation
CWTS IN	Inflow to the CWTS system	NA	W,M	NA	W,M	NA	M	NA	M	NA	SSF	NA	SSF	NA
CWTS MID	Mid points within the CWTS system, for water, between the cells, and for soils, within the cells	NA	W,M	M,SSF,A	W,M	W,M,A	M	M,A	NA	SSF,A	A	A	A	A
CWTS OUT	Outflow of constructed wetland treatment system	NA	W,M	NA	W,M	NA	M	NA	M	NA	SSF	NA	SSF	NA

Frequency Description

W	Weekly	BA	Bi-annually
Wd	Weekly when discharging	NLA	No longer active
W2	Every 2 Weeks	DCR	Daily Continuous Record during open season
M	Monthly	SSF	Spring, Summer, Fall (May, July/August, September)
Md	Monthly when discharging	SF	Spring and Fall
Q	Quarterly	F	Fall
SA	Semi-annually	NA	Not Applicable
A	Annually	NRM	No routine monitoirng

7.11.2 Maintenance

Provisions for reclamation maintenance 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. Maintenance will be completed on an as-needed basis, following inspections and recommendations of a qualified inspector. For costing purposes however, a major maintenance campaign was included every 10 years.

It is a reasonable expectation that site features will require ongoing or periodic maintenance in the closure period. Examples include:

Water conveyance structures:

- Ditches will require cleaning of debris, fines accumulation, sediments and periodic fixing of ditch sides/liners;
- Settling basins will require periodic cleaning of sediments; and
- Ditches and settling basins may require rip rap or boulder replacement or fixing.

Soil Covers:

- Covers will require periodic attention for erosion; and
- Covered areas may require additional cover material and/or armouring in areas where continued erosion is occurring.

7.12 Performance Uncertainty and Risk Management

7.12.1 Adaptive Management Plan

An Adaptive Management Plan (AMP) has been developed as part of this closure planning. This plan has benefited from reviews and comments from SFN, YG EMR and the Yukon Water Board, and the update to the Minto Mine Closure AMP has been structured to meet requirements of the regulatory bodies. The entire Closure AMP v2018-01 is attached in Appendix J2 and a summary is provided here.

AMPs are tools used to address the inherent uncertainty in closure planning. AMPs outline a range of possible, unexpected outcomes and the responses that will be undertaken to curb possible negative impacts associated with these unexpected situations.

An AMP is a flexible, iterative process that emphasises learning while doing. 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 operations and environmental monitoring at Minto. 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.

7.12.1.1 Adaptive Management Planning

Adaptive management is an approach to environmental management that, according to the Canadian Environmental Assessment Agency, is appropriate when a mitigation measure may not function as intended or when broad-scale environmental change is possible. Mine closure planning includes both of these potentialities due to the long-term planning horizon and associated uncertainty. Adaptive management plans are precautionary in nature, and provide a level of security in long term environmental planning. Adaptive management plans also allow for the inclusion of improved science into mitigation measures as they are continually revised.

Adaptive management has been evolving since its emergence in the 1970s. Adaptive approaches include an ability to incorporate knowledge into the management plan as the knowledge is gleaned and circumstances change. Eberhard et al. described the categories of knowledge that may trigger changes to water quality management plans; system understanding, measuring progress and anticipating changes. These categories allow for the inclusion of knowledge and adaptation of management to changed conditions. Embedding adaptation into environmental plans involves thinking about how the results of monitoring will change management actions. AMPs are a way to accept uncertainties and build a structured framework to respond to changing conditions.

Adaptive management conducts a flexible path with actions to take when specific triggers occur. AMPs are a formalization of a plan for performance monitoring and project re-evaluation in the future. The general structure of adaptive management can be described by the following steps:

1. Identify risk triggers associated with vulnerabilities or uncertainties;
2. Quantify impacts and uncertainties;
3. Evaluate strategies and define implementation path that allows for multiple options at specific triggers;
4. Monitor the performance and critical variables in the system; and
5. Implement or re-evaluate strategies when triggers are reached.

Although there are no widely used AMP terms, the steps listed above are representative of typical AMP processes. Within AMPs, triggers provide decision points in a stepwise decision-making framework that identifies how and when management action should be taken. A key characteristic of adaptive management is monitoring, which is used to advance scientific understanding and to adjust management policies in an iterative process. Adaptive management is a rigorous method for addressing uncertainties in ecosystem management.

Minto has used the general steps listed above to establish a set of adaptive management terms and apply them to the ongoing Minto closure planning process.

7.12.1.2 AMP Approach

An AMP is a management tool wherein a framework is provided to make quick and effective decisions to guide responses to unforeseen events. This document identifies areas of uncertainty within this RCP and its predictive elements and provides an AMP framework for each. For each component the AMP describes monitoring commitments, thresholds, triggers and responses to underperforming elements or emerging risks within the component. The steps laid out in the AMP framework are precautionary, and therefore they provide the confidence that action will be taken before adverse environmental impacts are observed.

Response planning, and results for anticipated events are contained within site management plans while AMPs guide responses to unforeseen or contingency events. This AMP provides a framework to guide responses to unanticipated monitoring results and to potential but low probability events where uncertainty exists.

It is difficult to predict the specific environmental condition that may arise which requires a response from management and, therefore, the AMP does not 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. The AMP responses also rely on the engagement of qualified professionals to evaluate the particulars of the situation and to make recommendations for further investigation, evaluation or action. Management should use the information provided in the AMP and undertake the appropriate response.

The Closure AMP has been the subject of extensive discussion and collaboration with Selkirk First Nation and their technical advisors through the Bilateral Technical Working Group Process. The working group has reached substantive agreement on the aspects of the AMP and on its application in bridging uncertainty in the closure planning process.

7.12.1.3 AMP Components

The Minto Mine Closure AMP has been developed to cover mine components with identified areas of performance uncertainty at closure. The AMP includes frameworks for the adaptive management of changing conditions related to:

- Surface Water Quality (including Mine Site, Constructed Wetland Treatment Systems, Minto Creek and McGinty Creek components);
- Groundwater Quality;
- Physical Stability of Mine Components;
- Water Management Infrastructure; and
- General Reclamation Measures, including Revegetation, Minto North Pit Water Levels, and Cover Systems.

The specific AMP framework for each of these components are described in detail in the attached AMP (Appendix J2).

7.12.1.4 AMP Framework

The AMPs for each component are laid out using a common element approach to create consistency in implementation of the AMP protocol for all components. The common elements are:

1. Description of the component - this includes, where applicable, the engineering design associated with the component. Thorough description and understanding of the component leads to narrative risk triggers and specific performance thresholds.
2. Risk narrative - describes the possible environmental impacts and environmental conditions that implementation of the AMP will prevent. The risk narrative is used to establish early warning indicators.
3. Monitoring the component
    - Specific Indicators are the environmental or physical parameters to be monitored and assessed. Specific indicators are measurable or observable, and are indicative of changes from the designed or expected condition.
    - Specific Performance Thresholds define the conditions, in terms of specific indicators, when action is triggered. Performance thresholds are staged to accommodate levels of concern and a diversity of actions. To the extent possible, specific performance thresholds will include early warning thresholds.
4. Responding to unexpected conditions of the component
    - Specific Responses are staged according to specific performance thresholds and they describe the actions to be implemented if specific performance thresholds are crossed. Specific responses were developed through various means including, consultation with SFN and their agents, site operations such as monitoring and management, and input from ACG as well as other consultants.
5. Reporting and Review
    - Monthly reporting includes all activities carried out under the Adaptive Management Plan and will be continued throughout active closure but will reduce frequency to annually for PCI and PCII.
    - Annual Report reflects annual changes made to the AMP as the site conditions change. The AMP should be modified whenever unexpected circumstances are encountered and the protocol is implemented or when additional proven science or technology becomes available.

7.12.1.5 AMP Risk Narrative, Specific Indicators and Specific Performance Thresholds

In concept, it is Minto's position that risk narrative, specific indicators, and specific performance thresholds have been selected in order to maintain closure objectives in the event of emergence of unanticipated conditions at and surrounding the project site during operations and post-closure. The risk narratives include those identified in the FMEA workshop (see sections 2.4.2 and 7.12.2) for which mitigations identified included addressing in adaptive management planning. The specific performance thresholds are numeric values against which measurements and sampling from the closure monitoring programs (Section 7.11) can be compared.

7.12.1.6 General Approach to AMP Specific Responses

The following general steps may be taken if any AMP performance thresholds(s) have been exceeded:

1. Internal notification to management, followed by timely notification to SFN and the Water Inspector that a performance threshold has been exceeded;
2. Investigation of the root cause of the exceedance;
3. If a root cause of the exceedance can be readily identified and remedied, the remedy will be implemented in a timely manner, and the water inspector will be notified of the remedy and the implementation according to permit requirements;
4. If a root cause cannot be readily identified, a study plan will be outlined and communicated to involve qualified professionals to assist in the identification of the root cause(s);
5. An action plan will be devised for the mitigation of the problem;
6. Increased monitoring/sampling frequencies to monitor the situation and see if prescribed mitigation is appropriate and effective;
7. Inspect and monitor any modification to infrastructure; and
8. Review, report and make changes to the AMP.

7.12.1.7 Annual Review and Annual Reporting

An annual review of the AMP will be performed and any necessary amendments or updates to the AMP elements will be made. The annual review will include a review of the relevant monitored data and AMP elements.

Updates, amendments, performance thresholds crossed, and trigger(s) activated will be provided to the appropriate governmental (including SFN) organizations as required and will be part of the annual report.

7.12.2 Risk Assessment

Failure Mode Effects Assessments (FMEA) are the primary risk assessment tool utilized in the closure planning for Minto Mine. Section 2.4.2 outlines the FMEA initiatives undertaken since 2013, and the full reports are included in Appendices D1, D2 and D3.

8 Reclamation and Closure Schedule and Execution Strategy

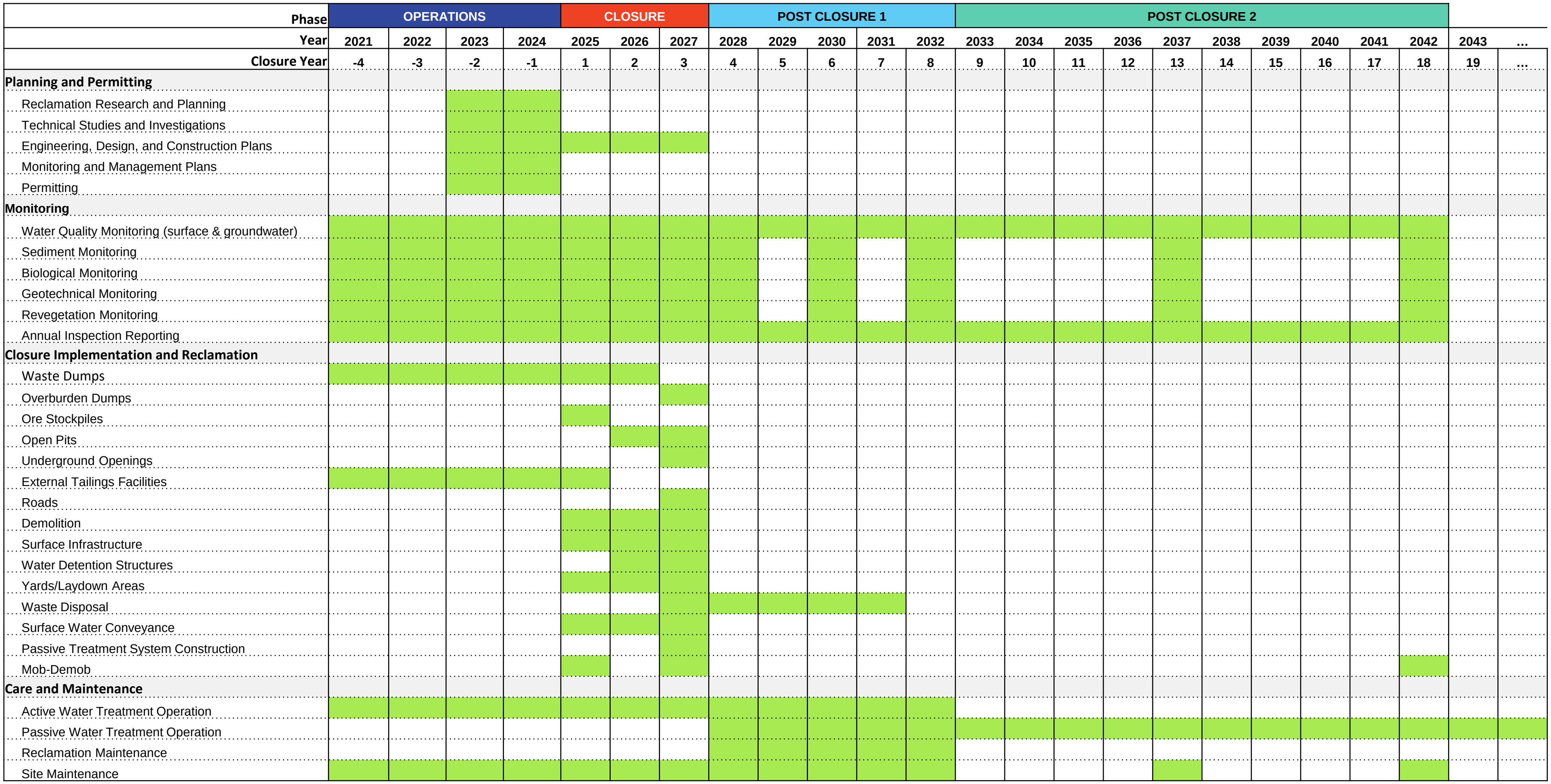
8.1 Reclamation and Closure Schedule

The conceptual schedule for reclamation and closure is presented in Figure 8-1. A breakdown of the percentage of each activity completed in each closure year is shown in the cash flow calculations in Appendix K (Worksheets 2, 7, and 12). The activity sequencing during closure has been balanced to some degree in terms of cost, in order to also balance the workforce during active closure; however, the actual construction sequencing will be determined by the construction manager during implementation.

The closure period will begin once all mineable ore and stockpile reserves have been processed. Active closure implementation has an estimated duration of 3 years starting in 2025. The post closure period has an overall duration of 15 years, with the Post-Closure I period having a duration of five years, and Post-Closure II period having a duration of 10 years.

Construction during closure implementation is expected to occur between April and October (7 months) of each year. Annual on-site care and maintenance activities during Post-Closure I is estimated to occur over 5 months. Maintenance during Post-Closure II is estimated to occur once every 5 years for 1 month.

Active water treatment is to continue throughout the closure period with the passive wetland treatment system expected to begin operations in Year 1 of post-closure. The active treatment system is assumed be dismantled and removed from site during final demobilization at the end of Post-Closure I.



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srk consulting

MINTO

Reclamation and Closure Plan

Conceptual Reclamation and Closure Schedule

Job No: 1CM002.044

Filename: Figure_ReclamationSchedule.pptx

Minto Mine

Date: Nov. 2020

Prepared by: PHM

Figure: 8.1

8.2 Execution Strategy

During active closure, the existing camp and offices will be used to support the closure workforce, with unused facilities and site trailers, demolished or dismantled as required. A limited number of facilities are to be maintained on site to support post-closure activities and will remain on site. These facilities are expected to consist of: a camp and kitchen trailer, an office trailer, the active treatment system facility, and mechanic/equipment warehouse to store supplies and equipment. A limited equipment fleet will also expected be maintained on site through to the end of Post-Closure I to allow for as needed repairs and maintenance, as well as to maintain the main site access road and airstrip.

The work-force during closure will vary depending on activities that are in progress at a particular point in time. Based on the 3 year, 7 month per year closure duration, and the total estimated man-hours calculated by the closure cost estimate, the average operational workforce (equipment operators and labourers) during closure is estimated to be approximately 15 to 20 workers. A similar number of personnel is estimated to be required for support (project management, field support staff, and camp support staff.

The post-closure periods will require significantly less personnel. The post-closure workforce will consist of water treatment and environmental staff, and a limited number of equipment operators to complete reclamation repairs and site maintenance. Details of the estimated required workforce during each post-closure period is provided in Worksheet 15 of Appendix K. The actual workforce will depend on the work to be completed within a given year.

In addition to the personnel listed in the tables, additional camp staff would be required for cooking and housekeeping. This results in a total estimated workforce of approximately 9 to 12 during Post-Closure I and approximately 5 during Post-Closure II.

9 Reclamation and Closure Liability

The estimates for reclamation and closure liability have been prepared in accordance with the costing guidance from YG EMR in the document Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and Closure Costing Guidance (YG, 2013). The closure liability estimates including the cost estimate basis, sources, and assumptions are provided in Appendix K. Figure 9-1 illustrates the reclamation units and where areas of the site were costed within the cost estimate.

The YG (2013) guidance document requires liability estimates for three separate conditions:

1. Current status (i.e. Year 0);
2. Peak Liability within the next two-year period; and,
3. End-of-mine (EOM) Life.

For the Minto Mine, the peak liability is expected to occur following mining of the Ridgetop North and Ridgetop South Pits in 2022. The Year 0 liability estimate was prepared to represent conditions at the site as of August 2020, prior to mining at the Ridgetop North and South. The end-of-mine life closure liability occurs in 2025 following completion of all open pit and underground mining, as well as the milling of all ore stockpiles by mid-2025.

Closure implementation is estimated to take 3 years for both liability estimates with construction occurring between April and September each year. The site is estimated to be access by air during the spring, and by barge following spring break-up. Two years of interim care and maintenance is assumed to be required after mining ceases and prior to implementation of the final closure plan for the Year 0 and Peak Liability estimates. These costs are not included in the EOM estimate as the closure plan would be finalized at the end-of-mining.

LEGEND

Area Boundary

Sub-area Boundary

SUB AREAS

1 Partially Oxidized Ore Stockpile
2 Partially Oxidized Ore Stockpile
3 Crusher Stockpile
4 Crushed Ore Stockpiles
5 Sewage Treatment
6 MVFE Laydown
7 North Stockpile
8 East Stockpile
9 West Stockpile
10 South Stockpile
11 Waste Rock Shell
12 Sewage Lagoons
13 Explosives Magazines
14 DYNO Compound
15 High Grade Waste Stockpile
16 Explosive Silos
17 Explosive Magazines
18 Area 118 Vent Raise
19 Exploration Camp
20 Waste Storage Area
21 Airstrip
22 Land Treatment Facility
23 Water Storage Pond Dam

NOTES

1. All dimensions are in meters unless otherwise stated.
2. Orthphoto provided by client, 2020.
3. Area and sub-area boundaries are approximate.

REFERENCE

NAD83 UTM Zone 8.

0m 100 200 300 400 500 600

srk consulting

MINTO

SRK JOB NO.:	1CM002.044
FILE NAME:	1CM002.044 - Reclaim Areas.dwg

Minto

Minto Closure Plan

Cost Estimate Reclaim Areas

DATE:	APPROVED:	FIGURE:
November 2020	phm	9-1

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As noted in Section 8, the Post-Closure I and Post-Closure II periods have durations of 5 years and 10 years, respectively, estimated for the cost purposes. During Post-Closure I, site access is maintained by air during the spring, and by barge following spring break-up. During Post-Closure II, site maintenance is assumed to be required every 5 years with the site accessed by barge and work completed in one month. Site access for monitoring events and geotechnical inspections when no barge is in place are assumed to be completed by helicopter. During Post-Closure II, the geotechnical inspection completed by helicopter will also be used to determine the maintenance requirements to be completed during the next summer.

Costs have also been allocated for on-going site maintenance past the Post-Closure II period into perpetuity. Routine site inspections and maintenance were assumed to be completed every 10 years, with access to the site established by barge. During these 10 year maintenance events, costs were allocated for passive treatment maintenance, site grading, as well as maintenance of the access road (including Big Creek Bridge).

Table 9-1 summarizes the reclamation and closure liability for the Year 0 scenario, peak two-year liability scenario, and the End-of-Mine (EOM) scenario. The costs are presented in 2020 Canadian Dollars.

Table 9-1: Reclamation and Closure Liability Cost Summary

Description of Cost	Year 0	Peak	EOM
Closure Implementation			
Direct Costs	$18,167,000	$21,084,000	$17,148,000
Care & maintenance costs to the end of implementation	$10,246,000	$10,392,000	$4,049,000
Indirect costs	$19,659,000	$20,760,000	$17,079,000
Cost inflation	$3,302,000	$5,762,000	$4,593,000
Sub-total - Implementation Costs	$51,375,000	$57,998,000	$42,869,000
Post-Closure NPV	$15,320,000	$14,754,000	$14,267,000
TOTAL FINANCIAL SECURITY	$66,695,000	$72,752,000	$57,137,000

10 References

Aboriginal Affairs and Northern Development Canada and Mackenzie Valley Land and Water Board. 2013. Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories.

Access Consulting and Horizon Ecosystem Consultants. 2010. Minto Mine Environmental Baseline Ecosystems and Vegetation Report.

Addison, M., D'Amato, V., Liles, D., Bilgin, A., Levin, G., Mongrain, R., and Harrington, J. 2005. Bench-Scale Evaluation of Multiple Technologies for In-situ Metals Precipitation. Proceedings of the 5th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Battelle Press, 2005.

BC Mine Waste Rock Pile Research Committee. 1991. Mined Rock and Overburden Piles Investigation and Design Manual.

BC Road Builders and Heavy Construction Association, 2016. 2015-16 Equipment Rental Rate Guide. Published July, 2015.

EBA Engineering Consultants Ltd, 1995. Geotechnical Design, Tailings/ Water Dam, Minto Project, Yukon. Prepared for Minto Explorations Ltd., West Vancouver, BC.

EBA Engineering Consultants Ltd, 1996. Waste Rock Stability Evaluation, Minto Project, Yukon Territory. Prepared for Minto Explorations Ltd., West Vancouver, BC.

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

EBA Engineering Consultants Ltd, 1998. Geotechnical Evaluation, Proposed Main Waste Dump, Minto Project, Yukon Territory. Prepared for Minto Explorations Ltd., West 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, 2007. Geotechnical Design Report, Dry Stack Tailings Storage Facility, Minto Mine, Yukon. Prepared for Minto Explorations Ltd, Vancouver, BC.

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, 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.

EBA Engineering Consultants Ltd, 2010d. Minto Mine Environment Baseline Report- Wildlife. Report prepared for Minto Exploration Inc.

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

Gault, A., Harrington, J., Robertson, C., Simair, M., and Friesen, V. 2018. Pilot Study of In Situ Biological Treatment at the Silver King Mine, Keno Hill, Yukon. In C. Wolkersdorfer, L. Sartz, A. Weber, J. Burgess, & G. Tremblay (Eds.), Mine Water – Risk to Opportunity (Vol I), 121–128.

Hallam, Knight, Piesold (HKP) Ltd. 1994. Minto Explorations Limited, Minto Project: Volume II Environmental Settings. Prepared for Minto Explorations Ltd.

Harrington, J. G., Wangerud, K., and Fundingsland, S. D. 2004. Restoration of ecosystems and long-term stabilization of initially acidic pit lakes, Gilt Edge Mine Superfund Site, South Dakota. Taylor & Francis Group.

Harrington, J. M. 2002. In situ treatment of metals in mine workings and materials. Tailings and Mine Waste ’02, 251–261.

Harrington, J. M., Harrington, J. G., Lancaster, E., Gault, A. G., and Woloshyn, K. 2015. Bioreactor and in situ mine pool treatment options for cold climate mine closure at Keno Hill, YT. Proceedings of the 10th ICARD IMWA annual conference. April 21-24, 2015. Santiago, Chile.

Harrington, J. M., Levy, D. B., and Harrington, J. G. 1999. Design and implementation of a leach field to remove metals, nitrate, selenium, and sulfate. Journal American Society of Mining and Reclamation, 1999(1), 540–545. https://doi.org/10.21000/JASMR99010540

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.

Houston, K. S., Milionis, P. N., Harrington, J. M., Harrington, J. R and Eppley, R. L. 2005. A Field Demonstration of In Situ Treatment and Prevention of Acid Mine Drainage in the Abandoned Tide

Mine, Indiana County, Pennsylvania. In the 26th West Virginia Mine Drainage Task Force Symposium papers. April 19-20, 2005. Morgantown, West Virginia.

Huggard, M. and Nadeau. C. 2013. Restoration Planning and Application of Ecological Succession Principles: United Keno Hill Mine Case Study. Presented at Northern Latitudes Mine Reclamation Workshop, Whitehorse, Yukon.

[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. 2010a. In-situ Treatment of Mine Pools and Pit Lakes: Interstate Technology & Regulatory Council. Available at: https://www.itrcweb.org/miningwaste-guidance/to_insitu.htm. Accessed November 2020.

[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: Technology 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.

Kellie, K.A. and R.A. DeLong. 2006. Geospatial survey options manual. Division of Wildlife Conservation, Alaska Department of Fish and Game, Fairbanks, Alaska, USA.

Lindsay, M.B.J. 2009. Passive In-situ Treatment of Acidic and Neutral Mine Drainage: Field and Laboratory Investigations [Doctoral Dissertation, University of Waterloo]. UWSpace. Avalable at: https://uwspace.uwaterloo.ca/handle/10012/4872. Accessed May 2020.

Matheus, P. and C. Omtzigt. 2013. Yukon revegetation manual: practical approaches and methods. Whitehorse, Yukon. yukonrevegetationmanual.ca

Minto Explorations Ltd. 2014a. Water Licence Amendment: Phase V/VI Expansion of Mining- Minto Mine. Prepared by Minto Explorations Ltd. June 2014.

Minto Explorations Ltd. 2014b. Minto Mine Phase V/VI Expansion Tailings Management Plan. May 2014.

Minto Explorations Ltd. 2014c. Minto Mine Phase V/VI Expansion Waste Rock and Overburden Management Plan. Minto Mine, Yukon.

Minto Explorations Ltd. 2014d. Minto Mine Phase V/VI Expansion Tailings Management Plan. Minto Mine, Yukon

Minto Explorations Ltd. 2015. Tailings and Water Management Plan. Letter Report, March 19, 2015.

Minto Explorations Ltd. 2016a. Environmental Monitoring, Surveillance and Reporting Plan. July 2016.

Minto Explorations Ltd. 2017. Minto Mine Water Licence QZ96-006 Quartz Mining Licence QML-0001 2015 Annual Report. March 2017.

Minto Explorations Ltd. 2018a. Tailings and Water Management Plan. February 2018.

Minto Explorations Ltd. 2018b. Waste Rock and Overburden Management Plan. February 2018.

Minto Explorations Ltd. 2018c. Underground Mine Development and Operations Plan. February 2018.

Morie, C., Panhorst, E., Ilgner, B., Lutes, C., Harrington, J. and Saunders J. 2004. In-situ Radionuclide Bioremediation and Stabilization through FeS Coprecipitation. Proceedings of the 4th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Battelle Press, 2004.

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

Murphy, R., Ely, J., Gillow, J., Gentile, M. and Harrington, J. 2008. Development of Long-Term Residual Treatment Capacity During InSitu Cr(VI) Reduction. Proceedings of the 8th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Battelle Press, 2008.

Ness, I., Janin, A. and Stewart, K. 2014. Passive Treatment of Mine Impacted Water In Cold Climates: A review. Yukon Research Centre, Yukon College.

New Mexico Energy, Minerals and Natural Resources Department, Mining and Minerals Division. 1999. Coal Mine Reclamation Program Vegetation Standards.

Nohara, D., Kitoh, A., Hosaka, M., Oki, T., 2006. Impact of climate change on river discharge projected by multimodel ensemble. Journal of Hydrometeorology 7, 1076-1089.

Natural England Commissioned Report, NECR100. 2012. Managing soil biota to deliver ecosystem services; Summary Report. Natural England, UK. www.naturalengland.org.uk

O'Donoghue, M, R. Ward, S. Westover, A. Reyner, J. Bellmore. 2008. Carmacks West Moose Management Unit. Summary of Early-Winter 2007 Moose Survey. Yukon Fish and Wildlife Branch, Department of Environment.

O'Donoghue, M. 2009. Survey of Sheep along the Yukon River from Minto to Fort Selkirk and on Mount Hansen (GMS 3-20).

Park, B., Mansfield, M., and Lewis, N.M. 2009. Bioremediation of Pit Lakes - Gilt Edge Mine. U.S. Environmental Protection Agency, Washington, DC, EPA/540/R-09/002.

Paulson, O., Harrington, J., and Harrington, J. 2004. Bioremediation of the Sweetwater Pit Lake – Four Years Following Treatment. Proceedings of the US EPA Meeting: Pit Lakes 2004, November 16 – 18, 2004. Reno, Nevada, Washington, D.C.

Saunders, J., Lee, M., Harrington, J., Lutes, C. and Wilkin, R. 2004. Strategy for in-situ bioremediation of arsenic in groundwater. Proceedings of the 4th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Battelle Press, 2004.

Smith, C.A.S., Meikle, J.C., Roots, C.F. (Eds.), 2004. Ecoregions of the Yukon Territory: Biophysical properties of Yukon Landscapes. Agriculture and Agri-Food Canada, PARC Technical Bulletin No. 04-01, Summerland, British Columbia, 313pp.

SRK Consulting (Canada) Inc. 2007. Pre-Feasibility Pit Slope Evaluation for Area 2 Open Pit, Minto Mine. Report prepared for Minto Explorations Ltd. October 2007.

SRK Consulting (Canada) Inc. 2008. Technical Report, Minto Mine, Yukon. Prepared for Minto Explorations Ltd, Vancouver, BC. June 2008.

SRK Consulting (Canada) Inc. 2009. Minto Phase IV Pre-Feasibility Technical Report. Prepared for Minto Explorations Ltd, Vancouver, BC. December 2009.

SRK Consulting (Canada) 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 (Canada) Inc. 2012. Letter Report: Detailed Review of Foundation Performance at Select Mine Waste Facilities and Main Pit South Wall. Prepared for Minto Explorations, Ltd. SRK Project Number 219500.050. November 19.

SRK Consulting (Canada) Inc. 2013a. Memo: South Diversion Ditch Realignment and Overflow Spillway.

SRK Consulting (Canada) Inc. 2013b. Memo: Preliminary Design of the Tailings Diversion Ditch Upgrade, to Minto Explorations Ltd., dated November 14, 2013

SRK Consulting (Canada) Inc. 2013c Freshet Geotechnical Site Inspection, Minto Mine, YT

SRK Consulting (Canada) Inc. 2013d. Phase V/VI Main Pit Dump Physical Stability Assessment. Report prepared for Minto Explorations Ltd., November 2013.

SRK Consulting (Canada) Inc. 2013e. Phase V/VI Main Waste Dump Expansion- Physical Stability Assessment. Report prepared for Minto Explorations Ltd., November 2013.

SRK Consulting (Canada) Inc. 2013f. Phase V/VI Ridgetop South & Area 118 Backfill Dumps Physical Stability Assessment. Report prepared for Minto Explorations Ltd., November 2013.

SRK Consulting (Canada) Inc. 2013g. Minto Mine Phase V/VI Expansion: Hydrogeological Characterization Report. Prepared for Minto Explorations Ltd., May 2013.

SRK Consulting (Canada) Inc. 2014a. Dry Stack Tailings Storage Facility: Results from Full-depth Sampling Along DSTSF Centerline. Technical Memorandum prepared for Minto Explorations Ltd., March 28, 2014.

SRK Consulting (Canada) Inc. 2014b. Upgraded Tailings Diversion Ditch Design. Technical Memorandum prepared for Minto Explorations Ltd., September 24, 2014

SRK Consulting (Canada) Inc. 2014c. Minto Mine Numerical Groundwater Model. Prepared for Minto Explorations Ltd., November 2014.

SRK Consulting (Canada) Inc. 2015a. Mill Valley Fill Extension Stage 2 Final Design Report. Prepared for Minto Explorations Ltd., September 2015.

SRK Consulting (Canada) Inc. 2015b. Minto 2015 Groundwater Model Update. Prepared for Minto Explorations Ltd., November 2015.

SRK Consulting (Canada) Inc. 2016a. Dry Stack Tailings Storage Facility Interim Cover Investigation. Technical memorandum prepared for Minto Explorations Ltd., April 7, 2016.

SRK Consulting (Canada) Inc. 2016b. SAT dump on Tailings. Technical memorandum prepared for Minto Explorations Ltd., March 31, 2016.

SRK Consulting (Canada) Inc. 2016c. Minto Mine – Closure Water Conveyance System Design Update Report. Prepared for Minto Explorations Ltd., August 2016.

SRK Consulting (Canada) Inc. 2017. Mill Valley Fill Extension Stage 2 – Performance Monitoring and Evaluation Criteria. Prepared for Minto Explorations Ltd., April 2017.

SRK Consulting (Canada) Inc. 2018. Lysimeter Installation Report, Minto Mine. Prepared for Minto Explorations Ltd. February 2018.

Tafti, R. and Mortensen, J.K., “Early Jurassic porphyry (?) copper (-gold) deposits at Minto and Williams Creek, Carmacks Copper Belt, western Yukon”. Yukon Exploration and Geology 2003, D.S. Emond and L.L. Lewis (eds.), Yukon Geological Survey, 2004.Yukon Environment. 2005a. Status of Caribou in the Yukon. Department of Environment Map ID ENV.009. Yukon Environment. 2007. Information for Decisions. 2007 Fish and Wildlife Inventory Program Project Summaries.

Yukon Government. 2004. Yukon Community Profiles – Pelly Crossing, The Economy. Available at: http://www.yukoncommunities.yk.ca/communities/pelly/economy/

Yukon Government. 2006. Handbook of Reclamation Techniques and Mining Land Use (Draft). Energy Mines and Resources Minerals Management Branch.

Yukon Government. 2009. Yukon Species at Risk. Available at http://www.environmentyukon.gov.yk.ca/wildlifebiodiversity/ [accessed on March 29, 2010].

Yukon Environment. 2010. Wildlife Key Areas. Produced by the Wildlife Key Area Inventory Program. Environment Yukon, Habitat Programs.

[YG] Government of Yukon. 2006. Yukon Mine Site Reclamation and Closure Policy.

[YG] Government of Yukon, Energy, Mines and Resources. (2008). Yukon Mine Site and Reclamation Closure Policy: Financial and Technical Guidelines.

[YG] Government of Yukon, Energy Mines and Resources, 2013. Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and Closure Costing Guidance.

[YG] Government of Yukon, Energy Mines and Resources, 2014. Yukon Mine Site Reclamation and Closure Policy Financial Guidelines.

[YG] Government of Yukon, Department of Community Services, 2016. Fair Wage Schedule, effective April 1, 2016. Accessed at http://www.community.gov.yk.ca/fairwage.html on July 15, 2016.

Personal Communication

Hegel, Troy. Environment Yukon, Caribou, Sheep, & Goat Biologist

Appendix A1
Minto Mine Site Assessment

Appendix A2
Wetland Treatment Research Program - Pilot Scale

Appendix A3
Minto Mine Constructed Wetland Treatment Research Program - Demonstration CWTS

Appendix A4
Minto Mine Constructed Wetland Treatment Research Program - Demonstration Scale 2015 Update

Appendix A5
Minto Mine Constructed Wetland Treatment Research Program - Demonstration Scale 2016 Update

Appendix A6
Minto Mine Constructed Wetland Treatment Research Program - Demonstration Scale 2017 Update

Appendix A7
Minto Mine Constructed Wetland Treatment Research Program - Demonstration Scale 2018 Update

Appendix A8
Minto Mine Constructed Wetland Treatment Research Program - Demonstration Scale 2019 Update

Appendix B
SFN Stakeholder & Regulator Engagement Table

Appendix C
Memo - Re-evaluation of Candidate Passive Treatment Technologies for Minto Mine Closure

Appendix D1
2013 FMEA Risk Register

Appendix D2
Minto Mine Closure - Failure Modes and Effects Assessment 2014 Workshop Report

Appendix D3
Minto Mine Closure - Failure Modes and Effects Assessment 2017 Workshop Report

Appendix E1
Scoping Level Cover Assessment for Minto Closure Covers

Appendix E2
Memo - Minto Mine Closure Covers: Results of Numerical Modelling to Bracket Percolation Predictions

Appendix E3
Updated Closure Cover Design for the Minto Mine 2018 Reclamation and Closure Plan

Appendix E4
Closure Landform Design and Reclamation Landform Units for the Minto Mine

Appendix F
Background Water Quality of Lower Minto Creek for Application in the Derivation of Post-Closure Water Quality Objectives

Appendix G1
Minto Mine Reclamation and Closure Plan – Preliminary Design Report for Treatment Wetland

Appendix G2
Closure Water Conveyance System Design 2018 Update Report, Minto Mine

Appendix H
Minto Site Characterization Plan 2018-01

Appendix I
Water and Load Balance Model Report 2018

Appendix J1
Minto Mine - Operations Adaptive Management Plan 2020-01

Appendix J2
Closure Adaptive Management Plan 2020-01

Appendix K
Minto Mine Closure Cost Estimates – RCP Revision 2020-01