CAPSTONE MINING CORP.

MINTO MINE

OPERATED BY MINTO EXPLORATIONS LTD.

Minto Mine Phase V/VI Expansion

Tailings Management Plan

June 2013

TABLE OF CONTENTS

1 Introduction 1
2 Background and Overview 1
2.1 Key Phase IV Site Components for Management of Tailings 1
2.2 Overview of Phase V/VI Mine Plan 2
3 Phase V/VI Storage Requirements 5
3.1 Tailings 5
3.2 NP:AP<3 Waste Rock 5
3.3 Water 5
3.4 Life-of-Mine In-pit TMF Storage Requirements 5
4 In-pit Tailings Management Facilities 6
4.1 Introduction 6
4.2 Storage Capacity 6
4.3 Main Pit TMF 6
4.3.1 Capacity 6
4.3.2 Main Dam 7
4.3.3 Management Considerations 7
4.4 Area 2 Pit TMF (A2PTMF) 8
4.4.1 Capacity 8
4.4.2 Management Considerations 11
4.5 Ridgetop North Pit TMF (RNPTMF) 12
4.5.1 Capacity 12
4.5.2 Management Considerations 12
4.6 Underground Backfill 13
5 Water Management Considerations 13
6 Deposition Schedule 14
7 References 16

LIST OF TABLES

Table 1: Volume requirements for the Phase V/VI tailings management plan. 5
Table 2: Natural storage capacities for Phase V/VI in-pit TMFs. 6

LIST OF FIGURES

Figure 1: Key Minto Mine Phase IV site components. 3
Figure 2: Key Minto Mine Phase V/VI site components. 4
Figure 3: Overview of Main Pit showing conceptual location of Main Dam. 7
Figure 4: Main Pit TMF volume-elevation curves. 8
Figure 5: Overview of Phase V pits (excluding Minto North) showing section line for Figure 6 and Figure 7. 9
Figure 6: Section through Area 2 Pit showing staging and spill elevations. 9
Figure 7: Section through Area 2 Pit showing tailings volume made available with staged mining of Area 2. 9
Figure 8: Storage curve for Area 2 Stage 2 (below 760 m elevation). 10
Figure 9: Storage curve for Area 2 Stage 3 (including Area 2 Stage 2 above 760 m elevation). 10
Figure 10: Conceptual post-closure water routing. 12
Figure 11: Storage curve for Ridgetop North. 13
Figure 12: Example Phase V/VI tailings deposition schedule. 15

1 Introduction

The objectives of the Phase V/VI Tailings Management Plan (TMP) are to summarize the quantities of mine waste (tailings and waste rock) that require management in tailings management facilities under the Phase V/VI mine plan, and to summarize how Minto Explorations Ltd. (Minto) proposes to manage these materials.

Phase V/VI mining consists of open pit mining from four separate pits as well as underground mining accessed by three portals. Ore released by Phase V/VI will be processed using the same milling infrastructure used in previous phases of mining, at a processing rate of 3850 tonnes per day (tpd). Minto may consider future mill expansion to increase throughput to the limit of its current licence, i.e., 4200 tpd.

This document is a summary of Minto's plan to manage both Phase V/VI tailings and NP:AP<3 waste rock produced from mining of the Phase V/VI open pits. As such, it refers to supporting engineering designs, as well as other plans for management of water, waste rock, and overburden where appropriate.

2 Background and Overview

Minto Mine has been operating since 2007. The current project activities are collectively referred to as Phase IV and will transition into Phase V/VI upon receipt of appropriate authorizations. Because the Phase V/VI TMP will build on the site configuration that results from Phase IV operations, an overview of key Phase IV site components is provided here to establish context.

2.1 Key Phase IV Site Components for Management of Tailings

The Phase IV site components that relate to managing Phase V/VI tailings are shown on the plan of arrangement (Figure 1) and briefly described here.

- Mill
    - The mill is located on the north side of the Minto Creek valley east of Main Pit and west of the camp. The mill processes stockpiled and run-of-mine ore at a nominal rate of 3850 tonnes per day and produces slurry tailings that are discharged to Main Pit.
- Main Pit
    - Main Pit is centered in the Minto Creek valley west of the mill area, and was the first deposit mined at Minto Mine; mining ended there in April 2011. The Phase IV TMP has this pit filled with slurry tailings, the deposition of which began on November 1, 2012.
- Area 2 Pit
    - Area 2 Pit is located south of the mill area and southeast of Main Pit. As part of the Phase IV mine plan, the pit is being mined in two stages, the first of which started in April 2011. The second stage (the last approved as part of Phase IV) pushes back the walls and deepens the pit; it is expected to be completed by Q1 2014. Once open pit mining of Area 2 Stage 2 is complete, it is scheduled to receive slurry tailings under the final stages of the Phase IV mine plan.
- South Wall Buttress (SWB)
    - The SWB is a rockfill structure that is designed to buttress the south wall of Main Pit and preserve its remaining volume for tailings and water storage purposes. Construction of the SWB

began in May of 2011 and it has received rock from Area 2 Pit since that time. It is scheduled for completion to its design capacity during the period of open pit mining under Phase IV.

2.2 Overview of Phase V/VI Mine Plan

The components of the proposed Phase V/VI mine plan (Minto 2013a) that are relevant to tailings management are shown in Figure 2 and comprise:

- Area 2 Stage 3 Pit,
- Ridgetop North Pit,
- Main Pit Dump, and
- Main Dam

Tailings production will transition from Phase IV to Phase V/VI when authorized. The nominal rate of mill throughput for Phase IV is 3850 tpd; this nominal processing rate will continue through Phase V/VI and will result in a seamless transition between project phases. The scheduled completion of Phase V/VI milling is Q3 2022.

Tailings will be discharged as slurry to the Main Pit, Area 2 Pit (both Stage 2 and Stage 3), and Ridgetop North Pit, and may be used for underground backfill in selected areas depending on the outcome of future underground mine engineering evaluations. Water stored in the pits will be reclaimed for use as process water, and will be transferred between pits to satisfy operational and storage requirements.

As described in the Phase V/VI waste rock and overburden management plan (WROMP), the great majority of waste rock generated in Phase V/VI will be released from the open pits, which are scheduled to be completed in 2017 (Minto 2013b). Waste rock with NP:AP<3 will be co-disposed with tailings in the Phase V/VI TMFs, in locations that will be saturated post-closure. References to NP:AP< 3 waste rock in this TMP are descriptive only— the WROMP and references therein define this category of waste rock and discuss requirements for managing it.

The remainder of this document summarizes the plans to manage the tailings and NP:AP<3 waste rock that will be produced during Phase V/VI.

Figure 1: Key Minto Mine Phase IV site components.

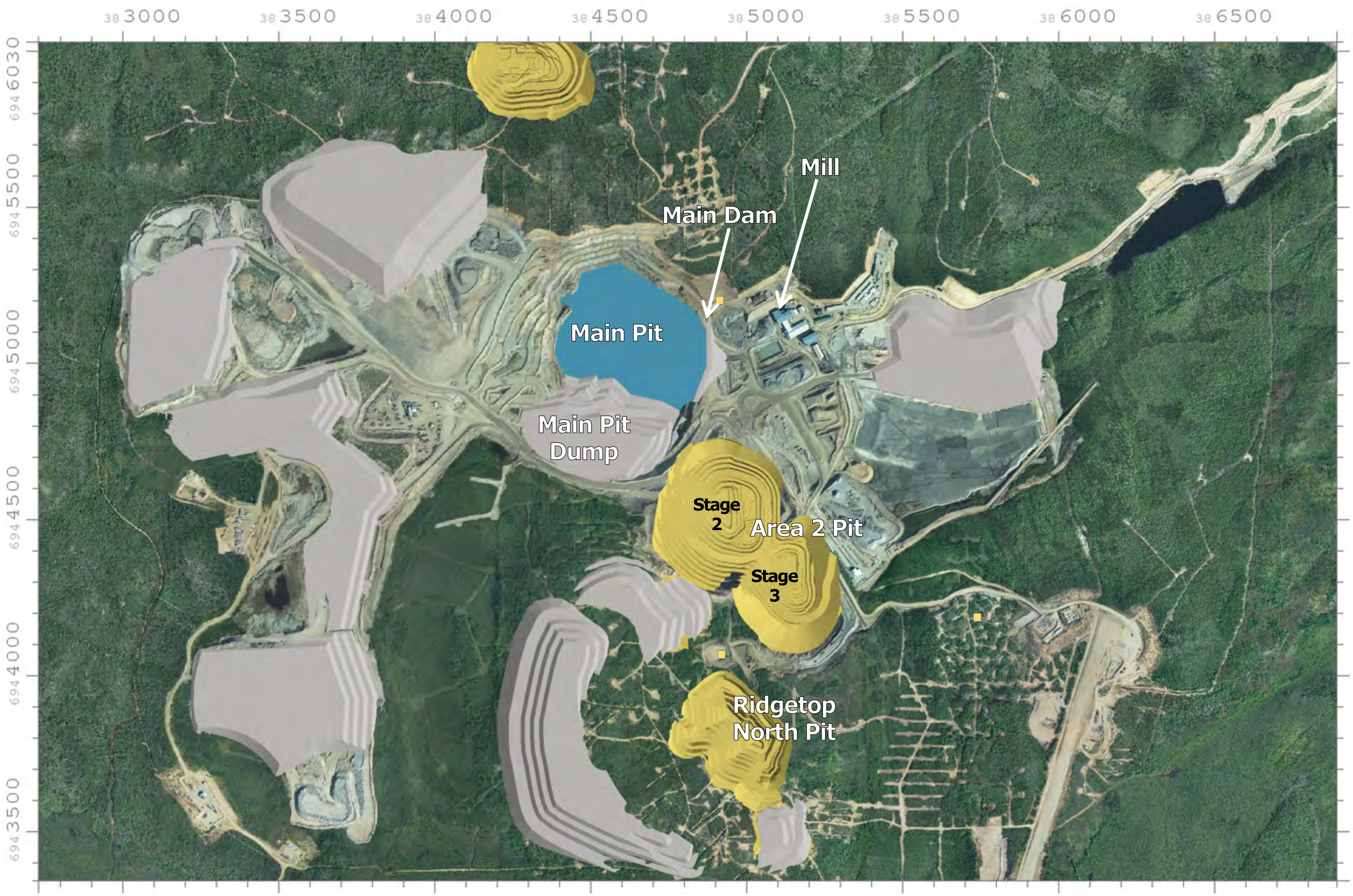

Figure 2: Key Minto Mine Phase V/VI site components.

3 Phase V/VI Storage Requirements

3.1 Tailings

From November 1, 2012, when dry-stacking operations ceased, through the completion of the Phase V/VI life-of-mine (LOM) plan, Minto will produce 13.3 Mt of tailings from 13.8 Mt of mill feed (assuming 96.7% mass pull to the tailings stream, with the balance reporting to concentrate). This tailings tonnage covers both the remainder of Phase IV and all of Phase V/VI. The two phases are considered together to facilitate integrated planning and to avoid having to account for processing stockpiled Phase IV ore after Phase V/VI begins.

The dry density of deposited tailings is assumed to be 1.1 t/m^3 for planning purposes; at this density, the 13.3 Mt of LOM tailings will require 12.1 Mm^3 of storage capacity.

3.2 NP:AP<3 Waste Rock

The Phase V/VI geochemical characterization report (SRK 2013a) and the WROMP (Minto 2013b) describe how NP:AP<3 waste rock was estimated and will be managed.

The total allowance for NP:AP<3 waste rock to be stored in the pits is 2.3 Mm^3. This includes material from Phase IV, some of which is already being stored beneath the final water level of Main Pit.

3.3 Water

Water storage requirements also need to be satisfied by the in-pit TMFs (specifically Main and Area 2 pits). The Phase V/VI water management plan (WMP) describes how the water storage requirements were determined (Minto 2013c); these requirements consist of a LOM accumulated water volume of 1.1 Mm^3 and a surge capacity of 975,000 m^3. The LOM accumulated water volume estimate relies on a number of forward-looking assumptions which are described in the WMP.

3.4 Life-of-Mine In-pit TMF Storage Requirements

Table 1 summarizes the total storage requirements for the Phase V/VI Tailings Management Plan.

Table 1: Volume requirements for the Phase V/VI tailings management plan.

Material	Mass (Mt)	Dry Density (t/m^3)	Volume (Mm^3)
Phase IV + V/VI Tailings	13.3	1.1	12.1
NP:AP<3 Waste Rock (Phase IV + V/VI)			2.3
Accumulated Water (end of Phase V/VI)			1.1
Surge Capacity			0.975
		Total Storage Volume Required:	16.4

4 In-pit Tailings Management Facilities

4.1 Introduction

Planning for storage of Phase V/VI tailings and waste rock began with estimating the expected quantities of tailings and waste rock, and considering alternatives for storage to contain the required volumes. Alternatives were assessed against a suite of criteria that included foundation stability, drainage control, minimizing the need for re-contouring during closure, and developing landforms that would be appropriate for closure.

The outcomes of the evaluation process were summarized in a memorandum (SRK 2013b). The preferred alternative for tailings storage was to utilize the existing Phase IV and the future Phase V/VI open pits within the Minto Creek watershed for storage of Phase V/VI tailings and NP:AP<3 waste rock. Through subsequent planning, Minto has concluded that the optimal configuration will include:

- expansion of Main Pit tailings capacity beyond the Phase IV limits
- expanding the Phase IV plan for use of Area 2 Stage 2 Pit to include use of the future Area 2 Stage 3 Pit
- incorporating the future Ridgetop North Pit as a tailings management facility.

4.2 Storage Capacity

Each pit has a natural spill elevation – the lowest point on the pit rim – that limits its storage capacity for tailings and/or water.

Table 2 summarizes the storage capacities below the natural spill elevations of each of the Phase V/VI in-pit tailings management facilities (TMFs). Comparison with the Phase V/VI storage requirements (including surge capacity for seasonal water storage) in Table 1 with the available in-pit volumes in Table 2 shows that additional storage volume beyond the natural capacity of the existing and future pits is required. Therefore, Minto intends to increase the storage capacity of the Main Pit by constructing a dam on the east side of the existing pit; further details relating to the dam are described in Section 4.3.

Table 2: Natural storage capacities for Phase V/VI in-pit TMFs.

In-pit TMF	Approximate Spill Elevation (m above sea level)	Volume Below Spill Elevation (Mm^3)
Main Pit	791	4.9
Area 2 Pit (Stages 2+3)	802	7.9
Ridgetop North Pit	862	1.9
	Total volume below spill elevations	**14.7**

Plans for each of the three in-pit TMFs are described in the following sections.

4.3 Main Pit TMF

4.3.1 Capacity

The total storage capacity of Main Pit to its natural spill elevation is 4.9 Mm^3 (as noted in Table 2). As part of Phase V/VI, Minto intends to construct a dam across the low point of the east wall of Main Pit to increase its storage capacity to roughly 6.9 Mm^3 (5.8 Mm^3 of tailings storage, and 1.1 Mm^3 of water storage volume in the pore space of the South Wall Buttress and Main Pit Dump (Figure 4)). This will provide the storage capacity required for Phase V/VI tailings and NP:AP<3 waste rock (based on the figures in Table 1 and Table 2).

4.3.2 Main Dam

A conceptual design has been developed for the proposed dam (SRK 2013c) which assumes construction using waste rock and overburden produced during the mining of Area 2 Stage 3 Pit. A low permeability core of compacted fine-grained overburden will be encapsulated with rockfill; based on the conceptual design, the dam crest will have an elevation of 806 m and the dam will be designed such that the full supply level of the MPTMF is 804 m (the natural spill elevation of the Main Pit is roughly 791 m (Table 2)). Figure 3 provides an overview of the conceptual dam design. The southern portion of the proposed dam will be founded on overburden soil; results of a detailed investigation into foundation conditions (with particular focus areas where ice-rich warm permafrost may be encountered) will need to be incorporated into the next stage of design.

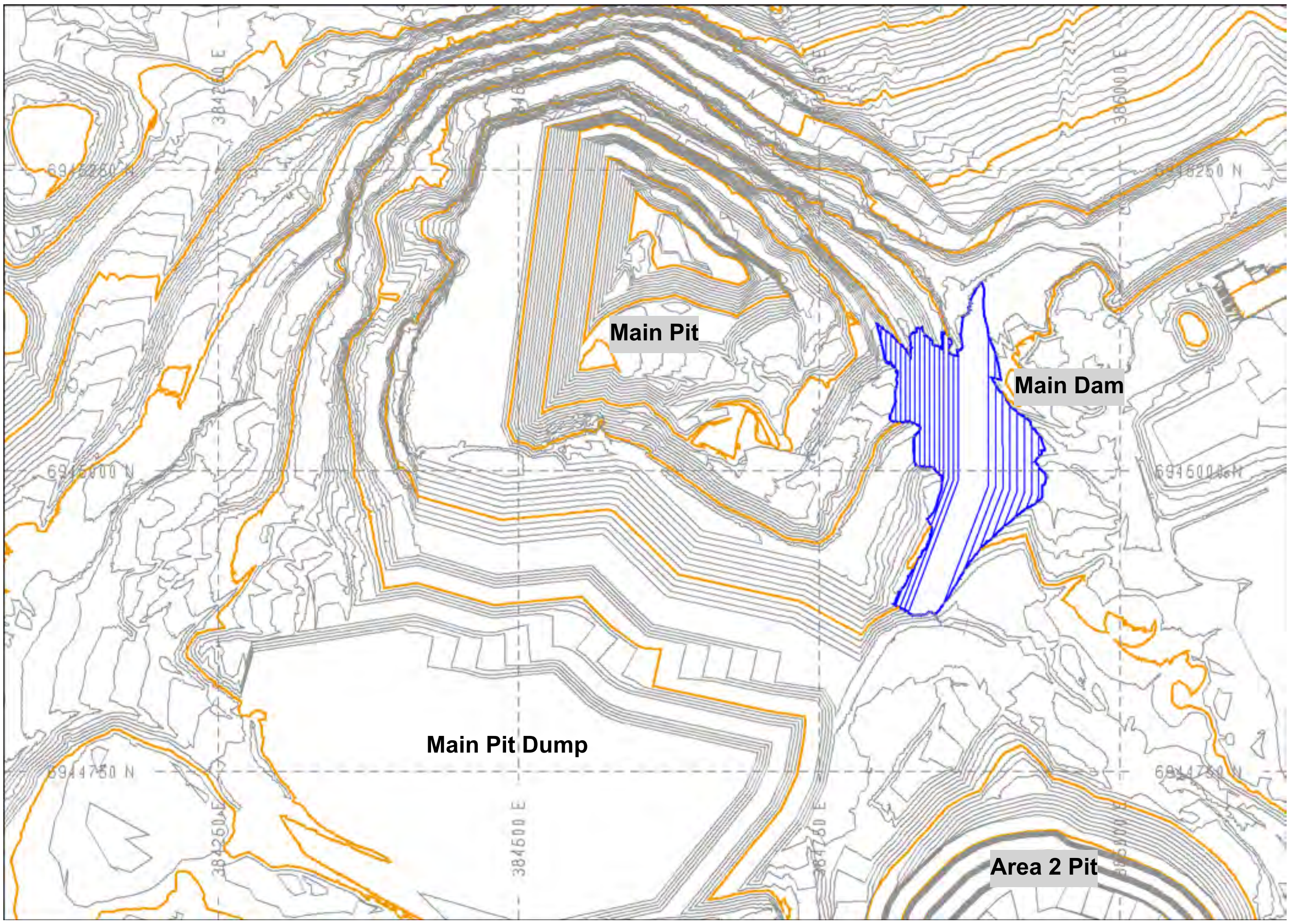

Figure 3: Overview of Main Pit showing conceptual location of Main Dam.

4.3.3 Management Considerations

The MPTMF will be operated such that a tailings beach is developed along the east side of the facility, minimizing the potential for seepage to the east. Storing NP:AP<3 waste rock within the MPTMF, completing the South Wall Buttress, and constructing the Main Pit Dump all require coordination with tailings placement to ensure optimal use of the MPTMF storage capacity. For all waste rock stored below the maximum operating limit of the MPTMF, water will fill the pore space as the adjacent tailings and water levels rise, and this volume of water needs to be taken into consideration during operational water management.

During closure, it is anticipated that the final tailings surface will be shaped to convey local runoff and water from upgradient catchments across the reclaimed MPTMF and through an engineered spillway to Area 2 Pit. The final tailings surface will be covered with an appropriate soil cover and conveyance works will be sized and designed according to appropriate closure criteria (ACG 2013).

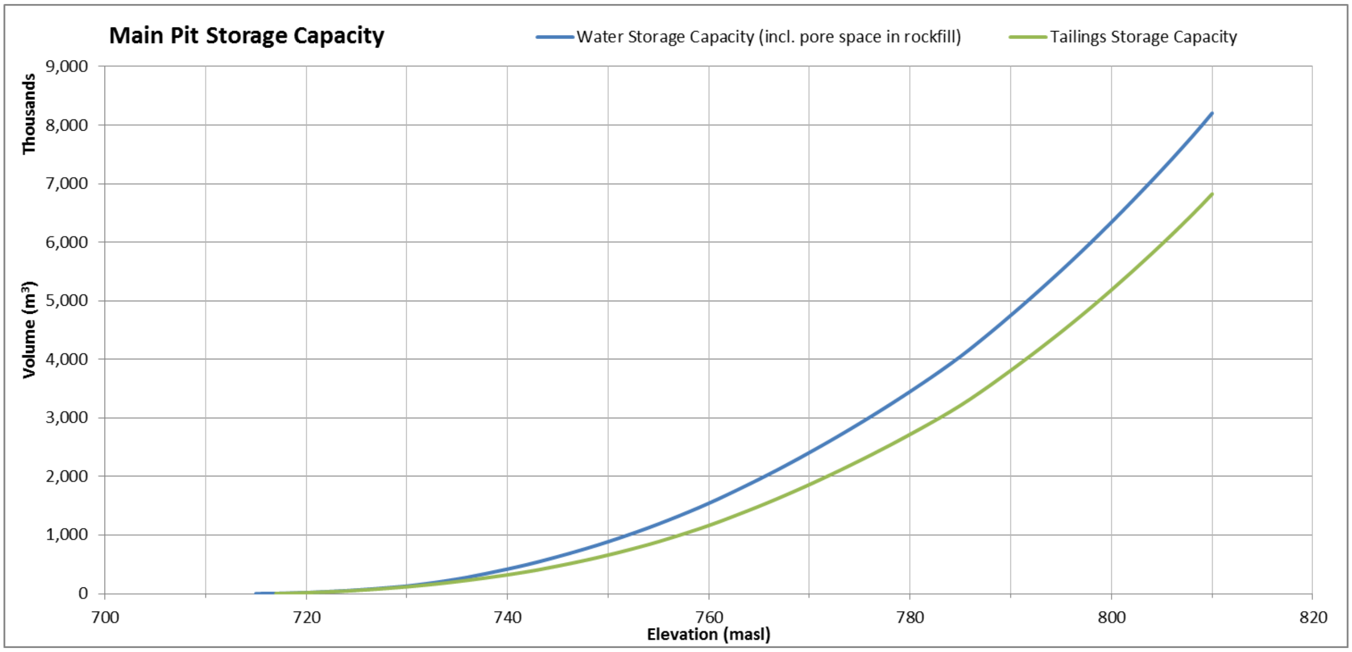

Figure 4: Main Pit TMF volume-elevation curves.

4.4 Area 2 Pit TMF (A2PTMF)

4.4.1 Capacity

The final Area 2 Pit TMF (A2PTMF) will consist of two intersecting pits separated by a saddle (Figure 5 and Figure 6). The larger and more northerly of the intersecting pits is a Phase IV development called Area 2 Stage 2 Pit (A2S2 Pit), while the smaller and more southerly pit will be a Phase V/VI development referred to as Area 2 Stage 3 Pit (A2S3 Pit).

A2S2 Pit is scheduled to receive tailings towards the end of Phase IV operations and into Phase V/VI operations. Prior to completion of A2S2 Pit, storage of tailings and water in A2S2 Pit is limited to that volume below the saddle elevation of 760 m (roughly 2.1 Mm^3) (Figure 7). After A2S3 Pit is complete (projected for Q4 2015), the entire volume of the combined A2S2 and A2S3 pits will be available for storage (Figure 7); the total storage capacity of the final Area 2 Pit below the natural spill elevation of 802 m will be approximately 7.9 Mm^3 (Table 2).

The storage curve for A2S2 Pit below the saddle elevation of 760 m is shown in Figure 8. The storage curve for A2S3 Pit is shown in Figure 9, with the volume stored in A2S2 Pit below 760 m subtracted from it. The total capacity of the A2PTMF is the sum of the two storage curves.

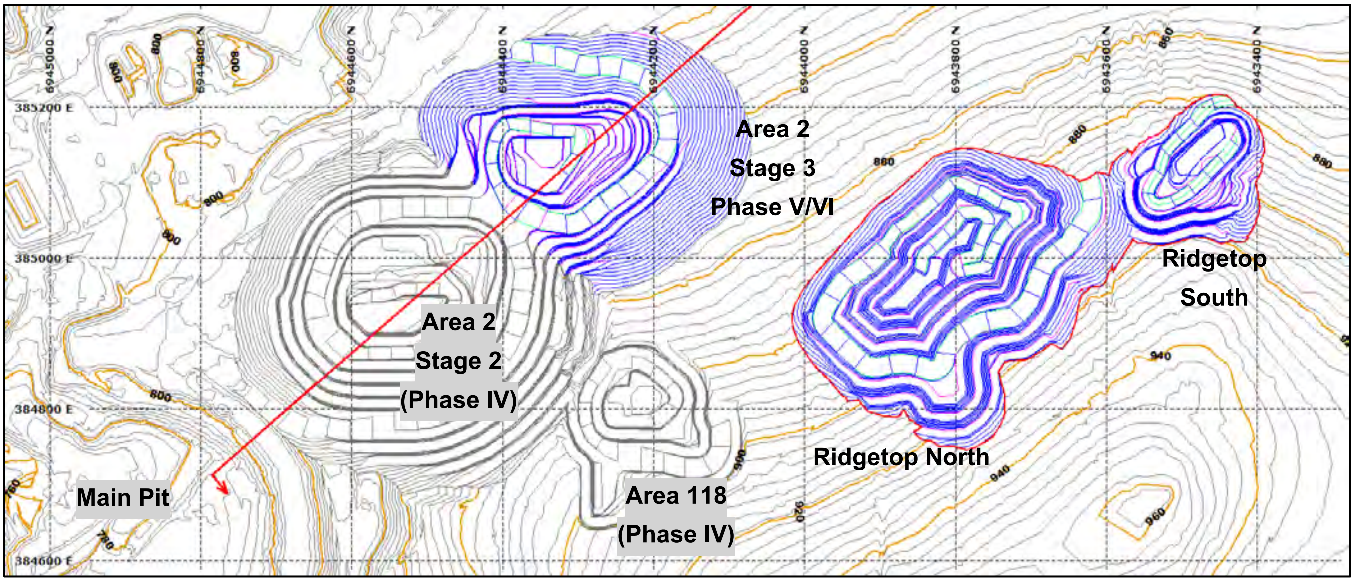

Figure 5: Overview of Phase V pits (excluding Minto North) showing section line for Figure 6 and Figure 7.

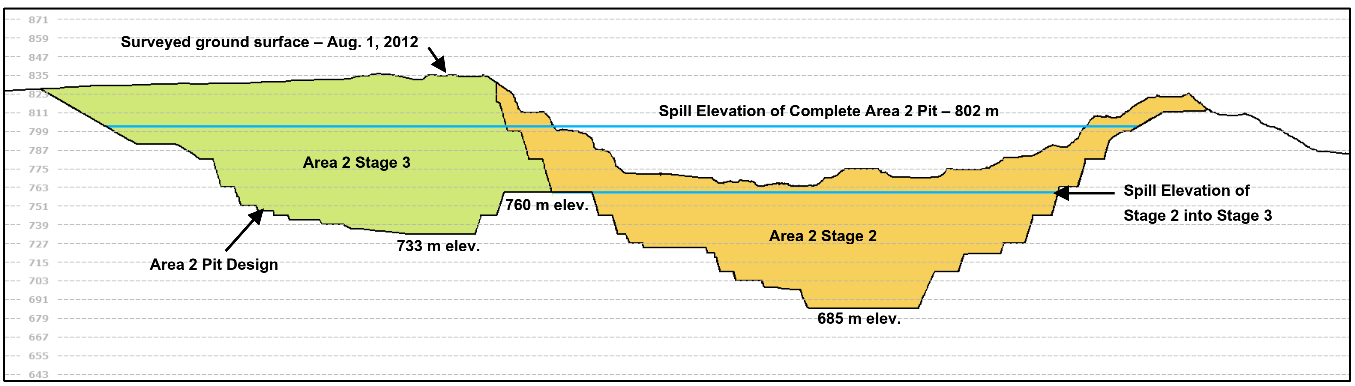

Figure 6: Section through Area 2 Pit showing staging and spill elevations.

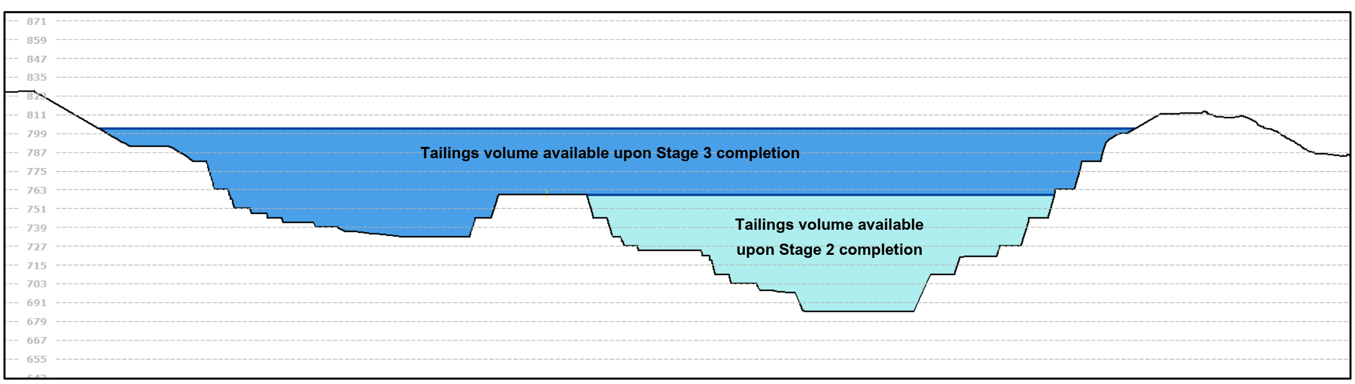

Figure 7: Section through Area 2 Pit showing tailings volume made available with staged mining of Area 2.

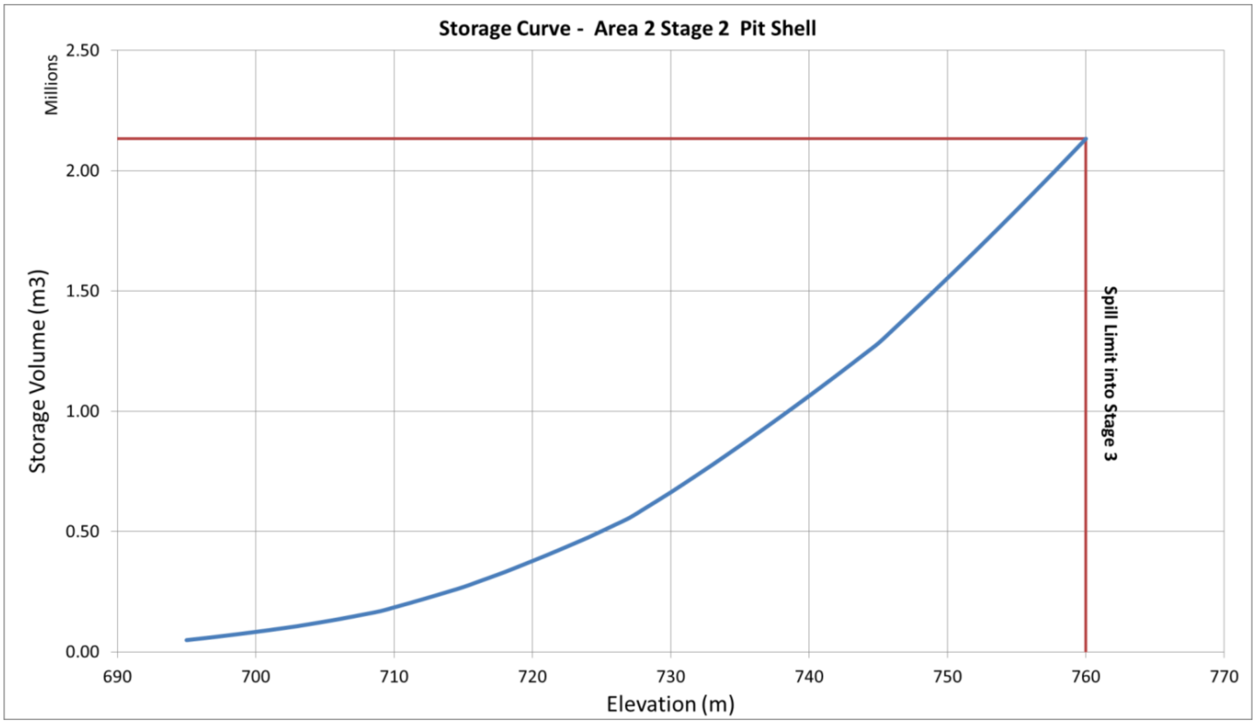

Figure 8: Storage curve for Area 2 Stage 2 (below 760 m elevation).

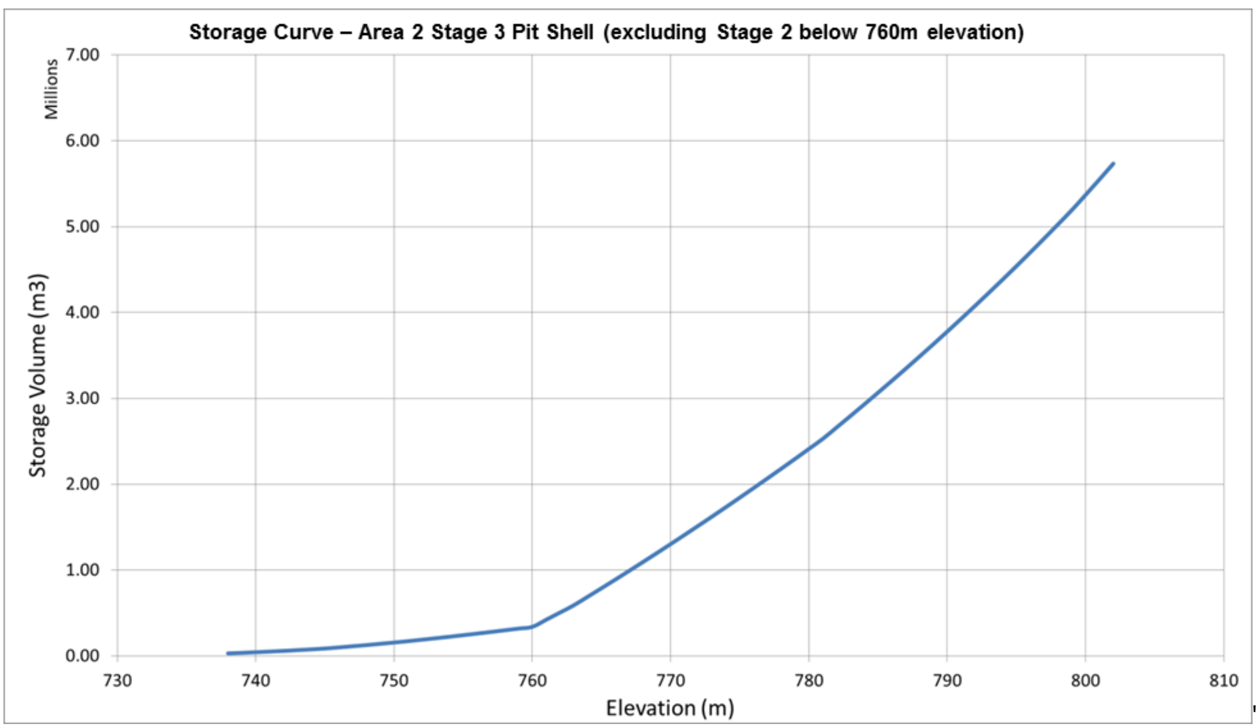

Figure 9: Storage curve for Area 2 Stage 3 (including Area 2 Stage 2 above 760 m elevation).

4.4.2 Management Considerations

At the end of Phase IV and the beginning of Phase V/VI, the A2PTMF will be used for storage of water, tailings, and NP:AP<3 waste rock. Once dam construction is under way, deposition will move back to the Main Pit TMF (MPTMF) and the function of A2PTMF will shift to being primarily a water management facility. In the final years of Phase V/VI operations, tailings will once again report to A2PTMF. These concepts are represented in the example Phase V/VI tailings deposition schedule that is discussed in Section 6. Excess water from both the Ridgetop North Pit TMF (RNPTMF) and MPTMF will be transferred to A2PTMF as required, and A2PTMF will be available to receive tailings when required.

The closure concepts for the A2PTMF are described in the Phase V/VI closure plan (ACG 2013); the following key aspects are summarized here for convenience. As the Minto site transitions into closure, the A2PTMF will receive water flows from:

- catchments above the pit;
- two major subcatchments of upper Minto Creek:
    - the south (W35a) subcatchment, which operationally will be routed to the water storage pond;
    - the southwest (W15) subcatchment, which will report to the A2PTMF through the MPTMF.

Post-closure, A2PTMF will discharge to the reconstructed Minto Creek channel via an appropriately designed and constructed spillway. After Phase V/VI tailings discharge is complete, it is expected to take from 2 to 4 years for A2PTMF to fill to capacity and discharge. The actual time to capacity will depend on water management decisions during and immediately following Phase V/VI operations, and on precipitation and runoff experienced at site during that time.

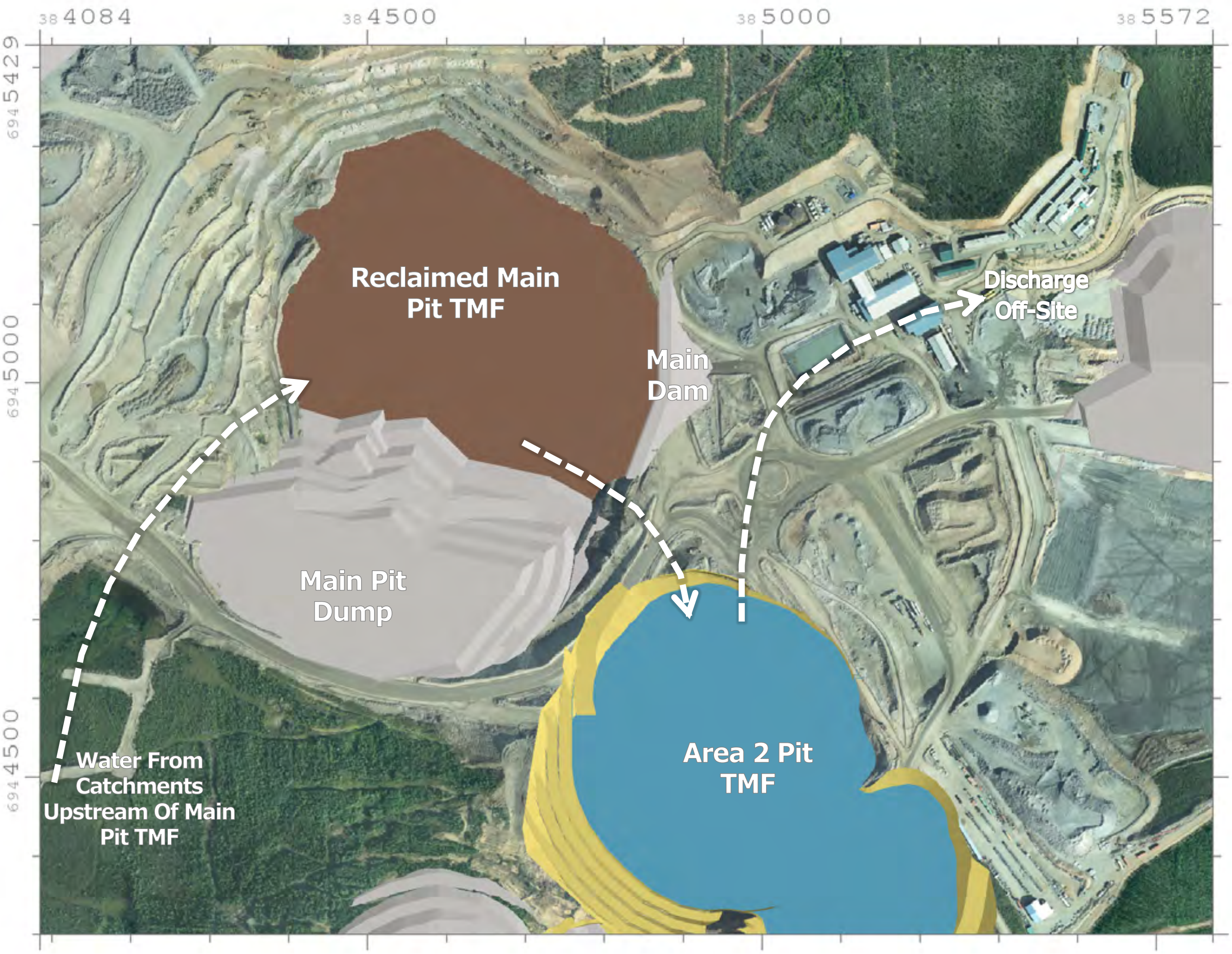

Figure 10: Conceptual post-closure water routing.

4.5 Ridgetop North Pit TMF (RNPTMF)

4.5.1 Capacity

Ridgetop North Pit (Figure 5) will be the final open pit mined as part of Phase V/VI, with mining scheduled to be completed during Q3 2017. The RNPTMF is projected to have a total storage volume of 1.9 Mm^3 (Table 2) below the natural spill elevation of 862 m. The storage curve for RNPTMF is shown in Figure 11. Because the final tailings surface will be at a shallow angle, tailings discharge will need to be carefully managed to ensure the available storage volume is used efficiently.

4.5.2 Management Considerations

The RNPTMF will receive only tailings slurry; no NP:AP<3 rock will be stored in this facility. During Phase V/VI operations, Minto anticipates pumping excess water from the RNPTMF to the adjacent A2PTMF for purposes of water management; there will be no surface discharge from the RNPTMF and no spillway.

After tailings placement is complete, an appropriate soil cover can be placed on the RNPTMF, contoured to control surface runoff and minimize or eliminate ponding.

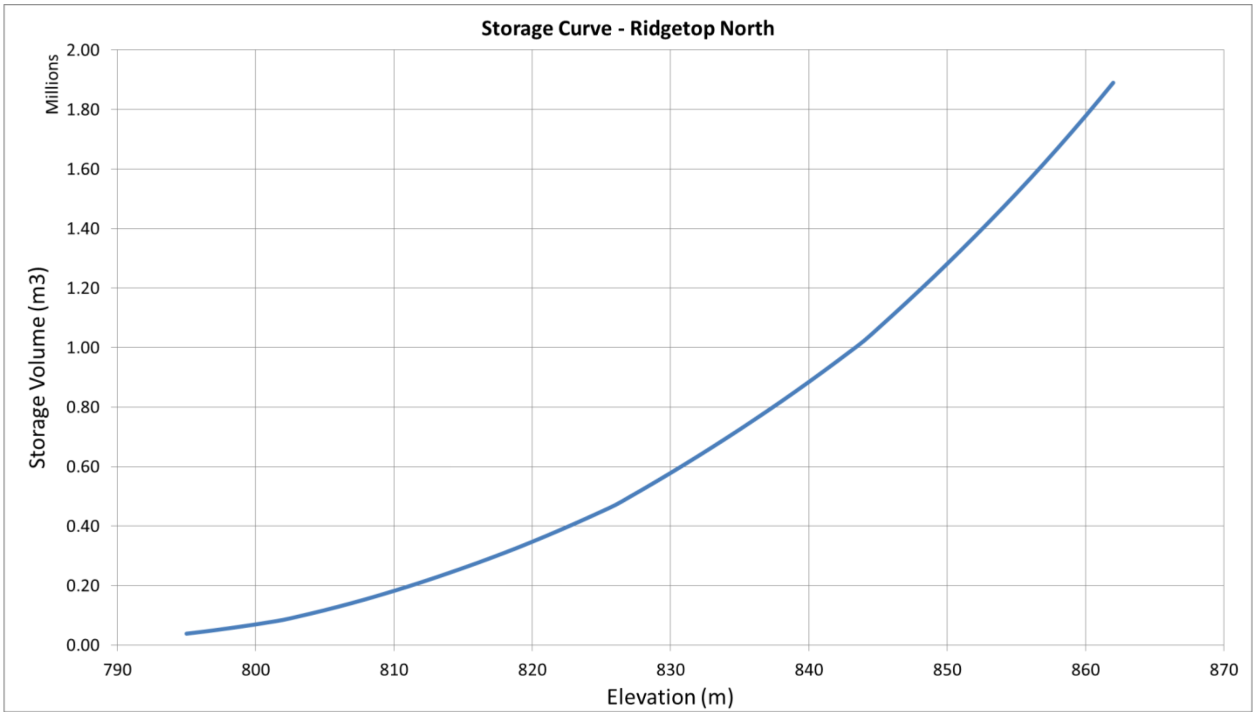

Figure 11: Storage curve for Ridgetop North.

4.6 Underground Backfill

Minto's underground mine plan currently uses a combination of room-and-pillar and post-pillar cut-and-fill mining methods. Should stopes of suitable size and continuity be delineated, Minto may employ open stoping methods in combination with cemented paste-fill or sand-fill. A portion of the tailings stream may therefore be used for underground backfill, although planning is not sufficiently advanced at this stage to estimate the quantities of tailings required for support. If underground backfill of tailings is undertaken, all tailings backfill will placed in workings that are below the respective portal elevation and are expected to be saturated in the long term.

It is not currently possible to calculate the quantity of tailings (if any) that will ultimately be needed for backfill, but any amount used underground would decrease surface storage requirements. In terms of environmental effects, loadings from underground backfilled tailings to the receiving environment would be similar to or lower than for similar tailings stored on surface. As such, the impact assessment that has been carried out for in-pit tailings disposal can be considered to apply to both in-pit and underground disposal of Phase V/VI tailings.

5 Water Management Considerations

Plans for water management at Minto during Phase V/VI operations are presented in the WMP (water management plan) (Minto 2013c). The following elements of this tailings management plan represent important areas of overlap between the TMP and the WMP.

- The operational requirement for maintaining a surge capacity of 975,000 m^3 will be achieved over the life of Phase V/VI by reserving adequate volume in a combination of A2PTMF and MPTMF.
- Process water for milling operations will be drawn from water stored in A2PTMF and MPTMF.

- Water will be transferred from RNPTMF to A2PTMF as required, with the specific objective of managing excess water in RNPTMF and thereby avoiding the need for surface discharge from RNPTMF.

6 Deposition Schedule

Minto intends to use the three Phase V/VI tailings facilities as required to store tailings solids and NP:AP<3 rock, and to manage water; these operational decisions will be based on water levels, achieved tailings density, and mill throughput.

The example deposition schedule detailed in Figure 12 represents a scenario based on design values for mill throughput and tailings density, as well as projected pit completion dates. The schedule includes the transition from Phase IV operations, and can be summarized as follows:

- The schedule begins with deposition of tailings and NP:AP<3 rock to the MPTMF. When A2S2 mining is complete and the A2PTMF is available, deposition shifts to the new TMF. This keeps fill volumes down in the MPTMF in advance of construction of the Main Dam. Tailings deposition in the Stage 2 portion of A2PTMF occurs while Minto North and A2S3 are mined.

- The Main Dam is completed using waste rock and overburden from A2S3; tailings deposition shifts back to the newly expanded MPTMF.

- Tailings are deposited into the RNPTMF once Ridgetop North Pit is complete; this allows the pit to be filled and may allow progressive reclamation of the RNPTMF prior to the end of Phase V/VI.

- When the RNPTMF is full, tailings deposition returns to the MPTMF and continues until it is at final design grade.

- Final tailings deposition reports to A2PTMF for the remainder of Phase V/VI operations.

In this example schedule, the A2PTMF is the mine’s primary water management facility.

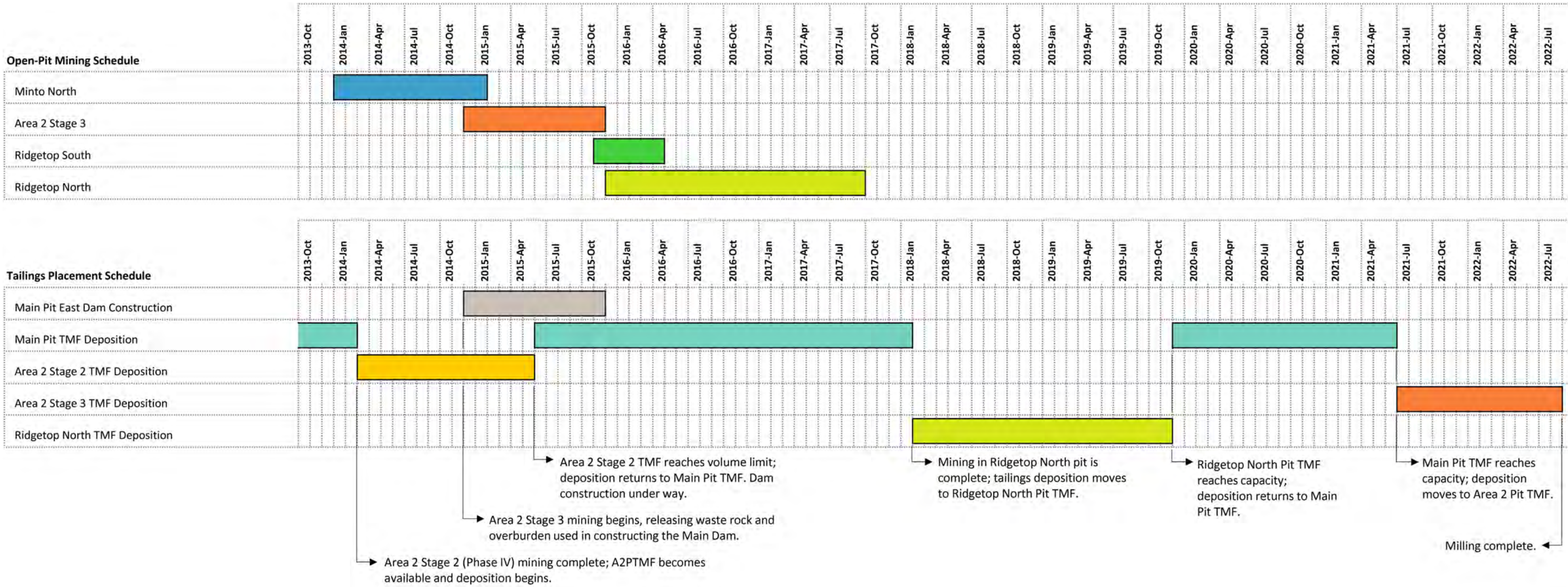

Figure 12: Example Phase V/VI tailings deposition schedule.

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SRK Consulting. 2013c. Main Dam Conceptual Design Report. Report prepared for Capstone Mining Corporation.

Main Dam Conceptual Design Report

Prepared for

Minto Explorations Ltd.

Prepared by

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1CM002.010
June 2013

Main Dam Conceptual Design Report

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Executive Summary

During the next planned phases of mining (Minto Phase V/VI), additional storage capacity will be needed for tailings and NP:AP < 3 waste rock (rock with neutralization potential: acid potential ratio values less than 3). Since the total volume of tailings and NP:AP < 3 waste rock is expected to exceed the natural capacity of Main Pit, a waste rock and tailings storage alternatives assessment, including an evaluation of candidate tailings disposal sites, was carried out. The assessment concluded the preferred tailings disposal strategy is hydraulically placed in-pit storage within Main, Area 2, and Ridgetop North pits. However, since there is insufficient natural containment capacity to store the planned waste volumes, operational volumes and required surge capacity for site surface runoff, engineered interventions are required to meet the required storage capacity.

After consideration of options for increasing in-pit storage capacity, Minto has identified construction of a containment dam to increase the storage capacity of Main Pit as the best solution. The subsequent conceptual design presented in this report is based on limited field characterization and engineering analysis. The concept has, however, been developed as far as practical using currently available factual, anecdotal, and inferred information. It is, however, acknowledged that the dam will be founded on challenging foundation materials that have in part contributed towards three significant mass ground movements on-site; therefore, diligent investigation and engineering analysis will be required as detailed engineering advances.

The design as presented has been developed with sufficient detail to meet the Yukon Environmental and Socio-economic Assessment Board's (YESAB) "Dam Guide: Design Expectation and Required Information", as it pertains to a Project Proposal submission.

The Main Dam will retain both tailings solids and free water during its operational phase. At closure the dam will not retain free water; however, surface runoff flow-through facilities will remain in place. Moderate seepage from the dam during the operational phase would be acceptable provided that the structural integrity of the dam is not compromised. Such seepage must, however, be monitored and captured if necessary to prevent negative downstream operational and environmental impacts.

A preliminary Dam Hazard Classification for the Main Dam has been carried out and concludes that, since the dam will be located upstream of the mill and processing facilities, there is likelihood for loss of life should a dam failure occur. The appropriate hazard category for the dam is therefore VERY HIGH.

To increase the design storage capacity of the Main Pit, a roughly 300 m long containment dam with a maximum crest height of 23 m must be constructed across the low point along its east wall. The average height of the dam is about 10 m. This dam will allow for continuation of the existing deposition strategy of conventional low solids content (50 to 60% solids by weight) slurry tailings. The Main Dam will have a Full Supply Level of 804 m and a total freeboard of 2 m, which puts the final crest elevation at 806 m.

A permanent spillway will be constructed south of the dam, directing water towards the Area 2 Pit in accordance with the site wide water management plan. The spillway has to be continuously crossed with mine haul trucks during operations and, therefore, it has been designed as a large swale with a 25 m base width and 10H:1V side slopes.

Construction material for the dam and spillway consists of core, transition and run-of-mine material. All the material will be sourced locally from mine development areas.

To advance engineering on the Main Dam from the conceptual level presented in this report through preliminary and ultimately detailed engineering, detailed foundation characterization, borrow identification and characterization, tailings confirmation characterization, and geotechnical and hydro-technical engineering analysis must be carried out. In addition, design, construction, and operations documentation must be prepared.

Table of Contents

1 Introduction 1
1.1 Background 1
1.2 Scope of Work 1
1.3 Report Layout 2
2 Site Characterization Data 3
2.1 Climate 3
2.2 Physiography 3
2.3 Surface Hydrology 3
2.4 Regional Geology 4
2.5 Bedrock Conditions 5
2.5.1 Composition 5
2.5.2 Weathered Bedrock 5
2.5.3 Fresh Bedrock 5
2.6 Major Features 6
2.6.1 Faults 6
2.6.2 Paleochannel 6
2.7 Overburden 6
2.8 Permafrost 7
2.9 History of Ground Instability 7
2.10 Hydrogeology 8
2.11 Tectonic Setting and Seismicity 8
2.12 Tailings 8
2.12.1 Physical Properties 8
2.12.2 Geochemical Properties 9
3 Design Criteria and Assumptions 10
3.1 Design Standards 10
3.2 Design Basis 10
3.3 Storage Requirements 10
3.3.1 Waste (Tailings and NP:AP < 3 Waste Rock) and Water Volumes 10
3.3.2 Other Considerations 11
3.4 Dam Hazard Classification 11
3.5 Inundation Zone 13
3.6 Water Balance 13
3.7 Geotechnical Criteria 13
3.7.1 Design Earthquake 13
3.7.2 Stability Criteria 14

3.8 Hydrotechnical Criteria 14
3.8.1 Inflow Design Flood 14
3.8.2 Freeboard 14
3.8.3 Spillway 14
4 Design Alternatives 15
4.1 Alternate Tailings Deposition Sites 15
4.2 Alternate Deposition Strategies 15
4.3 Alternate Dam Locations 15
4.4 Alternate Dam Designs 16
5 Design Analysis 17
5.1 Concept 17
5.1.1 Main Dam 17
5.1.2 Spillway 17
5.2 Foundation Conditions 17
5.2.1 Main Dam 17
5.2.2 Spillway 18
5.3 Geometric Design 18
5.3.1 Key 18
5.3.2 Core 18
5.3.3 Transition 18
5.3.4 Shell 18
5.3.5 Spillway Cut 18
5.3.6 Spillway Armouring 18
5.4 Slope Stability 19
5.4.1 Main Dam 19
5.4.2 Spillway 19
5.5 Settlement 19
5.6 Creep 20
5.7 Seepage 20
5.8 Hydrotechnical Design 20
5.8.1 Main Dam 20
5.8.2 Spillway 21
5.9 Instrumentation and Monitoring 21
6 Dam Construction 22
6.1 Construction Materials 22
6.2 Construction Equipment 22
6.3 Construction Quality Control and Quality Assurance 22
6.4 Construction Quantities 22

6.5 Construction Procedures 23
7 Dam Operation, Maintenance and Monitoring........ 24
7.1 Tailings Deposition (Operational) Plan 24
7.2 Water Management Plan 24
8 Dam Closure........ 25
9 Advancing Engineering 26
10 References........ 28

List of Figures

Figure 1: Site Location and Layout
Figure 2: Site Layout and Catchment/Groundwater Flow Directions
Figure 3: Permafrost Extent, Major Features and Historic Overburden Investigations
Figure 4: Inferred Overburden Thickness
Figure 5: Capacity and Surface Area vs. Stage Elevation
Figure 6: Plan Layout at Main Pit Tailings Management Facility
Figure 7: Main Dam Foundation Conditions (Permafrost and Major Features)
Figure 8: Main Dam Foundation Conditions (Overburden Thickness)
Figure 9: Typical Main Dam Cross Sections (Sheet 1 of 2)
Figure 10: Typical Main Dam Cross Sections (Sheet 2 of 2)
Figure 11: Typical Main Dam Profile
Figure 12: Main Dam Spillway Foundation Conditions (Permafrost and Major Features)
Figure 13: Main Dam Spillway Foundation Conditions (Overburden Thickness)
Figure 14: Typical Spillway Sections
Figure 15: Typical Spillway Cross Section

List of Tables

Table 1: Natural In-Pit Storage Capacity. 10
Table 2: Cumulative Tailings and NP:AP < 3 Production Estimates. 10
Table 3: Cumulative Storage Requirements through Completion of Phase V/VI. 11
Table 4: Dam Classification 12

1 Introduction

1.1 Background

The Minto Mine, owned and operated by Minto Explorations Ltd. (a wholly-owned subsidiary of Capstone Mining Corporation) is located 240 km north of Whitehorse in central Yukon, Canada as illustrated in Figure 1. Mine development started in 2007 and at that time, tailings deposition consisted of filtered tailings deposited onto a dry-stack facility. The mine subsequently expanded and is currently operating under the Phase IV mine plan. When the Phase IV water licence was received, tailings deposition transitioned to thickened (50 to 60% solids by weight) hydraulic placement of tailings directly into the Main Pit (Figure 2).

During the next planned phases of mining (Minto Phase V/VI), additional storage capacity will be needed for storage of tailings, water (operational and surge capacity) and waste rock with a neutralization potential: acid potential ratio value of less than 3 (NP:AP < 3). Since the total volume of tailings, water and NP:AP < 3 waste rock is expected to exceed the natural capacity of the Main Pit, a comprehensive waste rock and tailings storage alternatives assessment, including an evaluation of candidate tailings disposal sites, was carried out in 2012 (SRK 2013a).
This assessment concluded that the preferred tailings disposal strategy is thickened (50 to 60% solids by weight) hydraulically placed in-pit storage within the Main Pit, Area 2 Pit and Ridgetop North Pit. However, since there is insufficient natural containment capacity to store the planned waste volumes, operational volumes, and required surge capacity for site surface runoff, engineered interventions are required to meet the required storage capacity.

After consideration of options for increasing in-pit storage capacity, Minto has identified construction of a containment dam to increase the storage capacity of the Main Pit as the preferred solution. This report provides the conceptual design of this proposed tailings containment dam.

1.2 Scope of Work

SRK Consulting (Canada) Inc. was contracted by Minto to carry out a comprehensive tailings alternatives assessment (SRK 2013a), and, subsequently, to develop the conceptual design of the proposed tailings containment dam that will be located on the east side of the Main Pit (Figure 6). The design of the containment dam cannot be completely separated from the overall tailings management plan, and, therefore, this report discusses elements of the tailings management plan as it pertains to the conceptual dam design. Complete details of the tailings management plan are, however, described in Minto (2013a).

The design presented here is conceptual, which means that limited field characterization and engineering analysis have been carried out. The concept has been developed as far as practical, using currently available factual, anecdotal, and inferred information, and to sufficient detail to meet the Yukon Environmental and Socio-economic Assessment Board’s (YESAB) “*Dam Guide: Design Expectation and Required Information*” (Yukon Environment 2012) as it pertains to a project proposal submission.

1.3 Report Layout

Section 2 of this report provides a brief overview of the general site conditions that are relevant to the conceptual Main Dam design. Appropriate design criteria and assumptions are presented in Section 3. Dam design alternatives that were considered for the Main Dam are discussed in Section 4. Section 5 summarizes the conceptual design of the dam, while Section 6 gives an overview of the construction concepts for the dam. A discussion of the dam operation, maintenance, and monitoring is presented in Section 7. The conceptual closure plan for the dam is presented in Section 8. Section 9 concludes this report with a summary of additional characterization studies and engineering analysis that will be carried out as the design advances.

2 Site Characterization Data

2.1 Climate

The climate at Minto Mine is considered dry, sub-humid, sub-arctic with short cool summers and long cold winters. The average temperature in the summer is 10°C and the average temperature in the winter is -20°C (Minto 2012). The mean annual total precipitation is about 335 mm. This precipitation is split roughly 50/50 in the form of rain and snow. The mean annual evaporation at the site is about 402 mm (SRK 2013b).

Site specific climate data is available with records from two on-site weather stations with data spanning from 2005 to 2011. Regional climate data is available from the Pelly Ranch station, managed by Environment Canada. This station is located about 25 km north of Minto and has data dating back to 1955 (SRK 2013b).

2.2 Physiography

The property lies in the Dawson Range, part of the Klondike Plateau, an uplifted surface that has been dissected by erosion. Local topography consists of rounded rolling hills and ridges and broad valleys. The highest elevation on the property is approximately 1,000 m above sea level, compared to elevations of 460 m along the Yukon River. Slopes on the property are relatively gentle and do not present accessibility problems. Bedrock outcrops can often be found at the tops of hills and ridges. There are no avalanche risks on the property (Minto 2012).

Overburden is colluvium primarily comprised of granite-based sand from weathering of the granitic bedrock in the area and is generally thin but pervasive. Deeper deposits, especially the in-filled, pre-glacial channel (or paleochannel) approximately in the center of the property, include fine-grained silts and clays with sporadic inclusion of ice lenses and zones of massive ice. South-facing slopes generally do not contain permafrost and are well-drained. In contrast, valley bottoms and north-facing slopes typically contain permafrost. A more comprehensive description of the site geologic and overburden conditions are presented further on in this section.

Vegetation in the area is sub-arctic boreal forest made up of largely spruce and poplar trees. The area has experienced several wildfires over the years and has no old-growth trees remaining (Minto 2012).

2.3 Surface Hydrology

Minto Mine is situated in the headwaters of Minto Creek, which follows a moderately steep-sided ENE-trending V-shaped valley before reporting to the Yukon River (Figure 2). The profile of the creek contains a steep section where the channel is incised into exposed bedrock (commonly referred to as “Minto Canyon”), and it is useful to consider the upper and lower portions of the catchment independently.

The existing mine facilities and all but one of the proposed Phase V/VI facilities are located within the upper Minto Creek watershed, upgradient of the Water Storage Dam. The Water Storage Dam is constructed at a point where the Minto Creek valley narrows and naturally directs surface and groundwater flow through a narrow cross-section. Along the profile of Minto Creek between the Water Storage Dam and the top of Minto Canyon, overburden tapers out and is believed to eliminate substantial groundwater flow between the upper and lower portions of Minto Creek.

Lower Minto Creek extends from the Water Storage Dam to the confluence of Minto Creek with the Yukon River and is about three times the size of the Upper Minto Creek catchment. The lower catchment, however, includes a significant amount of undisturbed catchment area.

The Minto North Pit represents the only Phase V/VI project component located outside the Minto Creek watershed. It is situated in the headwaters of the McGinty Creek catchment located immediately north of the Minto Creek catchment. This water also discharges to the Yukon River. The Minto North Pit will be located just north of the catchment divide roughly 500 m north of the existing Main Waste Dump (itself wholly within the Minto Creek catchment) (Minto 2012).

2.4 Regional Geology

The Minto region is located within the central portion of the accretionary complex known as the Yukon-Tanana (YT) terrane, which lies between continental margin rocks of ancestral North America to the east and arc and oceanic terranes accreted in Mesozoic time to the west.
The pericratonic YT terrane is comprised of Proterozoic and Paleozoic metamorphic rock intruded by Mesozoic plutons and covered by extrusive volcanics of Upper Cretaceous and Tertiary age (Colpron 2005).

The YT terrane is located within the western portion of the Omineca Belt of the Cordillera and is composed of variably metamorphosed sedimentary and igneous rocks that have undergone similar geomorphologic processes over the past billion years of geological history, climate, and glaciation. Much of the northwestern portion of the Omineca Belt including the Minto region was not glaciated during the most recent event resulting in a thicker cover of soil and weathered rock in some areas of the region (Hart 2002).

The Minto Mine site is located within the Klotassin batholith, an intrusive granitic pluton that intruded the YT terrane in early Jurassic time. The Klotassin batholith consists primarily of granodiorite, but varies in composition from quartz diorite to quartz monzonite. The area to the south of the Minto Mine site is covered with basalt and andesite flows of the Upper Cretaceous, Carmacks Group. The batholith is intruded by basalt and andesite dikes believed to have been feeders of the Carmacks Group volcanics. Quartz-feldspar pegmatite veins and dikes are also common in the Klatossin batholith (Hatch 2006).

2.5 Bedrock Conditions

2.5.1 Composition

The project area is predominantly underlain by igneous rocks of granodiorite composition. The granodiorite is generally categorized based on textures associated with foliation. Massive granodiorite grades to foliated granodiorite characterized by increased biotite content. This biotite-rich foliated granodiorite hosts the mineralized zones of copper sulphide.

Minor amounts of other lithologies consisting of small dykes of simple quartz-feldspar pegmatite, aplite, and an aphanitic textured intermediate composition rock are also observed. Bodies of all of these units are relatively thin and rarely exceed 1 m core intersections. These dykes are relatively late, generally postdating the peak ductile deformation event; however, some pegmatite and aplite bodies observed in a rock cut located north of the mill complex are openly folded.

There has been evidence of conglomerate and volcanic flows in drill core. A conglomerate unit bearing local granodiorite clasts occurs across much of the southern part of the project area.

Over 50 laboratory tests have been carried out on cored bedrock samples including direct shear strength, uniaxial and triaxial compressive strength, direct tensile strength, unit weight, and elastic properties (SRK 2007).

2.5.2 Weathered Bedrock

The upper 5 to 15 m of bedrock is generally moderately to heavily weathered. Characterized by higher fracture frequencies, consistently low intact rock strength and zones of heavy alteration and oxidation, the weathered bedrock (or residuum) is of significantly lower quality than the unweathered (or fresh) rock below and is, therefore, considered to be a separate engineering lithology. Mean rock quality designation (RQD) and rock mass rating (RMR) values of 73 and 54, respectively, have been measured for the weathered rock, which, based on the Bieniawski RMR classification system, translates to fair to good quality rock mass (SRK 2007). Drilling and blasting of the weathered rock is not required when pit development is carried out.

2.5.3 Fresh Bedrock

The fresh or unweathered bedrock at Minto is a much more competent rock mass than the weathered, possessing lower fracture frequencies and significantly higher intact rock strengths. The fresh rock encountered is relatively massive and showed fewer signs of alteration and weathering when compared to the weathered rock. The fresh bedrock also demonstrated higher overall RMR values with a mean value of 64. The fresh rock would be described as a fair to good quality rock mass based on the Bieniawski RMR system. RQD values for the fresh rock were also higher than the weathered rock with a mean value of 85%.

Several zones of foliated granodiorite were encountered in the fresh rock but exhibited similar intact rock strengths and rock mass properties as did samples of non-foliated granodiorite (SRK 2007).

2.6 Major Features

2.6.1 Faults

Three significant fault structures intercept the Main Pit (Figure 3). The DEF fault is at the northern end of the Main Pit and strikes nearly east-west and dips north-northeast. This fault has been characterized with high gouge content that, based on water pressures measured across the fault, acts as a barrier to groundwater flow (SRK 2010).

The Minto Creek fault (or Fault 2) strikes almost perfectly east-west where it bisects the Main Pit and is believed to be north dipping (SRK 2008). Horizontal and lateral displacements have been observed, but are not clearly defined. Although surface expression of this fault exists for horizontal and vertical displacement, the magnitude of movement is not well characterized.

The third fault lies to the south of the previous two and strikes south-east to north-west, and possibly intersects the other two faults towards the western edge of the pit. This fault is believed to dip north-northeast.

2.6.2 Paleochannel

A deep erosional feature or paleochannel has been observed through previous geotechnical (Golder 1976 and EBA 1996) and resource drilling. The approximate location of this channel has been marked on Figure 3**.** This channel, which is up to 100 m deep in places, is a pre-glacial channel that has been in-filled with glacially-derived sediments consisting predominantly of silt and fine sand with occasional lenses of clay and coarse sand to gravel. The soil is high in organic content and is known to contain permafrost as well as ice lenses and massive ice up to 4 m thick in places.

2.7 Overburden

A large amount of overburden characterization has been carried out at the project site (ConeTec 2010; EBA 1994, 1995, 1997, 1998, 2006, 2007, 2008a, 2008b, 2011a, 2011b, 2012; Golder 1976; SRK 1994, 2008, 2010, 2012a, and 2012b). Figure 3 and Figure 6 provide a summary overview of the extent of this characterization.

Overburden thickness across the site is closely correlated with geomorphological features. Near topographic highs, there is little to no overburden, with increasing overburden thickness down valley slopes and generally the thickest deposits in valley bottoms (with the exception of the paleochannel described in Section 2.6). Overburden thicknesses range from very shallow (less than 5 m) close to bedrock outcrop zones to about 100 m along the paleochannel, and 30 to 50 m in the Minto Creek valley adjacent to the paleochannel.

Generally, ridge tops are dominated by sandy, residual soils grading to weathered bedrock. Fine weathered products have been washed downslope, which means within the valleys, finer sandy silts and clays are found. Layers of sandy gravel with cobbles are occasionally found within the overburden unit; however, the overburden appears sufficiently heterogeneous that continuous high conductivity zones are not expected (with the possible exception of the paleochannel).

2.8 Permafrost

Instrumentation to monitor ground temperatures has been installed across the site as part of various studies conducted since 1974. The current general understanding of permafrost distribution is presented in Figure 3 (adapted from EBA 2011a and EBAb). Generally north-facing slopes display geomorphic and vegetation evidence indicating the presence of permafrost or discontinuous permafrost. Ridge crests and south facing slopes typically do not have permafrost.

Where permafrost is present it is generally warm, with temperatures close to -0.5^{o}C. The active layer is variable ranging from less than 1 m to about 3 m thick. Total depth of permafrost is variable, but, in certain locations is known to extend down to the base of the paleochannel where massive ice has been identified at depth.

2.9 History of Ground Instability

The challenging overburden conditions as described in the preceding sections have, in part, contributed to significant ground instability at three locations on the Minto Mine site:

- Creep displacement of the Dry Stack Tailings Storage Facility;
- The Main Pit south wall failure; and
- Foundation movements of the southwest waste dump foundation.

The Dry Stack Tailings Storage Facility is constructed over the paleochannel. Detailed field characterization has confirmed that movement can be attributed to a shear surface occurring within a deep (26 to 64 m bgs), very ice rich clay layer located approximately 7 m from the bedrock contact. The geometry of the slip surface is well defined beneath the facility, but the exit of the surface has not been located. It is believed that the onset or increase in shearing beneath the facility was most likely a result of warming of the ice-rich clay layer caused by placement of the tailings and possibly the waste rock stock piles to the west. By raising the temperature in the ice-rich clay layer, the resistance to movement has been lowered likely more so than the actual mass of the added fill has increased the driving force (SRK 2012b). The proposed mitigation measure is a buttress in the form of the Mill Valley Fill Extension; however, movement has not ceased (but has slowed down) and a further addition to the buttress is being considered.

Geotechnical drilling, testing, and instrumentation indicated that displacements associated with the Main Pit's south wall failure and foundation movement of the southwest dump were linked and are associated with an ice-rich, plastic clay layer(s) generally within the lower portion of the paleochannel materials (i.e., essentially the same foundation conditions as underneath the Dry Stack Tailings Storage Facility). In contrast with the displacements associated with the Dry Stack Tailings Storage Facility, displacements of the Main Pit south wall and the southwest dump foundation are believed to have been initiated primarily by excavation of the Main Pit, which simply created a void for the ice-rich overburden soils to move towards due to gravitational forces. The buttress, which is being constructed, has slowed down the movement and is expected to completely stop movement when it has reached its design height (SRK 2012a).

2.10 Hydrogeology

At Minto, groundwater flow direction is dominated by topography, with groundwater flowing from the upland areas towards Minto Creek. Because the system has a main drainage channel (i.e., Minto Creek), groundwater can be captured and monitored at multiple points along the gradient, thus providing the opportunity to track possible effects on seepage from the Main Dam whether it emerges as toe seepage or reports to deeper groundwater. Figure 2 provides the generalized groundwater flow within the Upper Minto Creek catchment (SRK 2013c).

2.11 Tectonic Setting and Seismicity

The tectonics and seismicity of the southwestern Yukon Territory is influenced primarily by the Pacific and North American lithospheric plate margins. In the St. Elias region of the southwest Yukon Territory, northwest British Columbia, and southeast Alaska, the boundary of the two lithospheric plates changes from one of right lateral transform to one of subduction where instead of sliding past each other, the Pacific Plate is forced beneath the stable North American plate resulting in uplift of the St. Elias region. This transfer of force along the fault into uplift or mountain building dissipates tectonic energy, reducing seismic effects on the region northeast of or across the fault.

These same tectonic forces are responsible for displacements along the active, Denali Fault system. The most significant inland zone of seismicity in the Yukon follows the Dalton and Duke River segments of the Denali Fault system through the southwest area of the territory.

Located approximately 75km to the northeast, the Tintina Fault is the closest tectonic fault to the Minto Mine. The Tintina Fault is sub-parallel to the Denali Fault system and, like the Denali Fault system, is of right lateral transverse orientation. Although arguably considered inactive today, the Tintina Fault was at one time a major fault of the area defining the boundary of the accretionary zone and ancestral North America. Both the Denali and Tintina faults are believed to have displaced hundreds of kilometers over geologic history (SRK 2007).

2.12 Tailings

2.12.1 Physical Properties

At least three physical tailings characterization campaigns have been carried out specifically focused towards understanding the tailings performance as it relates to design of tailings deposition at the site (EBA 1997, Klohn Crippen Berger 2013, SRK 2012a and 2012b). This includes indicator properties (grain size distribution and Atterberg Limits), consolidation tests, settling tests, specific gravity, and strength and saturated hydraulic conductivity tests. In addition, there has been additional characterization of the in-situ dry-stack tailings specifically to evaluate strength characteristics of the material (SRK 2012a and 2012b). The tailings can be classified as sand and silt with a trace of low plasticity clay.

Although the tailings deposition changed from dry-stack placement to hydraulically placed tailings into the Main Pit over the period of operations to date, the actual tailings physical properties have not changed and, therefore, the available database of information remains valid.

The dry-stack tailings have a measured in-place dry density of 1.6 t/m^3 following consolidation (EBA 1997) with a saturated hydraulic conductivity of 9.65×10^{-6} cm/s. Settling data of the sub-aqueously, hydraulically placed tailings at different slurry contents of 55% and 60% recorded settled densities of 1.084 and 1.218 t/m^3, respectively (Klohn Crippen Berger 2013). Settlement was rapid and, therefore, these values are reasonable to assume for in-place dry-densities for in-pit tailings deposition.

2.12.2 Geochemical Properties

Tailings geochemistry data suggests that metal leaching and acid generation potential are low; therefore, unsaturated storage of tailings is acceptable, but should be minimized where possible to minimize low-level leaching of metals (SRK 2013d).

3 Design Criteria and Assumptions

3.1 Design Standards

The Main Dam will be designed (and ultimately constructed, operated and closed) in accordance with current Canadian (federal and territorial) and international best practice guidelines and principles. Specifically this includes the Canadian Dam Association's Dam Safety Guidelines (CDA 2007) and the Yukon Environmental and Socio-economic Assessment Board's (YESAB) "*Dam Guide: Design Expectation and Required Information"* (Yukon Environment 2012).

3.2 Design Basis

The Main Dam will retain both tailings solids and free water during its operational phase. At closure, the dam will not retain free water; however, surface runoff flow-through facilities will remain in place. The actual operational life of the structure is expected to be up to 10 years, and the operational design life will be set at 20 years. After closure, the structure will remain in perpetuity, and, as a result, the design life will be set at 200 years.

Moderate seepage from the dam during the operational phase would be acceptable provided the structural integrity of the dam is not compromised. Such seepage must, however, be monitored and captured if necessary to prevent negative downstream operational and environmental impacts.

3.3 Storage Requirements

3.3.1 Waste (Tailings and NP:AP < 3 Waste Rock) and Water Volumes

Table 1 summarizes the available storage capacity within the natural containment limits of the three pits that will be used to store tailings, water, and NP:AP < 3 waste rock. The planned tailings and NP:AP < 3 waste rock production numbers are listed in Table 2.

Table 1: Natural In-Pit Storage Capacity.

Period	Main Pit (Mm^3)	Area 2 Pit (Mm^3)	Ridgetop North Pit (Mm^3)	Total (Mm^3)
Phase IV	4.9[(a)]	0	0	4.9
Start of Phase V/VI (March 1, 2014)	4.9	2.0	0	6.9
End of Phase V/VI (Aug. 31, 2022)	4.9	7.9	1.9	14.7

Source:T:\1CM002.003_PhaseV_WaterQualityPrediction\Waste_Management\Integrated_Waste_Management\[Minto_Tails_and_Waste_Placement_1CM002_003_REV13_SRJ.xlsx]

Notes: (a) 4.9 Mm^3 capacity is to elevation 791 m (i.e., to the natural spill elevation). The Phase IV licence currently authorizes filling the Main Pit only to 786 m. To this elevation, the capacity is 4.2 Mm^3.

Table 2: Cumulative Tailings and NP:AP < 3 Production Estimates.

Period	Tailings (Mt)	NP:AP < 3 Waste Rock (Mt)
Phase IV - End	1.9	2.1
Phase V/VI - End	13.3	4.7

Source:T:\1CM002.003_PhaseV_WaterQualityPrediction\Waste_Management\Integrated_Waste_Management\[Minto_Tails_and_Waste_Placement_1CM002_003_REV13_SRJ.xlsx]

Conservatively, assuming a tailings dry density of 1.1 t/m^3 (Section 2.12.1) and a NP:AP < 3 waste rock density of 2.1 t/m^3, Table 3 summarizes the cumulative overall storage requirements for the planned tailings deposition strategy.

Table 3: Cumulative Storage Requirements through Completion of Phase V/VI.

Period	Tailings (million m^3)	Free Water (million m^3)	NP:AP < 3 (million m^3)	Surge Capacity [(b)] (million m^3)	Total (million m^3)
Phase IV - End	1.7	1.3	1.0[(a)]	0.975	5.0
Phase V/VI - End	12.1	1.1	2.3	0.975	16.4

Source:T:\1CM002.003_PhaseV_WaterQualityPrediction\Waste_Management\Integrated_Waste_Management\[Minto_Tails_and_Waste_Placement_1CM002_003_REV13_SRJ.xlsx]

Note: (a) A buttress to stabilize the wall on Main Pit will be partially constructed with Phase IV NP:AP < 3 material and will extend above the 786 m elevation, and potentially above 791 m. This will result in increased available storage area in Main Pit. (b) surge capacity required on October 31 each year in accordance with current Water Licence conditions.

In summary; up to the end of Phase V/VI, 16.4 Mm^3 of storage capacity is required within the three pits, but the actual natural containment volume of these pits are only 14.7 Mm^3 which leaves a shortfall of 1.7 Mm^3, assuming struck levels. The Main Pit storage capacity can be increased to make up this shortfall through construction of the Main Dam.

3.3.2 Other Considerations

Tailings placement will result in beach development, which means the assumption of struck levels as discussed in Section 3.3.1 is not entirely accurate. No specific tailings physical characterization has been carried out to confirm the expected tailings beach slope angle at Minto; however, typical copper tailings deposited sub-aerially are known to have beach slope angles that range between 0.5 and 2% (Vick 1990). Considering the Main Pit layout that allows for beach development around most of the perimeter of the pit, storage capacity loss is not expected to be significant and, therefore, is not likely to affect the overall selection of dam height. This will, however, be confirmed during subsequent stages of engineering.

Sub-aerial placement of hydraulic tailings in cold regions has been shown to result in development of thick ice lenses within the tailings (BGC 2003), which could under extreme cases reduce the tailings impoundment capacity by up to 20%. This can be prevented by adopting appropriate tailings placement protocols which limit the thickness of tailings layers placed during winter seasons, such that any ice lenses that do build up would thaw during the subsequent summer season. Considering the critical shortage of available tailings deposition space at Minto, it has been assumed that these deposition protocols will be implemented and strictly enforced, and, therefore, the design capacity does not make allowance for ice entrainment.

3.4 Dam Hazard Classification

The design, construction, operation and monitoring of dams in Canada have to be completed in accordance with appropriate territorial, provincial, and federal regulations and industry best practices. One of the foremost guidance documents in this regard is the 2007 Canadian Dam Safety Guidelines (CDA 2007) published by the Canadian Dam Association (CDA). The CDA recognizes that tailings dams are different than water dams and, as a result, is in the process of developing a technical bulletin to provide guidance on how the CDA guidelines may be tailored to tailings dams; however, until this technical bulletin is published, all mining dams should be evaluated in accordance with the guidelines currently available.

A key component of the guidelines is classifying the dam(s) in question into hazard categories (dam class) that establish appropriate geotechnical and hydro-technical design criteria. Table 4 is a reproduction of the recommended dam classifications as presented in the CDA guidelines. This classification is based on the Incremental Consequence of a dam failure (as opposed to Total Consequences). The Incremental Consequences of failure are defined as the total damage from an event with dam failure, less the damage that would have resulted from the same event (e.g., a large earthquake or a large flood event) had the dam not failed.

Table 4: Dam Classification

Dam Class	Population at Risk[1]	Incremental losses		
		Loss of Life[2]	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	Minimal short-term loss No long-term loss	Low economic losses; area contains limited infrastructure or services
Significant	Temporary only	Unspecified	No significant loss or deterioration of fish or wildlife habitat Loss of marginal habitat only Restoration or compensation in kind highly possible	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes
High	Permanent	10 or fewer	Significant loss or deterioration of *important* fish or wildlife habitat Restoration or compensation in kind highly possible	High economic losses affection infrastructure, public transportation, and commercial facilities
Very high	Permanent	100 or fewer	Significant loss or deterioration of *critical* fish or wildlife habitat Restoration or compensation in kind possible but impractical	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances)
Extreme	Permanent	More than 100	Major loss of *critical* fish or wildlife habitat Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances)

[1] Definitions for population at risk:

None—There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.

Temporary—People are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).

Permanent—The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).

[2] Implications for loss of life:

Unspecified – The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

Determination of the appropriate hazard rating is often subjective and is dependent on site-specific circumstances that may require an agreement between the proponent, regulators, and stakeholders. During the dam classification process, each of the four hazard rating components, in Table 4 (i.e., population at risk, loss of life, environmental and cultural values, and infrastructure and economics) is considered individually and the overall dam hazard rating is defined by the component with the highest (i.e., most severe) rating. It is important to note that the hazard rating refers to the downstream consequences in the inundation zone of a dam breach.

A preliminary dam hazard classification for the Main Dam has been carried out by SRK and concludes that since the dam will be located upstream of the mill and processing facilities, there is a likelihood for loss of life in the case of a dam failure. To this end, the appropriate hazard category for the dam is likely HIGH to VERY HIGH, and, as a result, the conceptual design assumes a hazard classification of VERY HIGH.

3.5 Inundation Zone

Yukon Environmental and Socio-economic Assessment Board's (YESAB) "*Dam Guide: Design Expectation and Required Information*" (Yukon Environment 2012) requires that if there is a human population at risk an inundation map be prepared showing the maximum extent of flooding related to a sudden full storage dam breach. As per the preliminary dam hazard classification described in Section 3.4 the potential human population at risk is Minto Mine personnel working in the mill and processing complex. At this time an inundation map has not been prepared.

3.6 Water Balance

In accordance with the existing water licence for Minto Mine, surface runoff from all areas upstream of the Main Pit is directed either into the Main Pit or offsite as discharge if water quality meets licence limits. On October 31 each year, a volume of 0.975 Mm^3 of available storage capacity must be available within Main Pit, specifically for purposes of providing surge capacity. Due to the large surge capacity requirement, the majority of the required volume must be maintained year round, as the throughput capacity of the mine's water treatment system over the treatment season is only a small fraction of the required volume. It is assumed that the condition for requiring the surge capacity would remain in future licence renewals; however, that it may not necessarily have to be within Main Pit, as long as a suitable alternative is provided such as the Area 2 Pit.

A detailed site water balance has been developed (SRK 2013e) which includes using the Main Pit as a tailings storage facility. The overall impact of this as it relates to storage volumes are summarized in Table 3.

3.7 Geotechnical Criteria

3.7.1 Design Earthquake

Based on the preliminary dam hazard classification of VERY HIGH assigned to the Main Dam, the Annual Exceedance Probability earthquake design ground motion will be at least the 1/5,000 year event (CDA 2007).

3.7.2 Stability Criteria

Overall dam geotechnical stability will be in accordance with requirements stipulated in the Canadian Dam Safety Guidelines (CDA 2007). This includes minimum factors-of-safety for static and seismic assessments for upstream and downstream dam slopes. Static assessment considers different stages of the dam including immediately following completion of construction, long-term, and, finally, full or partial drawdown. For seismic analysis, loading conditions include both pseudo-static and post-earthquake scenarios.

3.8 Hydrotechnical Criteria

3.8.1 Inflow Design Flood

Considering the preliminary dam hazard classification of VERY HIGH assigned for the Main Dam, the Inflow Design Flood will be a value equal to about 2/3 between the 1/1,000 year and the Probable Maximum Flood (CDA 2007).

The 24 hour duration 1:1,000 year recurrence interval peak flow for the Main Dam catchment, which is about 485 ha in size has been calculated as 4.1 m^3/s. The 24 hour duration Probable Maximum Flood peak is 41.4 m^3/s, which means the corresponding Inflow Design Flood peak is 29.0 m^3/s. At the dam Full Supply Level this translates to a total flood volume of about 529,000 m^3.

3.8.2 Freeboard

Normal freeboard (or total freeboard) is defined as the difference between the dam crest and the maximum reservoir (i.e., tailings impoundment in this case) operating level. Minimum freeboard on the other hand is defined as the difference between the dam crest and the maximum reservoir level during the Inflow Design Flood.

Normal freeboard will be governed by the most critical situation caused by either overtopping due to wind induced waves (wind event with an Annual Exceedance Probability of 1/1,000 years) or thickness of the insulating layer to prevent a frost susceptible core from freezing.

Minimum freeboard needs to ensure no overtopping by 95% of the waves caused by wind with an Annual Exceedance Probability of 1/2 years. All freeboard calculations need to account for future crest settlement.

In addition to the minimum freeboard design requirements, the top of the core must be above the normal operating reservoir level.

3.8.3 Spillway

The spillway will be sized to handle the Inflow Design Flood after allowing for attenuation within the reservoir. The spillway will be isolated from the dam and will be located at the Main Pit's southern edge and will direct water towards the Area 2 Pit.

4 Design Alternatives

4.1 Alternate Tailings Deposition Sites

A comprehensive tailings alternatives assessment was carried out in 2012 (SRK 2013a), and the results were evaluated as part of a stakeholder workshop. Nineteen different tailings and NP:AP < 3 waste rock deposition sites were evaluated, and the site selection was intentionally limited towards the Upper Minto Creek catchment (since all waste disposal activities occur within this area). In addition, areas occupied by the airstrip, mill, contractor laydown, and the Main Waste Dump were considered off-limits for new tailings or NP:AP < 3 waste rock disposal sites.

Four pre-screening (or fatal flaw) criteria were developed, and applied to provide a first evaluation of the viability of each alternative. The outcome of this was not a single individual site that could host all the required tailings and NP:AP < 3 waste rock. Therefore, the six sites that passed the pre-screening test were combined into three integrated alternatives that addressed the site wide waste storage needs.

The conclusion of the alternatives assessment was that in-pit storage of tailings and NP:AP < 3 waste rock was preferred. Specifically Main, Area 2, and Ridgetop North Pits were defined as the preferred waste disposal sites.

4.2 Alternate Deposition Strategies

Within the selected disposal sites, alternate tailings deposition strategies that were evaluated included continuation of sub-aerial or sub-aqueous hydraulically placed (50 to 60% solids) tailings, reverting back to filtered tailings and switching to cyclone tailings (SRK 2013a). Both filtered and cyclone tailings offer the advantage of eliminating the need for construction of Main Dam. There are, however, significant operational challenges with these strategies; the most important of which is associated with the weak tailings foundation base that currently exists in Main Pit due to the tailings placement methodology. Sub-aqueous deposition would offer the maximum environmental protection; however, the most significant drawback would be the requirement to maintain one or more water retaining dams at the site in perpetuity.

In addition to the technical and operational benefits that hydraulic placement of thickened tailings (i.e., continuation of the current practice) offer, a life-of-mine cost analysis confirmed that it would also be the most cost effective.

4.3 Alternate Dam Locations

Since the Main Dam is intended to increase the natural containment capacity of the Main Pit, there is only one logical location to construct the Main Dam (Figure 6). This area coincides with the primary access ramp to the pit. Within this general area there is naturally some room for optimization and minor adjustments to the dam location, whether it is for slightly improved foundation conditions, reduced construction volumes, accessibility or constructability; however, for this conceptual level design, such optimizations have not been evaluated.

Notwithstanding the fact that this is the only logical physical location to construct Main Dam, it is recognized that the foundations conditions, particularly the presence of ice-rich soils, will pose significant design challenges.

4.4 Alternate Dam Designs

Alternate dam design concepts that were considered, including a conventional low permeability core dam, and a rock-fill dam with geosynthetic liner. The locally available overburden soil appears to be of suitable quality to allow construction of a low permeability core, and therefore the use of geosynthetics was not considered further at this stage. Confirmation testing will be carried out during detailed engineering to confirm that these assumptions are appropriate.

Seepage management will require construction of some form of seepage control mechanism to tie the low permeability dam core to the foundation. Alternative seepage control mechanisms that were considered include:

- Sheet piles;
- Slurry wall;
- Grout curtain;
- Frozen foundation; and
- Excavation and backfill using low permeability core material.

The dam will be founded on a variable foundation including, exposed fresh bedrock, weathered bedrock, shallow overburden, and thick permafrost overburden containing ice lenses and/or massive ice. Preservation of permafrost in the long term will likely not be practical and therefore construction of a frozen core and/or frozen foundation dam was discarded as a viable option.

Constructability of sheet piles and/or slurry walls with such variable foundation conditions would be challenging and therefore those options were not given further consideration. The preferred seepage control method will be excavation to competent material (which will not necessarily mean fresh bedrock). Assuming fractured bedrock is encountered, a grouting program may be undertaken to ensure a proper seal. These assumptions will be revisited when detailed foundation characterization has been carried out.

5 Design Analysis

5.1 Concept

5.1.1 Main Dam

The natural storage capacity of Main Pit is limited by a low point along its east wall. To increase the design storage capacity to 16.4 Mm^3, a roughly 300 m long containment dam with a maximum height of 23 m must be constructed across this natural topographical low. The average height of the dam is about 10 m. This dam will allow for continuation of the existing deposition of using conventional low solids content (50 to 60% solids by weight) slurry tailings. Figure 6 through 11 provide a plan layout and typical cross sections through the proposed containment dam.

The Main Dam will have a Full Supply Level of 804 m and a total (i.e., normal) freeboard of 2 m, which puts the final crest elevation at 806 m.

5.1.2 Spillway

A spillway sized to handle the Inflow Design Flood after allowing for attenuation within the reservoir will be constructed at the Main Pit southern edge and will direct water towards the Area 2 Pit. This spillway will require a significant excavation for a design invert elevation of 804 m, with a 0.5% grade towards Area 2 Pit.

During operations, mine haul trucks need to pass between Main and Area 2 pits where the spillway will be constructed and, therefore, the spillway will be designed with grades to allow such traffic. A plan view and typical sections through this spillway are illustrated in Figures 12 through 15.

5.2 Foundation Conditions

5.2.1 Main Dam

No dedicated foundation characterization has been carried out; however, all available drill logs and test pits were reviewed to evaluate field conditions. Figure 7 and Figure 8 summarize the expected conditions. The dam will be constructed at the edge of the paleochannel, which means overburden thickness under the proposed footprint range from 0 up to 60 m along the southern abutment. Evaluation of the logs of the closest drill holes confirms the presence of ice lenses and permafrost and, therefore it is also possible that massive ice may be present.

A thick zone of unconsolidated fill (operationally referred to as the “Boulder Laydown”) covers most of the southern abutment. This material was placed during pit development and consists of oversize waste rock and random fill. This material, which ranges in thickness from a few meters to over 10 m thick, will be excavated prior to dam construction, significantly improving overall foundation conditions. Note that the overburden thickness map in Figure 8 includes this fill, and, therefore, after excavation, the remaining overburden fill will be significantly less. No permafrost is expected in this fill material, as it was placed during operations.

5.2.2 Spillway

Inferred foundation conditions under the proposed spillway are presented in Figures 12 and 13. Overburden is thick (up to 40 m), and it is known that this material contains ice lenses and massive ice.

5.3 Geometric Design

5.3.1 Key

The key trench will vary in depth based on the actual above ground height of the structure along its alignment, but will generally be about one-third the height of the dam in depth. The base width of the key trench will also vary and its side slopes will be at least 1H:1V assuming ground conditions will allow.

5.3.2 Core

The low-permeability core will be constructed using the locally available fine-grained overburden material placed in thin compacted lifts in accordance with strict engineering specifications. Coming out of the key trench, the core above ground will have a crest width of 6 m and 1H:1V side slopes.

5.3.3 Transition

A zone of transition material (engineered filter zone manufactured on-site through crushing and screening of waste rock) will clad the core. This purpose of this zone is to act as a filter zone between the core, and the shell to provide protection against piping failure. This zone may consist of a gradation of different sized materials according to standard filter design criteria.

5.3.4 Shell

The transition zone will be clad with a run-of-mine waste rock shell. The shell will extend 1 m above the crest of the fine-grained core will have a 15 m crest width and will have an upstream side slope of 2H:1V and a downstream side slopes of 3H:1V.

5.3.5 Spillway Cut

The base of the spillway will be 20 m wide and the side slopes, which will double as access road for mine haul trucks will be 10H:1V.

5.3.6 Spillway Armouring

Where exposed competent bedrock is not present, armouring capable of withstanding the Inflow Design Flood will be placed along the base and lower 1 m vertical height of the spillway channel. This armouring will likely be run-of-mine waste rock, although some selective sorting may be required. Appropriate filter design analysis will be carried out to determine transition material or filter fabric will be required between the excavation surface and the armouring layer.

5.4 Slope Stability

5.4.1 Main Dam

The preliminary upstream slope is 2H:1V, and the downstream slope is 3H:1V. No stability analysis has been carried out to date to confirm whether these slopes are appropriate, but the basis for the decision was the 32 m high Water Supply Dam (EBA 1995) in Minto Creek that has 2.5H:1V upstream and downstream slopes, which have been demonstrated to be stable. It is recognized that the comparison is not without limitations given the challenging foundation conditions at Main Dam compared to the bedrock foundation at the Water Supply Dam.

Dam stability is, however, expected to be significantly improved due to the presence of a large tailings beach against the upstream slope of Main Dam, which serves to significantly reduce the hydraulic gradient at the dam.

5.4.2 Spillway

The 10H:1V side slopes of the spillway cut are expected to be stable; however, appropriate stability analysis will be carried out in subsequent engineering phases.

5.5 Settlement

Foundation settlement beneath the Main Dam is expected as a result of conventional consolidation of the unfrozen overburden soils, as well as thaw consolidation associated with ice lenses and massive ice that may be present under the dam footprint. No settlement analysis has been carried out to date; however, consolidation settlement of unfrozen overburden soils is expected to be limited given the granular nature of the material. Thaw settlement could, however, be significant, especially considering massive ice up to 4 m thick observed along other areas of the paleochannel. Both of these forms of settlement are expected to very slow, and thaw settlement specifically may not occur for a very long time, and most likely not during the operational life of the dam; however, appropriate thermal analysis is required to confirm the timeline.

The settlement will manifest itself as deformations along the dam structure that could lead to irregular lowering of the crest, as well as cracking of the core. Furthermore, since the dam will be founded along variable foundations conditions extending from fresh bedrock to deep overburden with possible inclusion of massive ice, differential settlement is expected, further complicating conditions.

The dam will, therefore, have to be designed taking this into consideration. Mitigation measures that will be evaluated include increasing the dam and core height to accommodate settlement, alternate seepage control measures to allow the structure to be constructed without a crack-susceptible core, complete removal of problem soils and promoting thaw consolidation through mechanical means.

5.6 Creep

The possible presence of massive ice in the overburden foundation of the dam means the dam may be subject to creep deformation (Section 2.9). This creep deformation would manifest itself in the dam structure as both differential settlement and lateral movement. Without detailed foundation characterization and subsequent engineering analysis, it is not possible to determine the extent or rate of creep deformation; however, based on movement observed within the Dry Stack Tailings Storage Facility it could be significant.

Final design of the dam will, therefore, have to allow for such deformations and appropriate mitigation measures must be evaluated which may include shallow downstream slope angles, downstream buttressing, complete removal of problem soils and either promoting thaw of massive ice or keeping it frozen through mechanical means.

5.7 Seepage

An evaluation of seepage from Main Dam has not been carried out. Based on the understanding of the site wide hydrogeological regime, it is, however, reasonable to assume that any seepage would ultimately report at the Water Storage Dam that is wholly within the Upper Minto Creek Catchment (Figure 2), and this is within the footprint already impacted by mining activity. Seepage is expected to occur through the foundation via the fractured bedrock and/or the overburden soils. Based on currently available site data, the hydraulic conductivity of the foundation soils is estimated to be in the order of 10^{-9} cm/s under thawed conditions.

Following appropriate characterization studies and seepage analysis, seepage rates can be managed through grouting and/or deepening of the key trench. The tailings deposition plan calls for depositing of a tailings beach at least 100 m wide upstream of the dam, which will lengthen the seepage path considerably, with the resultant effect of limiting seepage rates via these pathways.

Seepage may also occur as preferential flow through the intercepted fault zones and/or the paleochannel. Further characterization and associated numerical analysis studies will be carried out to confirm the likelihood and magnitude of seepage via these pathways.

5.8 Hydrotechnical Design

5.8.1 Main Dam

Wave run-up calculations have not been carried out, so the appropriate minimum freeboard has not been established. Generally, it is considered best practice to have a minimum freeboard of at least 1 m. Without a spillway in place, based on the surface area of the Main Pit reservoir at the Main Dam Full Supply Level, the Inflow Design Flood (Section 3.8.1) will result in a water level rise of about 2.4 m. In reality, with the spillway in place, flood routing will be significant and based on the preliminary hydrotechnical spillway analysis (see below) it is estimated that the actual flood height will be less than 1 m. Therefore, for this preliminary design, the normal freeboard has been set at 2 m.

5.8.2 Spillway

Preliminary hydrotechnical analysis of the spillway suggest that to pass the Inflow Design Flood, using a 25 m base width and 10H:1V side slopes, the peak flood depth would be about 0.5 m with a corresponding subcritical flow velocity of about 2.2 m/s. For the conceptual design, a minimum freeboard of 0.5 m was assumed for the spillway.

5.9 Instrumentation and Monitoring

Given the challenging foundation conditions and subsequent possibility of significant deformations of the dam, a rigorous instrumentation and monitoring program will be implemented. Monitoring instrumentation will consist of direct and indirect methods. Direct monitoring will comprise of deformation and settlement monitoring, which will provide precise information as to the magnitude of movement. Indirect monitoring, consisting of piezometric levels and thermal monitoring, will provide early warning signs associated with the fundamental processes that may trigger foundation instability.

Deformation monitoring will include slope inclinometers installed along the downstream slope of the dam. These instruments will not only include shallow instruments within the dam structure, but also deep instruments to specifically monitor foundation creep. Given the overburden gradient downstream of the dam, a series of deep slope inclinometers will also be installed downstream of the dam to provide early warning of potential large scale movements triggered by the dam.

Both crest and embankment settlement will be monitored using a series of permanent settlement beacons strategically placed along the dam. These will be monitored using precise survey techniques.

Vibrating wire piezometers and deep ground temperature cables will be installed within and immediately up and downstream of the dam.

Notwithstanding the proposed instrumentation and monitoring plan, an observational approach will be adopted to continuously evaluate and, if necessary, implement contingency plans throughout the life of the structure.

6 Dam Construction

6.1 Construction Materials

Construction material for the dam and spillway consists of core, transition and run-of-mine waste rock material. All the material will be sourced locally from mine development areas, provided they have been confirmed to be geochemically suitable. Complete characterization of the target materials has not been carried out, but based on other similar characterization studies at site there should be no limitations.

The core material will be clayey silt overburden material. The transition material will be crushed rock using the run-of-mine waste rock material. The shell will be constructed from run-of-mine waste rock and riprap or armouring will be screened run-of-mine waste rock.

The core cannot be constructed from frozen material and can also not be constructed under freezing conditions. Dam construction will therefore be scheduled for summer or early fall.

6.2 Construction Equipment

Construction of the dam can, for the most part, be achieved using conventional earthworks equipment. Trucks, loaders, graders, excavators, smooth, and sheepsfoot drum vibratory roller compactors and track mounted bulldozers would not require special modifications other than being capable of operating continuously in extremely cold weather for components of the dam that may be constructed during winter months.

A mobile crushing and screening plant will be required to produce the transition material using the run-of-quarry material as feed stock.

Should grouting be necessary, a drill and appropriate grouting equipment will be required.

6.3 Construction Quality Control and Quality Assurance

Comprehensive Quality Assurance and Quality Control procedures will be developed and documented in a technical specifications document at the detailed engineering stage of the project. Quality control will be the responsibility of the contractor (or owner should Minto Mine wish to carry out the construction themselves) and/or monitoring equipment manufacturer. The engineer of record, who will be a professional engineer registered to practice in Yukon, will be responsible for quality assurance. Complete documentation of all quality assurance and quality control data will be provided in the relevant as-built reports.

6.4 Construction Quantities

Detailed construction quantities of the different construction materials for the dam and spillway have not been generated. The total bulk volume of fill required for the Main Dam is about 109,000 m^3, and the excavation volume required for the spillway is about 97,000 m^3.

6.5 Construction Procedures

The dam core must be constructed during a period when ambient air temperature at the site is above freezing so as to allow for proper compaction. A summary of the construction steps are as follows:

- **Foundation and abutment preparation**—The dam foundation will be prepared by stripping any organics, unconsolidated fill, loose overburden or highly weathered bedrock. If not in bedrock, the exposed foundation will be compacted.
- **Core construction**—The core will be constructed by placing approved fill material in thin lifts and compacting according to strict specifications. Moisture conditioning will be required to ensure the compaction specifications will be met; this includes drying of material if necessary.
- **Grout curtain**—Should grouting be necessary, the grouting will be done while the core is partially constructed. Grout holes will be drilled through at least 1 m of compacted core material to ensure a proper bond between the base of the core and the foundation (unless the grouting bond is deeper).
- **Transition material placement**—The transition zone will likely be raised as the core is raised for constructability reasons. Moisture conditioning will likely not be required, unless there are multiple filter zones which contain significant fines.
- **Shell material placement**—The shell material will be placed in lifts and compacted using a method specification without the need for moisture conditioning.
- **Instrumentation**—Instrumentation will be installed after completion of the dam. Drill holes for the inclinometers will be drilled and grouted in accordance with strict specifications. Drilling will however not be done into the core material.
- **Spillway excavation**—The spillway will be excavated to the desired grade and elevation. Free digging methods will be employed; however, should fresh bedrock be encountered drilling and blasting may be required.
- **Spillway armouring placement**—The armouring material will be placed in lifts and compacted using a method specification.

7 Dam Operation, Maintenance and Monitoring

7.1 Tailings Deposition (Operational) Plan

With the containment dam in place, tailings deposition can continue using the existing slurry tailings deposition strategy. To improve seepage performance and overall long-term stability of the dam, tailings discharge should be done using end point spigots from the crest of the dam and from the southern slope dividing Main Pit from Area 2 Pit. That will create a significant beach along the upstream slope of the area consisting of the coarsest tailings and pushing the pond at least 100 m from the upstream slopes. Once sufficient beach has been developed spigotting can be moved to other areas within the pit. Spigot points should be moved around to over time create a final tailings landform that is conducive to closure.

This deposition method is simple, not susceptible to process upsets/changes in the mill and is suited to mitigation of potential deformation of the Main Dam that might occur during the 10-year operational life of the Main Dam. Furthermore, this method is well understood on-site, and is expected to be easily executed by site operational staff. Based on performance elsewhere, the deposition method has also been proven to be manageable under the harsh climatic conditions experienced at the Minto site; however, care will have to be taken to avoid buildup of ice lenses in beaches.

7.2 Water Management Plan

Provided the containment freeboard is maintained, there is ample potential to allow for surge capacity in Main Pit or Area 2 Pit. Practically speaking, based on the design concept proposed for the containment dam, it is recommended that any excess water storage be managed with beach development in mind to minimize dam seepage. If the Main Pit is used to contain excess water it may be necessary to construct a permanent spillway prior to it reaching Full Supply Level. It would however be possible to defer spillway construction if the water level in Main Pit is controlled through the use of Area 2 Pit via active pumping for a period of time.

8 Dam Closure

At mine closure, the Main Pit will be expected to have a phreatic surface no greater than 804 m; however, it may be somewhat lower. This means there will be tailings in the Main Pit that will not remain saturated in perpetuity. Although the tailings have no acid generating potential and a relatively low metal leaching potential, a permanent closure cover should be provided. The cover should be designed to eliminate direct contact with tailings, provide a barrier against wind and water erosion, as well as to provide a medium to allow revegetation of the landscape.

The cover is anticipated to consist of a 0.5 m overburden layer overlying about 0.5 to 1 m of waste rock. The waste rock will be necessary as a trafficking layer since the unconsolidated nature of the tailings immediately following closure will make direct placement of a cover difficult (except possibly on the upper reaches of beaches). Further detail on cover concepts will be discussed in the Phase V/VI closure plan (Access Consulting Group 2013).

The tailings surface will be landscaped to drain towards the permanent spillway which will direct water to Area 2 Pit prior to placement of the cover. Although the containment dam will remain in place in perpetuity, the final closure will ensure that little or no water ponding will occur on the facility and therefore the long-term risk of the dam is considered to be low.

Long-term creep deformation of the Main Dam will have to be addressed as part of the overall Mine Closure Plan. To a large extent the potential consequences of such deformation is mitigated by the fact that there will be no ponded water, and that only a portion of the facility will be prone to this movement. Additional mitigation strategies that will have to be considered during development of the Closure Plan includes, but is not limiting to buttressing of the Main Dam.

9 Advancing Engineering

To advance engineering on the Main Dam from the conceptual stage presented in this report through preliminary and ultimately towards detailed engineering, the following work will be required:

- **Dam Hazard Classification**—A comprehensive dam hazard classification will be carried out taking into consideration inputs from stakeholders and regulators.
- **Inundation Mapping**—If it is concluded that the preliminary dam hazard classification presented in the report is appropriate and that there is a risk to human population, a comprehensive dam break analysis will be carried out and inundation maps will be produced.
- **Foundation Characterization**—In-situ characterization is required to confirm foundation conditions. This includes strength and seepage characteristics. Both disturbed and undisturbed samples will be collected and subjected to laboratory testing. In-situ hydraulic conductivity testing will also be carried out including weathered and fresh bedrock zones. Particular attention will be paid to the thermal characterization and the possible presence of ground ice.
- **Borrow Identification and Characterization**—Borrow locations for each of the construction material types will be confirmed and samples will be collected and submitted for laboratory testing. Testing will include detailed remoulded samples of core material to allow engineering analysis of the dam structure. Crushing tests will be required to confirm viability of generating the appropriate transition zone material. Durability testing will be required for the shell material. In all cases geochemical testing will be required to ensure that the structure would not pose any negative environmental risk.
- **Tailings Confirmation Characterization**—The available tailings characterization data will be reviewed to determine its suitability for detailed engineering, specifically the permeability and consolidation characteristics.
- **Geotechnical Engineering Analysis**—This will include a determination of the overall foundation and dam stability and the net effect of possible mitigation measures. Analysis will include, but will not be limited to determining the magnitude and rate of foundation settlement (both as a result of conventional and thaw consolidation), deformation analysis as a result of creep, and thermal analysis to evaluate onset of thaw consolidation and creep.
- **Hydrotechnical Engineering Analysis**—This will include wave run-up calculations for freeboard assessment, confirmation of the Inflow Design Flood and sizing of the spillway and associated riprap.
- **Design Documentation**—The design documentation will include a comprehensive design report, design drawings and engineering specifications. These documents will be prepared under the seal of a professional engineer licenced to practice in Yukon and will be submitted to Yukon regulators for review and ultimate approval.
- **Construction Documentation**—This will include construction drawings and a complete as-built report after dam construction has been completed. These documents will also be submitted to regulatory bodies, as required.

- **Operations Manuals**—An operation, maintenance, and surveillance (OMS) manual and emergency preparedness plan (EPP) will be prepared and submitted to regulators prior to commissioning the Main Dam. These will be prepared in general accordance with the Dam Safety Guidelines published by the Canadian Dam Safety Association (CDA 2007). The objective of the OMS manual will be to provide mine personnel with proper procedures to manage the dam. The purpose of the EPP is to identify and evaluate potential emergencies in order to determine adequate preventative remedial actions for the dam.

This report "*Main Dam Conceptual Design Report*" has been prepared by SRK Consulting (Canada) Inc.

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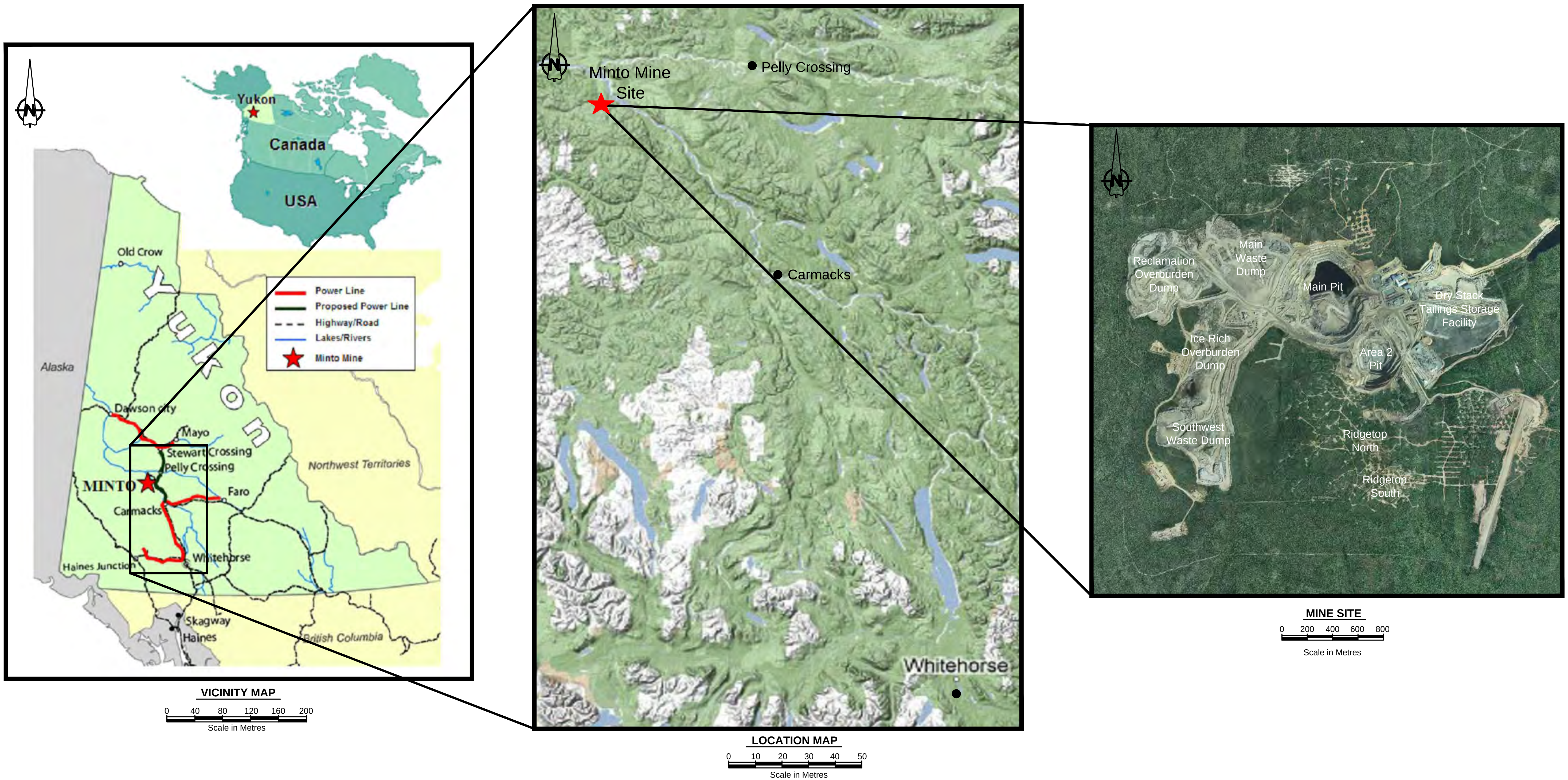
Figures



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

Main Dam Conceptual Design

Site Location and Layout

SRK JOB NO.: 1CM002.010	Minto Mine	DATE: June 2013	APPROVED: EMR	FIGURE: 1
FILE NAME: Site-location-figure1.dwg				

NOTES

1. Data presented in NAD 1983 UTM Zone 8N
2. Base Orthophoto provided by Minto Mine, August 2012

0 200 400 600 800 1000
Scale in Metres

LEGEND

Upper Minto Creek Catchment Boundary
Groundwater Flow Direction (Inferred)

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MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

Main Dam Conceptual Design

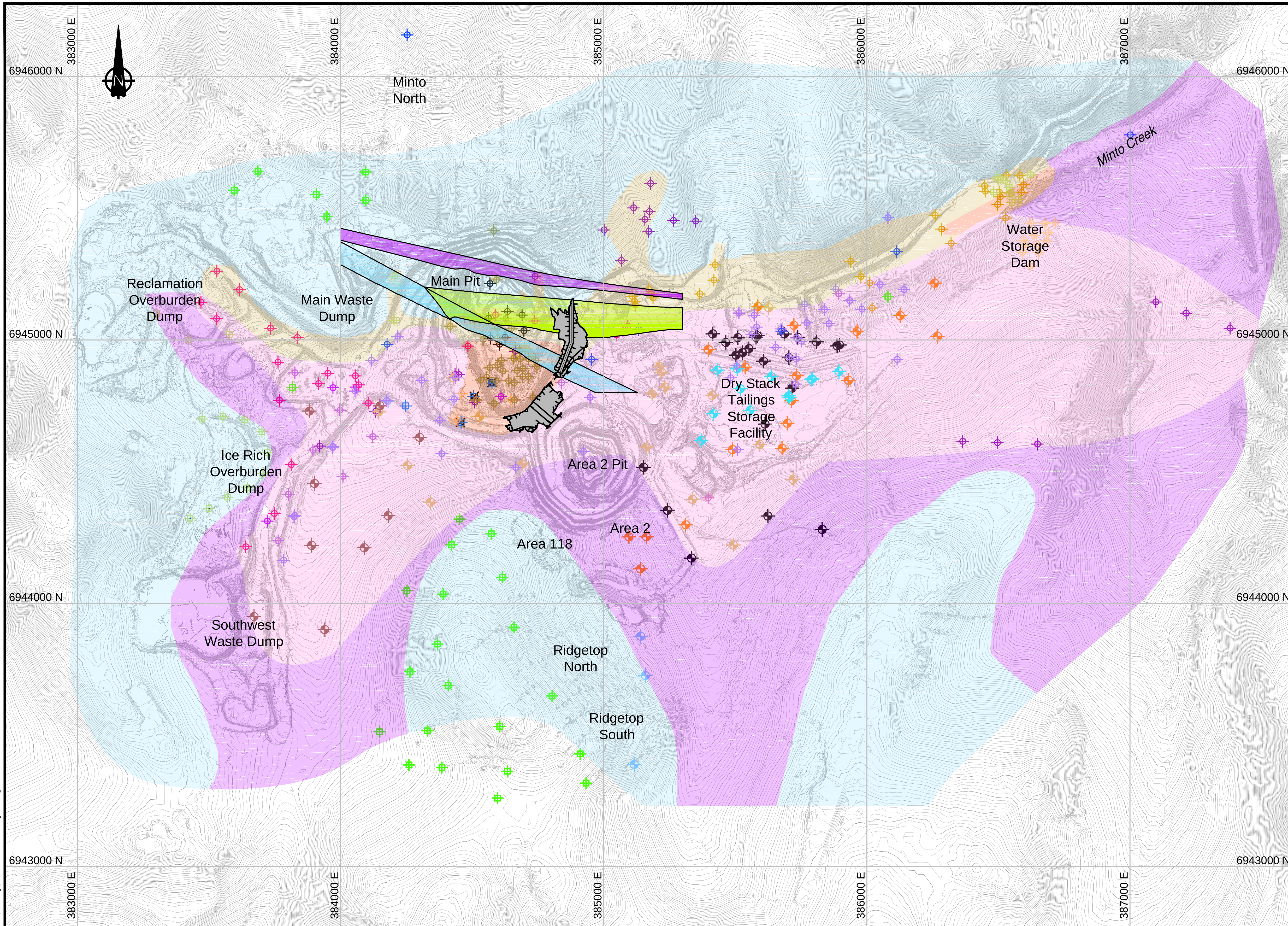
Site Layout and Catchment / Groundwater Flow Directions

SRK JOB NO.: 1CM002.010
FILE NAME: Site Layout figure 2.dwg

Minto Mine

DATE:	APPROVED:	FIGURE:
June 2013	EMR	2

P:\01_SITES\Minto\!040_AutoCAD\June 2013 (conceptual design)\Site Layout figure 2.dwg



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- Inferred DEF Fault Plane
- Inferred Fault 1 Plane
- Inferred Fault 2 Plane

0 200 400 600 800 1000

Scale in Metres

NOTES

1. Data presented in NAD 1983 UTM Zone 8N
2. Topographic information provided by Minto Mine, April 2013
3. Permafrost information adapted from EBA, October 2011

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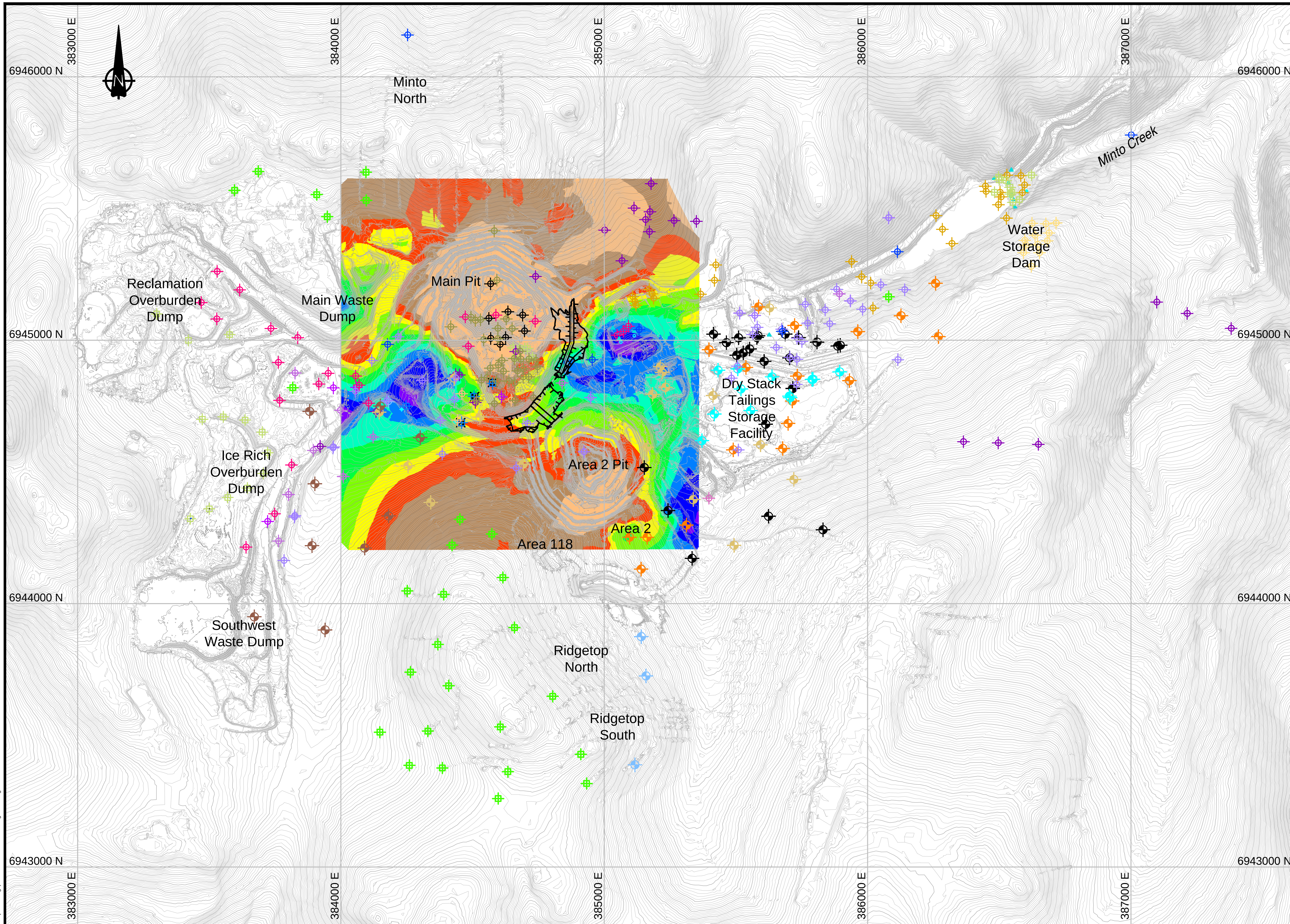
CAPSTONE MINING CORP. MINTO MINE OPERATED BY MINTO EXPLORATIONS LTD.

Main Dam Conceptual Design

Permafrost Extent, Major Features and Historic Overburden Investigations

SRK JOB NO.: 1CM002.010	Minto Mine	DATE: June 2013	APPROVED: EMR	FIGURE: 3
FILE NAME: Historic-overburden-Investigations.dwg				



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Overburden Thickness (m)

- 0
- 1 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 -50
- 50 -60
- 60 -70
- 70 - 80
- 80 - 90

0 200 400 600 800 1000

Scale in Metres

NOTES

1. Data presented in NAD 1983 UTM Zone 8N
2. Topographic information provided by Minto Mine, April 2013

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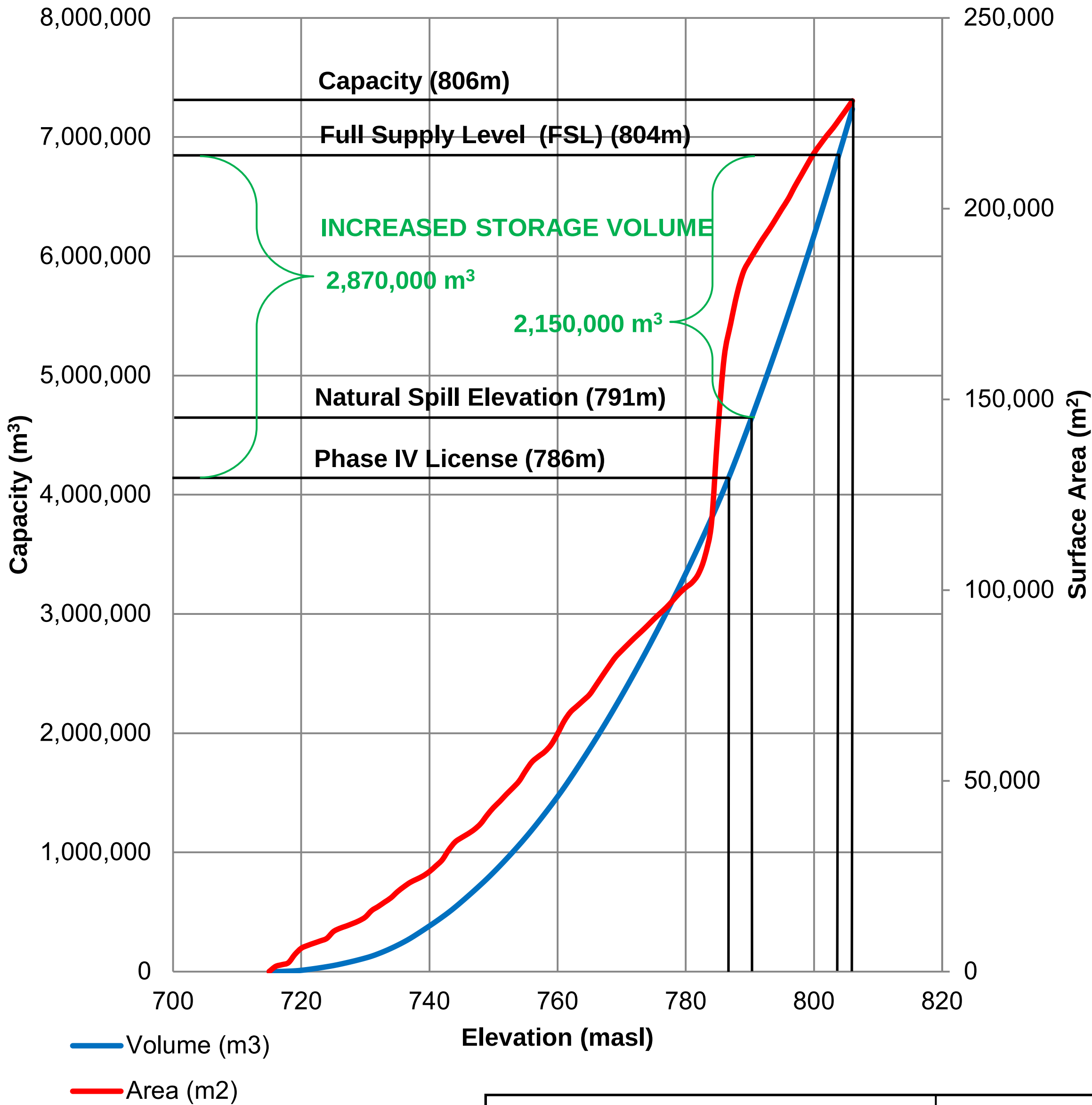
CAPSTONE MINING CORP. MINTO MINE OPERATED BY MINTO EXPLORATIONS LTD.

Main Dam Conceptual Design	
Inferred Overburden Thickness	
SRK JOB NO.: 1CM002.010	
FILE NAME: Historic-overburden-Investigations.dwg	Minto Mine
DATE: June 2013	APPROVED: EMR
FIGURE: 4	



Elevation	Volume (m³)	Area (m²)	Elevation	Volume (m³)	Area (m²)
715	56	20	763	1,785,134	69540
716	1,410	1352	764	1,868,975	71052
717	3,430	1816	765	1,954,154	72636
718	5,924	2336	766	2,041,393	75060
719	10,572	4484	767	2,130,616	77564
720	17,101	6108	768	2,221,757	80020
721	24,486	6856	769	2,314,613	82364
722	32,496	7460	770	2,409,258	84128
723	41,106	8048	771	2,505,664	85808
724	50,406	8716	772	2,603,819	87460
725	61,359	10460	773	2,703,671	89012
726	73,295	11328	774	2,805,205	90632
727	85,866	11924	775	2,908,425	92332
728	99,306	12580	776	3,013,316	93924
729	113,668	13300	777	3,119,864	95488
730	129,671	14288	778	3,228,341	97300
731	149,251	16008	779	3,338,983	99152
732	170,830	17048	780	3,451,613	100680
733	194,649	18196	781	3,566,123	102016
734	220,359	19340	782	3,682,665	104320
735	247,945	20912	783	3,801,550	108884
736	278,251	22220	784	3,923,509	117292
737	311,887	23376	785	4,050,150	141556
738	346,774	24208	**786**	**4,183,015**	**161064**
739	382,533	25060	787	4,320,592	169792
740	419,275	26204	788	4,461,936	177616
741	457,291	27684	789	4,605,998	183432
742	497,007	29280	790	4,752,430	186572
743	539,846	31856	**791**	**4,901,026**	**189324**
744	585,246	33948	792	5,051,705	192036
745	631,931	35096	793	5,204,488	194496
746	679,739	36092	794	5,359,367	197168
747	728,699	37240	795	5,516,396	199912
748	779,103	38772	796	5,675,899	202560
749	832,134	40996	797	5,838,492	205752
750	887,105	42988	798	6,004,032	208684
751	943,845	44640	799	6,172,243	211648
752	1,002,258	46456	800	6,343,273	214504
753	1,062,287	48124	801	6,516,842	216856
754	1,124,301	49936	802	6,692,757	219104
755	1,188,907	52588	803	6,870,930	221148
756	1,255,845	54944	**804**	**7,051,384**	**223476**
757	1,324,791	56360	805	7,234,243	225812
758	1,395,328	57628	**806**	**7,420,670**	**228244**
759	1,467,699	59492			
760	1,542,825	62352			
761	1,621,544	65592			
762	1,702,614	68008			

!020_Site_Wide_Data\Open_Pit_Physical_Data\Pit_Stage_Curves\Main Pit Water Storage Capacity - 2013-03-13.xlsx

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

Main Dam Conceptual Design

Capacity and Surface Area vs. Stage Elevation

Job No: 1CM002.012

Filename: Figure 5_Stage Capacity_Minto.pptx

Minto Mine

Date: May 31, 2013

Approved: EMR

Figure: 5

NOTES

1. Data presented in NAD 1983 UTM Zone 8N
2. Base Orthophoto provided by Minto Mine, August 2012

0 40 60 80 160 200
Scale in Metres

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MINTO MINE
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SRK JOB NO.:	1CM002.010
FILE NAME:	Site Layout figure 2.dwg

Minto Mine

Main Dam Conceptual Design

Plan Layout at
Main Pit Tailings Management
Facility

DATE:	APPROVED:	FIGURE:
June 2013	EMR	6

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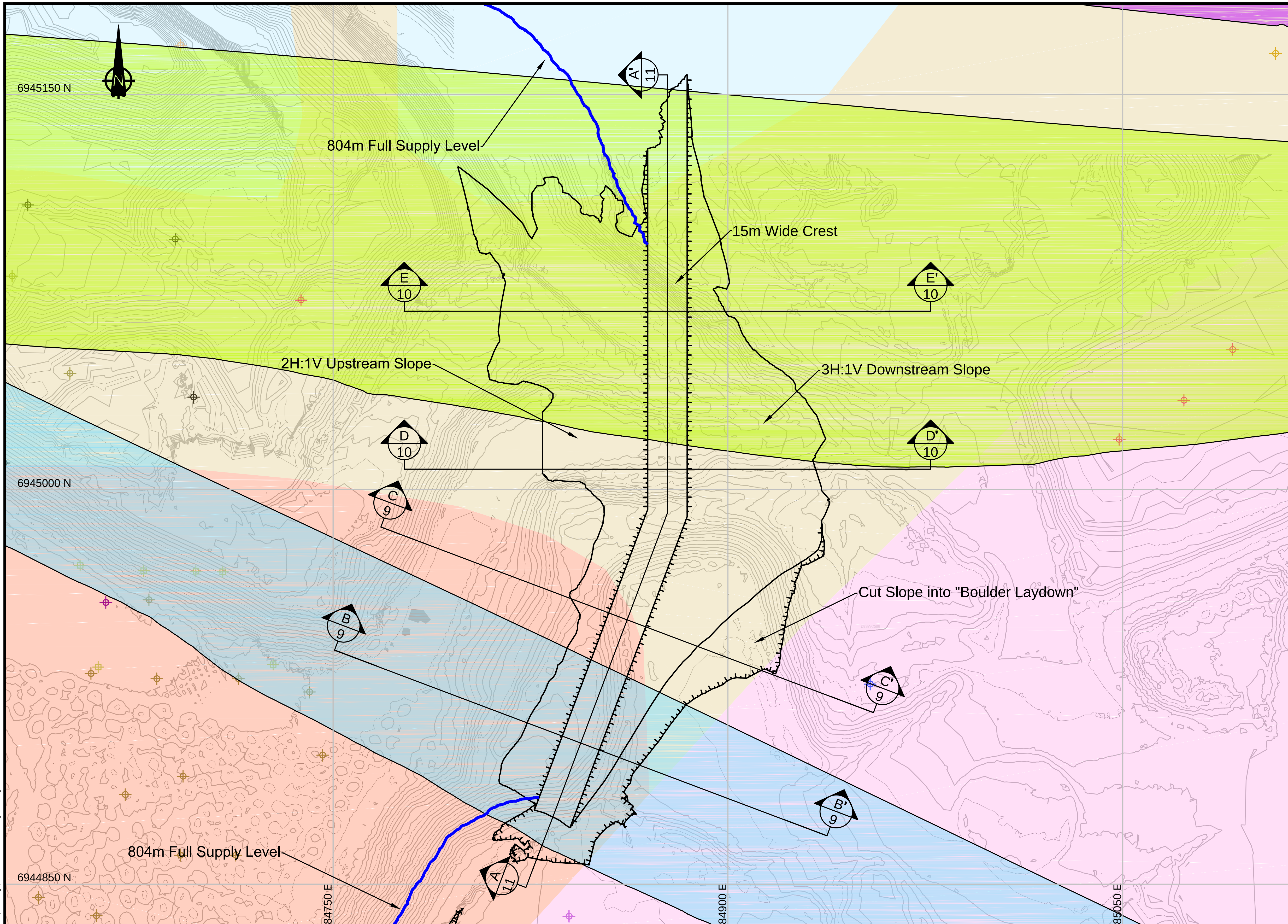

LEGEND

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NOTES

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3. Permafrost information adapted from EBA, October 2011

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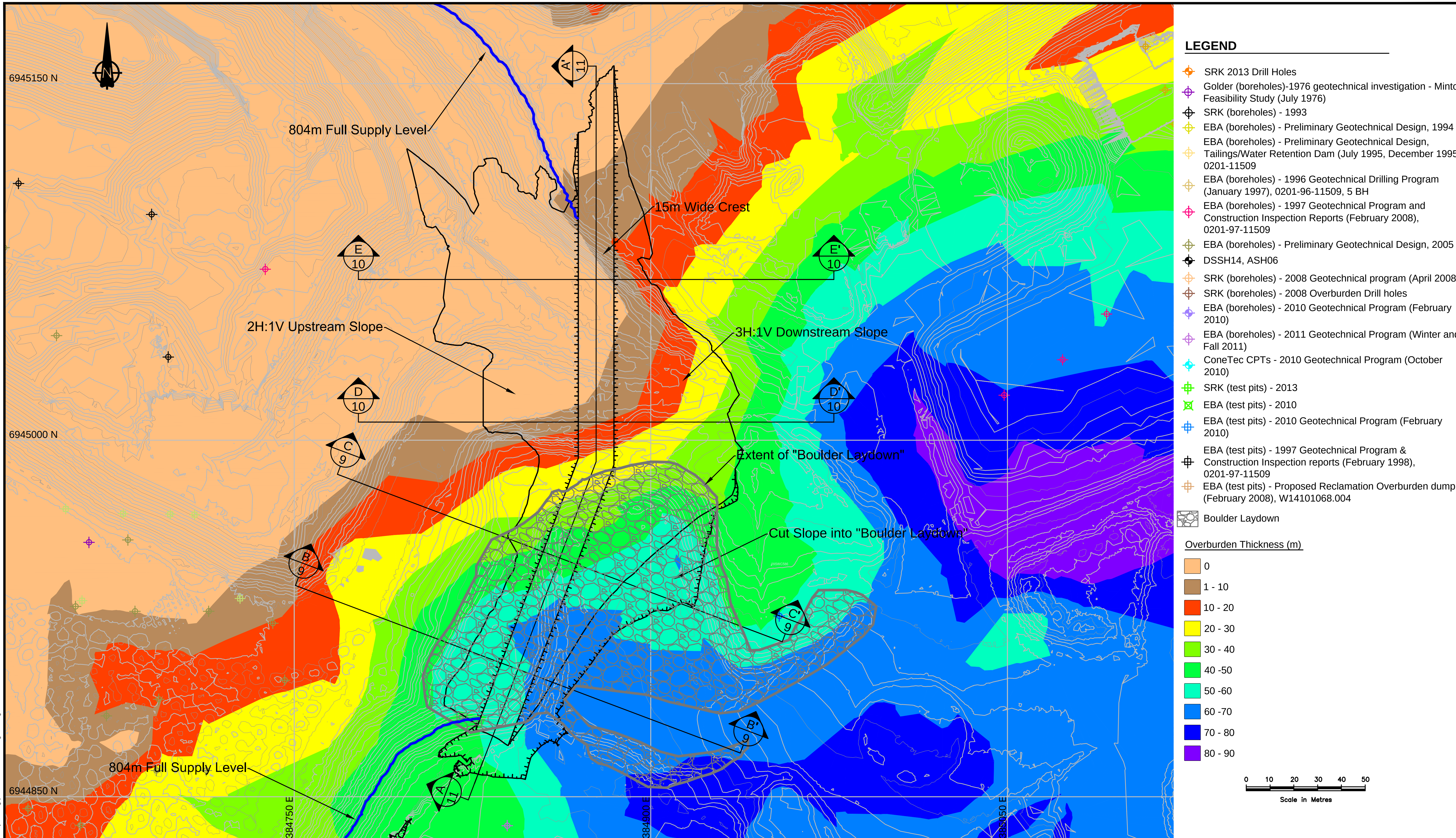
CAPSTONE MINING CORP. MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

Main Dam Conceptual Design

Main Dam Foundation Conditions (Permafrost and Major Features)

SRK JOB NO.: 1CM002.010	Minto Mine	DATE: June 2013	APPROVED: EMR	FIGURE: 7
FILE NAME: Historic-overburden-Investigations.dwg				



NOTES

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2. Topographic information provided by Minto Mine, April 2013

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SRK JOB NO.: 1CM002.010

FILE NAME: Historic-overburden-Investigations.dwg

CAPSTONE MINING CORP. MINTO MINE

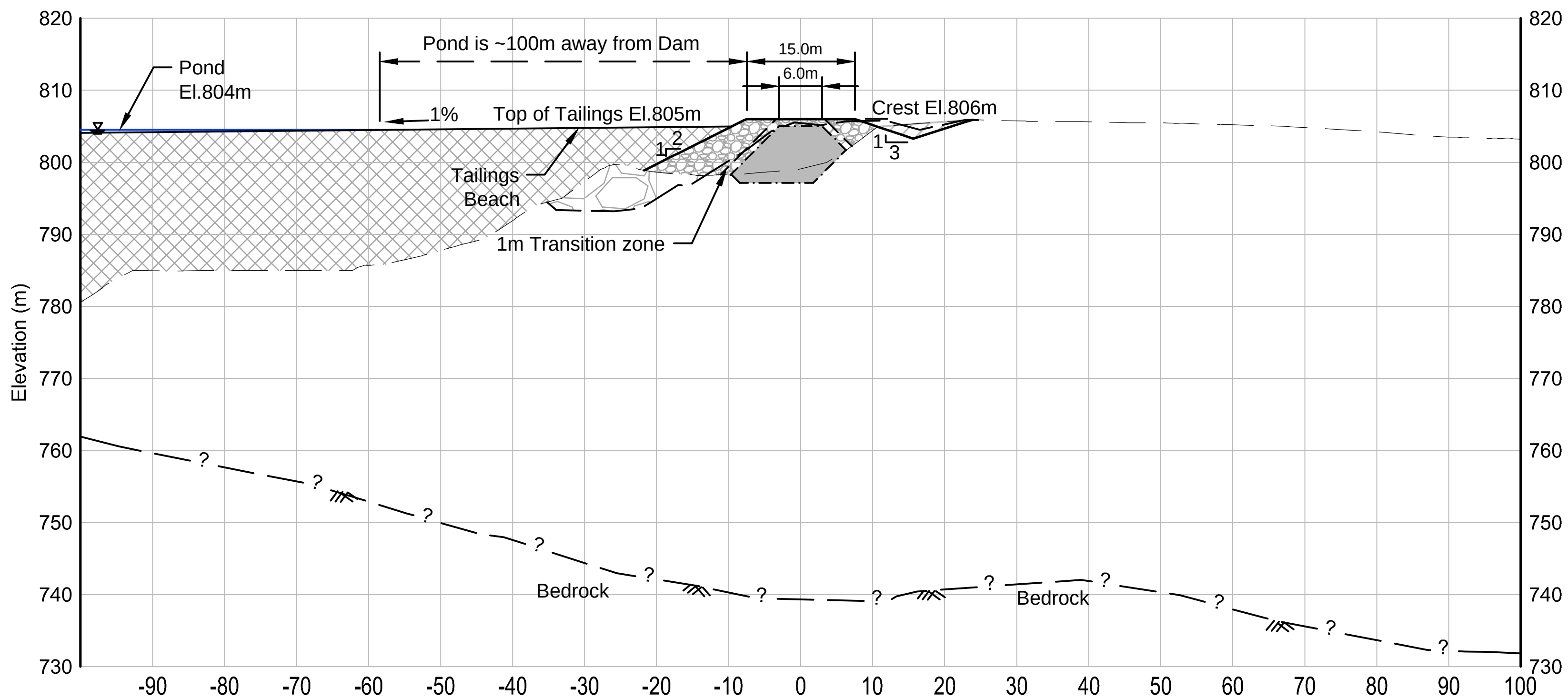
OPERATED BY MINTO EXPLORATIONS LTD.

Minto Mine

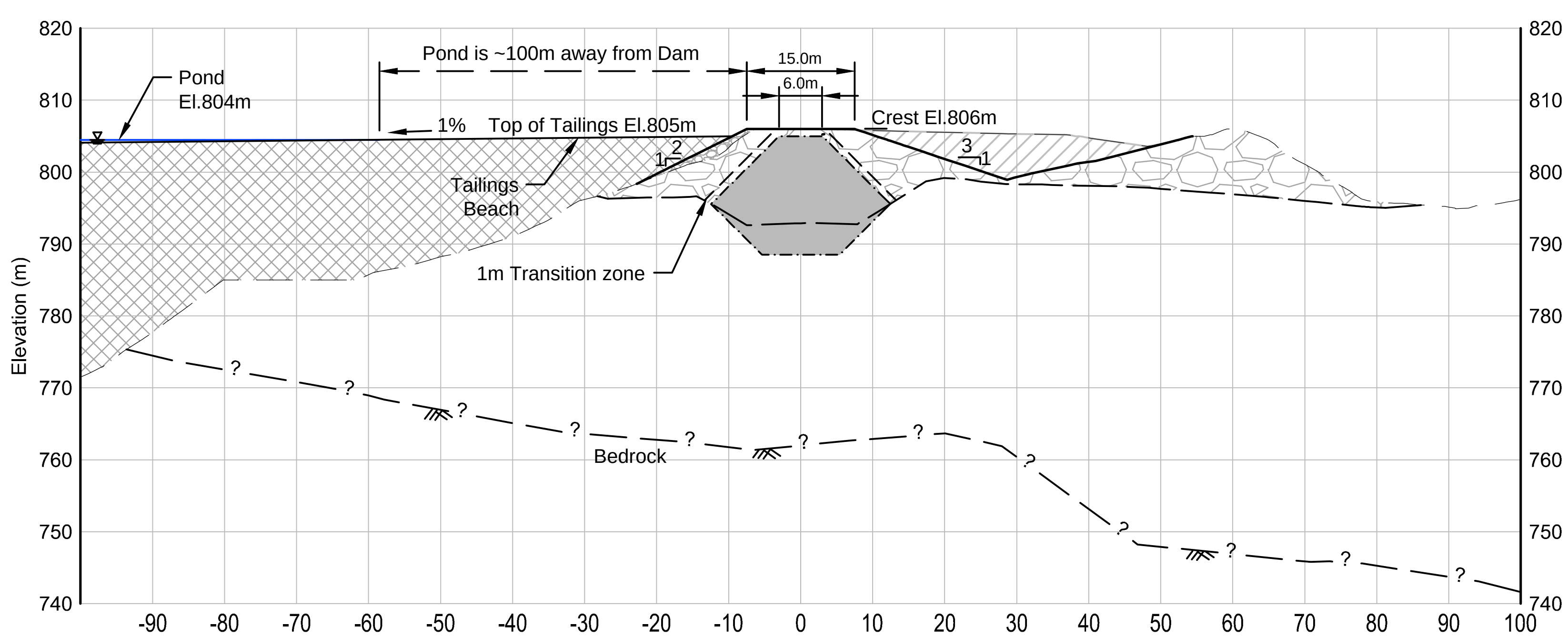
Main Dam Conceptual Design

Main Dam Foundation Conditions (Overburden Thickness)

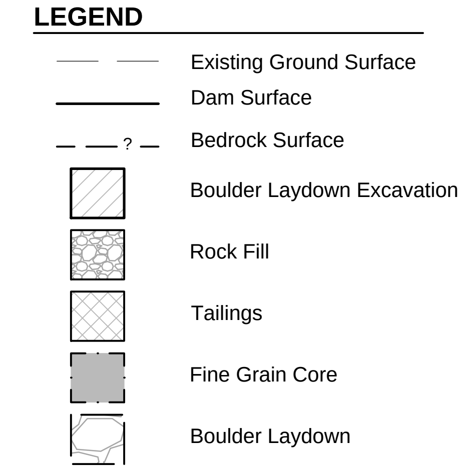
DATE:	APPROVED:	FIGURE:
June 2013	EMR	8



B
7
CROSS SECTION B - B'



C
7
CROSS SECTION C - C'



0 10 20 30 40 50
Scale in Metres

srk consulting

SRK JOB NO.: 1CM002.010
FILE NAME: 1CM002.010–Conceptual_Dam –20130627.dwg

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

Minto Mine

Main Dam Conceptual Design

Typical Main Dam Cross Sections (Sheet 1 of 2)

DATE:	APPROVED:	FIGURE:
June 2013	EMR	9

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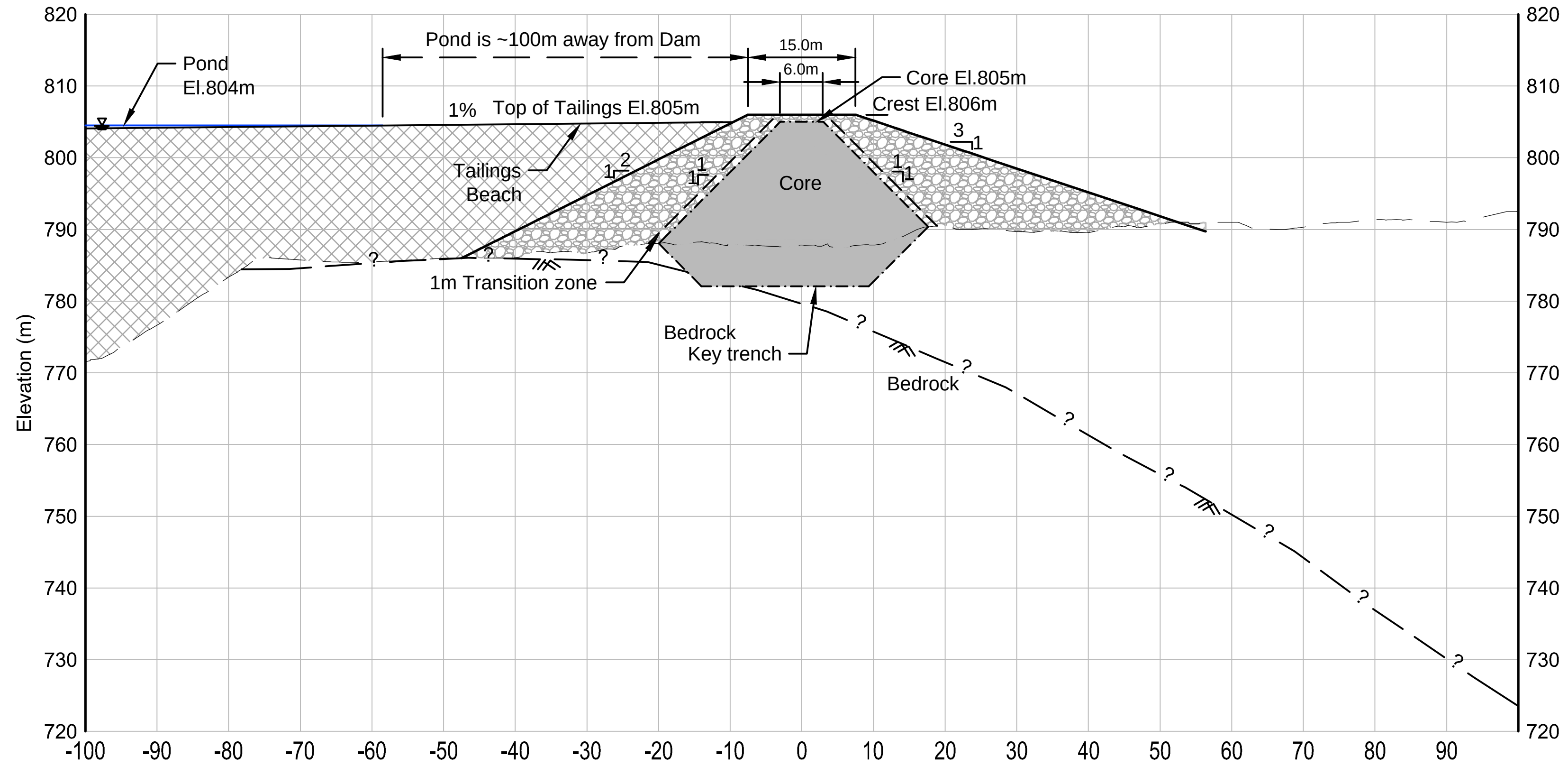
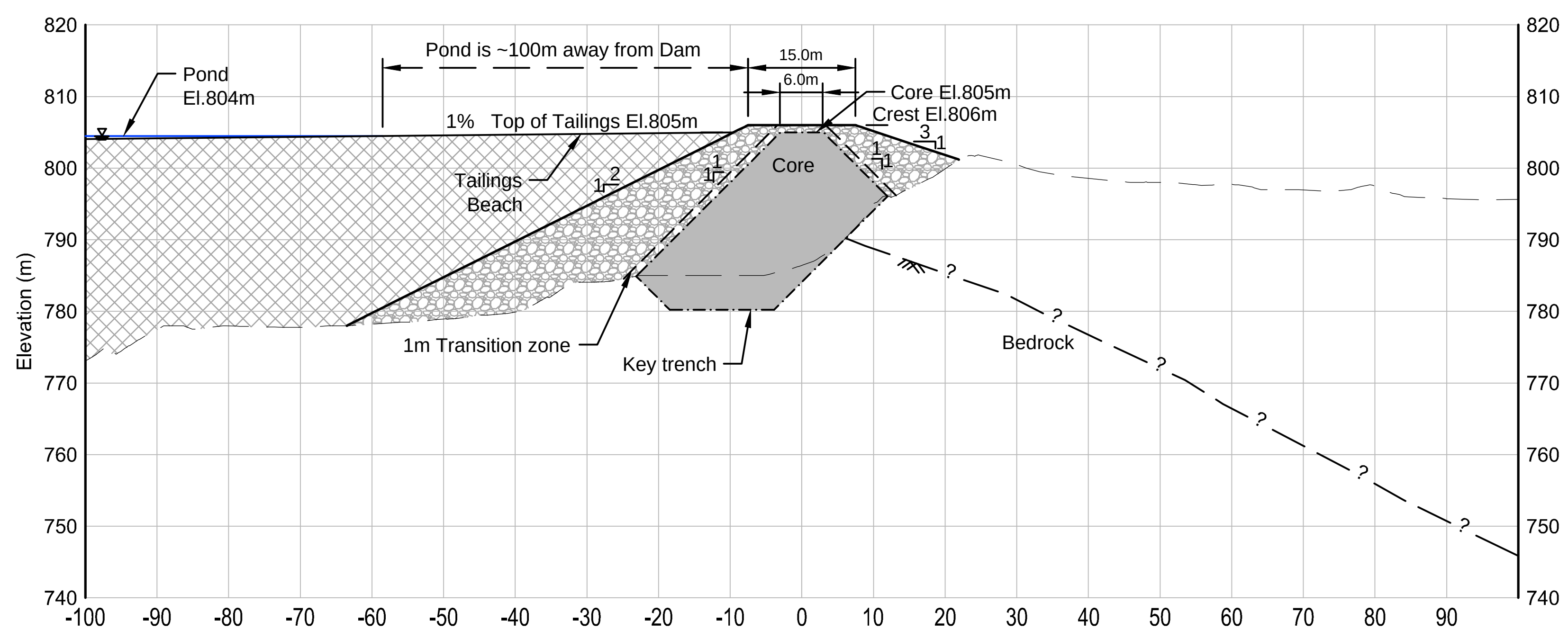


D/7 **CROSS SECTION D - D'**



E/7 **CROSS SECTION E - E'**

LEGEND

- Existing Ground Surface
- Dam Surface
- Bedrock
- Boulder Laydown Excavation
- Rock Fill
- Tailings
- Fine Grain Core

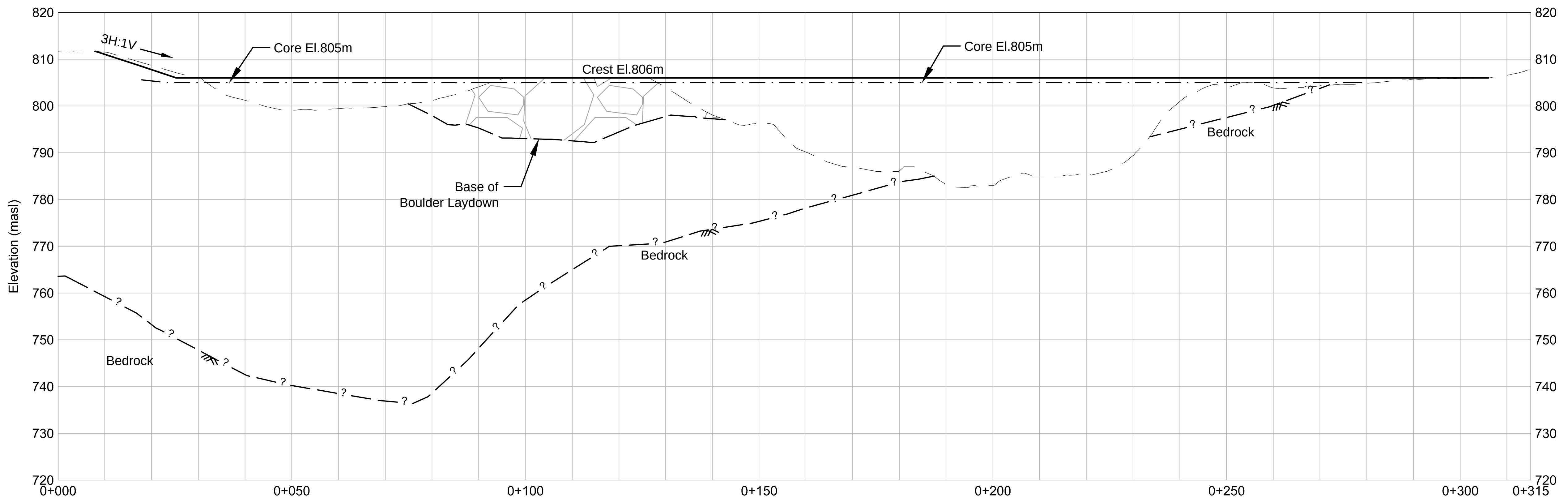
0 10 20 30 40 50
Scale in Metres

srk consulting	CAPSTONE MINING CORP. MINTO MINE OPERATED BY MINTO EXPLORATIONS LTD.	Main Dam Conceptual Design
SRK JOB NO.: 1CM002.010	Minto Mine	Typical Main Dam Cross Sections (Sheet 2 of 2)
FILE NAME: 1CM002.010–Conceptual_Dam –20130627.dwg		DATE: June 2013 / APPROVED: EMR / FIGURE: 10

J:\01_SITES\Minto\!040_AutoCAD\June 2013 (conceptual design)\1CM002.010-Conceptual_Dam -20130627.dwg

LEGEND

- Existing Ground Surface
- Dam Crest
- Bedrock Surface
- Top of Till Core
- Boulder Laydown



A / 7 **PROFILE A - A'**
Minto Dam

0 10 20 30 40 50
Scale in Metres

srk consulting	CAPSTONE MINING CORP. MINTO MINE OPERATED BY MINTO EXPLORATIONS LTD.	Main Dam Conceptual Design
SRK JOB NO.: 1CM002.010		Typical Main Dam Profile
FILE NAME: 1CM002.010–Conceptual_Dam –20130627.dwg	Minto Mine	DATE: June 2013 / APPROVED: EMR / FIGURE: 11

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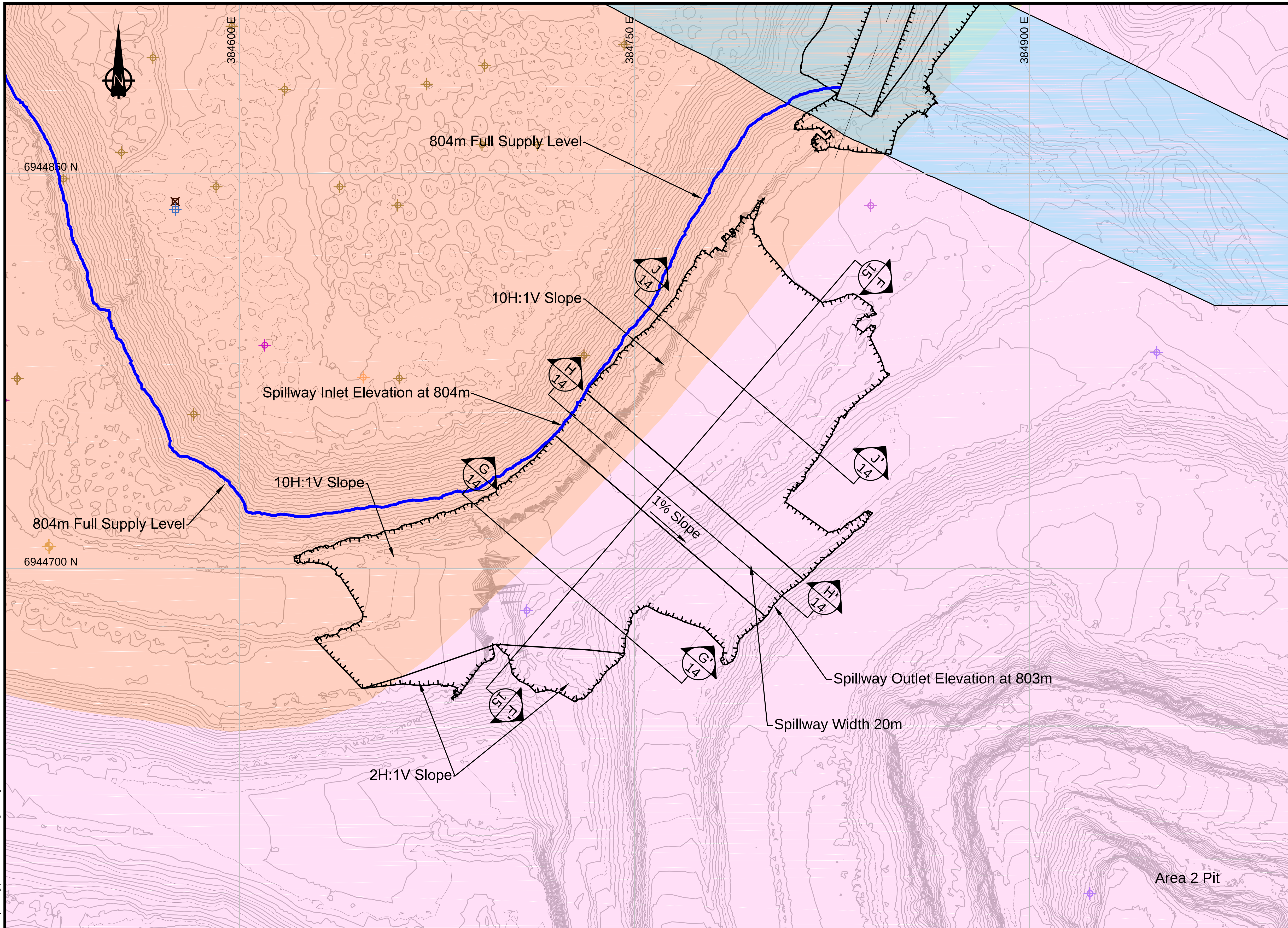

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- Inferred DEF Fault Plane
- Inferred Fault 1 Plane
- Inferred Fault 2 Plane

0 10 20 30 40 50
Scale in Metres

NOTES

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2. Topographic information provided by Minto Mine, April 2013
3. Permafrost information adapted from EBA, October 2011

srk consulting

SRK JOB NO.: 1CM002.010

FILE NAME: Historic-overburden-Investigations.dwg

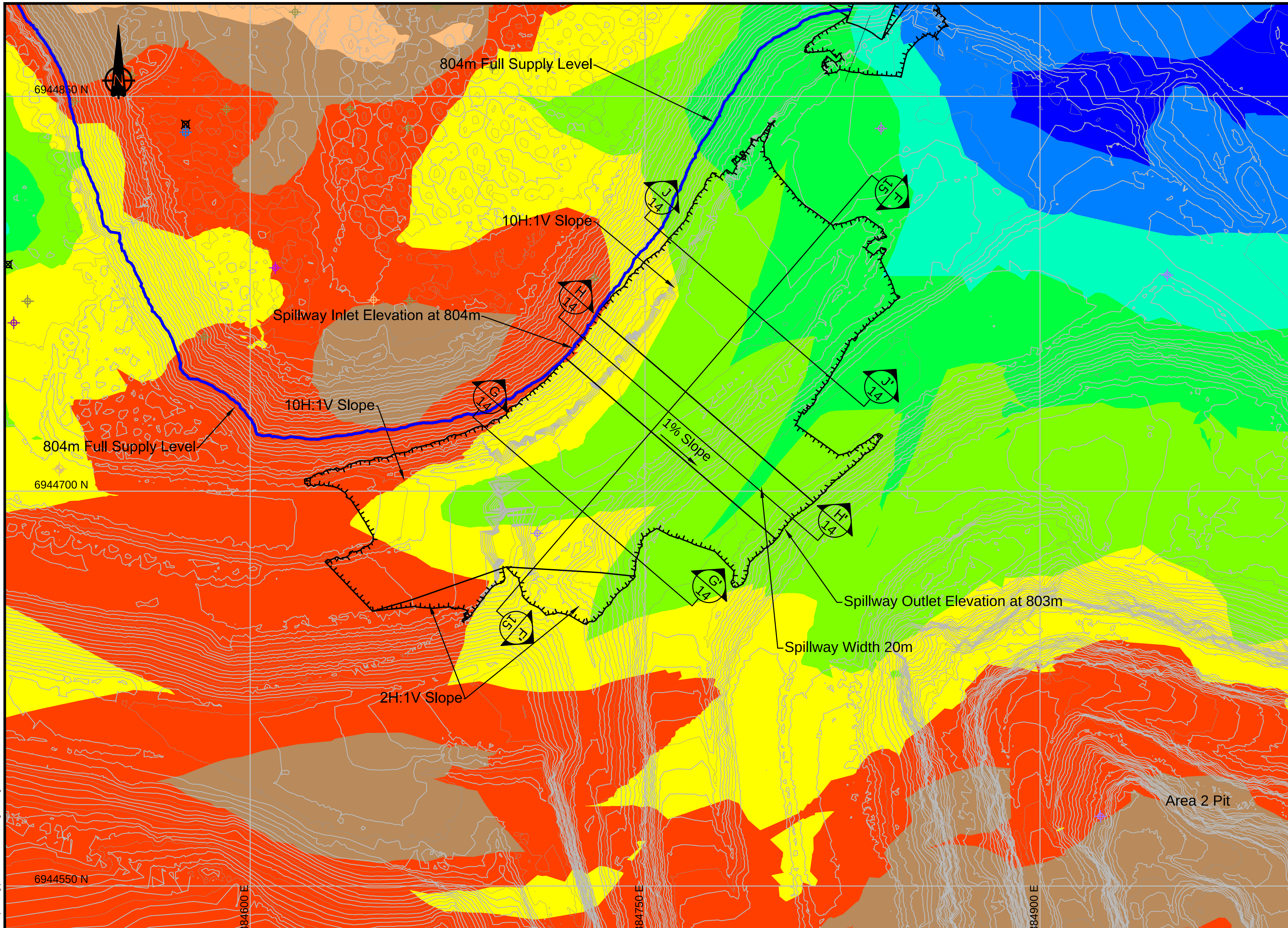
CAPSTONE MINING CORP. MINTO MINE

Minto Mine

Main Dam Conceptual Design

Main Dam Spillway Foundation Conditions (Permafrost and Major Features)

DATE:	APPROVED:	FIGURE:
June 2013	EMR	12



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Overburden Thickness (m)

- 0
- 1 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 -50
- 50 -60
- 60 -70
- 70 - 80
- 80 - 90

0 10 20 30 40 50
Scale in Metres

NOTES

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srk consulting

SRK JOB NO.: 1CM002.010

FILE NAME: Historic-overburden-Investigations.dwg

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

Minto Mine

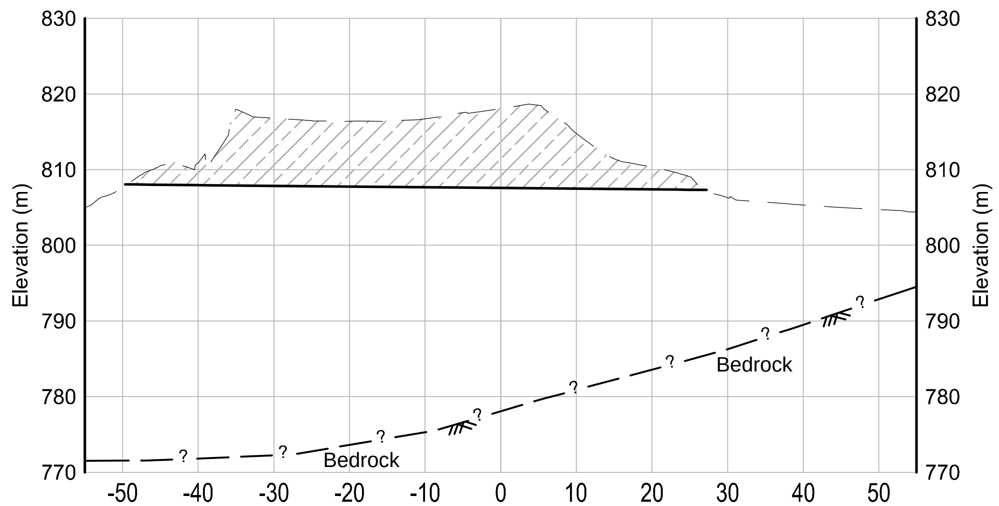
Main Dam Conceptual Design

Main Dam Spillway Foundation Conditions (Overburden Thickness)

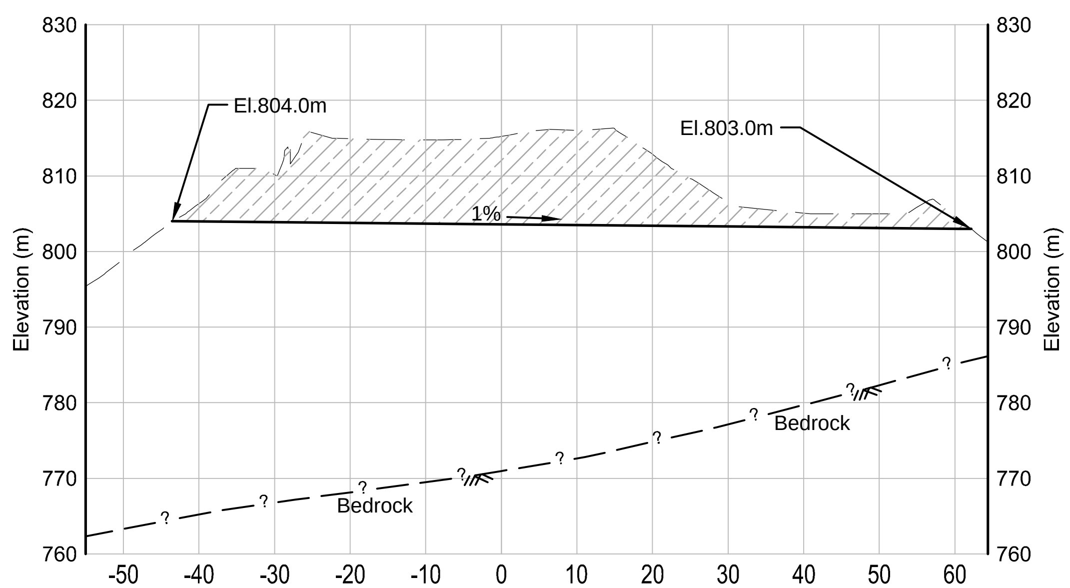
DATE:	APPROVED:	FIGURE:
June 2013	EMR	13

LEGEND

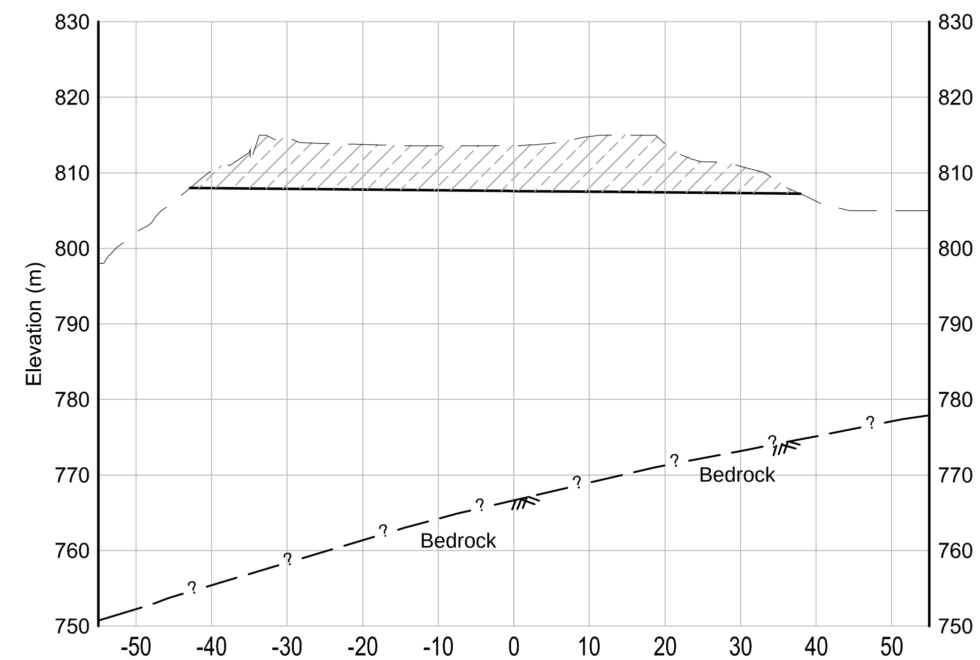
- Existing Ground Surface
- Spillway Surface
- Bedrock
- Material to be removed



G / 12 **SECTION G - G'**



H / 12 **SECTION H - H'**
Centerline of Spillway



J / 12 **SECTION J - J'**

srk consulting	CAPSTONE MINING CORP. MINTO MINE OPERATED BY MINTO EXPLORATIONS LTD.	Main Dam Conceptual Design
SRK JOB NO.: 1CM002.010		Typical Spillway Sections
FILE NAME: 1CM002.010–Conceptual_Dam –20130627.dwg	Minto Mine	DATE: June 2013 / APPROVED: EMR / FIGURE: 14

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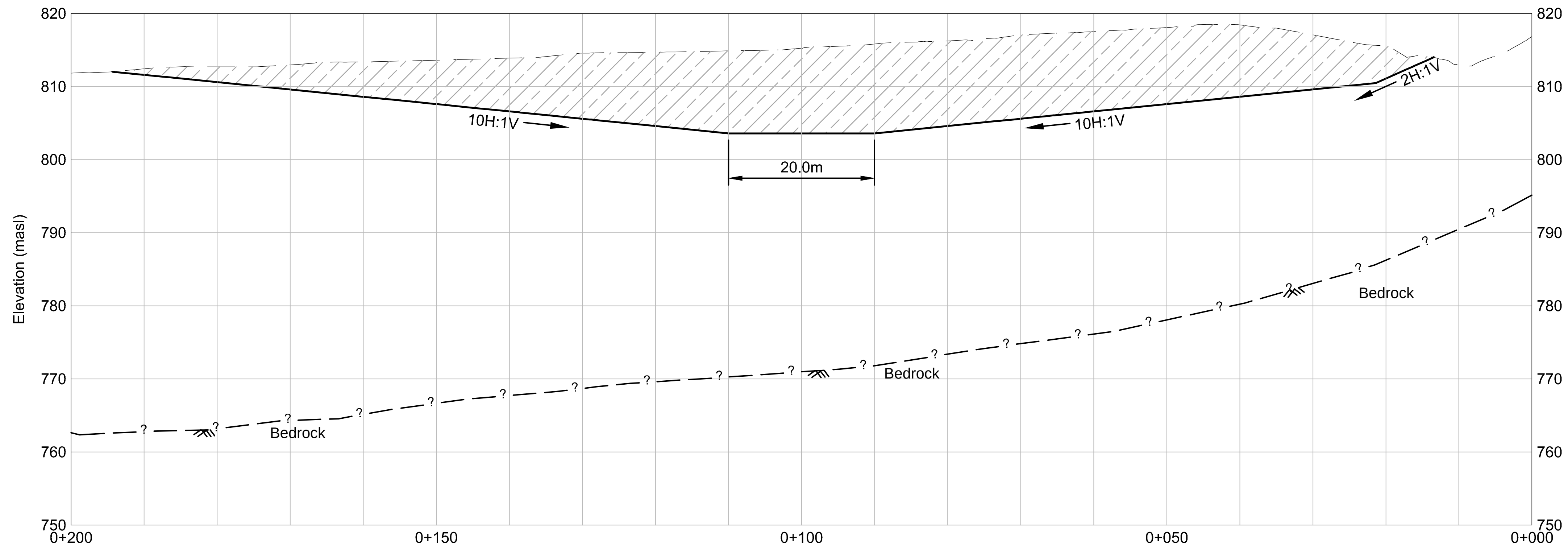
LEGEND

- Existing Ground Surface
- Spillway Surface
- Bedrock
- Material to be removed



F
12

CROSS SECTION F - F'
Spillway

0 5 10 15 20 25
Scale in Metres

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

SRK JOB NO.:	1CM002.010
FILE NAME:	1CM002.010–Conceptual_Dam –20130627.dwg

Minto Mine

Main Dam Conceptual Design

Typical Spillway Cross Section

DATE:	APPROVED:	FIGURE:
June 2013	EMR	15

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