Minto Mine
QML-0001

Underground Mine Development and Operations Plan
August 2014

Prepared by:
Minto Explorations Ltd.

Table of Contents

List of Figures

List of Tables

List of Appendices

1 Background

This Underground Mine Development and Operations Plan (UMDOP) has been prepared to satisfy the requirements of Quartz Mining Licence (QML-0001) for the development and mining of the underground at Minto Mine, owned by Minto Explorations Ltd.

Minto Mine has been in operation since 2007. Operations were focused solely on open pit mining from 2007 until 2012 at which time underground mine development commenced. Underground development continued through early 2013 at the Minto South portal.

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

This revision to the UMDOP compiles information previously submitted and approved for the Phase IV/V/VI underground and provides revised mine designs for the Minto South underground.

In August 2013, Energy, Mines and Resources published a guidance document for quartz mining projects that details the requirements for a Mine Development and Operations Plan under the QML. Some of those requirements are largely related to the surface mine operations and have been addressed in various other QML-0001 submissions, primarily the "*Mine Development and Operations Plan*."

2 Current Operations

Figure 2-1 shows an aerial overview of the mine site as of August 2013. The site configuration has not significantly changed since the photo was taken; open pit mining continued in the Area 2 pit until completion in January 2014, and mining commenced in the Area 118 pit in January and is expected to continue to September 2014 at a reduced rate. Waste rock from mining operations is currently being deposited in the Southwest Dump and the Area 2 Pit; the Mill Valley Fill Extension was completed in early 2013. Overburden was deposited in the Reclamation Overburden Dump, or in the Ice-Rich Overburden dump, depending on the ice content of the material; however, no overburden remains to be mined as part of the Phase IV mine plan.

2.1 Area 118 and Area 2 Underground Development via Minto South Portal

Underground development commenced at the Minto South Portal in mid-2012 with clearing of the overburden at the portal location and construction of an access road. The first blast occurred at the portal in September, and the portal was collared to 15 m with a steel portal access structure. Figure 2-2 shows the general surface layout at the Minto South Portal.

Development of the Minto South Underground continued in 2014: Figure 2-3 illustrates the current extent of the underground development. A fresh air raise, in addition serving as a secondary egress, was completed in January 2014.

2.2 M-Zone Underground

As part of the ongoing optimization of mining plans, Minto identified an opportunity to extract a portion of the Phase IV underground reserve, accessible from the bottom of the Area 2 pit, earlier in the mining sequence. This specific area was previously a stope within the Area 2 portion of the Phase IV Minto South Underground, where it was scheduled to be one of the last mined. It was given the name "M-zone" to distinguish it from other parts of the Phase IV underground plan.

In order to expedite the access to high-grade ore and avoid the risk of mining in close proximity to the tailings and water deposit slated for Area 2, a portal was collared at the bottom of the pit, along the west wall, directly into the ore. After a short development campaign along the footwall of the ore zone, the extraction of 250,000 tonnes of ore at 1.81% grade using an up-hole retreat mining method commenced and is currently ongoing.

This development required no new land disturbance, as both the portal and the ventilation raise are located in the bottom of Area 2 pit. The reserve did not represent an increase in mining rate, as equipment and resources from the Minto South Underground are being used.

This mining opportunity was time-critical, as the Area 2 pit is scheduled to be filled with tailings and water in Q4-2014.

As per the approval detailed in Section 1, M-zone surface construction and development commenced January 2014. As of late August 2014, M-zone development is complete, a secondary egress raise was broken through to surface, longhole production drilling is almost complete and ore extraction is ~70% complete.

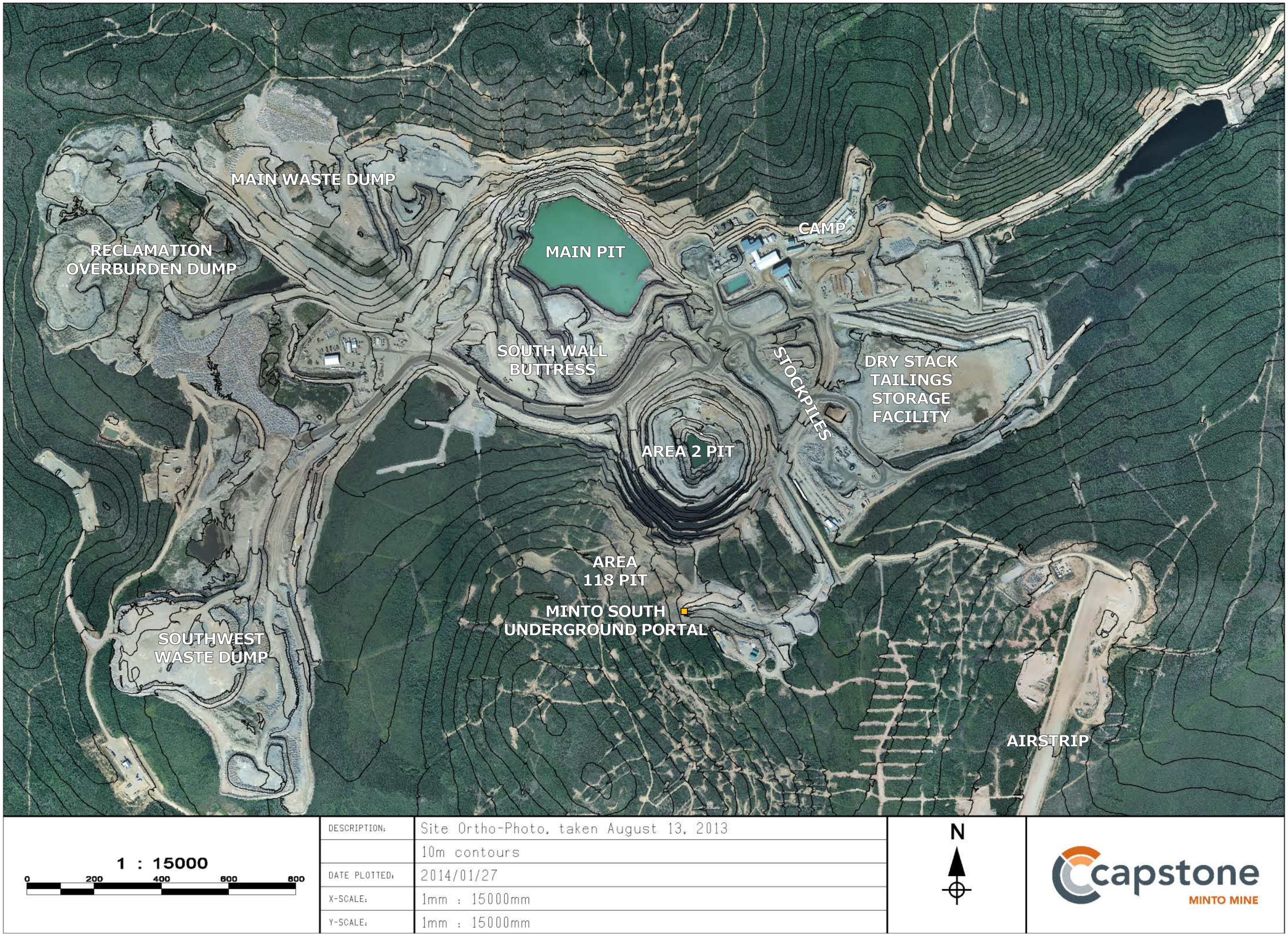


Figure 2-1: Site overview.

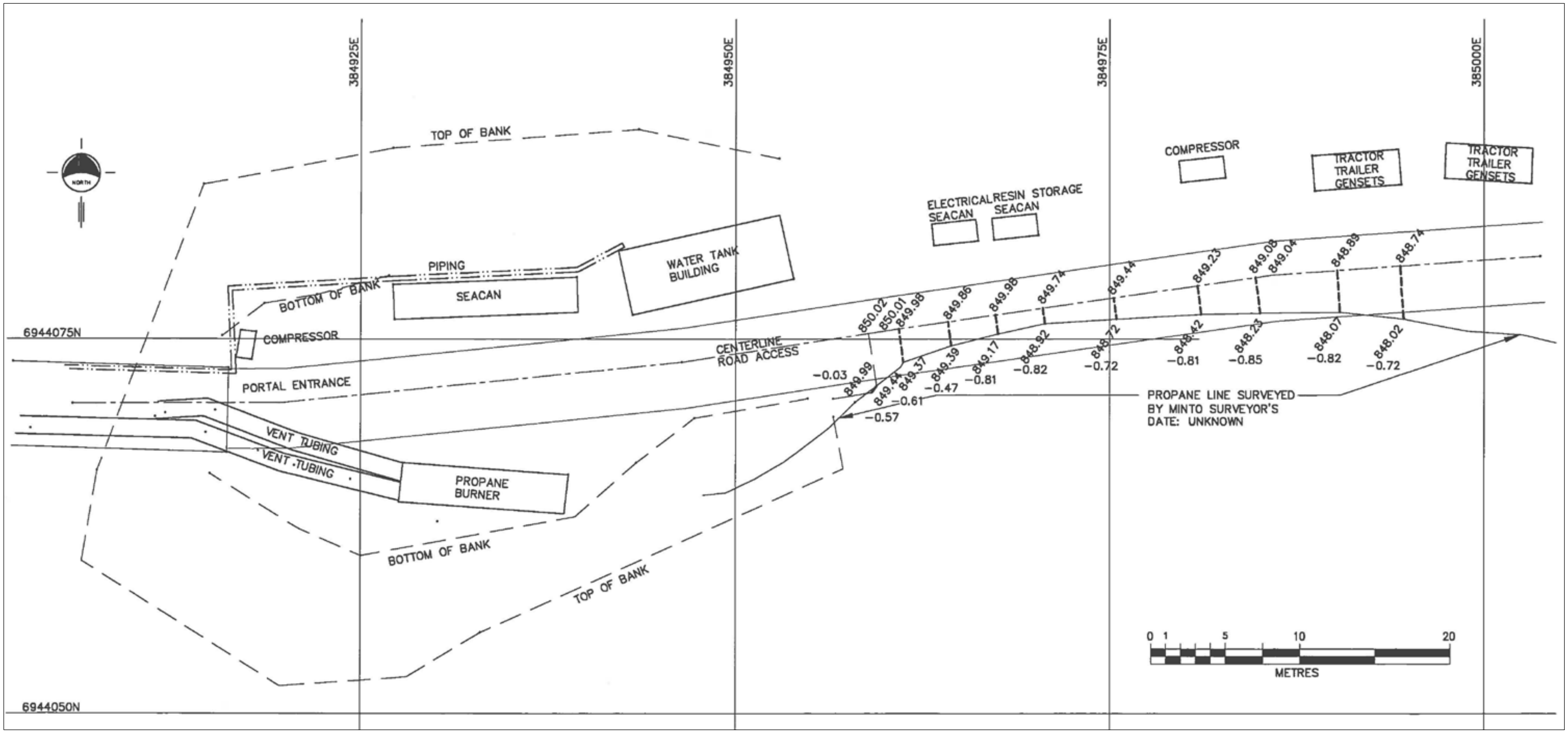


Figure 2-2: Schematic of Minto South Portal surface infrastructure.

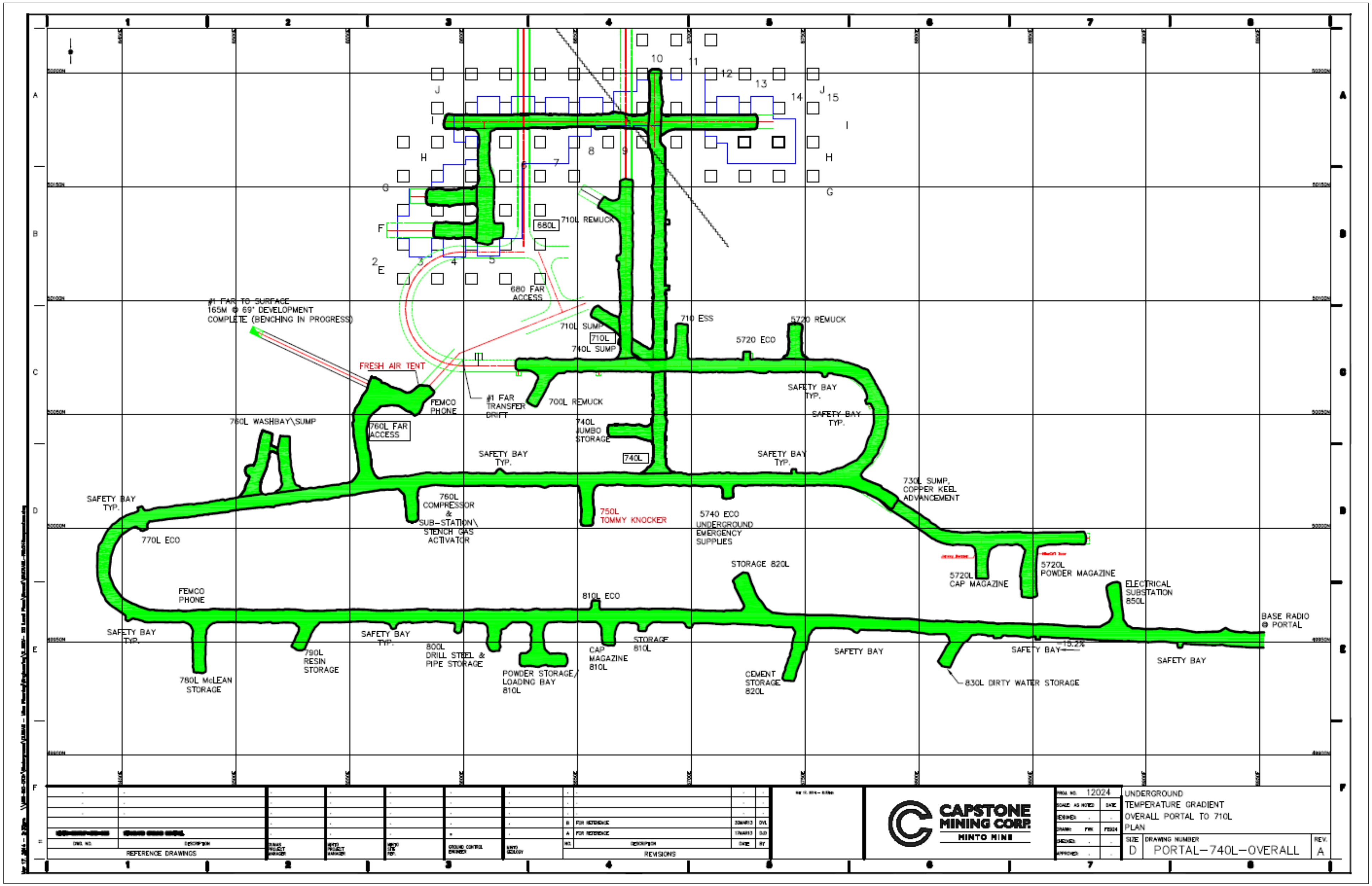


Figure 2-3: Minto South Underground development as of January 2014.

3 Deposits and Ore Reserves

The underground mining assessed as part of Phase IV consists of several stopes in the Area 2 and Area 118 zones, accessed via the Minto South Portal.

Phase V/VI adds several new ore zones to the mine plan:

- To the existing Minto South Underground complex, accessed from the Minto South Portal, Phase IV will add the Minto East and Copper Keel zones, as well as some deeper stopes in the Wildfire zone.
- A separate underground complex, known as the Wildfire Underground, will access the upper stopes of the Wildfire zone.

The following table summarizes the nomenclature associated with Minto's ore zones and lists the phase of permitting under which each has been assessed.

Underground Complex	Access	Zones	Permitting
Minto South Underground	Minto South Portal	Area 118	Phase IV
		Area 2	Phase IV
		Minto East	Phase V/VI
		Copper Keel	Phase V/VI
		Wildfire	Phase V/VI
M-zone	M-zone Portal	M-zone	Phase IV
Wildfire Underground	Wildfire Portal	Wildfire	Phase V/VI

Table 3-1: Nomenclature for underground complexes, portals, and zones at Minto.

Figure 3-1 shows all of the aforementioned ore zones and the development required to access them.

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

The Wildfire Underground accesses relatively shallow ore zones from a separate portal that will have its own dedicated infrastructure. It will be mined after the completion of the MSU; underground mining activity will transition to the Wildfire Underground as the other zones near completion.

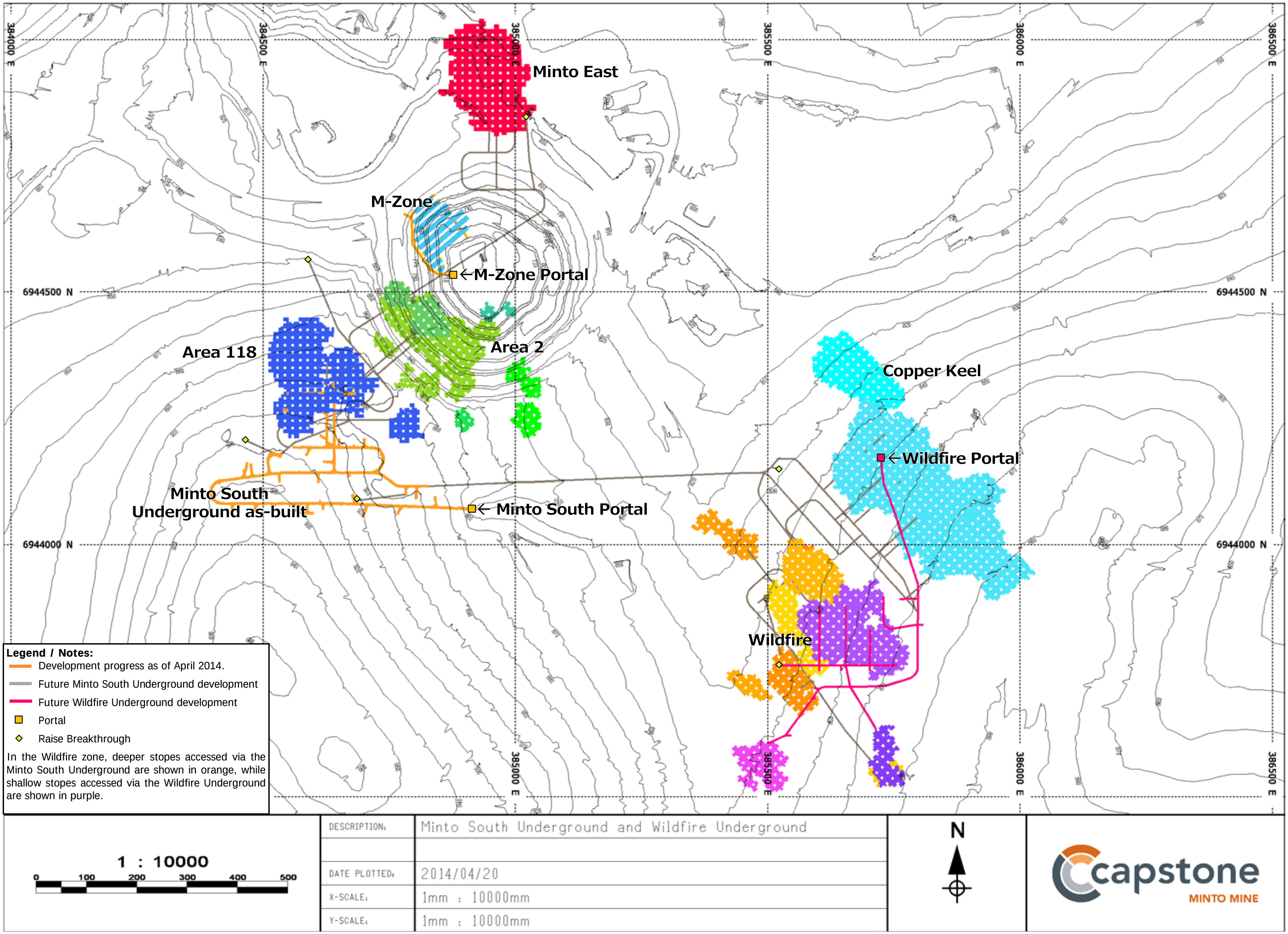


Figure 3-1: Plan view of underground development and ore zones.

3.1 Ore Reserves

Based on the reserves identified to date and the mine designs created around them, the volumes, tonnages, and grades presented in the table below are expected to be produced over the life of the underground operation.

Permitting	Ore Zone	Reserve Type	k-tonnes	Cu %	Au g/t	Ag g/t	Cu Mlb	Au k-oz	Ag k-oz
Phase IV	Area 2/118 (including M-zone)	Proven	0	0	0	0	0	0	0
		Probable	1731	1.76	0.74	7.19	67	41	400
		Sub-total	1731	1.76	0.74	7.19	67	41	400
Phase V/VI	Minto East	Proven	0	0	0	0	0	0	0
		Probable	709	2.28	1.04	6.15	36	24	140
		Sub-total	709	2.28	1.04	6.15	36	24	140
	Copper Keel	Proven	106	1.74	0.61	6.30	4	2	21
		Probable	1455	1.81	0.65	6.70	58	30	313
		Sub-total	1561	1.81	0.65	6.67	62	32	335
	Wildfire	Proven	301	1.80	0.65	6.06	12	7	59
		Probable	59	1.59	0.77	7.85	2	2	15
		Sub-total	360	1.77	1.00	6.35	14	9	74
	Underground Subtotal	Proven	407	1.78	0.81	6.12	16	10	80
		Probable	3954	1.87	0.73	6.83	163	97	869
		Sub-total	4361	1.86	0.76	6.77	179	107	949

Table 3-2: Reserves (including Phase IV Minto South Underground Reserves).

Ore volumes are reported at a cutoff grade of 1.20% and based on the stope designs prepared by SRK for the Phase IV Pre-feasibility Study. The volumes produced by the underground mine will change as detailed stope designs are prepared, taking into account the local ground conditions and optimizing the location of pillars based on in-fill drilling.

3.2 Scheduling

Initial development has occurred in the Area 118 zone by way of the Minto South Portal. Activity in that area ceased in January 2014 in order to concentrate efforts on M-zone mining. The Minto South Underground is currently on care and maintenance and will be kept in a state of operational readiness until mining resumes in October 2014.

The mining rate is currently planned at approximately 1,800 tonnes per day. A graph of ore release by month is presented in Figure 3-2.

With the exception of M-zone mining at the beginning of the schedule, which has had its ore release calculated on a blast-by-blast basis, uniform per-stope grades are used in the schedule.

The M-zone is time-sensitive due to the location of the portal at the bottom of the Area 2 pit, which will be required for tailings deposition by October 2014.

There is a gap in underground ore release between the completion of the M-zone in September 2014 and the resumption of mining in the Area 2 and Area 118 zones. Due to the high-grade ore released by the Minto North pit in 2015, additional underground ore would not add significant value to the mine. Mining activities will be suspended during this period; however, development will resume approximately two months before ore production.

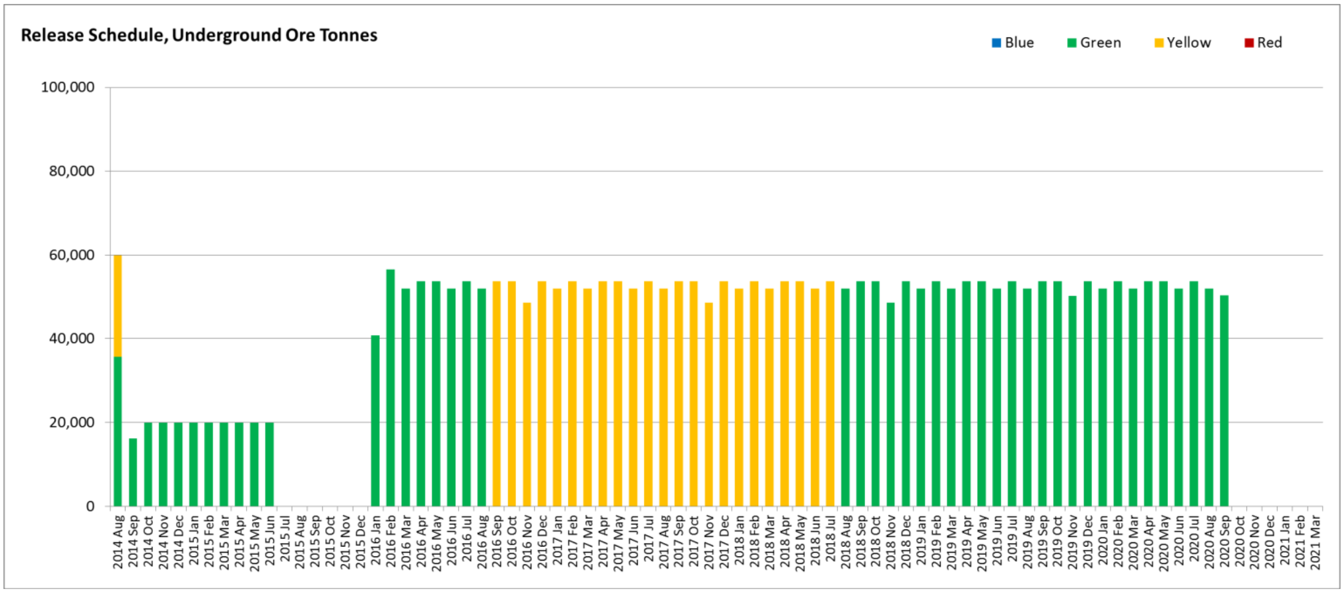


Figure 3-2: Underground ore release by month.

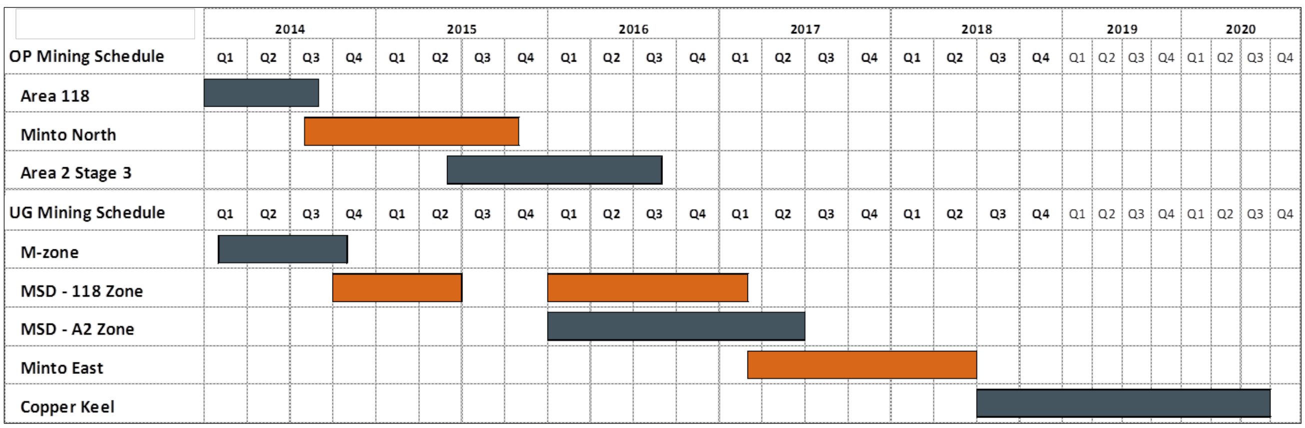


Figure 3-3: Gantt chart of ore zones mined.

4 Mine Development and Design

4.1 Minto South Underground

The mine design has been updated based on the success of the long hole mining method in the M-Zone. The design for the 118 zone will be primarily long hole with potentially room-and-pillar and post-pillar cut-and-fill mining methods. Infill drilling from underground sill development will be carried out during development to further delineate the ore body and optimize the mining method in this area. Long hole rib pillars are designed at 5m and room and pillar/post pillar cut and fill pillars are designed at 5.0m x 5.0m with a pillar spacing of 10.0m.

The main access to the Area 118 and Area 2 ore body has been developed at a 15% gradient. This access is used for all ore and waste haulage, personnel/equipment access, and services. It is also used as an exhaust airway.

The decline has been driven on the footwall side of the deposit and will provide multiple accesses to the ore body through a series of cross-cuts, sill drifts and an internal ramp.

Figure 4-1 shows a perspective view of the 118 longhole design in relation to existing 118 underground infrastructure.

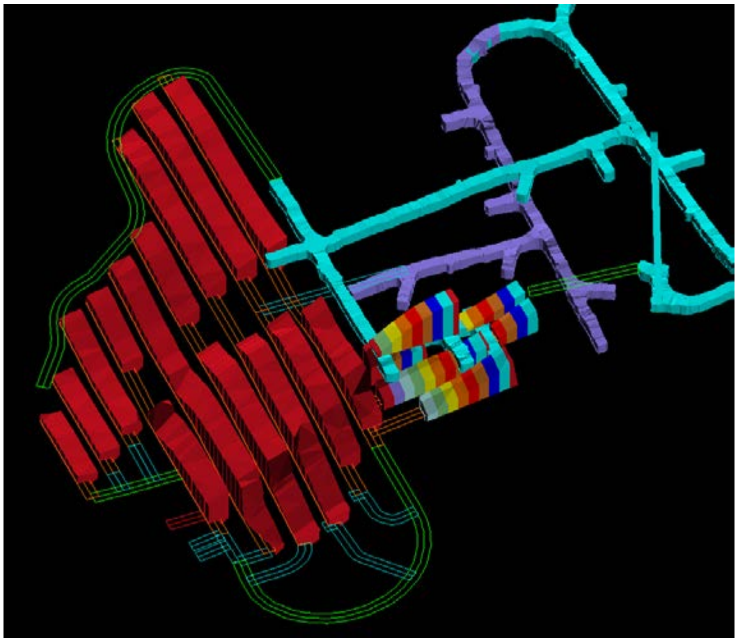


Figure 4-1: Perspective view of the 118 longhole design.

From the decline a series of 6m wide sill drifts will be driven along the footwall of the ore zone at 15 m spacing. Figure 4-2 provides an overview of all 118 development.

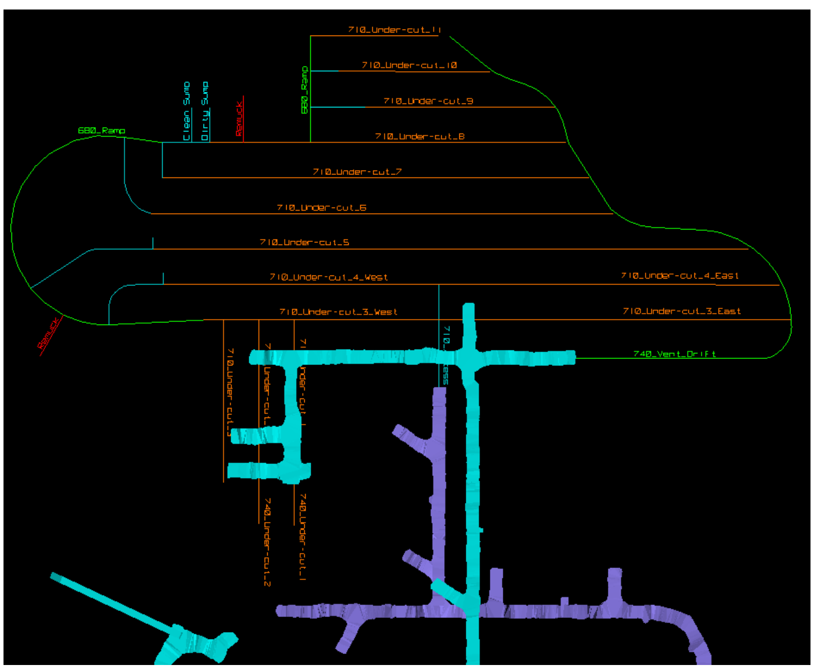


Figure 4-2: 118 development.

Starting at the east ends of these sill drifts and progressing back towards the access, rings of up-holes will be drilled to the hanging-wall contact using stinger drill rigs. To provide adequate void for blasted muck, 1.8m x

1.8m inverse raises consisting of six holes of 6” diameter, providing relief to 11 x 3” diameter holes will be drilled to start each block. Blast holes are loaded with bulk emulsion, 90g boosters, and 50 grain primacord. Generally, each block is started with one ring of blast holes on either side of an inverse raise; subsequent blasts increase the number of rings fired simultaneously to take advantage of the void space in each block. The ore will be mucked via remotely operated LHD’s, thus eliminating any exposure of personnel to the open void left by the mining method and the void is not backfilled. Blocks are 10 m wide, with 5 m rib pillars left in between.

A typical ring design is shown below in Figure 4-3.

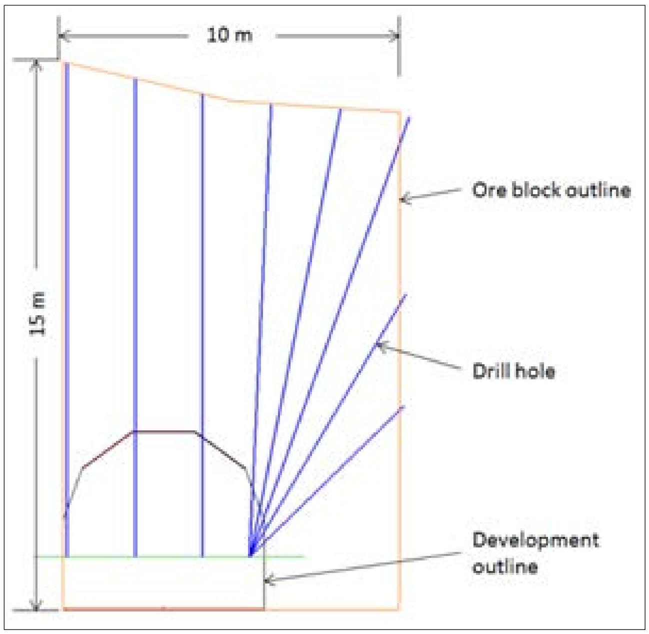


Figure 4-3: Typical Ring Section Design

The mining sequence for the long hole stopes generally progresses from south to north and east to west. Initial production will be from the north/south crosscuts on 740 and 710L where development already exists and final production in retreat will start in sill drift 8 and end with sill drift 3. Figure 4-4 shows the mining sequence in greater detail.

Figure 4-4: Longhole mining sequence.

The size of the decline was selected according to the mobile equipment size, equipment clearances, and ventilation requirements during development and production. It was estimated that a 5 m wide by 5 m high decline is satisfactory for a 40 tonne truck (50 t trucks in the future, if desired) and ventilation requirements for a 2,000 tpd production rate (see Figure 4-5 below). A 25 m or greater ramp curve radius will continue to be employed for ease of operation of the large mobile equipment.

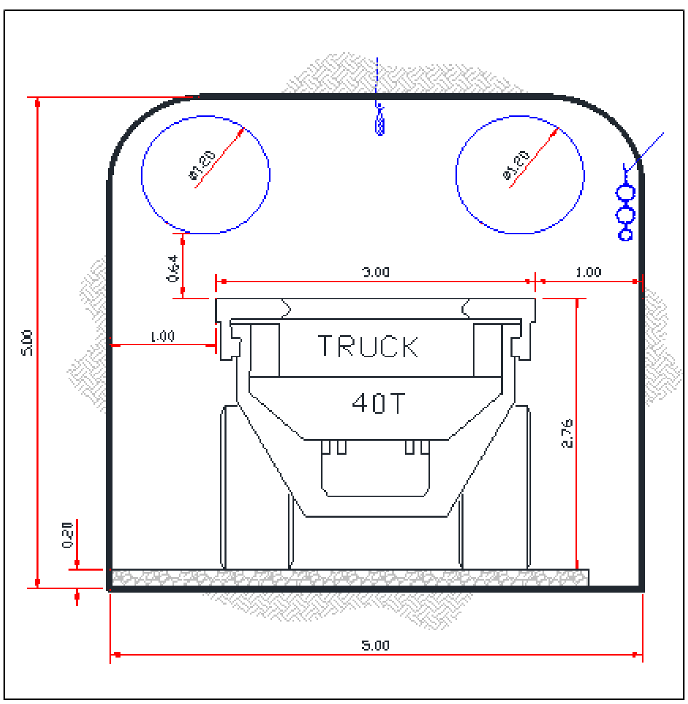


Figure 4-5: Typical decline cross-section.

Re-muck bays are typically developed every 150 m along the decline to improve the mining cycle efficiency and they are designed to hold two rounds of development muck. The re-muck bays are the same dimension as the decline and will be up to 15 m in length. Once they are no longer needed for development, the bays will be used for equipment storage, pump stations, drill bays, service bays, etc.

Generally ground support installation of 2.4m fully grouted resin rebar bolts on a 1.5m x 1.5m pattern with a 1.8 m bolt in the center for the back and all 1.8m bolts for the walls. Mesh is installed to within 1.5 m from the floor. More detail on ground support is presented in Section 6.

4.2 M-Zone

4.2.1 M-Zone Ore

The final ore lens to be mined as part of the Area 2 pit, known as the M-zone, dips at approximately 12° at a dip-direction of 330°, i.e., the lens dips N-NW into the northwest corner of the pit. The lens continues to have economic ore grades and widths for another 175 m into the wall; however, a further pushback of the Area 2 pit was determined to be uneconomic due to the high strip ratio. Underground mining of this lens was therefore selected as the preferred mining method.

Figure 4-6 and Figure 4-7 illustrate the ore lens in relation to the Area 2 pit.

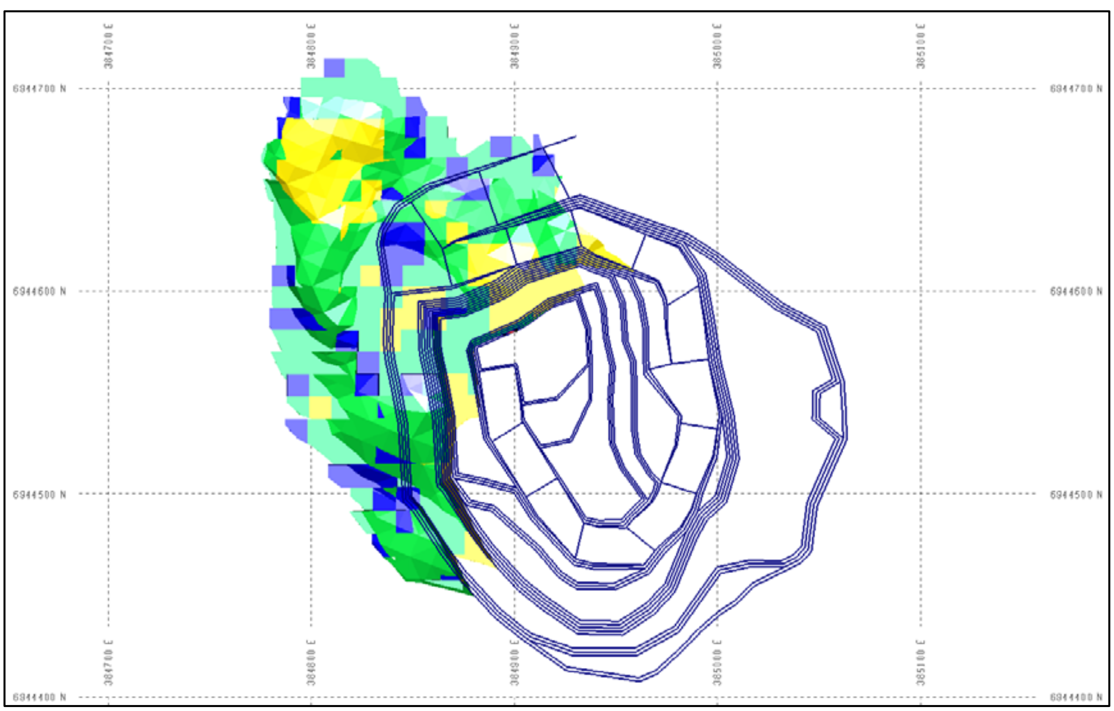


Figure 4-6: Plan view of M-Zone ore lens.

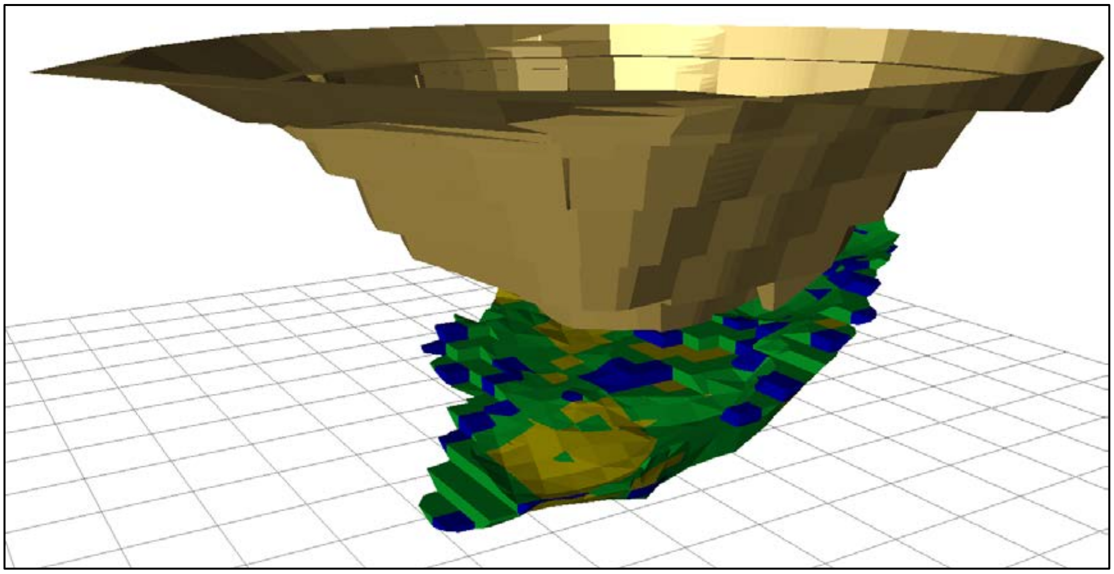


Figure 4-7: Perspective view of M-Zone ore in relation to pit design.

A decline was established from the bottom of the pit and a series of crosscuts were driven along the footwall of the ore zone at 15 m spacing. The crosscuts are 6 m wide. Figure 4-8 provides an overview of all M-zone development.

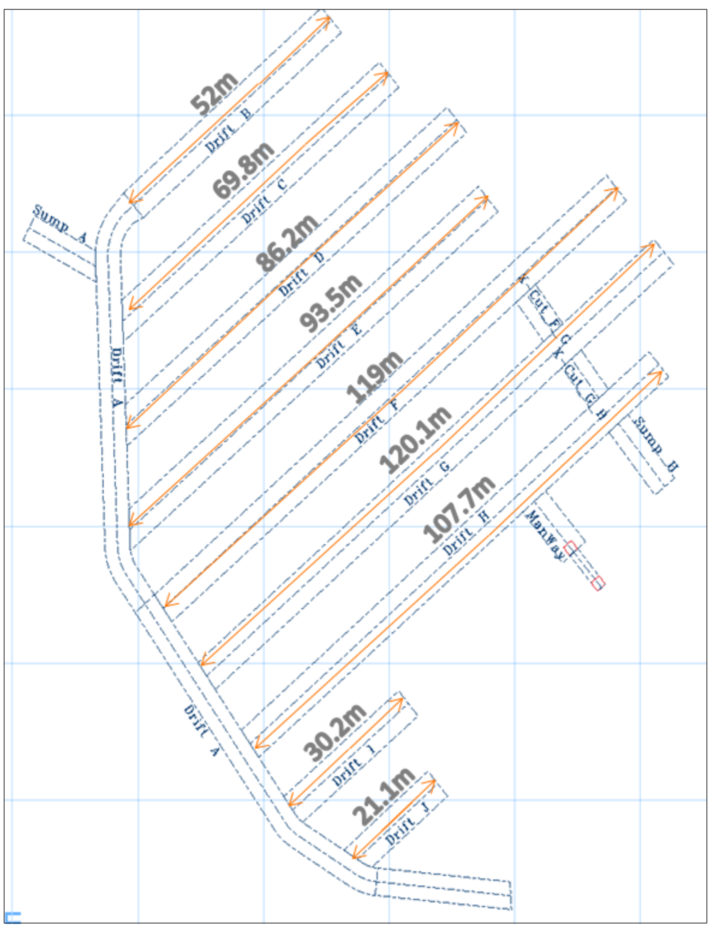


Figure 4-8: M-Zone Development Overview

Starting at the ends of these crosscuts and progressing back towards the access, rings of up-holes were drilled to the hanging-wall contact using stinger drill rigs. To provide adequate void for blasted muck, 1.8m x 1.8m inverse raises consisting of six holes of 6” diameter, providing relief to 11 x 3” diameter holes will be drilled to start each block. Blast holes are loaded with Dyno SL 25X300 stick powder and 50 grain primacord. Generally, each block started with one ring of blast holes on either side of the inverse raise; subsequent blasts increase the number of rings fired simultaneously to take advantage of the void space in each block. The ore is mucked via remotely operated LHD, thus eliminating any exposure of personnel to the open void left by the mining process and the void is not backfilled. Blocks are 10 m wide, with 5 m rib pillars left in between.

A ventilation raise and emergency egress was excavated near the east end of the M-zone development. The raise is 19m in length, 6 ft x 7 ft in cross-section, and inclined at 49° from horizontal.

A typical ring design is shown below in Figure 4-9.

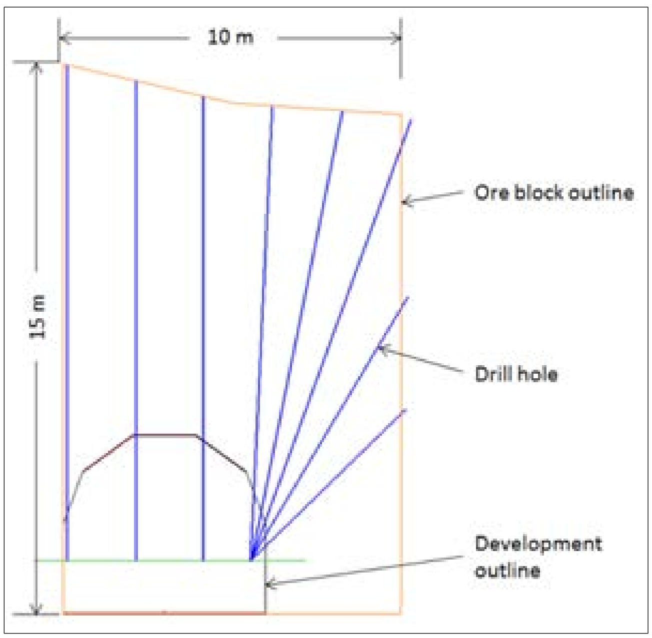


Figure 4-9: Typical Ring Section Design

The vertical dimensions of the blocks vary with the distance between the footwall and hangingwall; maximum block height is ~24 m.

5 Mine Operation

5.1 Minto South / Wildfire Underground Material Handling

A combination of 7, 8 and 10-yard LHD units and 42 tonne trucks were selected as being the most economical option for ore and waste haulage. The broken ore from the stopes is mucked by LHDs to remuck bays, or loaded directly onto 42 t underground trucks. The trucks are used to carry ore from the mine to one of the current open pit stockpiles.

The waste rock from development headings is mucked by LHDs directly to the trucks or to remuck bays located up to 150 m from the face. The waste rock is then hauled by the trucks to the surface storage pads at the portal.

Upon assaying of the development rounds, the waste is moved to the appropriate waste dump on surface as outlined in the *Waste Rock and Overburden Management Plan (WROMP)*. The protocols for segregation and placement of waste materials are consistent with the protocols for surface mining.

As underground mine production continues, it will be possible to use mine waste rock from development as stope backfill, supplemented with waste rock from surface operations wherever the room and pillar/post pillar cut and fill mining method is used. Trucks will be used to bring backfill material from surface to remuck bays, where it will be picked up by LHDs and hauled to its final destination.

5.2 M- Zone Material Handling

The short haul distances (maximum 260 m from the portal to the end of A block) make truck haulage unnecessary; all mucking is done with 7, 8 or 10-yard LHD units. A combination of Minto and contractor fleet is used for development, production mucking and ground support. A contractor is performing the longhole drilling.

6 Underground Geotechnical Assessment

Geotechnical characterization and design work has been carried out by SRK Consulting Ltd., Itasca Consulting Group Inc. and Minto for the M-zone (Area 2) and Minto South (Area 118) zones. A ground control management plan was developed and implemented in 2013 and has been used for all underground development to date.

The following points (italicized excerpts from the SRK Phase V Prefeasibility Study) summarize the general ore body conditions:

Resource continuity

*The (*mineralized*) zones bifurcate, which means that a mineralized zone can contain a significant amount of waste, or that thinner ore zones can merge with larger zones. A bifurcating geometry complicates geological modelling and may expect to increase internal dilution.*

The width and dip of mineralized zones are locally variable. The zones therefore appear to pinch-and-swell. The change in thickness might be as much as an order of magnitude over less than 30 m in horizontal distance.

At least some of the irregularity in the geometry and thickness of the mineralized zones is due to small-scale and large-scale structural displacements. No detailed structural model has been completed for either deposit, but at least two faults appear to be present in Area 2, and three possible faults displace the modelled zones in Area 118. Similar structures may be present throughout the deposit, each with displacements of a few metres or less.

Deposit boundaries

The boundary between Area 2 and Area 118 zones has been modelled as a fault. The drill hole intersections are of sufficient density to show the position of the fault accurately. Two additional faults have been modelled in order to explain intersection positions in Area 118, and these faults divide the Area 118 resource into three domains.

No study has been done on the drill core in order to define the characteristics of the faults. There are indications that these faults have the characteristics of high strain shear zones, rather than brittle structures.

The main geotechnical points from this are:

- Mineralization is considered to be variable in thickness, dip, and lateral continuity;
- Displacements occur through mineralization on the meter scale;
- Major boundary fault zones are present in Area 2/118 areas and have been modeled in 3D. A detailed structural model and structural characterization have not been completed, and;
- There is potential for fault zones to be present in the Copper Keel area.

6.1 Hydrogeological Assessment

A hydrogeological assessment has not been completed to define the potential inflows to the underground workings from large and small-scale structures. Minto's experience with open pit mining has been that static groundwater is encountered in blastholes, but that surface runoff is the major driver of pit dewatering requirements. Inflows encountered in the Minto South and Area 2 underground development to date have been associated with discrete water-bearing faults and with un-grouted diamond drillholes. No unmanageable inflows have been intersected and a common sump and pump dewatering system has been used without any grouting work required.

6.2 Minto South Underground

6.2.1 Orebody Geometry

The Minto South orebody has the following general characteristics:

Thickness (perpendicular to dip): 5 to 20m, generally less than 15m.
Span: 20 to 180m, generally less than 100m.
Dip: 0 to 40° from horizontal, generally less than 10°.

The shapes show poor continuity between areas, some of which may be the result of wide drill hole spacing. It is expected that these could become more continuous once tighter drill hole spacing, underground exposure, and a better understanding of the ore body geometry is achieved.

6.2.2 Mining Method

Due to the variable continuity and geometry of the mineralized zones, a combination longhole stope and room and pillar/post pillar cut and fill design has been assessed. Infill drilling from underground crosscuts will be carried out during development to further delineate the orebody and optimize the mining method and sequence for each area. The majority of mining is planned to be carried out using the longhole method, however small areas near the north end of the deposit may be considered for room and pillar/post pillar cut and fill where the orebody becomes relatively thin.

The following is a summary of the planned excavation and pillar geometry.

Table 6-1: Summary of Excavation and Pillar Geometry

Excavation/Pillar	Depth (m)	Width (m)	Height (m)	Length (m)
Development drifts, ramps	0-200	5	5	-
Longhole development drift	160-200	6	4.5	-
Longhole stope (non-entry)	160-200	10	9-25	29-180
Longhole pillar	160-200	5	9-25	29-180
Room (entry)	160-200	10	5-10	-
Pillar	160-200	5	5-10 (5m lifts with backfill)	5

6.2.3 Rock Mass Assessment

Rock mass characterization has been carried out based on core logging completed by SRK and underground mapping completed by Minto in development to date. A summary of rock mass quality is contained in Table 6-2 and rock structure in Figures 6-1 and 6-2. Experience in M-zone to date has indicated core logging data is likely conservative relative to conditions observed during excavation.

Table 6-2: Summary of Rock Mass Characterization for Minto South

Area	Source	Rock Type	Condition	Number of Samples	RMR			Q'		
					min	max	avg	min	max	avg
Minto South	Core Logging (SRK)	eG,pG,fG	Fresh	334 runs	22	81	58	-	-	-
			Weathered	59 runs	21	72	51	-	-	-
	Underground Mapping (Minto)	eG,pG	Fresh	-	-	-	74	0.9	14.2	6.0
		fG	Fresh	-	-	-	76	1.0	47.5	14.5

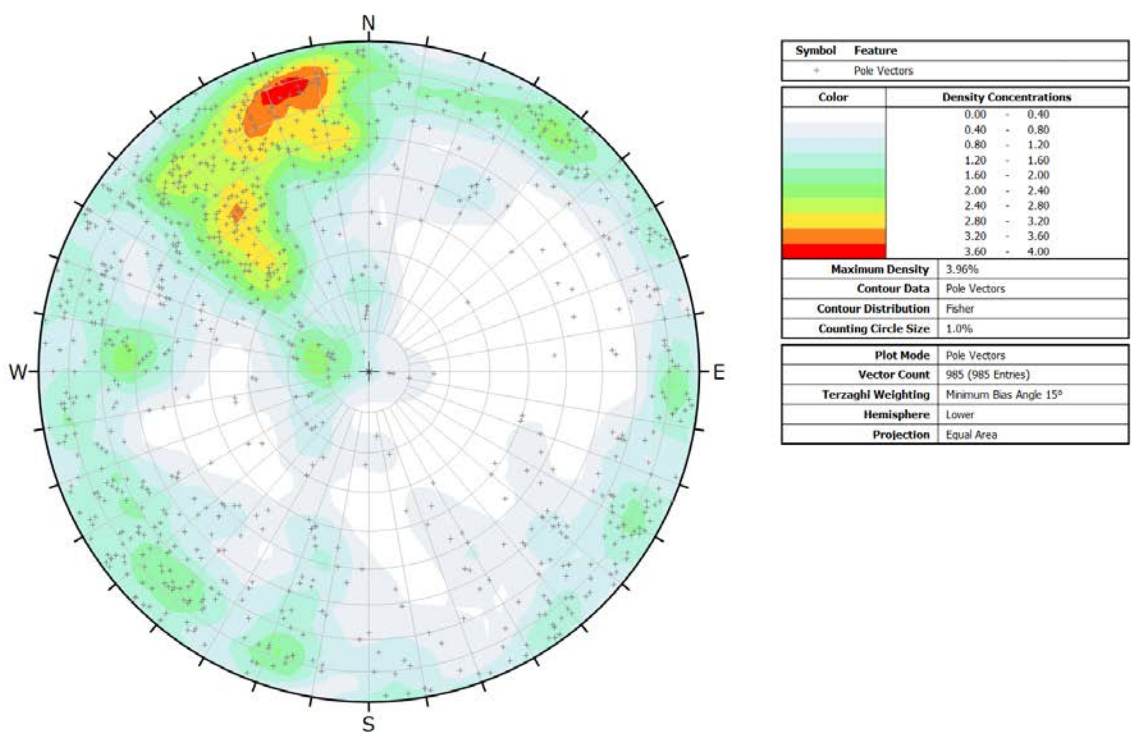


Figure 6-1: Stereonet of Rock Structure in Area 118 Waste Rock

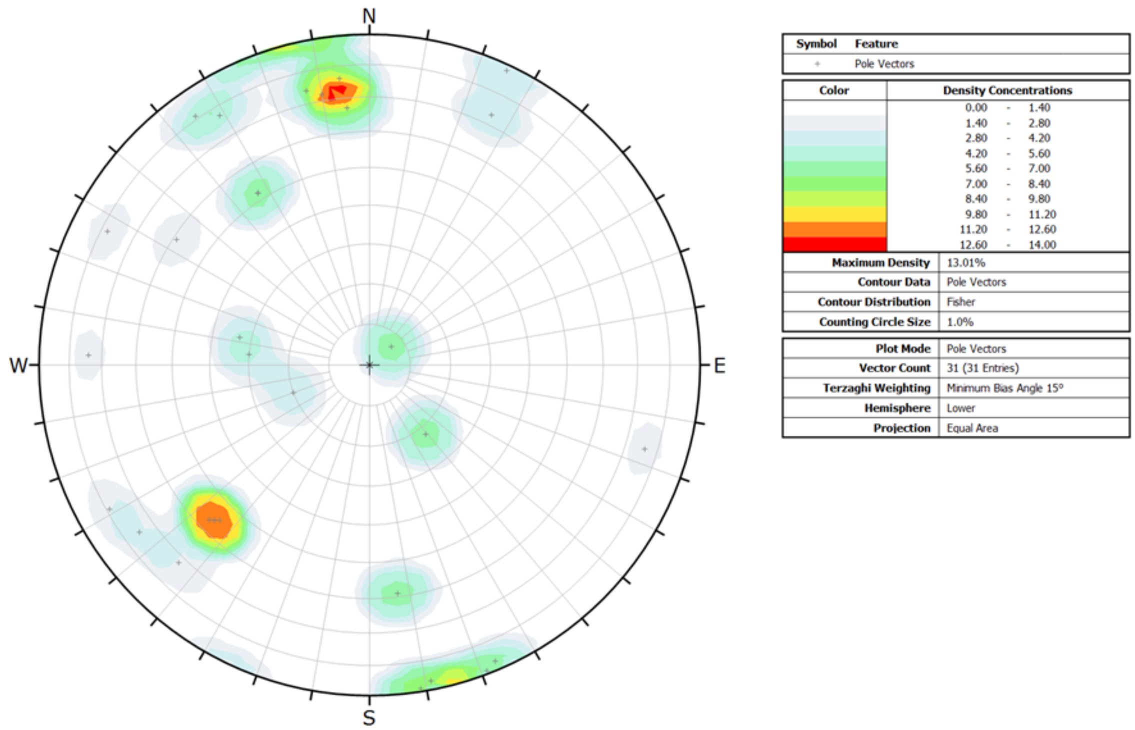


Figure 6-2: Stereonet of Rock Structure in Area 118 Waste Ore

Several faults have been interpreted through the Minto South orebody based on mineralization offsets. These have been included in the stability analyses however review of core photos indicates they are unlikely to represent significant planes of weakness.

6.2.4 Longhole Stope and Pillar Stability Analysis

Planned longhole stopes and pillars were assessed using a combination of empirical analysis, numerical modelling and experience in the Minto underground to date.

Empirical stope stability analysis was carried out using the Mathew's Stability Graph method. Descriptions of the stopes assessed are contained in Table 6-3 and results of the analysis are summarized in Table 6-5.

Table 6-3: Summary of Stope Geometry for Minto South

Stope	Stope Segment	Orientation	Depth (m) (to mid-stope height)	Max. Height (m) (floor to back)	Length (m)
710_1	-	N-S	182	20	29
710_2	-	N-S	187	18	53
710_3	E	E-W	182	19	120
	W	E-W	181	18	71
710_3	-	N-S	189	21	44
710_4	E	E-W	185	14	122
	W	E-W	187	17	86
710_5	E	E-W	188	13	109
	W	E-W	191	19	108
710_6	E	E-W	189	12	57
	W	E-W	194	22	119
710_7	-	E-W	199	25	177
710_8	E	E-W	196	11	43
	W	E-W	200	18	70
710_9	-	E-W	201	10	73
710_10	-	E-W	199	10	55
710_11	-	E-W	195	9	43
740_1	-	N-S	176	20	28
740_2	-	N-S	175	18	18
740_W_1	-	E-W	171	13	80
740_W_2	-	E-W	170	21	80
740_W_3	-	E-W	171	25	76
Average	**-**	**-**	***187***	***17***	***76***

Results of the analyses are presented below for average rock mass conditions. The analyses will be revised as more information on rock quality is collected during development. The geometries can be considered conservative as the maximum heights were used for each stope, and the full floor to back height was assessed when in practice the lower 4-6 m of the pillar is much wider due to the location and orientation of the fan holes.

Table 6-4: Minto South Mathew's Stability Graph Results

Stope	Stope Segment	Endwalls		Sidewalls		Backs	
		Stability	**Overbreak (ELOS) (m)**	**Stability**	**Overbreak (ELOS) (m)**	**Stability**	**Overbreak (ELOS) (m)**
710_1	-	Stable	<0.5	Stable	<0.5	Stable	1
710_2	-	Stable	<0.5	Stable	<0.5	Stable	1-2
710_3	E	Stable	<0.5	Stable	<0.5	Transition Stable-Unstable	1-2
	W	Stable	<0.5	Stable	<0.5	Transition Stable-Unstable	1-2
710_3	-	Stable	<0.5	Stable	<0.5	Stable	1-2
710_4	E	Stable	<0.5	Stable	<0.5	Transition	1-2

Stope	Stope Segment	Endwalls		Sidewalls		Backs	
		Stability	Overbreak (ELOS) (m)	Stability	Overbreak (ELOS) (m)	Stability	Overbreak (ELOS) (m)
						Stable-Unstable	
	W	Stable	<0.5	Stable	<0.5	Transition Stable-Unstable	1-2
710_5	E	Stable	<0.5	Stable	<0.5	Transition Stable-Unstable	1-2
	W	Stable	<0.5	Stable	<0.5	Transition Stable-Unstable	1-2
710_6	E	Stable	<0.5	Stable	<0.5	Transition Stable-Unstable	1-2
	W	Stable	<0.5	Stable	0.5-1	Transition Stable-Unstable	1-2
710_7	-	Stable	<0.5	Transition Stable-Unstable	0.5-1	Unstable	1-2
710_8	E	Stable	<0.5	Stable	<0.5	Stable	1-2
	W	Stable	<0.5	Stable	<0.5	Transition Stable-Unstable	1-2
710_9	-	Stable	<0.5	Stable	<0.5	Transition Stable-Unstable	1-2
710_10	-	Stable	<0.5	Stable	<0.5	Stable	1-2
710_11	-	Stable	<0.5	Stable	<0.5	Stable	1-2
740_1	-	Stable	<0.5	Stable	<0.5	Stable	1
740_2	-	Stable	<0.5	Stable	<0.5	Stable	0.5-1
740_W_1	-	Stable	<0.5	Stable	<0.5	Transition Stable-Unstable	1-2
740_W_2	-	Stable	<0.5	Stable	<0.5	Transition Stable-Unstable	1-2
740_W_3	-	Stable	<0.5	Stable	0.5-1	Transition Stable-Unstable	1-2

The results indicate all endwalls and sidewalls are predicted to be stable with the exception of 710_7, which plots in the stable-unstable transition zone. Overbreak (Equivalent Linear Overbreak/Slough, ELOS) is predicted to be <0.5m for most endwalls and sidewalls, occasionally up to 0.5-1m for some sidewalls.

Backs typically plot in the transition zone between stable and unstable and have an ELOS of 1-2m. The back of one stope, 710_7, plots in the unstable zone. This is described as “points falling in this zone indicate that the surface under consideration should require some form of pattern support. If support cannot be placed due to access constraints some failure with associated dilution should be anticipated, however a stable unsupported configuration should eventually be attained. Dilution is estimated to fall in the range of 10% to 30%.” (Stewart & Forsyth, 1995).

These results are consistent with conditions observed in longhole stoping in the M-zone where typical overbreak in sidewalls is 0-1m and 1-2m in backs. Overbreak is highly dependent on drilling and blasting practices and the experience gained in M-zone will be significant in minimizing overbreak in Minto South.

An example plot, showing the worst case scenario, Stope 710_7 is shown in Figure 6-3.

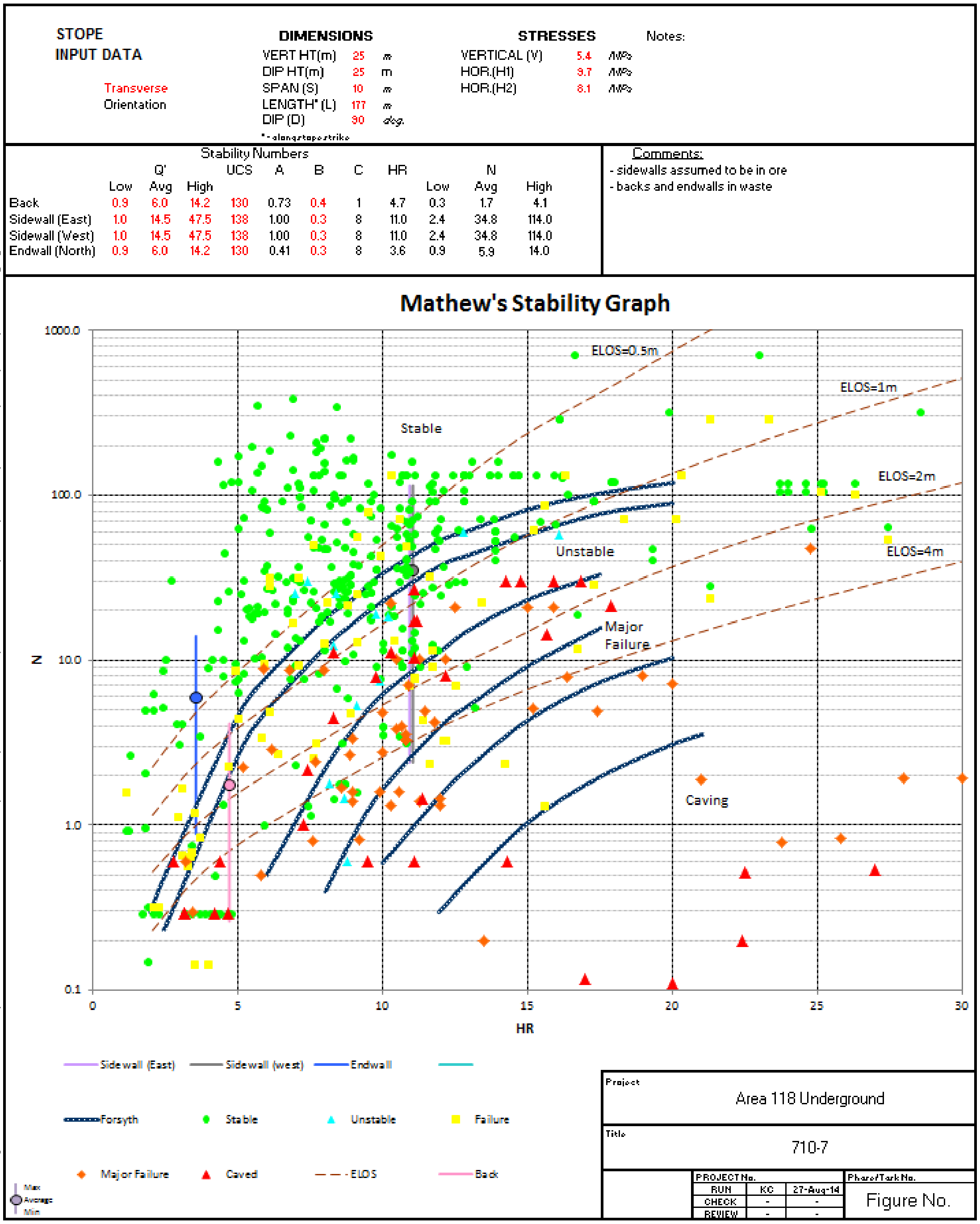


Figure 6-3: Example Mathew's Stability Graph for Stope 710_7

Numerical analyses were carried out by Itasca to assess the planned longhole stope design. Complete results are contained in the presentation "Minto 118 Zone – FLAC3D Analysis of the Longhole Base Case Option" (Itasca, 2014). Figure 6-4 and 6-5 show the finite difference model used for the analyses.

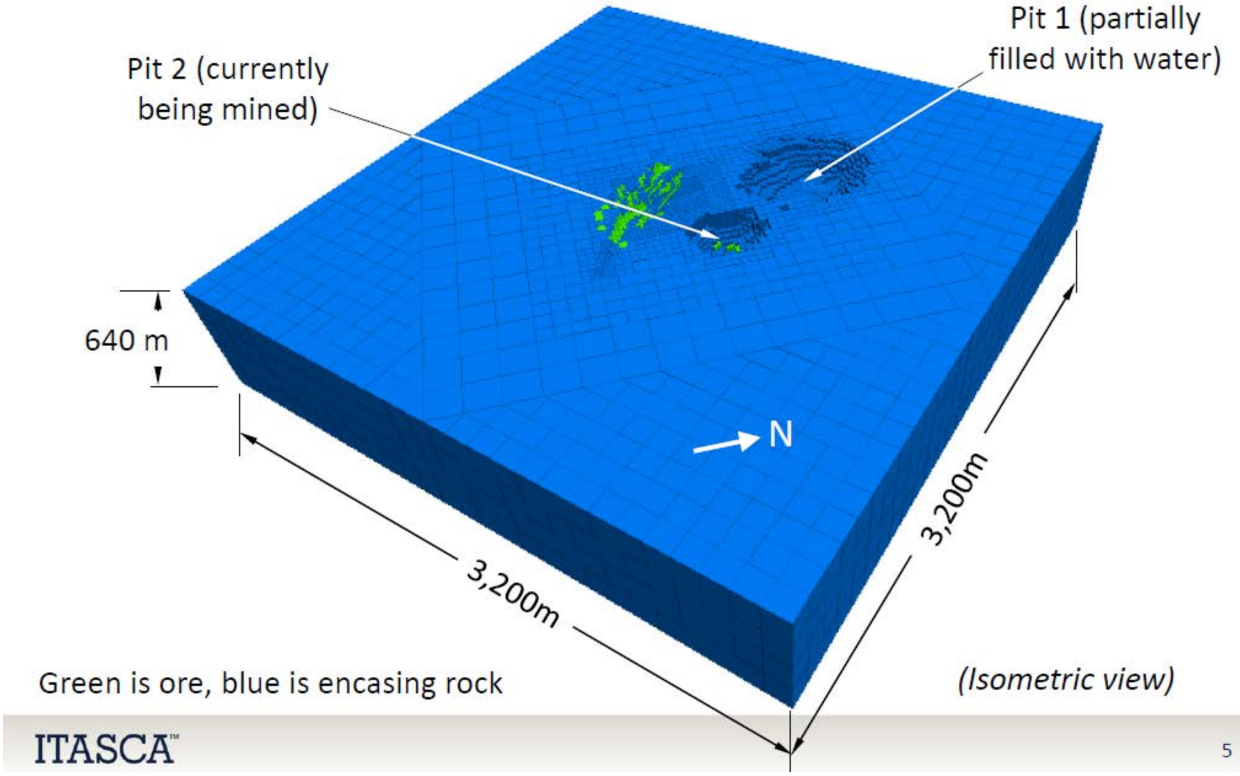


Figure 6-4: FLAC3D Model used for Longhole Analysis (Itasca, 2014)

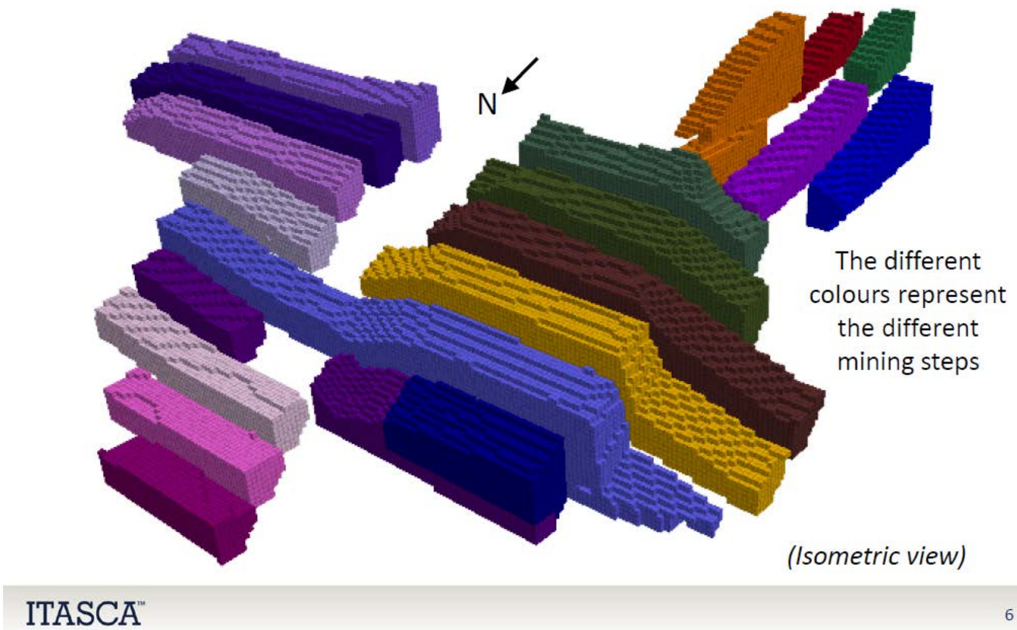


Figure 6-5: FLAC3D Model used for Longhole Analysis (Itasca, 2014)

Rock properties used in the model are presented below.

Property	Encasing "Waste" material	"Ore" material	Fill
Bulk modulus K (GPa)	26	26	0.025
Shear modulus G (GPa)	16	15	0.015
RMR_{89}/GSI	74/69	76/71	-
Peak friction angle (deg) [1]	61.9	60.5	43
Peak cohesion (MPa) [1]	3.24	2.82	0
Peak tensile strength (kPa)	466	387	0
Critical plastic strain interval (%) [2]	0.92	0.86	-
Residual friction angle (deg)	43.3	42.4	-
Residual cohesion (kPa)	162	141	-
Residual tensile strength (kPa)	0	0	-

1 Established with a tangential fit at sig3max = 3.3 MPa (for a mining depth of 140 m max), and a linear failure envelope. This overestimates friction, but provides a conservative estimate of cohesion, which matters most in our case.

2 Strain-softening interval between peak and residual strength (the same for the cohesion and friction). Based on GSI. The tensile critical strain was set to 0.00001% to reflect the more brittle behaviour of tensile failure.

The two major faults going through 118-Zone were incorporated in the model with ubiquitous joints, making them 3-4 zones wide. They were given the following properties: cohesion = 0 , tensile strength = 0, friction angle = 30°.

Conclusions from the analyses included the following (Itasca, 2014):

1. *The FLA3D model showed that the longhole option as modelled is mostly stable at the exception of the back of some stopes (mostly due to their local geometry)*
2. *The plasticity plots showed that most backs and walls behave well*
3. *However, the model showed that the backs on the eastern side of some of the west stopes are failing in tension due to their convex shape*
4. *The σ1 magnitude plots show a stress concentration in the order of 12-15 MPa in most of the pillars, with lower stresses in the north-south oriented rib pillars in the shallower stopes*

Based on the conclusions above, the shapes of stope backs will be flattened such that no abrupt convex shapes will be created in the mined stope backs. The analyses indicate pillars are predicted to be stable. Where excessive overbreak occurs, typically due to structure or poor drill and blast performance, the mining sequence from south to north provides good flexibility to shorten fan holes, thus narrowing the stope and leaving a wider pillar.

Kinematic analysis was also performed using the software Unwedge to assess potential structural instability in the stope backs and walls. Results are contained in Table 6-5. The analysis was based on structural mapping completed in Minto South underground to date and will be updated as more data is collected during development.

Table 6-5: Summary of Stope Geometry for Minto South

Exposure	Orientation	Stope Size	Maximum Possible Unstable Wedge (based on Minto South underground mapping to date)	
			Mass (tonnes)	**Apex Height (m)**
Back	N-S	Width = 10m	125	5
	E-W	Width = 10m	274	10
Sidewall	N-S	Min height = 9m	56	5
		Avg height = 17m	293	8
		Max height = 25m	744	10
	E-W	Min height = 9m	54	4
		Avg height = 17m	265	6
		Max height = 25m	764	9
Endwall	N-S	Min height = 9m	11	1
		Avg height = 17m	73	2
		Max height = 25m	156	3
	E-W	Min height = 9m	55	6
		Avg height = 17m	303	10
		Max height = 25m	380	8

Based on the analysis, the largest wedges, shown in Figure 6-6, are predicted to occur on the north sidewalls of the stopes. Because the stopes are non-entry, the potential wedges do no present a hazard to personnel, but can be a hazard to remote scoops working in the stope. Experience in the M-zone indicates wedges typically release with the blast or with blasts in adjacent stopes, therefore limiting the risk to equipment. As discussed above, the planned mining sequence from south to north will provide flexibility to narrow stopes and leave wider pillars in areas where significant wedges have released from the north wall of the previous stope. Stope performance will be monitored with cavity monitor surveys (CMS) after each blast to allow adaptation of the mine plan for subsequent drill and blast designs.

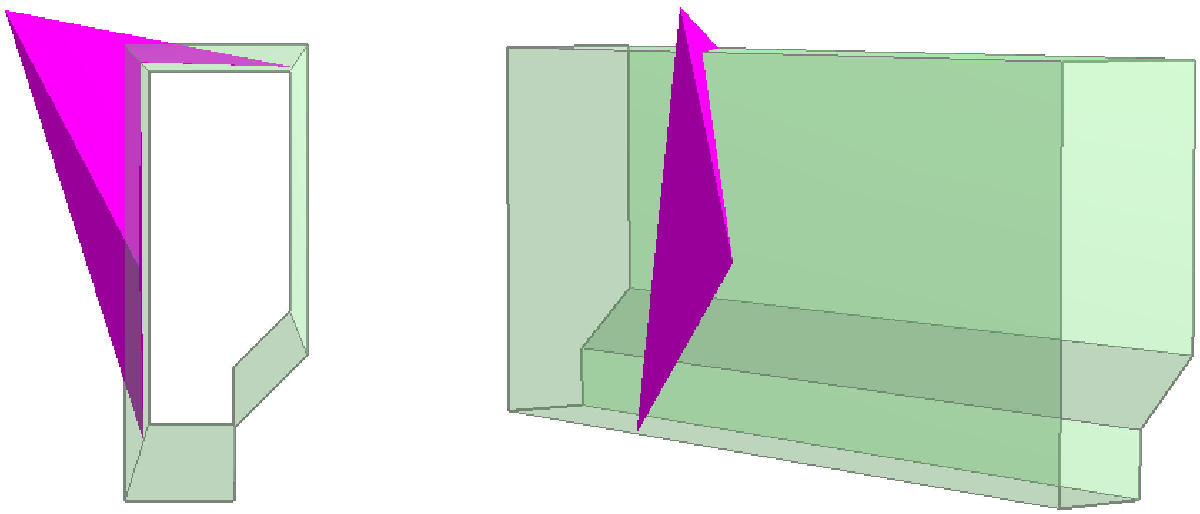


Figure 6-6: Largest Possible Wedge (based on mapping completed to date)

6.2.5 Room and Pillar Stability Analysis

Room and pillar mining is expected to make up a small percentage of the overall mine plan, however it has been assessed to allow flexibility where the geometry of the orebody is not suitable for longhole mining.

Planned mining geometry for room and pillar areas consists of 10m wide by 5m high rooms and crosscuts, and 5m square pillars. In some areas, a second 5m lift may be required in which case the lower lift will be backfilled with uncemented waste rock.

The room size has been assessed both empirically and numerically. The critical span curve for man entry openings (Ouchi et al., 2004) is shown in Figure 6-7 for 10m spans. Based on Minto mapping a 10m span is predicted to be stable however it is predicted to be potentially unstable based on SRK core logging. As discussed previously, experience to date in the M-zone indicates rock quality data from core logging is typically conservative relative to conditions observed during excavation.

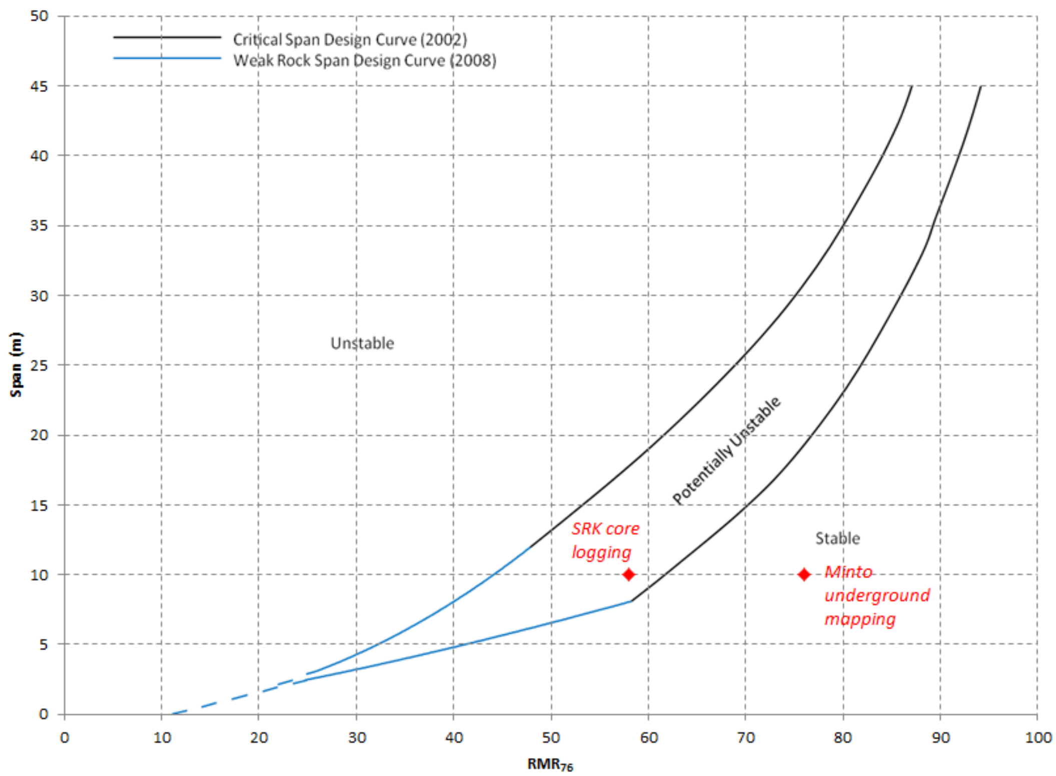


Figure 6-7: Critical Span Design Curve (Ouchi, 2004)

Numerical analyses using a combined discrete fracture network (DFN) and discrete element model were completed by Itasca in 3DEC to further assess room spans, particularly in intersections where greater spans will be required. Complete results are contained in the presentation "Minto 118 Zone – 3DEC/DFN Analyses" (Itasca, 2014). The model used is shown in Figure 6-8.

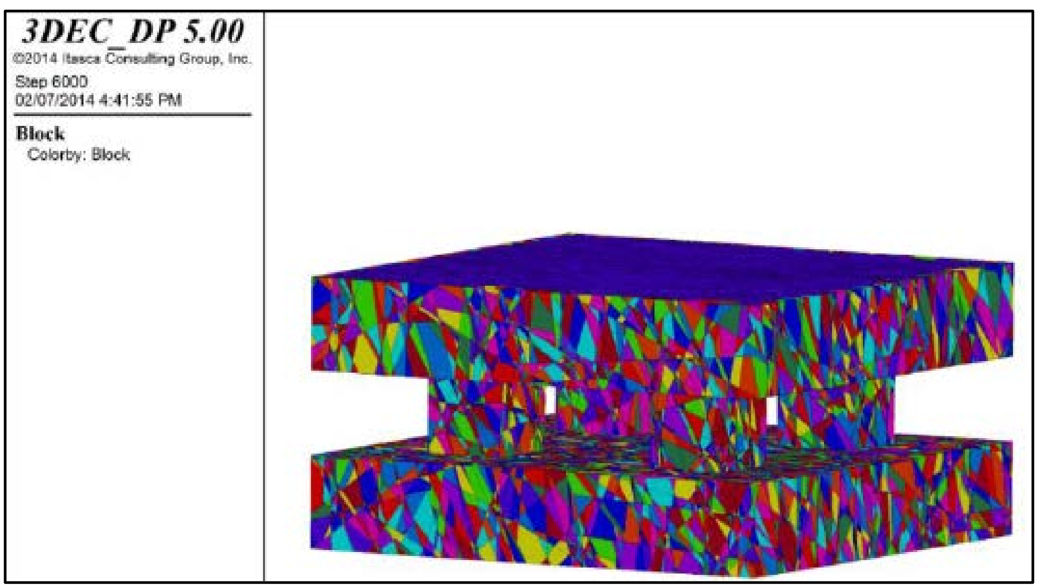


Figure 6-8: 3DEC/DFN Model used for Room Span Analysis (Itasca, 2014)

The analyses were run considering the standard Type 1 ground support, including 2.4m long resin-rebar on 1.5 x 1.5m spacing with a 1.8m center resin-rebar to pin the mesh, as well as secondary intersection support consisting of 5m long Super Swellex on a 1.8m x 1.8m spacing.

The analyses concluded that with no ground support an average of 132 tonnes became unstable in the intersection roof, to a maximum depth of 3.7m into the roof. With ground support installed the roof was predicted to be stable.

Major structures such as faults or highly fractured zones were not considered in the analyses. Where are major structures are identified during development mapping, spans will be limited or additional case specific ground support will be designed.

Pillar stability was also considered using a combination of empirical and numerical analysis. Factors of safety for several commonly used empirical pillar design methods are presented in Table 6-6 for the maximum orebody depth.

Table 6-6: Summary of Empirical Pillar Analysis

Depth (m)	Pillar Width (m)	Pillar Length (m)	Pillar Height (m)	Room Width (m)	W/H	Factor of Safety			
						Lunder &Pakalnis (1997)	Lunder (1994)	Hedley & Grant (1972)	Average
190	5	5	5	10	1	1.27	1.33	0.86	1.15

Numerical analysis was carried out by Itasca using the discrete element code 3DEC to consider pillar stability for a scenario where post pillar cut and fill would be used throughout the orebody. The complete results are contained in the report “Minto 118 Zone – Large –Scale 3DEC Analyses” (Itasca, 2014). The model used in the analysis is shown in Figures 6-9 and 6-10.

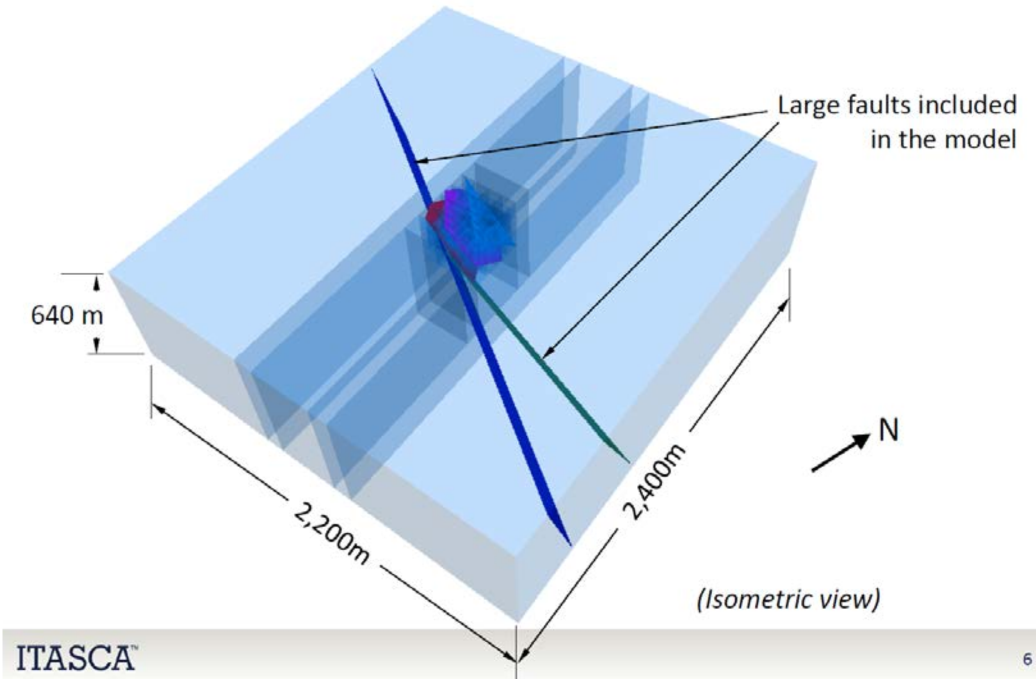


Figure 6-9: Post Pillar Cut and Fill 3DEC Analysis for Minto South Underground (Itasca, 2014)

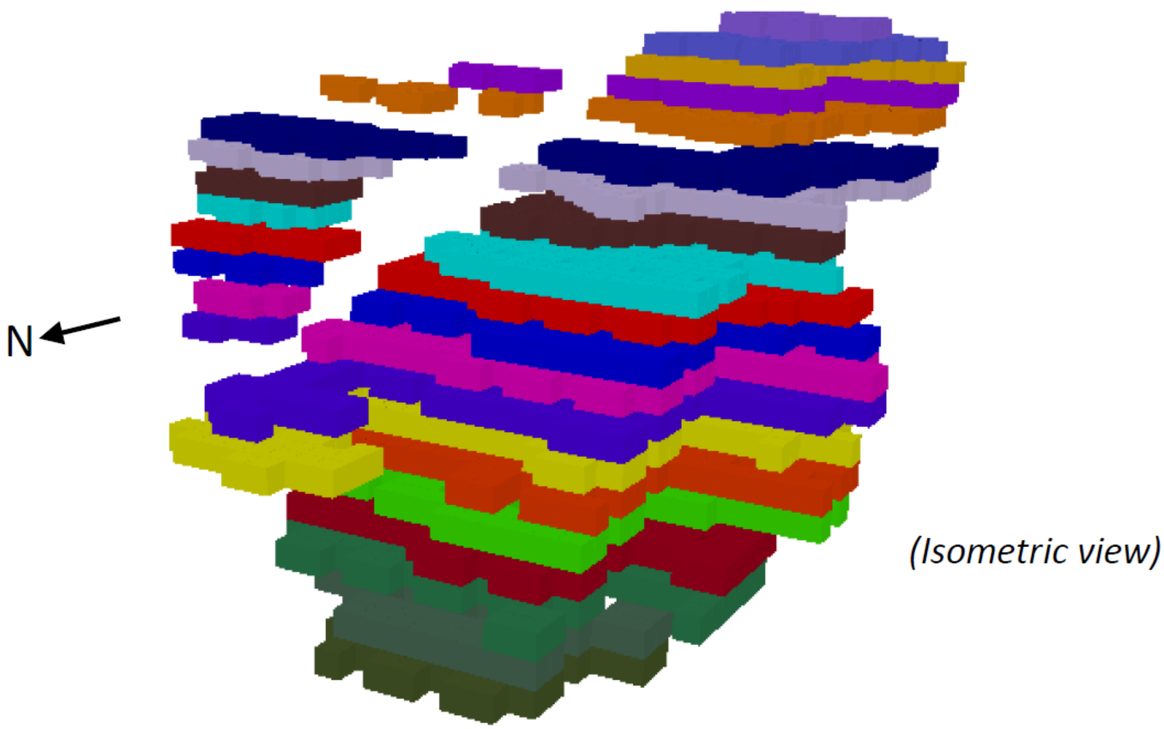


Figure 6-10: Post Pillar Cut and Fill 3DEC Analysis for Minto South Underground (Itasca, 2014)

Rock properties used in the model are presented below. Three major faults and a persistently steeply dipping joint set were included in the model as well as backfill for rooms/pillars more than one lift high.

Property	Encasing "Waste" material	"Ore" material	Fill	Faults and joints
Bulk modulus K (GPa)	26	26	0.025	-
Shear modulus G (GPa)	16	15	0.015	-
RMR_{89}/GSI	74/69	76/71	-	-
Peak friction angle (deg)[1]	61.9	60.5	43	30
Peak cohesion (MPa)[1]	3.24	2.82	0	-
Peak tensile strength (kPa)	466	387	0	-
Critical plastic strain interval (%)[2]	0.92	0.86	-	-
Residual friction angle (deg)	43.3	42.4	-	-
Residual cohesion (kPa)	162	141	-	-
Residual tensile strength (kPa)	0	0	-	

[1] Established with a tangential fit at sig3max = 3.3 MPa (for a mining depth of 140 m max), and a linear failure envelope. This overestimates friction, but provides a conservative estimate of cohesion, which matters most in our case.

[2] Strain-softening interval between peak and residual strength (the same for the cohesion and friction). Based on GSI. The tensile critical strain was set to 0.00001% to reflect the more brittle behaviour of tensile failure.

Conclusions from the analyses included the following (Itasca, 2014):

1. *The 3DEC model shows that all the post-pillars experience some degree of plasticity, some of them exhibiting 'tension now' and 'shear now'.*
2. *The plasticity plots also show that most room backs and walls behave well. However, the FLAC3D was better suited to evaluate "intact" rock mass performance.*
3. *The σ1 plots show stress concentrations in the post-pillars in the order of 20 MPa.*
4. *The shear displacement and slip plots show that many of those persistent shallow-dipping joints that intersect post-pillars can be expected to sustain some damage, but the associated displacements remain small.*
5. *Similarly, shear displacements are expected to be small.*
6. *The 3DEC model assumes that all pillars are 5m by 5m and comprised of "undisturbed" rock. Poor blasting practices and/or local discrete structures could result in pillars of smaller dimensions and/or lower strength. This would affect the stability of these pillars, and, potentially that of Zone 118.*

6.3 M-Zone Underground

The following section presents geotechnical characterization and analysis for the M-zone underground. Mining of the M-zone commenced in January, 2014 and at the time of this report production mining was completed in five of eight stopes.

6.3.1 Mining Method

The M-zone orebody is much flatter and more consistent than Minto South and as such is suitable for longhole stope mining throughout. A summary of excavation and pillar geometry is contained in Table 6-7.

Table 6-7: Summary of Excavation and Pillar Geometry

Excavation/Pillar	Depth (m)	Width (m)	Height (m) (max)	Length (m)
Development drifts, ramps	25-110	5	5	-
Longhole development drift	25-110	6	4.5	30-120
Longhole stope (non-entry)	25-110	10	23	30-120
Longhole pillar	25-110	5	23	30-120

6.3.2 Rock Mass Assessment

Rock mass characterization was carried out primarily based on observations in the open pit and underground mapping carried out in the development drifts. A summary of rock mass quality is contained in Table 6-8 and rock structure in Figures 6-11 and 6-12.

Table 6-8: Summary of Rock Mass Characterization for Minto South

Area	Source	Rock Type	Condition	Number of Samples	RMR			Q'		
					min	max	avg	min	max	avg
M-zone	Underground Mapping	eG,fG	Fresh	260 m	52	87	77	0.8	50.0	11.2

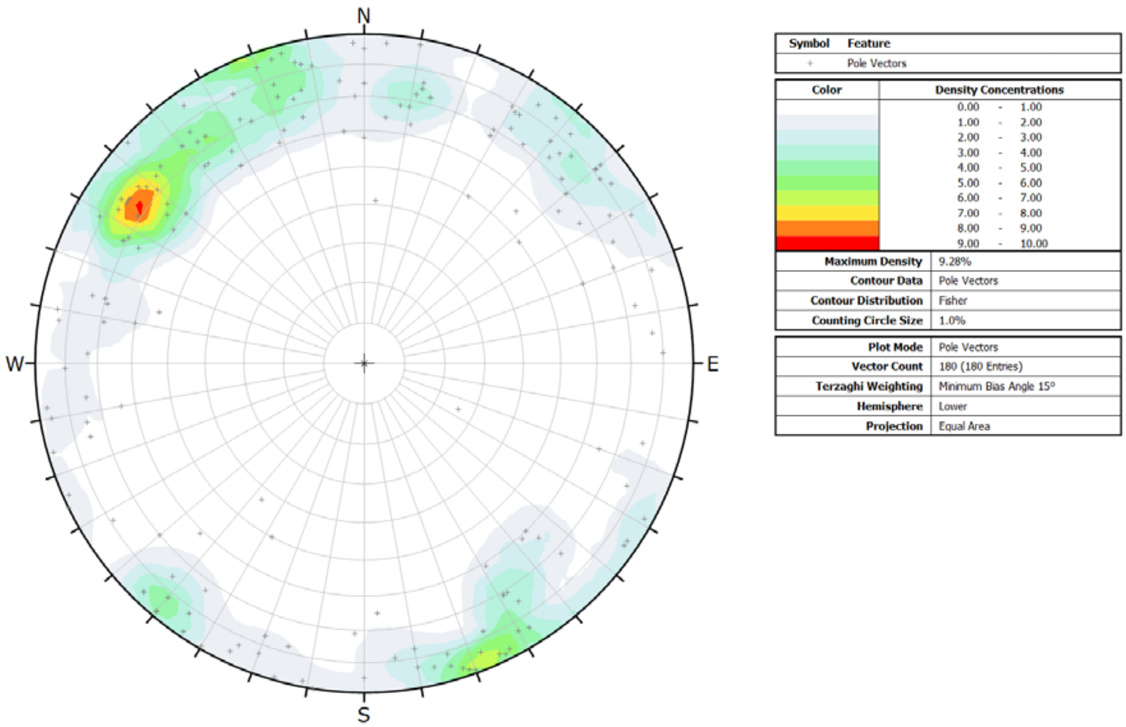


Figure 6-11: Stereonet of Rock Structure in M-zone Waste Rock

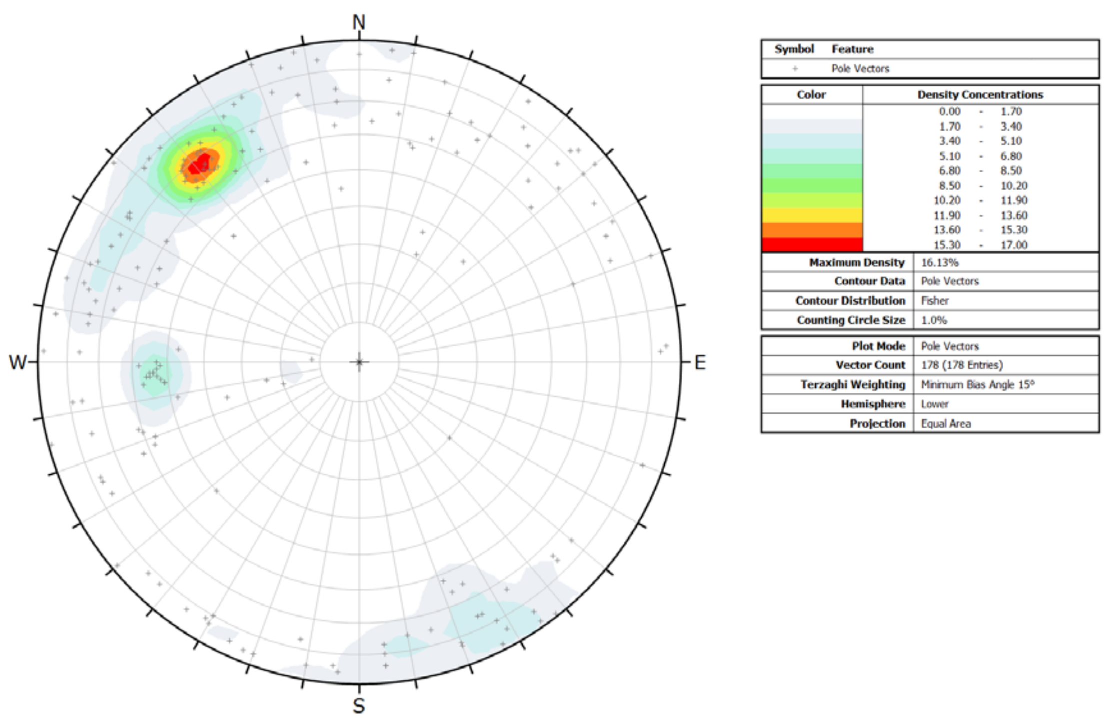


Figure 6-12: Stereonet of Rock Structure in M-zone Ore

6.3.3 Ground Control for the Portal Collar

The M-zone portal was collared at the bottom of the Area 2 pit on the 691 bench elevation. The portal collar/brow was pre-supported with 4m long Super Python bolts installed horizontally into the bench face prior to drilling/blasting into the face, shown in Figure 6-13. The bolts were also used to pin the bottom of draped mesh installed above and around the portal.

Short rounds were taken for the first few rounds into the portal. After each round, pattern ground support was installed as per Minto Ground Control Standards. Additional support, including 0-gauge welded wire mesh straps, split sets and Super Python bolts were installed in and around the portal brow.

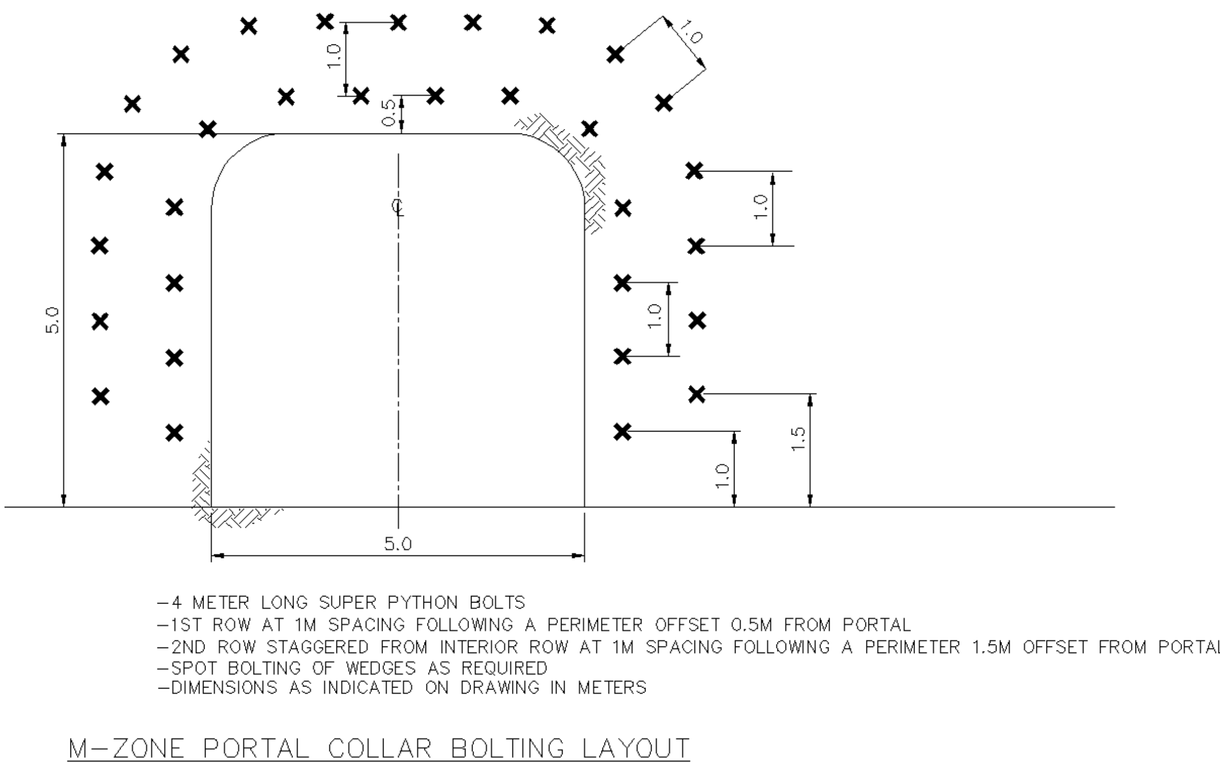


Figure 6-13: M-Zone Portal Collar Bolting Layout

In addition to the portal collar support, measures were implemented to mitigate the risk of rockfall hazards from the pit walls for workers and equipment working in the bottom of the pit:

- Scaling of bench faces prior to completing excavation of pit.
- Weekly wall inspection and GroundProbe radar to monitor pit walls – Ground Probe radar setup moved into the pit on the 739 bench to monitor the M-Zone portal area and highwall in detail.
- Rockfall fence installed above portal on the 715 bench to prevent small loose/rockfalls from walls/benches above.
- Rockfall curtain (draped twisted wire mesh) installed above and around the portal.
- Diversion of water above the portal to specific areas to avoid saturation and increased freeze/thaw on the benches/walls near the portal.

6.3.4 Longhole Stope and Pillar Stability Analysis

Planned longhole stopes and pillars were assessed using a combination of empirical analysis, numerical modelling and experience in the Minto underground to date.

Empirical stope stability analysis was carried out using the Mathew's Stability Graph method. Descriptions of the stopes assessed are contained in Table 6-9 and results of the analyses are summarized in Table 6-10.

Table 6-9: Summary of M-zone Stope Geometry

Stope	Width (m)	Length (m)	Height (m) (floor to back)	
			min	max
B	10	45	8	11
C	10	65	9	17
D	10	85	11	16
E	10	90	11	15
F	10	115	15	19
G	10	115	18	21
H	10	105	14	23
I	10	25	14	21
Average	***10***	***81***	***13***	***18***

Table 6-10: Summary of Mathew's Method Results for M-Zone Stopes

Stope	Endwalls		Sidewalls		Backs	
	Stability	Overbreak (ELOS) (m)	Stability	Overbreak (ELOS) (m)	Stability	Overbreak (ELOS) (m)
Minimum	Stable	<0.5	Stable	<0.5	• Stable for highest rock quality • Stable for average rock quality • Unstable for poorest rock quality	• <0.5m for average conditions • 1-2m for poorest conditions • 2-4m for poorest conditions
Average	Stable	<0.5	Stable	<0.5	• Stable for highest rock quality • Transition zone between stable and unstable for average rock quality • Unstable for poorest rock quality	• <0.5m for average conditions • 1-2m for poorest conditions • 2-4m for poorest conditions
Maximum	Stable	<0.5	Stable	• <0.5m for average rock quality • 0.5-1m for poorest rock quality	• Stable for highest rock quality • Transition zone between stable and unstable for average rock quality • Unstable for poorest rock quality	• <0.5m for average conditions • 1-2m for poorest conditions • 2-4m for poorest conditions

The analyses have been relatively accurate in M-zone stopes mined to date. Overbreak in walls is typically <0.5m but is highly dependent on drill and blast practices. Maximum overbreak in the back has been 3.5m, and is typically 1-2m. Part of one pillar has unraveled due to overblasting and poor structure orientation in a very low stress, relaxed area of the mine near the pit wall.

Detailed pillar stability analyses were carried out by Itasca Consulting Group Inc. to consider the stability of the planned 5 m wide rib pillars and the crown between the stopes and the pit wall. A detailed summary of the analyses is contained in the report "Three-Dimensional Numerical Simulation of the M-Zone at Minto Mine" (Itasca, January 10, 2014).

The analyses were carried out using the finite-difference code FLAC3D. Images of the mesh are shown in Figure 6-14 and 6-15.

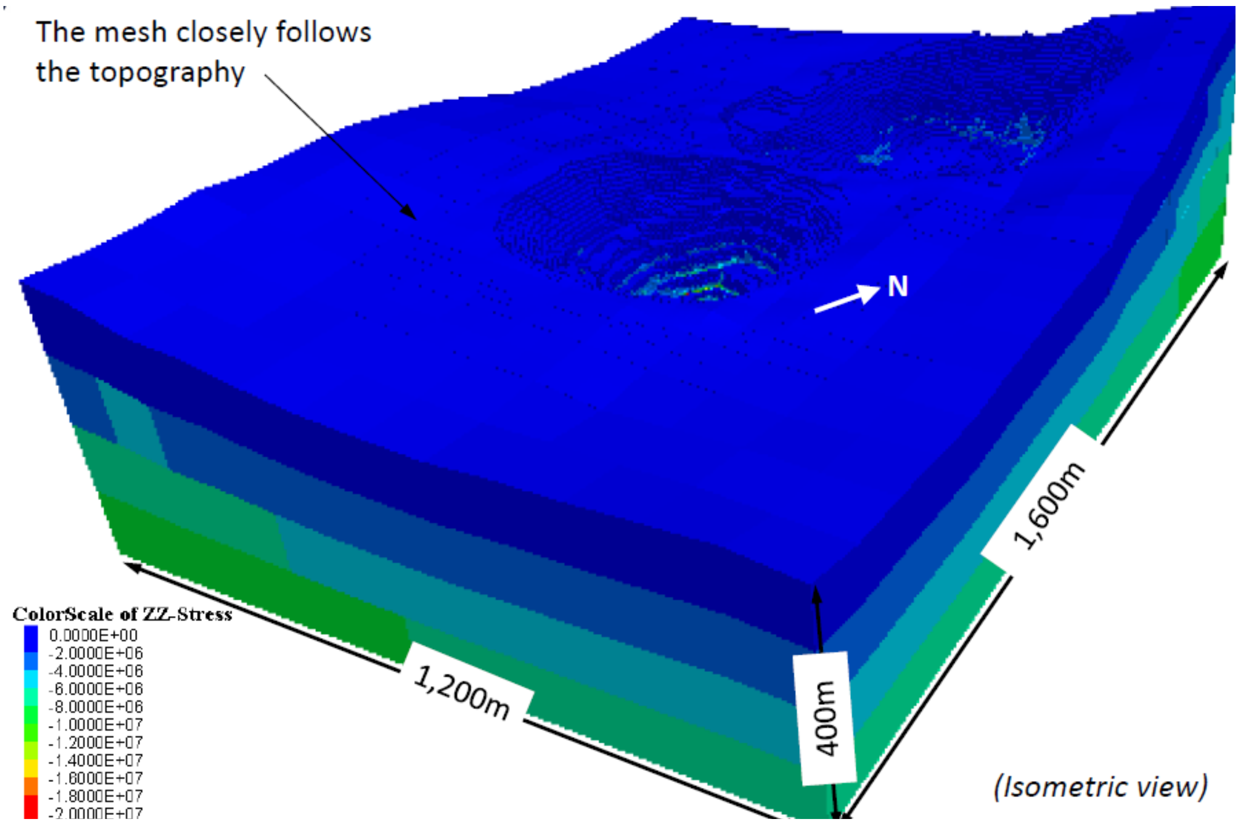


Figure 6-14: FLAC 3D model mesh

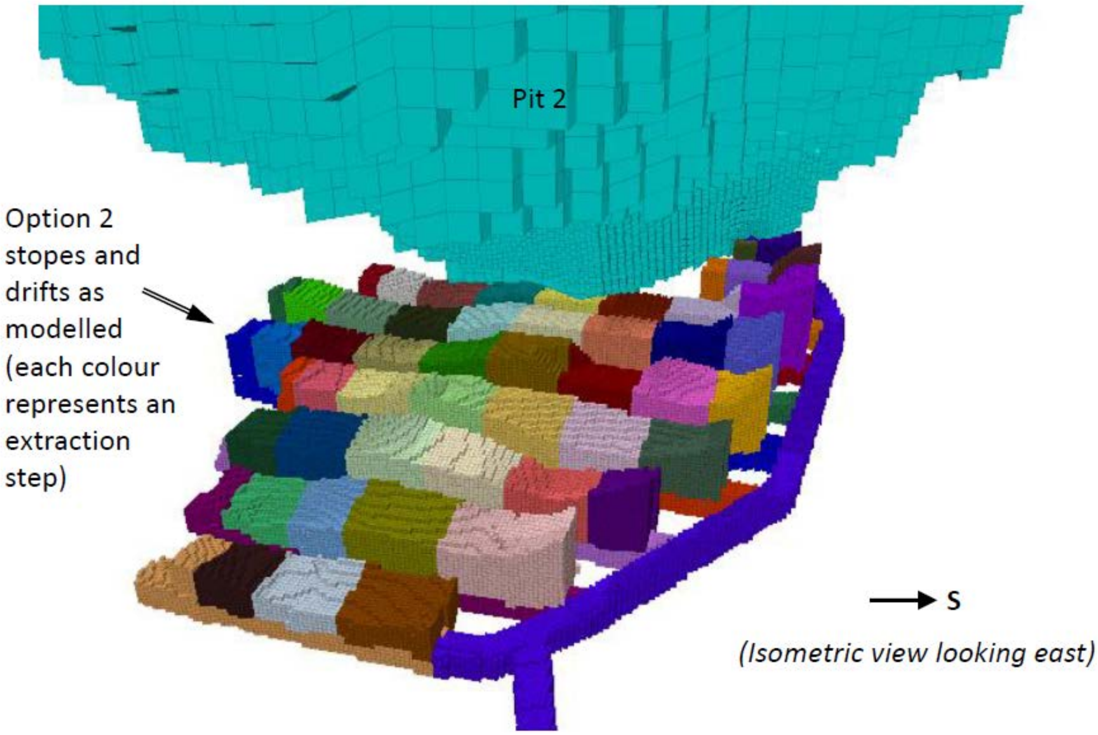


Figure 6-15: FLAC 3D Model Mesh of M-zone Stopes

Rock properties used in the model are shown below.

Property	Encasing "Waste" material	"Ore" material
Bulk modulus K (GPa)	26	26
Shear modulus G (GPa)	16	15
RMR_{89} / GSI	74 / 69	76 / 71
Peak friction angle (deg) [1]	61.9	60.5
Peak cohesion (MPa) [1]	3.24	2.82
Peak tensile strength (kPa)	466	387
Critical plastic strain interval (%) [2]	0.92	0.86
Residual friction angle (deg)	43.3	42.4
Residual cohesion (kPa)	162	141
Residual tensile strength (kPa)	0	0

[1] Established with tangential at sig3max = 3.3 (for mining depth of 140 m max), and a linear failure envelope. This overestimates friction, but provides a conservative estimate of cohesion, which matters most in our case.
[2] Strain-softening interval between peak and residual strength (the same for the cohesion and tensile strength). Based on GSI.

Sensitivity analyses were carried out to consider the following scenarios:

- Weakened, blast damaged zone around the excavations. This was analyzed using a zone of weaker rock properties approximately 3.5m around all underground excavations and 10m around the pit wall.
- Rotated in-situ stress orientation.
- Lower friction angle in both ore and waste to consider weaker than expected rock quality.
- Reduced critical plastic strain interval to consider brittle tensile failure of the rock mass.
- Complete removal of the central rib pillar to consider large-scale stability in the event of a pillar failure.

Conclusions from the analyses included the following (Itasca, 2014):

7. *The M-Zone rib pillars and stope roofs are mostly stable (i.e., show limited yielding) as modeled for both options 1 and 2, even when taking into account possible blast damage by assigning lower strength properties to the rock mass immediately around the underground excavations and open pit, or even assuming the complete failure (total removal) of a central rib pillar. This is mostly due to the low vertical stress in proximity to the open pit, relatively high horizontal stresses that provide confinement to the crown pillar (with the Base Case stress orientation) and fairly strong rock mass properties. No stope-scale runaway failure has been indicated in any of the scenarios we examined.*
8. *We cannot over-emphasize how crucial good blasting procedures (in terms of limited back-break and damage to the surrounding rock mass) will be in order to minimize the extent of the weaker D = 1 volume.*
9. *The bull nose near the stope closest to the open pit and the access to the underground area remains a concern for both options. Active yielding can be observed in these areas for both base cases and all the sensitivity analyses. The issue is critically important with regard to maintaining access to the M-Zone.*
10. *Geomechanical issues are expected mainly on the south side, between the stopes and the pit. Stopes with sequence numbers in the 30's in Option 1 and in the last four panels on the south side in Option 2 generally show a greater degree of interaction with the open pit due to their proximity to it. The crown pillar and walls in this area are likely to be weakened by the yielding from the stopes themselves combined with that from the pit above. Keeping these roofs stable may be more challenging. Instability in the open pit also could occur as a result of this yielding.*
11. *There remains some debate on critical plastic strains and the "correct" way to implement them for cohesion and tensile strength loss in inelastic strain-softening simulations. As a result, we recommend keeping the results from the brittle runs in mind, which are more conservative.*
12. *Although the numerical results do not show severe stress-related failure in the rock mass modeled as a continuum, the stress relaxation indicated around the excavations easily could lead to structural instability (as in the ramp). This aspect is NOT covered in the FLAC3D model. As a result, it will be crucial to assess whether persistent weak structural discontinuities extend around M-Zone, which could significantly affect the stope ribs and roofs. Persistent discontinuities that would delineate kinematically unstable blocks could have a very strong negative effect on the behavior of the excavations and the mining conditions in M-Zone. Considering the structural fabric in the pit above, this aspect needs to be resolved.*

Kinematic analyses were also completed for the M-zone stopes to assess potential structural instability. Results are summarized in Table 6-11.

Table 6-11: Summary of Kinematic Analysis for M-zone Stopes

Exposure	**Stope Size**	**Maximum Possible Unstable Wedge (based on Mapped Structure Sets)**	
		Mass (tonnes)	**Apex height (m)**
Sidewall	Min	8	1.2
	Max	225	3.6
	Avg	67	2.4
Endwall	Min	<1	<1
	Max	<1	<1
	Avg	<1	<1
Back	Min	55	2.0
	Max	3125	7.5
	Avg	1885	6.3

6.4 Ground Support Requirements

Ground support requirements for both M-zone and Minto South underground are contained in the Minto Underground Ground Control Plan, updated in June 2014. The following are summaries of ground support elements and requirements for development openings.

Table 6-12: Ground Support Elements

Support Element	Description	Minimum Breaking (tensile) Strength	Plate	Comment
Bolts	#6 (20mm) (3/4”) threaded rebar bolt w/ full column resin	12 tonnes	Domed - 12 x 12 cm domed (5” x 5”), 6 mm (1/4”)	-
	#6 (20mm) (3/4”) forged head rebar bolt w/ full column resin	12 tonnes	Domed - 12 x 12 cm (5” x 5”), 6 mm (1/4”)	Used for raise development.
	Super Swellex/Python (36 mm)	24 tonnes	Domed - 15 x 15 cm (6” x 6”), 6 mm (1/4”)	-
	Standard Swellex/Python (27 mm)	13 tonnes	Domed - 12 x 12 cm domed (5” x 5”), 6 mm (1/4”)	Used for face bolting only.
Resin	J-Lok Resin 30mm x 610mm cartridge 30 second (fast) 180 second (slow)	-	-	-
Mesh	7 gauge welded wire mesh	~ 2-3 tonnes bag strength	-	Galvanized for permanent excavations. Bright for short-term excavations.
Straps	0 gauge welded wire mesh straps	-	-	Galvanized for permanent excavations. Bright for short-term excavations.

Table 6-13: Ground Support Designs

Type		**Span (m)**	**Primary Support (minimum)**	**Comment**
1	**Development Drifts (typical ground conditions)**	5.0	2.4 m (8 ft.) rebar in back around perimeter of mesh sheets 1.8 m (6 ft.) rebar in back and walls to pin mesh at center 1.8 m (6 ft.) rebar in walls to 1.5 m above floor 1.5 x 1.5 m bolt spacing diamond pattern Galvanized welded wire mesh to 1.5 m above floor	Life of mine infrastructure in typical ground conditions.
2	**Production Drifts (typical ground conditions)**	6.0	2.4 m (8 ft.) rebar in back around perimeter of mesh sheets 1.8 m (6 ft.) rebar in back and walls to pin mesh at center 1.8 m (6 ft.) rebar in walls to 1.5 m above floor 1.5 x 1.5 m bolt spacing diamond pattern Bright welded wire mesh to 1.5 m above floor	Non-permanent development (e.g. stope/production room crosscuts) in typical ground conditions.
3	**Poor ground – fault zones**	≤6.0	2.4 m (8 ft.) rebar in back around perimeter of mesh sheets 4.0 m (12 ft.) Super Swellex/Python to pin mesh at center 1.8 m (6 ft.) rebar in walls to 1.5 m above floor 1.5 x 1.5 m bolt spacing diamond pattern Bright/Galvanized welded wire mesh to 1.5 m above floor	Poor ground, typically consisting of discrete faults (generally <0.3m thick).
Intersection Secondary Support				
1,2,3	**Intersections**	≤9.5	2.4 m (8 ft.) rebar in back around perimeter of mesh sheets 1.8 m (6 ft.) rebar in back and walls to pin mesh at center 1.8 m (6 ft.) rebar in walls to 1.5 m above floor 1.5 x 1.5 m bolt spacing diamond pattern 4 m (12 ft.) Super Swellex/Python in back and shoulders 1.8 x 1.8 m bolt spacing - Installed at least two rows past the intersection in each direction. Bright/Galvanized welded wire mesh to 1.5 m above floor	To be installed in addition to primary support pattern outlined above. Intersection support to be installed prior to taking wall slash, as per SWP (Appendix B).

6.5 Ground Control Monitoring

Monitoring is described in detail in the Minto Underground Ground Control Plan and the Minto Open Pit Ground Control Plan, both updated in June, 2014. The following table summarizes the primary elements of the monitoring programs.

Table 6-14: Summary of Ground Control Monitoring

Element	Description
Inspections	• Weekly pit wall inspections • Daily inspections of the M-zone crown pillar • Regular inspections of all underground workings • Ground control log book maintained by underground shifters
Geotechnical mapping	Rock quality and structure mapping is carried out regularly to identify major structures and changing conditions for use in geotechnical analysis and mine design.
Cavity monitor surveys (CMS)	Carried out after each blast is mucked out. More frequent surveys are done in the M-zone crown pillar stopes.
Blast vibration monitoring	An Instantel Series III Minimate Plus seismograph is used to monitor blast vibrations caused by underground blasts. Results are used in future drilling/loading designs.
GroundProbe Slope stability radar	Monitors M-zone pit walls and crown pillar constantly.
Multi-point borehole extensometers (MPBX)	Ten six-anchor MPBX are installed in the M-zone crown pillar to monitor the crown pillar and pit wall surrounding F,G,H and I stopes.
Prisms	Six prisms are set up and monitored daily above the M-zone crown pillar.

Additional monitoring in the Minto South underground may include multi-point borehole extensometers, closure stations and borehole stressmeters and will be designed in detail once exact pillar locations are determined after delineation drilling.

7 Ventilation, Ancillary Infrastructure, and Dewatering,

7.1 Mine Ventilation

7.1.1 Minto South Portal Ventilation

Initial production rates from the 118 zone underground are planned at 20,000 tonnes per month and a temporary ventilation system based on the current infrastructure and the existing ventilation system will support mining activities until rates increase in 2016. This system, designed by Stantec Inc., is a push system using two runs of 48" steel duct supplying heated air from the Minto South portal to working areas underground. Twin runs of axial fans installed in series every 300m will supply 100,000 cfm of fresh air and return air will exhaust to surface via the main access ramp.

Air volume requirements were calculated using the equipment fleet planned and CanMet approved diesel engine certification data. A total of 68,800 cfm is required at both 740L and 710L to support production and development activities involving 1 scoop on each level and 1 truck for both levels. Accounting for auxiliary support equipment and air leakage, a total airflow of 80,000 cfm for the working face per level will be required. This design has twin steel ducts supplying air to 740L near the working face and a separate set of twin steel ducts to pick up the air at 740L to take it down near to the 710L working face. Flexible ducts will carry the air closer to sweep the active face on both levels. See figures Figure 7-1 and Figure 7-2 below for details.

Figure 7-1: Temporary ventilation system

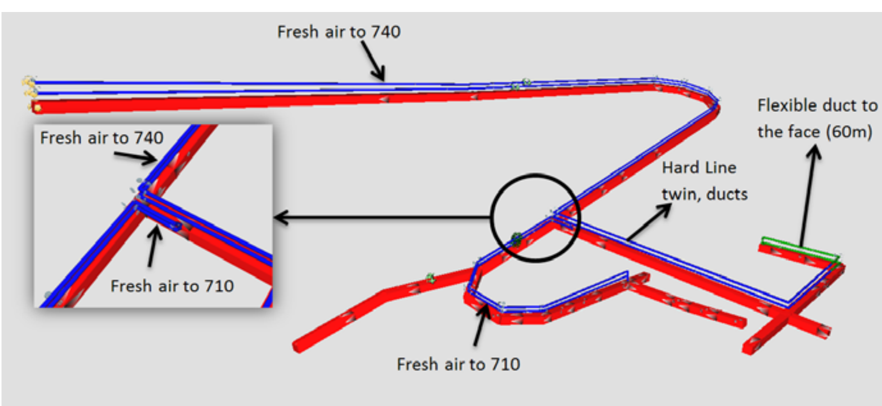


Figure 7-2: Temporary ventilation system detail

Once production rates increase, the permanent Minto South ventilation system will be implemented. The permanent Minto South Portal ventilation system, designed by Stantec Inc., is a push system with main fans located on surface. Main intake fans provide 132m^3/s (280,000 cfm) through a dedicated 3m x 5m intake raise (10 ft. x 16 ft.). Return air is exhausted to surface via the main access ramp. See figure Figure 7-3 below.

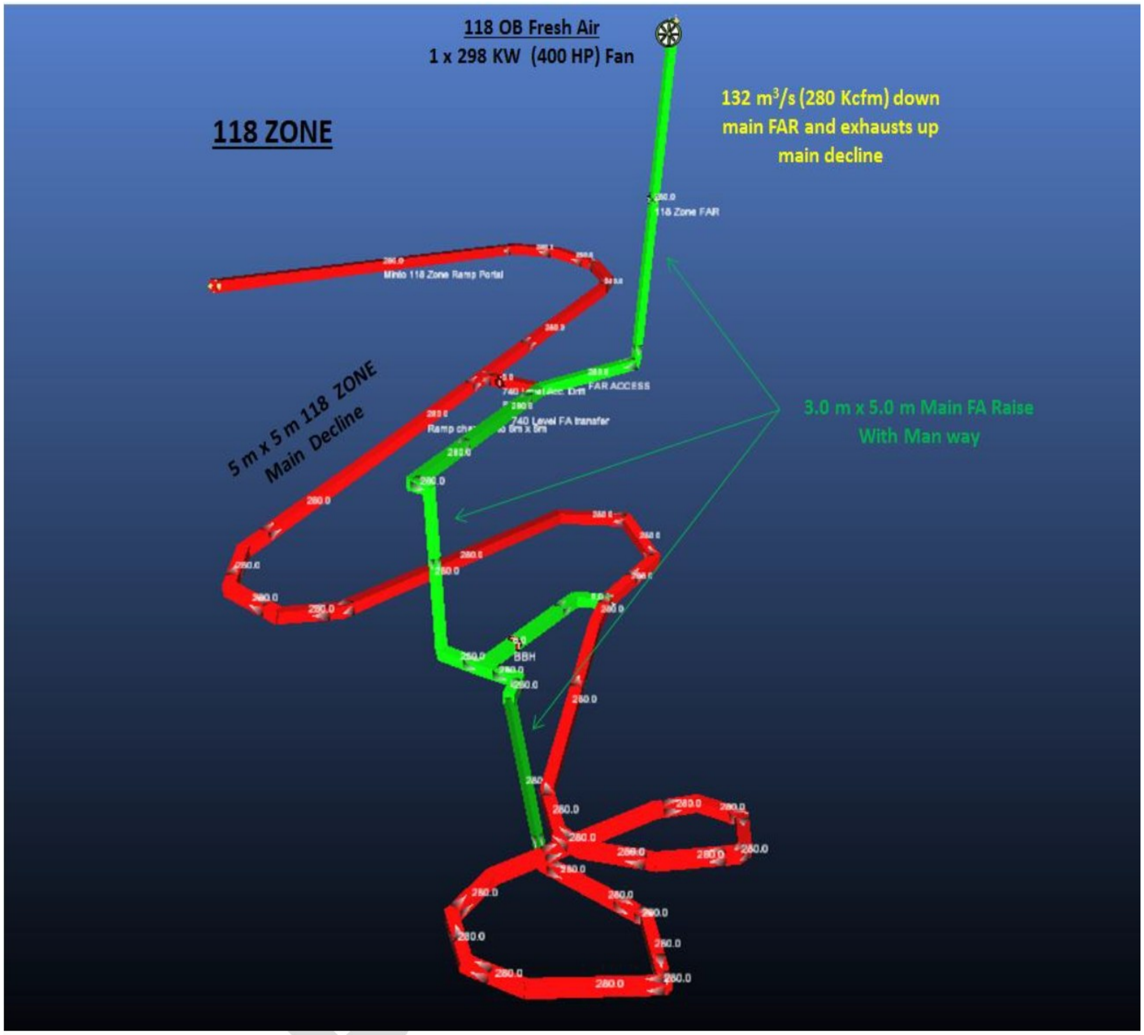


Figure 7-3: Minto South permanent ventilation system.

An egress escape way was driven by alimak to surface in the 118 Block in January 2014. The Fresh Air Raise consists of one 3 x 5 m alimak raise capable of delivering 132 m^3/s (280,000 cfm's) of air. This intake raise was developed on the west side of the Area 2 pit with the raise collar in an area of minimal overburden. It is planned to extend the intake raise down with the main ramp to the Area 2 UG ore zone. Ventilation access drifts will be developed to connect the level development and ramp to the ventilation raises. Those drifts will be 15 m to 40 m long and will be developed at -15% gradients to reduce the length of the raise. This system will be capable to meet the future needs of underground mining.

Air volume was calculated using CanMet approved diesel engine certification data. The CanMet rating of each piece of underground equipment was modified by utilization factors to represent the diesel equipment in use at any time. The expected diesel equipment fleet at Minto Mine for the 118 OB at full production is listed in the table below.

Table 7-1: Ventilation requirements Minto South Portal

Minto							
	1 dev + 2 Stope		Fleet	HP	Canmet Vent Rate	Utlization	CFM Required
	Development	1 x Sandvik LH410	1	325	18800	70%	13160
		1 x Sandvik jumbo	1	147	10000	30%	3000
		1 x Maclean 946 bolter	1	99.2	8800	30%	2640
		1 x MT42 Haul Truck	2	520	50200	100%	100400
		1 x Scissor Lift	1	85.7	7500	30%	2250
		1 x utility	1	134	7300	30%	2190
		1 x jeep	1	127	7300	30%	2190
		Subtotal Development					**125830**
	Stope	1 x Sandvik LH410	1	325	18800	70%	13160
		1 x Sandvik jumbo	1	147	10000	30%	3000
		1 x Maclean 946 bolter	1	99.2	8800	30%	2640
		1 x TH540 Haul Truck	1	543	31400	100%	31400
		1 x utility	1	134	7300	30%	2190
		1 x jeep	1	127	7300	30%	2190
		Subtotal Stoping					**54580**
	Ramp	1 x TH540 Haul Truck	1	543	31400	100%	31400
		Subtotal Ramp					**31400**
	Totals	Dev. Levels	1				125830
		Stope Levels	2				109160
		Ramp	1				31400
		Subtotal					**266390**
		Leakage				5%	13319.5
		Total 118 OB					**279709.5**
							280,000

A maximum of two stoping and one development levels are anticipated during steady state production. The main ramp has been allocated 15m^3/s (32,000 cfm) of fresh air to accommodate the loading and hauling activities of an additional haul truck travelling in the ramp.

Air movement to the stopes would be controlled by directing air flow with ventilation curtains and using auxiliary ventilation fans. Ventilation regulators, doors, and bulkheads would also be used to control airflow. To control the activities on the levels, signage will be placed at every level access identifying the equipment allowed on the level based on the CanMet rating of each piece of equipment.

150 HP fans will be used to provide auxiliary ventilation to development headings and production stopes where required.

7.1.2 M- Zone Ventilation

The M-Zone ventilation system, designed by Stantec Inc., is a positive or "push" system designed to deliver 80,000 cfm supplied by twin 48 inch / 26° / 1800rpm / 150hp fans, each pushing 40,000cfm into separate 48" duct lines.

The 80,000 CFM requirement was calculated by using the equipment CanMet and escapeway data shown in the table below.

Table 7-2: M-Zone Equipment Usage Underground

M Zone							
			Fleet	HP	Canmet Vent Rate	Utlization	CFM Required
	Production	1 x Sandvik LH410	3	325	18800	100%	56400
		Subtotal Stoping					**56400**
	Totals	Production	1				56400
		Escapeway	1		10000		10000
		Subtotal					**66400**
		Leakage				15%	9960
		Total M-Zone					**76360**
							80,000

Flexible 48 inch tees with dampers to control the direction and quantity of airflow were installed at the entrance to each crosscut. From each tee outlet, crews extended 48 inch flexible vent tubing into the crosscuts.

The total air along the portal access ramp and mining horizon are controlled by the two main fans near the portal entrance and a regulator door located at the ventilation raise as shown in the figure below. Both fans are equipped with variable frequency drives to control the total amount of air flow. No underground fans are required to control distribution.

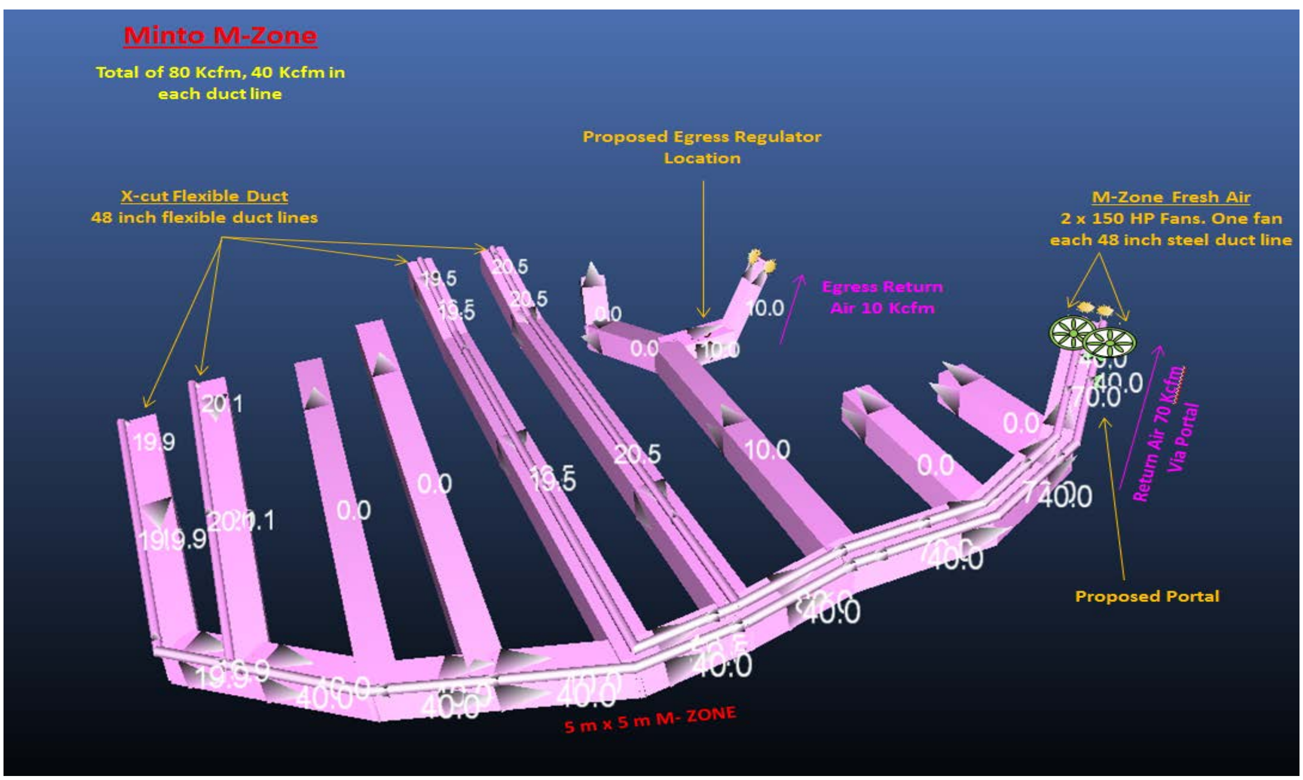


Figure 7-4: Ventilation system general arrangement.

7.2 Mine Air Heating

7.2.1 Minto South Portal Air Heating

The intake raise mine air heating system is required to heat the mine air during the winter months (October to April). The heating system capacity is designed for a 27°C (80 °F) temperature rise to allow for heating of the mine air at extreme low temperatures (-40°C has been recorded in the area). The direct propane fired system includes a 10MMBTUH burner, common control room, valve trains, electrics, and the proposed Alphair 10150-AMF-5500 Full Blade 710 rpm with a 300 HP motor for the main fan. The mine air heater is automatically controlled with the temperature set points adjustable as required based on a maximum flow of 132m^3/s (280,000 cfm) and a +3 degree C set point. The table below shows the estimated annual propane consumption.

Table 7-3: Average temperature by month and propane consumption (Minto South Portal).

Propane Consumption Sheet [37.4 degree F (+ 3 C)]

Basic Calculation is as Follows

Volume of Propane = [(Airflow in Acfm) * (Temp setpoint-Temp outside) * (1.08 Btu/(Acfm*F*hr)) * 24 hr/day * (Days in Month)] / [(21897 Btu / l of Propane)]

Area	Temperature setpoint (F)	Airflow (Acfm)	Propane Consumption October (Litre)	Propane Consumption November (Litre)	Propane Consumption December (Litre)	Propane Consumption January (Litre)	Propane Consumption February (Litre)	Propane Consumption March (Litre)	Propane Consumption April (Litre)	Total Winter Consumption (Litre)
Minto Mine	37.4	313000	118,302	382,362	567,392	629,415	465,244	292,885	50,018	**2,387,315**

7.2.2 M- Zone Portal Air Heating

The fresh air fans require mine air heating systems during the winter months. The heating system capacity is designed for a 50°C (-43°C to +7°C) temperature rise. Both fans connect to a direct propane-fired heating system comprised of a single 6.0 MBtu/hr heater, common control room, valve trains, electrics, and 150 HP variable frequency drives for the fan motors.

The target temperature for the fresh air supply is 3.0°C. At this temperature, 367,000 L of propane will be required to heat the M-zone in 2014 as shown in the table below. This assumes the full 80,000 cfm is supplied continuously; during initial decline development in January, the airflow was reduced to match the size and composition of the equipment fleet operating in the mine.

	Jan	Feb	Mar	Apr	Total
Average Temp (°C)	-27.4	-21.1	-11.2	0.5	
Propane Reqd (L)	161,000	119,000	75,000	13,000	367,000

Table 7-4: Average temperature by month and propane consumption (M-Zone)

7.3 Underground Electrical Power

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

- Main and auxiliary ventilation fans;
- Drilling equipment;

- Mine dewatering pumps;
- Air compressors; and
- Maintenance shop

7.3.1 Minto South portal Electrical Power

High voltage cable (4160V) enters the mine via the decline and is distributed to electrical sub-stations located just below the portal collar. The power cables are suspended from the back of development headings. All equipment and cables are protected to prevent electrical hazards to personnel.

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

7.4 Compressed Air

Minto currently has the following compressors:

- Two 350 CFM electrics (Both underground in Minto South)
- One 1000 CFM electric (M – Zone)
- One 750 CFM diesel

The electric compressors are used to supply air underground, while the diesel supplies surface air as required. Portable electric compressors provide compressed air requirements on an as-needed basis.

The underground mobile drilling equipment such as jumbos, bolters and Emulsion / ANFO loaders are equipped with their own compressors. The electric compressors are utilized for production drilling activities (Stinger drills) and to satisfy compressed air consumption for miscellaneous underground operations, such as: jackleg and stoper drilling, Alimak raise development and pumping with pneumatic pumps.

7.5 Dewatering and Effluent Treatment

7.5.1 Water Supply

The major drilling equipment such as jumbos, bolters, production drills and exploration drills use run-of-mine water obtained from the active pit area or from underground inflows into sumps. Currently, at the Minto South Portal, the supply water is pumped into a 45,000 liter (10,000gal) storage tank located at 5800L underground. The water inflow into the mine has been sufficient to supply the needs of underground development and when required water can be trucked to the portal and supplied to the storage tank underground.

7.5.2 Minto South Portal Dewatering

Underground water currently collects into 3 sumps which all dewater to the main dirty water sump at 760L. Overflow from the dirty sump is collected in a clean sump and is pumped to a final settling sump near the portal. This portal sump either discharges out to the permanent heat traced line on surface and on to the Area 2 Pit or returns underground to supply the mine feed storage tank. Once water has been pumped to the Area 2 Pit, it will be subject to treatment with the existing onsite facilities. The figure below shows the current water supply and dewatering system for Minto South Portal.

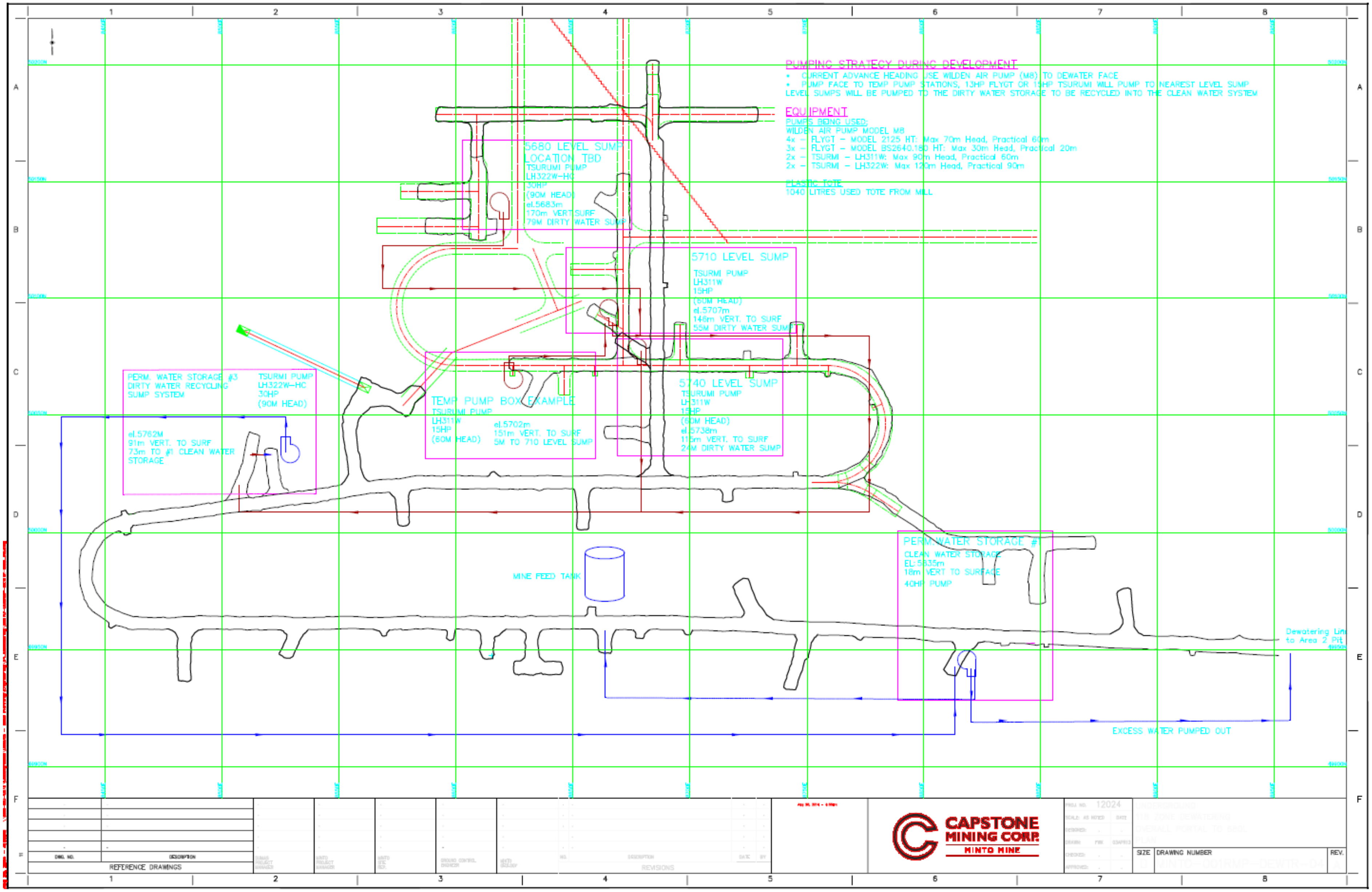


Figure 7-5: Minto South Portal supply/dewatering system

7.5.3 M- Zone Water Management

The portal is collared at 691m elevation while the bottom of the pit is at 676m elevation. The storage area at the bottom of the pit is approximately 30,000 m^3 which provides a buffer against spring runoff, high precipitation events, and pump downtime. Inflows into the pit can be estimated from past experience: between freshet and early September 2013, the Area 2 pit was not pumped and accumulated 68,000 m^3 of water.

As part of the dewatering setup installed during open-pit mining, an 8” non-insulated pipeline was run from the bottom of the pit and into Minto’s water conveyance network ultimately discharging into the main pit. This pipeline will continue to be used for dewatering the Area 2 pit.

Underground dewatering is achieved with two sumps as shown in the figure below. All development is graded to drain to these points and pumps from these locations push water out of a heat traced line that discharges into the bottom of the Area 2 pit.

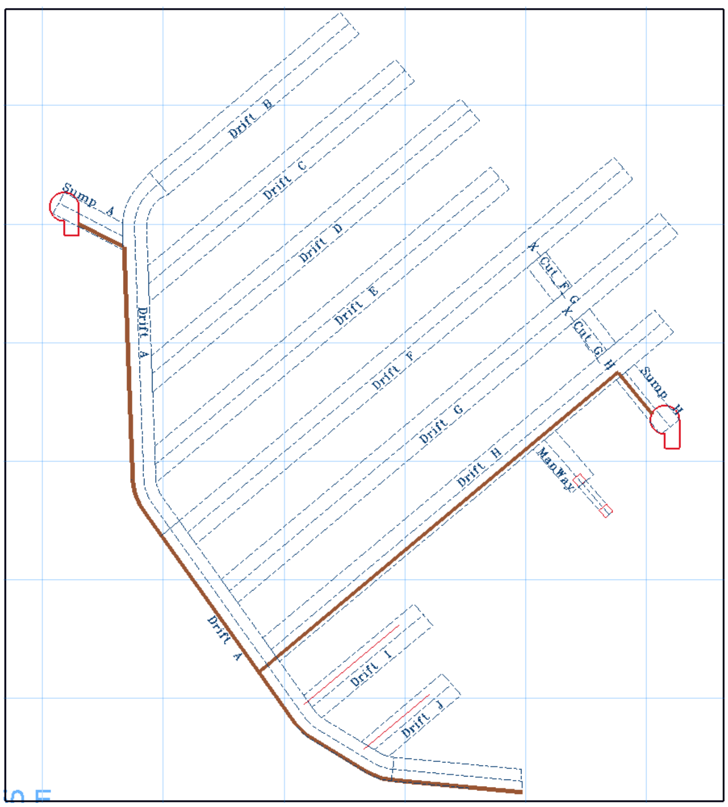


Figure 7-6: M-Zone dewatering general arrangement.

7.5.4 Mine Water Quality and Inflow Monitoring

The Water Use Licence QZ96-006 – Amendment 8 (WUL) outlines the monitoring and surveillance of the underground at Minto. W44 has been assigned as a station number and monitoring frequency as part of the licence for the Minto South portal access. A representative sample of underground inflows will be taken regularly, and flows will be monitored. The water pumped from the m-zone is considered to be Area 2 pit water and the sample station number is W45. Results of the monitoring work will be presented in the monthly WUL reports and summarised in the QML and WUL annual report.

7.6 Communications

A fiber optic communication system is used as the communication system for underground and surface operations. The system is based on radio over IP and will provide communications, personal tagging and tracking as well as critical equipment control. Underground personnel (such as mobile mechanics, crew leaders, and shift bosses) and mobile equipment operators (such as loader, truck, and utility vehicle operators) will be supplied with an underground radio for contact with the fiber optics network.

7.7 Explosive Storage and Handling

Explosives are stored on surface in permanent magazines; detonation supplies (NONEL, electrical caps, detonating cords, etc.) are stored in a separate magazine.

Underground powder and cap magazines will be prepared in Minto South Portal. Day boxes are used as temporary storage for daily explosive consumption.

Anfo is used as the major explosive for mine development. Packaged emulsion is used as a primer, in wet conditions, and for loading lifter holes in the development headings. Smooth blasting techniques are used as required main access development headings. Production activities will use bulk emulsion, 90g boosters, 50gr Primacord and EZ detonators.

All personnel underground are required to be in a designated Safe Work Area during blasting. A central blast system is used to initiate blasts for all loaded development headings and production blasts at the end of the shift. Safe work procedures that are currently being used at the mine are presented in Appendix C. Safe work procedures will be revised as required by the conditions in the mine.

7.8 Fuel Storage and Distribution

An average fuel consumption rate of approximately 5,000 l/d is estimated for the period of full production.

Haulage trucks, LHDs, and all auxiliary vehicles are fuelled at fuel stations on surface. Auxiliary tanks are used for the fuelling/lubing of drills and rock bolters. A 50,000 liter EnviroTank is installed on surface (Pad# 1).

All underground personnel are trained in site wide spill prevention and spill response protocols outlined in Minto Mine's Spill Contingency Plan.

8 Mine safety

8.1 General Mine Safety

Minto Mine and the development contractor emphasize safety in all duties at the mine; this philosophy is shared by and with senior management, on site supervisors and daily operators.

This project will be undertaken with a dedicated focus on *"Zero Harm".* All non-routine tasks will be assessed for risk to ensure suitable control measures are in place.

All work will be performed within the strict guidelines of both Minto's and the Contractor's safety programs. Both programs will comply with all required internal policies and procedures, as well as the Yukon Territory's legislated requirements.

The Contractor will utilize its Safety and Training Program, which includes risk assessments, job observations, workplace inspections and regular program audits. Any new work which is non-routine will be subjected to a full risk assessment which would then be used to develop new site specific work procedures. The Contractor will maintain detailed training records for every employee, both on-site and at their main office.

A key component of the Contractor's commitment to *"Zero Harm"* is the use of the *Zero Harm Safety System* and associated safety card in the field, which is consistent with current on-site practices.

All safety concerns are documented, assigned a responsible person, and tracked until rectified.

8.2 Emergency Response

Initially, when the working face is within 500 meters of the portal, emergency escape will be directly to the surface via the portal this is valid for Minto South and M-Zone. An Emergency Cache is located near the working face consisting of 6 – EBA 6.5 breathing apparatus, first aid supplies, Oxygen therapy unit, water, food, flashlights and blankets. Once the decline reaches 500 meters in length from the portal to the working face, a portable refuge station will be installed underground near the face. Portable refuge stations are maintained in locations of mine development to include refuge < 15 minute travel time by foot. All underground personnel will follow fresh air and escape to surface or take refuge in a refuge station during all emergencies that affect the underground. Refuge station posted "code of conduct" must be followed by everyone in the refuge station.The portable refuge stations are designed to be equipped with compressed air/oxygen cylinders, potable water, and first aid equipment; they will also be supplied with a fixed telephone line and emergency lighting. During the initial development phase, one refuge station, capable of 72 hours and 15 men is utilized. As manpower and distance increase a second portable refuge station will be commissioned. The portable refuge chambers will be moved to the new locations as the working areas advance, eliminating the need to construct permanent refuge stations.

Fire extinguishers will be provided and maintained in accordance with regulations and best practices at the underground electrical installations, pump stations, wash bays and other strategic areas. Every vehicle will carry at least one fire extinguisher of adequate size and proper type. Underground heavy equipment will be equipped with automatic fire suppression systems.

All underground personnel will be required to carry Ocenco M-20 self-contained self-rescuer (SCSR) devices. The Ocenco M-20- SCSR isolates the user's lungs from the surrounding atmosphere and utilizes compressed oxygen to provide respiratory protection. The M-20's will provide 15 – 20 minutes of Performance duration and 32 minutes of Rest duration. In addition to the personal devices, six devices with longer performance durations of 60 minutes will also be supplied and kept near the ramp face during development; personal CO detectors will be made available to the development crews.

A mine-wide stench gas warning system is installed at the main intake raise to alert underground workers in the event of an emergency. During the initial development phase; prior to completion of the main fresh air raise, stench gas warning will be in the temporary fresh air system.

The main access decline would provide primary access and the ventilation raises with dedicated manway would be equipped with ladders and platforms providing the secondary exit in case of emergency. This secondary egress is now complete.

The Emergency Response Team that is currently at Minto has both Surface and Underground competent responders working in coordination with defined mine rescue certified members and UG specialists within the contractor ranks.

Further information on mine safety for the underground mine is provided in the Emergency Response Plan in Appendix D.

8.3 Hours of Work

Minto requested and received an hours of work variance (presented in Appendix E), specific to the first 4,500 meters of ramp development and associated ore removal.

The requested hours of work variance for these 4,500 meters of underground development included:

- 11 hours per shift of underground exposure for workers in enclosed cabs of mobile equipment.
- 10.5 hours per shift of underground exposure for all other employees.
- Shift rotation of 3 weeks on and 3 weeks off for the contractor's staff employees.
- Shift rotation of 4 weeks on and 2 weeks off for the contractor's hourly rated employees.

8.4 Industrial Hygiene and Fatigue Management Programs

An industrial hygiene (IH) consultant was engaged to assist Minto in the development of an underground IH plan and a fatigue risk management programs (acceptable to YWCHSB) for, but not limited to, air quality, noise and fatigue. The consultant will be involved throughout the development to conduct regular review of the program and testing results. The purpose of this plan is to develop process and procedures to ensure the highest possible air quality is maintained, (TLV levels), manage noise and to develop and implement a Fatigue Management Program. The Fatigue Management Plan has been presented in Appendix G. The IH consultant will also be utilized in the definition and calculation of adjusted TLV values.

Until such times that the IH data confirms that air quality exposure is below the adjusted TLV concentrations, respirators will be a mandatory piece of PPE equipment to all employees entering the underground workings.

The plan is that that prior to the completion of the 4500 meters of development to apply for a permanent variance to the hours of work. The IH data and programs for air quality, noise and fatigue will form the bases of this request.

8.5 First Line Supervisory Training

The Contractor will comply with the Yukon Occupational Health and Safety (OH&S) regulation by obtaining First Line Supervisor's Provisional Certificates and working toward full certification during the development.

Safety considerations in Underground Equipment / Materials

8.5.1 Diesel Equipment

All diesel equipment used in the underground operation will be permitted and maintained to comply with section 15.58, 15.59, 15.61 and all related sections on the Yukon Occupational Health and Safety Regulation.

8.5.2 Portable Compressors

The current plan calls for electric compressors underground, however, if the diesel is required, it will be equipped with the necessary fire suppression, CO monitor and shut off requirements.

8.5.3 Shotcrete

Shotcrete used in the underground workings will be restricted to "wet system" process only; this will eliminate the cement dust particulate associated with dry shotcrete application.

8.6 WCHSB Reporting

Quarterly update meetings are scheduled to be held with YWCSHB to review the following:

- IH Program data and Fatigue Management Plan progress
- Updated Mining Plan

The dates of the Quarterly Update Meeting should be set annually, with some latitude for mutually acceptable alternative dates.

Any variances to defined engineering or administrative controls put in place and defined by the IH program will be reported to YWCHSB as soon as reasonable along with corrective actions that Minto will take toward elimination of further variances.

All aspects of the current surface health and safety program and compliment of Safety personnel in place at the Minto Mine will be extended to the underground operations during the initial development in cooperation with the contractor as we are considering this an additional department of our operation.

JOHSC worker representation will be extended to underground operations and will expand in conjunction with the size of the workforce associated to the underground operation

.

9 Conclusion

This Underground Mine Development and Operations Plan incorporates the requirements outlined by the Quartz Mining License. Minto recognizes that some changes to the mine plan and methods are likely as operations continue and more is learned about underground activities on site. This plan will be updated as necessary to reflect newly acquired information and knowledge obtained from ongoing operations.

Appendix A – Safe Work Procedure Blast Clearing M-Zone

Scope

This procedure pertains to all employees, client personnel, contractors, and visitors in the vicinity of the M Zone at Minto Mine site.

PURPOSE

To set out a safe method by which all underground personnel may be notified and cleared from the underground during underground blasting operations. Areas within that zone will be evacuated and guards will be positioned to prevent entry into that area during the blast.

RESPONSIBILITIES

Employer/Supervisor Responsibilities

To ensure all workers are accounted for and in a safe location during a blast.

Safety and Training Department Responsibilities

To assist in the blast clearing procedures and notify personnel affected by the blast.

Worker Responsibilities

To ensure they follow all instructions given by their supervisor and the safety department. Also, to notify their supervisor if there are any unsafe conditions present.

Blaster Responsibility

To inspect and review each blast for potential hazards that warrant special precautions to be taken when clearing for the blast. If for any reason there is a concern around the "safe zone", the blaster may call for special consideration in clearing for a blast.

Special Considerations

This SOP also includes Special Considerations concerning DDH (Diamond Drill Holes) that are in the area of the M Zone Development. (See Pictures 1)

APPLICATION

Regulations pertaining:

- Guards will be posted as necessary to guard all possible access points to the danger area.
- The blaster shall instruct the guards as to their duties and responsibilities.
- Guards shall be posted at locations that are protected from flying material and other hazards resulting from the blast.
- Once assigned to a post by the blaster, guard shall prevent all persons from entering the danger area.
- Guards shall remain at their posts until:
  - The charge is detonated and the "All Clear" signal sounds, or
  - They are personally relieved by the blaster.
- For surface blasts a signalling device, having a distinctive sound audible within the proximity of the danger area, shall be used to sound a warning of a blast.
- After a blast is detonated no person shall enter a blasted area until:
  - The blaster has given permission for work to proceed, and
  - Any hazards shall be identified by the blaster and controlled before other work resumes in the blasted area.

Specific Procedures:

Notification:

1. No person, without explicit permission of the blaster, shall be in the U/G M Zone Development.
2. A standard driving layout/block plan shall be provided and indicate any diamond drill holes that are within the daily blast plan. Any DDH within the 10 meter radius of the driving layout will initiate the "**Special Considerations Procedure"** to this Safe Operating Procedure.
3. Other than Dumas personnel and any contractors within the blast zone, no additional clearing should be required unless indicated by the blaster or the blast is within the 10 meter diameter of a DDH.

Clearing Procedure for Regular Production Blast :

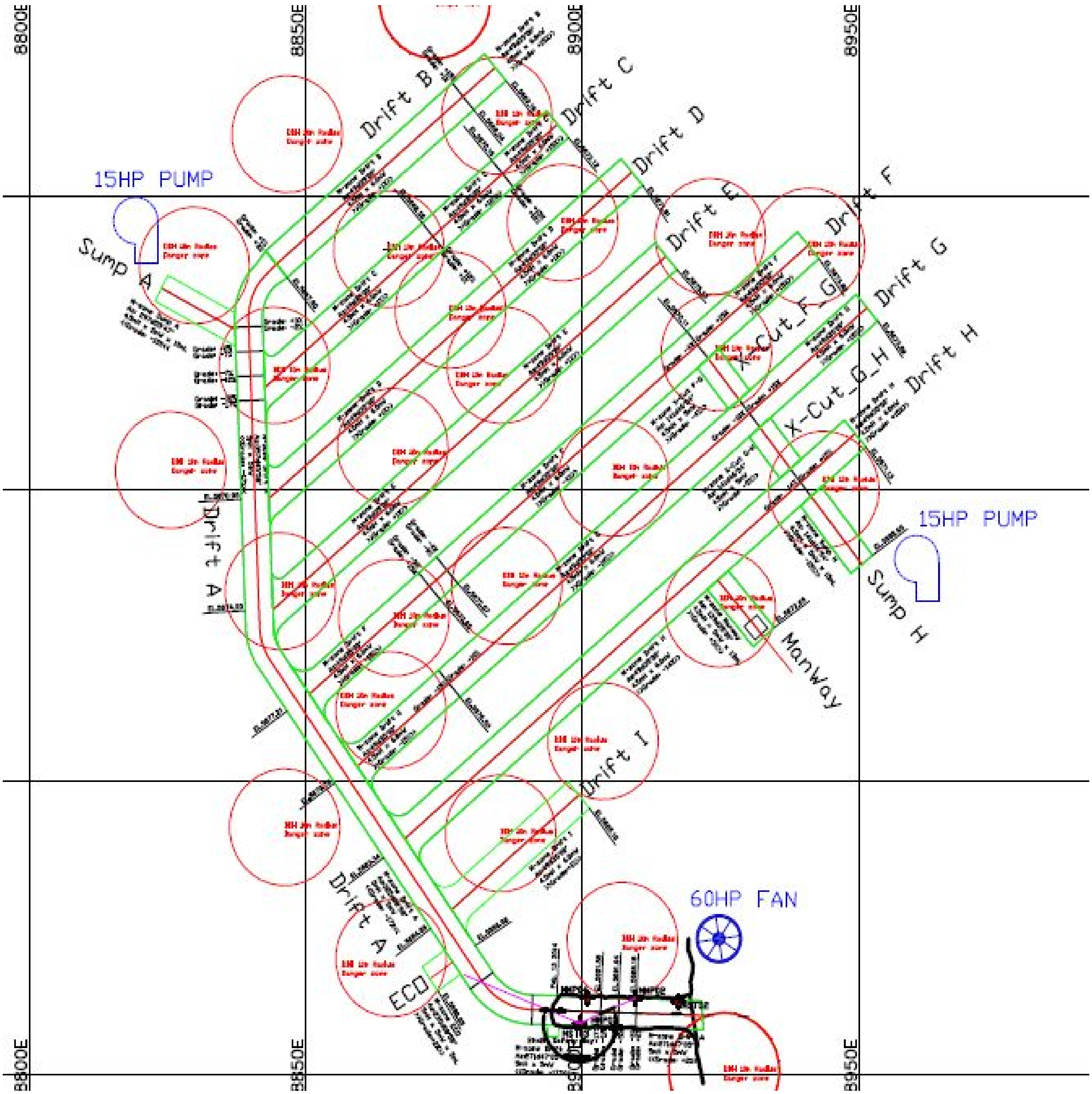
1. Dumas personnel and any visitors going to the Dumas work area (M Zone) will follow the Dumas Tag In/Tag Out Procedure. The M Zone Tag board is located in the Dumas Seacan at the pit bottom.
2. All non-essential personnel will clear the blast zone 30 minutes before scheduled blast.
3. The blaster will be blasting using a blast box installed at the Reefer van.
4. The blaster will place a guard in the proximity of the Reefer Van to visually guard the Portal opening.
5. When the guard is in place and has verified to the blaster that the area is clear of personnel, the blaster will communicate on channel 7 " Attention Attention there will be a blast in the M Zone in approximately 5 Mins" followed by 3 - 2 second air horn blast.
6. 10 Seconds before detonation. The blaster will give 1 – 3 second air horn blast.
7. After a blast is detonated no person shall enter a blasted area until the blaster has given permission for work to proceed, and any hazards shall be identified by the blaster and controlled before other work resumes in the blasted area.
8. Blaster will announce " All Clear for M Zone" on channel 7.

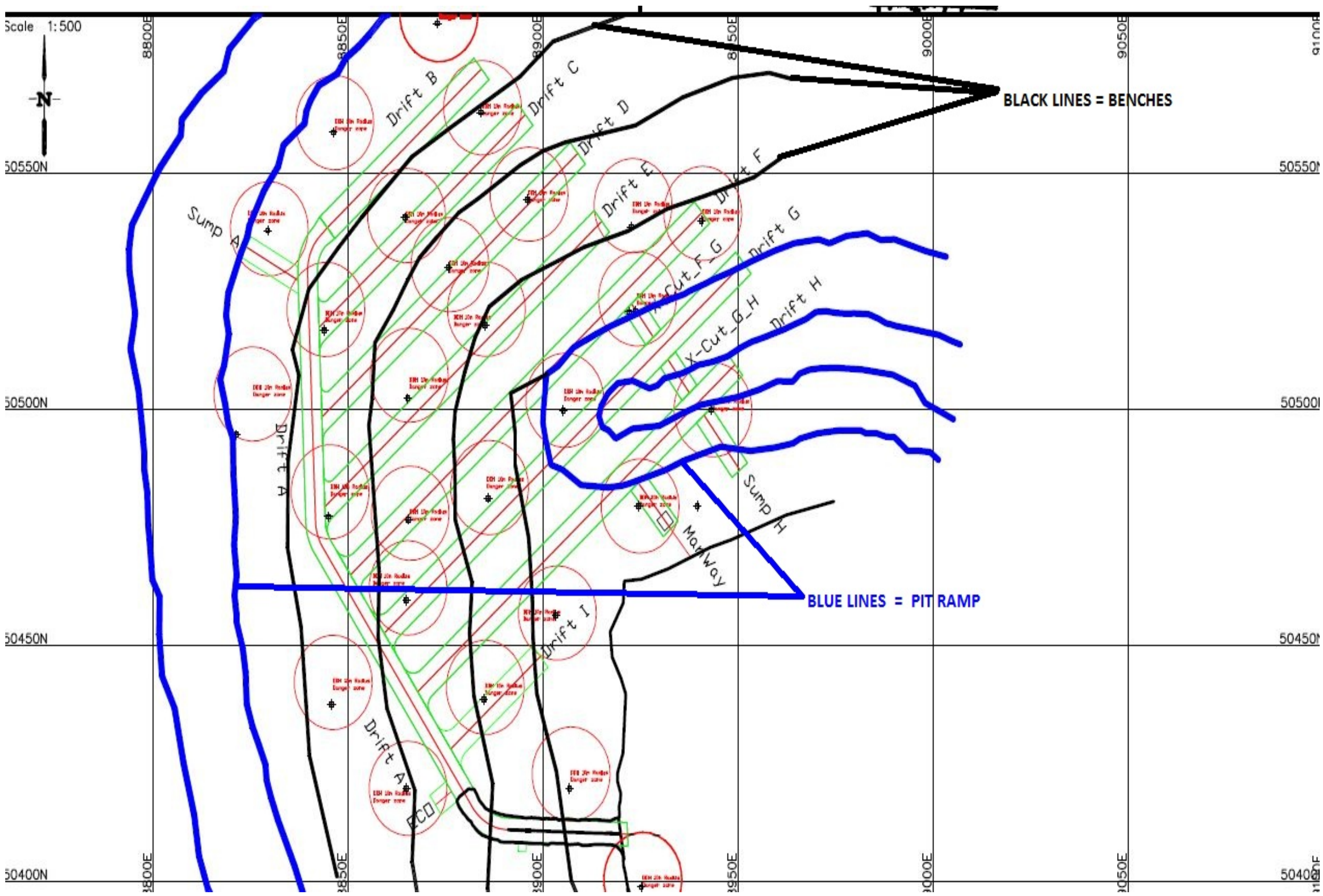
Clearing Procedure for 118 Pit Blast:

1. Pit Blast notification to be sent out as usual to notify Dumas personnel of the Pit Blast
2. Dumas Supervisor is to notify Blaster in Charge or designate if Dumas Crew has left the M Zone prior to Pit Blast.
3. In the event that Dumas Crews are still in the M Zone the Blaster in Charge or designate will travel to M Zone to ensure all Dumas Crews will remain in the U/G workings during the Pit Blast.
4. Other personnel in the M Zone will be cleared from the M Zone by the Blaster in Charge.
5. Dumas will ensure the 118 Portal is clear of personnel and the Tag Board in the Dumas office is clear.
6. A Dumas worker will be designated to guard the m-zone portal during the Blast. He will position himself 5 meters inside the portal with a Dumas Vehicle and radio.
7. Blaster in Charge will have Dumas Guard sign his form and clear the remainder of the M Zone on his way up to his post.
8. Dumas Guard will remain at his post until cleared from Blaster in Charge.
9. Dumas designate will sign Pelly form at the ERT & Mill as before.

Dumas Mine Planner/ or designate will notify Dumas Superintendent or designate when development is about to approach a DDH Area (24 hr notice)

1. Surveyor/Mine Technician will notify the group at the Minto morning meeting when a blast is expected to enter a 10m radius DDH Danger Zone. This will initiate the **"DDH Special Consideration"** portion of this blasting procedure and a site wide e-mail will be issued alerting all personnel and contractors who could possibly in the area of the M Zone Pit.
2. Only Dumas personnel will be allowed to remain **INSIDE** the Dumas Muster Station during the blast. The Blaster will be in the Reefer van during the blast. All other personnel are to leave the M Zone pit area 30 Mins before the blast.
3. The blaster will designate one guard to clear from the ramp bottom to the top and post himself as a guard at the "Entering M Zone" Call point sign.
4. Any vehicle or persons encountered in the ramp will be redirected to the top beyond the "Entering M Zone" sign.
5. The guard is to remain in the cover of his vehicle and will restrict all access to the ramp of the M Zone.
6. Guard at the top of the Pit will communicate with blaster to indicate all clear.
7. Blaster will initiate blast from inside the Reefer Van.
8. No one is to leave the Dumas Muster Station or Reefer Van for 1 minute after detonation.
9. No air horn blast required (all site personnel have been warned of a blast in the M Zone) in this situation.


8800E
8850E
8900E
8950E
15HP PUMP
Sump A
Drift B
Drift C
Drift D
Drift E
Drift F
Drift G
Drift H
X-Cut_F_G
X-Cut_G_H
15HP PUMP
Sump H
ManWay
Drift I
Drift A
Drift A
ECO
60HP FAN


Scale 1:500
N
BLACK LINES = BENCHES
BLUE LINES = PIT RAMP
Drift A
Drift B
Drift C
Drift D
Drift E
Drift F
Drift G
Drift H
Drift I
Sump A
Sump H
X-Cut_F_G
X-Cut_G_H
Manway
50550N
50500N
50450N
50400N
8800E
8850E
8900E
8950E
9000E
9050E

Reviewed by:

Project Manager: ___________________________Date: ___________________________

U/G Superintendent: ___________________________Date: ___________________________

U/G Shifter: ___________________________Date: ___________________________

Safety Department: ___________________________Date: ___________________________

Worker Rep. ___________________________Date: ___________________________

Minto Representatives:

___________________________Date___________________________

___________________________Date___________________________

___________________________Date___________________________

___________________________Date___________________________

Name Date Name Date

Appendix B – Minto Mine Emergency Response Plan – March 2014

Appendix C – Hours of Work Variance Request and Approval

RECEIVED
OCT 0 9 2012

YUKON WORKERS' COMPENSATION HEALTH AND SAFETY BOARD

401 STRICKLAND STREET, WHITEHORSE, YUKON Y1A 5N8 TELEPHONE: (867) 667-5645 FAX: (867) 393-6279 TOLL FREE: 1-800-661-0443

October 3, 2012

Mr. Ron Light
General Mine Manager
Minto Explorations Ltd.
Suite 900-999 W Hastings Street
Vancouver, BC V6C 2W2

Dear Mr. Light:

Re: Underground Hours of Work Variance

I have reviewed the additional information provided by Capstone Mining in the July 22, 2012 letter and the attached report. This information was provided to support your application to vary the hours of work established in section 15.13(1) of the Yukon Occupational Health and Safety Regulations Part 15 Surface and Underground Mines or Projects.

The letter provided accurately reflects the bulk of the discussion held on May 10, 2012. Upon review of my notes there are four additional items from our discussion that were agreed to which are not specified in your July 22 letter:

1) Capstone Mining will use the adjusted 2012 ACGIH TLV's as the exposure limits for workers working extended hours underground.
2) Capstone Mining will use the current Ontario OEL of 400 micrograms per cubic meter for diesel particulate as a baseline and adjust it for workers working extended hours underground.
3) All refuge stations will have a 72 hour capability.
4) Supervisors will receive specific training to identify cognitive impairment (fatigue, substance abuse, etc.) and deal with any issues in an appropriate manner.

Using the July 22, 2012 letter and the additions listed above as the minimum conditions, I am granting Capstone Mining the requested variance for the initial 4500 meters of underground development at the Minto Mine.

This variance will expire on March 31, 2014. A safety officer may establish additional conditions on this variance based on conditions at the mine site or results of industrial hygiene surveys. Failure to comply with the requirements of this variance will result in immediate revocation.

Sincerely,

Kurt Dieckmann,
Director, Occupational
Health and Safety

Appendix D – Fatigue Management Plan

Minto Mine

Capstone Mining Corporation's

Fatigue Risk Management Plan (FRMP) - DRAFT Copy

Table of Contents

Introduction

This policy was developed in consultation with Minto Mine management, supervisors, workers and contractors. It is reflective of current research and knowledge of fatigue and safety management systems, with a focus on fatigue risk management. It is designed to align closely with the existing Safety Management Systems at Minto Mine. It is based upon a five level fatigue risk management strategy that is designed to provide multiple layers of controls to assist in mitigating fatigue risk factors.

Scope of FRMP

This policy and supporting procedures apply to all supervisors and workers in the underground mine operations at Minto including direct Capstone employees, contractors or employees of contractors. Any worker who will, at any time, be spending more than 8 hours underground in the mine, shall comply with this Fatigue Risk Management Plan to ensure they maintain the capacity to safely perform work.

Objectives

This Fatigue Risk Management Plan seeks to mitigate risk factors associated with fatigue in Minto Mine's underground mining operations.

The key objectives of this Fatigue Risk Management Plan are to ensure a safe and healthy working environment free of fatigue related injury or illness by:

- controlling work related fatigue risk factors to minimize the likelihood of a worker being fatigued;
- minimising the risks of persons presenting for work or conducting work while impaired by fatigue;
- establishing appropriate steps to manage persons who are effected by fatigue; and
- reducing the likelihood of a fatigue related error or incident.

Communication Strategies

To ensure a common understanding of Capstone's Fatigue Risk Management Plan, a copy of the plan will be made available to all supervisors and workers involved in underground mining operations. The Minto Explorations Fatigue Management Policy Statement will be displayed in a visually accessible place to demonstrate commitment to properly mitigating fatigue factors.

Minto Explorations Fatigue Management Policy Statement

Minto Explorations Ltd. believes that the health and safety of its employees is fundamental to its business operations. Work related injury or illness is unacceptable and the company is committed to the identification, elimination, or control of workplace hazards for the protection of all employees. The goal is to have zero lost time accidents. The company is committed to implementing operational improvements that offer superior safety and occupational health management.

The management of fatigue in the underground mines is an integral part of Capstone's “Fit for Duty” Policy and as such, is a shared responsibility between Capstone, its contractors and its employees. All employees in the underground mining operations must undertake their work in accordance with this policy to the best of their ability and to take all reasonable care for their own safety and health, as well as the health and safety of their work colleagues.

Minto Explorations Ltd. understands fatigue is a risk factor and as such is committed to the following:

1. Zero harm to personnel due to fatigue related error.

2. Operating in accordance with industry standards, while meeting or exceeding compliance with all relevant legislative requirements.

3. Providing the expertise and resources needed to maintain a fatigue risk management system designed to recognize and manage fatigue risks to create safe systems of work and safe and healthy work environments.

4. Promoting fatigue awareness through appropriate training and education to ensure workers and supervisors are able to effectively manage fatigue and are able to communicate openly about fatigue related issues.

5. Ensuring employees understand their right and obligation to protect themselves from workplace hazards and alter or stop work if they believe fatigue is compromising the safety of themselves or others.

6. Ensuring all underground mine employees, sub-contractors and visitors are informed of, understand their obligations, and comply with this policy.

7. Measuring health and safety performance with regards to fatigue, the effectiveness of this policy in managing fatigue, and making improvements as warranted.

8. Investigating the causes of accidents and incidents including reviewing fatigue factors, and developing effective and immediate preventative and remedial actions as needed.

____

Sebastian Tolgyesi

Minto Mine Manger

Definitions

For the purpose of this document, the following definitions apply:

Fatigue: A physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase, or workload (mental and/or physical activity) that can impair a worker's alertness and ability to safely perform their duties. *(This definition is modified from Aviation IFALPA IATA FRMS for Operators, 2011).*

A Fatigue Risk Management Plan (FRMP) is an integrated set of management practices, beliefs and procedures for monitoring and managing the risks posed to health and safety by fatigue. It is based

on safety management system theory with an emphasis on risk management.

Capstone's FRMP incorporates:

The FRMP Document: The FRMP document defines and details the way that fatigue-related risk is dealt with in the underground mine at Minto, and is the written version of the FRMP.

Risk Mitigation Strategies: Contained within the FRMP are five levels of defenses designed to reduce the likelihood of a fatigue related error occurring. The FRMP includes tools, strategies and control measures for monitoring and managing fatigue-related risk.

Education and Training: All underground mine employees need to be aware of the risks posed by fatigue, understand the importance of controlling fatigue risk factors and understand the individual and organisational strategies that are employed in managing that risk. This is facilitated through both supervisor and worker education and training programs.

Revision and Review Functions: The system must be monitored for continuous improvement and to ensure it is flexible to changing work practices. The review function is essential and is therefore built into the Capstone FRMP framework.

Employee/Worker: Any person who works on the site, regardless of their employer. This includes direct Capstone employees, contractors and their employees.

Manager/Supervisor: Any person who is directly responsible for the supervision and well-being of other employees.

Company/Employer: Capstone Mining Corporation or Minto Explorations Ltd.

Contractor: A company hired by Capstone Mining Corp. to complete work on site. Employees of the contractor are referred to as employees/workers or managers/supervisors.

FRMP: Fatigue Risk Management Plan.

Shift: The hours between the start and finish of established daily work schedules.

Work Rotations/Cycles: The working period scheduled between any significant break away from work.

Work Schedules/Rosters: The hours to be worked for each day, shift, week, month or year, as

scheduled by the employer.

A complete list of definitions and terms related to this document can be found in Appendix B.

Standards and Legislation

The following standards and legislation were consulted in the preparation of this FRMP.

O.I.C. 2006/178

YUKON OCCUPATIONAL HEALTH AND SAFETY ACT

REGULATIONS: PART 15 – SURFACE and UNDERGROUND MINES or PROJECTS

Hours underground 15.13

(1) A worker shall only remain underground in an underground mine or project for more than eight hours in any consecutive 24 hours, measured from the time the worker enters to the time the worker leaves the underground workings:

(a) when an emergency causes an extension of the time,

(b) on one day of a week but only for the purpose of changing shift, or

(c) if the worker is a supervisor, pump worker, cage tender, or a person engaged

solely in surveying or measuring or in emergency repair work.

(2) The director may consider and approve an application for a modified hours of work schedule in an underground mine if the director is satisfied that the risk to the health or safety of the workers is not increased.

"**Underground mine or underground project**" means a mine or project that is not a surface mine and includes any work, undertaking or facility used in connection therewith.

Emergency Response

An emergency is defined in Capstone's Safety Management System. In the event of an emergency, workers and supervisors may be required to work outside of normal shift hours and fatigue may become a key safety issue. In the case of an emergency, all efforts should be made to properly mitigate fatigue risk factors through risk management strategies contained within this FRMP. Supervisors should be extra diligent in monitoring fatigue and in assisting workers in being aware of and managing fatigue to the best of their abilities. If possible, the emergency response manager should conduct regular fatigue assessments to determine if fatigue will become a safety hazard. When the emergency situation has finalized, all workers should be allowed a sufficient period to rest prior to recommencing work duties.

Training

Improving supervisor and worker competency in understanding, assessing and controlling fatigue risk factors, is an integral component of Capstone's FRMP. Specific training programs have been designed and delivered to key Minto employees involved in the underground mining operations. All new workers who will be involved in the underground mining operations will be trained in fatigue competency as part of their on-boarding process. Training records will be kept up-to-date to ensure fatigue competency.

Roles and Responsibilities

Capstone and all of its underground mining personnel share in the responsibility to minimize and manage the adverse effects of work related fatigue. As with all Safety Management Systems, the FRMP recognizes an integral role played by management, contractors and workers. Broadly, roles and responsibilities are outlined below.

Workers are responsible for:

• Obtaining sufficient sleep to be fit for work.

• Reporting when they have been unable to obtain sufficient sleep or when they feel at risk of making a fatigue related error.

• Complying with implemented Fatigue Risk Management Plans and policies including following all processes and completing all required documentation related to Capstone's FRMP.

• Participating in fatigue related education and training provided by Capstone.

• Participating in fatigue investigations as required.

• Seeking medical or other assistance with fatigue related health issues (such as illness or sleep disorders).

• Addressing any concerns regarding fatigue with a supervisor as required.

Supervisors are responsible for:

• Ensuring new workers are oriented and informed about issues relating to fatigue and the Capstone FRMP.

• Providing ongoing information and awareness to all underground mining workers regarding fatigue risk factors.

• Ensuring workers are following procedures and processes outlined in Capstone's FRMP.

• Conducting regular health and safety meetings that periodically discuss Fatigue Risk Management.

• Ensuring all observed and reported fatigue symptoms are properly addressed through consultation with workers and through agreed actions within the Capstone FRMP.

• Taking action if an employee is not fit for work due to fatigue.

• Reviewing and investigating all reports of fatigue related errors and incidents.

• Ensuring Capstone Fatigue Incident Investigation Information is gathered as part of any underground mine incident investigation.

• Setting a good example for workers by properly managing fatigue factors.

• Addressing any concerns regarding fatigue with workers and management as required.

Employer is responsible for:

• Creating and implementing a Fatigue Risk Management Plan and control strategies to mitigate fatigue related risk.

• Providing resources necessary for education and training to assist workers in building competency in identifying, assessing and controlling fatigue.

• Scheduling work to ensure adequate sleep opportunities for workers.

• Providing conditions that are conducive to managing fatigue, specifically providing adequately for nutritional, hydration and fitness needs of workers while at Minto Camp.

• Providing a proper sleep environment for workers when on duty at Minto Camp.

• Ensuring resources are available to maintain and regularly review and revise the FRMP.

• Supporting employees with non-work fatigue related issues through existing health and safety programs.

 Fatigue Causes9FatigueWorker –Individual FactorsWork EnvironmentWork SchedulingWork TasksOther Factors

Understanding Fatigue

Understanding fatigue is a key component of any fatigue risk management plan. It is essential for supervisors and workers to understand fatigue factors to be able to properly identify assess and mitigate fatigue risks.

Information required for understanding fatigue includes: circadian rhythms, sleep cycles, causes of fatigue, effects of fatigue, identifying signs of fatigue, and methods of controlling and managing fatigue. These key understandings are an integral part of the supervisor and worker training programs that are provided to all personnel involved in the underground mining operations. These training programs ensure all personnel involved have the understanding and competencies required to properly manage fatigue risk factors. A very brief summary of fatigue understandings is provided below.

Fatigue is an issue because it can impair a workers abilities and can significantly increase the risk of a safety incident occurring. Fatigue causes an increased risk of incidents because of reduced physical and mental abilities and an overall lack of worker alertness. When workers are fatigued they are more likely to have reduced awareness and reduced abilities to respond to changes in their working environment, to react emotionally and/or to exercise poor judgement. This leads to an increased likelihood of incidents occurring due to human error. Fatigue has also been positively linked to multiple long term health concerns such as: digestive issues, ulcers, obesity, diabetes, heart disease, stroke, and immune system deficiencies.

There are numerous factors that influence an individual's likelihood to become fatigued. Key risk factors include: quality and quantity of previous sleep obtained, disruption of circadian rhythms, time of day, age, overall health and nutrition, individual variations, sleep disorders, poor sleep hygiene, stress, family and social obligations, and drug or alcohol use.

Work factors can also greatly influenced fatigue. Key factors to consider include: shift work, particularly length, timing, and frequency of shifts; physical and mental requirements of job tasks; working environment; and inadequate breaks.

There are a number of strategies that can be employed to assist in managing fatigue. These strategies include organizational, individual and team-based countermeasures. All three types of control strategies are employed in this FRMP.

Increased awareness of fatigue factors and increased competency in identifying and managing fatigue will reduce fatigue related risk and the likelihood of fatigue related errors and incidents.

Fatigue Risk Assessments Completed at Minto Mine

Risk management encompasses the identification, assessment, control and evaluation of hazards that pose a meaningful risk to the health and safety of employees/workers (including contractors) and visitors to the workplace.

To properly deal with fatigue risk factors, it is important to both identify where fatigue is a hazard and to assess the level of risk that a given fatigue hazard represents.

Hazard assessments conducted at the Minto Mine site focused on reviewing hazards associated with fatigue. Assessments were conducted based on observations, consultation and discussions with workers, supervisors and contractors. The following areas were examined: mental and physical work demands; work scheduling and planning; environmental conditions; and individual and non-work factors. Risk assessments were based on both likelihood and severity. Results were graphed and quantified and may be viewed in their entirety in Appendix C. Results were used to create the Capstone 5 Level Fatigue Risk Management Plan. Below is a summary of the quantitative results of the initial hazard assessment conducted.

Table 1.1 Capstone's Minto Mine Fatigue Risk Assessment Results	Capstone Risk Points	Total Factor Points	Percent of High Risk Areas
Work Demands	18	30	60%

Work Scheduling - Hours	22	50	44%
Work Scheduling - Shifts	25	40	63%
Work Scheduling - Night Work	40	70	57%
Work Environment (listed as high as they are not currently fully assessed)	35	40	88%
Off Duty Factors	8	40	20%
Totals and Average %	148	270	55%

END PAGE