



KUDZ ZE KAYAH PROJECT

OPEN PIT MINE DEVELOPMENT AND OPERATIONS PLAN

REV04

June 2026

BMC MINERALS LTD.

This Management Plan has been developed to meet the appropriate subject objectives based on existing regulatory requirements, current or planned site activities, existing and expected site conditions, and designed outcomes at the time of writing. Operational processes/practices for achievement of licence terms and conditions may be updated from time to time as appropriate due to changes to relevant legislation and regulations, changes to site activities or conditions, differences from expected objective outcomes, or improvement of management practices. All rates, capacities, dimensions, weights, volumes and durations in text or figures are based on current feasibility level designs and are subject to change based on final design, licence conditions or site conditions encountered. Updates will be resubmitted to government authorities and/or stakeholders as required.

LIST OF REVISIONS

Issue Date	Revision Number	Description
September 2, 2020	Rev 00	For Issue to Agencies
November 19, 2020	Rev 01	Updated with commitments and Final Screening Report Recommendations
July 18, 2022	Rev 02	Update with sealed drawings per Yukon Water Board Secretariat (YWBS) IR3 (Figure 4-1 and Figure 5-6); Updated with BMC final due diligence review
June 21, 2024	Rev 03	Updated in response to Phase 4 IR from EMR dated June 9, 2023
June 1, 2026	Rev 04	Administrative updates in response to EMR completeness Check

SUMMARY OF REVISIONS

Information Request/Intervention	Document	Exhibit	Section	Revision
Rev 02				
YWBS IR-3.1	Open Pit Mine Development and Operations Plan	1.12	4.1	Replaced Figure 4-1 with sealed drawing
YWBS IR-3.1	Open Pit Mine Development and Operations Plan	1.12	5.1	Replaced Figure 5-6 with sealed drawing
Rev 03				
EMR Phase 4 IR General This plan focuses on open pit development and operations. There is very little detailed information on general mine construction nor the planned underground mining. Generally, QMLs contain a "Mine Development and Operations Plan" that includes mine construction, and all mining development and operations (open pit and underground in the case of KZK). This more detailed and delineated information is required. It is up to BMC how this information will be presented under the QML. Options for BMC: a) Include separate sections within this plan to cover both construction and underground mining development and operations, changing the name of the plan to represent the broader information. B) provide separate plans for the mine construction, development and operations as well as the underground mine development and operations. Each plan to be named appropriately.	Open Pit Mine Development and Operations Plan	1.12	Throughout	Additional information has been included on general mine construction throughout the Plan. An overview of the plans for underground mining have been included for context, with a separate Underground Mine Development and Operations Plan to be submitted to EMR for approval under the Quartz Mining License prior to development of the underground mine.
EMR Phase 4 IR General The geotechnical assessment completed by Dempers and Seymour (2019) is used as a basis for the open pit design. Provide the Dempers & Seymour, 2019, geotechnical assessment report.	Open Pit Mine Development and Operations Plan	1.12	Appendix A	The Dempers and Seymour geotechnical report has been included as Appendix A to the Open Pit Mine Development and Operations Plan.
EMR Phase 4 IR General Frozen material management is unclear throughout the application although there is potential to come across permafrost during mine construction. BMC may consider developing a separate frozen material management plan or including it in the waste rock and overburden plan. Either way, frozen material management strategies should be presented in the mine	Open Pit Mine Development and Operations Plan	1.12	3.2	Management of frozen and ice rich material has been detailed in a new section in the Plan.

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development and operations plan as it directly impacts mine construction and development. BMC to reference frozen material management strategies in applicable sections of plan (e.g. Section 3.1 - site preparation).				
EMR Phase 4 IR A concordance table is missing from the plan. BMC is to provide a concordance table that demonstrates how all applicable decision document terms and conditions and proponent commitments have been addressed. This concordance table should also indicate where revisions have been made based upon the information requests outlined in this table.	Open Pit Mine Development and Operations Plan	1.12		The Table of Concordance has been added.
EMR Phase 4 IR Introduction This section in the plan does not provide enough detail, and is vague. The introduction should provide a full overview/summary of mine development and operations. BMC to include a section on the general overview of the mine through it's various life cycles. This should include at a minimum: mine facilities overview, description of pits, rate of mining, general timeline of extraction, processing to closure, ore vs waste/tailings tonnage, crushing size prior to processing, etc.	Open Pit Mine Development and Operations Plan	1.12	1	An overview of the planned mine and facilities has been added to the Plan.
EMR Phase 4 IR Throughout and Section 2.1 – Geology The language in this plan needs to be consistent and provide clarity on zone vs pit. Figure 2-1 shows one large pit called the ABM Pit, but table 2-1 breaks it into the ABM Pit and the Krakatoa Pit. It is assumed that the ABM and Krakatoa zones make up the extent of the ABM pit, but this needs to be clarified and consistent in the plan. BMC to clarify throughout the plan ABM zone, Krakatoa zone, ABM open pit, Krakatoa open pit terms used and how they relate to one another.	Open Pit Mine Development and Operations Plan	1.12	2.2.1	Definitions for the ABM Open Pit, ABM Zone and Krakatoa Zone have been added to the Glossary, and usage of terms throughout the plan has been reviewed and is consistent. Additional text has been included in Section 2.2.1 to clarify terminology used in the Management Plan.
EMR Phase 4 IR Section 2.2.1 - Mine Plan This section does not provide enough detail, and is vague. A gantt chart was provided in the BMC presentation at the May 24th meeting that provided the	Open Pit Mine Development and Operations Plan	1.12	2.2.1 and 3.5	Additional information has been provided detailing the quantity of material mined from each stage of the open pit (and provisional underground mine) on an annual basis. The use of mined material in construction has been quantified as has the end placement of mined material. A Gantt chart of the preliminary project development schedule has been included in Section 3.5 of the plan.

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scheduling details needed for the plan. This section should generally be expanded upon to provide a more complete picture of the mine plan. BMC to provide more detail, for example: stages of development and production schedule, size of pit (depth, width), design of haul roads, daily and monthly mining rates with diluted averages, pre-production material use/placement, and should acknowledge end placement (e.g., X tonnes in Class C facility), etc.				The size of the open pit and haul road design was already detailed in Section 5 of the plan.
EMR Phase 4 IR Section 2.3 - Geotechnical Assessment There are no clear seismic design considerations. BMC to include a section discussing the seismic design considerations for the open pit and underground design in the next plan submission.	Open Pit Mine Development and Operations Plan	1.12	2.3	The seismic design analysis for the open pit has been included in Section 2.3.
EMR Phase 4 IR Section 2.3 - Geotechnical Assessment The plan mentions that the pit slope design is based on dewatered slopes, but does not provide detail on how this is achieved. BMC to provide reference to other plans where this is addressed, and update this plan accordingly to ensure consistency.	Open Pit Mine Development and Operations Plan	1.12	2.3	A reference to the Water Management Plan has been included.
EMR Phase 4 IR Section 2.3 - Geotechnical Assessment The plan mentions that the pit slope design is based on a minimum factor of safety of 1.2 but does not provide a reference to the guidelines used. BMC to provide rationale for a factor of safety of 1.2, and which standard/guidance this follows.	Open Pit Mine Development and Operations Plan	1.12	2.3	The appropriate reference has been added.
EMR Phase 4 IR Section 2.3 and Table 2-3 Lithologies described are generalized in comparison and difficult to reconcile with the Site Characterization Plan. Lithologies must be consistently referenced and reconciled across plans. BMC to reconcile lithology categories and descriptions, particularly with the Site Characterization Plan and appended ARD/ML report.	Open Pit Mine Development and Operations Plan	1.12	2.3	A reconciliation of geological lithology terms used in the Site Characterization Plan and relevant Appendices has been included in the Plan.
EMR Phase 4 IR Section 2.3 and Tables 2-4 and 2-5	Open Pit Mine Development and Operations Plan	1.12	2.3	A description has been added to the Plan to explain how the rock testing completed is representative of the planned open pit.

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Sampling for both UCS and strength parameters from direct shear tests are heavily weighted in favour of the felsic volcanic lithology. It is unclear how these tests can be considered representative of the mine deposit. Figure 2-2 of the Site Characterization Plan indicates that the felsic volcanic lithology is minor in comparison to rhyolite when it comes to pit make-up volumes. Clarify how samples taken for the UCS and strength parameters from direct shear tests are geotechnically representative of the planned mine deposit.				
EMR Phase 4 IR Section 3.1 - Site Preparation More information is required for site preparation. This section may be better presented if it was split into 1. vegetation and clearing; 2. foundation prep and construction; 3. overburden frozen material management; etc. BMC to expand on site preparation to give further details vegetation and clearing, foundation prep and construction, material management (including frozen material).	Open Pit Mine Development and Operations Plan	1.12	3.1 and 3.2	Additional information on construction specifications and frozen material management has been added to the Plan.
EMR Phase 4 IR Section 3.1 - Site Preparation The plan is missing reference to the Heritage Resources Protection plan or any procedures to follow when initially clearing and excavating for construction. HRPP states "Prior to the start of construction, Site Management and the Environmental Department will review previous heritage impact assessment to ensure construction activities do not have the potential to affect any known heritage resource." BMC to acknowledge the comment with revised wording in the next plan submission.	Open Pit Mine Development and Operations Plan	1.12	3.1	References to BMC's Heritage Resource Protection Plan and the Chance Find Procedure have been added. Noted that site management and the environmental department will review previous heritage impact assessments for potential to impact any known heritage resources prior to commencing construction activities.
EMR Phase 4 IR Section 3.1 - Site Preparation It is indicated that "cleared vegetation may be mixed in with topsoil stockpiles" for future use. Are there expected timber quantities and an intended use for timber? Clarify what type of vegetation is referred to in this section and if there is an intended use (e.g., reclamation pilot programs, seed collection, etc.).	Open Pit Mine Development and Operations Plan	1.12	3.1	Clarification has been added to the Plan. The intended use is for reclamation purposes as stated in the Plan.

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EMR Phase 4 IR Section 3.4.1 - Pre-Construction The plan mentions that "pre-construction activities may commence during final licensing or post final licensing". The wording should be changed to "pre-construction activities will commence as authorizations for activities are granted/issued". BMC to acknowledge the comment with revised wording in the next plan submission.	Open Pit Mine Development and Operations Plan	1.12	3.5	The description of site construction activities has been revised.
EMR Phase 4 IR Section 3.6 - Ore handling Ore handling requires clarity and additional information (e.g., how ROM pad will be divided, reference to QA/QC processes, etc.). This section may be better presented by dividing up into ore handling, transport and storage, crushing of ore and waste rock, mining rate to crusher, reference to process plant plan. BMC to acknowledge the comment with revised wording in the next plan submission.	Open Pit Mine Development and Operations Plan	1.12	3.7	Additional information on ore handling has been included in Section 3.7 of the Plan.
EMR Phase 4 IR Section 3.6 - Ore handling The plan states that The ROM pad will hold both ore for short term processing and low grade ore that may not be processed until later. BMC to clarify that the ROM pad may hold multiple stockpiles of different ore grades or metallurgical domain, and to elaborate on the expected classifications.	Open Pit Mine Development and Operations Plan	1.12	3.7	Clarification added to the Plan, including expected classifications.
EMR Phase 4 IR Section 3.6 - Ore handling BMC to review Workplace Health and Safety Regulations, Section 8.26 - Dust Collection. Personal Protective Equipment (PPE) is a last resort and does not replace requirements in 8.26 in the: - Crushing facilities, - Process conveyor(s) and - other dust production sources (haul roads, etc.) BMC to review Workplace Health and Safety Regulations Section 9 - Thermal Environment for the heating of buildings. BMC to acknowledge the comment with revised wording in the next plan submission.	Open Pit Mine Development and Operations Plan	1.12	3.7	Additional clarification has been added to the Plan.

Information Request/Intervention	Document	Exhibit	Section	Revision
EMR Phase 4 IR Section 4 - Associated Mine Services and Infrastructure This section describes ancillary infrastructure directly associated with the mine, but does not include mention of the camp, or any laydown areas. BMC to ensure this list is exhaustive and accurate.	Open Pit Mine Development and Operations Plan	1.12	4.1	Additional information has been added to cover all Project infrastructure, not just that applicable to the open pit mining operation.
EMR Phase 4 IR Section 4.1.1 - Mining Offices and Mine Dry Ensure facilities, gear and training required for the project meet the Yukon Mine Rescue Guidelines and workers are trained to the Western Canada Mine Rescue Manual. Ensure facilities, gear and first aid training required for the project meet Section 18 of the WHS regulations based on the risk assessment required in section 18.02. Ensure the mine dry facilities considers the Code of Practice 2022-01 Workplace Sanitary Amenities Code of Practice. Mine dry must have separate clean and dirty sides. BMC to acknowledge the comment with revised wording in the next plan submission.	Open Pit Mine Development and Operations Plan	1.12	4.1.2	Confirmation has been included in the Plan.
EMR Phase 4 IR Section 4.1.3 - Explosives and Magazine Storage Facilities The plan states that The Project will implement operational policies and procedures that meet or exceed the required acts and regulations. BMC to include reference to permits associated with activities and produce SOPS if not included in other authorizations.	Open Pit Mine Development and Operations Plan	1.12	4.1.4	Information on explosives related permits have been included in Section 4.1.4. This information is also available in the Hazardous Materials Management Plan. Procedures for the transportation, storage, manufacture and usage of explosives will be developed with the explosives contractor prior to commencing explosives usage at the Project.
EMR Phase 4 IR Section 4.1.3 - Explosives and Magazine Storage Facilities Reminder that the magazines require permits from the Workplace Health and Safety branch of the board. Applications can be found on the WHS website (see links below). BMC to acknowledge the comment with revised wording in the next plan submission.	Open Pit Mine Development and Operations Plan	1.12	4.1.4	This permit has been noted in Section 4.1.4.
EMR Phase 4 IR Section 4.3 - Fuel Storage This section should reference the Emergency Response Plan and Spill Contingency Plan in the case of a spill of diesel or LNG.	Open Pit Mine Development and Operations Plan	1.12	4.3	Reference to the Emergency Response and Health and Safety Plan has been added. The Spill Contingency Plan was already referenced.

Information Request/Intervention	Document	Exhibit	Section	Revision
BMC to acknowledge the comment with revised wording in the next plan submission.				
EMR Phase 4 IR Figures 5-1 to 5-5 The northern-most phase shown on figure 5-1 seems to disappear in the following figures (5-2 to 5-5). BMC to refine drawings to clarify planned stages of pit development.	Open Pit Mine Development and Operations Plan	1.12	5.1	Figures 5-2 to 5-4 have been corrected. No edit was required to Figure 5-5.
EMR Phase 4 IR Section 5.1.2 - Ground Movement Monitoring This section needs more elaboration such as: number, type, and location of prisms; survey methodology; definition of "regular basis" for visual inspections and survey monitoring (e.g., will engineering staff be involved in the monitoring program? Is there a threshold of movement established that would trigger some type of action? Is there pit evacuation criteria established?). If this is further delineated in the EMSRAMP, a reference should be provided. BMC to acknowledge the comment with revised wording in the next plan submission.	Open Pit Mine Development and Operations Plan	1.12	5.1.2	Additional information has been included on ground movement monitoring. Monitoring of pit slopes is also detailed in the Environmental Monitoring, Surveillance and Reporting Plan (BMC, 2024o), and a reference to this plan has been included. The open pit geotechnical stability assessment has been included as an appendix to the Plan.
EMR Phase 4 IR Section 5.2 - Haul Roads BMC to ensure that information presented in this section is consistent with the Road Construction Plan. BMC to acknowledge the comment with revised wording in the next plan submission.	Open Pit Mine Development and Operations Plan	1.12	5.2	The information presented in Section 5.2 has been reviewed and is consistent with that of the Road Construction Plan.

LIST OF ACRONYMS AND ABBREVIATIONS

BMC	BMC Minerals Ltd.
CIM	Canadian Institute of Mining, Metallurgy and Petroleum
g/cm ³	Grams per cubic centimetre
KZK	Kudz Ze Kayah
LNG	Liquified Natural Gas
m	Metre
Mpa	Megapascal
MRMR	Mining Rock Mass Rating
Mt	Million tonnes
oz	Troy ounce
PAG	Potentially Acid Generating
PGA	Peak Ground Acceleration
QA/QC	Quality Assurance/Quality Control
RMR	Rock Mass Rating
ROM	Run of Mine
t	Tonne
UCS	Uniaxial Compressive Strength

GLOSSARY

ABM Deposit: An accumulation of base and precious metal-rich VHMS mineralization. The deposit has been split into a number of zones by faulting.

ABM Open Pit: The open pit mine development associated with the ABM Deposit, comprising both the ABM Zone and the Krakatoa Zone.

ABM Zone: the western part of the ABM Deposit, separated from the Krakatoa Zone by the East Fault.

Direct Shear Test: A laboratory or field test used by geotechnical engineers to measure the shear strength properties of soil or rock material, or of discontinuities in soil or rock masses.

Discing: The effect of in situ stress on a rock mass observed in diamond drill core as narrow slices (or discs) of core.

Factor of Safety: A measure used in engineering design to represent how much greater the resisting capacity of a structure or component is relative to an assumed load. With respect to slope stability, Factor of Safety is the ratio of shear resistance to driving force along a potential failure plane. A Factor of Safety greater than 1.0 implies the available shear strength to resist failure is greater than the driving force to initiate failure.

Krakatoa Zone: The eastern part of the ABM Deposit, separated from the ABM Zone by the East Fault.

Mineral Reserve: The economically mineable part of a Measured and/or Indicated Mineral Resource. It includes diluting materials and allowances for losses, which may occur when the material is mined or extracted and is defined by studies at pre-feasibility or feasibility level as appropriate that include application of Modifying Factors. Such studies demonstrate that, at the time of reporting, extraction could reasonably be justified.

Mineral Resource: A concentration or occurrence of material of economic interest in or on the Earth's crust in such form, quality, and quantity that there are reasonable and realistic prospects for eventual economic extraction. The location, quantity, grade or quality continuity and other geological characteristics of a Mineral Resource are known, estimated, or interpreted from specific geological evidence and knowledge, including sampling. Mineral Resources are subdivided in order of increasing geological confidence, in respect of geoscientific evidence, into Inferred, Indicated and Measured categories. The Mineral Resource is stated inclusive of the Mineral Reserve. (CIM Council, 2014).

Overburden: Rock or soil overlying the bedrock or other underground feature.

Permafrost: Soil, rock or sediment that is frozen for more than two consecutive years. In areas not overlain by ice, it exists beneath a layer of soil, rock, or sediment, which freezes and thaws annually and is called the "active layer".

Potentially Acid Generating: Acid rock drainage occurs naturally in some environments as part of the rock weathering process but may be accelerated by large-scale earth disturbances in rocks containing an abundance of sulphide minerals. Rocks are assessed as to whether they may be potentially acid generating, if disturbed.

Probable Mineral Reserves: A Probable Mineral Reserve is the economically mineable part of an Indicated, and in some circumstances, a Measured Mineral Resource. The confidence in the Modifying Factors applying to a Probable Mineral Reserve is lower than that applying to a Proven Mineral Reserve. The Qualified Person(s) may elect, to convert Measured Mineral Resources to Probable Mineral Reserves if the confidence in the Modifying Factors is lower than that applied to a Proven Mineral Reserve.

Process Plant Facility: Facility where the ore gets processed to produce a concentrate, which is then loaded on trucks for transport.

Project (the Project): Refers to the Kudz Ze Kayah Mine property.

Proven Mineral Reserve: The economically mineable part of a Measured Mineral Resource. A Proven Mineral Reserve implies a high degree of confidence in the Modifying Factors. Application of the Proven Mineral Reserve category implies that the Qualified Person has the highest degree of confidence in the estimate with the consequent expectation in the minds of the readers of the report. The term should be restricted to that part of the deposit where production planning is taking place and for which any variation in the estimate would not significantly affect the potential economic viability of the deposit. Proven Mineral Reserve estimates must be demonstrated to be economic, at the time of reporting, by at least a Pre-Feasibility Study. Within the CIM Definition standards the term Proved Mineral Reserve is an equivalent term to a Proven Mineral Reserve.

Tailings: The material remaining after processing of ore to separate valuable minerals from the ore.

Tote Road: The existing 24 km road alignment between the Robert Campbell Highway and the ABM Deposit.

Uniaxial Compressive Strength: The capacity of a material to withstand axially directed crushing forces. When the limit of comprehensive strength is reached, specimens fail and are crushed. The Uniaxial Compressive Strength itself is the maximum force that a specimen can withstand before failure occurs.

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1 INTRODUCTION

BMC Minerals Ltd. (BMC) is the owner of the Kudz Ze Kayah (KZK) Project (the Project). Since acquiring the project in 2015, BMC has actively engaged in assessing historical work, optimizing design, resource drilling, economic assessment, baseline environmental studies, and First Nations and community engagement as well as the successful completion of the Executive Committee Screening by the Yukon Environmental and Social-Economic Assessment Board.

The Open Pit Mine Development and Operations Plan describes the open pit mining methods for the Project as well as associated infrastructure and support equipment required to enable mine development and operations. The plan also describes the physical monitoring program that will be established to ensure the stability of all open pit workings at the mine site.

An underground mine is also currently planned. A separate Underground Mine Development and Operations Plan will be submitted to the Department of Energy, Mines and Resources for approval under the Quartz Mining License prior to development of the underground mine. A general description of the proposed underground mine has been included in this Open Pit Mine Development and Operations Plan for overall Project context, but this is not intended to be a comprehensive plan for the construction and operation of the underground mine.

The Project involves open pit mining at a production rate of approximately 2.0 Mt per year of ore over the life of the mine. Waste mining rates will vary year by year as different pit stages are developed, with an average strip ratio of 10:1 over the life of the mine. Four main stages of pit development have been planned; early stages of pit development may be broken down into smaller components to account for local conditions if required.

Ore will be processed through a sequential flotation processing plant (BMC, 2026a). Ore will be crushed with a planned crushed product P_{80} of 130mm. Crushed ore will then be ground in a SAB circuit to a planned P_{80} of 70 μ m. Ground slurry will then undergo flotation; initially recovering copper, then lead and finally zinc, before passing to the tailings thickener and filtration system. Concentrates will be dewatered through thickening and filtration to produce concentrate suitable for transport to end market. Tailings will be thickened, filtered and hauled to the Class A Storage Facility for long term storage (BMC, 2026b).

Waste rock from the open pit mine will be classed according to acid generation and metal leaching potential and stored in one of three waste storage facilities according to classification (BMC, 2026c). Overburden will be placed in a separate stockpile and used for reclamation purposes.

The mine will be supported by infrastructure in addition to that noted above, including a 350 person camp, access and site roads, project offices and mine dry facilities, mine workshop and fuel storage facilities, explosives storage facilities, water treatment plant and water management ponds to collect and manage contact water.

1.1 PLAN REVIEW AND EXECUTION

BMC has had extensive engagement with Ross River Dena Council (RRDC) including community meetings in Ross River, Elders Oversight Committee Meetings, meetings with Chief and Council and engagement with RRDC's wholly owned environmental consultancy, Dena Cho Environmental and Remediation Inc. (Dena Cho). As part of this ongoing engagement, prior to this Plan being finalized Dean Cho conducted a detailed independent review of the draft plan. Issues raised during the Dena Cho review were addressed collaboratively through a number of workshops and where appropriate this plan was amended and additional commitments added.

BMC and Ross River Dena Council (in its role as lead community for the Kaska Nations, including Liard First Nation) are parties to an existing Socio-Economic Participation Agreement (SEPA) for the KZK Project. In 2019, BMC and RRDC (on behalf of all Kaska Nations) signed a Letter of Intent committing the parties to a modernization process for the existing SEPA. In March 2021, BMC tabled a proposed modernized SEPA with all Kaska leadership. The proposed SEPA includes provision for establishment of a Kaska/BMC Environmental Management Advisory Committee. Under the current proposal before Kaska, this committee will be tasked with, among other things, reviewing and providing input into environmental management plans, receiving and reviewing reports on implementation of those plans, reviewing monitoring plans/results, reviewing incident reports, and reporting back to Kaska members.

2 DESIGN CRITERIA

2.1 GEOLOGY

The regional and deposit geology is detailed in the Site Characterization Plan (BMC, 2026d) and includes details of the mineralization of the ABM Zone and Krakatoa Zone.

2.2 MINERAL RESERVES

Mineral Reserves are estimated in accordance with the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards on Minerals Resources and Reserves (CIM Council, 2014) or an equivalent standard.

The Mineral Reserve estimate for the Project is detailed in Table 2-1. All Mineral Reserves are classified as Probable Mineral Reserves (CSA, 2019).

Table 2-1: Project Mineral Reserve Estimate

Zone/Mine	Category	Ore (Mt)	Copper (%)	Lead (%)	Zinc (%)	Gold (g/t)	Silver (g/t)
ABM Zone, ABM Open Pit	Probable	13.4	0.9	1.5	5.9	1.3	131
Krakatoa Zone, ABM Open Pit	Probable	0.6	0.4	3.1	6.3	1.9	246
Total ABM Open Pit	Probable	14.0	0.9	1.6	5.9	1.3	136
Underground	Probable	1.7	0.4	2.3	5.0	1.3	147
Total KZK Project	Probable	15.7	0.9	1.7	5.8	1.3	138

2.2.1 Mine Plan

A single open pit, (the ABM Open Pit) forms the largest portion of the mine plan and has a production life of approximately nine years following Construction. The ABM Open Pit mines the ABM Deposit, with two separate Zones defined within the ABM Open Pit, being the ABM Zone and the Krakatoa Zone, which are used for mine planning (Chapter 5) and reporting of Mineral Reserves (Section 2.2). The current anticipated open pit mine schedule is summarized in Table 2-2, and broken down into ore and waste categories by mining stage (with material destinations) in Table 2-3. The expected contribution from the underground mine is included for context in Table 2-3.

Table 2-2: KZK Project Open Pit Mine Schedule

Open Pit	Unit	Total	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Ore mined	Mt	14.0	-	0.0	1.8	2.2	1.8	2.1	2.3	1.4	1.5	0.9
Zinc grade	%	5.9	-	8.1	6.5	6.3	6.5	5.3	5.6	5.9	5.5	5.4
Copper grade	%	0.9	-	0.4	0.5	0.9	1.1	1.2	1.0	1.0	0.7	0.8
Lead grade	%	1.6	-	2.9	2.0	1.7	1.6	1.3	1.5	1.4	1.6	2.2
Gold grade	g/t	1.3	-	2.0	1.7	1.5	1.3	1.2	1.2	1.0	1.2	1.6
Silver grade	g/t	136	-	221	165	147	142	121	123	107	126	174
Waste	Mt	139	0.9	5	14	30	32	27	10	10	6	3
Total Mined	Mt	153	0.9	5	16	32	34	29	12	12	8	4
Strip ratio (waste:ore)		9.9	N/A	269	8.1	13.7	17.8	12.9	4.4	7.4	4.1	2.9

Table 2-3: KZK Project Material Mining Schedule by Pit Stage

Mining Phase	Material	Unit	Total	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Dewater Trench	OB	Mt	0.9	0.9	-	-	-	-	-	-	-	-	-
Pit, ABM Zone Stage 1A	Class C	Mt	1.1	-	1.1	-	-	-	-	-	-	-	-
	OB	Mt	0.5	-	0.5	-	-	-	-	-	-	-	-
Pit, ABM Zone Stage 1B	Class A	Mt	0.8	-	0.0	0.7	0.0	-	-	-	-	-	-
	Class B	Mt	3.5	-	0.4	3.0	0.2	-	-	-	-	-	-
	Class C	Mt	2.7	-	2.6	0.1	-	-	-	-	-	-	-
	OB	Mt	1.3	-	0.8	0.5	-	-	-	-	-	-	-
	Ore	Mt	1.6	-	0.0	1.5	0.1	-	-	-	-	-	-
Pit, ABM Zone Stage 1C	Class A	Mt	0.8	-	-	0.3	0.5	-	-	-	-	-	-
	Class B	Mt	2.0	-	-	0.8	1.3	-	-	-	-	-	-
	Class C	Mt	0.4	-	-	0.4	-	-	-	-	-	-	-
	OB	Mt	1.6	-	-	1.5	0.1	-	-	-	-	-	-
	Ore	Mt	0.8	-	-	0.3	0.6	-	-	-	-	-	-
Pit, ABM Zone Stage 2	Class A	Mt	1.9	-	-	0.1	1.1	0.7	-	-	-	-	-
	Class B	Mt	8.3	-	-	1.1	6.8	0.4	-	-	-	-	-
	Class C	Mt	3.4	-	-	3.4	-	-	-	-	-	-	-
	OB	Mt	2.9	-	-	2.7	0.2	-	-	-	-	-	-
	Ore	Mt	2.7	-	-	0.0	1.5	1.2	-	-	-	-	-
Pit, ABM Zone Stage 3	Class A	Mt	1.4	-	-	-	-	0.4	0.7	0.3	-	-	-
	Class B	Mt	12.1	-	-	-	1.2	8.6	2.0	0.3	-	-	-
	Class C	Mt	34.7	-	-	-	17.7	16.9	-	-	-	-	-
	OB	Mt	1.6	-	-	-	0.9	0.7	-	-	-	-	-
	Ore	Mt	3.0	-	-	-	-	0.6	1.5	0.9	-	-	-
Pit, ABM Zone Stage 4	Class A	Mt	3.4	-	-	-	-	-	0.7	1.2	0.6	0.6	0.3
	Class B	Mt	13.9	-	-	-	-	0.9	7.9	2.9	1.7	0.5	0.0
	Class C	Mt	22.6	-	-	-	-	3.0	15.2	3.5	0.9	-	-

Mining Phase	Material	Unit	Total	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
	OB	Mt	1.0	-	-	-	-	0.4	0.6	-	-	-	-
	Ore	Mt	5.2	-	-	-	-	-	0.6	1.3	1.4	1.4	0.5
Pit, Krakatoa Zone	Class A	Mt	1.2	-	-	-	-	-	-	-	0.0	0.6	0.6
	Class B	Mt	7.8	-	-	-	-	-	-	0.5	2.4	3.2	1.7
	Class C	Mt	3.1	-	-	-	-	-	-	0.3	1.3	1.4	0.2
	OB	Mt	4.3	-	-	-	-	-	-	0.9	3.4	0.0	-
	Ore	Mt	0.6	-	-	-	-	-	-	-	0.0	0.1	0.5
Underground	Class A	Mt	0.1	-	-	-	-	-	-	0.1	0.1	0.0	0.0
	Class B	Mt	0.2	-	-	-	-	-	0.0	0.1	0.1	-	-
	Class C	Mt	0.3	-	-	-	-	0.0	0.1	0.1	0.0	-	-
	Ore	Mt	1.7	-	-	-	-	-	-	0.3	0.6	0.5	0.3
Total Mined	Class A	Mt	9.6	-	0.0	1.1	1.7	1.1	1.4	1.6	0.7	1.2	0.9
	Class B	Mt	47.9	-	0.4	4.8	9.4	9.9	10.0	3.9	4.2	3.7	1.7
	Class C	Mt	68.3	-	3.7	3.9	17.7	20.0	15.3	3.9	2.3	1.4	0.2
	OB	Mt	14.1	0.9	1.2	4.7	1.2	1.2	0.6	0.9	3.4	0.0	-
	Ore	Mt	15.7	-	0.0	1.8	1.8	1.8	2.1	2.5	2.0	2.0	1.3
	Total	Mt	155.7	0.9	5.4	16.2	32.2	33.9	29.4	12.7	12.6	8.3	4.0
Used for Construction	Class B	Mt	2.1	-	0.4	1.8	-	-	-	-	-	-	-
	Class C	Mt	7.3	-	3.7	3.6	-	-	-	-	-	-	-
Placed in Waste Storage Facility	Class A	Mt	9.6	-	0.0	1.1	1.7	1.1	1.4	1.6	0.7	1.2	0.9
	Class B	Mt	45.7	-	-	3.0	9.4	9.9	10.0	3.9	4.2	3.7	1.7
	Class C	Mt	61.0	-	-	0.3	17.7	20.0	15.3	3.9	2.3	1.4	0.2
	OB	Mt	14.1	0.9	1.2	4.7	1.2	1.2	0.6	0.9	3.4	0.0	-

Table 2-3 also details the quantities of waste rock and overburden that are planned to be placed in the various waste rock storage facilities and overburden stockpile. Towards the end of the mine life, as portions of the pit are no longer required for access, waste rock may be placed internally within the open pit footprint instead of being hauled to surface for placement in a waste rock storage facility.

Preproduction mining will focus on generating Class C waste rock for the Project's construction requirements (Class A Storage Facility buttress, pond embankments and mine haul roads). Class B waste rock generated during the preproduction phase and during the first year of production will be used for construction of the ROM / LGO Pad.

Once in production, mining will be scheduled to maintain a continual supply of ore to the Process Plant. Ore mining rates will average approximately 167,000 tonnes per month, but are anticipated to vary in accordance with short term planning. As indicated in Table 2-3, mining rates vary over the life of the mine as waste stripping requirements vary. The average mining rate over the life of the mine is 1.5Mt per month, peaking at 3.1Mt per month for the waste prestrip of the Stages 3 and 4 of the ABM Zone.

2.3 GEOTECHNICAL ASSESSMENT

Geotechnical assessment of the rock mass for open pit design was completed by Dempers and Seymour (Dempers & Seymour, 2019) and is included as Appendix A to this plan. Raw data for the Project comprised geotechnical logs of exploration and geotechnical diamond drill holes. Logged data included the following parameters:

- Geotechnical Interval: the from / to depth for each geotechnical interval;
- Core >10 cm: total length of all core greater than 10 cm within each geotechnical interval (Rock Quality Designation to be calculated);
- Discing: the total length of discing;
- Hardness or Qualitative Strength Index: estimated rock strength;
- Fractures per Interval per Angle Bin (0-30°, 30-60°, 60-90°, or 0-90°);
- Joint Sets (Jn): degree of jointing (number of joint sets present);
- Joint Roughness (Jr): the nature of the discontinuity;
- Fracture Infill (Ja): the type of joint infill and its alteration;
- Matrix Type: fault, intensive fracturing, sheared rock, etc.;
- Joint Wall Alteration; and
- Weathering.

The drill hole core logs were supplemented with geotechnical logging of core photographs. In total, the database consists of 7,378 m of geotechnical drilling data covering the Project area.

In addition to the drill hole core logging, optical and acoustic televiewer surveys were carried out in eight geotechnical diamond drill holes (total of 1,259 m). The optical and acoustic images along the survey intervals were used to supplement logged data and increase the confidence of structural interpretation.

Logged drill holes used for the geotechnical assessment are illustrated in Figure 2-1.

From a geotechnical perspective, the Project area comprises five principal lithological units (Mafic, Mudstone, Rhyolite, Wind Lake, and Felsic) that were used to describe the geotechnical environment. Lithological drill logging and mapping codes for the Project were originally developed with a range of uses in mind other than just that related to description of the geological environment as described in the Site Characterization Plan (BMC, 2026d). Logging for the purpose of identifying primary (or original) rock types for use in the development of detailed stratigraphic models for orebody modelling required a more detailed list of rock units and related lithological codes than was required for geotechnical or acid-rock drainage studies. After emplacement, the original rock units have been diagenetically and hydrothermally altered, altered, metamorphosed, deformed and in some cases weathered. A higher level grouping of altered and metamorphosed rock units based on mineral composition, metamorphic/structural fabrics and condition is more relevant from a geotechnical perspective.

In this context, five lithological units have been defined for geotechnical purposes: Mafic, Mudstone, Rhyolite Intrusive, Wind Lake and Felsic Volcanic. Felsic Volcanic is the predominant geotechnical lithology unit associated with the proposed mine. Although initially dealt with as a separate lithological unit, the Rhyolite Intrusive lithological unit is, along with the Rhyolite Coherent and Rhyolite Volcaniclastic lithological units, considered to be a Felsic Volcanic for geotechnical lithological purposes.

As understanding of the Project geology has grown over the years and different consultants have contributed to various aspects of project development, different terms have been used for some of the geological lithology units in the Site Characterization Plan (BMC, 2026d) and the various Appendices to this Plan. While different terms may have been used in different reports, the overall lithological framework has remained consistent throughout. The various descriptors used in the Site Characterization Plan and relevant Appendices are tabulated in Table 2-4 for reference. The descriptions used in Figure 3-2 of the Site Characterization Plan are the primary reference for geological stratigraphy within the local area of the ABM Deposit.

Table 2-4: Relationship of Terms Used for Geological Lithologies

SCP ¹ , Fig 3-2	SCP, Appendix F, Fig B.3	SCP Appendix G, Fig 2.3.2	SCP, Appendix O, Fig B.3	SCP, Appendix T, Table 2-1 ²
Wind Lake Formation				
• Mudstone	Sedimentary Rocks	Phyllites / Schists	Sedimentary Rocks	CARB MDS
• Mafic Volcanic	Mafic Volcanics	Phyllites / Schists	Mafic Volcanics	
Kudz Ze Kayah Formation				
• Felsic Volcanics	Volcaniclastic Rhyolite	Pit Metamorphics	Volcaniclastic Rhyolite	RHY
○ Felsic Intrusive	Incl. above	Incl. above	Incl. above	
○ Rhyolite Coherent	Incl. above	Incl. above	Incl. above	RHYc, RHYi
○ Rhyolite Volcaniclastic	Incl. above	Incl. above	Incl. above	RHYv
○ Mudstone	Incl. above	Incl. above	Incl. above	MDS
• Mafic intrusive	Orthogneiss	Pit Metamorphics	Orthogneiss	MAF

Notes:

1. SCP refers to Site Characterization Plan (BMC, 2026d).

2. Alteration qualifiers (AK – ankerite, CA – calcite, MU – muscovite, Cl – chlorite, PY – disseminated pyrite) are not relevant to the scale of primary geological lithologies compared in the table. However, alteration and textural qualifiers deemed relevant to the various studies may have been applied in each report.

A geotechnical structural model was developed using the geotechnically logged core, televiewer data and core photos and a total of 28 significant geotechnical features were identified and modelled in addition to the Fault Creek Fault and East Fault. These features have been classified according to their strike orientation (i.e. East-West, Northeast and North-Northeast).

Table 2-5 summarizes the rock mass properties by lithology and geotechnical feature.

Table 2-5: Rock Mass Property Summary

Rock Unit	Rock Strength (MPa)	Joint Condition	Fracture Frequency	RMR	MRMR
Mafic ABM	50 – 100	Rough and planar with soft sheared fine infill	5.5 / m spacing 0.18 m	43 – 59 Average 49	36 – 48 Average. 39
Mafic Krakatoa	50 - 100	Smooth and undulating with soft sheared fine infill	4.3 / m spacing 0.23 m	36 – 57 Average. 45	29 – 46 Average. 36
Mudstone	50 – 100	Smooth and undulating with soft sheared medium infill	4.8 / m spacing 0.21 m	38 – 50 Average. 44	31 – 40 Average. 36
Rhyolite ABM	100 – 130	Rough and undulating with soft sheared fine or no infill	3.9 / m spacing 0.26 m	48 – 60 Average. 52	39 – 48 Average. 42
Rhyolite Krakatoa	50 – 100	Rough and undulating with soft sheared fine or no infill	6.0 / m spacing 0.17 m	37 – 51 Average. 43	30 – 41 Average. 34
Wind Lake	50 – 100	Smooth and undulating with soft sheared fine infill	4.8 / m spacing 0.21 m	33- 49 Average. 41	27- 40 Average. 33
Felsic Volcanic	50 – 100	Rough and undulating with soft sheared medium infill	4.8 / m spacing 0.21 m	37 – 56 Average. 46	30 – 45 Average. 37
Fault Creek Fault	5 – 25	Polished with gouge infill	10 / m spacing 0.10 m	5 – 27 Average. 18	4 – 22 Average. 15
East Fault	5 – 25	Polished to smooth and undulating with gouge infill	>40 / m spacing <0.02 m	8 – 28 Average. 21	7 – 22 Average. 17
East West Structures (17)	5 – 25	Polished to smooth and undulating with gouge infill	>40 / m spacing <0.02 m	13 – 30 Average. 20	10 – 24 Average. 16

Rock Unit	Rock Strength (MPa)	Joint Condition	Fracture Frequency	RMR	MRMR
North East Structures ABM (2)	5 – 25	Polished to smooth and undulating with gouge infill	>40 / m spacing <0.02 m	12 – 28 Average. 18	10 – 23 Average. 15
North East Structures Krakatoa (2)	5 – 25	Polished to smooth and undulating with gouge infill	>40 / m spacing <0.02 m	12 – 31 Average. 23	10 – 25 Average. 18
North North East Structures ABM (4)	5 – 25	Smooth and undulating with soft sheared fine infill	>40 / m spacing <0.02 m	13 – 30 Average. 22	10 – 24 Average. 18
North North East Structures Krakatoa (3)	5 – 25	Smooth and undulating with soft sheared fine infill	>40 / m spacing <0.02 m	12 – 31 Average. 19	10 – 25 Average. 16

A laboratory testing program to support core logging information and improve the estimates of rock mass properties in the Project area was also conducted on selected rock core samples collected from geotechnical diamond drill holes. The results of the Uniaxial Compressive Strength (UCS) and Direct Shear testing are summarized in Table 2-6 and Table 2-7, respectively. The proportion of samples from each geotechnical lithological domain is consistent with the proportion of each domain within the ABM Open Pit.

Table 2-6: Summary of UCS Test Results

	Rock Type	Felsic Volcanic	Mafic	Wind Lake	Rhyolite	Mudstone
	Number of UCS Tests	15	1	3	1	1
Density (t/m ³)	Mean	2.78	2.78	2.78	2.78	2.77
UCS (MPa)	Lower Quartile	17	72	26	58	17
	Mean	42	72	33	58	17
	Upper Quartile	62	72	42	58	17

Table 2-7: Summary of Strength Parameters from Direct Shear Tests

Drill hole ID	Sample ID	Downhole Depth (m)	Lithology	Alpha / Beta	Micro	Infill	Discontinuity Type	Peak Friction Angle (°)	Residual Friction Angle (°)
K17-420	D1	156.8	Felsic Volc	45 / 135	5	4	Foliation	26.6	19.6
K17-422	D2	73.9	Felsic Volc	55 / 238	3	7	Foliation	23.8	20.3
K17-422	D3	184.7	Felsic Volc	58 / 008	5	4	Foliation	21.1	20.9
K17-422	D4	122.4	Felsic Volc	44 / 330	6	9	Joint	31.9	28.3
K17-424	D5	141.05	Felsic Volc	40 / 105	6	8	Joint	38.8	37.5
K17-427	D6	23.4	Felsic Volc	65 / 200	2	7	Foliation	29.5	26.4
K17-427	D7	90.3	Felsic Volc	46 / 225	3	9	Joint	37.1	31.0
K17-439	D9	44.8	Wind Lake	20 / 010	3	7	Foliation	27.8	25.5
K17-440	D10	94	Felsic Volc	No orientation line	3	3	Foliation	30.9	30.9

Using the geotechnical data and pit slope analysis, geotechnical domains were defined for the open pit, as shown in Figure 2-2. A range of analyses were conducted to determine stable pit slope parameters, including:

- Rock bridge analysis;
- Structural stability analysis; and
- Limit equilibrium and stress reduction analysis.

The pit slope design parameters developed through these analyses are detailed in Table 2-8, and overburden slope design parameters are detailed in Table 2-9. A 5 m wide catch berm will be excavated at the interface of the overburden and fresh rock to contain slumping of overburden should it occur. The slope design is based on dry dewatered slopes for all areas of the open pit. Dewatering of the open pit is described in the Water Management Plan (BMC, 2026e), and should be referred to for more detail.

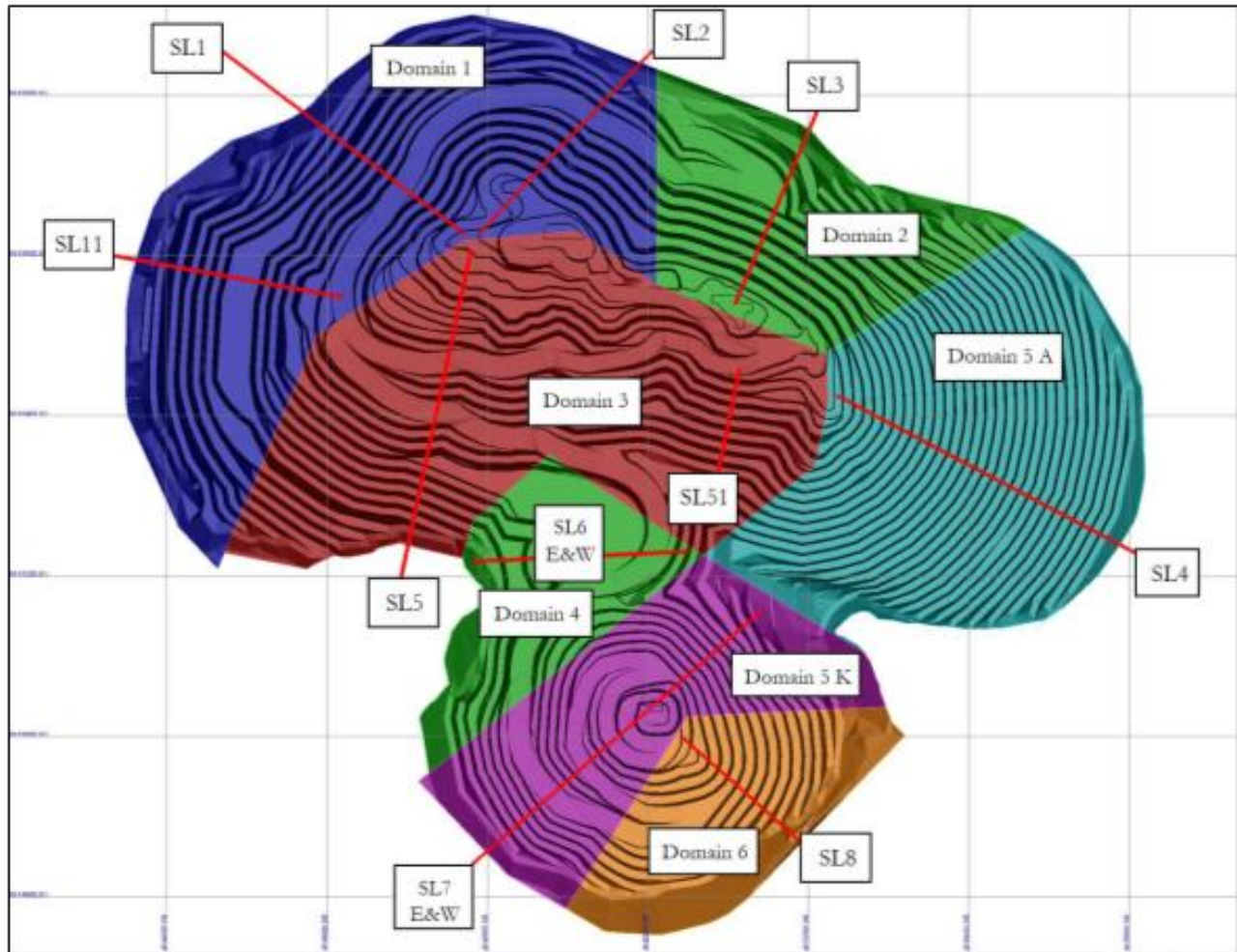


Figure 2-2: Geotechnical Domains for the ABM Open Pit

Table 2-8: Recommended Pit Slope Design Parameters in Rock

Domain and Section	Material, Depth	Bench Height (m)	Bench Width (m)	Bench Face Angle (°)	Inter Ramp Slope Angle, Toe to Toe (°)
Domain 1 SL 1	Rock, first 20 m	20	8	55	42
	Rock, below 20 m	20	8 or 12 *	70	46
Domain 1 SL 2	Rock, first 20 m	20	8	55	42
	Rock, below 20 m	20	10	70	49
Domain 2 SL 3	Rock, first 20 m	20	8	55	42
	Rock, below 20 m	20	10	70	49
Domain 3 SL5	Rock	10	8	55	34
Domain 4 SL6W	Rock, first 10 m	10	8	55	34
	Rock, below 10 m	20	12	65	43
Domain 4 SL6E	Rock, first 10 m	10	8	55	34
	Rock, below 10 m	20	12	65	43
Domain 5A SL4	Rock, first 10 m	10	8	55	34
	Rock, below 10 m	10	9	70	38
Domain 5K SL7W	Rock, first 10 m	10	8	55	34
	Rock, below 10 m	10	8	70	41
Domain 5K SL7E	Rock, first 10 m	10	8	55	34
	Rock, below 10m	10	8	70	41
Domain 6 SL8	Rock, first 10m	10	8	55	34
	Rock, below 10 m	10	10	65	34

*Domain 1 SL1 Fresh: 8m bench with a 27 m wide ramp or 12 m bench with no ramp.

Table 2-9: Recommended Overburden Slope Design Parameters

Overburden Depth (m)	Slope Angle (°)
0 to 10	30
10 to 20	25
Greater than 20	20

5 m minimum wide bench at interface of overburden and fresh rock.

The current pit design prepared by CSA Global (CSA, 2019) was evaluated by Dempers and Seymour (2019) for overall slope stability using limit equilibrium analyses under both static and dynamic (seismic) loading. Seismic analyses were used for an equivalent 1/2000-year event for the Site Class A area, estimated to be 0.101 PGA (NBC, 2020). This PGA has an equivalent horizontal equivalent of 0.0505 PGA and was applied as a constant force in the limit equilibrium model per Pyke (Pyke 1997). The seismic assessment of the ABM Open Pit (Dempers and Seymour, 2024) is included as Appendix B to this Plan.

The resulting Factors of Safety are detailed in Table 2-10, and were compared to the guidelines for factors of safety as recommended by Read and Stacey (2009), as shown in Table 2-11. A medium consequence of failure was considered appropriate for the ABM Open Pit. All slopes meet or exceed

the Factor of Safety at the Overall Slope Scale, except for the static assessment of Sections SL4 and SL7E. These sectors do not have a haul ramp present and accordingly the Inter Ramp Slope Scale has been considered for these sectors, with the recommended Factor of Safety being achieved.

Table 2-10: Limit Equilibrium Factor of Safety Results

Domain	Section	Factor of Safety (Static)	Factor of Safety (Dynamic)
Domain 1	SL1	1.4	1.3
	SL11	1.4	1.3
	SL2	1.3	1.2
Domain 2	SL3	1.4	1.3
Domain 3	SL5	1.9	1.7
	SL51	1.3	1.2
Domain 4	SL6E	1.3	1.2
	SL6W	2.6	2.3
Domain 5A	SL4	1.2	1.1
Domain 5K	SL7E	1.2	1.1
	SL7W	1.5	1.4
Domain 6	SL8	1.3	1.2

Table 2-11: Acceptance Criteria for Factors of Safety

Slope Scale	Consequences of Failure	Acceptance Criteria		
		Factor of Safety (min) (Static)	Factor of Safety (min) (Dynamic)	Probability of Failure (max)
Bench	Low to High	1.1	N/A	25% - 50%
Inter Ramp	Low	1.15 - 1.2	1.0	25%
	Medium	1.2	1.0	20%
	High	1.2 - 1.3	1.1	10%
Overall	Low	1.2 - 1.3	1.0	15% - 20%
	Medium	1.3	1.05	5% - 10%
	High	1.3 - 1.5	1.1	<=5%

From Read and Stacey (2009).

3 DESIGN AND CONSTRUCTION

The design and construction aspects discussed in this plan relate specifically to the mining operation. Other management plans developed as part of the Quartz Mining Licence should be referred to for specific design and construction information relating to specific mine infrastructure:

- Process Plant Development and Operations Plan (BMC, 2026a);
- Tailings Management Plan (BMC, 2026b);
- Waste Rock and Overburden Management Plan (BMC, 2026c); and
- Road Construction Plan (BMC, 2026f).

3.1 SITE PREPARATION

In accordance with the Heritage Resource Protection Plan (BMC, 2026g), prior to the start of construction activities, Site Management and the Environmental Department will review previous heritage impact assessments to ensure construction activities do not have the potential to affect any known heritage resources. In the event of an unexpected discovery of either disturbed or intact archaeological materials, historic, paleontological, or human remains during development or other site activities, the Chance Find Procedure as detailed in the Heritage Resource Protection Plan shall be followed.

As detailed in the Wildlife Protection Plan (BMC, 2026h):

- Clearing will be kept to a minimum and only include areas needed to safely construct and operate the Project;
- Clearing will be planned to minimize disturbance to bird nesting; and
- Nest surveys will be conducted as described below for any clearing during the nesting season (with involvement from Kaska First Nation representatives).

As much as practicable, land clearing will occur outside the nesting season. If land clearing is to be conducted during the nesting season (early May to late August), breeding bird surveys will be conducted prior to clearing and active nests will be buffered. This is required to ensure compliance with the *Migratory Birds Convention Act 1994* (Government of Canada, 1994) which prohibits the disturbance or destruction of migratory bird nests and eggs in Canada.

Site preparation for the open pit mine will take place in a number of stages, with the open pit footprint progressively expanding in accordance with the current staged pit design and mine schedule. Initial open pit mine development is planned to focus on the western slope of the Geona Creek valley while a dewatering trench system is established in the valley floor to progressively dewater the saturated overburden at the base of the valley. Timing of site preparation for other Project infrastructure will be undertaken in accordance with the Project construction schedule (Section 3.5).

Once excavation limits are set out, the footprint will be cleared of vegetation. Topsoil will be stripped and stored in strategically placed stockpiles throughout the Project site for reuse in progressive and final reclamation. Cleared vegetation may be mixed in with topsoil stockpiles for use in future reclamation works.

The amount of incidental lumber harvested during upgrading of the Access Road and construction of Project facilities is expected to be low. There will be limited opportunity for the use of this lumber harvested for construction purposes on the Project site, and it is proposed that any lumber harvested will be made available for public salvage. The lumber would be harvested directly by felling with chainsaws, limbing, bucking to manageable lengths, and then stockpiled by the gatehouse for public access. Some lumber may be salvaged after trees are uprooted with earthmoving equipment with larger pieces being separated and similarly prepared for public salvage.

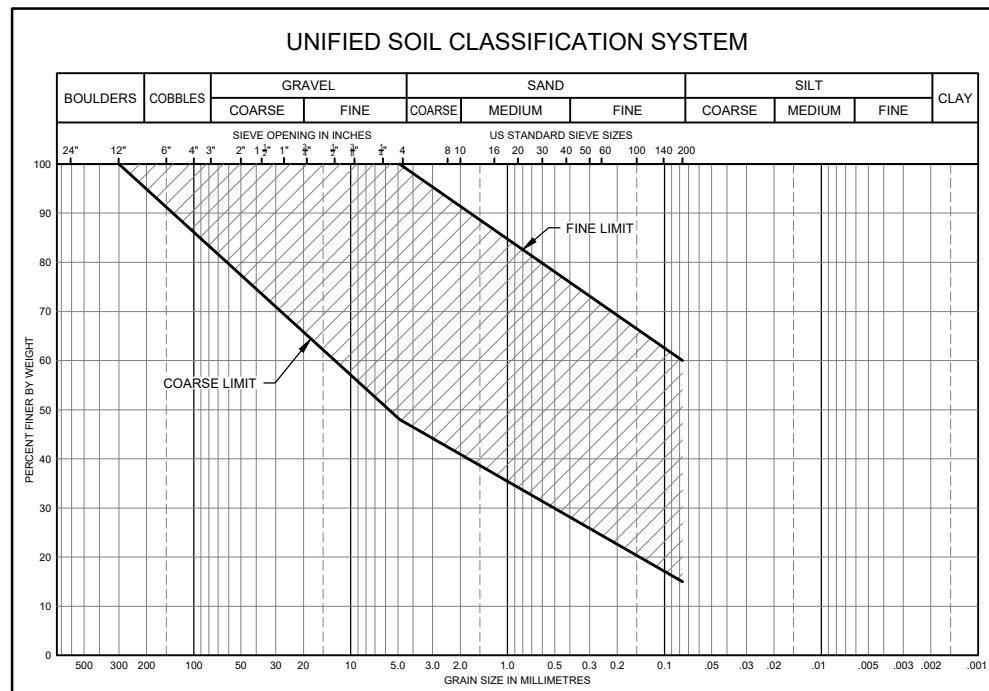
As overburden (other than topsoil) is removed during the preproduction phase, a geotechnical assessment of suitability of this material for construction will be made. Overburden that is assessed as being suitable for construction will either be hauled to the location intended for use and placed in a temporary stockpile or hauled to the Overburden Stockpile. The facilities that will potentially use overburden for construction include the Class A and B Storage Facility basins, Class A, B and C Storage Facility, Process Plant, Offices, Workshops, Roads and Overburden Collection Ponds and the Upper and Lower Water Management Ponds.

Preliminary construction material specifications are provided in Figure 3-1. These specifications will be reviewed and updated as required during final engineering.

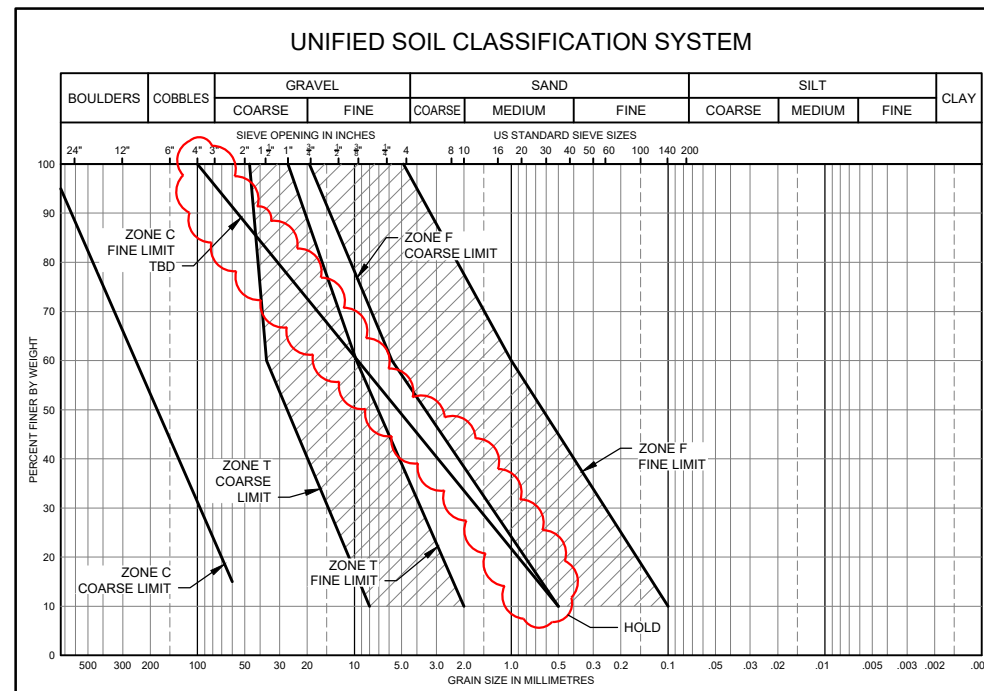
Overburden material deemed unsuitable for construction will be removed and transported to the Overburden Stockpile for storage or to temporary stockpiles for reuse as closure covers. Given the overburden will be used as a closure cover for the Class A, B, and C Storage Facilities, overburden stockpiles may be created adjacent to the final footprint of these facilities.

Care will be taken to segregate any frozen material removed during foundation preparation. These materials are unsuitable for immediate re-use but may be suitable for use in future reclamation works following thawing and draining of excess water. Frozen material will be transported to the Frozen Material Storage Area (within the footprint of the Overburden Stockpile) for management until thawed and drained (Section 3.2).

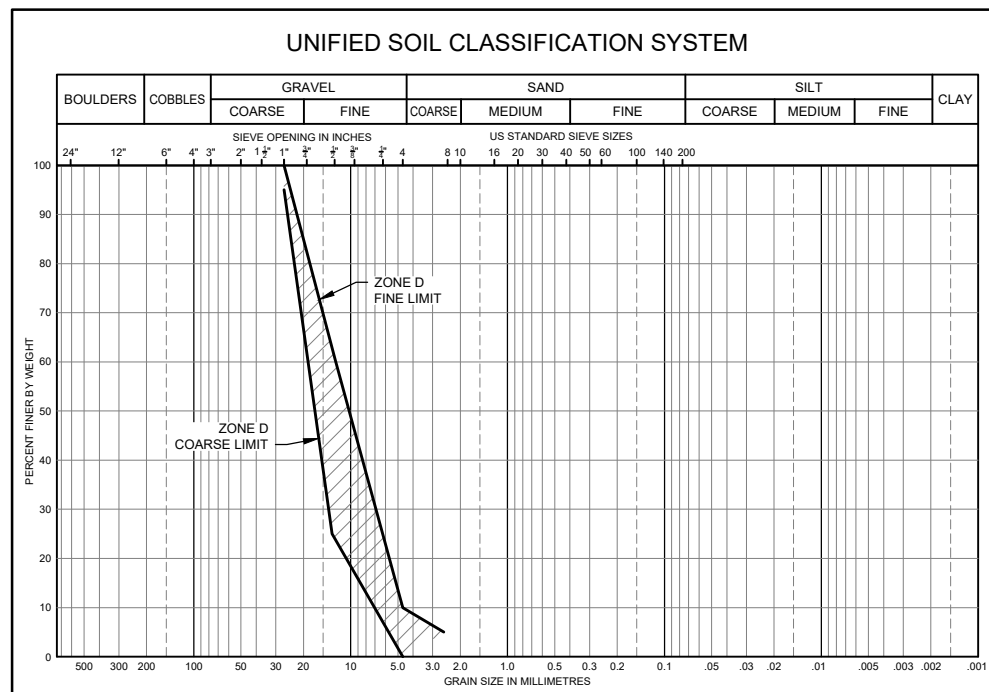
Once in the production phase, overburden that will not be required for construction purposes and will either be hauled to the Class A, B, or C Storage Facilities for use in progressive reclamation activities or alternatively to the Overburden Stockpile for storage until it is needed for final reclamation.



ZONE S



ZONE F, T, C



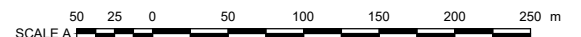
ZONE D

MATERIAL PLACEMENT AND COMPACTION REQUIREMENTS			
ZONE	MATERIAL TYPE	LOCATIONS	PLACING AND COMPACTION REQUIREMENTS
S	GLACIAL TILL	CORE ZONE	PLACED AND SPREAD IN MAXIMUM 300 MM THICK LAYERS (AFTER COMPACTION). VIBRATORY COMPACTED TO 95% OF STANDARD PROCTOR MAXIMUM DRY DENSITY AND +/- 2% OF OPTIMUM MOISTURE CONTENT OR AS APPROVED BY THE ENGINEER
F	FILTER SAND	CHIMNEY DRAIN	PLACED AND SPREAD IN MAXIMUM 300 MM THICK LAYERS AND COMPACTED WITH MINIMUM 4 PASSES OF 10 TON SMOOTH DRUM VIBRATORY ROLLER, OR AS APPROVED BY THE ENGINEER
T	GRAVEL	TRANSITION ZONE	PLACED AND SPREAD IN MAXIMUM 300 MM THICK LAYERS AND COMPACTED WITH MINIMUM 4 PASSES OF 10 TON SMOOTH DRUM VIBRATORY ROLLER, OR AS APPROVED BY THE ENGINEER.
C	WASTE ROCK	SHELL ZONE	PLACED AND SPREAD IN MAXIMUM 1000 MM THICK LAYERS AND COMPACTED BY SELECTIVE ROUTING OF MINE HAUL TRUCKS.
D	DRAINAGE GRAVEL	DRAINS	PLACED AROUND DRAINAGE PIPES AND WRAPPED WITH GEOTEXTILE.

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BMC MINERALS LTD.							
KUDZ ZE KAYAH PROJECT							
PRELIMINARY CONSTRUCTION MATERIAL SPECIFICATION							
 Knight Piésold CONSULTING				P/A NO.		REF NO.	
				VA101-640/11		VA24-01153	
				FIGURE 3-1			REV B

3.2 FROZEN MATERIAL MANAGEMENT

Discontinuous permafrost is known to be present within the Project area. Of the areas interpreted to contain permafrost, approximately one-quarter is inferred to be ice-poor and three-quarters is inferred to be ice-moderate. There are no areas of ice-rich permafrost (Palmer, 2023 and Appendix Q of the Site Characterization Plan (BMC, 2026d)). Ice-poor permafrost is defined as permafrost inferred to contain little to no visible (pore) ice, while ice-moderate permafrost is defined as permafrost inferred to contain thin seams and/or small, isolated lenses of segregated ice.

Until this material is thawed and drained of contained water it is not suitable for re-use as either a construction material or for reclamation works. A separate Frozen Material Storage Area will be established within the footprint of the Overburden Stockpile for storage and management of frozen materials.

Frozen material will be placed in unconsolidated piles as they are dumped by trucks in the designated storage area. If required, toe berms will be constructed to provide containment against flow sliding of thawing material in an uncontrolled manner.

Consideration will be given to management of water draining from the frozen material, such that it is efficiently routed to the Overburden Stockpile Collection Pond for sediment control and subsequent routing to the receiving environment. Other erosion control measures described in the Sediment and Erosion Control Plan (BMC 2026i), such as silt fences may also be adopted to manage and control sediment laden runoff from thawing of the frozen material.

During the construction phase of the Project, when the majority of frozen material is expected to be excavated, visual inspections of the Frozen Material Management Area will be undertaken on a weekly basis during spring, summer and fall to check on thawing progress, as well as the status of sediment and erosion control measures that have been implemented for management of the Frozen Materials Management Area. During the operational phase, when excavation and placement of frozen material becomes more sporadic, visual inspections will be completed on an as required basis.

Once thawed and drained, the frozen material may then be used for construction or reclamation works, or may be relocated to within the Overburden Stockpile for longer term storage until required for reclamation activities.

3.3 CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

A construction quality assurance and quality control (QA/QC) plan will be developed as part of the detailed design and will be included with the Issued for Construction drawing packages that will be provided to the Yukon Government Department of Energy, Mines and Resources prior to the construction of specific infrastructure components.

Measures that will be considered include:

- A suitably qualified environmental professional/technician to monitor Project construction activities;
- A suitably qualified professional to monitor construction and ensure all QA/QC testing is completed in compliance with the QA/QC plan, and that the construction is completed as per the Technical Specifications and design drawings;
- Monitoring of cut slopes and fill material;
- Salvaging and storing soil material suitable for reclamation;
- Foundation preparation and approvals;
- Permafrost (and excess ice rich material) identification;
- Construction of berms, lifts, interceptor ditches and sediment basins;
- Implementation of construction constraints related to climate conditions;
- Photographic logs of the construction process at each stage of construction; and
- Preparation of construction record drawings signed and sealed by a Professional Engineer registered in Yukon, where appropriate.

3.4 STABILITY ANALYSES

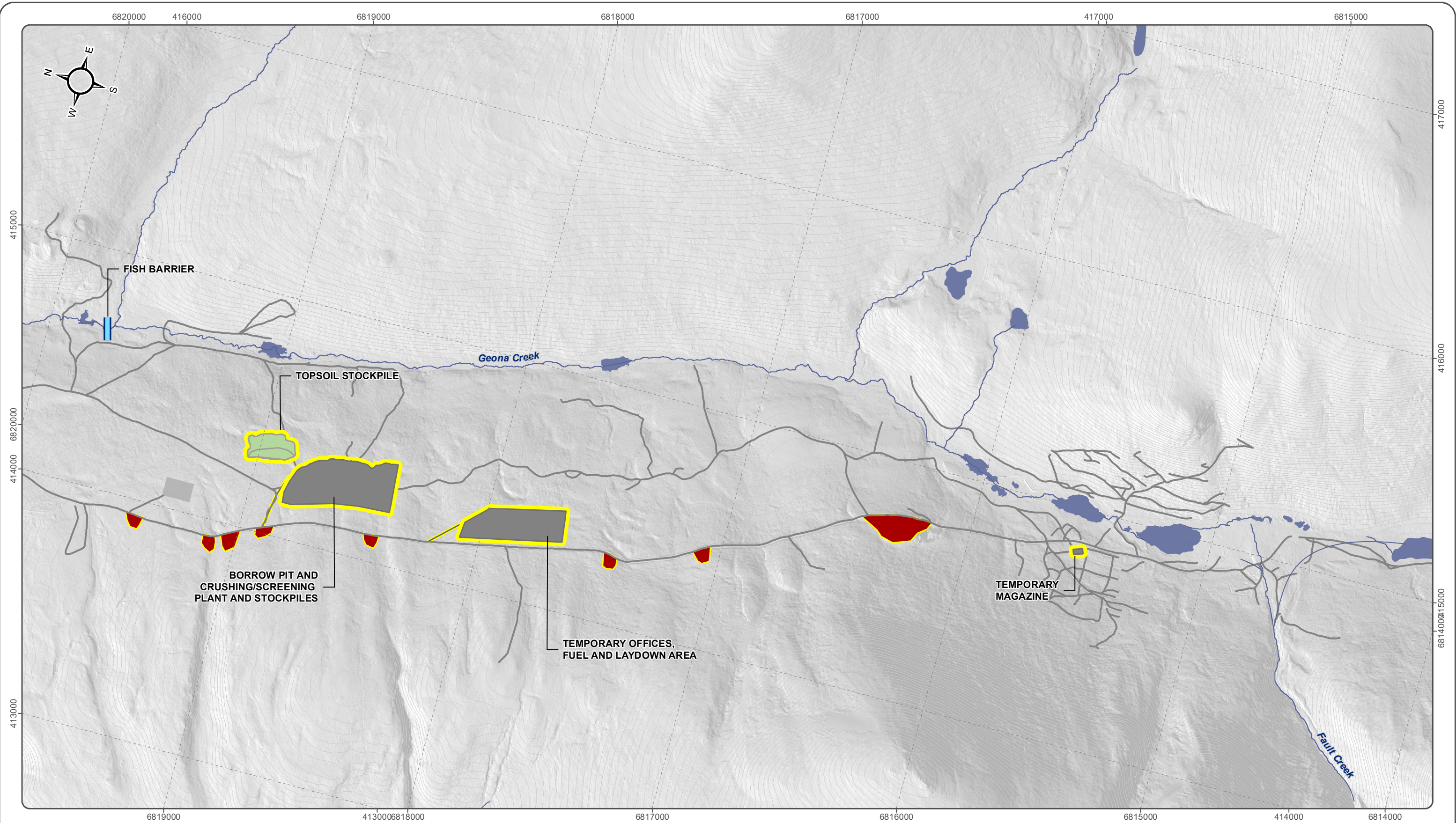
The stability analyses completed for the open pit mine is detailed in Section 2.2. Monitoring of pit slope stability during Operations is detailed in Section 5.1.2.

3.5 CONSTRUCTION SCHEDULE

The construction schedule and execution plan will account for seasonal conditions (temperature, precipitation, daylight hours), remoteness of the Project and construction on discontinuous permafrost. A preliminary construction schedule for the Project is detailed in Figure 3-2, with progressive site development illustrated in Figure 3-3 to Figure 3-8. Upon receipt of final regulatory approvals, confirmation of Project financing and board approval to proceed with construction, the construction schedule will be updated and will account for any required seasonal mitigations (i.e. timing windows for avoiding or minimizing impact to wildlife as identified in the Wildlife Protection Plan (BMC, 2026h).

		Yr-4				Yr-3				Yr-2				Yr-1				Yr1
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1 on
Receipt of Licences																		
Phase 1: Site Establishment																		
Temporary offices and fuel storage																		
Laydown area																		
Borrow pits																		
Crush / screen stockpile																		
Temporary magazine																		
Fish barrier in Geona Creek																		
Phase 2: Site Diversion Works																		
Diversion ditches																		
Sediment control ponds for diversion ditch outfalls																		
Fish offset ponds																		
Fault Creek diversion																		
Upgrade camp to 375 room capacity																		
Municipal wastewater treatment plant																		
Waste management facility																		
Phase 3: Process Plant Earthworks																		
Process plant earthworks																		
Overburden SP collection pond																		
Overburden SP initial site preparation																		
Tote Road upgrade to Access Road																		
Geona Creek diversion channel																		
Site Roads																		
Phase 4: Process Plant and Infrastructure Construction																		
Process plant construction																		
Process plant commissioning, operations																		
Power plant construction																		
LNG storage facility																		
Water treatment plant construction																		
Administration complex																		
Lower Water Management Pond																		
Site Roads																		
Phase 5: Mining Preparation																		
Workshop, fuel facility, washdown																		
Explosives facility																		
Class B WSF initial site preparation																		
Class B collection pond																		
Class C collection pond																		
Pit Rim Pond																		
Overburden dewatering trench																		
Site Roads																		
Phase 6: Mining																		
Class A WSF initial site preparation																		
Class A collection pond																		
Preproduction mining																		
Site Roads																		
Production mining																		
Upper Water Management Pond																		

Figure 3-2: Preliminary Construction Schedule



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0 250 500 750 Metres

- Features Built during Phase 1
- Mine Infrastructure Facility
- Topsoil Stockpile
- Borrow source
- Mine Road
- Existing Watercourse
- Existing Waterbodies



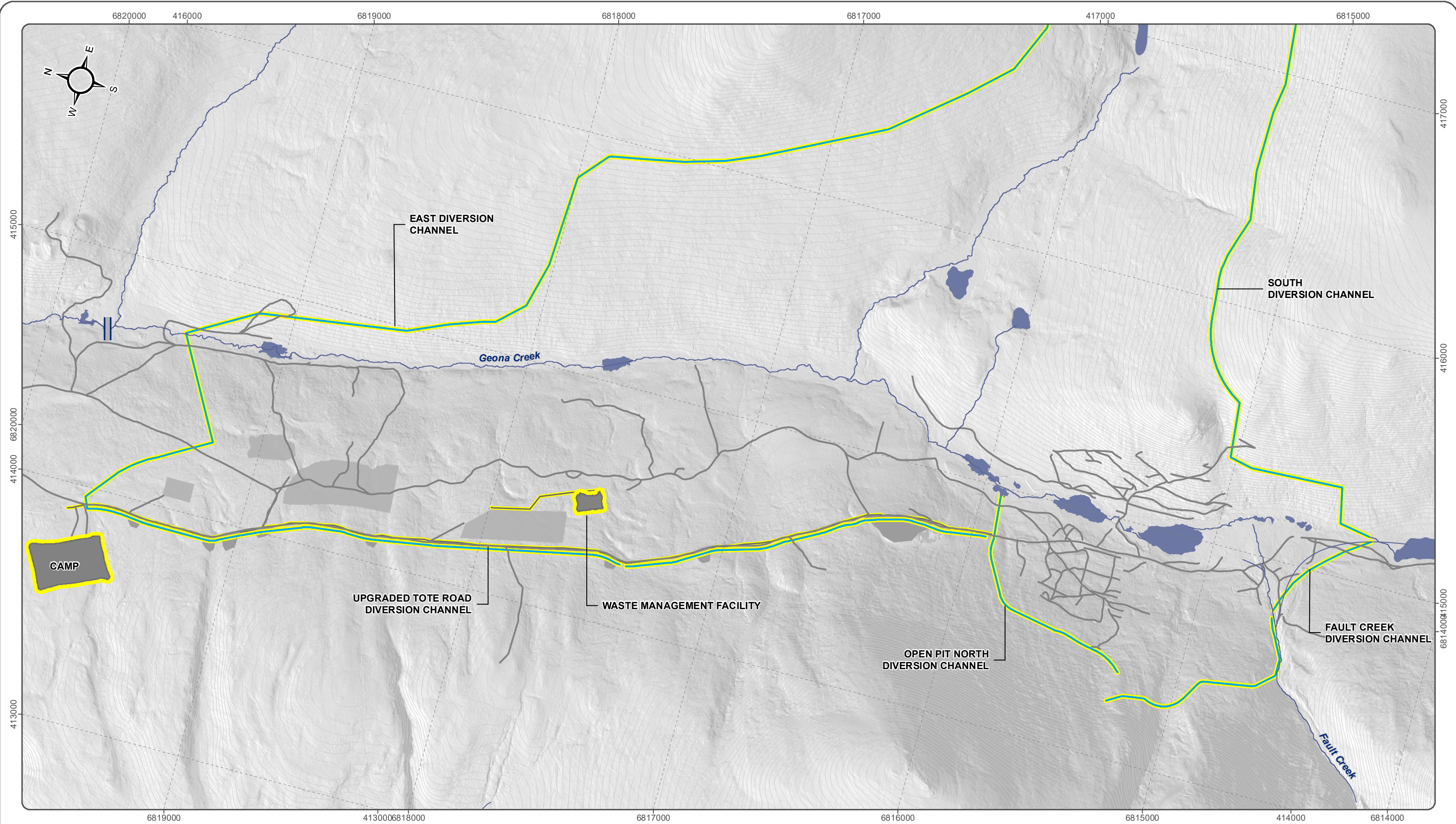
KUDZ ZE KAYAH PROJECT

FIGURE 3-3

PHASE 1 PROJECT DEVELOPMENT

JUNE 2024

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- Features Built during Phase 2
- Mine Infrastructure Facility
- Mine Infrastructure Built During Previous Phases

- Diversion Channel
- Mine Road
- Existing Watercourse
- Existing Waterbodies



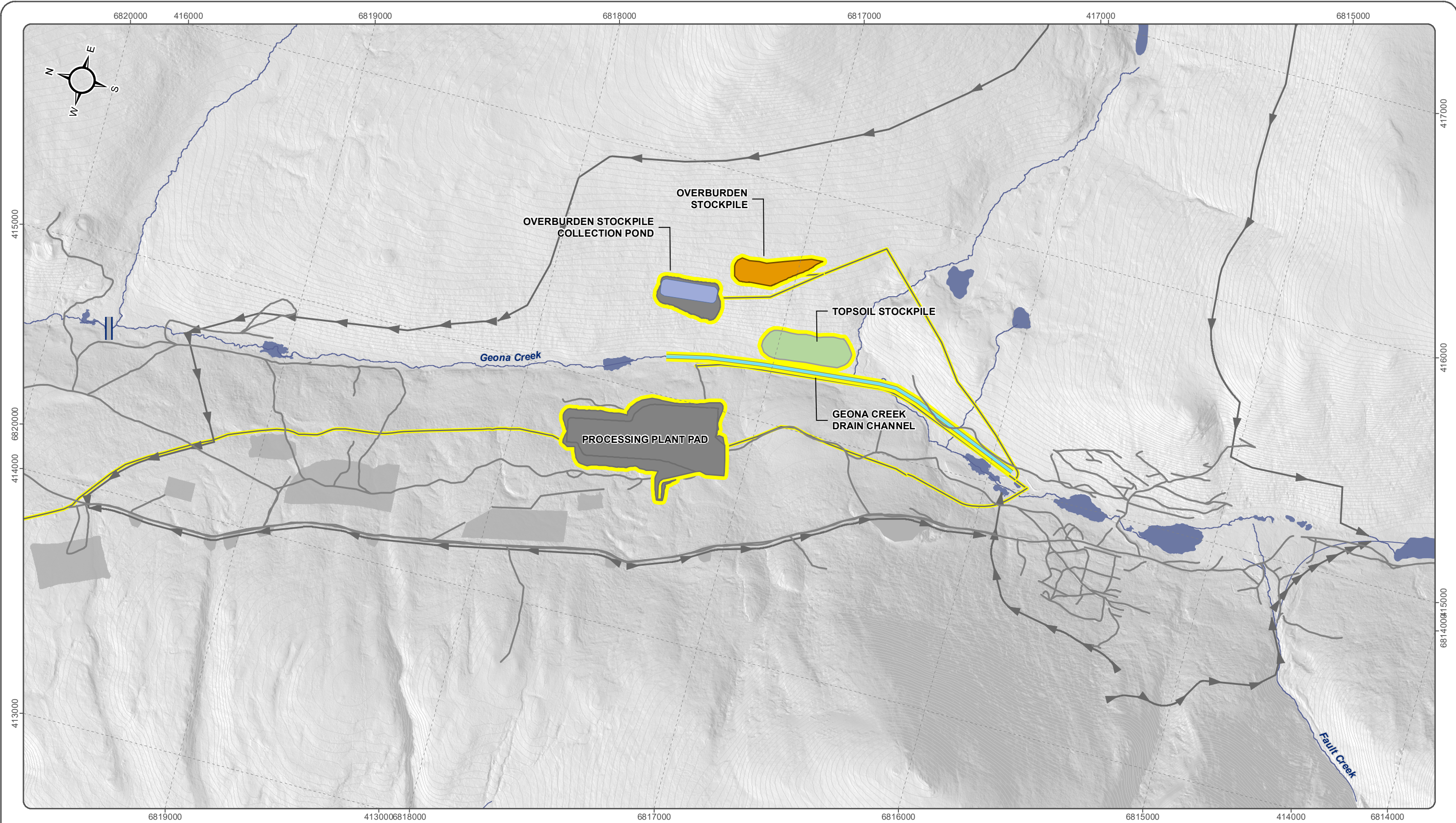
KUDZ ZE KAYAH PROJECT

FIGURE 3-4

PHASE 2 PROJECT DEVELOPMENT

JUNE 2024

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- Features Built during Phase 3
- Mine Infrastructure Facility
- Pond
- Stockpile, Overburden
- Topsoil Stockpile

- Mine Infrastructure Built During Previous Phases
- Drain Channel
- Diversion Channel

- Mine Road
- Existing Watercourse
- Existing Waterbodies

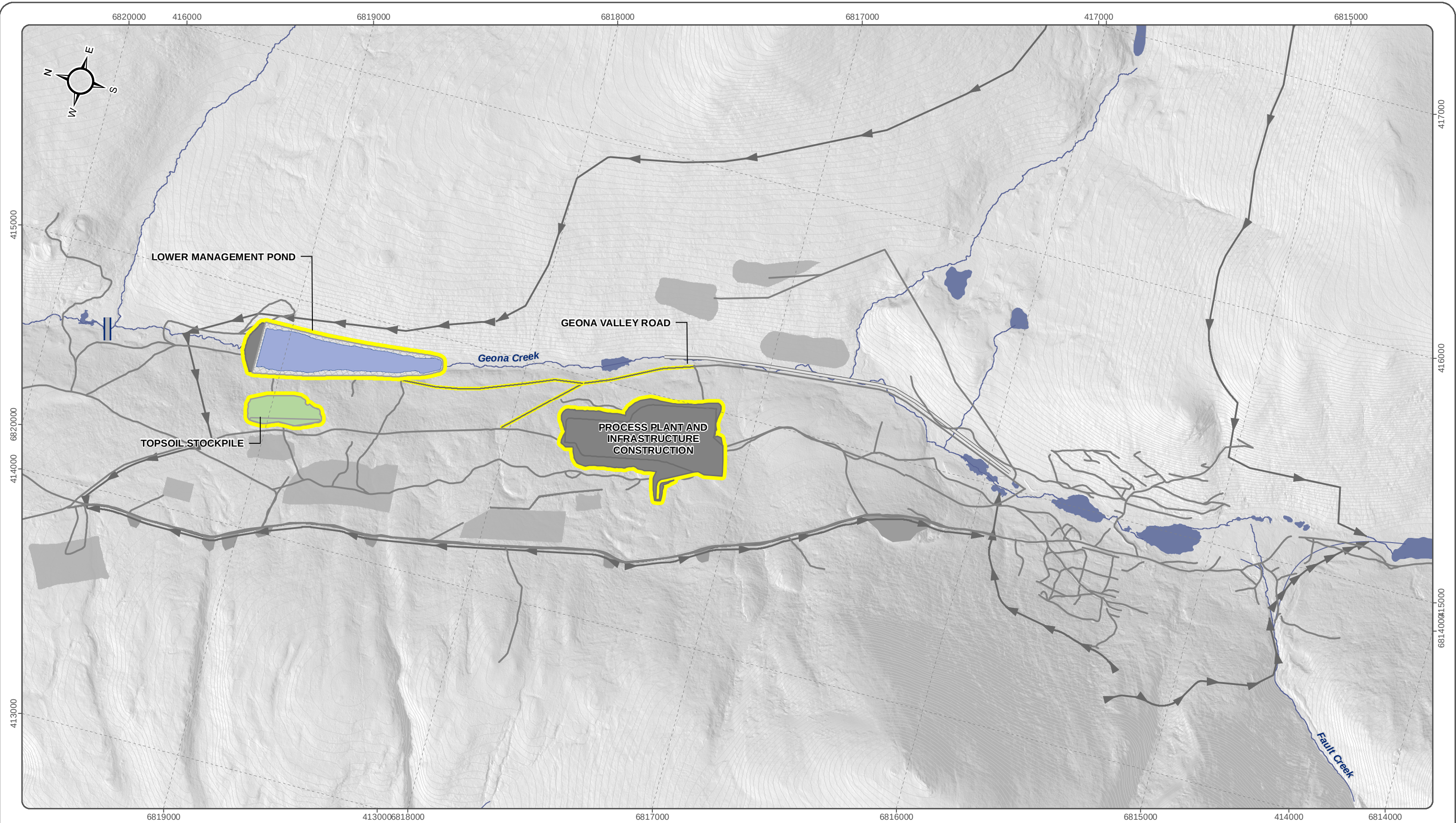


KUDZ ZE KAYAH PROJECT

FIGURE 3-5
PHASE 3 PROJECT DEVELOPMENT

JUNE 2024

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 1:15,000 (when printed on 11 x17 inch paper)

0 250 500 750 Metres

- | | | |
|---|--|--|
|  Features Built during Phase 4 |  Mine Infrastructure Built During Previous Phases |  Mine Road |
|  Mine Infrastructure Facility |  Diversion Channel |  Existing Watercourse |
|  Pond |  Drainage Channel |  Existing Waterbodies |
|  Liner | | |
|  Topsoil Stockpile | | |



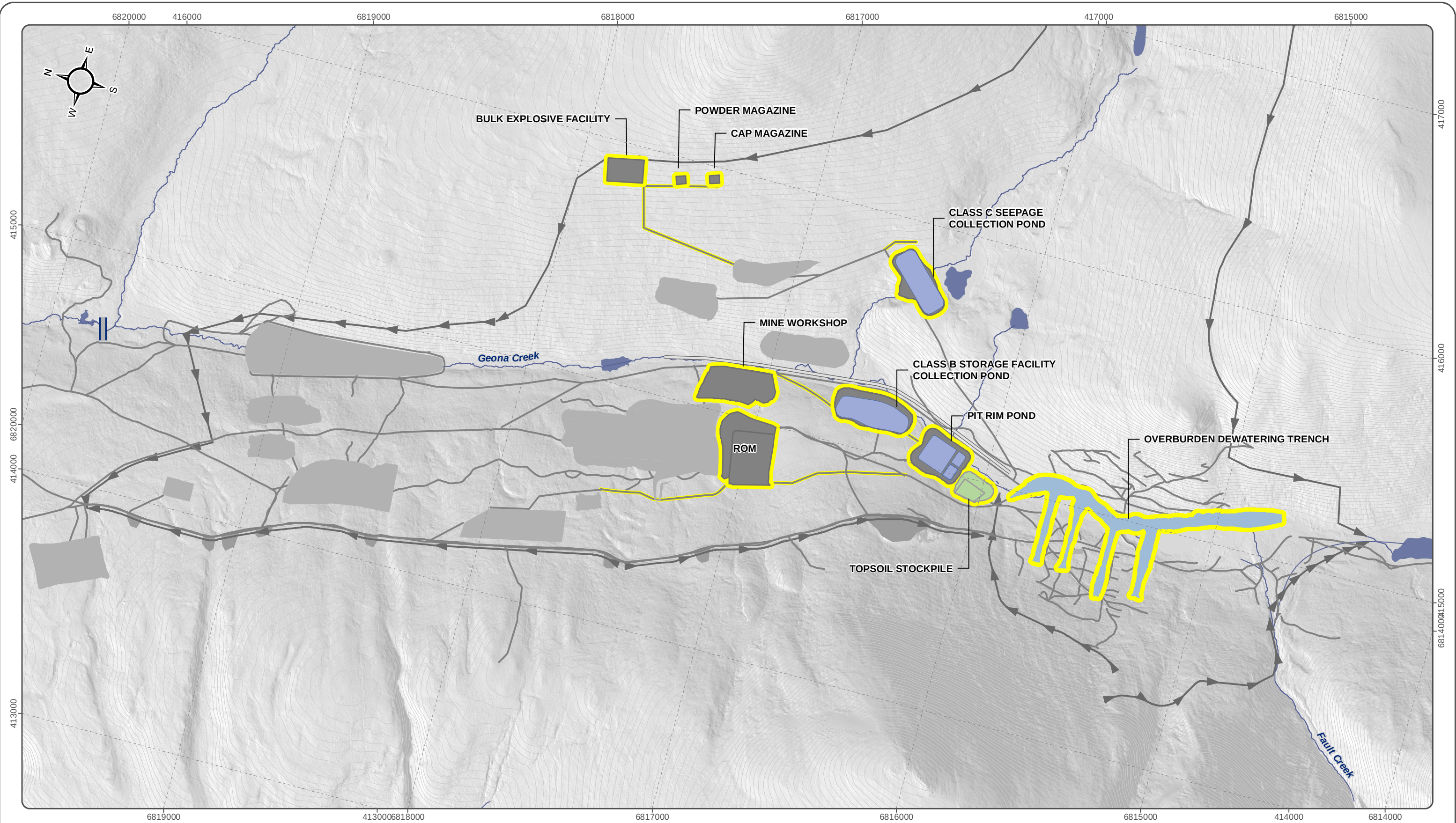
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FIGURE 3-6

PHASE 4 PROJECT DEVELOPMENT

JUNE 2024

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0 250 500 750 Metres

- | | | |
|-------------------------------|--|----------------------|
| Features Built during Phase 5 | Mine Infrastructure Built During Previous Phases | Mine Road |
| Mine Infrastructure Facility | Drainage Channel | Existing Watercourse |
| Pond | Diversion Channel | Existing Waterbodies |
| Water Management | | |
| Topsoil Stockpile | | |



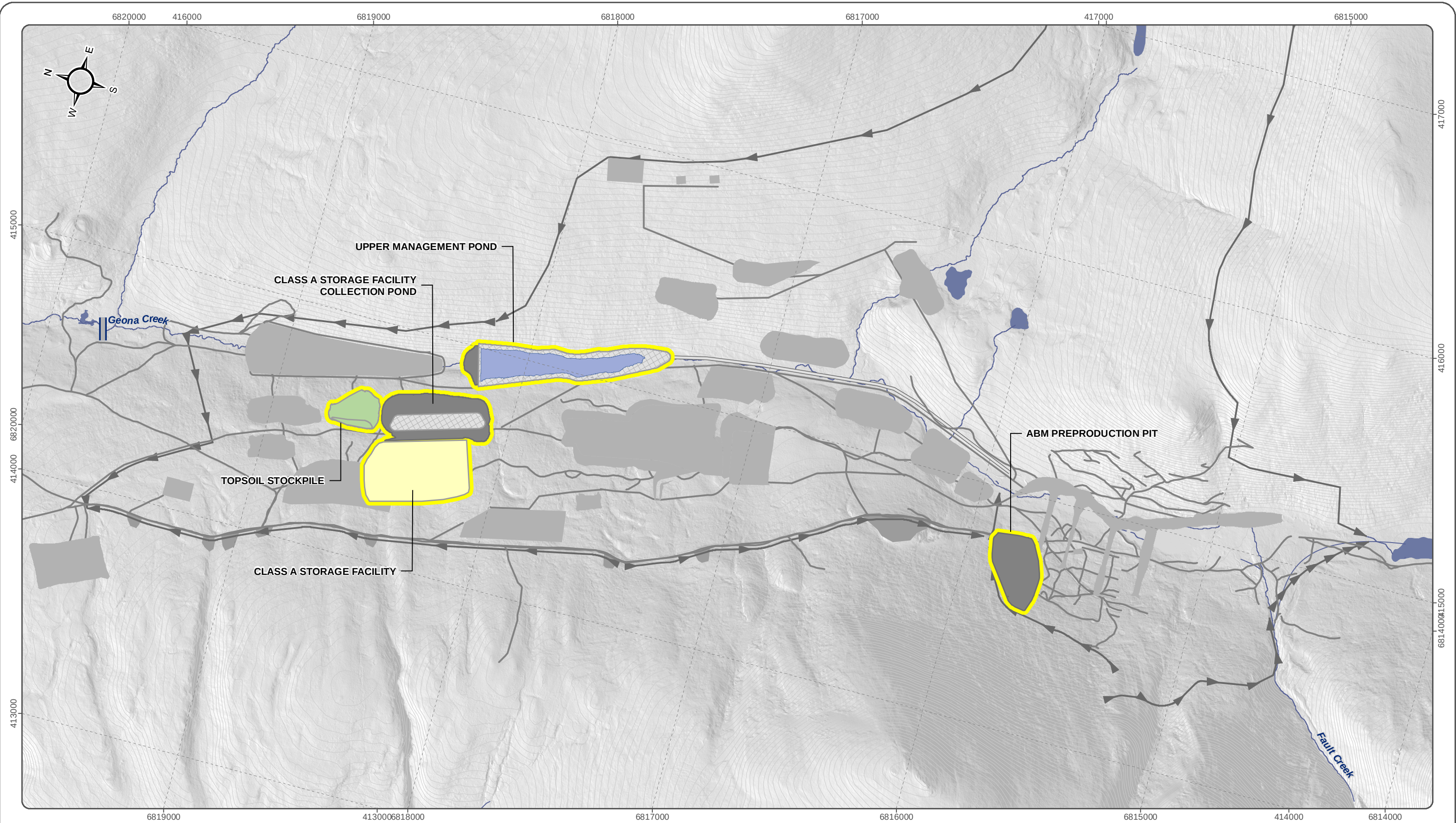
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FIGURE 3-7

PHASE 5 PROJECT DEVELOPMENT

JUNE 2024

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1:15,000 (when printed on 11 x17 inch paper)

0 250 500 750 Metres

- | | | |
|-------------------------------|--|----------------------|
| Features Built during Phase 6 | Liner | Drainage Channel |
| Mine Infrastructure Facility | Topsoil Stockpile | Diversion Channel |
| Pond | WRSA, Class | Mine Road |
| | Mine Infrastructure Built During Previous Phases | Existing Watercourse |
| | | Existing Waterbodies |



KUDZ ZE KAYAH PROJECT

FIGURE 3-8

PHASE 6 PROJECT DEVELOPMENT

JUNE 2024

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3.6 MATERIAL RELEASE SCHEDULE

The estimated material release schedule for the open pit mine is detailed in Table 3-1.

Table 3-1: Open Pit Material Release Schedule

Material	Units	Total *	Year - 2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Ore	million t (Mt)	14	-	0.0	1.8	2.2	1.8	2.1	2.3	1.4	1.5	0.9
Class A Waste	Mt	10	-	0.0	1.1	1.7	1.1	1.4	1.5	0.7	1.2	0.9
Class B Waste	Mt	48	-	0.4	4.8	9.4	9.9	10.0	3.7	4.1	3.7	1.7
Class C Waste	Mt	68	-	4.0	3.7	17.7	20.0	15.2	3.8	2.2	1.4	0.2
Overburden	Mt	14	0.9	1.7	4.3	1.2	1.2	0.6	0.9	3.4	0.0	-
Total	Mt	153	0.9	1	15.6	32.2	33.9	29.3	12.2	11.8	7.7	3.7

* All totals are approximate and have been rounded up

*Total material is 153 Mt

3.7 ORE HANDLING

Ore from ABM Open Pit mining operation will be hauled to the Run of Mine (ROM) pad for stockpiling into different classes of ore for subsequent blending into the Process Plant. The Process Plant Development and Operations Plan (BMC, 2026a) should be referred to for additional information on ore stockpiling. The ROM pad will hold both ore for short term processing and low grade ore that may not be processed until later. The ore stockpiles are situated at the base of the Class B Storage Facility.

Metallurgical domains and ore grades will be used for classification of mined ore into the various ROM ore stockpiles. In certain circumstances discrete stockpiles may be created to manage particular types of ore (for example a pocket of ore high in an element that is considered as a potential impurity in the produced metal concentrate).

Five separate metallurgical domains were identified during feasibility level assessment of the Project representing different mineralogical compositions. At the commencement of ore processing, it is expected that ore from each of these domains will be stockpiled separately to allow selective feed of ore into the processing plant and to allow reconciliation of plant performance to a particular mineralization style. As time progresses and the level of experience in processing the different metallurgical domains increases, it is anticipated that stockpile management will be simplified and different metallurgical domains will be stockpiled together.

Four of the metallurgical domains are sourced from the ABM Zone mineralization, while the fifth domain comprises Krakatoa Zone mineralization. The different metallurgical domains are:

- +1340RL – spatially controlled mineralogical zonation above 1340 m RL, with pyrite dominant over pyrrhotite and lacking a significant magnetite component, and with an elevated level of copper-silver bearing sulphosalt mineralization (primarily tennantite-tetrahedrite);
- MET2-4 – massive sulphide mineralization with pyrrhotite dominant over pyrite and a significant magnetite component;
- MET5-7 – massive sulphide mineralization with pyrite dominant over pyrrhotite and lacking significant magnetite component;
- MET8 – vein/stockwork mineralization with significant silicate gangue component; and
- Krakatoa - mineralization from the Krakatoa Zone, with pyrite dominant over pyrrhotite and lacking a significant magnetite component, and with an elevated level of silver-copper bearing sulphosalt mineralization (primarily freibergite).

The grade control ore model will be the foundation for assigning mined ore to the various ore stockpiles, supplemented by grab sample assays on an as required basis for confirmatory checks. The grade control ore model is a refinement of the life of mine geological model, specifically focussed on the ore planned to be mined over a six to twelve month period and informed by closer spaced infill grade control drilling. This drilling will serve to refine ore and waste boundaries, predicted mined grades and metallurgical domain categorization (or other stockpile classification as may be determined to be appropriate in the future).

The ROM stockpile area will be in use during operations and will be reclaimed when closure is initiated. Additional details are included in the Reclamation and Closure Plan (BMC, 2026j).

Ore will be reclaimed from the stockpiles and fed into the crushing circuit by front end loader. The crushed product will then be transferred to the crushed ore stockpile. The design of the crushing circuit may include a diverter gate to allow material (ore or waste) to be bypassed to a reinforced concrete bunker.

The diverter gate will be used to create a temporary stockpile of ore if an extended period of maintenance of the crushing facility is planned, so that crushed ore can continue to be fed into the grinding mills. In this situation crushed ore will be reclaimed from the concrete bunker and stockpiled. Non-Potentially Acid Generating (Class C) waste rock will also be periodically crushed and stockpiled for production of road base, blast hole stemming and reclamation material.

Provision has been made in the design for discharge from the diverter gate to feed a (future) stacker conveyor for stockpiling crushed ore or waste if conditions warrant following commencement of Operations.

The crushed ore stockpile has been designed to provide live storage capacity with reclaim feeders located in an under-pile tunnel. The live stockpile will be conical in shape with a cover designed to minimize dust generation and to prevent ingress of precipitation.

The crushing circuit will be operated on a dry basis. Dust generation within the crushing circuit will be managed by mechanical ventilation including dust filtration / extraction at strategic locations and will comply with all applicable regulations, specifically 8.26 of the *Workplace Health and Safety Regulations* (Yukon Government, 2022). Water will be applied to ROM ore stockpiles during summer months as required to minimize generation of dust from the ROM stockpile. Management of dust within the Process Plant facility is covered in more detail in the Process Plant Development and Operations Plan (BMC, 2026a). Heating of the Process Plant building is also discussed in this plan.

Ore stockpiled on the ROM pad is anticipated to range between 100,000 and 600,000 tonnes over the life of the mine and will vary with the management of changes to waste stripping requirements over the life of the mine. The footprint of the ROM stockpile will allow for haul trucks to dump their ore loads into segregated piles to allow any ore blending if required.

Low grade ore will be stockpiled on the ROM pad for future blending into the plant. At the end of the mine life any low grade ore remaining will be either fed into the Process Plant or placed on the Class A Storage Facility to enable reclamation and closure of the ROM pad.

4 ASSOCIATED MINE SERVICES AND INFRASTRUCTURE

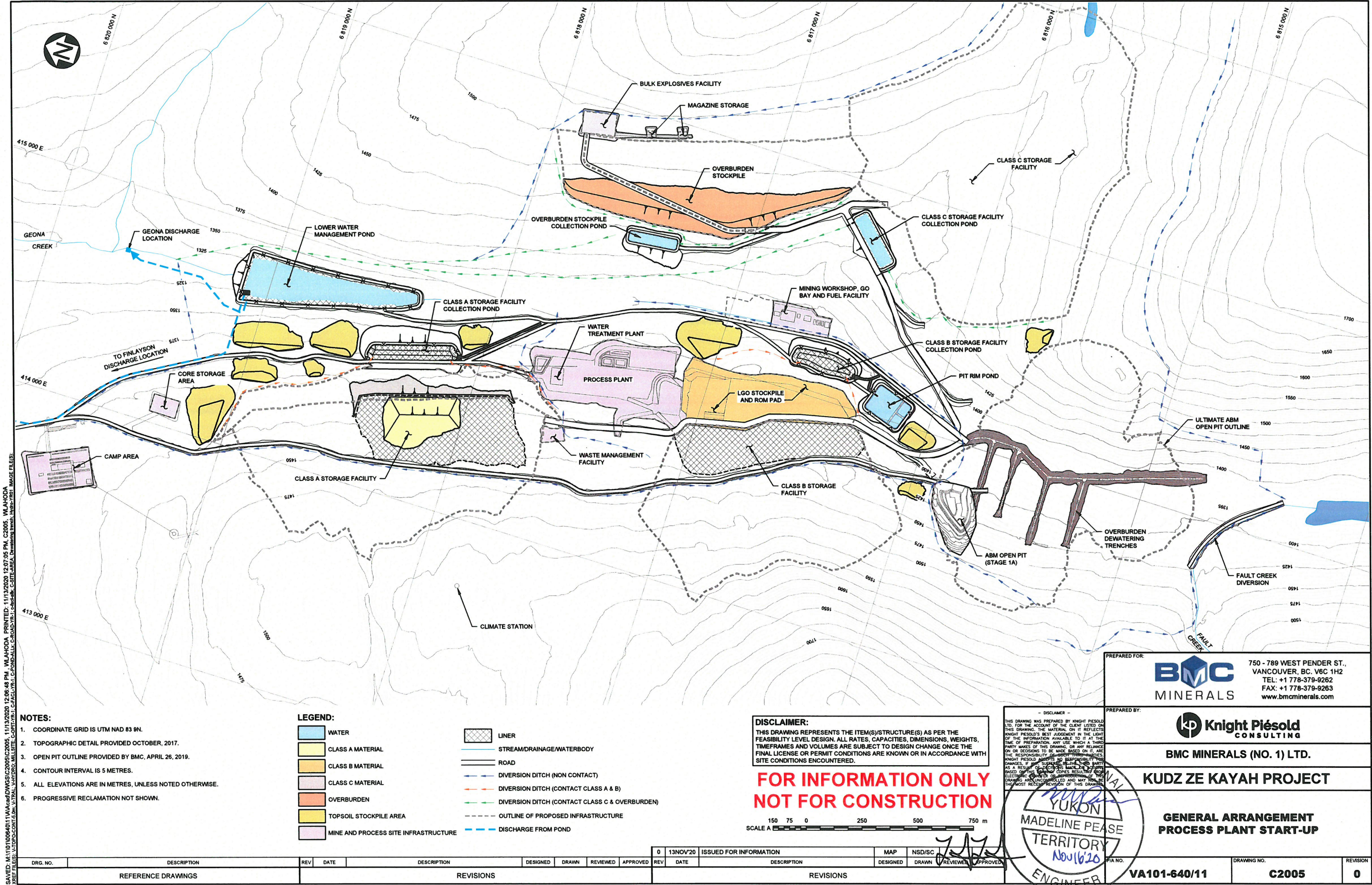
4.1 ANCILLARY INFRASTRUCTURE

Ancillary infrastructure planned for the Project is identified below, and in the Site General Arrangement in Figure 4-1:

- Camp;
- Project offices and mine dry facilities;
- Mining operations centre;
- Mining workshop;
- Fuel storage facility;
- Explosives storage facilities;
- Communication systems;
- Laydown area;
- Mine laboratory; and
- Core storage area.

Other project infrastructure such as water management ponds, access and site roads, Process Plant, water treatment plant, waste storage facilities and the waste management facilities are described in other Plans that form part of the Quartz Mining Licence application and these plans should be referred to for information on this infrastructure.

FIGURE 4-1: GENERAL ARRANGEMENT - PROCESS PLANT START UP



Compressed air for the mine will be required for production drill rigs. Drills will have dedicated on-board compressors to assist with flushing production drill holes. The truck shop will also have small, compressed air units to assist in the service of the mine fleet.

4.1.1 Mine Camp

A camp will be constructed at the northern end of the Project to provide accommodation and messing facilities for the site workforce during construction, operations and closure phases. The camp will have a capacity of 350 people. The camp will consist of modular dorm units, washroom facilities, a kitchen and dining area, and laundry facilities. A camp administration office and recreation room will also be constructed at the camp complex.

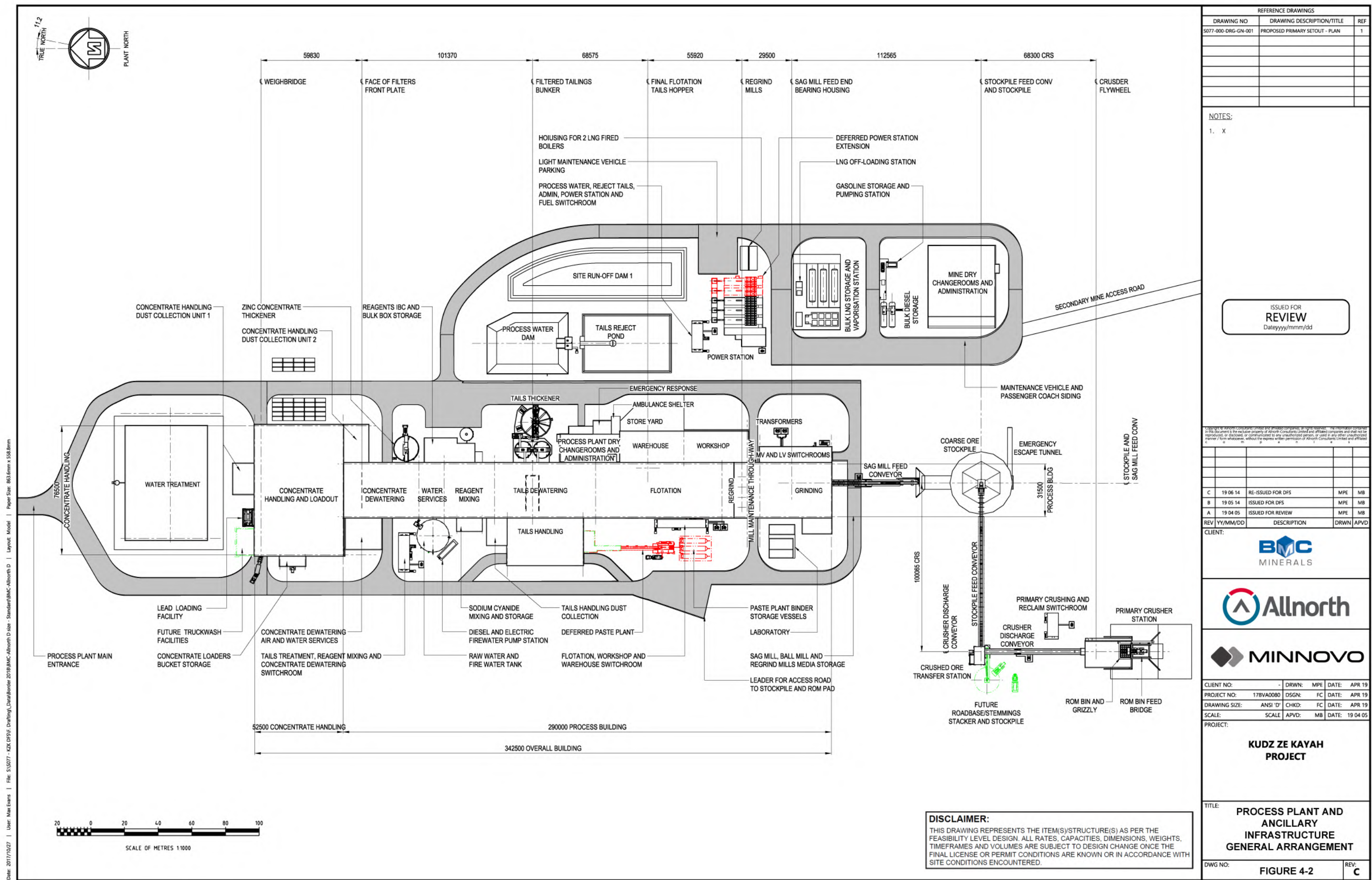
4.1.2 Project Offices and Mine Dry Facilities

Project offices and mine dry facilities will be located in the Process Plant and ancillary infrastructure area of the site (Figure 4-2). Mine administration and processing staff will be located in the Processing and Administration office area, directly adjacent to the Process Plant. Mining management and technical staff will be located in the mine offices, located at the southern end of Figure 4-2. The floor plan for both office complexes will be finalized during detailed design. The detailed design of the mine offices and will also take into account the facilities that will be provided by the open pit mining contractor.

It is currently planned to construct two separate mine dry facilities: one adjacent to the Process Plant for processing and administration staff, and a second one as part of the mine office complex. During detailed design, it may be decided to consolidate the mine dry requirements into a single facility. Mine dry facilities will have separate clean and dirty sides. The mine dry facilities will be compliant with the Workplace Sanitary Amenities Code of Practice (Yukon Workers' Safety and Compensation Board, 2022).

First aid, emergency response and ambulance facilities are planned to be located within the Processing and Administration offices. These facilities, and their compliance with applicable legislation and guidelines are detailed in the Emergency Response and Health and Safety Plan (BMC, 2026k).

Potable water will be supplied from water supply wells and/or surface water and treated to the required standards. Water supply wells will be located at the camp and/or the office complex as necessary to ensure adequate potable water supply. Offsite laboratory analysis of potable water will be conducted on a scheduled basis. In case of an issue with the potable water plant at the Project Offices, water can temporarily be sourced from plant at the camp.



4.1.3 Mine Operations Centre

Infrastructure to support the mining operation will be established as a dedicated Mining Operations Centre, located north of the open pit and adjacent to the Geona Creek Valley Road. A general arrangement of the proposed Mining Operations Centre is shown in Figure 4-3. The Centre will be expanded later for the underground mining operation.

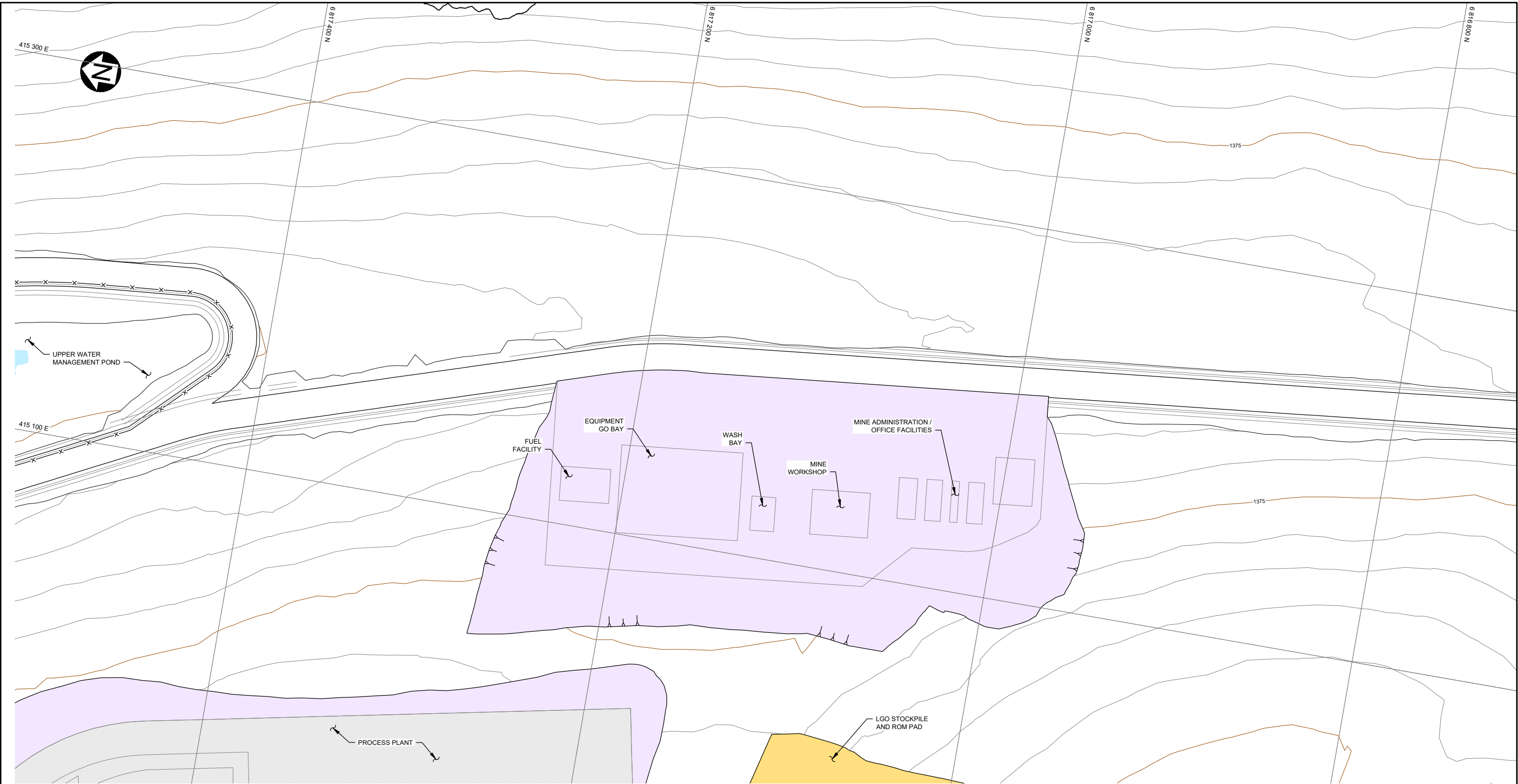
The Mining Operations Centre is anticipated to include the following, which will be finalized during detailed design:

- Contractor / client offices;
- Crew room;
- Wash car;
- Mine dry;
- Drill/blast/warehouse;
- Mine workshop facility;
- Truck wash bay;
- Fuel storage facilities; and
- Equipment ready line for pit equipment.

The site will be graded to a central location to allow collection and management of surface runoff from within the Mining Operations Centre area. Sediment traps and hydrocarbon capture facilities will be included in the detailed design.

Power for the Centre may be provided by a stand alone generator in the initial years of the operation until the full Power Plant capacity is installed.

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KUDZ ZE KAYAH PROJECT

PROPOSED MINING OPERATIONS CENTRE
GENERAL ARRANGEMENT



P/A NO. VA101-640/11
REF NO. VA24-01180

FIGURE 4-3

REV A

4.1.4 Explosives and Magazine Storage Facilities

An explosives storage area will be provided to the explosive contractor. Once a contractor is selected, the explosive contractor will install bulk explosive (emulsion and/or ANFO) storage tanks, emulsion plant and associated facilities to store and provide explosives and all other related blasting products such as detonators and packaged explosives to the mining operations. The facility will include magazines for detonators and packaged explosives installed in-line with regulatory requirements (Figure 4-4). Additional details are included in Appendix C of the Hazardous Materials Management Plan (BMC, 2026l).

The control and use of explosives within Canada and Yukon is regulated by federal and territorial acts and regulations. The Project will implement operational policies and procedures that meet or exceed the required acts and regulations. Table 4-1 lists the applicable federal and territorial acts, regulations, and guidelines applicable to the management of explosives at the Project.

Table 4-1: Applicable Federal and Yukon Legislation for Explosives

Acts	Regulations	Guidelines
Federal		
<i>Fisheries Act</i> (Government of Canada, 2019a)	<i>Metal and Diamond Mining Effluent Regulations</i> (Government of Canada, 2019b)	Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters
<i>Explosives Act</i> (RSC 1985 c.E-17) (Government of Canada, 2015)	<i>Explosives Regulations</i> (Government of Canada, 2019c)	
<i>Transportation of Dangerous Goods Act</i> (Government of Canada, 2019d)	<i>Transportation of Dangerous Goods Regulations</i> (Government of Canada, 2019e)	
Territorial		
<i>Worker's Health and Safety Act</i> (Yukon Government, 2021)	<i>Workplace Health and Safety Regulations</i> (Yukon Government, 2022)	
<i>Dangerous Goods Transportation Act</i> (Yukon Government, 2013)	<i>Dangerous Goods Transportation Regulations</i> (Yukon Government, 1995)	

As detailed in the Hazardous Materials Management Plan (BMC, 2026l), various permits are required for explosives use; for transportation, storage, manufacture and usage. A brief summary of the permits and licences required are listed below:

- Manufacturing and Storage Licence – Required under the *Explosives Act* (Government of Canada, 2015);
- Permit for Use of Explosives – Required under the *Explosives Act* (Government of Canada, 2015);
- Explosives Magazine Permit – Required under the *Explosives Act* (Government of Canada, 2015);
- Explosives Magazine Permit – Required under the *Workplace Health and Safety Regulations* (Yukon Government, 2022);
- Explosive Transportation Permits – Required under the *Explosives Act* (Government of Canada, 2015); and

- Blasting Permit – Required under the *Workplace Health and Safety Regulations* (Yukon Government, 2022).

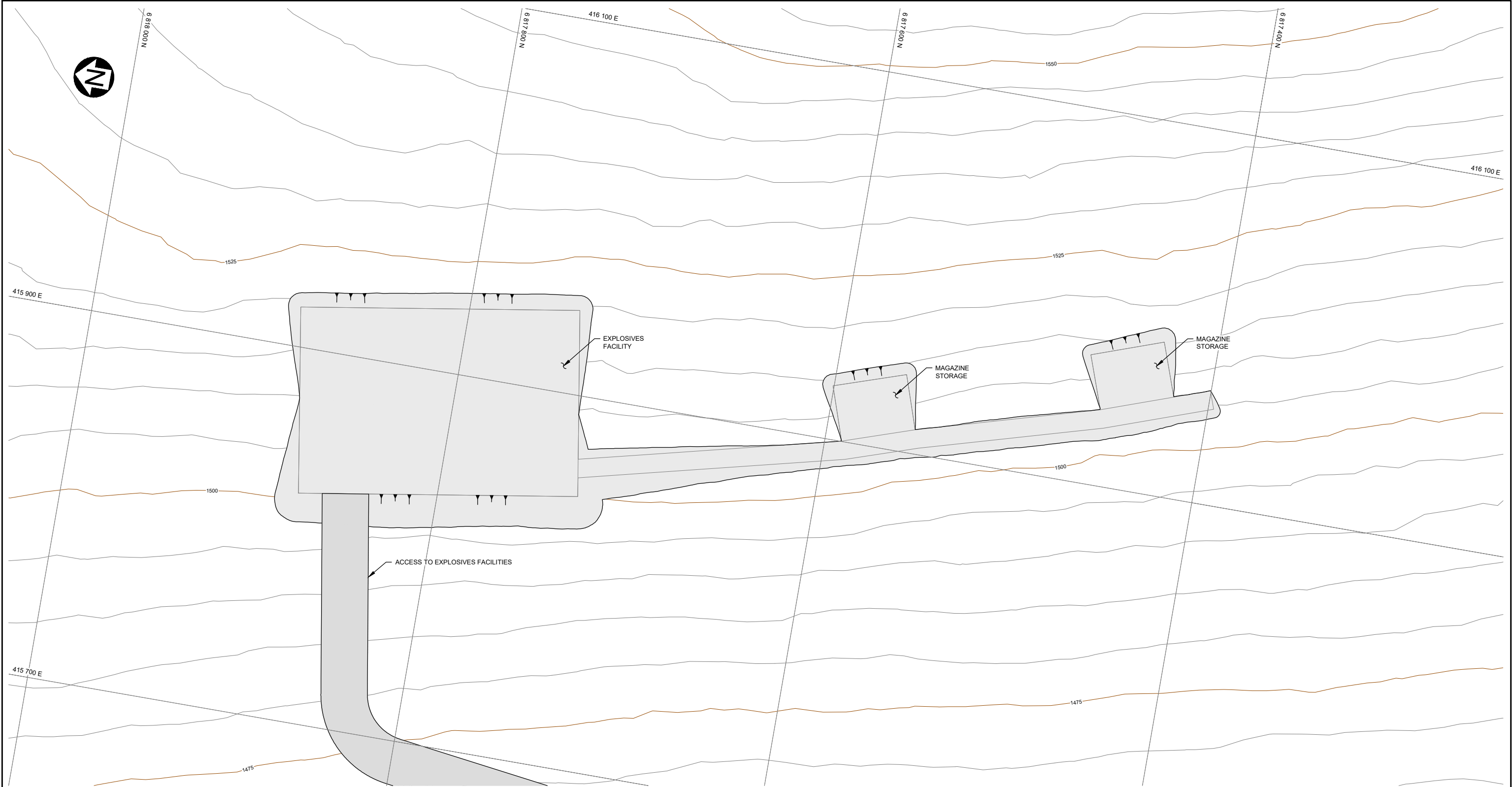
BMC will contract an explosives company to manage explosives use and obtain the above listed permits on BMC's behalf. The contract, and all required plans and procedures, will be finalized prior to explosive usage on the Project.

Bulk explosives and blasting agents will be utilized for all mining activities and will be stored and handled on the Site as per the requirements listed above.

Explosives will be stored in secure, fenced facilities separate from the main activity areas, adjacent to the Overburden Stockpile (Figure 4-1). Bulk explosives for open pit blasting purposes will be stored within the bulk explosives facility. A packaged explosive magazine will store cast boosters and all explosive products required for open pit operations. A separate detonator magazine will be available for storage of all detonators.

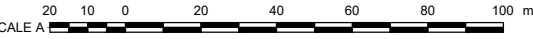
Blast designs will be produced by suitably qualified personnel. Specific safety protocols will be developed and strictly followed during blasting operations. The applicable management plans related to the safe storing and handling of explosives are in the Hazardous Materials Management Plan (BMC, 2026l) (which includes an Explosives Management Plan) and Spill Contingency Plan (BMC, 2026m).

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EXPLOSIVES AND MAGAZINE
STORAGE FACILITY



P/A NO.
VA101-640/11

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FIGURE 4-4

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4.1.5 Communication Systems

Site communication (voice and data) will be facilitated through terrestrial and/or satellite data systems.

Telephone, data, and facsimile services will be integrated through major site and office buildings. Internet and television will be provided throughout the camp.

In addition to phone/data systems, radio communication will also be used, with separate channels available for various functions such as emergency, access road, mining, processing, and administration functions.

4.1.6 Laydown Area

A laydown area will be established early in the construction schedule to facilitate receipt and storage of goods until required for construction (Figure 3-1). The laydown area will be constructed within the ultimate footprint of the Class A Storage Facility and will be covered over by the Class A Storage Facility during operations as the facility expands. By this time, the laydown area will no longer be required.

4.1.7 Mine Laboratories

A mine laboratory will be constructed in the Process Plant and ancillary infrastructure area of the site (Figure 4-2) for day-to-day analytical requirements for mine grade control, metallurgical investigation work, Process Plant on-line sample analyzer checks; concentrate product assaying and waste rock acid generation potential.

A small laboratory for water chemistry analysis will be constructed within the footprint of the Water Treatment Plant. It will be used for day-to-day analysis for control and operation of the Water Treatment Plant as well as analysis of environmental water samples.

Exploration and other environmental analytical testwork will be conducted at offsite laboratories.

The floor plan for the laboratories will be finalized during detailed design.

4.1.8 Core Storage Area

A core storage facility will be established at the northern end of the project area, as indicated in Figure 4-1. It will provide for covered storage of drill core and work areas for core logging.

4.2 WASTE ROCK, ORE, AND TAILINGS MANAGEMENT

As noted in Section 3.7, ore and low grade ore will be placed on the ROM pad. Metallurgical domains and ore grades will be used for classification of mined ore into the various ROM ore stockpiles.

Waste rock will be classified as either Class A, B, or C, based on its acid drainage and metal leaching potential over short- and long-term periods:

- Class A waste rock: strongly Potentially Acid Generating (PAG) waste rock, with an associated high potential for metal leaching in the near term (i.e., during the life of the mining operation);
- Class B waste rock: weakly PAG waste rock with a metal leaching potential, occurring over the longer term but unlikely during the life of the mining operations, that is lower than that of Class A; and
- Class C waste rock: Non-PAG waste rock with low potential for metal leaching.

Each class of waste rock removed from the ABM Open Pit, will be placed in a separate waste rock storage facility, designed to fulfil closure requirements. Topsoil and organic matter will be stripped and stockpiled in designated topsoil stockpiles located throughout the Project site. Suitable overburden stripped from the open pit area will be placed in the Overburden Stockpile for storage and reuse, or in temporary stockpiles adjacent to the waste rock storage facilities until used for closure cover. Stockpiles will be oriented so that the length is parallel with prevailing winds where practicable. The design, identification and management of Class B and C waste rock and overburden is provided in more detail in the Waste Rock and Overburden Management Plan (BMC, 2026c).

Management of tailings and Class A waste rock is detailed in the Tailings Management Plan (BMC, 2026b). The Process Plant will produce filtered tailings that will be transferred to the Class A Storage Facility and co-placed with Class A waste rock for long term storage.

4.3 FUEL STORAGE

A number of fuel sources will be required for the Project including LNG, diesel, gasoline and propane, with LNG and diesel planned as the primary fuel sources as summarized in Table 4-2.

Table 4-2: Summary of Fuel Storage and Distribution

Fuel Type	Storage Area	Estimated Volume
LNG	Power Plant Facility	300 m ³
Diesel - Power Generation	Power Plant Facility	227,000 litres
Diesel - Mining Operations	Mine Operations Centre	400,000 litres
Gasoline	Process Plant Facility	30,000 litres
Propane	Camp	40,000 litres
Aviation Fuel	Adjacent to the helipad at camp	Nominally 5,000 litres
Waste Oil	Storage tank by Mine Workshop	10,000 litres

The Power Plant generators may be dual fuel capable of operating with diesel or natural gas fuels. Liquefied natural gas will be stored in vacuum insulated tanks. Tanks will be located within an engineered containment berm and sized to hold 110% of the tank volume (BMC, 2026n).

Diesel for power generation will be stored in double walled diesel tanks. Fuel storage tanks will be appropriately protected from damage by earthen bunds, bollards, or other suitable measures.

The general arrangements for the LNG and diesel storage facilities for power generation are shown in Figure 4-5.

A double walled tank will be maintained on site for ancillary gasoline use, adjacent to the Power Plant fuel storage tanks. The gasoline tank will be appropriately protected from damage by bunds, bollards, or other suitable measures.

Diesel for mining operations will be stored in a separate bulk fuel Storage Facility located adjacent to the mine workshop (Figure 4-6), using double walled diesel tanks. Spill trays will be installed under all refuelling positions, and the fuel storage tanks will be appropriately protected from damage by earthen bunds, bollards, or other suitable measures.

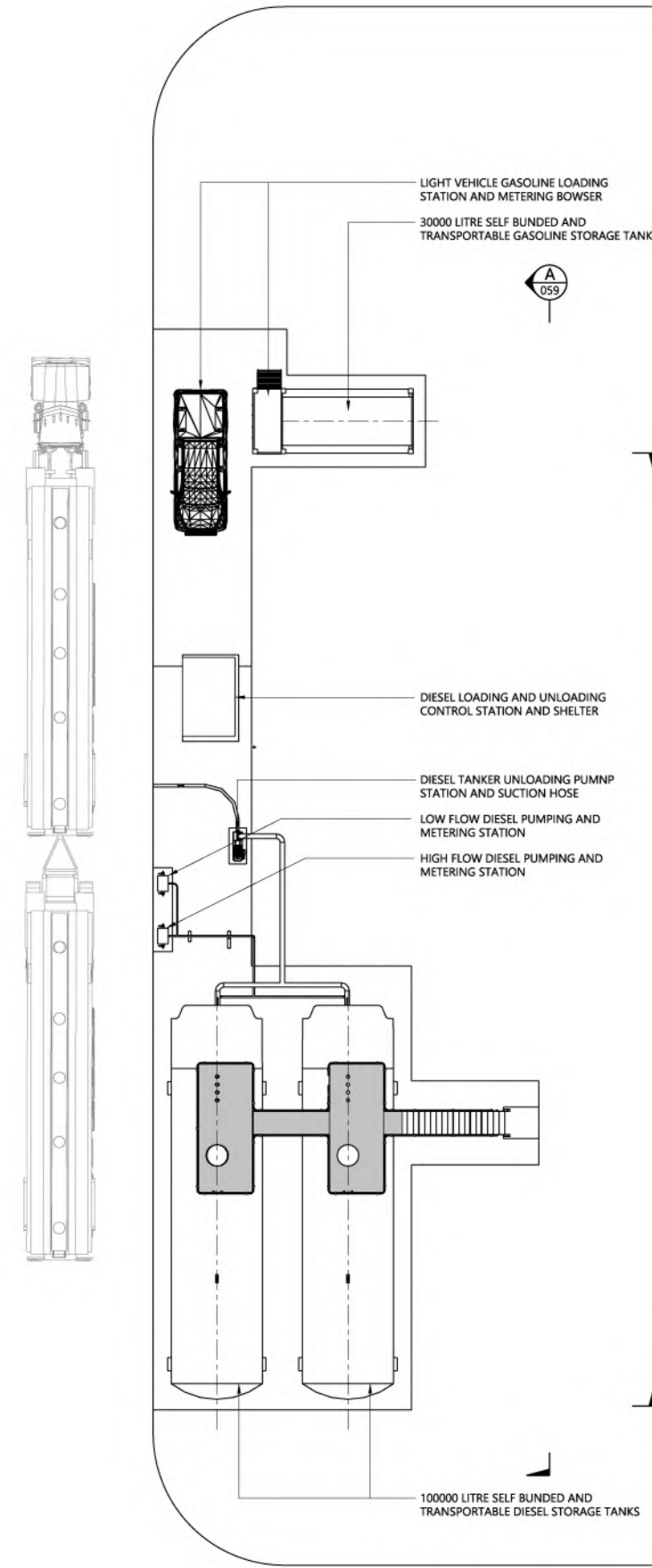
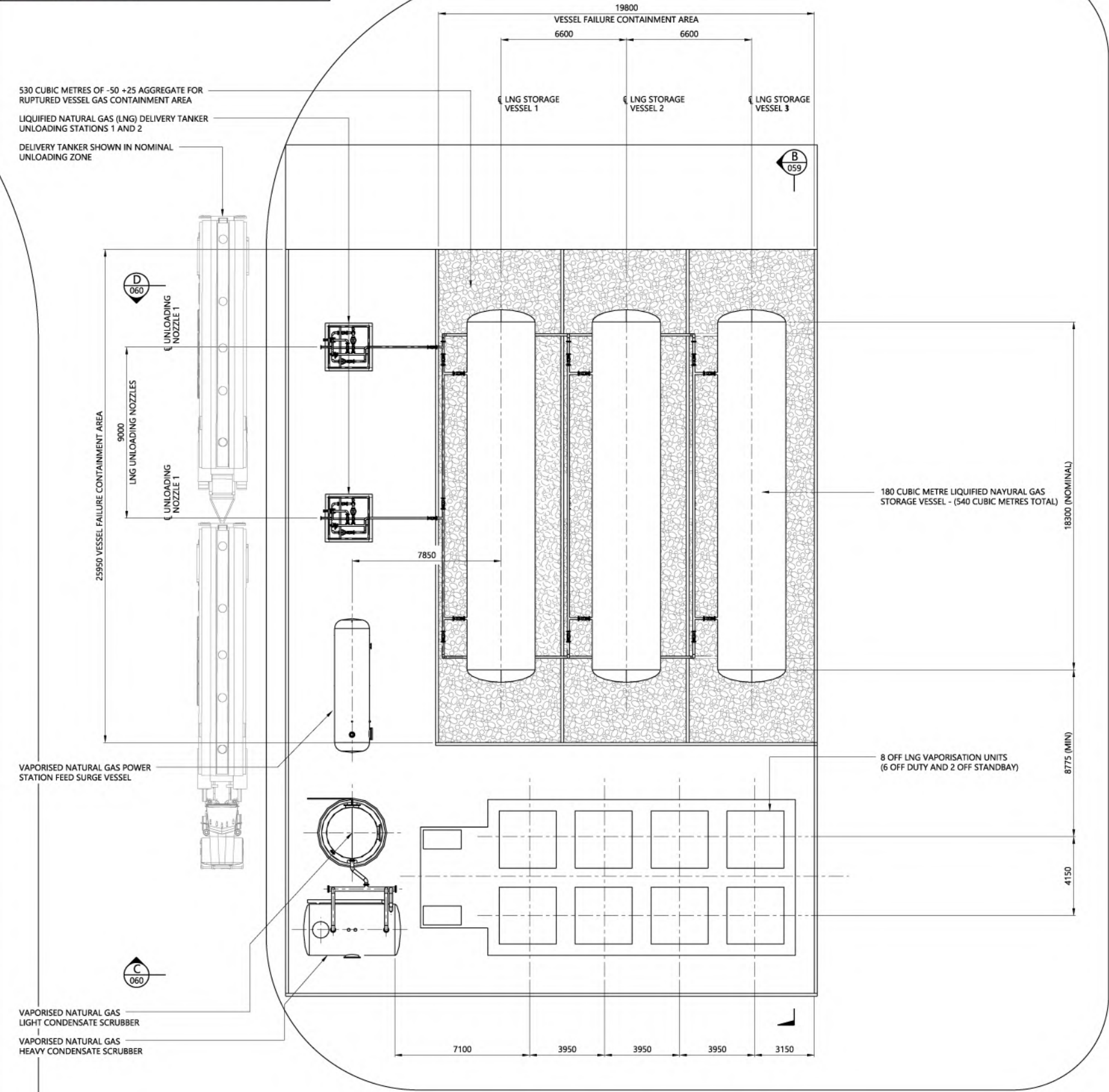
A small supply of aviation fuel will be maintained on site for exploration activities requiring helicopter support. It will also serve as a fuel supply for emergency helicopter evacuation should the need arise. Aviation fuel will be stored adjacent to the helipad, at camp, in a single fuel tank within a lined containment berm.

Propane tanks for camp heating will be located adjacent to the camp.

A waste oil storage tank will be located at the mine workshop with the waste oil to be used as a fuel source for a waste oil burner to warm the workshop in winter months.

Other management plans that are relevant to the safe use, handling and storage of fuels, or management of a fuel spill are the Hazardous Materials Management Plan (BMC, 2026l), Spill Contingency Plan (BMC, 2026f) and the Emergency Response and Health and Safety Plan (BMC, 2026k).

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REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
S077-000-DRG-GN-001	PROPOSED PRIMARY SETOUT - PLAN	1

- NOTES**
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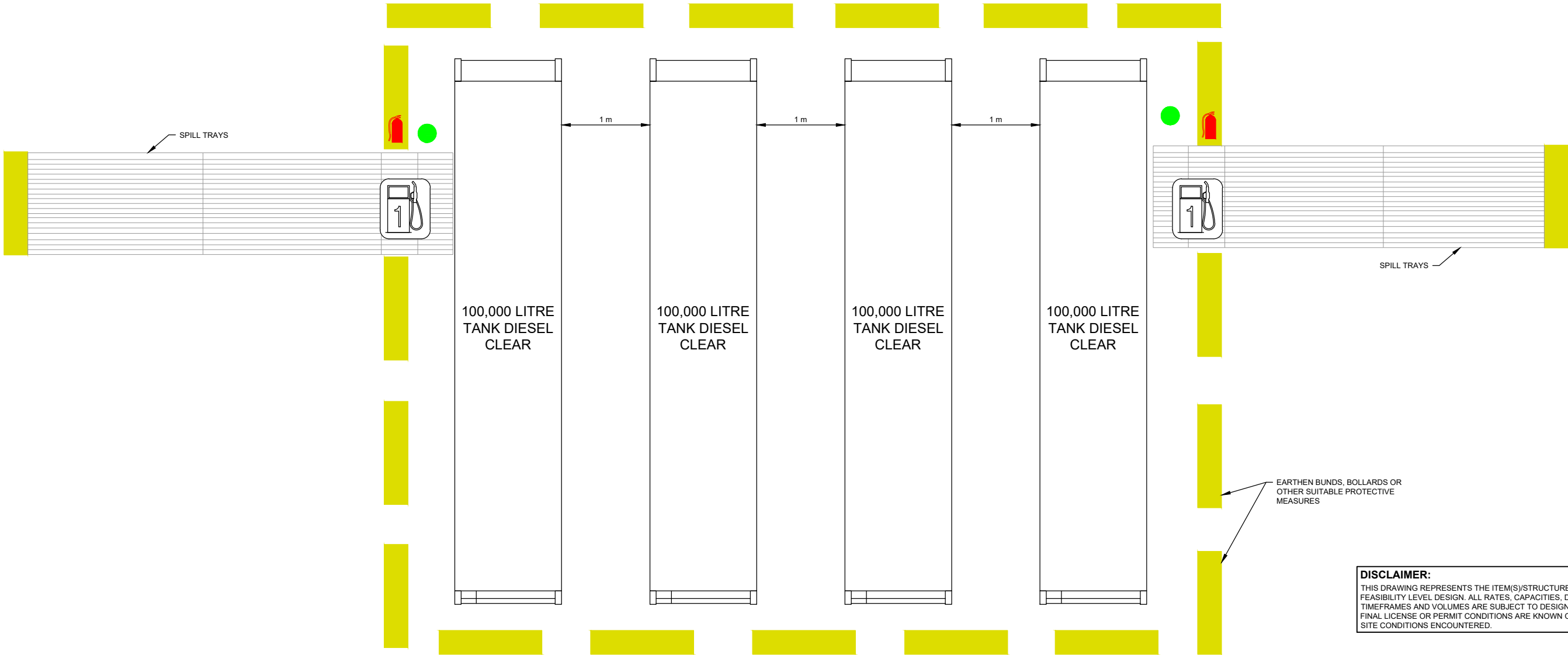
PROJECT:
**KUDZ ZE KAYAH PROJECT
DEFINITIVE FEASIBILITY STUDY**

TITLE:
**BULK FUEL STORAGE
GENERAL ARRANGEMENT
PLAN**

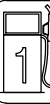
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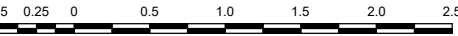


LEGEND:

-  FIRE EXTINGUISHER
-  BIN
-  EARTHEN BUNDS, BOLLARDS OR OTHER SUITABLE PROTECTIVE MEASURES
-  DIESEL PUMP

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FIGURE 4-6

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5 OPEN PIT MINING DESIGN AND METHODS

5.1 MINE DESIGN

The ABM Open Pit is currently planned (subject to final optimization) to be mined in a number of stages to manage waste stripping requirements. The ABM Zone is planned to be mined in four stages while the Krakatoa Zone is planned to be mined in a single stage. The planned interim phase designs are shown in Figure 5-1, Figure 5-2, Figure 5-3, Figure 5-4, and Figure 5-5. Wall and bench design parameters are detailed in Table 2-8.

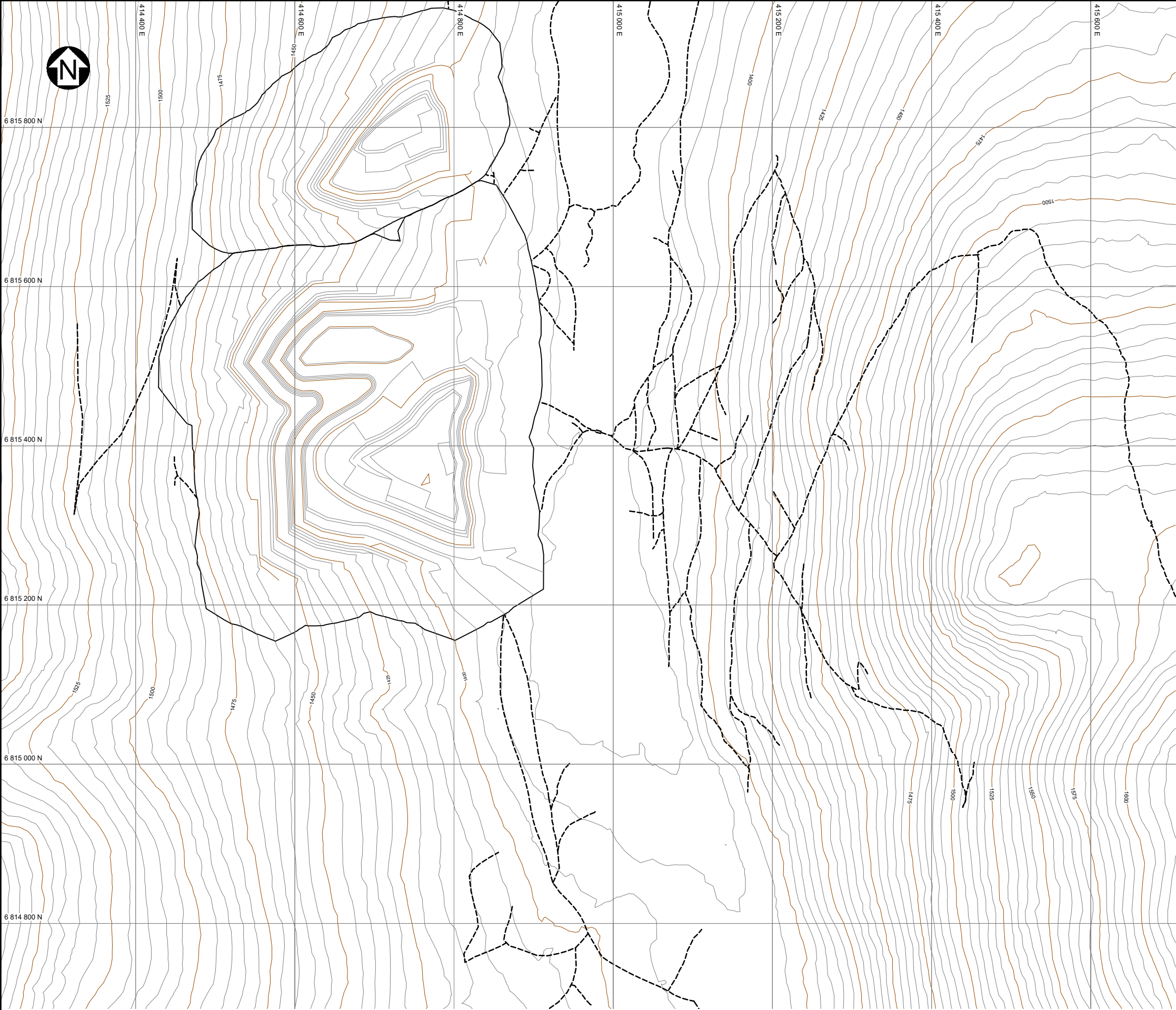
Due to the typically broad zones of mineralization, it is expected that the operational bench height will likely be ten metres. Final bench heights of ore and waste will be determined through drill and blast optimizations once operations commence.

The final pit floor of the ABM Zone portion of the pit is currently designed (subject to final optimization) to be at 1,220 masl, approximately 160 m below the Geona Creek valley floor. The pit walls will be higher on the western and eastern sides of the pit, progressing up the valley slopes and will be approximately 293 m and 313 m high, respectively. The final pit floor of the Krakatoa Zone portion of the pit is planned to be 126 m below the Geona Creek valley floor, with the western and eastern sides of the pit being approximately 162 m and 190 m high, respectively.

Mining of open pit stages 1A and 1B have been planned to commence on the western slope of the Geona Creek valley as a precautionary approach should the overburden at the bottom of the valley not be sufficiently dewatered for initial mining activity. As dewatering of the overburden progresses, mining of Stage 1C will be initiated. Should overburden dewatering progress faster than expected, Stages 1B and 1C may be combined into a single phase of development.

Stage 1A and 1B have been designed to produce overburden and Class C (non-PAG) rock for the construction of the site infrastructure during the preproduction period. Access roads to the open pit are shown in Figure 5-6. The main access road to the open pit approaches from the north, along the valley floor. Haul roads for transportation of ore and waste to their respective end destinations are linked from this main access road. A service road will be constructed around the perimeter of the pit for the purposes of monitoring and access.

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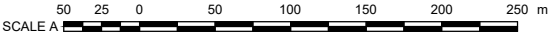
NOTES:

- COORDINATE GRID IS UTM NAD 83 9N.
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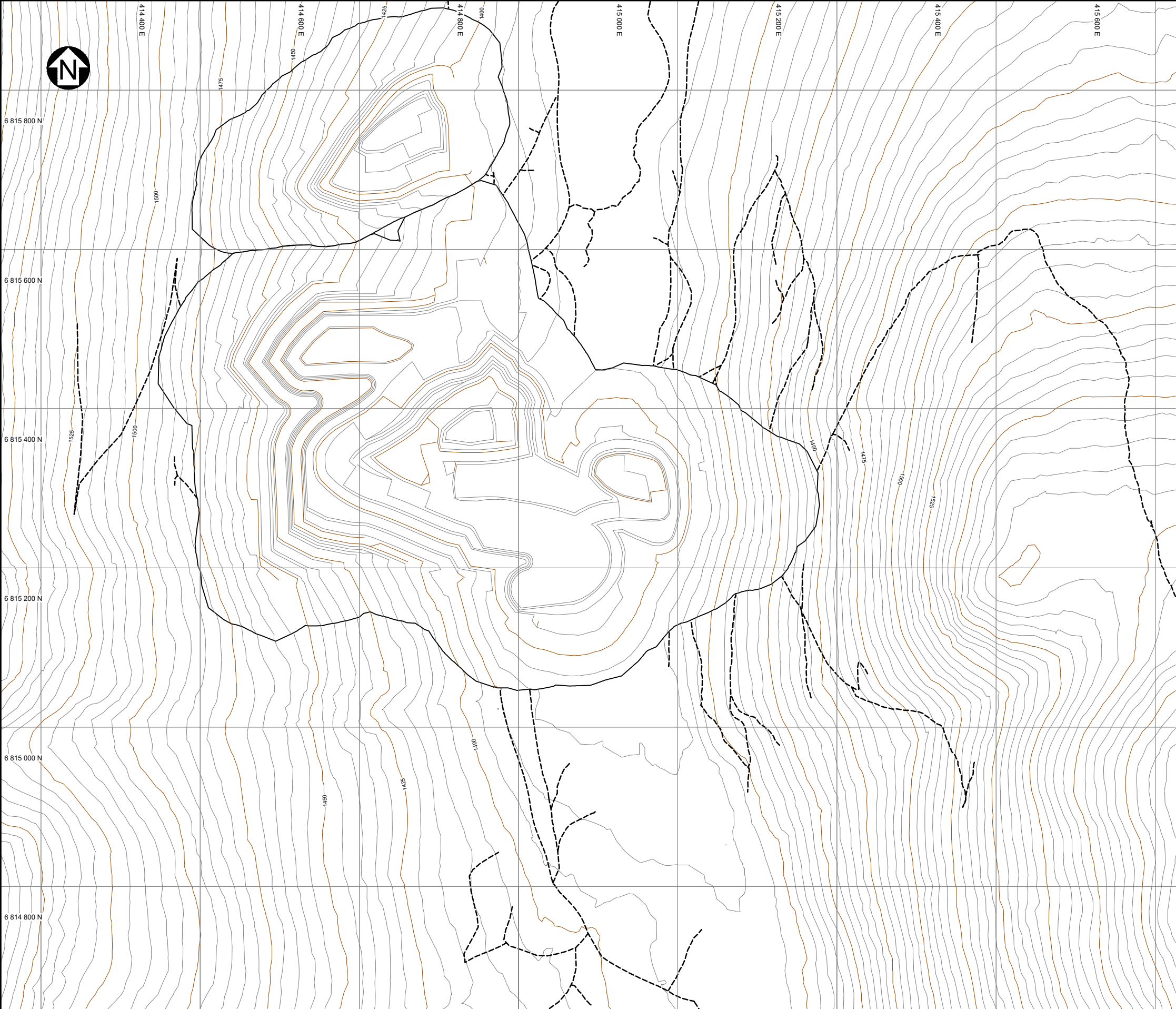
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PLANNED STAGE 1A AND 1B ABM OPEN PIT DESIGN			
		P/A NO. VA101-640/11	REF NO. 18
		FIGURE 5-1	REV A

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LEGEND:

- FACILITY OUTLINE
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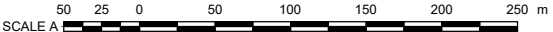
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ABM OPEN PIT DESIGN**



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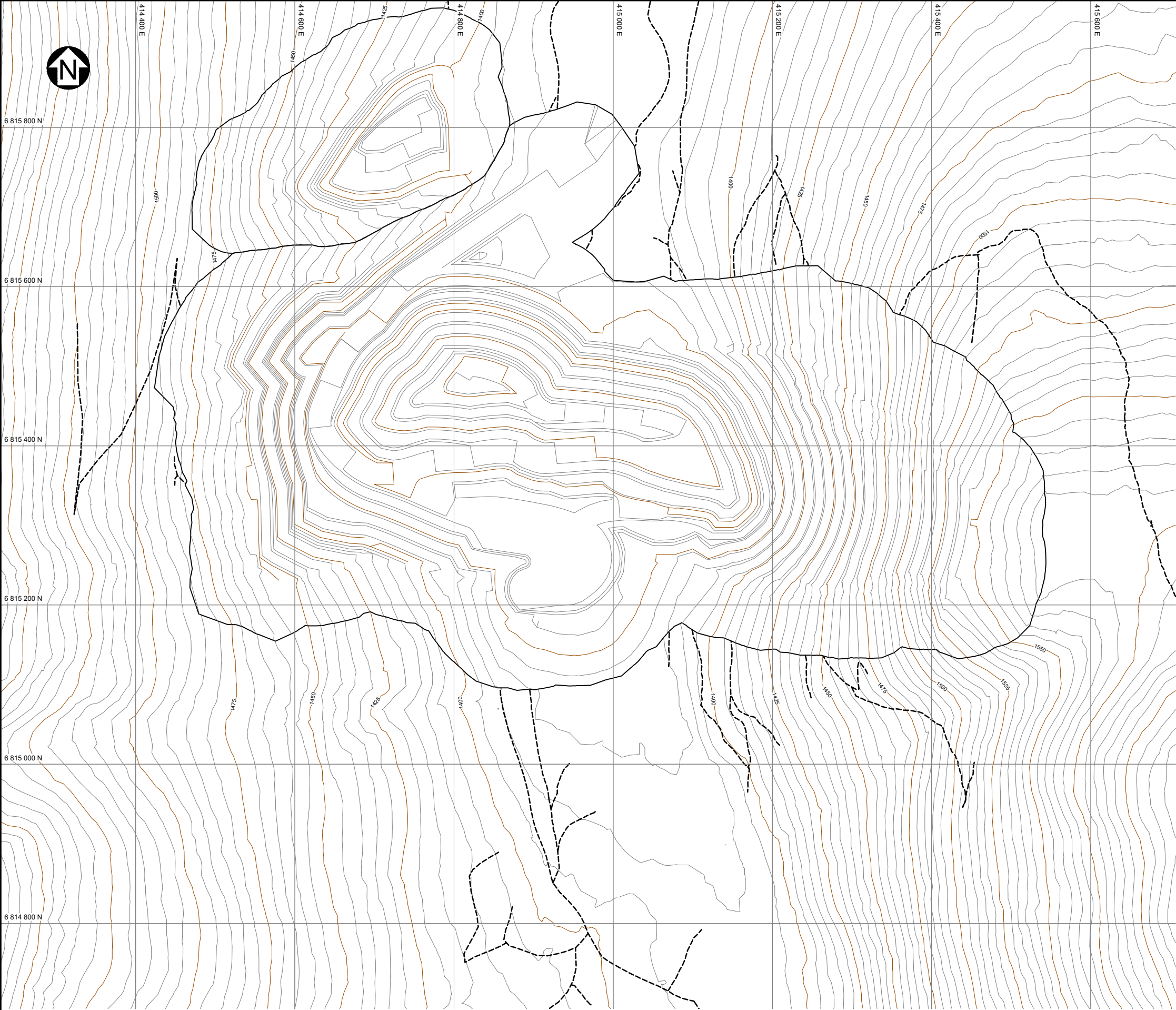
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FIGURE 5-2

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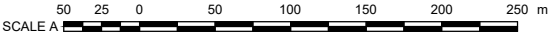
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KUDZ ZE KAYAH PROJECT

PLANNED STAGE 2
ABM OPEN PIT DESIGN



P/A NO.
VA101-640/11

REF NO.
VA24-01129

FIGURE 5-3

REV
B



- FACILITY OUTLINE
- - - - - EXISTING ACCESS ROAD / TRAIL

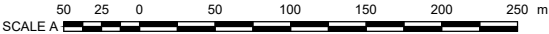
NOTES:

1. COORDINATE GRID IS UTM NAD 83 9N.
2. TOPOGRAPHIC DETAIL PROVIDED OCTOBER, 2017.
3. OPEN PIT OUTLINE PROVIDED BY BMC AUGUST 21, 2020.
4. CONTOUR INTERVAL IS 5 METRES.
5. ALL ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.

DISCLAIMER:

THIS DRAWING REPRESENTS THE ITEM(S)/STRUCTURE(S) AS PER THE FEASIBILITY LEVEL DESIGN. ALL RATES, CAPACITIES, DIMENSIONS, WEIGHTS, TIMEFRAMES AND VOLUMES ARE SUBJECT TO DESIGN CHANGE ONCE THE FINAL LICENSE OR PERMIT CONDITIONS ARE KNOWN OR IN ACCORDANCE WITH SITE CONDITIONS ENCOUNTERED.

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PLANNED STAGE 3 ABM OPEN PIT DESIGN



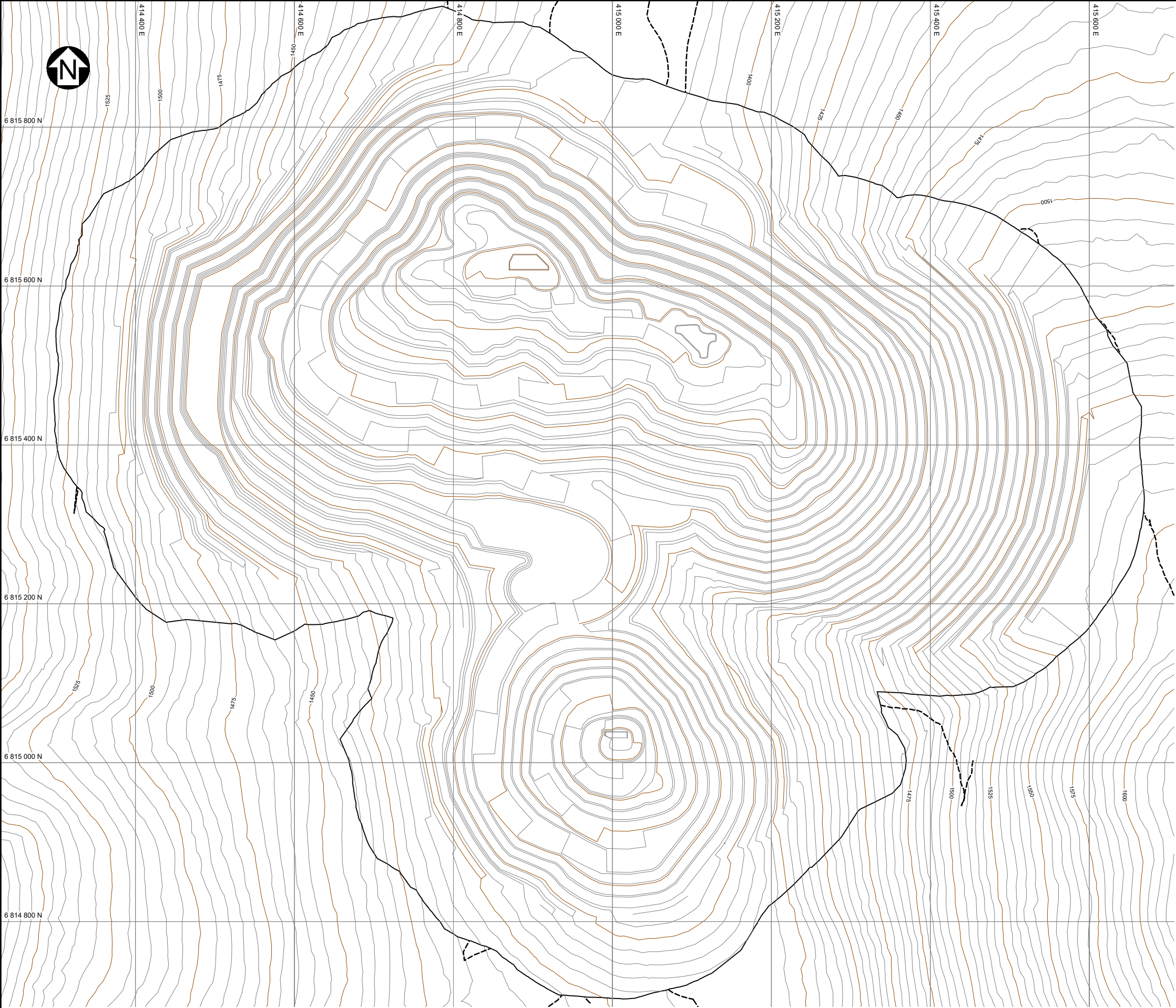
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WA24-01129

FIGURE 5-4

10

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LEGEND:

- FACILITY OUTLINE
- - - EXISTING ACCESS ROAD / TRAIL

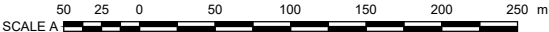
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- COORDINATE GRID IS UTM NAD 83 9N.
- TOPOGRAPHIC DETAIL PROVIDED OCTOBER, 2017.
- OPEN PIT OUTLINE PROVIDED BY BMC AUGUST 21, 2020.
- CONTOUR INTERVAL IS 5 METRES.
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KUDZ ZE KAYAH PROJECT

**PLANNED STAGE 4
ABM OPEN PIT DESIGN**



P/A NO.
VA101-640/11

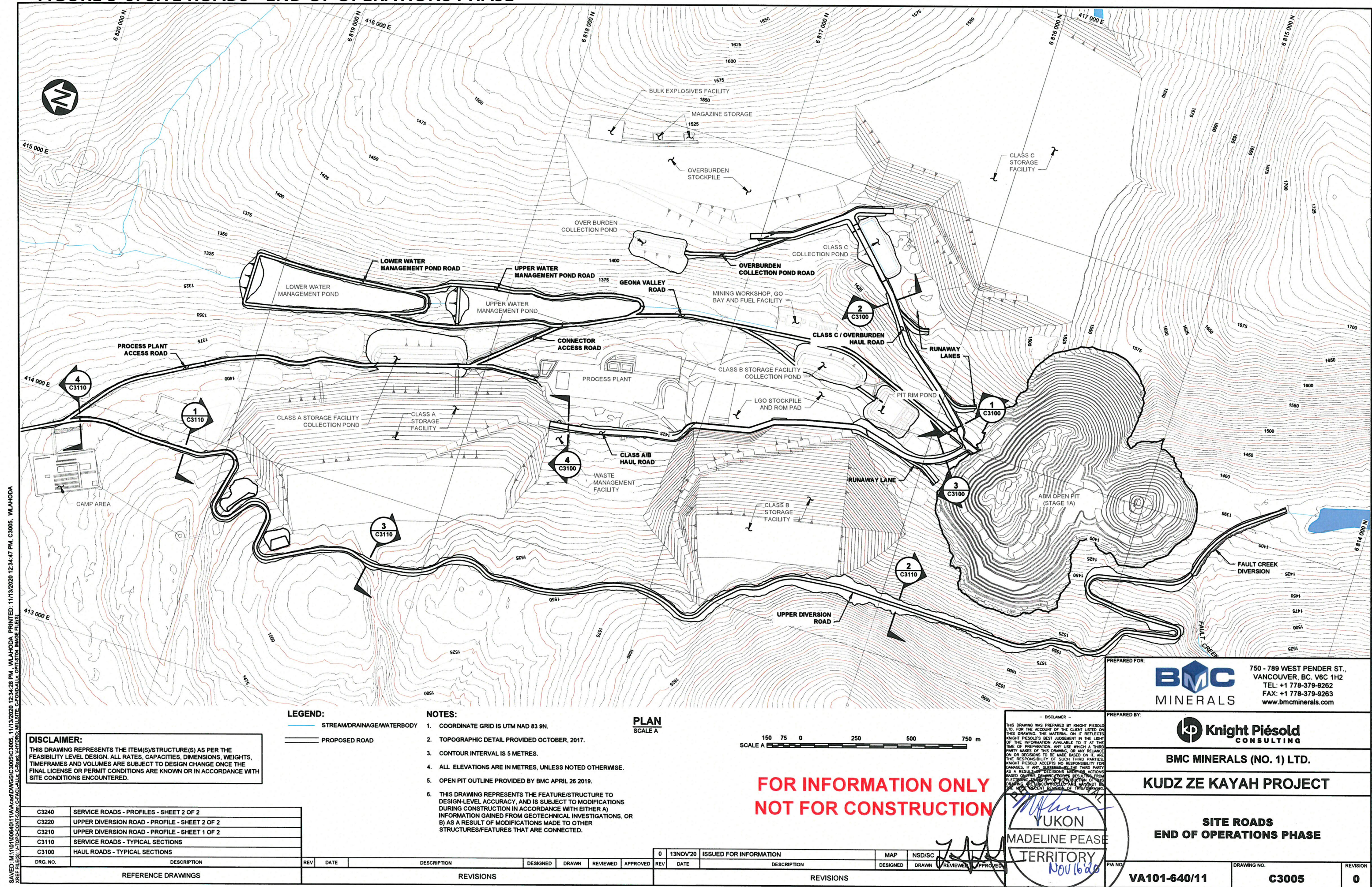
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FIGURE 5-5

REV
A

A	01SEP'20	ISSUED WITH REPORT	GLS	SC	GLS
REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED

FIGURE 5-6: SITE ROADS - END OF OPERATIONS PHASE



5.1.1 Wall Design and Overburden Stability

The open pit wall design parameters are detailed in Table 2-8 and Table 2-9. The Factors of Safety (static and seismic) for all geotechnical domains are detailed in Table 2-10, which assessed rock and overburden stability. As noted in Section 5.1 the operational bench height is anticipated to be 10 m. The majority of the geotechnical design domain provides for double benching to 20 m. Final pit walls will employ trim blasting methods to minimize wall damage.

5.1.2 Ground Movement Monitoring

The open pit will be monitored following the procedures described in the Ground Control Management Plan (GCMP). The initial GCMP will be developed during detailed design in conformance with industry standards of practice, as summarized in Read and Stacey (2009), and described in the Environmental Monitoring, Surveillance and Reporting Plan (BMC, 2026o).

A slope monitoring program will be implemented at the start of mining to monitor and minimize the adverse effects of instability on slopes. The monitoring program will include tension crack mapping, regular pit slope surveys and groundwater monitoring.

Visual inspections of active production areas will be conducted on a regular basis by suitably qualified personnel. Geotechnical conditions will be entered into the Ground Control Logbook and reviewed by shift supervisors to maintain awareness of geotechnical conditions.

A network of survey prisms will be established around the open pit for monitoring of pit wall movement. Approximately 20 to 40 prisms will be installed around the pit perimeter, including three backsights (control points), during the mine start-up to establish the initial survey monitoring system. These initial prisms will be monitored with a single theodolite surveying from two or three locations around the pit. The selected monitoring locations will be stable with good visibility of the prisms. During the progressive development and expansion of the pit, additional prisms will be installed as required to appropriately cover the open pit mine, with higher prism density expected in the eastern wall of the pit. Slope radar may be implemented for specific portions of the pit on an as required basis if continuous monitoring is assessed as being required.

Surveys will be completed on a regular basis and recorded in a format to track progressive movement, as defined in the Environmental Monitoring, Surveillance and Reporting Plan (BMC, 2026o). Additional monitoring and measurements may be taken as required for specific reasons such as after heavy rainfall events. Should an area of the pit be observed to have increasing movement, more regular surveys may be established to improve availability of monitoring data.

Groundwater monitoring will be completed to verify that the proposed groundwater dewatering program is fulfilling its intended purpose. Additional dewatering measures, including wall draining holes, will be implemented as required.

Ongoing geotechnical assessment of the rock mass environment will be conducted and may include rock quality and structural mapping to identify major structures and changes to ground conditions.

5.1.3 Blasting and Wall Control

Three different patterns are expected to be used for open pit blasting (Table 5-1), with parameters subject to adjustment as experience is gained in the field.

Table 5-1: Blast Design Parameters

Blast Parameter	Unit	Pattern 1	Pattern 2	Pattern 3
Rock Type	-	Ore, Select Waste	Class A Waste	All Other Bulk Waste
Hole Diameter	mm	102	165	165
Powder Factor	kg/m ³	0.62	0.80	0.42
Product Density	g/cm ³	1.2	1.2	1.2
Unit Charge Weight	kg/m	9.8	25.7	25.7
Bench Height	m	5	10	10
Stemming	m	2	3.3	3.3
Subdrill	m	0.7	1.2	1.2
Charge Weight per Hole	kg/hole	36	203	203
Spacing	m	4.0	5.9	8.1
Burden	m	2.9	4.3	6.0

Class A waste blasting is planned to utilize a higher powder factor than blasting of Class B and C waste to achieve the fragmentation required for effective placement, co-placement with tailings and compaction in the Class A Storage Facility. Emulsion is the primary bulk explosive expected to be used on site. The Explosives Management Plan, Appendix C of the Hazardous Materials Management Plan (BMC, 2026l) should be referred to for specific information regarding blasting operations and management on the site.

Trim and presplit blasting is aimed at limiting blast induced rock mass damage to the final pit wall, but still achieve adequate fragmentation for excavation. There are a number of techniques for trim blasting including:

- Presplit which serves to both define the plane of the subsequent wall and to limit gas penetration from nearby blasting;
- A final production blast with a trim blast incorporated in the design in order to limit blast induced rock mass damage; and
- A separate trim blast (not incorporated into a production blast) against the presplit plane designed to minimise damage.

The range of configurations employed to achieve this is wide, but the general principle is to provide sufficient timing to allow each hole burden full relief during the blast. A trim blast will typically comprise two to four rows of holes, and the last row (the buffer row) may have unique powder factors and timings.

Presplit blasting is expected to be applied around the final pit wall for the ABM Zone hanging wall and all the Krakatoa Zone pit final walls. The ABM Zone footwall is not planned to have presplit blasting applied due to its shallow angle on the footwall of the Deposit.

The key factors in designing and optimizing a trim blast are:

- Dynamic burden relief: any tendency for the blast to become over-confined is likely to cause damage through the presplit line and result in an unstable wall; and
- Buffer row charge distribution: explosive concentration must be low enough to avoid blast induced damage to the rock mass behind the wall, yet evenly distributed so as to ensure adequate breakage and removal of material from the presplit plane.

A conceptual trim blast cross section is shown in Figure 5-7.

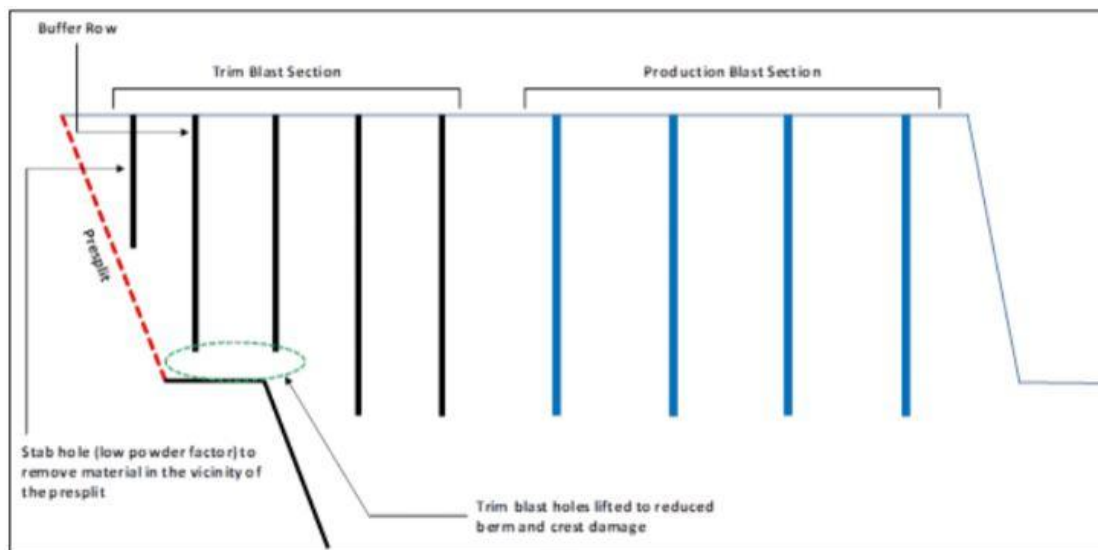


Figure 5-7: Conceptual Trim Blast Cross Section

Drill and blast practices will be reviewed throughout the life of the mine to optimize drill and blast performance and minimize non-productive noise, as well as investigating opportunities to reduce greenhouse gas emissions through a combination of optimizing drill and blast efficiencies and fragmentation performance affecting load and haul efficiencies.

A detailed blasting plan will be developed and implemented to optimize blasting operations and minimize non-productive noise.

5.2 HAUL ROADS

Current open pit ramp widths are based on a fleet of 140 tonne haul trucks, with 28.7 m wide ramps designed for a double lane road (including a safety catch bench on the pit crest side and a ditch on the pit wall side), and 21.2 m wide ramps have been designed for single lane traffic. Double lane

ramps will be used predominantly in the pit, reducing to single lane ramp width in the lower portion of each phase to reduce waste stripping requirements. Safety berm widths are based on a minimum of $\frac{3}{4}$ the height of the wheel of the largest vehicle operating in the pit. The haul road design parameters are shown in Table 5-2.

Table 5-2: Haul Road Design Parameters

Haul Road Parameters	Unit	140 tonne Truck
Truck operating width	m	7.5
Travel width - double lane (3 x width)	m	22.5
Travel width - single lane (2 x width)	m	15.0
Berm height = Tire height $3.0 \times \frac{3}{4}$	m	2.3
Repose angle (rock/mud)	degrees	40
Berm width	m	5.5
Drainage ditch	m	0.7
Total double lane	m	28.7
Total single lane	m	21.2

In pit haul roads have typically been designed at a gradient of 1:10, with localized use of 1:9 gradient where specific pit geometries require.

There are five primary destinations for hauling material from the pit:

- The ROM pad;
- Class A Waste Rock and Tailings Storage Facility;
- Class B Waste Rock Storage Facility;
- Class C Waste Rock Storage Facility; and
- Overburden Stockpile.

Surface haul roads have been designed to be nominally flat where practicable to maximize haulage productivities. Project roads will be regularly maintained to minimize vehicle noise associated with vibration, and ensure that haulage productivity rates are maintained.

Loaded haul trucks will have the right of way on all surface and in pit haul roads. Light vehicle access to the pit will be controlled and training and licensing protocols and procedures will be developed prior to the commencement of mining. Passing of heavy equipment on haul roads will generally not be allowed. However, procedures will be developed to allow for specific situations for passing (i.e. road maintenance).

The following standards, in order of highest to lowest priority, apply to rights of way at any area not controlled by traffic signs:

Emergency vehicles - when lights flashing;

- Trucks transporting dangerous goods:
 - Explosives transport vehicles;
 - Fuel trucks; and
 - Other dangerous goods trucks.
- Haul trucks;
- Bulk carriers (non dangerous goods);
- Heavy vehicles; and
- Light vehicles.

When two comparable trucks/vehicles meet, the blind side vehicle will have the right of way.

Additional information on the site roads is included in the Road Construction Plan (BMC, 2026f).

6 UNDERGROUND MINING OVERVIEW

The following is intended to provide an overview of BMC's expectations for underground mining at the ABM Deposit to provide context for the larger mining project. As noted in Chapter 1, a separate Underground Mine Development and Operations Plan will be submitted to the Department of Energy, Mines and Resources for approval under the Quartz Mining License prior to development of the underground mine.

Underground mine development is expected to commence approximately three years after the commencement of ore production from the ABM Open Pit. During this three-year period, development of the Stage 1C pit will have advanced sufficiently to excavate the 1,355 mRL bench where the portals are planned to access the underground mine (Figure 6-1).

Infrastructure that will be located on the 1,355 mRL bench to support the underground mine will include:

- Hut fitted with tag board, VHF radio, mine plans and emergency procedures, lighting;
- Intake air heating equipment;
- Ore and waste rehandle areas (for reload of underground ore and waste by the open pit fleet to final destination);
- Traffic and miscellaneous signage; and
- Parking for light and heavy vehicles.

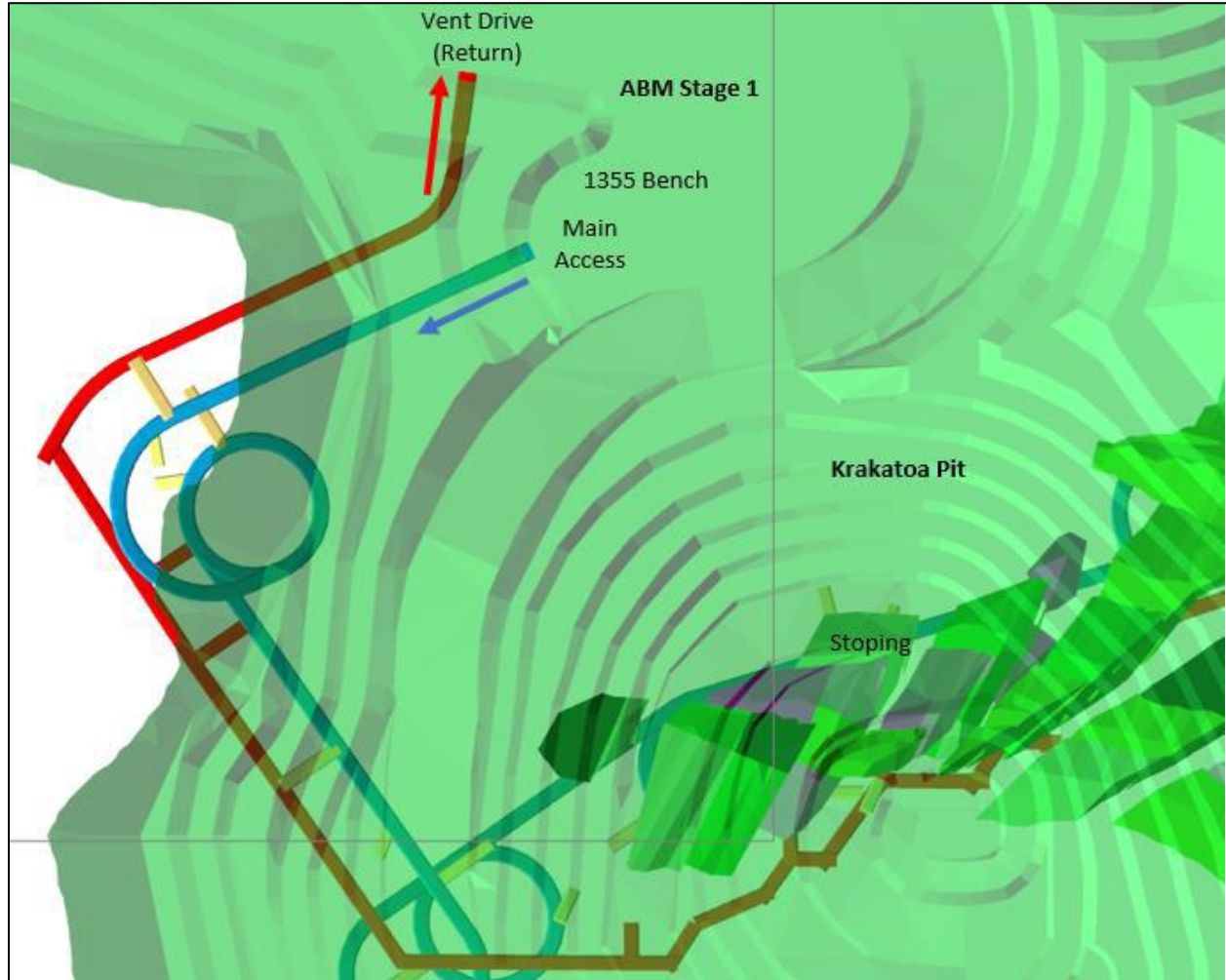


Figure 6-1: Main Access and Ventilation Ramp

Two portals will be established for the underground mine. The first portal will be the primary access to the underground mine and will facilitate truck haulage of ore and waste to the surface. The second portal will serve as exhaust airway for the primary ventilation network. The ventilation portal will also serve as a secondary means of egress from the underground mine in the event that the main ramp becomes blocked for any reason.

The ramp network is planned to be developed in the footwall of the Krakatoa Zone, providing access to levels on a 20m level spacing (Figure 6-2). First ore development is expected to occur 18 months after commencement of underground mine development, followed shortly by stoping ore. Ground support for development will vary to account for local ground conditions under direction of the geotechnical engineer.

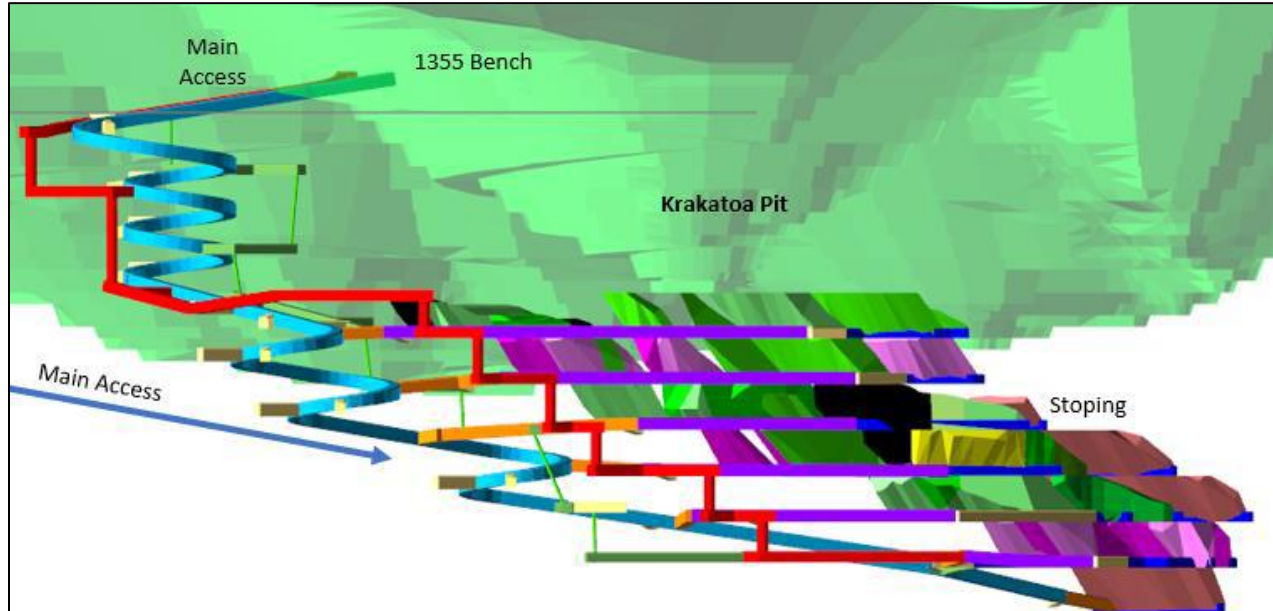


Figure 6-2: Ramp Location with Planned Production Levels

The mining method planned to be used for underground mining of the Krakatoa Zone is underhand longhole stoping with paste backfill. The binder content of the paste fill will be varied according to the geotechnical requirements of each stope being filled to achieve the required strength. A schematic of the mining sequence for this mining method is shown in Figure 6-3.

A paste backfill plant will be constructed adjacent to the Process Plant to produce paste backfill, as detailed in the Process Plant Development and Operations Plan (BMC 2020a). Standard agitator trucks will be used to transport fill from the paste backfill plant to the underground portal area, where it will be placed into the underground delivery system.

Primary ventilation will be facilitated through installation of a primary ventilation fan mounted in a bulkhead positioned nominally 20 m inside the return air portal. The bulkhead will also be fitted with a man door to provide secondary egress. Air entering the main portal will be heated during winter with either a diesel or propane fuelled heating system.

The primary means of communication in the underground mine will be through a leaky feeder radio system. All mobile equipment will be equipped with radios with handheld units used on an as required basis.

Refuge chambers will be installed at various locations to provide safe refuge for underground personnel in the event of an emergency. All refuge chambers will be equipped with radio communications, and water and breathing air for a minimum of 36 hours. An escapeway ladder network will be established between levels to allow escape from any level in the event of an emergency.

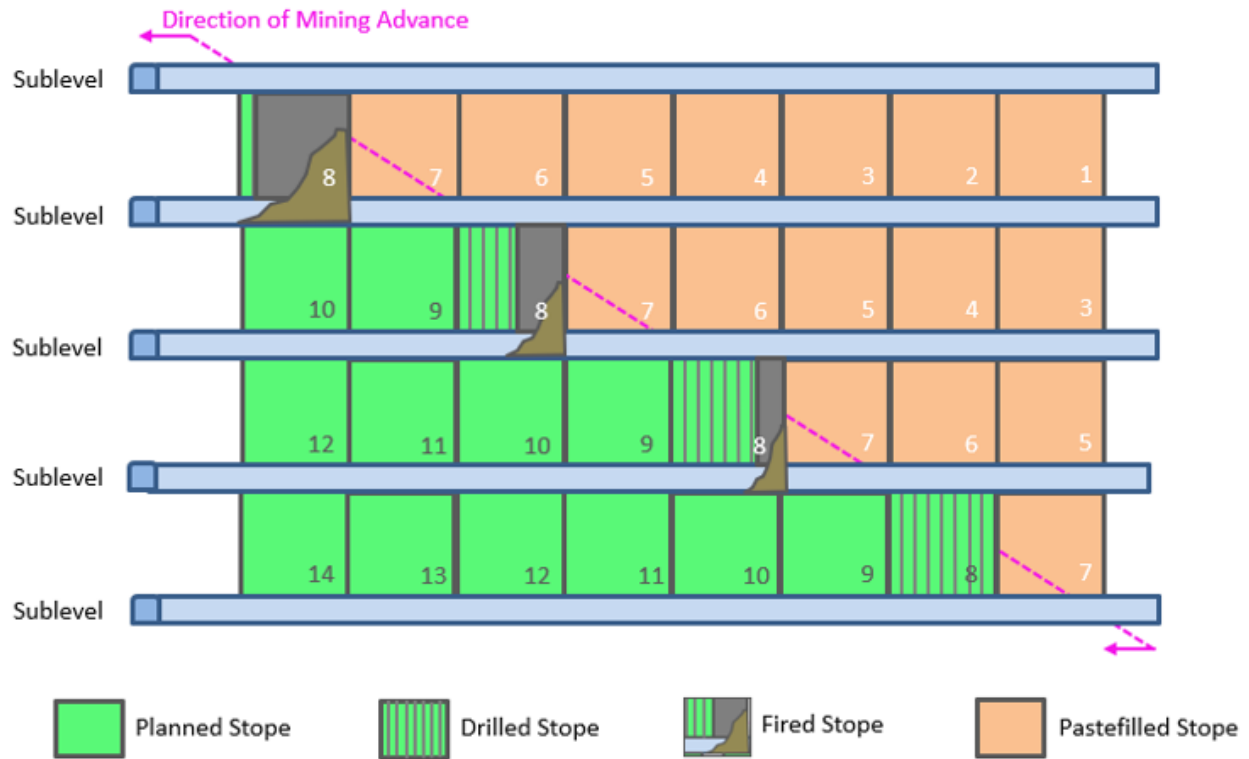


Figure 6-3: Example of Stopping Sequence

7 REFERENCES

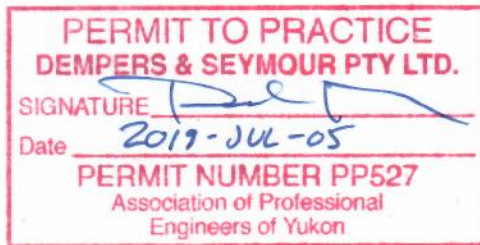
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APPENDIX A: FEASIBILITY OPEN PIT SLOPE DESIGN GEOTECHNICAL REPORT



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BMC Minerals (No1) Ltd
Kudz Ze Kayah Project - Pit Slope Design
Final Report
June 2019

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Reviewed by

Paul Hughes PEng

Executive Summary

Dempers & Seymour Pty Ltd (D&S) was commissioned by BMC Minerals (No1) Ltd (BMC) to undertake the pit slope design for the Kudz Ze Kayah Project located in the southeast Yukon in Canada.

Raw data for the project comprised geotechnical logs of exploration and geotechnical drillholes logged by D&S. This data was supplemented with geotechnical logs from core photographs and structural interpretation of televiewer surveys by D&S. In total the database consists of 7,378m of geotechnical data covering the project area.

29 significant geotechnical features have been identified and modelled in 3d by D&S. The features have been classified according to orientation – EW, NE and NNE.

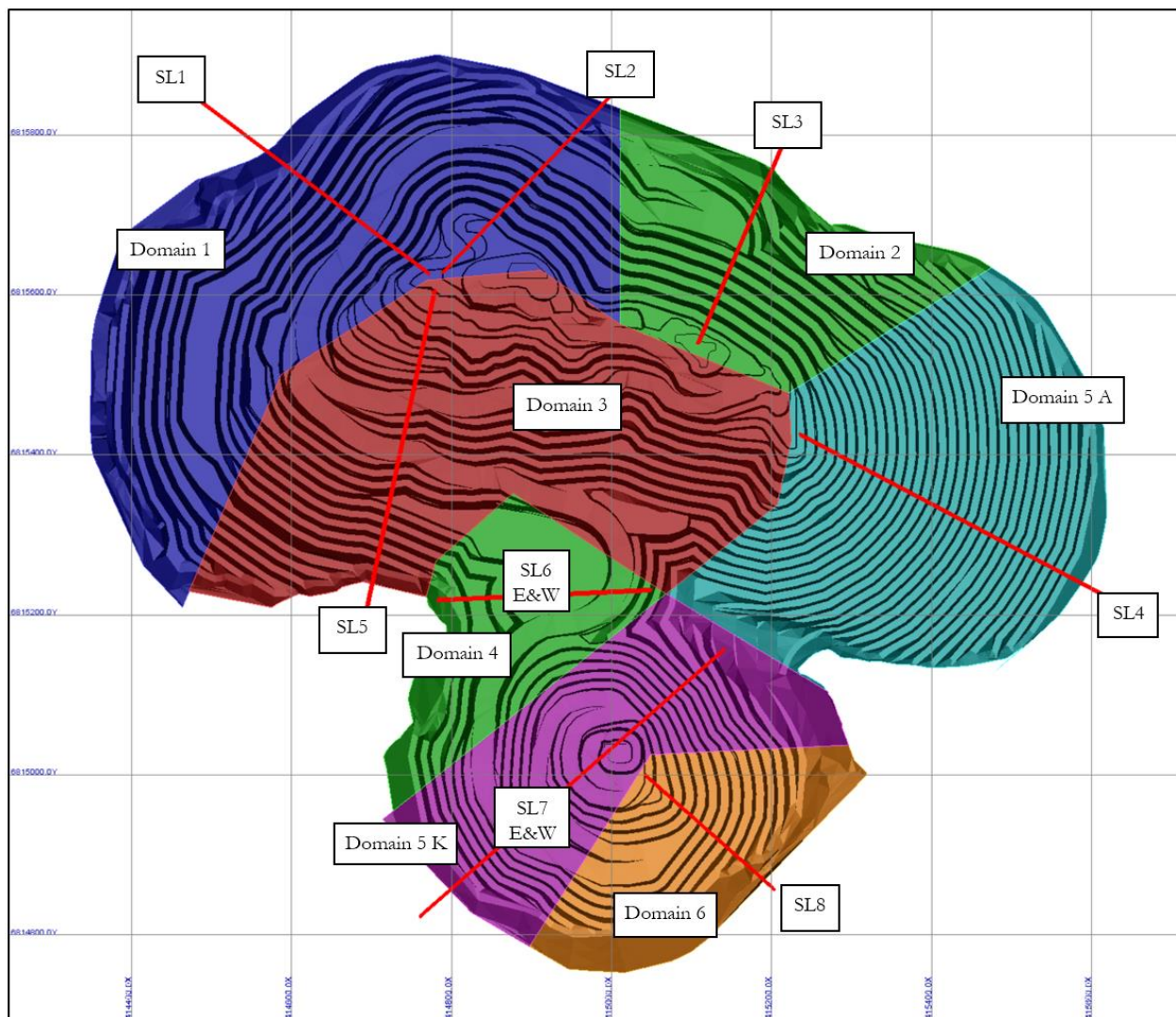
A 3d Mining Rock Mass Model (MRMM) was constructed based on lithological wireframes provided by BMC, geotechnical logs and significant geotechnical features.

Rock mass properties are summarised in the following table:

Rock Unit	Rock Strength	Joint Condition	Fracture Freq.	RMR	MRMR
MAFIC ABM	50MPa - 100MPa	Rough and planar with soft sheared fine infill	5.5 frac/m Spacing 0.18m	43 - 59 Average 49	35 - 48 Average 39
MAFIC KRAKATOA	50MPa - 100MPa	Smooth and undulating with soft sheared fine infill	4.3 frac/m Spacing 0.23m	36 - 57 Average 45	29 - 46 Average 36
MUDSTONE	50MPa - 100MPa	Smooth and undulating with soft sheared medium infill	4.8 frac/m Spacing 0.21m	38 - 50 Average 44	31 - 40 Average 36
RHYOLITE ABM	100MPa - 130MPa	Rough and undulating with soft sheared fine infill or no infill	3.9 frac/m Spacing 0.26m	48 - 60 Average 52	39 - 48 Average 42
RHYOLITE KRAKATOA	50MPa - 100MPa	Rough and undulating with soft sheared fine infill or no infill	6.0 frac/m Spacing 0.17m	37 - 51 Average 43	30 - 41 Average 34
WINDLAKE	50MPa - 100MPa	Smooth and undulating with soft-sheared fine infill	4.8 frac/m Spacing 0.21m	33 - 49 Average 41	27 - 40 Average 33
FELSIC/VOLCANIC	50MPa - 100MPa	Rough and undulating with soft sheared medium infill	4.8 frac/m Spacing 0.21m	37 - 56 Average 46	30 - 45 Average 37
CK FAULT	5MPa - 25MPa	Polished with gouge infill	10.0 frac/m Spacing 0.10m	5 - 27 Average 18	4 - 22 Average 15
EAST FAULT	5MPa - 25MPa	Polished to Smooth and undulating with gouge infill	>40 frac/m Spacing <0.02m	8 - 28 Average 21	7 - 22 Average 17
EW STRUCTURE	5MPa - 25MPa	Polished to Smooth and undulating with gouge infill	>40 frac/m Spacing <0.02m	13 - 30 Average 20	10 - 24 Average 16
NE STRUCTURE ABM	5MPa - 25MPa	Polished to Smooth and undulating with gouge infill	>40 frac/m Spacing <0.02m	12 - 28 Average 18	10 - 23 Average 15
NE STRUCTURE KRAKATOA	5MPa - 25MPa	Polished to Smooth and undulating with gouge infill	>40 frac/m Spacing <0.02m	12 - 31 Average 23	10 - 25 Average 18
NNE STRUCTURE ABM	5MPa - 25MPa	Smooth and undulating with soft sheared fine infill	>40 frac/m Spacing <0.02m	13 - 30 Average 22	10 - 24 Average 18
NNE STRUCTURE KRAKATOA	5MPa - 25MPa	Smooth and undulating with soft sheared fine infill	>40 frac/m Spacing <0.02m	12 - 31 Average 19	10 - 25 Average 16

The mass properties for the rock units are based on geotechnical logging undertaken by D&S. The properties for the Overburden unit were based on data provided by BMC.

ased on the Mining Rock Mass Model and rigorous pit slope analyses, geotechnical domains have been defined as shown in the following figure:



Recommended pit slope design configurations excluding haul ramps dependent on dry dewatered slopes for each geotechnical domain are given in the following table:

Domain and Section	Material	From RL	To RL	Batter Height (m)	Berm Width (m)	Batter Angle (Degrees)	Inter Ramp Slope Angle (Toe to Toe)
Domain 1 SL1	Overburden	Surface	1430	Overburden laid back to 25° semi saturated			
	Fresh	First 20m of fresh		20	8	55	42
	Fresh	1410	1230	20	* 8 or 12	70	46
Domain 1 SL2	Overburden	Surface	1370	Overburden laid back to 30° semi saturated			
	Fresh	First 20m of fresh		20	8	55	42
	Fresh	1350	1230	20	10	70	49
Domain 2 SL3	Overburden	Surface	1400	Overburden laid back to 25° semi saturated			
	Fresh	First 20m of fresh		20	8	55	42
	Fresh	1380	1240	20	10	70	49
Domain 3 SL5	Overburden	Surface	1410	Overburden laid back to 25° semi saturated			
	Fresh	1410	1230	10	8	55	34
Domain 4 SL6W	Overburden	Surface	1370	Overburden laid back to 30° semi saturated			
	Fresh	First 10m of fresh		10	8	55	34
	Fresh	1360	1320	20	12	65	43
Domain 4 SL6E	Overburden	Surface	1370	Overburden laid back to 30° semi saturated			
	Fresh	First 10m of fresh		10	8	55	34
	Fresh	1360	1320	20	12	65	43
Domain 5A SL4	Overburden	Surface	1530	Overburden laid back to 20° semi saturated			
	Fresh	First 10m of fresh		10	8	55	34
	Fresh	1520	1260	10	9	70	38
Domain 5K SL7W	Overburden	Surface	1370	Overburden laid back to 25° semi saturated			
	Fresh	First 10m of fresh		10	8	55	34
	Fresh	1360	1260	10	8	70	41
Domain 5K SL7E	Overburden	Surface	1400	Overburden laid back to 25° semi saturated			
	Fresh	First 10m of fresh		10	8	55	34
	Fresh	1390	1260	10	8	70	41
Domain 6 SL8	Overburden	Surface	1380	Overburden laid back to 30° semi saturated			
	Fresh	First 10m of fresh		10	8	55	34
	Fresh	1370	1260	10	10	65	34

* Domain 1 SL1 Fresh 8m berms with a 27m wide ramp or 12m berms with no ramp

Pit designs were completed using the recommended pit slope. The final DFS pit design (abm_pd_stage_4_20190408) was evaluated by D&S for overall slope stability using limit equilibrium analyses. The resulting Factors of Safety are equal to or exceed 1.2 and are within accepted guidelines for open pit slope stability.

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1 Introduction

Dempers & Seymour Pty Ltd (D&S) was commissioned by BMC Minerals (No1) Ltd (BMC) to undertake the pit slope design for the Kudz Ze Kayah Project (KZK) located in the southeast Yukon in Canada.

The scope of work for the project included:

- Geotechnical logging of exploration and geotechnical core.
- Processing of downhole televiewer surveys to obtain structural data
- Laboratory testing of selected core samples
- Create a 3d structural model of significant geotechnical features.
- Create a 3d Mining Rock Mass Model (MRMM) of relevant rock mass parameters and ratings
- Kinematic structural analyses
- Probabilistic and deterministic structural analyses
- Probabilistic and deterministic limit equilibrium analyses for rigorous pit slope design

Software utilized for the data evaluation and analyses comprised: DIPS, SWEDGE, SLIDE, GEMS, SURPAC, WellCad and EXCEL.

D&S completed the pit slope design in May 2018. The recommended pit slope configuration was used by BMC to develop final pit designs for the DFS which were provided to D&S for evaluation. This work was completed in May 2019.

This report details the work completed by D&S for the open pit slope design for the project together with conclusions and recommendations.

2 Geotechnical Data

The raw data used for this project consisted of core from nine targeted geotechnical drillholes and 17 exploration drillholes logged by D&S in 2017. The following geotechnical parameters were logged using domain logging methodology (Dempers et al 2010):

- Geotechnical Interval: The from to depth for each geotechnical interval
- Core >10cm: total length of all core > 10cm within each geotechnical interval (RQD to be calculated)
- Discing: The total length of discing
- Hardness or Qualitative Strength Index: estimated rock strength
- Fractures per interval per angle bin (0-30°, 30°-60°, 60°-90° or 0-90°)
- Joint Sets (Jn): degree of jointing (number of joint sets present)
- Joint Roughness (Jr): the nature of the discontinuity
- Fracture Infill (Ja): the type of joint infill and its alteration
- Matrix: type: fault, intense fracturing, sheared rock, etc.
- Joint Wall Alteration
- Weathering

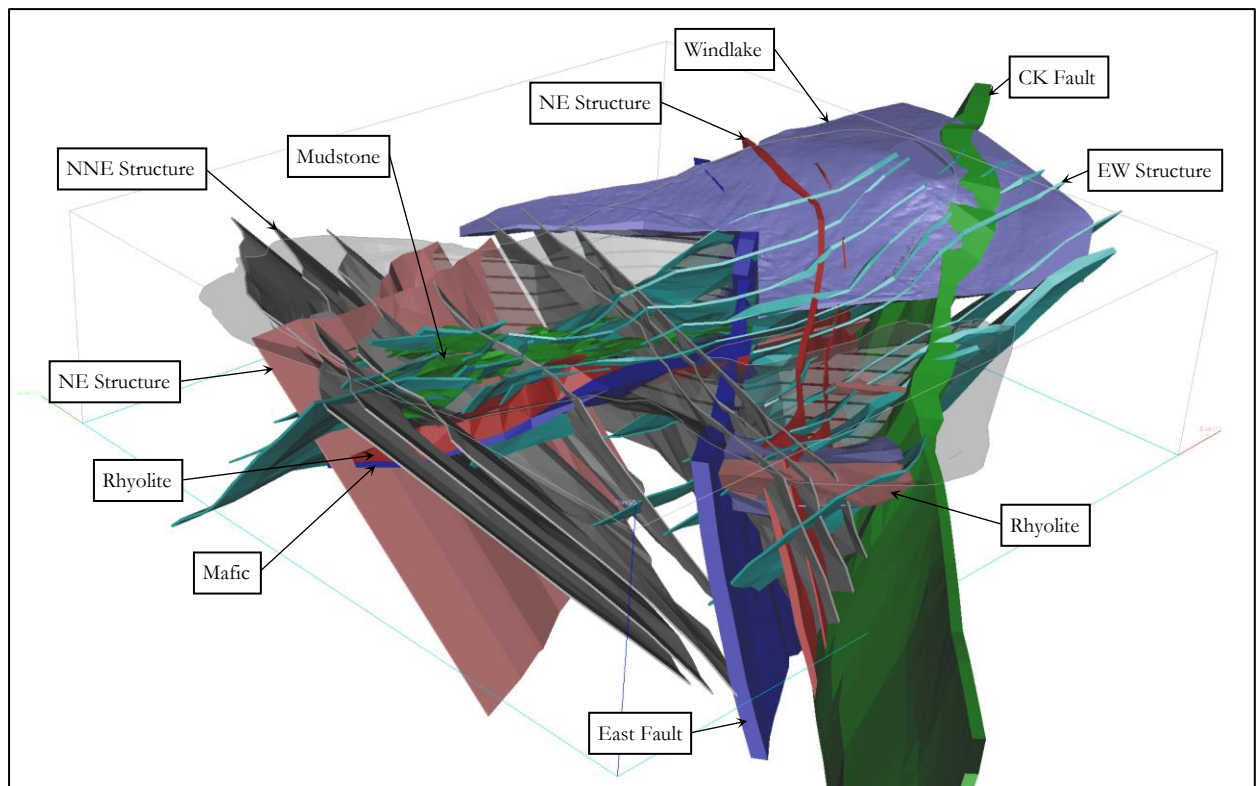
The drillhole core logs were supplemented by photo logging undertaken by D&S to extend the coverage of the MRMM.

Drillhole details are given in Table 1 and shown in Figure 1.

Table 1 Drillhole Details

HOLE-ID	Easting	Northing	RL	Length	Core Logging			Photo Logging		
					From	To	Interval	From	To	Interval
K15-203	414,850	6,815,544	1,395	173	96	173	77			
K15-228	414,748	6,815,380	1,409	95	9	95	86			
K15-238	414,902	6,815,741	1,389	245				130	245	115
K15-263	415,206	6,815,596	1,424	254				100	231	131
K15-265	415,207	6,815,595	1,424	285				130	254	124
K15-271	415,250	6,815,584	1,438	258				100	258	158
K15-277	415,249	6,815,348	1,443	358				250	358	108
K15-282	415,242	6,815,247	1,440	340	8	111	103	218	340	122
K15-292	415,157	6,815,154	1,411	312				150	300	150
K15-293	414,600	6,815,648	1,446	239	4	152	148	152	214	62
K15-297	415,050	6,815,303	1,386	350				221	350	129
K15-300	415,253	6,815,493	1,449	200	6	200	195			
K15-307	415,081	6,815,121	1,386	277	9	100	91	118	250	132
K15-309	415,155	6,815,156	1,410	306				159	283	124
K15-320	415,076	6,815,121	1,386	269	10	168	158	169	269	100
K15-321	415,078	6,815,225	1,388	308				169	308	139
K15-324	415,076	6,815,515	1,386	362				50	170	120
K15-325	415,159	6,815,052	1,406	404	6	152	146			
K16-353	414,882	6,814,999	1,390	159				8	159	151
K16-355	415,150	6,815,068	1,406	330				125	300	175
K16-358	415,105	6,815,167	1,394	348				160	280	120
K16-359	415,212	6,815,284	1,426	390				200	340	140
K16-360	415,105	6,815,168	1,394	330				170	285	115
K16-363	415,239	6,815,212	1,441	435				240	352	112
K16-370	415,074	6,815,186	1,386	281				139	277	138
K16-371	414,945	6,814,958	1,389	117	20	117	97			
K16-373	414,908	6,815,032	1,385	170	19	104	85	104	170	66
K16-375	414,503	6,815,418	1,469	171	12	171	159			
K16-376	415,074	6,815,128	1,385	170	6	170	164			
K16-385	415,448	6,815,529	1,518	645				260	354	94
K16-409	414,851	6,815,887	1,392	300				5	230	226
K16-417	415,212	6,815,291	1,427	366				220	328	108
K16-418	415,365	6,815,332	1,504	476	11	164	153			
K17-420	414,859	6,815,671	1,398	200	0	200	200			
K17-422	414,741	6,815,641	1,419	221	3	221	218			
K17-424	414,636	6,815,503	1,436	170	0	170	170			
K17-427	414,751	6,815,753	1,413	152	5	152	148			
K17-430	415,128	6,815,544	1,394	182	8	182	174			
K17-437	414,983	6,814,931	1,387	152	14	152	138			
K17-438	415,181	6,815,388	1,413	191	5	191	187			
K17-439	415,397	6,815,422	1,509	120	8	120	112			
K17-440	415,114	6,815,092	1,400	152	4	149	145			
K94-019	415,153	6,815,749	1,401	307				150	261	111
K94-021	414,749	6,815,750	1,413	240	9	193	184			
K94-023	414,851	6,815,750	1,395	258				110	210	100
K94-027	414,951	6,815,750	1,383	216				117	216	99
K95-113	415,242	6,815,524	1,440	221	6	221	216			
K95-135	415,153	6,815,569	1,403	194	9	160	151			
K95-148	414,951	6,815,601	1,382	210	6	210	205			

The KZK Project area comprises six lithological units that were used to describe the geotechnical environment. In addition, D&S created structural models of significant geotechnical features that will impact pit wall stability. The lithological units and structural models were used to constrain the MRMM. The units are shown in Figure 2.



Note:

Overburden cover sequence and Felsic Volcanic host rock not shown

Figure 2 Isometric view looking north east showing lithological units and structures

3 Laboratory Testing

3.1 Introduction

Samples of fresh rock were selected from the 2017 diamond drill holes, for the ABM and Krakatoa pits, for the following laboratory tests:

- Uniaxial Compressive Strength (UCS)
- Direct Shear

All the tests were conducted by Paul Hughes Consulting (Hughes 2017). The laboratory test report is contained in the data appendices on the attached CD.

3.2 UCS Tests

A total of 21 UCS tests were conducted. The mean results for UCS based on rock types are reported in Table 2, along with the upper and lower quartile values for the tested rock types.

The density of rock samples is measured as part of the UCS testing procedure and mean values are also reported in Table 2.

Table 2: Summary of UCS Test Results

	Rock Type	FELSVOLC	MAFIC	WINDLAKE	RHYOLITE	MUDST
	No. of UCS Tests	15	1	3	1	1
Density (t/m ³)	Mean	2.78	2.78	2.78	2.78	2.77
UCS (Mpa)	Lower Quartile	17	72	26	58	17
	Mean	42	72	33	58	17
	Upper Quartile	62	72	42	58	17

A comparison graph of UCS test results and logged Qualitative Strength Index values (QSI or Hardness) is presented in Figure 3.

The logged QSI values (each of which corresponds to a UCS range) for specific geotechnical domains are broadly consistent with the respective UCS test results from core samples, in that they are generally within a range of 0.5 of the QSI logged value providing confidence in the reliability of the strengths presented in the geotechnical logs.

Based on failure mode observations, some of the tests were identified as having failed along healed defects during testing and this explains why some UCS test values are lower than the logged QSI values. The rock strength is accounted for in the adjustments to the Rock Mass Rating. Failure on the healed joints is accounted for when mohr coulomb failure criteria ie failure on structure is applied as allocated for each cross section analysed.

The tests which failed along healed defects are highlighted on the graph in Figure 3.

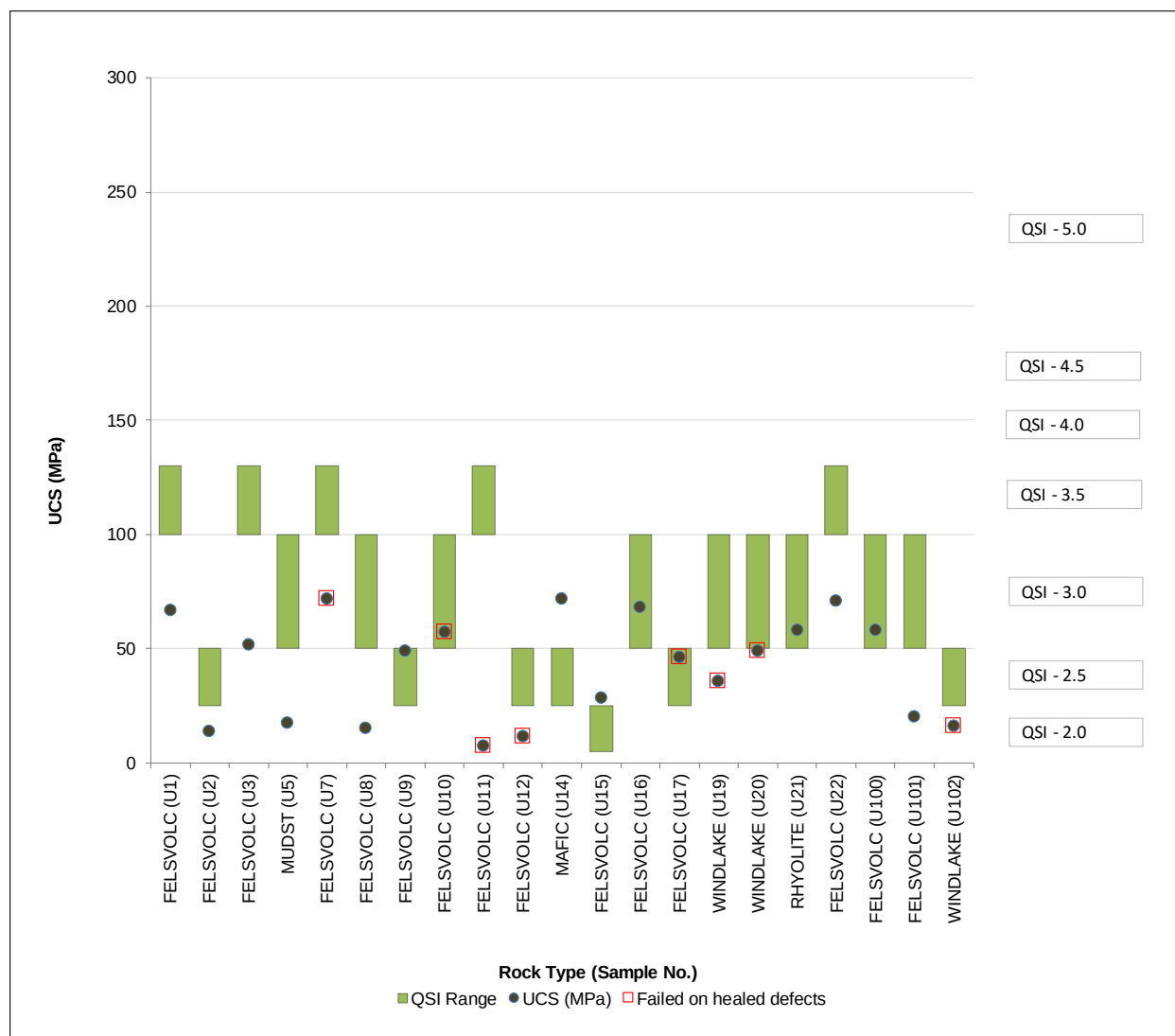


Figure 3: Logged QSI Strength Range Compared with Laboratory UCS Test Results

3.3 Direct Shear Tests

Direct shear tests were conducted on the prominent foliation and joint defects within samples of core from the fresh rock with the results shown in Table 3.

Table 3: Summary of strength parameters from direct shear tests

Drillhole ID	Sample ID	Depth (m)	Lithology	Alpha/ Beta	Micro	Infill	Discontinuity Type	Peak Friction Angle	Residual Friction Angle
K17-420	D1	156.8	Felsic Volc	45 / 135	5	4	Foliation	26.6	19.6
K17-422	D2	73.9	Felsic Volc	55 / 238	3	7	Foliation	23.8	20.3
K17-422	D3	184.7	Felsic Volc	58 / 008	5	4	Foliation	21.1	20.9
K17-422	D4	122.4	Felsic Volc	44 / 330	6	9	Joint	31.9	28.3
K17-424	D5	141.05	Felsic Volc	40 / 105	6	8	Joint	38.8	37.5
K17-427	D6	23.4	Felsic Volc	65 / 200	2	7	Foliation	29.5	26.4
K17-427	D7	90.3	Felsic Volc	46 / 225	3	9	Joint	37.1	31.0
K17-439	D9	44.8	WINDLAKE	20 / 010	3	7	Foliation	27.8	25.5
K17-440	D10	94	Felsic Volc	No Orientation Line	3	3	Foliation	30.9	30.9

These values were used together with data from the MRMM for the analyses.

4 Televue Data Interpretation

Televue surveys were carried out in eight drillholes with a total of 1,259m by Equity Exploration Consultants Ltd. using optical ALT 400BI 2G and acoustic 40ABI 2G tools. Both televue tools were used to survey each hole to create a pair of supplementary optical and acoustic images along the survey intervals which help to fulfil survey coverage and to increase the confidence of structural interpretation.

The televue survey was carried out immediately after drilling each geotechnical drillhole. Televue surveys were not undertaken in the existing geological drillholes which were grouted. Drillhole K17-437 was blocked near surface as it intersected the Creek Fault (CK Fault) and as a result no televue survey was carried out.

A summary for the televue surveyed drillholes is presented in Table 4. The televue survey data is provided in the data appendices on the attached CD.

Table 4 Televue survey summary

Hole ID	Drill Type	X	Y	Z	Max Depth (m)	Optical Televue (m)			Acoustic Televue (m)			Total Surveyed Length (m)	Comments
						From	To	Interval	From	To	Interval		
K15-420	HQ3	414859	6815671	1398	200	6	197	191	6	197	191	191	
K17-422	HQ3	414741	6815641	1419	221	11	218	207	11	216	205	207	
K17-424	HQ3	414636	6815503	1436	170	6	170	164	6	170	164	164	
K17-427	HQ3	414751	6815753	1413	152	6	151	145	6	150	144	145	
K17-430	HQ3	415128	6815544	1394	182	9	180	171	16	180	164	171	
K17-438	HQ3	415181	6815388	1413	191	9	136	127	9	124	115	127	OTV mostly blur
K17-439	HQ3	415397	6815422	1509	120	9	119	110	37	118	81	110	
K17-440	HQ3	415114	6815092	1400	152	4	148	144	7	148	141	144	

4.1 Data Quality Control

The quality of televue data was reviewed by D&S immediately after each hole survey was completed. Overall the televue images were good quality, provided adequate cover and were acceptable for structural interpretation.

4.2 Televue Structural Interpretation and Classification

The raw televue data was directly imported into WellCAD software for interpretation processing. The televue images were oriented to the high side of the drillhole with zero degrees at the start of the unrolled images. The images were then adjusted for viewing scale, contrast, brightness and colour to improve the visualisation of structural features.

Structures were identified using WellCAD software, based on the high side oriented images and called apparent structures to high side (HS). Using functions within the WellCAD software, a sine wave was fitted on the identified features of interest, after classifying all of the structures present according to the D&S structural classification, as shown in Table 5.

Table 5 D&S televiewer structural classification

	Code	Tadpole	Sine Wave	
1	#10			Water table
2	#11			Casing
3	#12			Lithology Contact
4	#13			Low Confidence
5	#14			Bedding/Foliation
6	#15			Open Bedding/Foliation
7	#16			Minor Closed Fracture
8	#17			Vein/Sealed Fracture
9	#18			Random/Non Continuous
10	#19			Partial Open Fracture
11	#20			Minor Open Fracture
12	#21			Major Open Fracture
13	#22			Broken Zone
14	#23			Micro Fault
15	#24			Fault Zone

Significant geotechnical features are coded as #15, #20, #21, #22, #23 and #24, and only these codes were used for the assessment. Defect code #22 “Broken zone” is interpreted for zones that are highly fractured with multiple joint sets or zones that have been partially broken and washed out. Defect code #24 “Fault zone” is interpreted for zones which have similar characteristics to defect code #22” but with evidence of gouge materials or evidence of displacement. Several zones of defect codes #22 and #24 have been identified in the project that were used for identification and modelling of geotechnically significant features.

Dip and dip direction for each structure is calculated from the sine wave amplitude, wave length and the crest locations. The apparent structural dataset is then converted to magnetic north orientation using the drillhole tilt and magnetic azimuth which were determined by the televiewer associate tools. The magnetic azimuth data produced by the televiewer tool indicated some interference by magnetic rocks in some intervals. These intervals were corrected prior to being used to convert the structural data. The grid north (GN) dip and dip direction of the structural data has been converted by adding 21.7° from the magnetic north data to convert to the mine grid. The structural data for each orientation reference is contained in the data appendices on the attached CD.

Examples of structural interpretation by D&S are shown in Figure 4 to Figure 6.

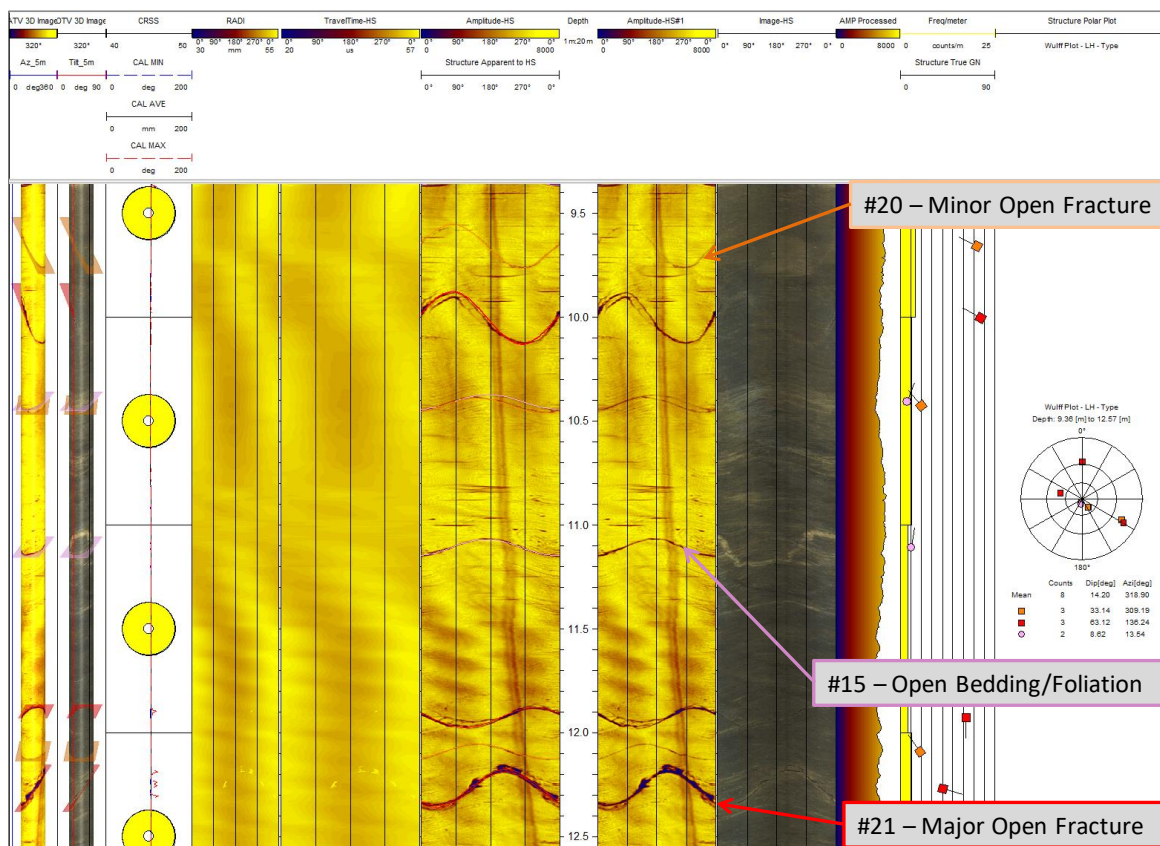


Figure 4 Example of D&S televiewer structural interpretation in K17-420

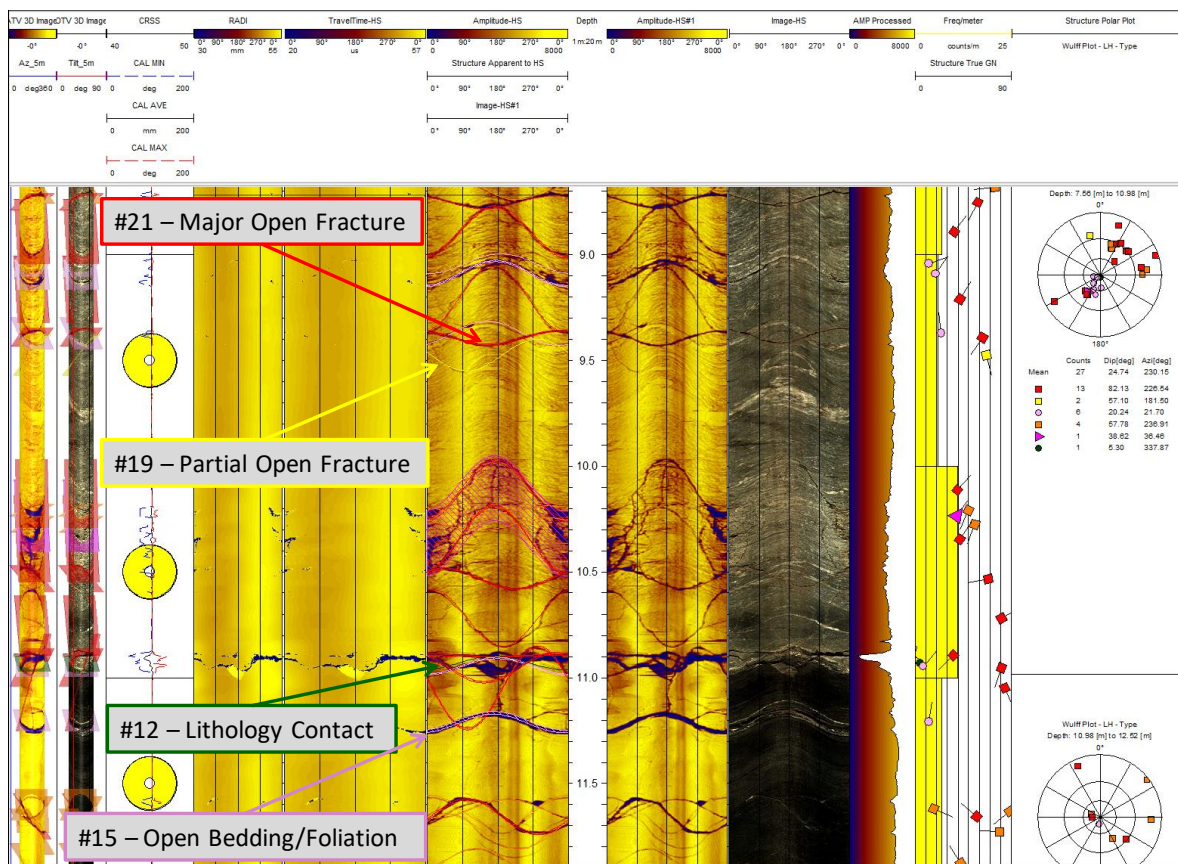


Figure 5 Example of D&S televiewer structural interpretation in K17-440

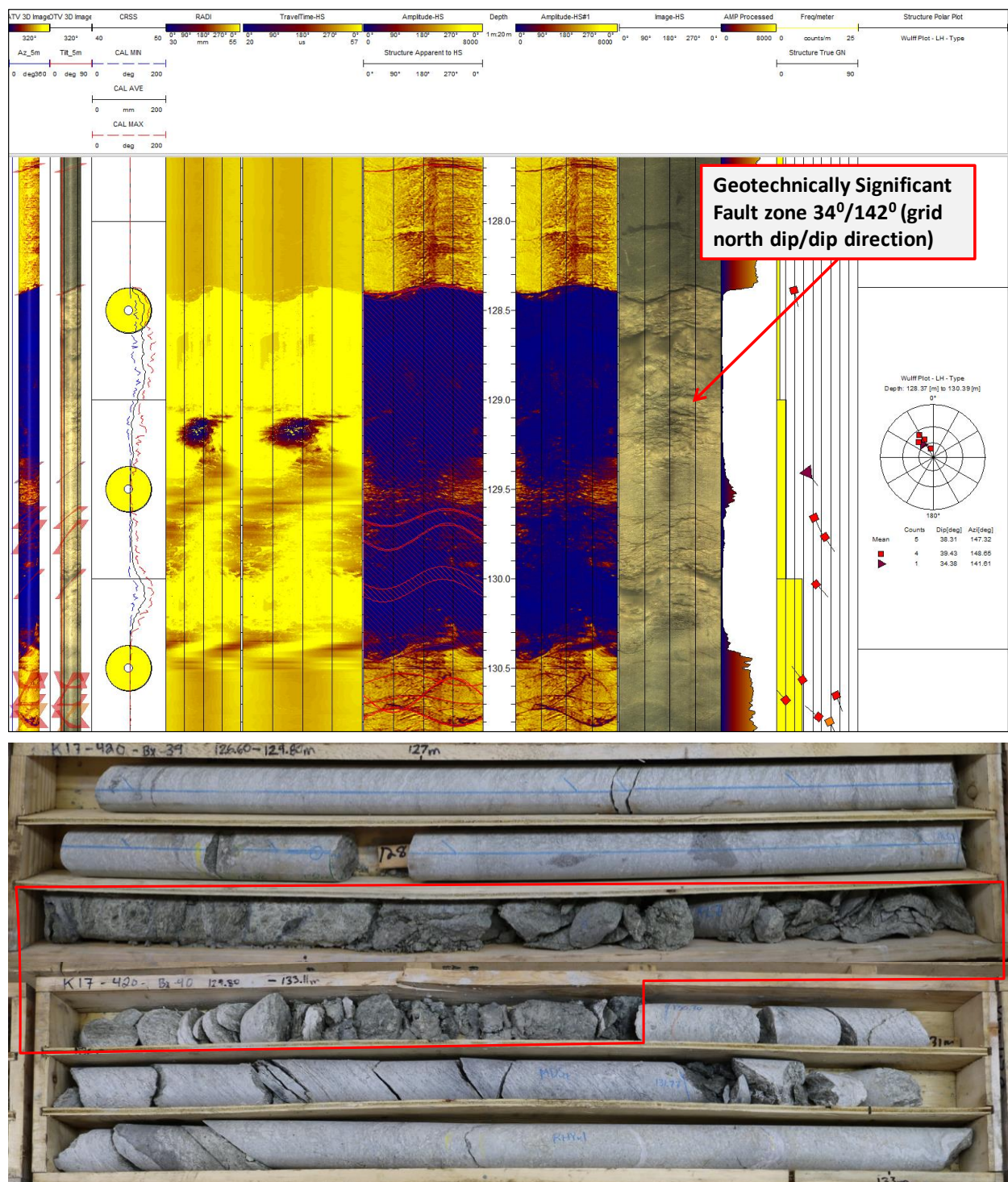


Figure 6 Televiewer images and core photos show the fault zone in drill hole K17-420

5 Geotechnical Structure Models

5.1 Data

A data set used for the modelling of geotechnically significant features comprised geotechnical logs, televiewer data and drill core photos as follows:

- A total of 49 geotechnically logged drillholes both field logging and core photo logging completed by D&S.
- Televiewer surveys from eight drillholes interpreted by D&S.
- Core photos from 332 drillholes.

5.2 Methodology

The geotechnical database was interrogated to identify significant geotechnical intercepts with characteristics given in Table 6.

Table 6 Filters used on geotechnical data to identify significant geotechnical features

Geotechnical Parameter	Limits
Thickness	≥ 0.4 m
Weathering	≤ 2
Hardness	≤ 2.5
Fracture Frequency Rating	≤ 7
Matrix (Dempers 2010)	M1, M2, M3

Televiewer survey data was also reviewed for broken zones and fault zones to determine structural orientations for the particular zones. Examples of fault zones identified in televiewer images confirmed with core photos are given in Figure 7 and Figure 8.

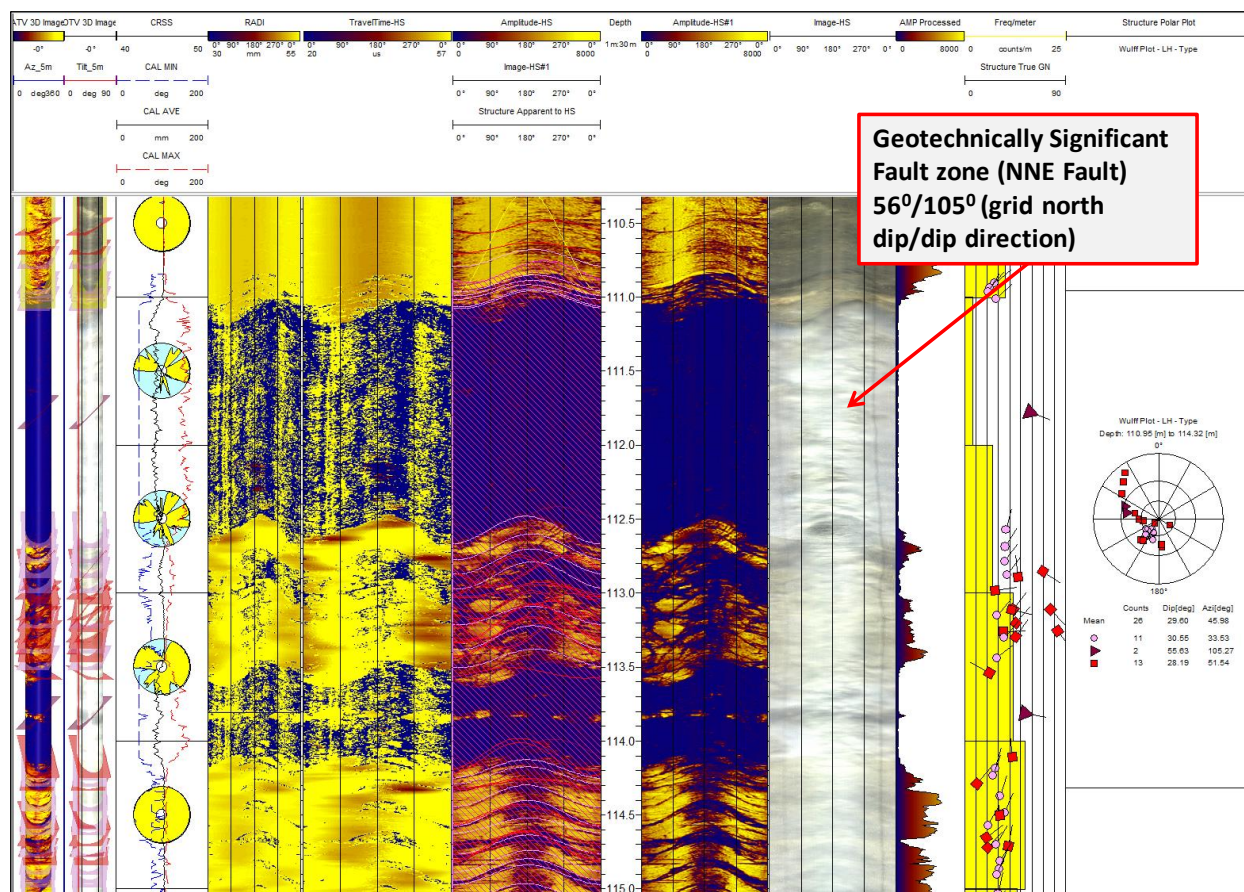


Figure 7 Example of fault zone identified with orientation in televiwer data and core photo in drillhole K17-430

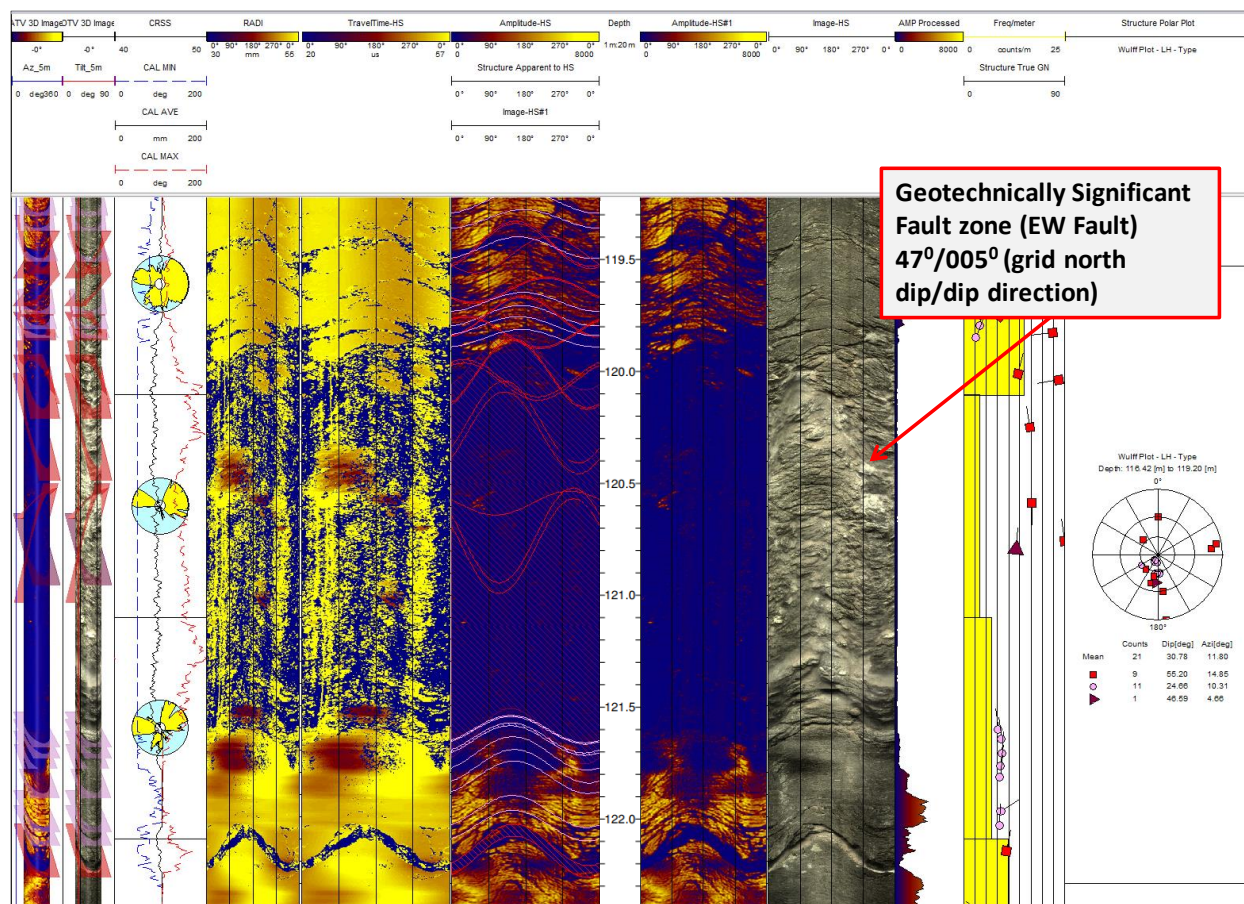


Figure 8 Example of fault zone identified with orientation in televiwer data and core photo in drillhole K17-440

5.3 Orientation Data

The televiewer data was the primary source used to identify the orientations of the geotechnically significant features. The dip and dip direction of geotechnically significant intercepts were identified for each structural code #22 – Broken Zone, #23 – Micro Fault and #24 – Fault Zones.

The stereonet plot of geotechnically significant intercepts, shown in Figure 9, indicates four significant structural orientations including NNE strike with moderate to shallow dip (45° to 65°), EW strike with moderate to shallow dip (30° to 65°), NE strike with moderate to steep dip (55° to 80°) and NNW strike with steep dip ($\sim 80^{\circ}$).

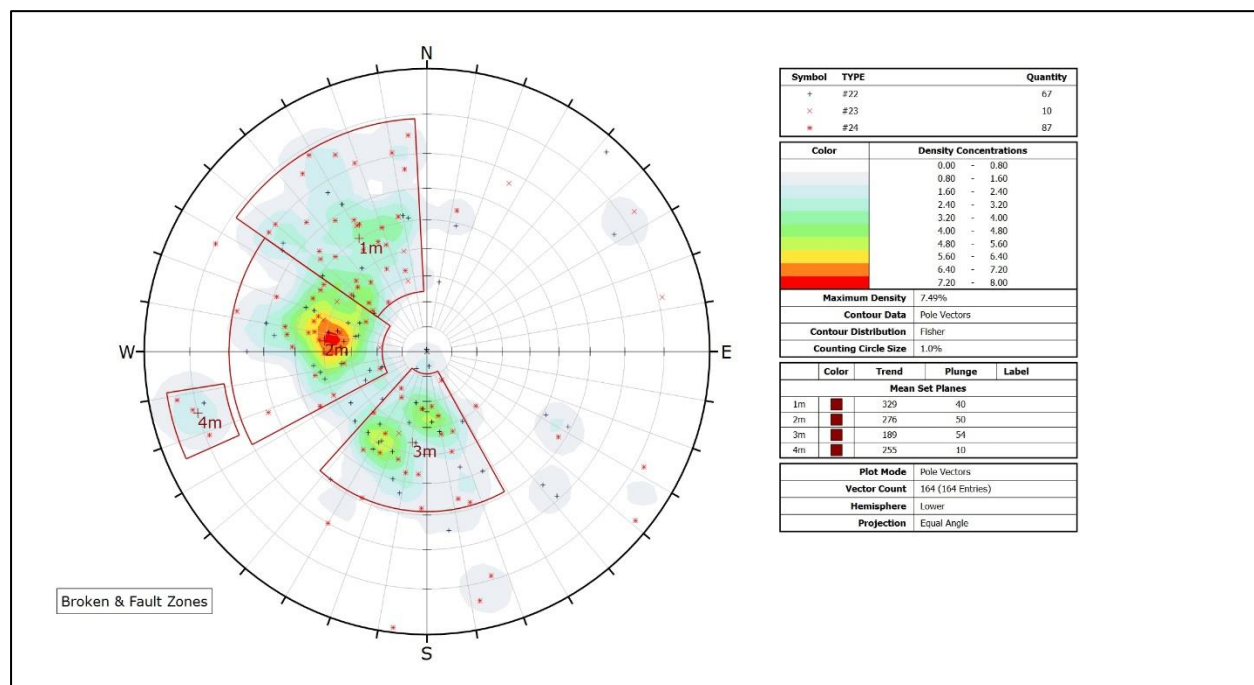


Figure 9 Stereonet of broken zones and fault zones identified in televiewer data.

5.4 Geotechnically Significant Structures

Based on the criteria filters in Table 6 and the geotechnical logs, televiewer data review and core photos logging, 869 intervals were identified as geotechnically significant intercepts.

All geotechnically significant intercepts were coded and coloured differently for review in Surpac together with the structural orientations which are presented in Figure 10. With the exception of the East Fault and Creek Fault which were interpreted by BMC, 29 new geotechnical significant features have been modelled based on the four major structural orientations and the geotechnically significant intercepts. The modelled features are generally shallower in the ABM pit area and steeper in the Krakatoa area.

The modelled features are characterised and detailed in Table 7.

Table 7 Geotechnically Significant Features

Structure ID	Object No.	Strike Orientation	Dip / Dip Direction	Thickness (m)	Strike Extent (m)	Dip Extent (m)	Type / Comments
GT01	1	NE	75 SE (145)	~3	800	300	Fault, partly gouge
GT02	2	NE	75 SE (145)	~10-30	900	300	Fault, partly gouge
GT03	3	NE	55 SE (155)	~2	700	600	Fault, partly gouge
GT04	4	NE	55 SE (155)	~2	300	500	Fault, partly gouge
GT05	5	NNE	65 ESE (105)	>3 upto 10	800	400	Fault, partly gouge, micro fracture
GT06	6	NNE	60-65 ESE (110)	>3 upto 10	800	500	Fault, partly gouge, micro fracture
GT07	7	NNE	55-65 ESE (110)	>3 upto 10	800	500	Fault, partly gouge, micro fracture
GT08	8	NNE	45-50 ESE (115)	3-5	900	600	Fault, partly gouge, micro fracture
GT09	9	NNE	45-50 ESE (115)	~3	800	600	Fault, partly gouge, micro fracture
GT10	10	NNE	45 ESE (115)	~3	800	700	Fault, partly gouge, micro fracture
GT11	11	NNE	50-55 ESE (115)	~2	400	500	Fault, partly gouge, micro fracture
GT12	12	E-W	50 N	>3 upto 20	300	300	Strongly foliated, fractured, interlayered gouge
GT13	13	E-W	40-50 N	>3 upto 10	600	600	Strongly foliated, fractured, interlayered gouge
GT14	14	E-W	40-50 N	~3	500	600	Strongly foliated, fractured, interlayered gouge
GT15	15	E-W	35 N	3-5	100	400	Strongly foliated, fractured, interlayered gouge
GT16	16	E-W	35-45 N	4 upto 7	400	500	Strongly foliated, fractured, interlayered gouge
GT17	17	E-W	65 N	~3	200	150	Strongly foliated, fractured, interlayered gouge
GT18	18	E-W	45-50 N	>3 upto 10	1000	300	Strongly foliated, fractured, interlayered gouge
GT19	19	E-W	30-45 N	4 upto 20	700	400	Strongly foliated, fractured, interlayered gouge
GT20	20	E-W	45 N	~4	350	450	Strongly foliated, fractured, interlayered gouge
GT21	21	E-W	40 N	~4	200	350	Strongly foliated, fractured, interlayered gouge
GT22	22	E-W	40-45 N	~3	200	300	Strongly foliated, fractured, interlayered gouge
GT23	23	E-W	45-55 N	~3	100	300	Strongly foliated, fractured, interlayered gouge
GT24	24	E-W	35-40 N	3 upto 30	1000	400	Strongly foliated, fractured, interlayered gouge
GT25	25	E-W	35-40 N	~5	600	400	Strongly foliated, fractured, interlayered gouge
GT26	26	E-W	40-45 N	~2 upto 10	350	400	Strongly foliated, fractured, interlayered gouge
GT27	27	E-W	35-45 N	~5	150	300	Strongly foliated, fractured, interlayered gouge
GT28	28	E-W	50-55 N	~4	300	300	Strongly foliated, fractured, interlayered gouge
GT29	29	NNW	80 ENE (075)	~1	400	400	Fault, partly gouge, brittle
East Fault	1	NE	70-80 SE (150)	~30	900	700	Fault, partly gouge. Modified from original model
Creek Fault	1	SW	75-90 NW (315)	15-80	2000	600	Fault, partly gouge. Modified from original model

The modelled features are shown Figure 11 and each structural set with examples of core photos are shown in Figure 12 to Figure 22.

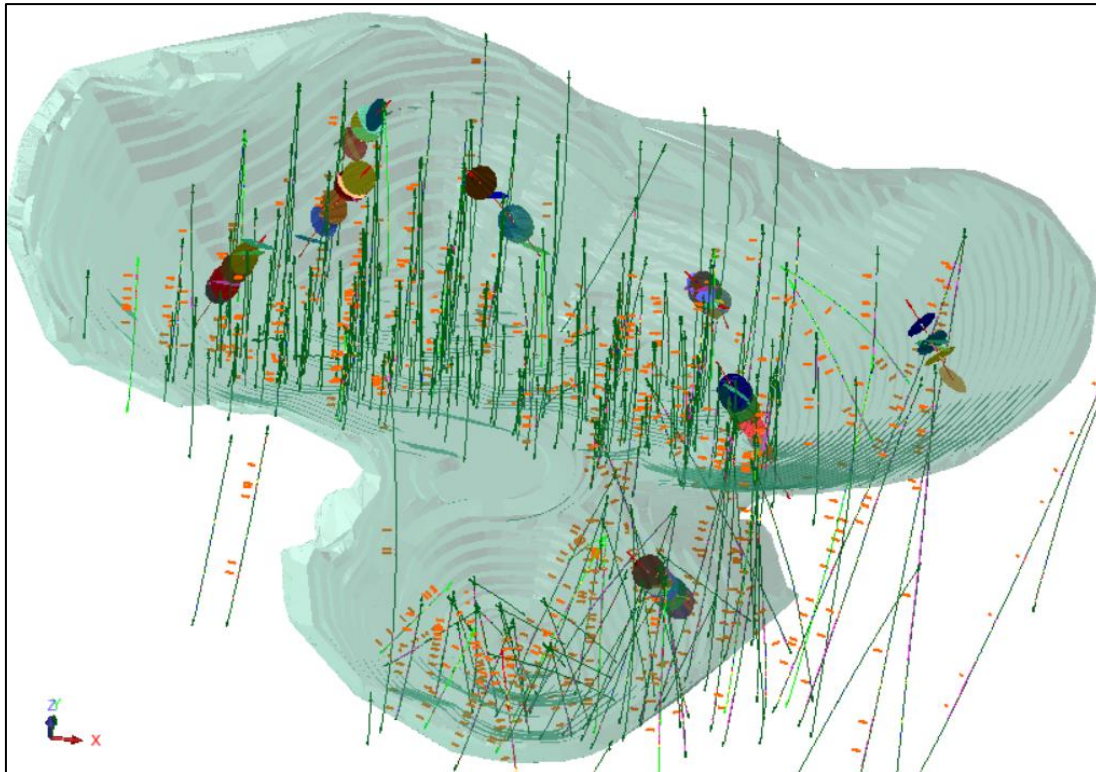


Figure 10 Isometric view looking north showing geotechnically significant intercepts and orientation discs identified from televiewer data

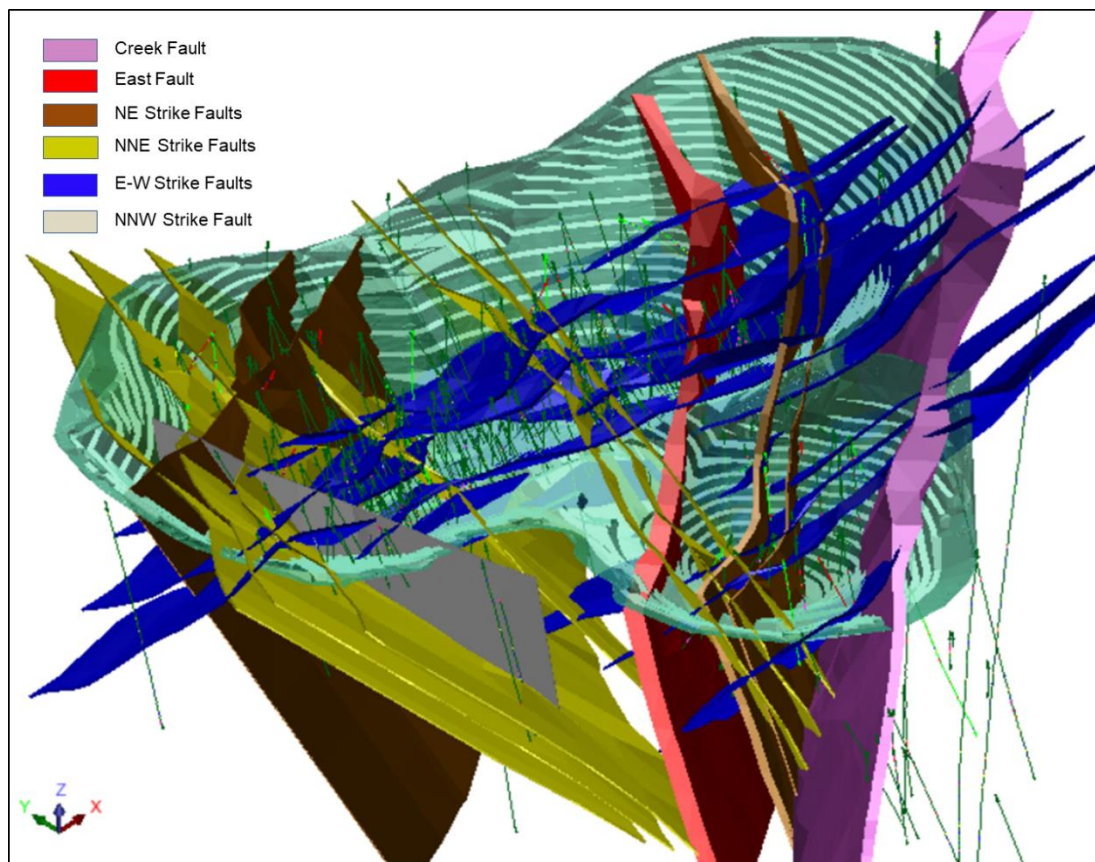


Figure 11 Isometric view looking north east showing interpreted geotechnical structures

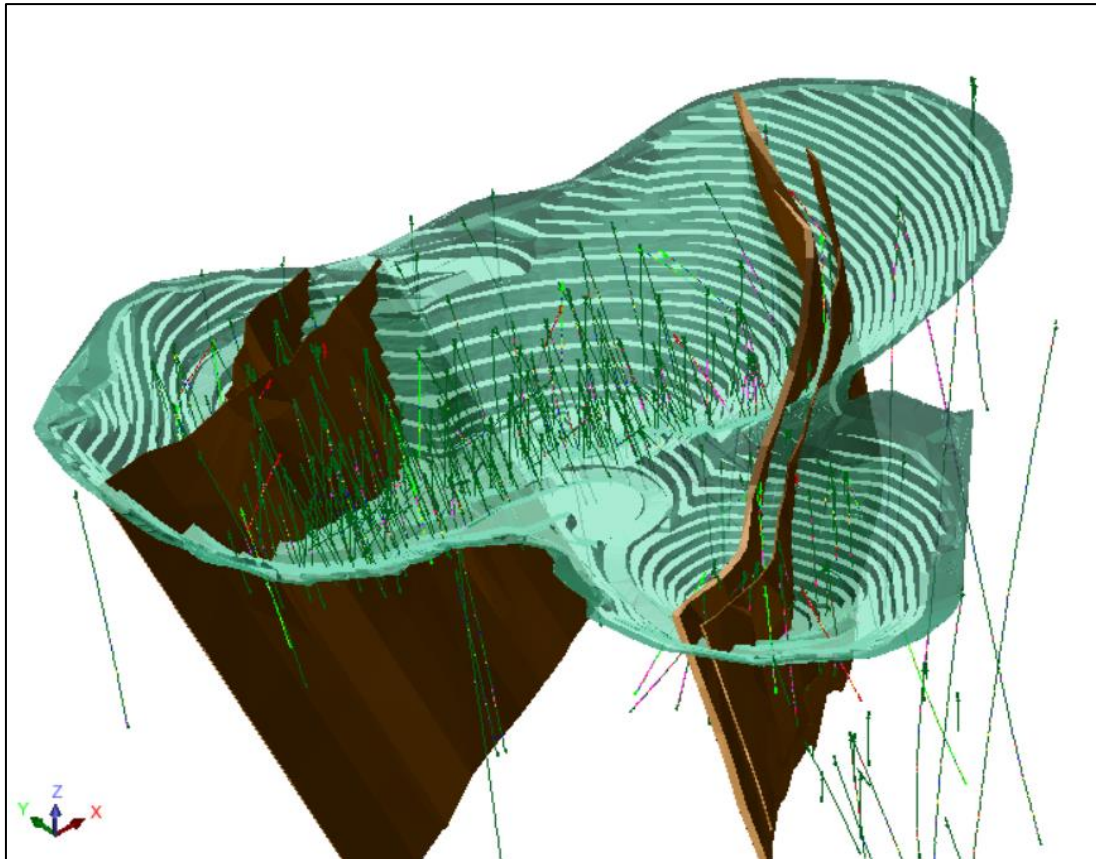


Figure 12 Isometric view looking north showing models of NE strike geotechnical structure



Figure 13 Core photo example of NE strike geotechnical structure in K15-307

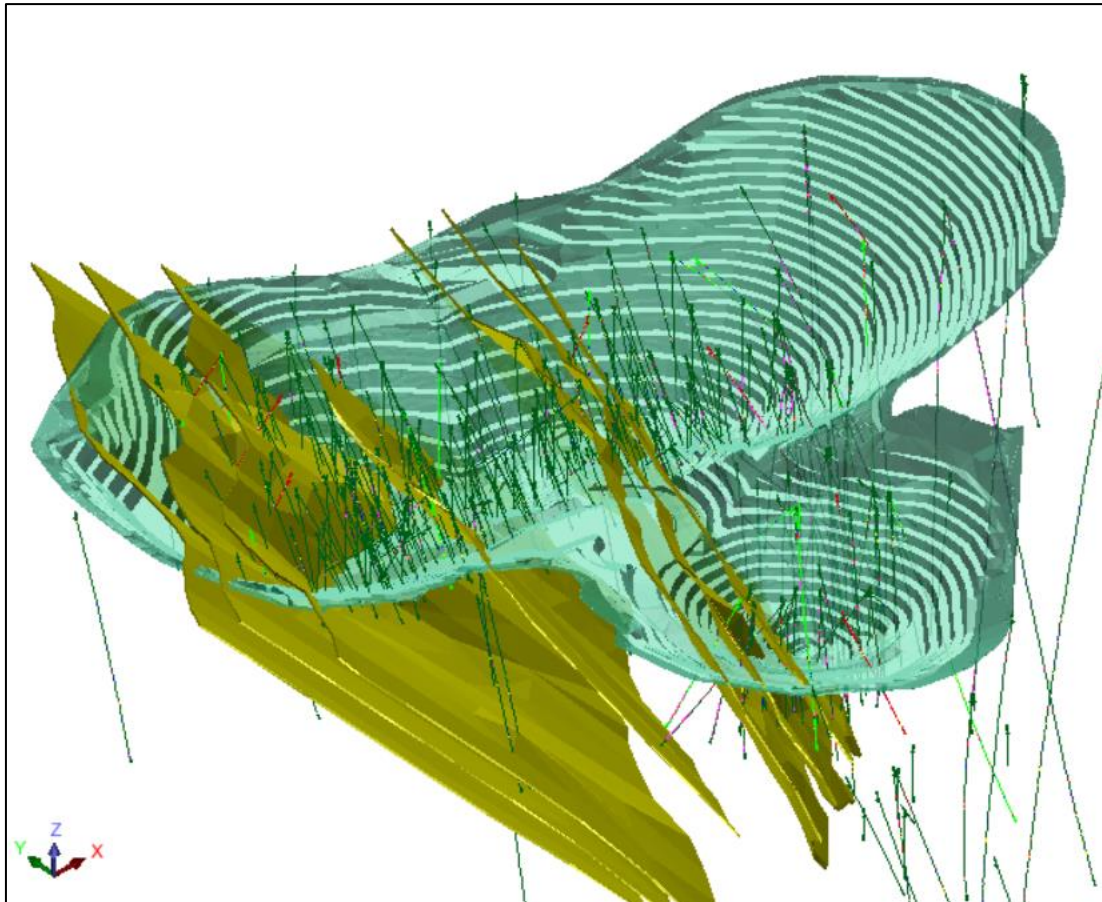


Figure 14 Isometric view looking north east showing models of NNE strike geotechnical structure



Figure 15 Core photo example of NNE strike geotechnical structure in K15-238

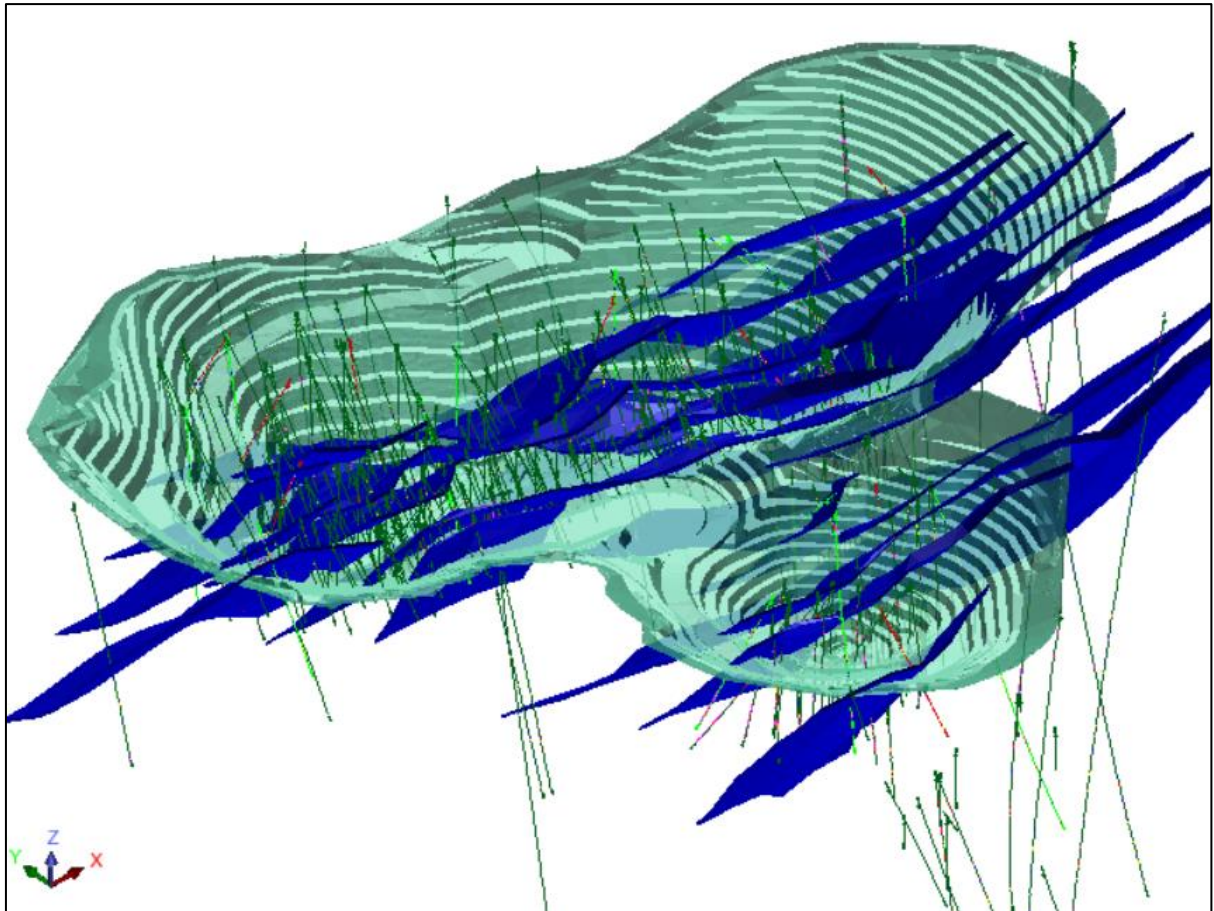


Figure 16 Isometric view looking north east showing models of E-W strike geotechnical structure



Figure 17 Core photo example of E-W strike geotechnical structure in K17-307

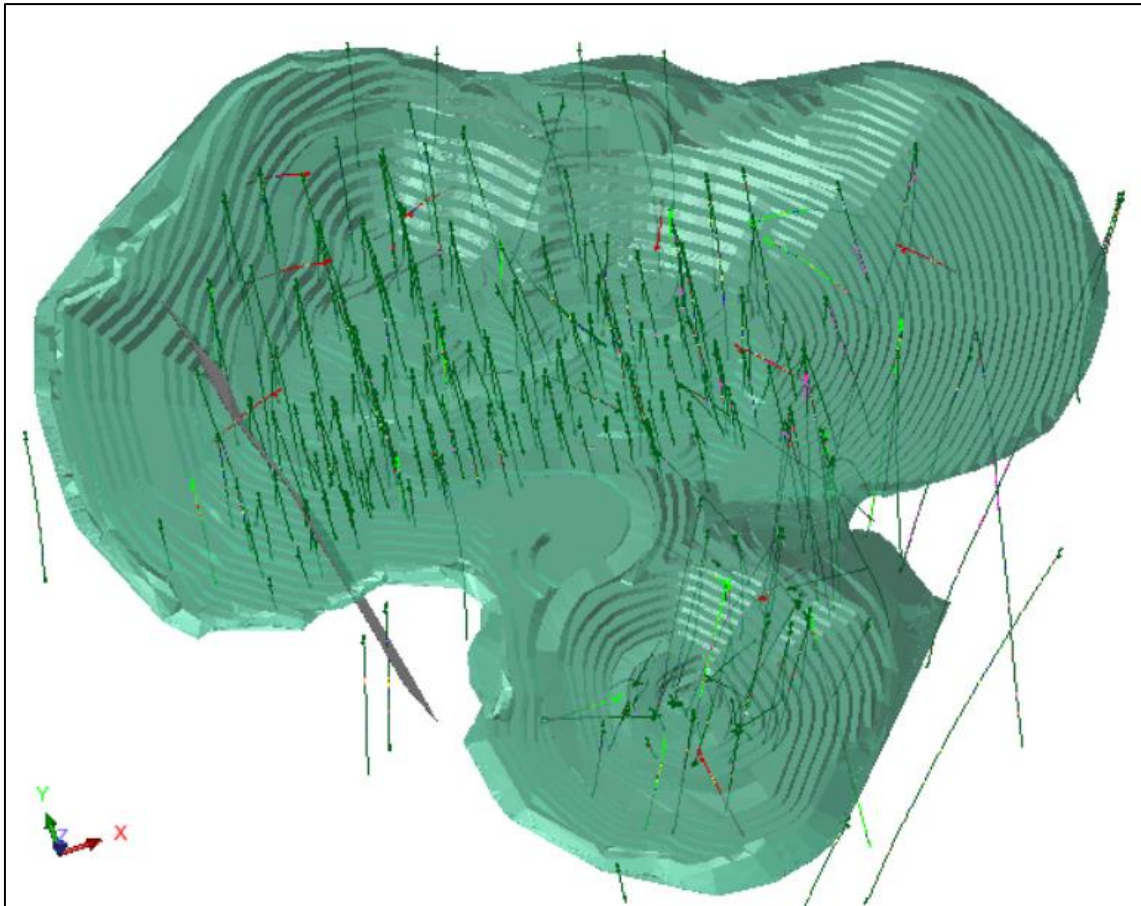


Figure 18 Isometric view looking north east showing models of NNW strike geotechnical structure



Figure 19 Core photo example of NNW strike geotechnical structure in K17-424

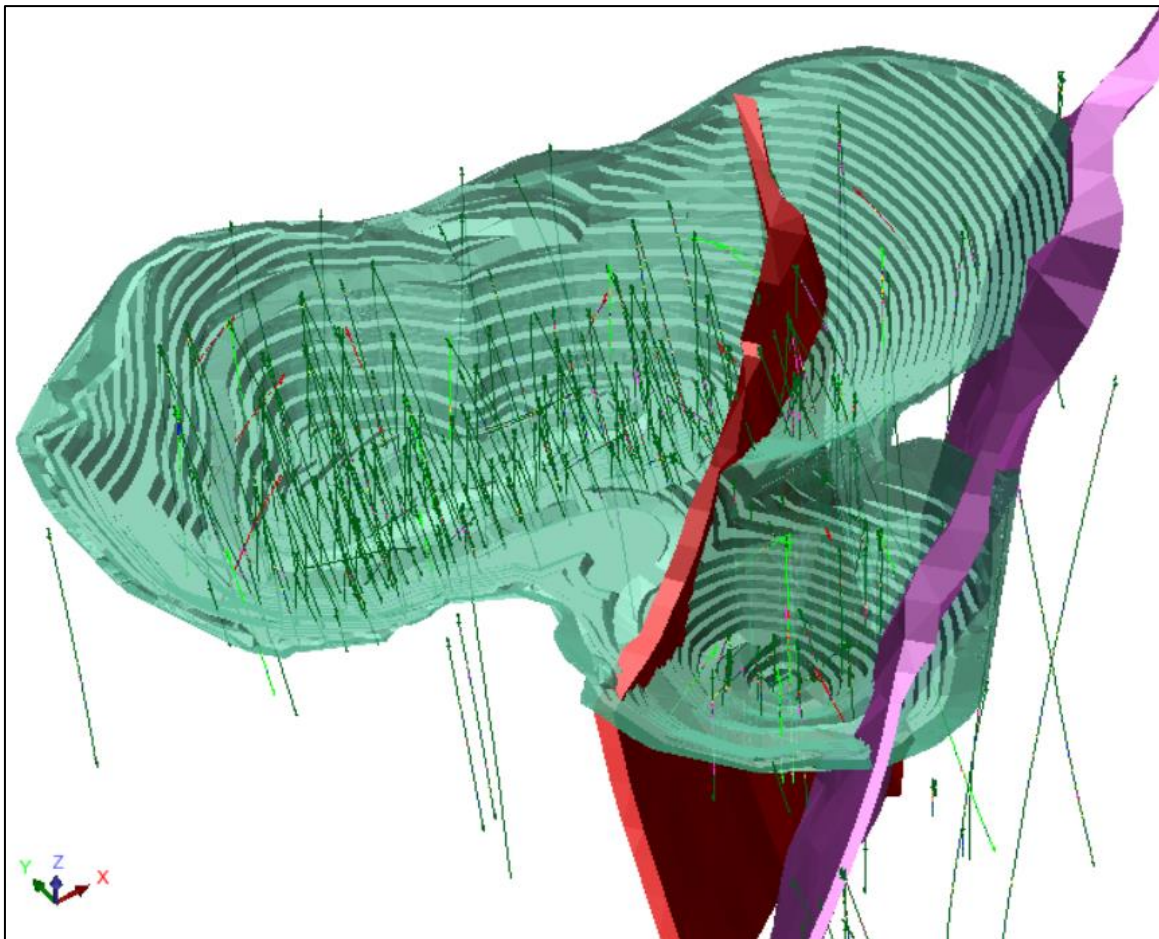


Figure 20 Isometric view looking north east showing modified models of East Fault and Creek Fault

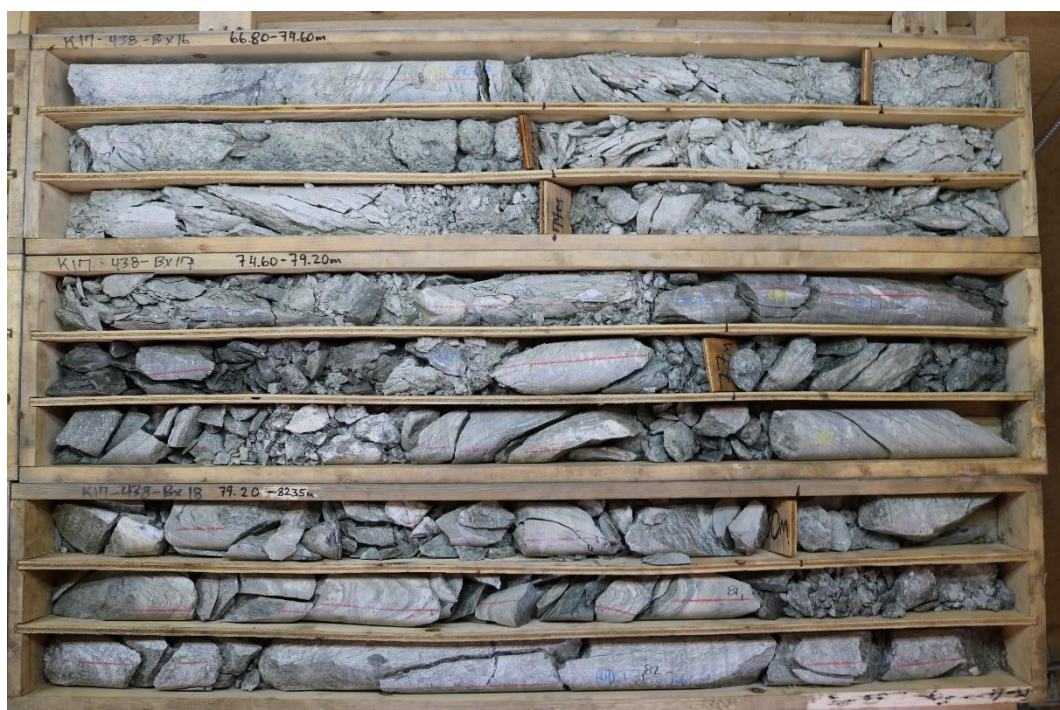


Figure 21 Core photo showing example part of the East Fault in K17-438



Figure 22 Core photo showing example part of the Creek Fault in K17-424

6 Rock Mass Ratings

6.1 Introduction

The MRMR (Laubscher 1990) classification system was used to determine empirical slope angles. The GSI classification system (Hoek et al 1995) was used to determine Hoek Brown slope parameters for the rigorous pit slope analysis.

6.2 MRMR Classification system

The MRMR classification system involves the assignment to the rock mass of an in situ rating based on measurable geotechnical and geological parameters and applies logged data, to assess likely mining conditions.

The input parameters with the associated range of ratings to determine the in situ Rock Mass Rating are as follows:

Input Parameter	Rating Range
Intact rock strength (IRS)	0 – 20
Rock quality designation (RQD)	0 - 15
Joint spacing (Js)	0 – 25
Fracture frequency per joint set (FF)	0 – 40
Joint condition (Jc)	0 – 40

RMR was determined as follows:

$$\text{RMR} = (\text{FF} + \text{RQD} + \text{Js})/2 + \text{IRS} + \text{Jc}$$

The rock mass can be classified according to the RMR rating as follows:

RMR Rating	Rock Mass Classification
<20	Class V Very Poor
21-40	Class IV Poor
41-60	Class III Fair
61-80	Class II Good
81-100	Class I Very Good

The in situ rating (RMR), out of a total of 100, is then adjusted to take account of the expected mining conditions to give the MRMR. The adjustments relate to the influence of weathering, orientation of structures, induced mining stress and blasting performance. The range of adjustments is as follows:

Adjustment	Range
Weathering	30 – 100%
Orientation	63 – 100%
Induced stress	60 - 120%
Blasting	80 – 100%

6.3 GSI Classification System

The Geological Strength Index GSI (Hoek et al 1995) with a scale of 0 - 100 is used for the estimation of the rock mass strength and rock mass deformation parameters based primarily on rock structure and rock block surface conditions. Based on the quantitative approach (Cai et al 2004), GSI can be determined from block size (joint spacing) and the joint condition factor defined as follows:

$$J_c = J_w * J_s / J_a$$

Where

J_w = Large scale waviness determined from logged Macro joint roughness

J_s = Small scale smoothness determined from logged Micro joint roughness

J_a = Joint alteration determined from logged Infill condition.

The rock mass can be classified according to GSI as shown in Figure 23.

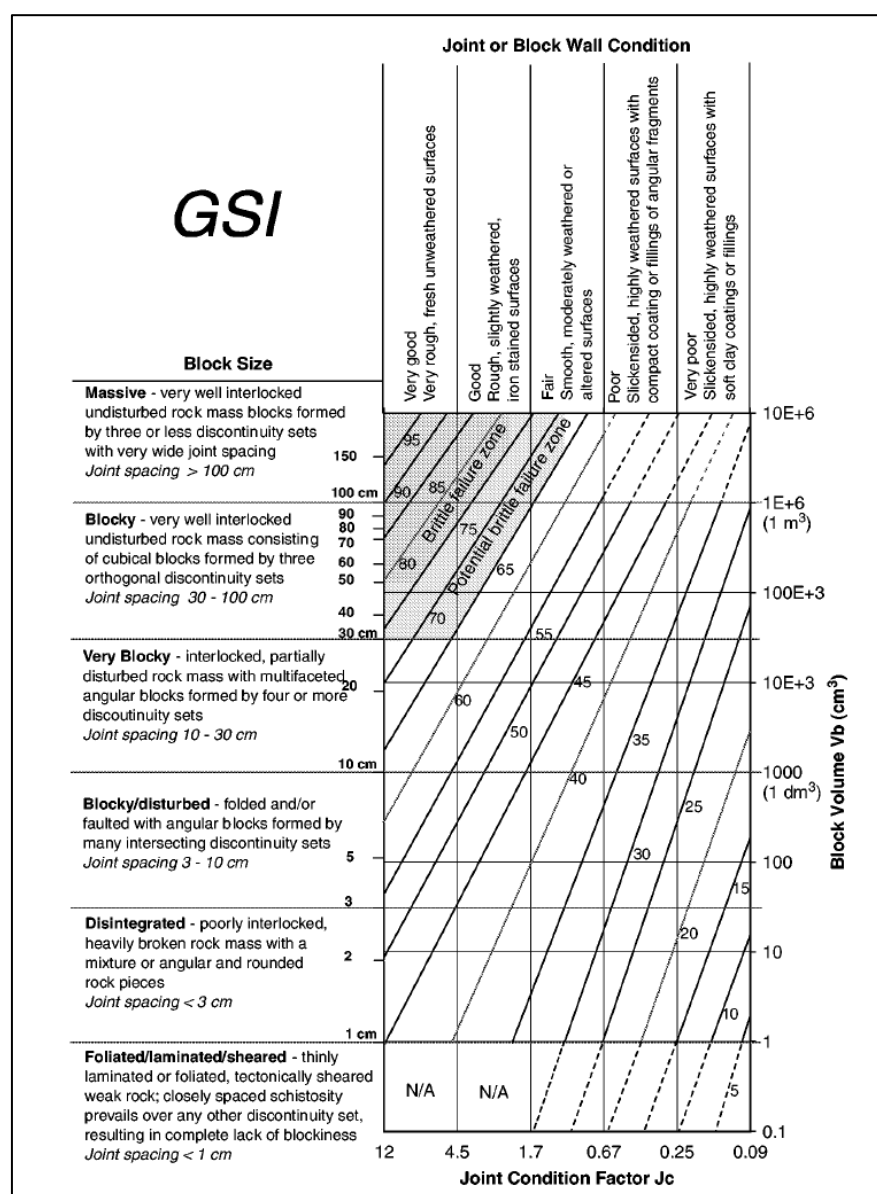


Figure 23 GSI Chart (Cai et al 2004)

7 Mining Rock Mass Model

7.1 Introduction

The MRMM modelling process involves creating a number block models by estimating rock mass values using the processed raw data geotechnical logs (Seymour et al 2007). For this project, the following block models were created:

- RMR and MRMR according to Laubscher's (Laubscher 1990) system.
- Inter Ramp Slope Angle
- Hardness (QSI) – rock strength index from geotechnical logging.
- Rock Block size – RQD/Jn represents the structure of the rock mass and gives a measure of block size.
- Discontinuity Shear Strength – Jr/Ja represents the roughness and frictional characteristics of the joint wall and infill material.
- GSI, Cohesion and angle of internal friction (Phi) to input directly for pit slope modelling
- Fracture Frequency to determine rock bridge

Three dimensional block models were created utilising raw drillhole data comprising rock mass parameters interpolated using inverse distance.

For this project, adjustments applied to the RMR values to determine MRMR for the various units are summarised as follows:

Weathering	=	100% - Fresh rock, no adjustment required
Orientation	=	85% - 3 joint sets plus a random
Induced Stress	=	100% - No principal stress effects on the in-situ rock mass
Blasting	=	95% - Conventional blasting techniques
Total	=	80.75%

The rock mass can be classified according to RMR and GSI as discussed in Section 6 of this report. Descriptions for Rock Strength (Hardness), Rock block size (RQD/Jn) and Discontinuity Shear Strength (Jr/Ja) indices are given in Table 8, Table 9 and Table 10 respectively.

Table 8: Logged hardness vs. estimated rock strength (UCS MPa)

Value	UCS (Mpa)
0.5	<1
1	1 - 5
2	5 - 25
2.5	25 - 50
3	50 - 100
3.5	100 - 130
4	130 - 160
4.5	160 - 180
5	> 180

Table 9 RQD/Jn

Value	Description
0 - 4	Very Poor
4 - 8	Poor
8 - 15	Fair
15 - 25	Good
25 - 50	Very Good

Table 10 Jr/Ja

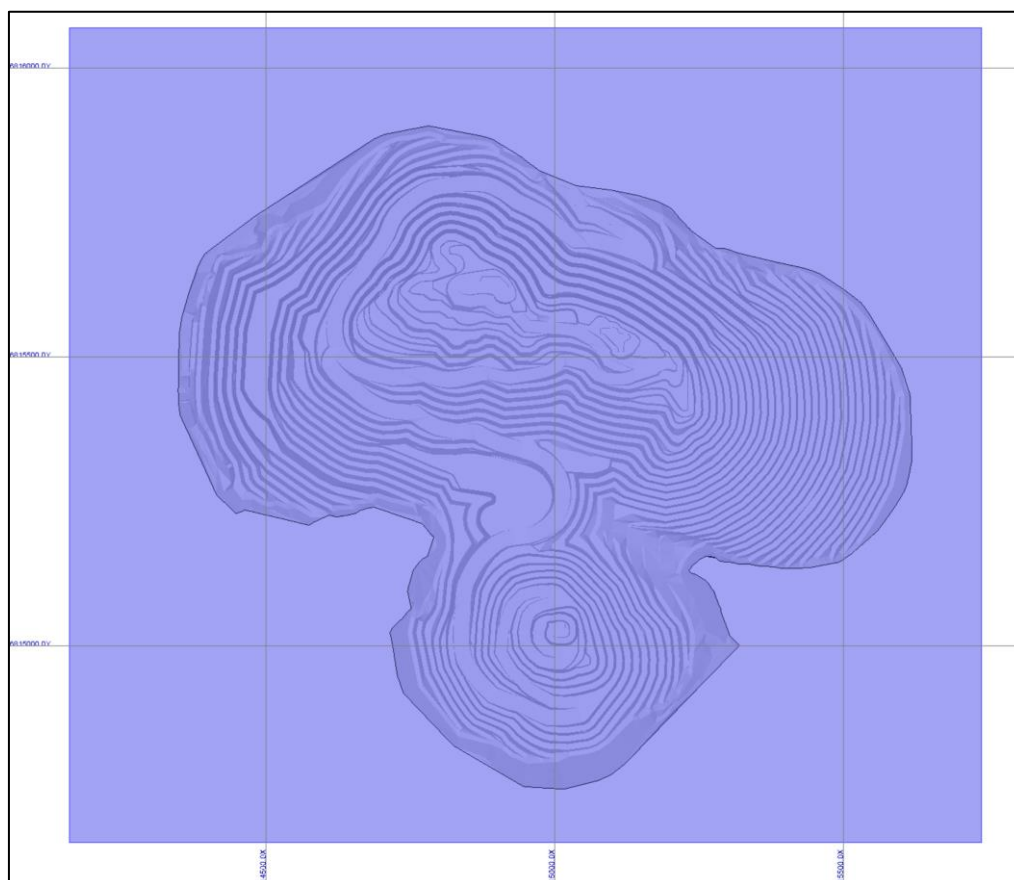
Value	Description
0 - 0.5	Very Poor
0.5 - 0.75	Poor
0.75 - 2	Fair
2 - 3	Good
3 - 4	Very Good

7.2 Model Details

The block model details are as follows:

- X (Easting) origin = 414,160E – 415,740E 316 blocks @ 5m
- Y (Northing) origin = 6,814,660N – 6,816,070N 282 blocks @ 5m
- Z (Elevation) origin = 1,000mRL – 1,700mRL 140 blocks @ 5m

The model grid is shown in Figure 24.

**Figure 24 Planview showing MRMM model grid**

Block models were estimated with search parameters summarised in Table 11

Table 11 Model Search Parameters

UNIT	SEARCH			ORIENTATION Dip/DipDir
	X	Y	Z	
Overburden	300	300	100	--
Mafic, Rhyolite ABM	300	300	50	25/000
Mafic, Rhyolite Krakatoa	300	300	50	30/030
Windlake, Felsic/Volcanic	200	200	200	--
CK Fault	500	300	50	75/320
East Fault	300	300	30	80/145
Mudstone	300	250	30	25/020
NE Structure Krakatoa	300	300	50	80/140
NE Structure ABM	300	300	50	55/150
NNE Structure Krakatoa	300	300	50	60/110
NNE Structure ABM	500	350	50	45/115
EW Structure	300	300	50	40/000

Minimum number of samples = 2, maximum = 12

Block estimates were constrained by the lithological wireframes provided by BMC, the geotechnical structural wireframes developed by D&S and the search ellipses. The orientations of the search ellipses were determined from the orientations of the lithological units and the main structural units.

The block sizes used for the MRMM (Easting = 5m x Northing = 5m x Elevation = 5m) were considered appropriate considering the data density and the project size.

More representative models were estimated by compositing the raw drillhole data to 2m without compositing across logged intervals. For example, if the logged interval was from 10m to 13m, with a composite interval of 2m, the resulting composites would be from 10m to 12m and from 12m to 13m.

The MRMM methodology developed by D&S (Seymour et al 2007) uses inverse distance interpolation to estimate rock mass parameters into the block models. During the estimation process for each unit, only raw composited data for that particular unit was used.

7.3 MRMM Results

Once the model estimation was completed, the block models were then calibrated against raw data and expected conditions. The block models were validated against the raw data visually in section and plan. Summary statistics for raw composited data and block model estimates are given in Table 12.

Table 12 Summary Average Statistics – Raw Composite Data vs. MRMM Estimates

	MAFIC		MUDSTONE		RHYOLITE		WINDLAKE		FELSIC/VOLC	
	Raw data	MRMM	Raw data	MRMM	Raw data	MRMM	Raw data	MRMM	Raw data	MRMM
RMR	45	45	44	44	48	47	41	42	46	45
MRMR	37	37	36	35	38	38	33	34	37	36
IR Slope Angle	48	48	48	48	49	49	47	47	48	48
Hardness	2.8	2.9	2.6	2.6	2.8	2.8	2.6	2.6	2.8	2.8
RQD/Jn	11.0	11.3	12.7	12.2	8.7	8.5	9.5	9.8	11.3	11.6
Jr/Ja	1.1	1.0	0.8	0.7	1.8	1.8	0.8	0.8	1.1	1.0
GSI	47.9	47.4	47.0	45.6	52.6	51.4	44.1	44.5	49.0	47.3
Phi	31.3	31.9	32.2	32.4	33.0	33.1	33.0	32.5	32.8	32.1
FF	20	19	21	20	18	18	19	19	20	20

	CK FAULT		EAST FAULT		EW STRUCTURE		NE STRUCTURE		NNE STRUCTURE	
	Raw data	MRMM	Raw data	MRMM	Raw data	MRMM	Raw data	MRMM	Raw data	MRMM
RMR	18	18	21	21	23	24	22	21	23	23
MRMR	15	15	17	17	19	19	18	17	19	18
IR Slope Angle	37	37	38	38	39	40	39	38	39	39
Hardness	1.2	1.2	1.3	1.2	1.7	1.8	1.6	1.7	1.7	1.6
RQD/Jn	2.9	3.3	2.8	2.5	3.6	3.5	2.4	2.2	4.0	3.8
Jr/Ja	0.3	0.3	0.4	0.4	0.5	0.6	0.5	0.4	0.5	0.5
GSI	21.5	21.4	26.6	26.8	27.2	27.7	27.6	25.7	27.5	27.2
Phi	23.7	23.7	23.4	22.3	25.7	25.9	25.8	25.4	23.7	23.1
FF	7	8	8	9	9	8	8	7	9	9

The differences between raw data and interpolated values are considered to be acceptable considering the data density and it is concluded that based on the raw data available, the block models give a reasonable representation of the likely rock mass conditions.

The rock mass quality of the main rock units is generally Fair with RMR values in the range 41-48.

The faults and geotechnical features are classified as Very Poor to Poor with RMR values in the range 18 – 24.

The MRMM was interrogated in section and in plan to assess the variability of the input parameters and the effect of the overall slope angle for the proposed pit design. As a result of this review the project area has been divided into seven domains, as shown in Figure 25.

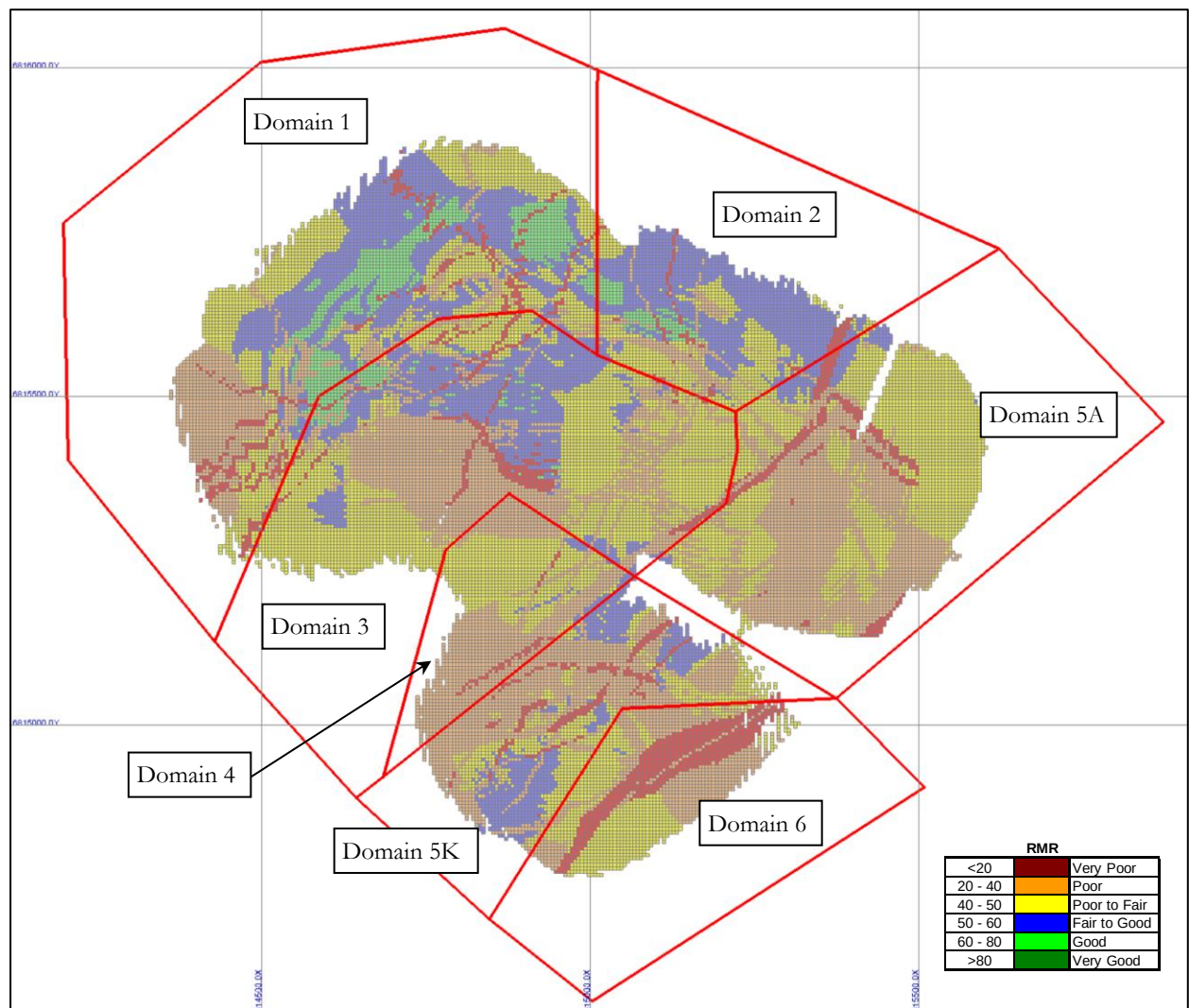


Figure 25 Geotechnical Domains

Representative cross-sections (marked in Figure 26) showing RMR block values and the pit outline are shown in Figure 27 to Figure 34.

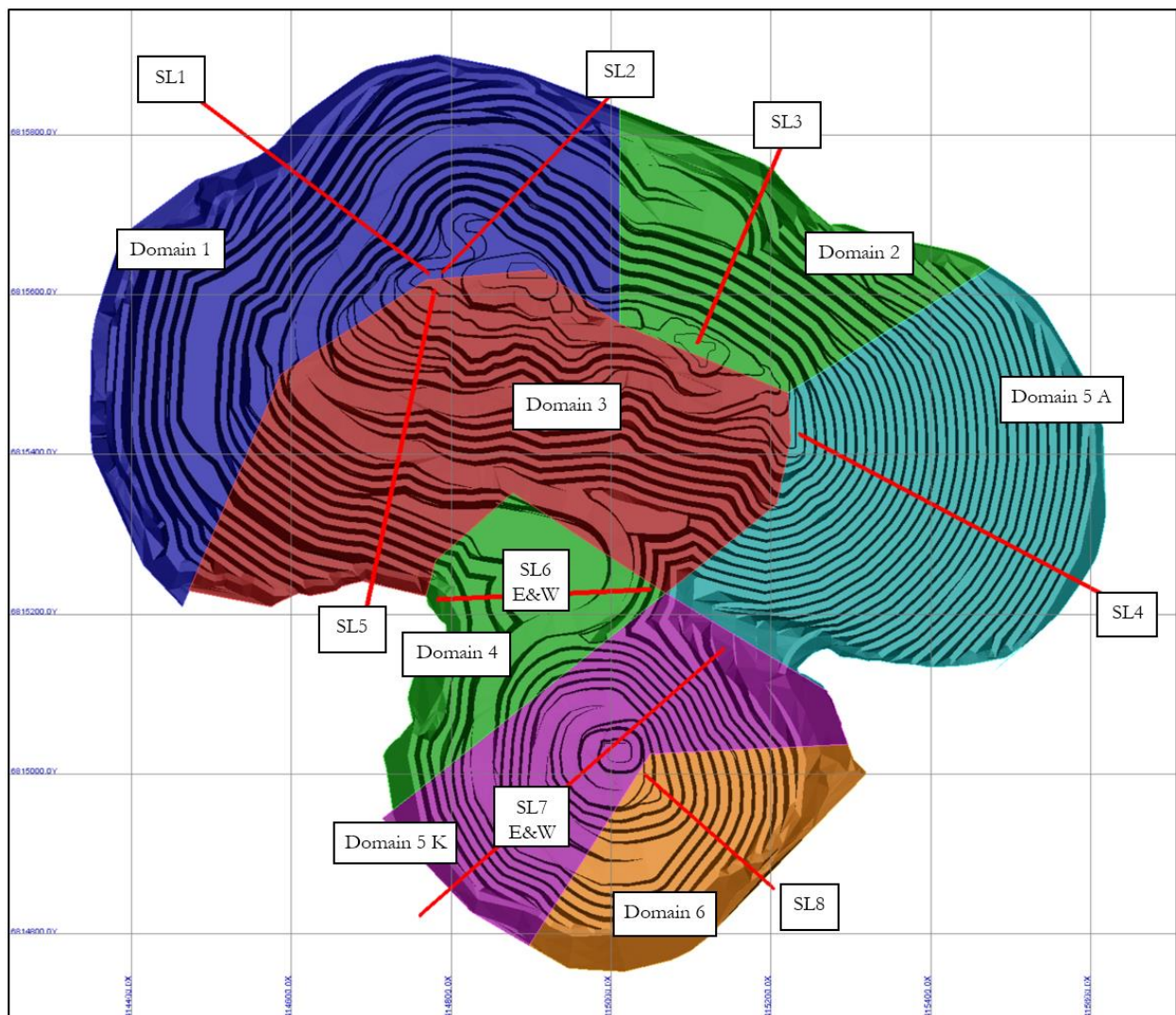


Figure 26 Representative cross-sections

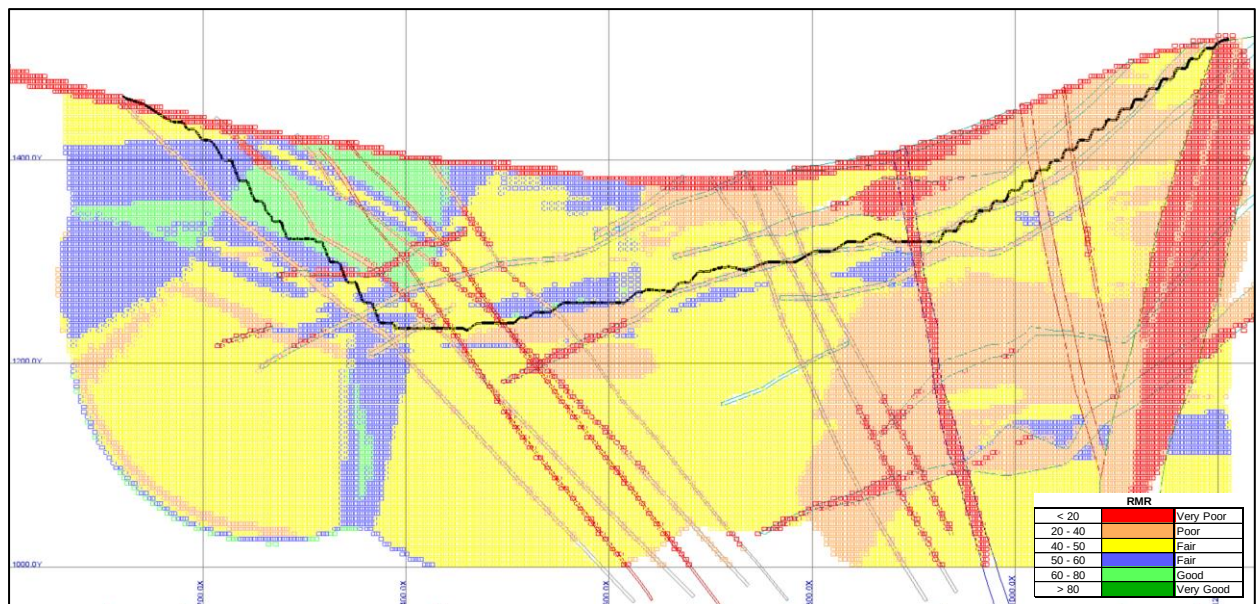


Figure 27 Section SL1 looking north east showing estimated RMR values, geotechnical features and the DFS pit outline

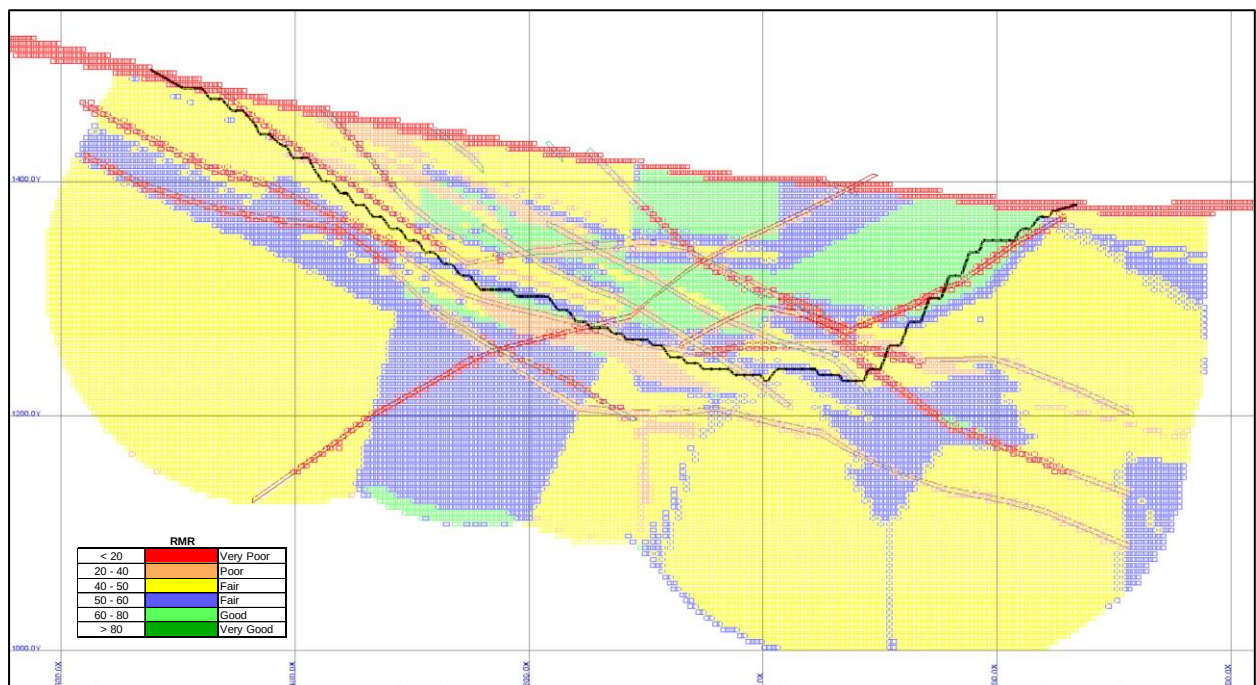


Figure 28 Section SL2 looking north west showing estimated RMR values, geotechnical features and the DFS pit outline

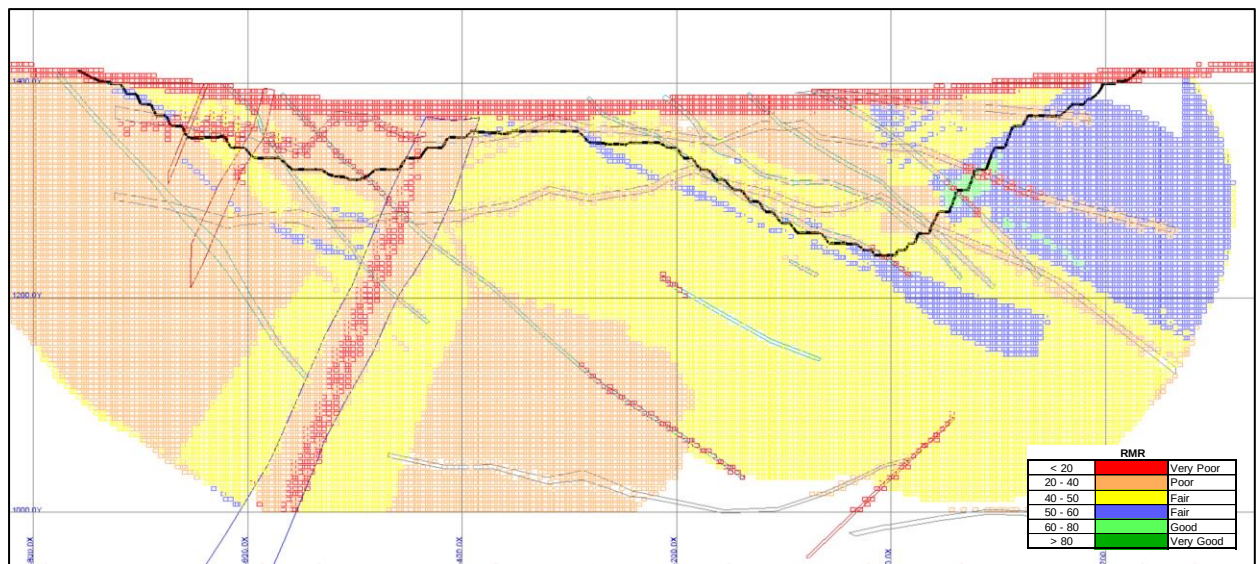


Figure 29 Section SL3 looking north west showing estimated RMR values, geotechnical features and the DFS pit outline

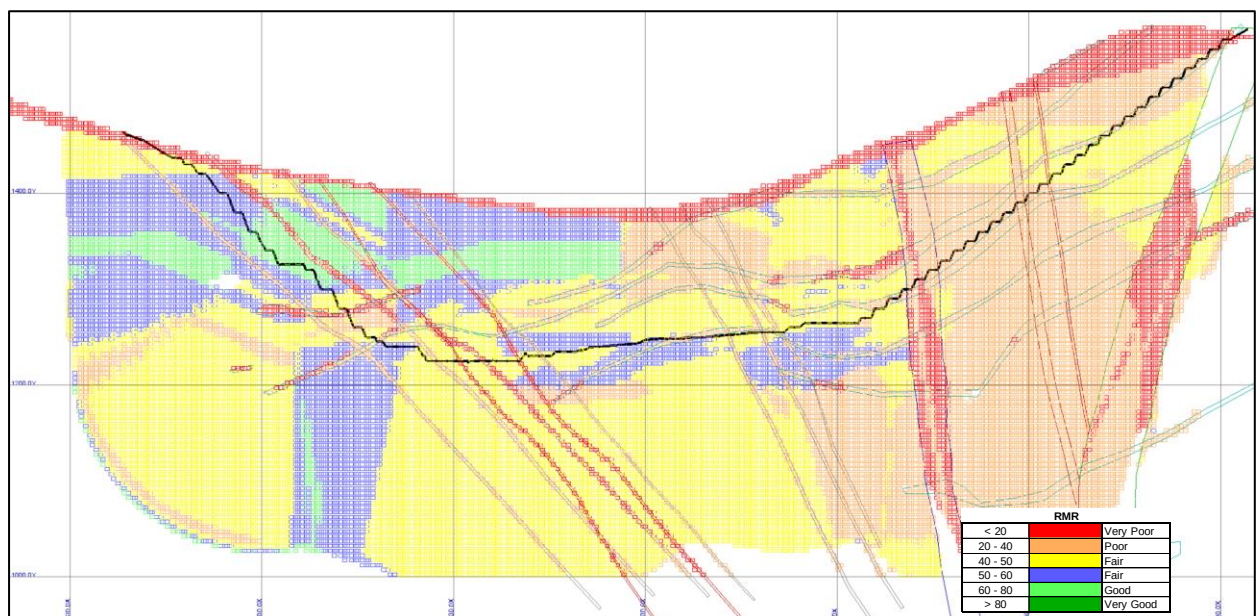


Figure 30 Section SL4 looking north east showing estimated RMR values, geotechnical features and the DFS pit outline

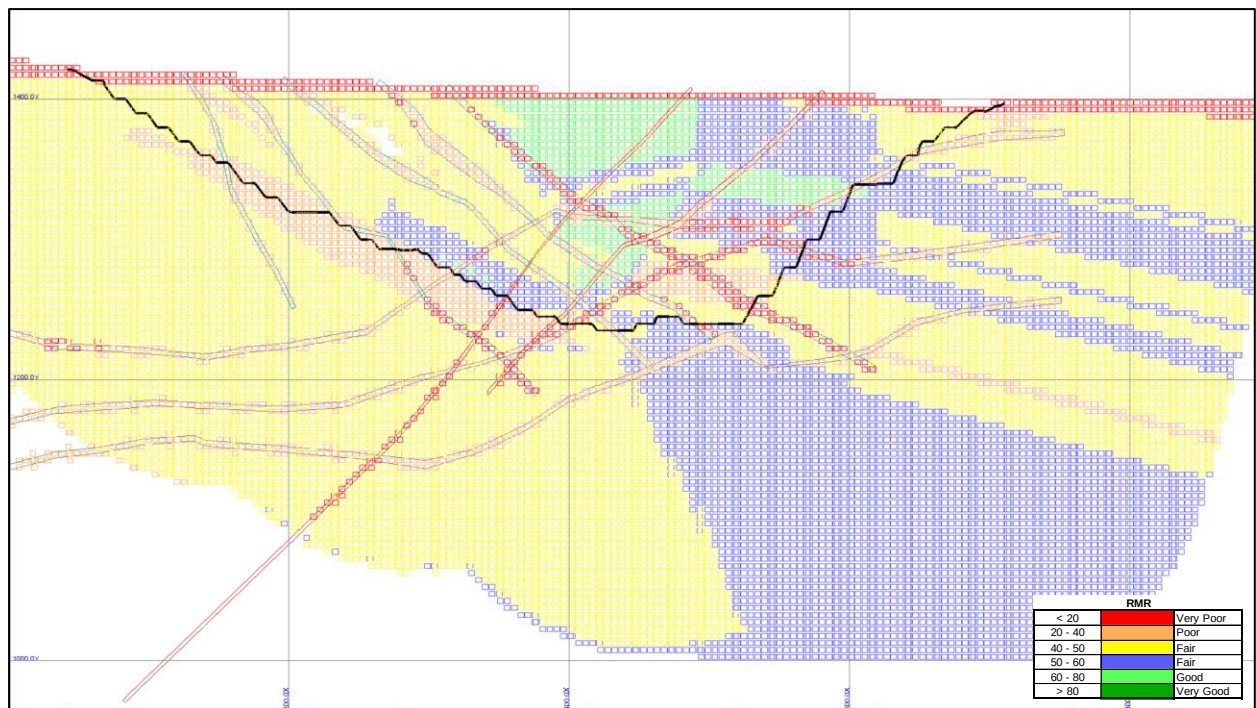


Figure 31 Section SL5 looking west showing estimated RMR values, geotechnical features and the DFS pit outline

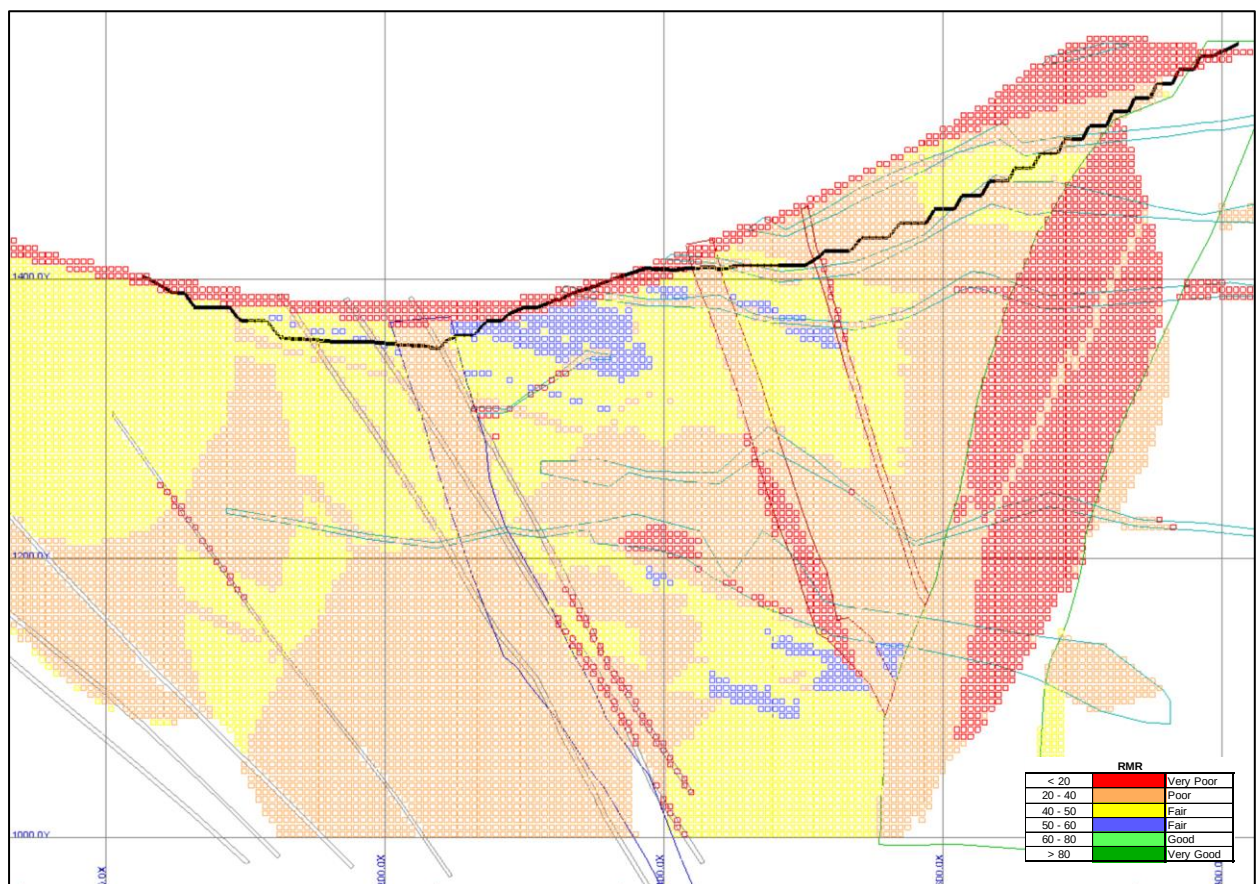


Figure 32 Section SL6 looking north showing estimated RMR values, geotechnical features and the DFS pit outline

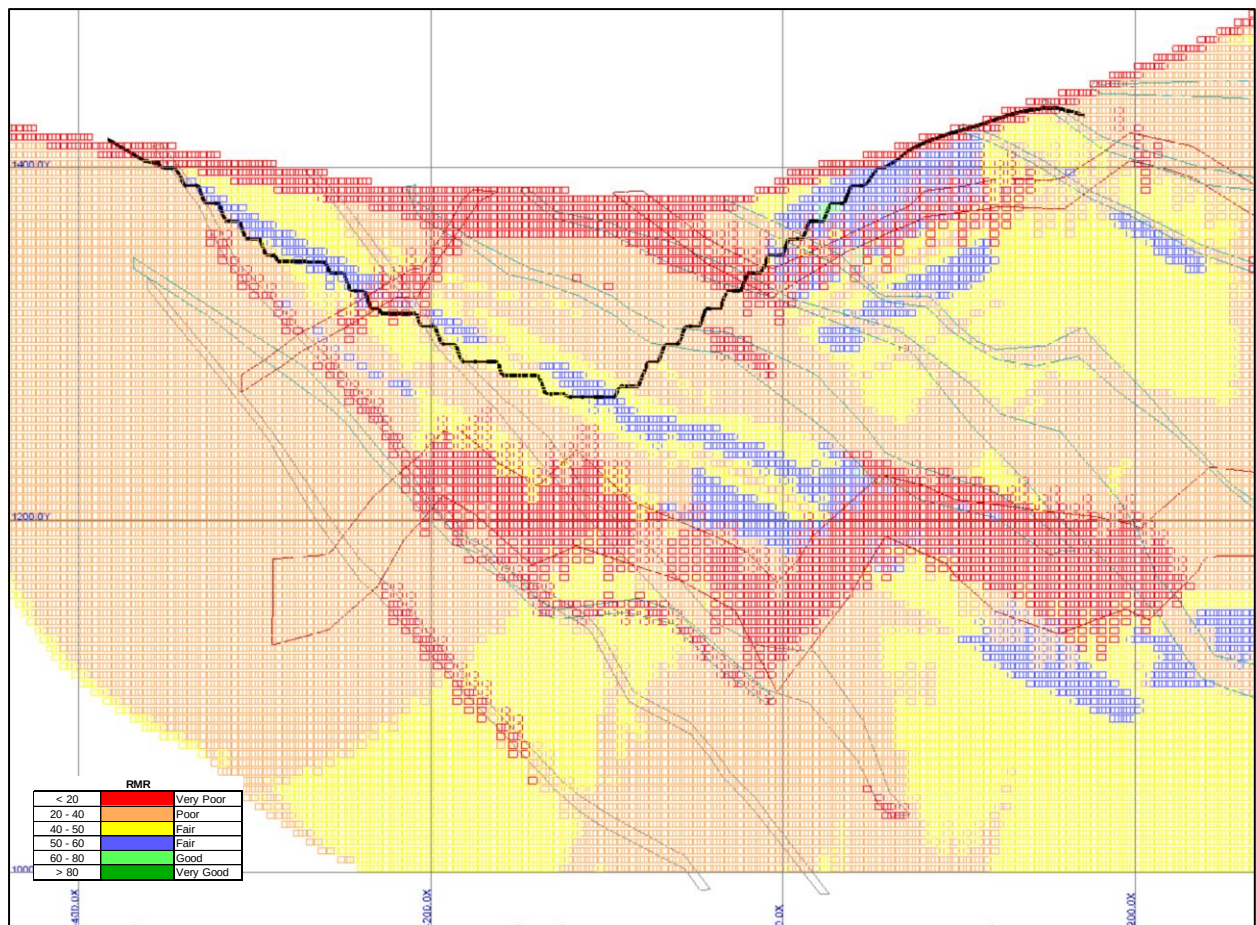


Figure 33 Section SL7 looking north west showing estimated RMR values, geotechnical features and the DFS pit outline

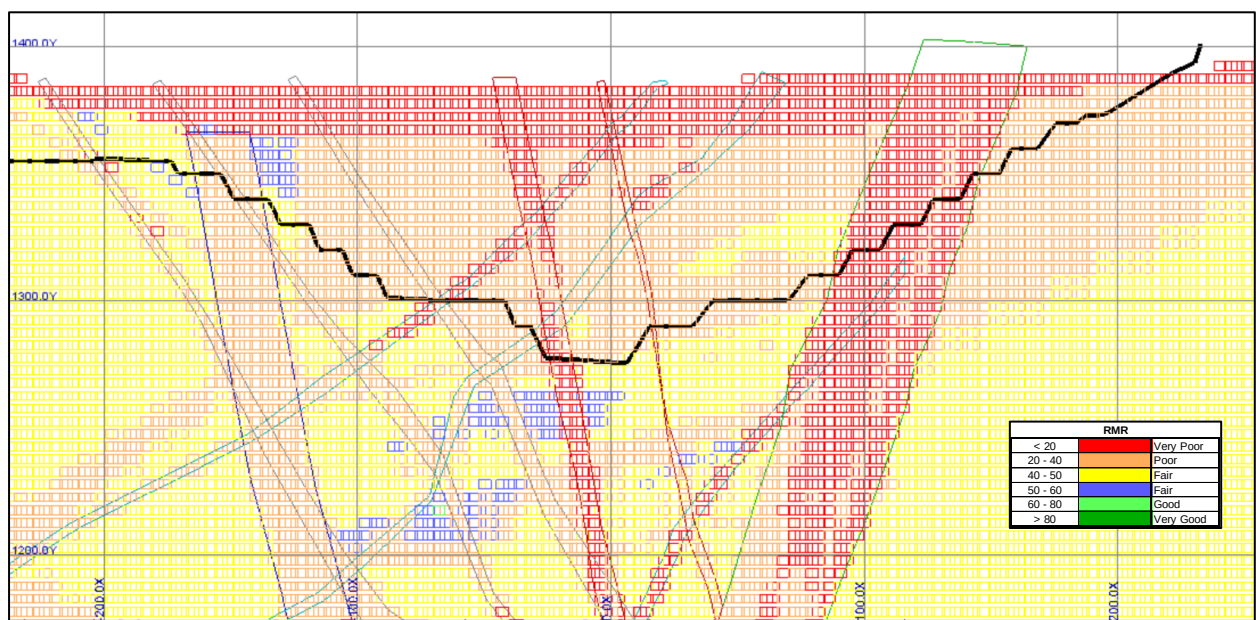


Figure 34 Section SL8 looking north east showing estimated RMR values, geotechnical features and the DFS pit outline

8 Rock Bridge

8.1 Introduction

Overall pit slope failure is a combination of failure through intact rock (termed rock bridge) and structure. Hoek-Brown failure criteria is used to determine the likelihood of failure occurring through intact rock and the Barton shear strength envelope is used to assess the likelihood of structurally controlled failure. Traditionally, the strength data determined from either or both of these criteria are then independently applied to limit equilibrium models to assess slope stability. Analyses using Barton may result in a conservative pit slope angle and Hoek-Brown a more aggressive pit slope angle. Generally, the respective strength parameters are adjusted based on experience to allow for rock bridge or structure.

In order for both methods to be applied simultaneously to slope stability design, fracture frequency determined in the MRMM is used to determine the ratio of rock bridge to structure expressed as a percentage of rock bridge. This ratio per rock type within each geotechnical domain is input into limit equilibrium models. Appropriate strength parameters are then assigned from Hoek-Brown and Barton which have been statistically analysed from parameters modelled in the MRMM. (Dempers 2011).

8.2 Determination of Rock Bridge Percentage

Seven geotechnical design domains have been identified as shown in Figure 25 and the average RMR fracture frequency rating (FFR) calculated from fracture frequency per rock type within each domain is determined from the MRMM. The FFR ranges from 0 to 40 as shown in Table 13.

Table 13 Fracture Frequency Rating (FFR) ranges.

Average joints per metre	Fracture Frequency Rating		
	1 joint set	2 joint sets	3 joint sets
0.10	40	40	40
0.15	40	40	40
0.20	40	40	38
0.25	40	38	36
0.30	38	36	34
0.50	36	34	31
0.80	34	31	28
1.00	31	28	26
1.50	29	26	24
2.00	26	24	21
3.00	24	21	18
5.00	21	18	15
7.00	18	15	12
10.00	15	12	10
15.00	12	10	7
20.00	10	7	5
30.00	7	5	2
40.00	5	2	0

The percentage of rock bridge for each rock type within each geotechnical domain is determined from the FFR with the maximum possible rock bridge set at 70%. Therefore; a FFR of 40 is equivalent to 70% rock bridge.

For example, a rock type within a particular geotechnical domain may have two fractures per metre with three joints sets which equates to a rating of 21 (highlighted in Table 13). The rock bridge percentage is determined as follows:

$$\begin{aligned}\text{Rock Bridge \%} &= \left(\frac{\text{FFR}}{\left(\frac{40}{0.7} \right)} \right) \times 100 \\ &= \left(\frac{21}{57} \right) \times 100 \\ &= 37\%\end{aligned}$$

The calculated rock bridge percentage values determined from the Fracture Frequency Rating (FFR) block model for each rock unit within each geotechnical domain (shown in Figure 25) are given in Figure 35.

Domain 1

Rock Type	FFR	Rock Bridge	Structure
OVERBURDEN	0	0%	100%
MAFIC	22	39%	61%
MUDSTONE	20	35%	65%
RHYOLITE	26	46%	54%
WINDLAKE			
FELSIC/VOLC	23	41%	59%
EW	8	14%	86%
NNE	9	16%	84%
NE	1	2%	98%
EAST			
CK			

Domain 2

Rock Type	FFR	Rock Bridge	Structure
OVERBURDEN	0	0%	100%
MAFIC	24	41%	59%
MUDSTONE	19	34%	66%
RHYOLITE	21	36%	64%
WINDLAKE	21	37%	63%
FELSIC/VOLC	20	36%	64%
EW	8	14%	86%
NNE	8	14%	86%
NE	1	2%	98%
EAST	1	2%	98%
CK			

Domain 3

Rock Type	FFR	Rock Bridge	Structure
OVERBURDEN	0	0%	100%
MAFIC	17	30%	70%
MUDSTONE	22	39%	61%
RHYOLITE	20	35%	65%
WINDLAKE			
FELSIC/VOLC	20	36%	64%
EW	8	14%	86%
NNE	8	14%	86%
NE	3	4%	96%
EAST	11	19%	81%
CK			

Domain 4

Rock Type	FFR	Rock Bridge	Structure
OVERBURDEN	0	0%	100%
MAFIC	14	25%	75%
MUDSTONE			
RHYOLITE	17	29%	71%
WINDLAKE			
FELSIC/VOLC	19	33%	67%
EW	8	14%	86%
NNE	7	13%	87%
NE			
EAST	11	20%	80%
CK			

Domain 5A

Rock Type	FFR	Rock Bridge	Structure
OVERBURDEN	0	0%	100%
MAFIC	20	35%	65%
MUDSTONE			
RHYOLITE	16	27%	73%
WINDLAKE	19	33%	67%
FELSIC/VOLC	17	29%	71%
EW	6	11%	89%
NNE			
NE	9	17%	83%
EAST	6	10%	90%
CK	3	5%	95%

Domain 5K

Rock Type	FFR	Rock Bridge	Structure
OVERBURDEN	0	0%	100%
MAFIC	19	33%	67%
MUDSTONE			
RHYOLITE	15	26%	74%
WINDLAKE			
FELSIC/VOLC	16	28%	72%
EW	8	14%	86%
NNE	8	14%	86%
NE	8	13%	87%
EAST	10	18%	82%
CK	3	5%	95%

Domain 6

Rock Type	FFR	Rock Bridge	Structure
OVERBURDEN	0	0%	100%
MAFIC	19	34%	66%
MUDSTONE			
RHYOLITE	15	26%	74%
WINDLAKE			
FELSIC/VOLC	19	33%	67%
EW	5	9%	91%
NNE			
NE	12	21%	79%
EAST			
CK	5	8%	92%

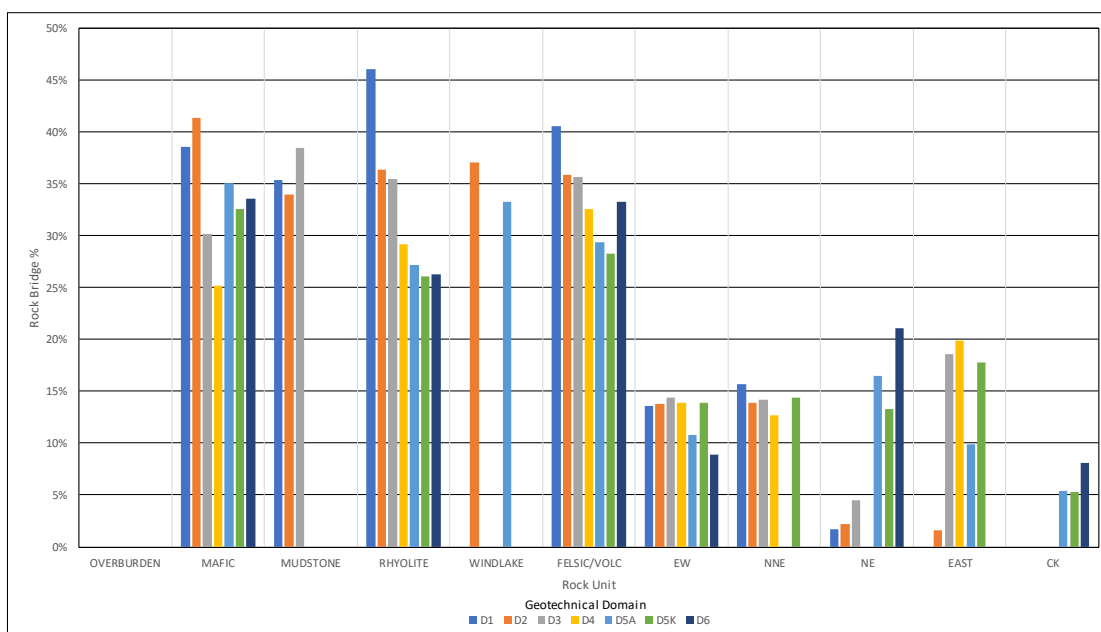


Figure 35 Rock Bridge by Geotechnical Domain

Having calculated the rock bridge percentage from the average FFR, the next stage is to determine the fracture frequency cut off rating, above which the rock mass is assigned rock bridge with Hoek-Brown failure criteria. Material below the cut off is assigned Barton shear strength properties. The cut off is determined from the cumulative fracture frequency for each rock type in each geotechnical domain obtained from the MRMM.

For example, the MUDSTONE unit in Domain 1 (Figure 35) has a FFR of 20 and a rock bridge percentage of 35%. The fracture frequency cut off rating based on the distribution of the fracture frequency data is 22 as shown in Figure 36. This process is repeated for every rock type in each of the geotechnical domains.

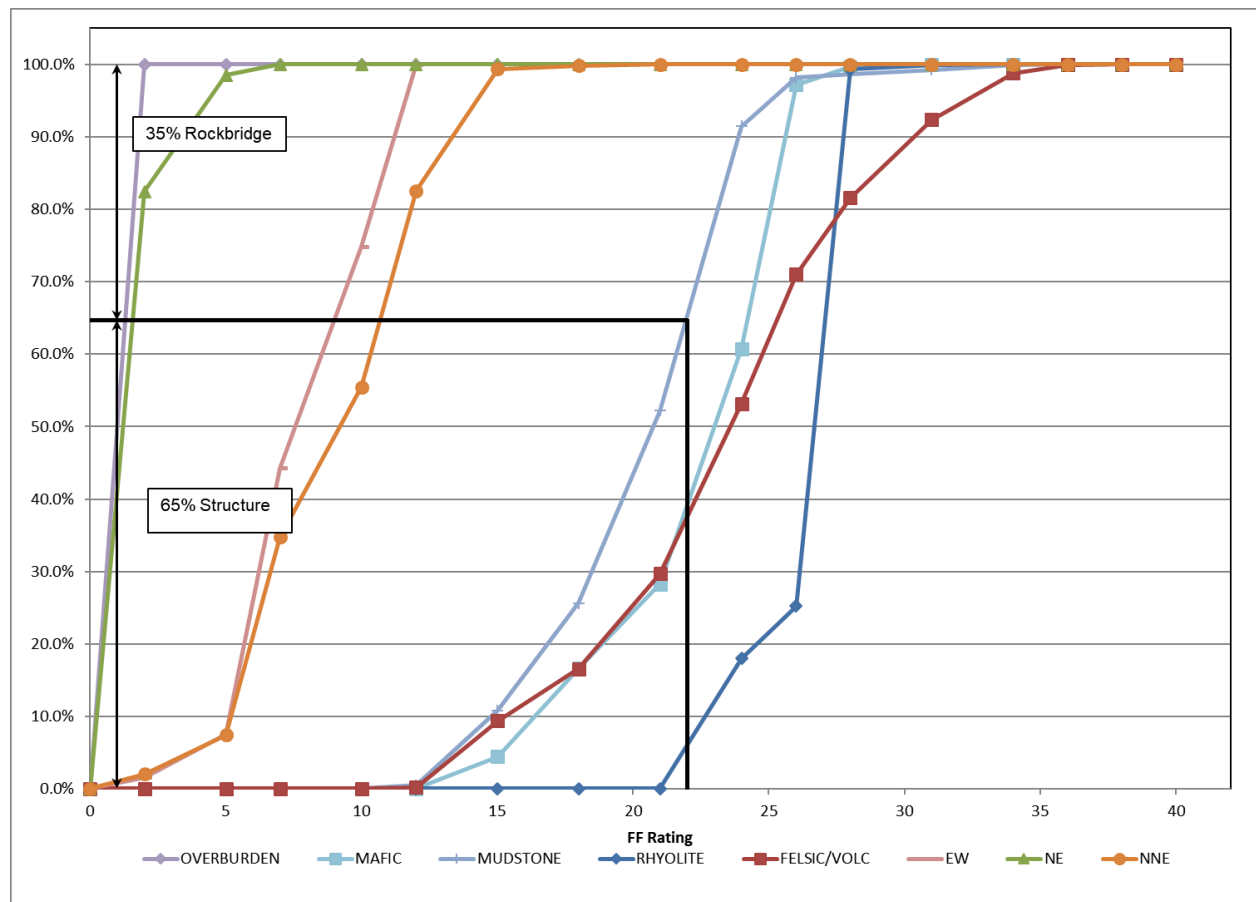
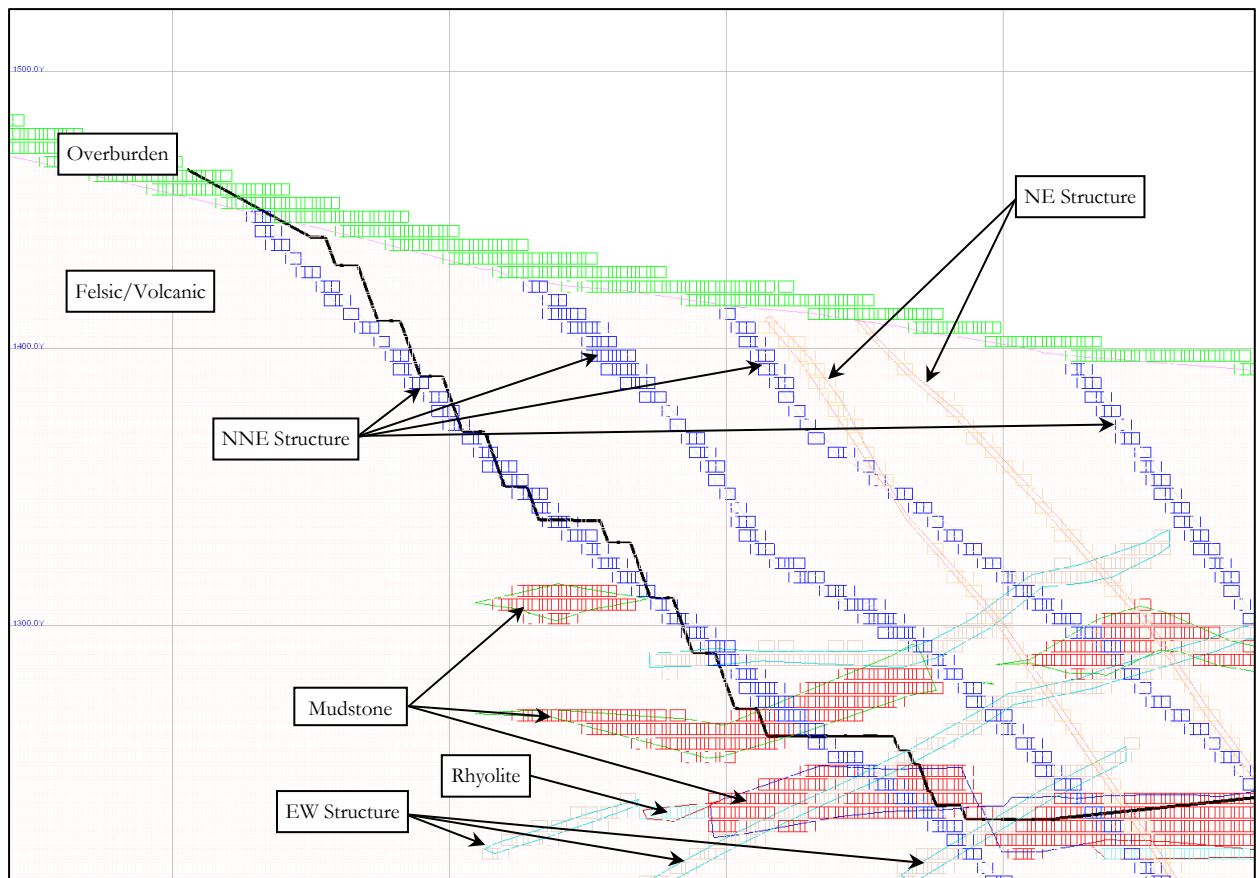


Figure 36 Domain 1 Cumulative Fracture Frequency

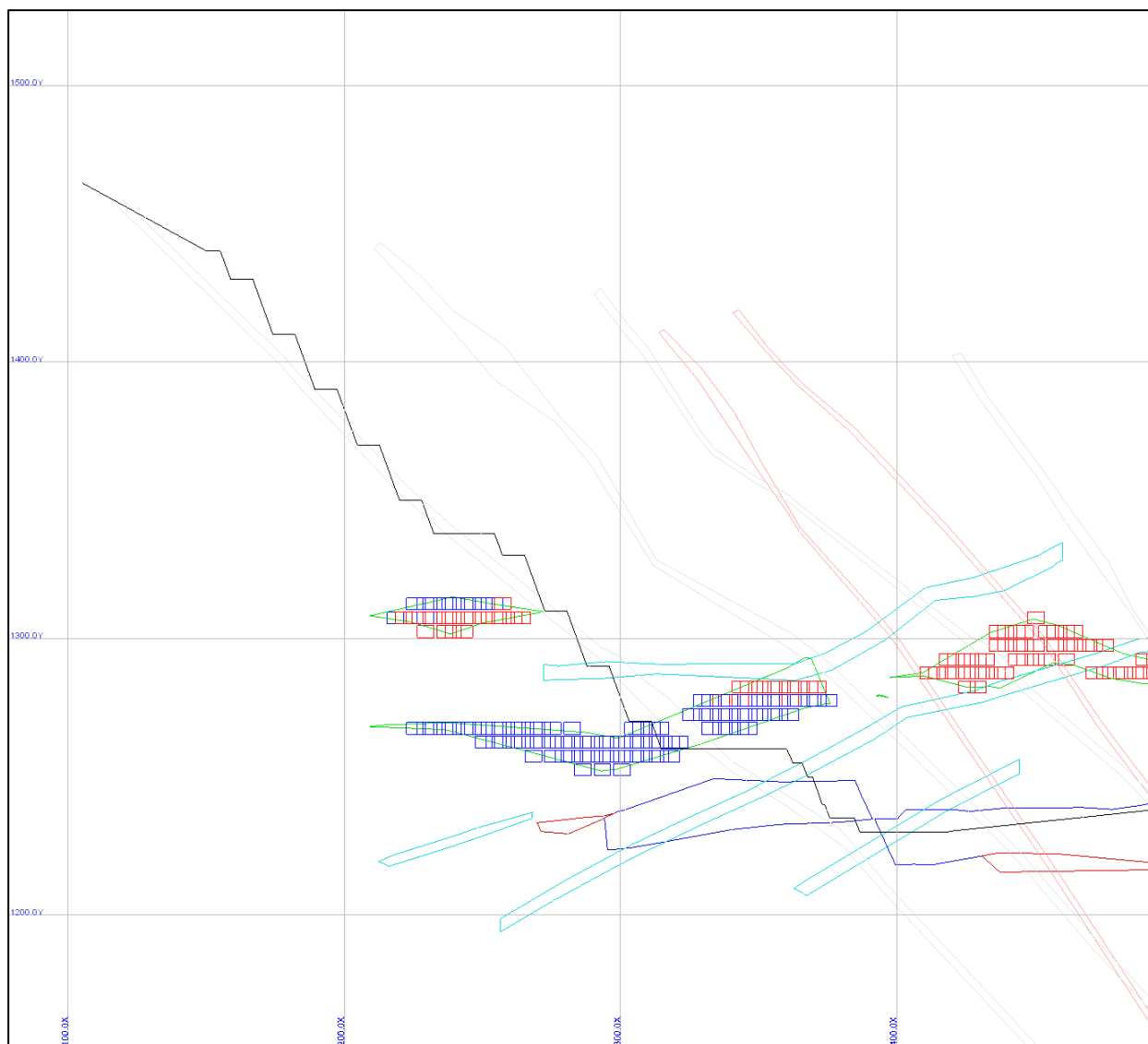
Finally, representative sections are created for each geotechnical domain which are input to limit equilibrium analyses for slope assessment (Refer to Section 11). The process is illustrated in Figure 37 to Figure 39.



Step 1

Create rock unit outlines from the MRMM

Figure 37 Domain 1 Section SL1 showing the MRMM rock unit block model and the PFS pit outline



Step 2

Each rock unit is sub-divided for rock bridge and structure based on the fracture frequency cut-off.

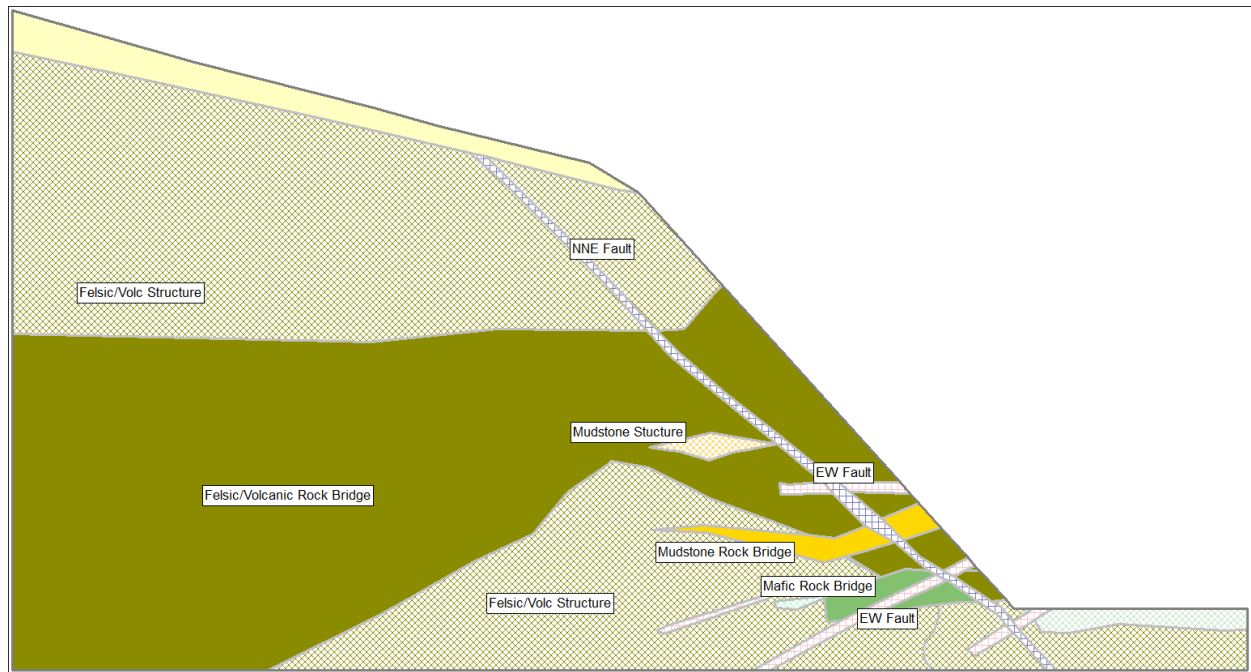
For example: The fracture frequency cut-off for the MUDSTONE unit = 22

Blue = Rock bridge $FFR > 22$

Red = Structure $FFR < 22$

This procedure is repeated for each rock unit.

Figure 38 Domain 1 Section SL1 Mudstone Unit - Rock bridge / Structure Domains with the PFS pit outline



Step 3

The section is exported to Slide once all of the rock units have been subdivided. Appropriate parameters are then assigned for either rock bridge or structure. The section represents the correct proportion of rock bridge to structure and the actual location based on the 3d MRMM.

Figure 39 Domain 1 Section SL1 – Complete profile for limit equilibrium analysis

9 Structural Data

9.1 Introduction

The structural stability analyses were based on the PFS pit designs available at the time. Subsequently, BMC provided the final DFS pit design which was reviewed by D&S to confirm the original analyses were applicable to the DFS pit design.

Structural data was compiled from boreholes located across the proposed ABM and Krakatoa pit locations from both downhole acoustic (ATV) & optical (OTV) surveys and from structural logging of diamond drillholes.

The data for the ABM pit identified 4,578 structures from seven televiewer surveyed holes. The data for the Krakatoa pit identified 1,725 structures from one televiewer surveyed hole and four previously logged drillholes (Rockland 2016). The structural data sources are summarised in Table 14.

Table 14: Structural Data Drillhole List

Hole ID	Logging Type	Pit Location
K16-371	Drillhole logging	Krakatoa
K16-373	Drillhole logging	Krakatoa
K16-376	Drillhole logging	Krakatoa
K16-377	Drillhole logging	Krakatoa
K17-420	Televiewer Logging	ABM
K17-422	Televiewer Logging	ABM
K17-424	Televiewer Logging	ABM
K17-427	Televiewer Logging	ABM
K17-430	Televiewer Logging	ABM
K17-438	Televiewer Logging	ABM
K17-439	Televiewer Logging	ABM
K17-440	Televiewer Logging	Krakatoa

A comparison of the structural data collected from the televiewer was conducted with representative structural logging from the K17-427 drillhole shown in Figure 40. The data shows a good correlation between the televiewer and logging data giving confidence on the results of the televiewer surveys.

The stereonet also highlights that the televiewer is able to collect more data than the logging as it does not rely on an orientation line that is quite often unavailable in the physical core due the shearing and other poor-quality section in the rock that prevent a reliable orientation line.

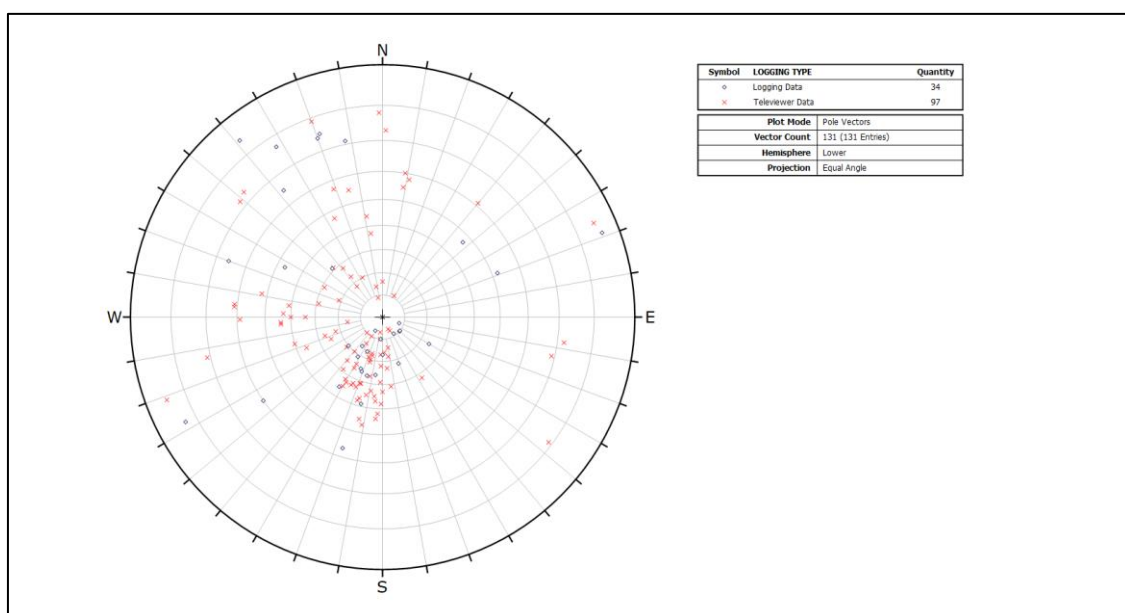


Figure 40: Stereographic pole plot comparison of Logged and Televiewer structure

9.2 Defect Set Orientations

Using the location within the proposed pits, the structural data was coded according to the principal rock types as defined by the MRMM. The principal rock types that intercept each pit are Felsic volcanic (FELSVOLC), Mafic (MAFIC), Mudstone (MUDST), Rhyolite (RHYOL) and Windlake (WIND) with the datasets for the ABM and Krakatoa pits shown in Figure 41 and Figure 42 respectively.

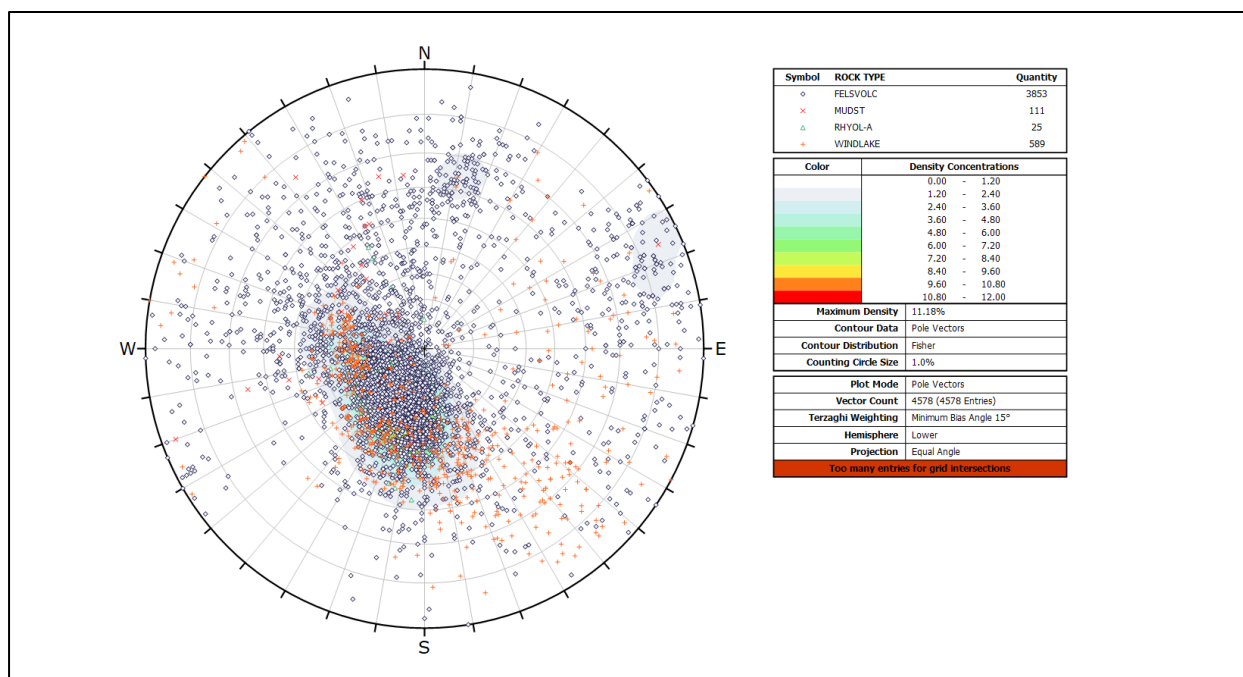


Figure 41: Stereographic pole plot ABM data by rock type

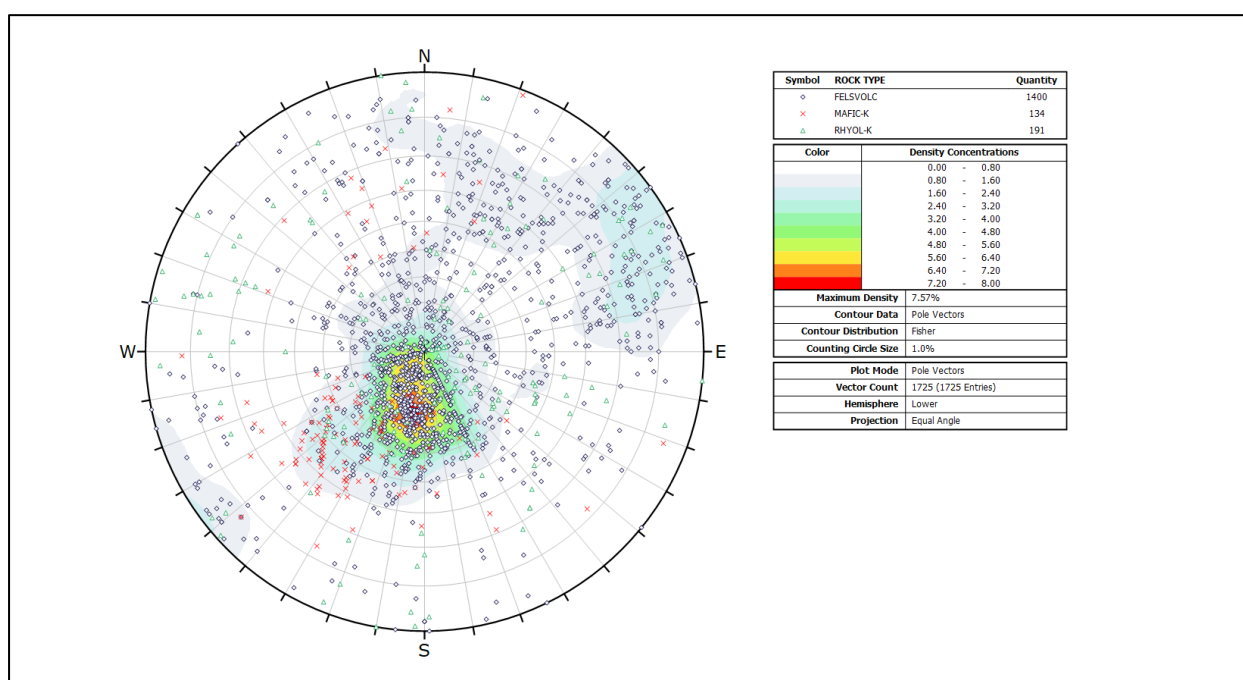


Figure 42: Stereographic pole plot Krakatoa data by rock type

Structural data was also tagged within geotechnically significant structures; however, this data was not included as the data points within the geotechnical structures are locally highly variable due to shearing. Therefore, the global plots of the structures were used as defined from the structural interpretation (Section 4) as shown in Figure 43

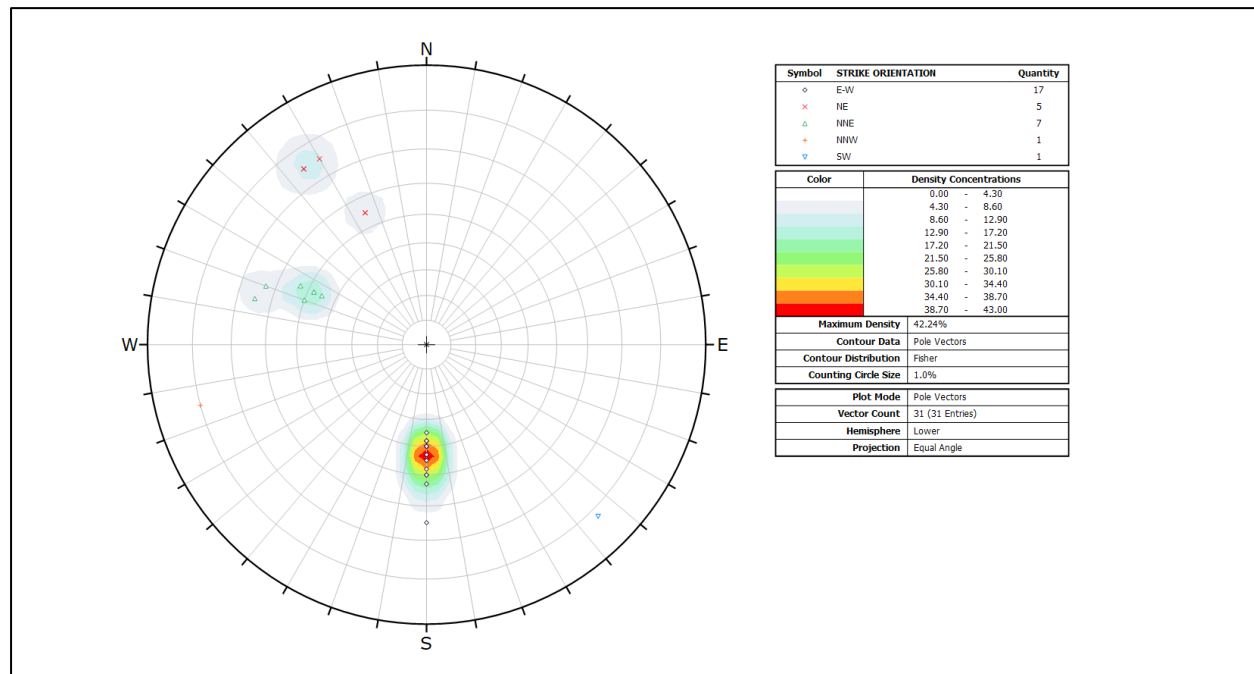


Figure 43: Stereographic pole plot Geotechnically Significant structures

The proportion of each rock type by pit area are as follows;

ABM Pit

- FELSVOLC (84% of data)
- MUDST (2% of data)
- RHYOL (<1%)
- WIND (13%)

While there are structures identified within the Rhyolite rock type for the ABM pit there are only 25 total structures identified which is insufficient for analysis. Therefore, the Rhyolite data was included with the Felsic volcanic data for the structural analysis.

Krakatoa Pit

- FELSVOLC (81% of data)
- MAFIC (8% of data)
- RHYOL (11% of data)

The data was further interrogated based on each rock type with stereographic projections and tables summarising the defect sets for each wall given in the following section.

9.3 Defect Set Orientations and Properties

The geotechnically significant structural data was evaluated for each of the rock types for both the ABM and Krakatoa PFS pits.

9.3.1 ABM Pit

Investigation of the ABM data shows that there is further subdivision within some of the rock types.

The FELSVOIC rock type shows a change in the dip direction orientation of the foliation between the West and the East sides of the pit with Figure 44 showing which holes fall within the Western and Eastern Sectors of the pit.

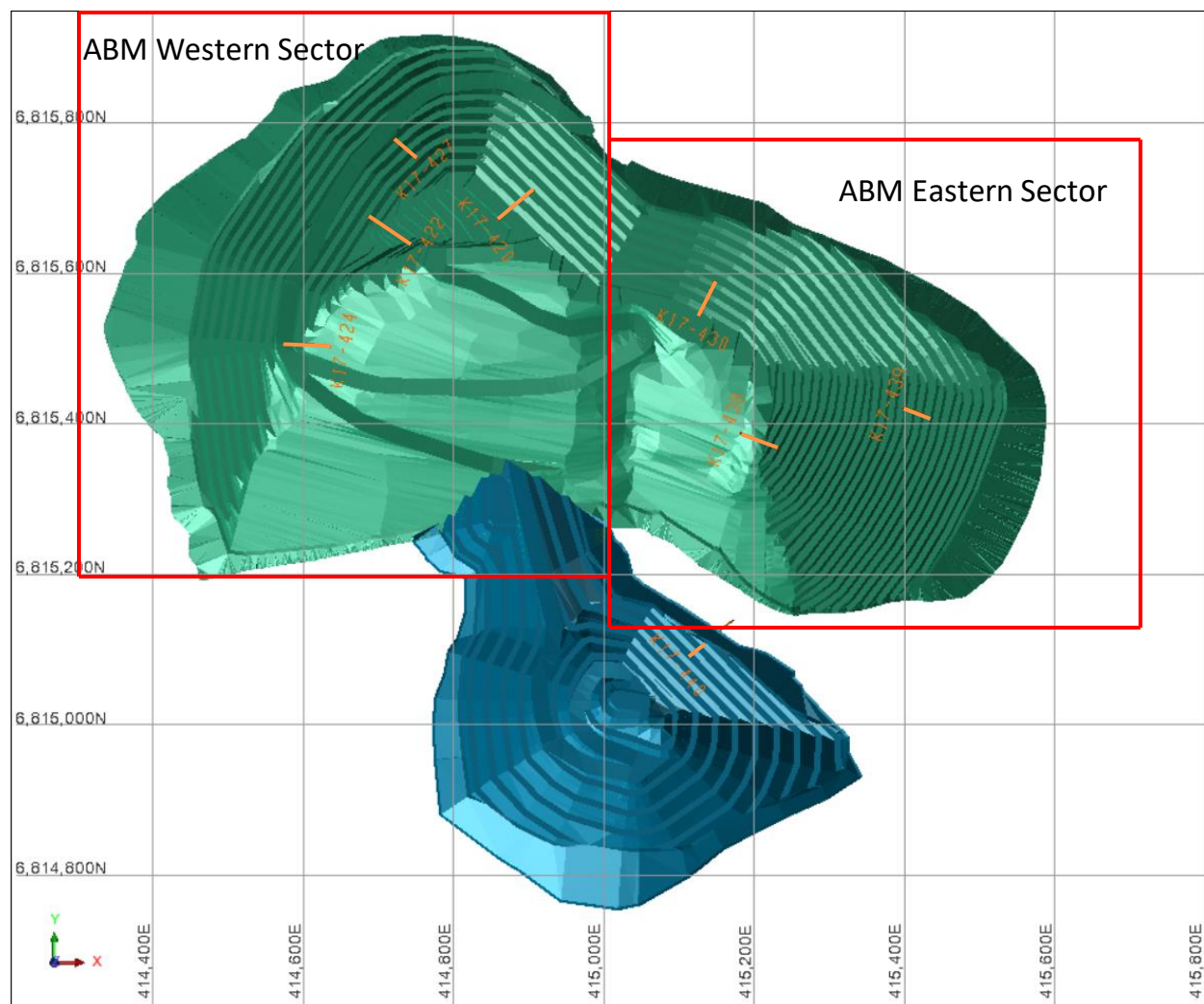


Figure 44: ABM PFS Pit Sectors for Stereographic Analysis

The mean set orientations and joint conditions for each rock type present in the pit walls are summarised in Figure 45 to Figure 48 and Table 15 to Table 18.

Furthermore, the WINDLAKE unit present in the Eastern Sector, Table 18, shows a change in the dip direction of the foliation with depth. Set 1 defines the foliation above 1450mRL and Set 1a defines the foliation below 1450mRL.

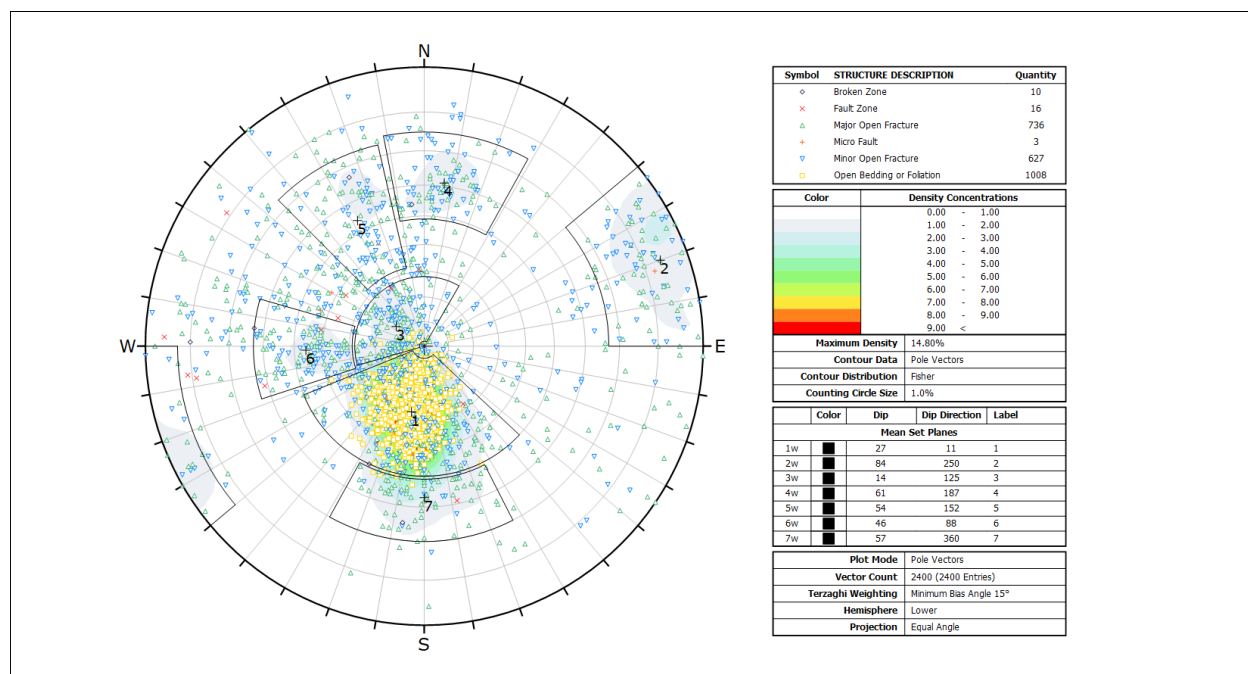


Figure 45: Stereographic plot – ABM pit Western Sector FELSVOLC

Table 15: Summary of ABM pit Western Sector FELSVOLC defect sets

ABM West Sector FELSVOLC Types Sets							
Set No.	Dip	Dip Range	Dip Direction	Dip Direction Range	Joint Type	Joint Condition	Infill Type
1	27°	04°-50°	011°	318°-068°	Foliation	Smooth & Undulating to Rough & Planar	Fine Softening Material to Fine Non-softening Material
2	84°	66°-90°	250°	234°-270° / 053°-090°	Joint	Smooth & Undulating to Rough & Undulating	Coarse Non-softening Material to Fine Softening Material
3	14°	01°-28°	125°	075°-208°	Joint	Smooth & Undulating to Rough & Undulating	Fine Softening Material to Coarse Non-softening Material
4	61°	50°-73°	187°	161°-207°	Joint	Rough & Planar to Smooth and Undulating	Medium Non-softening material to Medium Softening Material
5	54°	32°-70°	152°	136°-168°	Joint	Smooth & Undulating to Rough & Planar	Medium Softening Material to Coarse Non-softening Material
6	46°	30°-61°	088°	073°-107°	Joint	Rough & Undulating to Smooth & Undulating	Coarse Non-softening Material to Fine Softening Material
7	57°	51°-70°	360°	334°-052°	Joint	Smooth & Undulating to Rough & Undulating	Fine Softening Material to Medium Non-softening Material

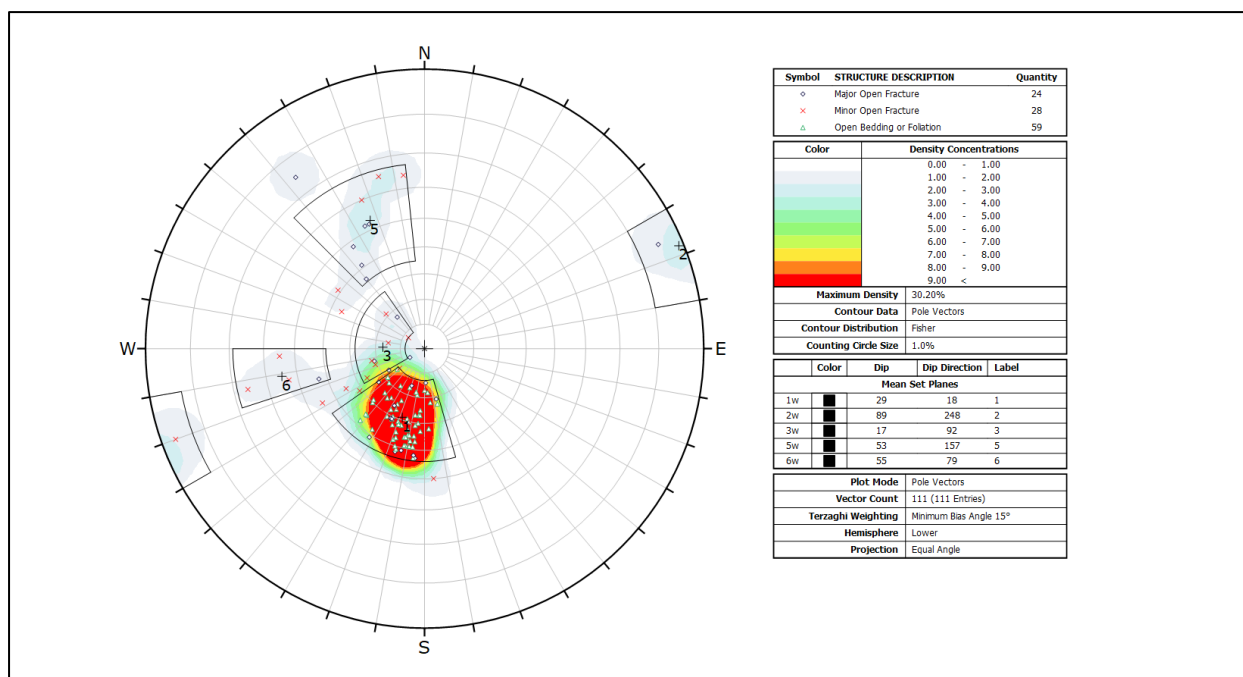


Figure 46: Stereographic plot – ABM pit Western Sector MUDSTONE

Table 16: Summary of ABM pit Western Sector MUDSTONE defect sets

ABM West Sector MUDST Types Sets							
Set No.	Dip	Dip Range	Dip Direction	Dip Direction Range	Joint Type	Joint Condition	Infill Type
1	29°	14°-86°	018°	348°-055°	Foliation	Smooth & Undulating	Gouge to Fine Non-softening Material
2	89°	84°-90°	248°	247°-250°	Joint	Smooth & Undulating	Fine Non-softening Material
3	17°	08°-25°	092°	064°-139°	Joint	Smooth & Undulating	Gouge to Fine Non-softening Material
5	53°	35°-65°	157°	140°-147°	Joint	Smooth & Undulating	Gouge to Fine Non-softening Material
6	55°	43°-66°	079°	074°-088°	Joint	Smooth & Undulating	Gouge to Fine Non-softening Material

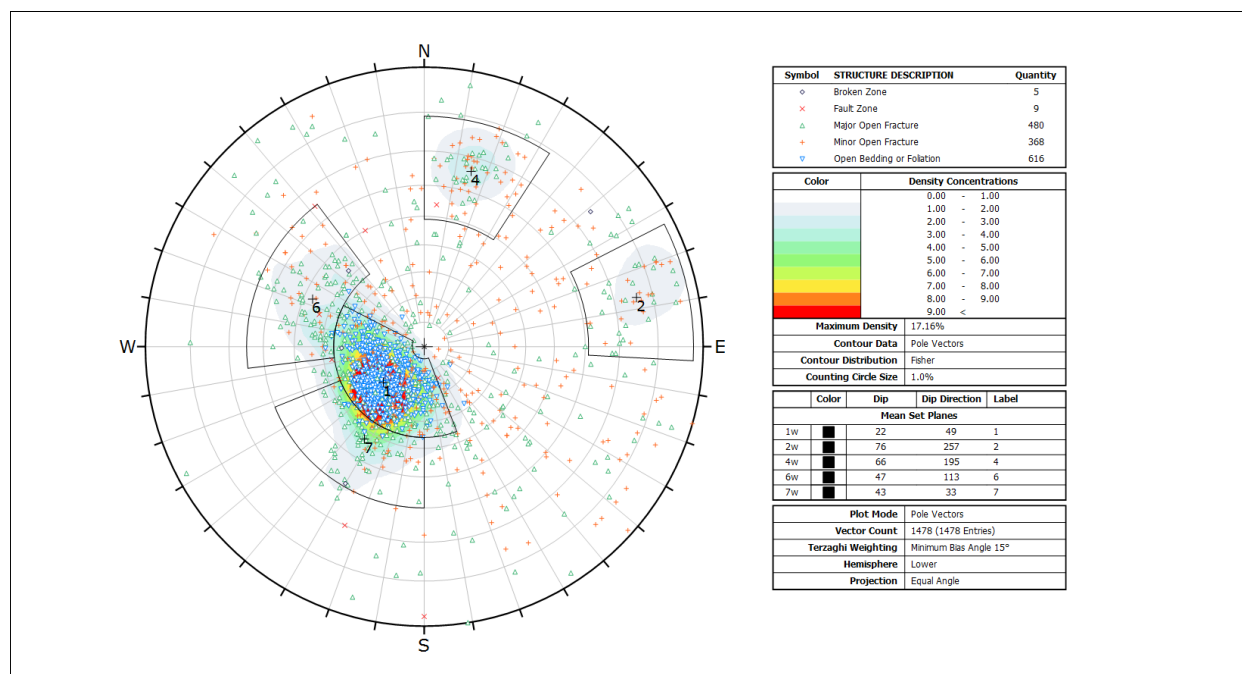


Figure 47: Stereographic plot – ABM pit Eastern Sector FELSVOLC

Table 17: Summary of ABM pit Eastern Sector FELSVOLC defect sets

ABM East Sector FELSVOLC Sets							
Set No.	Dip	Dip Range	Dip Direction	Dip Direction Range	Joint Type	Joint Condition	Infill Type
1	22°	04°-35°	049°	027°-115°	Foliation	Smooth & Undulating	Fine Non-softening Material to Fine Softening Material
2	76°	60°-86°	257°	245°-273°	Joint	Smooth & Undulating	Fine Non-softening Material to Fine Softening Material
4	66°	51°-79°	195°	182°-211°	Joint	Smooth & Undulating	Fine Non-softening Material to Medium Non-softening Material
6	47°	35°-64°	113°	086°-142°	Joint	Smooth & Undulating to Rough & Undulating	Fine Non-softening Material to Fine Softening Material
7	43°	35°-60°	033°	002°-066°	Joint	Smooth & Undulating	Fine Non-softening Material to Fine Softening Material

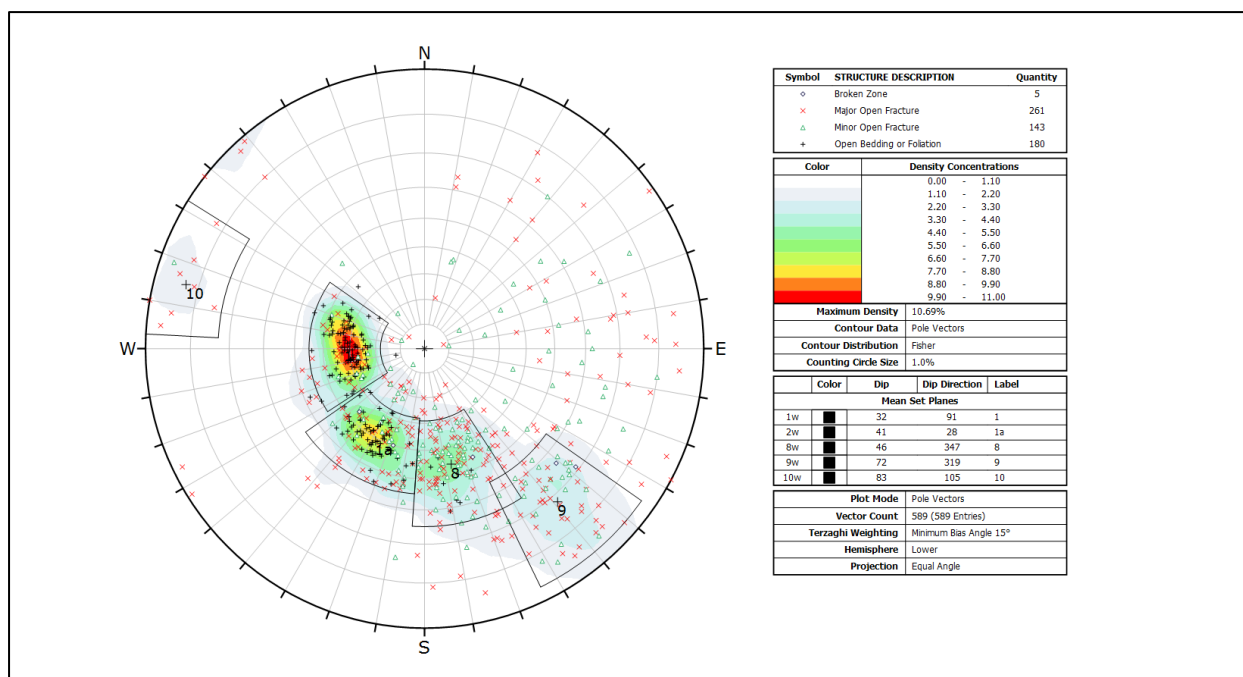


Figure 48: Stereographic plot – ABM pit Eastern Sector WINDLAKE

Table 18: Summary of ABM pit Eastern Sector WINDLAKE defect sets

ABM East Sector Windlake Sediment Sets							
Set No.	Dip	Dip Range	Dip Direction	Dip Direction Range	Joint Type	Joint Condition	Infill Type
1	32°	22°-44°	091°	058°-155°	Foliation Above 1450mRL	Smooth & Planar to Rough & Undulating	Fine Softening Material to Medium Softening Material
1A	41°	28°-54°	028°	007°-055°	Foliation Below 1450mRL	Smooth & Undulating to Smooth & Planar	Fine Softening Material to Fine Non-softening Material
8	46°	29°-64°	347°	329°-003°	Joint	Smooth & Undulating to Smooth & Planar	Fine Softening Material to Fine Non-softening Material
9	72°	57°-84°	319°	308°-333°	Joint	Smooth & Undulating to Smooth & Planar	Fine Softening Material to Coarse Non-softening Material
10	83°	74°-90°	105°	096°-122°	Joint	Smooth & Undulating to Smooth & Planar	Fine Softening Material to Clean

9.3.2 Krakatoa Pit

The mean set orientations and joint conditions for each rock type present in the pit walls are summarised in Figure 49 to Figure 51 and Table 19 to Table 21.

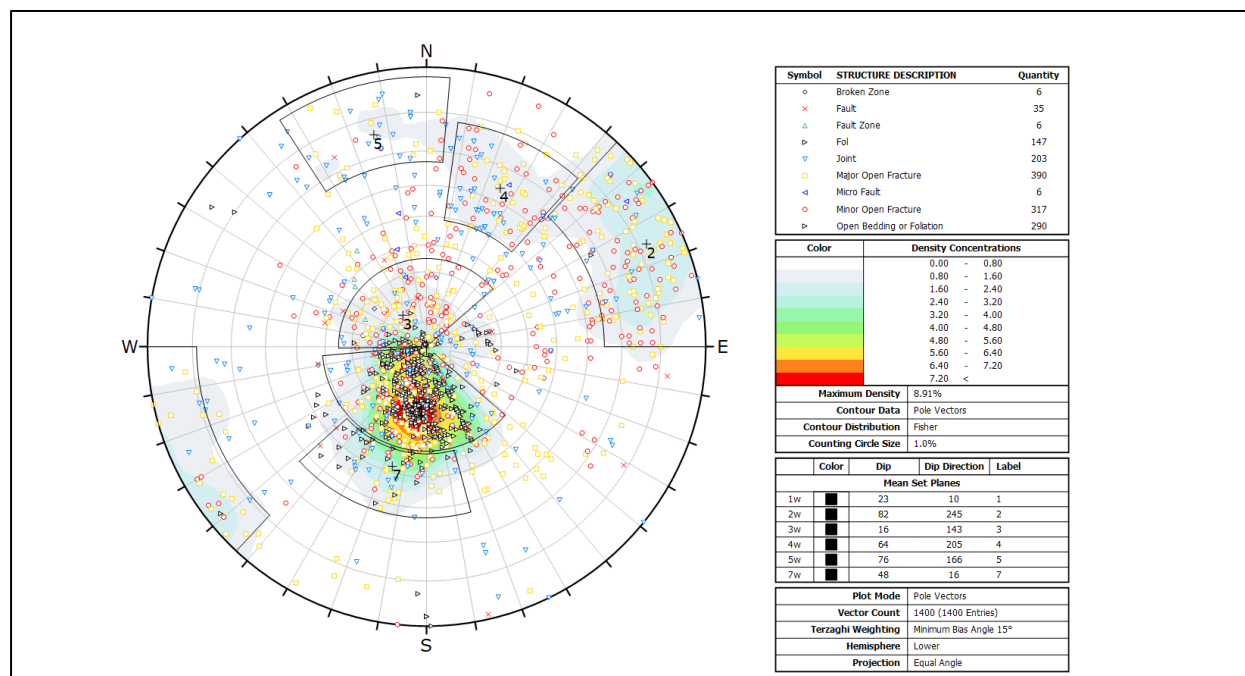


Figure 49: Stereographic plot – Krakatoa pit FELSVOLC

Table 19: Summary of Krakatoa pit FELSVOLC defect sets

Krakatoa Felsicvolcanic Sets							
Set No.	Dip	Dip Range	Dip Direction	Dip Direction Range	Joint Type	Joint Condition	Infill Type
1	23°	03°-41°	010°	313°-084°	Foliation	Smooth & Undulating to Rough & Undulating	Medium Non-softening Material to Medium Softening Material
2	82°	65°-90°	245°	223°-270° / 044°-085°	Joint	Smooth & Undulating to Rough & Undulating	Medium Non-softening Material to Coarse Softening Material
3	16°	02°-33°	143°	090°-231°	Joint	Smooth & Undulating to Rough & Planar	Medium Non-Softening Material to Fine Non-Softening Material
4	64°	49°-78°	205°	053°-071°	Joint	Smooth & Undulating to Rough & Planar	Medium Non-softening Material to Coarse Softening Material
5	76°	68°-87°	166°	148°-185°	Joint	Rough & Irregular to Smooth & Undulating	Coarse Softening Material to Medium Non-softening Material
7	48°	41°-63°	016°	346°-051°	Joint	Rough & Undulating to Smooth and Undulating	Coarse Softening Material to Medium Non-softening Material

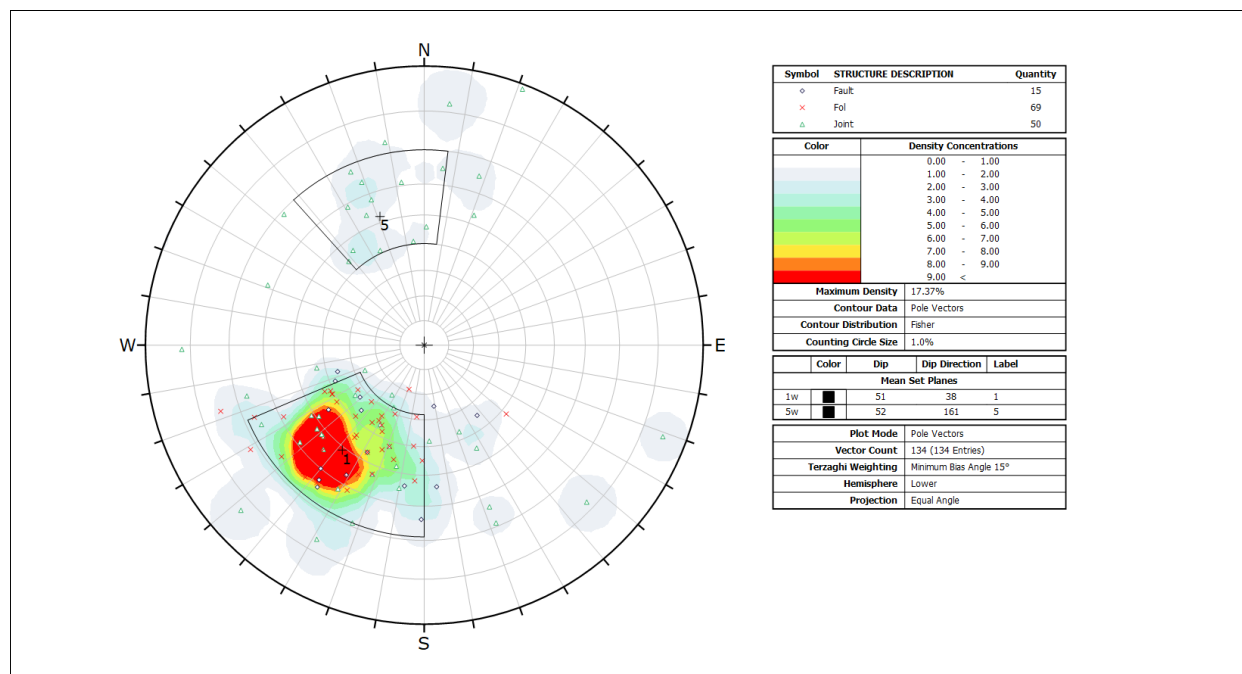


Figure 50: Stereographic plot – Krakatoa pit MAFIC

Table 20: Summary of Krakatoa pit MAFIC defect sets

Krakatoa Mafic Sets							
Set No.	Dip	Dip Range	Dip Direction	Dip Direction Range	Joint Type	Joint Condition	Infill Type
1	51°	27°-66°	038°	002°-067°	Foliation	Rough & Undulating to Rough and Planar	Fine Non-softening Material
5	52°	41°-68°	161°	139°-186°	Joint	Rough & Irregular to Rough & Undulating	Fine Non-softening Material

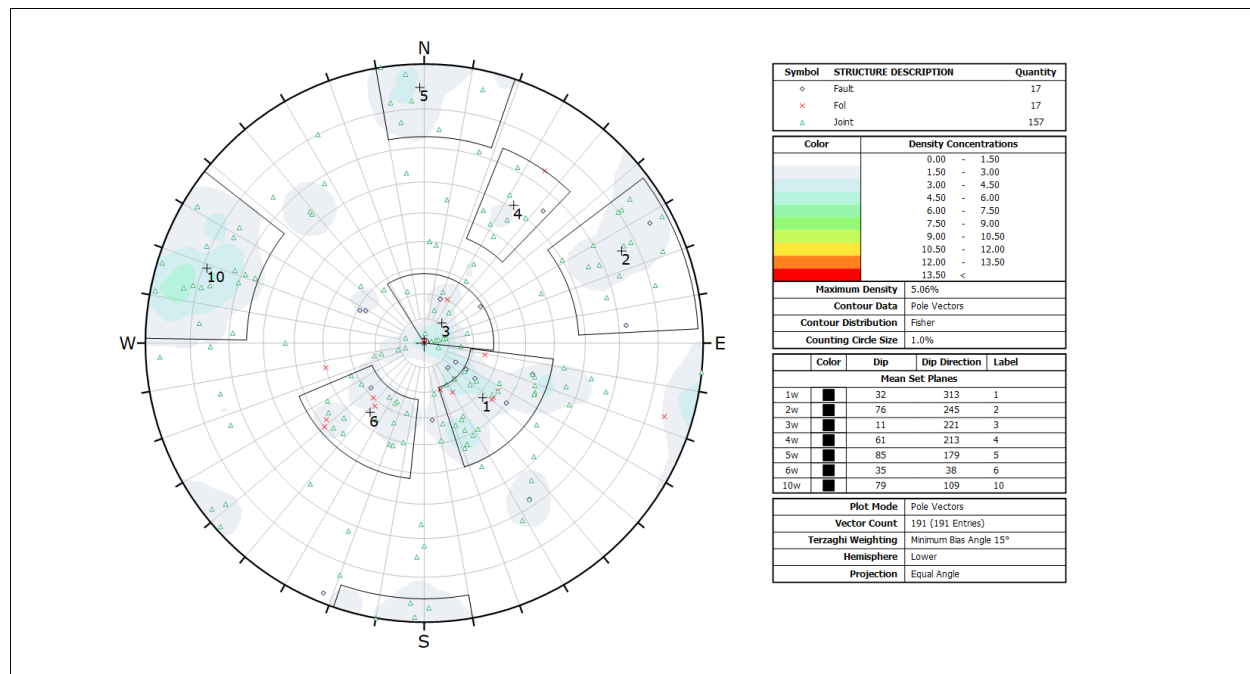


Figure 51: Stereographic plot – Krakatoa pit RHYOLITE

Table 21: Summary of Krakatoa pit RHYOLITE defect sets

Krakatoa Rhyolite Sets							
Set No.	Dip	Dip Range	Dip Direction	Dip Direction Range	Joint Type	Joint Condition	Infill Type
1	32°	19°-47°	313°	281°-339°	Foliation	Rough & Undulating to Rough & Irregular	Fine Non-softening Material to Clean
2	76°	59°-87°	245°	235°-265°	Joint	Rough & Irregular to Rough and Undulating	Fine Non-softening Material to Clean
3	11°	03°-26°	221°	162°-276°	Joint	Rough & Irregular to Rough and Undulating	Fine Non-softening Material to Clean
4	61°	49°-73°	213°	204°-223°	Joint	Rough & Undulating to Rough & Irregular	Fine Non-softening Material to Clean
5	85°	74°-90°	179°	172°-193° / 359°-004°	Joint	Rough & Irregular	Fine Non-softening Material to Clean
6	35°	26°-49°	38°	013°-067°	Joint	Rough & Undulating to Rough & Irregular	Fine Non-softening Material to Clean
10	79°	65°-90°	109°	093°-122°	Joint	Rough & Irregular to Rough and Undulating	Fine Non-softening Material to Clean

10 Structural Stability Analysis

Five main wall orientations in the ABM Pit and six main wall orientations in the Krakatoa pit were assessed for structural stability. The dip direction for each wall is shown in Figure 52, with Table 23 showing which design domain was applied to each wall as from Figure 25. Analysis was also separately conducted on the ABM pit Southern Wall. A range of bench heights, batter angles and berm widths that could be used to form the required inter ramp wall angles were analysed.

Furthermore, structural analysis was only conducted on the fresh rock as the overburden profile consists of highly weathered soils and will not fail with toppling, planar or wedge mechanics.

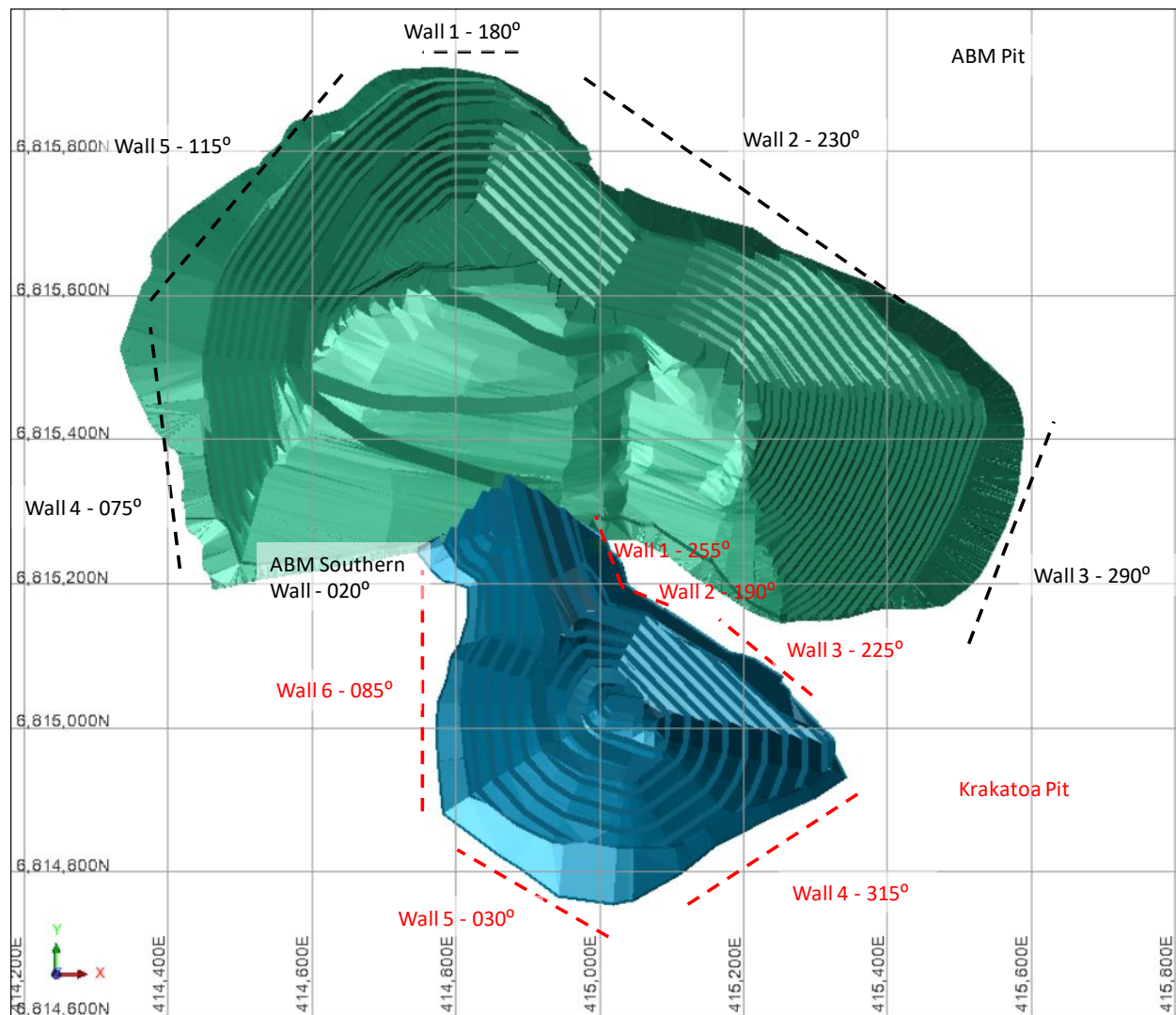


Figure 52: Principal pit walls (PFS Pit) used in stability analyses, showing with dip direction

Table 22: ABM Wall Orientations and Design Domain

Wall	Wall Dip Direction	Domain
1	180°	1
2	230°	1,2,5
3	290°	5
4	075°	1
5	115°	1

Table 23: Krakatoa Wall Orientations and Design Domain

Wall	Wall Dip Direction	Domain
1	255°	4
2	190°	5
3	225°	5
4	315°	6
5	030°	5,6
6	085°	4,5

The failure modes, (Toppling, Planar and Wedge) for each wall were initially assessed using kinematic analysis (in the Dips software) to ascertain the sets that have the potential to cause failure. Further probabilistic analysis was then undertaken on the identified potential failure sets using the RocTopple software for toppling failure and the Swedge software package for the wedge and planar failures.

Some wall orientations span multiple design domains, as shown in Table 22 and Table 23, which may necessitate separate analyses for each wall angle and domain combination. However as multiple batter angles were assessed, separate analyses for each wall that cross domains were only conducted if there was a significant change in the bench height or berm width. For example, ABM Wall 2 is present in Domains 1, 2 and 5 with only a 1m difference in berm width between Domains 1 and 2 from 11m to 12m respectively. This change has no material effect on the structural analysis for the walls and as such one analysis was conducted for both. However, there is a significant change in the bench height between Domains 1 and 2 and Domain 5 from 20m to 10m respectively, this change has significant impact on the analysis therefore a separate analysis was conducted for this wall domain combination.

The probabilistic analysis method uses a statistical distribution of joint orientations for each set based on the mean, and individually assesses the stability of a nominal 10,000 sample blocks. Results are reported as the percentage of blocks yielding a Factor of Safety (FoS), less than 1 i.e. failed.

The results of the probabilistic methods for the failure modes, which are reported as a percentage of failed poles or Probability of Failure (PoF), are classified using a risk ranking as shown in Table 24.

Table 24 Ranking of Probabilistic Results

Rank	% Failed
1	>50%
2	25 - 50%
3	5 - 25%
4	0 - 5%

The walls were analysed with differing rock strength parameters rules outlined as follows:

- Primarily Smooth and Undulating Foliation; Φ -27°
- Primarily Smooth and Undulating Joints; Φ -32°
- Primarily Rough and Undulating Joints; Φ – 36°
- Primarily Softening Infill; Cohesion -1kPa
- Primarily Non-Softening Infill; Cohesion -5kPa
- Unit density; 27.8kN/m³
- Fresh Tensile Strength; 1700kpa

Due to a lack of tensile strength data, the values for tensile strength have been estimated from experience with similar projects.

All results for the probabilistic analyses are provided in the appendices on the attached CD.

10.1 ABM Pit

The results of the analyses for the toppling, planar and wedge failure modes in the rock units of the ABM pit are separated between the Western Sector and the Eastern Sector in sections 10.1.1 and 10.1.2 respectively due to the difference in foliation dip. The South ABM wall was also analysed for wall stability in 10.1.3. While all of the walls were analysed and may contain a kinematically possible toppling, planar or wedge failure, only those sets that returned a PoF of greater than 0% at the maximum analysed batter angle of 75° were reported.

10.1.1 Western Sector

Results of the probabilistic analysis of the Western Sector are presented graphically in Figure 53 and in Table 25 to Table 27, with colour coding based on risk ranking. The berm width analysis for the analysed potential failures are shown in Table 28.

The results of the analysis indicate that the FELSVOLC unit, that represents the 84% of the ABM structural data, shows a maximum risk ranking of 3 and a maximum PoF of 8% at a maximum recommended batter angle of 70°.

Higher planar failure rates are associated with the MUDST unit, especially in the walls 1 and 5 for both planar and wedge failure. Both of these failure types in walls 1 and 5 have a risk ranking of 2 with between 29% and 49% PoF. However, these potential failure rates are not considered to be critically detrimental to the stability of the pit as the MUDST sets that contribute to this high rate of failure, (Sets 5 and 6) represent a relatively small percentage of the MUDST data (7% and 4% respectively).

The results from the berm width analyses show that the proposed berm widths (minimum 8m) would be sufficient to contain the volume of material from potential berm scale failures.

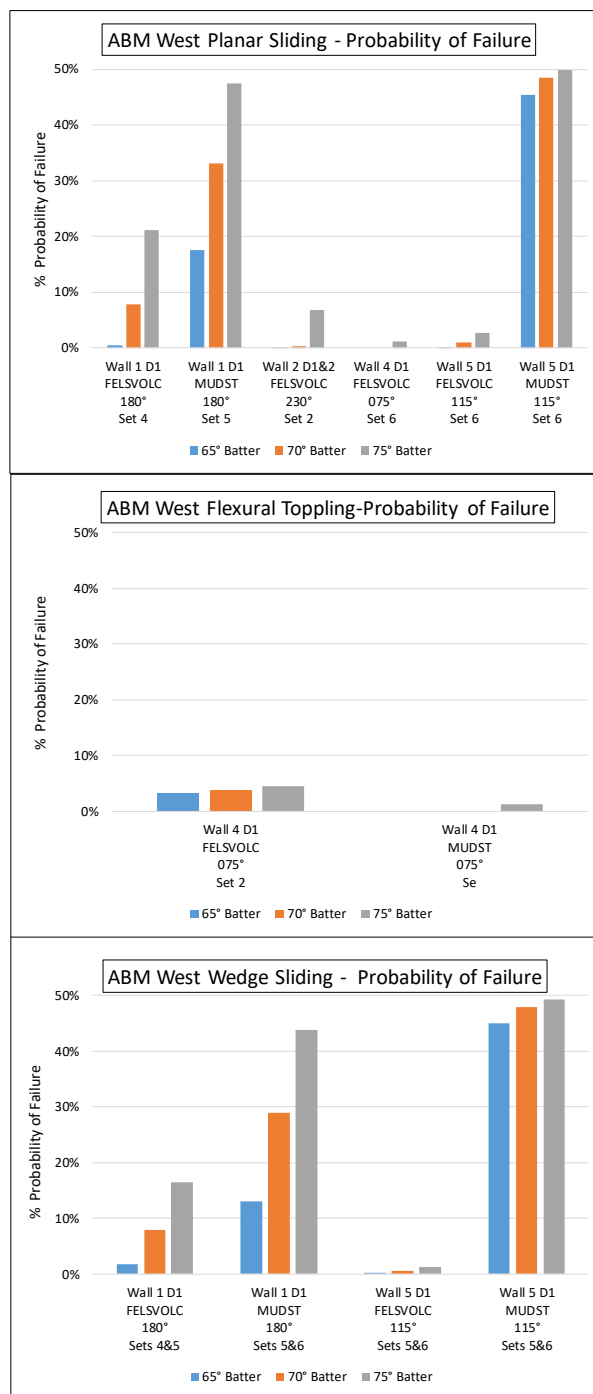


Figure 53: Results of the ABM Western Sector stability analyses

Table 25: Results of ABM Western Sector probabilistic analyses for planar failure (colour coded on Risk Ranking)

ABM West Planar Sliding Probabilistic Analyses						
Wall & Domain Rocktype Wall Angle Critical Set	Wall 1 D1 FELSVOLC 180° Set 4	Wall 1 D1 MUDST 180° Set 5	Wall 2 D1&2 FELSVOLC 230° Set 2	Wall 4 D1 FELSVOLC 075° Set 6	Wall 5 D1 FELSVOLC 115° Set 6	Wall 5 D1 MUDST 115° Set 6
65° Batter	0%	18%	0%	0%	0%	45%
70° Batter	8%	33%	0%	0%	1%	49%
75° Batter	21%	48%	7%	1%	3%	50%

Table 26: Results of ABM Western Sector probabilistic analyses for toppling failure (colour coded on Risk Ranking)

ABM West Toppling Probabilistic Analyses		
Wall & Domain Rocktype Wall Angle Critical Set	Wall 4 D1 FELSVOLC 075° Set 2	Wall 4 D1 MUDST 075° Set 2
65° Batter	3%	0%
70° Batter	4%	0%
75° Batter	5%	1%

Table 27: Results of ABM Western Sector probabilistic analyses for wedge failure (colour coded on Risk Ranking)

ABM West Wedge Sliding Probabilistic Analyses				
Wall & Domain Rocktype Wall Angle Critical Sets	Wall 1 D1 FELSVOLC 180° Sets 4&5	Wall 1 D1 MUDST 180° Sets 5&6	Wall 5 D1 FELSVOLC 115° Sets 5&6	Wall 5 D1 MUDST 115° Sets 5&6
65° Batter	2%	13%	0%	45%
70° Batter	8%	29%	1%	48%
75° Batter	16%	44%	1%	49%

Table 28: Results of ABM Western Berm Width analyses

ABM West Minimum Bench Width Analyses										
Wall & Domain Rocktype Failure Type	Wall 1 D1 FELSVOLC Planar	Wall 1 D1 MUDST Planar	Wall 1 D1 FELSVOLC Wedge	Wall 1 D1 MUDST Wedge	Wall 2 D1&2 FELSVOLC Planar	Wall 4 D1 FELSVOLC Planar	Wall 5 D1 FELSVOLC Planar	Wall 5 D1 MUDST Planar	Wall 5 D1 FELSVOLC Wedge	Wall 5 D1 MUDST Wedge
Planned Berm Width (m)	8	8	8	8	8 & 10	8	8	8	8	8
Minimum Required Berm Width at 65° Batter (m)	6.6	4.9	4.4	3.5	4.1	0.0	5.8	7.2	5.5	7.0
Minimum Required Berm Width at 70° Batter (m)	7.1	5.6	5.0	4.0	4.5	0.0	7.4	8.7	5.6	8.4
Minimum Required Berm Width at 75° Batter (m)	7.9	6.5	5.9	4.5	5.1	7.9	9.0	10.0	6.7	9.5

10.1.2 Eastern Sector

Results of the probabilistic analysis of the Eastern Sector are presented graphically in Figure 54 and in Table 29 to Table 30, with colour coding based on risk ranking. The berm width analysis for the analysed potential failures are shown in Table 31.

The results of the analysis indicate that all of the rock types show a maximum risk ranking of 4 and a maximum PoF of 5% at a maximum recommended batter angle of 70°. It should also be noted that the PoF in Wall 2 FELS/VOLC significantly increases from 5% to 47% as the batter angle increases from 70° to 75° highlighting the importance of maintaining the recommended batter angle during mining.

The results from the berm width analyses show that the proposed berm widths would be sufficient to contain the potential berm scale failures.

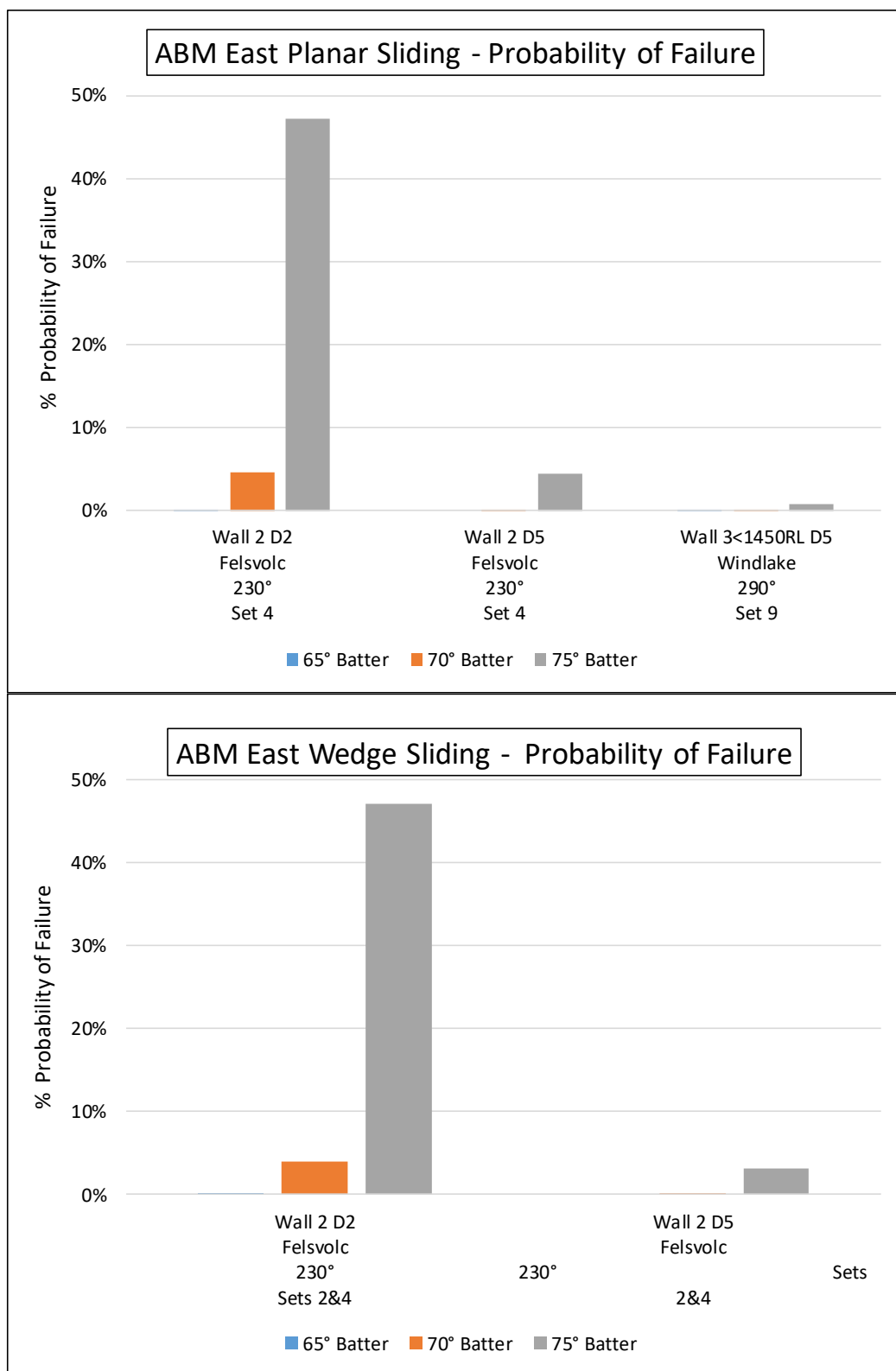


Figure 54: Results of the ABM Eastern Sector stability analyses

Table 29: Results of ABM Eastern Sector probabilistic analyses for planar failure (colour coded on Risk Ranking)

ABM East Planar Sliding Probabilistic Analyses			
Wall & Domain	Wall 2 D2	Wall 2 D5	Wall 3<1450RL D5
Rocktype	Felsvolc	Felsvolc	Windlake
Wall Angle	230°	230°	290°
Critical Set	Set 4	Set 4	Set 9
65° Batter	0%	0%	0%
70° Batter	5%	0%	0%
75° Batter	47%	4%	1%

Table 30: Results of ABM Eastern Sector probabilistic analyses for wedge failure (colour coded on Risk Ranking)

ABM East Wedge Sliding Probabilistic Analyses		
Wall & Domain	Wall 2 D2	Wall 2 D5
Rocktype	Felsvolc	Felsvolc
Wall Angle	230°	230°
Critical Set	Sets 2&4	Sets 2&4
65° Batter	0%	0%
70° Batter	4%	0%
75° Batter	47%	3%

Table 31: Results of ABM Eastern Berm Width analyses

ABM East Minimum Bench Width Analyses					
Wall & Domain	Wall 2 D2	Wall 2 D5	Wall 2 D2	Wall 2 D5	Wall 3<1450RL D5
Rocktype	Felsvolc	Felsvolc	Felsvolc	Felsvolc	Windlake
Failure Type	Planar	Planar	Wedge	Wedge	Planar
Planned Berm Width (m)	10	9	10	9	9
Minimum Required Berm Width at 65° Batter (m)	4.5	0.0	3.9	0.0	3.3
Minimum Required Berm Width at 70° Batter (m)	5.0	2.7	4.6	2.5	2.4
Minimum Required Berm Width at 75° Batter (m)	6.3	3.1	6.1	2.8	2.0

10.1.3 ABM Southern Wall

The Southern wall in the ABM pit will be mined to the footwall contact with an inter ramp slope angle of 34° . The structural data indicates that foliation dips in the same direction as the wall and there is a wide range in foliation dip from 4° to 49° , therefore analysis was conducted to investigate the potential for planar failure.

The analysis shows that the range of potential wall angles from 26° to 35° has a PoF of 0%, however if the inter ramp slope angle increases above 35° the PoF begins to rise.

10.2 Krakatoa Pit

Results of the probabilistic analysis of the Krakatoa pit are presented graphically in Figure 55 and in Table 32 to Table 33, with colour coding based on risk ranking. The berm width analysis for the analysed potential failures are shown in Table 34. While all of the walls were analysed and may contain a kinematically possible toppling, planar or wedge failures only those sets that returned a PoF of greater than 0%, at the maximum analysed batter angle 75° , were reported.

The results of the analysis indicate that, with the exception of wall 5, the Krakatoa structural data, shows a risk ranking of 3 and a PoF ranging from 0% to 8% and are not expected to cause significant failure at a maximum recommended batter angle of 70° .

Wall 5 in the FELSVOLC rock type has the highest risk ranking of 2 in planar failure and 3 wedge failures with a PoF of 32% and 20% respectively at 70° . While this has the potential to cause batter scale failure in this section of the wall, the wall spans both domain 5 and 6. The differing proposed batter angles of 70° and 65° in domains 5 & 6 respectively results in wall 5 Domain 6 having a risk ranking of 3 and a maximum planar failure PoF of 15%. While wall 5 has a relatively higher probability of failure compared to the rest of the pit, the berm width analysis in Table 34 shows that the proposed berm width of 8m would be sufficient to contain any localised failure in this area.

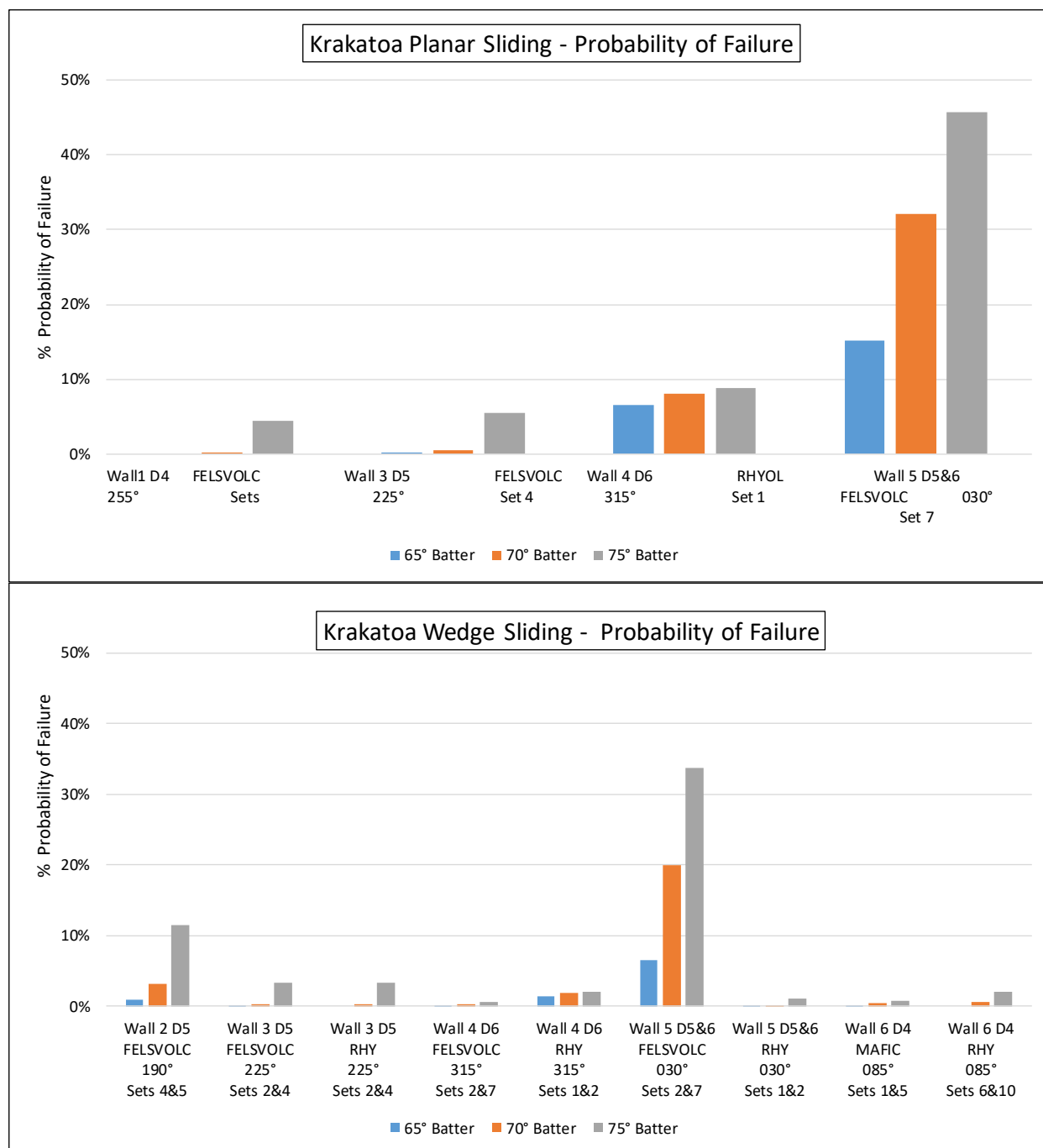


Figure 55: Results of the Krakatoa stability analyses

Table 32: Results of Krakatoa probabilistic analyses for planar failure (colour coded on Risk Ranking)

Krakatoa Planar Sliding Probabilistic Analyses				
Wall & Domain Rocktype Wall Angle Critical Set	Wall1 D4 FELSVOL C 255° Sets	Wall 3 D5 FELSVOLC 225° Set 4	Wall 4 D6 RHYOL 315° Set 1	Wall 5 D5&6 FELSVOLC 030° Set 7
65° Batter	0%	0%	6%	15%
70° Batter	0%	0%	8%	32%
75° Batter	4%	5%	9%	46%

Table 33: Results of Krakatoa probabilistic analyses for wedge failure (colour coded on Risk Ranking)

Krakatoa Wedge Sliding Probabilistic Analyses									
Wall & Domain Rocktype Wall Angle Critical Set	Wall 2 D5 FELSVOL C 190° Sets 4&5	Wall 3 D5 FELSVOLC 225° Sets 2&4	Wall 3 D5 RHY 225° Sets 2&4	Wall 4 D6 FELSVOLC 315° Sets 2&7	Wall 4 D6 RHY 315° Sets 1&2	Wall 5 D5&6 FELSVOLC 030° Sets 2&7	Wall 5 D5&6 RHY 030° Sets 1&2	Wall 6 D4 MAFIC 085° Sets 1&5	Wall 6 D4 RHY 085° Sets 6&10
65° Batter	1%	0%	0%	0%	1%	7%	0%	0%	0%
70° Batter	3%	0%	0%	0%	2%	20%	0%	0%	1%
75° Batter	12%	3%	3%	1%	2%	34%	1%	1%	2%

Table 34: Results of Krakatoa Berm Width analyses

Krakatoa Minimum Bench Width Analyses													
Wall & Domain Rocktype Failure Type	Wall1 D4 FELSVOLC Planar	Wall 2 D5 FELSVOLC Wedge	Wall 3 D5 FELSVOLC Planar	Wall 3 D5 FELSVOLC Wedge	Wall 3 D5 RHY Wedge	Wall 4 D6 FELSVOLC Wedge	Wall 4 D6 RHYOL Planar	Wall 4 D6 RHY Wedge	Wall 5 D5&6 FELSVOLC Planar	Wall 5 D5&6 FELSVOLC Wedge	Wall 5 D5&6 RHY Wedge	Wall 6 D4 MAFIC Wedge	Wall 6 D4 RHY Wedge
Planned Berm Width (m)	12	8	8	8	8	10	10	10	8 & 10	8 & 10	8 & 10	12	12
Minimum Required Berm Width at 65° Batter (m)	0.0	1.8	1.4	1.4	0.0	2.5	3.4	2.5	2.6	2.0	2.1	4.4	0.0
Minimum Required Berm Width at 70° Batter (m)	6.8	2.1	2.6	2.4	2.1	2.8	4.0	2.7	3.0	2.1	2.5	5.9	5.2
Minimum Required Berm Width at 75° Batter (m)	6.7	2.9	3.4	2.8	2.7	3.0	4.4	2.9	3.5	2.3	2.3	7.3	6.2

11 Limit Equilibrium and Stress Reduction Analyses

11.1 Introduction

For the purposes of these analyses it has been assumed that all structures are continuous and the pit slopes are dewatered.

11.2 Material Strength Properties

Material strength properties were determined from the following sources:

- Barton Empirical Shear Strength Criterion (Barton et al, 1977):
- Mining Rock Mass Model
- Hoek- Brown failure criterion
- Empirical shear strength parameters Unified Soil Classification System (USCS)
- Material strength properties from earlier studies (Golder 1996, Knight Piesold 2018)

11.3 Overburden

The overburden comprises surficial deposits which range from 0.m to > 20m thick.

The profile comprises a silt layer up to 1m thick, glacial till and colluvium. The deepest zone of overburden is on the valley floor. The material is saturated to semi saturated comprising well graded sands with cobbles and coarse grained sand and gravel. Typical overburden profile is shown in Figure 56. Shear strength parameters determined for input to analyses of the overburden is shown in Table 35.

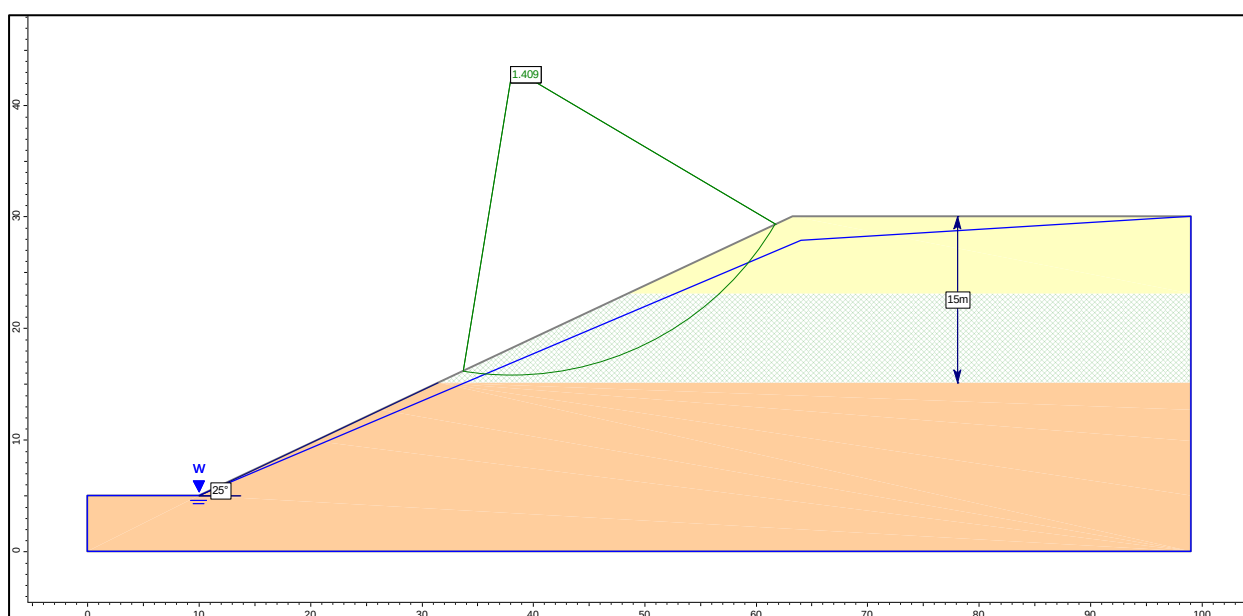


Figure 56: Typical Overburden Profile

Table 35: Material Strength Overburden

Material	Density Saturated (kN/m ²)	Friction Angle (Degrees)	Cohesion (kPa)
Sand with Gravel	19	34(+3)	0
Gravel and Sand	20	40(+5)	0

Analyses were carried out varying depth of overburden relating to slope angles of 20°, 25° and 30°. Earthquake loading was carried out with a horizontal seismic coefficient of 0.1 (Melo & Sharma 2004, Natural Resources Canada 2015). Output and results from these analyses are shown in Figure 57 and Figure 58.

**Figure 57: Limit Equilibrium Analyses for Overburden**

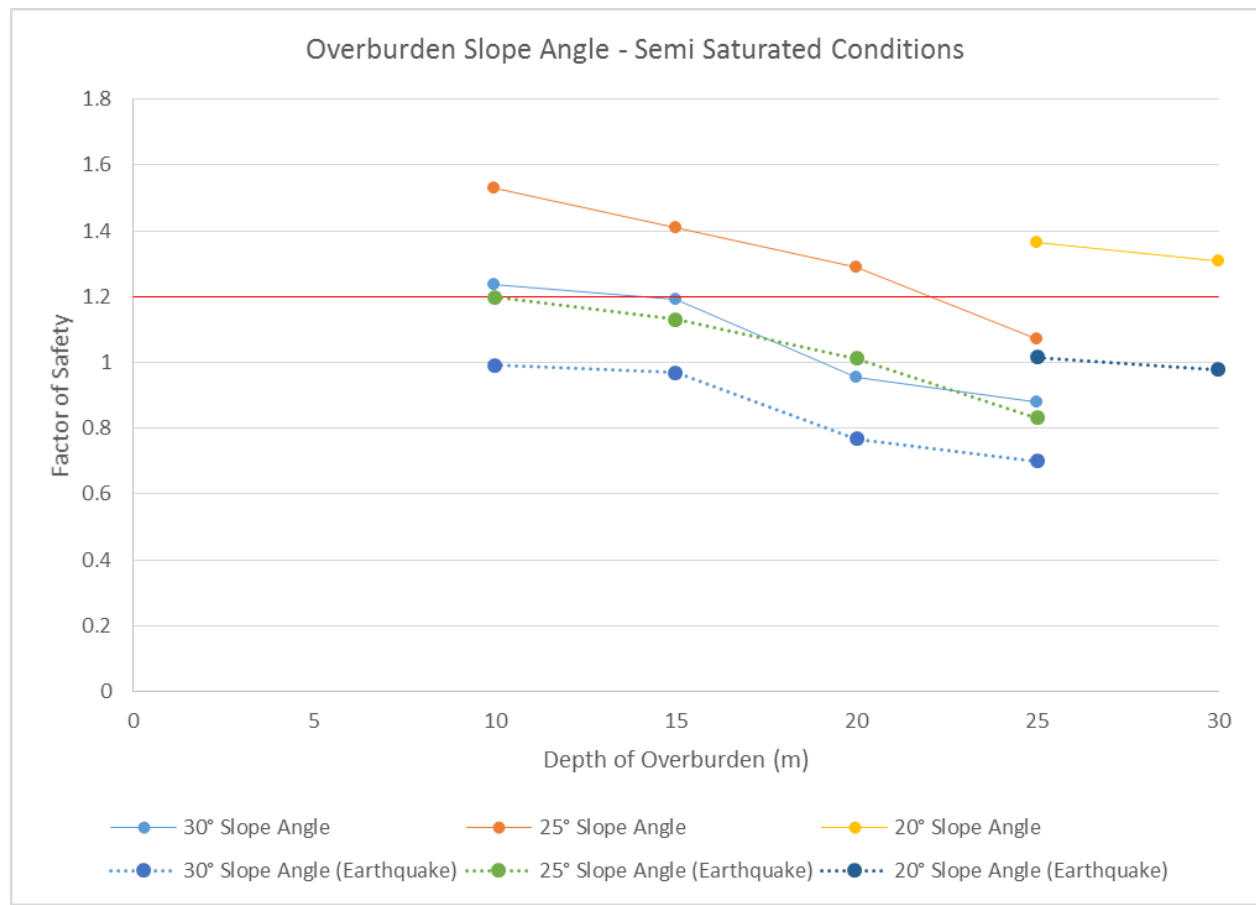


Figure 58: Results of Overburden Analyses

Analyses indicate overburden slopes can be mined as follows:

- Overburden < 10m - 30° slope angle
- Overburden ≥ 10m and < 20m - 25° slope angle
- Overburden ≥ 20m - 20° slope angle

11.4 Fresh Rock

Mohr Coulomb parameters, GSI and UCS estimated in the MRMM for each rock unit were applied to probabilistic limit equilibrium analyses for each rock type and geotechnical domain to represent discontinuity shear strength parameters and rock bridge. The data was grouped into the geotechnical domains shown in Figure 25. The data set representative of the domains is shown in Table 36 to Table 38.

Table 36 Statistical Evaluation of Material Strength Properties from MRMM (D1, D2 & D3)

KZK Domain 1

		MAFIC	MUDSTONE	RHYOLITE	FELSIC/VOLC	EW	NNE	NE
Cohesion								
	Rel Min	146.66	113.23	85.28	111.81	52.77	57.60	39.78
	Rel Max	112.15	94.62	98.32	185.09	64.45	81.69	20.82
	Mean	194.96	136.49	203.98	125.14	61.48	67.35	73.39
	Std Dev	50.04	49.11	52.90	68.02	35.08	27.07	12.97
Phi								
	Rel Min	2.34	2.44	1.15	6.46	7.53	7.38	4.04
	Rel Max	0.87	3.89	1.36	8.86	4.36	3.83	3.60
	Mean	32.07	31.69	32.46	33.27	26.52	23.31	23.23
	Std Dev	0.46	0.89	0.66	2.04	1.79	1.57	2.94
GSI								
	Rel Min	20.07	15.35	12.27	29.20	12.89	11.55	9.69
	Rel Max	12.04	39.69	23.13	38.66	24.76	13.66	6.27
	Mean	53.01	44.32	60.55	53.73	25.93	27.10	19.71
	Std Dev	6.02	5.49	5.43	11.28	4.77	3.50	3.06
UCS								
	Rel Min	58.71	42.57	49.23	72.61	19.90	13.54	12.28
	Rel Max	47.03	67.18	30.43	42.44	22.79	32.02	11.66
	Mean	102.45	61.87	99.31	87.56	20.93	17.73	13.32
	Std Dev	23.11	22.43	20.88	28.55	6.41	7.16	7.89

KZK Domain 2

		MAFIC	MUDSTONE	RHYOLITE	WINDLAKE	FELSIC/VOLC	EW	NNE	NE	EAST
Cohesion										
	Rel Min	126.10	70.03	44.31	6.64	147.73	59.28	31.57	15.07	5.91
	Rel Max	103.98	58.93	93.88	0.22	121.60	99.47	68.37	13.43	1.91
	Mean	249.21	164.66	181.23	23.88	167.41	93.40	58.22	55.95	15.46
	Std Dev	39.84	48.02	52.41	0.18	51.73	28.00	19.70	8.32	2.00
Phi										
	Rel Min	0.93	1.53	0.36	2.30	4.12	6.64	6.46	0.23	0.11
	Rel Max	0.41	0.99	0.36	2.10	6.02	2.53	7.39	0.21	0.04
	Mean	32.02	31.65	32.13	36.40	32.80	25.34	18.74	26.54	26.07
	Std Dev	0.25	0.55	0.20	0.08	1.15	1.55	3.08	0.13	0.04
GSI										
	Rel Min	17.73	9.82	4.60	8.16	23.52	19.05	16.64	1.50	0.31
	Rel Max	4.62	3.91	9.07	3.43	16.49	13.49	12.72	1.69	1.51
	Mean	57.17	47.94	54.07	53.36	52.24	27.20	26.93	18.81	11.05
	Std Dev	3.57	2.07	5.23	0.23	6.12	3.72	2.95	0.93	0.60
UCS										
	Rel Min	59.05	44.98	8.33	32.74	72.49	16.18	12.78	4.59	0.00
	Rel Max	19.12	15.91	4.99	0.16	34.18	23.01	21.30	4.10	0.00
	Mean	121.79	69.17	100.00	95.67	95.82	21.25	17.07	20.34	1.00
	Std Dev	11.92	10.30	1.81	0.51	21.50	5.07	5.51	2.54	0.00

KZK Domain 3

		MAFIC	MUDSTONE	RHYOLITE	FELSIC/VOLC	EW	NNE	NE	EAST
Cohesion									
	Rel Min	64.78	141.28	78.38	118.81	38.88	54.30	22.59	12.62
	Rel Max	185.03	39.57	147.77	156.77	142.88	85.24	26.65	5.39
	Mean	112.54	199.75	142.02	145.52	64.68	64.05	66.94	33.95
	Std Dev	58.65	20.50	45.67	41.92	29.81	27.93	9.58	3.06
Phi									
	Rel Min	1.91	0.97	1.38	4.02	10.36	3.44	5.27	1.79
	Rel Max	1.24	2.29	2.58	4.87	6.24	2.77	2.79	5.73
	Mean	32.17	31.79	32.73	32.44	23.13	23.19	24.93	19.77
	Std Dev	0.52	0.83	0.75	1.28	3.96	1.13	2.45	1.72
GSI									
	Rel Min	13.75	10.17	9.80	18.54	11.51	11.87	4.82	15.63
	Rel Max	18.06	25.26	15.01	38.31	12.62	12.54	7.06	9.99
	Mean	43.75	52.72	54.07	49.66	25.39	26.99	21.93	29.05
	Std Dev	7.76	7.80	5.72	5.70	3.63	4.19	3.15	7.96
UCS									
	Rel Min	49.46	45.76	46.34	61.27	14.63	13.38	14.18	5.54
	Rel Max	73.77	40.20	33.38	46.91	25.72	21.50	10.80	18.46
	Mean	77.20	81.45	92.76	83.09	24.28	17.10	19.18	6.54
	Std Dev	28.97	15.12	15.27	21.03	7.47	7.35	6.85	4.97

Table 37 Statistical Evaluation of Material Strength Properties from MRMM (D4, 5A & 5K)

KZK Domain 4

		MAFIC	RHYOLITE	FELSIC/VOLC	EW	NNE	EAST
Cohesion							
	Rel Min	37.58	39.18	70.53	36.02	41.13	10.00
	Rel Max	41.77	65.66	84.92	27.19	55.50	8.63
	Mean	59.62	94.59	119.03	43.65	58.21	31.16
	Std Dev	15.03	38.96	24.48	22.86	25.34	3.15
Phi							
	Rel Min	1.24	0.61	2.40	0.98	5.77	3.65
	Rel Max	1.84	1.03	3.97	1.30	2.48	3.76
	Mean	32.71	32.76	31.77	27.52	24.51	21.88
	Std Dev	0.54	0.40	1.56	0.86	1.90	2.12
GSI							
	Rel Min	8.14	4.72	16.90	8.82	7.66	10.70
	Rel Max	8.58	9.44	17.60	9.62	8.14	9.14
	Mean	39.51	43.43	45.86	22.07	24.64	30.12
	Std Dev	2.45	5.72	3.42	4.88	3.12	4.05
UCS							
	Rel Min	34.30	19.33	24.48	6.95	11.26	5.12
	Rel Max	36.15	30.34	61.24	18.05	21.57	11.77
	Mean	59.28	72.40	46.31	20.52	18.30	9.09
	Std Dev	11.14	18.73	18.19	4.53	5.28	4.29

KZK Domain 5A

		MAFIC	RHYOLITE	WINDLAKE	FELSIC/VOLC	EW	NE	EAST	CK
Cohesion									
	Rel Min	177.33	11.91	49.06	120.69	45.64	11.16	19.61	6.06
	Rel Max	62.96	20.37	141.92	160.59	80.29	15.14	25.62	18.30
	Mean	251.46	149.00	65.18	138.04	67.39	18.72	29.07	11.53
	Std Dev	50.54	9.81	36.59	44.99	28.91	5.97	8.77	4.05
Phi									
	Rel Min	0.61	2.99	2.69	4.14	8.44	3.41	5.51	2.43
	Rel Max	0.88	1.47	3.65	3.88	3.01	3.09	4.23	1.48
	Mean	31.67	32.89	32.78	32.18	26.36	26.48	23.41	25.17
	Std Dev	0.31	1.21	1.25	1.26	2.08	0.81	3.13	0.88
GSI									
	Rel Min	13.26	11.32	14.05	18.04	9.36	13.56	12.59	8.73
	Rel Max	7.46	5.76	13.38	16.40	8.57	10.85	13.57	8.86
	Mean	53.07	49.02	44.74	47.08	27.42	30.03	22.65	15.48
	Std Dev	4.60	4.74	5.87	5.49	3.39	4.25	6.54	1.95
UCS									
	Rel Min	57.88	41.90	42.78	51.57	20.24	22.01	9.51	3.48
	Rel Max	25.65	25.29	51.15	47.60	24.43	71.82	40.25	5.53
	Mean	121.71	74.71	64.56	72.52	25.57	28.18	10.51	4.48
	Std Dev	16.14	19.78	18.50	21.83	9.99	12.77	8.32	1.48

KZK Domain 5K

		MAFIC	RHYOLITE	FELSIC/VOLC	EW	NNE	NE	EAST	CK
Cohesion									
	Rel Min	119.77	38.73	83.47	52.25	38.40	10.79	7.13	5.64
	Rel Max	150.07	91.83	132.09	78.74	47.73	21.73	6.25	59.44
	Mean	140.08	83.80	94.80	59.69	42.86	14.68	28.16	13.92
	Std Dev	65.18	27.09	50.83	28.62	17.22	5.83	2.25	5.96
Phi									
	Rel Min	2.53	3.69	8.08	6.93	6.32	5.71	4.18	4.96
	Rel Max	2.15	2.30	6.84	2.89	1.88	3.09	2.43	1.57
	Mean	32.46	33.48	32.42	26.61	25.64	24.89	23.10	24.65
	Std Dev	0.86	1.58	2.02	1.47	0.90	1.33	2.27	1.01
GSI									
	Rel Min	15.62	12.41	25.47	17.80	16.43	17.34	7.22	4.84
	Rel Max	25.89	10.73	29.10	16.20	9.49	16.92	6.84	14.06
	Mean	46.83	48.31	41.45	25.79	24.63	24.82	28.41	16.29
	Std Dev	7.44	5.71	8.83	5.13	4.73	6.15	3.38	2.99
UCS									
	Rel Min	48.50	40.50	49.24	18.08	19.10	9.70	6.98	2.77
	Rel Max	85.07	31.79	84.82	24.41	28.53	25.80	7.82	9.70
	Mean	73.02	68.21	56.47	19.83	20.18	10.79	10.97	4.43
	Std Dev	27.02	17.51	25.70	6.25	9.18	8.08	3.72	2.40

Table 38 Statistical Evaluation of Material Strength Properties from MRMM (D6)

KZK Domain 6							
		MAFIC	RHYOLITE	FELSIC/VOLC	EW	NE	CK
Cohesion							
	Rel Min	83.22	46.30	90.12	29.60	8.94	11.89
	Rel Max	158.46	50.44	83.10	41.98	2.88	53.72
	Mean	129.02	104.19	114.86	54.94	33.38	19.66
	Std Dev	47.31	29.55	36.39	11.42	2.63	10.74
Phi							
	Rel Min	1.26	2.38	2.54	5.90	0.37	5.24
	Rel Max	2.45	2.77	5.74	1.46	2.46	3.51
	Mean	32.30	32.59	32.92	27.85	23.24	23.64
	Std Dev	0.65	1.07	0.90	0.73	0.76	1.67
GSI							
	Rel Min	11.13	11.22	15.05	18.12	0.18	10.03
	Rel Max	15.28	5.51	7.67	8.44	1.21	16.21
	Mean	45.78	50.15	44.68	27.38	28.41	18.00
	Std Dev	5.25	3.30	3.50	5.92	0.36	4.89
UCS							
	Rel Min	31.98	22.02	55.22	22.83	0.88	4.71
	Rel Max	51.13	31.40	19.43	24.30	5.52	37.21
	Mean	73.35	53.12	77.70	25.39	13.83	5.96
	Std Dev	24.74	9.03	10.58	8.57	1.53	4.24

11.5 Slope Modelling

Failure mechanisms will be partly structurally controlled and partly rock mass controlled. In order for failure to occur a certain amount of Rock Bridge will need to fail. The percentage of Rock Bridge in each rock type was calculated from the fracture frequency rating and modelled as a unique zone (as described in Section 8 of this report). Deterministic analysis using two dimensional limit equilibrium analyses was carried out. Material strength properties were determined from the MRMM for each rock unit per geotechnical domain. The analyses were carried out for each geotechnical domain as per the design sections indicated in Figure 25.

The assessment of each section included the calculation of Factor of Safety (FoS) and Probability of Failure (PoF). The analyses were carried out under dewatered slope conditions. These analyses returned FoS > 1.2. Sample output from these analyses for geotechnical domains are shown in Figure 59 to Figure 68.

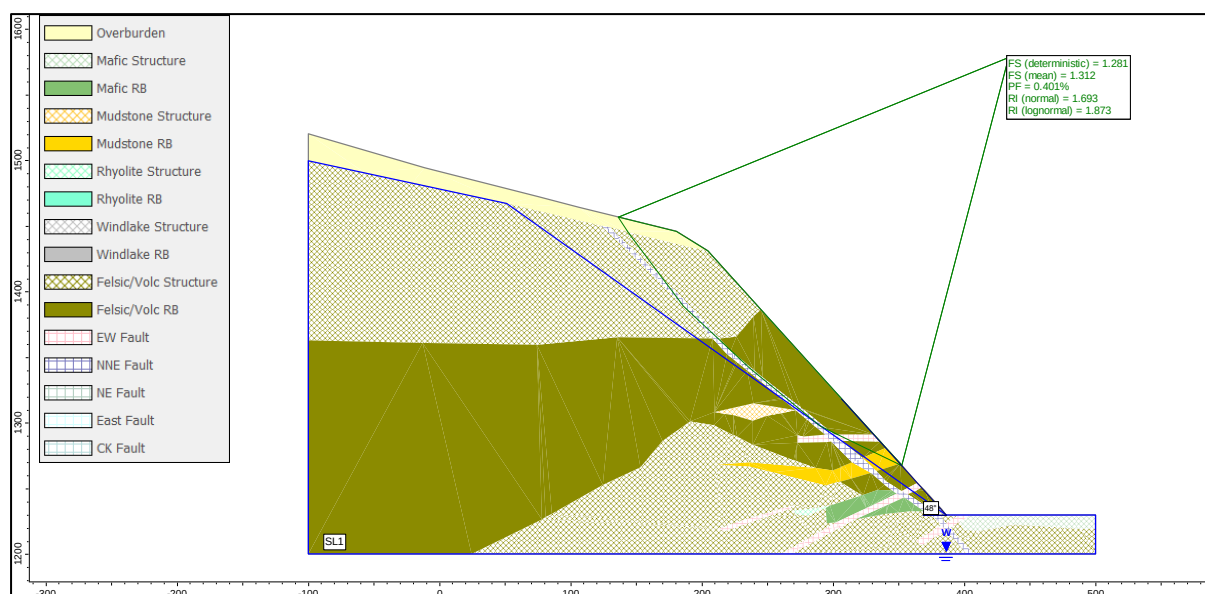


Figure 59: Limit Equilibrium Analyses for SL1 Section

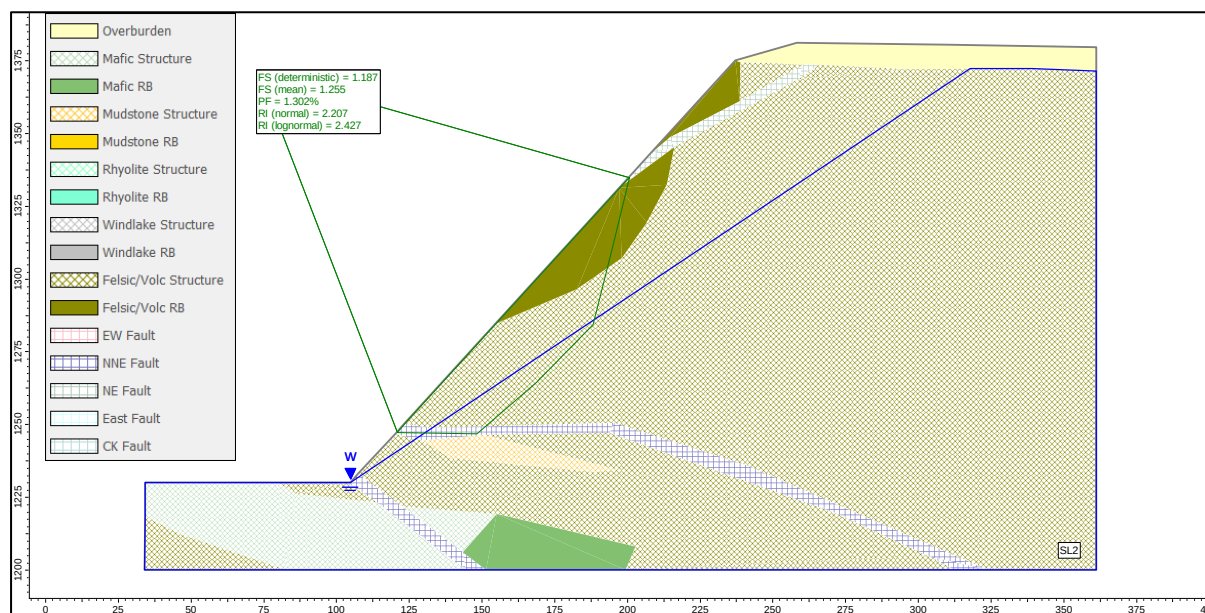


Figure 60: Limit Equilibrium Analyses for SL2 Section

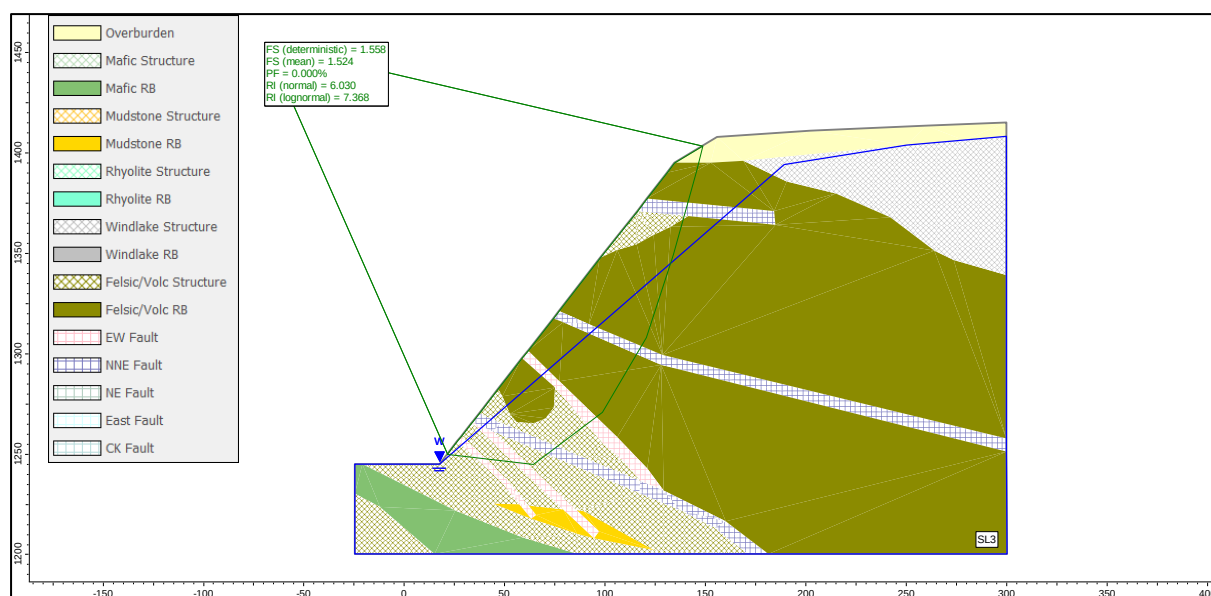


Figure 61: Limit Equilibrium Analyses for SL3 Section

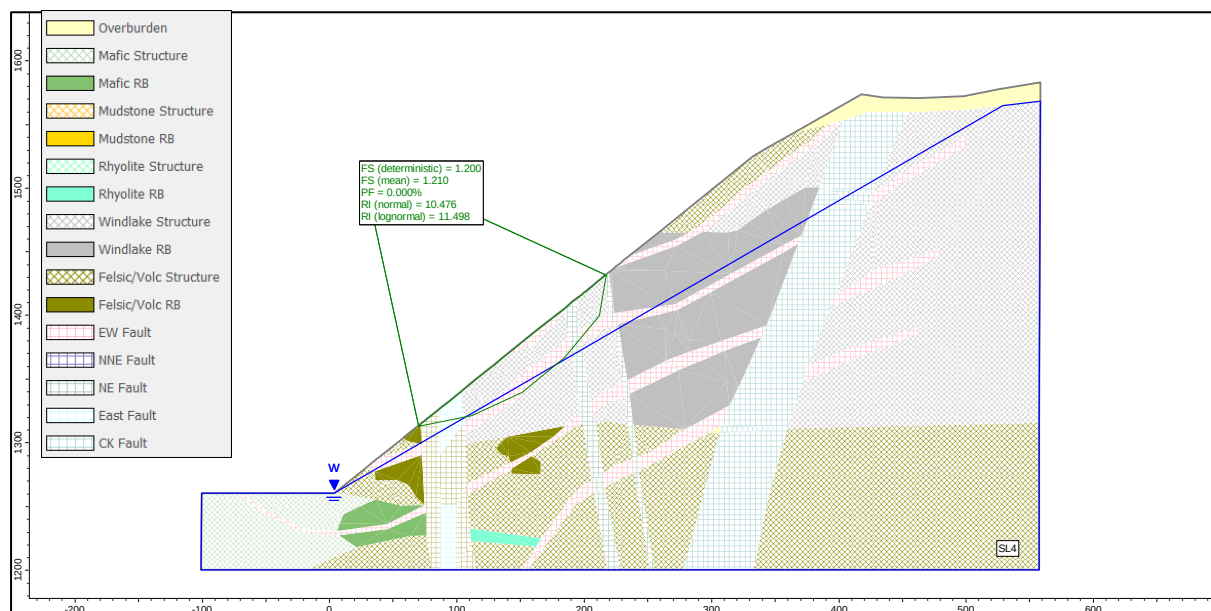


Figure 62: Limit Equilibrium Analyses for SL4 Section

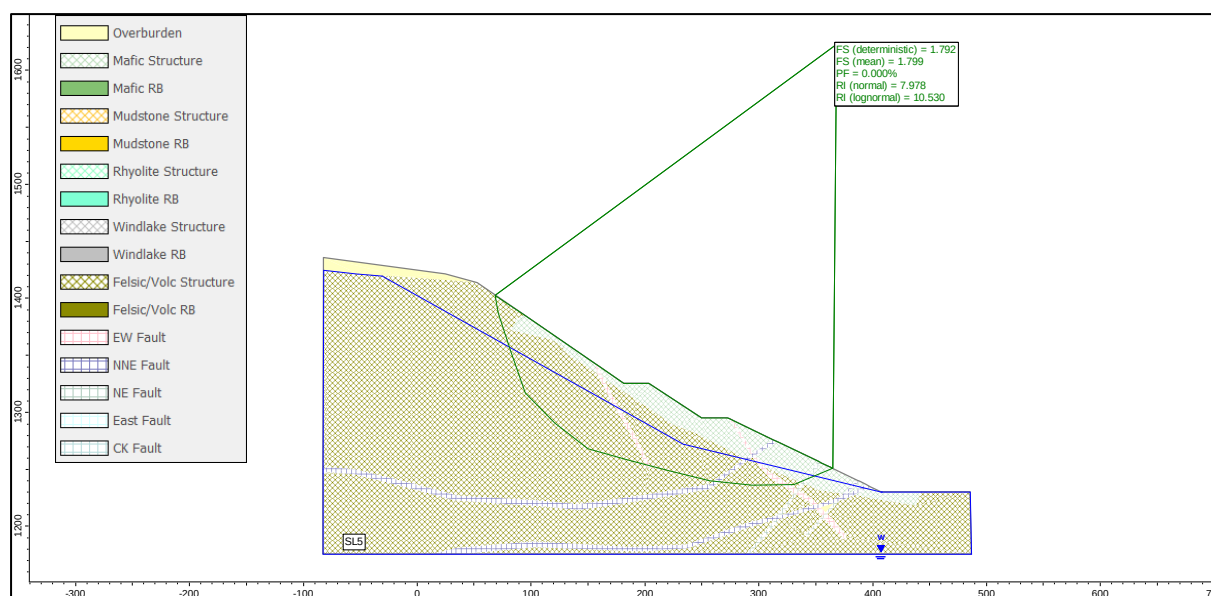


Figure 63: Limit Equilibrium Analyses for SL5 Section

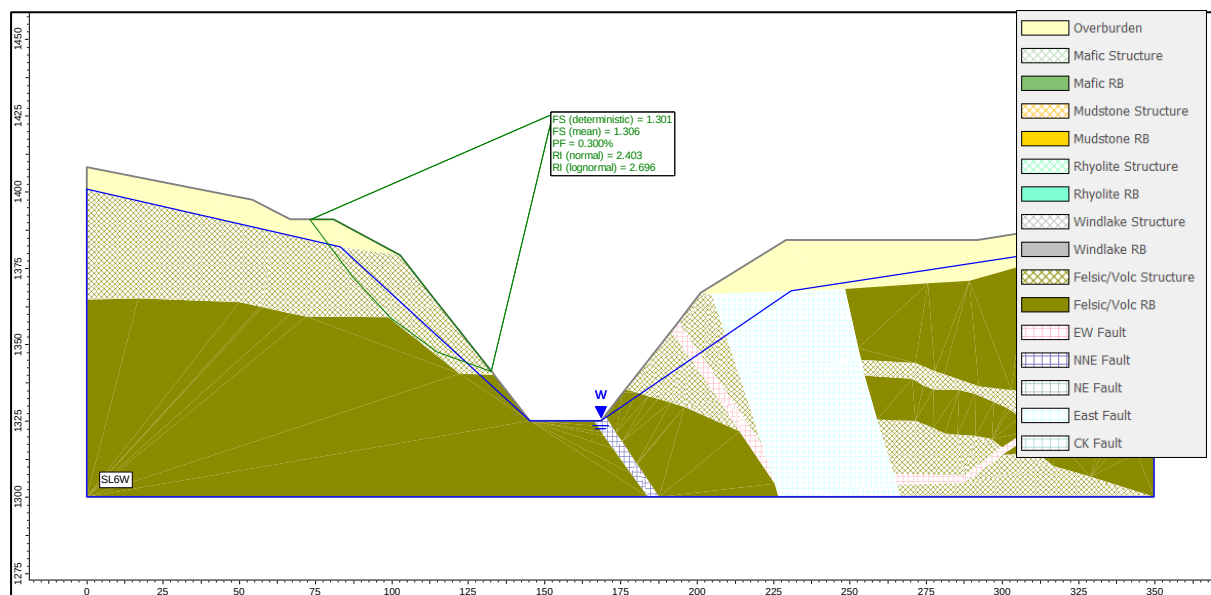


Figure 64: Limit Equilibrium Analyses for SL6W Section

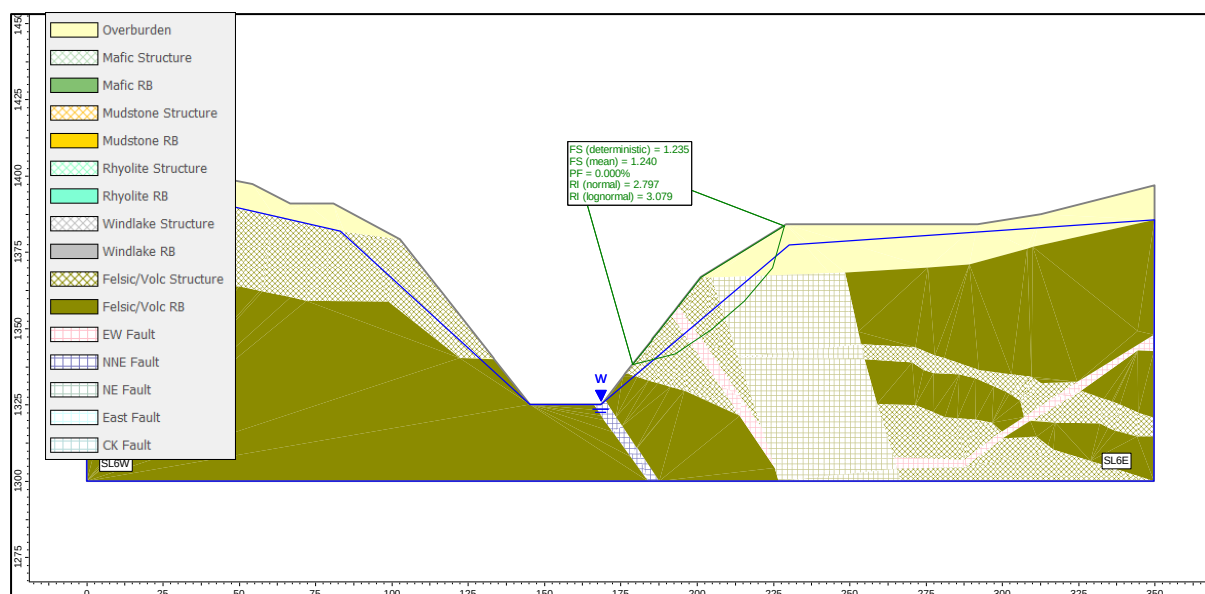


Figure 65: Limit Equilibrium Analyses for SL6W Section

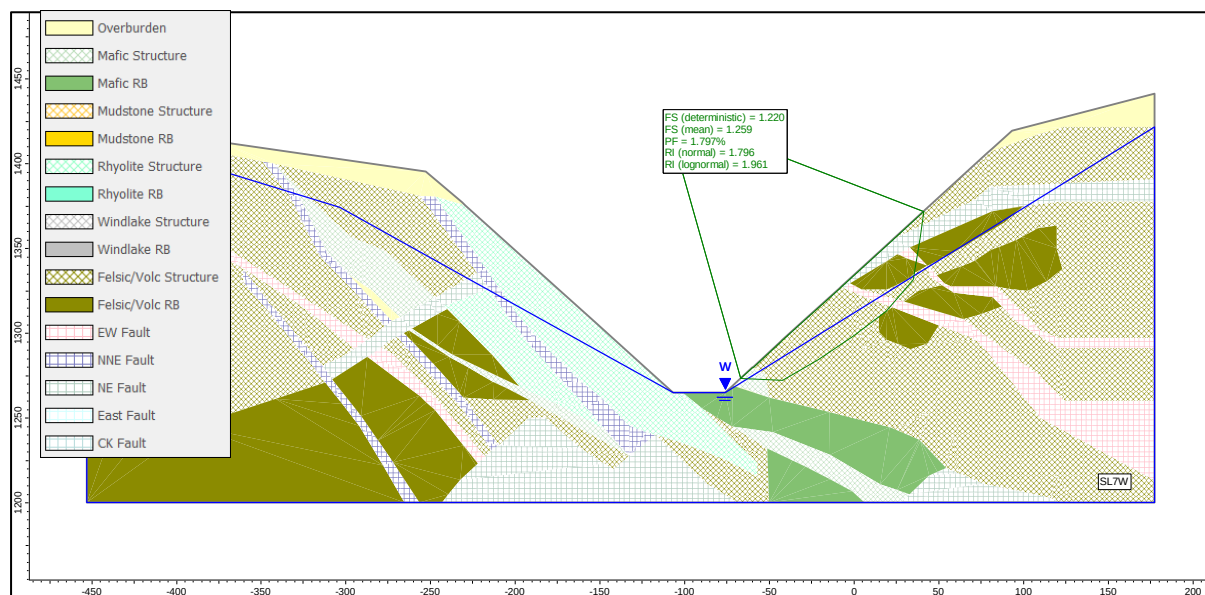


Figure 66: Limit Equilibrium Analyses for SL7W Section

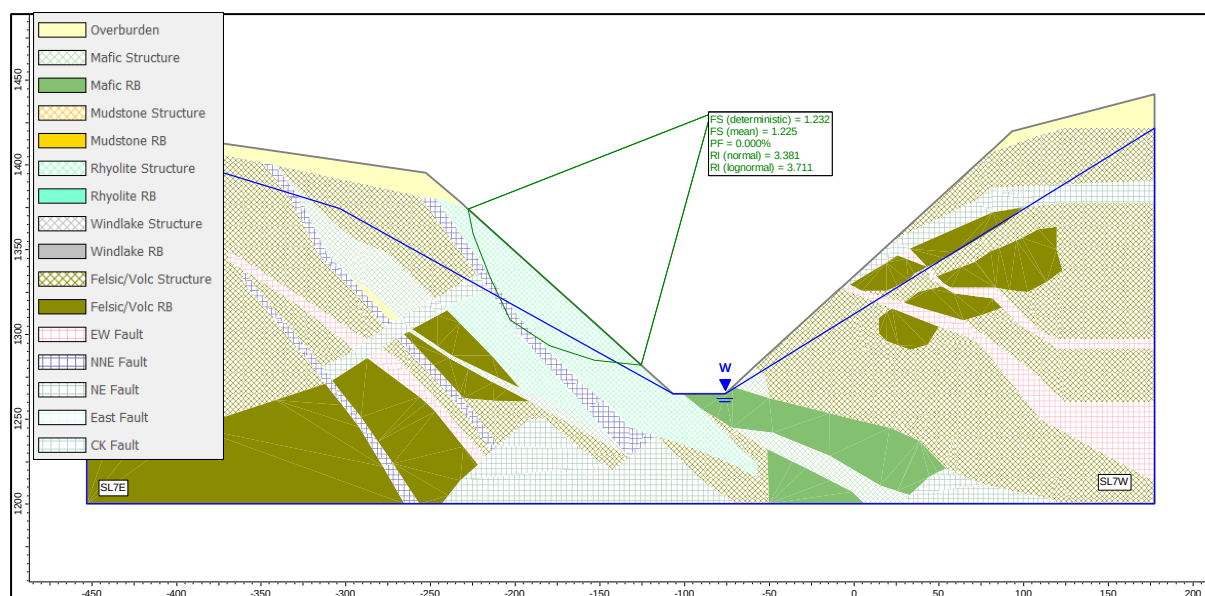


Figure 67: Limit Equilibrium Analyses for SL7E Section

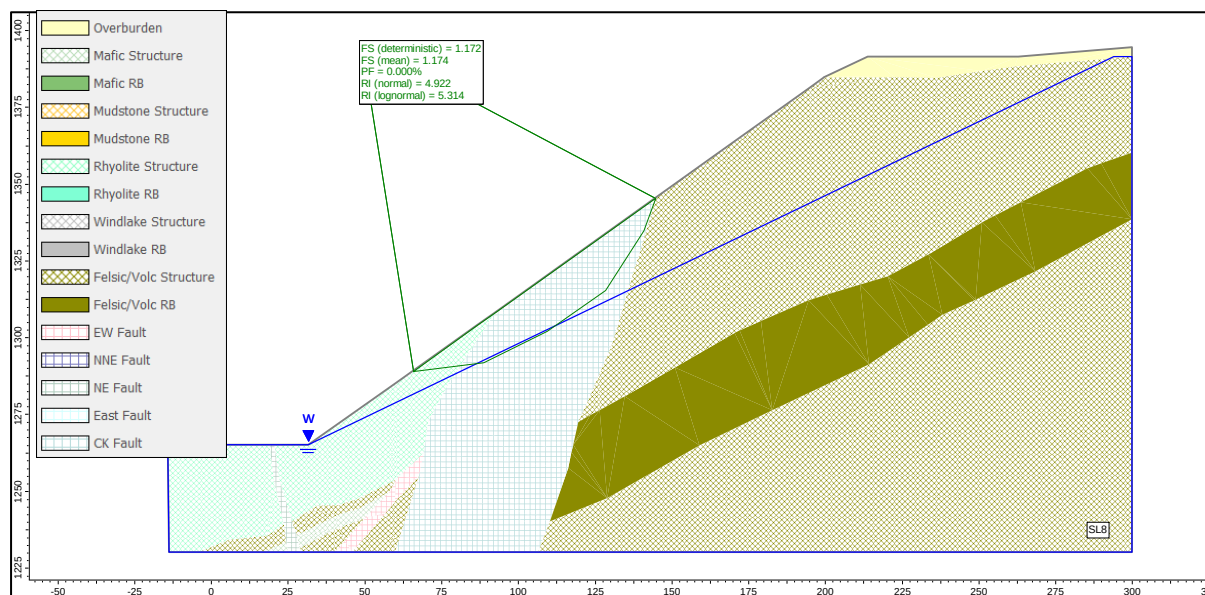


Figure 68: Limit Equilibrium Analyses for SL8 Section

12 Pit Slope Configuration

The pit slope configuration was developed based on the analyses completed for this study. The recommended configuration is given in Table 39.

Table 39: Recommended Pit Slope Configuration

Domain and Section	Material	From RL	To RL	Batter Height (m)	Berm Width (m)	Batter Angle (Degrees)	Inter Ramp Slope Angle (Toe to Toe)
Domain 1 SL1	Overburden	Surface	1430	Overburden laid back to 25° semi saturated			
	Fresh	First 20m of fresh		20	8	55	42
	Fresh	1410	1230	20	* 8 or 12	70	46
Domain 1 SL2	Overburden	Surface	1370	Overburden laid back to 30° semi saturated			
	Fresh	First 20m of fresh		20	8	55	42
	Fresh	1350	1230	20	10	70	49
Domain 2 SL3	Overburden	Surface	1400	Overburden laid back to 25° semi saturated			
	Fresh	First 20m of fresh		20	8	55	42
	Fresh	1380	1240	20	10	70	49
Domain 3 SL5	Overburden	Surface	1410	Overburden laid back to 25° semi saturated			
	Fresh	1410	1230	10	8	55	34
Domain 4 SL6W	Overburden	Surface	1370	Overburden laid back to 30° semi saturated			
	Fresh	First 10m of fresh		10	8	55	34
	Fresh	1360	1320	20	12	65	43
Domain 4 SL6E	Overburden	Surface	1370	Overburden laid back to 30° semi saturated			
	Fresh	First 10m of fresh		10	8	55	34
	Fresh	1360	1320	20	12	65	43
Domain 5A SL4	Overburden	Surface	1530	Overburden laid back to 20° semi saturated			
	Fresh	First 10m of fresh		10	8	55	34
	Fresh	1520	1260	10	9	70	38
Domain 5K SL7W	Overburden	Surface	1370	Overburden laid back to 25° semi saturated			
	Fresh	First 10m of fresh		10	8	55	34
	Fresh	1360	1260	10	8	70	41
Domain 5K SL7E	Overburden	Surface	1400	Overburden laid back to 25° semi saturated			
	Fresh	First 10m of fresh		10	8	55	34
	Fresh	1390	1260	10	8	70	41
Domain 6 SL8	Overburden	Surface	1380	Overburden laid back to 30° semi saturated			
	Fresh	First 10m of fresh		10	8	55	34
	Fresh	1370	1260	10	10	65	34

* Domain 1 SL1 Fresh 8m berms with a 27m wide ramp or 12m berms with no ramp

Pit designs were completed using the recommended pit slope configuration and BMC provided the DFS pit designs for evaluation. The final pit design (abm_pd_stage_4_20190408) was evaluated for overall slope stability using limit equilibrium analyses. The pit design and analysed sections are shown in Figure 69.

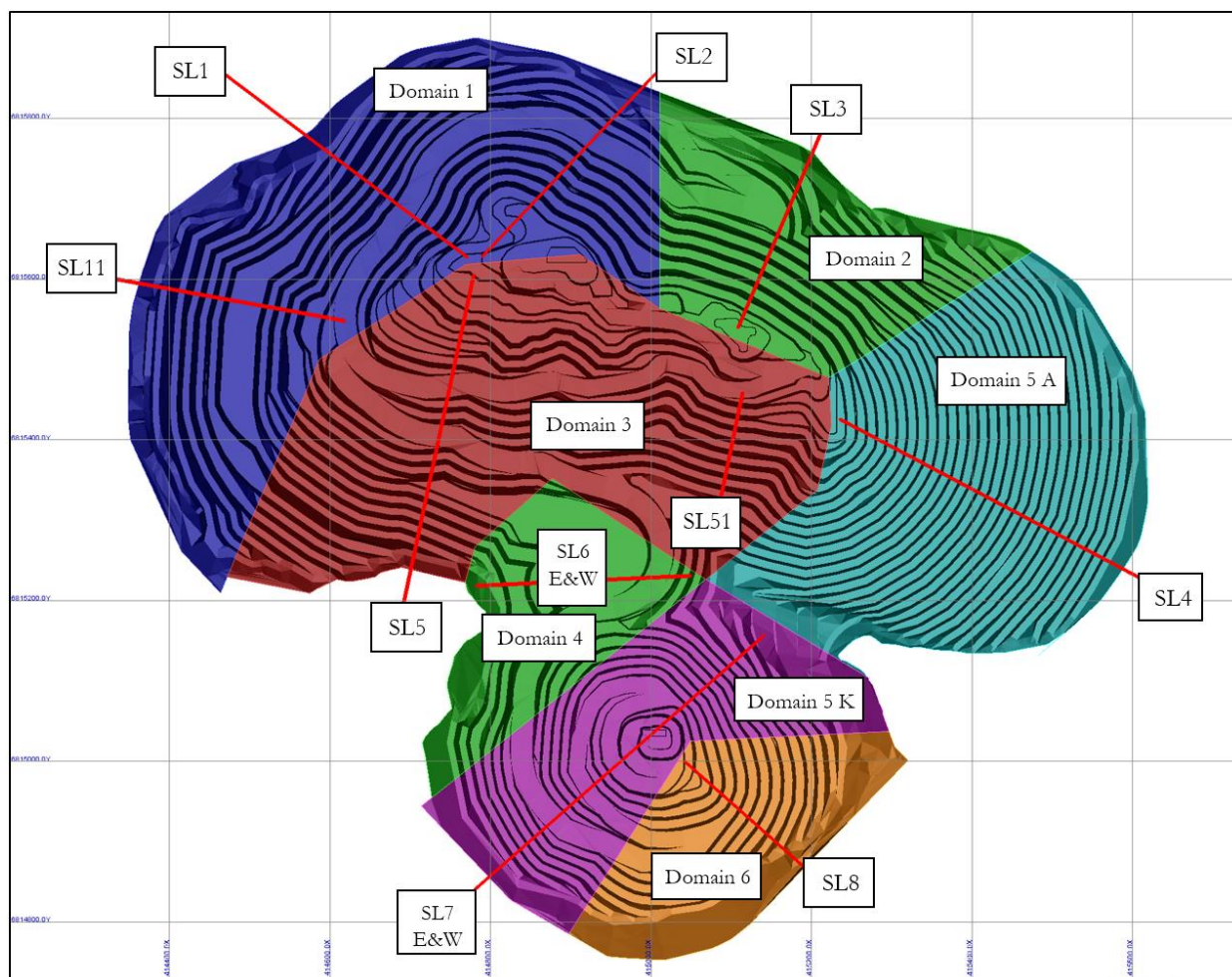


Figure 69 Planview showing DFS Pit Design (abm_pd_stage_4_20190408) and Analysed Sections

The pit slope design profiles representing the most critical zone (generally the deepest section) for each section of the pit were analysed. The sections correspond with the geotechnical domains developed from the MRMM.

Examples of the output from these analyses are shown in Figure 70 to Figure 81.

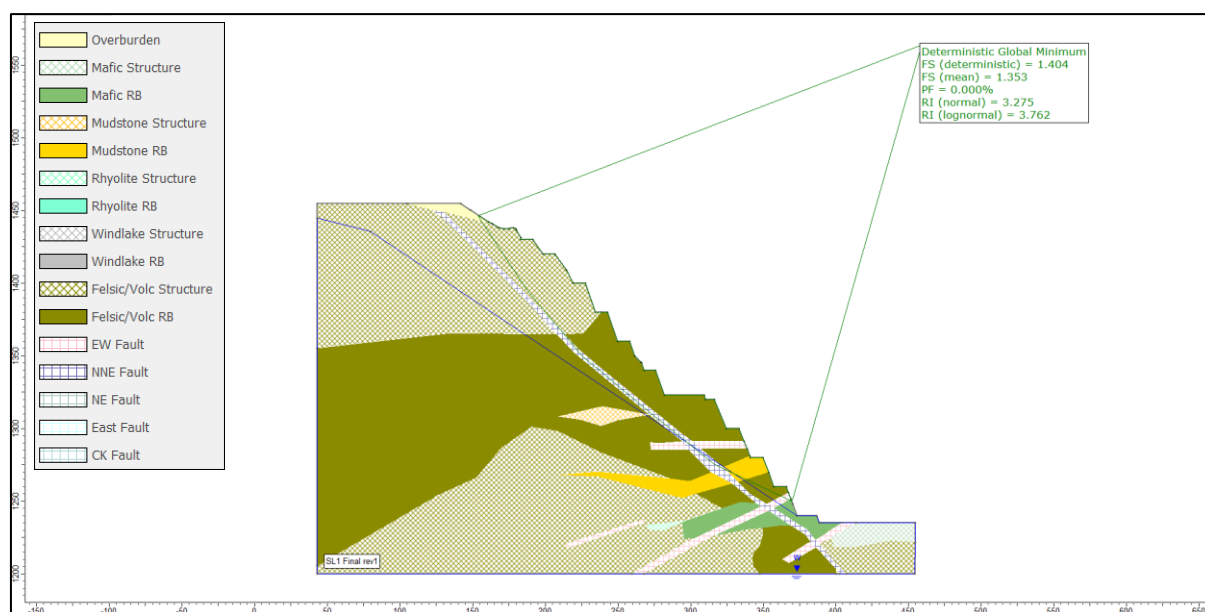


Figure 70: Limit Equilibrium Analyses for SL1 Section - DFS Pit

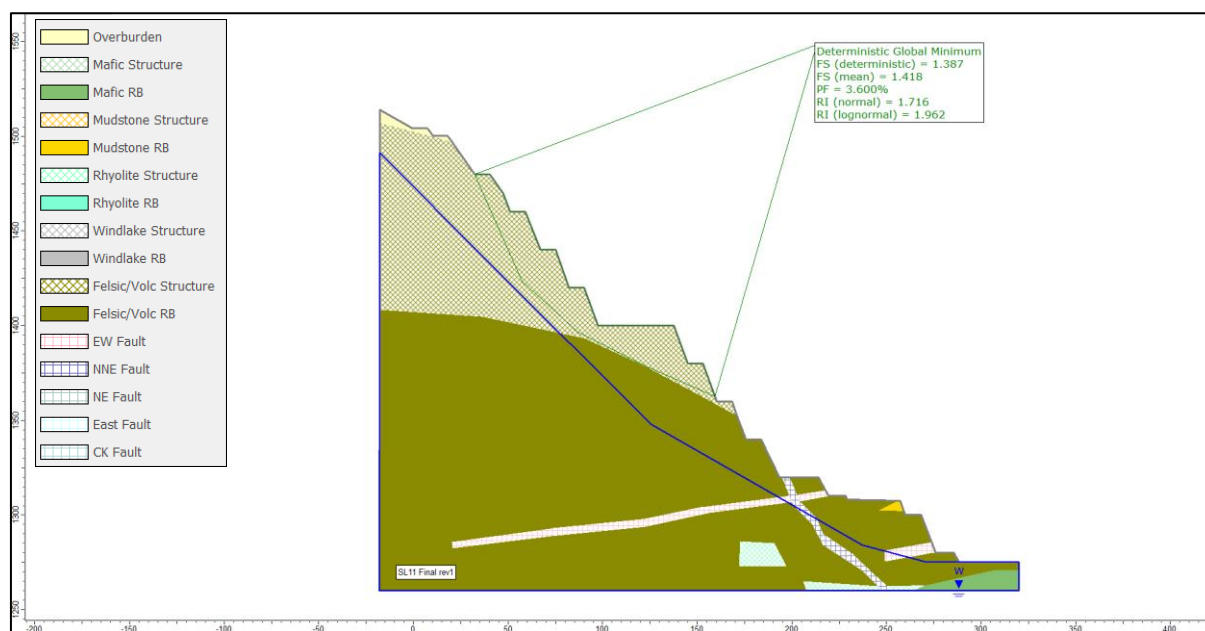


Figure 71: Limit Equilibrium Analyses for SL11 Section - DFS Pit

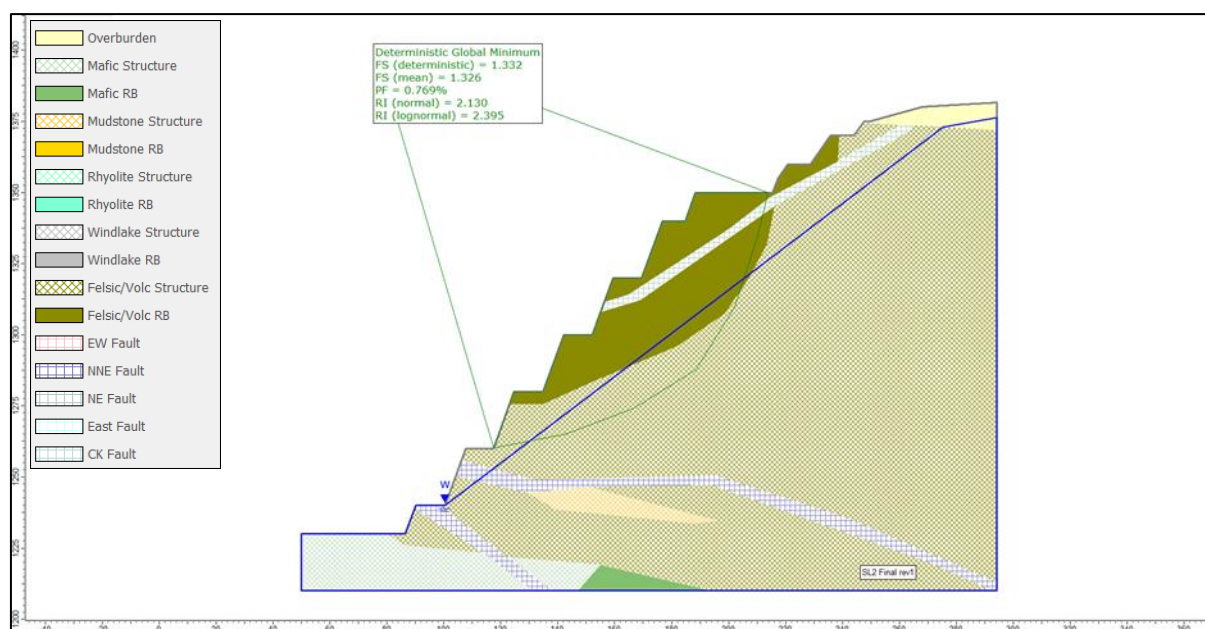


Figure 72: Limit Equilibrium Analyses for SL2 Section - DFS Pit

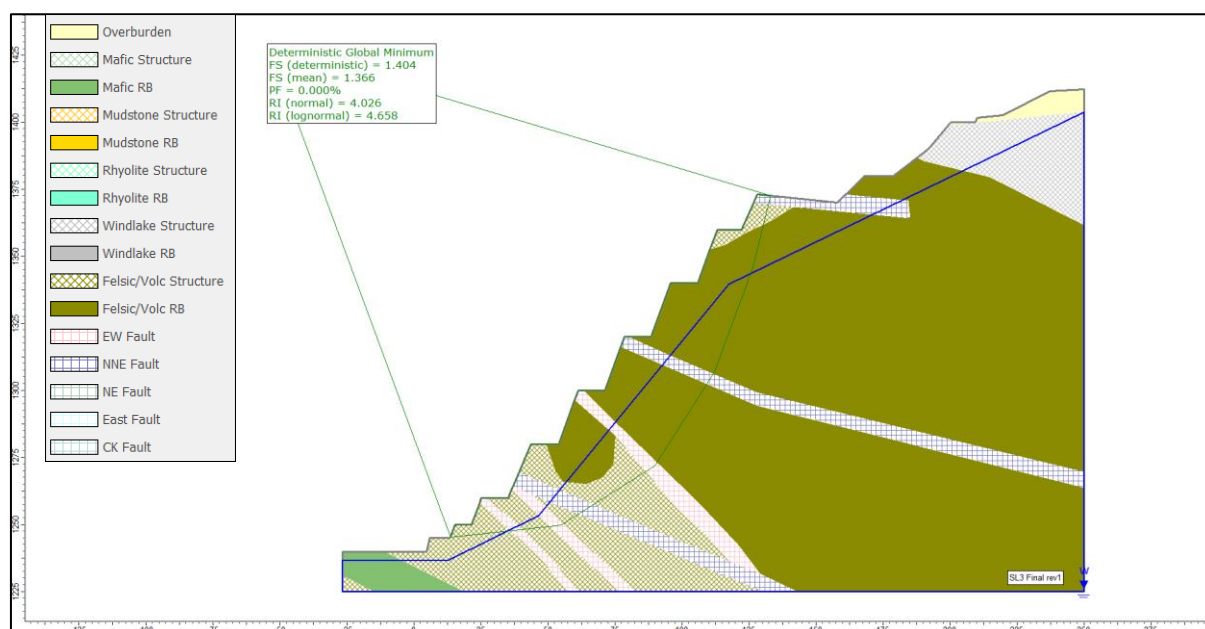


Figure 73: Limit Equilibrium Analyses for SL3 Section - DFS Pit

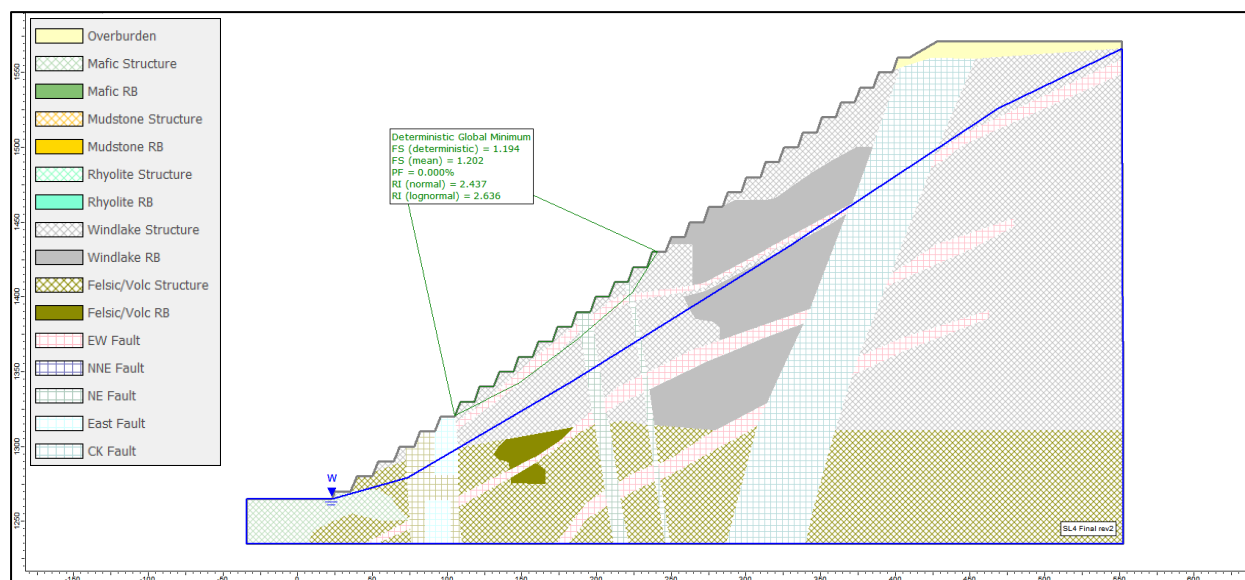


Figure 74: Limit Equilibrium Analyses for SL4 Section - DFS Pit

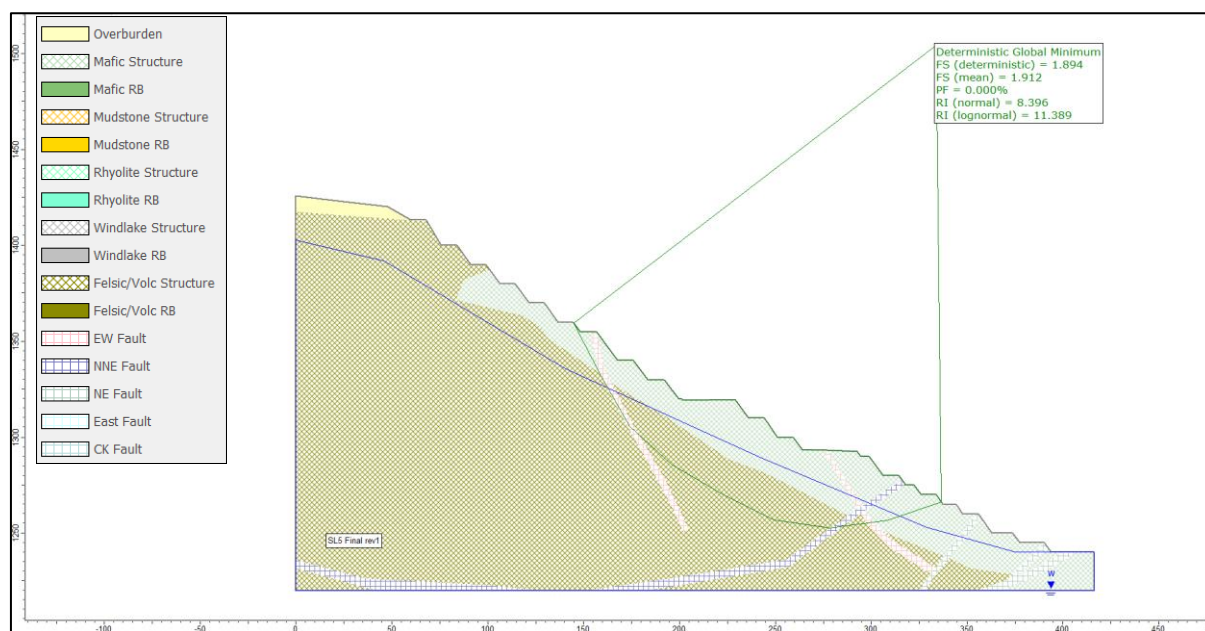


Figure 75: Limit Equilibrium Analyses for SL5 Section - DFS Pit

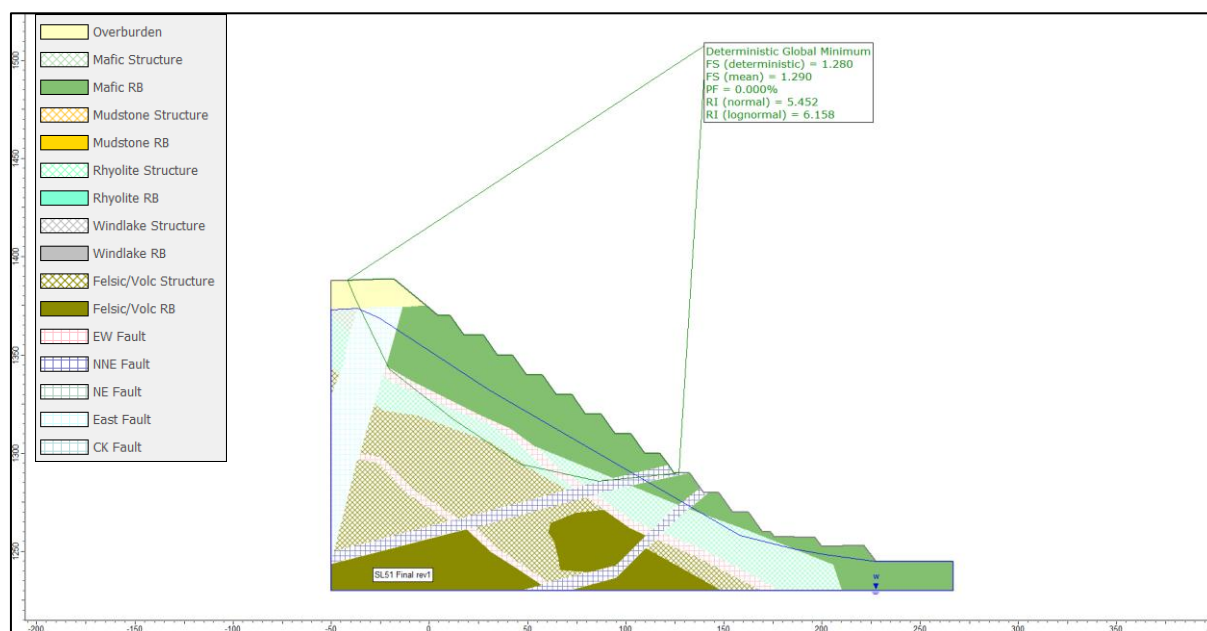


Figure 76: Limit Equilibrium Analyses for SL51 Section - DFS Pit

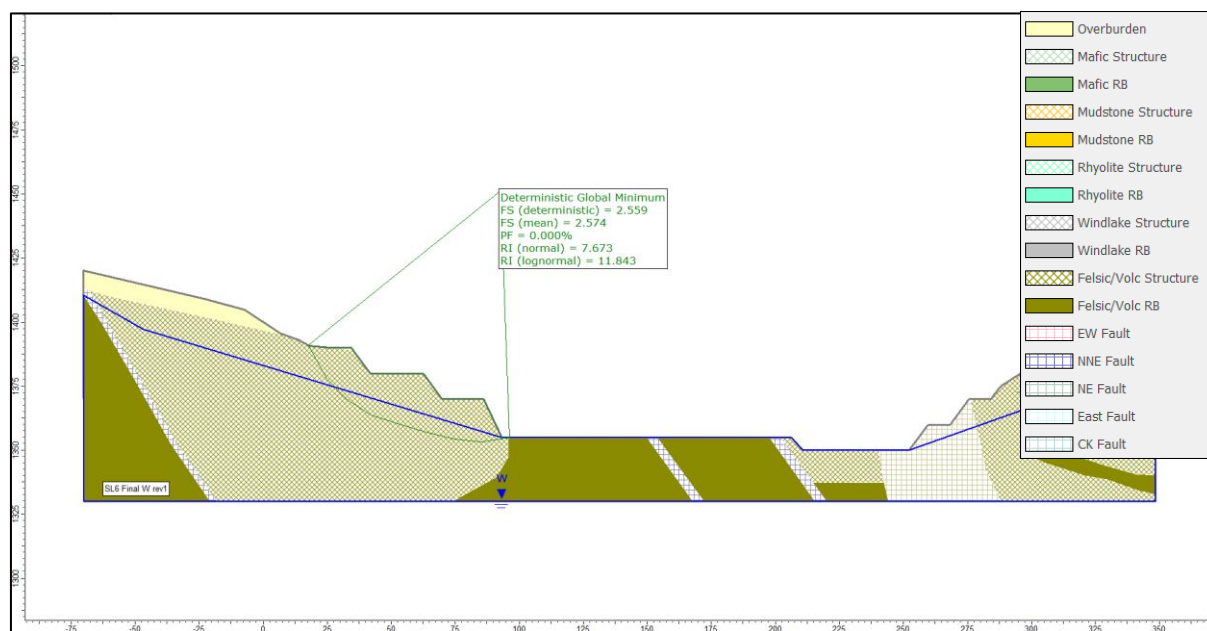


Figure 77: Limit Equilibrium Analyses for SL6 W Final Section - DFS Pit

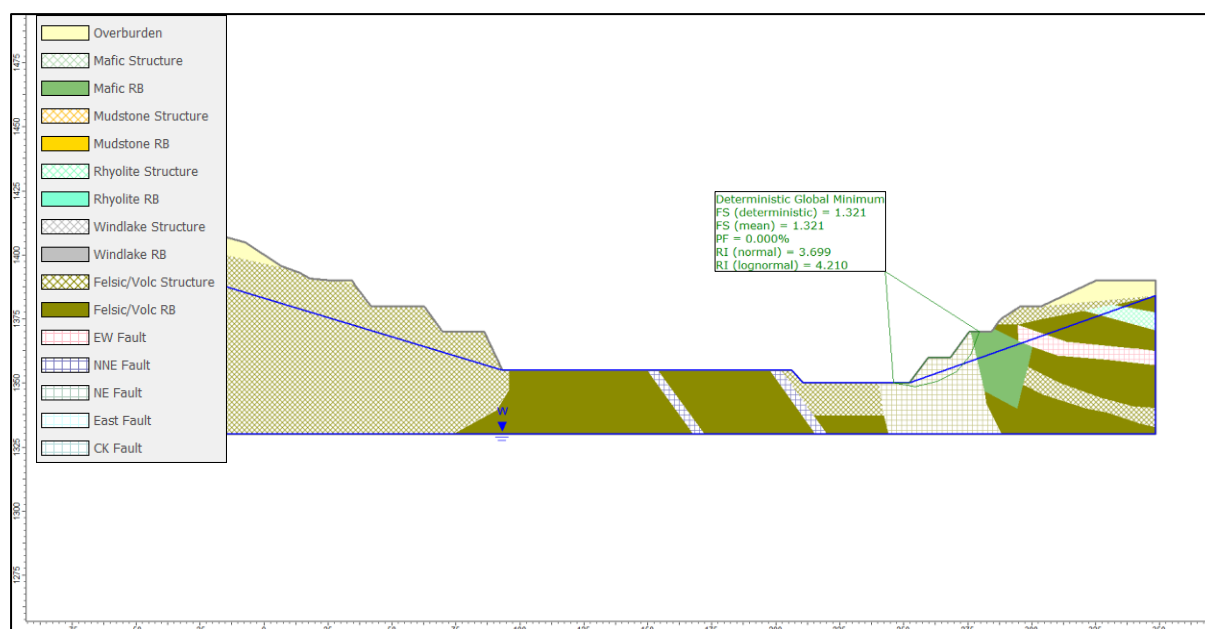


Figure 78: Limit Equilibrium Analyses for SL6 E Final Section - DFS Pit

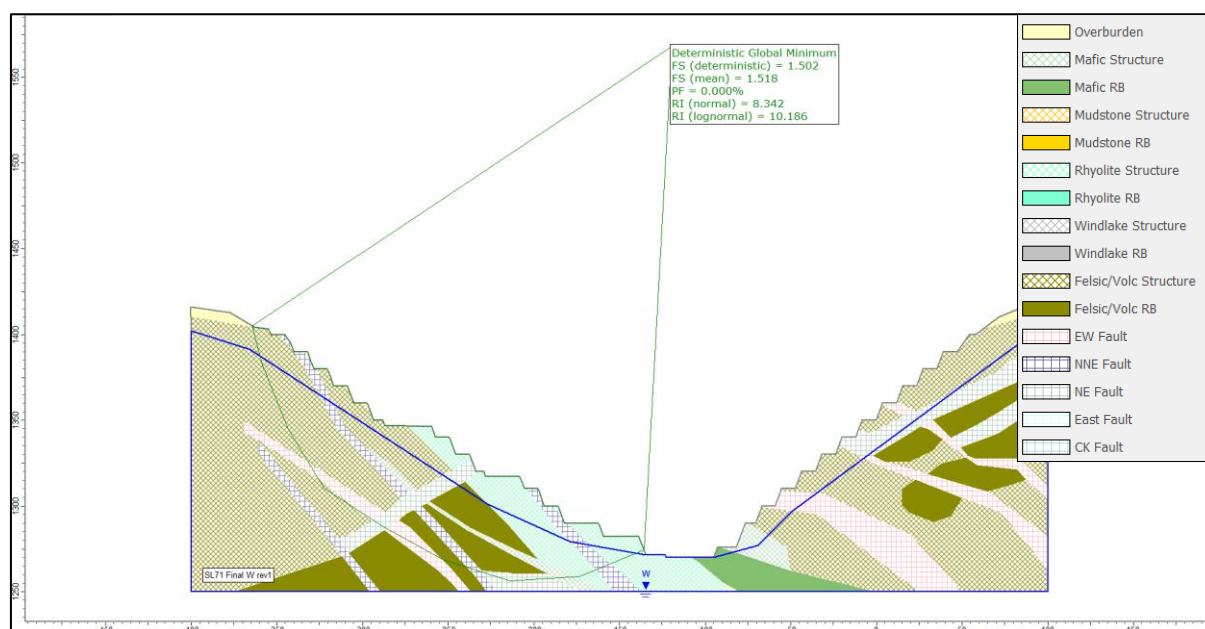


Figure 79: Limit Equilibrium Analyses for SL7 W Section - DFS Pit

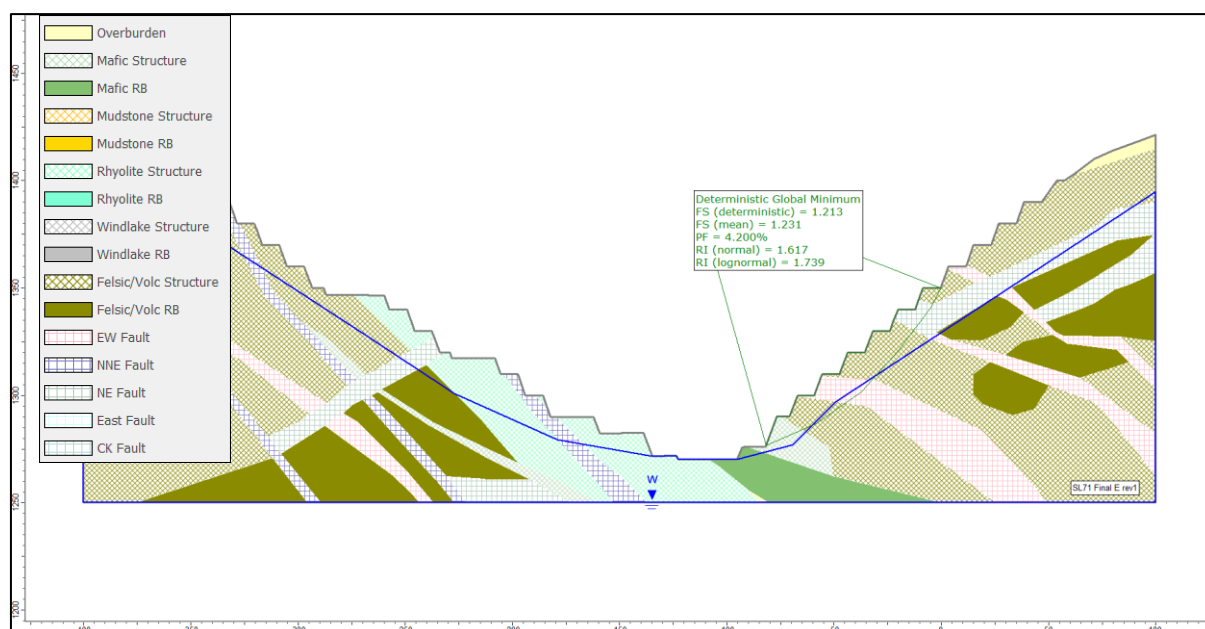


Figure 80: Limit Equilibrium Analyses for SL7 E Section - DFS Pit

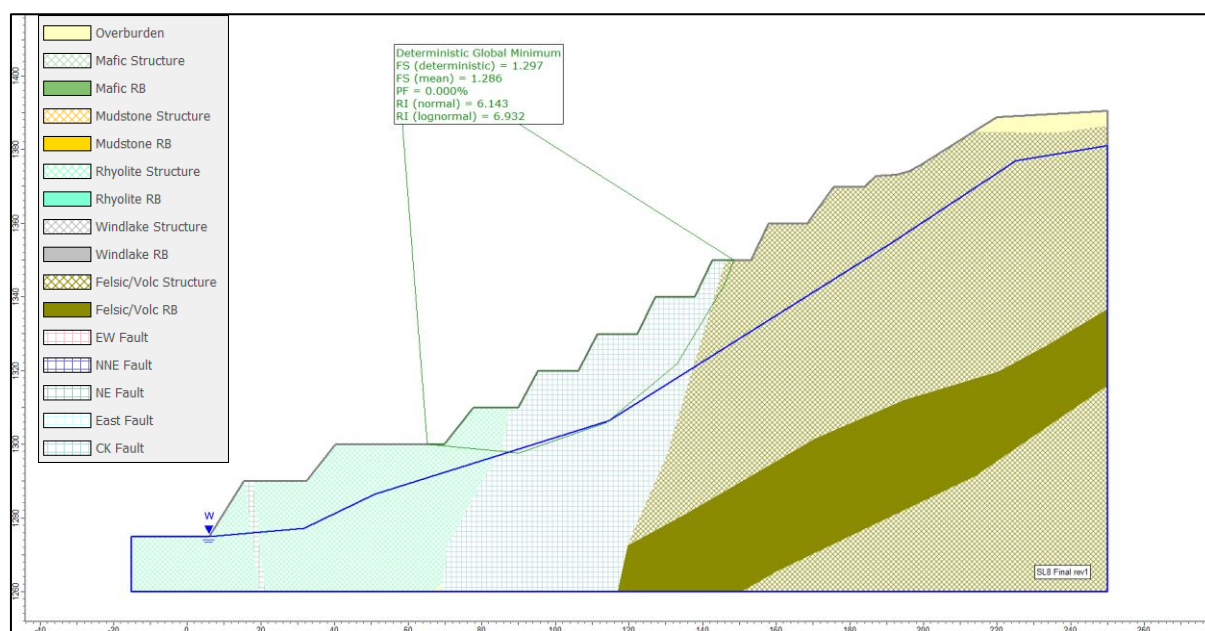


Figure 81: Limit Equilibrium Analyses for SL8 Section - DFS Pit

The results from the analyses are summarised in Table 40.

Table 40 Summary Limit Equilibrium Results

Domain	Section	Factor of Safety
Domain 1	SL1	1.4
	SL11	1.4
	SL2	1.3
Domain 2	SL3	1.4
Domain 3	SL5	1.9
	SL51	1.3
Domain 4	SL6E	1.3
	SL6W	2.6
Domain 5A	SL4	1.2
Domain 5K	SL7E	1.2
	SL7W	1.5
Domain 6	SL8	1.3

The resulting Factors of Safety are equal to or exceed 1.2 and are within accepted guidelines for open pit slope stability.

13 Monitoring and Slope Management

A slope monitoring program must be implemented at the start of mining to monitor and minimise the adverse effects of instability on slopes.

13.1 Tension crack mapping

All cracks must be mapped regardless of apparent cause. Cracks which appear to be the result of blasting, or local bench displacement may form a pattern indicating larger displacement when plotted on a pit map. The ends of the cracks should be marked so that new cracks or extensions of existing cracks can be identified.

13.2 Survey monitoring

A definite monitoring schedule must be established. In the event of heavy rain or a large blast, additional measurements should be taken. Prism spacing will depend on the locations and width of cracked areas.

13.3 Groundwater

Measuring and understanding the groundwater levels is very important, as excess water pressure can be responsible for major failures. Groundwater level must be monitored; data should graphically show the following:

- Water levels v time
- Map of piezometer surface
- Rainfall

Groundwater data collected as mining proceeds will help to indicate development of potential problems and appropriate measures can then be implemented to alleviate these problems (for example sub-horizontal drain holes or vertical dewatering bores).

14 Conclusions and Recommendations

The following conclusions and recommendations are made:

- The rock mass at KZK is classified as Poor to Fair with high ratio of geological structure.
- 29 significant geotechnical features have been identified and modelled in 3d. The features have been classified according to orientation and structure type.
- The NNE geotechnical features are parallel to the west wall of the pit. It is important that these features do not form the wall as instability will occur. The west wall should either be pushed back to mine out the features or at least 10m of competent rock left between the wall and the feature. The current DFS pit design accommodates the known features in this way. It is recommended that additional drilling be undertaken into the west wall to investigate the possible locations of additional NNE trending features.
- The NNW geotechnical feature is less than 1m in thickness and is located in primarily in the south wall of the final pit. In this location the feature has no impact on wall stability and was not included in the Mining Rock Mass Model.
- A 3d Mining Rock Mass Model was constructed based on lithological wireframes provided by BMC, geotechnical logs and significant geotechnical features.
- Six geotechnical domains have been defined and the pit slopes have been designed using appropriate parameters for each geotechnical domain. The pit slope configuration comprises 10m to 20m bench heights with 55° to 70° batter angles. Berm widths are 8m, 10m or 12m. Inter ramp slope angles are 25° to 30° in the overburden material depending on depth and 34° to 49° in fresh rock.
- The original geotechnical design work completed by D&S was based on the Pre-Feasibility Study pit design in terms of pit wall locations and orientation and final pit depth. Subsequently D&S has reviewed the Definitive Feasibility Study (DFS) final pit design and confirm that the original geotechnical work is appropriate and applicable to the DFS pit design.
- The ultimate pit (abm_pd_stage_4_20190408) has been designed using the recommended pit slope configuration. This pit has been assessed for overall stability using limit equilibrium analyses by D&S. The resulting Factors of Safety are equal to or exceed 1.2 and are within accepted guidelines for open pit slope stability.
- A monitoring and slope management programme should be implemented to establish benchmark criteria for the pit and then provide ongoing data to determine overall slope performance.
- A ground control management plan must be implemented when mining commences.
- Geotechnical data collection incorporating window mapping, photographic records and surveys of mapped areas should also be recorded as mining progresses. Batter slope performance and structural evaluations of the batters must be carried out during mining to improve current design confidence levels

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APPENDIX B: OPEN PIT SEISMIC SLOPE STABILITY ASSESSMENT



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14 February 2024

George Smith
Group Engineer
BMC Minerals

Dear George,

Dempers & Seymour (D&S) has completed a series of analyses of the KZK DFS pit slope design to assess the slope stability during a seismic event. Best practices are used in determining the minimum factor of safety required for the overall slope angles of the open pit. The accepted guidelines (Read and Stacey 2009) have been applied to determine the acceptance criteria for minimum factor of safety. For the KZK pit, a medium consequence of failure for overall stability was selected with a minimum factor of safety of 1.05 for the dynamic design criteria shown in Table 1.

Table 1: Dynamic Design Acceptance Criteria

Slope Scale	Consequences of Failure	Acceptance Criteria		
		FOS (min) (Static)	FOS (min) (Dynamic)	POF (max) P(FoS<1)
Overall	Low	1.2 - 1.3	1	15% - 20%
	Medium	1.3	1.05	5% - 10%
	High	1.3 - 1.5	1.1	<5%

The seismic design analysis considered the limit equilibrium stability of the DFS final pit design (abm_pd_stage_4_20190408) evaluated by D&S (D&S 2019) for overall slope stability. Limit equilibrium analyses were used for an equivalent 1/2000-year event for the Site Class A area, estimated to be 0.101 PGA (NBC, 2020). This PGA has an equivalent horizontal equivalent of 0.0505 PGA and was applied as a constant force in the limit equilibrium model per Pyke (Pyke 1997). It should be noted that there are few recorded instances in which earthquakes have been shown to produce significant instability in hard rock open pits. Recent studies indicate that earthquakes have produced small shallow slides and rock falls in rock slopes, but none on a scale sufficient to disrupt mining operations (Read and Stacey, 2009).

The pit slope profiles representing the most critical zone (generally the deepest section) for each section of the pit were analysed as shown in Figure 1.

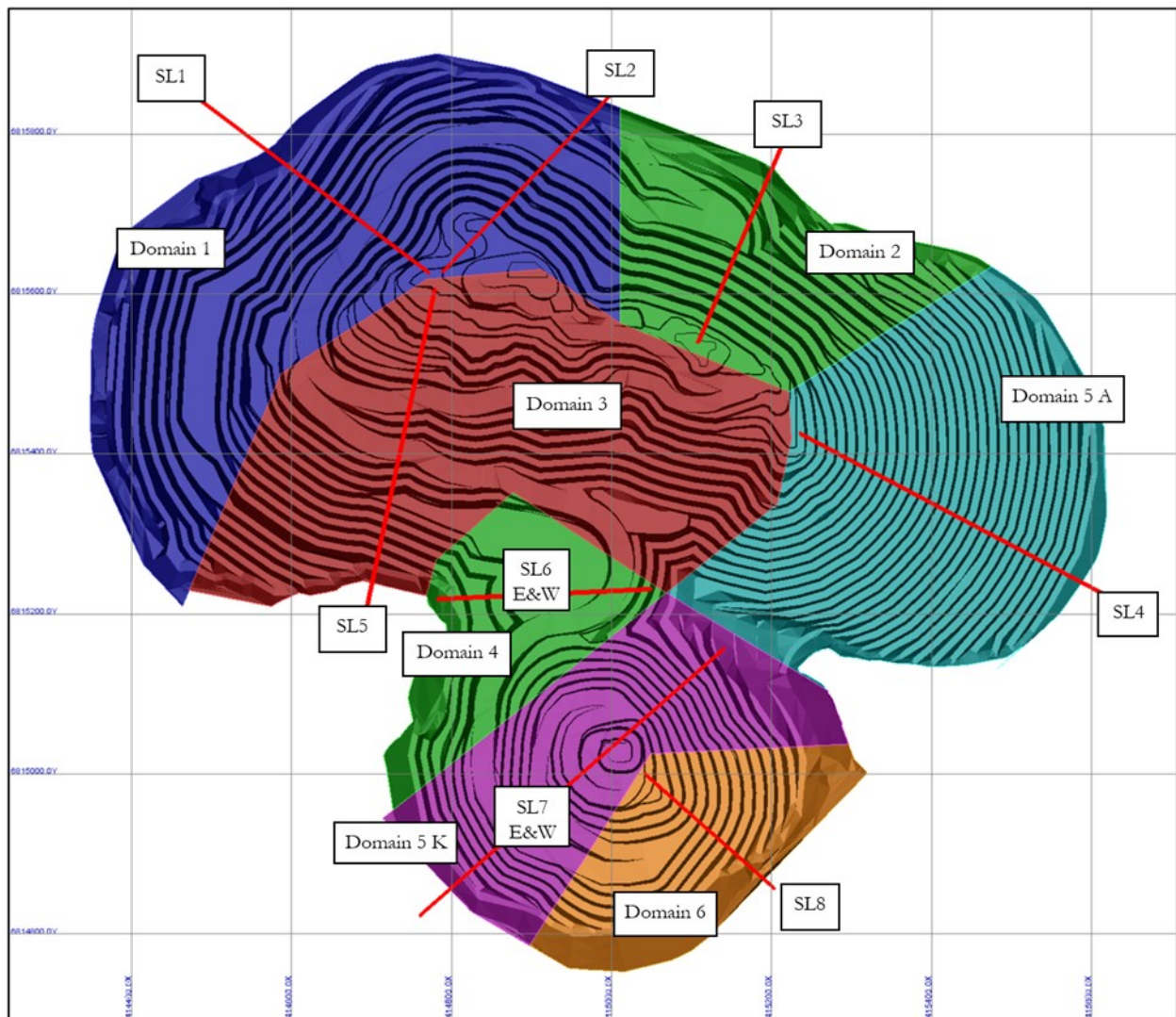


Figure 1 Planview showing DFS Pit Design (abm_pd_stage_4_20190408) and Analysed Sections

Output from these analyses is shown in Figure 2 to Figure 13.

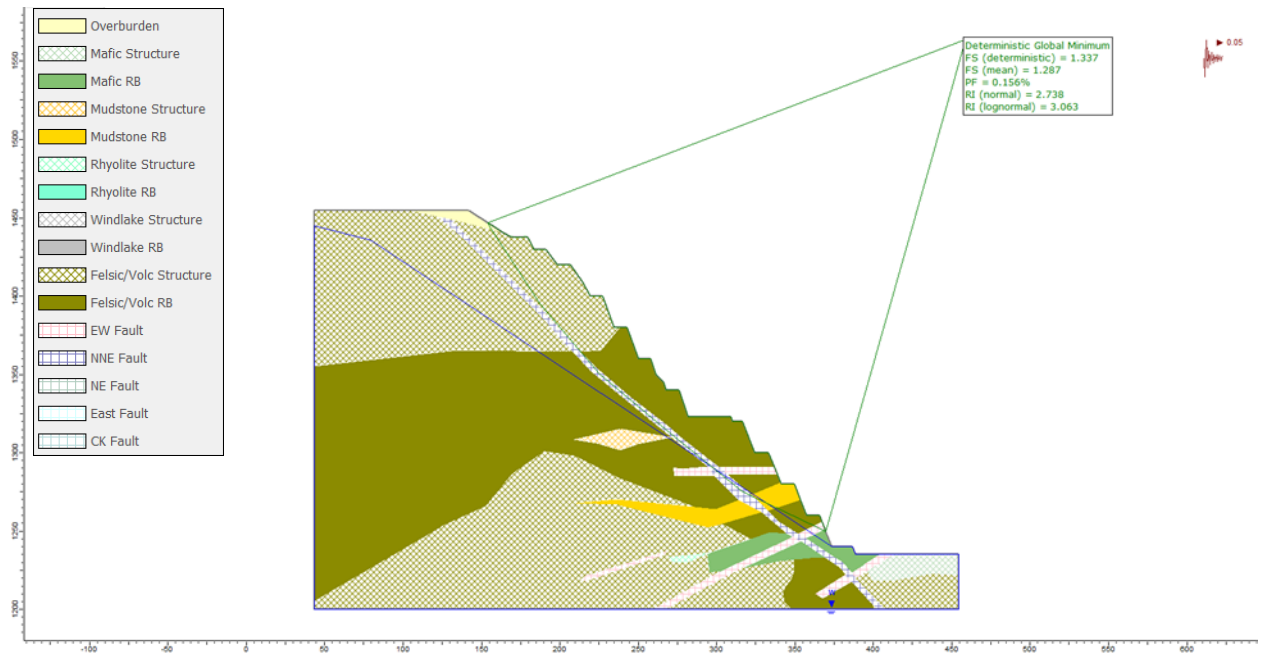


Figure 2: Limit Equilibrium Analyses for SL1 Section - DFS Pit

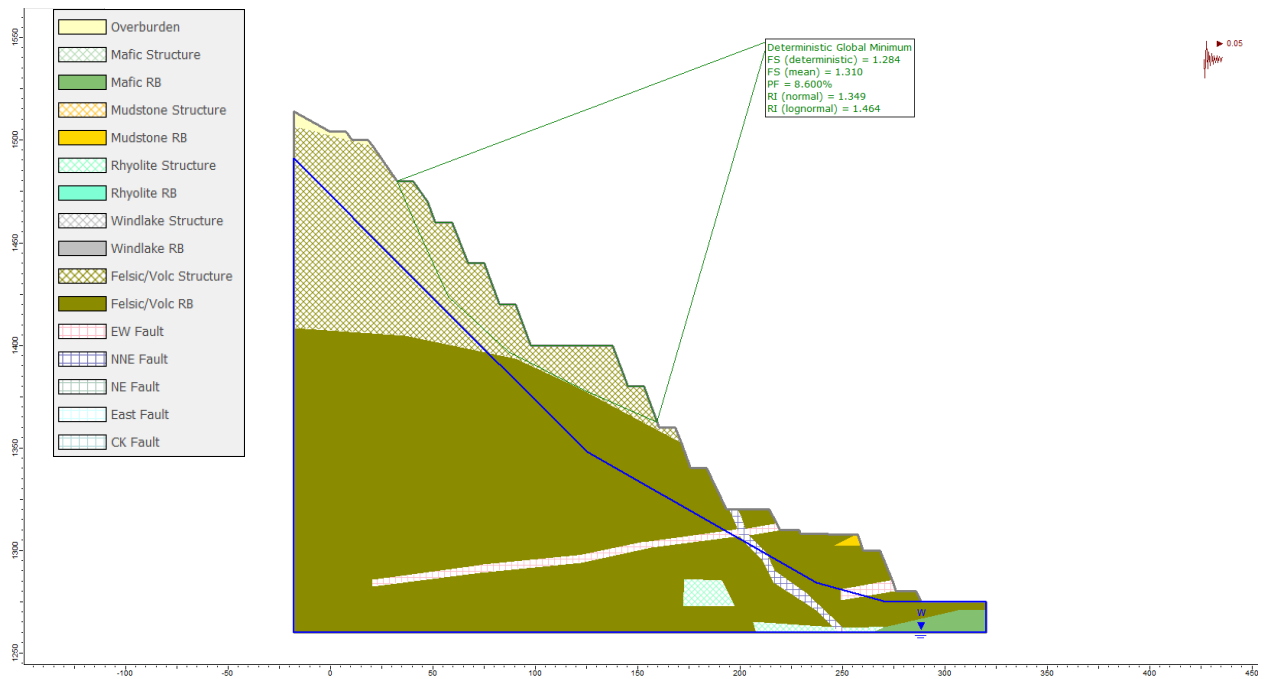


Figure 3: Limit Equilibrium Analyses for SL11 Section - DFS Pit

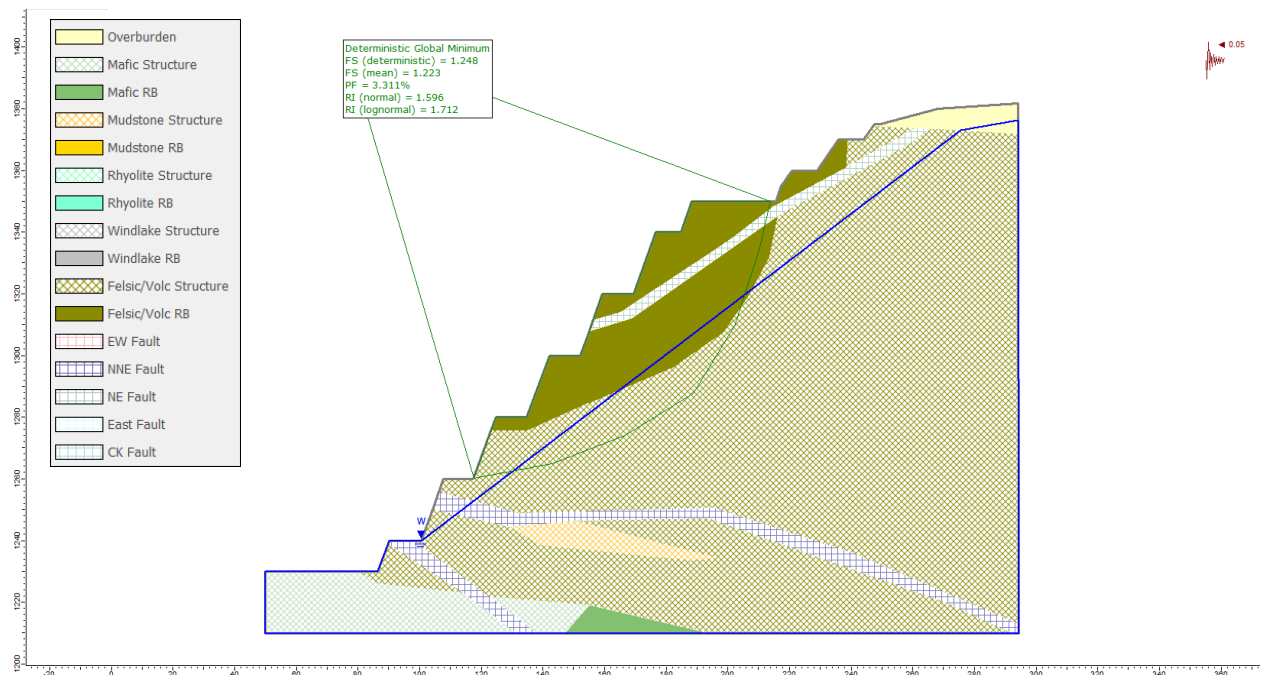


Figure 4: Limit Equilibrium Analyses for SL2 Section - DFS Pit

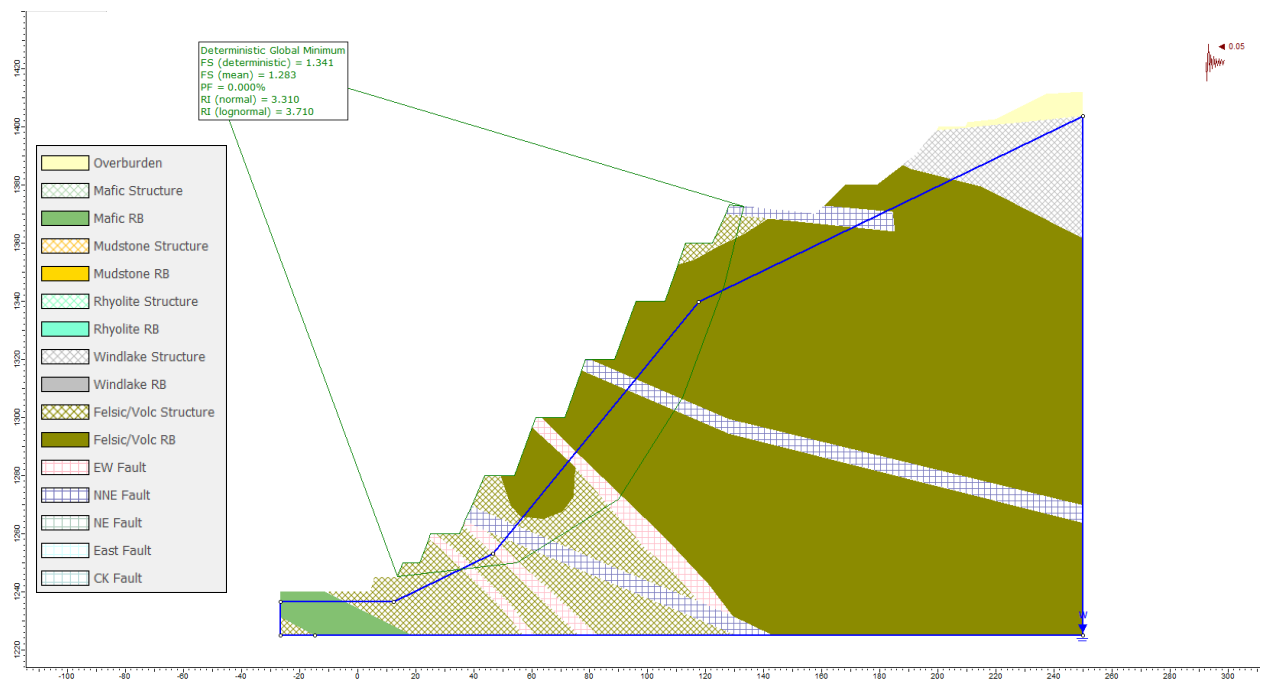


Figure 5: Limit Equilibrium Analyses for SL3 Section - DFS Pit

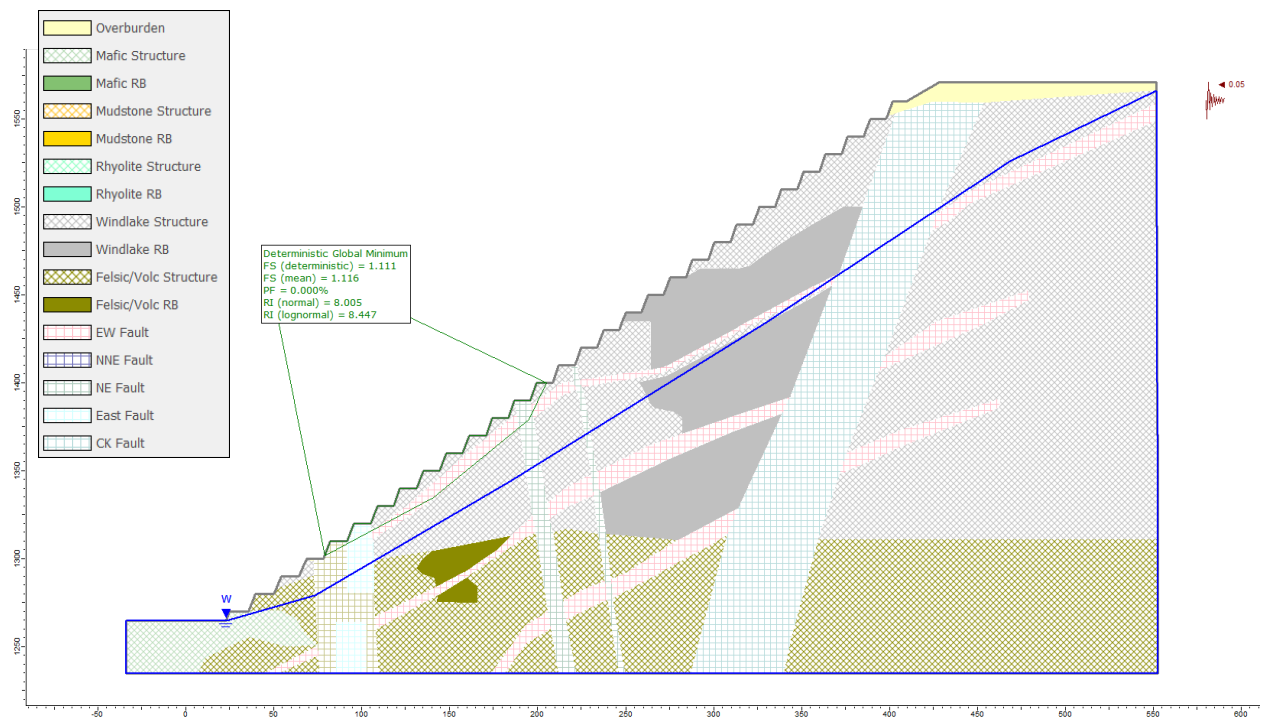


Figure 6: Limit Equilibrium Analyses for SL4 Section - DFS Pit

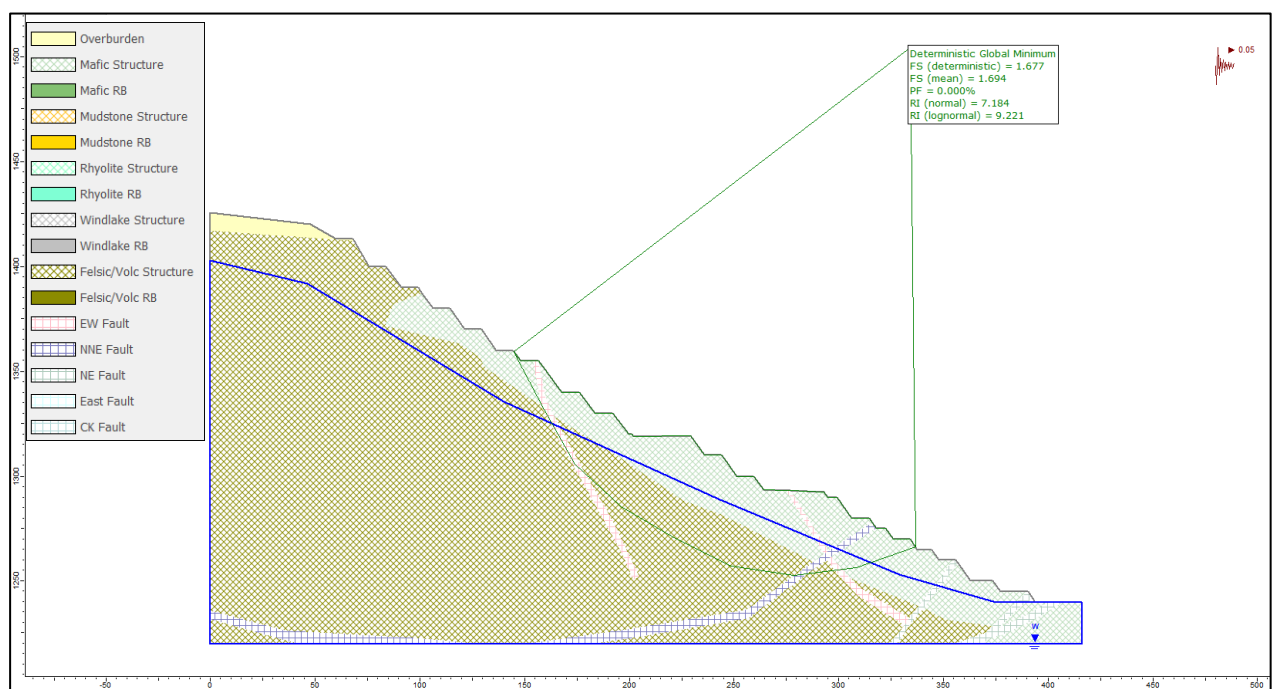


Figure 7: Limit Equilibrium Analyses for SL5 Section - DFS Pit

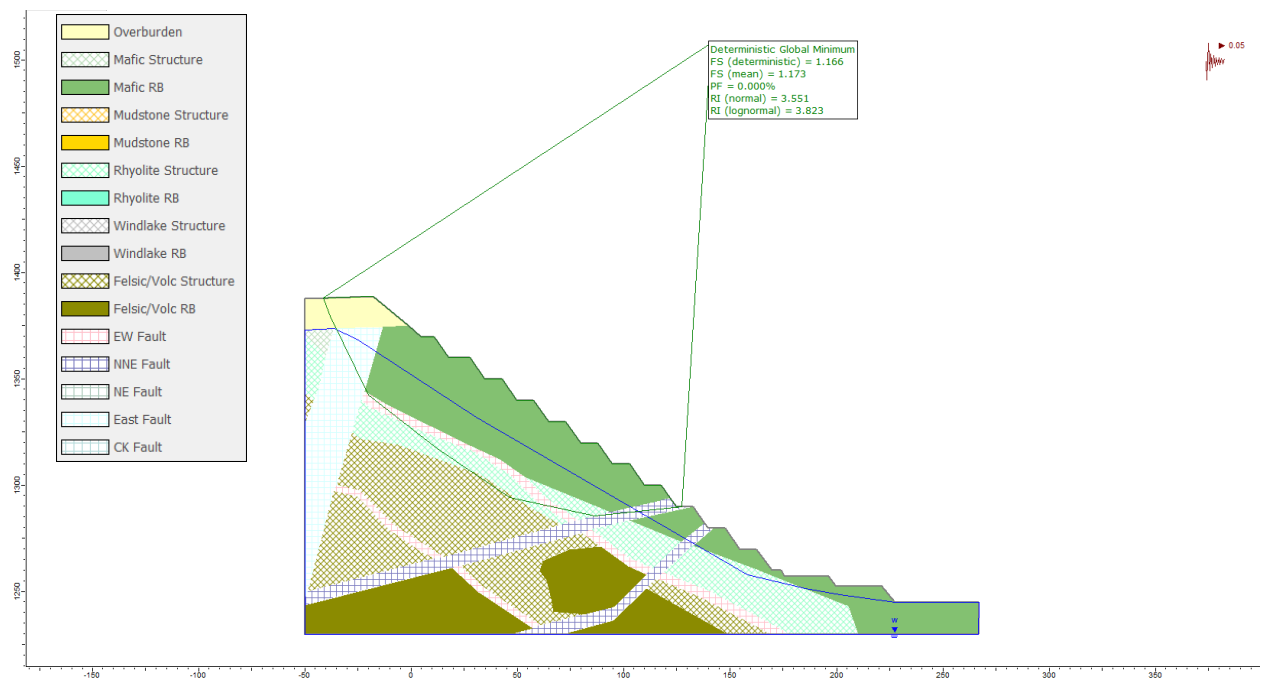


Figure 8: Limit Equilibrium Analyses for SL51 Section - DFS Pit

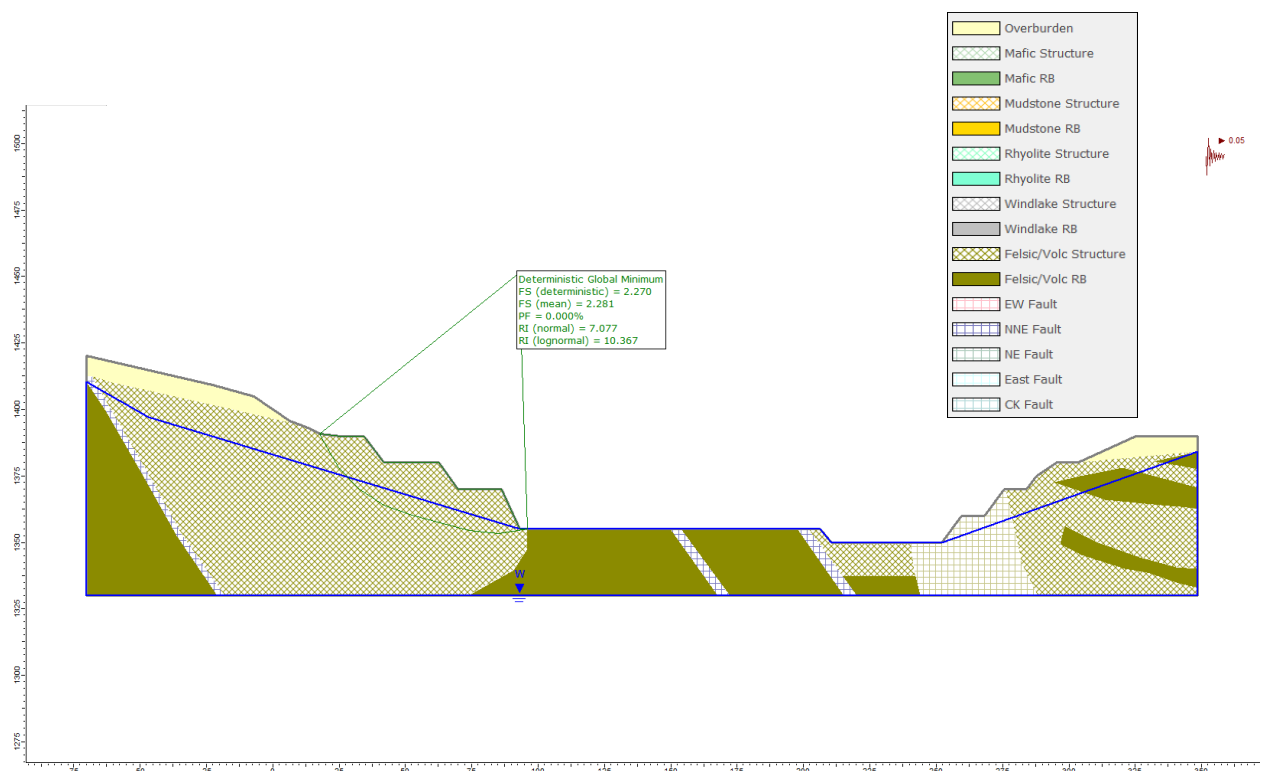


Figure 9: Limit Equilibrium Analyses for SL6 W Final Section - DFS Pit

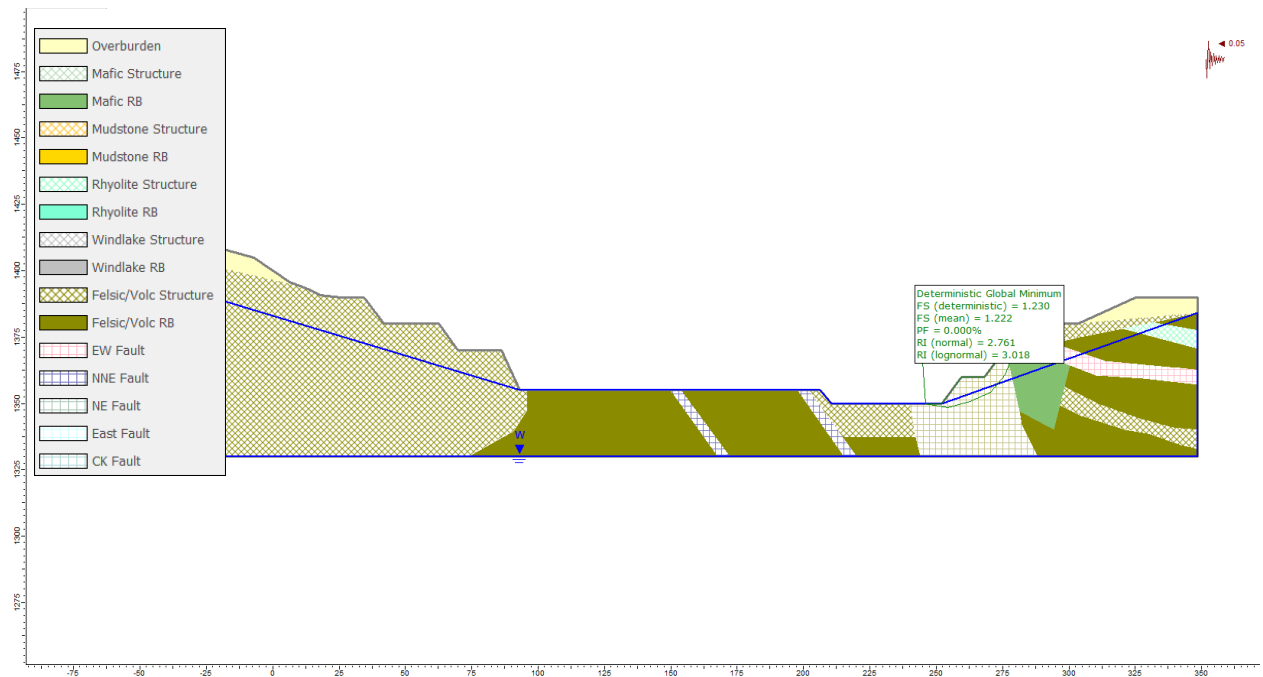


Figure 10: Limit Equilibrium Analyses for SL6 E Final Section - DFS Pit

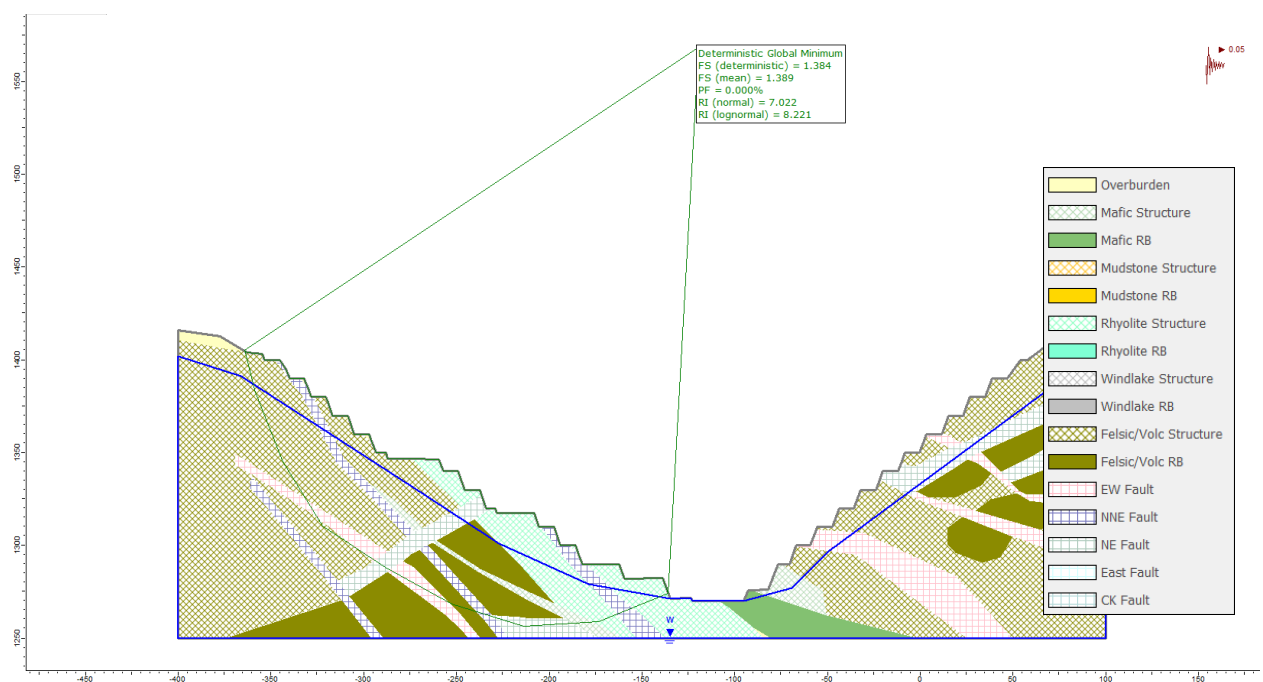


Figure 11: Limit Equilibrium Analyses for SL7 W Section - DFS Pit

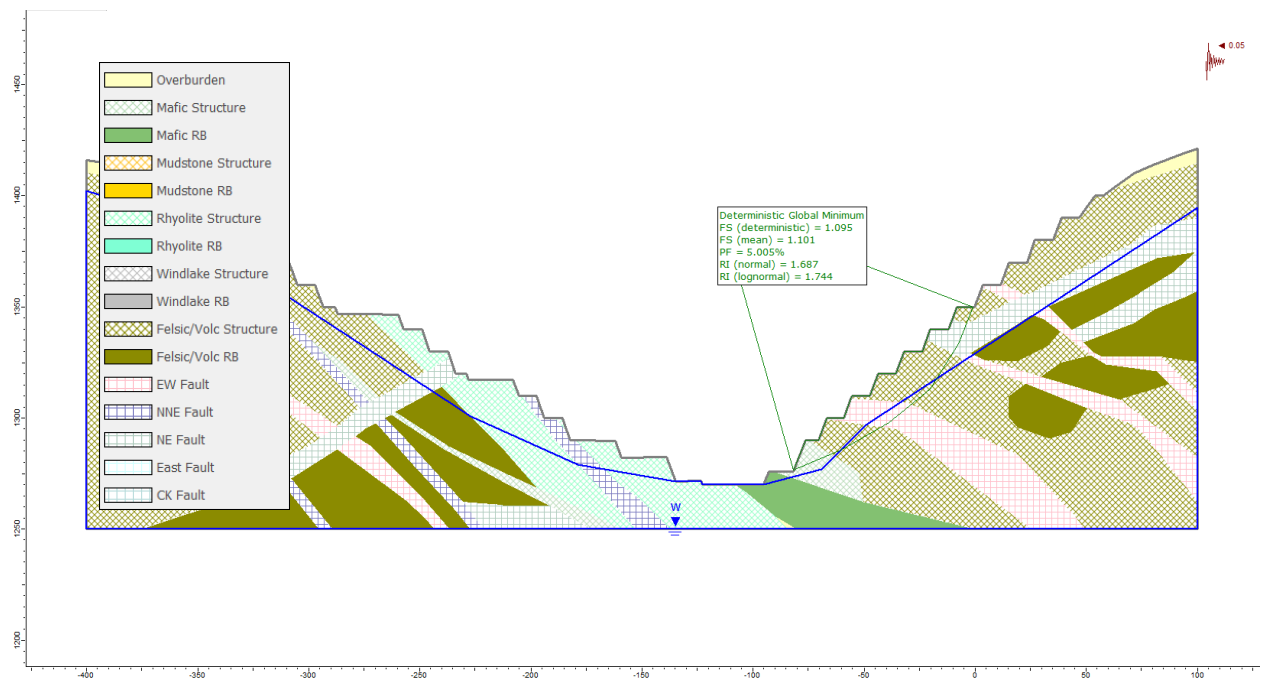


Figure 12: Limit Equilibrium Analyses for SL7 E Section - DFS Pit

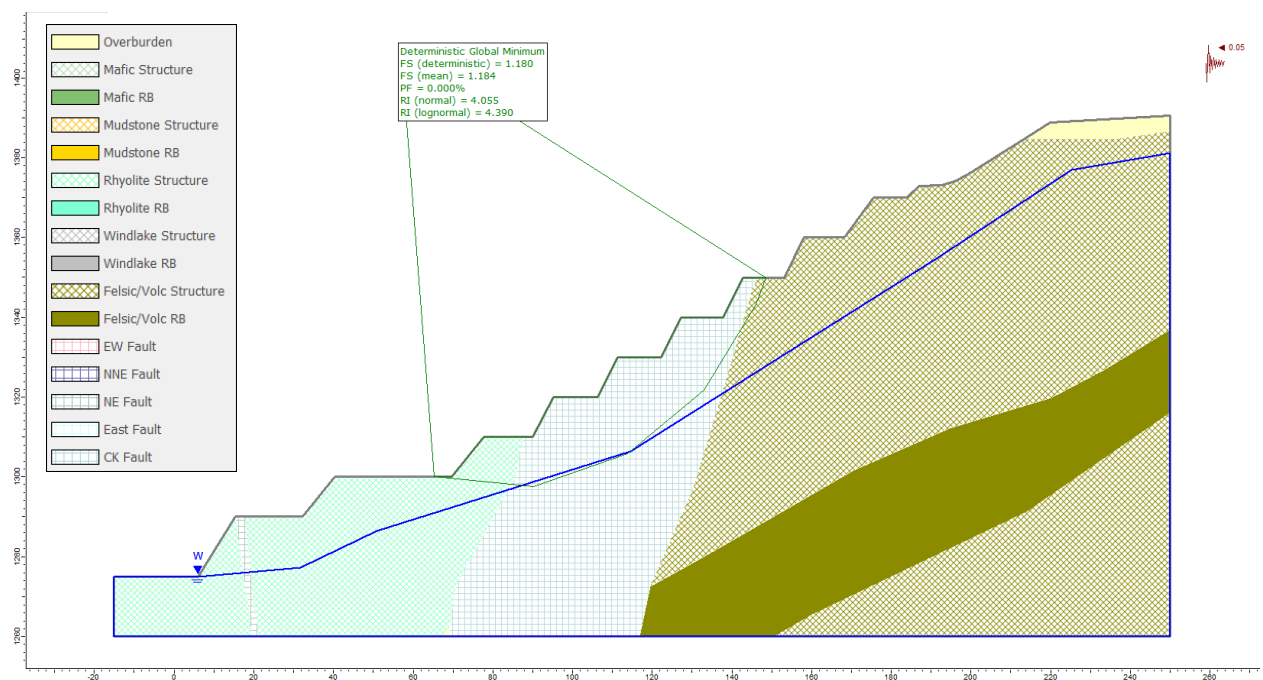


Figure 13: Limit Equilibrium Analyses for SL8 Section - DFS Pit

Results from the seismic evaluation for pit slope stability are summarised in Table 2 and shown in Figure 14.

Table 2 Summary of Analyses for Seismic Loading Limit Equilibrium Results

Domain	Section	FoS (Dynamic)
Domain 1	SL1	1.29
	SL11	1.29
	SL2	1.22
Domain 2	SL3	1.28
Domain 3	SL5	1.69
	SL51	1.17
Domain 4	SL6E	1.22
	SL6W	2.28
Domain 5	SL4	1.12
Domain 5K	SL7E	1.1
	SL7W	1.38
Domain 6	SL8	1.18

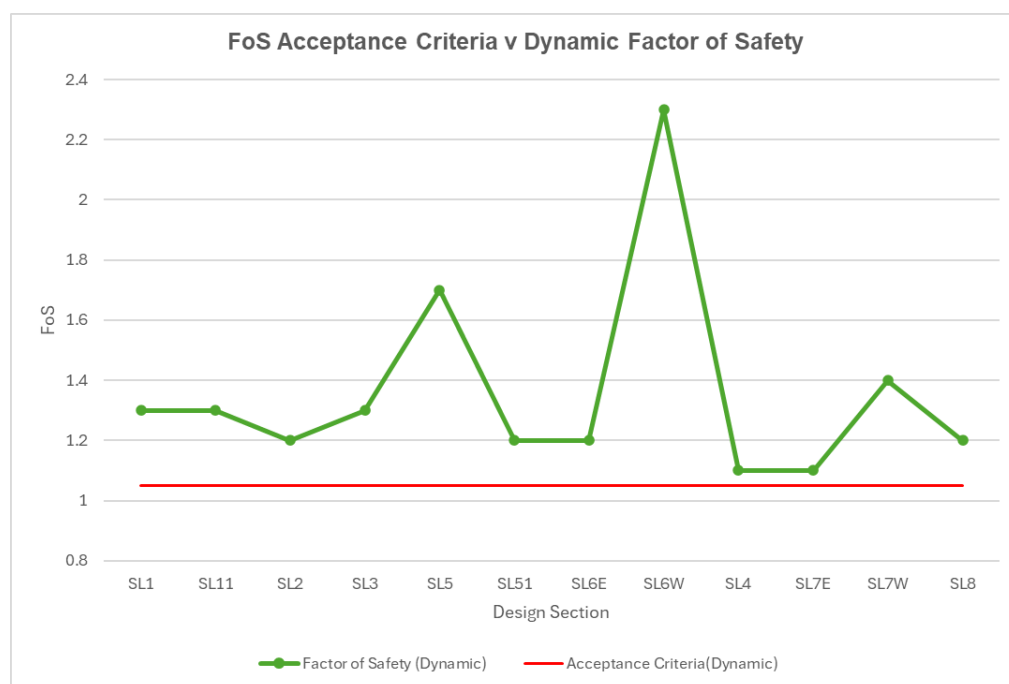


Figure 14: FoS Results from Analyses v Acceptance Criteria

The results from the analyses carried out indicates Factors of Safety exceed 1.05 (acceptance criteria) and are within accepted guidelines for open pit slope stability.

This letter should be read in conjunction with Dempers & Seymour Pit Slope Design, Final Report. (D&S 2019).

Yours Sincerely

Gary Dempers

References:

Dempers & Seymour. (2019) BMC Minerals (No1) Ltd, Kudz Ze Kayah Project - Pit Slope Design, Final Report. June 2010.

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APPENDIX C: TABLE OF CONCORDANCE

Reference No.	Proponent Commitment / Mitigation	Where addressed
YESAB R164	The existing debris flood deposit and alluvial fan will be excavated as part of the overburden stripping during the mining process. As part of the mine design a safety bench will be left at the crest of the pit to prevent the entry of any material from the surrounding overburden and debris flows. The slope of the overburden will be a maximum of 30° and the width of the safety bench will be a minimum of 5 m.	See Section 2.3 of the Open Pit Mine Development and Operations Plan
YESAB R284	The layout and location of the LNG facility will be refined as more detailed design work progresses to support the application of licences from the Department of Energy, Mines and Resources.	See Section 4.3 of the Open Pit Mine Development and Operations Plan
YESAB R2-20	Groundwater conditions in bedrock will continue to be monitored during operations, incorporating drain holes to address confined aquifers that may not be successfully dewatered by the network of dewatering wells.	See Section 5.1.2 of the Open Pit Mine Development and Operations Plan
BMC Response to Public Comments on the DSR	During the detailed engineering phase of the Project construction and throughout the Project Operations phase, BMC will continue to consider various other options to reduce greenhouse gas emissions in the areas of: • optimization of drill and blast process; • selection of mining fleet; • optimization of process plant layout; • optimizing ore comminution and flotation; • optimization of underground ventilation; and • building design. These items and more will be ongoing during mining and processing so as to minimize energy consumption which if successful will reduce greenhouse gas emissions.	Section 5.1.3 of Open Pit Mine Development and Operations Plan
Project Proposal Chapter 6 (BMC, 2017a) and BMC Response on Draft Screening Report (BMC, 2020)	Cover over the live portion of coarse ore stockpile	Section 3.7 of Open Pit Mine Development and Operations Plan
Project Proposal Chapter 6 (BMC, 2017a)	Progressive reclamation of disturbed areas	Section 3.1 of Open Pit Mine Development and Operations Plan
Project Proposal Chapter 6 (BMC, 2017a)	Road and exposed surfaces watering, as required	Section 3.7 of Open Pit Mine Development and Operations Plan
Project Proposal Chapter 6 (BMC, 2017a)	Orientation of material stockpiles so that the length is parallel with prevailing winds where practicable.	Section 4.2 of the Open Pit Mine Development and Operations Plan
Project Proposal Chapter 7 (BMC, 2017a)	Maintain the Project roads regularly to minimize vehicle noise associated with vibration.	Section 5.2 of Open Pit Mine Development and Operations Plan
Project Proposal Chapter 7 (BMC, 2017a)	Adhere to BMC's blasting plan that implements controlled blasting procedures, optimizes blasting operations, and minimizes non-productive noise.	Section 5.1.3 of Open Pit Mine Development and Operations Plan