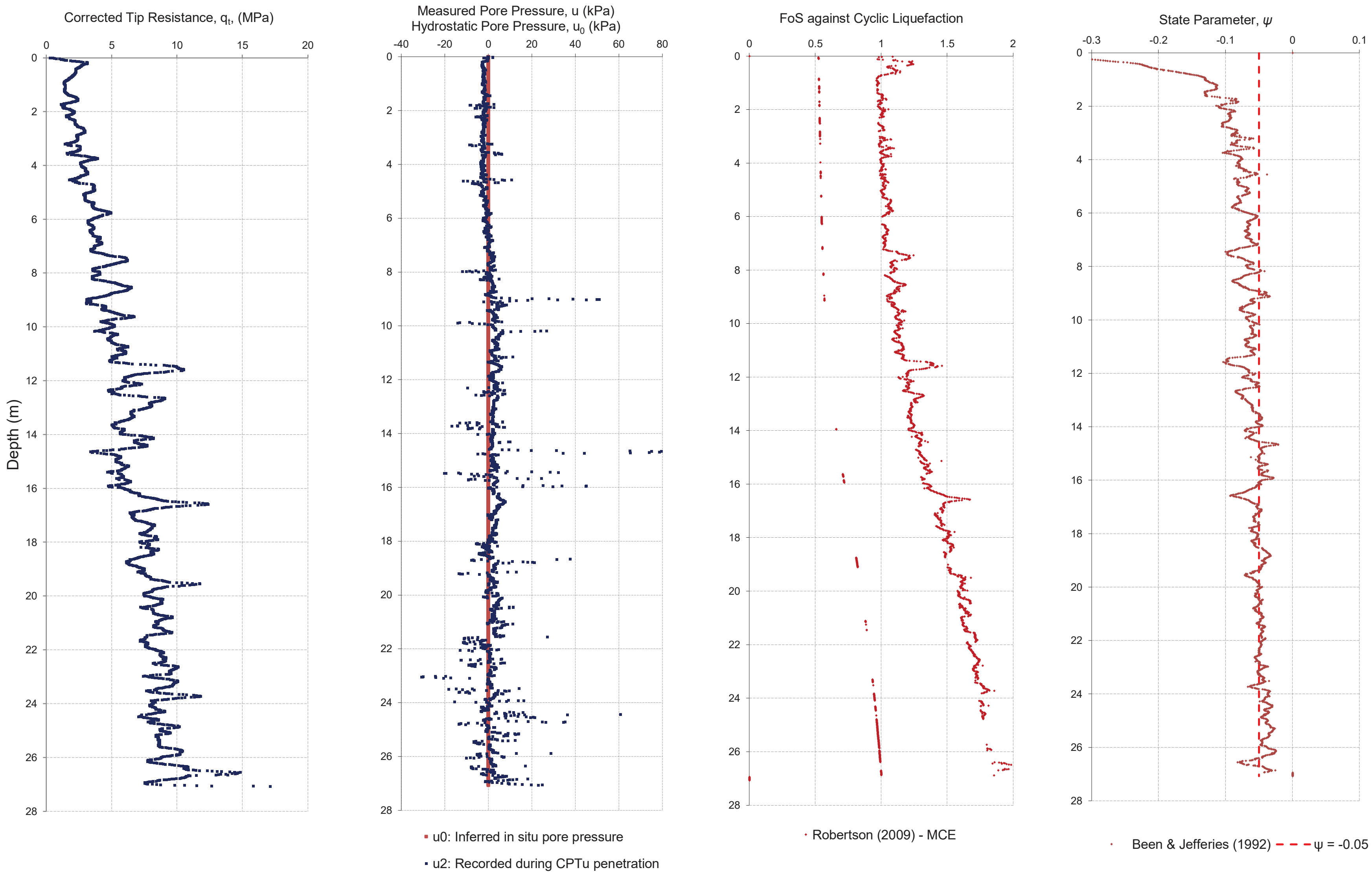
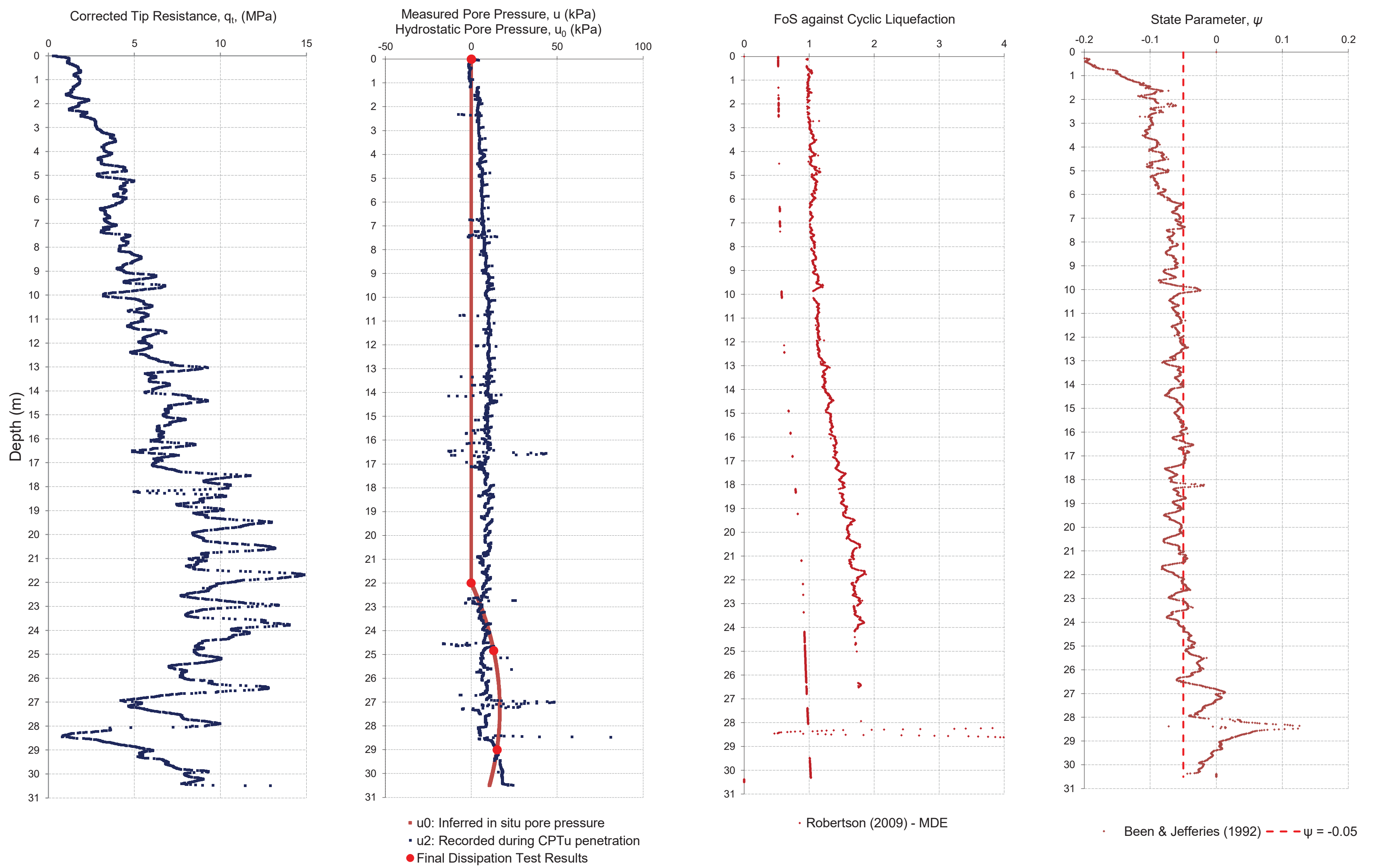


MCE: 1:10 000 years PGA: 0.1471 m/s^2

CLIENT CBH Resources			PROJECT Rasp Mine TSF Design	
DRAWN JE	DATE 14-Feb-20		BW CPTu 02	
CHECK 0	DATE 00-Jan-00			
SCALE NTS	A4		PROJECT No.	1896230



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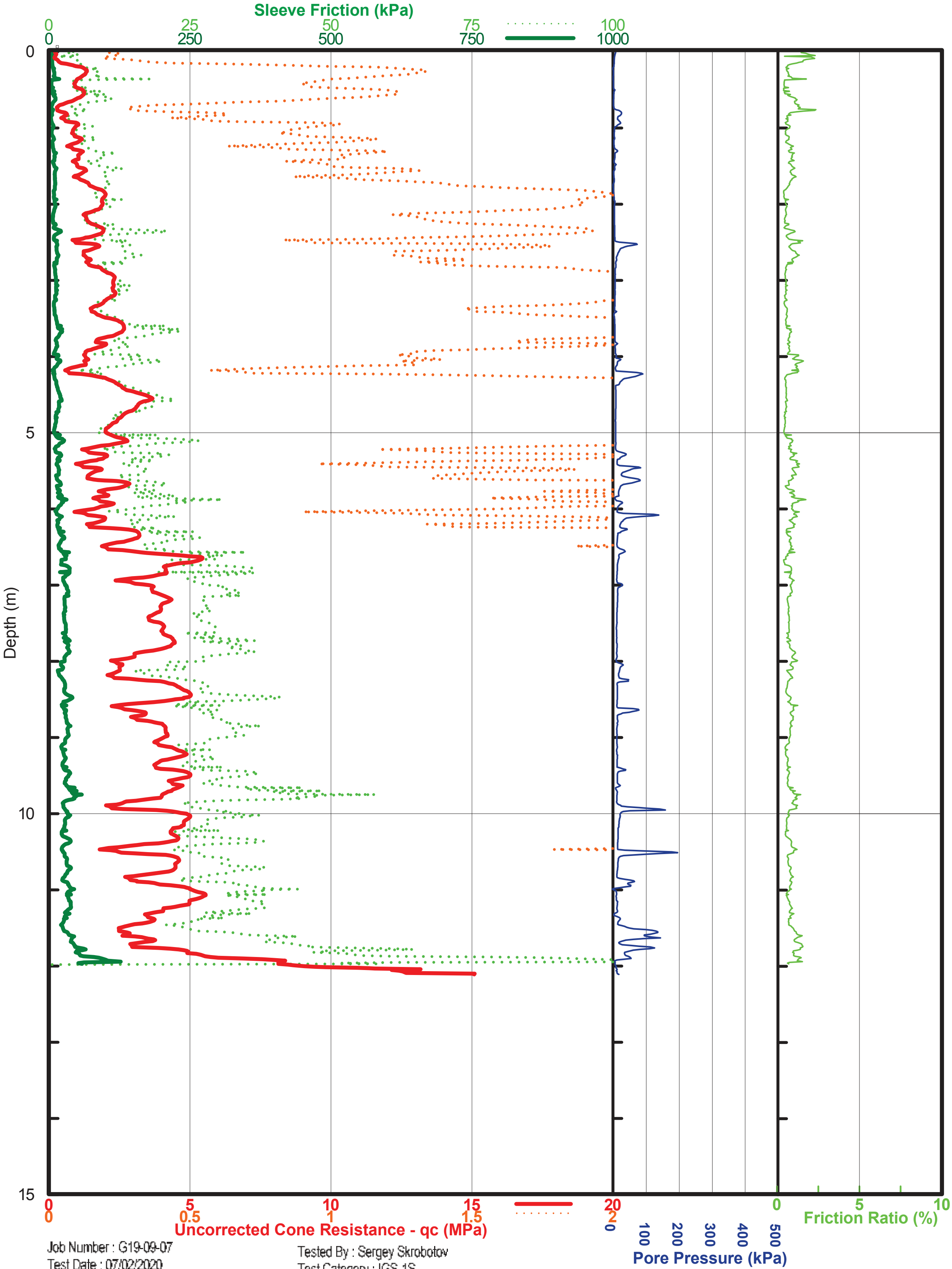
	DRAWN JE	DATE 13-Feb-20	BW CPTu 03	
	CHECK 0	DATE 00-Jan-00		
	SCALE NTS	A4	PROJECT No.	1896230

CONE PENETROMETER TEST RESULT

CBH Resources
RASP Mine TSF
Broken Hill NSW

CPT1



Job Number : G19-09-07
Test Date : 07/02/2020
GPS Position : 31°57'33.0"S, 141°28'34.1"E
Rig : Mad Mack
Cone Number : S15CFIIP.S19219
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Equipment at Risk

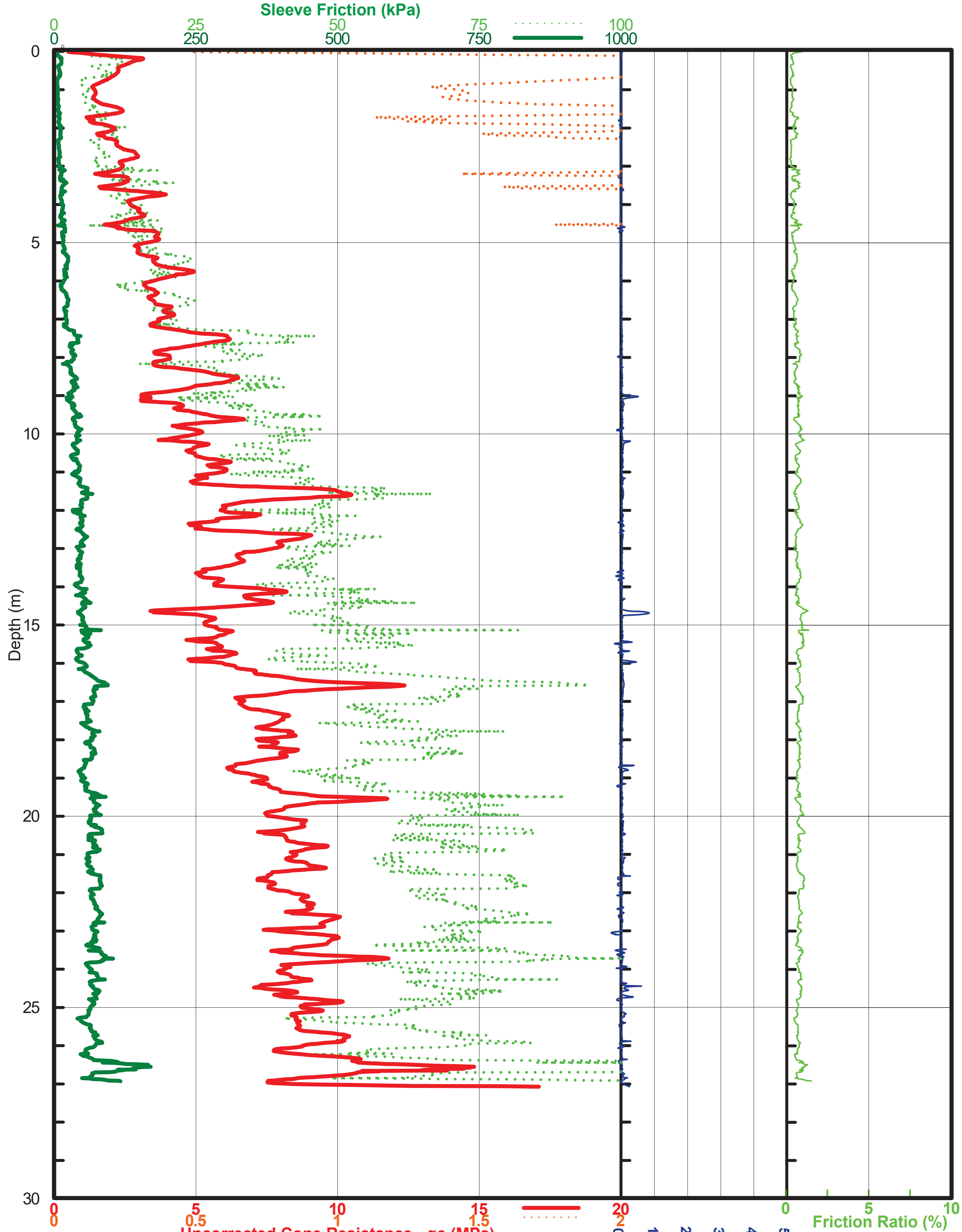
Tested By : Sergey Skrobotov
Test Category : IGS-1S
Checked By : Tony Hitchcock

Insitu Geotech Services Pty Ltd
IGS

CONE PENETROMETER TEST RESULT

CBH Resources
RASP Mine TSF
Broken Hill NSW

CPT2



Job Number : G19-09-07
Test Date : 06/02/2020
GPS Position : 31°57'37.6"S, 141°28'21.2"E
Rig : Mad Mack
Cone Number : S15CFIIP.S19219
Predrill Depth : 0.00m
Dissipation Tests @ : N/A
Terminated Due To : Lifted Rig

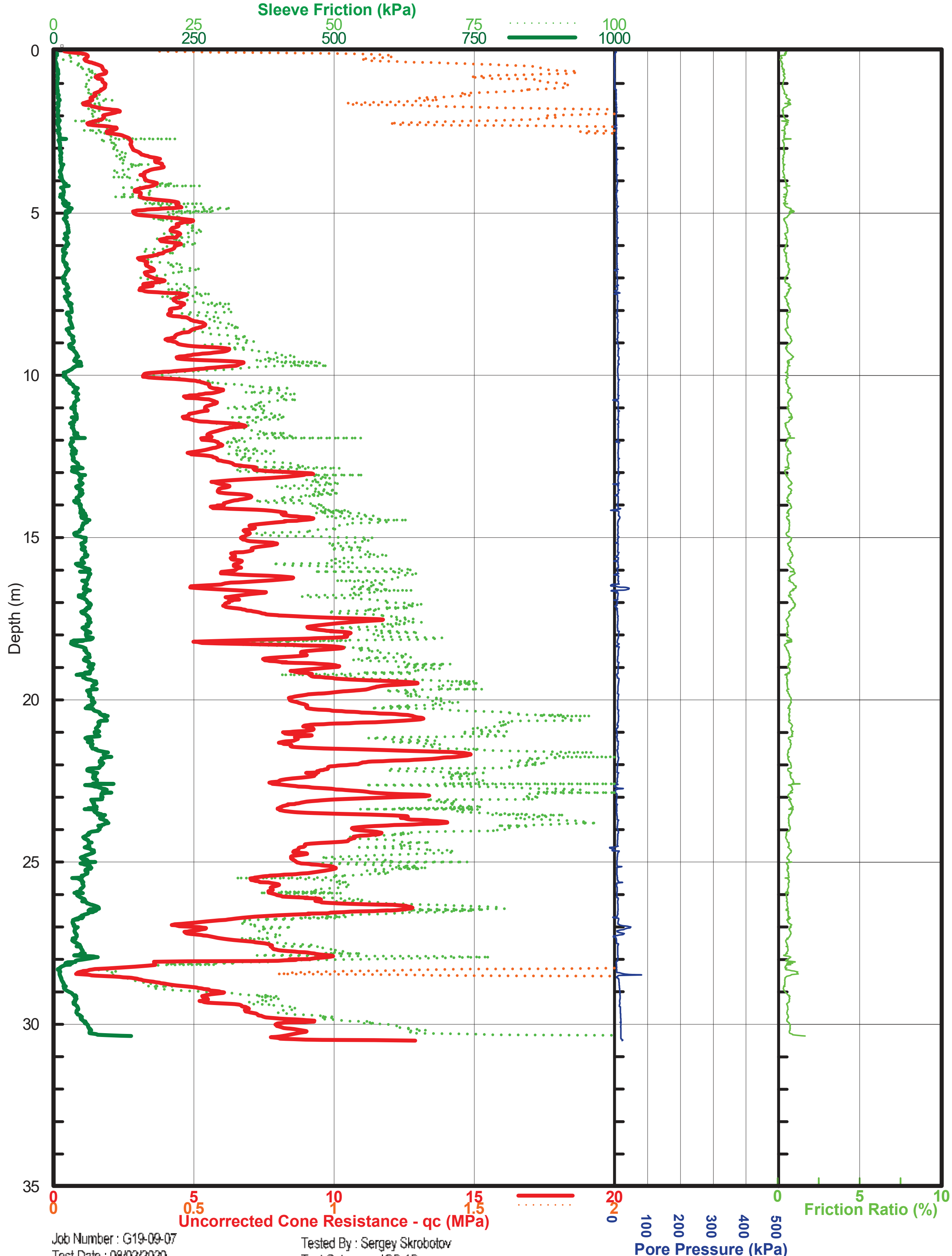
Tested By : Sergey Skrobotov
Test Category : IGS-1S
Checked By : Tony Hitchcock

Insitu Geotech Services Pty Ltd
IGS

CONE PENETROMETER TEST RESULT

CBH Resources
RASP Mine TSF
Broken Hill NSW

CPT3



Job Number : G19-09-07
Test Date : 06/02/2020
GPS Position : 31°57'41.3"S, 141°28'19.6"E
Rig : Mad Mack
Cone Number : S15CFIIP.S19219
Predrill Depth : 0.00m
Dissipation Tests @ : 28.48m
Terminated Due To : Lifted Rig

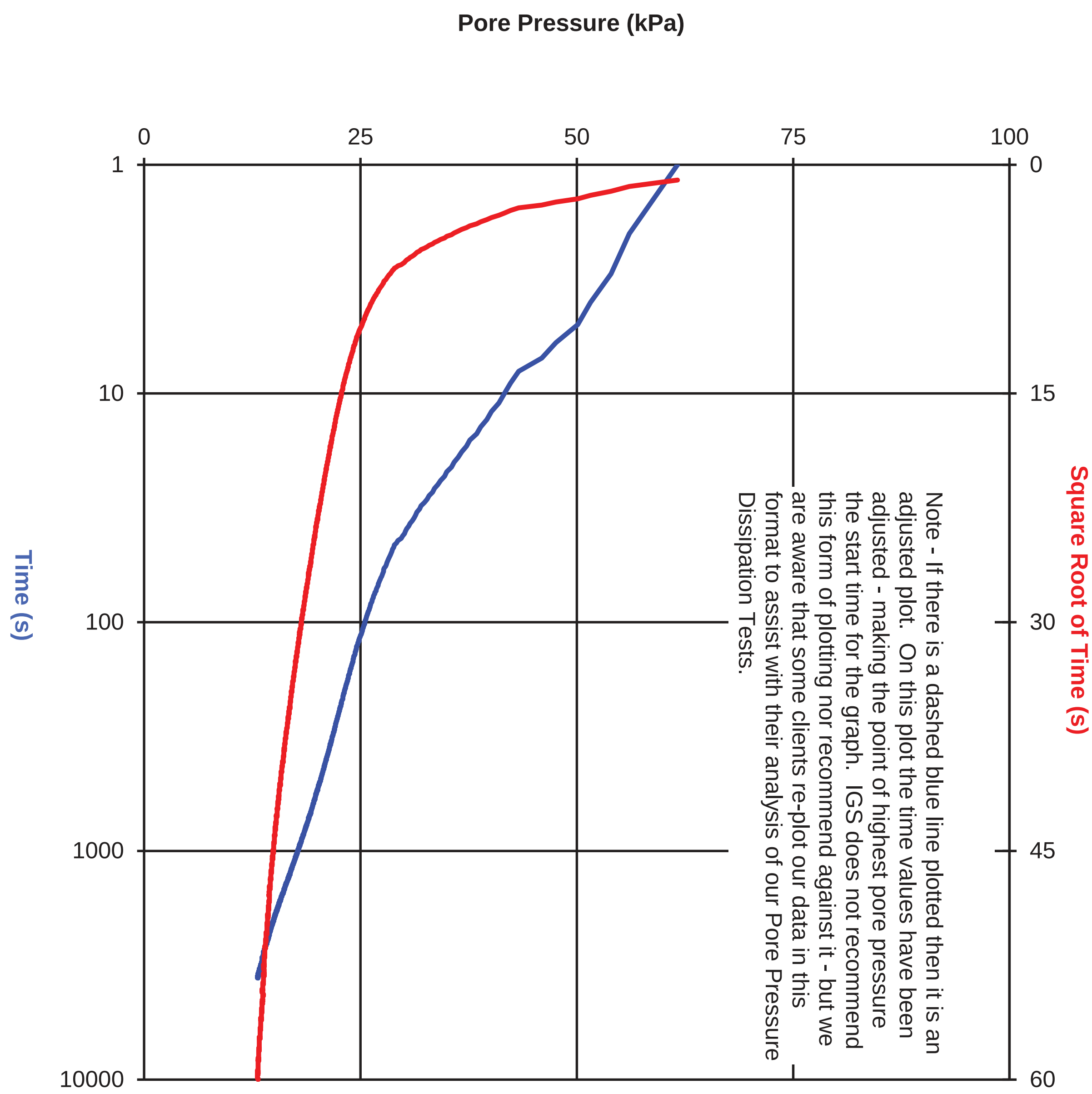
Tested By : Sergey Skrobotov
Test Category : IGS-1S
Checked By : Tony Hitchcock

Insitu Geotech Services Pty Ltd **IGS**

PORE PRESSURE DISSIPATION TEST RESULT

CBH Resources
RASP Mine TSF
Broken Hill NSW

CPT3
Depth: 28.48m

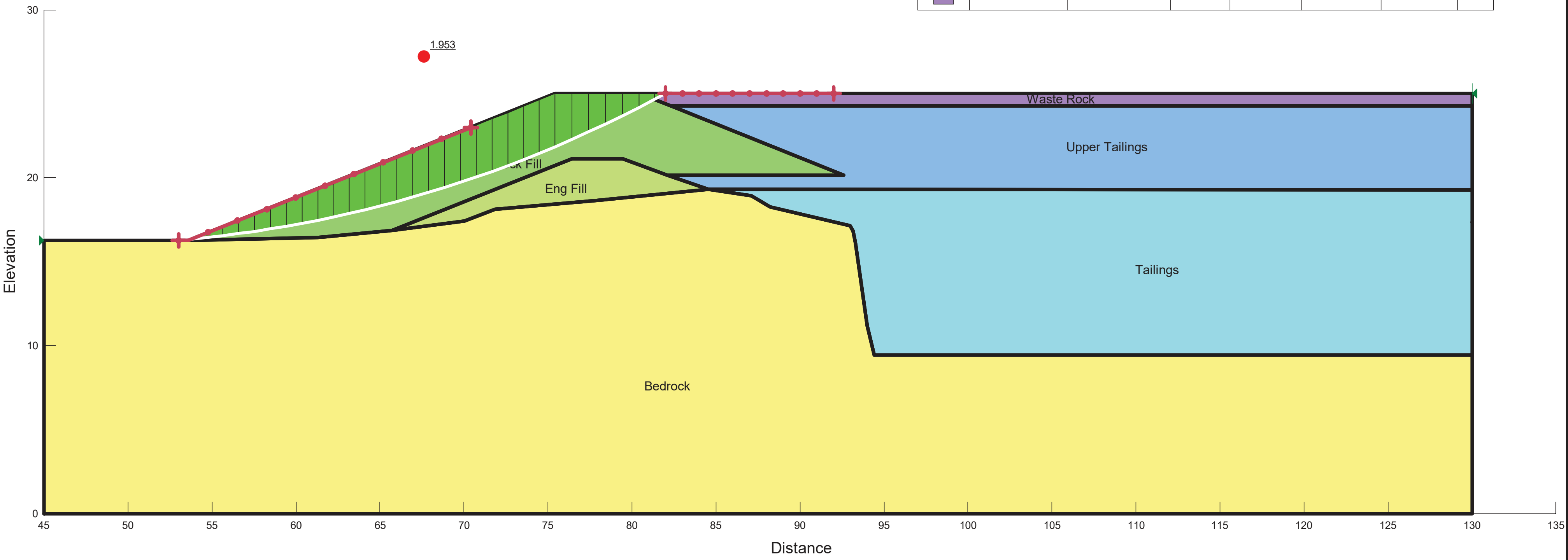


Tested By: Sergey Skrobotov
Test Duration: 1 Hours, 0 Minutes
Test Date: 08/02/2020
Job No: G19-09-07
Cone: S15CFIIP.S19219

APPENDIX B

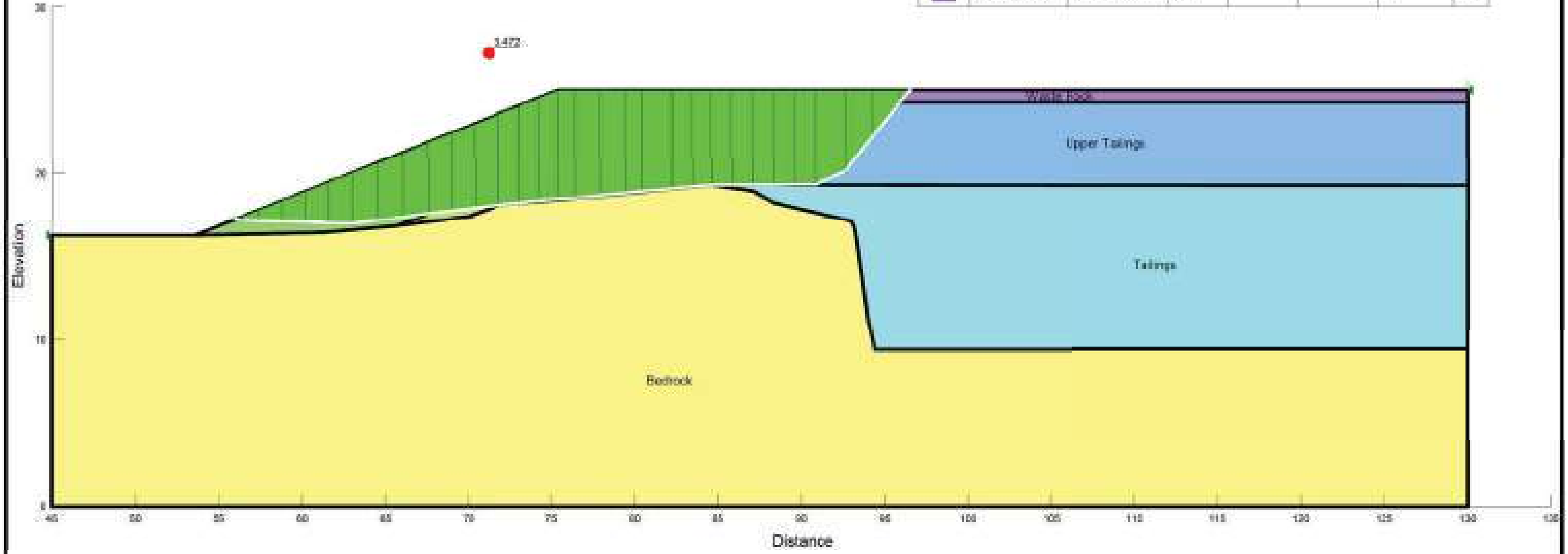
Slope Stability Outputs

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion' (kPa)	Phi' (°)
	Bedrock	Bedrock (Impenetrable)					
	Eng Fill	Mohr-Coulomb	18			0	30
	Rock Fill	Mohr-Coulomb	20			0	32
	Tailings	SHANSEP	16.7	0	0.12		
	Upper Tailings	SHANSEP	16.7	0	0.21		
	Waste Rock	Mohr-Coulomb	20			0	32



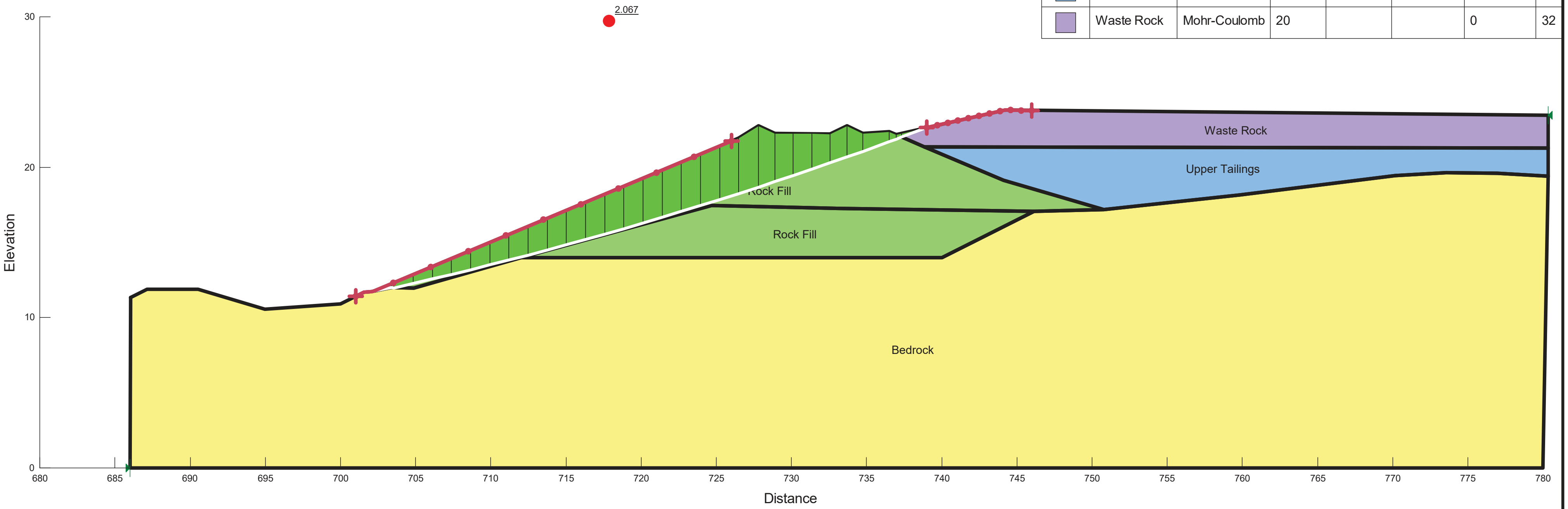
Embankment 1 As-constructed	
Embankment 1 with rock stockpile (breach failure).gsz	
19/03/2020	1:350

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion' (kPa)	Phi' (°)
	Bedrock	Bedrock (Impenetrable)					
	Eng Fill	Mohr-Coulomb	18			0	30
	Rock Fill	Mohr-Coulomb	20			0	32
	Tailings	SHANSEP	16.7	0	0.12		
	Upper Tailings	SHANSEP	16.7	0	0.21		
	Waste Rock	Mohr-Coulomb	20			0	32

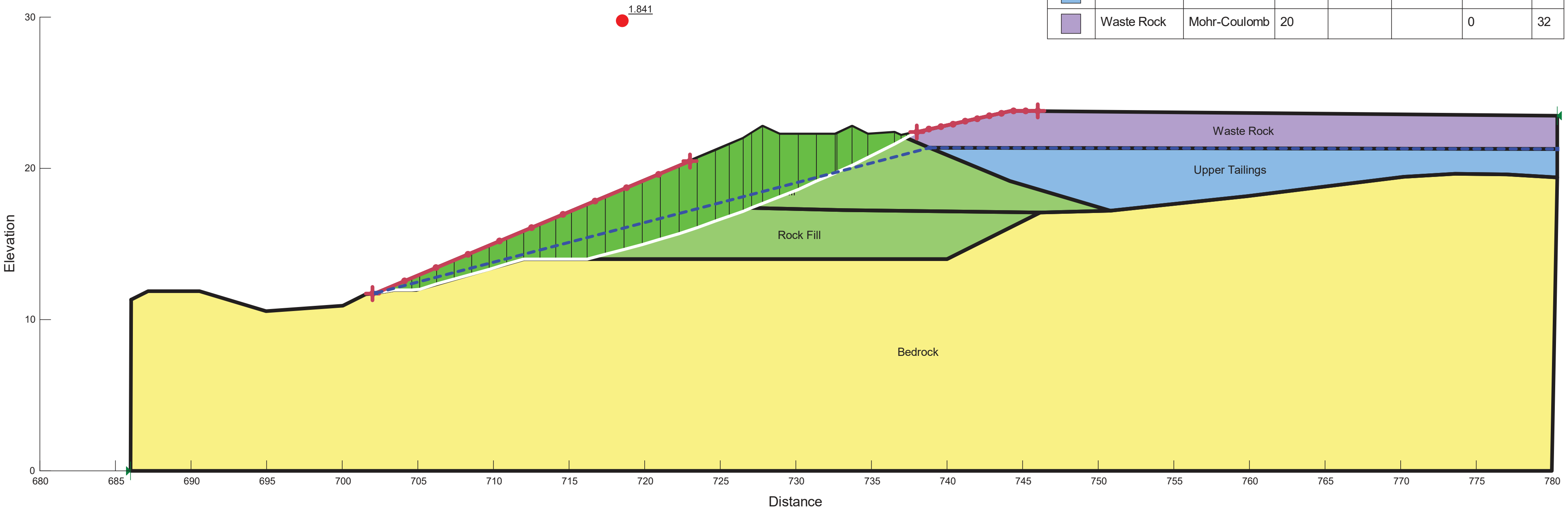


Embankment 1 upper tailings forced failure (3)	
Embankment 1 with rock stockpile (upper tailings failure).gsz	
23/03/2020	1:350

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion' (kPa)	Phi (°)
	Bedrock	Bedrock (Impenetrable)					
	Rock Fill	Mohr-Coulomb	20			0	32
	Upper Tailings	SHANSEP	16.7	0	0.21		
	Waste Rock	Mohr-Coulomb	20			0	32



Embankment 2	
Embankment 2 with rock stockpile (breach failure).gsz	
19/03/2020	1:390



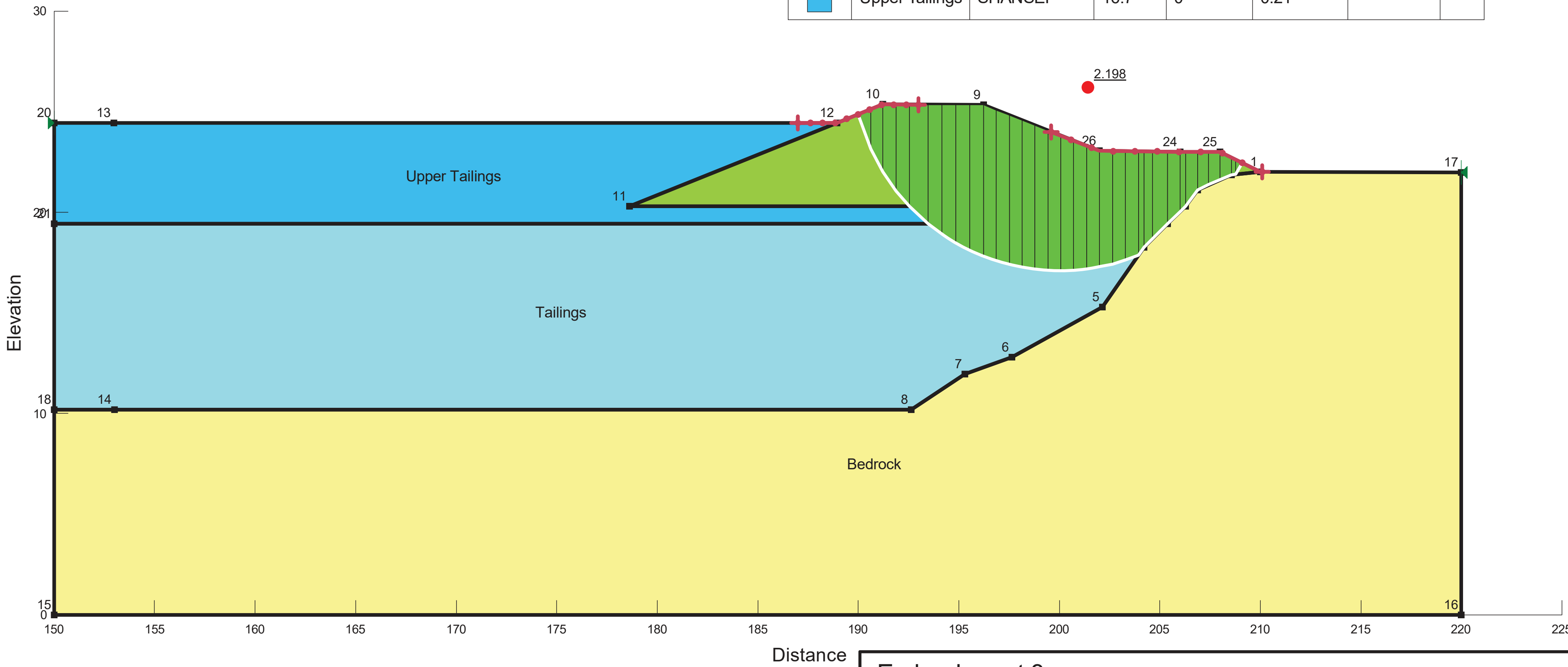
Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion' (kPa)	Phi' (°)
	Bedrock	Bedrock (Impenetrable)					
	Rock Fill	Mohr-Coulomb	20			0	32
	Upper Tailings	SHANSEP	16.7	0	0.21		
	Waste Rock	Mohr-Coulomb	20			0	32

Embankment 2

Embankment 2 with rock stockpile and phreatic surface (breach failure).gsz

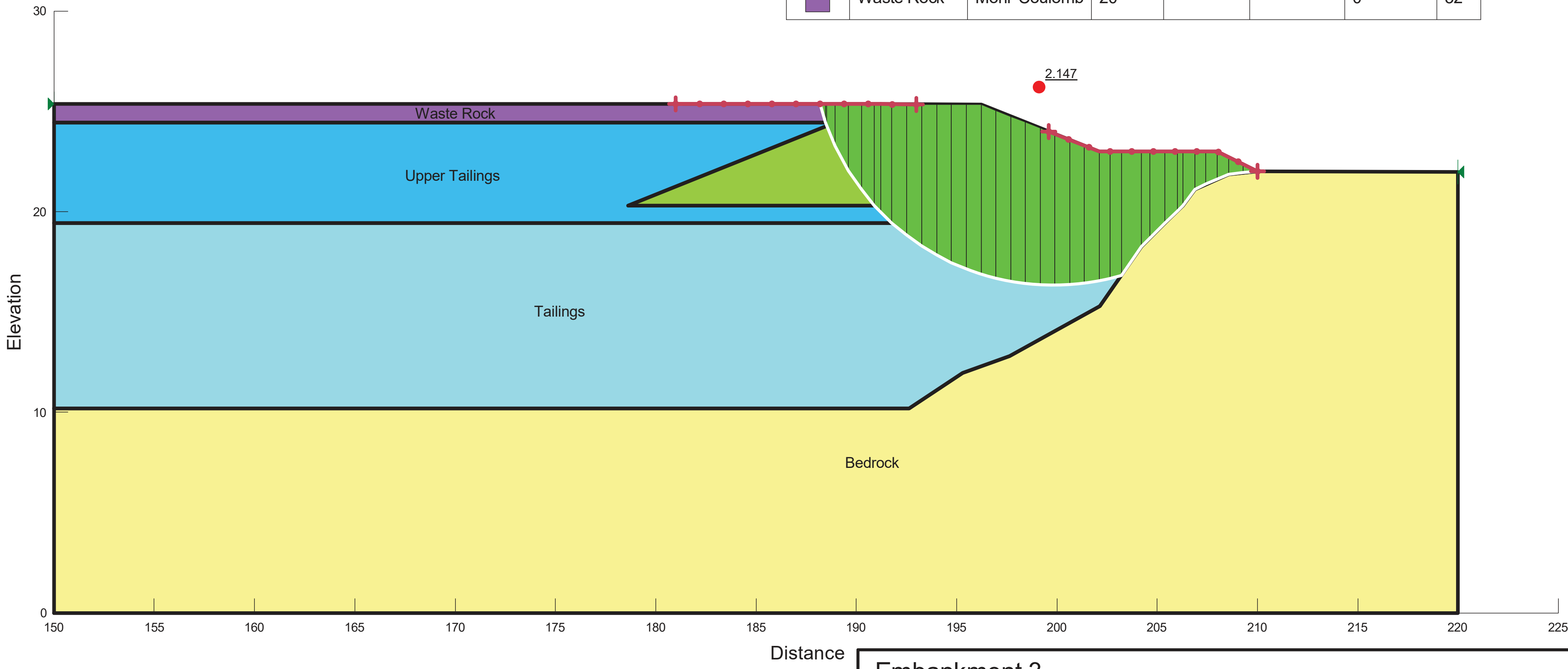
19/03/2020 1:400

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion' (kPa)	Phi' (°)
	Bedrock	Bedrock (Impenetrable)					
	Rock Fill	Mohr-Coulomb	20			0	32
	Tailings	SHANSEP	16.7	0	0.12		
	Upper Tailings	SHANSEP	16.7	0	0.21		



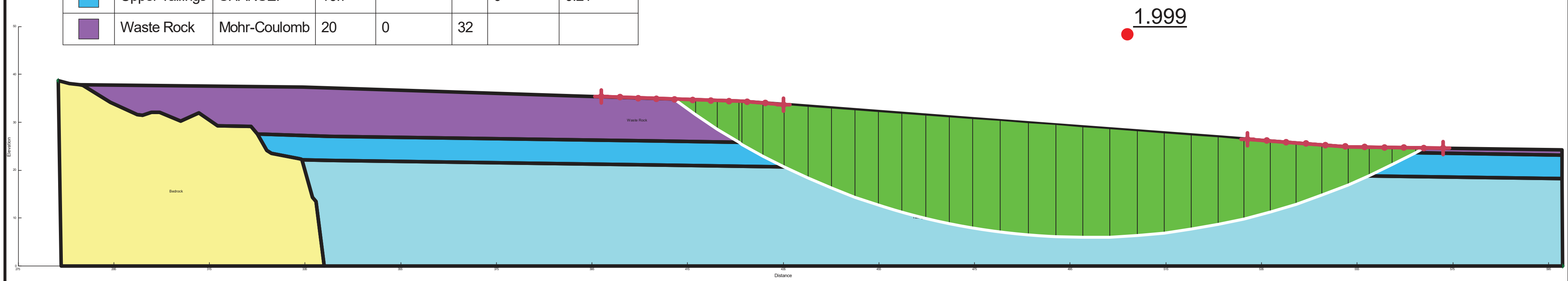
Embankment 3
Embankment 3 with flat mound.gsz
20/03/2020 1:300

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion' (kPa)	Phi' (°)
	Bedrock	Bedrock (Impenetrable)					
	Rock Fill	Mohr-Coulomb	20			0	32
	Tailings	SHANSEP	16.7	0	0.12		
	Upper Tailings	SHANSEP	16.7	0	0.21		
	Waste Rock	Mohr-Coulomb	20			0	32



Embankment 3
Embankment 3 with rock stockpile and flat mound.gsz
20/03/2020 1:300

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Bedrock	Bedrock (Impenetrable)					
	Tailings	SHANSEP	16.7			0	0.12
	Upper Tailings	SHANSEP	16.7			0	0.21
	Waste Rock	Mohr-Coulomb	20	0	32		



Waste Rock Stockpile

Waste Rock Stockpile.gsz

18/03/2020 1:1,225

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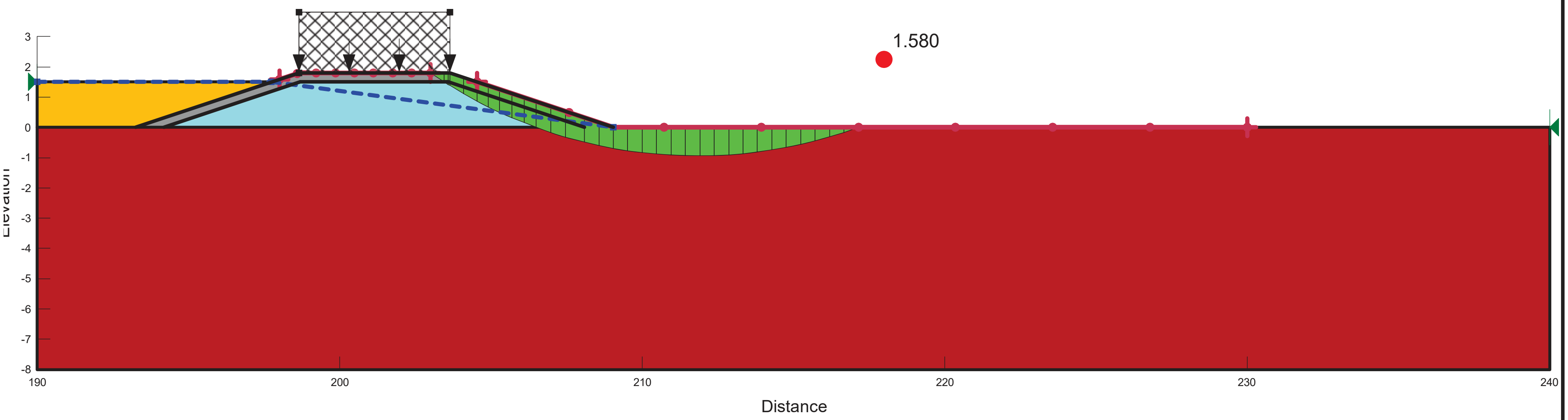
APPENDIX H

Slope/W Outputs for Intermediate Embankment Stability Assessment

Color	Name	Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Maximum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bund Tailings	Mohr-Coulomb	21.36				0	33
	Existing tailings	SHANSEP	21.36	0		0.12		
	Saturated Tailings	SHANSEP	17.255	0	2	0.12		
	Waste Rock	Mohr-Coulomb	21.5754				0	37



Intermediate Embankment Slope Stability Analysis

Intermediate Embankment Slope Stability Analysis.gsz

17/02/2021 1:195

APPENDIX I

Ground Control Engineering Report titled 'Stability Assessment of Pit Slope Comprising Historic Tailings' ref. G0201 Rev 05, dated 20 August 2019.

20th August 2019

Attn: Mr Eamonn Dare
Technical Services Superintendent
Broken Hill Operations Pty Ltd
Rasp Mine
130 Eyre Street
BROKEN HILL NSW 2880

RE: KINTORE OPEN PIT – STABILITY ANALYSIS OF PIT SLOPE COMPRISING HISTORIC TAILINGS

Ground Control Engineering Pty Ltd (GCE) was engaged by Broken Hill Operations Pty Ltd (BHOP) to undertake a preliminary slope stability assessment for the pit slope in the Kintore Pit which is comprised of historic tailings. The slope forms the northern end-wall in the existing Kintore Pit and as such, will form the northern bounding wall during the proposed future placement of 'new' filtered, dry tailings in the Kintore Pit.

GCE conducted two-dimensional limit equilibrium analysis of the pit slope comprised of historic tailings. The aim of the analysis was to assess the stability of the slope with varying fill level of 'new' tailings in the pit and degree of potential water saturation of the slope. This summary report outlines the results of the modelling and key findings of the preliminary slope stability assessment.

Yours sincerely,

GROUND CONTROL ENGINEERING PTY LTD

Ceirin Byrne
Principal Geotechnical Engineer
M 0406 856 380
E cbyrne@groundcontrolengineering.com.au

Cameron Tucker
Principal Geotechnical Engineer
M 0406 856 380
E ctucker@groundcontrolengineering.com.au

1 Introduction and Scope

GCE was requested by Broken Hill Operations Pty Ltd (BHOP) to undertake a geotechnical slope stability assessment of the historic tailings slope which forms the northern end-wall in the existing Kintore Pit. BHOP plans to backfill the Kintore Pit with filtered 'dry' tailings, whereby the historic tailings slope will form the northern bounding wall during placement of the tailings.

The scope of work for this assessment incorporated two-dimensional slope stability analysis of the following:

- Existing north wall pit slope, comprised of historic tailings, and;
- Various slope configurations incorporating the progressive filling of the pit with new tailings and associated potential transient groundwater saturation profiles.

2 Data Provided

BHOP provided GCE with the following data and report:

- Current 'as-built' pit surface as DXF file.
- Kintore Pit: Preliminary Decline Plug Design – Golder report, 17 October 2018 (Ref. 1)

3 Stability Analysis of Historic Tailings Slope

Sections 3.1 to 3.4 of this report describe the method, assumptions and parameters used in the slope stability analyses. The results and conclusions of the analyses are outlined in Sections 3.5, 3.6 and Appendix A.

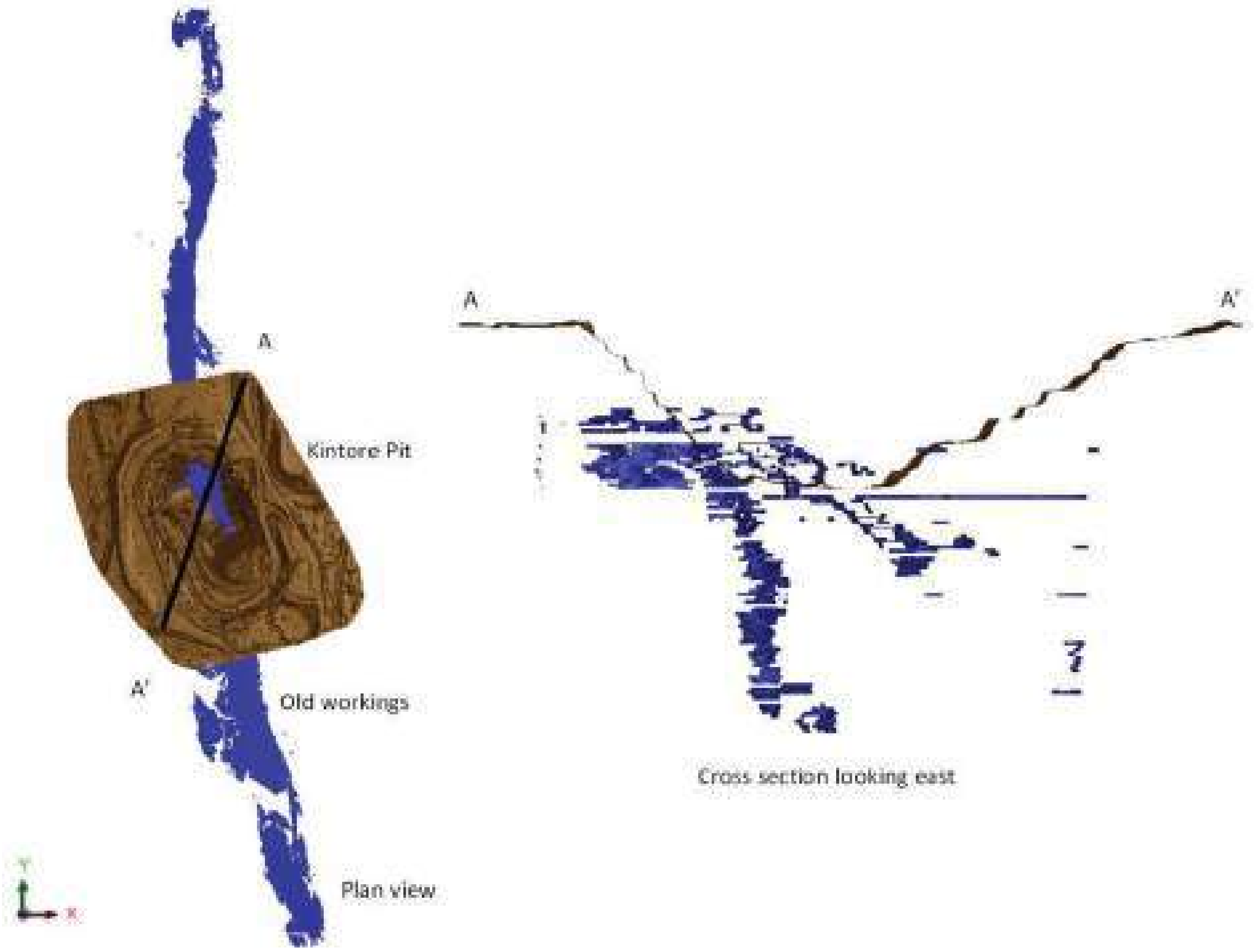
3.1 Modelling method

The industry standard Rocscience Inc. software *Slide* was used to conduct limit equilibrium slope stability analyses of selected two-dimensional cross-sections of the Kintore Pit. Circular failure surfaces were generated using a grid search and analysed using the Bishop method to determine the slope Factor of Safety (FOS). Circular failure through the historic tailings slope is considered the most likely slope failure mechanism given the weak, consistent and structure-less material properties assigned to the remnant tailings. The remnant tailings have been modelled to behave similarly to massive weak rock and/or soil. There is no observed structure within the exposed tailings slope that may induce kinematic style failure mechanisms such as toppling, wedge or planar failure.

The location of the section line where the cross-sections were generated for the analyses is shown in Figure 1. The location was selected by GCE to evaluate the likely 'worst case' slope configurations, approximately perpendicular to the historic tailings slope and with consideration of the most likely failure mechanism.

The 2D modeling does not incorporate or quantify the stabilizing influence of confinement related to the circular pit geometry. The stability of the remnant tailings slope will likely be positively influenced by slope confinement geometry in the pit corner, as shown in Figure 1.

Figure 1 Section line location with respect to existing as-built pit



Mine slope design is essentially governed by two factors:

1. The consequences of failure; and
2. The degree of inherent uncertainty.

To accommodate these two design factors, it is common practice to apply an appropriate Factor of Safety (FOS) and/or Probability of Failure (POF) to the design geometry of mine slopes. An example of FOS and POF design criteria is provided in Table 1. The design criteria have been developed from the Western Australian, Department of Mines, Industry Regulation and Safety (now DMIRS), Geotechnical Considerations in Open Pit Mines.

Table 1: Examples of design criteria for open pit walls

Wall Class	Consequence of Failure	Design FOS	Design POF	Pit Wall Examples
1	Not serious	Not applicable		Walls not carrying major infrastructure) where all potential failures can be contained within containment structures
2	Moderately serious	1.2	10%	Walls not carrying major infrastructure
-3	Serious	1.5	1%	Walls carrying major mine infrastructure (e.g. treatment plant, ROM pad, tailings structures)
4	Serious	2.0	0.30%	Permanent pit walls near public infrastructure and adjoining leases

As the fill slope will be effectively covered and buttressed by future tailings, a FOS of 1.3 was applied to reflect the temporary nature of the slope.

3.2 Slope configurations assessed

Three main slope configurations were assessed for stability, as described below and shown in Figures 2 to 4.

The cross-sections used in the *Slide* modelling incorporate the estimated material boundaries, pit wall geometry and inferred (potential) groundwater profiles.

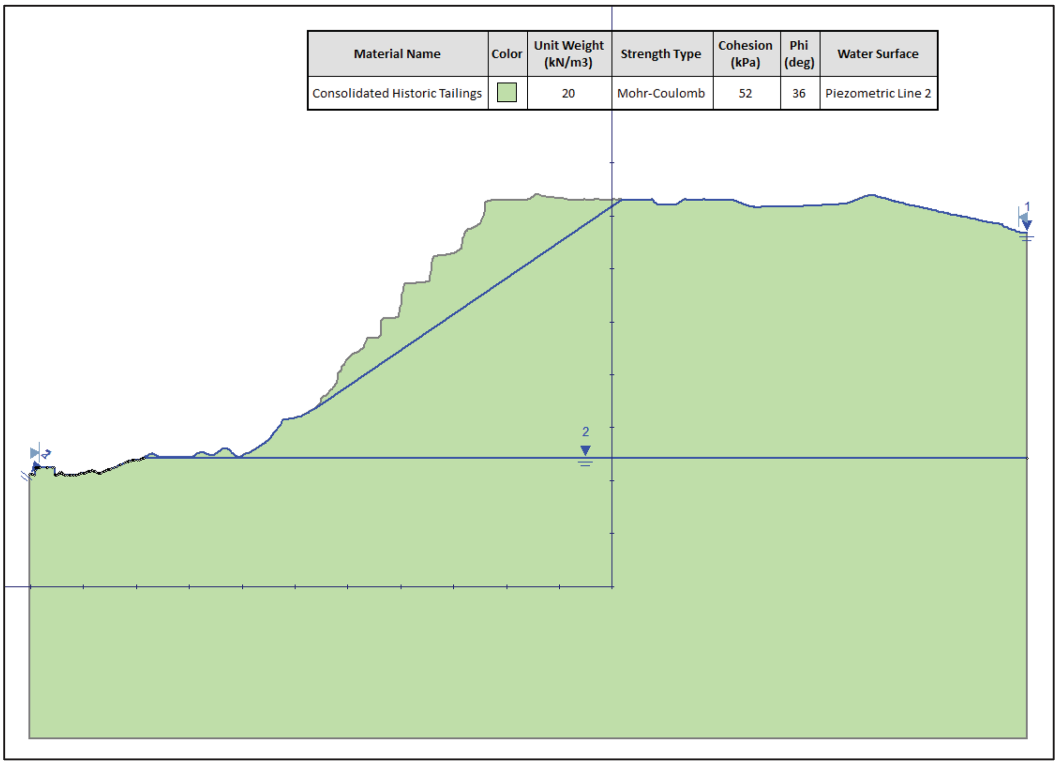
All slope configurations were run with three different groundwater cases, including a "dry" case. The groundwater and material properties applied in the models are described in Sections 3.3 and 3.4 of this report respectively.

NB: Static loading only has been modelled in the current slope stability assessment. The effects of seismic loading and water hammer (resulting from seismic loading) on the 'new' tailings proposed to be placed in the pit were considered in the report by Golder Ref. 1. Golder recommend the final design for the sealing plugs at the base of the Kintore Pit account for complete saturation of the material placed in the pit when full under static and seismic conditions.

<u>Slope configuration #1 – no 'new' tailings</u>:

Existing historic tailings pit wall slope, prior to commencement of backfilling pit with 'new' tailings, as shown in Figure 2.

Figure 2 Slope configuration #1 – no 'new' tailings

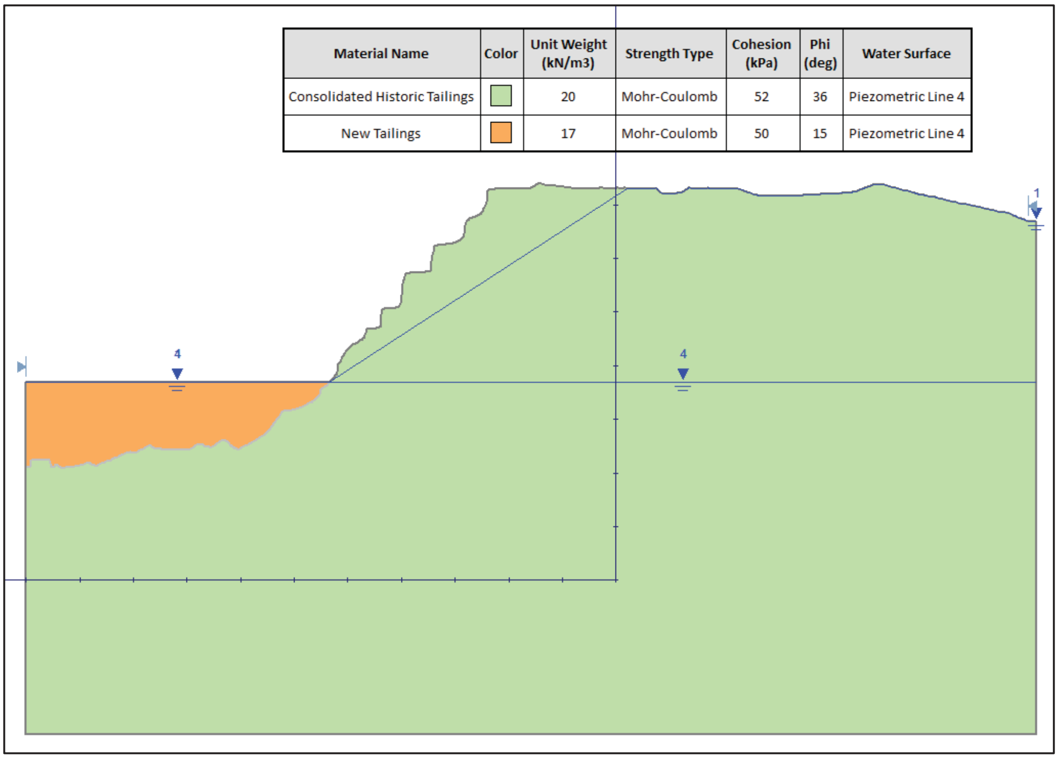


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface
Consolidated Historic Tailings		20	Mohr-Coulomb	52	36	Piezometric Line 2

Slope configuration #2 - 25m of 'new' tailings:

Placement of 25m of 'new' tailings in the pit, adjacent to the existing historic tailings pit wall slope, as shown in Figure 3.

Figure 3 Slope configuration #2 - 25m of 'new' tailings

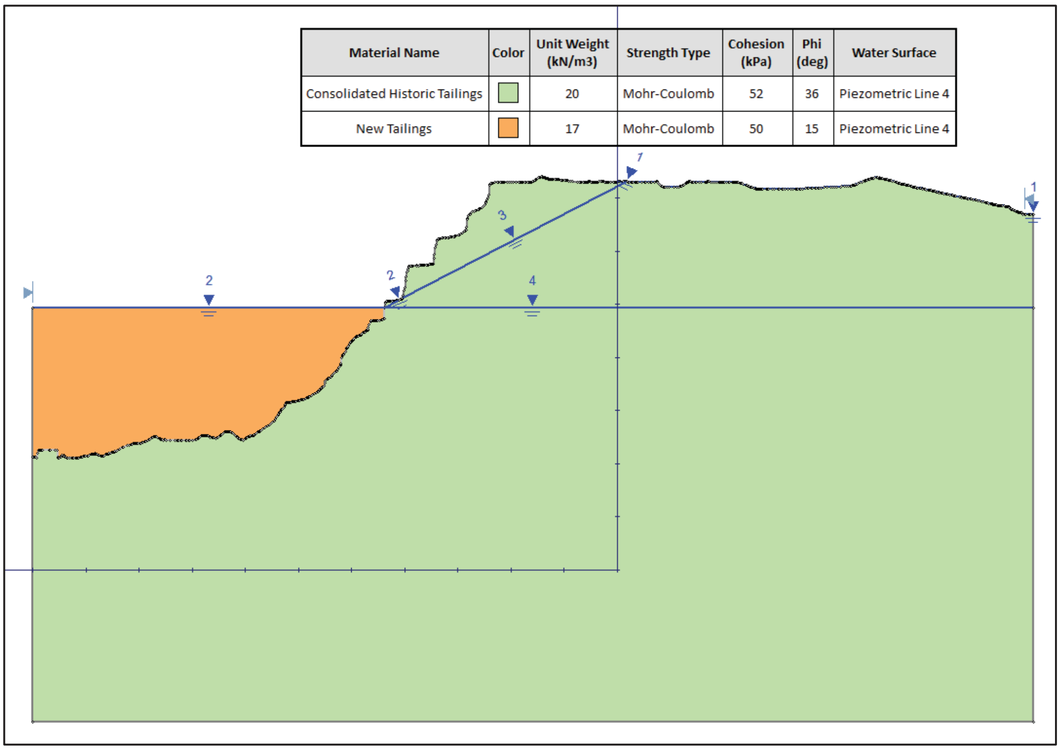


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface
Consolidated Historic Tailings		20	Mohr-Coulomb	52	36	Piezometric Line 4
New Tailings		17	Mohr-Coulomb	50	15	Piezometric Line 4

Slope configuration #3 - 50m of 'new' tailings:

Placement of 50m of 'new' tailings in the pit, adjacent to the existing historic tailings pit wall slope, as shown in Figure 3.

Figure 4 Slope configuration #3 - 50m of 'new' tailings



3.3 Material properties

The estimated material properties assigned to each material type used in the modelling are outlined in Table 1. The properties assigned to the historic tailings, comprising the existing north pit wall slope, are based on a combination of laboratory testing and back-analysis of slope performance.

Representative samples of the historic tailings slope material were collected on site for subsequent laboratory testing. The testing included:

- 2 x UCS tests – dry samples
- 3 x UCS tests – saturated samples
- 1 x Direct Shear test

The number and location of samples was limited by slope access constraints.

The material properties outlined in Table 1 were derived from the combination of direct shear testing, saturated and unsaturated UCS testing of intact samples from the existing fill slope and on GCE precedent experience of comparable materials and understanding of the slope performance to date.

Figure 5 shows the UCS samples before and after UCS testing.

Figure 5 Unsaturated UCS test samples

Test 1

Intact sample

Crushed sample

Test 2

Intact sample

Crushed sample

Figure 6 Saturated UCS test results

Intact sample

Crushed sample

The insitu material was successfully tested under dry conditions, however, total disintegration and strength loss was observed under saturated conditions.

Table 1 Material shear strength properties

Material Type	Unit Weight (kN/m³)	UCS (kPa)	Cohesion (kPa)	Friction Angle
Historic tailings slope (unsaturated)	20	222	52	36°
Historic tailings slope (saturated)	20	0	1.3	0°
'New' tailings (estimated)	17		50	36°

3.4 Groundwater

GCE understands that all water inflow will be removed from the pit via an installed drainage system and that groundwater will not be allowed to accumulate at the bottom of the pit or in the pit wall slopes. However, the groundwater profile and potential fluctuation following major rainfall events in the area of the Kintore Pit is currently not well defined as there are no groundwater monitoring bores in the vicinity of the tailings slope and Kintore Pit. There may be periods after heavy rainfall events where part of the historic tailings slope and 'new' tailings will be saturated and a transient piezometric surface may be present within the slope.

To assess the impact that groundwater may have on slope stability, three main groundwater conditions were modelled as follows:

1. "Dry" – No groundwater applied in the model. This scenario is used as a reference to assess the **base case** stability of the slope and the subsequent sensitivity of the modelled failure paths to the introduction of groundwater.
2. "Flat" – a horizontal piezometric surface is applied at the level of the top of the 'new' tailings, applying to both the 'new' tailings and the historic tailings slope.
3. "Sloped from top of new tailings to 50m setback from pit crest" – a sloping piezometric surface is applied from a 50m setback from the pit crest, down to the level of the top of the tailings, applying to both the 'new' tailings and the historic tailings slope.

GCE understands that the historic tailings slope has been observed at Rasp over a number of years to be effectively free draining and it is assumed to be highly permeable. As such, groundwater condition number 3 as described above is considered to be an unlikely, transient, "worst case" scenario.

Material testing conducted has highlighted the potential for disintegration of the historic tailings material when saturated with water. BHOP should consider the potential for slope washout at the toe of the historic tailings slope following significant rainfall events. Water must not be allowed to accumulate and 'pond' at the toe of the historic tailings slope while placing 'new' tailings in the pit.

3.5 Summary of slope stability assessment results

The results of the stability modelling are presented in Appendix A and summarized as follows:

(Factor of Safety is abbreviated as FOS.)

Slope configuration #1 - no 'new' tailings:

- Dry case and horizontal piezometric surface case
    - No failure surfaces are indicated at FOS < 1.
    - Minimum FOS = 1.142, corresponding to a multi-batter slope scale circular failure surface with moderate depth of failure. This indicates that, with the estimated material properties applied, the existing dry slope is relatively close to the threshold of stability.
    - At FOS < 1.3, numerous potential multi-batter slope scale failure surfaces are indicated.
- Sloped piezometric surface case
    - Significant reduction in slope stability from the dry condition. However, as described in Section 3.4, the historic tailings slope is understood by GCE to be highly permeable, effectively free draining, and hence this worst case groundwater scenario is considered to be unlikely.

Slope configuration #2 - 25m of 'new' tailings:

- Dry case and horizontal piezometric surface case
    - No failure surfaces are indicated at FOS < 1.
    - Minimum FOS = 1.164, corresponding to a multi-batter slope scale failure surface from the top of the 'new' tailings to the pit crest. This indicates that, with the estimated material properties applied, the slope is relatively close to the threshold of instability.
    - At FOS < 1.3, numerous potential multi-batter slope scale failure surfaces are indicated. However, slope stability is somewhat increased from slope configuration #1 - no 'new' tailings case.
- Sloped piezometric surface case
    - Significant slope scale instability at FOS = 1.116. In this case, potential for circular failure resulting in significant floor heave through the tailings is indicated at FOS < 1.3.

Slope configuration #3 - 50m of tailings:

- Dry case and horizontal piezometric surface case
    - No failure surfaces are indicated at FOS < 1.
    - Minimum FOS = 1.421, corresponding to a multi-batter slope scale failure surface from the top of the 'new' tailings to the pit crest.
    - At FOS <1.3, no failure surface is indicated. Slope stability is significantly increased from slope configurations #1 and #2.
- Sloped piezometric surface case
    - No material change or reduction in slope stability from the dry condition.

3.6 Conclusions and recommendations

The following comments relate to the slope stability analyses and FOS results outlined in Sections 3.1 to 3.5 and Appendix A.

- The preliminary slope stability analyses conducted by GCE highlights the potential for slope scale instability of the historic tailings slope forming the north wall of the Kintore Pit under certain hydrogeological conditions.
- The placement of 'dry' tailings at the base of existing historic tailings slope is expected to increase the stability of the slope. Particularly when the filled depth in the pit reaches 50m or greater.
- Circular failure or composite failure with a major circular component appears to be the most likely potential failure mechanism.
- Horizontal piezometric groundwater surfaces incorporated at various levels in the modelling, have minimal impact on the stability of the historic tailings slope.
- When a potential "worst case" sloped piezometric groundwater surface is incorporated at various levels in the modelling it has been shown to significantly reduce the stability of the historic tailings slope. Modelling of the current slope configuration #1 where no 'new' tailings have been placed in the pit, indicates a minimum FOS = 0.875 for the sloped groundwater case. However, GCE understands that the historic tailings slope has been observed by Rasp over a number of years to be effectively free draining and the consolidated tailings material is permeable. As such, the sloped groundwater surface incorporated in the modelling is currently considered to be a relatively unlikely, "worst case", transient groundwater scenario.
- Given the reduction in slope stability indicated by the modelling for the sloped groundwater scenarios, GCE recommends that Rasp determine an appropriate stand-off period and procedure following rainfall events or if pooled water is observed at the base of the tailings slope, whereby the tailings slope (crest and toe) will be isolated and access to the pit will be restricted until any accumulated groundwater has drained from the pit walls. These restrictions are required while filtered tailings are being placed in the Kintore Pit and personnel access is required.
- The installation of groundwater monitoring bores in the tailings slope is recommended to ensure that the level of piezometric surface remains below the "worst case" modelling configuration.
- GCE recommends that a large bund (minimum 2m height) is installed along the length of the toe of the historic tailings slope during placement of 'new' tailings to provide a barrier against minor rockfall from the adjacent slopes. The bund will need to be progressively moved and re-established as the level of the tailings backfill rises in the pit.

4 References

1. Golder, (2018) '*Kintore Pit: Preliminary Decline Plug Design*', Ref 1896230-017-R-Rev0, 17 October 2018

DOCUMENT INFORMATION

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Distribution	PDF to client, for review and comment

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DRAFT02	Draft report	C. Byrne, C. Tucker	12/05/19
DRAFT03	Draft report	C. Byrne, C. Tucker	
DRAFT04	Draft report	C. Byrne, C. Tucker	06/08/19

DOCUMENT REVIEW AND SIGN OFF

Version	**Reviewer**	**Position**	**Signature**	**Date**
DRAFT02	C.Tucker	Principal Geotechnical Engineer		12/05/19
DRAFT02	C.Tucker	Principal Geotechnical Engineer		
DRAFT02	C.Tucker	Principal Geotechnical Engineer		06/08/19
V04 FINAL	C.Tucker	Principal Geotechnical Engineer		20/08/19

APPENDIX A

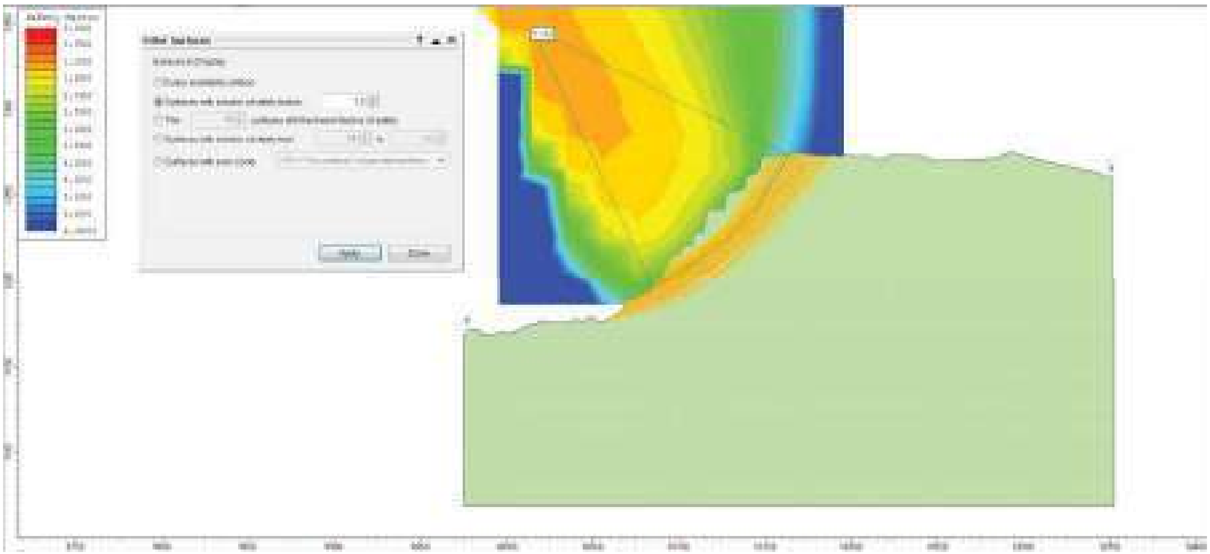
Kintore Pit Historic Tailings Slope Stability Modelling Results Summary

Consolidated tailings: c = 52, phi = 36

<u>Slope configuration #1 - no 'new' tailings</u>:

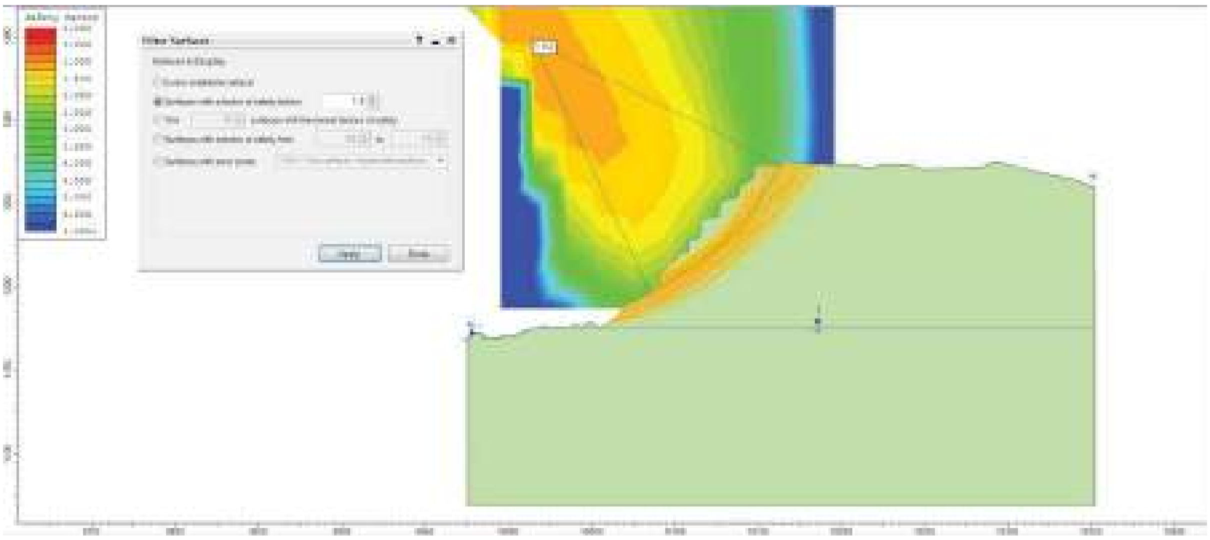
A. No tailings, no water

- FOS min = 1.142, multi-batter slope scale failure.
- FOS < 1.3, numerous failure surfaces indicating significant slope scale failure potential.



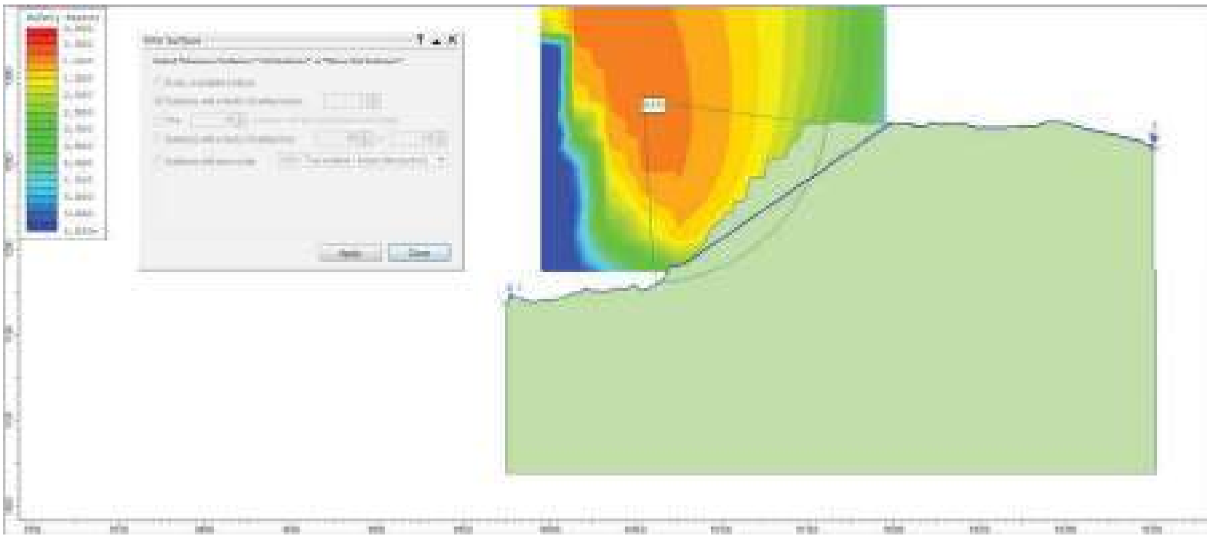
B. No tailings, horizontal water table at base of pit

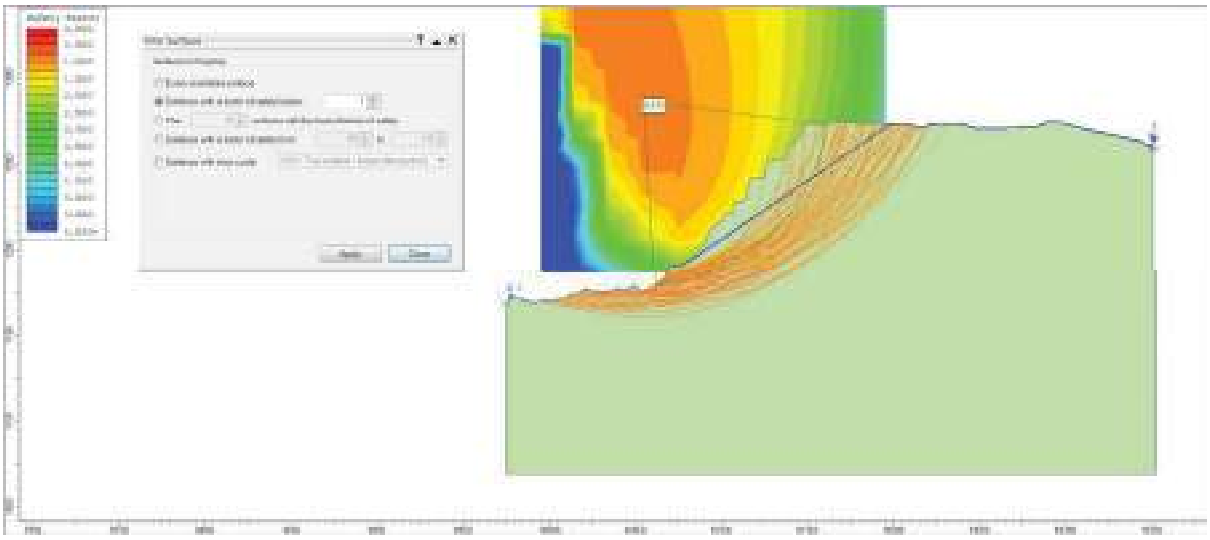
- FOS min = 1.142, multi-batter slope scale failure.
- FOS < 1.3, numerous failure surfaces indicating significant slope scale failure potential.
- No material change from dry condition.



C. No tailings, water sloped from base of pit to 50m setback from pit crest ("worst case")

- FOS min = 0.875, significant multi-batter slope scale failure indicated.
- FOS < 1.0, significant slope scale failure, including floor heave indicated.
- Significant reduction in stability from dry condition. Low likelihood, transient groundwater condition.

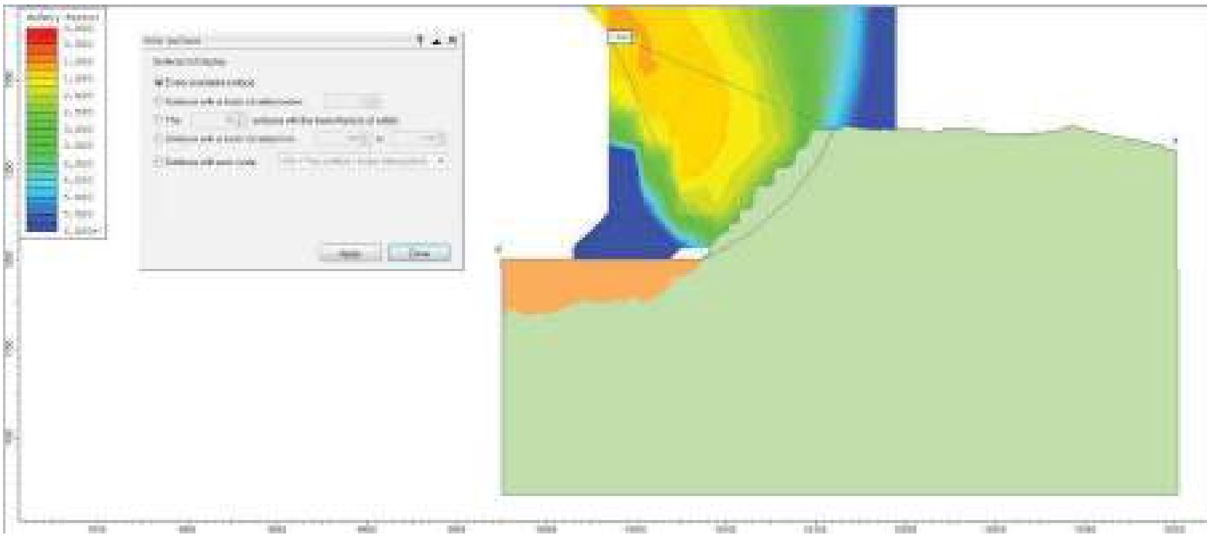


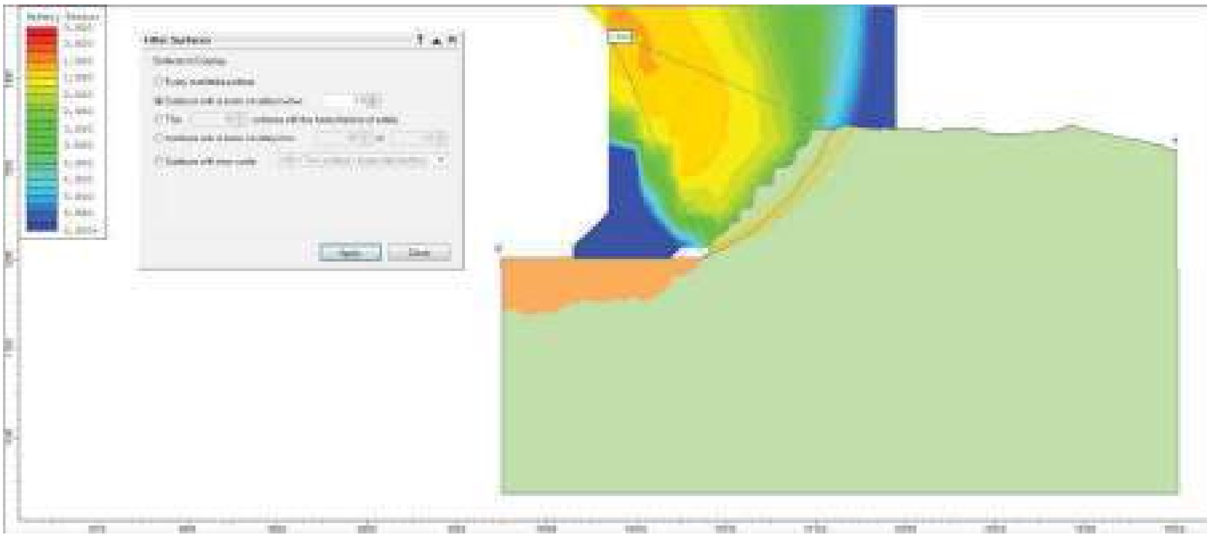


Slope configuration #2 - 25m of 'new' tailings:

A. 25m tailings, no water

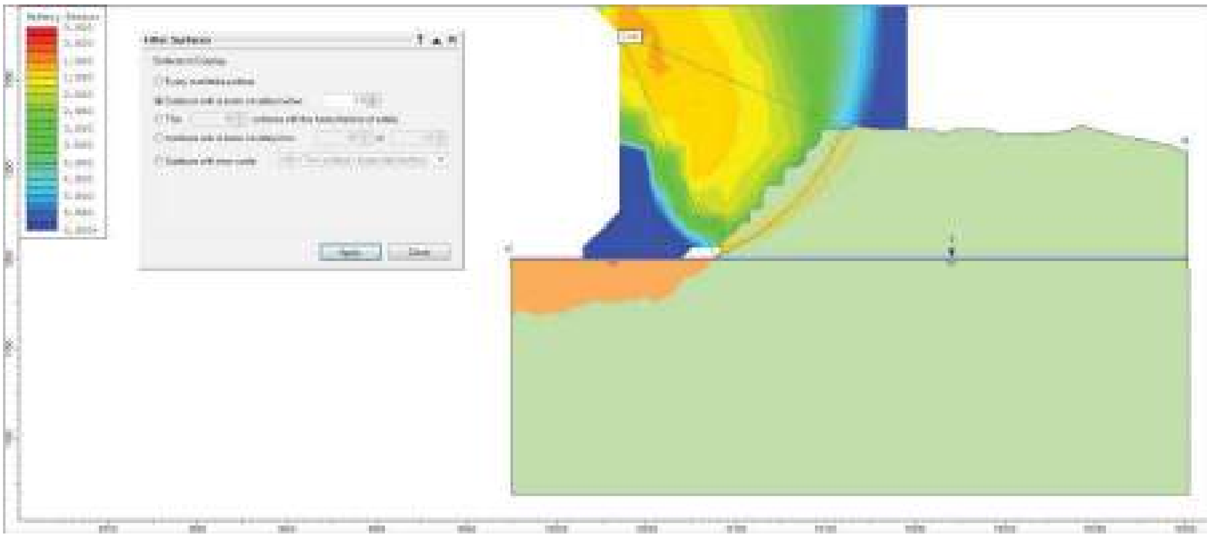
- FOS min = 1.164, slope scale failure
- FOS < 1.3, significant slope scale failure indicated. However, stability slightly increased from 'no tailings' case. i.e. current slope configuration.





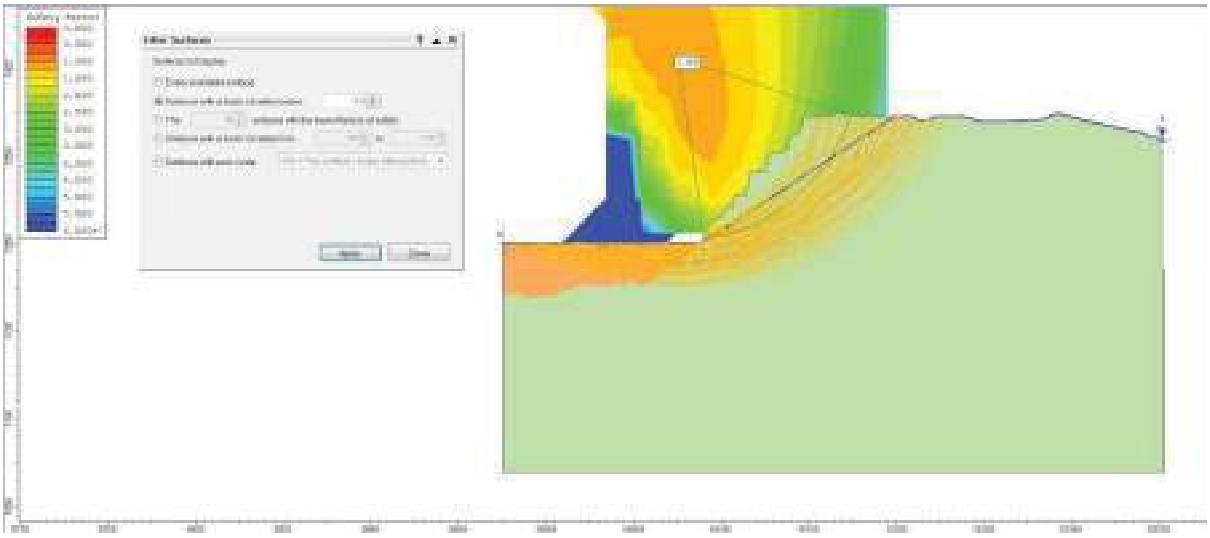
B. 25m tailings, horizontal water table at top of tailings

- FOS min = 1.164, slope scale failure.
- FOS < 1.3, significant slope scale failure indicated.
- No material change from dry condition.



C. 25m tailings, water sloped from top of tailings to 50m setback from pit crest ("worst case")

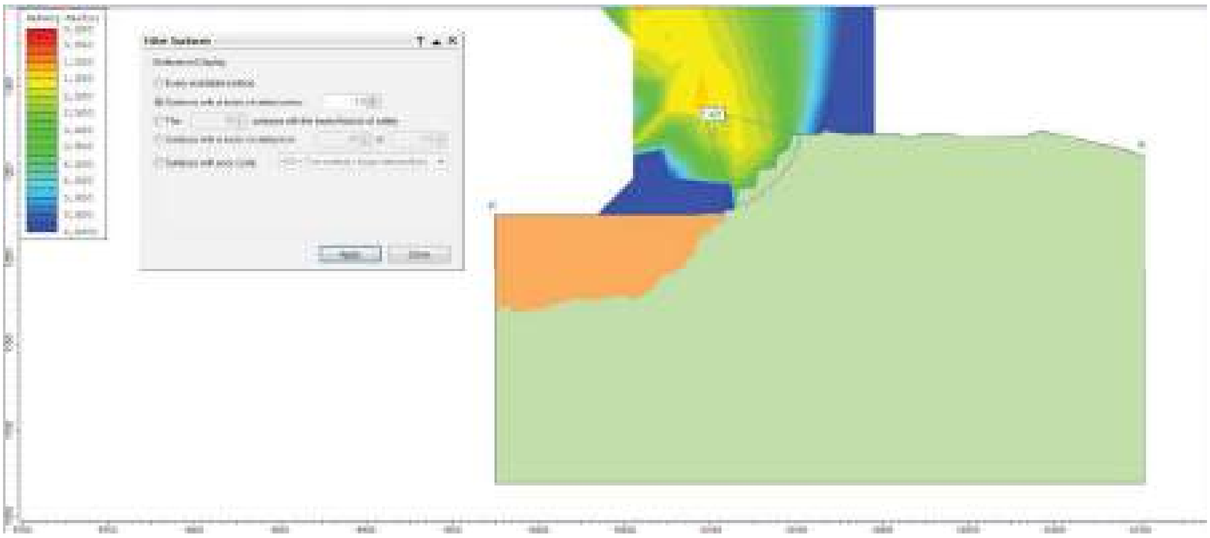
- FOS min = 1.116, slope scale failure.
- FOS < 1.3, significant slope scale failure, including floor heave indicated.
- Significant reduction in stability from dry condition. Low likelihood, transient groundwater condition.



Slope configuration #3 - 50m of 'new' tailings:

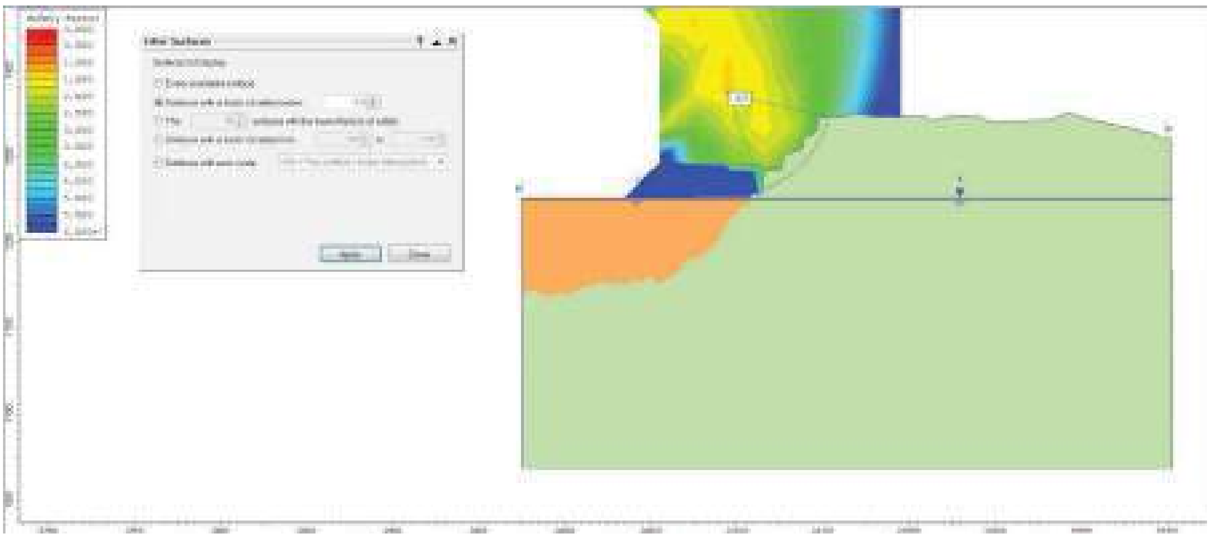
A. 50m tailings, no water

- FOS min = 1.421, slope scale failure to top of tailings.
- FOS < 1.3, no failure surfaces indicated. Stability significantly increased from 'no tailings' case. i.e. current slope configuration.



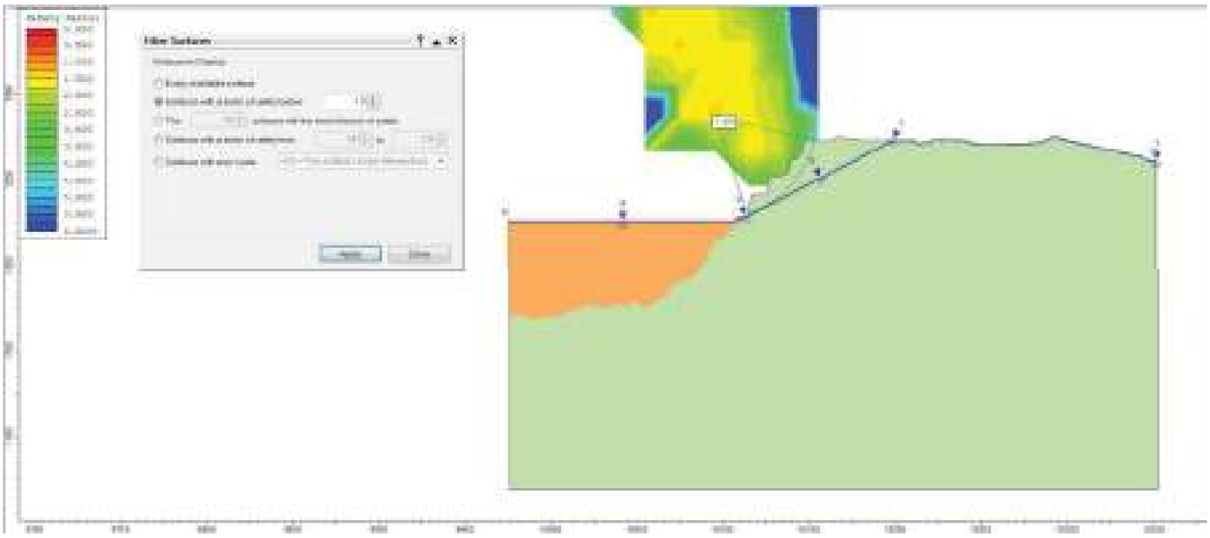
B. 50m tailings, horizontal water table at top of tailings

- FOS min = 1.421, slope scale failure to top of tailings.
- FOS < 1.3, no failure surfaces indicated.
- No change from dry condition.



C. 50m tailings, water sloped from top of tailings to 50m setback from pit crest ("worst case")

- FOS min = 1.420, slope scale failure to top of tailings.
- FOS < 1.3, no failure surfaces indicated.
- No material change from dry condition.



APPENDIX J

Ground Control Engineering Report G0197_RE01_VE01 Kintore Pit Waste Rock Slope Stability Assessment, dated 20 August 2019.

GROUND CONTROL ENGINEERING Pty Ltd
www.groundcontrolengineering.com.au
GEOTECHNICAL AND MINING ENGINEERING SERVICES
PO Box 893 Malanda QLD 4885
ABN 98 124 6688 542

20th August 2019

Attn: Mr Eamonn Dare
Technical Services Superintendent
Broken Hill Operations Pty Ltd
CBH Resources – Rasp Mine
130 Eyre Street
BROKEN HILL NSW 2880

Reference G0197

RE: KINTORE OPEN PIT – SLOPE STABILITY ANALYSIS OF EXISITING IN-PIT WASTE ROCK DUMP, DURING TAILINGS PLACEMENT

Ground Control Engineering Pty Ltd (GCE) was engaged by the Rasp Mine to undertake a slope stability assessment of the existing in-pit waste rock dump in the Kintore Pit. The waste rock dump slope will form the south-east bounding wall during the proposed placement of thickened 'dry' tailings in the Kintore Pit.

GCE conducted two-dimensional limit equilibrium analysis of the waste dump slope. The aim of the analysis was to assess the stability of the waste dump slope with varying tailings fill level and degree of potential water saturation. This summary report outlines the results of the modelling and key findings of the slope stability assessment.

Yours sincerely,

GROUND CONTROL ENGINEERING PTY LTD

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1 Introduction and Scope

GCE was requested by the Rasp Mine to undertake a geotechnical slope stability assessment of the existing waste rock dump in the Kintore Pit. CBH plans to backfill the Kintore Pit with thickened 'dry' tailings, whereby the waste rock dump slope will form the south-east bounding wall during placement of the tailings.

The scope of work for this assessment incorporated two-dimensional slope stability analysis of the following:

- Existing waste rock slope configuration, and;
- Various waste rock slope configurations incorporating the progressive filling of the pit with tailings and associated potential transient groundwater saturation profiles.

2 Data Provided

CBH provided GCE with the following data and report:

- Current pit surface including existing waste rock backfill area, as DXF file.
- Kintore Pit: Preliminary Decline Plug Design – Golder report, 17 October 2018 (Ref. 1)

3 Stability Analysis of Waste Rock Dump

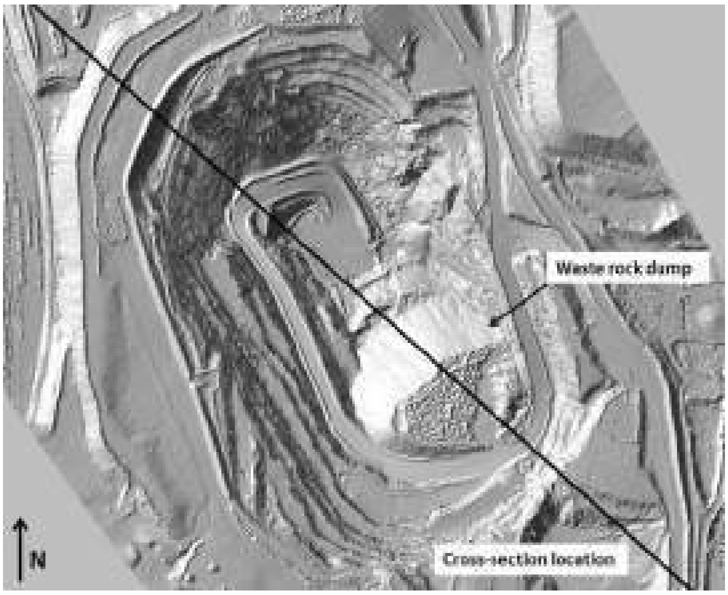
Sections 3.1 to 3.4 of this report describe the method, assumptions and parameters used in the slope stability analyses. The results and conclusions of the analyses are outlined in Sections 3.5, 3.6 and Appendix A.

3.1 Modelling method

The Rocscience Inc. software *Slide* was used to conduct limit equilibrium slope stability analyses of selected two-dimensional cross-sections of the Kintore Pit. Circular failure surfaces were generated using a grid search and analysed using the Bishop method to determine the slope Factor of Safety (FOS). Circular failure through the waste rock slope is considered the most likely slope failure mechanism.

The location of the section line where the cross-sections were generated for the analyses is shown in Figure 1. The location was selected by GCE to evaluate the 'worst case' slope configurations, approximately perpendicular to the waste rock slope and with consideration of the most likely failure mechanism.

Figure 1 Section line location with respect to existing as-built pit and waste rock dump



3.2 Slope configurations assessed

Three main slope configurations where assessed for stability, as described below and shown in Figures 2 to 4.

The cross-sections used in the *Slide* modelling incorporate the material boundaries, pit wall and waste dump geometry and inferred (potential) groundwater profiles.

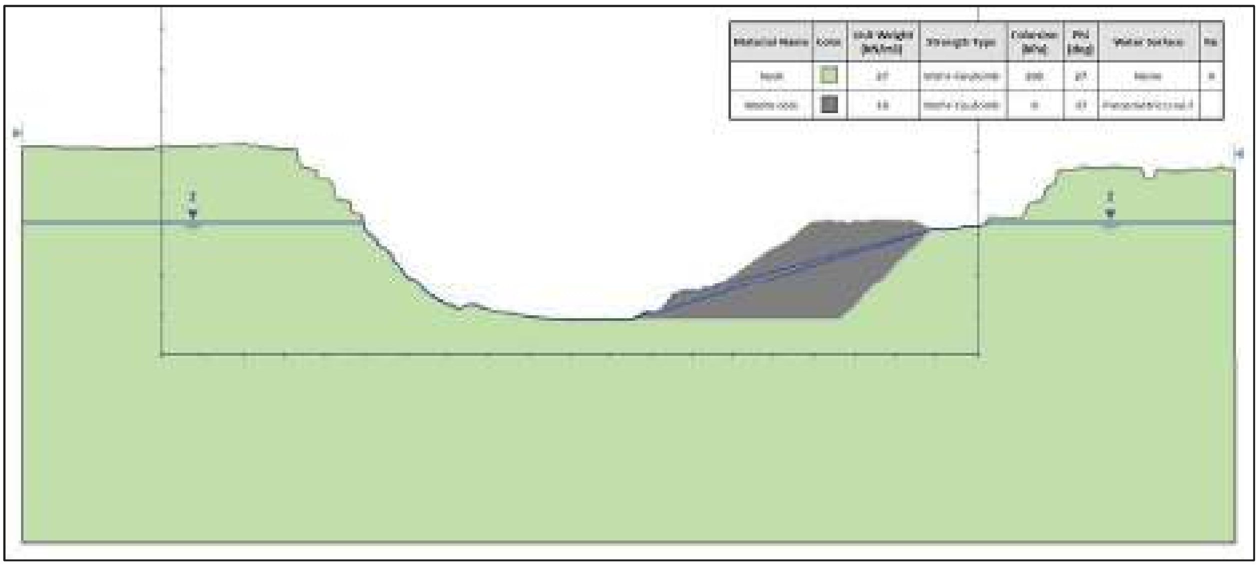
All slope configurations where run with three different groundwater cases, including a “dry” case. The groundwater and material properties applied in the models are described in Sections 3.3 and 3.4 of this report respectively.

NB: Static loading only has been modelled in the current stability assessment. GCE recommends that the impact of seismic loading is considered as part of a more comprehensive stability assessment.

<u>Slope configuration #1 - no tailings</u>:

Existing waste rock dump slope, prior to commencement of backfilling pit with tailings, as shown in Figure 2.

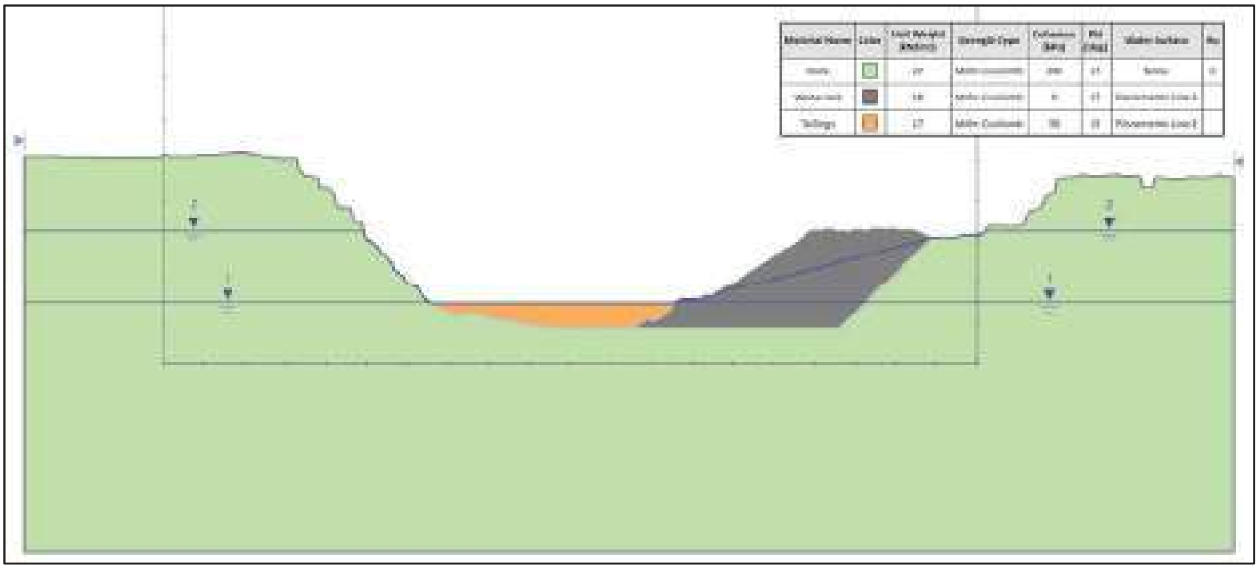
Figure 2 Slope configuration #1 – no tailings



Slope configuration #2 - 15m of tailings:

Placement of 15m of tailings in the pit, adjacent to the existing waste rock dump slope, as shown in Figure 3.

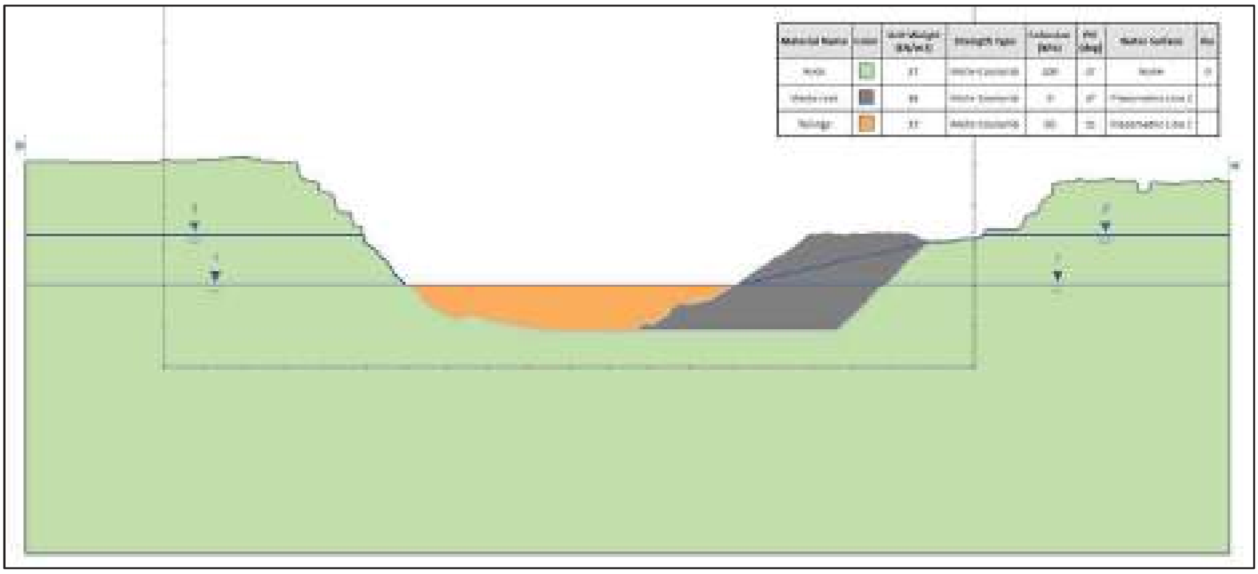
Figure 3 Slope configuration #2 - 15m of tailings



Slope configuration #3 - 30m of tailings:

Placement of 30m of tailings in the pit, adjacent to the existing waste rock dump slope, as shown in Figure 3.

Figure 4 Slope configuration #3 - 30m of tailings



3.3 Material properties

The estimated material properties assigned to each material type used in the modelling are outlined in Table 1.

It must be noted that the properties outlined in Table 1 are estimates only, based on GCE precedent experience of comparable materials and from the Golder report; Kintore Pit: Preliminary Decline Plug Design –17 October 2018.

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Table 1 Material shear strength properties (estimated)

Material Type	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle
Rock (in-situ Gneiss)	27	200	27°
Waste rock	18	0	37°
Tailings	17	50	15°

3.4 Groundwater

GCE understands that all water inflow will be removed from the pit via an effective drainage system and that groundwater will not accumulate at the bottom of the pit or in the tailings and waste rock slope(s). However, the groundwater profile and potential fluctuation following major rainfall events in the area of the Kintore Pit must be considered during the filling of the Kintore pit with classified tailings.. There may be periods after heavy rainfall events where part of the waste rock slope and tailings will be saturated and a transient piezometric surface will be present within the slope.

To assess the impact that groundwater may have on slope stability, three main groundwater conditions were modelled as follows:

1. "Dry" – No groundwater applied in the model. This scenario is used as a reference to assess the base case stability of the slope and the subsequent sensitivity of the modelled failure paths to the introduction of groundwater.
2. "Flat" – a horizontal piezometric surface is applied at the level of the top of the tailings, applying to both the tailings and waste rock materials.
3. "Sloped from top of waste rock" – a sloping piezometric surface is applied from the top of the waste rock, down to the level of the top of the tailings, applying to both the tailings and waste rock materials.

3.5 Summary of waste rock slope stability assessment results

The results of the stability modelling are presented in Appendix A and summarised as follows:

(Factor of Safety is abbreviated as FOS.)

<u>Slope configuration #1 - no tailings</u>:

- Very minor, shallow, sloughing style instability is indicated at FOS < 1. This may manifest as minor riling, which is typical of waste rock slopes.
- At FOS = 1.3, very shallow circular failure (sloughing) is indicated for both the "dry" and "water sloped from top of waste rock to pit floor" scenarios.
- The "worst case" transient groundwater scenario whereby a sloping piezometric surface is applied from the top of the waste rock, down to the mid-level of the slope indicates moderate slope scale instability at FOS < 1. This represents a significant reduction in slope stability from the dry condition.

However, the waste rock slope is understood by GCE to be free draining and hence this worst case groundwater scenario is considered to be very unlikely.

Slope configuration #2 - 15m of tailings:

- At FOS = 1.3, very shallow circular style failure (sloughing) is indicated for both the “dry” and “flat”, piezometric surface at the level of the top of the tailings, scenarios.
- The “flat” piezometric surface scenario indicates potential for slope scale instability (relatively shallow) at FOS = 1.36. Potential for circular failure resulting in floor heave through the tailings is indicated at FOS = 1.81.
- The “worst case” transient groundwater scenario whereby a sloping piezometric surface is applied from the top of the waste rock, down to the top of the tailings indicates potential for slope scale failure at FOS = 1.17. In this case, potential for circular failure resulting in floor heave through the tailings is indicated at FOS = 1.39.

Slope configuration #3 - 30m of tailings:

- At FOS = 1.3, very shallow circular style failure (sloughing) is indicated for all groundwater scenarios modelled.
- Potential for slope scale instability (upper exposed slope above tailings only) is indicated at FOS = 1.52. Potential for circular failure resulting in floor heave through the tailings is indicated at FOS = 1.65 in the “worst case” transient groundwater scenario.

3.6 Findings and recommendations

The following comments relate to the analyses and FOS results outlined in Sections 3.1 to 3.5 and Appendix A.

- The slope stability analyses conducted by GCE indicates that current, free draining, waste rock dump slope has a FOS for overall slope scale stability of greater than 1.3.
- Generally speaking, the placement of ‘dry’ tailings at the base of existing waste rock dump slope is expected to increase the stability of the slope.
- The modelling highlights the potential for shallow, circular style failure (sloughing) in all cases. This may materialise as minor rilling, which is typical of waste rock slopes. GCE recommends that a large bund is installed along the length of the toe of the waste rock dump during placement of tailings to shield against rockfall from the adjacent slope. The bund will need to be progressively moved and re-established as the level of the tailings backfill rises in the pit.
- The slope stability model incorporating 15m of tailings (slope configuration model #2) and the “worst case” transient groundwater scenario, whereby a sloping piezometric surface is applied from the top of the waste rock, down to the top of the tailings, indicates potential for slope scale failure at FOS = 1.17. In this case, potential for circular failure resulting in floor heave through the tailings is indicated at FOS = 1.39.

4 References

1. Golder, (2018) '*Kintore Pit: Preliminary Decline Plug Design*', Ref 1896230-017-R-Rev0, 17 October 2018

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Version	Description of changes/amendments	Author(s)	Date
DRAFT01	Draft report	C. Byrne	19/03/19
FINAL	Final report – no changes requested	C. Byrne / C. Tucker	20/08/19

DOCUMENT REVIEW AND SIGN OFF

Version	Reviewer	Position	Signature	Date
DRAFT01	C.Tucker	Principal Geotechnical Engineer		19/03/19
FINAL	C.Tucker	Principal Geotechnical Engineer		20/08/19

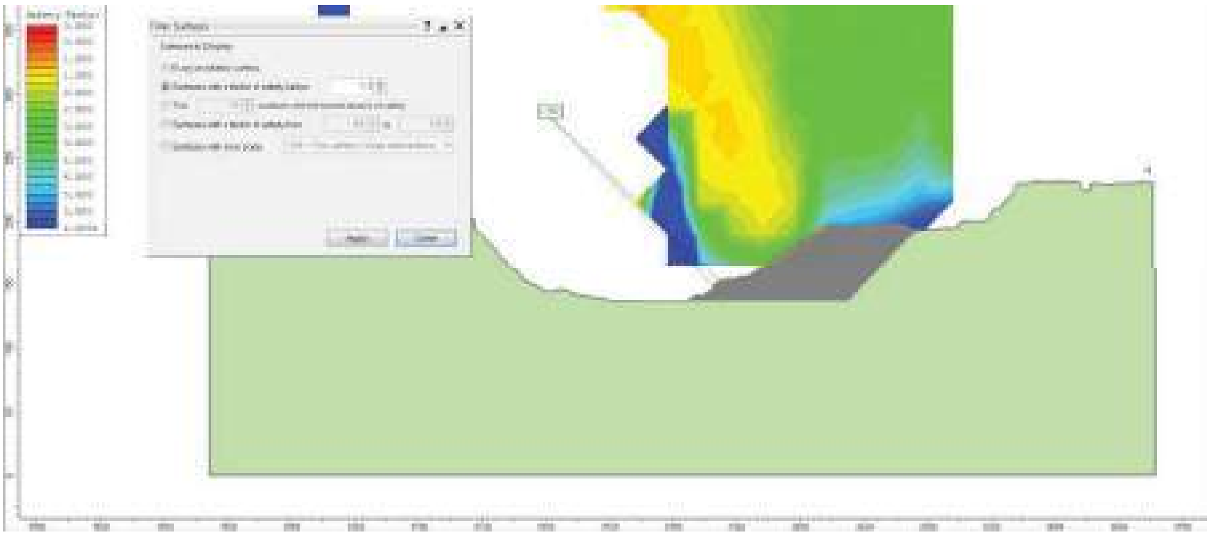
APPENDIX A

Kintore Pit Waste Rock Slope Stability Modelling Results Summary

Slope configuration #1 - no tailings:

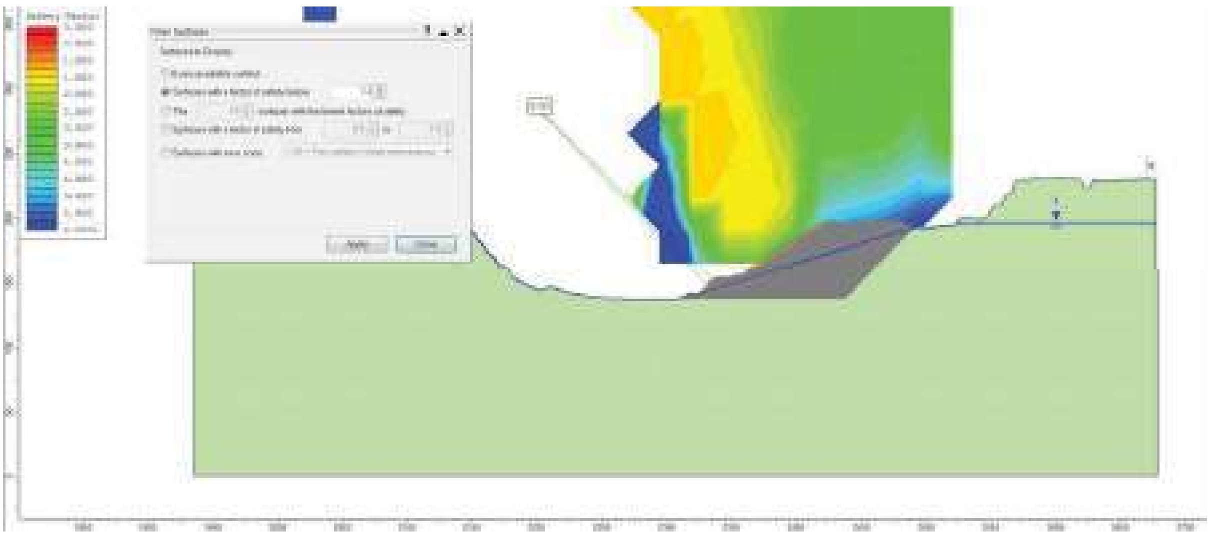
A. No tailings, no water

- FOS min = 0.763, very shallow, minor sloughing failure only
- FOS < 1.3, shallow sloughing only



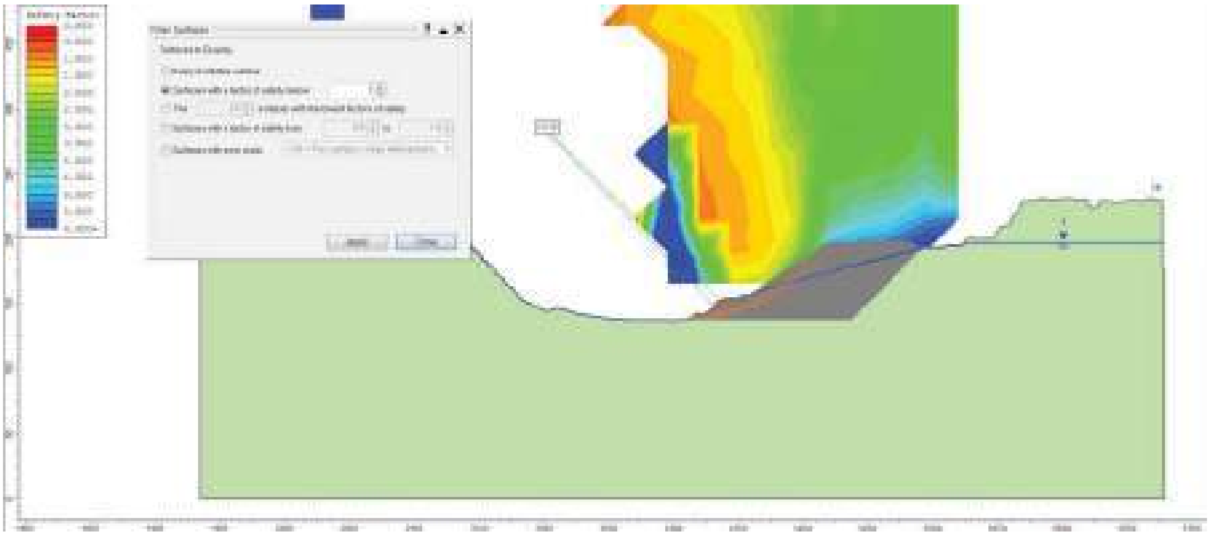
B. No tailings, water sloped from top of waste rock to pit floor

- FOS min = 0.763, very shallow, minor sloughing failure only
- FOS < 1.3, shallow sloughing only
- No change from dry condition



C. No tailings, water sloped from top of waste rock to mid slope ("worst case")

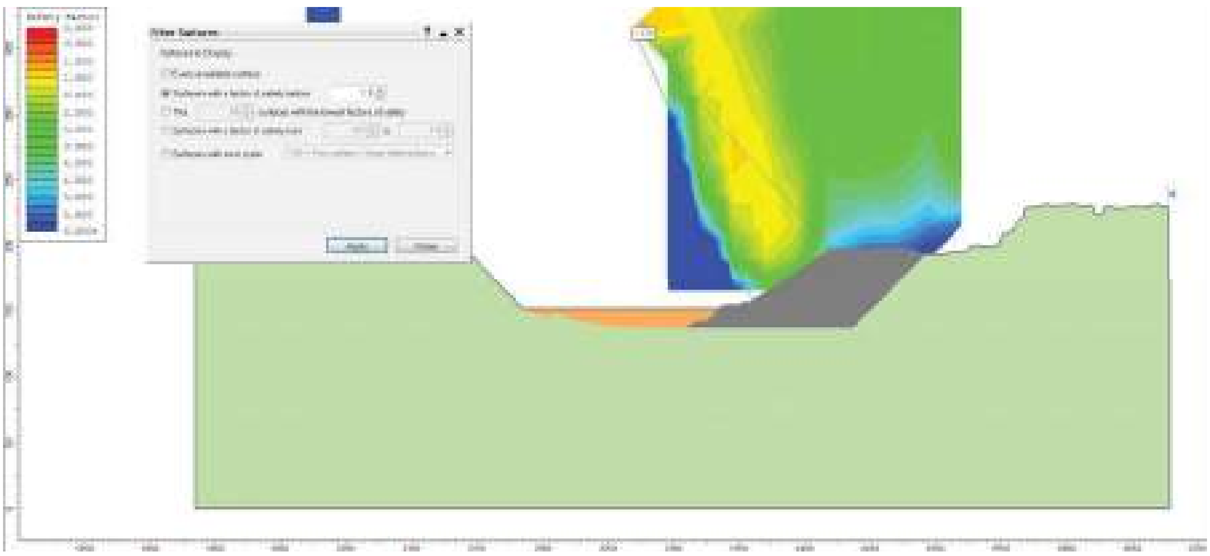
- FOS min = 0.018, very shallow, minor failure only
- FOS < 1.0, moderate slope scale failure indicated
- Significant reduction in stability from dry condition. However, would require large rainfall event.



Slope configuration #2 - 15m of tailings:

A. 15m tailings, no water

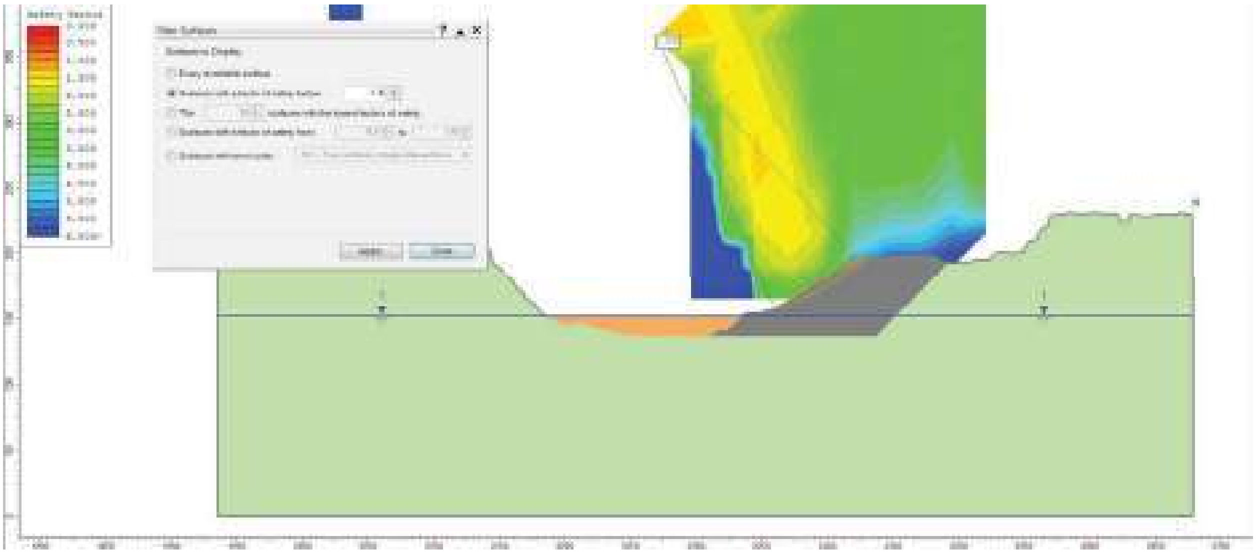
- FOS min = 1.172, shallow, sloughing failure only
- FOS < 1.3, shallow sloughing only
- Tailings increase stability of overall waste slope when dry



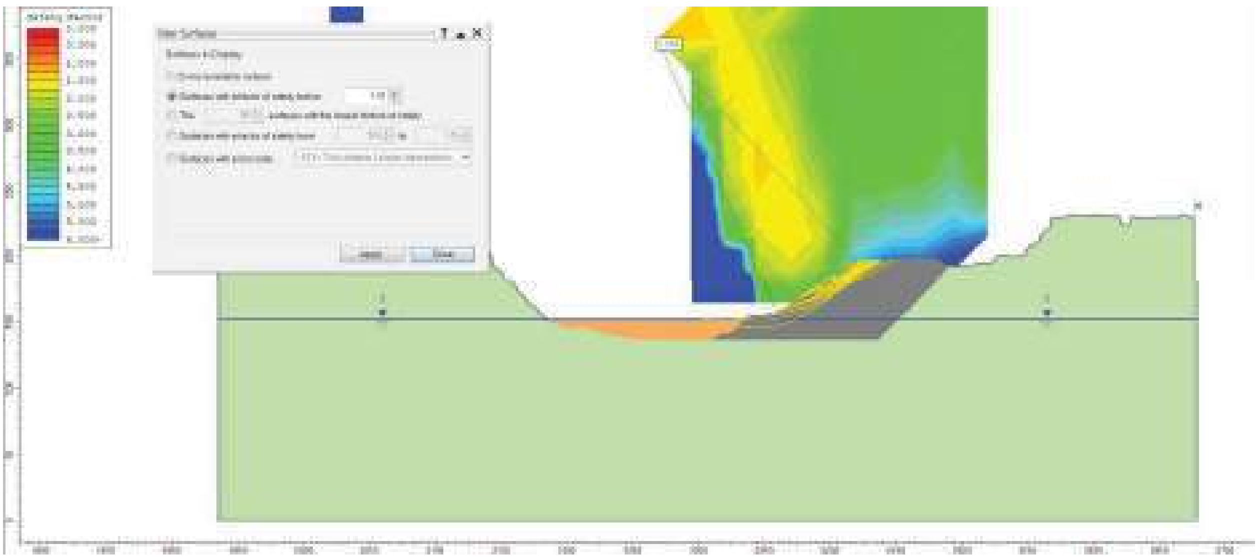
B. 15m tailings, water flat at top of tailings

- FOS min = 1.172, shallow, sloughing failure only, no change from dry condition
- FOS for slope scale failure = 1.36, tailings increase stability of overall waste slope
- FOS < 1.3, minor slope scale shallow sloughing failure indicated
- FOS for floor heave in tailings = 1.81

Slope scale failure case shown below (FOS=1.36):



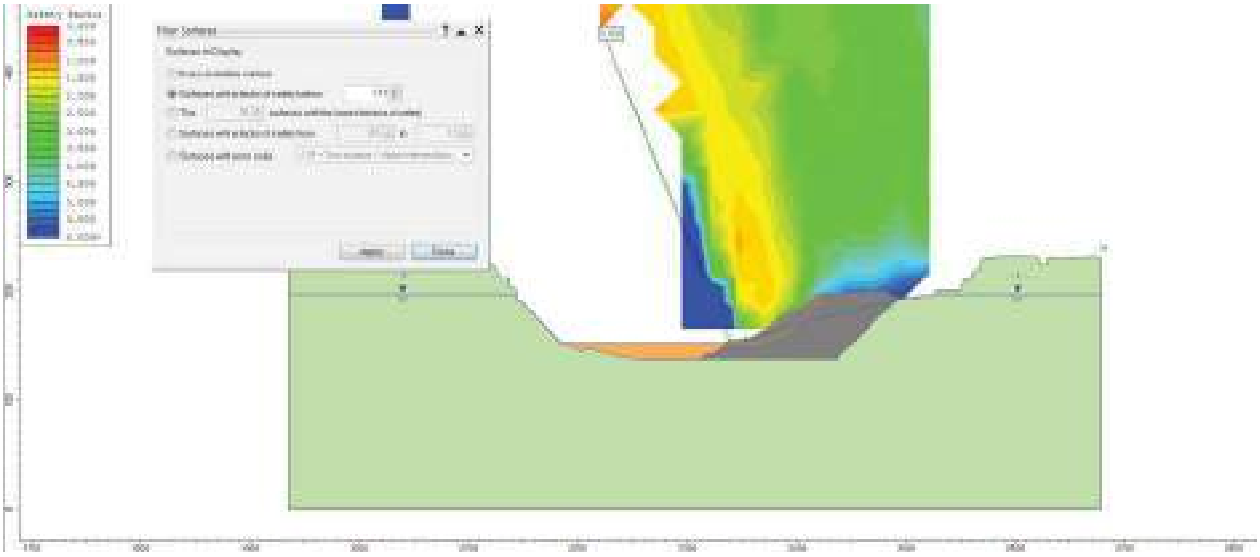
Floor heave through tailings case shown below (FOS=1.81):



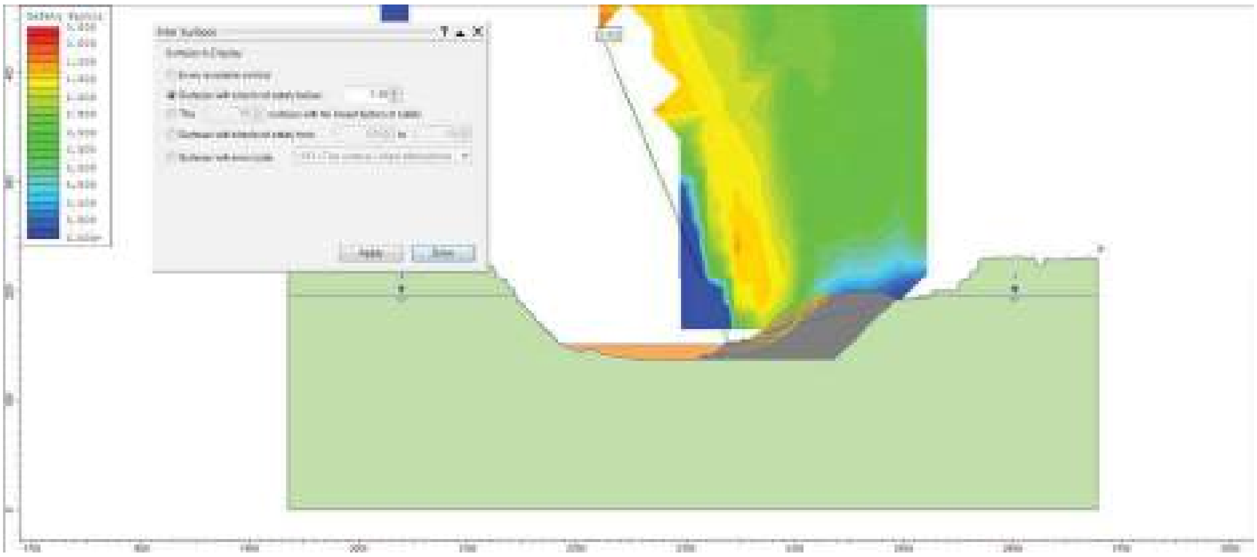
C. 15m tailings, water sloped from top of waste rock to top of tailings (“worst case”)

- FOS min = 0.658, very shallow, minor failure only
- FOS for slope scale failure = 1.17
- FOS < 1.3, moderate slope scale failure indicated
- FOS for floor heave in tailings = 1.39

Slope scale failure case shown below (FOS=1.17):



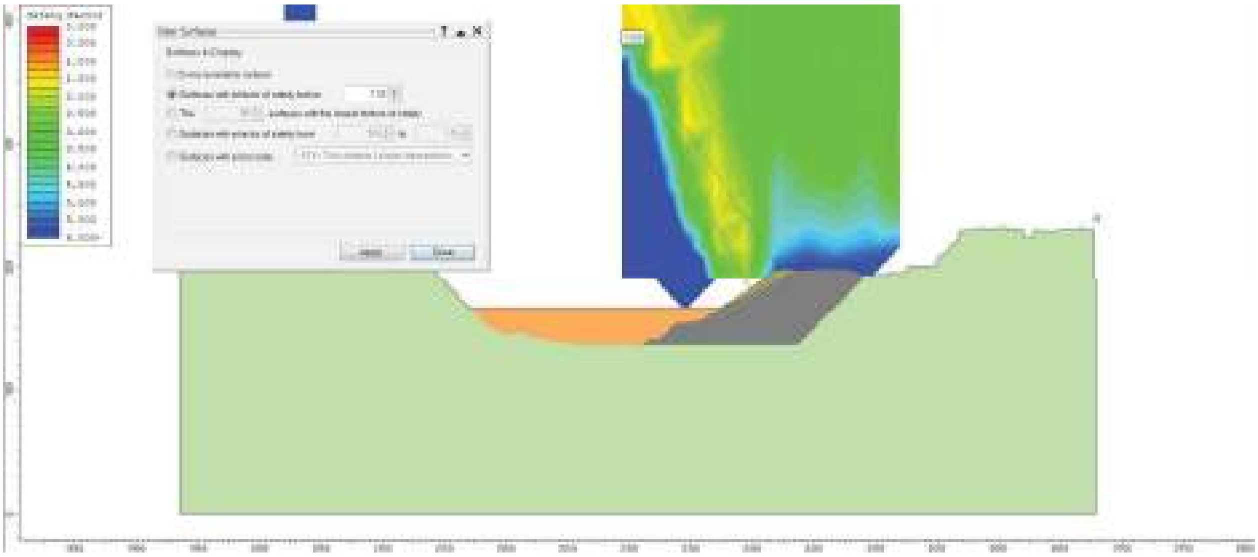
Floor heave through tailings case shown below (FOS=1.39):



Slope configuration #3 - 30m of tailings:

A. 30m tailings, no water

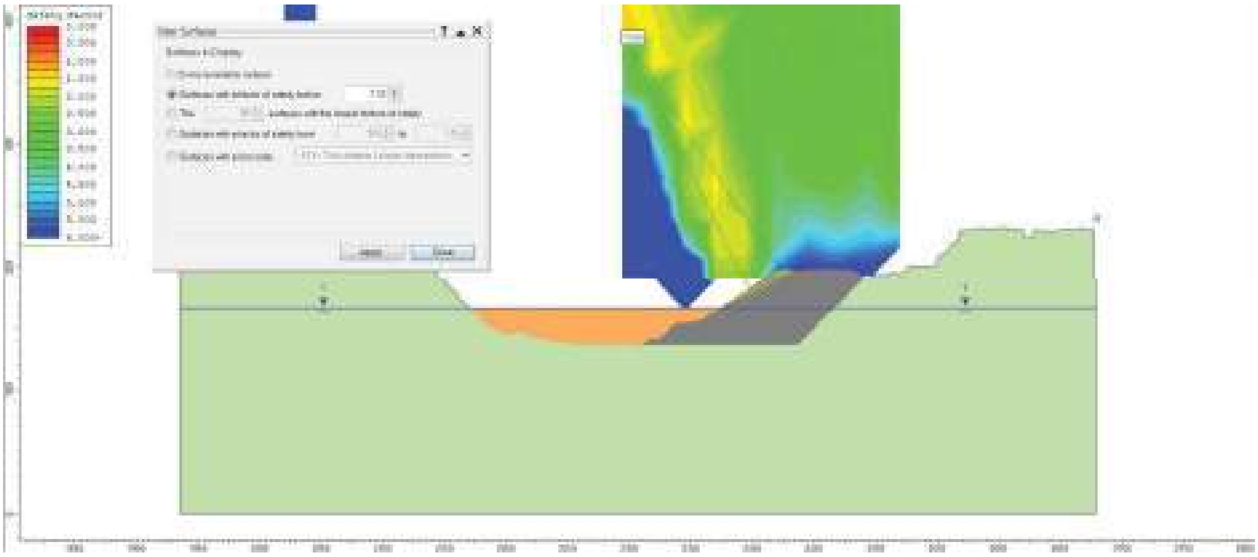
- FOS min = 1.268, very minor, shallow, sloughing failure only
- FOS < 1.3, very minor, shallow, sloughing failure only
- FOS for slope scale failure = 1.52 (upper exposed slope interval above tailings only), tailings increase stability of overall waste slope.
- FOS for floor heave in tailings = 1.83
- Tailings increase stability of overall waste slope when dry



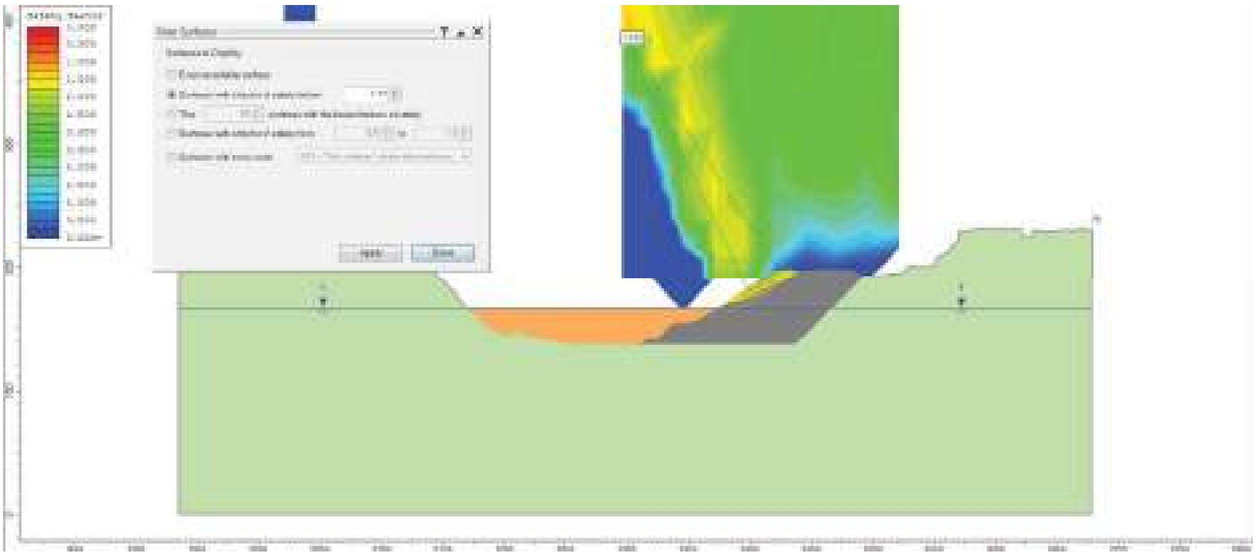
B. 30m tailings, water flat at top of tailings

- FOS min = 1.268, very minor, shallow, sloughing failure only
- FOS < 1.3, very minor, shallow, sloughing failure only
- FOS slope scale = 1.52 (upper exposed slope interval above tailings only), tailings increase stability of overall waste slope.
- FOS for floor heave in tailings = 1.77, reduction from 1.83 when dry. Not significant.
- Tailings increase stability of overall waste slope

Slope scale failure case shown below (FOS=1.52):



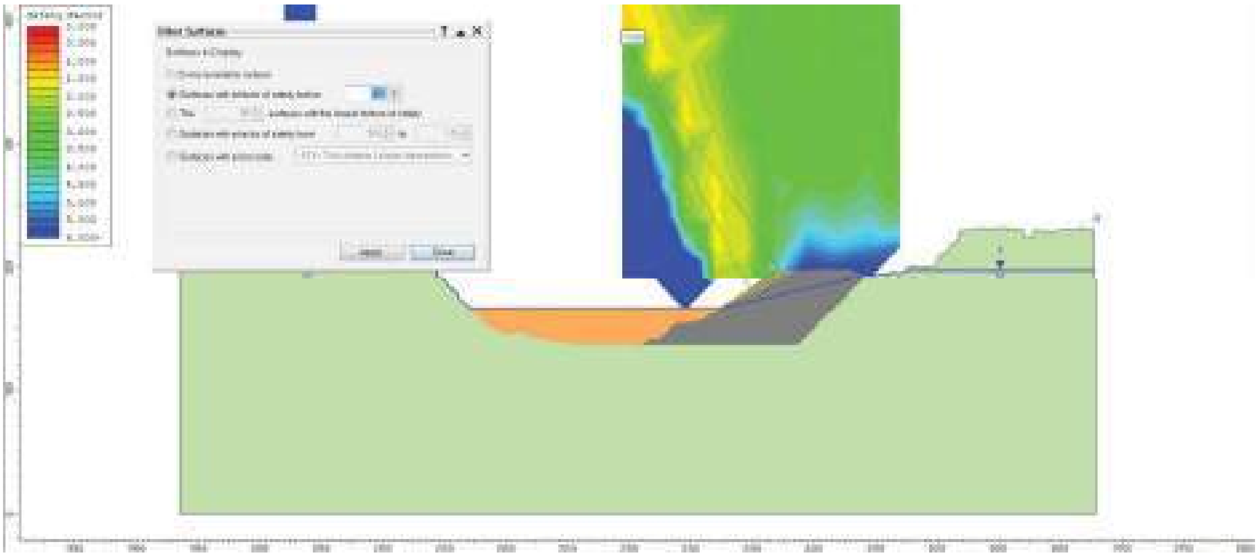
Floor heave through tailings case shown below (FOS=1.77):



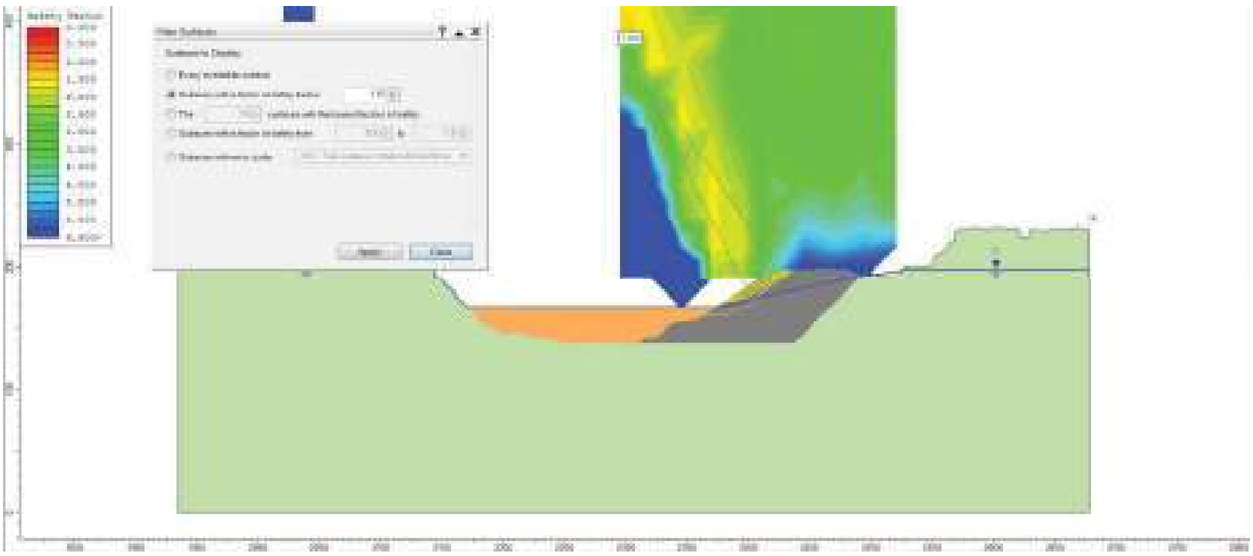
C. 30m tailings, water sloped from top of waste rock to top of tailings ("worst case")

- FOS min = 1.268, very minor, shallow, sloughing failure only
- FOS < 1.3, very minor, shallow, sloughing failure only
- FOS for slope scale failure = 1.52 (upper exposed slope above tailings only), tailings increase stability of overall waste slope.
- FOS for floor heave in tailings = 1.65, reduction from 1.83 when dry. Not overly significant.
- Tailings increase stability of overall waste slope

Slope scale failure case shown below (FOS=1.52):



Floor heave through tailings case shown below (FOS=1.65):



APPENDIX K

‘Rasp Mine – Potential Impact of Blasting on Tailings Storage Facility’ ref: 1896230-024-M-Rev0 dated 4 October 2019

GOLDER

TECHNICAL MEMORANDUM

DATE 4 October 2019 **Project No.** 1896230-024-M-Rev0

TO Andrew McCallum
Broken Hill Operations Pty. Ltd.

CC Gwen Wilson

FROM Fred Gassner **EMAIL fgassner@golder.com.au**

RASP MINE - POTENTIAL IMPACT OF BLASTING ON TAILINGS STORAGE FACILITY

Golder Associates Pty Ltd (Golder) was retained by Broken Hill Operations Pty Ltd (BHOP) to undertake an assessment of liquefaction potential of tailings storage facilities related to blasting activities for the Rasp Mine. This assessment is undertaken to also inform the risk of stored tailings inrush from the impacts of mine blasts. Two existing tailings storage facilities (TSF) exist on the mine and a third facility is being planned.

1.0 INTRODUCTION

1.1 Overview

Historic tailings storage facility (TSF 1)

TSF 1 is located to the south of the processing plant and has not been used for tailing deposition for more than 15 years. The TSF is a surface structure with the TSF constructed on top of the original ground surface. The top of the TSF is covered by a layer of slag and includes drainage slots to remove stormwater from the surface of the TSF.

An investigation comprising Cone Penetration Testing in 2008 indicated that the base of the tailings was saturated and low strength, but the rest of the tailings was partially saturated with strengths of soft to firm to stiff. From the 2008 investigation it was concluded that the base tailings at that time may be liquefiable under seismic loading. Since then the surface drainage of the TSF has been improved which may have improved the ground conditions.

Blackwood Pit TSF (TSF 2)

TSF 2 is the currently active TSF for the mine. The existing operation comprises of thickened tailings being deposited as a slurry into the Blackwood pit adjacent to the processing plant on site. This TSF has been operational for more than 10 years with the tailing elevation approaching the crest elevation of the pit. The TSF is currently being upgraded with three perimeter embankments constructed along the low areas of the pit rim. The upgrade also includes an emergency spillway at the north east end of the pit. The pit includes a number of old mine workings adjacent and below the pit. Prior to commissioning the TSF, the mine conducted risk assessments related to the potential risk of the tailings inrush to the proposed ongoing mine works, which are remote to the old workings.

Kintore Pit TSF (TSF 3)

BHOP is proposing to backfill its Kintore Pit with tailings. The tailings will be dewatered using vacuum filters, spread in layers and compacted with a roller. The pit itself is over 100 m deep with an adit near the base of the pit that leads to active underground workings. It is important that the in-pit tailings storage facility (TSF) be designed to mitigate the risk of sudden inflow of tailings and water to the underground workings. The design of the pre-deposition works for tailings deposition is currently being developed for consideration by the appropriate authorities.

1.2 Tailings

The current TSF (TSF 2) which is near full contains slurry deposited full stream tailings, or feed tailings. The tailings are sun dried in layers and can be accessed approximately 1 week after deposition. This is a very dry part of the country (200 mm to 400 mm rain per year and evaporation in excess of 2 metre per year). The deposition point is closest to a future boxcut area for a new adit to the mine and the decant end of the TSF beach is at the far end (north east end) of the pit. The rate of rise of tailings in TSF 2 is approximately 4 meter per year.

The future TSF (TSF 3) will contain an at least 30 m wide strip of dewatered (filter press) compacted full stream tailings around the perimeter of the pit, that is compacted at optimum moisture content, plus the finer and potentially slightly wetter tailings placed in the centre of the TSF. The finer tailings are related to proposed cyclone treatment of the full stream tailings with the coarse split being directed to the underground workings for backfill and the finer split being placed in the TSF. The finer split of the tailings will also be dewatered and compacted in layers in TSF 3.

Golder carried out the laboratory testing to assess the liquefaction potential of Rasp Mine tailings (Golder, 2018). The report concluded that static liquefaction of the compacted fine tailings at depth cannot be ruled out if the tailings remain saturated. The concept design for tailings placement in the Kintore pit therefore includes compacted full stream around the perimeter of the Kintore pit, a rockfill bridging layer and drain across the base of the pit and plugs in the existing MLD drive adjacent to the pit base. Note a length of the old MLD drive under the pit will be closed and plugged with a new section currently being planned to be constructed to the east of the pit floor to address the needs of ventilation to Shaft 6.

This report is prepared to assess the potential of liquefaction of the tailings related to anticipated future blasting operations at the mine.

1.3 Blasting

The following summarizes the blast parameter critical to this assessment, which have been provided by BHOP:

Table 1: Parameters for the Proposed Blast Types

Pit	Blast Type	Distance [1] (m)	MIC [2] (kg)	Blast Duration [3] (sec.)
TSF 1	Stope	> 500	250	4
	Boxcut	110	100	1
	Decline development	100	60 [4]	-
TSF 2	Stope	160	250	4
	Boxcut	120	100	1
	Development	95	60 [4]	-
TSF 3	Stope	200	250	4
	Boxcut	970	100	1
	Development	1020	60 [4]	-

1) *Minimum separation distance between the blast and tailings in TSF.*
2) *Maximum instantaneous explosive charge weight.*
3) *Maximum blast duration in seconds.*
4) *Twelve (12) holes on the same delay with 5 kg per hole.*

2.0 GROUND VIBRATION LIMITS

A peak ground acceleration (PGA) based method is commonly used to assess the earthquake-induced liquefaction potential of soils with the “simplified procedure” (Youd and Idriss, 2001). However, there are fundamental differences between blast-induced ground vibrations and ground vibrations caused by earthquakes. Ground vibrations initiated by blasts typically contain less energy, have a higher spectral frequency content, and have significantly shorter time duration than earthquake-induced ground vibrations (less than two seconds versus more than half a minute to several minutes). According to Pfeifer (2010), the amount of damage from blasting correlates best to the peak particle velocity (PPV), while PGA is more appropriate when evaluating damage from earthquakes.

Appropriate limits for blast-induced liquefaction and vibrations at earth dams and embankments have been discussed in numerous publications, including Charlie et al. (1987, 1992, 2001), Al-Qasimi et al. (2005) and Pfeifer (2010).

Charlie et al. (2001) found that no significant increase in residual Pore Water Pressure (PWP) was induced by explosives when the PPV was less than 15 mm/s to 35 mm/s. Charlie et al. (1987, 1992) suggested the following criteria for blasting near dams and embankments (Table 2) based on liquefaction potential and susceptibility to pore pressure increases.

Table 2: General Guidelines to Vibration Damage Thresholds for Blasting Near Dams and Embankments

Dam and Embankment Construction	PPV Limit (mm/s)
Dams and embankments constructed of or having foundation materials consisting of loose sand or silts that are sensitive to vibration	15
Dams and embankments having medium-dense sand or silts within the dam or foundation materials	50
Dams and embankment having materials insensitive to vibrations in the dam or foundation materials	100

Source: Charlie et al. 1987.

Al-Qasimi et al. (2005) described a research study with intended to determine the potential for explosive detonation to induce residual pore pressure and determine the possibility of triggering flow-liquefaction in the tailings located under an experimental embankment. Little or no excess pore pressure was induced from single or multiple detonations in a level deposit of loose, saturated, sand-size mine tailings when PPV was less than 10 mm/s. Blast-induced residual pore pressure and cyclic-liquefaction occurred for a single detonation at a PPV exceeding 650 mm/s and multiple detonations with millisecond delays at a PPV exceeding 130 mm/s.

As the containment of the proposed dewatered tailings in TSF 3 is the pit wall rock, a PPV limit of 100 mm/s would provide a reasonable level to avoid potential liquefaction. TSF 2 (where the future raise embankments are partially constructed on desiccated tailings) may contain foundation materials that are sensitive to vibration, a PPV limit of 15 mm/s would provide a reasonable level to avoid potential liquefaction. TSF 1 is an old tailings dam with most of the material is a relatively dry state, and moderate density based on old piezocone testing conducted on the TSF before the improved water management was implemented on the surface. The base of the TSF was saturated at that time, so for this TSF a PPV of less than 25 mm/sec would provide a reasonable level to avoid potential liquefaction. It is noted that these preliminary limits do not consider the energy related to the blasting, so these preliminary limits are conservative.

3.0 VIBRATION ATTENUATION MODEL

3.1 Predictive Vibration Model

Two of the most important variables that affect the PPV induced by a blast are the distance from the source (seismic waves attenuate with distance) and the maximum instantaneous explosive charge weight (MIC). The most common method of normalizing these two factors is by means of plotting the scaled distance (distance divided by the square root of the charge weight per delay) against the PPV.

The PPV (mm/s) is given by the following equation:

$$PPV = K(SD)^e \qquad \text{(Eq.1)}$$

where K and e are site constants and the Scaled Distance (SD) is defined as:

$$SD = \left(\frac{D}{\sqrt{W}}\right) \qquad \text{(Eq.2)}$$

where D is the distance (m) between the blast and receptor;

W is the MIC (kg) detonated.

According to the Australian Standards, the PPV can be estimated by the following equation when blasting to a free face in average conditions (JKMRC, 1996): $PPV = 1140(SD)^{-1.60}$

where PPV is the Peak Particle Velocity (mm/sec)

SD = Scaled Distance (m/kg$^{1/2}$) as defined above

The model is plotted on Figure 1.

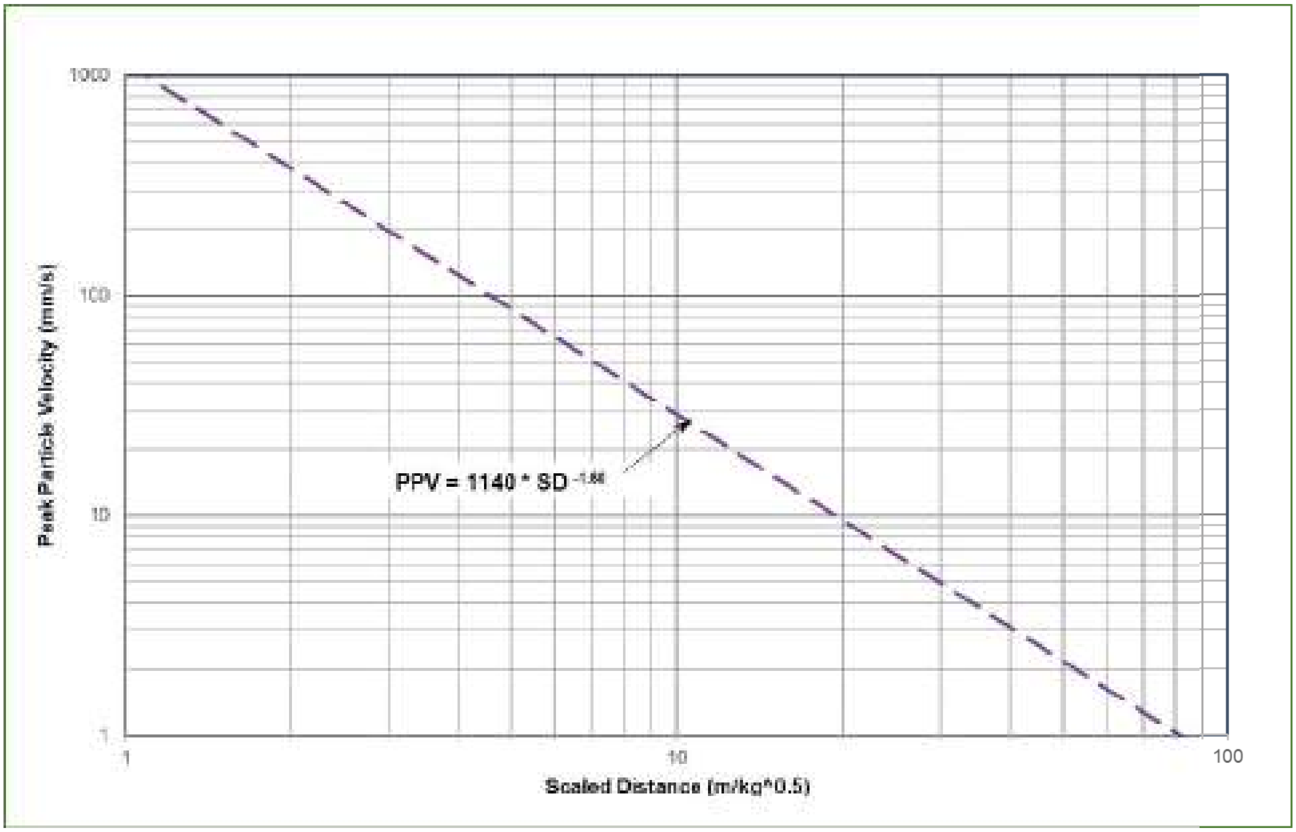


Figure 1: Proposed Ground Vibration Model

The vibration monitoring data was collected at receptors located from 300 m to over 1300 m from a given blast. Vibration monitoring has not been conducted at the tailings. Thus, the PPVs for the recorded events are likely significantly less than maximum anticipated vibration levels that could be expected at the tailings within the TSF's.

3.2 Impact of the Rock-Tailings Boundary

While most blast-induced tailings liquefaction assessments in literature consider the impact of the blasts on tailings embankments, the TSF 2 and 3 entails the pit wall rock as the retaining structure. Several authors have addressed blast induced vibrations on tailings backfill in underground stope. As part of their assessments, the effect of the rock-backfill interface was considered.

Mohanty and Trivino (2014) presented a blast vibration monitoring case study in a stope backfilled with 2-4% Cemented Paste Backfill (CPB) during its curing stage. A systematic seismic monitoring program was implemented to characterize the nature of CPB and its surrounding rock when subjected to a normal production blasting operation. The particle velocity and the frequency content in CPB compared to its surrounding rock is shown to be lower by almost two orders of magnitude for the PPV, and almost an order of magnitude lower in the frequency (Shasavari et al., 2014). The main reason is that the propagation of wave has been through two different media with different stiffness and elastic parameters.

Johnson et al. (2007) investigated the response of CPB to dynamic loads based on rockburst observations in the Galena mine. The results also showed that 95% of the initial energy was reflected away from the CPB specimen and only 5% of the energy was absorbed.

Studies have shown that much of the blast vibrations are reflected at rock CPB interface. Emad (2013) found that only 18% - 30% of the blast vibrations were transmitted into the CPB. The current assessment has considered transmission of 30% across the rock-tailings interface.

3.3 Tailings Raise Embankments

As mentioned in Section 2.0, the future raise embankments of TSF 2 are to be partially constructed on desiccated tailings and should have a PPV limit of 15 mm/s. In that case, the blast induced vibrations at the embankment toe will be those at the tailings surfaces that will form the foundation of the embankments.

As the pathway from the blast vibration source to the future embankment receptors differs for TSF 1 and TSF 2, the attenuation model will be different for each. That is, the vibration waves will have to cross the rock/tailings boundary for TSF 2 while those for TSF 1 may be affected by amplification at the top of the facility.

The northern embankment (Embankment 2) of the TSF 2 has been constructed and is founded on a rock and rockfill foundation.

The other two embankment raises (Embankments 1 and 3) are founded partially on rock and partially on tailings. The models used in this assessment is based on data collected at sensitive receptors surrounding the mine. It is proposed to also collect data at the sites of the future raise embankment sites. This would enable the development of refined models for each of the embankment raise sites to inform any modification to the nearby blasting design.

4.0 IMPACT ASSESSMENT

Based on the discussions above, an estimate of the of the PPV levels at the proposed pit tailings on both the rock wall and within the tailings. As the TSF 1 is on surface rather than within an excavated open pit, the predicted PPVs are represented by Figure 2. Figure 2 indicates that the TSF 1 embankment will not exceed the 25 mm/s limit for Stope, Boxcut and Development blast at distances greater than 171 m, 110 m and 85 m, respectively.

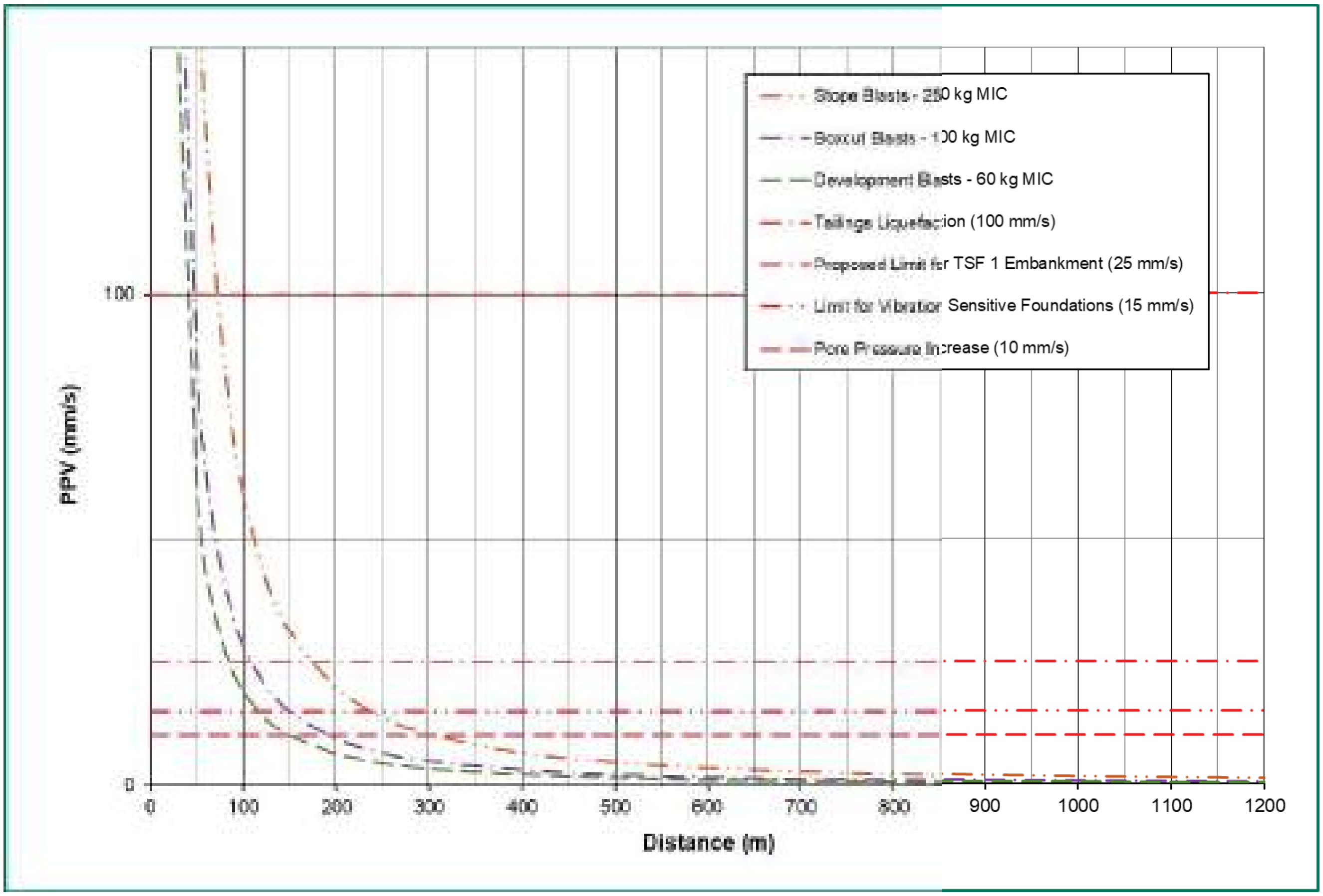


Figure 2: Estimated PPV in Rock at a Range of Separation Distances for the Proposed Blast Types

The estimated vibration levels within the tailings are shown in Figure 3. The estimated PPVs within the tailings suggest that all three proposed blast types will not exceed the tailings liquefaction threshold of 100 mm/s beyond 34 m from the blast.

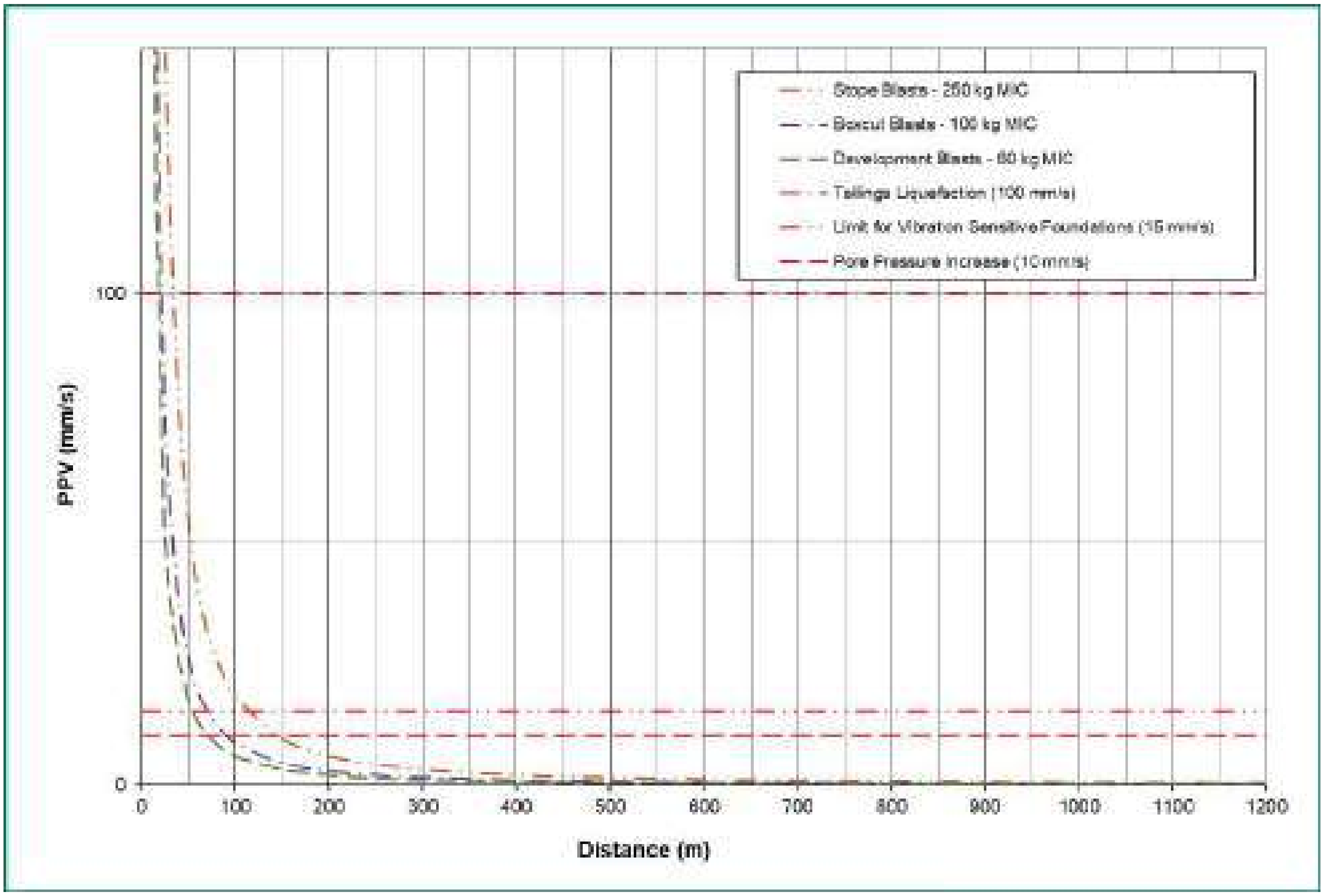


Figure 3: Estimated PPV in Tailings at a Range of Separation Distances for the Proposed Blast Types

The estimated PPVs for the proposed blast types at each of the pits are summarized in Table 3.

Table 3: Estimated PPV Levels for Proposed Blast Types

Pit	Blast Type	Distance [1] (m)	PPV (mm/s)	
			In Wall Rock	In Tailings
TSF 3	Stope	200	19.7	5.9
	Boxcut	970	0.76	0.23
	Development	1020	0.46	0.14
TSF 2	Stope	160	28.1	8.4
	Boxcut	120	21.4	6.4
	Development	95	20.7	6.2
TSF 1 [2]	Boxcut	110	Not applicable	24.6
	Decline Development	100	Not applicable	19.0

1) *Minimum separation distance between the blast and tailings in TSF.*
2) *Estimated PPV for the TFS 1 embankment.*

The estimated blast-induced vibrations will reach the threshold at which the PWP increases (10 mm/s). However, the energy related to the proposed blasts will be relatively low compared to the energy of an earthquake. Experience has shown that liquefaction has not occurred for earthquake events with a magnitude of 4 or less. Blast energy will be limited by overpressure, noise and vibration limitations set for the works related to the surrounding receptors. The tailings liquefaction is unlikely for the proposed blasting and minimum separation distances.

The blast vibrations predicted for the TSF 1 embankment are marginally below the limit of 25 mm/s for both the Boxcut and the Decline Development blasts at the estimated minimum separation distances to the structure.

5.0 SUMMARY AND RECOMMENDATIONS

Based on our analysis of data provided by BHOP and summary of the work carried out by numerous researchers on the potential liquefaction of tailings, the following provides our summary of findings and recommendations:

- The proposed blast types are unlikely to induce liquefaction in designed tailings at the TSF's.
- Vibration monitoring of the blasts should be carried at the facilities to verify the modelled vibration values. This would allow for the refinement of the vibration attenuation model based on site-specific data at distances where tailings liquefaction is a consideration.
- Monitoring of induced vibrations from the blasting as it approaches the tailings. This will provide a record of the PPV at the specific locations in question and enable refinements of the developed models. At TSF 2, the developed model could be used for assessing the potential impact of a future embankment raise.
- Instrumentation of a tailings should be undertaken. Ideally, this would include both ground vibration and porewater sensors. This would allow for the site-specific assessment of:
  - The PPV induced in the tailings (rather than in the rock only) and refinement of the vibration attenuation model within the tailings; and
  - Potential rises in pore water pressure for given recorded PPVs.
- Should vibration monitoring exceed a warning level of 70% of the limits described, a redesign of the blasts should be undertaken. This is particularly important for the TSF 1 embankment which is predicted to be marginally below the limit of 25 mm/s at the nearest approach of blasting.

6.0 CLOSURE

We trust that this report meets BHOP’s needs and should you require any additional information, please do not hesitate to contact the undersigned.

Daniel Corkery
Associate, Senior Blasting Consultant

Fred Gassner
Senior Principal

DC/fwg/dc

https://golderassociates.sharepoint.com/sites/25201g/deliverables/024 blasting assessment/1896230-024-m-rev0.docx

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APPENDIX L

'RASP Mine - Site Water Management Plan' dated January 2019 (ref BHO-PLN-ENV-004) (the SWMP).

Rasp Mine

Zinc – Lead – Silver Project

Project Approval No. 07-0018

January 2011

Site Water Management Plan

BHO-PLN-ENV-004

Updated

January 2019

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Contents

1. Introduction

1.1 Overview

Broken Hill Operations Pty Ltd (BHOP), a wholly owned subsidiary of CBH Resources Limited (CBH), owns and operates the Rasp Mine (the Mine), is located centrally within the City of Broken Hill on Consolidated Mine Lease 7 (CML7). The Mine produces zinc and lead concentrates which it dispatches via rail to Port Pirie in South Australia and Newcastle in New South Wales.

Project Approval (PA) was granted in January 2011 (07_0018) and mining commenced in April 2012. Modifications to the PA have been granted on a number of occasions and details can be found on the CBH web site. The existing operations include underground mining operations, a processing plants, a rail siding for concentrate dispatch and other associated infrastructure.

Mining has been undertaken within CML7 since 1885 and the entire site has been disturbed with little or no remnant native vegetation.

The mine is located at a high point in the regional topography and is a prominent feature in the City of Broken Hill. Most of the site is raised from the adjoining area in the form of an extensive mound, formed from waste rock and tailing. Site elevations vary from 356 m AHD at the parking bay for the Miners Memorial to approximately 216 m AHD at the base of Kintore Pit.

The total area of CML7 is approximately 342 ha. There are several surface exclusion zones within CML7, these include rehabilitation areas and areas with no or limited surface rights. These exclusion zones comprise approximately 123.7 ha. BHOP is not responsible for the surface water management in these exclusion zones.

1.2 Purpose

The purpose of this Site Water Management Plan (SWMP) is to outline the responsibilities and actions for monitoring and managing water in relation to the operations of the Rasp Mine.

The SWMP has been developed in accordance with the:

- Project Approval 07-0018 Conditions (as modified);
- Rasp Mine Environment Protection Licence 12559;
- CML7 and Mining Purpose Leases (MPLs) 183, 184, 185 and 186, and
- Commitments made by Broken Hill Operations Pty Ltd to monitor and manage water related activities.

The SWMP satisfies the requirements for a *Water Management Plan* as outlined in Schedule 3, Condition 23 of the PA.

1.3 Objectives

The primary objectives for this SWMP are to:

- To comply with section 120 of the Environment Operations Act 1997, which prohibits the pollution of waters.
- Prevent discharge of potentially contaminated surface waters from active mine areas off-site.

- Separate runoff from the mine processing plant area and groundwater collection ponds from areas of general runoff.
- Limit disruption to the mining activities and provide a safe working environment.
- Identify erosion and sediment control measures for the site and outline control measures and a monitoring plan for areas considered susceptible to erosion
- Outline a water monitoring program for the site to include both surface and ground waters; Provide a site representative water balance.
- Provide reporting requirements based on statutory obligations and internal processes.

1.4 Surface Water Management Goals

The topography of the site and the arid climate conditions provide opportunities to develop a SWMP that satisfies the operational requirements of the mining activity and prevents release of runoff from active areas of the mine site for rainfall events up to the design frequency event – 100 year average recurrence interval (ARI) 24 hour rainfall event. A set of goals were developed in order to guide this SWMP, these goals are:

- Retain runoff from a 100 year ARI 24 hour rainfall event from the active mine areas. The high evaporation rate would allow retained water to evaporate in a relatively short period. This goal will minimise impact on the downstream environments.
- Retain runoff locally in small ponds / storages at various locations in the mine site, utilising the existing landform where feasible to maximise evaporation. This would:
  - Eliminate the need to construct a large storage and avoid hazards associated with large storages.
  - Help in the sedimentation process that would remove suspended solids from the runoff.
  - Minimise erosion potential by eliminating the requirement to carry large discharge to a smaller number of large storages.
- Provide appropriate spillways for the local ponds to convey flows greater than the 100 year ARI runoff event. Spillways will be set at the 100 year ARI 24 hour storm event storage level.
- Use the available capacity of Horwood Dam to contain the 100 year runoff event from various sub-catchments.
- Use the available capacity of S22 to contain runoff from TSF 1, Mt Hebbard (catchment 19) and adjacent catchments to the northwest, in addition provide storage for mine water settlement ponds including underground mine dewatering and groundwater from Shaft 7.
- Divert runoff away from Kintore Pit to reduce the flooding risks in the Pit and associated potential impact on mining operations.
- Provide appropriate sediment and erosion measures on site.
- Divert stormwater surface runoff from undisturbed areas around mining affected water storage facilities.
- Monitor the groundwater bores on site.
- Summarise the results of the site water balance model.
- Address the conditions of the PA, Statement of Commitments and Environment Protection Licence conditions.

1.5 Consultation

The SWMP has been prepared in consultation with the Department of Industry – Water (DI-W), the Environment Protection Authority (EPA) and the Division of Resources and Geoscience (DRG) as required by PA07_0018.

1.6 Supporting Plans and Documents

Table 1-1 lists the plans, procedures and associated forms developed in accordance with this Plan.

Table 1 - Water Management Associated Documents

Document Title	BHOP Document Code	Associated Forms
Pollution Incident Response Management Plan	BHO-PLN-ENV-002	• Incidents entered into INX inControl electronic database.
Site Water Monitoring Procedure	BHO-ENV-PRO-011	• Groundwater Monitoring Form • Surface Water Monitoring Form • Mine Water Monitoring Form
The Erosion and Sediment Control Monitoring Procedure	BHO-ENV_PRO-018	• Environmental Inspection Form
Eyre Street Dam Monitoring Procedure	BHO-PRO-ENV-027	• Eyre St Trench Inspection Form

2. Statutory Requirements

Table 2-1 details the statutory requirements as prescribed in the:

- Project Approval 07_0018 (modified) pursuant to the *Environment Planning and Assessment Act 1979*;
- BHOP Environment Assessments and Statement of Commitments, and
- Environment Protection Licence 12559 pursuant to the *Protection of the Environment Operations Act 1997*.

Table 2 - BHOP Water Management Requirements and Obligations

Reference	Requirement	Relevant Section within this Plan
Project Approval 07_0018 (modified)		
Sched 3 Cond 21	Except as may be expressly provided by an Environment Protection Licence issued under the Protection of the Environment Operations Act 1997, the Proponent shall comply with section 120 of that Act, which prohibits the pollution of waters.	Section 1.3
Sched 3 Cond 22	The Proponent shall ensure that it has sufficient water for all stages of the project, and if necessary, adjust the scale of mining operations to match its water supply. *Note: The Proponent is required to obtain the necessary water licences for the project under the Water Act 1912 and/or Water Management Act 2000.*	Section 11
Sched 3 Cond 23(a)	A Site Water Balance which must include details of: • Sources and Security of water supply; • Water use of site; • Water management on site; and	Section 11

Reference	**Requirement**	**Relevant Section within this Plan**
	• Any off-site water transfers. Investigate and implement all reasonable and feasible measures to minimise water used by the project	
Sched 3 Cond 23(b)	An Erosion and Sediment Control Plan, which must: • Identify activities that could cause soil erosion, generate sediment or affect flooding; • Describe measures to minimise soil erosion and the potential for transport of sediment to downstream water, and manage flood risks; • Describe the location, function and capacity of erosion and sediment control structures and flood management structures; and • Describe what measures would be implemented to maintain the structures over time.	Section 8 Sections 7, 8, 9 Sections 7, 8, 9 Sections 8 and 14.2
Sched 3 Cond (c)	A Surface Water Management Plan, which must include; • Detailed baseline data on surface water flows and quality in creeks and other waterbodies that could potentially be affected by the project; • Surface water and stream health impact assessment criteria including trigger levels for investigating any potentially adverse surface water impacts. • Program to monitor and assess: o Surface water flows and quality o Impacts on water users o Stream health; and o Channel Stability	Section 13 There are no surface rivers, streams or creeks on site.
Sched 3 Cond (d)	A Groundwater Monitoring Program, which must: • Provide a program to monitor seepage movement within and adjacent to the tailings storage facility; • Include details of parameters and pollutants to be monitored for: o Water from mine dewatering o Groundwater locations to the east of TSF1 o Surface water represented by Horwood Dam o Water captured by the toe drains of the tailings storage facility. o Water seepage from the tailings storage facility; and o The background local groundwater system • Outline performance parameters against monitoring data will be compared to determine whether seepage is occurring, and whether an unacceptable impact on local groundwater may be occurring; and • Include details of contingency measures to be implemented in the event that an unacceptable impact is identified	Section 12
Sch4, 1	**Environmental Management Strategy** The Proponent shall prepare and implement an Environmental Management Strategy for the project to the satisfaction of the Director-General. This strategy must: (a) be submitted to the Director-General for approval by the end of June 2011; (b) provide the strategic framework for the environmental management of the project; (c) identify the statutory approvals that apply to the project;	See Environmental Management Strategy

Reference	Requirement	Relevant Section within this Plan
	(d) describe the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the project; (e) describe the procedures that would be implemented to: • keep the local community and relevant agencies informed about the operation and environmental performance of the project; • receive, handle, respond to, and record complaints; • resolve any disputes that may arise during the course of the project; • respond to any non-compliance; and • respond to emergencies; and (f) include: • copies of any strategies, plans and programs approved under the conditions of this approval; and • a clear plan depicting all the monitoring required to be carried out under the conditions of this approval. Management Plan Requirements The Proponent shall ensure that the management plans required under this approval are prepared in accordance with relevant guidelines, and include: (a) detailed baseline data; (b) a description of: • the relevant statutory requirements (including any relevant approval, licence or lease conditions); • any relevant limits or performance measures/criteria; and • the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures; (c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria; (d) a program to monitor and report on the: • impacts and environmental performance of the project; and • effectiveness of any management measures (see (c) above); (e) a contingency plan to manage any unpredicted impacts and their consequences; (f) a program to investigate and implement ways to improve the environmental performance of the project over time; (g) a protocol for managing and reporting any: • incidents; • complaints; • non-compliances with the conditions of this approval and statutory requirements; and • exceedances of the impact assessment criteria and/or performance criteria; and (h) a protocol for periodic review of the plan. Note: The Secretary may waive some of these requirements if they are	

Reference	**Requirement**	**Relevant Section within this Plan**
	unnecessary or unwarranted for particular management plans.	
Sch4, 2	Management Plan Requirements The Proponent shall ensure that the management plans required under this approval are prepared in accordance with relevant guidelines, and include: (a) detailed baseline data; (b) a description of: • the relevant statutory requirements (including any relevant approval, licence or lease conditions); • any relevant limits or performance measures/criteria; and • the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures; (c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria; (d) a program to monitor and report on the: • impacts and environmental performance of the project; and • effectiveness of any management measures (see (c) above); (e) a contingency plan to manage any unpredicted impacts and their consequences; (f) a program to investigate and implement ways to improve the environmental performance of the project over time; (g) a protocol for managing and reporting any: • incidents; • complaints; • non-compliances with the conditions of this approval and statutory requirements; and • exceedances of the impact assessment criteria and/or performance criteria; and (h) a protocol for periodic review of the plan. Note: The Secretary may waive some of these requirements if they are unnecessary or unwarranted for particular management plans.	Section 7.2 Section 2 Section 2, Sections 7, 8, 9 Sections 5, 7, 8, 9, 10, 11 Section 11 Sections 7.3, 8.4, 10 Section 11 Sections 11 Section 11.3
Sch4, 3	**Annual Review** By the end of June 2012, and annually thereafter, the Proponent shall review the environmental performance of the project to the satisfaction of	Section 11.2

Reference	Requirement	Relevant Section within this Plan
	the Secretary. This review must: (a) describe the development (including any rehabilitation) that was carried out in the past year, and the development that is proposed to be carried out over the next year; (b) include a comprehensive review of the monitoring results and complaints records of the project over the past year, which includes a comparison of these results against the: • relevant statutory requirements, limits or performance measures/criteria; • monitoring results of previous years; and • relevant predictions in the documents referred to in Conditions 2 of Schedule 2; (c) identify any non-compliance over the past year, and describe what actions were (or are being) taken to ensure compliance; (d) identify any trends in the monitoring data over the life of the project; (e) identify any discrepancies between the predicted and actual impacts of the project, and analyse the potential cause of any significant discrepancies; and describe what measure will be implemented over the next year to improve the environmental performance of the project.	
Sch4, 4	**Review of Strategies, Plans and Programs** Within three months of: (a) the submission of an annual review under Condition 3 above; (b) the submission of an incident report under Condition 5 below; (c) the submission of an audit report under Condition 7 below, or (d) any modification of the conditions of this approval (unless the conditions require otherwise), the Proponent shall review, and if necessary revise, the strategies, plans, and programs required under this approval to the satisfaction of the Secretary. *Note: This is to ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the project.*	Section 11.3
Sch4, 5	**Incident Reporting** The Department must be notified in writing to compliance@planning.nsw.gov.au immediately after the Proponent becomes aware of an incident. The notification must identify the project (including the application number and the name of the project if it has one), and set out the location and nature of the incident.	Section 11.1

Reference	Requirement	Relevant Section within this Plan
Sch4, 5A	**Non-compliance Notification** The Department must be notified in writing to compliance@planning.nsw.gov.au within 7 days after the Proponent becomes aware of any non-compliance with the conditions of this approval. The notification must identify the project and the application number for it, set out the condition of approval that the project is noncompliant with, the way in which it does not comply and the reasons for the non-compliance (if known) and what actions have been done, or will be, undertaken to address the non-compliance.	Section 11.1
Sch4, 6	**Regular Reporting** The Proponent shall provide regular reporting on the environmental performance of the project on its website, in accordance with the reporting arrangements in any approved plans or programs of the conditions of this approval.	Section 11.2
Sch4, 7	**Independent Environmental Audit** By the end of December 2011, and every three years thereafter, unless the Secretary directs otherwise, the Proponent shall commission and pay the full cost of an Independent Environmental Audit of the project. This audit must: (a) be conducted by suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Secretary; (b) include consultation with the relevant agencies; (c) assess the environmental performance of the project and whether it is complying with the relevant requirements in this approval and any relevant EPL or Mining Lease (including any assessment, plan or program required under these approvals); (d) review the adequacy of any approved strategies, plans or programs required under these approvals; and, if appropriate (e) recommend measures or actions to improve the environmental performance of the project, and/or any strategy, plan or program required under these approvals. *Note: This audit team must be led by a suitably qualified auditor and include experts in any fields specified by the Secretary.*	Section 11.3
Sch4, 8	**Independent Environmental Audit** Within six weeks of the completing of this audit, or as otherwise agreed by the Secretary, the Proponent shall submit a copy of the audit report to the Secretary, together with its response to any recommendations contained in the audit report.	Section 11.3
BHOP Statement of Commitments		
EA	BHOP is committed to the following water conservation measures: • Treatment of mine dewatering to enable usage in the processing plant;	Section 5 and 8

Reference	Requirement	Relevant Section within this Plan
	• Tailings water to be returned to the processing plant for reuse; • Water to be recycled from Horwood Dam to the processing plant; • The silver tank is a raw water holding tank for water to be used in the processing plant, reducing the potential for evaporation from open type storages; • Investigate the use of grey water from domestic facilities for use in ground management; and • Installation of flow metres to monitor water usage.	
EA	Measures to manage water quality that will be included in BHOP's water management program include: • Provision and location of spill kits and requirements for training; • Design and installation of chemical storage to include bunds with suitable sumps, and where appropriate roofed to prevent stormwater entry; • Bunding of the diesel refuelling station; • Oil / water separators to be installed at vehicle wash facilities and the diesel refuelling station; • Management of sediment and sludge from vehicle washing facilities; • Water quality monitoring including groundwater (represented by mine dewatering) and at locations to the east of TSF1, and surface water represented by Horwood Dam; • Monitor the quality and quantity of water captured by the toe drains on the Tailings Storage Facility (TSF); and • Monitor the movement of seepage sourced from the TSF and to monitor the quality of the local groundwater system.	Section 5
EA	In addition the recommendations from the Stormwater Management Plan as proposed by Golder Associates (Golder 2010, Annexure J) will be implemented and will address potential impacts from new Project activities prior to the commencement of those activities. This Plan includes: • Erosion and sediment control measures; • Design requirements for on-site retention evaporation basins; • Requirements for management of catchment areas, including drains, pipework, bunding and sumps; and • Quarterly inspections of the site storm water management structures to confirm that they are operational.	Section 9
EA	A Groundwater Management Plan will be prepared to provide details of the monitoring of seepage movement within and adjacent to the TSF.	Section 5.3, 7.1
EA	If sufficient water is not available, the scale of their operations will be adjusted to match the licensed water entitlements.	Section 11
EA	Finally, all necessary licences under the *Water Act 1912* will be obtained prior to the commencement of activities on site.	Section 1.2
MOD1	Divide Catchment 25 into two catchments, 25A and 25B with two smaller storm water storage basins, S25A which diverts water away from the vent shaft and flows into S25B.	Section 3.2
MOD4	The following mitigation measures will be implemented for water seepage: • Incorporate TSF2 seepage controls recommended by Golder and as required by the DSC.	Section 7.1

Reference	Requirement	Relevant Section within this Plan
	• Line each embankment of the TSF with a geomembrane liner. • Collect seepage in a filter sand layer on the upstream slope of each embankment of the TSF extension where collection drains will be installed. • Periodically monitor seepage at the TSF extension via inspection chambers installed on the drainage pipes.	
MOD4	The following mitigation measures will be implemented for stormwater: • Review and update the BHOP Site Water Management Plan to address stormwater management at the CBP and TSF2 embankments to collect and retain a 1:100 year, 72 hour rainfall event. • Construct a spillway at TSF2 to meet the NSW DSC requirements.	Section 5.3
Environment Protection Licence 12559		
Section 3 L1.1	Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.	Section 1.3
Section 3 L8.1	All storm water and other surface water holding ponds identified in the Site Water Management Plan must be designed, constructed and maintained to accommodate the stormwater runoff generated in a 100 year (24 hour) Average Recurrence Interval rain event.	Sections 6, 7, 8, and 9
Section 3 L8.2	The water storage ponds listed below must have the base and wall artificially lined with an impermeable high density polyethylene liner: 1) "Mine Settlement Ponds" and "Backfill Plant Sediment Pond" identified in Figure 3 of the Rasp Mine Site Water Management Plan. 2) "Plant Event Pond" and the "Overflow Event Pond" identified in Figure 4 of the Rasp Mine Site Water Management Plan.	Sections 2.1, 2.2, 12.1.7, and 9
Section 4 O4.1	All surface water storage ponds must be maintained to ensure that sedimentation does not reduce their capacity by more than 10% of the design capacity.	Section 8
Section 5 M1.1	The results of any monitoring required to be conducted by this licence or a load calculation protocol must be recorded and retained as set out in this condition.	Sections 11, 12, 13, and 15
Section 5 M1.2	All records required to be kept by this licence must be: a) in a legible form, or in a form that can readily be reduced to a legible form; b) kept for at least 4 years after the monitoring or event to which they relate took place; and c) produced in a legible form to any authorised officer of the EPA who asks to see them.	Section 15
Section 5 M1.3	The following records must be kept in respect of any samples required to be collected for the purposes of this licence: a) the date(s) on which the sample was taken; b) the time(s) at which the sample was collected; c) the point at which the sample was taken; and d) the name of the person who collected the sample.	Sections 12, 13, and 15

Reference	Requirement	Relevant Section within this Plan
Section 5 M2.1	For each monitoring/discharge point or utilisation area specified below (by a point number), the licensee must monitor (by sampling and obtaining results by analysis) the concentration of each pollutant specified in Column 1. The licensee must use the sampling method, units of measure, and sample at the frequency specified.	Table 7.1
Section 5 M2.2	Lists the water monitoring requirements for nominated locations and includes – pollutant, unit of measure, frequency and sampling method. Surface Waters points 29, 31, 32, 33, 34 Receiving waters points 35 and 36 Ground waters points 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52 Water from shaft 7 and mining extraction points 53 and 54	Table 7.1, 8.1, 8.2
Section 5 M5.1	The licensee must keep a legible record of all complaints made to the licensee or any employee or agent of the licensee in relation to pollution arising from any activity to which this licence applies.	Sections 12, 13 and 15
Section 5 M5.2	The record must include details of the following: a) the date and time of the complaint; b) the method by which the complaint was made; c) any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect; d) the nature of the complaint; e) the action taken by the licensee in relation to the complaint, including any follow-up contact with the complainant; and f) if no action was taken by the licensee, the reasons why no action was taken.	Section 15
Section 5 M5.3	The record of a complaint must be kept for at least 4 years after the complaint was made.	Section 15
Section 5 M5.4	The record must be produced to any authorised officer of the EPA who asks to see them.	Section 15
Section 6 R1	Details requirements for reporting water monitoring results in the Annual Return to the EPA.	Section 15
Section 6 R2	Details requirements for notifying of environmental harm to the EPA.	Section 11.1.2
Section 6 R3	Details requirements for written reports that can be requested by the EPA.	Section 11.1.2

3. Site Description

The Mine is located centrally within the City of Broken Hill and is surrounded by transport infrastructure, areas of commercial and industrial development and some residential housing. The Mine is bounded by Eyre Street and Holten Drive to the south and east, Perilya's Broken Hill North Mine to the east and its South Mine to the west, and the commercial centre of Broken Hill to the north. The Mine site is dissected by two major State roads, South Road (Silver City Highway SH22) to the southwest and Menindee Road (MR66) to the northeast. The Broken Hill railway station is located directly to the north of the Mine and lies on the main Sydney – Perth railway line. Residential and commercial areas surround the Mine with pasture land to the southeast.

3.1 Site Facilities

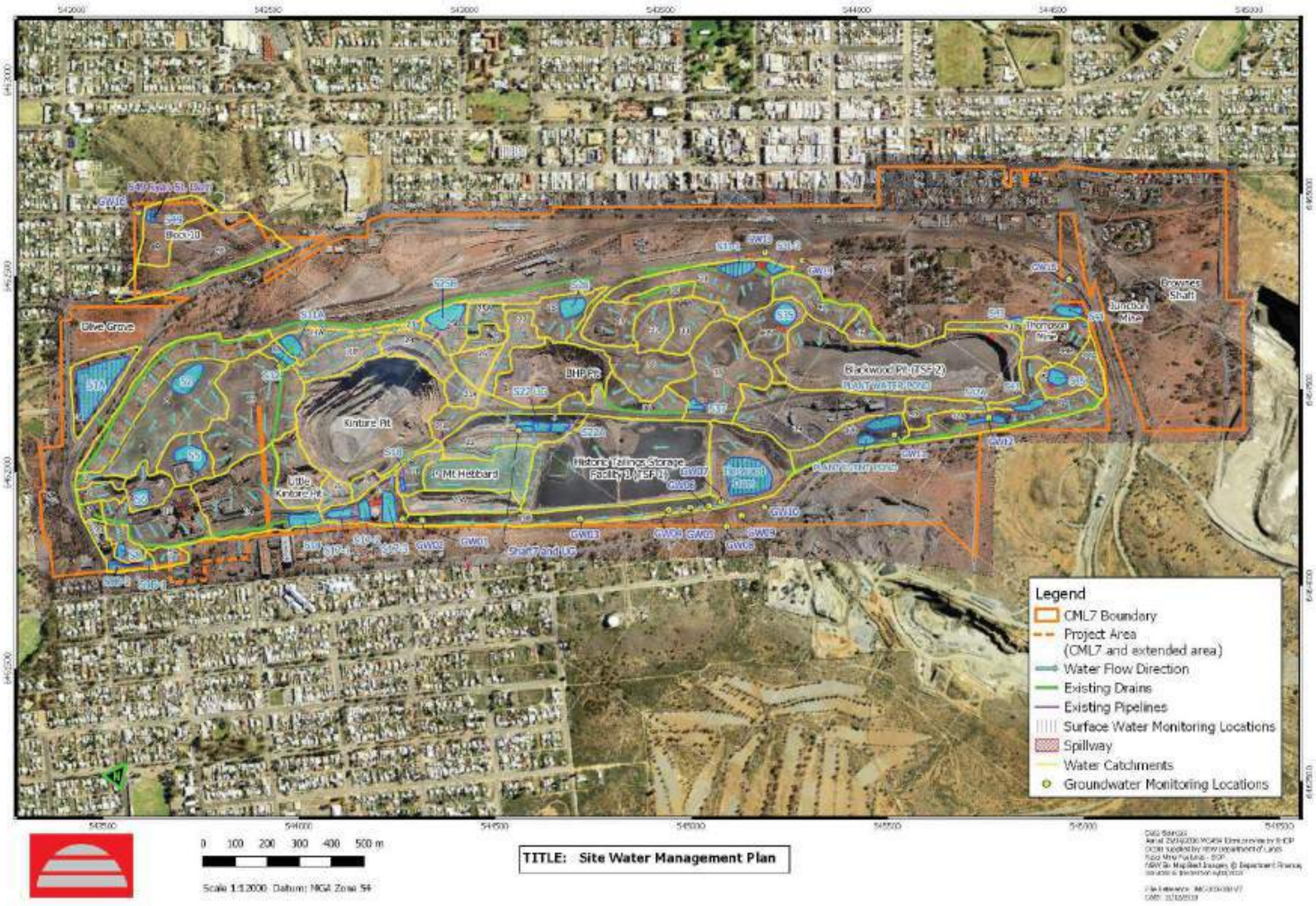
The Mine consists of the following site facilities:

- Open Pit and Waste Rock Dumps;
- Workshops;
- Processing Plant;
- Services – Primary Ventilation, Concrete Batching Plant, Backfill Plant and Sub-Stations;
- TSF1 historic tailing storage;
- TSF2 current tailing deposition;
- Sealed and unsealed roads; and
- Free Areas (non-active mining areas).

3.2 Site Catchment Areas and Water Storage Locations

The site has been subdivided into 60 catchment areas, with 39 storage locations. Figure 1 outlines catchment boundaries within the Mine as well as water flow direction and water storage locations.

Figure 1 - Site Water Management Plan

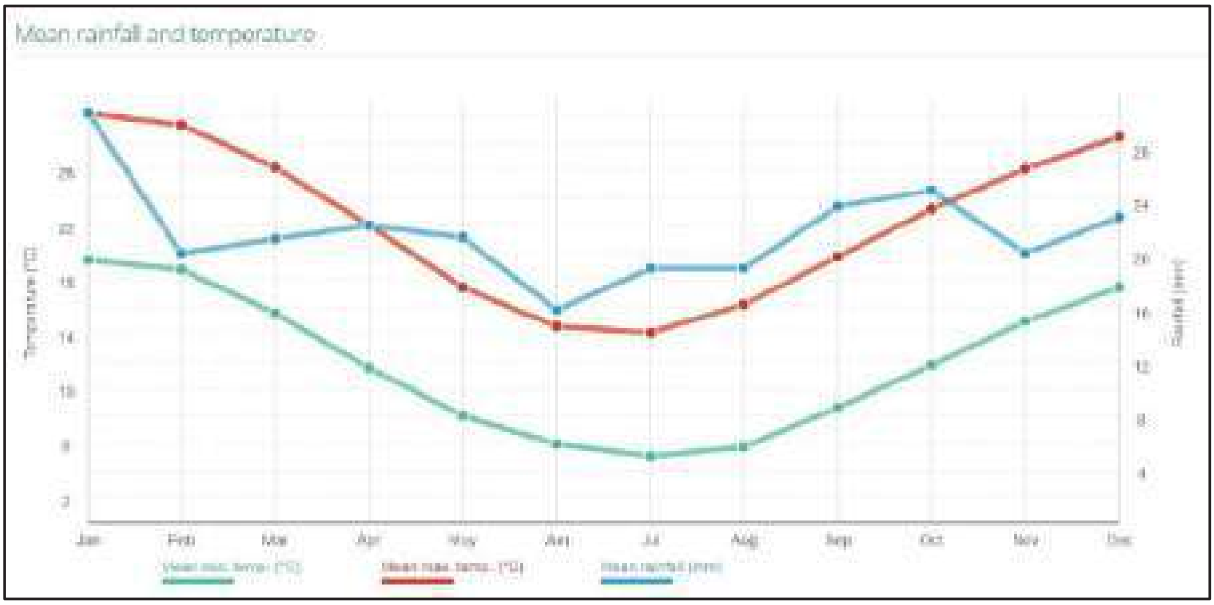


3.3 Surface Hydrology

3.3.1 Rainfall and Temperature

The local climate is arid with an average annual rainfall of approximately 250 mm. A review of the Bureau of Meteorology (BOM) data for the last 120 years indicates limited seasonal variation in average rainfall depths, with mean monthly rainfall varying within a narrow band from approximately 17 mm to 24 mm during the year. The monthly mean temperature varies from 33°C in January to 15°C in July. **Figure 2** shows the monthly variations of rainfall and temperature.

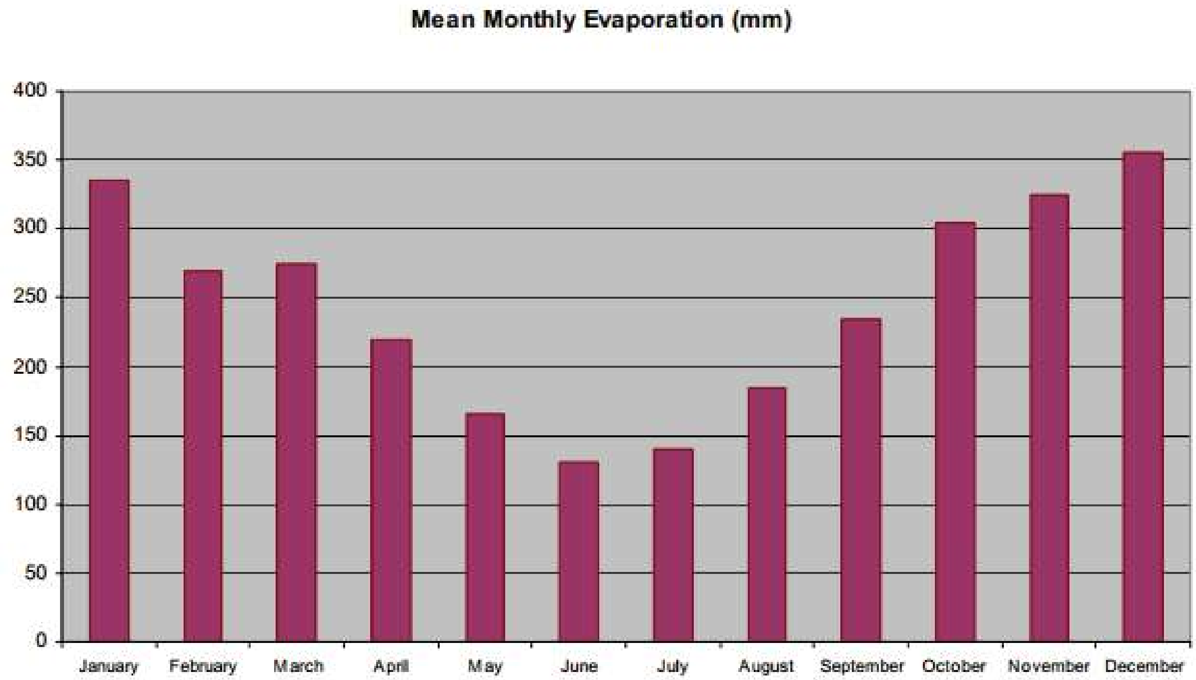
Figure 2 Average Temperature and Rainfall Summary



3.3.2 Evaporation

The average annual evaporation is approximately 2,614 mm. This estimate has been derived from the BOM grid data for the entire Australian Continent. The evaporation rate varies from approximately 12 mm/day in December to 4mm/day in June. The monthly variations for evaporation are presented in **Figure 3**.

Figure 3 Average Monthly Evaporation



Evaporation far exceeds the rainfall in the Broken Hill area, with mean monthly evaporation more than 15 times the mean monthly rainfall in January and approximately 5 times more in July.

3.3.3 Rainfall data

Rainfall data were sourced from BOM and is displayed is **Table 3**.

Table 3 - Design Rainfall Data

DURATION	Rainfall (mm)			
	10 years ARI	20 Years ARI	50 years ARI	100 Years ARI
30 minutes	23.7	28.3	34.5	39.3
1 hour	30.9	36.8	44.9	51
2 hours	38.2	45.6	55.8	64
3 hours	42.6	51	62	71
6 hours	51	61	75	86
12 hours	61	73	90	104
24 hours	73	87	108	124
48 hours	83	101	124	142
72 hours	87	105	130	149

3.3.4 Rainfall Excess Estimation

The surface water storage and drainage of the Mine is designed to manage runoff volumes generated from a 100 year ARI rainfall event. Before runoff can occur, a portion of rainfall is lost to initial absorption by the materials to bring them to field moisture capacity. This loss is termed initial loss which is approximately 15 mm, while a continuing loss due to infiltration is estimated to be 4 mm per hour (Golders 2012). The adopted loss rates were used in conjunction with the design rainfall to derive the rainfall excess or the volume of runoff from each catchment. The estimated rainfall excess for the 100 year event is presented in **Table 4**.

Table 4 - Estimated Rainfall Excess for 100 Year ARI Rain Event

Duration	Rainfall Excess (mm)
30 minutes	28.3
1 hour	39.2
2 hours	49.6
3 hours	55.4
6 hours	64
12 hours	70
24 hours	**73**
48 hours	62
72 hours	55

The critical duration for the 100 year ARI event is the one that corresponds to the largest rainfall excess and hence the volume of runoff. For the 100 year event, the critical rainfall excess occurs for the 24 hour event and is equal to 73 mm, **Table 4**.

3.3.5 Drainage Layout

The drainage layout for the Rasp Mine site is based on the rainfall data and excess rainfall outlined in Sections 3.3.3 and 3.3.4.

Based on the runoff management criteria, the Mine site is subdivided into 64 small catchments and sub-catchments with various engineered water diversions to retain the 1:100 year rainfall event. The catchment runoff volumes and catchment areas are presented in the **Tables 5 and 6**.

4. Water Catchments and Storage

4.1 Water Catchments and Storage

The Mine site has been divided into water catchments which are detailed in **Table 5** and **Figure 1.** **Table 6** provides details of the 64 catchment areas in regards to runoff management and details which catchment areas report to which individual storage area. Individual catchment calculations were provided by Golders Associates in the original SWMP (2011).

Table 5 - Catchment Details

Catchment Number	Area (ha)	Runoff Volume (100 year event) (m^3)	Catchment Number	Area (ha)	Runoff Volume (100 year event) (m^3)
1	5.099	3,739	26	1.669	1,224
1A	4.223	3,097	27	1.062	779
2	6.822	5,003	28	2.414	1,771
3	0.528	387	29	2.083	1,526
4	0.726	533	30	0.852	625
5	2.065	1,514	31	5.426	3,980
6	1.504	1,103	32	1.507	1,105
7	0.842	618	33	2.155	1,580
8	0.863	633	34	2.937	2,154
9A	0.602	441	35	6.152	4,512
9B	0.598	439	36	3.002	2,202
10	3.513	2,576	37	2.571	1,886
11A	1.355	994	39	3.430	2,515
11B	2.298	1,685	39A	1.732	1,270
12	0.485	355	40	1.345	986
13A	6.658	4,883	41	1.241	910
13B	0.652	478	42A	3.760	2,758
14	6.299	4,620	42B	2.823	2,070
15	0.769	564	43	0.45	383
16	0.773	567	44A	1.695	1,243
17	2.353	1,725	44B	2.606	1,911
18	1.102	808	45	1.215	891
19	3.817	2,799	46	1.065	781
20A	2.394	1,756	47	2.181	1,600
20B	1.513	1,110	48	6.881	5,047
21A	1.396	1,024	49	2.660	1,951
21B	1.931	1,416	Horwood Dam	5.152	3,779
22	4.188	3,071	Kintore Pit	13.376	9,810
23	0.392	287	Little Kintore Pit	2.623	1,924
24	1.566	1,148	BHP Pit	5.984	4,388
25A	1.238	908	TSF 1	14.050	10,304
25B	2.164	1,609	Blackwood Pit	13.135	9,633

The storage requirements for these water catchments are outlined in **Table 6**.

Table 6 - Water Storage Requirements

Storage	Reporting Catchments	Runoff Volume for Storage (m^3)	Surface Area of Storage (m^2)	Maximum depth of storage (m)[1]	Lined or unlined	Spillway	Comments
C1 West Drain	1	3,739	N/A	N/A	Unlined	No	The West Drain acts as an attenuation drain for the 100 year ARI rainfall event. Overflows from the West Drain for events greater than 100 year ARI event are directed through an existing box culvert S1A.
S1A	1A, 3, 4	4,017	16,300	0.56	Unlined	Yes	Catchment forms storage. Direct runoff from C3 and C4 report to the existing box culvert crossing under the road before discharging into S1A. Overflows from C1 for events > the 100 year ARI event also report through the box culvert under south road to S1A. Underground water storage tanks south of C7, pump sump water into the existing drain in C4 where flow is diverted into S1A. Storage S1A has the capacity to retain the 500 year ARI storm event.
S2	2	5,003	5,320	1.24	Unlined	Yes	Existing storage S2 retains the 100 year ARI storm event with overflows discharging to the drainage channel, via a spillway located in C13A.
S5	5	1,514	2,380	0.94	Unlined	Yes	Overflow path to catchment 13B drainage channel.
S6	6	1,103	2,195	0.80	Unlined	Yes	Storage to retain 100 year ARI storm event, overflowing to S1A through C4.
S8	8	633	815	1.08	Unlined	Yes	S8 does not have the capacity for a 100 year ARI storm event, and overflows to S9B-2.
S9B-1 and S9B-2	9A and 9B	880	1,700	0.82	Unlined	Yes	Retains a 1:100 storm event then overflows to street system.
S11A	11A	994	3,460	0.59	Unlined	Yes	Existing pond, overflows report to S12.
S11B	11B	1,685	3,500	0.78	Unlined	Yes	Existing pond, capacity large enough for a 100 year ARI storm, with overflows diverted into S12 and eventually Horwood Dam.
S12	12	355	1,800	0.50	Unlined	Yes	Existing pond. Overflow reports to drainage channel located in C13A and eventually into Horwood Dam.
S14	7, 10, 13 and 14	13,174	3,467	2.25	Unlined	Yes	S14 receives direct runoff from C7, C10, C13 and C14. Overflow for events greater than a 100 year ARI storm report to C17.
S17-1, S17-2 and S17-3	15, 16, 17 and part of 18 and 20B	4,265	7,425	0.87	Unlined	Yes	Three existing storage areas located either side of the existing tank. Storage areas S17-1 and S17-2 are connected by existing pipes with overflow to be pumped to Horwood Dam.
S18	Part of C18	389	397	1.28	Unlined	Yes	Existing pond receives partial runoff from C18. This pond will capture part of a 100 year ARI storm event, overflows report to S17-3.
Plant Water Pond and Plant Event Pond	39, 39A	3,785	2,150	2.06	Lined	Yes	Receives runoff from Process Plant site and decant water pumped from Blackwood Pit. Water is reused in the Plant and augmented by water from the lined mine water ponds at Mt Hebbard Gully (S22). Overflows from the Plant Water Pond discharge to the Plant Event Pond located in C42B, any overflows are directed to Horwood Dam.
S22	18 (partial), 19, 20A, 21A, 21B, 22 and TSF1	20,489	5,606	3.95	Lined, Mine water compartments only	No	Existing storage area. In addition to providing storage for a 100 year ARI storm event from catchments 18, 19, 20A, 21A, 21B, 22 and TSF1, S22 is used for the storage and settling of water from the operating underground mine workings, and groundwater from Shaft 7. Mine dewatering occupy 2 storage areas within S22. No over flow path is required as the capacity of the gully is in excess of 40,000 m^3.
S22A	Direct	Direct Rainfall	18,000	4.00	Lined	No	Receives excess direct from Shaft 7 water when S22 Lochness is full. A pipe is installed to

Storage	Reporting Catchments	Runoff Volume for Storage (m^3)	Surface Area of Storage (m^2)	Maximum depth of storage (m)[1]	Lined or unlined	Spillway	Comments
	rainfall						provide gravity flow back into S22 when required.
North-Western Drain	23	287	N/A	N/A	Unlined	Outlet	Existing storage channel located within exclusion and rehabilitation zone will receive runoff from the embankment located in C23. BHOP are not responsible for controlling drainage works outside of the exclusion and rehabilitation zones.
S25B	24, 25, 25A, 25B, 26	4,889	2,405	1.45	Unlined	No	Storage volume is sized to contain the 100 year ARI storm, with overflows spread over the floor of C25B.
S28	27, 28, 29, and partial 34	4,613	3,895	1.48	Unlined	Yes	S28 to receive runoff from C28, C29 and part of C34. Overflow will flow onto the existing road and into the existing railway drainage system off site.
S31-1 and S31-2	30, 31, 46, 47	6,761	5,330	2.01	Unlined	Yes	Capacity for a 100 year ARI storm. Overflows from S31-1 to S31-2. Pond includes flow from Federation Way. S31-2 overflows to railway drain.
S35	33, 35	6,092	4,255	1.73	Unlined	Yes	Runoff from C33 flows through existing pipes prior to entering C35. Overflows from S35, for events greater than a 100 year storm, ARI report to Blackwood Pit.
S37	Partial 37	943	1,215	1.08	Unlined	Yes	Receives runoff from approximately half of C37. Overflows to drainage channel in C36 and into BHP Pit. The remaining discharge from C37 flows through to S41.
S41	37 (partial), 38, 38A, 40, 41	3,994	1,980	2.32	Unlined	Yes	None
S42A	42A	2,758	2,565	1.38	Unlined	Yes	Runoff from C42A captured in an existing drainage channel and into S42A. Overflows from S42 report to Horwood dam.
S43	43	383	450	0.5	Unlined	Yes	Receives direct runoff from C43. Designed for 1 in 100yr rainfall event.
S44	44A, 44B	3,154	2,135	1.78	Unlined	Yes	None
Sediment Pond in C44B.	Rail siding area	N/A	N/A	N/A	Unlined		None
S45	45	891	2,170	0.71	Unlined	Yes	None
Drainage Channel in C48	48	5,047	N/A	N/A	Unlined	N/A	None
S49	49	1,951	1,560	1.55	Unlined	Yes	Catchment 49 is a rehabilitated area within CML7. Runoff from this catchment is captured in three small detention ponds within S49.
Little Kintore Pit	Little Kintore Pit	1,924	N/A	N/A	Unlined	No	Only direct rainfall onto catchment reports to Little Kintore Pit.
Kintore Pit	Kintore Pit	9,810	N/A	N/A	Unlined	No	Estimation of direct rainfall volume on Kintore Pit for the 100 year storm event.
BHP Pit	32, Partial 34 and 36, BHP Pit	9,312	N/A	N/A	Unlined	No	Receives runoff from catchments without storage areas and overflows from S37.
Blackwood Pit	Blackwood	9,633	N/A	N/A	Unlined	No	Blackwood Pit receives overflows from S35 when in excess of a 1 in 100 year ARI.

Storage	Reporting Catchments	Runoff Volume for Storage (m^3)	Surface Area of Storage (m^2)	Maximum depth of storage (m)[1]	Lined or unlined	Spillway	Comments
Horwood Dam	42B, 20C, Horwood Dam	7,663	24,729 m^3	N/A	Unlined	Yes	Catchments 20C and 42B report directly to Horwood Dam, with overflows from S14, S17-1, S17-2, S17-3, S41, S42A, S45 also reporting to Horwood Dam. Storage can retain 100 year ARI storm event. However, a spillway is required to provide controlled discharge during extreme storm events (i.e. in excess of a 100 year ARI storm).
Pattos Pond	Direct rainfall	Direct rainfall	1,500	0.5	Lined		Receives water from S22.
Sump at CBP	Direct rainfall	Direct rainfall	2.5	0.5	Unlined		Receives water from batching plant.
Sump at Backfill Plant	Direct rainfall	Direct rainfall	2.5	0.5	Lined		Receives water from backfill plant.

Note 1 = Includes 0.3 m freeboard.

4.2 Peak Flow Estimation

The rational method was applied in estimating the peak flow rates from selected catchment areas that outfall through proposed hydraulic structures, such as culverts and pipes, or into proposed drainage channels. The estimated peak flow may be applied in the preliminary sizing of culverts or in selecting geometric dimensions of drainage channels. The peak flow accounts for flow from basins overflowing into other basins up to a 100 year ARI rainfall event. The construction and shaping of the drainage channels and culverts will include a freeboard of 300 mm above the estimated water level for the 100 year ARI event.

The Rational Method formula applied in the estimation of peak flow is:

Qy = 0.278 CIA (Engineers Australia 1998)

Where:

Qy = Peak flow rate (m^3/s)

C = Runoff Coefficient

I = Average rainfall intensity (mm/hr)

A = Area of the catchment (km^2)

The average rainfall intensity for the time of concentration (Tc) and a 100 year ARI storm was estimated based on BOM design rainfall intensity chart for Rasp Mine area and the Bransby-Williams formula for time of concentration (Engineers Australia 1987). The peak flow rates entering drainage channels and hydraulic structures were estimated by Golder Associates.

5. Site Water Sources

The system for managing water at the Mine is specific to the types of water on the site and are summarised in the following sections.

Broken Hill's water supply comes from the Stephens Creek Reservoir, Umberumeka Reservoir, Imperial Lake and the Menindee Lakes Scheme on the Darling River. Water extracted from underground and Shaft 7 is also used on the Mine site.

The Mine also uses reclaimed water from various sources wherever possible, for example, Horwood Dam, Plant Water Pond, Patto's Pond and any other water storage areas that have sufficient water for pumping.

5.1 Potable and Waste Water

Potable water is supplied by Essential Water from Menindee Lakes. This water is treated raw water. Potable water is stored in a 22.5kL poly tank located near the Mine site boom gate. Potable water is pumped to the Processing Plant, Backfill Plant, workshops, ablution blocks and administration offices. Potable water is used for safety showers and eye-washers, crib huts, ablution blocks, laundry and other washing facilities. It is stored in poly tanks at various locations.

Bottled water is used as drinking water.

Waste water is not treated on site and is removed via the Broken Hill City Council sewerage system.

5.2 Raw Water

Raw water is externally supplied to the Mine from Essential Water and comes from Menindee Lakes. It is used for top up water in the Processing Plant. The main storage tanks for raw water are the Silver Water Tank and the Mill Raw Water Tank.

5.3 Dirty Water

Dirty water from Mine activities typically consists of surface runoff generated within active mining areas of the site including diesel refuelling area (including wash bay), site vehicle wash bay, maintenance workshop area, processing area, backfill plant, concrete batching plant, haul road and general roads and core storage.

Dirty water from these activities is directed to a series of dirty water ponds, open cut pits, and tailings storage facilities, to allow for evaporation, treatment or reuse on the site.

Runoff from the diesel refuelling area and maintenance workshops is directed to an oil/water separator for treatment and reused for site dust suppression. Localised hydrocarbon spills will be contained and controlled using spill kits provided at various locations around the site. Chemical and hydrocarbon storage and management on site is outlined in the Chemical Management Plan.

Runoff from the Processing Plant area is directed to the lined Process Plant Pond where it is collected for reuse in the Processing Plant, this in turn overflows to the Process Event Pond, which will contain a 1:100 year rainfall event and overflows are directed into Horwood Dam.

Blackwood Pit (TSF2) retains the tailings from the Processing Plant, and supernatant water, when available is transferred to the Process Event Pond and reused in the Plant.

The Backfill Plant is located to the south west of the site in C27. This catchment includes a lined Backfill Plant sediment pond, isolating any potentially contaminated runoff in this area from the general runoff of the site.

A sump collects waste water runoff from the Concrete Batching Plant.

All stormwater is treated as contaminated once it enters the Mine and makes contact with the disturbed surface. A series of sediment / water storage basins across the site is used to collect and manage stormwater runoff and prevent its release. Overflow from dirty water storage basins can be directed to Horwoods Dam where it will be stored temporarily until transferred to process ponds.

TSF2 Embankment Lift

With the lift of the TSF2 embankments a spillway will be installed on the north-eastern corner of TSF2 and direct overflow from TSF2 to storage pond S42A which will overflow to Horwood Dam.

The existing tension cracks at the edge of the Pit at Embankment 1 will be filled with tailings prior to construction of this Embankment. This will occur at the same time as repair works around the existing edge bund located at the Pit rim to the south of British Flats and the old mining residence. Drainage pipes with inspection chambers will also be installed. These minor works will involve the use of a small excavator and roller with manual labour for the placement of the pipes and fill.

Embankments 1 and 3 will be constructed over some tailings as well as weathered bedrock and will require deposition of tailings within the embankment footprint to form a well-drained foundation for the embankments to be confirmed by inspection and assessment of geotechnical condition, and may require the construction of a pioneering layer comprising compacted rockfill over a geotextile. Geomembrane liners will be constructed over the upstream faces over a sand filter curtain. The geomembrane liner will be keyed into the tailing beach.

A Stormwater Collection Pond will be constructed to the north of Embankment 2 to store rainwater from runoff from the outer slope of Embankment 2. The Stormwater Collection Pond will be excavated into in situ materials to form a 1.5 m deep pond for the collection and retention of rainwater runoff from Embankment 2. It is intended to be an evaporation pond similar to some of the other stormwater control ponds at the Mine and will contain a 1 in 100 year 72 hour rainfall event.

5.4 Shaft 7 and Mine Water

Water is extracted from underground via pumps at Shaft 7 and underground mine workings to maintain safety of personnel in the Rasp Mine and also the adjacent Perilya South Mine. This groundwater has been contaminated by the naturally elevated metals consistent with a zinc/lead/silver orebody and by historic mining activities. Water is extracted and stored within lined facilities located within water storage basin S22. S22 has a total storage capacity of approximately 40,000 m^3 and receives runoff from the surrounding catchments and water pumped from the S17 ponds. Lined compartments have been installed within this area for the separate storage and settling of underground extracted water. This water is returned underground for reuse and is treated (in Patto's Pond) and used in the Processing Plant.

5.5 Eyre Street Dam

TSF1 is an historic tailing storage facility and is not used as a tailing facility by the Rasp Mine. According to historical documents Eyre Street Dam was situated adjacent to TSF1 and formed part of the then mine's water management system. An open cut trench running along the toe of TSF1 formerly directed water to the Eyre Street Dam. Water was then pumped from the Eyre Street Dam to the adjacent Horwood Dam which in turn was pumped to the Western Dam now rehabilitated and houses the Olive Grove. The original trench and Eyre Street Dam were decontaminated and filled in as part of rehabilitation works in the early 1990's.

A 2011 investigation into the seepage at the Eyre Street Dam resulted in the construction of a new trench which was designed to intercept potential seepage from TSF1 and direct the water into Horwoods Dam via a pump and pipe system. As part of the groundwater monitoring program, the trench will be inspected weekly to assess changes to water levels that may indicate seepage. Inspection sheets are completed at each inspection. A float pump is installed at the downstream end of the trench to direct any seepage into Horwood Dam.

6. Water Balance

Figure 4 provides a schematic diagram summarising the site water balance. The diagram identifies the water sources, the use and management of water on site.

The primary user of water on site is the Processing Plant and underground mining operations. Water losses occur in water retained in the tailings, water in concentrate, water used for dust suppression, concrete batching, and seepage at the TSF.

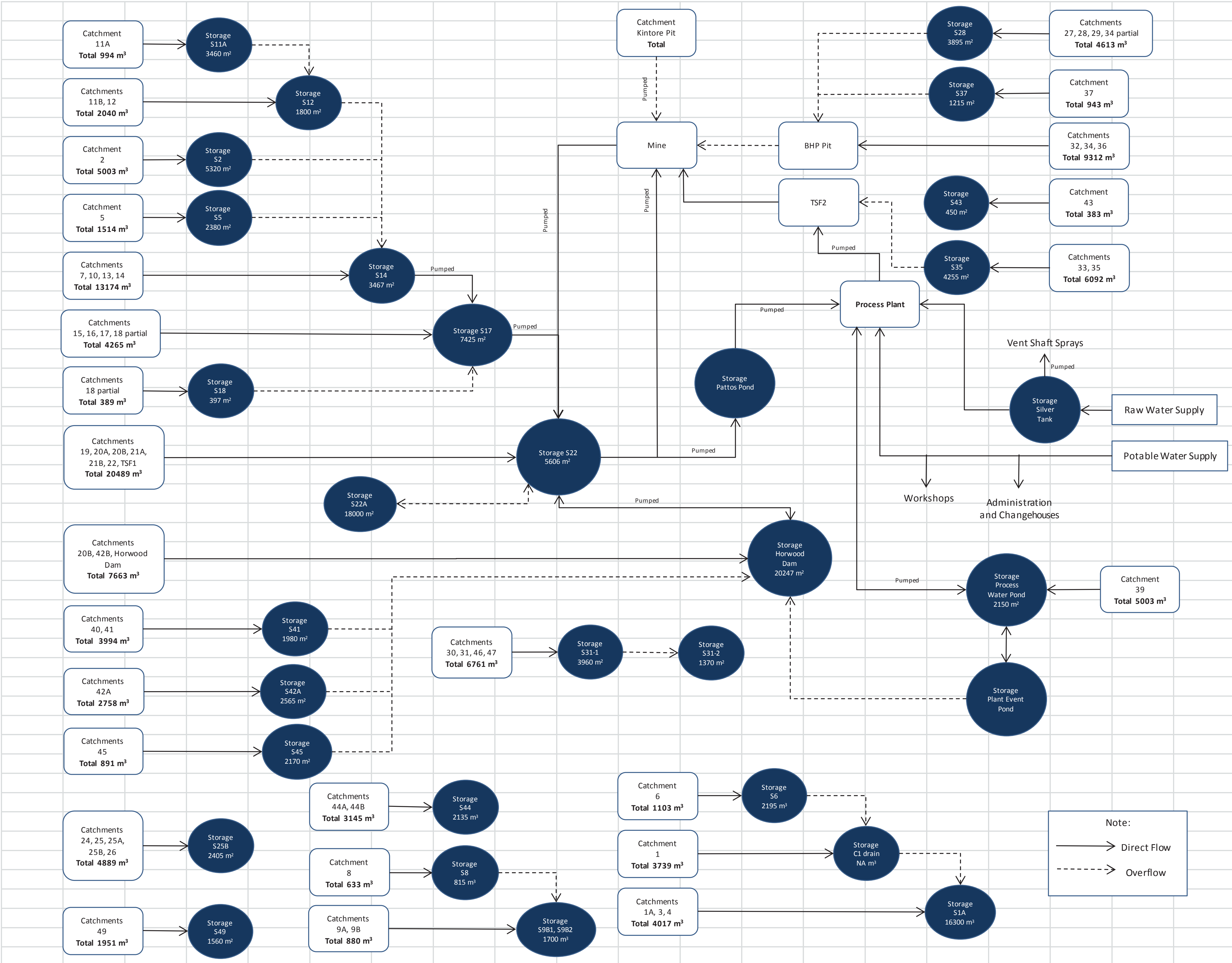
The closed water circuit for the mining operations results in complete management of process water with no off-site wastewater discharge directly from the operations. The Plant Water Pond, Plant Event Pond, and TSF2 capture and return potentially mineralised sediment to the processing circuit.

Key aspects of the water management strategy include:

- The separation of raw water and potable water requirements. Raw water requirements includes processing, workshop, vehicle wash-bay and dust suppression, while potable water requirements include showers, toilets and laundry;
- Reclaiming of water from the tailings storage facility to the Processing Plant; and
- Reclaiming of water for preparation and pumping of underground backfill.

Observations regarding the rate of water usage on site are monitored.

Figure 4 - Schematic for Site Water Balance


Catchment 11A Total 994 m³
Storage S11A 3460 m²
Catchments 11B, 12 Total 2040 m³
Storage S12 1800 m²
Catchment 2 Total 5003 m³
Storage S2 5320 m²
Catchment 5 Total 1514 m³
Storage S5 2380 m²
Catchments 7, 10, 13, 14 Total 13174 m³
Storage S14 3467 m²
Catchments 15, 16, 17, 18 partial Total 4265 m³
Storage S17 7425 m²
Catchments 18 partial Total 389 m³
Storage S18 397 m²
Catchments 19, 20A, 20B, 21A, 21B, 22, TSF1 Total 20489 m³
Storage S22 5606 m²
Storage S22A 18000 m²
Catchments 20B, 42B, Horwood Dam Total 7663 m³
Storage Horwood Dam 20247 m²
Catchments 40, 41 Total 3994 m³
Storage S41 1980 m²
Catchments 42A Total 2758 m³
Storage S42A 2565 m²
Catchments 45 Total 891 m³
Storage S45 2170 m²
Catchments 30, 31, 46, 47 Total 6761 m³
Storage S31-1 3960 m²
Storage S31-2 1370 m²
Catchments 44A, 44B Total 3145 m³
Storage S44 2135 m²
Catchments 24, 25, 25A, 25B, 26 Total 4889 m³
Storage S25B 2405 m²
Catchment 8 Total 633 m³
Storage S8 815 m²
Catchments 49 Total 1951 m³
Storage S49 1560 m²
Catchments 9A, 9B Total 880 m³
Storage S9B1, S9B2 1700 m²
Catchment 6 Total 1103 m³
Storage S6 2195 m²
Catchment 1 Total 3739 m³
Storage C1 drain NA m²
Catchments 1A, 3, 4 Total 4017 m³
Storage S1A 16300 m²
Catchment Kintore Pit Total
Mine
BHP Pit
TSF2
Process Plant
Storage Pattos Pond
Storage S28 3895 m²
Catchments 27, 28, 29, 34 partial Total 4613 m³
Storage S37 1215 m²
Catchment 37 Total 943 m³
Catchments 32, 34, 36 Total 9312 m³
Storage S43 450 m²
Catchment 43 Total 383 m³
Storage S35 4255 m²
Catchments 33, 35 Total 6092 m³
Vent Shaft Sprays
Storage Silver Tank
Raw Water Supply
Potable Water Supply
Workshops
Administration and Changehouses
Storage Process Water Pond 2150 m²
Catchment 39 Total 5003 m³
Storage Plant Event Pond
Pumped
Note:
Direct Flow
Overflow

7. Groundwater Monitoring Program

The regional groundwater near the site is depressed due to long term pumping from the underground mines in the area, resulting in the depressed groundwater level below the site being more than 100 m below the surface level, with a hydraulic gradient into the site at depth. The groundwater monitoring program will be undertaken with the purpose of recording perched groundwater movement. Due to the depth of the regional groundwater at the site there is little interaction between the shallow perched groundwater and the regional groundwater.

The objectives of the groundwater monitoring program are to:

- Provide a program to monitor seepage movement within and adjacent to the tailings storage facility (TSF2).
- Provide details of parameters and pollutants to be monitored and background local perched groundwater parameters.
- Establish a contingency measure in the event that an unacceptable impact is identified.

7.1 Seepage movement monitoring

Short term perched seepage may occur from surface water infiltration into the permeable rock mounds on the site. When the volume of infiltrated water is high, resulting from sufficient rainfall volume at the site, the rock mounds may reach field capacity and result in seepage through the mound. The seepage may exit laterally from the rock mounds, when the seepage front reaches the high strength low permeable rock formation generally below the site. This form of short term seepage may present itself as near surface seepage zones. Stormwater management has been designed to reduce the extent of surface ponding near those areas (**Table 7-1**) to limit the volume of water infiltration into the rock fill mounds.

The perched groundwater monitoring bores will record the depth at which seepage may occur. The monitoring bore depths do not extend to the drawn down regional groundwater.

Monitoring of the existing and constructed boreholes will provide an early warning if seepage is occurring near the CML7 lease boundary. Water from mine dewatering at Shaft 7 and from underground mine dewatering will form part of the groundwater monitoring program. Samples of groundwater from boreholes is collected every three months; permitting water is present at these times. Mine water samples (Shaft 7 and Mine Dewatering) are collected monthly, with pH recorded using field sheet BHO-FRM-ENV-007.

A summary of the location and function of each borehole is listed in **Table 7** and their locations indicated in **Figure 1**.

Table 7 - Location and Function of Mine Dewatering Samples and Groundwater Monitoring Boreholes

Borehole ID / Mine Dewatering	Monitoring Frequency	Location	Function / Purpose
GW01, GW02	Quarterly	South-East of Mt Hebbard	To monitor if seepage is occurring from Mt Hebbard

GW03, GW04, GW05, GW06, GW07, GW08, GW09	Quarterly	South east of TSF1	To monitor potential seepage flows from the historic TSF1 and Horwoods Dam towards the CML7 boundary. The Eyre Street pit sump was installed to intercept potential seepage from TSF1 and direct the water to Horwoods Dam via a pump and pipe system.
GW10	Quarterly	Downstream of Horwood Dam	According to the investigation of 2011, perched seepage measured at this bore is not considered to be related to water from Horwood Dam and is used to monitor potential seepage from Eyre Street Dam.
GW11, GW12	Quarterly	East of Blackwood Pit	The ground conditions to the south-east of Blackwood Pit are relatively intact with no or limited mine workings in the area. Due to the north-east and south-west length of the Pit there is a possibility for the formation of a perched aquifer as a result of groundwater mounding around the south-east side of the Pit whenever the Pit is receiving tailings. BoresGW11 and GW12 are installed to the south east of the Pit to a depth of 5 m below the base level of Blackwood Pit. These bore locations were selected based on the lower ground level towards the south-east of the Pit, and to be outside the area of influence of the isolated mine drives on the south-east side of the Pit. Borehole to monitor potentially perched water as a result of potential groundwater mounding from TSF2 water
GW13, GW14, GW15	Quarterly	Adjacent to storage areas S44, S31-1 and S31-2	To monitor if movement of perched groundwater is occurring from the storages
GW16	Quarterly	To the west of storage area S49	To monitor potential seepage from S49 towards Ryan Street
Shaft 7	Monthly	Shaft 7 (S22)	To assess groundwater quality of pumped water from Shaft 7
Mine Dewatering (underground feed)	Monthly	Decline at Kintore Pit (S22)	To assess groundwater quality at decline

The area located to the north and east of the Rasp Mine forms part of the adjacent Perilya mine lease. The ore body strikes from the north-east of the Rasp Mine to Shaft 7, where dewatering takes place. The regional groundwater cone of depression is therefore expected to exist along this ore body alignment, resulting in significant depth to regional groundwater north-east and south-west of the CML7.

The south-west to the north-west area of the Rasp Mine was historically extensively mined by underground workings comprising shafts, drives and stopes and as such is not expected that groundwater will be encountered due to the existence of the drained old mine workings.

Seepage collection outlet pipes installed in the TSF2 embankments will include inspection chambers to be inspected and recorded on a monthly basis.

7.2 Groundwater Quality Parameters

7.2.1 Baseline Chemical Properties of Groundwater

Groundwater quality monitoring was undertaken in May 2007 and August 2011 at Shaft 7.

As seasonal or other non-mining influences haven not been characterised at Rasp Mine, these water quality monitoring results act to establish initial baseline parameters and trigger levels for the monitoring program. Groundwater quality results for August 2011 will be used as baseline data for assessing changes in groundwater and perched groundwater quality results.

Groundwater quality results for May 2007 and August 2011 are provided as Appendix E.

7.2.2 Selected Groundwater Quality Monitoring Parameters

Groundwater quality monitoring at the groundwater monitoring locations described in **Table 7** is undertaken in accordance with conditions of the Rasp Mine Environment Protection Licence 12559. **Table 8** indicates the groundwater analytical suite to be monitored.

Table 8 - Groundwater Analytical Suite

Parameter	Unit	Analytical Method	2007 Results	2011 Results	30% Trigger Value
pH1	-	Field Meter	6.1	5.8	4.06 - 7.54
Electrical Conductivity	µS/cm	APHA Method 2510 B	NS	13900	9730
Total Dissolved Solids (TDS)	mg/L	APHA Method 2540 C	11000	8000	5600
Major Ions					
Total Alkalinity	mg/L as $CaCO_3$	APHA Method 2320 C	42	18	12.6
Sulphate (SO_4)	mg/L	APHA 4110	4300	9660	6762
Chloride (Cl)	mg/L	APHA 4110	1500	1360	952
Calcium (ca)	mg/L	USEPA 3015A	575	472	330
Magnesium (Mg)	mg/L	USEPA 3015A	NS	395	277
Sodium (Na)	mg/L	USEPA 3015A	1830	3550	2485
Metals (Dissolved)					
Iron (Fe)	mg/L	USEPA 3015A	0.252	0.2502	0.175

Cadmium (Cd)	mg/L	USEPA 3015A	NS	6.91	4.84
Lead (Pb)	mg/L	USEPA 3015A	0.05	2.02	1.4
Manganese (Mn)	mg/L	USEPA 3015A	340	865	606
Zinc (Zn)	mg/L	USEPA 3015A	790	2890	2023

7.3 Contingency Measures

It is necessary to establish the quality of surface water collected from waterbodies within the Mine lease to compare the results to the measured groundwater quality. This is done to assess whether a change in groundwater and surface water conditions on site is occurring. Any changes will be assessed based on trend changes relative to the baseline chemical properties of 2011.

7.3.1 Groundwater

The site's groundwater is deep and is extracted as part of mining. The underground extraction system results in inward flow of the groundwater into the Mine. Hence, groundwater at the Mine is likely to be impacted by off-site sources due to the inward hydraulic gradient into the Mine. If contaminants are detected greater than 30% above the baseline 2011 groundwater quality values of collected water in the S22 mine water compartments, then an investigation will take place.

7.3.2 Perched Groundwater

Perched groundwater quality is expected to contain significant concentrations of lead, manganese and zinc due to the seepage contact with the near surface materials on site and the surrounding areas. Perched groundwater occurs periodically after significant rainfall, so monitoring ability in some bore locations may be sporadic. Where frequent groundwater seepage is identified, BHOP will investigate options to intercept the seepage and direct the water into an onsite storage area. Measures may include seepage collection drains with a sump, lining of the area related to the source of the seepage or construction of additional surface water management structures to direct flow away from the perched groundwater affected area. Contingency measures to address groundwater impact may also include the investigation of groundwater extraction at the area of concern.

Potential seepage from Blackwood Pit-related tailings may occur. Most of this seepage will occur in the underground workings and will be managed as part of underground water extraction. If seepage occurs towards the east of the area, it is expected to be measured in monitoring bores GW11 and GW12 to the east of Blackwood Pit. If a trend is suspected, or if contaminates are detected at greater than 30% above the 2011 baseline values, an investigation will be undertaken to determine the source of contamination and the level of environmental risk and the remedial action required. Options for remedial actions include the following:

- Changes to the tailing deposition method and strategy to limit water storage on the tailing surface.
- Changes to the tailing deposition water content to reduce the amount of water in the tailing storage facility.
- Installation of a perched groundwater extraction system through a series of bores or a cut-off trench adjacent to the site boundary.

8. Surface Water Monitoring

8.1 Monitoring Program for Stormwater Ponds

Monitoring of water quality is conducted in accordance with PA07_0018 and EPL 12559 conditions at the following locations listed in **Table 9**. These ponds have the potential to overflow off-site.

Table 9 - Monitored Surface Water Storage Ponds

Storage Ponds w/ Potential for Off-site release	Depth (m)	Surface Area of Storage (m^2)	Location	Description and Flow
S1A	0.56	16,300	Bounded by South Rd, Mine and Olive Grove	Located on a non-active mining area of the site. A large storage and is likely to discharge in very rare events. Capacity to hold a 1:500 storm event then discharges through a culvert in a southerly direction.
S9B-2	0.82	1,700	Adjacent south Rd, at the south east corner of the site	Holds a 1:100 storm event. The contributing catchments to this pond are quite small, discharges to the town's stormwater system.
S31-1	2.01	3,960	North Mine boundary at Federation Way.	Holds a 1:100 storm event. Located on a non-active mining area of the site. A discharge from these slopes flows to the water storage ponds located at the rail complex.
S44	1.78	2,135	Northeast corner of Rail Loadout	Discharges into the existing rail complex surface water storage pond.
S49	1.55	1,560	Below the Block 10 lookout	Located on a non-active mining area of the site. As part of detailed design the option to discharge excess runoff to a local depression immediately to the North West of the storage would be investigated to limit the likelihood of excess flow down Adelaide Street.
Horwood Dam		NA	East of TSF1	Holds four times the est. 1 in 100yr storm event. Discharges off-site into Stephen's Creek catchment.

Sampling is undertaken twice per year at 6 monthly intervals, this has been determined as October, being the wettest month historically and April (meeting the 6 month requirement). The water quality results will also be used to compare groundwater quality measured in groundwater monitoring bores near four of these ponds.

To obtain a representative sample, the pond water quality is measured when the pond has contained water for at least one week and the pond is at a minimum of 20% capacity.

It is expected that the ponds listed above will remain dry for majority of the year so the subgrade around the pond will be partially saturated, resulting in very low permeable conditions. Hence, short term storage of water is expected to result in limited moisture migration into the subgrade which will be extracted by evaporation once the pond is empty again.

8.2 Monitoring Program for Off-site locations

Two off-site locations are included in the surface water monitoring program conducted in accordance with PA07_0018 and EPL 12559 twice per year in October and April (refer above). These are described as Downstream 1 and Downstream 2. The Downstream 1 sampling point is located within a drainage line upstream of Acacia Creek at Bonanza Street, 1.5 Km to the south of the mine. Downstream 2 is located within Stephens Creek, directly upstream of the Stephen's Creek bridge on the Barrier Highway, 7.91 Km to the east of the site. **Appendix 1** shows these locations.

8.3 Selected Surface Water Quality Monitoring Parameters

No initial background water quality values were identified for surface water at the site. **Table 10** provides the surface water analytical suite used to measure surface water quality.

Table 10 - Surface water quality monitoring parameters

Parameter	Unit	Recommended Analytical Method
pH[1]	pH Unit	Field Meter
Electrical Conductivity	µS/cm	APHA Method 2510 B
Total Dissolved Solids (TDS)	mg/L	APHA Method 2540 C
Major Ions		
Sulphate (SO_4)	mg/L	APHA 4110
Chloride (Cl)	mg/L	APHA 4110
Sodium (Na)	mg/L	USEPA 3015A
Metals (Dissolved)		
Cadmium (Cd)	mg/L	USEPA 3015A
Lead (Pb)	mg/L	USEPA 3015A
Manganese (Mn)	mg/L	USEPA 3015A
Zinc (Zn)	mg/L	USEPA 3015A

Note 1 = Field analysis only.

8.4 Contingency Measures

Should the measured water quality in Horwood Dam be considered to present a significant risk to the receiving environment (such as the downstream creek and Stephens Creek Reservoir) or have the potential to discharge water, then the water level in Horwood Dam will be lowered by pumping to increase its storage capacity for subsequent rainfall events. Water pumped from Horwood Dam will be stored either in the BHP Pit, Blackwood Pit, or S22. All of these storages have additional capacity compared to the estimated 1:100 year storm event runoff from each of the respective catchments.

The risk to receiving waterbodies is based on the background water quality in the waterway and the water quality of runoff from the catchment of the creek.

8.5 Site Water Management Equipment

All equipment used in the management of site water (eg. pumps and pipes) is included on the routine maintenance schedule to ensure optimum operational condition. Any maintenance works carried out on equipment is recorded on the Pronto maintenance database.

8.6 Water Transfer between Dams

Water transfers from Shaft 7 to S22 and from the Eyre St Trench to Horwoods Dam are measured using flow meters and recorded.

9. Erosion and Sediment Control

Mining activities and weather conditions may result in soil erosion, generation of sediment or flooding.

Mining activities include:

- Underground works with limited surface stockpiling;
- Transportation activities; and
- Maintenance activities on the surface and landscape.

The main prime source for erosion at the Mine is related to weathering due to wind and water runoff.

The susceptibility to soil erosion, the generation of sediment and flooding as a result of water erosion has been minimised by dividing the site into small catchments. The catchment layouts generally conform to the existing landform and where practical, storage areas have been provided within the catchment. The majority of catchments have their own storage pond capturing rainfall and sediment from the surrounding area. Where storage areas are not provided within a catchment, due to site restrictions, drainage channels discharge runoff into nearby catchment storage ponds. This design approach limits the potential for the transportation of sediment to downstream waters and manages the risk of flooding within local catchments. The capacity of the required water storages and channels to meet the requirements of the 1:100 year storm event is described **Table 6**.

9.1 Stormwater Structures Monitoring

The Mine assesses the continued capacity of each storage pond against the required capacity quarterly or after storm events, identifying where repair or upgrade works, desilting, dewatering, or other relevant action is required in order to create and maintain the required water storage capacity. A Surface Water Structure Inspection Form is used for the reporting requirements of this SWMP.

The Erosion and Sediment Control Inspection Procedure outlines the requirements for conducting these inspections.

A storm event is defined as either:

- at least 30 mm of rain is recorded within a 2 hour period; or
- at least 75 mm of rain is recorded within 3 consecutive days.

Pond storage capacity reduction (due to sediment build-up) is monitored using surveying. Where storages are reduced by a maximum of 10% of the design requirement (i.e actual storage capacity is 90% of the design storage requirement), the Mine will carry out de-silting works.

Routine ESC inspections consist of a visual assessment for erosion, flooding, trash, algal growth, or significant sediment build-up. Storage capacity is assessed by viewing sediment depth markers, and volume assessment based on survey data, where appropriate (eg. after significant de-silting). Observations and recommendations are recorded on the ESC Inspection Checklist.

The integrity of the engineered bunds at storage areas S1A, S9B-1 and S9B-2, S31, S44 and S49 will be assessed after heavy rain events to investigate whether additional methods need to be put in place to ensure seepage is prevented / stopped. Observations are recorded in the Surface Water Structure Inspection Form.

9.2 Removal of Sediment from ESC Structures

Accumulated sediment within designated stormwater drains and water storage ponds removed and disposed into one of the existing mine pits on-site. Disposal of sediment into the existing pits reduces the likelihood of the sediments being remobilised. Removal and disposal of sediment from the drainage network is recorded in the ESC Inspection Checklist. The Surface Water Structure Inspection Form highlights areas within the drainage network that are in frequent need of repair and allows the Mine to make informed decisions on the need, location, function, and capacity of additional erosion and sediment control structures.

9.3 Erosion Maintenance on Batter Slopes

As the majority of batter slopes exist on the mine boundary, are relatively steep, and consist of weathered rock or predominantly large rock particles, it is not practical to reshape slopes as an ESC control measure. Historical erosion to the slopes has removed most of the finer materials and the existing surfaces now comprise relatively large and course particles resulting in a self-armoured surface with limited erosion potential. As a control measure to limit further erosion to batters, surface water is diverted away from the batter slopes or to open drainage channels which report to water storages. Most slopes include a stormwater collection drain along the toe draining to a water storage within the catchment.

Soil binder additives are also utilised across all accessible slopes (and free areas) throughout the site. Liquid dust suppressant (usually mixed with green dye) is mixed with water and applied by water truck or water cannon to exposed surfaces annually or as required.

10. Trigger Action Response Plans

Aspect	Normal	Trigger 1	Trigger 2	Notifications
Surface water storage	Storages function as designed and meet design criteria by containing stormwater events.	**Trigger:** Storages fill quicker than expected or are not dewatered prior to a rainfall event. **Response:** Dewater and survey to ensure there is no excess sediment collection and review catchment runoff calculations. Staff training and communication.	**Trigger:** Emergency discharge from Storages **Response:** Collect samples of discharge water. Dewater as soon as possible. Investigate cause. Review storage design. Staff training and communication.	**Trigger 1**: Notify Environmental staff. **Trigger 2:** Notify external stakeholders as required by PIRMP.
Erosion and Sediment Control	There is no evidence of erosion or sediment build-up.	**Trigger:** Evidence of surface erosion or sedimentation (storage capacity <90%). **Response:** Repair erosion and address	**Trigger:** Offsite erosion or sediment transport **Response:** Contain cause and impact where possible including	**Trigger 1**: Notify Environmental staff. **Trigger 2:** Notify external stakeholders as required by PIRMP.

Aspect	Normal	Trigger 1	Trigger 2	Notifications
		runoff cause. Remove sediment.	diverting flows. Review controls.	
Groundwater quality	Variation in long-term groundwater monitoring results <30%.	**Trigger:** >30% variation in long-term results from one monitoring event. **Response:** Re-sample and re-test. Investigate source of variation with aim of determining mine-related impact.	**Trigger:** >30% variation in long-term results from more than one scheduled event. **Response:** Expand investigation with use of specialists. Increase monitoring frequency. Review monitoring locations.	**Trigger 1**: Notify Environmental staff. **Trigger 2:** Notify external stakeholders as required by PIRMP.
Perched groundwater levels (G11 and G12)	Groundwater level within long-term range	**Trigger:** Increase in level outside expected range **Response:** Re-sample. Investigate source of variation with aim of determining mine-related impact.	**Trigger:** Level does not decrease after one quarter. **Response:** Expand investigation with use of specialists. Increase monitoring frequency. Review monitoring locations.	**Trigger 1**: Notify Environmental staff. **Trigger 2:** Notify external stakeholders as required.
Groundwater levels	Groundwater level within long-term range considering rainfall	**Trigger:** >1m drop in level **Response:**	**Trigger:** >1m drop in level does not recover after one quarter	**Trigger 1**: Notify Environmental staff. **Trigger 2:**

Aspect	Normal	Trigger 1	Trigger 2	Notifications
		Re-sample. Investigate source of variation with aim of determining mine-related impact.	**Response:** Expand investigation with use of specialists. Increase monitoring frequency. Revise monitoring locations and potential for bore recovery.	Notify external stakeholders as required.
Surface water quality	Variation in long-term surface water monitoring results <30%.	**Trigger:** >30% variation in long-term results from one monitoring event. **Response:** Re-sample and re-test. Investigate source of variation with aim of determining mine-related impact.	**Trigger:** >30% variation in long-term results from more than one scheduled event. **Response:** Expand investigation with use of specialists. Increase monitoring frequency. Review monitoring locations.	**Trigger 1**: Notify Environmental staff. **Trigger 2:** Notify external stakeholders as required.

11. Reporting and Review

11.1 Reporting Groundwater or Surface Water Incidents

11.1.1 Internal

All incidents related to ground and surface water shall be recorded and reported using the INX InControl system for incident reporting and investigation.

Any operational incident related to ground or surface water includes:

- Any off site release, eg. seepage, leakage, discharge.
- Any exceedances of trigger levels or trend changes to chemical parameters, against the August 2011 groundwater quality results used as baseline data or established values based on monitoring data over time.

11.1.2 External

Incidents that have the potential to cause environmental harm are required to be reported to the:

- Department of Planning and Environment;
- Environment Protection Authority; and
- Other relevant government agencies eg. BHCC, Health, WorkCover, Fire and Rescue.

Notification shall be made immediately to each relevant authority when material harm to the environment is caused or threatened in accordance with the relevant legislation. In this case the Pollution Incident Response Management Plan (PIRMP) shall be implemented and the EPA notified via the Environment Line on 131 555 as soon as practicable.

BHOP will provide a report, as required, within seven days of the date of the incident.

The Senior Environmental Advisor will be responsible for preparing reports to the government agencies which will be signed off by the General Manger prior to submission.

Complaints will be recorded, managed and documented in accordance with the Complaints Handling Procedure.

11.2 Regular Reporting

The following reports shall be prepared and submitted.

11.2.1 Monthly Management Report

- Summary of incidents, including cause and actions taken (or to be taken) to reduce the risk of a reoccurrence.
- Summary of monitoring results.

11.2.2 Rasp Mine Website

- Summary of water quality monitoring results, updated monthly.
- Summary of community complaints, updated monthly.
- A current copy of the approved SWMP.

11.2.3 Annual Environment Management Report / Annual Review

The Annual Environment Management Report / Annual Review shall be complied and submitted each year in accordance with conditions of Consolidated Mine Lease 7 (Condition 3) and the Project Approval 07_0018 (modified) (Schedule 4 Condition 3).

The review will:

- Include a comprehensive review of the monitoring results and complaints records of the project over the past year, which includes a comparison of these results against the:
- Relevant statutory requirements, limits or performance measures/criteria
- Monitoring results of previous years
- Relevant predictions in the documents EAR, PPR and their respective response to submissions and BHOP Statement of Commitments.
- Identify any non-compliance over the past year, and describe what actions were (or are being) taken to achieve compliance.
- Identify any trends in the monitoring data over the life of the project.
- List any incidents occurring during the period as described in **Section 10.1.1**.
- List any works to be undertaken in the following year to rectify or improve site water management.

The AR will be submitted to the Director General – DP&E to meet this condition.

The Report / Review will be prepared in accordance with relevant guidelines and provided to government agencies for consultation prior to submission to the Department of Planning and Environment (DP&E), and the Division of Resources and Geoscience (DRG) each year.

11.2.4 Annual Return

An Annual Return outlining ground and surface water quality monitoring results, non-compliances (with respect to EPL 12994) and community complaints will be prepared on the appropriate form and submitted to the EPA as required each year.

11.3 Auditing and Review

11.3.1 Site water Management and Review

The SWMP will be reviewed, and if necessary revised, within three months of submission of:

- An Annual Review.
- An Incident Report related to ground or surface water.
- Any modification of the Project Approval.
- Variation to the EP License.

Any reviews will reflect changes in environmental expectations, technology and operational procedures as well as operational experience gained as mining progresses.

In addition to the above review requirements, reviews will be conducted to assess the effectiveness of procedures against the objectives of the SWMP. This Plan will be revised due to:

- Deficiencies being identified.
- Extremes in environmental conditions.
- Improvements in knowledge or technology advancements.
- A change in the activities or operations associated with the Rasp Mine.

Any amendments to the SWMP will be undertaken in consultation with the appropriate regulatory authorities and approved in the same manner as the initial SWMP.

The Senior Environment Advisor is responsible for the audit and review of the SWMP under any of the above triggers.

An Independent Environmental Audit of the project will be conducted every three years from December 2011 and will assess the performance of the project and compliance with the approval and any relevant EPL or Mining Lease. Within six weeks of completing the audit, a copy of the audit report will be submitted to the Secretary of the DPE. This plan will be reviewed during the audit.

12. References

Institution of Engineers, Australia (1987) *Australian Rainfall and Runoff: A Guide to Flood Estimation* , Vol. 1, Editor-in-chief D.H. Pilgrim, Revised Edition 1987 (Reprinted edition 1998), Barton, ACT

Landcom. (2004) *Managing Urban Stormwater – Soils and Construction.* 4th Edition, March 2004. Volume 1. (Reprinted edition 2006). Parramatta, NSW

ANZECC. (1992) Australian water quality guidelines for fresh and marine waters. Australian and New Zealand Environment and Conservation Council, Canberra

13. Appendices

Appendix 1 – CML7 Environmental Monitoring Location

0 100 200 300 400 500 m

Scale 1:10,000 Datum: MGA Zone 54

Map of CML7 Environmental Monitoring Locations

Data Sources:
Aerial 25/04/2016 MGA54 10cm - CBH
Environmental Monitoring Locations and CML7 Boundary - CBH.
NSW Six Map Best Imagery © Department Finance, Services & Innovation. 6/03/2018

File Reference: JMC-C003-002 V2
Date: 26/04/2018

APPENDIX M

BHOP Report ‘Project Brief – Kintore Pit TSF3’ dated September 2020.

Rasp Mine

Zinc – Lead – Silver Project
Project Approval No. 07-0018 (SSD-814)

Project Brief

Kintore Pit TSF3

September 2020

Broken Hill Operations Pty Ltd
BROKEN HILL

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EXECUTIVE SUMMARY

Broken Hill Operations Pty Ltd (BHOP) [a wholly owned subsidiary of CBH Resources Limited (CBH)] owns and operates the Rasp Mine (the Mine), located centrally within the City of Broken Hill on Consolidated Mine Lease 7 (CML7). The Mine produces zinc and lead concentrates which are dispatched via rail to Port Pirie in South Australia and Newcastle in New South Wales.

Mining has been undertaken within CML7 since 1885. The existing operations at the Mine include underground mining, processing plant, rail siding for concentrate dispatch and other associated infrastructure. These operations are undertaken in accordance with Project Approval PA07_0018 (as modified) (PA) granted from the then Minister for Planning on 31 January 2011, under Part3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Pursuant to Section 4.22 of the EP&A Act, BHOP seeks to modify its Project Approval primarily to allow for tailing to be co-deposited with excess waste rock from underground mining operations into Kintore Pit. This would also require relocation of the underground mine access portal and decline. A number of minor modifications to the PA will also form part of the modification and these are summarised below.

The purpose of this document is to provide preliminary information, including an overview of the proposed Modification (MOD6), its location and setting within the environment, to assist with identifying the potential key issues to be addressed in the Environment Impact Statement (EIS). The EIS will be submitted to the Department of Planning, Industry and Environment (DPIE), to support the application. Results from preliminary risk reviews and early consultation with regulators are also provided.

Proposed Modification

Summary of proposed MOD6:

- Establish Kintore Pit as Tailing Storage Facility 3 (TSF3) for naturally dried tailing co-disposed with excess underground waste rock;
- Relocate the mine portal and access decline with associated infrastructure, to a new boxcut;
- Utilise Blackwood Pit TSF2 for harvesting solar and wind dried tailing;
- Conduct periodical crushing of non-ore material in Kintore Pit and/or BHP Pit;
- Utilise waste rock for rehabilitation capping; and
- Administrative amendments for annual reporting and noise criteria.

Predictions for the life of TSF2, following installation of the embankments (MOD4), is now late 2022. The extended life of the facility is due to improved tailing settling rates and reduction in mine production. Mining will cease at that time if no other tailing storage facility is available.

BHOP engaged Golder Associates Pty Ltd (Golder) to undertake a review of potential sites in and around the Rasp Mine and it was concluded that Kintore Pit would be the optimum location for tailing storage. Studies have shown that in establishing Kintore Pit as TSF3, tailing would need to be further dewatered from the current 35% moisture content achieved by the milling process, to reduce inrush / inundation risk to underground mining operations. BHOP propose to utilise the natural solar and wind drying process offered within Blackwood Pit TSF2 to harvest thin layers (up to 1m) of naturally dried tailing prior to stockpiling and transferring to Kintore Pit.

Excess waste rock from underground mining, in particular any material that is greater than 0.5% lead, would continue to be placed in Kintore Pit and be co-disposed with tailing. Some waste rock that has a lead content greater than 0.5% would also be permanently stored in the infill area of BHP Pit. Waste rock suitable for rehabilitation capping would be separated and placed on the current Kintore Pit Tipple or BHP Pit prior to confirmation testing of lead levels.

BHOP currently conduct crushing activities of non-ore materials in Kintore Pit (EA) and BHP Pit (MOD7) and propose to continue these activities using a mobile crusher when required to produce material for road base, bunding and / or other site requirements.

BHOP seek to commence progressive rehabilitation activities over ‘free areas’ (ie non-active mining areas) across CML7 by using excess waste rock from underground that has been tested and contains less than 0.5% lead.

BHOP also seek to adopt new noise criteria as identified during the noise modelling assessment for MOD6 in accordance with the NSW EPA *Noise Policy for Industry (2017)* and attended noise monitoring results. BHOP also propose to seek a change to the reporting period and submission date for the Annual Review (required under PA) to align reporting requirements with the annual Environment Management Report (required under the CML7).

Summary of Potential Key Risks

A risk review workshop was facilitated by HMS Consultants Australia Pty Ltd (HMS) on the proposed conversion of Kintore Pit to a tailing storage facility. The objective of this risk review was to assist in determining a safe and suitable option for converting the Kintore Pit into a TSF. In addition BHOP sought feedback from regulators to identify their requirements for the development of the Project. Risks were considered for both construction activities and future operations of the Project. Additional risks from new activities eg tailing harvesting, have been identified and included in this Brief.

A number of key potential risks have been identified that require further investigation. A summary of the main risks identified is provided below:

Inrush – From seepage and liquefaction of deposited tailing entering mine workings beneath Kintore Pit and from liquefaction of tailing contained in TSF1 and TSF2 as a result of blasting for the new portal and decline. BHOP has opted to further dewater the tailing prior to deposition into Kintore Pit and will include a stand-off distance from the portal and decline to TSF1 and TSF2. A number of studies have been commissioned to inform the design and assess and advise on the implementation of strategies to protect safety of personnel, these include liquefaction, tailing compaction testing, seepage modelling and seismic assessments.

Ground failure Kintore Pit – From the load of tailing / waste rock placed within Kintore Pit given the removal of crown pillars beneath the Pit and depth to the base of the Pit (10 m). Suitably qualified consultants have been engaged to undertake a geotechnical study and stability analysis to determine potential risks and recommendations for safety assurance.

Ground failure Blackwood Pit – From tailing harvesting activities potentially impacting the integrity of the embankment structures and from high rainfall events impacting Blackwood Pit tailing surface. Suitably qualified consultants have been engaged to provide a geotechnical study for tail harvesting activities which will also address water management and surface stability. Importantly the Dam Design Engineer for Blackwood Pit TSF2 MOD4 has been engaged to design the tailing harvesting process to assure integrity of embankment design.

Dust – Primarily from earthworks, truck movements, crushing and tailing harvesting. Dust from the site has the potential to contain lead. Suitably qualified consultants have been engaged to undertake a comprehensive air assessment and conduct a human health risk assessment to provide predictions for blood lead levels (BLL) in the community, in particular any impact on children’s BLL.

Noise, vibration and overpressure – From mobile equipment, truck movements, trafficking the tailing surface and vibration and overpressure from blasting activities. Suitably qualified consultants have been engaged to undertake a noise assessment and a vibration and overpressure assessment. An assessment of flyrock from surface blasting for the proposed new portal will also be undertaken with stand-off distances identified.

Vibration Blackwood Pit – From trafficking on the tailing surface by trucks and mobile equipment, subsidence within cell structures causing vehicles to sink. Suitably qualified consultants have been engaged to assess vibration risks including the potential for liquefaction of the tailing.

Water – Surface water management around rehabilitation capping and water quality. Water management around the rehabilitation capping forms part of the scope of works for the design engineer for this capping. An assessment of the impacts to the current Site Water Management Plan is also part of this study. A consultant has also been engaged to assess potential impacts to water quality from tailing placement in TSF3 and waste rock used for rehabilitation capping.

Waste rock contamination – From waste rock used for progressive rehabilitation capping. A consultant has been engaged to conduct an assessment of the potential for contamination from the waste rock including a long term assessment.

There will be no further land disturbance as all Project activities are located in mining areas that are already highly disturbed. No vegetation will be disturbed. No heritage items will be impacted.

Benefits of the project

The proposed modification would:

- Permit mining at the Rasp Mine to continue post 2022 with additional storage of tailing;
- Significantly reduce the surface distance of hauling ore from underground to the ROM Pad;
- Provide rehabilitation capping over free areas of the site with material lower in lead content;
- Ensure continued employment of 186 full-time employees, 32 full-time contractors and indirectly over 200 casual contractors that provide specialist services when required;
- Engagement of approximately 20 contractors during construction and an additional 6 full time employees for operations;
- Allows the filling of legacy open pits;
- Allow the resource to be fully utilised, and
- Allow BHOP to continue to support the sustainability and economy of Broken Hill.

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1.0 INTRODUCTION

This Section provides an introduction to Broken Hill Operations Pty Ltd and the Rasp Mine, and outlines the purpose of this document and the proposed modification, the need for the modification and highlights changes from the current Project Approval. Future consultation commitments are also outlined.

1.1 Background

Broken Hill Operations Pty Ltd (BHOP) [a wholly owned subsidiary of CBH Resources Limited (CBH)] owns and operates the Rasp Mine (the Mine), which is located centrally within the City of Broken Hill on Consolidated Mine Lease 7 (CML7). The Mine produces zinc and lead concentrates which are dispatched via rail to Port Pirie in South Australia and Newcastle in New South Wales.

Mining has been undertaken within CML7 since 1885. The existing operations at the Mine include underground mining, processing plant, rail siding for concentrate dispatch and other associated infrastructure. These operations are undertaken in accordance with Project Approval PA07_0018 (as amended) (PA) granted from the then Minister for Planning on 31 January 2011, under Part3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

BHOP will seek to modify its Project Approval, pursuant to Section 4.22 of the EP&A Act, primarily to allow for tailing to be co-deposited with excess waste rock from underground into Kintore Pit. This would also require relocation of the underground mine access portal and decline. A number of minor modifications to the PA will also form part of the modification and these are summarised below.

The purpose of this document is to provide preliminary information, including an overview of the proposed Modification (MOD6), its location and setting within the environment, to assist with identifying the potential key issues to be addressed in the Environment Impact Statement (EIS). The EIS will be submitted to the Department of Planning, Industry and Environment (DPIE), to support the application. Results from preliminary risk reviews and early consultation with regulators are also provided.

1.2 Proposed Modification

Summary of proposed MOD6:

- Establish Kintore Pit as Tailing Storage Facility 3 (TSF3) for naturally dried tailing co-disposed with excess waste rock;
- Relocate the mine portal and access decline with associated infrastructure, to a new boxcut;
- Utilise Blackwood Pit TSF2 for harvesting solar and wind dried tailing;
- Conduct periodical crushing of non-ore material in Kintore Pit and/or BHP Pit;
- Utilise waste rock for rehabilitation capping; and
- Administrative amendments for annual reporting and noise criteria.

Predictions for the life of TSF2, following installation of the embankments (MOD4), is now late 2022. The extended life of the facility is due to improved tailing settling rates and reduction in mine production (July 2020 revised). Mining will cease at that time if no other tailing storage facility is available.

BHOP engaged Golder Associates Pty Ltd (Golder) to undertake a review of potential sites in and around the Rasp Mine and it was concluded that Kintore Pit would be the optimum location for tailing storage. Studies have shown that in establishing Kintore Pit as TSF3, tailing would need to be further dewatered from the current 35% moisture content achieved by the milling process, to reduce inrush / inundation risk to underground mining operations. BHOP propose to utilise the natural solar and wind drying process offered within Blackwood Pit TSF2 to harvest thin layers (up to 1 m) of dry tailing prior to stockpiling and transferring to Kintore Pit. This would allow continued fresh tailing to be deposited into this facility which would be naturally dried and removed, resulting in cyclical rotation of depositing, drying, harvesting and transferring of tailing to Kintore Pit TSF3.

Current underground mine access is via a portal located in Kintore Pit. It is proposed to establish a new portal to be located within a boxcut.

Excess waste rock from underground mining, in particular any material that is greater than 0.5% lead, would continue to be placed in Kintore Pit and be co-disposed with tailing. Waste rock suitable for rehabilitation capping would be separated and placed on the current Kintore Pit Tipple or BHP Pit prior to confirmation testing of lead levels. Waste rock that has a lead content greater than 0.5% would be permanently stored in Kintore Pit or in the in-fill area of BHP Pit.

Crushing of non-ore material is currently undertaken in Kintore Pit (EA) and BHP Pit (MOD7) and BHOP propose to continue these activities using a mobile crusher when required to produce material for road base, bunding and / or other site requirements. Crushing is undertaken on an ad hoc basis only when required typically 2 or 3 times per year over a few days during daytime hours only.

BHOP seek to commence progressive rehabilitation activities over ‘free areas’ (non-active mining areas), across CML7 by using excess waste rock from underground that has been tested and contains less than 0.5 percent lead (<0.5%Pb).

BHOP propose to adopt new noise criteria as identified during the noise modelling assessment for MOD6 in accordance with the NSW EPA *Noise Policy for Industry (2017)* and attended noise monitoring results.

BHOP also propose to seek a change to the reporting period and submission date for the Annual Review (AR) (required under PA conditions) to align reporting requirements with the annual Environment Management Report (EMR) (required under the CML7).

1.3 Proposed Changes to the Project

The current Project Approval permits underground mining of the Western Mineralisation, the Centenary Mineralisation and Main Lode from Blocks 7 to 12 until 31 December 2026 extracting up to 750,000 tonnes of ore per annum and 8,450,000 tonnes of ore over the life of the Project. It also permits the processing of ore and the dispatch of concentrate products from the Mine by rail. There are a number of auxiliary facilities including maintenance workshops, inventory, chemical and explosives storages, backfill and concrete batching plants and a rail siding. **Table 1-1** provides a summary of existing approved project components compared to the proposed modifications.

Table 1-1 Comparison of Existing Approval and Proposed MOD6

Component	Approved Rasp Mine	Proposed MOD6
Mine Life	15 years (includes construction and closure) from 2011 to 2026.	No change, however operations will cease in 2022 without approval for additional capacity for tailing storage.
Tenement Status	CML7 – Incorporates the Rasp Mine.	No change
Mining Methods	Underground mining using various methods including long hole, benching, modified Avoca, room and pillar or uphole retreat. Within Western and Centenary Mineralisation and Main Lodes Blocks 7 to 12.	No change to mining methods. MOD6 proposes a new access portal to the underground mine, within a boxcut, and access decline.
Mining Rate and Total Production	750 000 tpa ore. Total production over life of Project: Approximately 8,450,000 t	MOD6 is based on a mine plan to the end of 2026 based on 500,000 tpa ore, 146,000 tpa of waste (to surface) and 480,000 tpa of tailing harvested and transferred to Kintore Pit TSF3.
Waste Rock Disposal	Underground: Backfill. Surface: Material (<0.5% Pb) to be used for road repair and bunding and rehabilitation at closure	MOD6 proposes that excess waste rock from U/G mining be: - co-disposed with tailing in TSF3 and/or placed permanently in BHP Pit, - testing confirms <0.5%Pb and can be used for rehabilitation capping, and - material from construction of the boxcut and decline be permanently stored in Little Kintore Pit and BHP Pit.
Underground Ventilation	2 x 450 kW primary ventilation fans located 160 m	No change

Component	Approved Rasp Mine	Proposed MOD6
	below ground and exhausting centrally within CML7.	
Processing Methods	Crushing, grinding, flotation, thickening and filtration at on-site processing facilities.	No change
Processing Rates	250 tph in crushing plant and 93.8 tph in grinding plant.	No change
Concentrate Production	Lead: 44,000 tpa (concentrate 73% Pb and 985 g/t Ag) Zinc: 87,000 tpa (concentrate 50% Zn)	No change
Tailing Disposal	Course stream returned to mine void and finer stream to be directed to tailing storage facilities.	MOD6 proposes to: - establish a tailing storage facility at Kintore Pit TSF3 with an approximate 10 year life, and - utilise the surface of TSF2 to naturally dried tailing which will be harvested and relocated to TSF3.
Facilities	Other associated facilities such as Backfill Plant including a cement silo, Concrete Batching Plant, Rail Loadout, Warehouse, core preparation and inventory storage and workshops.	Periodic surface crushing to continue in Kintore Pit (EA) and BHP Pit (MOD7) for road base and bunding requirements.
Services	Extensions to existing substations, water lines and phone lines. New 22kV overhead power lines to be constructed.	MOD6 proposes to relocate services currently within Kintore Pit that support the underground mining to an area adjacent the proposed boxcut. This would include portable buildings used for underground equipment, crib and substation.
Water Supply / Extraction	Potable / treated water 9 ML/a Raw untreated water 139 ML/a Reclaimed / recycled water 300 ML/a Extraction up to 390 ML/a.	No change.
External Roads	No changes to external road network.	No change.
Employment Numbers	Current numbers are: Employees: 186[1] Contractors: 32	MOD6 proposes increases in personnel: During construction: Employees – 0 Contractors – 20 For operations: Employees – 6 Contractors – 0
Hours of Operation	Underground Operations: 7 days per week, 24 hours per day Shunting 7 days per week, 7am to 6pm (not conducted). Construction hours 7am to 6pm Mon-Fri and 8am to 1pm Sat, no construction work on Sundays or Public holidays. Activities not listed above – 7 days per week, 24 hours per day.	No change to operating hours of current activities. MOD6 proposes to campaign harvesting tailing from TSF2 over a roster basis which will occur only on day shift. MOD6 proposes to construct the boxcut – 7am to 6pm Monday to Saturday and Sunday 8am to 6pm.
Disturbance Footprint	CML7 consists of 342.66 Ha Current land disturbance due to Rasp Mine activities is 28.4 Ha	MOD6 will require review to clarify disturbance areas in line with the rehabilitation capping.

Note 1: New employee and contractor numbers reflect Rasp Mine restructure in July 2020.

1.4 Regulatory Framework

The Rasp Mine was declared a Major Project under the *State Environment Planning Policy (SEPP) (Major Development) 2005* (now repealed) and was approved in January 2011 by the then NSW Minister for the Department of Planning and Infrastructure under Part 3A of the EP&A Act. Following repeal of Part 3A and Section 75W (transition provision) of the EP&A Act, the application for this Modification is made pursuant to Section 4.55 of the EP&A Act. The Rasp Mine Project has been transitioned to a State Significant Development (SSD-814) and MOD6 will be considered under the assessment pathway for State Significant Development (SSD).

1.5 Existing Environment

The Mine is located centrally within the City of Broken Hill and is surrounded by transport infrastructure, areas of commercial and industrial development and some residential housing **Figure 1-1**.

The Mine is bounded by Eyre Street and Holten Drive to the south and east, Perilya's Broken Hill North Mine to the east and South Mine to the west, and the commercial centre of Broken Hill to the north. The Mawsons Concrete and Quarry Pty Ltd lies adjacent to the Mine on Holten Drive. The Mine site is dissected by two major State roads, South Road (Silver City Highway SH22) to the southwest and Menindee Road (MR66) to the northeast. The Broken Hill railway station is located directly to the north of the Mine and lies on the main Sydney – Perth railway line. Residential and commercial areas surround the Mine with pasture land to the southeast.

The land within CML7 has several surface exclusion zones, which contain rail lines and stock yards to the north, Perilya employee housing to the north east, the former Italo International (Bocce) Club (now Southern Cross Care Broken Hill Ltd) and previous lawns bowling club to the south west (now Silver City Removals) and other commercial and residential properties.

The site has been mined for over 135 years leaving the site highly disturbed with a number of heritage buildings and structures. The majority of the site is covered with historic waste rock or tailing material, there is little topsoil and vegetation.

1.6 Reason for the Proposed Modification

At current tailing deposition (following installation of the TSF2 embankments (MOD4)), the life of Blackwood Pit TSF2 will be completed in late 2022. In MOD4 it was identified that under current volumes storage capacity within TSF2 would cease in mid-2021. Actual experience has indicated that the tailing is settling with a higher density, increasing the maximum volume for deposition and extending the life of the facility. In addition the current mine plan has changed to a high grade lower tonnes strategy which results in less tailing production. This has resulted in an increase to the life of the current tailing storage facility with a new fill date to late 2022.

In the original Environment Assessment (EA) for the Project it was planned for tailing to be placed in both above ground tailing storage facilities and underground, via the Backfill Plant, to fill mining voids. The tailing waste stream from ore processing has been approved to be deposited in the historic tailing facility (TSF1) and in the disused Blackwood Pit (TSF2). BHOP chose to deposit tailing in TSF2 and not use TSF1. This decision was based on the greater capacity of TSF2 (3.1 Mt) compared to the capacity of TSF1 (970,000 t) and the significant construction costs associated with the use of TSF1 ($7.2 M) compared to the cost of extending TSF2 ($3.5 M).

In the initial EA BHOP underestimated the amount of mine development that was required to access the Main Lode and Western Mineralisation ore bodies. The need to undertake more underground mining development has impacted the amount of waste generated. In the original EA it was predicted that approximately 250,000 t of waste rock would be produced each year for a production rate of 750,000 t of ore. Actual total waste rock produced has averaged 368,000 t per year since commencement of operations peaking in 2015 and 2018 with 452,000 t. BHOP has chosen to place the additional waste rock underground to fill voids and stopes, as it is more economic to dispose of waste rock underground where possible rather than transporting waste to the surface. Thus there has been no suitable void space underground for the backfill of tailing**. Table 1-2** summarises tailing and waste rock placement as predicted in the original EA (at a production rate of 750,000 t) and what has actually been placed since commencement of operations.

A review was conducted by Golder Associates Pty Ltd (Golder) of potential off-site locations for tailing storage in and around the vicinity of the Mine (within 10 kms of the Rasp Mine site). A summary of this review will be included in the EIS. Acting on this review BHOP has determined to use Kintore Pit (the Pit) as TSF3, which will necessitate the relocation of the Mine access portal currently located within Kintore Pit.

Figure 1-1 Location of Kintore Pit within CML7

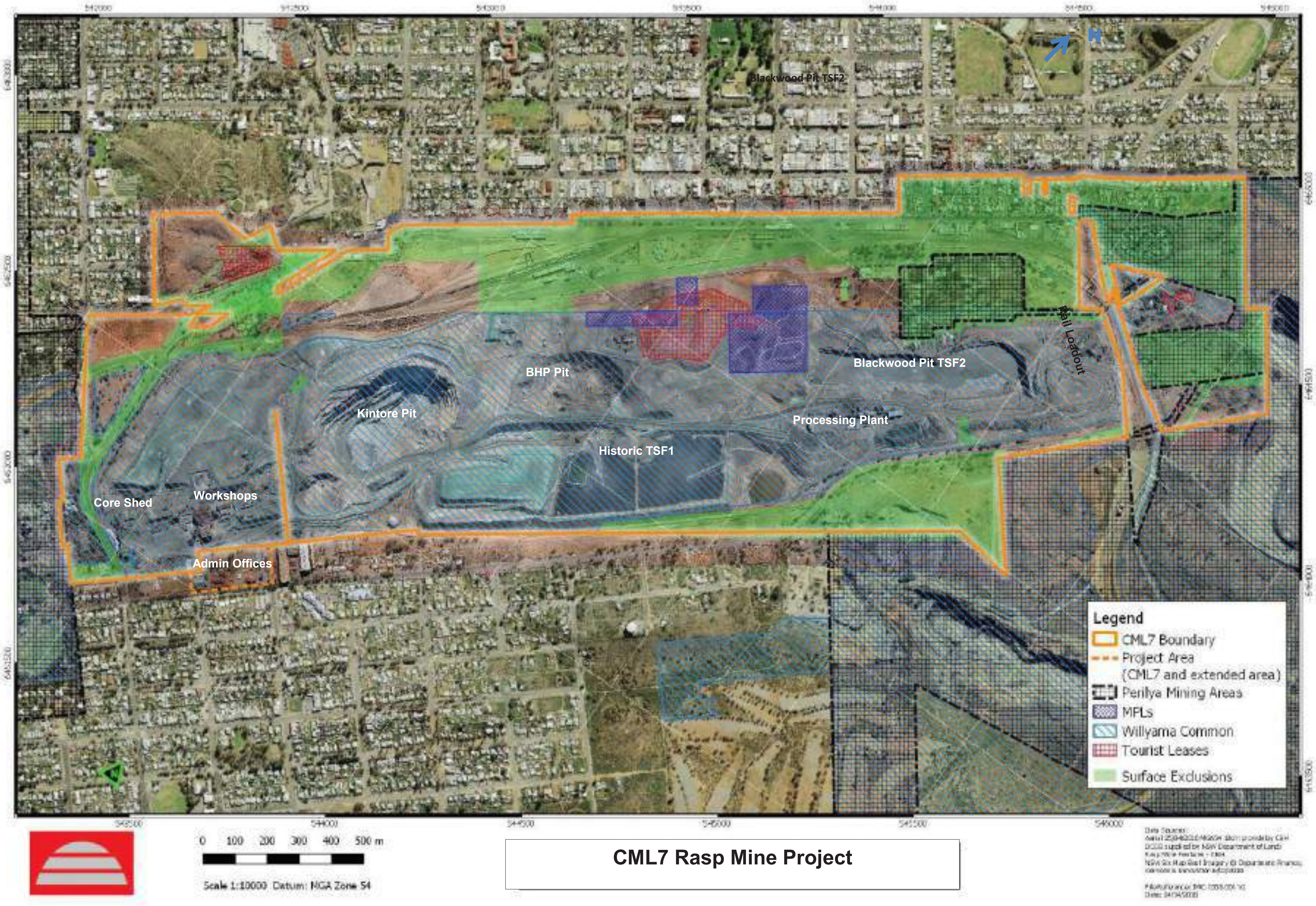


Table 1-2 Summary of Proposed (EA) and Actual Placement of Waste Rock and Tailing

Year (to 30 June)	EA Tailing in Underground backfill per year (t)	EA Tailing deposited in TSF1 (t)	EA Tailing deposited in TSF2 (t)	EA Waste Rock U/G (t)	Actual/ Planned[2] Tailing in TSF2 (t)	Actual waste rock placed underground (t)	Actual waste rock stored Kintore Pit (t)	Actual Total waste rock (t)
2012	97,969	273,281	0	250,000	322,111	47,527	150,000[1]	197,527
2013	195,938	195,138	0	250,000	574,833	230,607	150,000[1]	380,607
2014	195,938	195,138	0	250,000	486,749	223,473	163,304	386,777
2015	216,563	216,563	0	250,000	499,598	223,611	228,942	452,553
2016	247,500	88,281	159,219	250,000	555,837	265,369	96,888	362,257
2017	278,438	0	278,438	250,000	622,161	215,897	76,578	292,475
2018	309,375	0	309,375	250,000	644,828	330,577	121,864	452,441
2019	309,375	0	309,375	250,000	588,407	242,626	28,841[3]	401,811[4]
2020	309,375	0	309,375	250,000	488,789[2]	199,637[2]	135,000[2]	389,637[2/4]
TOTALS	**2,160,471**	**968,401**	**1,365,782**	**2,250,000**	**4,783,313**	**1,979,324**	**1,410,989**	**3,316,085**

Note[1]: Estimated
Note[2]: Planned
Note[3]: Waste material to surface totaled 2019 - 159,185t with 28,841t was placed in Kintore Pit and 130,344t placed in BHP Pit due to safety issues re- use of tipple in Kintore Pit. Planned waste material to surface 2020 – 389,637t with 135,000t to be placed in Kintore Pit and 55,000t in BHP Pit.
Note[4]: Also includes waste material placed in BHP Pit.

Waste rock will continue to be generated from mining activities in excess of suitable voids underground and require surface storage. This has resulted in the placement of this waste rock for co-disposal with the tailing in TSF3 and for rehabilitation capping.

Crushing of non-ore material is currently undertaken in Kintore Pit (EA) and BHP Pit (MOD7) and BHOP propose to continue these activities using a mobile crusher to produce material primarily for underground road base, surface bunding and / or other site requirements. The alternative is to buy-in aggregate type material at considerable cost.

Requests for administrative changes are also included in this EIS to:

- Seek new noise criteria for operations. This is to address the results of additional noise monitoring identified during completion of noise modelling for MOD6 and requirements outlined in the NSW EPA *Noise Policy for Industry (2017)*; and
- Align reporting requirements for the annual Environment Management Report (EMR) required by the mining lease and Schedule 4 Condition 3 of the PA requirements for an Annual Review (AR). These reports although similar have different time periods requiring two separate reports to be written and submitted within months of each other. Aligning these reports will streamline their formulation by BHOP and review by the regulator, removing duplication.

1.7 Consultation and Key issues

Meetings have been held with the relevant regulators to discuss the proposed modification - DPIE, the Broken Hill City Council (BHCC), Resource Regulator (RR) and the Environment Protection Authority (EPA). Requirements suggested by these regulator meetings are summarised in **Table 1-3**. This document details the aspects of the proposed modification and will be used to formalise consultation with these agencies. Consultation is planned with regulators to review the proposed tailing harvesting for the (naturally) drying, retrieval and transferring of tailing from Blackwood Pit TSF2 to Kintore Pit TSF3.

The Briefing Paper is being updated to alert regulators to proposed changes since the original Briefing Paper was first issued in June 2018, and to seek any changes, additions or amendments to issues to be addressed in the EIS (to those listed in **Table 1-3**).

Further consultation with the community will be undertaken during the formulation of the EIS and a community briefing meeting will be held to outline the proposed project and seek feedback.

Once the proposed concepts are developed consultation will also be undertaken with the Resources Regulator in regards to safety matters.

Table 1-3 Summary of Agency Requirements

Government Agency	Issues Identified
Broken Hill City Council Meeting: 25 June 2018	The BHCC does not have any initial concerns with the proposed project however dust and noise should be controlled and heritage structures avoided. There is no issue with visual amenity as it was considered an already disturbed mine site.
EPA Meeting: 27 June 2018	• Provide a description of waste rock to be transported to stockpiles including, particle size and metals content. • Human health risk assessment and in particular an assessment of potential impact on children's blood lead levels and describe air quality control measures used to ensure there is no net increase in blood lead levels. • Air quality assessment. • Noise assessment. • Provide groundwater assessment following tailing placement in Kintore Pit. • Provide seepage analysis for Kintore Pit. • Clarify and justify construction hours and describe the process to provide breaks from noise and activities for local residents. • Assessment of vibration and overpressure from new portal and decline development. • Provide summary of community consultation with local residents particularly in regards to noise and working hours. • Provide details in rehabilitation plan of methods to ensure minimum dust emissions from the site.
DP&E Meeting: 28 June 2018	• Project to follow the assessment pathway for a State Significant Development with MOD3 as the baseline. DPE to provide further information, include summary of assessment pathway in EIS. • Clarify and justify why waste rock stockpile capacities exceed requirement. • Consult with Resource Regulator re safety issues for underground mine workers. • Seepage analysis for Kintore Pit. • Groundwater quality assessment for Kintore Pit. • Air quality assessment. • Human Health Risk Assessment, indicating impact to children's blood lead levels. • Describe the dewatering/filtering system for tailing and its location. • Provide a summary of BHOP contributions to Health NSW. • Provide an assessment of blasting vibration and over pressure at portal and decline. • Provide assessment of the requirement for controlled actions under the EPBC Act, in relation to Broken Hill status on the National Heritage List (BH). • Provide an assessment for fauna (bats) habitat in old shafts / adits within Kintore Pit. • Provide an assessment of any visual impacts from the modification.
DRG Meeting: 29 June 2018	• Provide stability analysis of TSF1 (from collapse beneath) and TSF2 (from batter/embankment failure) for safe storage of waste rock. • Provide details for stormwater management on stockpiles. • Provide information on the geochemical characteristics of the boxcut material, variation within the material, and waste rock generally, this includes all relevant metals. Also its homogeneity. • Provide details of potential impact of tailing on ground water. • Provide an assessment of slumping of tailing in Kintore Pit at closure (also Blackwoods). • Justify the use of waste rock armouring against other dust mitigation measures. • Provide details of water management including seepage management, water expression through the pit walls and excess water from dewatering tailing. • Provide seepage analysis for Kintore Pit and detail methods to eliminate/minimise seepage. • Provide a noise assessment with modelling particularly in relation to the development of the boxcut. • Provide details for heritage within BHP Pit and how it will be protected. • Outline how noise and dust will be managed and any impacts to visual amenity. • Provide details of the design of the boxcut and entry point to Haul Road, e.g. final height of exit from boxcut to the ROM. • Provide assessment of potential liquefaction of Blackwood Pit tailing and the required stand-off

Government Agency	Issues Identified
	distance for new underground workings. • Show sizing of materials – waste rock and from boxcut and if fines show how they will be removed prior to covering 'free areas'. • Provide details for monitoring – air, water, slumping or subsidence (post closure). • Provide any details of waste generation e.g. fines from dewatering and how they will be treated. • Provide an assessment of long term geochemical degradation i.e. 100 to 500 years of waste rock used on surface coverings. • Provide assessment of alternatives for rehabilitation (for dust suppression). • Explain what the final landform will be.

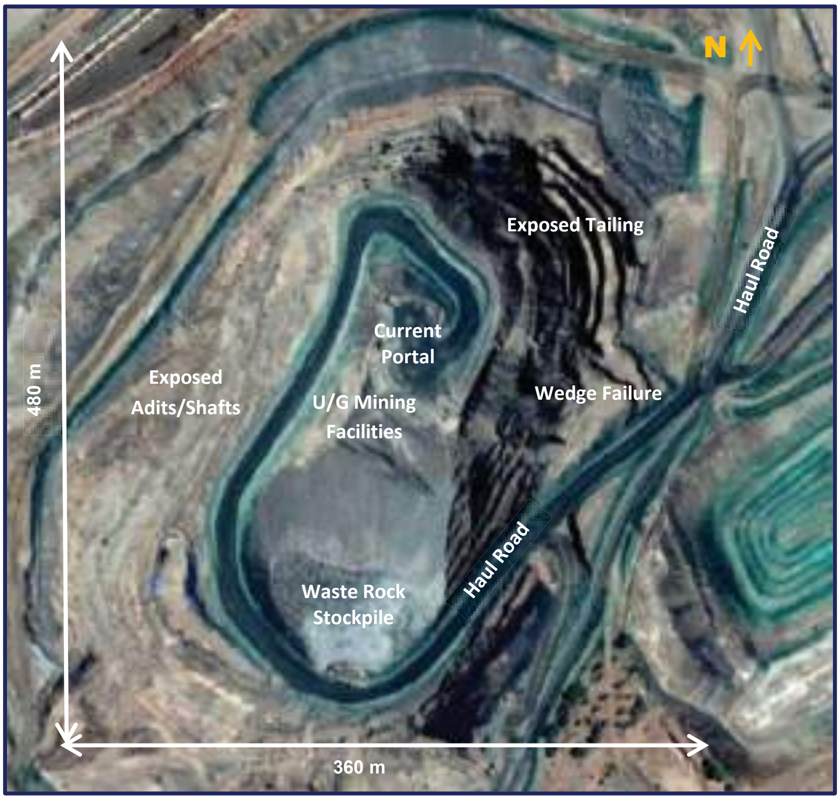
2.0 LOCATION OF PROPOSED MODIFICATION

This Section describes the location for tailing placement (Kintore Pit), the location for the new mine access portal and decline, tailing harvesting, non-ore crushing activities, waste rock placement and rehabilitation capping.

2.1 Kintore Pit

Kintore Pit (the Pit) is a large open pit mined in the 1970s currently used for underground mining access via a mine portal and decline and is located to the west of CML7, **Figure 1-1**. The Pit is approximately 100 m deep (RL210 to RL310) on the southern perimeter and approximately 480 m (north to south) by 360 m (east to west), **Figure 2-1**. Waste rock is used to fill underground voids and is stored in the Pit when there are no suitable voids available. On average 159,000 t per year has been stored in the Pit since mining commenced in 2012 to the end of 2019 (**Table 1-2**). An additional 135,000 t is planned to be placed during 2020 bringing the total stored in Kintore Pit to 1,410,989 t. This material will remain in the Pit. The current Haul Road will remain to provide access to the Pit.

Figure 2-1 Kintore Pit



No vegetation is required to be removed, there are no heritage items located in the vicinity and there will be no additional land disturbance. There are no known fauna (eg bats) living in the old adits and shafts visible within the Pit. As part of operations of TSF3, voids will be inspected and an assessment for bat habitats would be conducted as they become safely accessible within the Pit. This will be outlined in the EIS.

2.2 New Portal

It is proposed to access underground mine workings via a new portal to be located adjacent to the Haul Road north-west of TSF1, **Figure 2-2**.

Figure 2-2 Indicative Proposed Portal Location

This will require the construction of a boxcut to obtain the required depth to connect to competent rock. The Haul Road will be realigned to meet this boxcut. The decline will be located to the northeast of the boxcut heading northwest to join existing and planned underground development.

This location will allow underground access to northeast areas of the Mine and will be closer to the ROM Pad which is used to stockpile ore prior to crushing, resulting in a reduction of the surface haul road route, from 2 km to 200 m. The area contains an historic waste rock dump and is already disturbed; no vegetation or heritage items are in the vicinity. It was included as a 'free area' in the original EA. There will be no additional land disturbance.

2.3 Periodic Crushing

Crushing activities are currently undertaken in Kintore Pit (EA) and BHP Pit (MOD7) and BHOP propose to continue these activities using a mobile crusher to produce material for road base, bunding and / or other site requirements. The location for these crushing activities is depicted in **Figure 1-1**.

2.4 Waste Rock Placement and Rehabilitation Capping

Since the commencement of mining operations BHOP has placed approximately 1,410,989 t of waste rock from underground workings into Kintore Pit (end 2019). Current mine plans (under the reduced production rates) have calculated total waste rock from mining operations to be brought to the surface from 2021 to the end of 2026 (current approved mining) as approximately 920,000 t.

It is proposed to co-dispose waste rock in Kintore Pit with the tailing (naturally dried that will be transferred from Blackwood Pit TSF2) with some material containing low or nil lead stored on the Kintore Pit Tipple or in BHP Pit where it would be tested and once its lead (Pb) content confirmed to be below <0.5%Pb used for rehabilitation capping.

In addition the development of the boxcut may generate approximately 440,000 t of waste material. This material has been deemed to be >0.5%Pb and will be permanently stored in Little Kintore Pit and in the infill area of BHP Pit, and then capped. Material from the new section of decline, to be installed to join existing and planned underground development, would be placed underground until the new portal opens and subsequently in the infill area of BHP Pit. All of this material is deemed to have a lead content >0.5%Pb.

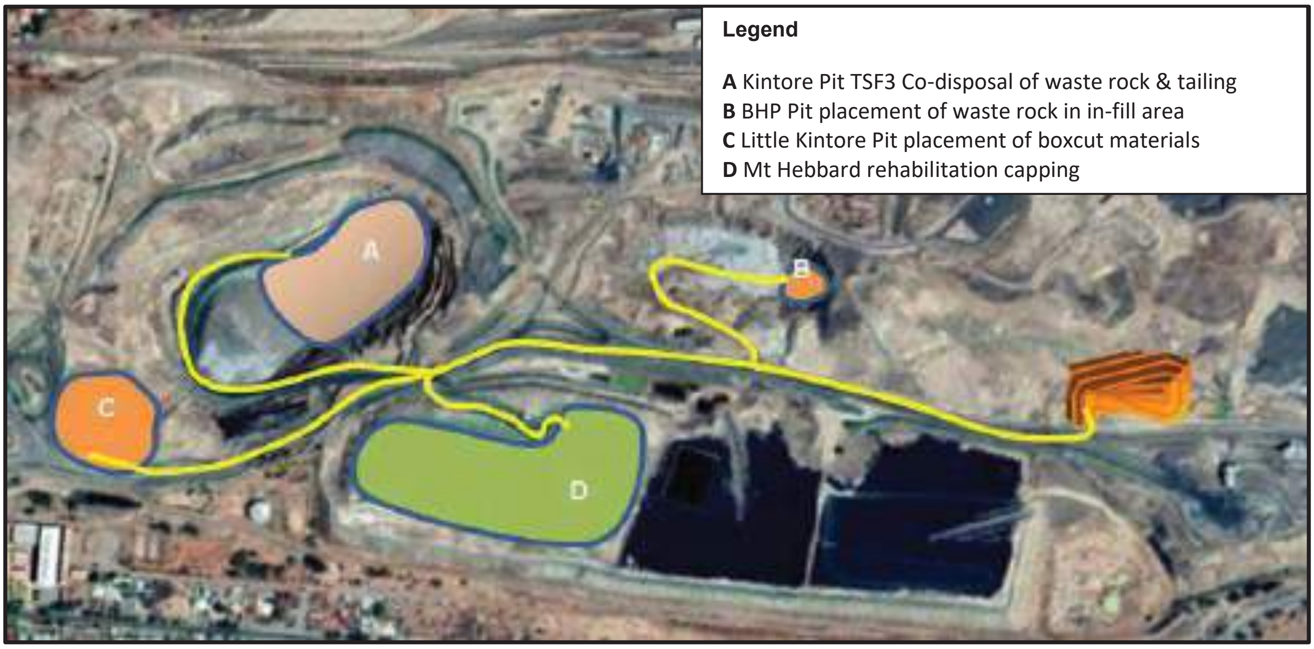
Table 2-1 provides a summary of the proposed placement for waste rock and quantities to be used for progressive rehabilitation capping. **Figure 2-3** indicates the proposed locations.

Table 2-1 Options for Waste Rock Placement and Rehabilitation Capping

Option	Location	Dimensions (at widest points) (m)	Area (m^2)	Lift Height (m)	Capacity (kt)
A	Kintore Pit co-disposed with tailing	W 360 L 480	NA	210	11,350
B	BHP Pit infill area only	D 14 W 80 L 80	NA	Infilled to current Pit floor level	197
C	Little Kintore Pit	D 17 W 125 L 130	NA	Infilled to current surface level	310
D	Atop Mt Hebbard historic tailing storage facility as rehabilitation capping.	L 320 W 130	32,000	NA	90
				TOTAL STORAGE CAPACITY	11,947

Note: 1 Waste Rock Loose density 2.2 g/cm^3
2 Final tonnages are indicative only and will be refined during final design, accuracy of final waste tonnage ±20%

Figure 2-3 Indicative Location Options for Waste Rock Placement and Rehabilitation Capping



3.0 DESCRIPTION OF PROPOSED MODIFICATION

This Section outlines details for the placement of tailing co-deposited with waste rock in Kintore Pit, installation of a new mine access portal and decline, tailing harvesting activities, non-ore crushing, waste placement and rehabilitation, and required administration changes.

3.1 Tailing and Waste Rock Co-disposal in Kintore Pit

Process tailing is currently deposited into Blackwood Pit TSF2 which will reach capacity in late 2022 when mining will cease if no alternative location has been approved for tailing disposal. Excess waste rock from underground mining is currently stored in Kintore Pit.

BHOP engaged Golder to undertake an investigation of both on-site and off-site opportunities for tailing storage. Golder identified several off-site possibilities all requiring land acquisition and extensive earthworks. The placement of tailing into Kintore Pit was the preferred option as there is no increase to the disturbance footprint and less impact to public and private land with the installation of pipe-works and access tracks. It was also the most cost effective option. Filling the Pit also provides a safer option at mine closure. An alternative analysis of these options will be provided in the EIS.

A general layout for the Pit is provided in **Figure 3-1**.

Investigations undertaken by Golder identified a number of issues that need to be considered in the design of the Pit as a storage facility, these include:

- Open cut excavations of the Pit that have exposed tailing from an old storage facility in the northern batter of the Pit.
- Old timber supports from crushed relict mine workings.
- Adits and shafts to old workings that are present in the batters on each side of the Pit, including behind the waste rock storage pile.
- Current Main Lode Drive (MLD) and old mine workings which are located below the Pit floor with a minimum rock cover thickness to the old workings of (approximately 10 m) and to the MLD (about 15 m). Once current mining operations are completed future access to the MLD will not be required and prior to commencement of tailing / waste rock disposal into the Pit, the MLD will be filled with waste material and barricaded to prevent access,

- Crown pillars separating the Pit floor from the old workings that were removed either during open pit mining or by previous underground remnant mining.
- A slope wedge failure that has occurred in the eastern batter of the Pit where the intersection of discontinuity planes in the rock slope have day-lighted in the batter slope. Failure of the wedge occurred in 2014 following a period of heavy rain.

Access to the current underground mine workings is via a portal and decline located at the base of the Pit into the toe of the western batter slope. The lower slopes of the western batter above and around the decline portal have been supported by a combination of resin bolts, split sets, cable bolts and fibre reinforced shotcrete. A plan view of the decline and access ramp is presented in **Figure 3-1** and shows the MLD branching at about 160 m with one ramp continuing to the northern mine workings and one turning back under the pit floor and connecting to the southern mine workings (Block 7).

The storage capacity of the Pit has been estimated by Golder at approximately 4.2 Mm^3. At current production rates for both waste rock generation and tailing placement, this provides approximately 12 years of capacity. There is the opportunity for this capacity to be extended by installing wall raises to the perimeter of the Pit however this will not form part of the MOD6 application.

The use of Kintore Pit as a tailing and waste rock storage facility requires closing the current underground mine access portal and decline. This will require managing old workings and recent mine workings beneath and around the Pit, to ensure dried and compacted tailing is contained within the Pit and address the risk of inrush to the underground workings. It will also involve the filling of the MLD and installing barricades to prevent access as this drive will no longer be required.

Based on current knowledge Golder have provided a concept design to install a concrete monolithic plug seal (20 m length) down the decline from the portal, followed by 50 m of waste rock backfill into the current decline. There are a number of safety measures being considered for the Pit and the plug seal will be designed as an additional safety measure against uncontrolled flow of seepage water or tailing into the mine workings. The final design of the plug will be made following a detailed geotechnical and risk assessment of the portal and decline rock conditions and will be provided in the EIS together with other required preparations within the Pit.

BHOP mining personnel are undertaking a review of all possible seepage / water flows through underground workings, including known historic workings, to identify any routes that may pose a risk to safety and require barriers. Where potential risks are identified Golder will design appropriate barriers with timing for their installation which will be reviewed by a geotechnical consultant.

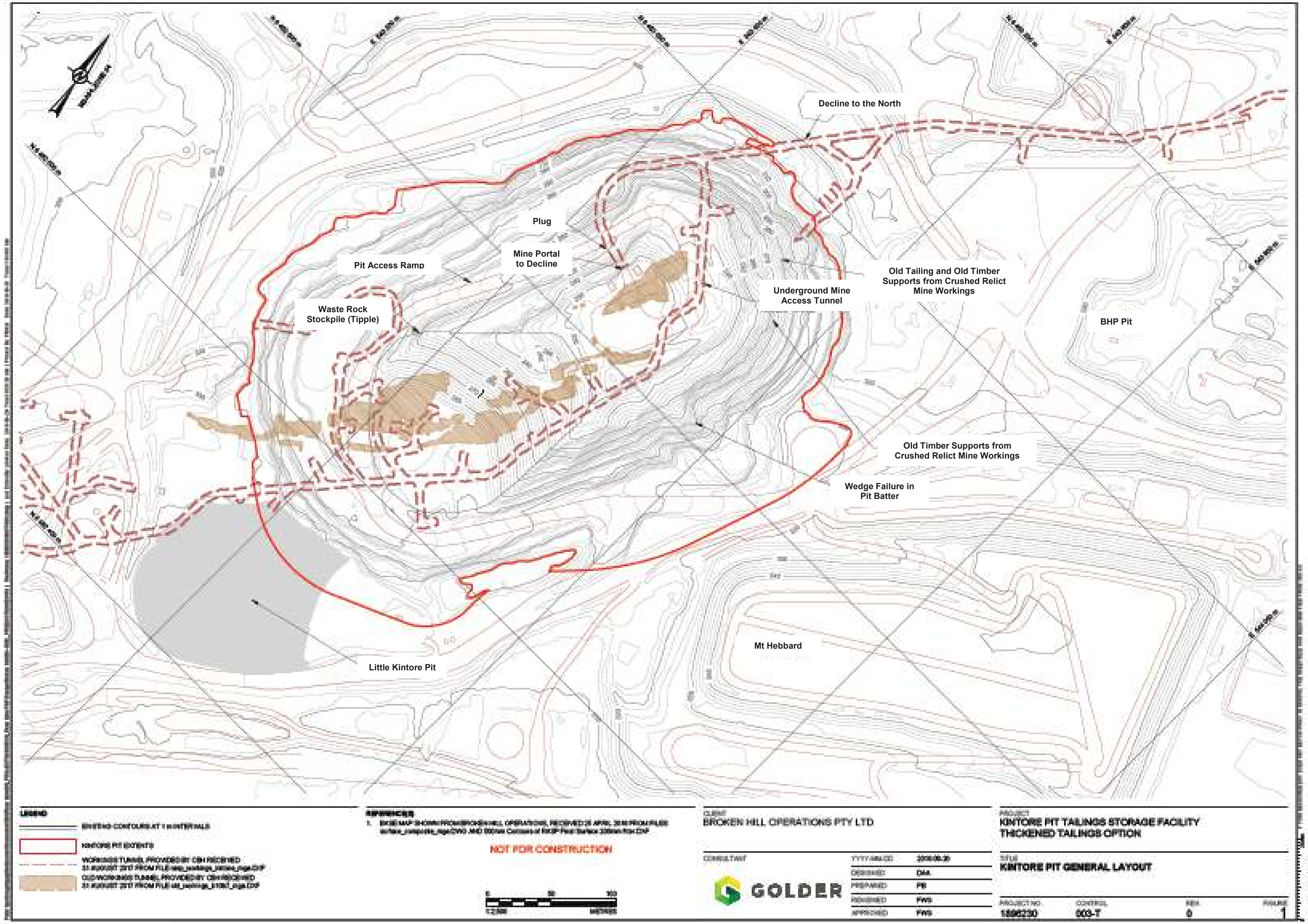
3.2 Tailing Harvesting

A risk assessment workshop held to address the risk of tailing inrush concluded that the tailing would need to be dewatered prior to deposition within the Pit, **Section 4.0**. BHOP engaged Golder to identify the maximum water content of the tailing to minimise the risk of inrush/inundation into underground mine workings. Golder concluded that to further minimise the potential for liquefaction of the tailing the optimal compaction moisture content was 10% for full stream tailing. This also results in a tailing that is sufficiently moist that it will not be dust generating but dry enough to be immediately trafficable. BHOP proposes to naturally (wind and solar) dry the tailing on the surface of Blackwood Pit TSF2 transferring the dried tailing for permanent storage into Kintore Pit TSF3.

Preliminary test results have shown that the current moisture content of the settled tailing in Blackwood Pit TSF2 varies between 9% to 12.5% therefore, where near surface tailing is removed, the required moisture level can be attained with no additional drying. The moisture content of the waste rock is approximately 3%.

The process for harvesting is currently under review with several options currently being assessed by Golder as the TSF2 Dam Engineer. With the installation of the embankments Blackwood Pit TSF2 was classified as a Declared Dam under the NSW *Dam Safety Regulations 2019* and once the harvesting methodology is known, consultation will be undertaken with Dam Safety NSW in accordance with these Regulations.

Figure 3-1 Kintore Pit General Layout



As a guide TSF2 would be divided into bays separated by bunding. Bunds will be constructed from waste rock material and are proposed to be approximately 1 m in height and 5 m wide to allow for access.

Figure 3-2 provides an indicative layout option for harvesting tailing. Tailing will be deposited alternatively between the bays keeping tailing beaching in the same direction without water pooling between the bays or tailing spilling from one bay to another. Any excess water will be directed (via natural gravity flow) to the northeast end of Blackwood Pit which will be kept to a minimum by pumping the water for reuse, in accordance with the current TSF Maintenance and Operations Manual.

Fresh tailing would continue to be placed in TSF2 and allowed to dry naturally (solar and wind), once sufficiently dried the tailing would be harvested and then transferred to Kintore Pit TSF3 continuing the cycle.

It is proposed to “shave” thin layers of the naturally dried tailing using specialised machinery such as a grader and dozers (D6) which will run along the length of a Bay scraping the tailing into windrows. These thinner layers are related to the drying time of hydraulically placed tailing allowing the layer to dry to the required moisture level.

Figure 3-2 Indicative Layout Option for Tailing Harvesting

Conceptual methodology proposes the use of two dozers to push the shaved tailing to the end of the Bay and form stockpiles in readiness for loading into trucks (60 t with 55 t payload) by an excavator and transferred to TSF3 or alternatively tailing may be pushed and directly loaded into trucks. Trucks would operate on an all-weather access track within TSF2 minimising the need for trucking directly on the tailing surface.

Tailing production within the mill operates 24 hours per day and may operate on a campaign basis or at current operating times (7 days per week). Tailing will be pumped to TSF2 as per normal methods with modified spigot locations. All other activities may occur on any day of the week, day shift only with operating hours 7 am to 6 pm Monday to Saturday and 8 am to 6 pm Sundays.

Under the current mine plan it is proposed to harvest a maximum of 480,000 tpa. **Table 3-1** indicates movements for the operation of mobile equipment for tailing harvesting activities and trucking to transfer tailing to TSF3.

Table 3-1 Indicative Mobile Equipment and Trucking Movements for Tailing Harvesting and Transfer

Equipment	Movements	
	Year	Day
2 D6 Dozers and 1 excavator	24,000	182
Trucks (55t payload)	8727	32

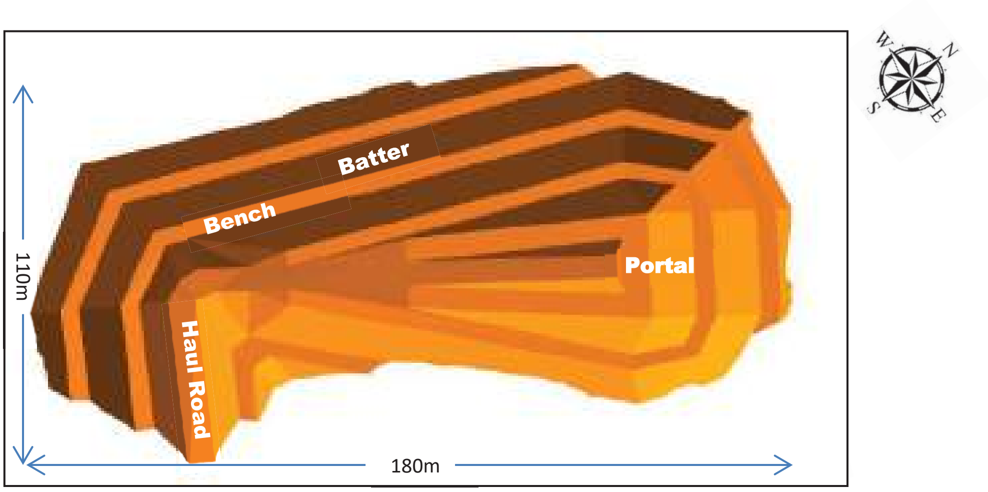
Full stream tailing will contains approximately 10% moisture and dusting is not expected however, a water spray system and water truck will be able to control any dust generation. In addition activities will be restricted to current site dust controls on windy days.

In addition the method for co-disposal of tailing with waste rock is currently under review by Golder.

3.3 New Boxcut, Portal and Decline Development

The construction of the proposed new underground access portal would require a boxcut constructed at a depth to reach competent hard rock material prior to the development of the new decline. The current design concept for the boxcut has been reduced, from that described in the previous Briefing Paper, to 180 m long and 110 m wide and up to 30 m deep at its lowest point prior to entry into the decline, **Figure 3-3**.

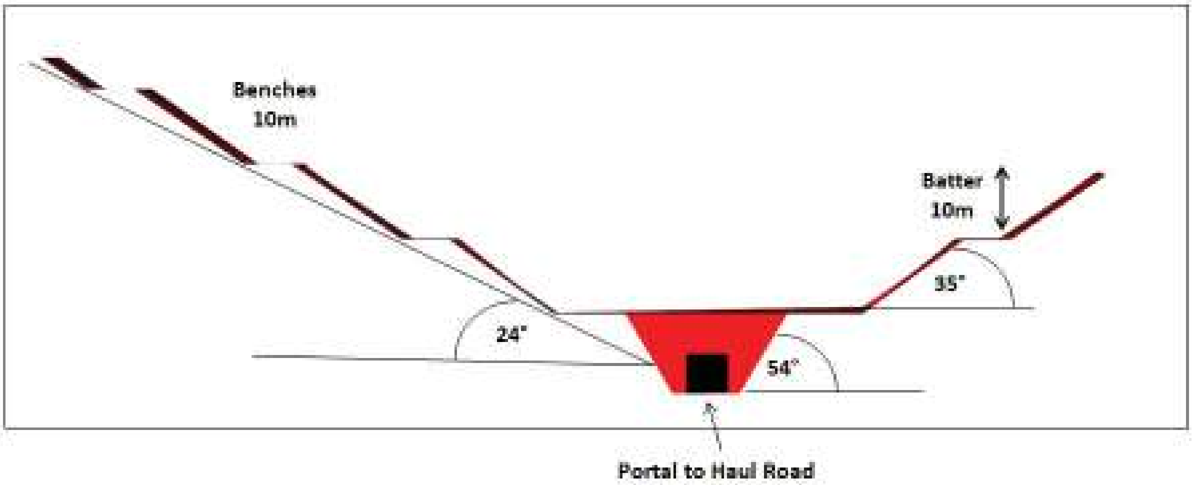
Figure 3-3 Indicative Proposed Boxcut and Portal



The overall slope angles for the boxcut would be 24^{o} with the Fill batter angle 35^{o} and the Rock batter angle 54^{o}, the benches would be 10 m wide and the batters 10 m high, **Figure 3-4**. This current design is the result of additional geotechnical information and improves geotechnical stability; the angle of the benches has been flattened, the benches have been made wider and the batters reduced in height and access has been moved slightly to the south to align better with the ROM Pad entry. The design may be further refined and this will be detailed in the EIS.

The boxcut will require the removal of approximately 440,000 t of material made up of predominately competent rock, waste and mixed rock fill, with small amounts of tailing (16,000 t) and slag (17,000 t). This waste material has been deemed >0,5%Pb as it is considered too difficult to separate out the lower Pb material. This material will be transferred to Little Kintore Pit and BHP Pit for permanent storage. On completion these Pits will be capped with material that has been tested and confirmed to be <0.5%Pb.

Figure 3-4 Cross-cut for Indicative Boxcut Design



A new decline will be installed from the proposed new portal and extend 400 m to meet existing and planned underground development. The total waste from this new section of decline is estimated as 40,000 t. The decline will be excavated from underground where possible with waste material placed in underground voids, once access is gained through the new portal, the material will be taken to BHP Pit for permanent storage. Conservatively all of this material has been deemed to go to BHP Pit for air and noise assessment modelling.

The proposed construction of the boxcut would be undertaken in three stages utilising a 65 t excavator, grader (12 m), 3 water carts (40,000 L), two D9 size dozers and up to six 43 t dump trucks. The 43 t trucks will be under-filled to 40 t to minimise spillage and dust exposure. The construction period will be approximately six months. This will require, over approximately 104 days, 10,889 truck movements taking waste material to in-pit storage areas (average 1,665 m distance). Using six 43 t trucks loaded to 40 t equates to approximately 11 truck movements per hour. This anticipates utilising shift times of 7 am to 6 pm, 6 days per week. It is proposed to undertake work on Sundays that will not adversely impact neighbours, particularly from machinery/truck generated noise, for example, maintenance activities.

The decline will be completed over an estimated period of three months, working normal mine shifts from underground over 24 hours per day 7 days per week and working 7 am to 6 pm 6 days per week from the surface, once access is gained through the new portal. Blasting methods will be designed by a mining specialist to minimise potential impact from vibration and overpressure, particularly in relation to the portal development. It is proposed where possible to mine the decline from underground to minimise surface impacts. Flyrock may be a potential risk with the development of the portal face and will be assessed as part of the EIS.

In operation there will be no change to the number and type of haul trucks used currently for transporting ore to the ROM Pad. The surface haulage distance to the ROM Pad will reduce from approximately 2 km to 200 m.

3.4 Periodic Crushing

Surface crushing of ore is undertaken in a fully enclosed crusher building under negative pressure venting to a baghouse. BHOP do not propose any changes to this activity.

Crushing of non-ore material (waste rock) is currently undertaken in Kintore Pit (EA) and BHP Pit (MOD7) and BHOP propose to continue these activities. Crushing is periodically conducted using a hired mobile crusher to produce material for road base (predominantly for underground roads), bunding and / or other site requirements.

Where waste rock material is proposed for use on the surface it is tested to confirm it contains <0.5%Pb prior to its placement. It is initially moisture conditioned with a water truck then stockpiled using a dozer. Moisture of the feed stockpile is maintained by use of a water truck equipped with sprays and high-pressure water cannon. An enclosed conveyor with water sprays is used to deliver crushed material to the stockpile. Following crushing the material is stockpiled for site use and dust is minimised using a water truck.

Crushing occurs periodically on a needs basis up to three times per year with the crushing activity occurring during day-time only, Monday to Friday, over a few days for each campaign.

3.5 Waste Rock Placement and Rehabilitation Capping

3.5.1 Waste Rock Characteristics

A waste rock study was undertaken in 2017 by Pacific Environment Ltd (PEL) for PA 07_0018 MOD4, Appendix K *Waste Rock Classification, March 2017*. PEL found that the bulk of the waste rock is composed of Garnet Pelite (GPE) and Psammopelite (PM), then Garnet Spotted Psammopelite (SPM) with very minor quantities of dolerite (DOL) and Garnet Quartzite (GQ) present. All of these rock types are described as hard and competent units with the exception of Garnet Pelite (GPE) 1 and 2, which is noted as a softer rock type that has been more susceptible to accommodating shearing. Conversely, DOL1 and DOL2 is rated as extremely hard rock with very high uniaxial compressive strength (UCS). An explanation of these geological rock description terms was contained within the report and will be described in the EA. The following discussion provides some highlights from the Report.

3.5.2 Particle size and moisture content

The waste rock composition was analysed for particle size and moisture content, and these results are presented in **Table 3-1**. PEL found that the moisture content of all samples was very low. Moisture content has a significant effect on rock strength, lower moisture contents are typically linked to increased rock strength which will impact how much weathering of the rock may occur over time.

PEL also found that the waste rock samples showed a consistent trend with a low proportion of small particle sizes. Laboratory reports showed that 4 of the 5 samples had 1% of the sample passing a 75 µm sieve; while one sample had 2% passing the 75 µm sieve. Significant volumes of dust are unlikely to be generated from particle sizes greater than 75 µm.

Table 3-2 Size and Moisture Characterisation

Sample ID	Moisture Content	Sieve sizes - Percentage Passing				
		75 mm	53 mm	19 mm	2.36 mm	75 µm (silt and clay)
1	3.1%	100%	52%	23%	8%	**2%**
2	1.6%	68%	49%	14%	3%	**1%**
3	3.1%	85%	47%	15%	5%	**1%**
4	3.4%	70%	47%	16%	5%	**1%**
5	3.4%	71%	49%	11%	3%	**1%**

Note - Results in **bold** represent particle sizes that are potentially 'dust producing'

Furthermore PEL found that the greatest percentage of any sample passing a 2.36 mm sieve was only 8%, with 2.36 mm considered to be the geotechnical cut-off point for fine grained soils. Silt is classed as particles of less than 75 µm, but greater than 2 µm; particles of less than 2 µm are classed as clay. Therefore, the average silt content of the five samples is 1.2%, which may include some proportion of clay particles and may be dust generating.

PEL also commented that "*importantly, it is also noted that the proportion of small or fine grained material in the waste rock pile is likely strongly influenced by the method of mining (blasting) rather than being reflective of the rock's natural degradation and erosion (which will be slow).*"

3.5.3 Metals Content

It is known that the waste rock comprises a number of different rock types, in varying quantities. The waste rock samples were crushed prior to metals analysis being undertaken in order to homogenize the sample. This eliminated or reduced the possibility of preferentially sampling of the finer material, that may potentially introduce a bias to analytical results. Samples (six) were taken in August and September 2016.

The analytical results have been summarised in **Table 3-3** and the National Environment Protection Measure (NEPM) Health Investigation Level (HIL) guidelines are provided for comparison. PEL concluded that the "Recreational' guidelines would be the most relevant given potential future land use.

The concentrations of all metals analysed, with the exception of lead, are within the NEPM HIL-C (recreational) and HIL-D (industrial/commercial) guideline criteria. Four of the six samples exceed the NEPM HIL-C (recreational) criteria for lead in soil, and two of the samples (samples 3 and 5) exceed HIL-D (industrial/commercial) lead criteria. The mean lead concentration of all six samples was 2,371.5 mg/kg exceeding the NEPM HIL-C guideline value of 600 mg/kg and the HIL-D guideline value of 1,500 mg/kg.

Table 3-3 Summary of Laboratory Analysis Results, Moisture and Heavy Metals

Analyte	NEPM Guidelines			Sample ID (results in mg/kg)					
	HIL A (Residential)	HIL C (Recreational)	HIL D (Commercial)	Initial (Composite)	1	2	3	4	5
Arsenic	100	300	3,000	13	9	241	34	26	75
Barium	ND	ND	ND	40	30	30	30	30	20
Beryllium	60	90	500	<1	<1	<1	<1	<1	<1
Boron	4,500	20,000	300,000	<50	<50	<50	<50	<50	<50
Cadmium	20	90	900	6	<1	5	57	4	17
Chromium	100	300	3,600	17	22	13	10	20	17
Cobalt	100	300	4,000	8	9	16	14	10	11
Copper	6,000	17,000	240,000	93	15	55	240	45	141
Lead	300	600	1,500	543	57	**905**	**9010**	**684**	**3030**
Manganese	3,800	19,000	60,000	78	91	258	405	174	188
Nickel	400	1,200	6,000	12	18	18	12	19	18
Selenium	200	700	10,000	<5	<5	<5	<5	<5	<5
Vanadium	ND	ND	ND	15	22	18	14	28	22
Zinc	7,400	30,000	400,000	1780	222	1420	21500	973	4060
Mercury	10	13	180	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
Moisture Content (%)	-	-	-	1.3	3.1	1.6	3.1	3.4	3.4

During the original Human Health Risk Assessment completed by Dr Roger Drew, Toxikos 2010, sampling was undertaken from various areas across the Mine and tested for lead content and its bioaccessibility. It was found that lead content alone did not determine how much was taken up into the human body and that the older more weathered material had the highest bioaccessibility, **Table 3-4**.

Table 3-4 Bioaccessibility of Lead in Surface Soils – Rasp Mine

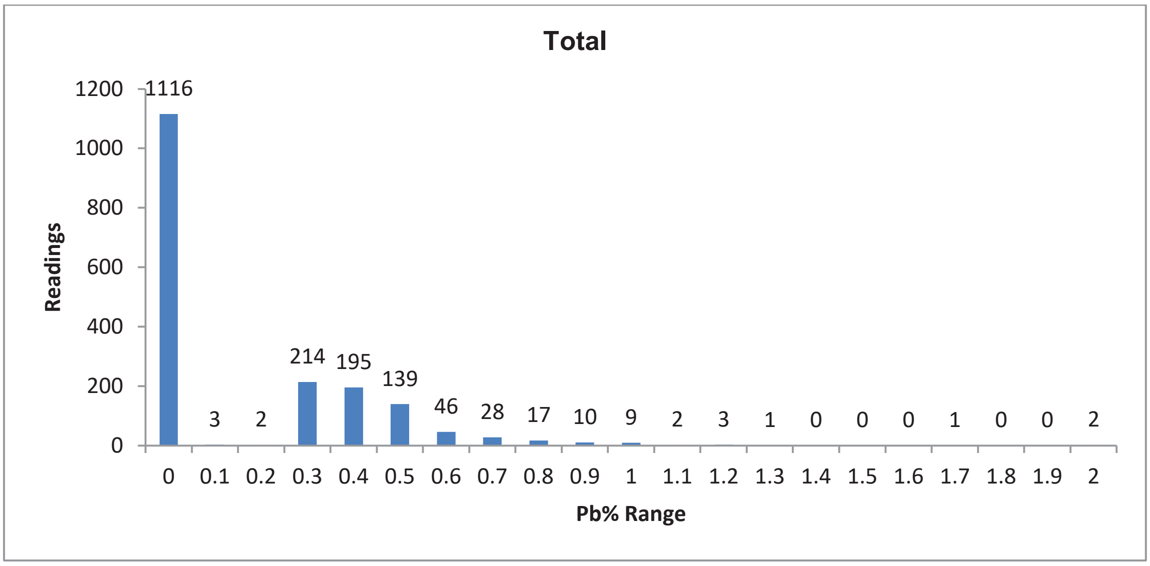
Sampling Point	Lead Concentration (mg/g)	Lead Concentration (mg/kg)	Lead Concentration (%)	Bioaccessibility (Bac) (%)
1	31	31,000	3.1	**14.6**
2	8.8	8,800	0.88	**3.6**
3	7.1	7,100	0.71	**8.5**
4	11.8	11,800	1.18	**6.1**
5	18.7	18,700	1.87	**3.7**

These lead concentration results are well above the levels found in waste rock sampling from the Kintore Pit Tipple with the exception of one sample (9,010 mg/kg) with the next closest result, 3,030 mg/kg. Therefore bioaccessibility of waste rock is expected to be low.

Figure 3-4 shows a summary of results of lead in waste rock from the Kintore Pit Tipple and the noise bund wall, undertaken for the Concrete Batching Plant. The results were obtained in-field using an XRF unit and maintaining a conservative approach by adopting the data at the highest end of the error margin. The number of readings taken was 1788 of which 1116 or 62.4% could not detect any lead, 93.3% (1669) of readings detected lead levels below 0.5% which is consistent with the findings by PEL of 0.237% lead content.

Broken Hill ore type is characterised for its very low pyrite content and the waste rock has even lower concentrations of pyrite, there is no visual evidence of acid drainage on the site. Some salts were evident in sampling and samples were high in calcium (major neutralising agent) however, there is insufficient information to draw any conclusions and further studies will be undertaken with the analysis reported in the EIS.

Figure 3-4 Waste Rock Sampling for Concrete Batching Plant



3.5.4 Waste Rock and Waste Material Placement

The material from the proposed new boxcut and decline is deemed to have a lead content greater than 0.5%. It is proposed that this material will be permanently stored in-pit within Little Kintore Pit and the in-fill area of BHP Pit. The volume of material is estimated at approximately 440,000 t from the boxcut and 40,000 t from the new decline (some of this material will be placed in underground voids prior to breakthrough and access is available to the surface via the new portal). The capacity of Little Kintore Pit has been estimated to hold 310,000 t and BHP Pit in-fill area 197,000 t.

It is also proposed to install waste rock with low lead content (<0.5%) as rehabilitation capping on the 'free areas' (non-active mine areas) of the site.

Location A – Kintore Pit TSF3

Location A Kintore Pit TSF3 has a capacity to hold approximately 9.4 Mt of tailing and it is proposed to co-deposit tailing with excess waste rock from underground mining.

No vegetation will be removed and there will be no addition to land disturbance.

Location B – Within BHP Pit, infill area only

BHP Pit is located centrally on the Lease near Delprats Mine and was in operation by BHP Pty Ltd in the 1890's through to the early 1900's, mining within the Pit ceased around 1907. No vegetation remains within the area and the area has been highly disturbed. Location B is approximately 717 m from the proposed new portal. There are a number of heritage items from the BHP era listed on the Broken Hill Local Environment Plan 2013, including building foundations, rock made wall, parts of an original headframe and a timber race, none of these items would be impacted. Barricades and signage are in place to separate activities currently undertaken in BHP Pit (ie waste rock storage, crushing and explosives storage) from heritage items.

BHP Pit is 180 m by 340 m and houses the Rasp Mine explosives magazine and ANE storage. The area proposed for waste rock storage lies to the north where the Pit is deeper. This proposed infill area is approximately 80 m (w) by 80 m (l) and 14 m deep and has a capacity of approximately 197,000 t.

Location C – Within Little Kintore Pit

Little Kintore Pit is located adjacent and to the south-west of Kintore Pit. It is approximately 130 m in diameter and 17 m deep. It is 1,751 m from the proposed new portal. Little Kintore Pit contains an old shaft that will be capped prior to material placement. There are no heritage items within Little Kintore Pit and there is no vegetation. The land is already disturbed by previous mining.

BHOP proposes to place waste rock containing higher levels of lead within Little Kintore Pit and cover with waste rock containing lead levels less than 0.5%. The capacity for waste rock storage at Little Kintore Pit is 310,000 t.

Location D - Atop Mt Hebbard

Mt Hebbard is an historic tailing storage facility completed in the 1970s. It lies to the south of CML7 adjacent to residential housing located along Eyre Street. This area was identified as elevated in lead by the Human Health Risk Assessment in the original EA.

The area is approximately 320 m x 130 m and there are no vegetation or heritage items within the area.

Preparation works will be required to upgrade the road to Mt Hebbard to allow truck access. These activities are expected to be of short duration occurring during daytime hours only.

BHOP have engaged a consultant to design capping placement to provide a permanent solution to minimise dust from wind entrainment and address surface water management. This study will also confirm that the surface is suitable and trafficable for the waste rock placement activities.

3.6 Administrative Amendments

Requests for administrative changes are also included in this EIS.

Noise Criteria

BHOP propose to seek new noise criteria in line with the results of additional noise monitoring identified during completion of noise modelling for MOD6 and requirements outlined in the NSW EPA *Noise Policy for Industry (2017) (NPfI)*. The NPfI has increased the minimum day RBL from 30 dB to 35 dB and the noise modelling for MOD6 will be undertaken in accordance with the new requirements. In addition further attended monitoring has been undertaken and this will be used to inform noise criteria levels for MOD6.

Annual Review / Annual Environment Management Report – waiting for section from Devon

Currently BHOP are required to provide two separate reports detailing environmental management performance to the Department of Planning Industry and Environment (DPIE):

(1) PA07_0018 Schedule 4 Condition 3 requires submission to the DPIE Compliance Section of an Annual Review (AR), and
(2) CML7 Condition 3 requires submission to the DPIE Resource Regulator of an Environment Management Report annually (EMR).

The reports are similar in their content; the MER reports on activities in a calendar year and is due on March 1 each year, and the AR is required to be submitted by the end of June each year for the reporting period may to April. This requires considerable duplication of staff time for to both identify and collect information and produce the two separate reports.

BHOP propose to provide a consolidated report addressing all issues for the one reporting period and as current internal reporting requirements run from January to December efficiencies could be gained if these reports aligned. Therefore BHOP seek a change to the PA to require the submission of the Annual Review to be March 1 to align to the EMR.

4.0 PRELIIMINARY ENVIRONMENTAL REVIEW

4.1 Preliminary Risk Review

In April 2018, HMS Consultants Australia Pty Ltd (HMS) was engaged by BHOP to facilitate a risk assessment on the proposed conversion of Kintore Pit to a tailing storage facility. The objective of the Kintore Pit TSF risk review was to assist in determining a safe and suitable option for converting the Kintore Pit into a TSF. This was attended by relevant BHOP management and consultants covering the fields of metallurgy, tailing storage design, mining engineering, geotechnical engineering, environment and safety **Tables 4-1** and **4-2** identify the potential relevant matters and key issues identified in the preliminary environment assessment for the proposed Kintore Pit tailing storage, new portal and waste rock stockpiles.

A risk review was also conducted by SP Solutions Pty Ltd in January 2020 and a further review is scheduled in September 2020. These assessments will further inform the EIS.

In addition BHOP conducted consultation meetings with regulators to identify their requirements for the development of the Project. These are summarised in **Table 1-3** and are addressed in **Tables 4-1** (potential risks during construction) and **4-2** (potential risks during operations).

The proposed MOD6 has the potential to result in additional environmental impacts to noise (including vibration and overpressure), air quality and community health. There is also a potential additional risk to mine safety from inrush and pit wall collapse associated with the depositing tailing above current mine workings and decline. In addition with the construction of the proposed new portal there is a potential risk of flyrock. BHOP will engage specialist consultants to provide assessments of potential significant impacts and advise on recommended measures to control any risks and inform detailed design. A summary of their conclusions and recommendations will be provided in the EIS.

Table 4-1 Review of Relevant Matters - Construction

Issue	Relevance	Key Issue
KINTORE PIT TSF3 (Preparation Works)		
Noise	Noise will be generated by: - closing portal and installing cement plug. Not considered a key issue as this work will be undertaken at the bottom of the Pit (110 m deep). - transport of cement for concrete plug. Not considered a key issue as cement trucks already enter the mine 24 hours/day for shotcrete, consistent with current practice. - truck movements within the Pit transporting waste rock material from the Tipple to the floor of the Pit together with excavators and dozers. Given the depth of the Pit and the time duration for these activities noise was not considered a key issue. However construction noise within the Pit will be included in the noise modelling for operations as it is planned to be completed 7 days per week during daytime hours.	 No No No
Dust	Dust will be generated by: - cement trucks to construct plug, not considered a key issue as there will be no increase in truck movements as haul trucks will cease from this location so no additional traffic in this area - excavation and truck movements from relocation of waste rock from Kintore Pit Tipple to Pit floor. Although the majority of dust will be contained within the Pit, it is considered a key risk given the volume to be relocated and the number of truck movements.	 No Yes
Community Health	The extent of preparatory works required will involve earthworks and the relocation of waste rock within the Pit which will be dust generating and will be included in the air quality and health risk assessments.	Yes
Traffic & Transport	There will be some increased traffic on public roads due to delivery of supplies and equipment but these will not be discernable from current deliveries.	No
Water	Additional water will be used for: - cement to construct plug, not considered significant as recycled water is proposed to be use - dust suppression, not considered significant as recycled water is proposed to be used	 No No
Heritage	No heritage items are located in the proposed project locations.	No
Fauna	The use of old adits or shafts within the Pit walls by fauna is not considered likely due to difficult access. There are no known fauna currently in these old workings and there is no safe access to inspect any openings.	No
Land Disturbance	No vegetation to be removed, no additional land disturbance will be required.	No
PORTAL & DECLINE (New Boxcut & Little Kintore Pit Preparation Works)		
Noise	Noise will be generated by: - earthworks using bulldozer and excavator to construct boxcut - Installing access ramp and filling / capping old shaft in Little Kintore Pit (impacts not considered material due to short duration of activities - surface blasting - truck movements removing waste material	 Yes No Yes Yes
Vibration and Overpressure	Vibration and overpressure will be generated by: - blasting to construct the portal and decline - vibration impacts to TSF1 and/or TSf2 causes liquefaction of tailing	 Yes Yes
Flyrock	Flyrock may be generated during surface blasting for the portal opening.	Yes
Dust	Dust will be generated by:	

Issue	Relevance	Key Issue
	- earthworks using bulldozer and excavator to construct boxcut - Installing access ramp and filling / capping old shaft in Little Kintore Pit (impacts not considered material due to short duration of activities - blasting activities for portal and decline - truck movements removing waste material	Yes No Yes Yes
Community Health	It has been assumed that the excavated/waste material will be >0.5%Pb and has been included in the air and health assessments.	Yes
Traffic & Transport	There will be some increased traffic on public roads due to delivery of supplies and equipment, it is not expected that these will be discernable from current deliveries. Increased traffic on internal roads will be addressed via the site's Construction Environment Management Plan.	No Yes
Water	Additional water will be used for: - cement for shotcrete at portal and decline not considered significant as recycled water is proposed to be used - dust suppression, not considered significant as recycled water is proposed to be use	No No
Power	High voltage power line runs along the Haul Road adjacent to the proposed boxcut and portal access.	Yes
Heritage	No heritage items are located in the proposed project locations.	No
Land Disturbance	No vegetation to be removed, no additional land disturbance will be required.	No
TAILING HARVESTING TSF2 (Preparation works)		
Noise	Noise will be generated by: - earthworks using bulldozer and excavator to form dividing bund between bays and platform for harvested tailing stockpiles (if required) As these works will be conducted over one week it is not considered a key issue however noise will be included in the construction scenario for modelling.	No
Dust	Dust will be generated by: - minor earthworks to form dividing bund between tailing drying areas and platform for harvested tailing stockpiles As these works will be conducted over one week it is not considered a key issue however dust will be included in the construction scenario for modelling.	No
Community Health	Tailing contains very low Pb levels (average <0.3%) As these works will be conducted over one week it is not considered a key issue however results from the air modelling will include any dust generated from this activity and will be used for the human health risk assessment.	No
Traffic & Transport	There will be no increase in traffic movement due to these activities.	No
Water	Additional water will be used for: - dust suppression, not considered significant as recycled water is proposed to be use	No
Heritage	No heritage items are located in the proposed project locations.	No
Land Disturbance	As these works will be completed within TSF2 on already disturbed land.	No
WASTE ROCK PLACEMENT & REHABILITATION CAPPING (Preparation works)		
Noise	Noise will be generated by earthworks using an excavator to upgrade the road to the top of Mt Hebbard to allow truck access. As it is expected that this will be of a short duration (less than 1 week) and conducted during daylight hours, it is not considered material to noise levels.	No
Dust	Dust will be generated by earthworks using an excavator to upgrade the road to the top of Mt Hebbard to allow truck access. As it is expected that this will be of a short duration (less than 1 week), it is not considered material to dust levels.	No
Land Disturbance	As these works will be completed within TSF2 on already disturbed land.	No

Table 4-2 Preliminary Risk Review - Operation

Issue	Relevance	Key Issue
KINTORE PIT TSF3 (Placement of tailing and waste rock)		
Inrush	Inrush could occur from: - moisture content of tailing, - tailing liquefaction from seismic event, mine blasting, subsidence of old workings, Pit wall failure - water migration along major fault lines, unknown connection from underground workings to TSF - seepage or perched water table accumulation - old workings that may provide a pathway for water flow - erosion of pit walls, particularly old tailing slope	Yes Yes Yes Yes Yes Yes
Ground Failure	Ground failure could occur from: - Pit wall failure - Fault zones and geological structures - Stress change during filling - Failure of ground support in current drives - Failure of Pit floor	Yes Yes Yes Yes Yes
Noise	Noise will be generated by: - earthmoving equipment spreading and compacting the tailing, primarily as tailing reaches closer to the surface - trucking of excess waste rock from underground mining	Yes Yes
Dust	Dust may be generated by: - earthmoving equipment spreading and compacting the tailing and waste rock primarily as material rises in the Pit - as the level of tailing rise closer to the surface and the tailing further dries out - trucking of excess waste rock from underground mining	Yes Yes Yes
Community Health	Dust, which may contain lead, may be generated from tailing and waste rock primarily as the surface of the material rises closer to the surface	Yes
Water	Water may collect in a sump within the Pit, particularly with rainfall events (this will be used for dust suppression within the Pit or recycled to the Mill as current practice) Tailing may impact groundwater water quality.	No Yes
Traffic & Transport	Transfer of harvested tailing from Blackwood Pit TSF2 to Kintore Pit TSF3 will be undertaken by trucks.	Yes
Waste Management	There are no wastes generated from the tailing deposition	No
Fauna	The use of old adits or shafts within the Pit walls by fauna is not considered likely due to difficult access. There are no known fauna currently in these old workings To address the potential for fauna habitats within old adits and shafts an inspection (when safe access is available) shall be undertaken. It is proposed that these inspections occur during the life of the facility as tailing levels rise and access to old voids/workings becomes available.	Yes
Land Disturbance	Activities will be undertaken on already disturbed land	No
Rehabilitation	Rehabilitation of the filled Kintore Pit will need to be considered	Yes
PORTAL & DECLINE		
Noise	Although the Haul Road will be shortened a new section of road will be used exiting from the boxcut to the Haul Road requiring noise modelling to be updated. Waste will be transferred from underground via the portal to Kintore Pit Tipple and Kintore Pit TSF3 by trucks. Vehicle movements for changeover will now be conducted in the Laydown Area adjacent the boxcut and not on Kintore Pit floor.	Yes Yes Yes
Dust	From new portal road to Haul Road. Waste will be transferred from underground via the portal to Kintore Pit Tipple and	Yes

Issue	Relevance	Key Issue
	Kintore Pit TSF3 by trucks. Vehicle movements for shift changeover will now be conducted in the Laydown Area adjacent the boxcut and not on Kintore Pit floor.	Yes Yes
Community Health	There will be no additional impacts to community health with reduced haulage route some reduction may occur. Waste will be transferred from underground via the portal to Kintore Pit Tipple and Kintore Pit TSF3 by trucks.	No Yes
Surface Water	There will be no additional water used, management of rainwater runoff and collection around the boxcut and portal will be addressed in the Site Water Management Plan.	Yes
Traffic & Transport	The surface Mine Haul Road taking ore to the ROM Pad will intersect with trucks from harvested tailing and traffic from the Mill and Rail Loadout area.	Yes
Waste Management	No additional waste generated	No
Land Disturbance	There will be no additional land disturbance	No
Rehabilitation	The boxcut will need to be rehabilitated	Yes
TAILING HARVESTING		
Noise	Will be generated by mobile equipment within Blackwood Pit TSF2 and truck movements transferring tailing to Kintore Pit TSF3.	Yes
Dust	Will be generated by excavator and dozers scraping and collecting the tailing and placing in stockpiles, truck loading and trucking movements transferring tailing to Kintore Pit TSF3.	Yes
Community Health	Tailing contains some lead (average 0.3%Pb).	Yes
Ground Failure	Impacts to the integrity of the embankment structures could occur from: - Vibration of mobile equipment and trucking activities - Activities within the Pit that undermine the foundations of the embankments - High rainfall events impact surface integrity resulting in loss or roll-over of mobile equipment or trucks	Yes Yes
Vibration	Vibration from mobile equipment and trucks operating within TSF2 impact surface stability and may result in subsidence.	Yes
Surface Water	Water sprays will be used for dust suppression however will be limited and recycled water to be used.	No
Traffic & Transport	Internal traffic with interaction between ore haul trucks and tailing transfer trucks.	Yes
Waste Management	No additional waste generated	No
Land Disturbance	Activities will be undertaken on already disturbed land within Blackwood Pit TSF2.	No
Rehabilitation	Rehabilitation of Blackwood Pit TSF2 will be delayed. A conceptual rehabilitation plan was provided as a part of MOD4.	No
PERIODIC CRUSHING		
Noise	There will be some noise generated from increased traffic and crushing activities however due to the short duration of these activities, which are to be conducted during daytime only, it is not expected to have a material impact on noise levels.	No
Dust	There will be some dust generated by increased traffic, stockpiling, crushing and material collection and placement. However due to the short duration and low instance during the year for these activities it is not expected to have a material impact.	No
Community Health	There will be some dust generated by increased traffic, stockpiling, crushing and material collection and placement. However due to the short duration and low instance for these activities it is not expected to have a material impact on community health.	No
Water	There will be some additional water used for dust suppression in regards to stockpiled material and crushing activity, however due to the short duration and low instance for these activities water demands are not expected to impact current water supplies.	No

Issue	Relevance	Key Issue
Traffic & Transport	There will be some increase in internal traffic taking material to stockpiles for crushing and removing and placing crushed material. However as these activities are for short periods no impact to current traffic systems are expected.	No
Heritage	There are no listed heritage items located in Kintore Pit, the listed heritage items located in BHP Pit have been barricaded for protection from all mining activities and will not be affected.	No
Visual Amenity	Crushing activities will be conducted in-pit and will not be visible from residential areas of Broken Hill.	No
Land Disturbance	There will be no additional land disturbance as crushing activities will be conducted in disused mine open pits.	No
WASTE ROCK PLACEMENT & REHABILITATION CAPPING		
Noise	Noise will be generated by: - haul trucks delivering waste rock for rehabilitation capping - dumping of waste rock	 Yes Yes
Dust	Dust will be generated by: - haul trucks delivering waste rock - dumping of waste rock - stockpiling waste rock and loading into trucks on the Tipple, for rehabilitation capping	 Yes Yes Yes
Water	There may be some changes to surface water management and this will be addressed in the updated Site Water Management Plan - water may be used for dust suppression during dumping - management of rainwater runoff and collection around capped area	Yes
Community Health	Waste rock will be confirmed at <0.5%Pb which is a reduction on the content of the current surface materials. A reduction in current dust from wind entrainment is expected removing the need for the application of chemical dust suppressant. Transport of waste from the Kintore Pit Tipple to the capping area may result in dust with elevated Pb levels.	No Yes
Geotechnical and Geochemical Characteristics	Waste material to be paddocked dumped. Surface stability may be impacted by waste rock placement activities. Long term impacts of material are unknown and will be addressed in a Long Term Waste Rock Study.	Yes Yes Yes
Traffic & Transport	There will be no affects to off-site traffic or transport Some increase in internal traffic only from Kintore Pit Tipple to capping area and is not expected to impact.	No
Spontaneous Combustion	The waste rock has very low concentrations of pyrite and therefore the material is not considered to have a risk of spontaneous combustion	No
Heritage	There are some heritage items located in BHP Pit however these are separated with barricades from current mining operations and will not be impacted by the placement of waste rock. Confirmation will be sought to confirm if a controlled action under the EPBC Act. Details shall be outlined in the EIS	No
Visual Amenity	The rehabilitation capping will be offset from the edge of the capping area and will not be visible from the town and will be consistent with the current mining landscape.	No
Land Disturbance	There will be no additional land disturbance, capping areas have no vegetation.	No

4.2 Kintore Pit Tailing TSF3 – Discussion of Key Issues

The key potential issues identified for pit preparation works and the storage of tailing and waste rock in Kintore Pit are discussed in the following sections.

4.2.1 Dust

Potential key issue

Pit preparation works include the movement of approximately 300,000 t of material with truck movements within the Pit taking the majority of this material from the Kintore Pit Tipple to the floor of the Pit. Although most of the activities will be undertaken 100 m from the surface over a period of 3 months, given the volume of material and number of traffic movements it was considered to include this as a key issue.

Dust generation during the operation of the dozer / roller working on the tailing is unknown. It is anticipated that potential dust issues may only arise when the level of tailing / waste rock rises closer to the surface.

Proposed management measures and studies

- Pit preparation and construction works will be undertaken within the Pit and any dust generated will be managed through normal operating practices. Dust generated from these activities has been included in the dust modelling under the construction scenario.
- The dust modelling results will inform the human health risk assessment.
- Method for tailing deposition to minimise dust and will be addressed in the Golder design report.
- Air modelling consultants will also review any additional requirements for dust monitoring.
- As tailing rises closer to the surface instigate additional dust mitigation measures.
- Use of chemical dust suppressant, where required.
- Conduct air quality modelling and include potential for dust generation during construction and operation, include operations in the cumulative air quality assessment. Model the potential for lead bearing dust to lift off tailing storage facility.
- Update of the Air Quality Management Plan.

4.2.2 Community Health

Potential key issue

Dust, which may contain lead, may be generated as the tailing rises closer to the surface.

Proposed management measures and studies

- Conduct dust modelling and include potential for lead bearing dust generation in cumulative air quality assessment.
- Include the potential for lead bearing dust from tailing in Human Health Risk Assessment and predictions for Broken Hill community blood lead levels.
- Assess and determine dust monitoring requirements for Kintore Pit.
- As the tailing rises closer to the surface instigate additional dust mitigation measures.

4.2.3 Inrush

Potential key issue

BHOP operate a portal and decline from the base of Kintore Pit to access underground mine workings. The MLD runs beneath the Pit allowing access to both the south-west and north-west workings. Historic workings are also located beneath and around the Pit, not all of these historic mine areas are known and/or logged. Any crown pillars that may have been below the Pit have been removed by previous mining. The portal access and a number of exposed and unknown voids, shafts, adits and geological faults are within the Pit. Not all possible water pathways are known.

Inrush poses a credible risk to underground workings where water can find its way via various pathways:

- Tailing and waste rock contain water which may pose an inrush risk.

- Possible liquefaction of the tailing which may occur from a seismic event, mine blasting, subsidence of old workings or pit wall failure which can trigger the event.
- Water could also enter underground workings from migration along major fault lines, unknown connections between underground workings to the TSF, seepage or perched water table accumulation which suddenly releases and erosion of pit walls, particularly the old tailing slope.

Proposed management measures and studies

Measures to minimise the risk of inrush will be determined during the detailed design however the preliminary risk assessment has identified the following measures to be considered and studies to be undertaken:-

- Fill the MLD with waste rock and barricade to prevent access prior to disposal of tailing / wast rock into Kintore Pit TSF3.
- Dewatering of full stream tailing to achieve the optimal compaction using naturally dried tailing from Blackwood Pit – tailing harvesting methods study and in-situ compaction testing.
- Adequate tailing compaction within Kintore Pit (critical state moisture content assessment).
- Design of tailing placement in TSF3 to address drainage and potential for seepage and will be addressed in the Golder concept design report.
- Installation of an engineered plug seal to portal to be designed to withstand full hydrostatic head and possible dynamic loads and other plugs/barriers as determined by further investigations.
- Undertake a seismic study.
- Undertake a mine water pathway study and assessment for further barriers if required.
- Sealing adits and old mine workings in the Pit walls where required (with waste rock) compacted tailing / waste rock will provide a base from which to treat these openings.
- Underground drive seepage water management.
- Surface water management - collect and pump excess water from the Pit and recycle to the Mill.
- Update the Tailing Maintenance and Management Plan.

4.2.4 Ground Failure

Potential key issue

The MLD is located beneath the Pit. The material above the MLD to the Pit floor is approximately 10 m to 15 m and crown pillars have already been removed.

Proposed management measures and studies

With the completion of current mining plans there access along this Drive will no longer be required, It is proposed to fill the Drive with waste rock and install barricades to stop access. BHOP will engage a suitably qualified consultant to confirm the methodology and provide safety assurance.

4.2.5 Noise

Potential key issue

Construction works will be undertaken within the Pit and any noise generated will be managed through normal operating practices. Although noise was not considered a key potential issue for pit preparation works, given the current level of truck movements within the Pit, as activities 7 days per week (during day time hours) BHOP has included noise generation in the noise modelling for operations.

During operations a dozer will be used within the Pit to spread materials and a roller to compact the tailing, the potential for noise to be an issue will only be evident when the tailing reaches closer to the surface.

Proposed management measures and studies

- Conduct noise modelling for pit preparation works as part of operations noise assessment.
- Incorporate truck and mobile equipment movements in noise assessment.

- Conduct cumulative assessment for post MOD6 operations.
- Update of the Noise Management Plan.

4.2.6 Water Assessment and Management

Potential key issue

There may be some mixing of water from tailing with groundwater which may impact groundwater quality.

Proposed management measures and studies

- Provide groundwater assessment following tailing placement in Kintore Pit and the potential impact on groundwater quality.
- Provide seepage analysis for Kintore Pit, including water expression through the Pit walls.
- Provide details of water management including seepage management and stormwater management in the Pit.
- Provide underground drive seepage water management.
- Update the Tailing Maintenance and Management Plan.

4.2.7 Rehabilitation

The rehabilitation of Kintore Pit will be required and needs to be developed in consultation with DRG, BHCC and the inter-government group reviewing closure and rehabilitation options for the whole of the Line of Lode. A preliminary closure concept shall be provided in the EIS for both Kintore Pit and Blackwood Pit tailing storage facilities. The following items will be addressed:

- Details of rehabilitation plans and methods to ensure minimum dust emissions from the site.
- An assessment of slumping of tailing in Kintore Pit at closure.
- Justification for the use of waste rock armouring against other dust mitigation measures.
- Details for monitoring – air, water, slumping or subsidence post closure.
- Assessment of alternatives for rehabilitation (for dust suppression).
- Description of the final landform (subject to advice received from DRG and the inter-government group).

4.3 Boxcut, Portal & Decline – Discussion of Key Issues

The key issues identified during the construction and operations of the new portal are discussed in the following sections.

4.3.1 Noise

Potential key issue

A number of potential key issues for noise were identified during the preliminary risk review resulting from construction activities including noise from earthworks using bulldozer and excavator to construct boxcut, trucking of material to Little Kintore and BHP Pits and surface blasting.

There were no key issues identified during operations as the surface Haul Road taking ore to the ROM Pad for processing will be shortened. A new section of road (50 m to 100 m) will be installed exiting from the proposed portal to the Haul Road, the current Haul Road will then be crossed to gain access to the ROM Pad. Noise modelling will be updated to include these changes.

Proposed management measures and studies

Measures to minimise noise will be determined following noise modelling as part of the EIS, however the following will be considered:-

- Construction of boxcut and portal to be during daytime hours only, with plans to identify what equipment will be in use and its location over the weekly period.
- Schedule of works to minimise potential noise impacts to surrounding neighbours on Sundays.
- Identification and assessment of all feasible and reasonable mitigation measures that can be implemented.
- Use of 'squawker' type reverse alarms on vehicles used on site.
- Timing of surface blasting to minimise impacts to surrounding neighbours.
- Development of Construction Environment Management Plan – New Portal.
- Modelling of noise for construction and operations, including cumulative noise levels with operations.
- Update of the Noise Management Plan.

4.3.2 Vibration and Overpressure

Potential key issue

Vibration and overpressure will be generated during construction from blasting to create the portal and decline. There were no potential key issues identified for vibration and overpressure during operations.

The new portal and decline will be located close to TSF1 and / or TSF2. During construction blasting activity or truck movements may have the potential to impact these facilities causing liquefaction. The propensity for historic tailing material (TSF1 and TSF2) to liquefy as a result of the development of the decline and mining activities is unknown.

Proposed management measures and studies

- Design of blasting methods, parameters, blast size and during and the timing of blasts.
- Review monitoring requirements for blasting.
- Vibration and overpressure modelling will be undertaken to predict potential impacts for portal and decline development.
- Assess the potential vibration and overpressure impacts to surrounding residential and sensitive receptors.
- Assess the potential for liquefaction of TSF1 or TSF2 from blasting activities and in the case of TSF2, surface truck movements.
- Update the Technical Blasting Management Plan.

4.3.3 Flyrock

Potential key issue

Flyrock may be generated during the construction of the portal.

Proposed management measures and studies

The blast plans shall assess and indicate an exclusion zone which will be signed off by a competent person. The establishment and management of the exclusion zone shall be conducted via a formal procedure which explains the boundaries, evacuation, clearance checking methods, and requirements for removing the exclusion zone.

Summary details will be outlined in the Construction Environment Management Plan – New Portal.

4.3.4 Dust

Potential key issue

During the construction phase dust will be generated by earthworks using dozers and excavators to construct the boxcut, and truck movements to remove waste material. Increase in traffic with heavy and light vehicles using the Haul Road during construction of the boxcut and new portal.

During operations dust will be generated by haul trucks taking ore to the ROM Pad, however, this is not identified as a key issue as the shorter Haul Road will reduce dust levels from truck movements.

During operations dust will also be generated by truck movements transporting waste rock to Kintore Pit TSF3 for co-disposal with tailing. Waste rock will also be taken to Kintore Pit Tipple and/or BHP Pit for testing of its Pb content prior for use as rehabilitation capping (expected average one truck per day, Monday to Friday only).

In addition vehicles entering the Laydown Area at shift change may also generate some dust.

These activities will be included in proposed dust modelling which will include a cumulative assessment.

Proposed management measures and studies

- During construction water sprays and water trucks will be used to minimise dust. Dust management will be outlined in the Construction Environment Management Plan – New Portal.
- Management of potential dust generating activities on windy days will be addressed via current procedures which include suspension of works if required (where winds exceed 50 kph).
- Use of chemical dust suppressant, if required.
- The majority of the route transporting waste material will be on sealed roads.
- The section of the new road from the portal to the Haul Road shall be sealed.
- Conduct safety assessment for vehicle interactions on the Haul Road, including identification of control measures.
- Formulate Traffic Management Plan for Construction.
- An air quality assessment will be undertaken by a specialist and will include modelling to identify other areas for dust mitigation measures including a cumulative assessment with proposed operations.
- Update of the Air Quality Management Plan.

4.3.5 Community Health

Potential key issue

Dust, which may contain lead, may be generated with removal of materials for the boxcut, portal and decline and transport of these materials to storage areas.

Proposed management measures and studies

- Undertake analysis of the chemical properties of waste materials.
- Assess the potential for lead bearing dust from material removal and ongoing waste rock placement and assess the bioaccessibility of these materials.
- Identify and describe the air quality control measures used to ensure there is no net increase in blood lead levels.
- Review dust monitoring requirements for construction of the boxcut and portal, and road transport of this material, including ongoing waste rock removal via the portal to waste stockpiles.
- Determine dust suppression measures including the use of water sprays, misting and water truck or other as identified.
- Complete a Human Health Risk Assessment (including a cumulative assessment with current operations).

4.3.6 Power

A high voltage power line (22kV) runs along the ore Haul and Mill Roads. An assessment will be conducted to determine safety risks associated with the interaction of both construction vehicles and operations traffic and determine any required control measures.

4.3.7 Rehabilitation

At the time of mine closure the boxcut and portal will require rehabilitation. This will require some reshaping of the batters around the portal and backfill of the portal. A conceptual closure landform will be proposed in the EIS.

4.4 Tailing Harvesting - Discussion of Key Issues

There were no key issues identified for preparation works for tailing harvesting. The following key issues were identified for operation of the tailing harvesting.

4.4.1 Noise

Potential key issue

Noise will be generated by mobile equipment operating within Blackwood Pit TSF2 and truck movements transferring harvested tailing to Kintore Pit TSF3.

Proposed management measures and studies

Noise modelling undertaken for MOD6 will include noise generated by tailing harvesting activities and trucking of tailing to Kintore Pit TSF3.

4.4.2 Dust

Potential key issue

Dust will be generated by excavator and dozers scraping and (trucks) collecting the tailing and placing in stockpiles, truck loading and trucking movements transferring tailing to Kintore Pit TSF3.

Proposed management measures and studies

Surface tailing has a moisture content of approximately 12% and is not expected to be dusty. Normal operating practices such as the use of a water truck and chemical suppressants will be applied to minimise dust emissions during operations. The water spray system will also assist to further minimise dust.

Dust modelling undertaken for MOD6 will include dust generated by all tailing harvesting activities including trucking of tailing to Kintore Pit. All relevant metals have been included in this modelling which will form the basis for the Human Health Risk Assessment.

4.4.3 Community Health

Potential key issue

The tailing has a smaller particle size than waste rock and contains an average of 0.3% Pb.

Proposed management measures and studies

- Dust generated from tailing harvesting will be included in the dust modelling which will form the basis for the Human Health Risk Assessment.

4.4.4 Ground Failure and Vibration

Potential key issue

There is potential for the integrity of the embankments to be impacted by the vibration of mobile equipment and trucks operating within Blackwood Pit TSF2 and harvesting activities that could undermine the embankments particularly at EMB1 and EMB3 which are located on the tailing surface. High rainfall events may impact surface integrity resulting in loss or roll-over of mobile equipment or trucks.

Proposed management measures and studies

Golder, the nominated Design Engineer for Blackwood Pit TSF2, have been engaged to provide a methodology for tailing harvesting and will address these risks in their design report. In addition BHOP will consult with Dam Safety NSW regarding the harvesting process methodology and the potential to impact embankment integrity.

4.4.5 Traffic & Transport

Potential key issue

BHOP has identified a potential risk for internal traffic with interactions between ore haul trucks and tailing transfer trucks and both of these trucks with light vehicles.

Proposed management measures and studies

- An assessment will be undertaken by BHOP to determine controls and from the outcome of this investigation the Traffic Management Plan will be updated.

4.5 Waste Rock Placement and Rehabilitation Capping - Discussion of Key Issues

The key issues identified for waste rock placement and rehabilitation capping are discussed in the following sections.

4.5.1 Noise

Potential key issue

Noise will be generated by:

- During construction, by waste material being transferred from the boxcut to Little Kintore Pit (LKP) and BHP Pit.
- During operations, by haul trucks delivering waste rock to Kintore Pit TSF3 for co-disposal with tailing, and Kintore Pit Tipple and BHP Pit for testing and use as rehabilitation capping once Pb content is confirmed to be <0.5%Pb.
- Paddock dumping of waste rock at the rehabilitation capping area.

Proposed management measures and studies

Measures to minimise noise will be determined following noise modelling as part of the EIS, however the following will be considered:-

- Identification and assessment of all feasible and reasonable mitigation measures that can be implemented.
- Placement activities to occur during daylight hours only.
- Use of ‘squawker’ type reverse alarms on vehicles used on site.
- Modelling of noise, including cumulative noise levels with current operations.
- Update of the Noise Management Plan.

4.5.2 Dust

Potential key issue

Dust during the operation of waste rock stockpiles will be generated by:

- Haul trucks delivering waste rock to the stockpiles in Kintore Pit tipple and BHP Pit.
- Truck loading and dumping of waste rock in pits and at rehabilitation capping areas.

Proposed management measures and studies

Measures to minimise dust will be determined following air quality modelling as part of the EIS, however the following will be considered:-

- Use of a water truck and water sprays.
- Management of potential dust generating activities on windy days including suspension of works if required (winds exceed 50 kph).
- An air quality assessment will be undertaken by a specialist and will include modelling to identify other areas for dust mitigation measures including a cumulative assessment with operations.
- Update of the Air Quality Management Plan.

4.5.3 Community Health

The waste rock will contain low levels of lead and there is the potential, where dust is generated, to impact community health. BHOP will engage a suitably qualified specialist to assess any potential for health impacts and will provide the findings and recommendations in the EIS.

4.5.4 Geotechnical and Geochemical Characteristics

The design of rehabilitation capping will be completed by an experience engineer to provide the most appropriate structure and dumping method to minimise dust generation over time and address storm water management and acid mine drainage. In addition an assessment of the waste rock materials will be undertaken to provide a design that is safe, stable and non-polluting. Confirmation of the surface suitability and trafficability for the proposed waste rock placement activities will also be assessed.

Proposed Studies

- Assessment of long term geochemical degradation ie 100 to 500 years of waste rock used on surface coverings.
- Rehabilitation design report.

4.5.5 Rehabilitation

The waste material placement within LKP and BHP Pit will be capped with material containing <0.5% Pb and be shaped to align with the surrounding landform. Conceptual rehabilitation designs will be included in the EIS which will also address:

- Measures to minimise dust emissions from the site.
- Justification for the use of waste rock armouring against other dust mitigation measures.
- Details for monitoring – air, water, slumping or subsidence (post closure).
- An assessment of alternatives for rehabilitation (for dust suppression).
- Description of final landform.

4.6 Cumulative Environmental Impacts

The potential for cumulative impacts, that is impacts from construction and new operations with current operations, will be considered in the EIS, particularly in relation to potential noise and dust impacts.

It is also intended to hold a presentation event for the community of Broken Hill prior to finalisation of the EIS and details of this consultation will be included in the final EIS report.

5.0 BENEFITS OF THE MODIFICATION

The proposed modification would:

- Permit mining at the Rasp Mine to continue post 2022 with additional storage of tailing;
- Significantly reduce the surface distance of hauling ore from underground to the ROM Pad;
- Ensure continued employment of 186 full-time employees, 32 full-time contractors and indirectly over 200 casual contractors that provide specialist services when required;
- Engagement of approximately 20 contractors during construction and an additional 6 full time employees for operations
- Allows the filling of legacy open pits.
- Allow the resource to be fully utilised, and
- Allow BHOP to continue to support the sustainability and economy of Broken Hill.

It is considered that the proposed modification could be implemented with appropriate management of the increased risk of noise and dust generated primarily during the short construction period.

Placing tailing on the Lease in a disused pit results in no additional land disturbance, no interruption to local land use and farmers, no dust and noise that would result from off-site road traffic (from an off-site location) reduced costs for design, construction and operation.

Without approval of the MOD6 the Rasp Mine will cease operation in 2022 when current capacity for tailing storage is attained.

6.0 APPROVAL REQUIREMENTS

In addition to the application to the Department of Planning, Industry and Environment to modify the Project Approval 07_0018, BHOP will also seek to modify its Mining Operations Plan and will consult with the EPA to determine if any variation to its Environment Protection License 12559 is required.

7.0 ADDITIONAL INFORMATION

For additional information please contact:
Gwen Wilson
Group Manager – Safety health Environment Community
CBH Resources Ltd
Broken Hill Operations Pty Ltd
M: 0431 483 825

8.0 ACRONYMS

AR	Annual Review required under PA07_0018
BHCC	Broken Hill City Council
BHOP	Broken Hill Operations Pty Ltd
CBH	CBH Resources Ltd
CML7	Consolidated Mine Lease 7
DOL	Dolerite
DPIE	NSW Department of Planning Industry and Environment
EA	Original Project Environment Assessment Report
EIS	Environment Impact Statement
EMR	Environment Management Report required annually under CML7
EP&A Act	NSW *Environment Planning & Assessment Act 1979*
EPA	NSW Environment Protection Authority
g	grams
Golder	Golder Associates Pty Ltd
GPE	Garnet pelite
GQ	Garnet quartzite
GRES	GR Engineering Services Ltd
Ha	hectare
HIL	Health Investigation Level
HMS	HMS Consulting Consultants Australia Pty Ltd
kg	kilogram
km	kilometres
kph	kilometres per hour
kW	kilowatts
kV	kilovolts
(l)	Long
L	litre
LEP	BHCC Local Environment Plan 2013
LKP	Little Kintore Pit
m	metres
M	million
m^3	cubic metres
mg	milligram
MOD1	Relocation of the main ventilation shaft
MOD2	Crushing of ore permitted to occur at any time
MOD3	Extend underground mining into Block 7 (includes the Zinc Lodes)

MOD4	BHOP Modification for the erection of a Concrete Batching Plant and the construction of embankments to extend the life of TSF2
MOD5	Proposed modification for a Stores Warehouse extension, installation of a cement silo and adjustments to air quality monitoring requirements.
MOD6	Proposed modification to the PA for placing tailing in Kintore Pit and relocation of the mine access portal and waste rock stockpiles
MOP	Mining Operations Plan
NEPM	National Environment Protection Measure
Normandy	Normandy Mining Investments
NSW	New South Wales
PA	Project Approval 07_0018
Pb	lead
PEL	Pacific Environment Ltd
Perilya	Perilya Broken Hill Operations Pty Ltd
the Pit	Kintore Pit
PA	Project Approval 07_0018
PM	Psammopelitic
PM10	Particulate matter with equivalent aerodynamic diameter of 10 micrometres
RR	NSW Division of Resources Regulator
Rasp Mine	the Mine
ROM Pad	Run of Mine Pad (for ore storage prior to crushing)
SEPP	NSW State Environment Planning Policy
SPM	Garnet spotted psammopelite
SSD	State Significant Development
t	tonnes
tpa	tonnes per annum
tph	tonnes per hour
TSF1	Historic tailing storage facility
TSF2	Blackwood Pit tailing storage facility
TSF3	Proposed Kintore Pit tailing storage facility
UCS	Uniaxial Compressive Strength (measure of rock strength)
U/G	Underground
µg	microgram
µm	micrometre
(w)	Width
XRF	X-Ray Fluorescence Analyzer
Zn	zinc

APPENDIX N

Ground Control Engineering Report G0202 Geotechnical Assessment of the Rasp Mine Box Cut, dated 17 December 2020.

17 December 2020

Giorgio Dall'armi

General Manager

Broken Hill Operations (BHOP) – Rasp Mine

GEOTECHNICAL ASSESSMENT OF THE RASP MINE BOX CUT

Dear Giorgio,

Please find Ground Control Engineering's (GCE) report presenting a geotechnical assessment and slope design parameters for a proposed box cut for the Rasp Mine, Broken Hill NSW.

We trust that this report meets your requirements. Should you require further clarification, please do not hesitate to contact the undersigned.

Yours sincerely,

GROUND CONTROL ENGINEERING PTY LTD

Cameron Tucker

Principal Geotechnical Engineer

M 0400 449 845

E ctucker@groundcontrolengineering.com.au

Executive summary

Ground Control Engineering Pty Ltd (GCE) was commissioned by Broken Hill Operations (BHOP) to undertake a geotechnical assessment of a proposed box cut to replace the current access to the Rasp underground mine, currently situated at the base of the Kintore open pit.

GCE have completed a geotechnical assessment to develop slope design parameters for the box cut and provided preliminary ground support design requirements for the portal batter and upper sections of the decline linking the boxcut with the current Rasp underground workings.

The location for the boxcut was selected by BHOP based on operational factors. The location sites the boxcut excavation in historic surface waste rock and backfill material placed during the mining of the nearby historic BHP and Blackwood open pits. The boxcut location is also near historic underground, sand-filled workings., The location of the old workings has been estimated using original survey mining plans. The preferred location for the boxcut does not intersect the known underground workings apart from the Wilson and Darling Shafts located on what will be the western wall of the boxcut. These shafts originally connected the underground workings to the surface; however, it is understood these shafts were filled after abandonment. A known limitation with the underground historic data is accuracy and completeness of the available records. Investigative methods including probe hole drilling in the vicinity of the shafts and review of historic information is required.

Box cut slope design

Four geotechnical units (FILL, WEATHERED, TRANSITION and FRESH) were defined from geotechnical logging, and slope design parameters determined by empirical design and numerical modelling methods.

The upper portion of the box cut will be excavated in the FILL unit deposited as waste rock and backfill material from previous mining. The strength of this material is defined by its level of compaction, drainage characteristics and angle of repose. There are no records regarding the composition of the FILL unit and is assumed to be homogenous with respect to material properties for the purpose of this assessment.

The lower portion of the boxcut will be excavated in weathered rock (WEATHERED unit). The WEATHERED unit describes rock in a state of weathering ranging from extremely weathered to highly weathered with pervasive fracturing. The strength of the WEATHERED unit is variable, ranging from very low strength to low strength rock.

Slope design parameters for the box cut slopes are provided in the table below.

Bench Number	Geotechnical Unit	Maximum Batter Angle	Maximum Batter Height in Material	Bench Width	Maximum Slope Angle in Material	Maximum Slope Height
1	FILL	35°	10 m	8m	29°	18m
2	FILL / WEATHERED CONTACT	40°	10 m	10m	NA	10m
3	WEATHERED	54°	11 m	10m	34°	16.5m

Surface erosion

The annual rainfall in Broken Hill is less than 250mm per annum. Long term erosion of the boxcut batters and berms is not expected to compromise the stability of the boxcut slopes apart from minor narrowing of the berms and the forming of erosion channels on the batter slopes in FILL unit. Broken Hill occasionally experiences high intensity rainfall events which may result in increased boxcut slope erosion. Measures to control long term erosion should be adopted by Rasp and access to the benches in the FILL unit should be maintained if remedial works are required. The boxcut design incorporates wide berms to account for potential erosion of the berm crests over the longer term, however, erosion protection is recommended for permanently exposed boxcut slopes and benches.

Seismic loading

The Rasp Mine experiences irregular, low level seismic activity in part due to historic and current mining activity in the area. A preliminary assessment of seismic loading on the boxcut slopes was undertaken during this analysis. A peak ground acceleration (PGA) value of 0.15 was applied to the analysis according to the Geoscience Australia NSHA18 hazard map, the map depicts the mean PGA for a 10% probability of exceedance in 50 years. The results of the analysis predict stable boxcut slopes when a seismic coefficient of 0.15g is applied to the model. Such an event is unlikely to trigger failure of the de-watered slopes but should warrant a detailed inspection for possible remediation. Any TARP that is developed for ground conditions for the boxcut should include seismic activity.

Portal batter design

The portal face is expected to be excavated in the WEATHERED unit. Ground conditions are expected to be “Very Poor’ to ‘Poor’. GCE recommend that the final portal ground support design and initial decline support design is finalised once the portal batter is established.

Decline design and ground conditions

The decline will commence in the WEATHERED or TRANSITION rock unit, the expected ground conditions for the initial decline development are expected to be “Very Poor’ to ‘Poor’, consistent with the assessment of the rock units in this report. Ground conditions are expected to improve as the decline progresses towards less weathered rock units. An improved level of data pertaining to ground conditions along the decline path is recommended to refine the rock mass characterisation information which will facilitate the prediction of ground conditions ahead of the decline face.

The ground conditions for the decline will be managed according to the requirements of the Rasp Principal Hazard Management Plan (PHMP) – Ground or Strata Failure. Adverse ground conditions that fall outside the scope of the PHMP will be managed by exception.

Contents

Figures

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Appendices

1 Introduction

Ground Control Engineering Pty Ltd (GCE) was commissioned by Broken Hill Operations (BHOP) to undertake a geotechnical assessment and provide slope design parameters for a proposed box cut to replace the current access to the Rasp underground mine, currently situated at the base of the Kintore open pit.

The proposed location for the boxcut sites the excavation in historic surface waste rock and backfill material placed during the mining of the nearby BHP and Blackwood open pits. The boxcut location is also near historic underground, sand-filled workings. The location of the old workings has been estimated using historic survey mining plans. The location for the boxcut does not intersect the known underground workings apart from the Wilson and Darling Shafts located on what will be the western wall of the boxcut. These shafts originally connected the underground workings to the surface; however, it is believed that these shafts were filled after abandonment. A known limitation with the underground historic data is accuracy and completeness of the available records. Investigative methods including probe hole drilling in the vicinity of the shafts and review of historic information is required.

2 Scope of Work

The scope of work for this report was based on discussions between GCE and Rasp Mine technical management and comprised the following items:

1. Produce a conceptual boxcut design based on the BHOP preferred location.
2. Assess the condition of the slopes in the nearby areas to the proposed boxcut location.
3. Review of drill core from the geotechnical drilling programs to identify the base of the historic fill material and rock units.
4. Geotechnical analyses to define the site geotechnical conditions, determine slope design parameters and provide a ground support guidance for the decline portal.

The results of the 2018 and 2019 geotechnical logging and testing has formed the basis of the following assessment methods undertaken for this report:

1. Empirical analysis of overall wall angles (derived from Rock Mass Rating (RMR) values), from the geotechnical logging of drill holes from the 2018 and 2019 box cut drilling programs.
2. Two-dimensional limit equilibrium modelling to assess the Factor of Safety (FOS) of design slope configurations.
3. Empirical assessment of anticipated ground conditions for the upper sections of the proposed decline to determine preliminary ground support requirements.

2.1 Project description

Broken Hill Operations (BHOP) operate the Rasp Mine in Broken Hill NSW. The mine is an underground operation situated approximately in the centre of the Broken Hill Line of Lode. The access to the underground mine is via a portal constructed in the base of the Kintore open pit which was completed in the 1991. BHOP plan to convert the Kintore Pit into a tailings facility which will require an alternative access to the underground workings.

Figure 1 shows the location of the current portal location and proposed boxcut excavation

Figure 1 Kintore pit and box cut design outline within existing topography.

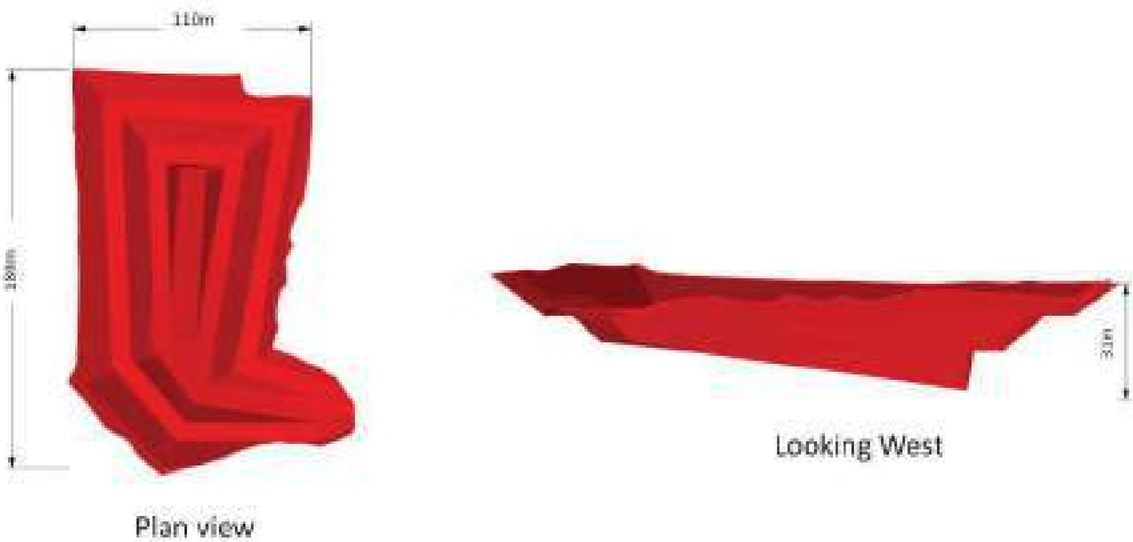
2.2 Boxcut dimensions

The proposed boxcut design dimensions are shown in Table 1 and Figure 2. The width of the box cut is constrained by the location of Rasp mine infrastructure on the eastern side of the boxcut and the mine boundary

Table 1 Boxcut design dimensions

Boxcut dimension	Unit	No
Length	m	180
Width	m	110
Maximum depth	m	31
Excavation voluime	m^3	181,000

Figure 2 Boxcut design dimensions, plan view and looking west.



2.3 Information sources

The following reports and data were provided to GCE for this assessment:

<u>Geotechnical logging and testing</u>

- BHOP Geotechnical logs and core photographs from the 2018 and 2019 box cut drilling programs:
  - 2018 Program
    - MLDD 3873
    - MLDD 3874
    - MLDD 3875
    - MLDD 3876
    - MLDD 3877
    - MLDD 3878
    - MLDD 3879

- 2019 Program
    - MLDD4132
    - MLDD4133
    - MLDD4134
    - MLDD4135
    - MLDD4136
    - MLDD4137
    - MLDD4138
    - MLDD4139
    - MLDD4140
- Trilab, 2018, 4 triaxial test results (3 consolidated-undrained (CU) triaxial tests).

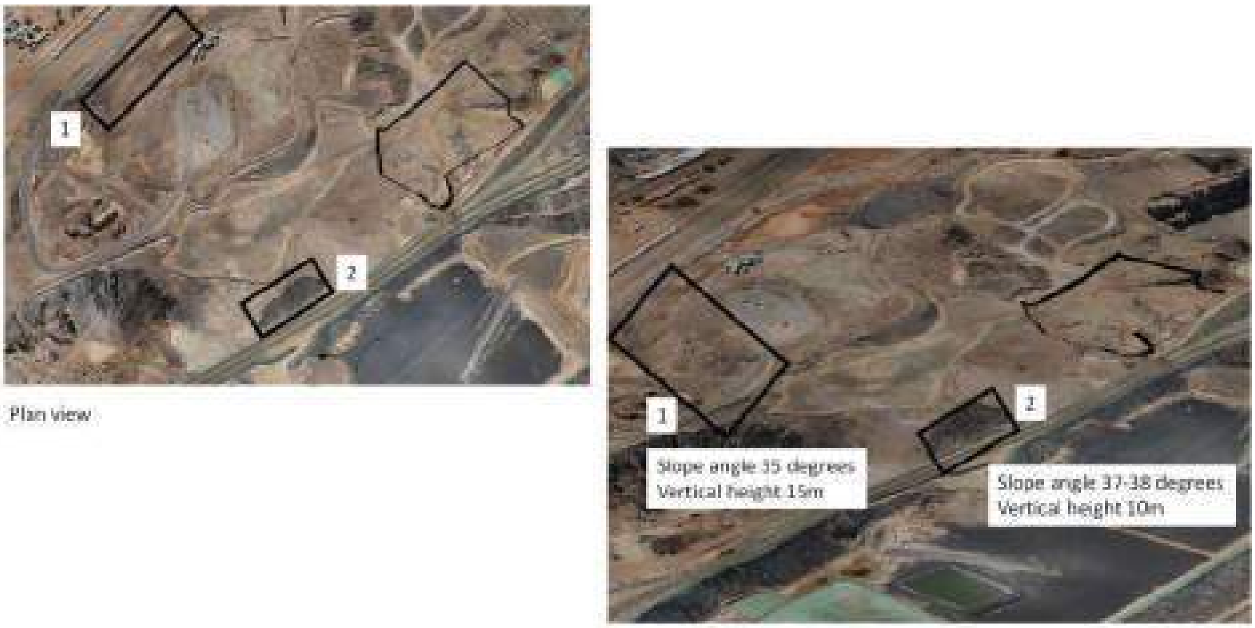
<u>Models and surfaces provided by BHOP</u>

- Surpac files showing location of historic underground workings
- Aerial survey data of the mine lease.

<u>Back analysis of existing slopes in the area</u>

There are several historically stable slopes in the immediate area of the boxcut that were constructed using waste rock and fill material during the mining of the Blackwood Pit Figure 3 shows the location of the fill slopes in relation to the proposed boxcut location.

Figure 3 Existing fill slopes in the boxcut area



Plan view

Perspective view
(Looking north - east)

2.4 Limitations

The geotechnical data collected from the drilling programs was analysed to define the boundaries between fill material, weathered rock, and fresh rock and to determine the insitu strength properties of the rock units.

Insitu strength testing of the fill material was considered, however due to the depth of the material and the variable nature of deposition, insitu strength testing was considered an unsuitable method for determining the material properties of the fill material. The material properties adopted for assessing the fill material have been derived from GCE's experience with waste rock and sandfill material behaviours, from back-analyses of the performance of historic fill sites on site.

Access restrictions and depth of fill cover limited the extent of the drilling program in the western area of the boxcut area. Several holes were drilled in this area without definitively intersecting rock due to the depth of fill cover.

The location of the old workings in the vicinity of the proposed boxcut location were digitised from historic mining plans by BHOP. The accuracy of this information cannot be verified or guaranteed without probe drilling or accessing the workings.

The location for the boxcut does not intersect known underground workings apart from the Wilson and Darling Shafts located on what will be the western wall of the boxcut. These shafts originally connected the underground workings to the surface; however, it is believed that these shafts were filled after abandonment. The location of the Wilson and Darling Shafts is shown in Figure 4.

Figure 4 Wilson and Darling Shaft locations – plan view

3 Geotechnical data collection

3.1 2018 and 2019 Geotechnical drilling programs

Seven diamond drill holes were completed in 2018, followed by 9 diamond drill holes in 2019, spaced over the boxcut surface area. The purpose of the drilling was to locate the base of the historic fill material that overlies the surface of the intended boxcut location and to characterise the weathering profile of the rock below the historic fill material. The details of the drill holes are provided in Table 2. The information gained from the geotechnical logging also formed the basis of the empirical analyses that was used in the determination of the portal batter and initial decline ground support design. a plan view of the hole locations is shown in Figure 5.

Table 2: 2018 /2019 Geotechnical drilling program – drill hole details

Hole ID	Depth (m)	Dip	Easting (m)	Northing (m)	RL (m)
MLDD3873	45.0	-90.0	9888.6	2351.0	10334.6
MLDD3874	36.0	-90.0	9989.4	2333.6	10325.0
MLDD3875	42.6	-90.0	9985.0	2177.8	10324.6
MLDD3876	44.4	-90.0	9935.2	2085.4	10335.5
MLDD3877	53.6	-90.0	9802.2	2259.7	10354.0
MLDD3878	42.0	-90.0	9771.0	2365.0	10352.0
MLDD3879	42.0	-90.0	9782.4	2426.0	10344.8
MLDD4132	41.0	-90.0	9842.4	2526.1	10343.3
MLDD4133	40.9	-90.0	9806.8	2524.2	10343.0
MLDD4134	40.1	-90.0	9807.2	2499.1	10343.2
MLDD4135	40.0	-90.0	9806.3	2477.5	10343.0
MLDD4136	40.1	-90.0	9806.9	2524.7	10342.9
MLDD4137	40.3	-90.0	9844.6	2500.1	10340.7
MLDD4138	41.0	-90.0	9876.1	2485.0	10342.1
MLDD4139	40.3	-90.0	9879.8	2501.7	10341.8
MLDD4140	40.9	-90.0	9886.0	2548.7	10335.8

Figure 5 Plan view of diamond drill investigation holes

Laboratory testing – Rock samples

Seven representative samples from the WEATHERED zone were taken from three of the drill holes and submitted for unconfined compressive strength (UCS) and triaxial testing. The results are summarised in Table 3 and Table 4 and presented in Appendix A

Table 3: UCS test results from 2018 geotechnical drilling

Hole ID	Sample Interval		UCS (MPa)	Failure mode
	From (m)	To (m)		
MLDD3874	24.7	24.9	16.0	Shear on bedding plane
MLDD3875	30	33.0	13.4	Multiple fracturing
MLDD3876	21	21.25	24.3	Fracture along core axis
MLDD3876	30	30.2	16.5	Shear on bedding plane

Table 4 Triaxial test results from 2018 geotechnical drilling

Hole ID	Sample Interval		Friction angle (°)	Cohesion (KPa)
	From (m)	To (m)		
MLDD3874	18.7	19.0	49.7	270.9
MLDD3876	31.4	31.6	32.2	92.4
MLDD3877	48.6	48.8	51.4	240.1

4 Geotechnical model

Based on the information obtained from the geotechnical core logging and review of digital models, GCE have divided the rock mass into geotechnical units. Four geotechnical units have been defined and slope design parameters determined based on the orientation of the box cut walls and geotechnical characterisation of the rock mass. By using this approach, zones of the rock mass with similar geotechnical properties and anticipated slope performance can be grouped together.

Table 5 lists the geotechnical units and their prevalence in the geotechnical drill holes.

Table 5: Geotechnical units as logged in the drill holes

Geotechnical Unit	Metres Logged
FILL	118
WEATHERED unit - Extremely Weathered to Highly Weathered rock	238.46
TRANSITION unit - Highly Weathered to Moderately Weathered rock	160
FRESH rock	15.9

4.1 Rock mass quality

The box cut will be excavated in slopes comprising material from the FILL and WEATHERED units with the upper batter (approximately 15m) excavated predominantly in the FILL unit and the lower batter and portal face excavated in the WEATHERED unit. The boxcut is not expected to intersect the TRANSITION or FRESH rock units.

The boundaries of the units were defined using information from the recent drilling programs. The spatial distribution of the drilling data was limited by access to the area where the western wall and end wall of the boxcut is planned to be excavated. For this assessment, the material properties for the east, west and end wall of the boxcut are considered homogenous.

Further characteristics to note include:

- The upper batter will be excavated entirely in the FILL unit deposited from previous mining. The strength of this material is defined by its level of compaction, drainage characteristics and angle of repose. The FILL unit is assumed to be homogenous with respect to material properties.
- The WEATHERED unit is characterised by material affected by ground water and oxidation. The unit is of very low to low strength.
- Several fragmented and highly fractured zones were intersected in all the drill holes in each of the (natural) units. These zones were characterised by sheared, low strength material in various states of weathering.

4.2 Ground water and surface water

The geotechnical drilling program intersected several intervals where ground water was present indicated by saturated material in the core. These areas were located at the interface between the FILL unit and WEATHERED units. It is likely the saturated layer was the product of a perched water table rather than a natural water table.

The perched water table is not expected to adversely affect slope stability as the ground water in the area drains through the old workings and is collected in the current Rasp underground workings. However, provisions for dewatering infrastructure (e.g. dewatering bores and depressurisation holes) should be made to manage groundwater and surface water flows during excavation of the boxcut and to reduce deterioration and weakening of the slopes due to water ingress.

This assessment does not consider surface water flows or flood bunding around the box cut. A hydrological assessment of inflows (both groundwater and storm water) into the box cut is recommended to accurately assess drainage requirements and manage water flowing into the decline.

As a minimum, good drainage infrastructure that prevents surface water running over slopes and pooling on berms will be required.

5 Geotechnical design

5.1 Design criteria

Mine slope design is essentially governed by two factors:

1. The consequences of failure; and
2. The degree of inherent uncertainty.

To accommodate these two design factors, it is common practice to apply an appropriate Factor of Safety (FOS) and/or Probability of Failure (POF) to the design geometry of mine slopes. An example of FOS and POF design criteria is provided in Table 6. These design criteria have been developed from a combination of Western Australian, Department of Mines, Industry Regulation and Safety.

Table 6: Examples of design criteria for open pit walls

Wall Class	Consequence of Failure	Design FOS	Design POF	Pit Wall Examples
1	Not serious	Not applicable		Walls not carrying major infrastructure) where all potential failures can be contained within containment structures

2	Moderately serious	1.2	10%	Walls not carrying major infrastructure
3	Serious	1.5	1%	Walls carrying major mine infrastructure (e.g. treatment plant, ROM pad, tailings structures)
4	Serious	2.0	0.30%	Permanent pit walls near public infrastructure and adjoining leases

For this analysis, a FOS of 1.5 was applied to reflect that the boxcut will be life of mine, permanent infrastructure.

5.2 Empirical assessment

Rock mass rating (RMR)

GCE have completed an empirical assessment of the rock mass comprising the WEATHERED and TRANSITION units using the geotechnical logging data processed into Rock Mass Rating (RMR), then Mining Rock Mass Rating (MRMR), to determine general slope angles. This approach is based on rock mass quality and assesses the likelihood of shear failure through the rock (rather than along structures). This has proven to be a highly effective approach for small to intermediate pit slopes where the method is based on numerous similar case studies.

Table 7 Core logged based on RMR

and

Table 8 show RMR values determined from assessment of the logging data.

Table 7 Core logged based on RMR

RMR Range	Description	Metres logged
≤ 20	Very Poor Rock	35
21 to 40	Poor Rock	86
41 to 60	Fair Rock	58.3
61 to 80	Good Rock	39.3
81 to 100	Very Good Rock	3

Table 8: RMR statistical data for each geotechnical unit

Geotech Unit	RMR				
	Minimum	25% Quartile	Median	75% Quartile	Maximum
WEATHERED	0	39	50	58	79
TRANSITION	0	56	65	73	83

Mining rock mass rating (MRMR)

MRMR values were derived for the WEATHERED and TRANSITION units and used to guide the determination of inter-ramp slope angles (IRSA) for the lower pit walls comprising the WEATHERED and TRANSITION units using the method of Haines and Terbrugge (1991). Median data was used to assess the design to account for the small number of data points available for the assessment (Table 9).

Table 9: MRMR statistical data

Geotechnical Unit	MRMR				
	Minimum	25% Quartile	Median	75% Quartile	Maximum
WEATHERED	0	11.3	23.5	40.0	34.4
TRANSITION	0	11.7	24.8	57.2	57.2

The Haines and Terbrugge design chart utilise MRMR to determine inter ramp slope angles (IRSAs) based on a number of case studies comprising pit slopes in rock. For this case, the Haines and Terbrugge design chart is applied to the bottom 10m bench which will be excavated in the WEATHERED unit. Overall stope stability will be addressed in Section 5.3

IRSAs for Factor of Safety 1.5, using the median value MRMR are shown in Table 10.

Table 10: IRSA using Haines and Terbrugge design chart

Geotechnical Unit	MRMR Median	Slope Height (m)	IRSA (Haines & Terbrugge)
WEATHERED	23.9	16	42°

5.3 Slope stability modelling

Representative sections were modelled using "Slide" 2D limit equilibrium software by Rocscience to identify slope design configurations that met or exceeded the FOS criteria.

The material properties for all units remained fixed for all slope configurations (Table 11). The Bishop simplified and GLE/Morgenstern-Price methods were used to assess for circular failure. Results are presented in Appendix B

Table 11: Material properties for Slide modelling

Geotechnical Unit	Strength Type	Unit Weight (kN/m^3)	Strength Parameters	
			Cohesion (kPa)	Friction Angle
FILL	M-C	20	5.0	36°
WEATHERED	M-C	24	92	32°
TRANSITION	M-C	24	270	50°

Notes: M-C – Mohr-Coulomb

Figure 6 show the overall model geometry for permanent slopes and Figure 7 shows detailed model geometry for the east wall of the boxcut.

Figure 6 Slide model configuration for permanent slopes

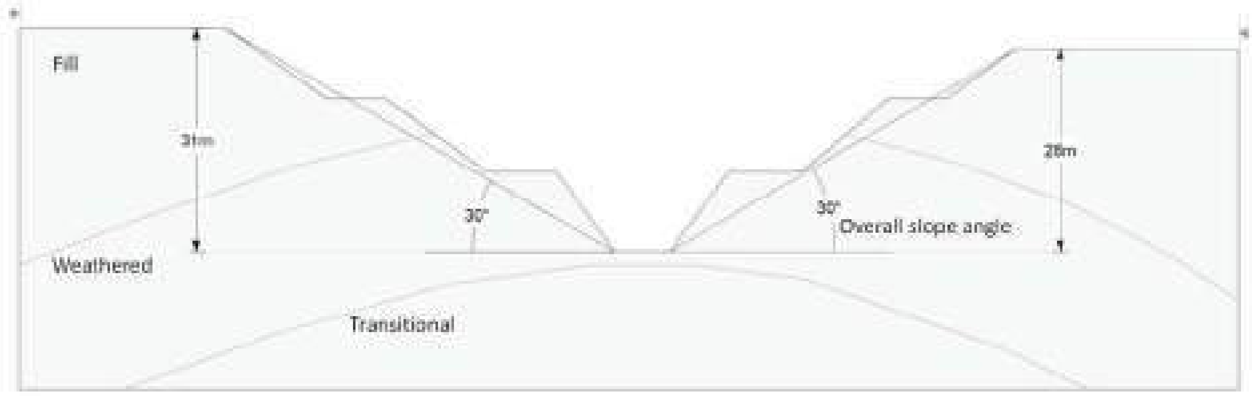
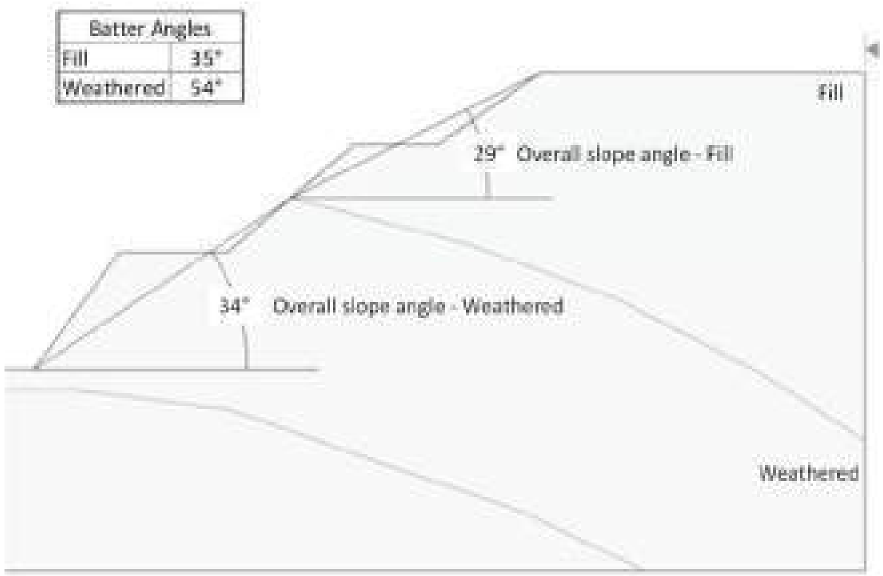


Figure 7 Detailed model geometry



Discussion on modelling results;

The results of the modelling indicate an overall slope angle of 30 degrees or less meets or exceeds the Factor of Safety criteria of 1.5

Slopes in the FILL unit

Based on the assumed geotechnical conditions, the modelling indicates stable slopes in the FILL unit at the proposed slope configuration.

Slopes in combination of FILL and WEATHERED units

Slopes constructed in both the FILL and WEATHERED units are expected to be stable at the proposed slope configuration.

Slopes in the WEATHERED unit

The results of the modelling indicate the slopes in the WEATHERED unit are expected to be stable at the proposed slope configuration.

Portal batter face

It is expected that the portal batter will be excavated in the WEATHERED unit. The stability of the portal batter may be compromised if FILL unit is present above the crown of the portal. Further detailed geotechnical assessment and a specific ground support design corresponding to the ground conditions encountered, will be required for the portal and portal batter face once it is exposed. It is important to note that the depth and overall shape of TRANSITION and WEATHERED units is based on limited information.

Two-dimensional modelling cannot account for confinement of slopes from the side walls (by the end wall) and the end wall (by the side walls). As such, it could be considered that the FOS results may be slightly higher if this confinement of abutting walls are incorporated into the modelling.

The model results are presented in Appendix B.

Seismic loading

The Rasp Mine experiences irregular, low level seismic activity in part due to mining activity in the area. A preliminary assessment of seismic loading on the boxcut slopes was undertaken during this analysis. A peak ground acceleration (PGA) value of 0.15 was applied to the analysis according to the Geoscience Australia NSHA18 hazard map, the map depicts the mean PGA for a 10% probability of exceedance in 50 years. The results of the analysis predict stable boxcut slopes when a seismic coefficient of 0.15g is applied to the model. Such an event is unlikely to trigger failure of the de-watered slopes but should warrant a detailed inspection for possible remediation. Any TARP that is developed for ground conditions for the boxcut should include seismic activity.

Surface erosion

The annual rainfall in Broken Hill is less than 250mm per annum. Long term erosion of the boxcut batters and berms is not expected to compromise the stability of the boxcut slopes apart from minor narrowing of the berms and the forming of erosion channels on the batter slopes in FILL unit. Broken Hill occasionally experiences high intensity rainfall events which may result in increased boxcut slope erosion. Measures to control long term erosion should be adopted by Rasp and access to the benches in the FILL unit should be maintained if remedial works are required. The boxcut design incorporates wide berms to account for potential erosion of the berm crests over the longer term, however, erosion protection is recommended for permanently exposed boxcut slopes and benches.

6 Portal batter design

The portal face is expected to be excavated in the WEATHERED unit. Ground conditions are expected to be “Very Poor’ to ‘Poor’ GCE recommend that the final portal ground support design and initial decline support design is finalised once the portal face is established and ground support is installed. Due to expected poor ground conditions, controlled perimeter blasting is recommended to avoid damaging the drive profile during the construction of the portal.

For ‘Very Poor’ ground conditions (Q<1), the portal face and wall should be supported with the following elements:

- 75 mm FRS (fibre reinforced shotcrete), strength UCS 40 MPa after 28 days over mesh. The FRS should cover the entire portal face and wrap over the portal bench by at least 2m and a minimum of 10m of wall coverage back from the face.
- The portal face should be cable bolted using 10m length, twin strand cable bolts at 2m centres. Cable bolts may be drilled slightly upwards at less than 5 degrees from the horizontal.
- Install 9m long spiling bars at approximately 300mm centres around the portal arch. Overlap 1.5m between spiling rounds.
- Ground improvement techniques including soil nailing and pressure grouting may be required for the portal batter if very poor ground conditions are encountered. This work should be undertaken before establishing the ramp to the portal batter face.

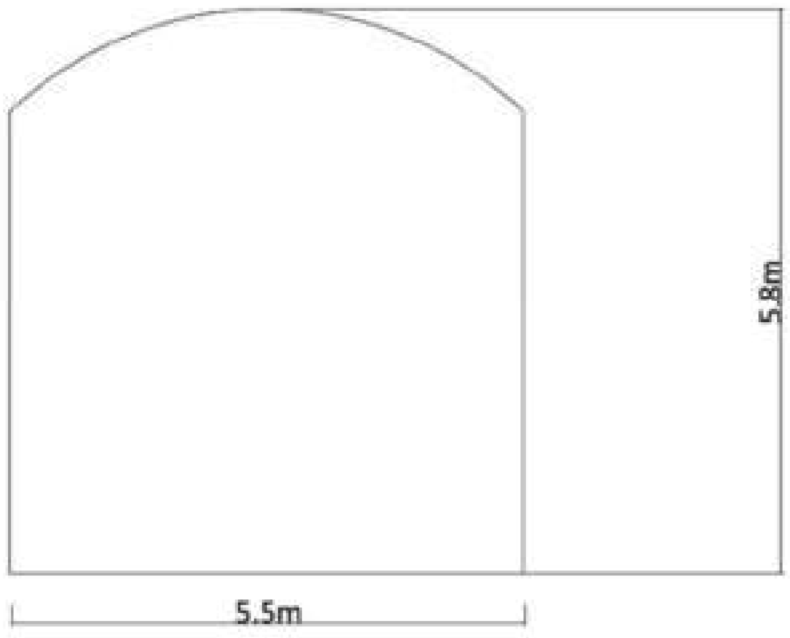
The proposed portal face design is shown in Appendix C. The support guidelines should be re-evaluated once the portal face is established.

7 Initial decline design

7.1 Decline ground conditions

The decline will be excavated using the same ached profile that is in use for the Western Min decline, the dimensions of the decline are shown in Figure 8.

Figure 8 Decline excavation profile for the decline



The decline will commence in the WEATHERED unit, the expected ground conditions for the initial decline development are expected to be "very poor" to "poor", consistent with the assessment of the rock unit in this report. Ground conditions are expected to improve as the decline progresses through the TRANSITION and FRESH rock units. An improved level of data pertaining to ground conditions along the decline path is recommended to refine the rock mass characterisation information for the decline path which will facilitate the prediction of ground conditions ahead of the decline face.

7.2 Decline ground support

Rasp have a comprehensive system for managing ground conditions during development which is detailed in the Principal Hazard Management Plan – Ground or Strata Failure. It is expected that the procedures for managing ground conditions and ground support methodology will be applied to the decline. unexpected changes in ground conditions will be managed by exception which may require, specific ground support design.

The ground support configurations that will be applied to the decline are shown in Appendix D.

8 Summary of findings

8.1 Box cut slope design parameters

The recommended slope design parameters for the box cut slopes are presented in Table 12 and are to be read in conjunction with the comments that follow the table. They have been reached using a combination of geotechnically derived results from the following methods:

- Empirical assessment
- 2D slope stability modelling

Table 12 Summary of slope design parameters

Bench Number	Geotechnical Unit	Maximum Batter Angle	Maximum Batter Height in Material	Bench Width	Maximum Slope Angle in Material	Maximum Slope Height
1	FILL	35°	10 m	8m	29°	18m
2	FILL / WEATHERED CONTACT	40°	10 m	10m	NA	10m
3	WEATHERED	54°	11 m	10m	34°	16.5m

The following comments are critical to application of the slope design parameters presented above:

- Dewatered slopes are recommended to ensure the long-term stability of the box cut. Provision for depressurised walls (de-watering holes may be required) and surface drainage should be made.
- The slope design parameters are appropriate for good final wall blasting techniques (i.e. pre-split and/or trim blasted) and good slope management (e.g. scaling walls). Note: pre-split blasting may not be the best method in the weathered, low strength ground due to the damage potential from explosive energy directly against the final walls.
- Routine geotechnical inspections of batters and berms, and the commissioning of a slope movement monitoring system (i.e. a system of prisms set up along berm crests and routinely surveyed by mine surveyors).
- A preliminary seismic loading analysis indicates stable boxcut slopes when a seismic coefficient of 0.15g is applied to the model. Such an event is unlikely to trigger failure of the de-watered slopes but should warrant a detailed inspection for possible remediation. Any TARP that is developed for ground conditions for the boxcut should include seismic activity.
- Long term erosion of the boxcut batters and berms is not expected to compromise the stability of the boxcut slopes apart from minor narrowing of the berms and the formation of erosion channels on the batter slopes in FILL unit. Broken Hill occasionally experiences high intensity rainfall events which may result in increased boxcut slope erosion. Measures to control long term erosion should be adopted by Rasp and access to the benches in FILL unit should be maintained if remedial works are required.
- Erosion protection is recommended for the portal batter and bench to prevent damage to the portal batter surface support.

8.2 Portal face design

- The portal face will be excavated in the WEATHERED unit. Ground conditions are expected to be 'Very Poor' to 'Poor'. GCE recommends that the final portal ground support design and initial decline support design is finalised once the portal face is established.
- Preliminary ground support requirements for 'Very Poor' and 'Poor' to 'Fair' rock mass quality are provided in Section 5.

8.3 Decline design and ground conditions

The decline will commence in the WEATHERED or TRANSITION rock unit, the expected ground conditions for the initial decline development are expected to be "Very Poor' to 'Poor', consistent with the assessment of the rock units in this report. Ground conditions are expected to improve as the decline progresses towards less weathered rock units. An improved level of data pertaining to ground conditions along the decline path is recommended to refine the rock mass characterisation information which will facilitate the prediction of ground conditions ahead of the decline face.

The ground conditions for the decline will be managed according to the requirements of the Rasp Principal Hazard Management Plan (PHMP) – Ground or Strata Failure. Adverse ground conditions that fall outside the scope of the PHMP will be managed by exception.

Appendix A Laboratory test results

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

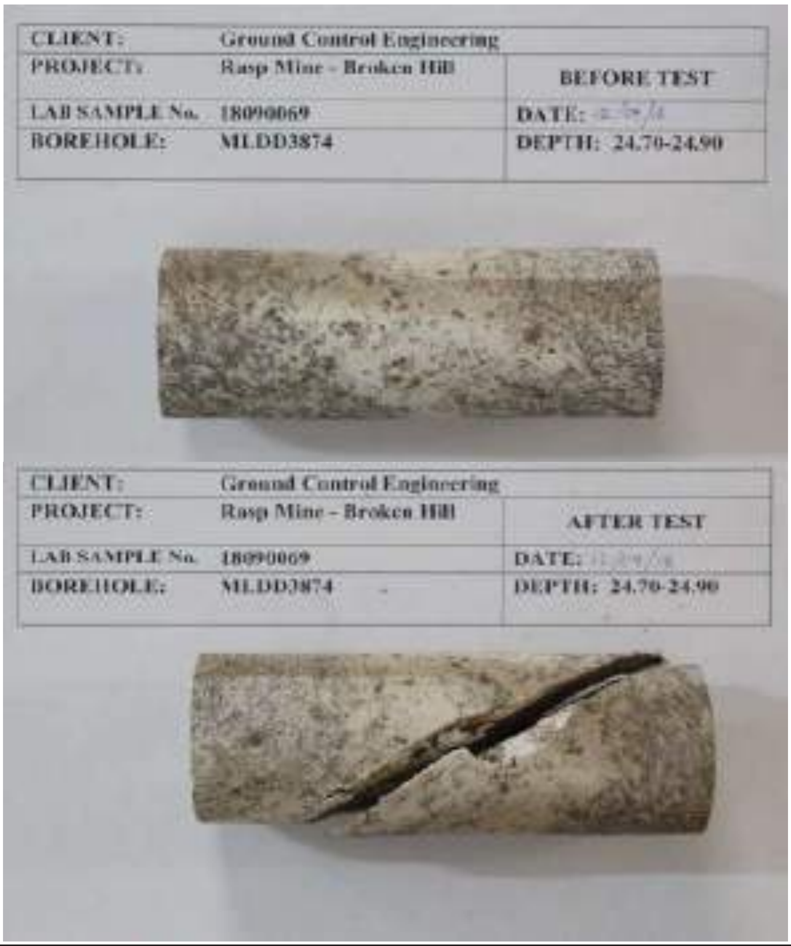
Test Method: AS 4133.4.2.1 & AS 4133.1.1.1

Client	Ground Control Engineering	**Report No.**	18090069-UCS
		Workorder No.	0004803
Address	16 Farmer Street, Edmonton QLD 4869	**Test Date**	12/09/2018
		Report Date	13/09/2018
Project	Rasp Mine - Broken Hill		
Client ID	MLDD3874	**Depth (m)**	24.70-24.90
Description	-		
Sample Type	Single Individual Rock Core Specimen		

TEST DETAILS

Average Sample Diameter (mm)	60.5	Moisture Content (%)	0.2
Sample Height (mm)	159.9	Wet Density (t/m^3)	2.76
Duration of Test (min)	5:23	Dry Density (t/m^3)	2.75
Rate of Loading (MPa/min)	2.97	Bedding (°)	60
Mode of Failure	Shear	Test Apparatus	Kelba 1000 kN Load Cell
Rupture Angle (°)	65		
UCS (MPa)	**16.0**		

Before and After Testing Photo's



NOTES/REMARKS:
Stored and tested as received
Sample/s supplied by the client

Photo's not to scale

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory
N. Maddison

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ACCREDITED FOR TECHNICAL COMPETENCE
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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS 4133.4.2.2 & AS 4133.1.1.1

Client	Ground Control Engineering	**Report No.**	18090070-UCS
		Workorder No.	0004803
Address	16 Farmer Street, Edmonton QLD 4869	**Test Date**	12/09/2018
		Report Date	13/09/2018
Project	Rasp Mine - Broken Hill		
Client ID	MLDD3875	**Depth (m)**	21.00-21.25
Description	-		
Sample Type	Single Individual Rock Core Specimen		

TEST DETAILS

Average Sample Diameter (mm)	60.9	Moisture Content (%)	0.2
Sample Height (mm)	164.4	Wet Density (t/m^3)	2.85
Duration of Test (min)	25:05	Dry Density (t/m^3)	2.84
Rate of Displacement (mm/min)	0.10	Bedding (°)	80
Mode of Failure	Shear	Test Apparatus	100 kN Load Cell in Compression Machine
Rupture Angle (°)	80		
	UCS (MPa)	**24.3**	

Before and After Photo's

NOTES/REMARKS:
Stored and tested as received
Sample/s supplied by the client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

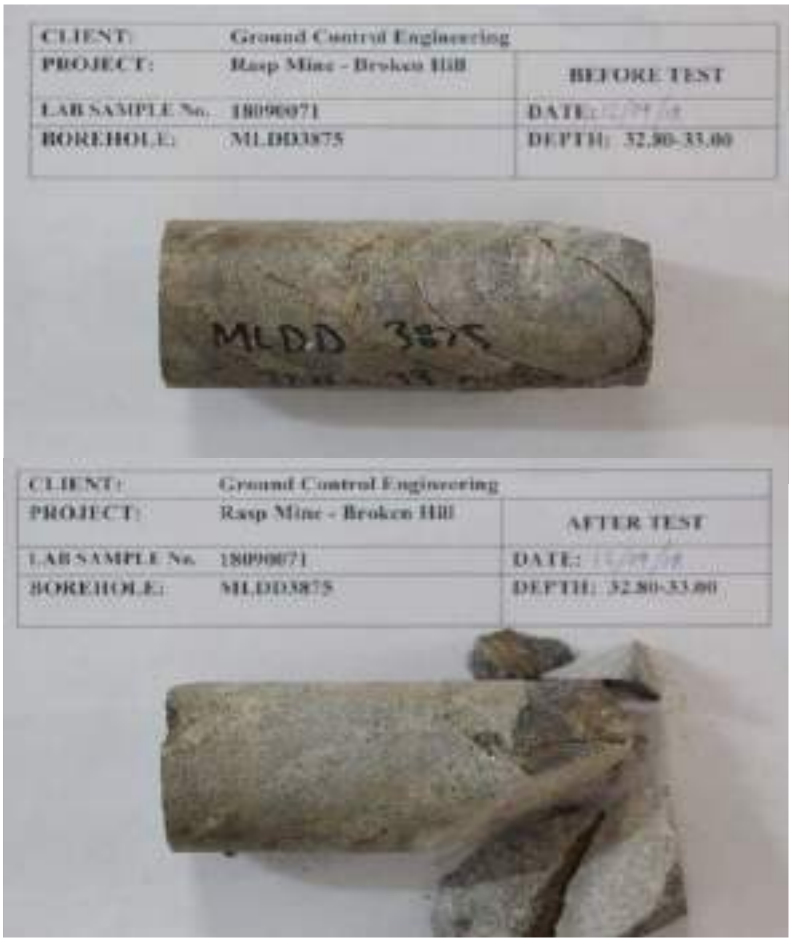
Test Method: AS 4133.4.2.2 & AS 4133.1.1.1

Client	Ground Control Engineering	**Report No.**	18090071-UCS
		Workorder No.	0004803
Address	16 Farmer Street, Edmonton QLD 4869	**Test Date**	12/09/2018
		Report Date	13/09/2018
Project	Rasp Mine - Broken Hill		
Client ID	MLDD3875	**Depth (m)**	32.80-33.00
Description	-		
Sample Type	Single Individual Rock Core Specimen		

TEST DETAILS

Average Sample Diameter (mm)	61.0	Moisture Content (%)	0.3
Sample Height (mm)	153.8	Wet Density (t/m^3)	2.69
Duration of Test (min)	19:53	Dry Density (t/m^3)	2.68
Rate of Displacement (mm/min)	0.10	Bedding (°)	70
Mode of Failure	Shear	Test Apparatus	Kelba 1000 kN Load Cell
Rupture Angle (°)	70		
UCS (MPa)	**13.4**		

Before and After Photo's



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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

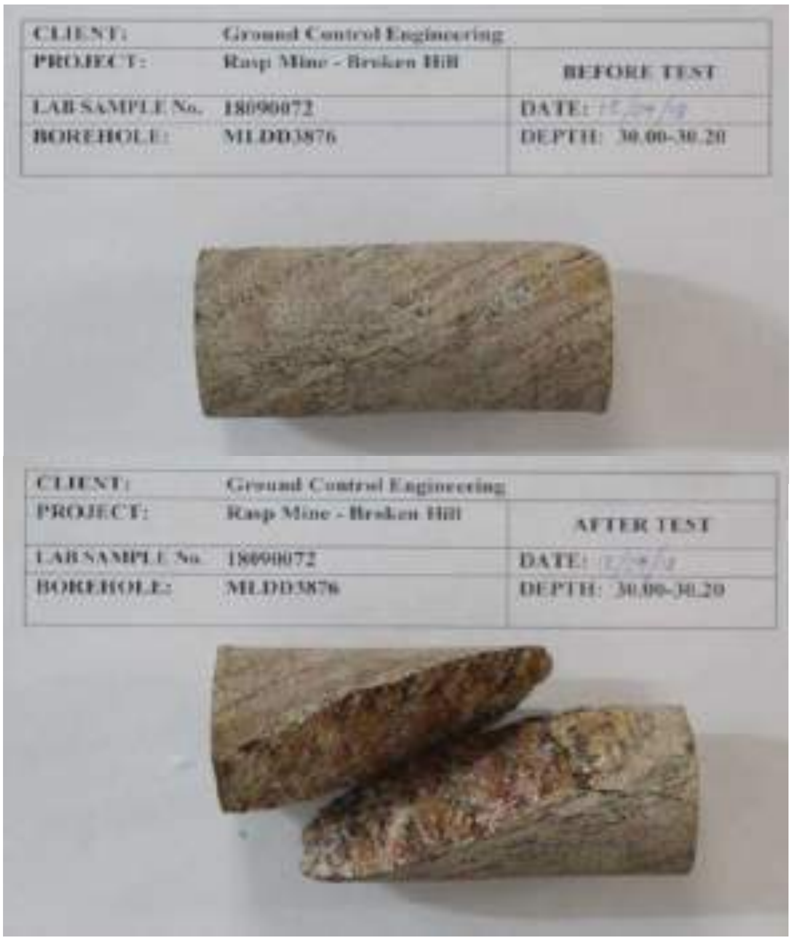
Test Method: AS 4133.4.2.2 & AS 4133.1.1.1

Client	Ground Control Engineering	**Report No.**	18090072-UCS
		Workorder No.	0004803
Address	16 Farmer Street, Edmonton QLD 4869	**Test Date**	12/09/2018
		Report Date	13/09/2018
Project	Rasp Mine - Broken Hill		
Client ID	MLDD3876	**Depth (m)**	30.00-30.20
Description	-		
Sample Type	Single Individual Rock Core Specimen		

TEST DETAILS

Average Sample Diameter (mm)	60.8	Moisture Content (%)	0.3
Sample Height (mm)	131.6	Wet Density (t/m^3)	2.69
Duration of Test (min)	21:21	Dry Density (t/m^3)	2.68
Rate of Displacement (mm/min)	0.10	Bedding (°)	70
Mode of Failure	Shear	Test Apparatus	100 kN Load Cell in Compression Machine
Rupture Angle (°)	70		
UCS (MPa)	**16.5**		

Before and After Photo's



NOTES/REMARKS:
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Sample/s supplied by the client
* Length to diameter ratio less than 2.5:1
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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Ground Control Engineering	**Report No.:**	18090073 - CU
		Workorder No.	0004803
Address	16 Farmer Street, Edmonton QLD 4869	**Test Date:**	28/09/2018
		Report Date:	12/10/2018
Project:	Rasp Mine - Broken Hill		
Client Id.:	MLDD3874	**Depth (m):**	18.70-19.00
Description:			

SAMPLE & TEST DETAILS

Initial Height:	128.5	mm	Initial Moisture Content:	3.1	%	Rate of Strain:	0.007	%/min
Initial Diameter:	60.7	mm	Final Moisture Content:	9.8	%	B Response:	98	%
L/D Ratio:	2.1 : 1		Wet Density:	2.34	t/m^3			
			Dry Density:	2.27	t/m^3			

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses* σ'_1	σ'_3	σ'_1 / σ'_3	*Deviator Stress*	*Strain*
120 kPa	624 kPa	504 kPa	504 kPa	591 kPa	1628 kPa	33 kPa	49.774	1595 kPa	1.15 %
243 kPa	747 kPa	504 kPa	504 kPa	606 kPa	2665 kPa	141 kPa	18.917	2525 kPa	1.58 %
494 kPa	1000 kPa	506 kPa	506 kPa	584 kPa	4516 kPa	416 kPa	10.864	4100 kPa	2.21 %

FAILURE ENVELOPES

Interpretation between stages :	**1 to 2**	**2 to 3**	**1 to 3**
Cohesion C' (kPa) :	**212.1**	**330.7**	**270.9**
Angle of Shear Resistance Φ' (Degrees) :	**54.2**	**47.9**	**49.7**
Failure Criteria:	Peak Principal Stress Ratio		

Remarks: Tested as Received

Sample/s supplied by the client

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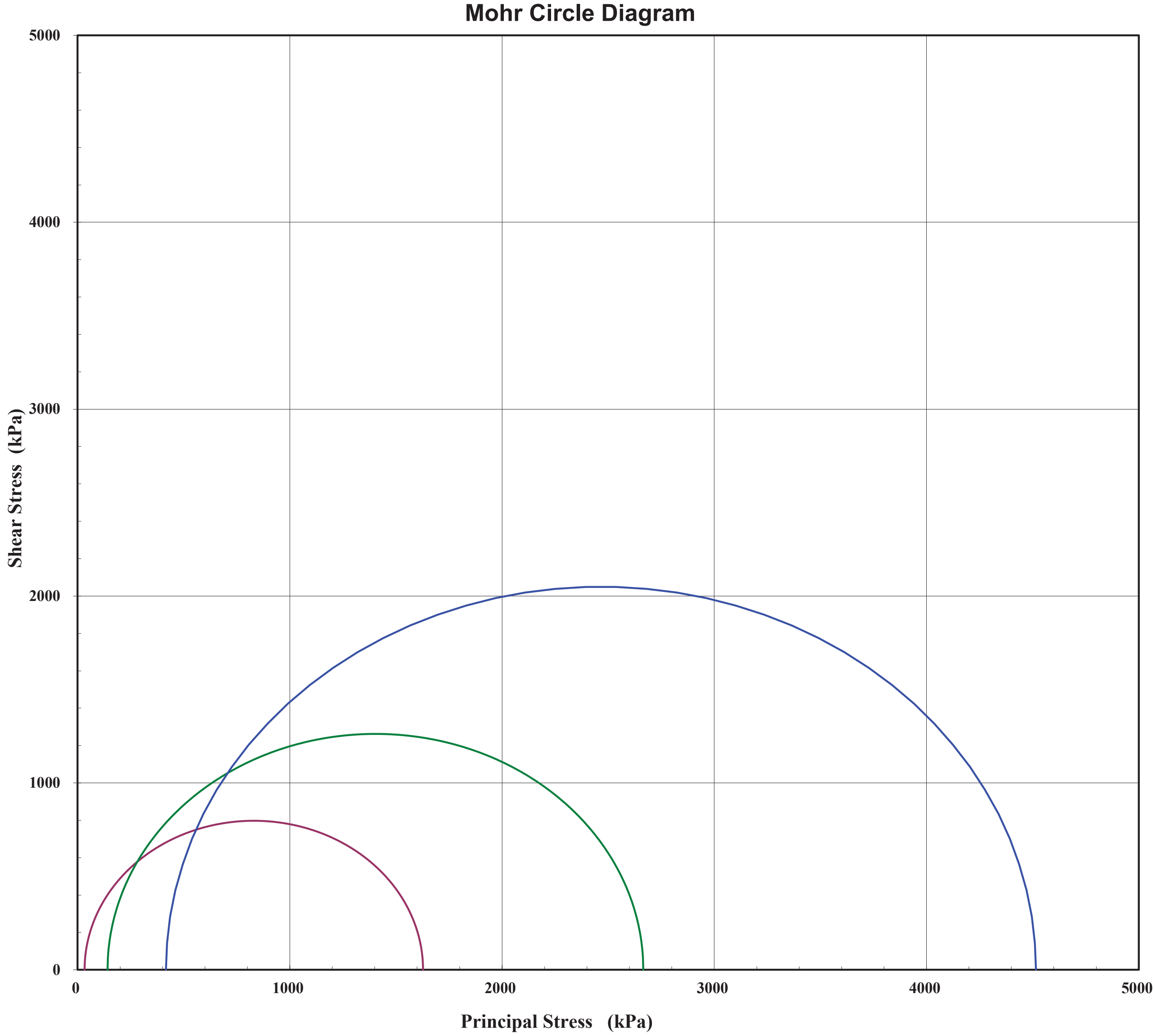
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Ground Control Engineering	**Report No.:** 18090073 - CU

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	212.1	330.7	270.9
Angle of Shear Resistance Φ' (Degrees) :	54.2	47.9	49.7
Failure Criteria:	Peak Principal Stress Ratio		

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

REP03001

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Authorised Signatory

C. Channon

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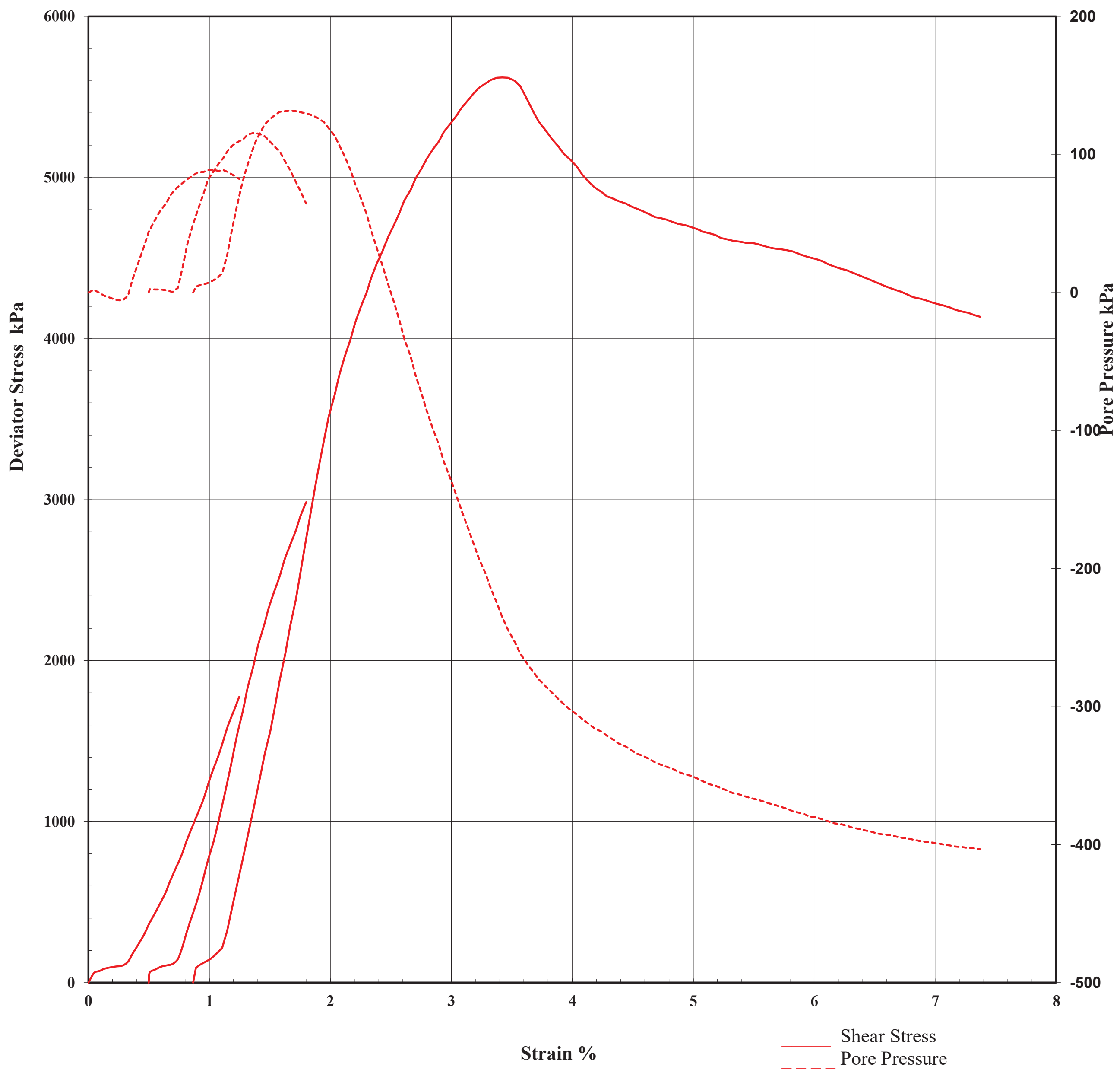
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Ground Control Engineering	**Report No.:** 18090073 - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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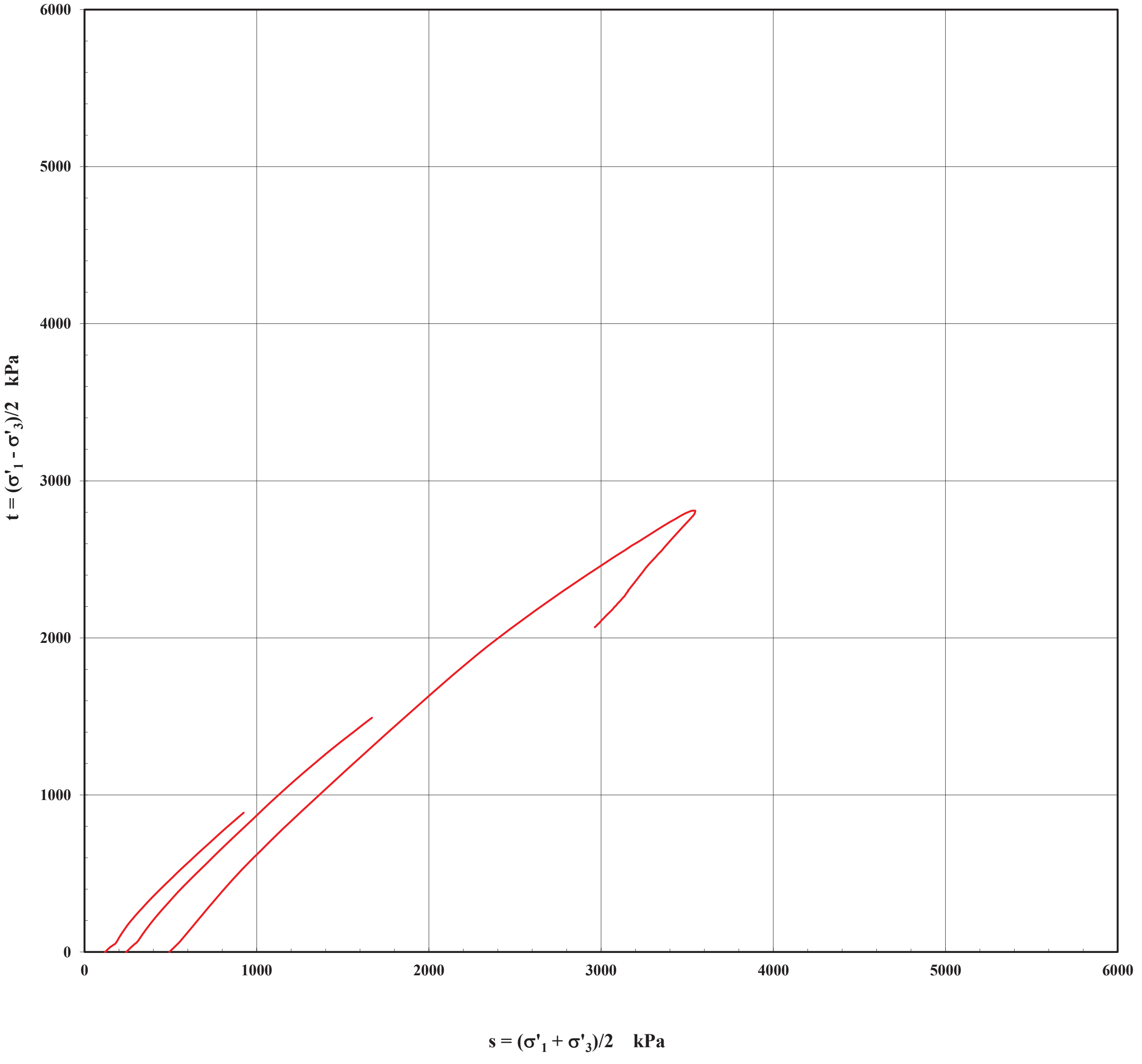
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Ground Control Engineering	**Report No.:** 18090073 - CU

MIT Method - Effective Stress Path



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Note: Graph not to scale

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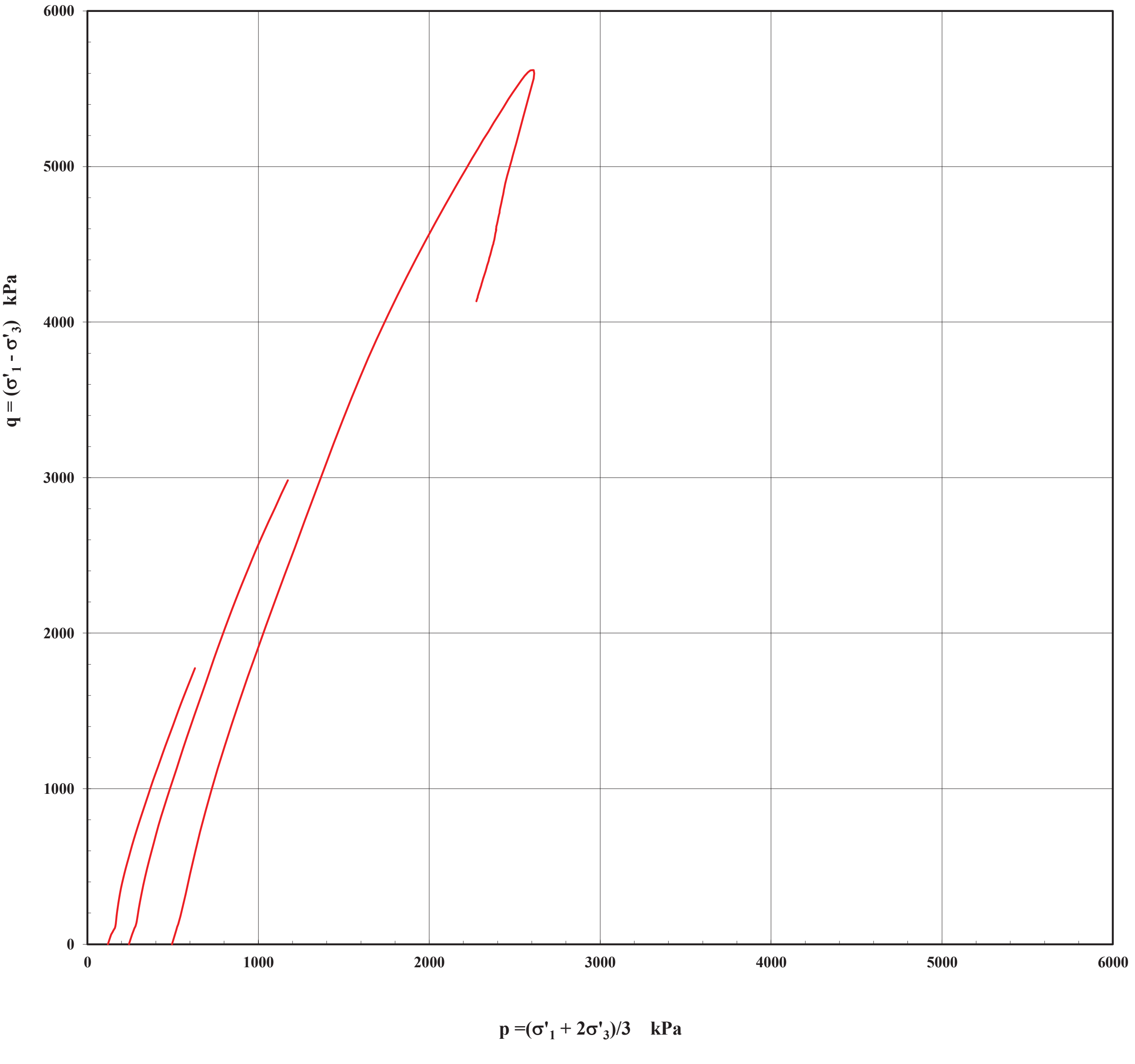
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Ground Control Engineering

Report No.: 18090073 - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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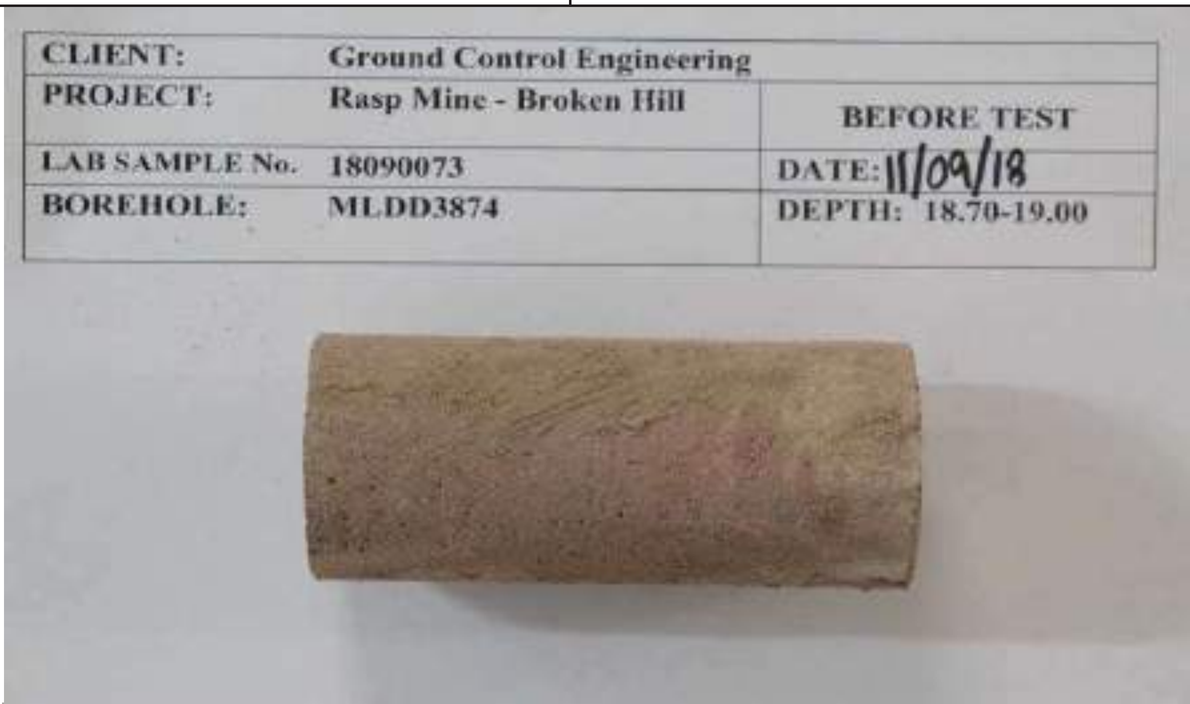
Client: Ground Control Engineering	**Report No.:** 18090073 - CU



Remarks: Tested as Received

Sample/s supplied by the client

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Ground Control Engineering	**Report No.:**	18090074 - CU
		Workorder No.	0004803
Address	16 Farmer Street, Edmonton QLD 4869	**Test Date:**	26/09/2018
		Report Date:	10/10/2018
Project:	Rasp Mine - Broken Hill		
Client Id.:	MLDD3876	**Depth (m):**	31.40-31.60
Description:			

SAMPLE & TEST DETAILS

Initial Height:	125.6	mm	Initial Moisture Content:	1.1	%	Rate of Strain:	0.007	%/min
Initial Diameter:	60.7	mm	Final Moisture Content:	8.3	%	B Response:	99	%
L/D Ratio:	2.1 : 1		Wet Density:	2.23	t/m^3			
			Dry Density:	2.21	t/m^3			

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses* σ'_1	σ'_3	σ'_1 / σ'_3	*Deviator Stress*	*Strain*
128 kPa	627 kPa	499 kPa	499 kPa	559 kPa	531 kPa	68 kPa	7.802	463 kPa	0.83 %
253 kPa	751 kPa	498 kPa	498 kPa	574 kPa	968 kPa	177 kPa	5.466	791 kPa	1.58 %
503 kPa	904 kPa	401 kPa	401 kPa	488 kPa	1688 kPa	416 kPa	4.054	1272 kPa	2.38 %

FAILURE ENVELOPES

Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	64.6	125.4	93.4
Angle of Shear Resistance Φ' (Degrees) :	36.9	30.1	32.2

Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client

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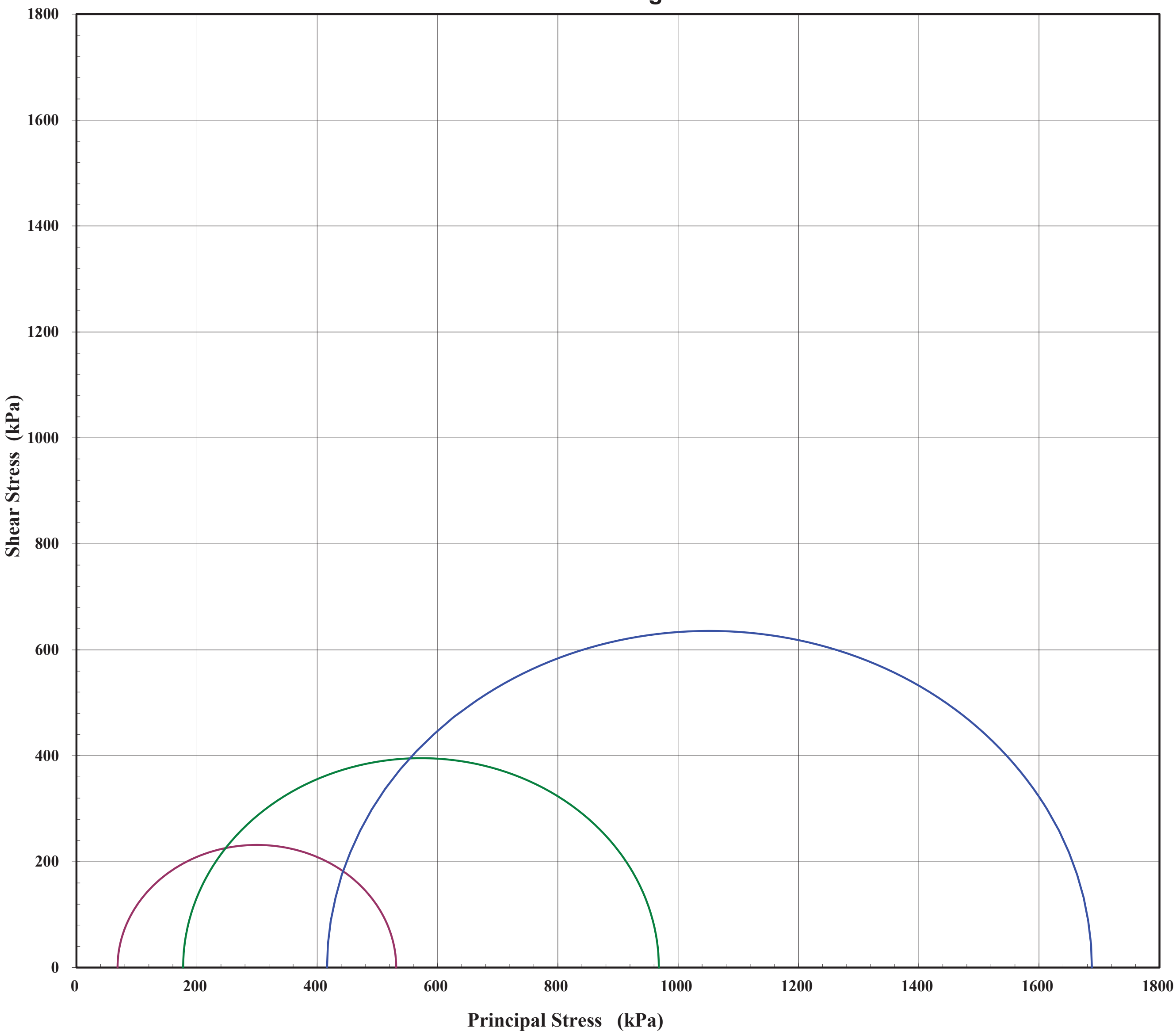
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Ground Control Engineering

Report No.: 18090074 - CU

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	64.6	125.4	93.4
Angle of Shear Resistance Φ' (Degrees) :	36.9	30.1	32.2
Failure Criteria:	Peak Principal Stress Ratio		

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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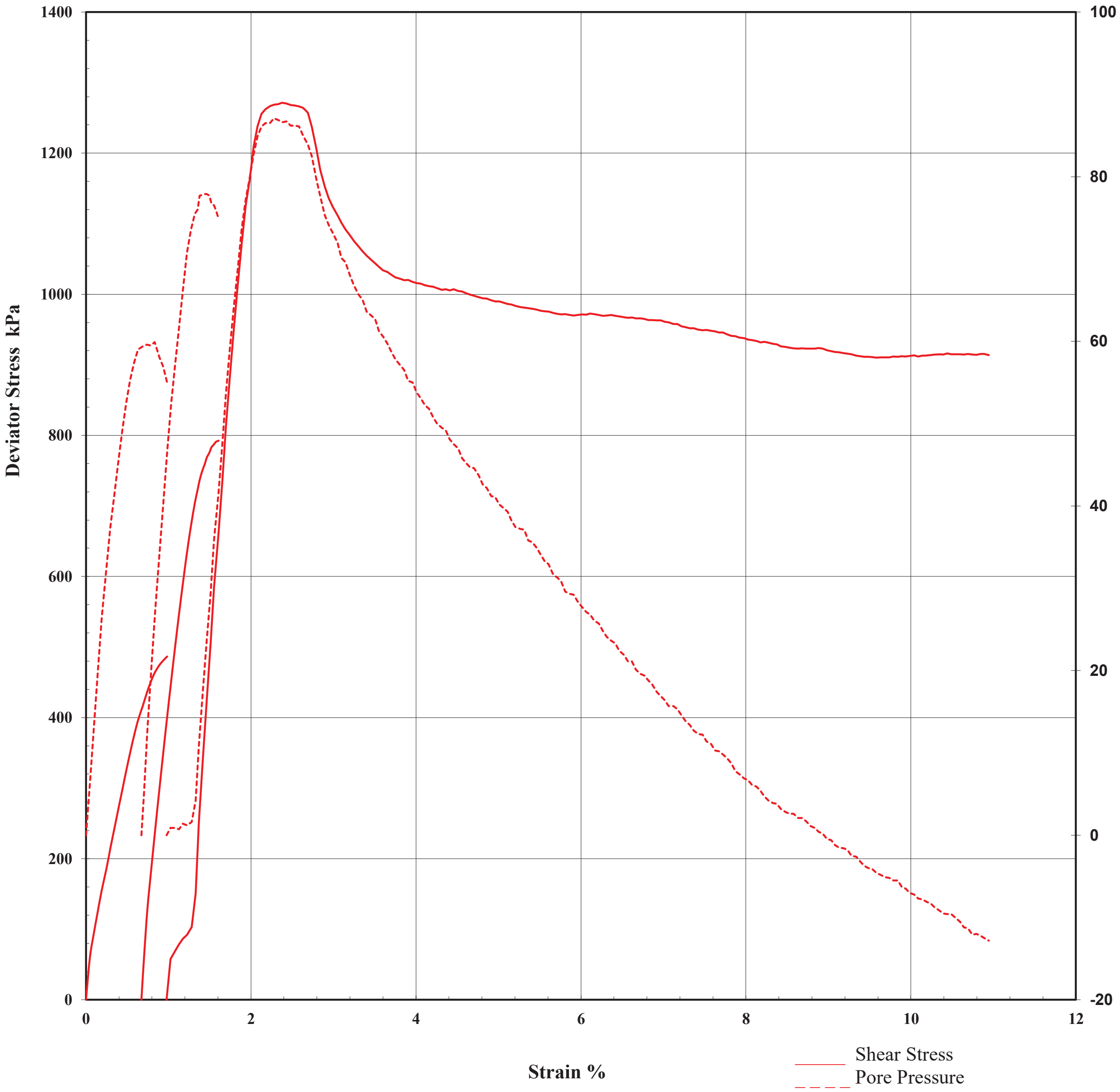
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Ground Control Engineering	**Report No.:** 18090074 - CU

Stress/Strain & Pore Pressure/Strain Diagram



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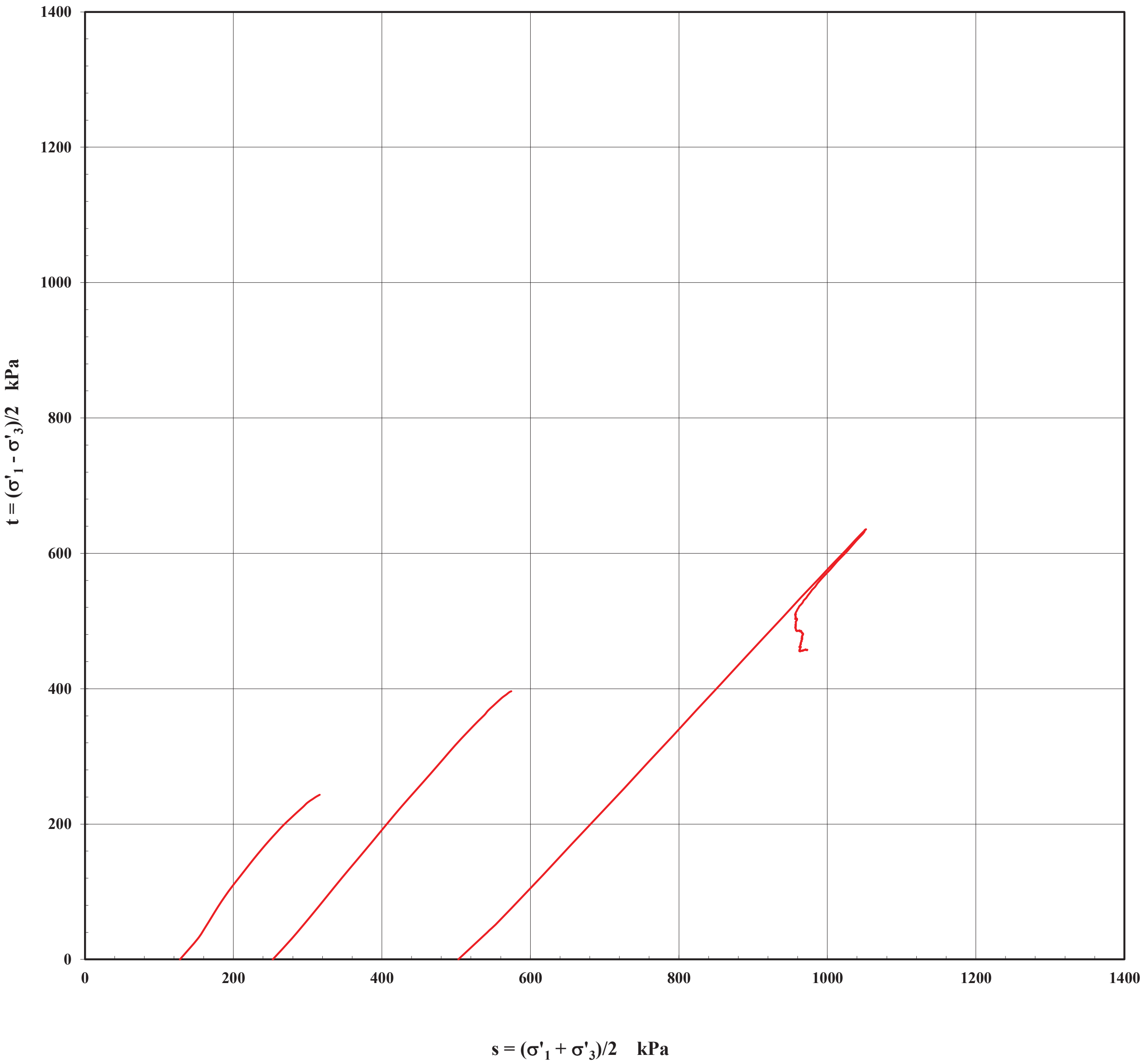
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Ground Control Engineering

Report No.: 18090074 - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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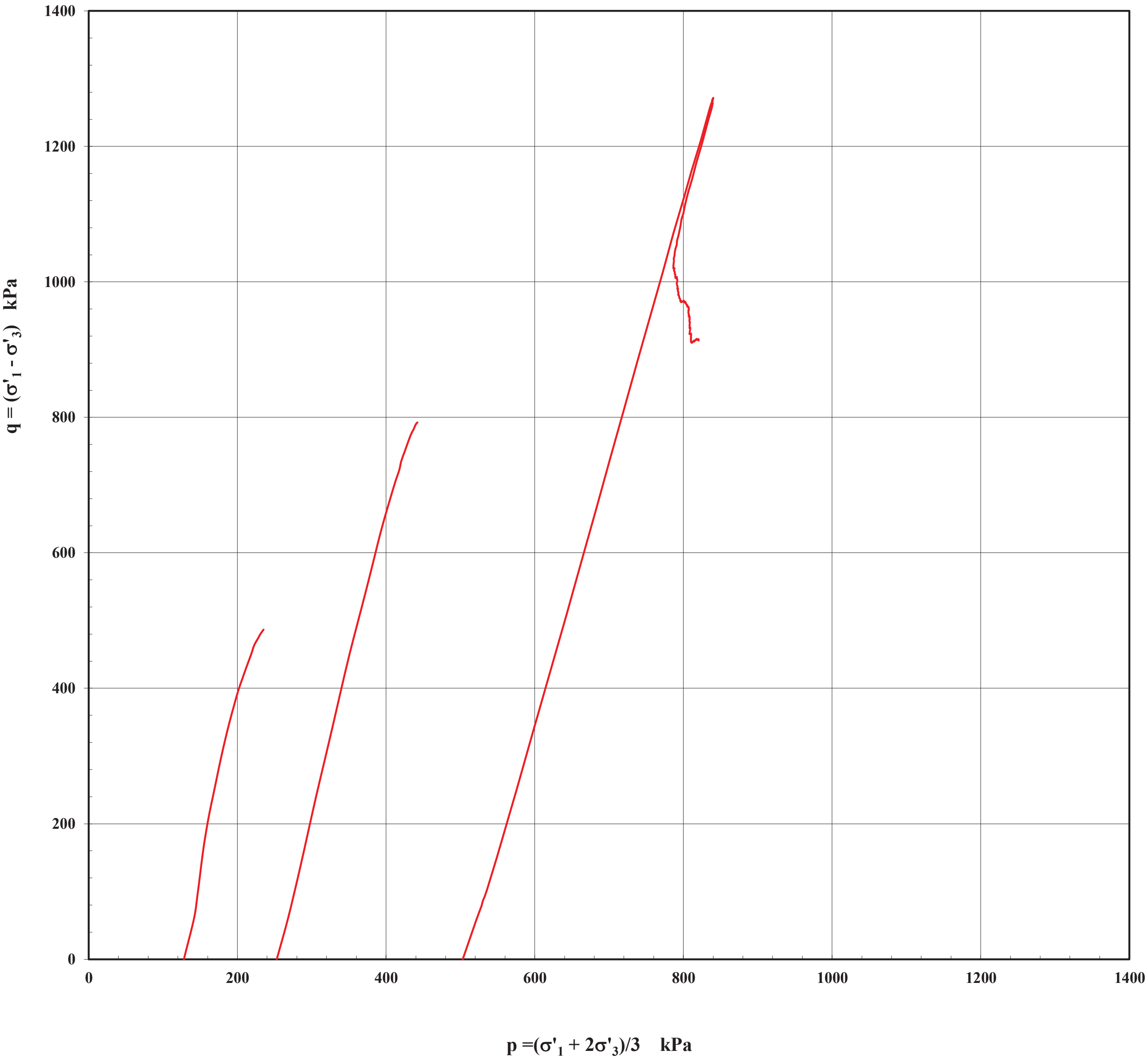
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Ground Control Engineering	**Report No.:** 18090074 - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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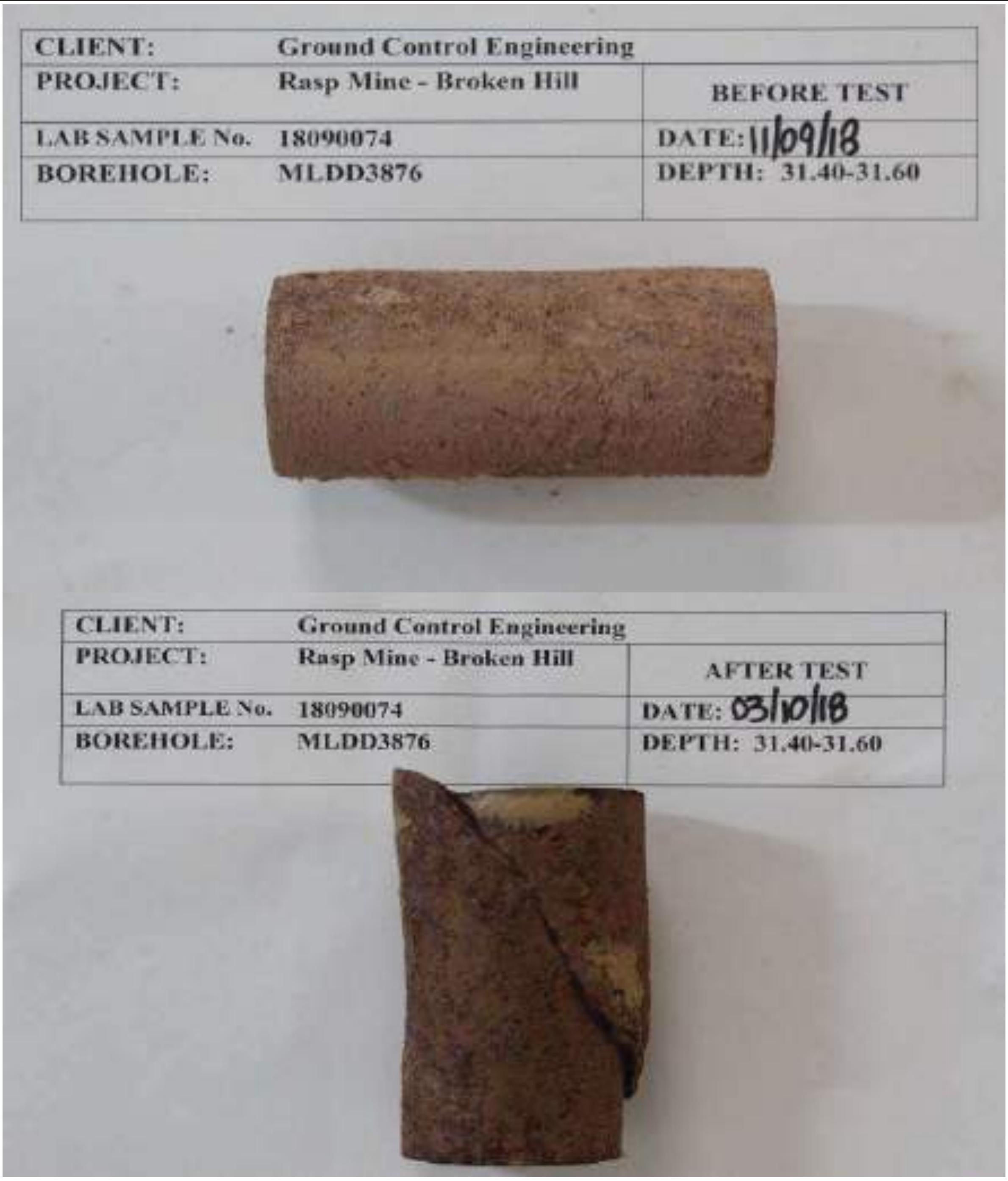
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Ground Control Engineering	**Report No.:** 18090074 - CU



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Note: Photo not to scale

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Ground Control Engineering	**Report No.:**	18090075 - CU
		Workorder No.	0004803
Address	16 Farmer Street, Edmonton QLD 4869	**Test Date:**	25/09/2018
		Report Date:	12/10/2018
Project:	Rasp Mine - Broken Hill		
Client Id.:	MLDD3877	**Depth (m):**	48.60-48.80
Description:			

SAMPLE & TEST DETAILS

Initial Height:	126.0	mm	Initial Moisture Content:	3.1	%	Rate of Strain:	0.007	%/min
Initial Diameter:	61.3	mm	Final Moisture Content:	6.6	%	B Response:	99	%
L/D Ratio:	2.1 : 1		Wet Density:	2.47	t/m^3			
			Dry Density:	2.40	t/m^3			

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses* σ'_1	σ'_3	σ'_1 / σ'_3	*Deviator Stress*	*Strain*
127 kPa	624 kPa	497 kPa	497 kPa	517 kPa	2084 kPa	107 kPa	19.480	1977 kPa	1.14 %
252 kPa	750 kPa	498 kPa	498 kPa	466 kPa	4044 kPa	284 kPa	14.240	3760 kPa	1.61 %
505 kPa	1001 kPa	496 kPa	496 kPa	471 kPa	5490 kPa	530 kPa	10.358	4960 kPa	1.86 %

FAILURE ENVELOPES

Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	135.2	489.9	240.1
Angle of Shear Resistance Φ' (Degrees) :	56.5	45.2	51.4
Failure Criteria:	Peak Principal Stress Ratio		

Remarks: Tested as Received

Sample/s supplied by the client

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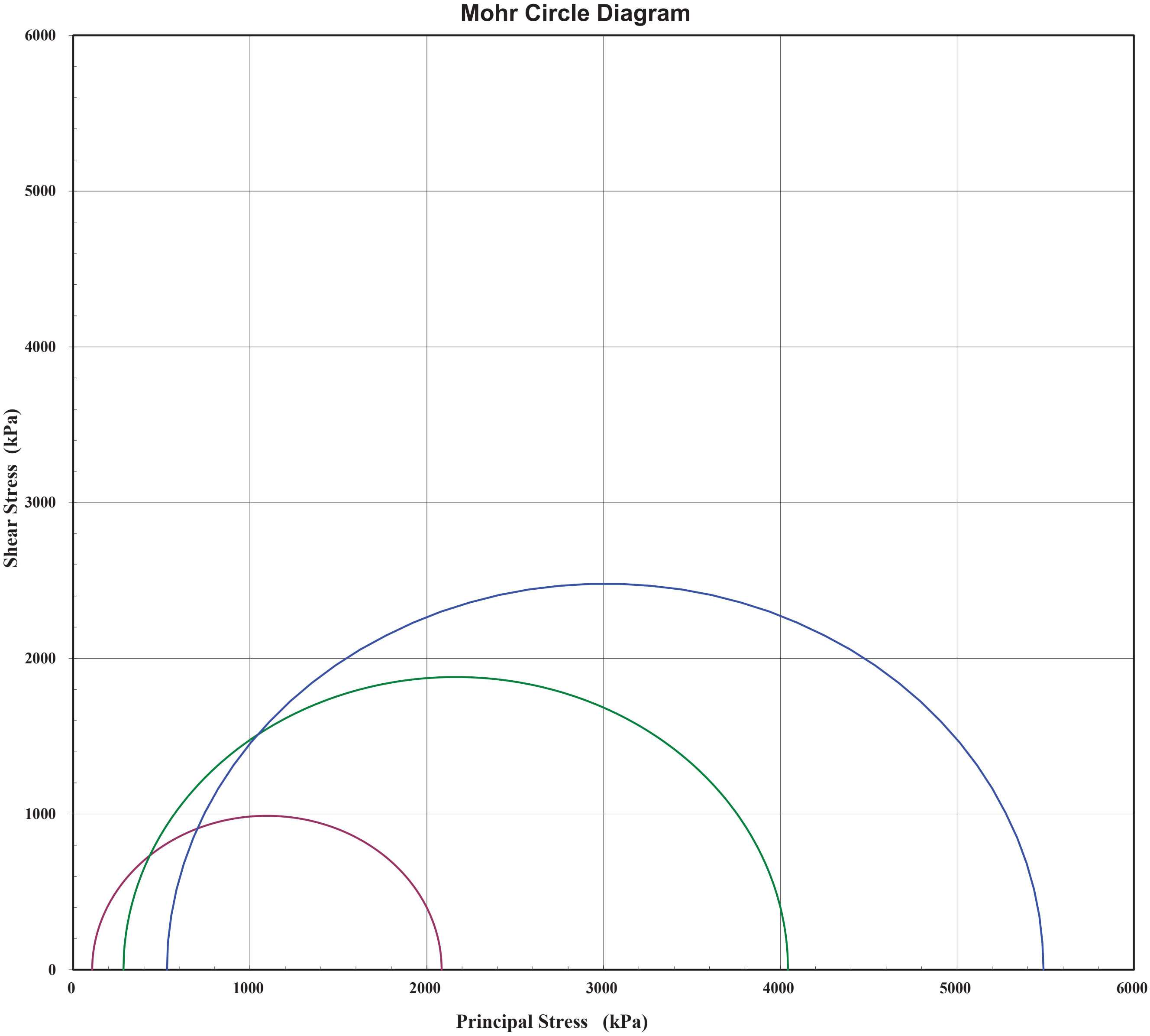
Test Method: AS1289.6.4.2

Client: Ground Control Engineering	**Report No.:** 18090075 - CU



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Remarks: Tested as Received

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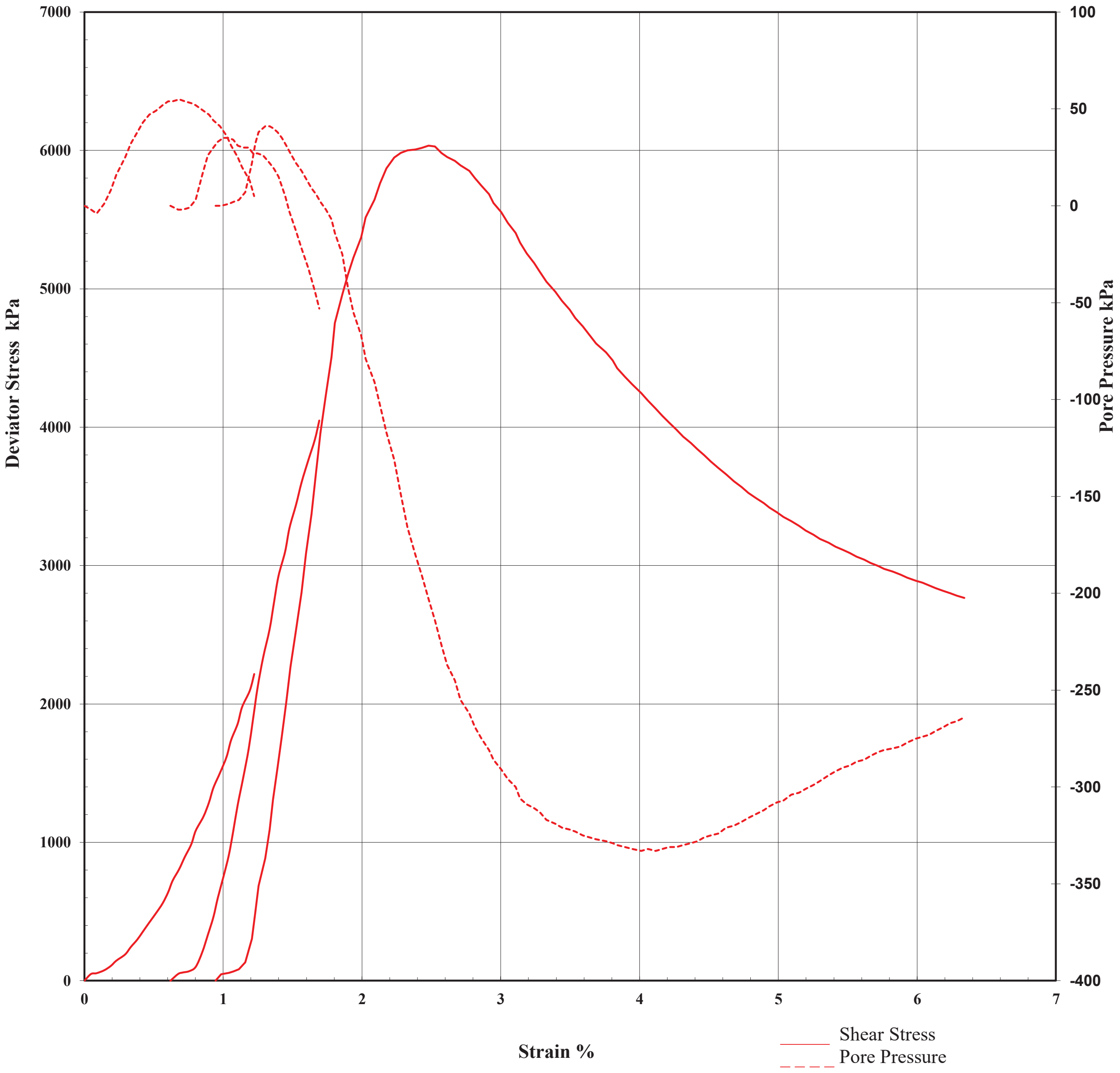
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Ground Control Engineering	**Report No.:** 18090075 - CU

Stress/Strain & Pore Pressure/Strain Diagram



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TRIAXIAL TEST REPORT

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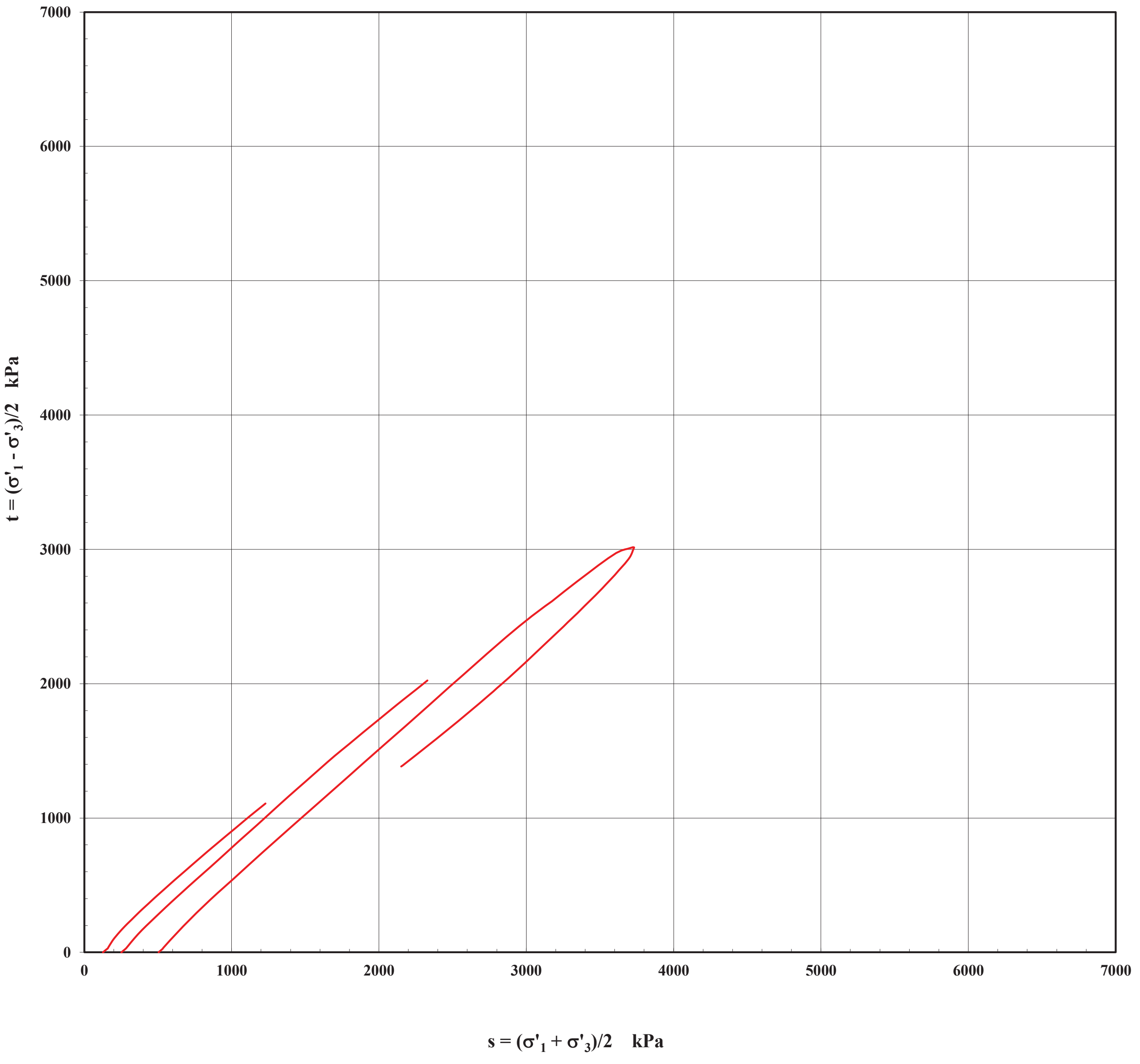
Client: Ground Control Engineering	**Report No.:** 18090075 - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

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Note: Graph not to scale

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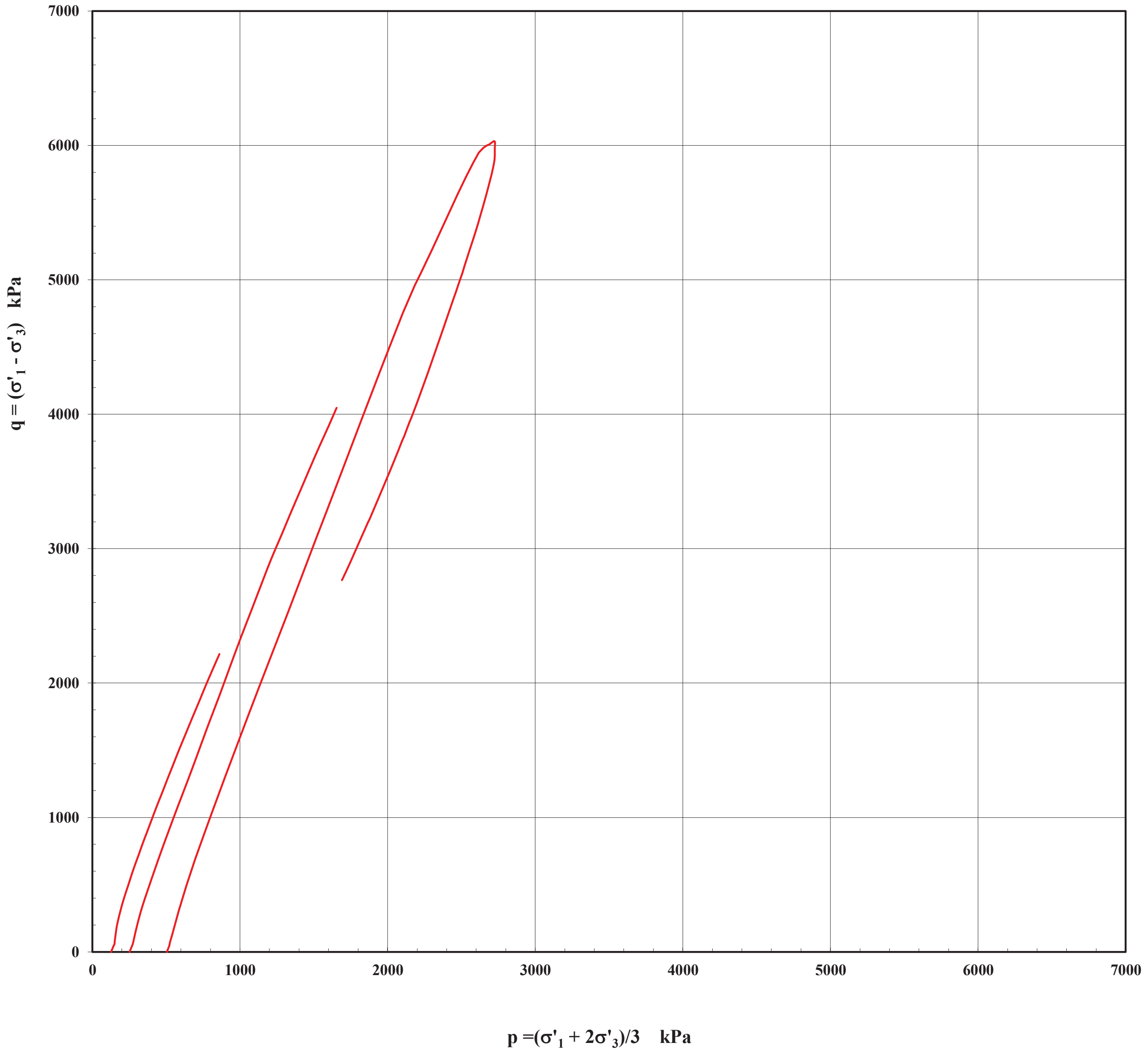
Client: Ground Control Engineering

Report No.: 18090075 - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

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Client: Ground Control Engineering	**Report No.:** 18090075 - CU

Remarks: Tested as Received

Sample/s supplied by the client

Note: Photo not to scale

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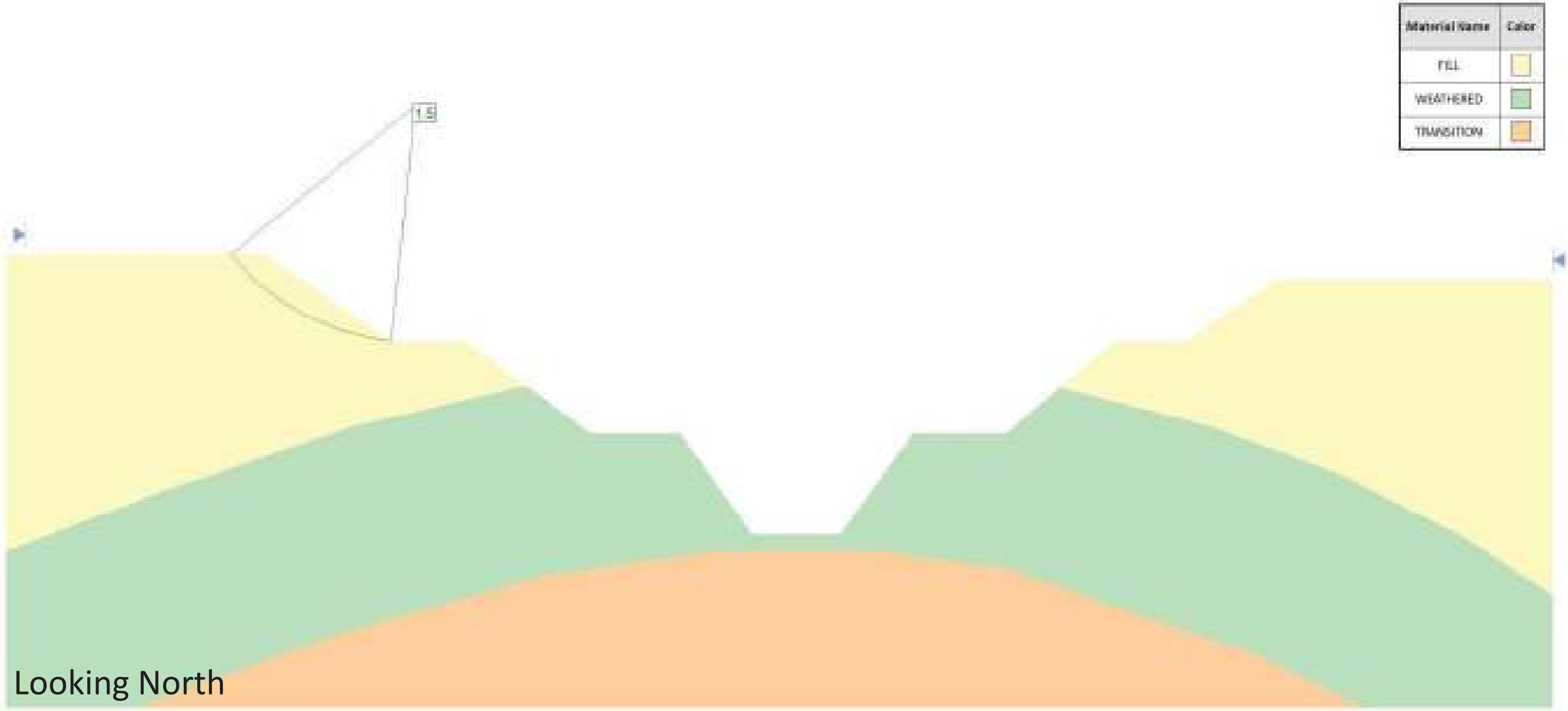
Laboratory Number 9926

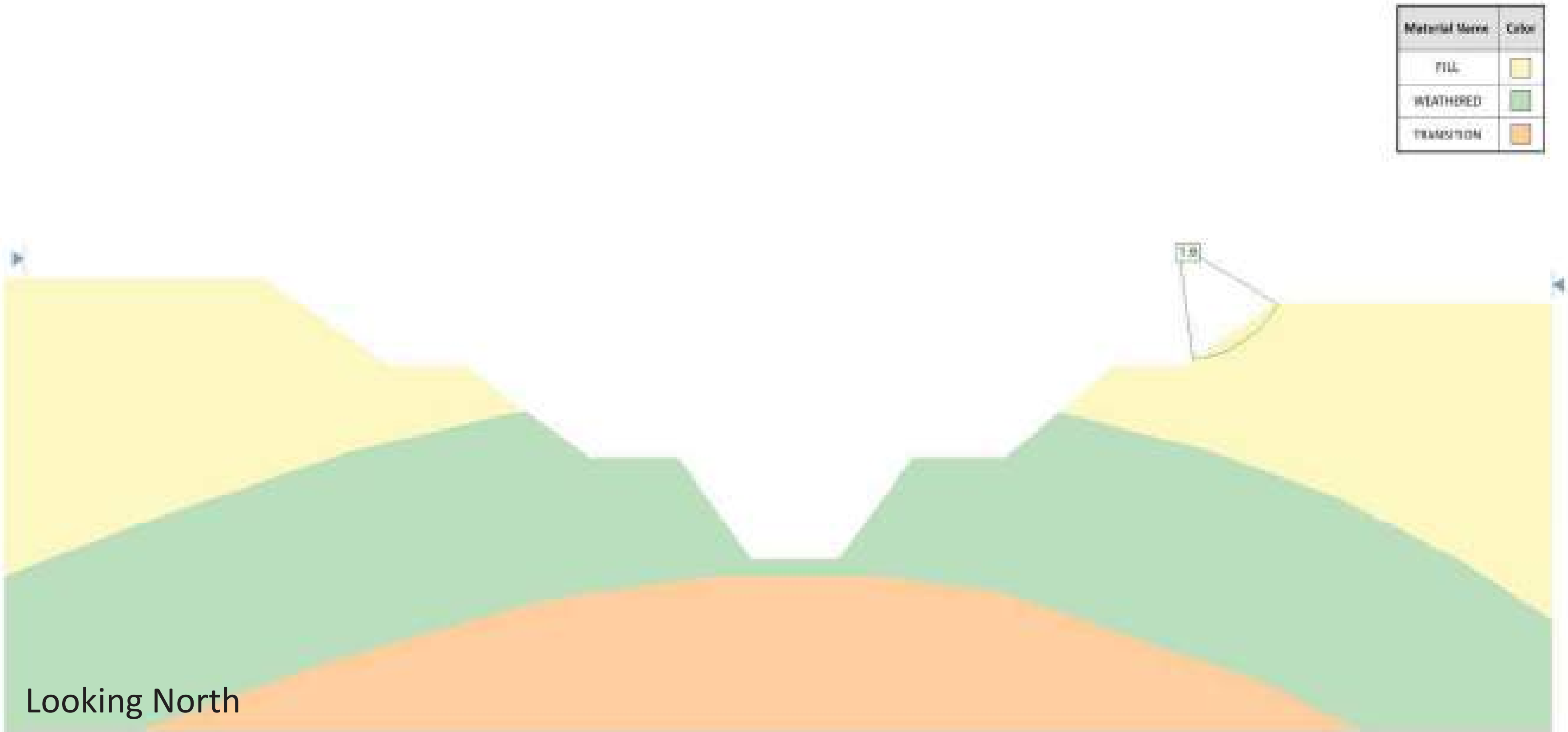
Appendix B Slide Model Results

West Wall

Model Results - Factor of Safety

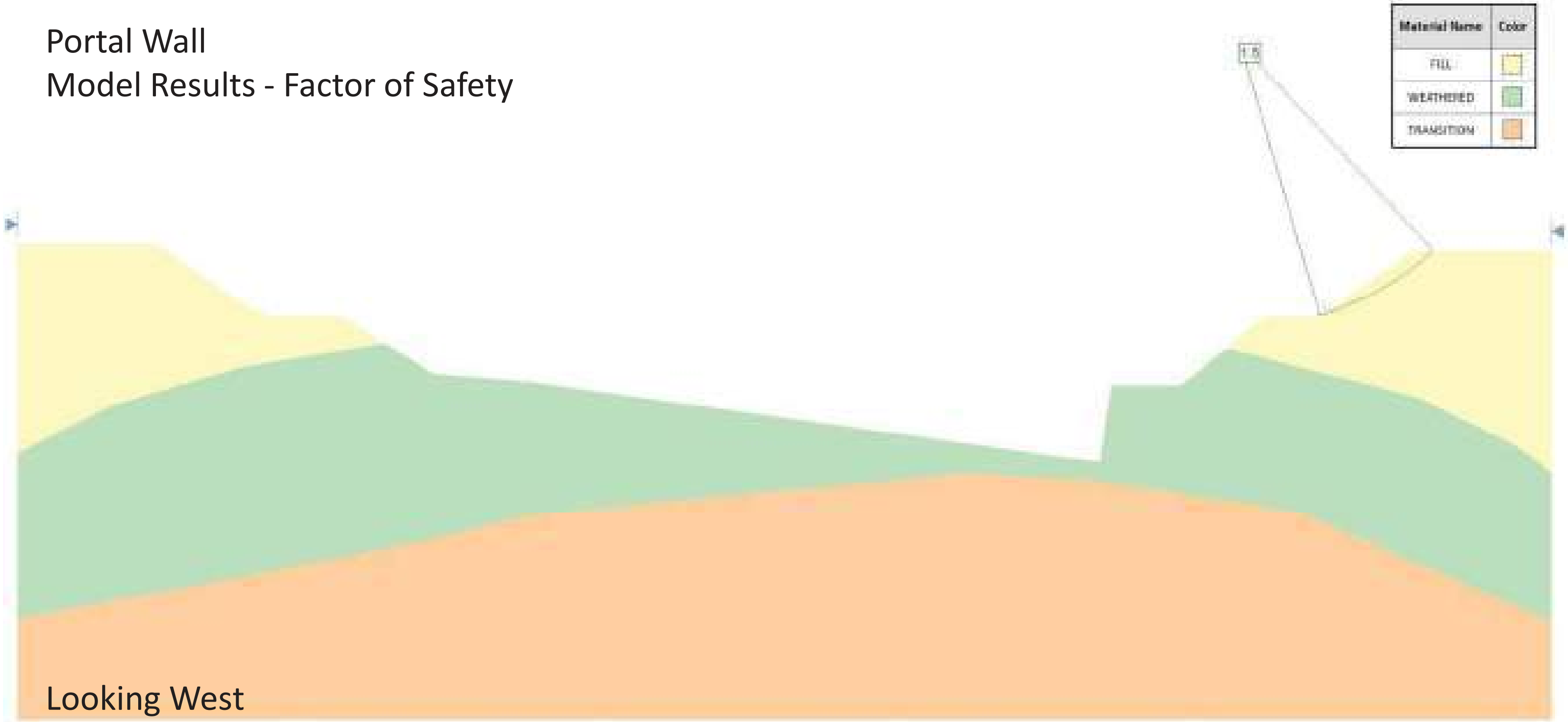


East Wall
Model Results - Factor of Safety



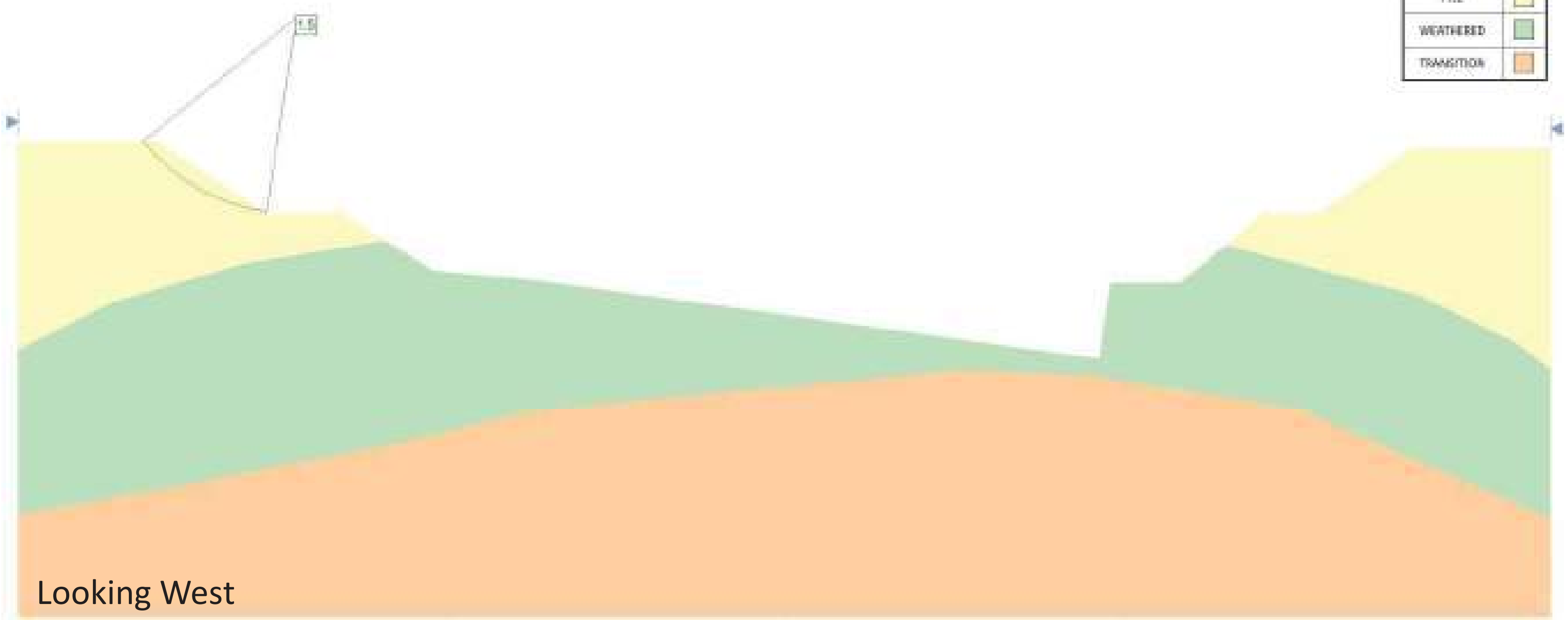
Looking North

Portal Wall
Model Results - Factor of Safety



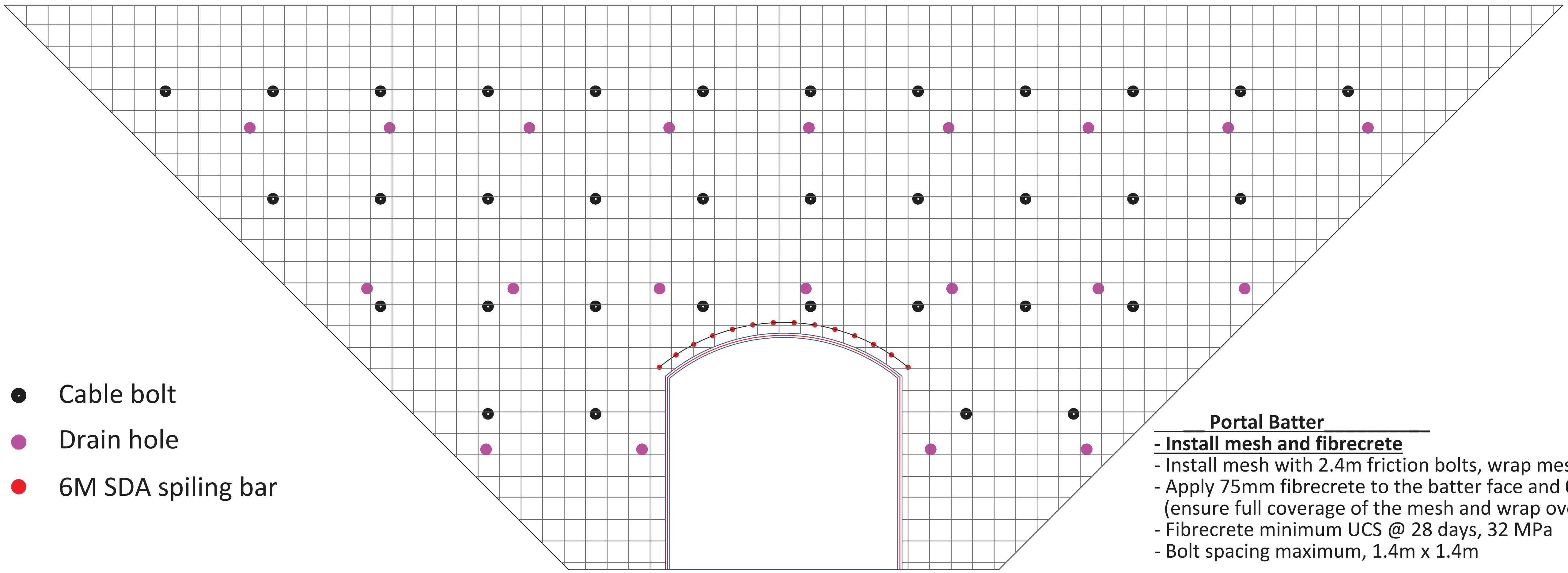
End Wall

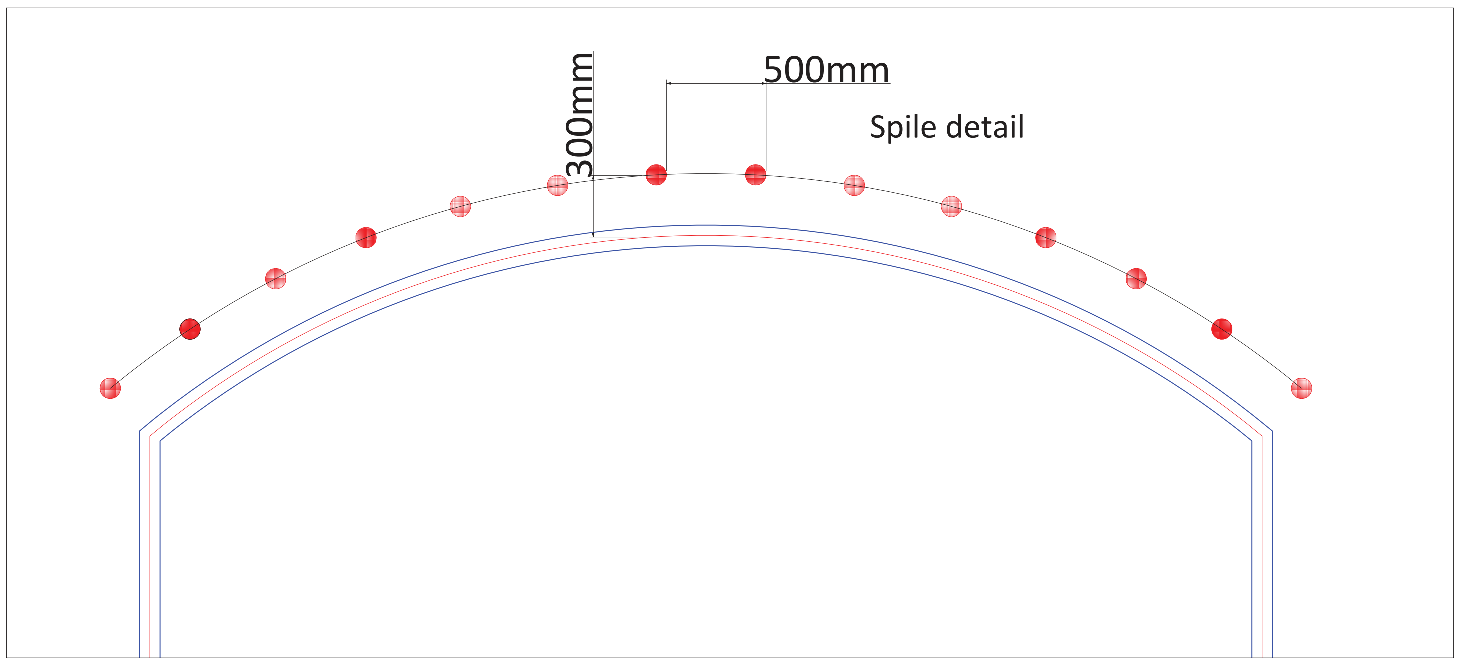
Model Results - Factor of Safety



Appendix C Portal Batter Ground Support Design

PORTAL FACE GROUND SUPPORT REQUIREMENTS





Portal Batter

- Install mesh and fibrecrete
- Install mesh with 2.4m friction bolts, wrap mesh 0.5m over crest
- Apply 75mm fibrecrete to the batter face and 0.5m over crest (ensure full coverage of the mesh and wrap over crest)
- Fibrecrete minimum UCS @ 28 days, 32 MPa
- Bolt spacing maximum, 1.4m x 1.4m

- Install cable bolts
- Twin strand, 25T per strand, w:c ratio 0.35 to 0.4 (full column)
- Plate and jack 1 cable to 4T
- Length, 10m
- Spacing maximum, 2.5m x 2.5m
- Crest to top row of cable bolts, 2.0m

- Install spiling bars
- Install prior to firing decline face
- 9m long, (2 x 3m coupled R32N bars)
- Overlap between spiles - 2.0m
- Drill holes 5 degrees up.
- Grout spiles with OPC with w:c ratio 0.35 to 0.4 (full column)

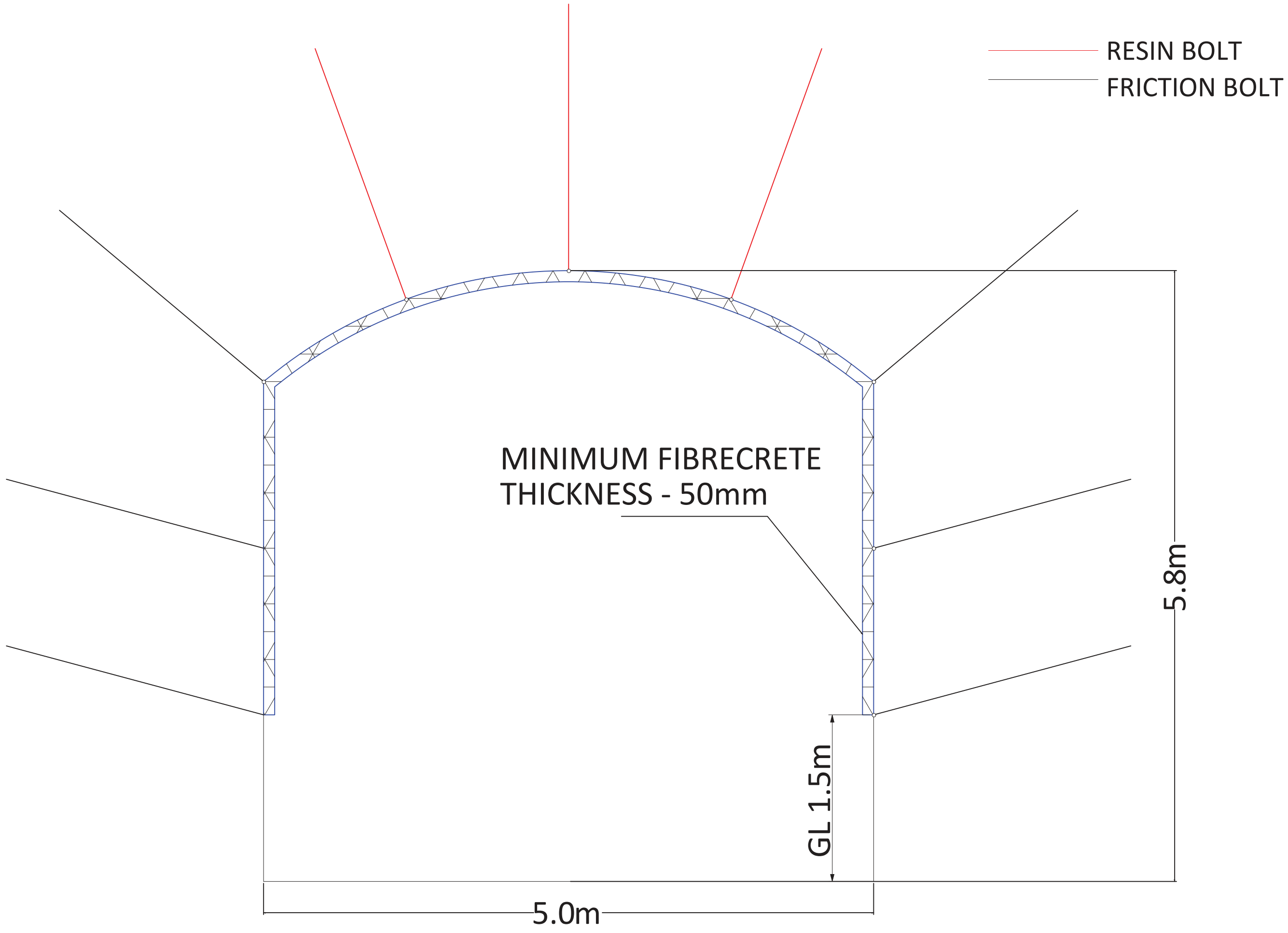
- Drain holes
- Drill drain holes to 6.0m depth, drain hole diameter 45mm
- Drill drain holes 5 degrees up
- Spacing - 3.5m x 3.5m
- Top row to crest - 2.8m

Side walls
- Mesh sidewalls with 2.4m friction bolts,wrap mesh 0.5m over crest.
- Spacing maximum, 1.4m x 1.4m
- Apply minimum 75mm fibrecrete to mesh (ensure full coverage of the mesh and wrap over crest)
- Minimum extent of sidewall coverage - 6.0m back from portal entrance.

Appendix D Decline Ground Support Designs

CBH Resources Limited

RASP MINE



PROFILE A
GROUND SUPPORT STANDARD F1

PROFILE: 5.8mH x 5.0mW ARCH
MINIMUM GROUND SUPPORT REQUIREMENTS FOR GOOD GROUND CONDITIONS

REFER TO TARP FOR POOR GROUND CONDITIONS IF GROUND CONDITIONS ARE POOR (PTO)

SPECIFICATIONS		
DRILLING DETAILS	HOLE DIAMETER FRICTION BOLT RESIN BOLT HOLE DEPTH COLLAR TOLERANCE ROW & RING SPACING	 45mm 32mm 2.4m 100mm 1.5m
RESIN BOLT	BOLT LENGTH NOMINAL DIAMETER MINIMUM YIELD STRENGTH	2.4m 20mm 195 KN
FRICTION BOLT	BOLT LENGTH NOMINAL DIAMETER YIELD CAPACITY - MINIMUM	2.4m 46mm 130 KN
FIXTURES	DOMED PLATES STUBBY BOLTS	150mm X 150mm X 5mm 39mm x 0.9m
FIBRECRETE	UCS (28 DAY) MINIMUM TOUGHNESS FIBRE TYPE FIBRE DOSAGE MINIMUM THICKNESS	40 MPa 400 J STEEL 40 KG/M3 50 MM

GEOTECHNICAL ENGINEER	UNDERGROUND SUPERINTENDENT	MANAGER MINING	DATE

NOT TO SCALE

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