Appendix 4

Additional Information Supporting the Project Description

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A4.1 INTRODUCTION

This Appendix has been prepared to accompany the Project Description presented in Section 3 of the EIS. This Appendix provides additional information relevant to the Project Description that for the sake of conciseness has been excluded from Section 3. The information presented in this Appendix should be read in conjunction with the information presented in Section 3.

A4.2 SAR OPEN CUT LAYOUT AND DESIGN

A4.2.1 Introduction

The design and layout of the SAR Open Cut is presented in Section 3.5.2.2 and **Figure 3.5.3** of the EIS. This subsection provides an overview of studies undertaken to inform the proposed layout and design.

A4.2.2 SAR Open Cut Optimisation

The open cut optimisation was undertaken by Proactive Mining Solutions (PMS) using Whittle optimisation software. The optimisation process comprises a detailed, three-dimensional model together with the JORC-compliant resource estimate described in Section 1.2 as well as geological, geotechnical, economic and scheduling inputs as they were then understood to derive the optimal open cut mining solution. That optimal solution maximises recovery of the defined ore and provides a basis upon which to complete the detailed open cut design.

A4.2.3 Geotechnical Analysis

The geotechnical analysis for the SAR Open Cut was undertaken by geotechnics and ground engineering firm WSP. The resulting report (WSP, 2021) describes the details of the test work undertaken, the geotechnical model developed and characterises each of the materials to be intersected. The following provides a brief summary of the key findings of that report, a copy of which is presented as **Appendix 8**. Reliance is placed upon the geological description of the SAR Mine Site presented in Section 1.4.2 and that information is not repeated here.

The geotechnical model consists of four horizons as follows.

- Alluvium – This unit comprises Quaternary and Tertiary-aged alluvium or transported material characterised as silty clays with variable amounts of sand and gravels with a very stiff to hard consistency. The thickness of this unit is variable between 40m and 70m from surface.
- Saprolite – This unit represents highly weathered basement rocks with a variable mix of silty clays, sandy gravelly clays, sandy clayey silt with minor very low strength rock fragments. Clays are typically very stiff to hard consistency and medium to high plasticity. The thickness of this unit is typically less than 15m.
- Weathered or oxidised rock – This unit comprises low strength, highly weathered basement rocks, primarily Mingelo Volcanics
- Slightly weathered and fresh rock – This unit comprises a rock mass with high to very high strength.

WSP (2021) identified four major structural sets within the slightly weathered and fresh rock that would influence the geotechnical stability of the rocks during and following mining.

- Set FL1 – very steeply dipping (89°) to the east (097°), consistent with the main foliation.
- Set FL2 – very steeply dipping (84°) to the southwest (220°) consistent with a northwest/southeast striking fault within the Roswell deposit.
- Set FL3/FL4 – moderately to steeply dipping (55° to 79°) to the south (175° to 187°) consistent with post-mineralisation dolerite dykes.
- Set FL5 – moderately dipping (50°) to the east (095°), potentially associated with the main foliation.

Based on performance of the TGO open cuts, WSP (2021) identified the potential failure mechanisms within the SAR Open Cut as follows.

- Circular failure through the alluvium, saprolite and weathered rock.
- Combination of sliding along structure and rock mass failure through the weathered rock.
- Structurally controlled failures along defects in the saprolite and rock.

WSP (2021) states that material strength of the alluvium, saprolite and weathered rock will be the main control on stability, although failure along relict structures in the saprolite and along structure in the weathered rock will also control stability. In the weathered rock and slightly weathered and fresh rock units, the orientation of the major structures such as faults and shears relative to the Open Cut walls will be the main control on stability.

WSP (2021) used limit equilibrium analyses and to assess slope stability in the alluvium, saprolite and weathered rock and kinematic and statistical analyses using the assessed major structure sets and the open cut wall orientations fresh rock. Based on that analysis, **Table A4.1** presents the open cut design criteria recommended by WSP (2021). These criteria have been adopted by the Applicant.

Table A4.1
Recommended Open Cut Design Criteria

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Horizon	Bench		Berm Width (m)	Inter Ramp Angle (°)
	Height (m)	Angle (°)		
North Pit				
Alluvium	15	45	12	29
Saprolite	15 to 20	45 to 60	8 to 12	29 to 46
Weathered Rock	20	60	8	46
Slightly Weathered and Fresh Rock	20	65 to 75	8	49 to 56
Central Pit				
Alluvium	15	45	12 to 16	26 to 29
Saprolite	15 to 20	45 to 60	8 to 16	26 to 46
Weathered Rock	20	60	8	46
Slightly Weathered and Fresh Rock	20	70 to 75	8	53 to 56

Table A4.1 (Cont'd)
Recommended Open Cut Design Criteria

Page 2 of 2

Horizon	Bench		Berm Width (m)	Inter Ramp Angle (°)
	Height (m)	Angle (°)		
South Pit				
Alluvium	15	45	12 to 16	26 to 29
Saprolite	15 to 20	45 to 60	8 to 16	26 to 46
Weathered Rock	20	60	8	46
Slightly Weathered and Fresh Rock	20	70 to 75	8	53 to 56
Source: WSP (2021) – after Tables ES1 to ES6				

WSP (2021) identified that the principal geotechnical risk is instability of the alluvium and saprolite in areas where slope heights are greater than approximately 60m high, primarily in the west and south walls. In order to mitigate that risk WSP (2021) recommended that the South and Central Pits be mined (and subsequently backfilled) first. This would allow detailed observations of the geotechnical stability of those pits to be undertaken and the design criteria for the larger North Pit and associated final void to be refined, if required. WSP (2021) recommends a range of other mitigation measures be developed and implemented by the Applicant.

Finally, AMC undertook an assessment of the long-term stability of the SAR North Pit final void. That report, referred to as AMC (2021b) is presented in **Appendix 9**. AMC (2021b) determined that the principal risk to the long-term stability of the final void is erosion of the alluvium and saprolite, rock mass failure at a bench and multi-bench scale and unravelling of weathered rock within the pit walls. AMC (2021b) determined that an allowance for a cut back of between 47m on the western wall and 68m on the eastern wall should be made. Notwithstanding this, AMC (2021b) noted that determining long-term wall stability prior to the commencement of mining operations is challenging because of the difficulties in obtaining meaningful data. AMC (2021b) recommends the Applicant reassess the long-term stability of the SAR North Pit once mining operations have commenced and additional data has been obtained. The Applicant would undertake that assessment during mining of the South and Central Pits, as well as during Stage 1 of the SAR North Pit, prior to establishment of the terminal faces of the Open Cut.

A4.2.4 Design Response

In light of the above and taking into consideration the uncertainties associated with assessing the long-term geotechnical and erosional stability of an open cut prior to the commencement of mining operations, the Applicant would implement the following measures to ensure the layout and design of the North Pit provides adequate flexibility in the event that current assumptions in relation to the geotechnical or erosional stability prove to be inaccurate.

- Establish a minimum 50m offset distance between the SAR North Pit crest and SAR Open Cut Clean Water Diversion Bund.
- Engage a suitably qualified and experienced geotechnical engineer to review the performance of the SAR South and Central Pits, as well as Stage 1 of the North Pit and provide recommendations in relation to the long-term stability of the SAR Open Cut North Pit.

A4.3 WASTE ROCK MATERIAL CHARACTERISATION

A4.3.1 Introduction

Material characterisation for mining operations is critical for determining the measures required to manage waste rock throughout and following the life of the Project. The Applicant engaged RGS Environmental Consultants Pty Ltd (RGS) to undertake a material characterisation of waste rock to be extracted from the Caloma Eastern Cutback and the SAR Open Cut. The resulting reports, referenced hereafter as RGS (2021a) and RGS (2021b) respectively, are presented as **Appendices 10** and **11** respectively. The following subsections present an overview of the results of those assessments.

A4.3.2 Caloma Eastern Cutback

A4.3.2.1 Introduction

The Caloma Eastern Cutback is an approved activity and is expected to produce approximately 5.8Mt of waste rock, the vast majority of which would be placed within the Caloma 2 Open Cut. Potential exists for waste rock below the base of oxidation (approximately 180m AHD) to be used for construction of Project-related infrastructure, including internal haul roads and external public roads. In order to determine if that these materials are be suitable for the proposed uses, the Applicant engaged RGS (2021a) to characterise waste rock material within the Caloma Eastern Cutback below 180m AHD.

A4.3.2.2 Sample Selection

RGS (2021a) identified the following lithologies within the Caloma Eastern Cutback and selected a representative range of 50 samples as follows.

- Dolerite .... 14 samples
- Volcaniclastic sandstone .... 5 samples
- Feldspar-phyric porphyry .... 15 samples
- Mudstone .... 4 samples
- Peperite/Feldsparphyric porphyry .... 1 samples
- Mudstone/Volcaniclastic siltstone .... 9 samples
- Peperite .... 2 samples

A4.3.2.3 Sample Analysis

The selected samples were subjected to static geochemical acid base account characterisation to determine the following.

- pH[1]
- Electrical conductivity (EC)[1]

[1] Based on a 1:5 (weight to volume) mixture of sample to deionised water.

- Total Sulphur by Leco Analyser. Those samples with total sulphur $\geq$0.15% were subjected to the Chromium Reducible Sulphur test to determine the sulphide sulphur content of the samples
- Acid Neutralising Capacity.[2]
- Metals/metalloids in whole rock.
- Major cations in whole rock.

Based on the above results, sample lithology and weathering, eight composite samples were prepared, and the samples were mixed with deionised water and the water was tested for the following.

- pH and EC
- Titratable acidity and alkalinity
- Soluble metals/metalloids
- major soluble cations
- major soluble anions

A4.3.2.4 Acid Base Account Testing

Acid base account testing provides an evaluation of the balance between a sample's Net Acid Production Potential (NAPP) and Net Acid Generation (NAG) potential.

A sample's NAPP is the balance between:

- the Maximum Potential Acidity, namely the maximum amount of acid, measured as kilograms of H_2SO_4 per tonne of sample, based on the total sulphur concentration; and
- the Acid Neutralising Capacity, or the capacity a sample to neutralise acid, measured as kilograms of H_2SO_4 able to be neutralised per tonne of sample.

A NAPP that is greater than zero indicates that a sample has the potential to generate an acidic leachate if exposed to oxygen and water.

A sample's NAG is measured by the addition of hydrogen peroxide to a sample to oxidise reactive sulfide, then a measurement of pH and titration of any net acidity produced. A NAG result, namely a NAGpH of less than 4.5 indicates that the sample is potentially acid forming (PAF).

Comparison of NAPP and NAG result provides a useful indication of the potential of a sample to produce an acidic leachate. In summary, samples may be classified as follows.

- Potentially Acid Forming (PAF), namely the sample has sufficient reactive sulfide minerals to potentially produce acidity when all available neutralising minerals have been consumed.

[2] The acid neutralising capacity is the capacity of a sample to neutralise acid, measures as kilograms of H_2SO_4 able to be neutralised per tonne of sample.

- Non-acid Forming (NAF), namely the sample will not produce an acidic leachate.
- Uncertain, namely the sample's potential to generate an acidic leachate cannot be determined based on the Acid Base Account test.

Figure A4.1 presents the results of the Acid Base Account testing. In summary, nine of a total 13 mudstone and volcanic siltstone samples were classified as PAF. Dolerite and feldspar-phyric porphyry samples were classified as NAF. These samples typically also had very low total sulphur concentrations and RGS (2021a) classified them as negligible risk for generating acid. Other samples were classified as NAF, with variably negligible or low risk of generating acid.

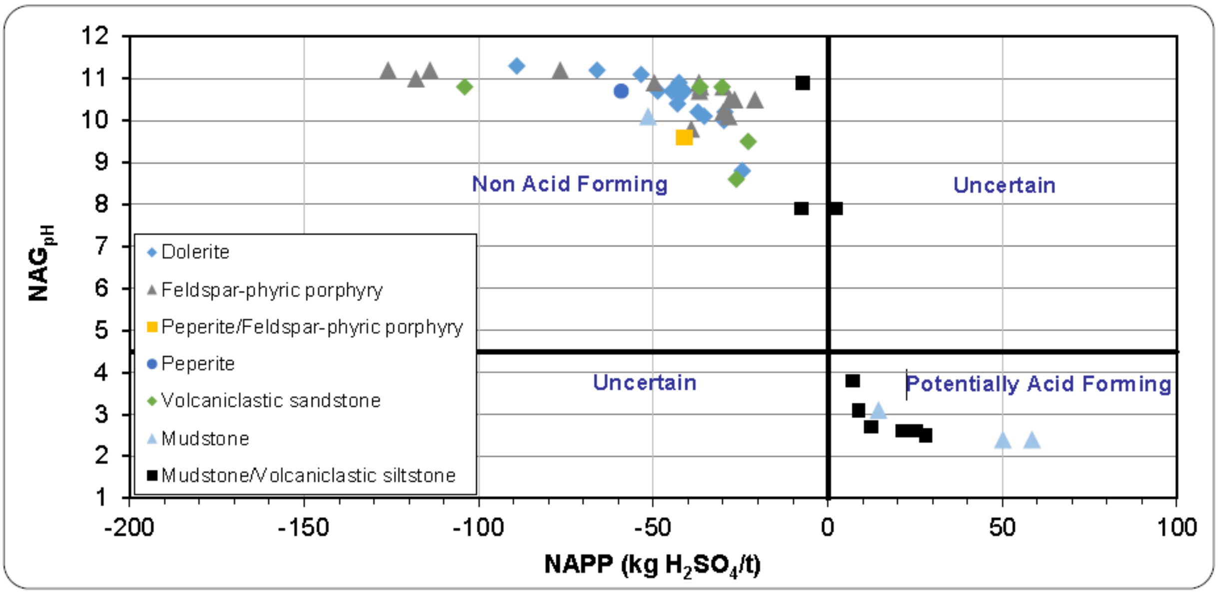


Figure A4.1
NAPP and NAG Results – Caloma Eastern Cutback Samples

Source: RGS (2021a) – Figure 3-6

A4.3.2.5 Multi-element Analysis – Solids

RGS (2021a) undertook multi-element analysis of the selected 50 samples and compared the results with average crustal abundance of each element. The results of that analysis are presented in Attachment B of RGS (2021a) and may be summarised as follows.

- Magnesium and sodium are mildly enriched in six dolerite samples and one mudstone sample.
- Arsenic and copper are mildly to strongly enriched in two dolerite and 5 feldspar-phyric porphyry samples. Arsenic enrichment is not unexpected within the TGO Mine Site as mineralisation is associated with the mineral arsenopyrite (FeAsS).

A4.3.2.6 Multi-element Analysis – Water

RGS (2021a) selected eight composite samples and mixed them with deionised water and measured elemental abundance in the liquid fraction. This test provides a conservative assessment of the metals that may leach from these materials during and following mining operations. The results were compared with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* dated 2018 and may be summarised as follows.

- The pH of the water extracts was alkaline, with seven of the eight composite samples marginally above the applied guideline values of pH 9 in freshwater aquatic ecosystems.
- The electrical conductivity values for the water extracts are low relative to the applied guideline values.
- The concentration of soluble major ions in most of the water extracts from the composite samples are relatively low and generally dominated by sodium, chloride and sulfate.
- Soluble trace metal/metalloid concentrations water extracts from the eight composite waste rock samples are generally low with most of the results below the relevant laboratory limit of reporting. Some water extract samples have elevated concentrations of aluminium (all eight samples) and arsenic (one dolerite sample) greater than the applied freshwater aquatic ecosystems guideline values. However, all trace metal/metalloid concentrations are well within the livestock drinking water guideline values.[3]

A4.3.2.7 Conclusions and Recommendations

Based on the above RGS (2021a) concluded the following.

- The diorite and feldspar-phyric porphyry waste rock materials are classified as NAF, with a low risk of acid generation and a high factor of safety with respect to acid mine drainage.
- The only lithologies sampled that contain material classified as PAF are mudstone and mudstone/volcaniclastic siltstone.
- Total metal concentrations in waste rock are generally not significantly enriched compared to median crustal abundance, with the exception minor sporadic enrichment of arsenic and copper in diorite and feldspar-phyric porphyry waste rock.

[3] Slightly elevated concentrations of some metals/metalloids in water extracts from rock samples, compared to receiving environment water quality guidelines, is common for mine waste materials. It should also be noted that during sample collection and laboratory preparation, the physical agitation and mixing of the samples can affect the physical stability of minerals and increase their solubility in a “first flush” leaching event, such as a static water extract test, which may not reflect the field situation where rocks of varying sizes will be dumped/stockpiled and rainfall/hydrological interaction with these materials is highly variable.

- Initial water contact with the waste rock materials is likely to be slightly to moderately alkaline, fresh (non-saline) with metals/metalloids in material represented by the NAF waste rock samples likely to be sparingly soluble with concentrations expected to remain within applied freshwater aquatic ecosystem and livestock drinking water quality guideline criteria. Some metal/metalloids may be marginally more soluble in initial contact water from waste rock compared to applied freshwater aquatic ecosystem guideline values. However, all trace metal/metalloid concentrations are well within the livestock drinking water guideline values. In the short-term, soluble metal/metalloid concentrations are unlikely to impact upon the quality of surface and groundwater resources.
- In the longer-term, metal/metalloid solubility from any PAF materials has the potential to increase, if these materials are not covered and are left exposed to oxidising conditions.

In light of the above, RGS (2021a) recommended the following. The Applicant has accepted these recommendations.

- Avoid placing any PAF waste rock materials or materials with elevated total sulphur content on or near the surface of the final Waste Rock Emplacements.
- Monitor surface water runoff, including pH and electrical conductivity, downstream of any waste rock emplacement containing PAF materials and/or ore stockpile areas should be regularly monitored for pH and EC.

A4.3.3 SAR Open Cut

A4.3.3.1 Introduction

The proposed SAR Open Cut is expected to generate approximately 141Mt of waste rock over the life of the Project. In order to ensure appropriate long-term management of this material, the Applicant engaged RGS (2021b) to characterise waste rock material within the SAR Open Cut.

A4.3.3.2 Sample Selection

RGS (2021b) undertook a review of the drilling database for the SAR deposits and selected 85 samples with grades of less than 0.5g/t gold from the following nine distinct lithological units from within the SAR Open Cut pit shell.

- Alluvium..11 samples
- Andesite..26 samples
- Dacite..3 samples
- Monzodiorite..4 samples
- Quartz..3 samples
- Saprock/Saprolite..13 samples

- Volcaniclastic conglomerate..4 samples
- Volcaniclastic sandstone..18 samples
- Volcaniclastic siltstone ....3 samples

A4.3.3.3 Sample Analysis

The selected samples were subjected to static geochemical acid base account characterisation to determine the following.

- pH
- Electrical conductivity (EC)
- Total Sulphur by Leco Analyser. Those samples with total sulphur $\geq$0.15% were subjected to the Chromium Reducible Sulphur test to determine the sulphide sulphur content of the samples.
- Acid Neutralising Capacity

Based on the above results, sample lithology and weathering, 11 composite samples were prepared and the solid and soluble fractions and were subjected to the following additional physical and chemical tests.

- Titratable acidity and alkalinity
- Metals/metalloids in whole rock
- Cations in whole rock
- Soluble metals/metalloids
- Major cations
- Major anions
- Exchangeable cations
- Emerson Aggregate Testing
- Particle Sizing and Particle Size Classification
- Particle Density

A4.3.3.4 Acid Base Account Testing

Figure A4.2 presents the results of the Acid Base Account testing. In summary, one SAR Open Cut sample may be classified as PAF, two as uncertain and 82 samples may be classified as NAF.

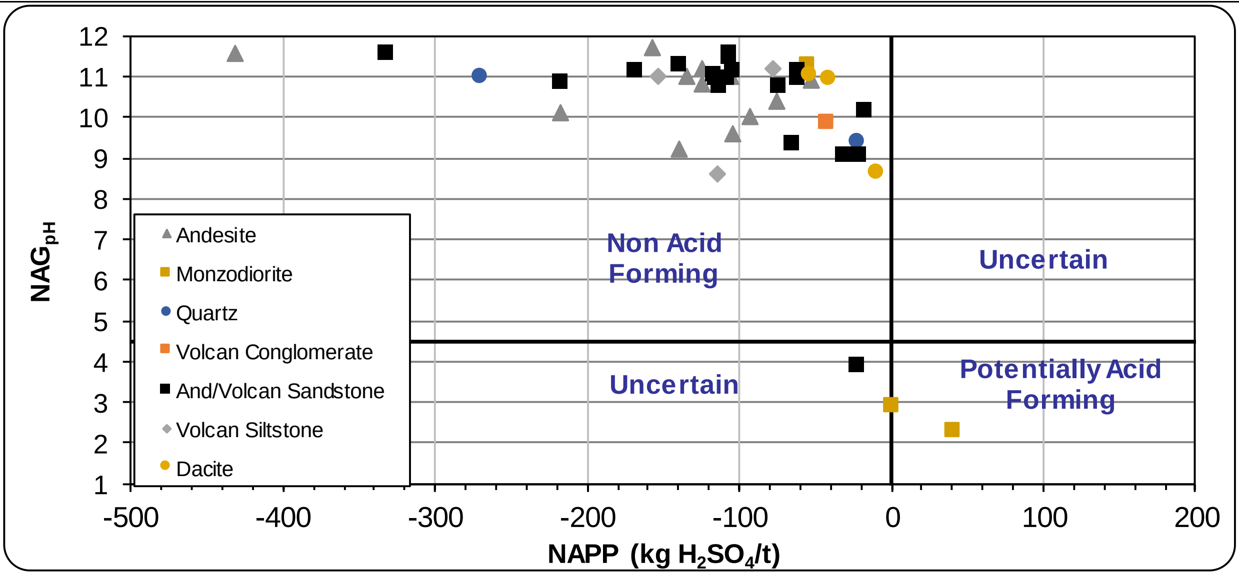


Figure A4.2
NAPP and NAG Results – SAR Open Cut Samples

Source: RGS (2021b) – Figure 3-6

A4.3.3.5 Multi-element Analysis – Solids

RGS (2021b) selected 11 composite samples based on the initial Acid Base Account results for multi-element analysis in solids. The results, and comparison with typical Geochemical Abundance Index, are presented in Appendices B2 and B3 of RGS (2021b). The results of that analysis identified that most elements were not significantly enriched when compared with average crustal abundance. However, arsenic is relatively enriched and arsenic concentrations in Fresh Andesite (346 mg/kg) and Quartz (628 mg/kg) are higher than the National Environmental Protection Council Health-based Investigation Levels for soils in public open spaces (300mg/kg). Notwithstanding this, waste rock with elevated arsenic levels would be placed

A4.3.3.6 Multi-element Analysis – Water

RGS (2021b) also assessed the potential solubility and mobility of elements/metalloids in a 1:5 weight of sample to volume of deionised water solution for the above 11 samples. The results of analysis are presented in Appendix B5 of RGS (2021b) and may be summarised as follows.

- The pH of the water extracts was typically neutral to alkaline.
- The EC values for the water extracts was generally low.
- Soluble major ions are relatively low with the exception of the water extract from the single PAF monzodiorite sample, which has elevated concentrations of calcium and sulfate.
- Soluble trace metals and metalloid concentrations in the composite rock samples are generally low with some water extract samples having elevated concentrations of aluminium (8 samples, possibly as a result of sample contamination), arsenic (2 samples) and chromium (2 samples).

A4.3.3.7 Physical Testing

RGS (2021b) undertook additional testing and determined that the alluvium, saprolite, and saprock lithologies may be prone to dispersion, and potentially tunnelling. By contrast, other lithologies are unlikely to be dispersive.

A4.3.3.8 Conclusion

Based on the above, RGS (2021b) concluded the following.

- The overwhelming majority of tested materials are classified as NAF, with a low risk of acid generation and a high factor of safety with respect to acid mine drainage.
- Some of the igneous lithologies have elevated sulphur content (as sulphide) and have the potential to oxidise over time and be a potential source of neutral mine drainage and saline drainage.
- Total metal concentrations in waste rock are generally not significantly enriched compared to applied guideline values and median crustal abundance in un-mineralised soils. The only exception is arsenic in some of the fresh igneous and quartz lithologies.
- The majority of metals/metalloids in samples tested are likely to be sparingly soluble, with aluminium, arsenic and chromium potentially marginally more soluble. However, all trace metal/ metalloid concentrations are well within the livestock drinking water guideline values.
- In the short-term soluble metal/metalloid concentrations are unlikely to impact upon the quality of surface and groundwater resources. However, in the longer-term metal/metalloid solubility from any PAF materials has the potential to increase, if these materials are not covered and are left exposed to oxidising conditions.
- Some waste rock materials may potentially be susceptible to dispersion and erosion.

In light of the above, the Applicant does not propose any particular management measure to address risks associated with the production of acid mine or neutral metalliferous drainage.

A4.4 SAR WASTE ROCK EMPLACEMENT DESIGN ASSESSMENT

A4.4.1 Introduction

During engagement for the Project, a range of feedback was received in relation to the proposed SAR Waste Rock Emplacement (see Section 5.2.2). In particular, surrounding residents expressed a desire to see a “natural” looking emplacement that was sympathetic with surrounding landforms. A common theme was that residents did not want to see the more “traditional” waste rock emplacements design of Waste Rock Emplacements 1 and 2 repeated for the SAR Waste Rock Emplacement.

In addition, the Resources Regulator identified that the application should address the following.

> "Identification and description of those aspects of the site or operations that may present barriers or limitations to effective rehabilitation, including an assessment of high-risk rehabilitation landforms (such …waste rock dumps, etc). This should include … identifying and adopting geomorphic design principles to achieve a natural and stable landform outcome. It should also include a constraints and opportunities analysis of alternative final landforms giving consideration to geotechnical stability, geomorphic stability (soil types, soil erosion, etc), water management, integration with the characteristics of the surrounding natural landform and minimising sterilisation of land post-mining. For large and complex sites, there should be a commitment to undertake landform evolution modelling throughout the mine life to address long-term erosion and stability risks."

In light of the above, the Applicant engaged Landloch Pty Ltd to undertake an erodibility testing and modelling program for a range of landform design options for the SAR Open Cut. The resulting report entitled *Landform Design – San Antonio and Roswell Waste Rock Emplacement*, referred to hereafter as Landloch (2021b), is presented as **Appendix 12**.

A4.4.2 Design Options Assessed

In determining design options to be assessed by Landloch (2021b), the Applicant has sought to achieve the following design objectives.

- Minimise the area of agricultural land and native ecosystems disturbed.
- Maximise the "natural" appearance of the proposed Waste Rock Emplacement.
- Ensure that the proposed final landform is stable and unlikely to be subject to unacceptable erosion.
- Ensure that the final landform is capable of a productive final land use.

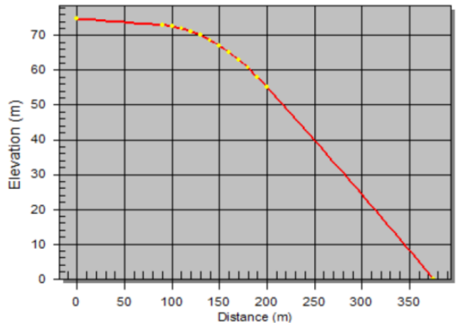
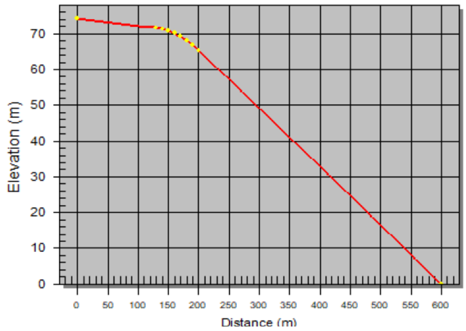
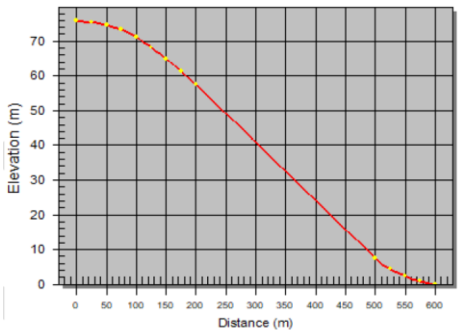
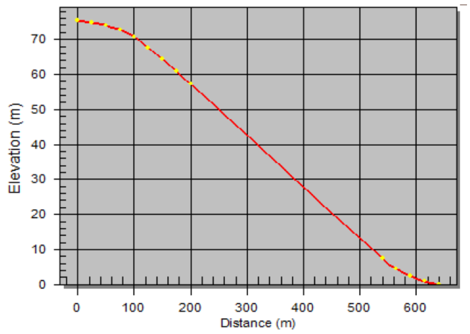
The Applicant identified four SAR Waste Rock Emplacement design scenarios for assessment by Landloch (2021b) (**Table A4.2**).

A4.4.3 Assessment Methodology

Landloch (2021b) undertook the following to assess the erodibility and stability of the design scenarios.

- Analysis of three bulk samples of soil material as follows to determine the erodibility parameters and settling velocity for each. The sampled Soil Mapping Units are described in Section 6.8.2.5.
  - Chromosol and sodosol topsoil
  - Chromosol subsoil
  - Gilgai topsoil

Table A4.2
SAR Waste Rock Emplacement Erosion Modelling Scenarios

Design Scenario	**Scenario RS#1**	**Scenario RS#2**
Emplacement Height	75m	75m
Slope and Distance from Crest • 0m to 100m • 100m to 200m • 200m to base	 2% or 1:50 (V:H) Increase from 2% to 33% 33% or 1:3 (V:H)	 2% or 1:50 (V:H) Increase from 2% to 16.7% 16.7% or 1:6 (V:H)
Slope Shape	Linear	Linear
Surface Roughness	3cm	3cm
Graphical Representation		
Design Scenario	**Scenario RS#3**	**Scenario RS#4**
Emplacement Height	75m	75m
Slope and Distance from Crest • 0m to 100m • 100m to 200m • 200m to 500m • 500m to base	 Increase from 2% to 5% Increase from 5% to 16.7% Linear slope at 16.7% Decreases from 16.7% to 4%	 Increase from 2% to 5% Increase from 5% to 14.7% Linear slope at 14.7% Decreases from 16.7% to 4%
Slope Shape	S-shaped	S-shaped
Surface Roughness	3cm and 7cm	3cm
Graphical Representation		
Source: Landloch (2021b) – modified after Table 3		

- Modelling of the anticipated erosion for each of the proposed design scenarios using the following software packages.
  - WEPP runoff/erosion model of Flanagan and Livingston (1995).

    This model considers runoff and erosion on 2-dimensional batter slopes to predict runoff, erosion, and deposition. The WEPP model has a number of advantages, including the ability to rapidly assess a wide range of slope gradients, profile shapes, slope lengths, materials (soils), and surface vegetation cover and provide erosion and runoff predictions at a range of time scales.
  - SIBERIA landform evolution model of Willgoose *et al*. (1989).

    The SIBERIA landform evolution model is a 3-dimensional topographic model that predicts the long-term development of channels and hillslopes in a catchment on the basis of runoff, erosion, and deposition. SIBERIA has been successfully applied to explain aspects of geomorphology of natural landforms and has been extensively used in the context of mining and subjected to extensive validation.

Landloch (2021b) modelled vegetative cover as follows.

- 0% cover - representing bare soil without any vegetation.
- 50% cover – representing moderate cover that may occur under drought conditions.
- 70% cover – representing high cover that may occur under normal conditions.
- 90% cover – representing the observed vegetative cover on the existing rehabilitated Waste Rock Emplacement 2 and Waste Rock Emplacement 3 and the Peak Hill Gold Mine Waste Rock Emplacement.

Finally, Landloch (2021b) adopted the following target criteria for the modelled landforms.

- Soil loss - mean maximum erosion rate at any one point on the slope of 5 t/ha/y.
- Gully erosion – less than 300mm.

A4.4.4 Assessment Results

The initial WEPP modelling of Scenarios RS#1 and RS#2 identified the following.

- Each soil type is predicted to have soil erosion rates of less than 2t/ha/year at slopes of 2%, irrespective of vegetative cover.
- On slopes greater than 2%, chromosol and sodosol topsoil resulted in the lowest erosion rate of the three materials tested.
- At slopes of 33% or 1:3 (V:H), only the chromosol and sodosol topsoil resulted in acceptable rates of soil erosion and only under 90% vegetive cover.
- At slopes of 16.7% or 1:6 (V:H), chromosol and sodosol topsoil achieved soil erosion rates of less than 2t/ha/year under 90% vegetative cover. Under 70% cover, soil erosion rates marginally exceeded the conservative 5t/ha/year erosion rate. The only other material to achieve the 5t/ha/year soil erosion criterion was the gilgai topsoil, and only under 90% vegetative cover.

In light of the above, and to further refine the recommended design criteria, Landloch (2021b) modelled scenarios RS#3 and RS#4 assuming use of chromosol and sodosol topsoil only. In summary, the revised scenarios included an S-shaped slope with a rounded upper surface and concave foot slopes. Two maximum slope scenarios were modelled, namely 16.7% or 1:6 (V:H) and 14.7% or 1:7 (V:H). In addition, each scenario included two surface roughness assumptions, namely 3cm and 7cm. Surface roughness relates to the micro-relief of the ground surface and any long-lasting relief (e.g. crests and trough) formed by tillage or ripping. Observed surface roughness of the Waste Rock Emplacements 2 and 3 is 3cm. Surface roughness of 7cm may be achieved by deep ripping the final landform along the contour following placement of topsoil.

The results may be summarised as follows.

- Increasing surface roughness from 3cm to 7cm resulted in substantial reductions in modelled soil erosion, with both the 50% and 70% vegetative cover options achieving the 5t/ha/year criterion.
- Reducing the maximum slope of the waste rock emplacement from 16.7% or 1:6 (V:H) to 14.7% or 1:7 (V:H) resulted in only minor reductions in soil erosion rates.

Finally, Landloch (2021b) undertook modelling of the proposed SAR Waste Rock Emplacement using the SIBERIA model, with a modelling period of 1,000 years based on the following assumptions.

- Slope - distance from crest
  - 0m to 100m .... 2% or 1:50 (V:H)
  - 100m to 200m ....Increase from 2% to 16.7%
  - 200m to base .... 16.7% or 1:6 (V:H)
- Maximum elevation...335m AHD
- Use of chromosol and sodosol topsoil only.
- Vegetation cover of 50% and 70%.

Table A4.3 presents the results of the SIBERIA modelling. **Figure A4.3** graphically presents the results of modelling at the 500-year time period under the 70% vegetative cover scenario. Landloch (2021b) summarise these results as follows.

- Long-term average soil loss would be less than the target 5t/ha/y under a 60% vegetation cover scenario. The Applicant notes that the current vegetation cover at both TGO and the Peak Hill Gold Mine is approximately 90%.
- Gullies are expected to begin to erode through the proposed 300mm of soil cover after 500 years. These gullies primarily form at the convex section of the proposed emplacement where the slope transitions from 5% to 16.7% (**Figure A4.3**). In order to mitigate the formation of gullies in this area, Landloch (2021b) has recommended placement of a soil/rock matrix in that location.

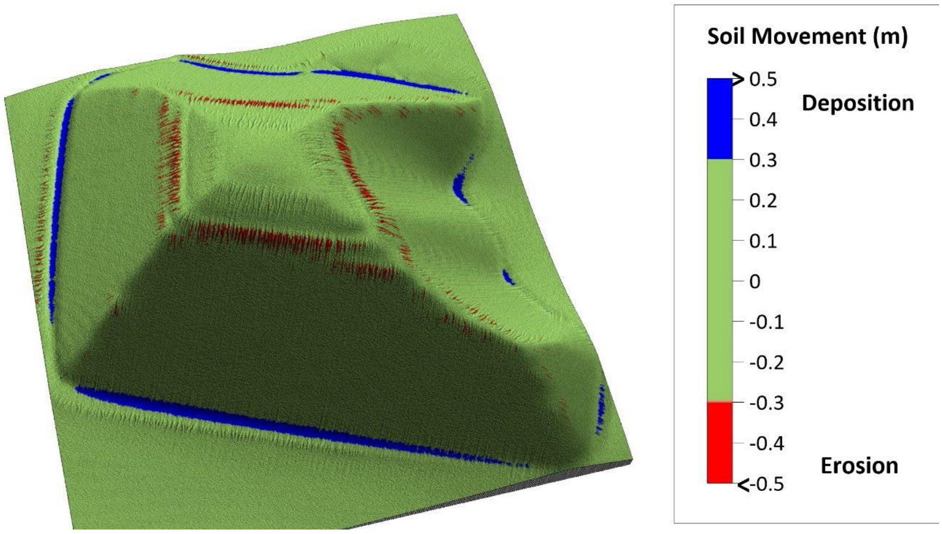


Figure A4.3
SIBERIA Modelling Results – 500 years and 70% Vegetative Cover

Source: Landloch (2021b) – Figure 10

Table A4.3
Results of SIBERIA Modelling

Simulation Year	Average Erosion Rate (t/ha/y)		Cumulative Erosion Depth		Maximum Gully Depth	
	Vegetation Cover					
	50%	70%	50%	70%	50%	70%
Target Criteria	**<5t/ha/y**		**-**		**<0.3m**	
10	**5.2**	2.4	17mm	8mm	<0.3m	<0.3m
50	**5.3**	2.5	35mm	16mm	<0.3m	<0.3m
100	**5.3**	2.5	53mm	25mm	<0.3m	<0.3m
500	**5.5**	2.7	71mm	34mm	**0.5m**	**0.4m**
1000	**5.6**	2.8	90mm	43mm	**0.9m**	**0.7m**

Source: Landloch (2021b) – modified after Table 6

A4.5 MINE CLOSURE AND REHABILITATION

A4.5.1 Introduction

Section 3.14 of the EIS provides a range of information relating to the proposed Rehabilitation and Mine Closure for the Project. This subsection provides additional details relating to the proposed Strategy.

A4.5.2 Rehabilitation and Mine Closure Consultation and Documentation

Section 5 of the EIS describes the engagement undertaken for the Project. **Table A4.4** identifies key rehabilitation and mine closure-related consultation outcomes. Each of the matters raised have been considered in detail in preparation of the Rehabilitation and Mine Closure Strategy for the Project.

Table A4.4
Rehabilitation and Mine Closure Consultation

Matter Raised	Summary of feedback
Community Consultation	
Final landform and visual amenity	• A “natural” final landform. • Limited final voids.
Final land use, including post-mining economic activity	• Ongoing productive use of the land to generate local employment and economic activity. • Consider options for post-mining industrial/commercial use of the land.
Water	• Post-mining surface water flows largely unchanged from pre-mining flows. • Limited retention of surface water flows within the Project Site.
Agriculture, weeds and pests	• Maximise the area available for agriculture post-mining. • Manage weeds and pests during and following mining. • Actively engage and cooperate with neighbours re land management activities.
Biodiversity	• Manage and preserve existing biodiversity. • Prefer agricultural land not lost to biodiversity offsets.
Traffic and transport	• Public roads, including the Newell Highway, in the same standard or better than at the start of mining operations.
Government Agency Consultation	
Final landform	• SAR Waste Rock Emplacement to incorporate geomorphic design. • Long-term stability of the final voids, including consideration of mass movement and erosion potential. • Consideration of final Tailings Storage Facility design and construction.
Final land use	• Consideration of future mining potential and non-sterilisation of future resources.

In addition, the Strategy has been designed with reference to the following documentation.

- *Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry* (Commonwealth Government, 2016).
- *Mine Closure and Completion – Leading Practice Sustainable Development Program for the Mining Industry* (Commonwealth Government, 2016).
- *Strategic Framework for Mine Closure* (ANZMEC, 2000).
- *Integrated Mine Closure: Good Practice Guide* (ICMM, 2019).

- *Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure – Revision* 1 (ANCOLD, July 2019)
- *Safety Bund Walls around Abandoned Open Pit* Mines (WA Department of Industry and Resources, 1997).
- *Form and Way: Rehabilitation Management Plan for Large Mines*.
- *Form and Way: Rehabilitation objectives, rehabilitation completion criteria and final landform and rehabilitation plan for large mines.*
- *Guideline: Achieving rehabilitation completion (sign-off).*
- *Guideline: Rehabilitation controls.*
- *Guideline: Rehabilitation objectives and rehabilitation completion criteria.*
- *Guideline: Rehabilitation Records.*
- *Guideline: Rehabilitation Risk Assessment.*

Finally, the following regional and local strategic documents were reviewed during the development of the Strategy. The key documents which were considered include the following.

- *Economic Development Strategy for Regional NSW*.
- *Central West and Orana Regional Plan 2036.*
- *Regions at the Ready: Investing in Australia's Future.*
- *Narromine Shire Community Strategic Plan 2027*.
- *Narromine Local Environmental Plan 2011*.

Sections 2.1.2 and 2.1.3 of the EIS present a detailed discussion of how the Project has been designed to meet the objectives of these documents. Broadly, however, these documents emphasise the importance of balancing land uses within the Region to minimise potential land use conflicts and maximise the efficient and sustainable use of resources to provide the maximum support for local residents and the economy. The importance of agriculture, the natural environment and industry (including mining) are recognised in each of these documents. These objectives are reflected in the proposed final land uses and rehabilitation objectives of the Project.

A4.5.3 Final Land Use Domains

A4.5.3.1 Final Land Use Options Assessment

In assessing options for the proposed final land use, the Applicant took into account the following.

- The approved final land uses presented in Appendix 6 of MP 09_0155.
- Land uses permissible without development consent within Zones RU1 and SP2 of the *Narromine Local Environment Plan 2011*.
- Feedback during community consultation as described in Section 5 of the EIS.

- Existing land uses surrounding the Project Site as described in Section 2.2.2 of the EIS.
- The Applicant's long experience from operating and successfully rehabilitating the Peak Hill Gold Mine and sections of the TGO Mine Site.

Feasible options for post-mining land uses of the Project Site include the following.

- Agriculture – consistent with surrounding land uses, noting that the Applicant is investing significant resources to increase the agricultural productivity of the non-mining land within and surrounding the Project Site.
- Native ecosystem – sections of the TGO Mine Site are identified as Biodiversity Offset Areas under the 2015 Property Vegetation Plan. The Applicant has committed to retain these trees for nature conservation in perpetuity. Other sections of the Project Site are currently vegetated with native and non-native vegetation, including with Fuzzy Box Woodland and Weeping Myall Threatened Ecological Communities.
- Industrial – the Project Site is serviced by a range of infrastructure that could potentially be re-purposed for non-mining purposes, including:
  - high voltage electrical supply and distribution networks;
  - water supply and storage infrastructure;
  - excellent road access to the Newell Highway;
  - large areas of hardstand; and
  - numerous buildings, sheds, workshops and associated infrastructure.

  Potential industrial uses could include intensive agriculture, renewable power generation or manufacturing.
- Water storage area - including numerous sediment basins, large dams and partially water-filled final voids.
- Final voids - two final voids would be retained post-mining, namely the Wyoming 1 and SAR North Pit. These voids may be available for water storage or backfilling with suitable material.
- Public roads – The realigned Newell Highway and Kyalite Road and associated intersections would continue to be used as public roads.
- Tourism – the Project Site is easily accessible from the Newell Highway, a commonly used tourist route, and potential exists for a tourism enterprise or attraction operated by third parties.
- Care and maintenance – when mining operations cease, the Project Site could be placed under care and maintenance until available resources make the recommencement of mining operations viable.

The final land use options assessment determined that with limited caveats, namely the receipt of development consent for those activities not currently permissible without consent, that each of the proposed final land use options were feasible. However, in the absence of a short-term plan to recommence mining operations, the "care and maintenance" option was not considered acceptable to the community and regulators. As a result, that final land use option was not considered further.

A4.5.3.2 Proposed Final Land Use Domains

Section 3.14.4 and **Figures 3.14.4** and **3.14.5** of the EIS present an overview of the proposed final land use domains for the Project Site. The following presents a more detailed description of each of the proposed land uses and domains.

Domain 1 - Agriculture – Cropping and Grazing

Primarily located on gently sloping land, land use within this domain would be consistent with existing agricultural land use within and surrounding the Project Site. Agricultural operations would primarily comprise grazing with intermittent cropping as climatic and other factors permit. Selected Project-related infrastructure, including unsealed roads, hardstand areas, sheds and other buildings, water storages and pipelines and power lines may be retained for post-mining agricultural use. Where required, the area of selected infrastructure such as roads and hardstand areas may be reduced in size to that required for ongoing agricultural use. Buildings and other infrastructure not required for agricultural use would be removed.

Domain 2 - Agriculture – Low Intensity Grazing

Located on moderately sloping, rehabilitated waste rock emplacements, land use within this domain would consist of intermittent grazing, primarily for the purposes of fuel load and weed management. A primary consideration for land managers would be the maintenance of vegetative cover and prevention of soil erosion, in particular during the initial years following completion of rehabilitation operations.

Domain 3 - Agriculture or Industrial

Primarily located on areas of gently sloping rehabilitated mining infrastructure, land within this domain would have the following characteristics.

- Hardstand areas and roads, including site access roads and convenient access to the Newell Highway and the Inland Rail at Tomingley West.
- Electrical infrastructure, including 66kV, 22kV and 11kV transmission lines and lower voltage distribution infrastructure, as well as substations and switch yards.
- Water supply pipeline, with connections to the "Woodlands" and "Dappo" bore and a licenced allocation of up to 1,400MLpa.
- Water storages, including the Caloma Central Dam, SAR Water Storage Dam, former sediment basins and Wyoming 1 and SAR North Pit final voids and underground workings.

Potential industrial uses of this domain include but are not limited to the following.

- Intensive agriculture.
- Power generation, including solar, with the potential for pumped hydro power storage and generation.
- Manufacturing.

Each of these potential commercial land uses are currently permissible only with development consent or would require rezoning of the land under the *Narromine Local Environment Plan 2011*. In addition, further community consultation would be required. As there is no certainty that such consent or rezoning would be granted or that the community would accept such uses, the default land use for this domain would be agriculture. The Applicant would, actively investigate post-mining industrial land uses throughout the life of the Project.

Domain 4 - Native Ecosystem / Biodiversity Offset

Sections of the Project Site are currently the subject of a 2015 Conservation Property Vegetation Plan (see **Figure 3.14.4** of the EIS). Those areas would be retained in perpetuity as biodiversity offsets.

In addition, sections of the Project Site, primarily within road reserves and former Crown land, are currently vegetated with well-established native vegetation, including vegetation classified as Fuzzy Box Woodland and Weeping Myall Threatened Ecological Communities. NSW legislation does not permit clearing of native vegetation without appropriate approvals. As a result, those areas would continue to be used as native ecosystems.

No additional Biodiversity Offsets Areas are proposed within the Project Site, with biodiversity credits required for the Project to be obtained off-site through alternative means.

Domain 5 - Water Storage Areas

A range of existing farm dams would be retained. In addition, the following mine-related infrastructure would be retained as water storages for the final land use. Where required, these water storages would be tested for contamination and any identified contaminated materials would be treated or removed from the Project Site to a suitable licenced facility.

- Wyoming Central Dam.
- SAR Water Storage Dam.
- TGO and SAR sediment basins.

Where required, sediment within these water storages would be tested for contamination and any contaminated materials would be removed and appropriately remediated or disposed of prior to conversion for agricultural or industrial use.

Domain 6 - Final Voids

Two final voids would be retained, namely the Wyoming 1 and SAR Open Cut North Pit. These voids have a suitable relinquishment bund and fence with warning signs constructed around the perimeter. The location of the relinquishment bund would be determined at mine closure, however, Landloch (2021a) for the purposes of the erosional stability assessment for the final open cuts, has assumed a distance of 20m.

Access to the final voids would be suitable blocked, either through the placement of a suitable quantity of material across the entrance to the access ramp and/or through the use of a lockable gate.

Domain 7 - Public Road

The proposed realigned Newell Highway and Kyalite Road and associated intersections would be retained and would continue to be used as public roads managed by the relevant roads authority. The Newell Highway underpass and Kyalite Road overpass would be removed or retained in consultation with the relevant roads authority.

A4.5.4 Rehabilitation Risk Assessment

Clause 7 of Schedule 8A, to the *Mining Regulation 2016* identifies that

> "The holder of a mining lease must conduct a risk assessment (a rehabilitation risk assessment) that—
>
> (a) identifies, assesses and evaluates the risks that need to be addressed to achieve the following in relation to the mining lease—
>
> (i) the rehabilitation objectives,
>
> (ii) the rehabilitation completion criteria,
>
> (iii) for large mines—the final land use as spatially depicted in the final landform and rehabilitation plan, and
>
> (b) identifies the measures that need to be implemented to eliminate, minimise or mitigate the risks."

As a result, a risk assessment was undertaken generally in accordance with *Australian Standards HB 203:2006*, *AS/NZS 4360:2004* and *AS/NZS ISO 31000:2018 Risk Management – Principles & Guidelines*.

Rehabilitation risks were identified and assessed jointly by the Applicant and R.W. Corkery & Co. Pty Limited. Site-specific threats to rehabilitation were assessed based on both the results of previous rehabilitation as well as observations of site-specific conditions and threats to rehabilitation observed during site inspections. This risk assessment was completed with consideration of existing controls as well as those risk controls proposed in the EIS.

In particular, in undertaking this risk assessment, the following was considered.

- Climate data, including long-term data from surrounding Bureau of Meteorology stations and short-term data from the on-site TGO weather station. Data considered included rainfall, temperature, evaporation and wind (see Section 6.1 of the EIS).
- Existing topography and surface water flow paths, including detailed contours, mapped watercourses and modelled surface water flow paths (see Sections 6.1 and 6.6 of the EIS).
- Agricultural and soils data including detailed soil analysis, distribution and the characteristics of the identified soil mapping units, existing land capability, recommended soil management measures and soil inventories (see Sections 3.3.3.5, 6.8 and 6.9 of the EIS).

- Biodiversity information, including the distribution of existing vegetation communities (see Section 6.10 of the EIS).
- Waste rock and residue material characteristics and measures to ensure these materials do not pose a risk to rehabilitation of the Project Site (see Section 3.6.2 of the EIS).
- Landform design, particularly an assessment of the erosional stability of the SAR Waste Rock Emplacement (see Section 3.6.4 of the EIS) and the mass movement and erosional stability of the final voids (see Section 3.5.2 of the EIS).
- Surface water management for the final landform, including ensuring continued flow of surface water to downstream catchments.
- Finally, and most importantly, site experience in shaping and rehabilitating Waste Rock Emplacements 2 and 3 within the TGO Mine Site.

For each identified risk to rehabilitation, potential adverse outcomes were identified and allocated a risk rating based on the potential consequences and likelihood of occurrence. **Tables A4.5, A4.6** and **A4.7** present the consequence, likelihood and risk rating used during this analysis. Where risks were determined to be unacceptable, namely those risks classified as "Moderate" additional risk controls are proposed.

As final land use for the Domain 3 – Agriculture or Industrial have yet to be determined, no risk assessment has been completed for this domain. This is considered to be acceptable because in the event that the final land use is "Agriculture," risks associated with the "Agriculture – Cropping and Grazing" and "Agriculture – Low Intensity Grazing" would be relevant. In the event that the final land use is "Industrial," further approval/development consent would be required and the application for that approval/development consent would address any risks associated with the proposed land use.

In addition, the realigned Newell Highway and Kyalite Road and associated intersections would be constructed in accordance with the requirements of Transport for NSW and Narromine Shire Council and operational responsibility for each road would be transferred to the road authorities prior to commissioning. As a result, risks associated with the final land use within that domain would be addressed by the roads authorities. As a result, rehabilitation risks associated with the "Public Road" final land use domain have not been considered.

Table A4.8 presents the results of the rehabilitation risk analysis assuming the implementation of standard mitigation measures and those outlined within the EIS.

Table A4.5
Qualitative Consequence Rating

Level	Descriptor	Description
1	Negligible	No detrimental impact on the final land use is measurable or envisaged.
2	Minor	An event which could have temporary and minor effects on the suitability of the final land use.
3	Moderate	An event which would create substantial temporary or minor permanent damage to the suitability of the final land use.
4	Major	An event which could have a substantial and permanent consequence to the suitability of the final land use.
5	Severe	A major event which could cause severe damage to the suitability of the final land use with actual or potential loss of credibility with key stakeholders, environmental liability, regulatory intervention, national publicity/complaints, or could close the operation prematurely.
Note: Rating modified after AS ISO 31000:2018 Risk Management – Guidelines		

Table A4.6
Qualitative Likelihood Rating

Level	Descriptor	Description
A	Certain	Is an ongoing occurrence or will occur under all conditions.
B	Almost Certain	Is expected to occur in most circumstances.
C	Likely	Will probably occur in most circumstances.
D	Possible	Will probably occur under favourable circumstances.
E	Unlikely	May occur, but only under favourable circumstances.
F	Rare	Not expected to occur, unless subject to exceptional circumstances.
G	Very Rare	Theoretically possible but not expected to occur.
Source: Rating modified after HB 89:2012 – Figure B7		

Table A4.7
Qualitative Risk Rating

Likelihood	Consequences				
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe
A Certain	M	H	H	VH	VH
B Almost Certain	M	M	H	VH	VH
C Likely	M	M	H	H	VH
D Possible	L	M	M	H	H
E Unlikely	L	L	M	M	H
F Rare	L	L	L	M	M
G Very Rare	L	L	L	L	M
Risk Rating: L = Low, M = Moderate, H = High and VH = Very High					
Source: Modified after HB 89:2012 – Figure B8					

Table A4.8
Rehabilitation Risk Assessment

Risk	Risk Control	Final Land Use Domain					Additional Risk Control – EIS Section where addressed
		Agriculture – Cropping and Grazing	Agriculture – Low Intensity Grazing	Native Ecosystem	Water Storage Area	Final Voids	
General							
Insufficient skills and experience of rehabilitation personnel.	Engagement of qualified and experienced staff. Engagement of consultants to address specific areas requiring specialist expertise.	L (G3)					3.14.2 and A4.5.5
Lack of clearly defined responsibilities.	Clear reporting structures and key performance indicators in staff position descriptions. Well defined scope for specialist consultants	L (G3)					3.14.7.2, 3.14.9 and A4.5.5
Insufficient funding for or prioritisation of rehabilitation activities.	Progressive rehabilitation. Rehabilitation provisioning. Rehabilitation research and trials. Updated rehabilitation cost estimate and security bond.	L (F3)					3.14.9 and 3.14.10
Active Mining Phase							
Inappropriate biological resource (e.g. subsoil, topsoil, vegetative material, seedbank) salvage and maintenance practices.	Detailed soils assessment, including soil stripping, stockpiling, salvage and placement procedures. Test and ameliorate stockpiled soils and adjust soil placement procedures prior to rehabilitation. Maintain adequate soil inventories and ensure adequate soil resources for rehabilitation of SAR Mine Site.	L (F3)		N/A			3.3.3.4, 3.3.3.5 and 6.8 (generally)
Limited pre-existing and stockpiled biological resources for use (e.g. topsoil, woody debris).	Maintain current soil inventory and ensure adequate soil resources for rehabilitation of TGO Mine Site Utilisation of appropriate woody debris where possible from any clearing activities.	L (F3)		N/A			3.3.3.4, 6.8.5 and 6.8.7
Ineffective impoundment of geochemical and geotechnically unsuitable reject and waste rock materials.	Material characterisation of residue and waste rock. Appropriate design of Residue Storage Facility cap. Surface water and groundwater monitoring.	L (G3)		N/A		L (G3)	3.6.2, 3.8.3.2, 6.6.8 and 6.7.8

Table A4.8 (Cont'd)
Rehabilitation Risk Assessment

Risk	Risk Control	Final Land Use Domain					Additional Risk Control – EIS Section where addressed
		Agriculture – Cropping and Grazing	Agriculture – Low Intensity Grazing	Native Ecosystem	Water Storage Area	Final Voids	
Active Mining Phase (Cont'd)							
Adverse geochemical/chemical composition of materials such as overburden, interburden, processing wastes, subsoils and topsoils and imported cover materials.	Material characterisation of residue and waste rock. Surface water and groundwater monitoring.	L (G3)		N/A		L (G3)	3.6.2, 3.8.3.2, 6.6.8 and 6.7.8
Adverse surface and groundwater quality and quantity (underground and surface operations).	Appropriate design, constriction, management and maintenance of erosion and sediment control structures. Separation of clean, raw, dirty, mine and process water and retention of mine and process water under all circumstances and dirty water under all circumstances, except those that exceed the design criteria for the sediment basins. Maintenance of adequate storage and pump and pipe capacity within the Project Site.	L (E2)				N/A	3.9 (generally), 6.6.8 and 6.7.8
	Storage of all hydrocarbons and chemicals in accordance with the appropriate Australian Standard and manufacturer's instructions. Test for and remove contaminated materials from water storages to be retained for the final landform.	L (E2)				N/A	3.3.2.6, 3.11.4 and 3.14.8.3
Decommissioning Phase							
Impacts on heritage items during decommissioning.	Aboriginal and historic heritage assessments. Heritage registers and spatial database.	L (F2)					6.11 and 6.12 (generally)
Hazards associated with retained infrastructure.	Assessment of structures prior to relinquishment / public access.	L (F3)	N/A		L (F3)		3.14.3.8
Contamination resulting from associated activities (e.g. storage and use of hydrocarbons/chemicals, drilling fluids, spillage of dirty or produced saline water, brine, sewage).	Storage of all hydrocarbons and chemicals in accordance with the appropriate Australian Standard and manufacturer's instructions. Contamination assessment prior to decommissioning and remediation of any identified contamination	L (F2)		N/A	L (F1)	N/A	3.3.2.6, 3.11.4 and 3.14.8.3

Table A4.8 (Cont'd)
Rehabilitation Risk Assessment

Risk	Risk Control	Final Land Use Domain					Additional Risk Control – EIS Section where addressed
		Agriculture – Cropping and Grazing	Agriculture – Low Intensity Grazing	Native Ecosystem	Water Storage Area	Final Voids	
Decommissioning Phase (Cont'd)							
Generation of material and waste products from the demolition process.	Waste products generated during decommissioning transported from site and disposed of at an appropriate management facility.	L (F1)					3.11 (generally)
Groundwater accumulation in former underground workings (e.g. potential for fill and spill or impacts on regional ground water users).	Groundwater Impact Assessment (see Section 6.7). Limited groundwater users, low transmissivity of the fractured rock aquifer, substantial depth to groundwater table, final voids will remain a groundwater sink.	L (F2)					6.7.6
Exposure or access to final voids or underground workings.	Backfilling of Wyoming 3, Caloma 1 and 2 final voids and SAR Open Cut South and Central Pits. Installation of a safety bund during operations and an relinquishment bund following completion of mining operations. Blocking or installing locked gates on haul roads into final voids. Plugging and sealing of portals and vent rises. Ongoing post-closure monitoring.	N/A				M (E4)	3.14.8.3
Habitation of structures and/or underground workings by native fauna (e.g. bats).	Plugging and sealing of portals and vent rises to prevent access by fauna.	N/A					3.14.5
Landform Establishment Phase							
Erosion and mass movement issues associated with landform construction (SAR Waste Rock Emplacement).	Assessment of final landform design and stability (see Sections 3.5.2 and 3.6.4 of the EIS). Geotechnical assessment prior to mine closure	L (F2)	M (E3)	N/A		M (E4)	3.6.5 and 3.14.8.3

Table A4.8 (Cont'd)
Rehabilitation Risk Assessment

Risk	Risk Control	Final Land Use Domain: Agriculture – Cropping and Grazing	Final Land Use Domain: Agriculture – Low Intensity Grazing	Final Land Use Domain: Native Ecosystem	Final Land Use Domain: Water Storage Area	Final Land Use Domain: Final Voids	Additional Risk Control – EIS Section where addressed
Landform Establishment Phase (Cont'd)							
Ineffective impoundment of geochemical and geotechnically unsuitable residue and waste rock materials.	Material characterisation of residue and waste rock (see Sections 3.6.2 and 3.8.2 of the EIS). Surface water and groundwater monitoring.	L (G3)		N/A		L (G3)	3.6.2, 3.8.3.2, 6.6.8 and 6.7.8
Lack of availability of suitable materials for encapsulation or capping of adverse materials.	Maintain adequate rehabilitation material inventories and ensure adequate resources for capping of Residue Storage Facilities	N/A	M (E4)	N/A			3.3.3.5
Final landform unsuitable for final land use (e.g. unstable landform).	Assessment of final landform design and stability (see Sections 3.5.2 and 3.6.4 of the EIS). Geotechnical assessment prior to mine closure.	L (F2)	M (E3)	N/A		M (E4)	3.6.5
Lack of availability of suitable materials for construction of final landform features (e.g. safety exclusion bunds).	Maintain adequate rehabilitation material inventories and ensure adequate resources for capping of Residue Storage Facilities	N/A	L (F2)	N/A		L (F2)	3.3.3.5, 3.6.5 and 3.14.9
Growth Medium Development Phase of Rehabilitation							
Inappropriate physical and structural properties of substrate. Subsoil and topsoil deficit for rehabilitation activities. Substrate inadequate to support revegetation (e.g. lack of organic matter, nutrient deficiency, lack of soil biota, adverse soil chemical properties, exposed hostile geochemical materials, and any other factors impeding the effective rooting depth).	Detailed soils assessment, including soil stripping, stockpiling, salvage and placement procedures (see Section 6.8 of the EIS) Test and ameliorate stockpiled soils and adjust soil placement procedures prior to rehabilitation. Maintain adequate soil inventories and ensure adequate soil resources for rehabilitation of SAR Mine Site.	L (F3)		N/A			3.3.3.4, 3.3.3.5, 3.14.9 and 6.8 (generally)
	Maintain current soil inventory and ensure adequate soil resources for rehabilitation of TGO Mine Site Ecosystem Function Analysis monitoring. Existing and future rehabilitation research and trials.	L (F3)		N/A			

Table A4.8 (Cont'd)
Rehabilitation Risk Assessment

Risk	Risk Control	Final Land Use Domain: Agriculture – Cropping and Grazing	Final Land Use Domain: Agriculture – Low Intensity Grazing	Final Land Use Domain: Native Ecosystem	Final Land Use Domain: Water Storage Area	Final Land Use Domain: Final Voids	Additional Risk Control – EIS Section where addressed
Ecosystem and Land Use Establishment Phase of Rehabilitation							
Lack of availability and quality of target seed resources, including genetic integrity.	Harvesting of onsite seed resources Identify quality commercial suppliers. Ecosystem Function Analysis monitoring.	L (F3)		N/A			3.3.3.4, 3.14.7, 3.14.8, 3.14.9 and 3.14.10
Poor seed viability, seed dormancy.							
Predation of seed.	Insect and pest control. Ecosystem Function Analysis monitoring.	L (F2)					
Weed infestation associated with both introduction and control (or lack thereof).	Regular inspection and control programs. Rehabilitation monitoring program.	L (E2)					
Adopting inappropriate or inadequate rehabilitation techniques, including equipment fleet.	Experience with rehabilitation to date. Progressive rehabilitation (and adaption based on experience) Existing and future rehabilitation research and trials.	L (E2)					
Inappropriate revegetation species mix for targeted final land use.	Identification and characterisation of analogue sites. Monitoring by a specialist agronomist.	L (E2)					
Adverse weather and climatic influences (e.g. drought; intense rainfall events; bushfire and climate change).	Meteorological monitoring and long-term forecasts. Progressive rehabilitation across multiple years Rehabilitation planning / scheduling.	M (D3)					
Areas not available for revegetation during optimal seasonal conditions.							
Lack of habitat structures for colonisation or use.	Not applicable – returning to agricultural use	N/A					3.14.3
Lack of infrastructure to support intended final land use (e.g. bunding, fences, watering facilities).	Establishment / maintenance of infrastructure for continued agricultural use of non-mining land during mining operations	L (G2)					

Table A4.8 (Cont'd)
Rehabilitation Risk Assessment

Risk	Risk Control	Final Land Use Domain: Agriculture – Cropping and Grazing	Agriculture – Low Intensity Grazing	Native Ecosystem	Water Storage Area	Final Voids	Additional Risk Control – EIS Section where addressed
Ecosystem and Land Use Development Phase of Rehabilitation							
Adverse weather and climatic influences (e.g. drought; intense rainfall events; bushfire and climate change).	Meteorological monitoring and long-term forecasts. Progressive rehabilitation across multiple years. Repeat revegetation operations as required in the event of initial sub-standard strike rate. Rehabilitation planning / scheduling.	M (D3)		N/A			3.14.7, 3.14.9
Post-closure water quality and quantity issues (e.g. erosion, sedimentation, acid-drainage, high salinity).	Maintain Erosion and Sediment Control Plan until monitoring indicates no significant risk of uncontrolled / excessive erosion and sedimentation. Ongoing surface water and groundwater monitoring	L (G2)	M (E4)	N/A	L (G2)	M (A1)	3.14.9
Damage to rehabilitation (e.g. fauna, domestic stock, vandalism, vehicular interactions, bushfire, insects and plant disease).	Ongoing weed and pest control programs Site access control, including fencing and formed roads. Fuel load management	L (E2)		N/A			3.14.8.3
Insufficient establishment of target species and limited species diversity.	Monitoring by a specialist agronomist.	L (E2)		N/A			3.14.8.3 and 3.14.9
Erosion and failure of landform, drainage and water management/storage structures.	Assessment of final landform design and stability (see Sections 3.5.2 and 3.6.4 of the EIS). Geotechnical assessment prior to mine closure Visual inspection and remediation program.	L (G1)	M (E3)	N/A		H (E5)	3.6.5 3.14.8.3 and 3.14.9
Lack of resources for rehabilitation maintenance.	Progressive rehabilitation Adequate rehabilitation provisioning. Rehabilitation planning / scheduling. Rehabilitation cost estimate and security bond.	L (F3)					3.14.8, 3.14.9 and 3.14.10

A4.5.5 Rehabilitation Implementation

Section 3.14.9 of the EIS identified the proposed rehabilitation implementation measures, including measures that would be implemented to re-establish vegetation on rehabilitated lands. **Table A4.9** presents the species mix that would indicatively be utilised, consistent with the approved TGO *Mining Operations Plan.* Where the rehabilitated lands are proposed to be used for cropping operations, alternate species may be used, including wheat, millet, barley or another crop.

Table A4.9
Indicative Species to be used during Rehabilitation

Scientific Name	Common Name	Scientific Name	Common Name
Pasture Species – Areas to be returned to grazing			
Austrostipa scabra	Rough Speargrass	*Themeda australis*	Kangaroo Grass
Austrostipa densiflora	Foxtail Speargrass	*Austrostipa setacea*	Corkscrew Grass
Austrodanthonia sp.	Wallaby Grass	*Chloris sp.*	Umbrella Grass
Bothriochloa macra	Redgrass	*Microlaena stipoides*	Weeping Grass
Cymbopogon refractus	Barbed-Wire Grass	*Paspalidium jubiflorum*	Warrego Summer Grass
Paspalum dilatum	Paspalum	*Eragrostis lacunaria*	Purple Lovegrass
Eulalia fulva	Silky Browntop	*Panicum effusam*	Hairy Panic
Digitaria sanguinalis	Summer Grass	*Diplachne fusca*	Brown Beetle Grass
Dactyloctenium radulans	Button Grass	*Digitaria brownii*	Cotton Panic
Echinochloa colonum	Awnless Barnyard Grass	*Dicantheum sericeum*	Queensland Bluegrass
Enteropogon acicularis	Curly Windmill Grass	*Sporobolus creber*	Western Rat's Tail Grass
Grassland Species – Areas with slopes >6%			
Chloris gayana	Rhodes Grass	*Cenchrus ciliaris*	Buffel Grass
Pennisetum clandestinum	Kikuyu	*Cynodon dactylus*	Couch Grass
Phalaris sp	Phalaris	*Digitaria eriantha*	Premier Digit
Lolium rigidum	Rye Grass	*Eragrostis curvula ssp.*	Consol Lovegrass
Trifolium repens ssp	White Clover	*Trifolium subterraneum*	Sub-clover
Medicago truncatula	Barrel Medic	*Medicago scutelata*	Snail Medic
Trifolium resupinatum	Persian Clover	*Trifolium hirtum*	Rose Clover
Hordeum vulgare	Barley	*Avenaa ludoviciana*	Black Oats
Source: Approved TGO *Mining Operations Plan* – modified after Table 21			

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