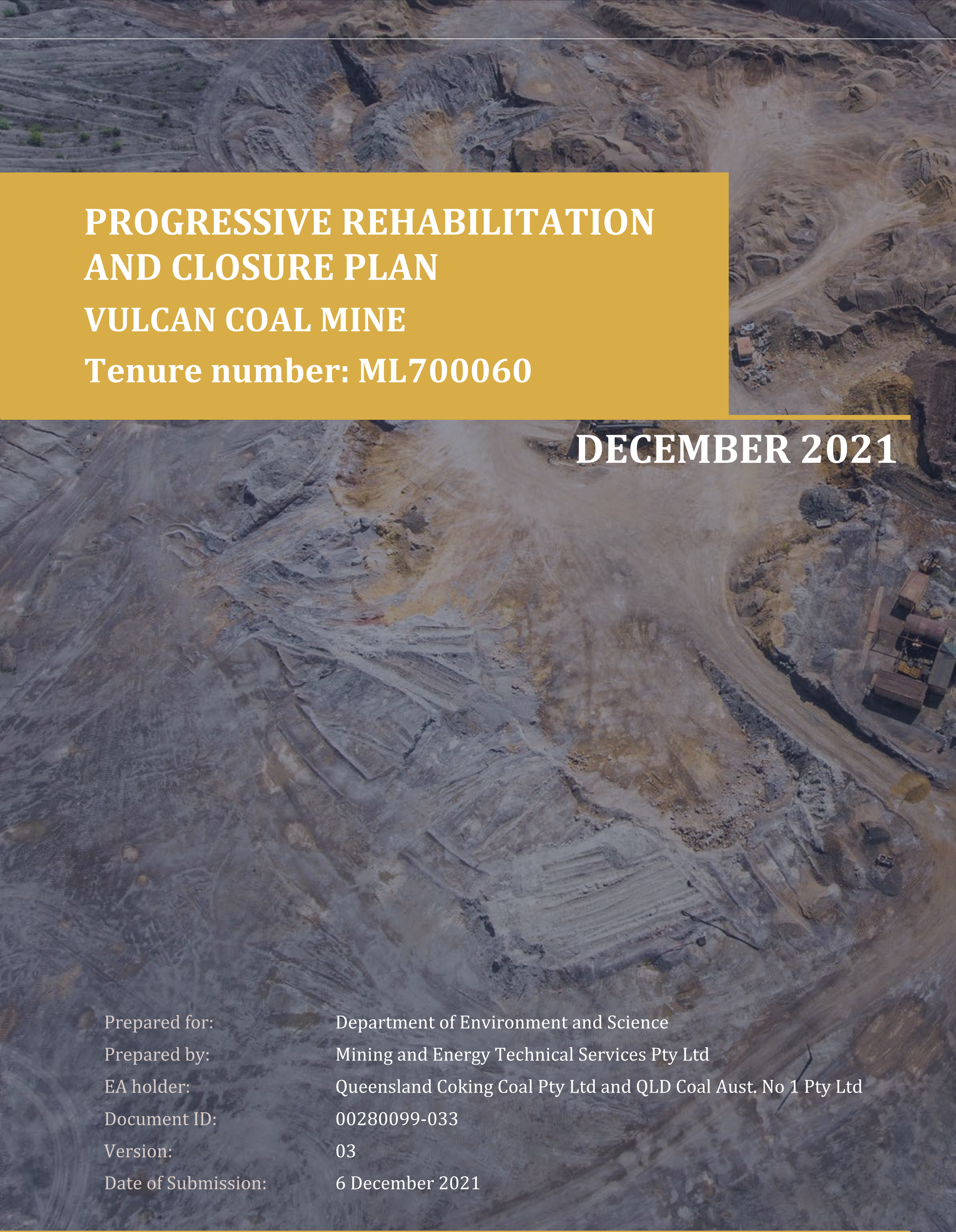

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

VULCAN COAL MINE

Tenure number: ML700060

DECEMBER 2021

Prepared for:	Department of Environment and Science
Prepared by:	Mining and Energy Technical Services Pty Ltd
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Document ID:	00280099-033
Version:	03
Date of Submission:	6 December 2021

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1 INTRODUCTION

The Vulcan Coal Mine (the Mine or VCM) is a small-scale coal mine operated by Vitrinite Pty Ltd (Vitrinite).

A Progressive Rehabilitation and Closure Plan (PRC Plan) accompanied a site-specific application for an environmental authority (EA) to undertake the Environmentally Relevant Activities (ERAs) associated with the Mine. The Mine was approved by the Queensland Government and operates under EA0002912 and in accordance with the original PRCP schedule PRCP_EA0002912_V1. ML700060 which was granted on 14 September 2021. A subsequent minor amendment to the EA and PRCP schedule was approved on 24 November 2021.

To secure a reliable mechanism for transport of its coal to market, Vitrinite proposes to establish a Coal Handling and Preparation Plant (CHPP), Train Load-out facility (TLO) and a dedicated rail loop on ML700060. Ancillary infrastructure will also be required, which includes product stockpiles, updated water management infrastructure, access roads and a number of minor amendments to existing infrastructure layouts. The CHPP technology proposed will produce dry tailings, which will be co-disposed with waste rock within existing proposed waste rock dumps.

This version of the VCM PRC Plan incorporates the infrastructure amendments and has been developed in accordance with Sections 126C and 126D of the *Environmental Protection Act 1994* and to meet the requirements specified in the Queensland Government's *Progressive Rehabilitation and Closure Plans Guideline* (DES 2019a).

The PRC Plan comprises two main components. The rehabilitation planning component (**Sections 1** to **9**) provides information on the characteristics of the site, legislative requirements, stakeholders, post-mining land use, rehabilitation goals, rehabilitation methodology, risk assessment and monitoring program. The PRC Plan schedule component (**Section 10**) provides a final site design and a detailed schedule of progressive rehabilitation activities including rehabilitation milestones.

The PRC Plan presents Vitrinite's strategy for managing mining activities in a way that maximises the progressive rehabilitation of the land to a stable condition, as well as specifying the condition to which Vitrinite will rehabilitate the land before the EA is surrendered.

1.1 Project Location

The Mine is located in the Bowen Basin, Queensland. It lies adjacent to Saraji Road, 33 kilometres (km) south-southeast of Moranbah and 34 km north-northwest of Dysart (**Figure 1-1**). It falls within the jurisdiction of the Isaac Regional Council. The Mine is located immediately south and west of existing, large-scale coal operations, the Peak Downs Mine and Saraji Mine.

1.2 Site Description

1.2.1 Resource Tenures

The Mine has been developed on mining lease (ML) 700060 (**Figure 1-1**). The ML covers an area of approximately 407 hectares (ha) and is situated over multiple underlying tenures (EPC 1732 and 1234). The ML overlies adjacent portions of existing Exploration Permit Coal (EPC) 1732 and 1234 tenements (held by Qld Coal Aust No.1 Pty Ltd and Queensland Coking Coal Pty Ltd, respectively). Both Qld Coal Aust No.1 Pty Ltd and Queensland Coking Coal Pty Ltd are fully owned by Vitrinite. A list of the properties, tenure, usage and owners/managers within the ML boundary are outlined in **Table 1-1**.

Table 1-1 Land Tenure and Real Property Descriptions for the Mine

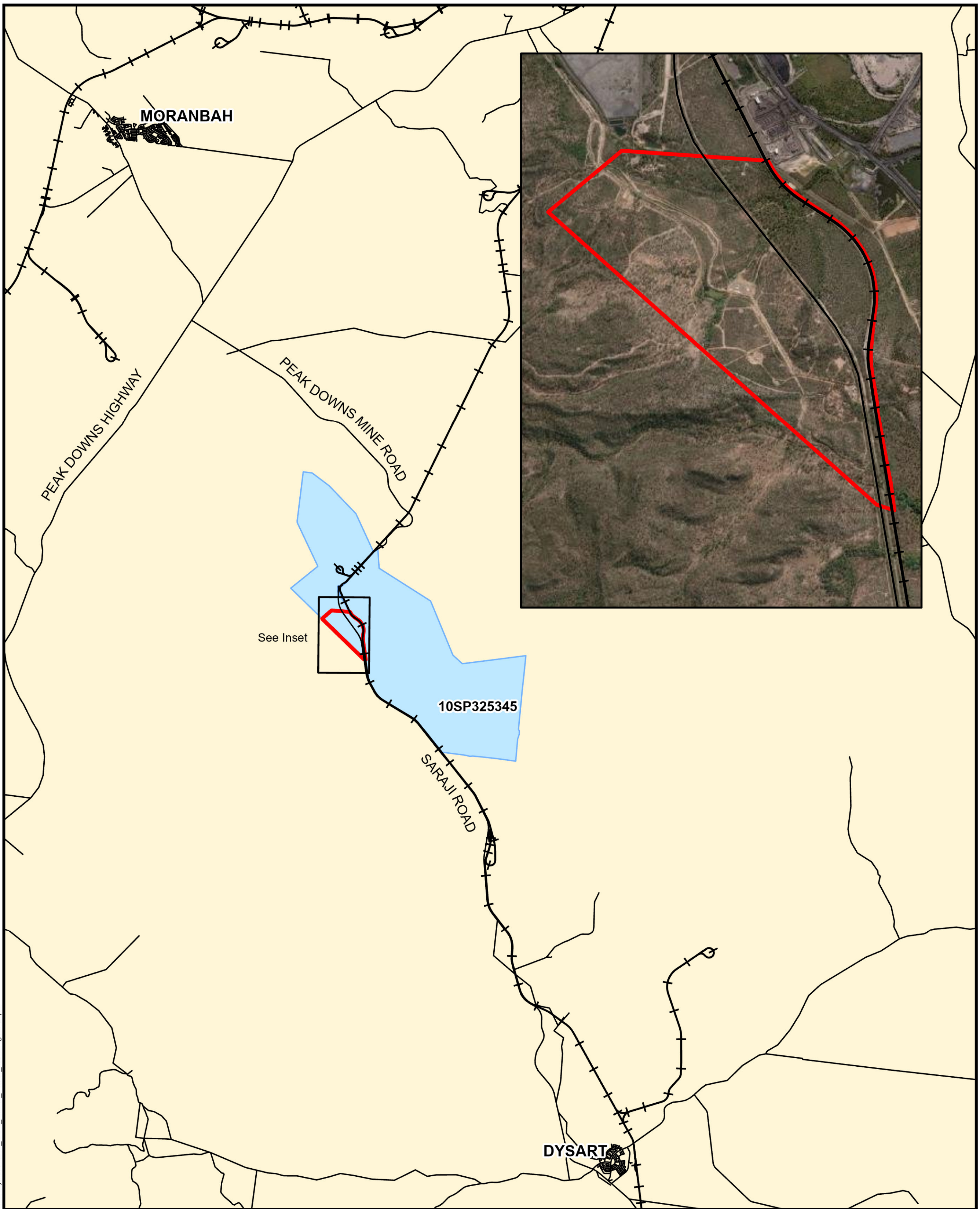
Lot/Plan	Tenure	Usage	Owner	Area (ha)
10/SP325345	Lands Lease	Extractive	BHP Billiton/Mitsubishi Alliance (BMA)	369
26/CNS125	Land Lease	Rail freight transport	Aurizon	13
Saraji Road	Road Reserve	Road for public use	Isaac Regional Council	25

The Mine falls within the Isaac Regional Council local government area. The region has a distinct mining influence with multiple significant coal mining operations in the immediate vicinity of the Mine.

The majority of the land within the ML has been previously disturbed by agriculture and mining-related activities. There are no rural or residential dwellings located within 10 km of the Mine.

1.2.1 Topography

The Mine lies on plains and foot slopes along the eastern edge of the Harrow Range. The Harrow Range (immediately west of the Mine) is generally 100-170 metres (m) higher than the surrounding plain. The plain itself slopes gently towards to the east, and varies in elevation from 270 mAHD in the west to 250 mADH in the east (**Figure 1-2**).



Legend

- Road
- Railway
- ML 700060
- Lot 10 Plan 325345

Source: State of Queensland (Department of Resources) 2021, Vitrinite 2021, METServe 2021, Maxar.

Vulcan Coal Mine

Project Location

0 3 6 12

Kilometers

Scale: 1:350,000 (A4)

6/12/2021

Datum: GDA94
Projection: MGA55

FIGURE 1-1

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

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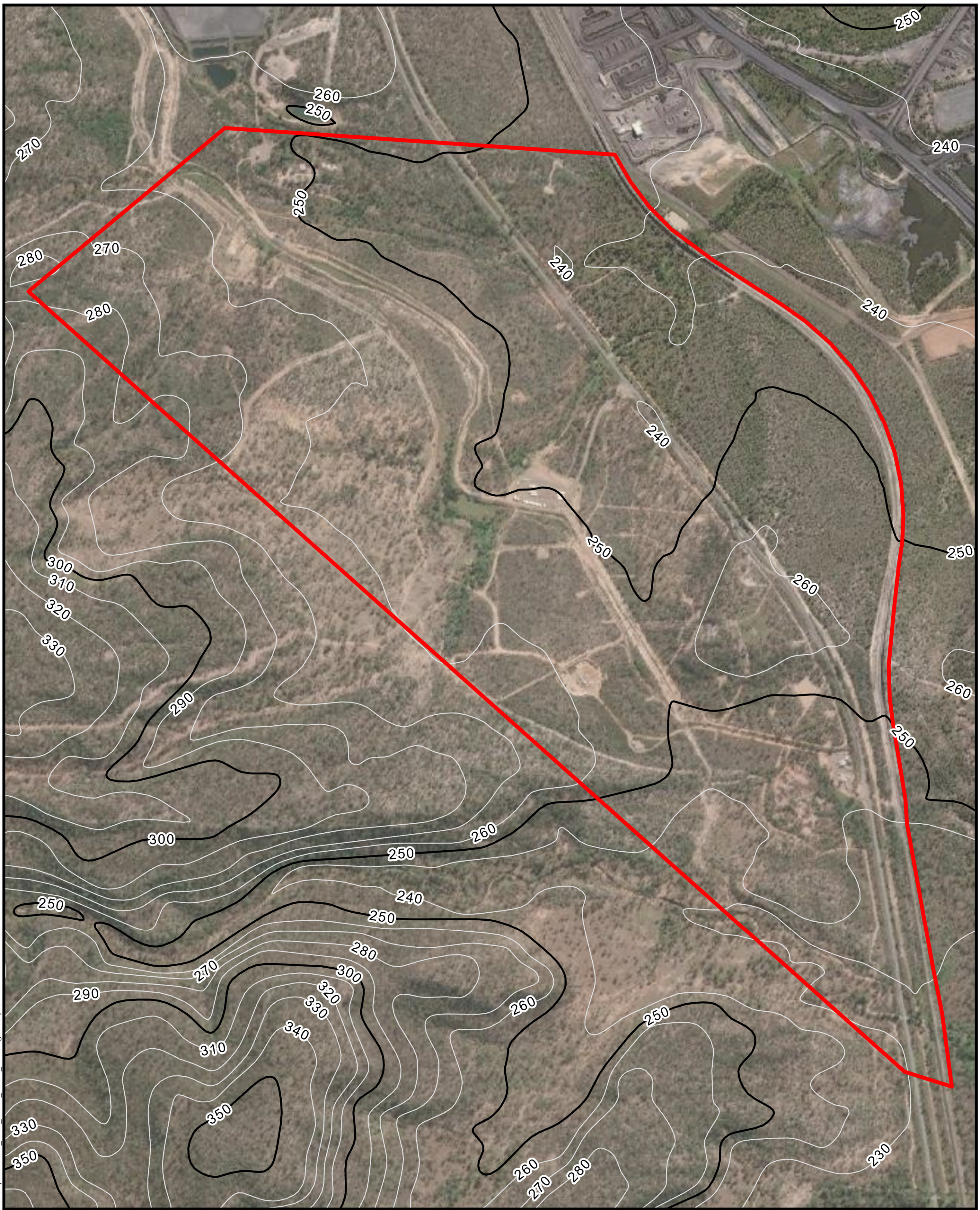

Legend

ML 700060

Contours

10m

50m

Source: State of Queensland (Department of Resources) 2019-2021, Maxar.

Vulcan Coal Mine

Site Topography

0 250 500

Meters

Scale: 1:18,000 (A4)

3/12/2021

Datum: GDA94
Projection: MGA55

FIGURE 1-2

VITRINITE
BRIGHTER COAL

METSERVE
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1.2.2 Climate

The Mine area is subtropical, with hot summers and mild winters. The nearest Bureau of Meteorology (BoM) weather stations are Mount Lebanon (29 km northwest) and Seloh Nolem (29 km east), both of which are currently closed. The nearest active weather station is Moranbah Airport (35 km north-northwest), which only commenced operations in 2012. Given the inconsistency of locally available data for discerning long-term average weather patterns, the Queensland Department of Environment and Science's SILO database was used for estimating average rainfall on site. The SILO database uses mathematical interpolation to fill temporal and spatial data gaps from BoM's weather stations. Based on data generated for the SILO grid point -22.35, 148.20, the mean and median annual rainfall for the Mine is 590.6 millimetres (mm) and 575.1 mm, respectively. However, this varies widely between years: standard deviation = 204.2, range = 275.5 to 1,152.7 mm. On average, 70% of the annual rainfall occurs between November and March (**Figure 1-3**).

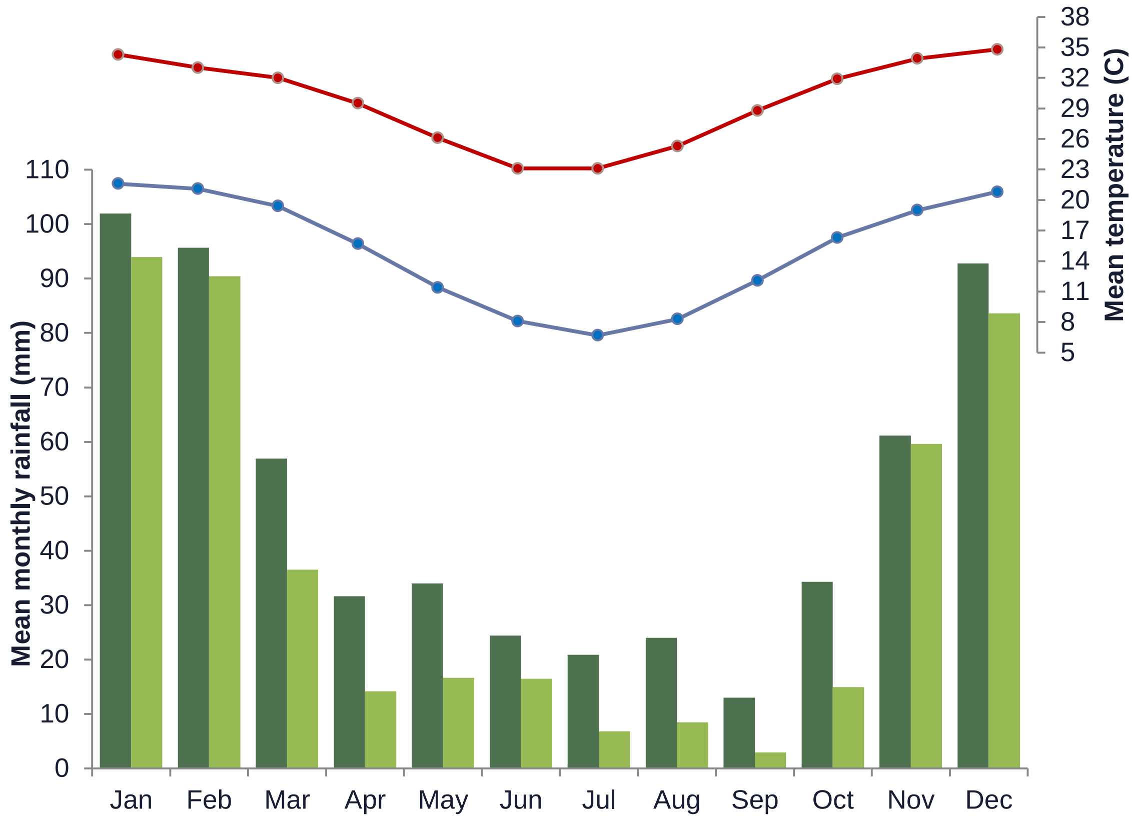


Figure 1-3 Average weather conditions at the Mine.

Green bars refer to the mean (dark) and median (light) monthly rainfall over the past 50 years, as interpolated in the SILO database (DES 2019b) for the SILO grid point -22.35, 148.20. Mean monthly maximum (red) and minimum (blue) temperatures over the past 50 years come from the Clermont Post Office meteorological station.

The mean potential evaporation rate for every month exceeds the mean rainfall for the respective month. However, the size of this deficit varies with season. The period between September and December is historically the driest (**Table 1-2**), which has been considered when planning earthworks and planting programs as part of this PRC Plan.

Table 1-2 Mean potential evaporation rates and mean water deficits at the Mine throughout the year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean rainfall	102	95.65	56.94	31.64	33.96	24.38	20.86	23.99	13	34.26	61.17	92.78
Mean evaporation	220.2	178.9	182.9	145.3	115.5	91.85	102.2	132.7	173.3	216	225.6	237
Mean water deficit	118.3	83.25	126	113.6	81.56	67.47	81.33	108.8	160.3	181.7	164.5	144.2

(from the SILO grid point -22.35, 148.20).

Climate change models produced by the CSIRO (2015) suggest with medium confidence that there will be long-term decreases in average winter and spring rainfall over the next 80 years. Long-term changes in summer and autumn rainfall are also possible, but the direction is unclear (CSIRO 2015). On the short timescales of the Mine, the influence of natural rainfall variability is projected to predominate over trends due to increasing greenhouse gas emissions (CSIRO 2015), and the rainfall data presented in **Figure 1-3** is therefore most relevant to the Mine during the rehabilitation and vegetation establishment stage. Over the next 80 years, however, an increase in the intensity of extreme rainfall events is projected with high confidence, and the time spent in drought is projected to increase with medium confidence. These long-term changes can affect the prospect of survival for long-lived trees.

The effect of climate change on temperature is projected to be more apparent short-term than for rainfall. For the near future (2030), the annually averaged warming across all emission scenarios is projected to be around 0.5 to 1.4 °C above the climate of 1986–2005 (CSIRO 2015); note that the current climate (as at the end of 2019) is already 0.24 °C warmer than the 1986-2005 average (CSIRO 2015). This warming is projected to be 1.3 to 5.0 °C by 2090 (CSIRO 2015). Temperature changes have been considered both for the vegetation establishment phase of rehabilitation and for the long-term survival of trees post-relinquishment. Species to be used in revegetation all have widespread geographic distributions (including hotter and drier locations than the Mine area). It is therefore unlikely that the Mine area currently represents the limit of environmental tolerance for any of the species utilised.

1.2.3 Geology

The geology of the Mine area is influenced by its position within the Bowen Basin, one of Queensland's largest depositional zones, formed through a period of rifting and subsidence lasting from the Early Permian to the Mid-Triassic. The area surrounding the Mine is dominated by clastic sedimentary rocks of marine and lacustrine origin, including sandstones, mudstones, siltstones and coal (Geoscience Australia 2019). Rock strengths range from extremely-low-strength weathered sandstone to high-strength fresh sandstone.

The solid geology of the region includes the:

- Moranbah Coal Measures – Permian, comprising coal and inter-seam material composed of sandstone, shale, siltstone with minor clay stone; and
- Back Creek Group – Early to Late Permian, comprising quartzose to lithic sandstone, conglomerate, siltstone, carbonaceous shale and coal. Occurs beneath the Moranbah Coal Measures, and outcrops to the west of the disturbance footprint.

The Permian sediments are covered by a thin veneer of unconsolidated to semi-consolidated Cainozoic sediments (Tertiary to Quaternary alluvium and colluvium):

- Qr – Qr - (QLD) (Qr) – Quaternary clay, silt, sand, gravel and soil with colluvial and residual deposits; and
- TQa – QLD (TQa) – Late Tertiary to Quaternary poorly consolidated sand, silt, clay, minor gravel and high level alluvial deposits.

Across the Mine area, the uppermost stratum is generally a highly weathered regolith comprising a heterogeneous distribution of fine to coarse-grained sand, clay, sandstone and claystone. These are either Tertiary sediments or a weathered profile that had developed during the Tertiary on Permian strata (hydrogeologist.com.au 2020). The base of weathering typically extends to depths of 5 to 45 mbgl (metres below ground level), where the unweathered Moranbah Coal Measures commence. In the vicinity of the Mine, the cumulative thickness of coal appears to be between 5 m and 15 m. The Mine intends to access the lower seams of the Moranbah Coal Measures (the ALEX and Dysart Lower-Lower (DLL) coal seams).

Outcropping to the west of the Mine is the basal section of the Moranbah Coal Measures, a sequence of sandstones and siltstones, with imbedded coal. The ALEX coal seam lies near the top of this sequence, just below the base of weathering. It is of high quality and low ash content, and is approximately 1 m thick. It overlies resistant, quartzose, medium to coarse-grained sandstone, locally referred to as the Mesa Sandstone due to the characteristic mesa plateaus that have formed in the region. At its base, the Mesa Sandstone grades into the Mesa Siltstone.

The DLL coal seam lies immediately below the Mesa Siltstone. It lies near the base of the Moranbah Coal Measures. The DLL consists of a 2.5-m-thick seam with four plies, and contains moderate to high-ash, good-quality coal. An additional and separate 1-m-thick coal ply beneath the main seam plies, results in a total coal thickness within the target sequence of approximately 3.5 m.

Beneath the Moranbah Coal Measures are the Exmoor and Blenheim formations of the Back Creek Group. The top of the Exmoor formation is characterised by prominent, coarse-grained, siliceous boulder sandstone in outcrop, whilst the top of the Blenheim Formation is characterised by fossiliferous and worm-burrowed sandstone.

No igneous intrusions have been encountered within the Mine area to date in either drilling or field mapping exercises. However, neighbouring mining operations (the north and far west of EPC1234 and EPC1729) have localised basalt dykes and potential sills within their leases.

A conceptual diagram of the main geological units is shown in **Figure 1-4**, and representative stratigraphy of the Mine area is shown in **Figure 1-5**.

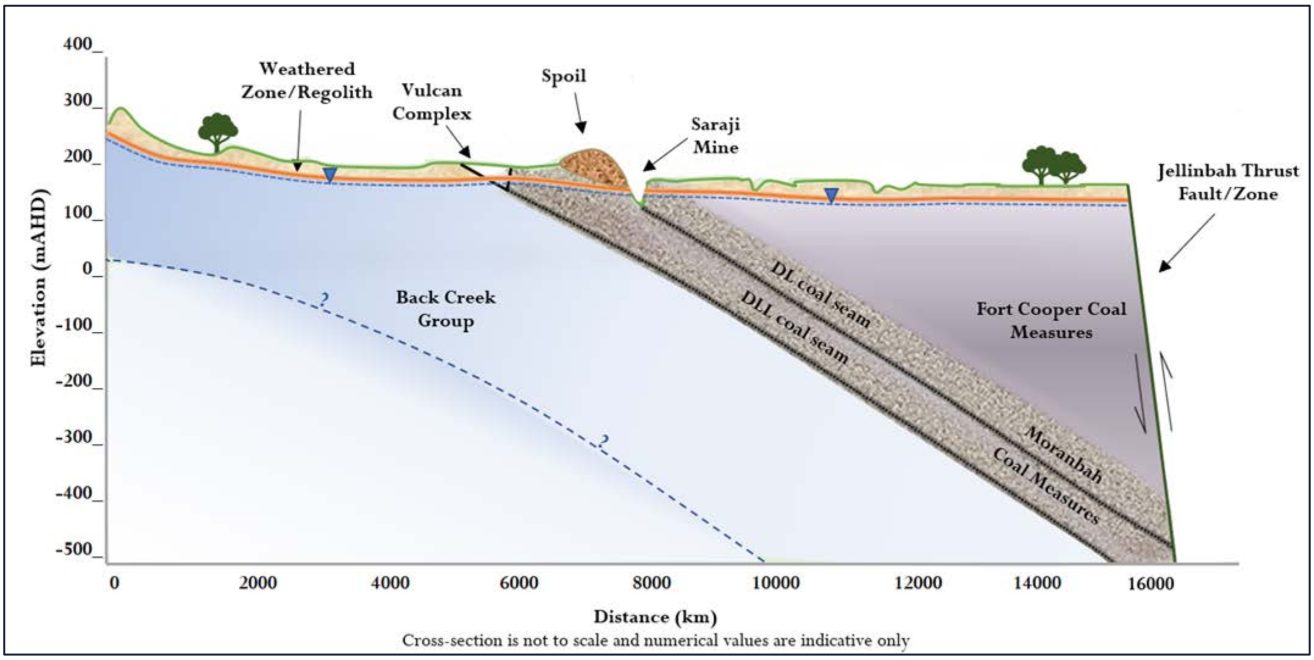


Figure 1-4 *West-to-east conceptual geological model of the Mine area (hydrogeologist.com.au 2020)*

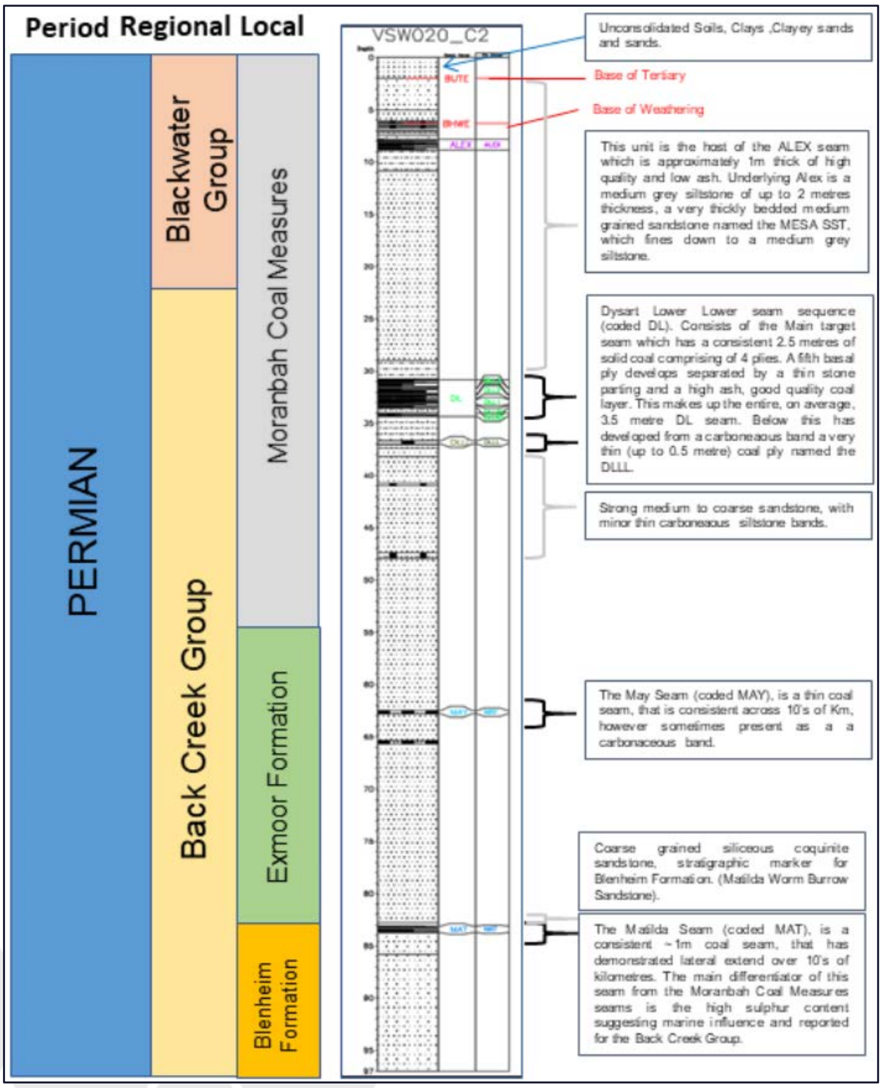


Figure 1-5 *Representative stratigraphy of the Mine area (hydrogeologist.com.au 2020)*

1.2.4 Hydrology

The Mine is located within the 'Isaac western upland tributaries' area of the Isaac River sub-basin, which in turn forms part of the Fitzroy Basin. The Mine is located in the headwaters of the Boomerang Creek catchment.

The Mine area contains several ephemeral tributaries of Boomerang Creek, and all drain towards the east. The tributaries of Boomerang Creek which intersect the Mine area include (**Figure 1-6**):

- Drainage Line 1;
- Drainage Line 2; and
- the existing drainage diversion.

The Boomerang Creek catchment commences to the west of the Mine area and drains in an easterly direction towards Saraji Road, the Norwich Park Branch Railway and the Peak Downs Mine. The headwater tributaries of Boomerang Creek are ephemeral streams which experience flow only after sustained or intense rainfall.

These highly emphemeral tributaries converge before joining Boomerang Creek, which then flows an additional 21 km east of the Mine before joining the Isaac River.. The Isaac River ultimately flows into the Fitzroy River, which empties into Keppel Bay near Rockhampton. These ephemeral creeks have limited flow, typically only after heavy rainfall events. Flows typically last for less than a fortnight after heavy rain events.

Drainage line 1 traverses the north of the ML, which drains most of the ML east of the existing flood levee. This tributary flows beneath Saraji Road and the Norwich Park branch railway, before discharging into the Peak Downs Mine, where it feeds existing highly modified water storages. This tributary will be diverted as part of the Mine, to allow access to the underlying coal. The tributary will be reinstated post-mining by constructing a drainage corridor through backfilled spoil as shown in **Section 1.3.3**. A new culvert crossing will be constructed under the realigned Saraji Road just upstream of the existing railway culverts. This will connect to the existing channel and utilise the existing railway culverts. The typical pre-mining dimensions of this tributary through the Mine area are:

- channel bed widths of 2 m to 5 m;
- channel top widths of 10 m to 25 m;
- channel depths 0.5 to 1 m; and
- overbank floodplain widths of 20 m to 50 m.

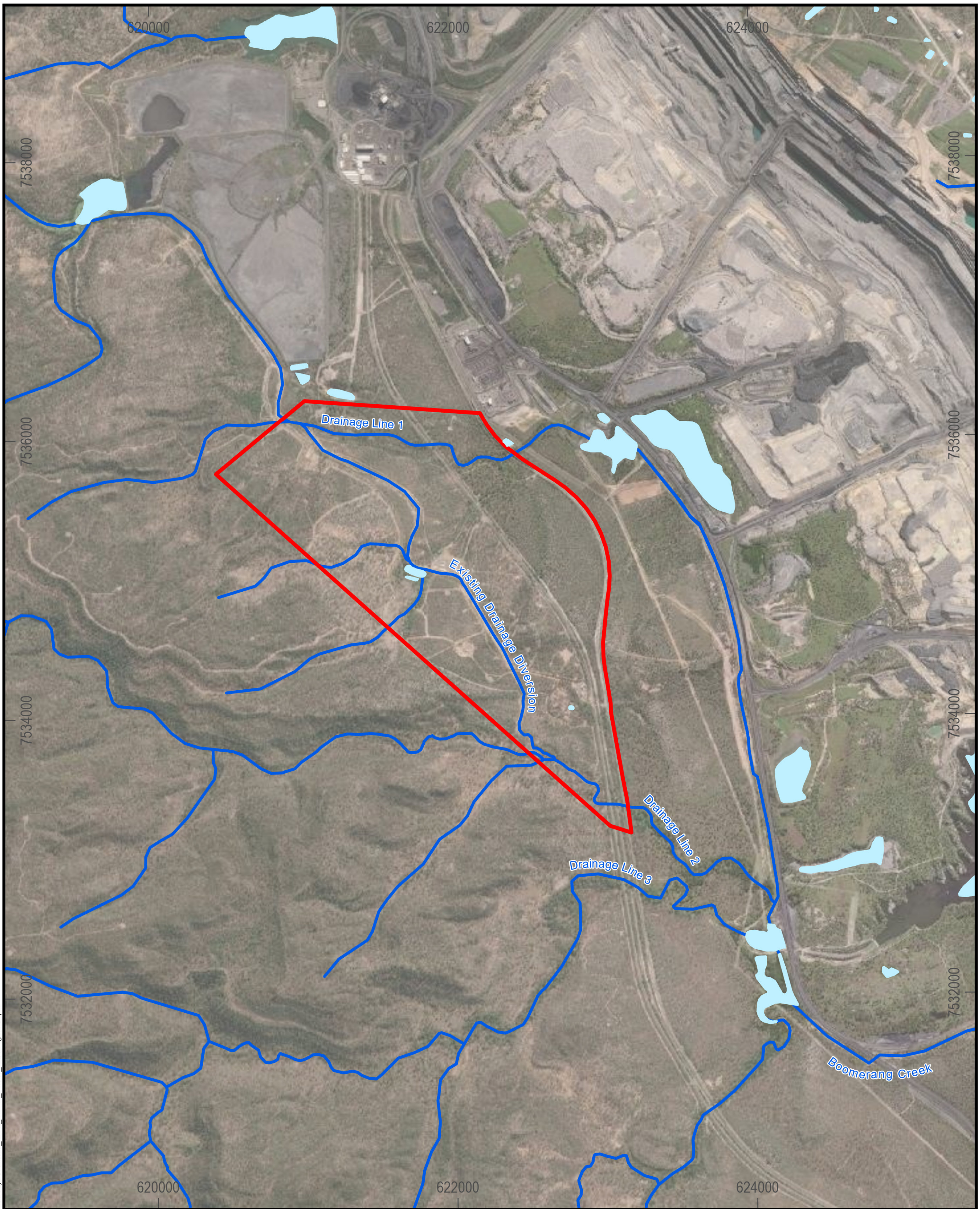
An existing drainage diversion traverses the ML, along the western edge of the flood levee and drains into Drainage Line 2 to the south of the ML. This diversion and levee were built in the 1970s to allow the construction of a tailings dam within the Peak Downs Mine. The Mine will include upgrades to an existing approved crossing of the existing drainage diversion. A second vehicle crossing will be included as part of the infrastructure upgrades for the Mine.

Drainage Line 2 flows through the south-eastern corner of the ML, where it has the following dimensions:

- channel bed widths of 3 m to 5 m;
- channel top widths of 10 m to 30 m;
- channel depths 1 to 2 m; and
- overbank floodplain widths of 50 m to 150 m.

Drainage Line 2 will not be modified as part of the Mine.

In accordance with Section 126D(3) of the *Environment Protection Act 1994*, any voids situated wholly or partly within a flood plain (0.1% annual exceedance probability (AEP)) must be rehabilitated to a post-mining land use (PMLU) with a stable condition. While no voids or NUMAs are proposed for the Mine, flood plain modelling was undertaken as part of baseline assessments, to inform Mine planning of flood risks during operations and rehabilitation. This flood plain modelling revealed that small parts of the disturbance footprint for the Mine occur within a flood plain (**Figure 1-7**). Note that this map shows the flood plain according to pre-mining conditions.



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Legend

- Local Drainage Feature
- Dam/Reservoir Area
- ML 700060

Source: State of Queensland (Department of Resources) 2021, METServe 2021, WRM 2021, Maxar.

Vulcan Coal Mine

Surface Water Hydrology

0 0.5 1

Kilometers

Scale: 1:40,000 (A4)

3/12/2021

Datum: GDA94

Projection: MGA55

FIGURE 1-6

VITRINITE BRIGHTER COAL

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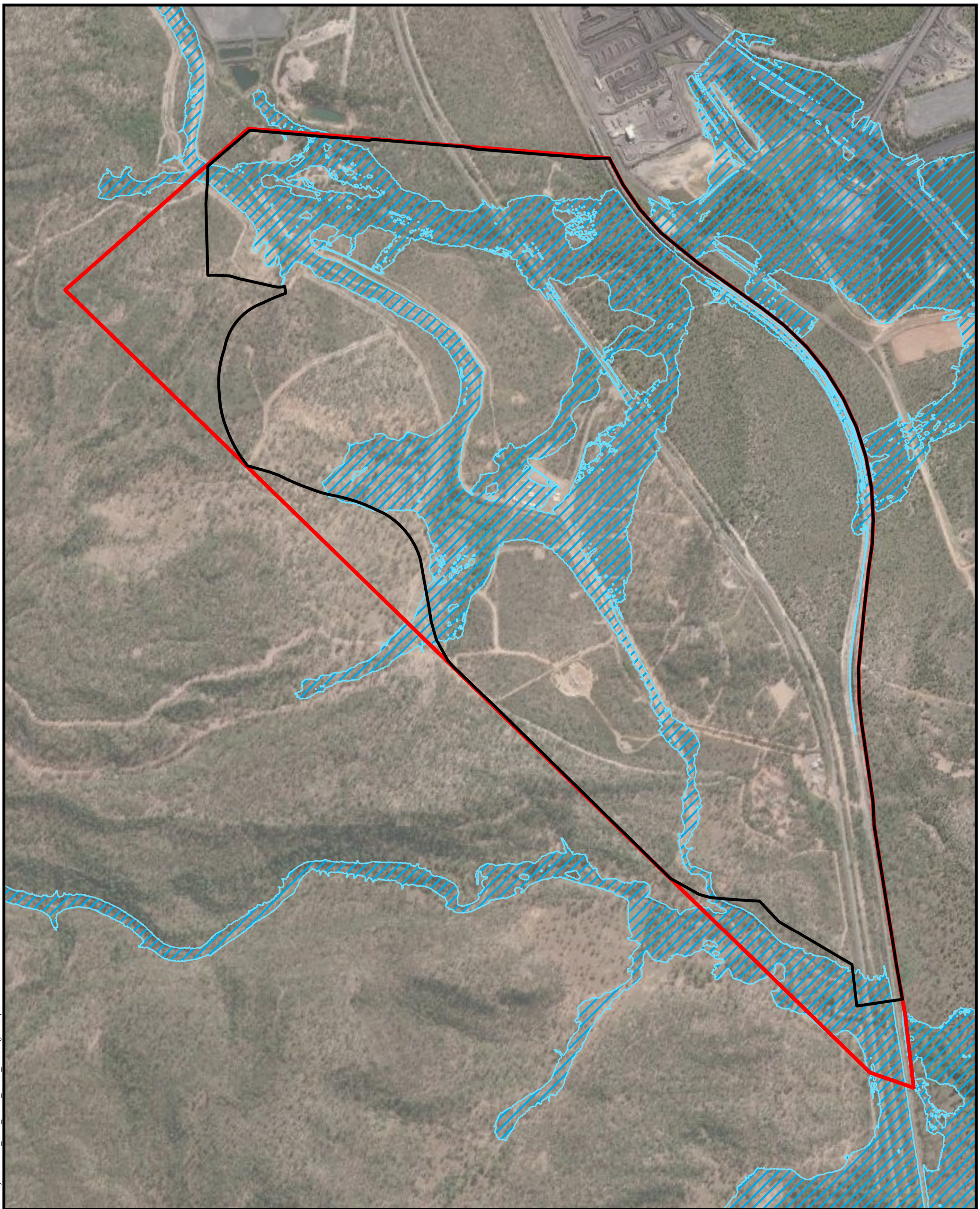

Legend

- ML 700060
- VCM Revised Maximum Disturbance Footprint
- 0.1% Annual Exeedance Probability (AEP) peak flood

Source: State of Queensland (Department of Resources) 2021, METServe 2021, WRM 2021, Maxar.

Vulcan Coal Mine

Flood Plain Extent

0 250 500

Meters

Scale: 1:18,000 (A4)

3/12/2021

Datum: GDA94
Projection: MGA55

FIGURE 1-7

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

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The collection of water quality data has been restricted by infrequent flows within local waterways due to their ephemeral nature. Baseline water quality testing has been undertaken at 2 receiving water locations (VSW1, VSW2), which have been monitored during natural flow events(see **Section 9.1.8: Figure 9-3**). The 80th percentiles of numerous water quality attributes (shown in bold in **Table 1-3**) exceed water quality objectives specified in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018), the *Isaac River Sub-basin Environmental Values and Water Quality Objectives* (DEHP 2013) or the Model Mining Condition guidelines (DES 2017).

Table 1-3 80th percentiles of water quality attributes at VSW1 and VSW2, compared to published water quality objectives (WQOs) and model mining conditions (MMC) values

Parameter	Unit	80th percentile of VSW1 + VSW2	WQO triggers		MMC trigger value
			Value	Relevant environmental value	
Physico-chemical Parameters					
pH	-	7.11	< 6.5 or > 8.5	Aquatic ecosystem[a]	
Sodium adsorption ratio	-	6.60	-		
Electrical conductivity	**µS/cm**	**1,328**	**> 720 (baseflow) > 250 (high flow)**	**Aquatic ecosystem[a]**	
Total dissolved solids	mg/L	863	> 2,000	Stock watering[a]	
Total suspended solids	**mg/L**	**91**	**> 55**	**Aquatic ecosystem[a]**	
Turbidity		**203**	**> 50**	**Aquatic ecosystem[a]**	
Dissolved oxygen	mg/L	7.54	< 4	Aquatic ecosystem[a]	
Dissolved Metals					
Aluminium	**mg/L**	**0.302**	**> 0.055**	**Aquatic ecosystem[b]**	**> 0.055**
Arsenic	mg/L	0.001	> 0.024	Aquatic ecosystem[b]	> 0.013
Cadmium	mg/L	<0.0001	> 0.01 > 0.0002	Stock watering[a] Aquatic ecosystem[b]	> 0.0002
Chromium	mg/L	<0.001	> 1 > 0.001	Stock watering[a] Aquatic ecosystem[b]	> 0.001
Cobalt	mg/L	0.002	-		> 0.090
Copper	**mg/L**	**0.002**	**> 1 > 0.0014**	**Stock watering[a] Aquatic ecosystem[b]**	**> 0.002**
Lead	mg/L	<0.001	> 0.1 > 0.0034	Stock watering[a] Aquatic ecosystem[b]	> 0.004
Manganese	mg/L	0.189	> 10 > 1.9	Irrigation[a] Aquatic ecosystem[b]	> 1.9
Molybdenum	mg/L	0.001	-		> 0.034
Nickel	mg/L	0.003	> 1 > 0.011	Stock watering[a] Aquatic ecosystem[b]	> 0.010
Selenium	mg/L	<0.01	> 0.02 > 0.005	Stock watering[a] Aquatic ecosystem[b]	> 0.001
Silver	mg/L	<0.001	-		> 0.001
Uranium	mg/L	0.001	> 0.1	Irrigation[a]	> 0.001
Vanadium	mg/L	<0.01	> 0.5	Irrigation[a]	> 0.010
Zinc	**mg/L**	**0.0084**	**> 0.008**	**Aquatic ecosystem[b]**	**> 0.008**
Boron	mg/L	0.076	> 5 > 0.37	Stock watering[a] Aquatic ecosystem[b]	> 0.37
Iron	mg/L	0.81	-		> 0.3
Mercury	mg/L	<0.0001	> 0.002 > 0.00006	Irrigation[a] Aquatic ecosystem[b]	> 0.0002
Total Metals					

Parameter	Unit	80th percentile of VSW1 + VSW2	WQO triggers		MMC trigger value
			Value	Relevant environmental value	
Aluminium	mg/L	3.212	> 5		
Arsenic	mg/L	0.002	> 0.5		
Cadmium	mg/L	<0.0001	> 0.01		
Chromium	mg/L	0.002	> 1		
Cobalt	mg/L	0.003	> 0.1		
Copper	mg/L	0.004	> 1		
Lead	mg/L	0.004	> 0.1		
Manganese	mg/L	0.2102	> 10		
Molybdenum	mg/L	0.001	> 0.05		
Nickel	mg/L	0.0058	> 1		
Selenium	mg/L	<0.01	> 0.02		
Silver	mg/L	<0.001	-		
Uranium	mg/L	0.001	-		
Vanadium	mg/L	<0.01	-		
Zinc	mg/L	0.0202	> 5		
Boron	mg/L	0.064	> 5		
Iron	mg/L	4.19	> 10		
Mercury	mg/L	<0.0001	> 0.002		
Major Cations and Anions					
Total hardness as $CaCO_3$	**mg/L**	**188**	**> 150**	**Drinking water[a]**	**> 150**
Hydroxide alkalinity as $CaCO_3$	mg/L	<1	-		
Carbonate alkalinity as $CaCO_3$	mg/L	<1	-		
Bicarbonate alkalinity as $CaCO_3$	mg/L	97.2	-		
Total alkalinity as $CaCO_3$	mg/L	97.2	-		
Sulphate as SO_4	mg/L	194	> 770		
Chloride	mg/L	262	-		
Calcium	mg/L	26	-		
Magnesium	mg/L	29.8	-		
Sodium	**mg/L**	**208**	**> 30**	**Drinking water[a]**	
Potassium	mg/L	9.6	-		
Fluoride	mg/L	0.18	> 2	Irrigation[a]	
Total anions	meq/L	12.84	-		
Total cations	meq/L	13	-		
Ionic balance	%	3.71	-		
Nutrients					
Ammonia as N	**mg/L**	**0.30**	**> 0.02**	**Aquatic ecosystem[a]**	**> 0.74**
Nitrite as N	mg/L	0.028	-		
Nitrate as N	mg/L	1.37	-		> 0.248
Nitrite + nitrate as N	mg/L	1.39	-		
Total Kjeldahl nitrogen as N	mg/L	2	-		
Total nitrogen as N	**mg/L**	**2.88**	**> 0.5**	**Aquatic ecosystem[a]**	

Parameter	Unit	80th percentile of VSW1 + VSW2	WQO triggers		MMC trigger value
			Value	Relevant environmental value	
Total phosphorus as P	**mg/L**	**0.15**	**> 0.05**	**Aquatic ecosystem[a]**	
Reactive phosphorus as P	mg/L	0.01	> 0.02	Aquatic ecosystem[a]	
Hydrocarbons					
C6 – C10 fraction	µg/L	<20	-		
C10 – C40 fraction	µg/L	<100	-		
Biological					
Chlorophyll a	mg/m^3	<4	-		

[a]*Isaac River Sub-basin Environmental Values and Water Quality Objectives* (DEHP 2013)
[b]*Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018): trigger values for slightly-moderately disturbed systems (95% level of protection).

1.2.5 Hydrogeology

In the vicinity of the Mine, all geological formations yield low volumes of groundwater and hence would not typically be classified as aquifers in most hydrogeological settings. However, as individual lithological units within these formations have higher hydraulic conductivities than the intervening units, and groundwater in these formations is to be assessed for the determination of impact, they are referred to as aquifers for the purposes of this plan.

The following geological formations may contain groundwater (hydrogeologist.com.au 2020):

1) Quaternary alluvium: Confined to discrete channels in the beds of existing waterways. Alluvial sediments are unsaturated and disconnected laterally.

2) Tertiary sediments and weathered regolith: Silts and clays, which comprise the bulk of the regolith overlying the coal measures, are densely compacted, hard and generally dry. Sand and gravel lenses embedded within the regolith are permeable but have low hydraulic conductivity and limited lateral and vertical extent. These have a potential to represent unconfined to confined aquifers, depending on location.

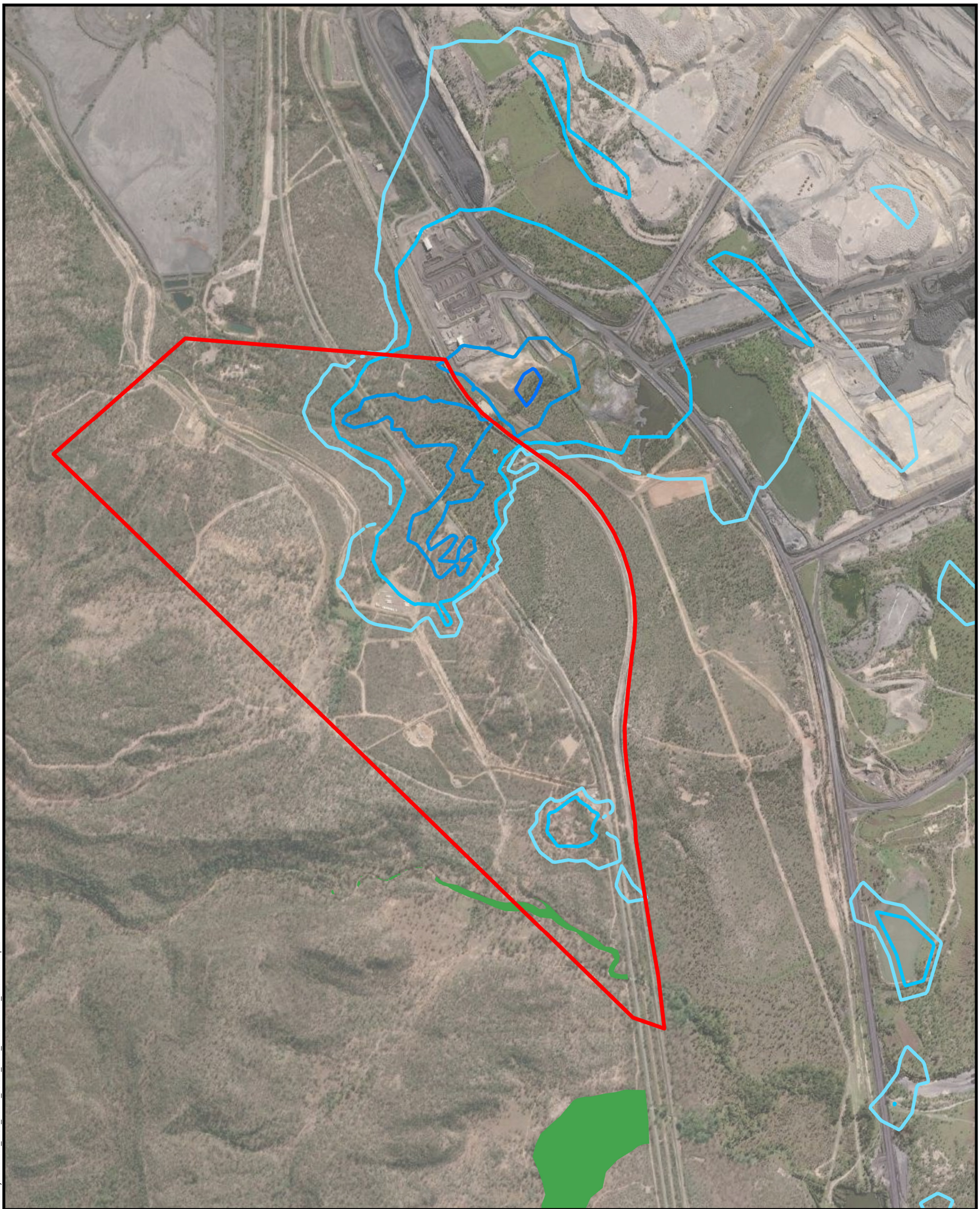
3) Permian coal measures: The ALEX and DLL coal seams are poor aquifers of low hydraulic conductivity. They are confined above and below by low-permeability regolith and sedimentary rocks. Nevertheless, these represent the largest and uppermost aquifers across most of the Mine area.

4) Back Creek Group: This formation of sandstones, siltstones and shale forms a largely impervious layer beneath the DLL coal seam aquifer. However, the Back Creek Group also contains narrow coal seams that can act as poor aquifers.

Groundwater is between 2 m and 30 m deep within the Mine area but generally between 5 m to 30 m deep in the area of the proposed open pit. There are areas on the northern and southern Mine boundaries with depth to groundwater less than 5 m. Due to the depth to groundwater, aquatic groundwater-dependent ecosystems (GDEs) are absent from most of the local land surface. A small extent of possible groundwater-dependent terrestrial vegetation occurs where the groundwater is 5 to 20 m deep (**Figure 1-8**), which is out of reach of most plant's roots, but within reach of some species. Hydrogeologist.com.au (2020) has developed a numerical groundwater flow model of the survey area and broader region to predict the effects of the Vulcan Coal Mine on local groundwater levels. This assessment was reviewed and updated to consider the effects of the construction of additional infrastructure, including a rail loop, coal handling and preparation pland and a train load out facility. The drawdown predicted from the Mine is limited in geographic extent (up to 3,000 m to the northeast toward existing mining) and magnitude (up to 10 m). The zone of drawdown does contain some potential GDEs, but only within the clearing footprint. No remnant vegetation outside the clearing footprint is found within the zone of drawdown. There is no predicted change to groundwater drawdown extent or magnitude as a result of the construction of infrastructure beyond that in the Groundwater Impact Assessment (hydrogeologist.com.au 2020). In summary, negligible impacts to GDEs are predicted to result from the Vulcan Coal Mine, beyond that which will occur due to vegetation clearing.

Fault zones can influence groundwater transmission rates and flow directions; however, there are no known fault zones in or near the Mine. Within the coal measures, groundwater largely flows along the bedding planes of the coal seams. In general, groundwater flows from the west to the east, mimicking the surface water drainage pattern (hydrogeologist.com.au 2020). The low hydraulic conductivity and small storage of local aquifers means that their levels have remained largely unaffected by 40 years of dewatering at adjacent mines, just 600 m away.

The pH of local groundwater is neutral to slightly acidic (hydrogeologist.com.au 2020). Salinity levels, however, are relatively high; groundwater is brackish to saline (electrical conductivity of 2,700 to 11,700 µS/cm) (hydrogeologist.com.au 2020). This conductivity is driven mostly by high concentrations of sodium and chloride (with moderate bicarbonate in some samples), consistent with it being sodic water of marine origin. This groundwater is generally unsuitable for irrigation, but it may be used in limited quantities as water for livestock. Conductivity above 7,463 µS/cm is associated with declines in animal health if consumed for prolonged periods (ANZG 2018). All groundwater on site fails to meet guidelines for drinking water suitability for humans. Overall, groundwater on site has no or limited value for most uses, with the exception of limited stock watering and potential industrial purposes related to mining.



Legend

ML 700060 Boundary

Possible Groundwater-dependent Terrestrial Ecosystems

Predicted Drawdown

1 m

2 m

5 m

10 m

Source: Vitrinite 2019, hydrogeologist.com.au 2020, METServe 2019-2021, Maxar.

Vulcan Coal Mine

Maximum Drawdown of Groundwater Predicted

0 0.25 0.5 1

Kilometers

Scale: 1:25,000 (A4)

3/12/2021

Datum: GDA94
Projection: MGA55

FIGURE 1-8

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI010_Vulcan_Complex_Project_Jupiter_section\ARCGIS\Projects\VI010_RAIL_LOOP_PRCP_GDE_Groundwater_Drawdown.aprx

1.2.6 Soil

The *Report on Lands of The Isaac-Comet Area* (Story *et al.* 1967), mapped at a scale of 1:500,000, indicates the Mine area contains the following land system units:

- Carborough Land System: The Carborough Land System is characterised by mountains and hills with broken and dissected local relief ranging between 30 m to 400 m. Structural benches and cliffs are common landforms with severe weathering occurring in some areas. This mountainous land system has formed shallow, coarse-textured, rocky soils. A small area of the Carborough Land System is also characterised by lower slopes and hills and alluvial flats with a local relief between 10 m to 60 m. Texture-contrast soils have formed in these areas and possess thick sandy topsoil. Geology in this land system is comprised of partly weathered quartz sandstone.
- Cotherstone Land System: The Cotherstone Land System is characterised by hills and prominent strike ridges as well as gentler undulating terrain associated with low indefinite strike ridges and colluvial foot slopes. The more prominent strike ridges possess a local relief varying between 10 m to 30 m and have developed shallow course-textured to rocky soils. The gentler undulating terrain has a local relief of less than 15 m and is associated with texture-contrast soils with a sandy upper-horizon. The geology in this land system is weathered Permian sandstone and shale.
- Monteagle Land System: The Monteagle Land System is predominantly characterised by low-lying plains and colluvial foot slopes with local relief generally below 6 m. This land system is associated with texture-contrast soils composed of a thick sandy topsoil and neutral to strongly alkaline subsoils. Geology in this land system is comprised of undissected Tertiary sandstones and clays.

Mapping at a scale of 1:100,000, based on soil surveys undertaken on site, revealed two soil management units (SMUs) within the ML (**Figure 1-9**). These are described below.

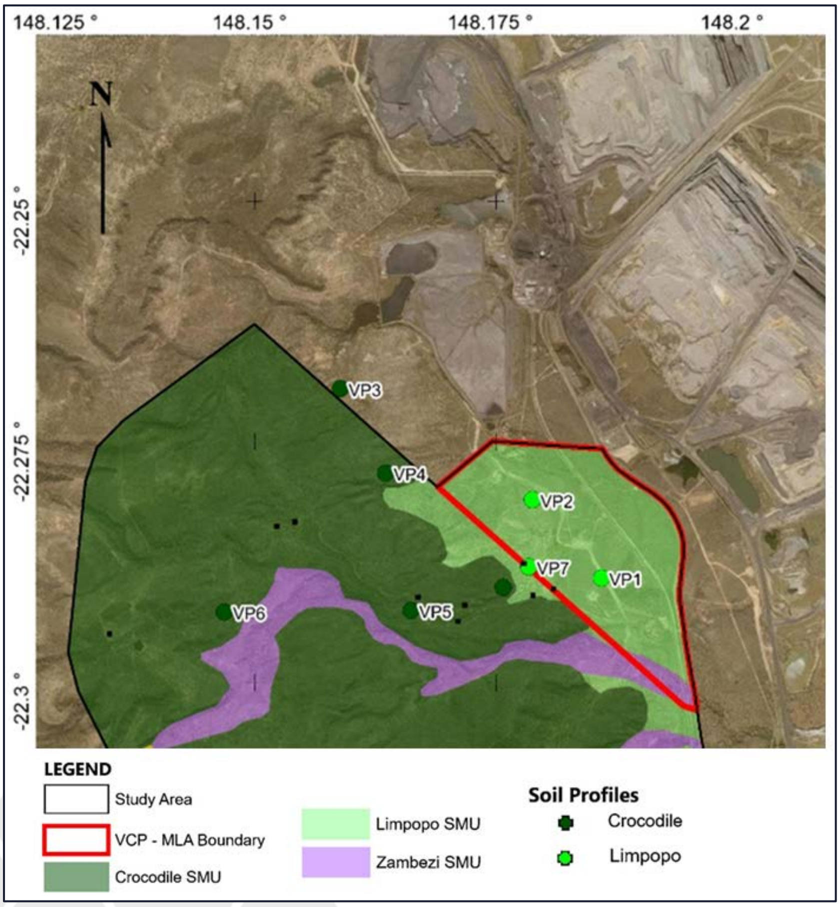
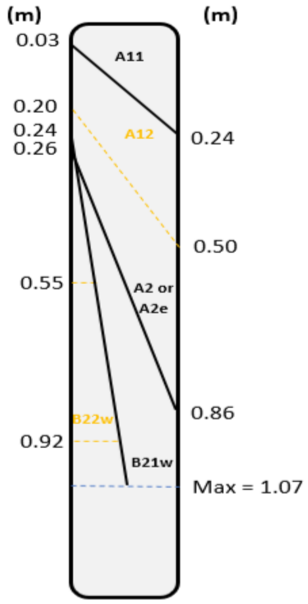


Figure 1-9 Soil management units (SMUs) of the Mine (VCM) area

Limpopo SMU

This is a brown texture-contrast soil unit. This soil management unit comprises 95% of the Mine area. Soils are classed as brown sodosols. Soil textures grade from sands to clay sands in the surface soils to light clays in deeper horizons. The Limpopo SMU belongs to the Monteagle land System and the Back Creek Geological Group.

The Limpopo SMU has a moderately acidic soil profile (pH 5.5-5.6). Salinity levels are very low. Sandy surface soils are non-sodic and not vulnerable to dispersion. However, clay subsoils (below 0.5 m) are sodic and susceptible to dispersion. The topsoil is dominated by sand (79%) with 8% silt and 10% clay. This texture may be at risk of slumping. Soils are deficient in phosphorus, nitrates, potassium, copper, zinc and boron.



The Limpopo SMU typically has the following soil profile:

The **surface soil** (A11, A12) is brown to a dark-brown (7.5YR4/4, 7.5YR3/3) sand to loamy sand with a loose structure. It has a field pH that ranges between 5 and 6, with a clear to gradual change to;

The **lower surface soil** (A2 or A2e) is a brown to greyish brown (7.5YR4/4, 10YR5/2) with some profiles within this soil unit displaying bleaching in this horizon (A2e). Predominant textures observed in this horizon range from sandy loams to sandy clay loams with a loose to weak polyhedral structure and a field pH of 6. Clear to gradual change to;

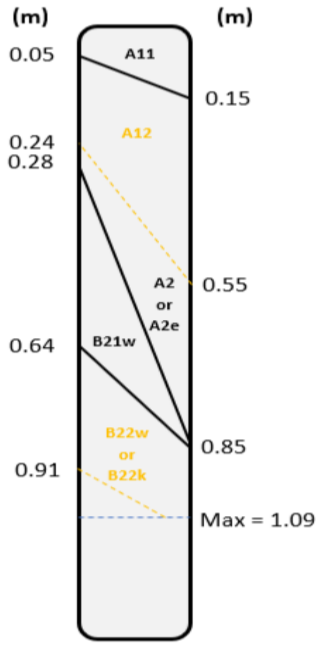
The **subsoil** (B21w, B22w) includes dark yellowish brown to a dark greyish brown (10YR4/4, 10YR4/2) clayey or sandy loams and light clays clay with weak to moderate strength polyhedral structure. Mottling was often observed in this horizon with colours ranging between red, orange and yellow. This horizon has a field pH of 5.5 to 7.

Zambezi SMU

This unit contains grey texture-contrast soils, with a sandy surface and clay subsoil. Within the ML, this soil management unit is confined to the vicinity of Drainage Line 2. This unit comprises 4% of the Mine area.

Lower horizons display diffuse orange to yellow mottles. Soils are classed as grey sodosols. The Zambezi SMU belongs to the Cotherstone Land System and the TQa geological formation (late-Tertiary to Quaternary poorly consolidated alluvium).

The Zambezi SMU has a slightly acidic (pH 6.4 to 6.7) topsoil (to 0.3 m deep), which becomes progressively alkaline with depth (to pH 9 at >0.8 m depth) and mildly acidic (pH = 6) subsoil. Salinity levels are low throughout the soil profile. The subsoil is strongly sodic and the risk of dispersion is high below 0.3 m depth (Emerson Class 2). The topsoil is dominated by sand (77%), with 14% silt, 9% clay and <1% gravel. It has a loose to weak platy structure, and low organic matter content (2%). Soils are deficient in nitrates, sulphates, phosphorus, copper and zinc.



The Zambezi SMU typically has the following soil profile:

The **surface soil** (A11/A12) is dark brown to very dark greyish brown (7.5YR2.2.5/5, 10YR3/2) coarse-grained loamy sand with loose to very weak platy structure. It has a field pH of 5.5 to 7, with a clear to abrupt change to;

The **lower surface soil** (A2/A2e) is a brown to greyish brown (7.5YR5/4, 10YR5/2) loamy sand, with some profiles displaying this as a bleached horizon with loose single-grained structure and a field pH of 6 to 7.5. Clear to abrupt change to; and

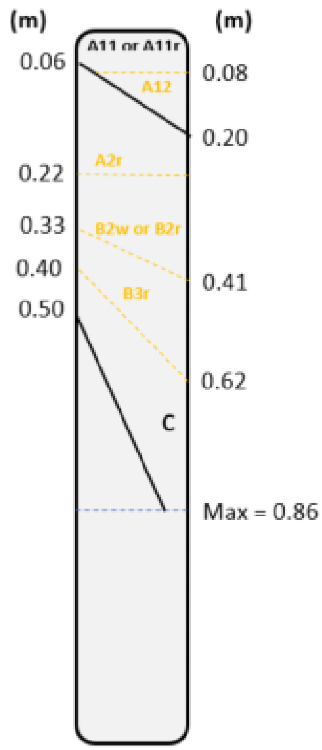
The **lower subsoil** (B2w) is a light grey to grey (10YR7/2, 7.5YR6/1) clayey loam sand to silty clay loam with moderate polyhedral structure. This horizon has a field pH of 7 to 9.

Crocodile SMU

A shallow rocky soil unit associated with hill slopes and plateaus. Soil textures grade from loam at the surface, to loamy sands with depth; often containing rock material with little to no pedologic development throughout the solum. This unit comprises 1% of the Mine area and is confined to the western boundary of the ML.

The Crocodile SMU is strongly acidic throughout the solum with only a minor increase in pH at depth (5.4-5.6). In the upper part of the profile (to an approximate depth of 0.3 m), this has the potential to limit the availability of essential nutrients and increase the risk of aluminium toxicity. Electrical Conductivity and Chloride levels are very low throughout the profile. The topsoil is dominated by sand (52%) and gravel (30%) with 10% silt and 8% clay. This particle size distribution could limit the ability of the soil to hold and store plant available water.

The Crocodile SMU typically has the following soil profile:



The **surface soil** (A11/A11r/A12) is a black to very dark greyish brown (10YR2/1, 10YR3/2) sand to sandy loam with loose to weak polyhedral structure with some profiles containing moderately strong to strong sub-angular rock material. The soil unit has a field pH of 4.5 - 5.5, demonstrating an abrupt to clear change to;

The **lower surface soil** (A2r) is not a common horizon observed for this SMU. It is a dark brown (10YR3/3) loamy sand with an abundance (comprising 50 - 90% of this horizon) of moderately strong coarse fragments approximately 2 - 6 cm in diameter. It has loose structure and a field pH of 5.5 to 5.0. Gradual change to;

The **subsoil** (B2w/B2r) is a dark greyish to reddish brown (10YR3/2, 2.5YR2.5/4) loamy sand to clay loam with weak to moderate polyhedral structure. It can contain rounded to angular course fragments which make up < 10% of the horizon. This horizon has a field pH of 4.5 to 5.5, with a gradual change to;

The **lower profile** (C) contains either consolidated or unconsolidated partly weathered rock material that appear to have originated from underlying sandstone and siltstone with some profiles possessing an overlying transitionary horizon (B3r). Depending on the rock material present, this horizon can range from dark red to light yellow-brown colour.

1.2.7 Land Stability

All soil units contained within the ML are sandy-textured with poor water- and nutrient-holding capacity (AARC 2020). This causes them to support a relatively modest grass cover (usually 20-25%, as assessed in the late wet season: METServe 2020). Furthermore, while topsoils in all local soil management units are relatively stable, subsoils in the most widespread unit (Limpopo) are dispersive and prone to erosion (AARC 2021). Consequently, the land is predisposed to ongoing stability issues in its pre-mining state, and gully erosion is widespread along minor drainage lines in the western half of the ML, where grazing intensity is highest (**Figure 1-10**).

Figure 1-10 Extensive gully erosion in heavily grazed portions of the ML

Slopes within the Limpopo soil management unit are generally less than 10%, which assists in maintaining stability. However, slopes may exceed 30% in certain areas within the Limpopo soil unit (refer **Section 6.1**). Slopes of up to 50% are frequent in the Crocodile soil management unit (along the western boundary of the Mine), but extensive rock outcropping and heavy vegetation cover in these areas protect against erosion (refer **Section 6.1**), and gully erosion was scarce on this soil management unit.

1.2.8 Vegetation

Four regional ecosystems occur in the ML. All four occur (mostly as regrowth) within the disturbance footprint (**Table 1-4; Figure 1-11**). 1.9% of the disturbance footprint comprises remnant vegetation, 31.7% comprises high-value regrowth and the majority (66.4%) comprises cleared pastures. No threatened plant species have been recorded or are likely to occur within the Mine disturbance footprint (METServe 2020).

Heavy grazing was a notable feature of the ML. This manifested through the altered composition of the understorey vegetation (Fensham *et al*. 1999; Walker *et al*. 2006). Native perennial grasses were scarce, while introduced pasture grasses (especially *Cenchrus ciliaris*, *Bothriochloa pertusa*, *Melinis repens* and *Urochloa mosambicensis*) dominated, along with native annual species (e.g., *Alloteropsis cimicina*, *Setaria surgens*, *Dactyloctenium radulans*, *Perotis rara*) (METServe 2020). Across all vegetation sampling sites assessed within the broader region, weeds made up an average of half the understorey biomass, although this varied by regional ecosystem (**Table 1-4**).

Table 1-4 Regional ecosystems present within the Mine footprint. Data extracted from METServe (2020)

Regional Ecosystem	BVG*	Short description	VM class†	Biodiv. Status‡	Mean weed dominance§	Mean canopy cover‖	Mean grass cover	Mean herb cover	Mean bare ground	Area to be disturbed (hectares)	
										Remnant	Regrowth
11.3.25	16a	*Eucalyptus camaldulensis* forest fringing drainage lines.	LC	OC	86.7%	90.0%	43.3%	15.3%	7.7%	0	2.6
11.5.9	18b	*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and/or remnant surfaces.	LC	NC	39.9%	49.5%	23.3%	6.4%	32.3%	0	96.3
11.10.3	24a	*Acacia shirleyi* or *Acacia rhodoxylon* open forest on coarse-grained sedimentary rocks. Crests and scarps.	LC	NC	11.3%	63.2%	25.8%	1.9%	16.8%	13.1	11.9
11.10.7	12a	*Eucalyptus crebra* woodland on coarse-grained sedimentary rocks.	LC	NC	36.8%	54.5%	19.9%	3.2%	35.3%	0	11.3
Non-remnant	-	Cleared pasture, +/- scattered trees or young regrowth.	-	-	92.0%	18.9%	55.3%	3.7%	26.8%	221.3	

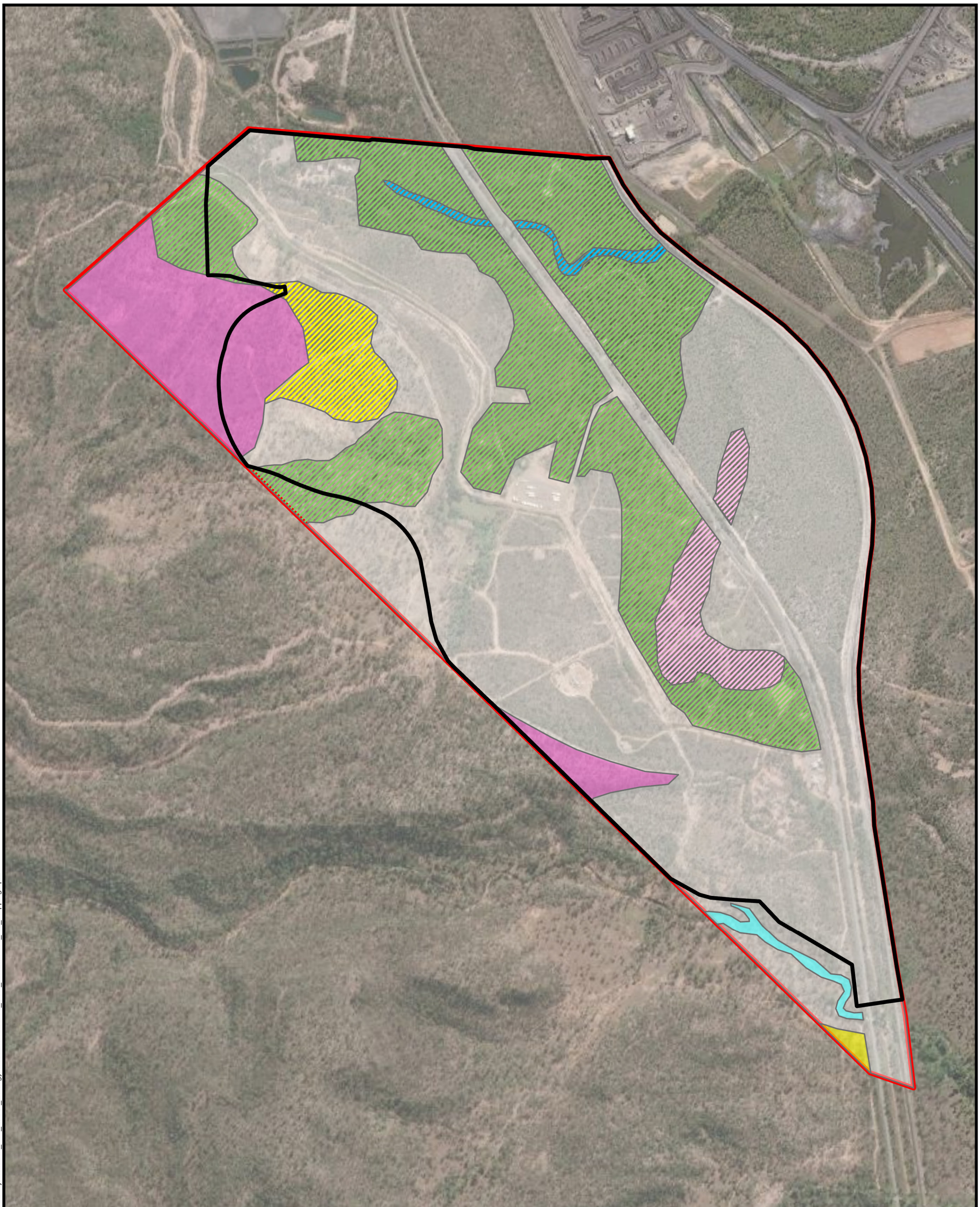
*BVG = broad vegetation group.

†VM class = classification under the *Vegetation Management Act 1999*: E = endangered, OC = of concern. LC = least concern.

‡Biodiversity status relates to environmentally sensitive areas under the *Environmental Protection Act 1994*: E = endangered, OC = of concern, NC = no concern at present.

§Mean percentage of the understorey vegetation within each regional ecosystem that comprises non-native species (pasture grasses and weeds).

‖Canopy cover is the combined foliage projective cover of all woody vegetation (trees and shrubs).



Legend

Field Verified RE

- 11.10.3
- 11.10.7
- 11.3.25
- HVR 11.10.3
- HVR 11.10.7/11.10.3
- HVR 11.3.25
- HVR 11.5.9
- non-rem

- ML700060 Boundary
- VCM Revised Maximum Disturbance Footprint

Source: State of Queensland (Department of Resources 2021; Vitrinite 2021; METServe 2020-2021; Maxar.

Vulcan Coal Mine

Field Verified Ecosystem Mapping

0 250 500

Meters

Scale: 1:18,000 (A4)

3/12/2021

Datum: GDA94
Projection: MGA55

FIGURE 1-11

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI010_Vulcan_Complex_Project_Jupiter_section\ARCGIS\Projects\VCM_Rail_CHPP_EcologyAssessment\VI010_VCP_FieldVerified_RE_Mapping.aprx

1.2.9 Significant Species

Field surveys of a 6,552-hectare (ha) area surrounding and including the ML detected 40 species of mammal, 133 species of bird, 35 species of reptile, 14 species of frog and 423 species of vascular plants. Among this biodiversity are five species that constitute matters of state and/or national environmental significance (MSES and MNES, respectively). An additional three species that constitute MNES or MSES are likely to utilise the survey area in some capacity, while a further 17 species are possible inhabitants or visitors (**Table 1-6**).

Avoidance of disturbance to habitat for significant species was an important consideration during design of the Mine. Avoidance of disturbance to the maximum extent practicable was achieved by:

1) minimising the total disturbance footprint by incorporating in-pit dumping of waste rock, which negates the need for extensive ex-pit dumping;

3) minimising the total disturbance footprint by utilising accommodation facilities in nearby towns, rather than on site;

4) locating the Mine and ancillary infrastructure away from remnant vegetation, especially along waterways, which constitutes habitat for several significant species; and

5) designing the Mine and ancillary infrastructure so that it avoids disturbance to an existing dam, which is used by Squatter Pigeons for drinking and is possibly used on occasion by other MNES and MSES.

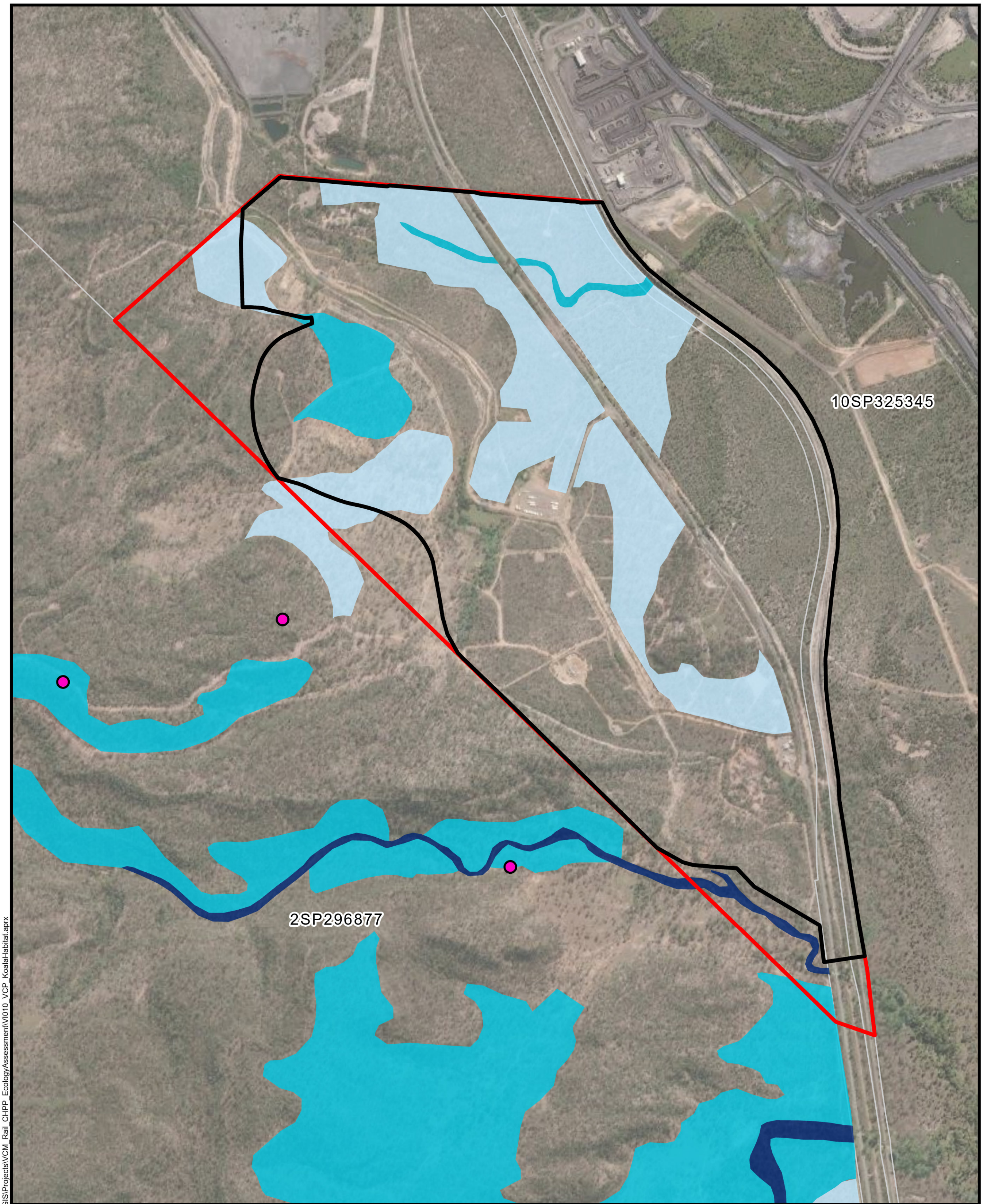
Despite these efforts to avoid disturbance, potentially significant residual impacts to three species (Koala *Phascolarctos cinereus*, Squatter Pigeon *Geophaps scripta scripta,* and Short-beaked Echidna *Tachyglossus aculeatus*) may arise as a result of the Mine. In order to reduce the long-term impacts of the Mine on each of these species, their ecological requirements have been taken into account during the planning of post-mining land uses and rehabilitation methodology. A summary of the ecological requirements of these three species are provided below.

Koala

The Koala is a MNES (vulnerable species) and MSES (vulnerable species). Koalas inhabit open forests and woodlands containing species that are known food trees. Within the Isaac Regional Council area, primary food trees consist of *Eucalyptus camaldulensis** and *Eucalyptus tereticornis*, while secondary food trees include *Eucalyptus brownii*, *Eucalyptus coolabah*, *Eucalyptus ochrophloia*, *Eucalyptus orgadophila*, *Eucalyptus populnea** and *Eucalyptus crebra** (Australian Koala Foundation 2015). The three species with an asterisk are found naturally within the ML. Three habitat classes (primary, secondary and marginal) have been mapped across the ML and adjacent areas (**Figure 1-12**). These habitat classes are defined in **Table 1-5**. While the Mine will avoid impacts to primary habitat for the Koala (where 77% of sightings occurred during surveys), loss of some secondary and marginal habitat is predicted. The reestablishment of secondary food trees on rehabilitated land is expected to reduce long-term impacts of the Mine on the Koala. This will re-establish secondary and marginal habitat within the disturbance footprint.

Table 1-5 Classes of Koala habitat contained within the ML

Habitat Type	Regional Ecosystems	Justification
Primary Habitat	Remnant 11.3.25	Dominated by primary food trees; abundant large trees; high subsoil moisture; abundant shady *Melaleuca* for shelter.
Secondary Habitat	Regrowth 11.3.25	As for primary habitat, but trees are less favoured due to their smaller size.
	Remnant 11.5.9 or 11.10.7.	Dominated by secondary food trees; moderate density of large trees.
Marginal Habitat	Regrowth 11.5.9 or 11.10.7.	Dominated by secondary food trees; large trees (>30 cm diameter at breast height) are absent.
Non-habitat	Remnant or regrowth 11.10.3 or cleared areas.	Primary food trees absent. Secondary food trees comprise less than 10% of the canopy.



Legend

- ML700060 Boundary
- Cadastral Boundary
- VCM Revised Maximum Disturbance Footprint
- Koala Sighting

Koala Habitat

- Primary
- Secondary
- Marginal

Source: State of Queensland (Department of Resources) 2021, Vitrinite 2019-2021, METServe 2021, Maxar.

Vulcan Coal Mine

Koala Habitat in the Vicinity of the Project

0 250 500

Meters

Scale: 1:20,000 (A4)

6/12/2021

Datum: GDA94
Projection: MGA55

FIGURE 1-12

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI010_Vulcan_Complex_Project_Jupiter_section\ARCGIS\Projects\VCM_Rail_CHPP_EcologyAssessment\VI010_VCP_KoalaHabitat.aprx

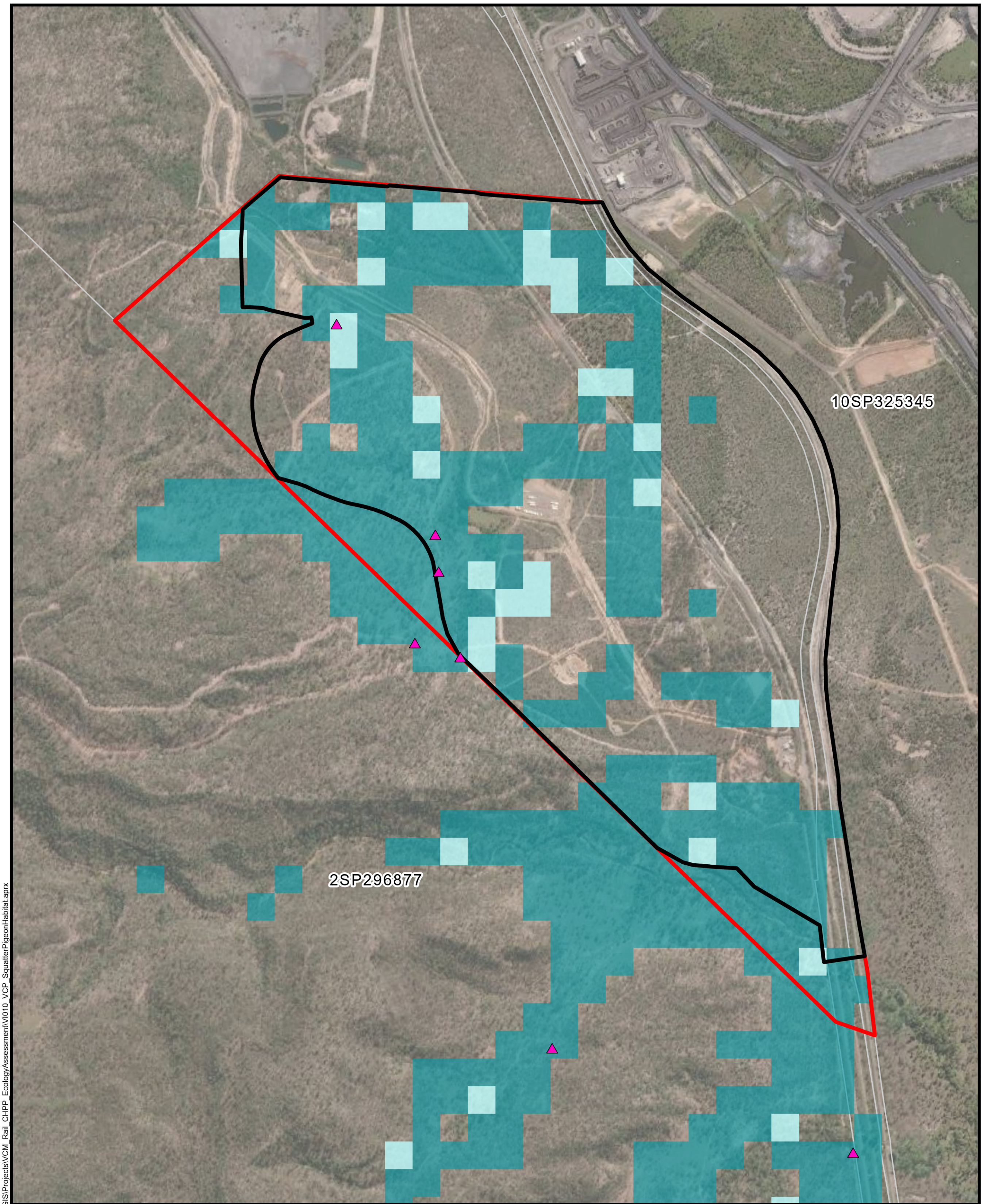
Squatter Pigeon

The Squatter Pigeon is both a MNES (vulnerable species) and MSES (vulnerable species). Squatter Pigeons inhabit a wide range of open forests to sparse open woodlands and scrub, primarily on sandy or gravelly soils, supporting a patchy understorey of grasses and herbs, mixed with areas of bare ground. Squatter Pigeons are not dependent on remnant vegetation, and readily feed on some introduced pastures (METServe 2020). A moderate intensity of grazing is beneficial to the species, as it creates favourable open patches of ground for foraging. Nevertheless, Squatter Pigeons require some degree of tree cover, and based on data gathered from 60 records of Squatter Pigeons across the region containing the Mine, a minimum Normalised Differential Vegetation Index of 0.125 (measured across a 1-ha cell in the late dry season) was required for the habitat to be suitable for the species (METServe 2020). Habitat mapping was undertaken for the species based on vegetation density and soil type (**Figure 1-13**). The species' frequent use of cleared habitats meant that it was not possible to design the Mine without disturbing habitat for the Squatter Pigeon. Over 2,900 ha of Squatter Pigeon habitat was mapped in the vicinity of the Mine, suggesting that the 3% of vegetation which will be removed will have a negligible impact on local populations of the species. Nevertheless, post-mining land uses that are conducive to the long-term conservation of Squatter Pigeons on rehabilitated land (e.g., native habitats or low-intensity cattle grazing) are preferred. Likewise, the species' ecological needs (e.g., density of tree cover) were considered during the development of completion criteria.

Short-beaked Echidna

The Short-beaked Echidna is a MSES (special least concern species). Short-beaked Echidnas inhabit all types of vegetation contained within the ML, including cleared pastures. Their chief ecological requirement is a supply of ants and termites on which to feed. Post-mining land uses that support populations of ants and termites, as well as provide a moderate amount of vegetation cover for protection from weather and predators, will facilitate the long-term conservation of the species on site.

Due to the unspecific habitat needs of Short-beaked Echidnas, it is expected that any rehabilitated sites that support other species of conservation significance (i.e., Koalas and/or Squatter Pigeons) will also be suitable for echidnas. The species is therefore not considered further when planning post-mining land uses or appropriate completion criteria.



Legend

- ML700060 Boundary
- Cadastral Boundary
- VCM Revised Maximum Disturbance Footprint
- Squatter Pigeon Sighting

Squatter Pigeon Habitat

- Primary
- Secondary

Source: State of Queensland (Department of Resources) 2021; Vitrinite 2019, 2021; METServe 2021; Maxar.

Vulcan Coal Mine

Squatter Pigeon Habitat in the Vicinity of the Project

0 250 500

Meters

Scale: 1:20,000 (A4)

6/12/2021

Datum: GDA94
Projection: MGA55

FIGURE 1-13

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI010_Vulcan_Complex_Project_Jupiter_section\ARCGIS\Projects\VCM_Rail_CHPP_EcologyAssessment\VI010_VCP_SquatterPigeonHabitat.aprx

Table 1-6 Species of national or state environmental significance flagged by databases as being potentially present in the local region

Taxon	Species	Common Name	EPBC status*	NC status†	Habitat requirements	Presence in survey area‡	Significant Impact?‡
Bird	*Geophaps scripta scripta*	Squatter Pigeon	V	V	Open grassy woodland with areas of bare ground, on land zones 3, 5 and 7.	C	Y
Mammal	*Phascolarctos cinereus*	Koala	V	V	Vegetation communities containing large food trees (*Eucalyptus* spp.), especially near watercourses.	C	Y
Mammal	*Tachyglossus aculeatus*	Short-beaked Echidna	-	SL	Cosmopolitan habitat usage; anywhere termites can be found.	C	N
Mammal	*Petauroides volans*	Greater Glider	V	V	Tall, old-growth eucalypt forest with tree hollows.	C	N
Bird	*Rhipidura rufifrons*	Rufous Fantail	M	SL	Dense woody vegetation, including vine thickets, paperbark forests and rainforest.	C	N
Bird	*Apus pacificus*	Fork-tailed Swift	M	SL	Almost exclusively aerial, foraging on flying insects above all habitat types.	L	N
Bird	*Gallinago hardwickii*	Latham's Snipe	M	SL	Freshwater wetlands with well-vegetated muddy edges.	L	N
Reptile	*Denisonia maculata*	Ornamental Snake	V	V	Gilgais on heavy clay soil, especially where *Acacia harpophylla* grows.	L	N
Bird	*Rostratula australis*	Australian Painted-snipe	E	V	Freshwater wetlands with well-vegetated muddy edges.	P	N
Reptile	*Acanthophis antarcticus*	Common Death Adder	-	V	Forested areas with deep leaf litter and/or abundant rocks.	P	N
Bird	*Erythrotriorchis radiatus*	Red Goshawk	V	E	Large tracts of undisturbed forest, especially near the ecotone between rainforests, melaleuca swamps and open eucalypt woodlands. Within the survey area, it is most likely in densely forested riparian habitats.	P	N
Reptile	*Egernia rugosa*	Yakka Skink	V	V	Potentially any vegetated habitat with fallen timber or rocks. There are no nearby records, but habitat is available locally.	P	N
Grass	*Aristida annua*	Annual Wiregrass	V	V	Open eucalypt woodlands and pastures ranging from sandy loams to basalt-derived clay. The survey area lies outside the known distribution of the species; the most northern record is 35 km south.	P	N
Bird	*Calidris acuminata*	Sharp-tailed Sandpiper	M	SL	Estuarine and freshwater wetlands with extensive shallow, muddy margins.	P	N
Bird	*Cuculus optatus*	Oriental Cuckoo	M	SL	Primarily coastal forest and woodland. Rarely moves inland west of the coastal ranges.	P	N

Taxon	Species	Common Name	EPBC status*	NC status†	Habitat requirements	Presence in survey area‡	Significant Impact?ǂ
Bird	*Gelochelidon nilotica*	Gull-billed Tern	M	SL	Primarily a coastal species. Can occur over inland lakes.	P	N
Bird	*Monarcha melanopsis*	Black-faced Monarch	M	SL	Typically associated with rainforest. Migrating individuals may utilise dense riparian vegetation in a transient capacity.	P	N
Bird	*Myiagra cyanoleuca*	Satin Flycatcher	M	SL	Tall wet forests of the coast and nearby ranges. Vagrant individuals may occasionally occur inland, where they are most likely in denser forests (e.g., along waterways).	P	N
Bird	*Plegadis falcinellus*	Glossy Ibis	M	SL	Shallow, marshy edges of large freshwater wetlands.	P	N
Mammal	*Macroderma gigas*	Ghost Bat	V	E	Primarily coastal ranges, where large cave systems occur near extensive forests. The nearest record is 85 km northeast.	P	N
Reptile	*Furina dunmalli*	Dunmall's Snake	V	V	Strongly associated with *Acacia harpophylla* and cracking clay soils. The survey area is outside the known distribution of the species.	P	N
Reptile	*Lerista allanae*	Allan's Lerista	E	E	Inhabits root systems of grass tussocks growing on black clay soils.	P	N
Grass	*Dicanthium queenslandicum*	King Blue-grass	E	V	Grasslands or open woodland on clay soils, with low grazing pressure. Favourable soils within the survey area were subject to high grazing pressure.	P	N
Mammal	*Dasyurus hallucatus*	Northern Quoll	E	LC	Rugged escarpments in wetter forested areas.	P	N
Grass	*Dicanthium setosum*	Bluegrass	V	LC	Grasslands or open woodland on clay soils, with low grazing pressure.	P	N

*Status under the *Environment Protection and Biodiversity Conservation Act 1999*: E = endangered, V = vulnerable, M = migratory. These species constitute MNES.

†Status under the *Nature Conservation Act 1992*: E = endangered, V = vulnerable, SL = special least concern, LC = least concern. Species other than least concern constitute MSES.

‡Presence within the broader survey area encompassing the ML: C = presence confirmed, L = likely to be present, P = possibly present.

ǂIs a significant impact likely to arise from the Mine?: Y = yes, N = no (based on a detailed ecological assessment by METServe 2020).

1.2.10 Pre-mining Land Use

The land within the ML is zoned as Rural under the Isaac Regional Council Planning Scheme. The lot containing the Mine (lot 10, SP325345) is a Land Lease with an industrial purpose, and most of the lot contains operational areas of the Peak Downs Mine. The land has an agriculture land class of C2 (land suitable for grazing on native pastures on lower fertility soils) or C3 (land suitable for light grazing on native pastures in accessible areas, and includes steep land), in accordance with the *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI and DNRM 2015). The pre-mining land use is primarily low-intensity cattle grazing. A total of 96% of the mining footprint had been formerly cleared of its natural vegetation; the remaining 4% comprised native remnant vegetation with an understorey that has been highly modified by grazing (see **Section 1.2.8**). The dominant land use adjacent to the Mine (to the north and east) is coal mining.

The ML does not contain areas of regional interest (priority living areas, priority agricultural areas, strategic cropping land and strategic environmental areas) protected under the *Regional Planning Interests Act 2014.*

Saraji Road, a public, sealed roadway administered by Isaac Regional Council, passes through the ML. This serves an annual average of 2,270 vehicles per day (as surveyed in 2021: Stantec 2021).

A railway line managed by Aurizon runs immediately inside the eastern boundary of the ML. A flood levee constructed by BHP Billiton/Mitsubishi Alliance (BMA) (owners of the Saraji and Peak Downs Mines) runs through the centre of the ML.

A number of small industrial compounds also existed on the site. These provided supporting infrastructure to a number of commercial operations that utilised small portions of the ML.

Vitrinite was granted an Environmental Authority (EA0002054) and a Mineral Development Licence (MDL3039) to permit extraction of a bulk sample of coal from within the footprint of the Mine. Prior to commencement of the Mine, Vitrinite extracted approximately 600 kilotonnes (kt) of high-quality coking coal from the bulk sample pit for testing by a number of international coal consumers. The waste rock dump required for the bulk sample phase of the Mine is being developed as an extension of the bulk sample dump. While disturbance resulting from the bulk sample is not considered part of the Mine (as it has previously been approved), rehabilitation of the bulk sample footprint forms part of this PRC Plan, as this footprint is incorporated into the operations of the Mine.

Land Suitability Ratings

An assessment of land suitability for cattle grazing has been undertaken by AARC (2021), in accordance with the *Guidelines for Agriculture Land Evaluation in Queensland* (DSITI and DNRM 2015) and *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques* (DME 1995). This assessment took into account water availability, nutrient deficiency, soil physical factors, salinity, rockiness, microrelief, pH, exchangeable sodium percentage, wetness, water erosion, flooding, and vegetation regrowth. The results of this assessment are shown in **Table 1-7**. Sandy soils on the plains (Limpopo and Zambezi) had a land suitability class of 4 (marginal land for grazing). Sandstone escarpment areas of the Crocodile soil management unit had a class of 5 (unsuitable for grazing) (**Figure 1-14**). Class 4 land is categorised as marginal for grazing improved pastures, although it is largely considered suitable for grazing native pastures of variable quality. Class 5 land is unsuitable for any form of pasture improvement and is limited to low productivity grazing of native pastures. Class 5 land may require destocking in poor seasons.

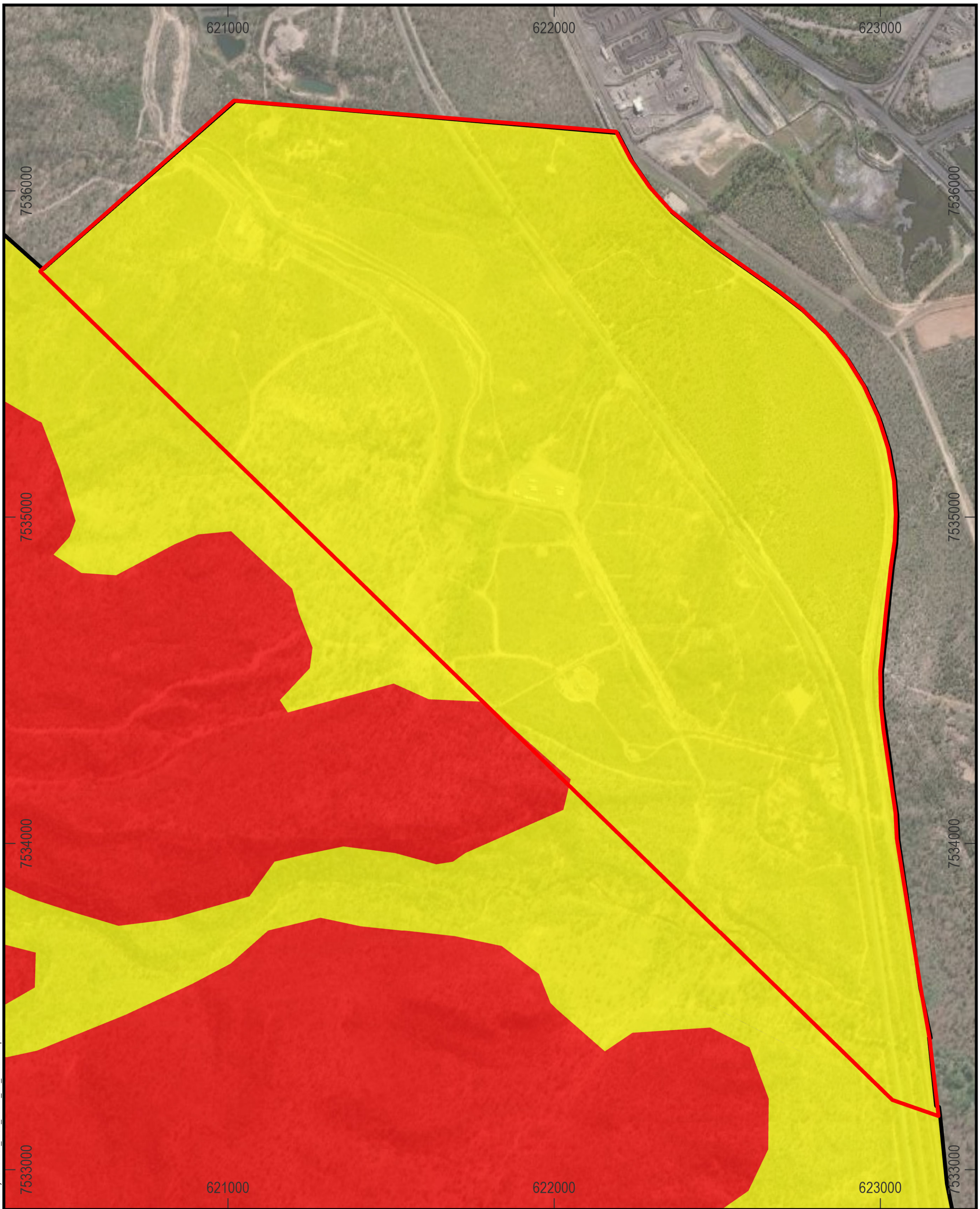
Table 1-7 Summary of pre-mining land suitability limitations for cattle grazing

Limitation	Crocodile	Limpopo	Zambezi
Water availability	5	3	4
Nutrient deficiency	4	4	4
Soil physical factors	1	1	1
Salinity	1	1	1
Rockiness	3	1	1
Microrelief	1	1	1
pH	2	2	2
ESP	1	1	1
Wetness	1	2	2
Water erosion	2	1	1
Flooding	1	1	2
Vegetation Regrowth	1	2	2
Overall Suitability Rating	**5**	**4**	**4**

Although not proposed as a PMLU, a similar land suitability assessment has been undertaken for the land's potential for rain-fed broadacre cropping (**Table 1-8**). This revealed that the majority of the ML has a land suitability class of 4 (unsuitable for rain-fed broadacre cropping with severe limitations) (**Figure 1-15**).

Table 1-8 Summary of land suitability limitations for rain-fed broadacre cropping

Limitation	Crocodile	Limpopo	Zambezi
Water availability	5	4	5
Nutrient deficiency	3	4	4
Soil physical factors	3	1	1
Soil workability	2	1	1
Salinity	1	1	1
Rockiness	3	1	1
Microrelief	1	1	1
Wetness	1	2	3
Topography	4	1	2
Water erosion	5	2	2
Flooding	1	1	3
Overall Suitability Rating	**5**	**4**	**5**



Legend

- ML700060
- Study Area

Land Suitability (Cattle Grazing)

- Class 4
- Class 5

Source: AARC Environmental Solutions 2019, 2020; Maxar.

Vulcan Coal Mine

Land Suitability Classes for Cattle Grazing

0 250 500

Meters

Scale: 1:17,000 (A4)

6/12/2021

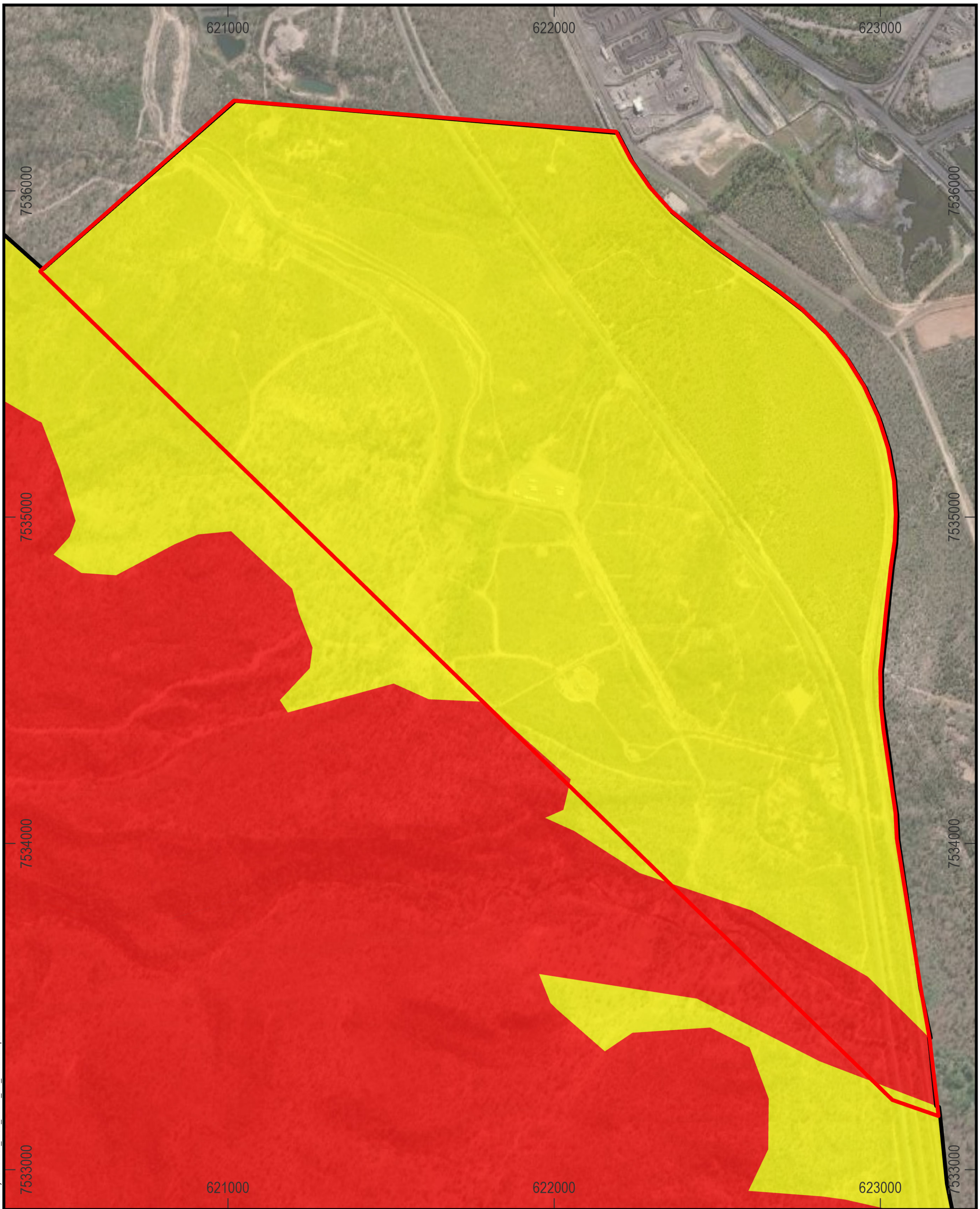
Datum: GDA94
Projection: MGA55

FIGURE 1-14

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI010_Vulcan_Complex_Project_Jupiter_section\ARCGIS\Projects\VI010_RAIL_LOOP_EA_AMEND.aprx



Legend

- ML700060
- Study Area

Land Suitability (Rainfed Broadacre Cropping)

- Class 4
- Class 5

Source: AARC Environmental Solutions 2019, 2020; Maxar.

Vulcan Coal Mine

Land Suitability Classes for Rainfed Broadacre Cropping

0 250 500

Meters

Scale: 1:17,000 (A4)

6/12/2021

Datum: GDA94
Projection: MGA55

FIGURE 1-15

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI010_Vulcan_Complex_Project_Jupiter_section\ARCGIS\Projects\VI010_RAIL_LOOP_EA_AMEND.aprx

Based on the land suitability assessments summarised above, the soil management units present on site have been assigned the agricultural land classifications listed in ***Table 1-9****.*

Table 1-9 Agricultural land classes (AARC 2021)

Soil Management Unit	Land Class	Class Description
Crocodile	C3	Pasture Land – Land suitable for light grazing on native pastures in accessible areas, and includes steep land.
Limpopo	C2	Pasture Land – Land suitable for grazing on native pastures on lower fertility soils.
Zambezi	C3	Pasture Land – Land suitable for light grazing on native pastures in accessible areas, and includes steep land.

1.2.11 Land Holders

Landholders listed in **Table 1-10** currently manage land on which the Mine is to take place.

Table 1-10 Land tenure and real property descriptions for the Mine

Lot/Plan	Land holder	Tenure
Saraji Road	Isaac Regional Council	Road Parcel
Lot 26 on CNS125	Aurizon	Lands Lease
Lot 10 on SP325345	BHP Billiton/Mitsubishi Alliance (BMA)	Lands Lease

1.3 Relevant Activities

1.3.1 Environmentally Relevant Activities

Environmental Authority EA0002912 has been granted for the Mine. The Environmentally Relevant Activities (ERAs) for which this EA has been issued are Mining Black Coal and Ancillary Activities (**Table 1-11**).

Table 1-11 Environmentally Relevant Activities

Activity	Environmentally Relevant Activity	Mine Requirement
Mining Black Coal	Resource Activity, Schedule 3, ERA 13	The Mine will extract up to 6 Mt of coal through an open cut operation.
Crushing, milling, grinding or screening	Ancillary Activity 33: Crushing, grinding, milling or screening more than 5,000 t of material in a year.	The Mine will crush and screen up to 1.95 Mtpa of ROM coal.
Mineral Processing	Resource Activity, Schedule 2, ERA 31 (2) processing, in a year, the following quantities of mineral products , other than coke (b) more than 100,000t	The Mine will process up to 1.95 Mtpa of ROM coal.

1.3.2 Project Description

The Mine is a small-scale coal mine that will extract approximately 6 Mt of run-of-mine (ROM) hard coking coal at a rate of up to 1.95 Mtpa. Coal extraction occurs via a single open-cut pit. Truck-and-shovel mining operations are employed to develop the pit.

The Mine will operate for approximately four years. It has developed from the bulk sample project, which commenced in 2020 and ran for approximately 12 months while the Mine was undergoing environmental authority and mining lease application processes. The Mine will comprise a further three years of mining and a number of years of rehabilitation.

Coal Handling and Preparation Plant

For processing, the Mine will include a modular CHPP (**Figure 1-16**) to process ROM coal into a number of marketable products (coking coal and thermal coal).

In summary the CHPP will operate as follows:

- haul trucks will deliver ROM coal from the pit to the ROM hopper. The trucks will dump directly into the ROM hopper or onto the 100 kt ROM stockpile for reclaim by a front end loader.
- the raw coal will be sized before being conveyed to a 300 t raw coal surge bin before being fed to the CHPP at up to 550 t/h.
- the CHPP will be an open steel structure. Coal will be processed through three circuits to produce a primary and secondary product (metallurgical and thermal).
- tailings will be dewatered in a tailings treatment facility to produce a dry tailings product. Recovered water will be recirculated to the process plant fur reuse.
- coarse, fine and dry tailings will be conveyed to a reject bin, where it will be trucked loaded into trucks for placement within active waste rock dumps (primarily within the in-pit Waste Rock Dump (WRD)).
- products will be conveyed and stacked on the product coal stockpiles. Product coal will be reclaimed via dozer push into coal valves and conveyed to the TLO.

The CHPP will operate 24 hours a day, seven days per week.

Rail Loop

A rail loop will connect to the existing network in the south-east of the ML and will traverse the south-western boundary of the ML. The loop is positioned in the western portion of the ML, between the ML boundary and the existing BMA flood levee that runs north-south through the ML (**Figure 1-16**). The loop will require approximately 4.5 km of rail to be located on the ML. A number of areas of cut and fill will be required along the alignment to facilitate required grades.

Controlled level crossings are proposed where the rail line will cross Saraji Road and connect to the existing Goonyella rail network.

Product coal will be railed from the Project rail loop onto the Goonyella Rail network. Export options include Dalrymple Bay to the north and the RG Tanna terminal, in Gladstone, to the south.

Train Loadout

A TLO will be positioned on the eastern side of the loop, on the western side of the existing levee (**Figure 1-16)**. Product coal will be transported by aerial conveyor, across the levee from the product stockpile to the TLO. Appropriate design controls will be incorporated to manage potential impacts on surface water systems from fugitive coal from the overpassing conveyor.

The TLO will link the product stockpiles with the proposed rail loop to load at a rate of 3,500 tph. The train load out facility will be managed via a fully automated system, including overload protection and load veneering. The facility will be positioned over the rail line and will incorporate a suitable under rail spillage pit.

Waste Rock Dumps

A small ex-pit Waste Rock Dump (WRD) has been established prior to commencing in-pit dumping activities which will continue for the life of the operation. Existing offices, car parks and warehouses in the far northwest of the ML are augmented with additional infrastructure, such as workshops and further warehouses. This Mine Infrastructure Area is connected via haulroads to a ROM pad and heavy vehicle parking area located midway along the western edge of the open cut.

In-pit dumping and dry tailings co-disposal will fill the majority of the pit during operations with the remaining final void to be backfilled upon cessation of mining, resulting in the establishment of a low waste rock dump landform over the former pit area in the south. The northern portion of the In-pit dump will be backfilled to surface for economic and drainage reason. The ex-pit WRD will be rehabilitated in-situ.

Due to the swelling of re-deposited waste rock, the in-pit WRD will extend up to approximately 30 m above the surrounding ground level, and batters will have a slope to a maximum of 15%. A central plateau will drain to the west (for more detail, refer to **Section 6.1**).

An assessment of waste rock geochemistry has concluded that the waste rock does not propose a significant risk of generating acidic, saline or metalliferous drainage, and no selective handling and treatment measures are considered required or proposed.

Saraji Road Realignment

A realignment of the existing Saraji Road and services infrastructure to the eastern boundary of the Mining Lease area, adjacent to the existing rail easement, is also approved. The re-alignment will occur on lease; however, the connection back to the existing alignment of Saraji Road to the north will extend off lease and is approved through an alternative process under the Land Act, 1994 (**Figure 1-16**).

Workforce

The construction of the CHPP and rail loop will require a workforce of approximately 130 people for a period of 18 months. The peak operational workforce is anticipated to comprise 80 positions. It is assumed that approximately half the workforce commutes daily from Moranbah, while the other half commutes from Dysart. There are two 12-hour shifts per day, with crews operating on a 7-days-on, 7-days-off roster.

Diversion Channel

Vitrinite proposes to raise a section of the existing BMA diversion levee and undertake earthworks and channel widening along the existing drainage diversion at the northern end of the ML boundary. The proposed works would be undertaken to mitigate flood impacts of the proposed crossing of the existing drainage diversion which connects the rail loop to the haul road on the eastern side of the levee. The levee and channel upgrades were iteratively designed to mitigate the impacts of the crossing and include:

- Raising the northern section of the levee (by up to 1 m);
- Widening the existing drainage diversion channel to a base width of 30 m with a batter slope of 1V:6H on the left bank and 1V:20H on the right bank. The widened channel extends from the ML boundary to the end of the spillway (up to 550 m in length); and
- Extending the existing levee spillway width (spillway height of 253.7 mAHD) from 40 m to 200 m.

Flood Protection Levee

A flood levee is proposed along the western edge of the proposed mining operations to protect the site from potential floodwater that overflows from the existing drainage diversion. Part of the proposed flood levee may be formed by a haul road that will be located around the western side of the pit. The location of the proposed flood levee is shown in **Figure 1-16**.

The flood protection levee is proposed to cross the existing drainage diversion and associated levee to the west of the pit. Under existing conditions, the existing drainage diversion and levee is overtopped during large flood events. Minor modifications to the existing drainage diversion and associated levee will be undertaken to maintain the existing flow characteristics in the vicinity of the haul road crossings.

The flood protection levee will be a regulated structure under the EP Act and will therefore be required to have a crest above the 0.1% annual exceedance probability (AEP) event.

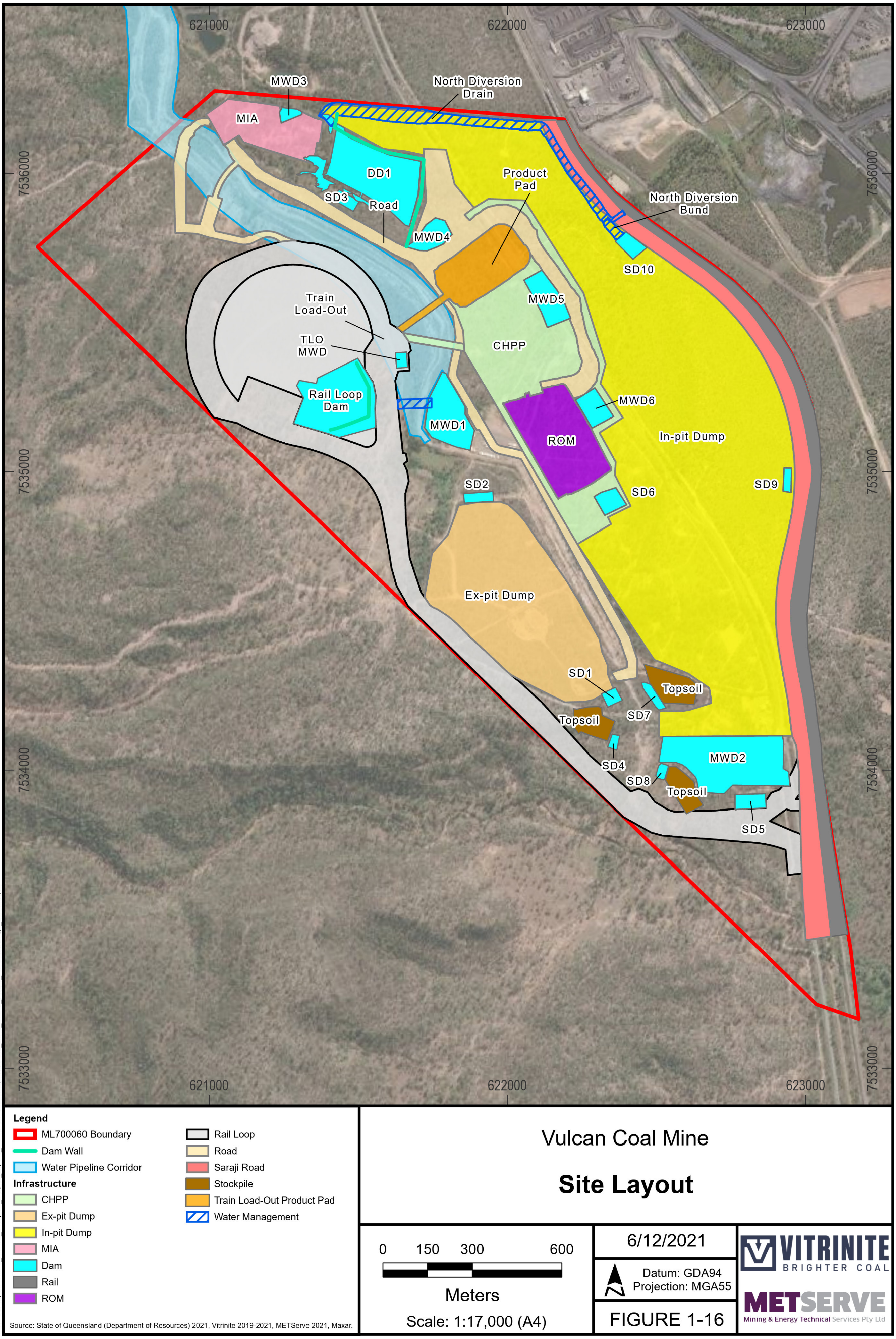
Water Demand, Supply and Management

The addition of the CHPP will increase the site water demand. Vitrinite has secured supply from the Bingegang pipeline which will supply supplementary water demands as required. Vitrinite also has approval to receive mine affected water from neighbouring mine sites.

A key objective of the mine site water management system is to reuse surface water from coal processing and runoff captured within the mine affected water system. Recycling mine water will reduce the required volume of water from external sources.

Explosives Magazine

The existing approved explosives magazine will not be established in the previously proposed and approved location in the western portion of the Mining Lease. This area is now required to facilitate construction and operation of the rail loop and required exclusion zones can no longer be maintained. Instead, explosives will be delivered to site on an as-needs basis with no long term storage on site proposed.



Source: State of Queensland (Department of Resources) 2021, Vitrinite 2019-2021, METServe 2021, Maxar.

Vulcan Coal Mine

Site Layout

6/12/2021

FIGURE 1-16

1.3.3 Water Management

Surface water management infrastructure is established progressively to divert clean water around operational areas and to manage runoff from disturbed areas (WRM 2021). A series of drains and bunds are established to direct runoff to sediment control structures. Mine water dams is constructed as a water supply for dust suppression. This also receives any accumulated pit water that requires dewatering. Groundwater modelling indicates that the amount of pit dewatering required is expected to be negligible (hydrogeologist.com.au 2020). This is due to the small size and low conductivity of any aquifers intercepted by the open-cut pit. The water management infrastructure in place in and around the final landform once land becomes available for rehabilitation is discussed further in **Section 6.1.6**. This water management infrastructure includes the following:

- Northern diverted water drain (operational in Stage 2) - a diversion drain which has been designed to divert water around the northern side of the pit;
- Southern diversion drains (operational in Stages 1 and 2) – two drains on the western side of the out of pit emplacement and rail loop which will drain the undisturbed catchment to the west of the mining area around the ex-pit WRD and toward the existing drainage diversion, which drains to the receiving waters;
- During operations, a gravity drain exists between the existing flood protection levee and the pit, draining north towards SD6 and SD11. It is designed to convey at least a 1% AEP (1 in 100-year ARI) flow event. As the pit progresses to the north, the sections of the levee that are no longer required for pit flood protection will be replaced by the waste rock dump and rehabilitated. This will allow the progressive staging of drainage from the in-pit WRD to drain to Sediment Dam 11 (SD11). The functionality of this levee may be built into haul road designs which would negate the need for a separate levee structure;
- The diverted water dam DD1 exists in Stage 2 to collect water from an undisturbed catchment (catchment area of approximately 56.8 ha) adjacent to the pit. In addition, DD1 may potentially provide some level of flood protection for the pit during the final year of operations;
- a rail loop dam is proposed as a clean water catchment dam used to supplement site water demands via MWD1/MWD2;
- Temporary bunds, drains and re-contouring to the north of the pit progression will prevent runoff and flood waters from flowing into the pit. These are designed to convey at least a 5% AEP (1 in 20-year ARI) flow event. These drainage features will be mined through as the pit progresses northwards and may be implemented to delay the requirement for DD1;
- There are six mine-affected water dams, MWD1, MWD2,MWD3, MWD4, MWD5 and MWD6. MWD1 and MWD2 are used to store water pumped from the pit following rainfall events. MWD3 collects runoff from the mine workshop and laydown area, whilst MWD4, MWD5 and MWD6 capture runoff from the product pad/ROM pad/CHPP area;
- 12 ‘Type D’ sediment basins, designed to contain 85th percentile 5-day rainfall volumes; and
- Sediment control measures (e.g. catch drains, check dams, grass swales and sediment traps) built into the design of haul roads.

The benign nature of waste rock material to be stored on site means that few surface water and groundwater contaminants with the potential to impact environmental values are expected. The chief contaminant that requires management is sediment/turbidity, which is managed via the installation of sediment ponds, fed by drainage lines that gather mine-affected water. Salts are also potentially more elevated in runoff from active mining areas than from natural landscapes (WRM 2021).

The water management strategy at the Mine is based on the following objectives:

- To maintain separation between up-catchment water and mine-affected water;
- To capture mine-affected runoff (e.g. CHPP, mine industrial area, haul road/ROM pad runoff), and store and reuse this as mine water supply;

- To divert water runoff from upstream catchments around the active mining area;
- To limit external catchment runoff draining into pits;
- To manage sediment from disturbed catchment areas (e.g. ex-pit WRD, cleared/pre-strip areas) by using erosion and sediment control measures prior to release offsite; and
- To manage any mine-affected water releases to the receiving environment in accordance with environmental release conditions.

There are four pathways through which water from the Mine can enter the receiving environment:

- dewatering overflows from sediment dams;
- overflows from mine-affected water dams and the open cut pit;
- runoff from diverted water catchments; and
- runoff from rehabilitated catchments.

A computer-based operational simulation water balance model has been developed for the Mine (WRM 2020, 2021). Due to the changing infrastructure over the Mine's short lifespan, separate models were developed to represent two separate Mine scenarios or stages. These models were used to assess the performance of the water management system. The models revealed that the combined volumes of the mine-affected water dams are not expected to exceed their full storage volume under the natural range of environmental conditions at the Mine. Some redistribution of water to MWD1 from the other MWDs will be required. Some controlled discharges may be required in wet years (the wettest 5th percentile) in order to empty runoff draining into the open cut pit. Consistent with the IECA guidelines (2008), sediment dams do not provide 100% containment for captured runoff. Hence overflows will occur from sediment dams when rainfall exceeds the design standard. Under median weather conditions, up to 29 ML/yr are expected to be released from sediment dams, whereas in wet years (the wettest 10th percentile), up to 198 ML/yr may be released (WRM 2021). The release of water within sediment dams is expected to slightly elevate the salt content of Boomerang Creek (downstream) with moderate releases (0.54 ML/d), but have no effect on downstream water with large releases (39 ML/d), due to the greater dilution factor associated with heavier rain events (WRM 2021). Salinity levels in spilled water are forecast to remain below the low-flow water quality objective for the Isaac River sub-basin as specified in the *Environmental Protection (Water) Policy 2009*.

Overall, the risk and expected harm of releasing mine-affected water to the general environment is low. The downstream receiving waters are heavily modified and have been diverted through the Peak Downs operations. Controlled releases of mine water are not proposed. Furthermore, groundwater assessments predict a negligible need for groundwater management, a coal-handling-and-processing plant is not proposed, and dump runoff quality is expected to be suitable for release to the receiving waters (following sediment removal). Any potential releases of contaminants to the receiving waters from mine water dams are unlikely to have an adverse effect.

When a sediment dam catchment is successfully rehabilitated, and water quality monitoring of the runoff has established that it is within acceptable limits, the sediment dam and associated drainage infrastructure will be decommissioned. Surface runoff and seepage from the rehabilitated catchment will be allowed to shed directly to the receiving environment. When the drainage corridor is rehabilitated, DD1 will be decommissioned. DD1 will remain until this time to allow in-stream vegetation to establish before receiving upstream catchment flows.

2 LEGISLATIVE REQUIREMENTS AND GUIDELINES

2.1 *Mineral Resources Act 1989*

Resource activities are regulated through a 'resource authority' under the *Mineral Resources Act 1989*. This provides resource companies with the right to enter land and undertake the approved activity. Under section 107(10) of this act, a mining claim can only be surrendered once improvement restoration (i.e., returning the tenement to substantially the same condition it was in before mining) has been carried out and the relevant environmental authority has been surrendered.

2.2 *Environmental Protection Act 1994*

The *Environmental Protection Act 1994* (EP Act) is the principal legislation for protecting environmental values potentially affected by the resource industry in Queensland. The EP Act grants the Queensland Government the power and means to assess, approve and prescribe conditions on proposed mining projects.

The EP Act requires that all areas of disturbed or undisturbed land within the relevant mining tenure be rehabilitated to a post-mining land use (PMLU), or managed as a non-use management area (NUMA). Section 125(1)(n) of the EP Act requires a proposed PRC plan to accompany site-specific EA applications for a mining activity. Sections 126C and 126D stipulate the requirements for PRC plans and PRC Plan schedules, respectively.

Under the EP Act, the Queensland Government is responsible for the issuing of an environmental authority (EA) to carry out a mining activity and approval of a PRC Plan schedule for a PRC plan. Under section 172(4) of the act, if the PRC Plan schedule is refused, the EA application must also be refused. Under sections 426(1) and 431A of the act, an applicant is unable to undertake any relevant activities until an EA with a PRC Plan schedule is approved. The EA and PRC Plan schedule includes all conditions imposed on the authority and schedule. The EP Act also prescribes the requirements for surrendering an EA, including the preparation of final rehabilitation reports and post-mining management reports.

2.3 *Mineral and Energy Resources (Financial Provisioning) Act 2018*

In Queensland, the *Mineral and Energy Resources (Financial Provisioning) Act 2018* regulates a financial provisioning scheme for reducing potential risks to the Government in the event an EA holder fails to meet their environmental and rehabilitation obligations. This act also amended the EP Act to require mining companies to develop PRC plans.

2.4 Progressive Rehabilitation and Closure Plans Guideline

This guideline, prepared by the Queensland Government Department of Environment and Science, contains information to assist applicants in developing a PRC plan as part of a site-specific EA application for a new mining activity. The administering authority must consider this guideline when making a decision about a PRC Plan schedule under section 176A of the EP Act.

2.5 Rehabilitation Requirements for Mining Resource Activities

This guideline has been prepared by the Queensland Government Department of Environment and Science to assist mining companies to propose acceptable rehabilitation outcomes and strategies. The administering authority must consider this guideline when making a decision about a PRC Plan schedule under section 176A of the EP Act.

2.6 *Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's key piece of legislation protecting matters of national environmental significance. Actions that will or are likely to impact matters of national environmental significance require approval from the Environment Minister under the EPBC Act. Any conditions attached to this approval that pertain to rehabilitation of the site after mining must be adhered to under the EPBC Act.

3 STAKEHOLDER ENGAGEMENT

3.1 Stakeholder Consultation Plan

A Stakeholder Engagement Plan that complies with section 126C(1)(c)(iv) of the EP Act was prepared to guide stakeholder engagement activities associated with project planning, the environmental approvals process and the development of the PRC Plan. This Stakeholder Engagement Plan has been submitted to DES as part of the site-specific EA application supporting information.

Given that the PMLUs seek to re-establish for the most part, the current site land uses, the key stakeholders for rehabilitation of the site were deemed to be:

- BHP Billiton/Mitsubishi Alliance (BMA), landholder of Lot 10 on SP325345 and manager of the Saraji and Peak Downs Mines;
- Aurizon, manager of the Norwich Park branch railway; and
- Isaac Regional Council, manager of Saraji Road.

For the purposes of the PRC Plan, BMA was considered to be the primary stakeholder as the underlying landholder and downstream neighbour of the Mine. Other stakeholders, including the Department of Environment and Science and the Department of Resources have also been consulted.

In accordance with section 126C(1)(c)(iv) of the EP Act, the Stakeholder Engagement Plan also discusses ongoing stakeholder engagement during progressive rehabilitation and closure.

Given the small scale and short duration of the Mine (all rehabilitation works to be completed within 5 years), and the proposal to return the land to its pre-mine land use, it is considered unlikely that stakeholder perspectives on PMLUs will change significantly during the course of progressive rehabilitation, particularly if the rehabilitation activities are implemented successfully as anticipated.

Vitrinite will provide relevant stakeholders with copies of the annual rehabilitation progress return. Distribution of the annual rehabilitation progress return will be utilised as the mechanism for communication of any proposed changes to the PRC Plan, and to obtain feedback from stakeholders for consideration in ongoing planning and activities. Should significant amendment of the PRC Plan be proposed, stakeholders will be engaged as part of the amendment process.

Further detail regarding the PRC Plan annual reporting mechanism is outlined in **Section 9.1.11.**

3.2 Stakeholder Consultation Register

A stakeholder consultation register that complies with section 126C(1)(c)(iii) of the EP Act is appended to the Project Stakeholder Engagement Plan (SEP).

The stakeholder consultation register is a record of all consultation activities citing: attendees, topics of discussion, outcomes and ongoing commitments for each consultation meeting. The stakeholder consultation register listed details of over 35 consultation meetings that took place over the course of the intial engagement on the Project PMLU's. The previously agreed PMLU's are not proposed to be changed in this update to the PRC Plan.

A second more detailed consultation register was also compiled (appended to the SEP), providing a specific detailed record of all consultation with BMA. BMA is considered one of the primary stakeholders for the purposes of the PRC Plan, as the underlying landholder and downstream neighbour of the Mine.

During the consultation process outlined above, topics of discussion with stakeholders have included the proposed PRC Plan approach, the plan for the mine, PMLUs, areas of disturbance, rehabilitation and management methods, progressive rehabilitation and closure timeframes.

4 POST-MINING LAND USE

The ML hosted five land uses prior to the Mine. All of these five land uses are to be reinstated as post-mining land uses (PMLUs) once operations cease:

- low-intensity cattle grazing (also provides some habitat for threatened fauna);
- public road;
- railway used for coal transport;
- supporting infrastructure (offices, parking, warehouses) for neighbouring mining operations; and
- flood levee constructed to protect neighbouring coal mines.

It is anticipated that the pre-mining commercial supporting infrastructure will be relocated off site to facilitate the mining activities and that, once established in an appropriate alternative location, subsequent relocation to return to the site would be unfavourable. However, BMA has expressed a desire to retain some of the Mine's infrastructure to support their nearby operations.

Most of the ML will have a PMLU of low-intensity grazing. Where supported by available soils, locally native plant species are to be incorporated into the planting mixes where grazing is the PMLU, to create pastoral land that partly restores habitat values for threatened fauna (namely, the Squatter Pigeon and Koala) impacted by the Mine. In accordance with Part 3 of the *Environmental Protection (Rehabilitation Reform) Amendment Regulation 2019*, a PMLU of low-intensity grazing:

- is viable, having regard to the use of land in the surrounding region;
- is consistent with how the land was used before a mining activity was carried out on the land;
- is consistent with a use of the land permitted under the Planning Act; and
- will deliver, or aim to deliver, a beneficial environmental outcome.

The locations of these PMLUs are described within the PRC Plan schedule (**Section 10.1**). Through in-pit dumping of waste rock, no voids will remain on site after mining. No non-use management areas (NUMAs) are proposed.

Based on previous studies, grazing is an achievable PMLU in the Bowen Basin (Bisrat *et al.* 2004). To achieve the PMLU, rehabilitated land should have a land suitability class of at least 4 (marginal land for grazing), which was the land suitability class on site prior to mining (see **Section 1.2.10**).

The Goonyella Aurizon rail line and flood levee PMLUs are existing pre-mine land uses that will not be affected by the Mine and will therefore not be subject to any rehabilitation activities.

The realigned Saraji Road will be established very early on in the Mine. Construction and commissioning of the new road infrastructure will effectively establish the PMLU from the outset. Therefore, significant rehabilitation activities to achieve the PMLU are not anticipated. Agreements for the ongoing management and maintenance of the road will be in place prior to its construction.

Other PMLUs considered in place of "low-intensity grazing" included "native vegetation communities" (regional ecosystems 11.5.9 and 11.10.3), "forestry" (hardwood *Eucalyptus* plantations) and "agriculture" (dryland cropping), but the limited topsoil materials and high cost of creating a productive growing medium with the materials available limit the feasibility of the latter two options (see **Section 4.3** for an assessment of each option).

4.1 Accordance with Stakeholders' Requests

Through the consultation process undertaken for the development of this PRC Plan, all relevant stakeholders expressed support for the PMLUs.

4.2 Regulatory Constraints

There are relatively few regulatory constraints on the post mining land use on the ML. These are discussed below.

4.2.1 Isaac Regional Planning Scheme

Under the *Isaac Regional Planning Scheme*, the Mine is located in a "Rural" zone. The *Isaac Regional Planning Scheme* defines uses suitable for "Rural" zones as cropping, intensive horticulture, aquaculture, grazing, intensive animal industries, renewable energy facilities and extractive industries. These defined uses are consistent with the PMLUs for the Mine.

4.2.2 Mackay, Isaac and Whitsunday Regional Plan

The Queensland Government, via its *Mackay, Isaac and Whitsunday Regional Plan*, maps the Mine in a "regional landscape and rural production area", which includes land used for agriculture, water catchment, traditional uses, conservation areas and native forests. The PMLUs are consistent with these planned land uses.

The area to the west of the ML is mostly mapped as being of "high ecological significance", while the ML itself mostly lacks ecological significance under the *Mackay, Isaac and Whitsunday Regional Plan*. This plan aims to minimise the impact of development on such areas of high ecological significance, and a PMLU that is compatible with restoring many of the original environmental values is consistent with this regional plan.

4.3 Assessment of Options

A PMLU of "road reserve" is the only reasonable option for the Saraji Road corridor, as it will endure throughout and beyond the Mine life. Likewise, the two pre-existing land-uses that will be undisturbed by the Mine (railway line and flood levee) will remain as PMLUs. A PMLU of "mine-support infrastructure" will be adopted for the area containing infrastructure to be retained by BMA following the completion of the Mine.

However, four potential PMLUs were assessed as part of planning for the remainder of the Mine disturbance area. These included:

1) Low-intensity cattle grazing with low- to medium-density of native trees;
2) Native vegetation communities (regional ecosystems 11.5.9 and 11.10.3);
3) Hardwood (e.g., *Corymbia citriodora*) plantation forestry; and
4) Dryland cropping.

These PMLUs were selected because they are land uses consistent with the *Isaac Regional Planning Scheme* and the *Mackay, Isaac and Whitsunday Regional Plan*.

In order to compare the relative merit of each PMLU option, a scoring system was applied across ten cost/benefit criteria, in accordance with the *Progressive Rehabilitation and Closure Plans Guideline* (**Table 4-1**). This awarded a score of 1-5 for each consideration (cost/benefit), with the sum of all scores across considerations used to compare PMLU options. Even though different rehabilitation areas have slightly different rehabilitation methods and milestones, they are assessed together due to their similar constraints.

This assessment revealed that low-intensity grazing was the most appropriate PMLU for the Mine (**Table 4-1).** There are other reasons, not considered in **Table 4-1**, why forestry and cropping are higher risk options for the Mine. In Queensland, plantation forestry is largely limited to coastal regions, and the performance of plantations is untested within the Isaac Regional Council area. Cropping is also considered to be higher risk, given the dispersive subsoils across most of the Mine area (see **Section 1.2.6**). Regular cultivation of the topsoil is likely to expose these subsoils to erosion, with irreversible outcomes.

According to the *Rehabilitation Requirements for Mining Resource Activities v2.01*, optimal PMLUs are those highest up in the following hierarchy:

1) avoid disturbance that will require rehabilitation;
2) reinstate a "natural" ecosystem as similar as possible to the original ecosystem;
3) develop an alternative outcome with a higher economic value than the previous land use;
4) reinstate previous land use (e.g. grazing or cropping);
5) develop lower value land use; or
6) leave the site in an unusable condition or with a potential to generate future pollution or adversely affect environmental values.

The favoured PMLU, low-intensity grazing, falls 4th on this hierarchy. The 2nd and 3rd PMLUs in the hierarchy were assessed as options in **Table 4-1**, but were ranked as slightly less desirable due to a combination of the site's physical and chemical constraints and/or economic benefits.

Table 4-1 Assessment of PMLU options for the Mine

Considerations	PMLU Options*				Justification
	Low-intensity grazing	Native ecosystems	Forestry	Cropping	
Physical constraints	4	4	3	2	Shallow soil, sloping land and a hot/dry climate with limited access to irrigation mean that no land use achieves a score of "5". However, these are relatively minor constraints on re-establishing grazing or native ecosystems. Forestry is largely untested in such a dry climate, so this is awarded a neutral score of "3". Cropping is strongly limited (though not impossible) by the lack of access to irrigation and the thin, sandy soil and is awarded a score of "2".
Chemical constraints	4	4	2	1	Topsoil has poor nutrient-holding capacity, while subsoils are generally dispersive. These attributes largely preclude cropping as an option. They also pose substantial constraints on the performance of forestry, given that stressed trees are less likely to produce a desirable form for milling. While chemical constraints also affect the re-establishment of grazing and native ecosystems, this limitation is relatively minor.
Available materials	4	4	2	1	No land use has a score of "5" due to limited amounts of fresh topsoil that can be directly deposited onto disturbed areas (most soil requires some period of stockpiling, which reduces its quality as a growing medium). Nevertheless, this is expected to be a minor limitation for re-establishing grazing or native ecosystems as land uses. As forestry is an undeveloped industry in this climatic zone, strains of timber trees that perform well in local conditions would need to be investigated and mass-produced, something that is not likely to be achievable in the short timeframe of the Mine. For cropping to be viable, existing soil would need to be overlaid with large quantities of suitable topsoil, to provide a favourable growing medium for crops and protect underlying soils from dispersion/erosion. Such material is unavailable.
Relative cost	4	3	2	1	The scores awarded reflect the costs of obtaining the materials required to instate each land use, and therefore generally reflect the scores awarded for material availability. The reason that grazing is slightly cheaper to instate than native ecosystems is due to the relatively simpler plant communities to be established on pastoral land. Restoring native ecosystems would require a more complex seed mix, which is more costly to collect/obtain.
Economic benefits for the community or landholder	4	1	3	5	Scores were based on the potential gross annual income generated from each land use once each has been instated. It is independent of the relative costs described above.
Environmental benefits	3	5	2	1	Scores were based on the biodiversity of native flora that are likely to coexist with the land use, ranging from 5 = full diversity in native ecosystems, to 1 = no native species in crops. Forestry could vary from 2 to 4, depending on the dominance of weeds vs native species in the understorey. It is assumed that, as few native species are expected to regrow in stockpiled soils without active addition of seed, forestry would most likely create a monoculture of timber trees with few native species below. As a diversity of native grasses and trees will be planted in land used for grazing, biodiversity in this land use will be moderate (3).
Social value (recreation, public amenity, employment)	2	2	3	4	High scores were awarded for land uses dependent on a regular supply chain of materials, machinery or labour (maximising employment, for example cropping and, to a lesser extent, forestry). Moderate scores were also awarded for land uses that provide scenic amenity (forestry, native ecosystems), and/or those compatible with recreational activities such as bushwalking or hunting. Scores tended to be relatively similar across potential land uses, as the land uses providing maximum employment opportunities tended to have fewer recreational or public amenity benefits.
Compatibility with surrounding land uses	5	5	3	3	Grazing, native ecosystems and mining are the predominant surrounding land uses. Therefore, grazing and native ecosystems are fully compatible, while forestry and cropping are neutral. The latter two options will require application of water, fertiliser and/or pesticides, which may impact neighbouring land uses.

Considerations	PMLU Options*				Justification
	Low-intensity grazing	Native ecosystems	Forestry	Cropping	
					However, this incompatibility is minor.
The land use before mining commenced	5	5	1	1	Land-uses in place on site prior to mining are awarded "5" and those not in place are awarded "1".
Compatibility with planning instruments under the *Planning Act 2016*	5	5	5	5	All options are fully compatible with the *Isaac Regional Council Planning Scheme* and the *Mackay, Isaac and Whitsunday Regional Plan.*
Total Score	**40**	**38**	**26**	**24**	

*For each consideration, each PMLU option is awarded a relative score (1-5), where 5 is feasible/desirable and 1 is prohibitive/undesirable. The sum of the scores across all considerations was used to compare the favourability of each option.

4.4 Statutory Constraints to be Imposed

Due to the lack of NUMAs and reactive waste rock material, and the fact that the final landform will generally resemble the surrounding landscape, few statutory constraints are expected to be imposed on future land managers of the Mine area. Given that vegetation cover will be important to the minimisation of erosion on sloping landforms, limits on stocking rates are considered appropriate. Any restrictions on the future stocking rates are to be described in the Post-mining Management Report (see **Section 9.6**) and imposed through a Site Management Plan, to be adopted by future land managers of the site. This is to be confirmed following pasture development and performance monitoring.

5 REHABILITATION GOALS

Under section 176A(3)(c)(i) of the *Environmental Protection Act 1994,* mined land must be rehabilitated to a stable condition. Land is in a stable condition, as defined in section 111A of the *Environmental Protection Act 1994*, if: (a) the land is safe and structurally stable, (b) there is no environmental harm being caused by anything on or in the land; and (c) the land can sustain a post-mining land use. These three components of stability are the general rehabilitation goals for all areas disturbed by mining in Queensland. They have been developed from the ecologically sustainable development policy framework, especially in relation to intergenerational equity, polluter pays principle, protection of biodiversity, and maintenance of essential ecological processes.

5.1 Rehabilitation Objectives, Indicators and Completion Criteria

A clearly defined set of rehabilitation objectives has been developed for each PMLU for the Mine. For each objective, one or more rehabilitation indicators (measurements of progress towards the rehabilitation objectives) are proposed. These indicators are designed to be auditable against completion criteria, which act as targets for the rehabilitation process. Each completion criterion is applied to the PRCP Schedule as a milestone criterion for the later stages of rehabilitation (**Section 10.3.1**). The full list of rehabilitation objectives, indicators and completion criteria is shown in **Table 5-1**. For details about how each indicator is to be measured, refer to **Section 9**.

Table 5-1 Rehabilitation objectives, indicators and completion criteria

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
PMLU A: Low-intensity cattle grazing					
A1	Land is to be stable	a) Indices of Landscape Function Analysis (Tongway and Hindley 2004). b) Depth of active rills and gullies	Sites are to be monitored at the time of planting and then every two years for 10 years after planting.	a) Landscape function analysis scores for soil stability, infiltration/runoff and nutrient cycling have started to plateau, and the plateau values predicted from sigmoidal curves fitted to the data are equivalent to or exceed values at analogue sites. b) No active rill or gully erosion deeper than 15 cm present.	a) This methodology has been widely applied to rehabilitated mine sites across Australia, and is strongly correlated with soil aggregate stability, soil nutrient cycling and water infiltration (Tongway and Hindley 2004). b) Provides a supplementary observational method of early erosion detection and early intervention.
		Percentage cover of rock, woody debris, litter, grasses and herbs within a 10 m × 50 m plot.	Late wet season (February-May), every two years for 10 years after planting.	Grazed land maintains a percentage groundcover of between 50% and 96% on slopes up to 10% and between 70% and 96% on slopes between 10-15%.	A percentage cover of ≥50% protects slopes from erosion (Loch 2000; Waters 2004; Carroll *et al.* 2010). Cover ≥70% is required to achieve background rates of erosion on slopes steeper than 10% (AARC 2021). Excessive groundcover inhibits the recruitment of trees and shrubs, and a maximum value of 96% cover was observed within reference sites in stable, unmined vegetation communities (METServe 2020).
A2	Land is to be non-polluting	Levels of contamination present following remediation efforts that take place after infrastructure decommissioning and removal.	Prior to the commencement of topsoil placement.	A site suitability statement prepared by an approved auditor is to conclude that land is not contaminated and is suitable for the PMLU.	This indicator requires assessment to achieve rehabilitation milestone 2, but does not need to be re-assessed at rehabilitation completion unless a new source of potential contamination occurs (e.g., a hydrocarbon spill).

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
		Water quality at permanent monitoring locations downstream of the Mine.	Annually, following rain events.	Surface water in downstream monitoring locations is to remain within site-specific water quality monitoring limits listed in environmental authority EA0002912 (**Table 5-2**).	Site-specific surface water quality triggers are based on baseline surveys undertaken at the site.
		Groundwater quality within permanent monitoring bores.	Quarterly.	Groundwater in downstream monitoring bores remains within site-specific water quality monitoring limits detailed in environmental authority EA0002912 (**Table 5-3**).	Site-specific surface water quality triggers are based on baseline surveys undertaken at the site.
A3	Koala food trees are to have a similar dominance within rehabilitated vegetation communities (except RA1) as they did in vegetation present on site prior to mining.	Proportion of the total basal area of woody vegetation at the site that comprises *Eucalyptus crebra, Eucalyptus populnea* or *Eucalyptus camaldulensis*.	Sites are to be monitored six and ten years after planting.	*Eucalyptus crebra* and/or *Eucalyptus populnea* are to constitute ≥21% of the total basal area of woody vegetation on sand plains. **AND** *Eucalyptus camaldulensis* is to constitute ≥33% of the total basal area of woody vegetation along Ripstone Creek and Drainage Line 2.	Relative dominance of Koala food trees is based on secondary site data gathered from nine sand plain reference sites and three riparian reference sites (METServe 2020).
	Trees are to be sufficiently tall to be used by Koalas and to escape browsing by cattle (except RA1).	Mean height of the tallest ten trees per hectare	Sites are to be monitored six and ten years after planting.	The mean height of the tallest ten trees per hectare is ≥4 m.	The Queensland Environmental Offsets Policy defines non-juvenile Koala habitat trees to be those with a height greater than 4 m (DES 2020). Such trees are also beyond the reach of cattle.
A4	Density of woody vegetation within rehabilitated areas (except RA1) is to be sufficient for Squatter Pigeons.	The mean Normalised Difference Vegetation Index (NDVI) calculated using Landsat imagery captured following at least two months without rain (e.g., late dry season).	Sites are to be monitored at the time of planting and then every two years for 10 years after planting.	Rehabilitated areas have a mean NDVI between 0.1240 and 0.1778	Ecological surveys of the local region found that Squatter Pigeons are confined to vegetation with a density that falls within the range of NDVI values used as the completion criterion (METServe 2020).
A5	Weeds listed under the *Biosecurity Act* are not to exceed densities typically present in unmined, grazed landscapes within the ML and neighbouring areas.	Percentage cover within a 10 m × 50 m plot.	Between February and April, every two years for 10 years after planting.	Rehabilitated areas have ≤0.2% cover of *Parthenium hysterophorus* **AND** rehabilitated areas have ≤0.1% cover of *Harrisia martinii* **AND** Any other weeds listed under the *Biosecurity Act* are to be present in densities of <1 individual per hectare.	Completion criteria are based on the densities of each weed recorded during ecological surveys of the region prior to mining (METServe 2020). As weed densities vary by soil type, only data from soil types present within the ML are incorporated into the completion criteria.
A6	Pasture is to be as productive within rehabilitated areas as in neighbouring unmined areas within the same soil management unit.	Pasture mass (t/ha) of ungrazed plots.	Sites are to be monitored at the end of the growing season (April-May) and end of the dry season (September-November) six and ten years after planting.	Rehabilitated areas have a pasture biomass that is not >10% less than pasture biomass on unmined areas wihin the same soil management unit measured at the same time, as measured under both wet and dry conditions.	Pasture biomass is the standard unit of productivity used widely in the grazing industry (Cayley and Bird 1996).

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
	Rehabilitated land is to have the same land suitability class for grazing as pre-mining score.	Land suitability class	Sites are to be monitored six and ten years after planting.	Rehabilitated areas are to have a land suitability class of 4 or lower.	Prior to mining, the land had a suitability class for cattle grazing of 4 (AARC 2021).
PMLU B: Road Reserve					
B1	Design and construction in accordance with agreed conditions.	Isaac Regional Council (IRC) assessment.	At the completion of all works within the realigned road reserve.	IRC has notified Vitrinite that the new road alignment is accepted "off maintenance", in accordance with processes described by the signed compensation agreement between Vitrinite and IRC.	The Saraji Road realignment will be undertaken during the operational phase of the Mine, and comprises infrastructure to remain on site after the Mine is completed. As such, there are no specific rehabilitation requirements other than to construct and commission the realigned road infrastructure in accordance with conditions specified in an agreement between Vitrinite and IRC.
PMLU C: Retained Infrastructure					
C1	The infrastructure retained meets the conditions of the signed agreement with BMA.	The types of infrastructure retained, and their condition, as assessed by BMA	At the completion of the operational phase	BMA accepts responsibility for infrastructure in accordance with a formal written agreement.	BMA will ultimately accept ownership and liability of this infrastructure, so this is to be in accordance with the signed agreement.

Table 5-2 Preliminary surface water quality trigger values

Analyte	Unit	Trigger Value	Source*
pH	pH Units	<6.5 and >8.5	WQO (aquatic ecosystem)
Electrical conductivity	µS/cm	1,328	Locally derived
Filtered Metals			
Iron	mg/L	0.81	Locally derived
Lead	mg/L	0.004	MMC (aquatic ecosystem)
Mercury	mg/L	0.0002	MMC (aquatic ecosystem)
Arsenic	mg/L	0.024	WQO (aquatic ecosystem)
Aluminium	mg/L	0.302	Locally derived
Molybdenum	mg/L	0.034	MMC (aquatic ecosystem)
Selenium	mg/L	0.01	MMC (aquatic ecosystem)
Total Metals			
Iron	mg/L	10	WQO (irrigation)
Lead	mg/L	0.1	WQO (stock)
Mercury	mg/L	0.002	WQO (aquatic ecosystem)
Arsenic	mg/L	0.5	WQO (stock)
Aluminium	mg/L	5.0	WQO (stock)
Molybdenum	mg/L	0.05	WQO (irrigation)
Selenium	mg/L	0.02	WQO (stock)
Hydrocarbons			
C6-C10 Fraction	mg/L	20	MMC (aquatic ecosystem)
C10-C40 Fraction	mg/L	100	MMC (aquatic ecosystem)
Major Cations and Anions			
Bicarbonate as $CaCO_3$	mg/L	97	Locally derived
Sodium	mg/L	208	Locally derived
Carbonate as $CaCO_3$	mg/L	97	Locally derived
Calcium	mg/L	26	Locally derived
Chloride	mg/L	262	Locally derived
Potassium	mg/L	10	Locally derived
Magnesium	mg/L	30	Locally derived

*MMC: Model Mine Conditions ESR/2016/1936 (DES 2017); WQO: Relevant Water Quality Objective (refer to **Table 1-3**); Locally derived: Interim value based on the 80th percentile of combined dataset from the monitoring locations VSW1 and VSW2.

Table 5-3 Preliminary groundwater quality trigger values

Analyte	Unit	MB04	MB05	MB13
pH (field)	pH Units	<5.5 >8.0	<5.5 >8.0	<5.5 >8.0
Electrical conductivity (field)	µS/cm	12,849[1]	2,756[1]	3,000[1]
SO_4	mg/L	176[1]	284[1]	398[2]
Aluminium (total)	mg/L	4.8[1]	6.2[1]	6[1]
Arsenic (total)	mg/L	0.013[3]	0.013[3]	0.013[3]
Iron (total)	mg/L	288[1]	2.9[1]	2.8[1]
Lead (total)	mg/L	0.008[3]	0.008[3]	0.008[3]
Mercury (total)	mg/L	0.0006[3]	0.0006[3]	0.0006[3]
Molybdenum (total)	mg/L	0.034[3]	0.034[3]	0.034[3]
Selenium (total)	mg/L	0.005[3]	0.005[3]	0.005[3]
Total Petrolium Hydrocarbons C6-C9	µg/L	<20[4]	<20[4]	<20[4]
Total Petroleum Hydrocarbons C10-C36	µg/L	<50[4]	<50[4]	<50[4]

[1] Site specific values using 95th percentiles.
[2] Deep WQO.
[3] ANZG (2018).
[4] Limit of Reporting.

6 REHABILITATION METHODOLOGY

6.1 Landform Design

6.1.1 Overview

The final landform design has sought to limit the Mine's final landform footprint whilst maximising usage of open pit disturbance areas. This has resulted in the majority of mine waste being stored in the open cut pit with a small ex-pit WRD required to facilitate initial mining activities. Due to waste rock swell factors following blasting and handling, the in-pit WRD will fill the void and extend to between 20 and 30 m above the pit crest in the south. This will result in a low final landform over the southern portion of the former pit, with a low ex-pit WRD to the west **(Figure 6-1**). The northern part of the In-Pit WRD will be backfilled to surface level. The final landform will be higher than the pre-mining landform in a localised area (due to a small hill in the pre-mining landform); however, the overall landform will be an elevated plateau (see **Figure 6-1**). The outer batters will be shaped to a maximum of 15% and will contain surface water management measures to drain water from the landform plateau to the surface water drainage features within the surrounding landscape.

The pit will be backfilled progressively, utilising a combination of paddock dump and end-tipping techniques. Dump lifts are generally anticipated to be low, enhancing rapid material settlement. The shaping and profiling of placed waste will be completed with bulldozers. Final landform geometry will be surveyed progressively to maintain adherence to the final landform and surface water management design. Sub-soil, rock mulch and topsoil will be spread with bulldozers and will be the subject of depth and distribution survey and quality control monitoring, as detailed in **Section 9**.

All other mining activities will result in limited change to the pre-mining topography and hence all areas excluding the in-pit WRD, the ex-pit WRD and the ROM pad will resemble the pre-mining landform. To achieve this, minor shaping or reprofiling works will be undertaken once infrastructure has been removed, in order to smooth the ground surface and merge the landform into the surrounding natural contours.

The CHPP and ROM pad will remain slightly elevated above the original ground level (by 2-5 m), with edges smoothed to merge with surrounding areas.

No Non-Use Management Areas (NUMAs) are proposed.

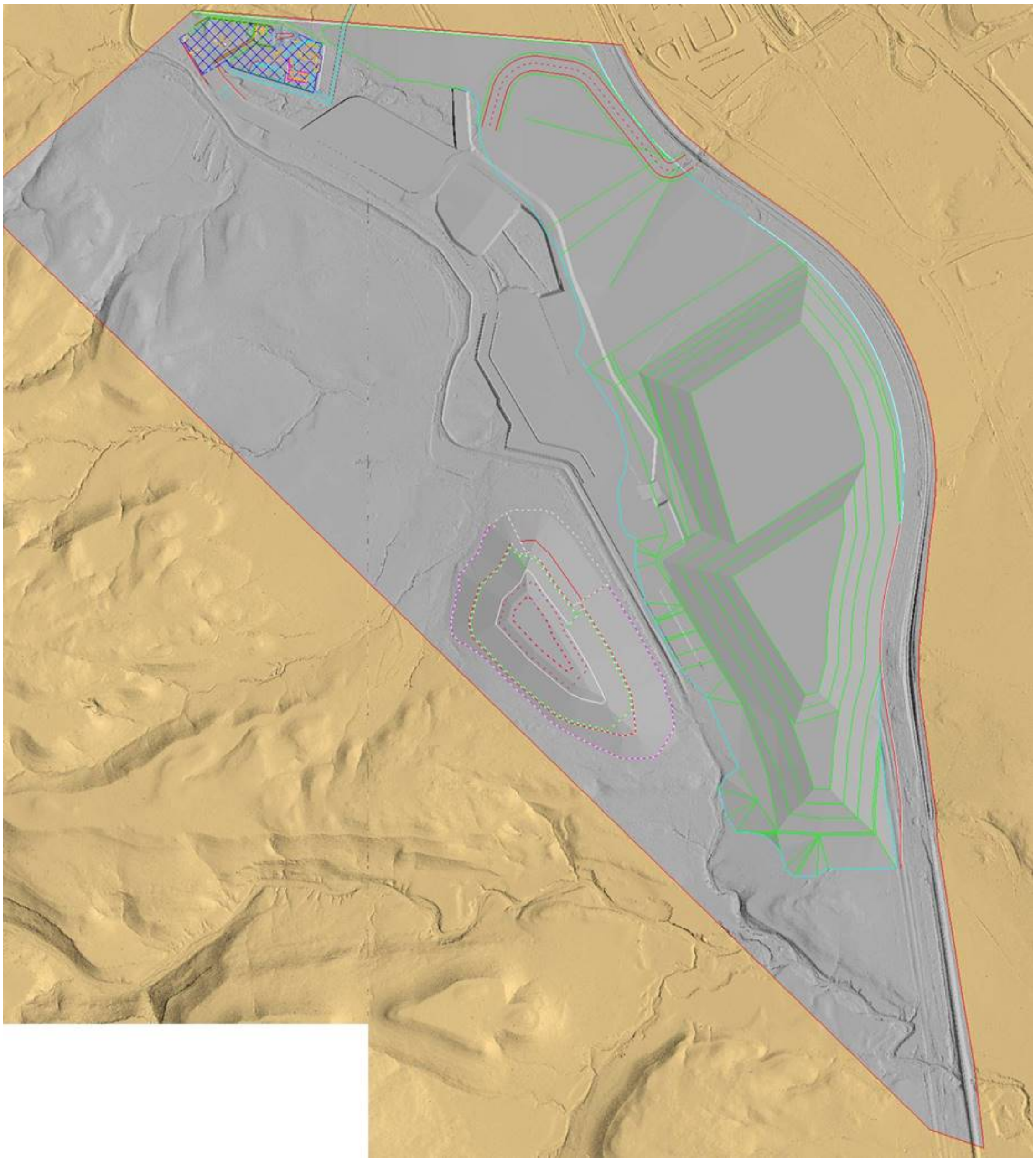


Figure 6-1 Final landform

6.1.2 Design Assumptions and Limitations

The design of the final landform was based on the following limitations and assumptions:

- The footprint of the in-pit WRD is constrained by the boundaries of the pit, which is itself constrained by coal availability and the easement of Saraji Road along the eastern boundary of the ML. For logistic reasons, dumped waste rock will have steeper batters than 15%, which are later recontoured to a 15% slope, resulting in a final landform that extends slightly beyond the original boundaries of the pit;
- The footprint of the ex-pit WRD is constrained by the flood plain and levee in the north-east (to ensure minimal impact to existing surface water features) and the ML boundary and rail loop in the west;
- In order to produce a final landform that merges with the surrounding landscape, a maximum elevation of 280 m (reduced level (RL) based on the Australian Height Datum) was selected for the ex-pit WRD, to closely match the pre-mining and adjacent topography. Furthermore, a hill that occurred within the footprint of the bulk sample pit previously rose to RL 270 m pre-mining;

- The height of the in-pit WRD is determined by the volume of waste rock to be removed during mining and the amount that can be stored in the ex-pit WRD given the above constraints in height and footprint;
- A swell factor of 30% has been assumed, which can be accommodated within a dump with a maximum elevation of RL 280 m. This swell factor is conservative, as 20-25% is typically observed elsewhere in the Bowen Basin;
- For stability reasons, a maximum slope of 15% was used on the final landforms (based on assessments by AARC 2021: summarised in **Section 6.1.8** of this PRC plan) and, where possible, this was reduced further;
- Drainage structures were incorporated into the design of the final landform to further improve long-term stability. Drainage designs were based on recommendations and assessments by WRM (2021) and have been engineered so that catchment boundaries and flows are as similar as practicable to the pre-mining state;
- The plateau formed by the in-pit WRD has a 1% slope to the west, so that surface water is directed away from Saraji Road and into existing drainage systems.

6.1.3 Cover Design

Geochemical characterisation of waste rock has demonstrated that no waste rock to be produced through the life of the Mine has the potential for acid mine drainage, neutral metalliferous mine drainage or saline mine drainage (RGS 2020). Due to the benign nature of all waste rock material on site, no low permeability (air and water) cover system is considered required or proposed.

Despite no need for a cover that protects waste rock from oxidation, waste rock will be placed in such a way to facilitate vegetation re-establishment. Following the return of waste rock to the open cut pit, at least 300 mm of subsoil (removed from the pits prior to mining and stockpiled (**Section 6.2.6**) is to be spread over the rock (**Figure 6-2**). This will enhance the water-holding capacity of the soil and provide a more favourable growing environment for vegetation. Given the vulnerability of local subsoils to dispersion, some waste rock will be mixed with the subsoil (approximate ratio of rock to subsoil of 1:3), to provide protection from erosion, in the unexpected event that that rock mulch cover and developing grass cover doesn't provide adequate protection, and the overlying topsoil becomes eroded in places.

Topsoil will be spread over the subsoil/rock mix at a depth of 250 mm to provide a favourable medium for plant establishment. Note that this cover design varies slightly between rehabilitation areas due to material availability and rehabilitation requirements (**Table 6-1**). In addition a number of topsoil and subsoil ameliorative measures will be implemented, wherever required, to ameliorate poor soil structure, low moisture retention and low nutrient concentrations that may be encountered with the Limpopo SMU (**Section 1.2.6**).

Amelioration measures that can be utilised where required, include the application of organic matter, fertiliser, rapid establishing cover crops, and hydro mulching. More specific detail on the application of these measures is provided in **Section 6.2.**

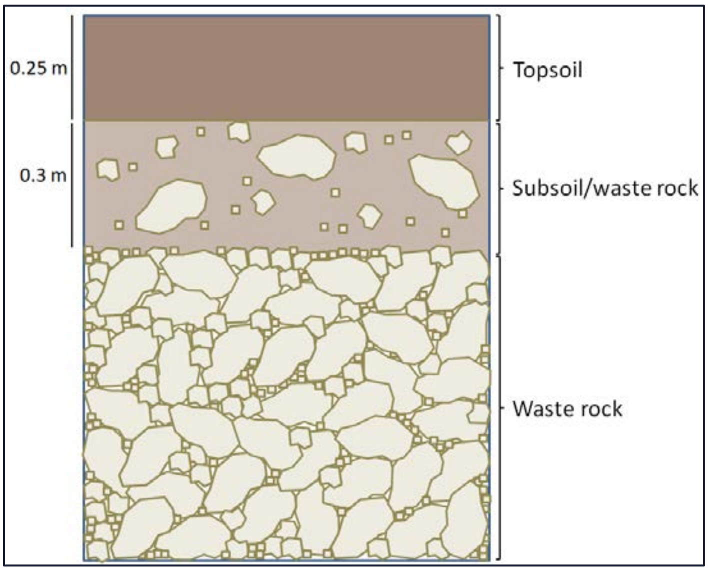


Figure 6-2 Cover design to optimise plant growth

There is strong evidence to support the suitability of the cover design for plant establishment:

- Many independent studies across north-eastern Australia have found that 75-95% of total root biomass within open eucalypt forests and woodlands is contained in the upper 0.5 m of the soil profile (Eamus *et al.* 2002; Zerihun *et al.* 2006; Grant *et al.* 2012), so a soil depth of 55 centimeters (cm) is expected to be suitable for supporting tree growth.
- The cover design is similar to the natural soil profile on the Crocodile soil management unit, which has an average soil depth of 0.62 m above rock (see **Section 1.2.6**) and supports a dense cover of native vegetation.
- Trials undertaken at the adjacent Saraji Mine compared vegetation establishment on waste rock (spoil) that received 0 cm, 10 cm or 30 cm of topsoil prior to planting (Kopittke *et al.* 2004). Grass established at higher densities in the topsoil treatments than on the spoil; however, even on spoil, grass achieved 70% cover. Native trees and shrubs actually established better without topsoil, due to reduced competition with grass, but natural thinning over the first ten years resulted in a final stem density that was equivalent to the topsoil treatments. The spoil at Saraji is more saline than that at the Mine (Kopittke *et al.* 2004), suggesting that local waste rock is unlikely to pose a barrier to root growth for local vegetation. Based on these trials, the cover system is expected to be ideal for establishing a productive pasture with a moderate density of native woody vegetation.

Table 6-1 Cover variations in each rehabilitation area

Rehabilitation Area	Deviation from standard cover design	Justification
RA1: Ex-pit WRD	Topsoil is to be placed directly on waste rock without an intermediate layer of subsoil.	Insufficient subsoil material is available at an appropriate stage of mining development to apply this to the ex-pit WRD.
RA2: In-pit WRD	None	N/A
RA3: Infrastructure	Topsoil is to be placed directly onto prepared disturbed surfaces.	Apart from the rail loop, where deeper incisions may be required for cuttings, no waste rock or subsoil is to be removed from infrastructure areas and therefore these remain intact.For the rail loop, subsoils will be replaced during the backfilling of any excavations which will resemble conditions previous to subsoil removal.
RA4: Dams and sediment ponds	Land is to be reformed prior to the deposition of topsoil. No waste rock or subsoil is added,	There is to be minimal disturbance to the soil profile at dams once reforming has been

Rehabilitation Area	Deviation from standard cover design	Justification
	beyond what is already contained within the dam walls.	conducted and topsoil returned.
RA5: Saraji Road	No cover is proposed.	RA5 is to remain an asphalt road in perpetuity.
RA6: Retained Infrastructure	No cover is proposed.	As the infrastructure within RA6 will remain at completion, there is no requirement for cover development.

6.1.4 Mine Waste Geochemistry

A geochemical assessment has been undertaken of the overburden and interburden (waste rock), and coal rejects (RGS 2020). This found that waste rock at the Mine had a universally low sulphide content and high acid-neutralising capacity due to high pH. All material assessed was non-acid-forming and considered essentially barren for oxidisable sulphur. All carbonaceous interburden samples within the ML were classified as non-acid-forming and, as a bulk material, carbonaceous interburden is considered to be non-acid-forming.

An analysis of the concentrations of 22 metals and metalloids (and four other trace elements) within overburden and interburden revealed that no samples were relatively enriched, compared to the mean crustal abundance of each element (RGS 2020). The potential solubility of any metals/metalloids in the materials was investigated further through water extract and kinetic leach column tests. Most metal/metalloid concentrations tested in the water extracts were below the applied water quality guideline criteria. The main exceptions were aluminium (four samples) and copper (three samples), which have a concentration in some of the water extracts above the applied freshwater aquatic ecosystem water quality guideline value for 95% species protection (ANZG 2018), but below the applied guideline values for livestock drinking water. Based on these results, the risk of potential impact on the quality of surface runoff and groundwater from bulk mining waste materials at the Mine is low. The results of the kinetic leach column tests supported the results of the water extracts; namely, that the concentration of metals/metalloids in the leachate is low and typically below the laboratory limit of reporting. The concentrations of all metals/metalloids were below the applied water quality guideline criteria for aquatic freshwater ecosystems (95% species protection level) (ANZG 2018).

Like the waste rock, the coal reject material had a mean acid-neutralising capacity that was well over (more than twice) the maximum potential acidity. However, there was variability between samples, such that one sample (out of 11) was classified as “potentially acid-forming”, and a further three samples were classified as “uncertain”. As a bulk mixed material, coal reject has a relatively low risk of generating acidic drainage. This risk can be further lessened by disposing of reject materials within cells contained within waste rock dumps, which have a very high acid-neutralising capacity. As for waste rock, leachate from coal reject samples did not have elevated metal concentrations during kinetic leach column tests. All processing wastes, including reject material and dry tailings, will be stored within active waste rock dumps (primarily the in-pit dump), removing the requirement for a tailings storage facility at the site. Priority will be given to disposal of processing wastes within in-pit dumps at depth; however, scheduling constraints may necessitate storage of some material in out-of-pit waste rock dumps.

The in-pit disposal of mixed coarse and fine reject materials within waste rock cells is also a low risk strategy as the much larger volume of waste rock typically has very low sulphur content and excess ANC. This mining waste management strategy is currently used at a number of coal mines in the Bowen Basin (RGS, 2020).

Overall, surface runoff and seepage from the overburden/interburden material is expected to be pH neutral to slightly alkaline and have a low level of salinity. Dissolved metal and metalloid concentrations in surface runoff and leachate from bulk mining waste materials are expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources.

6.1.5 Material Availability

All materials (i.e. topsoils, subsoils, and waste rock) to be used for rehabilitating disturbed land will be sourced from the disturbance footprint and stockpiled during the mining process, until required for rehabilitation. Given that the post-mine landform will be similar but not identical to the pre-mine landform, discrepancies are likely between the quantities of materials obtained from each area and the quantities required to be returned. As can be seen by the materials balance shown in **Table 6-2**, any discrepancies caused by alterations to the landform are expected to be balanced by (a) replacing a slightly thinner layer of topsoil than removed and (b) mixing rock with subsoils. Also note that some stockpiles will be retained in association with retained infrastructure, in order to provide BMA with a resource to rehabilitate this area once no longer required for their operations.

Table 6-2 Materials balance for topsoils and subsoils to be used for rehabilitation

Material	Amount removed from disturbance footprint (m^3)	Amount required for rehabilitation (m^3)	Balance (m^3)
Topsoil*	780,693	599,157	+181,536
Tertiary Subsoil†	499,754	374,815	+124,939
Permian waste rock	16,289,000	47,610^	+16,241,390

*The top 30 cm of topsoil is removed from most disturbed areas prior to mining, while 25 cm is returned to all rehabilitated areas.
†The top 30 cm of subsoil is removed from some disturbed areas (extraction areas and dams) prior to mining, and three parts of this is diluted with one part rock when returned to rehabilitated areas.
^Requirement for one part rock dilution of the Subsoil allocation, and additional requirement of an additional 20 cm of coverage for slopes, batters and drainage areas of the final landform (approximately 40% of final landform surface area).

Drilling conducted by Vitrinite has identified medium to high-strength sandstone resources both above and between coal seams that are likely to be suitable for use in rock mulching. Based on the geological modelling of Vitrinite's coal projects, which locally extends beyond the disturbance footprint of the VCM, this resource is expected to be abundant far beyond the requirements for landform construction.

The available waste rock material will be approximately 16,289,000m^3 (**Table 6-2**). Based on geological drilling logs there is a high degree of confidence that a significant resource of competent sandstone is present in the waste rock material that will be excavated during mining activities.

The geochemical and geophysical characteristics of waste rock will be assessed to identify the suitable strata for use in landform stabilisation. Once these strata are confirmed, mine scheduling and selective handling will be applied to ensure that adequate suitable material is available for the progressive rehabilitation of landforms. Further information on waste rock testing is provided in **Section 6.2.8.**

6.1.6 Drainage and Surface Water Management

The potential impacts of the final landform on surface water resources will be mitigated through the implementation of a mine site water management system. During closure, the system will revert from the operational water management system, which is designed to control the flow and storage of water of different qualities across the site, to one that primarily seeks to manage drainage from the final landform, control erosion and sediment and divert upstream runoff around the final landform. The relevant elements of the operational surface water monitoring program will be continued in closure to monitor and confirm water management system performance.

Final Landform Drainage

The conceptual final landform drainage is presented in **Figure 6-3** (WRM Figure A). This presents the drainage principles to be implemented on the final landform. The drainage plan has been developed with the aim of retaining certain water infrastructure constructed during operations, for the management of surface waters during closure. The landform is intended to be free-draining and to discharge water to the receiving environment that is consistent with water quality from surrounding background sites.

The key features and marked cross sections of the final landform that are depicted in **Figure 6-3** (WRM Figure A) are presented in **Figure 6-4**, **Figure 6-5** and **Figure 6-6** (WRM Figure B, Figure C and Figure D).

The key drainage features of the final waste rock dump landforms include:

- The final surfaces of the ex-pit and in-pit WRDs have been designed to shed water and avoid concentrated flows. Drainage structures will be constructed on the top of the dumps, on the batter slopes and at the toe of the dumps that will be designed to minimise erosion and avoid ponding;
- Plateau drains will collect runoff from the plateau and generally drain flows to the western side of the landform. Contour banks on the western side of the in-pit WRD will collect residual runoff which is not collected in the plateau drains;

- Drop structures will collect runoff from the plateau drains and control the flow down the batter slopes, discharging the flow at the toe of the landform;
- Contour banks will control runoff from the batters;
- Surface water drains will collect runoff at the toe of the dumps and direct it towards sediment dams. These surface water drains will be retained from the operational phase of the Mine;
- Most of the surface water draining to the western edge of the in-pit WRD ultimately drains north, where it joins a drainage corridor that follows the northern edge of the in-pit WRD and connects to an existing drainage line; and
- Erosion control measures will be used in the construction of the plateau drains, surface water drains, contour banks and drop structures as appropriate. These control measures (shown in **Figure 6-6** to **Figure 6-8**) may include topsoiling and vegetating the drainage structures, incorporating erosion resistant liners (e.g. geotextile liners) and/or rock lining the structures.

A number of dams will be retained or introduced as part of the final landform design:

- Sediment dams SD1 and SD2–will collect surface water runoff generated from the ex-pit WRD and release it to the receiving waters;
- SD3- will collect water runoff from the Northern mine access road and releasing to the receiving waters of Drainage Channel 1;
- SD4- collects surface runoff from the topsoil stockpile south of the out of pit spoil dump and releases through drainage line 2 via the existing diversion drain;
- Sediment dams SD5- SD12–willcollect runoff from the in-pit WRD and releases through both Drainage channel 1 and 2;
- A catchment runoff dam DD1 will collect undisturbed runoff from the northwest of the final landform. It will spill to the drainage corridor. DD1 will be retained until the drainage corridor has been fully established; and
- Mine water dams from the operational phase (i.e. MWD1 – MWD6) shown in **Figure 6-3** will be decommissioned following rehabilitation of infrastructure areas.

When a sediment dam catchment is completely rehabilitated, and water quality monitoring of the runoff has established that it meets the trigger values listed in **Table 5-2**, the sediment dam and associated drainage infrastructure will be decommissioned. Surface runoff and seepage from the rehabilitated catchment will be allowed to shed directly to the receiving environment.

The existing flood levee and drainage diversion, which drains southward through the Mine area between the in-pit and ex-pit WRDs, was constructed in the Mine area prior to its commencement. The flood levee will be retained for the final landform. The conceptual cross sections (and associated flooding results) shown in **Figure 6-4** to **Figure 6-6** incorporate the existing levee.

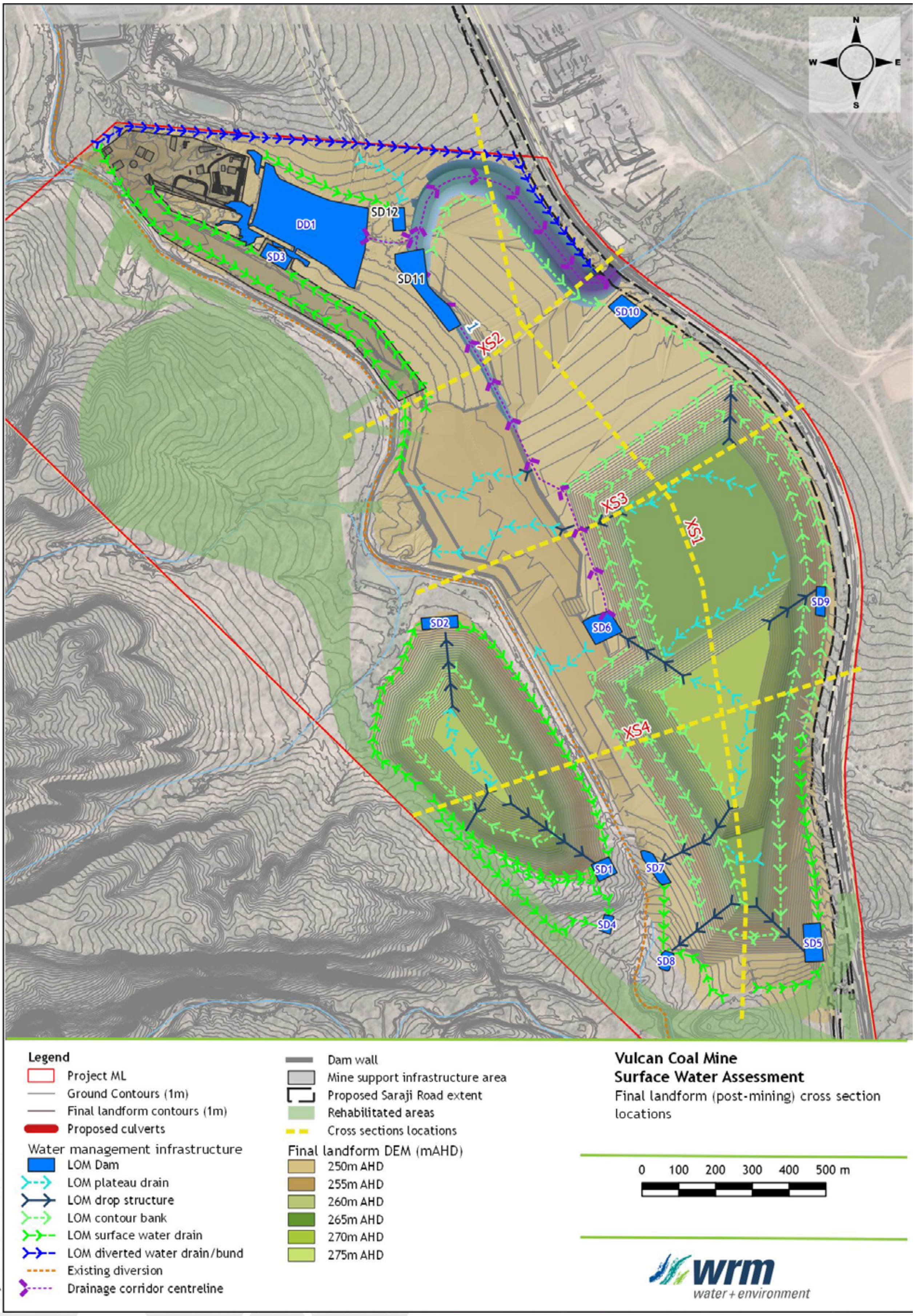


Figure 6-3 Conceptual Final Landform Drainage Plan

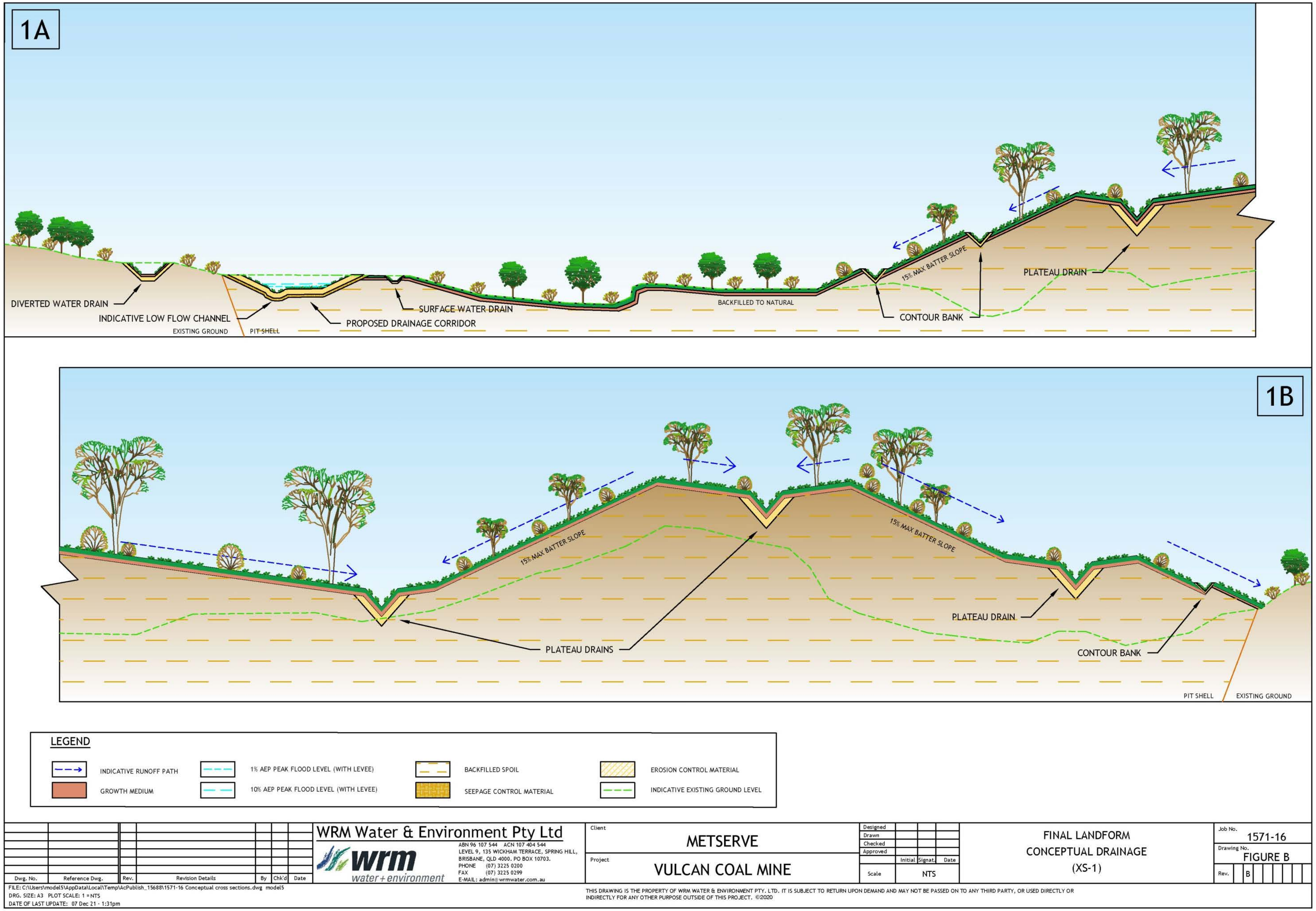


Figure 6-4 Final Landform Drainage XS-1

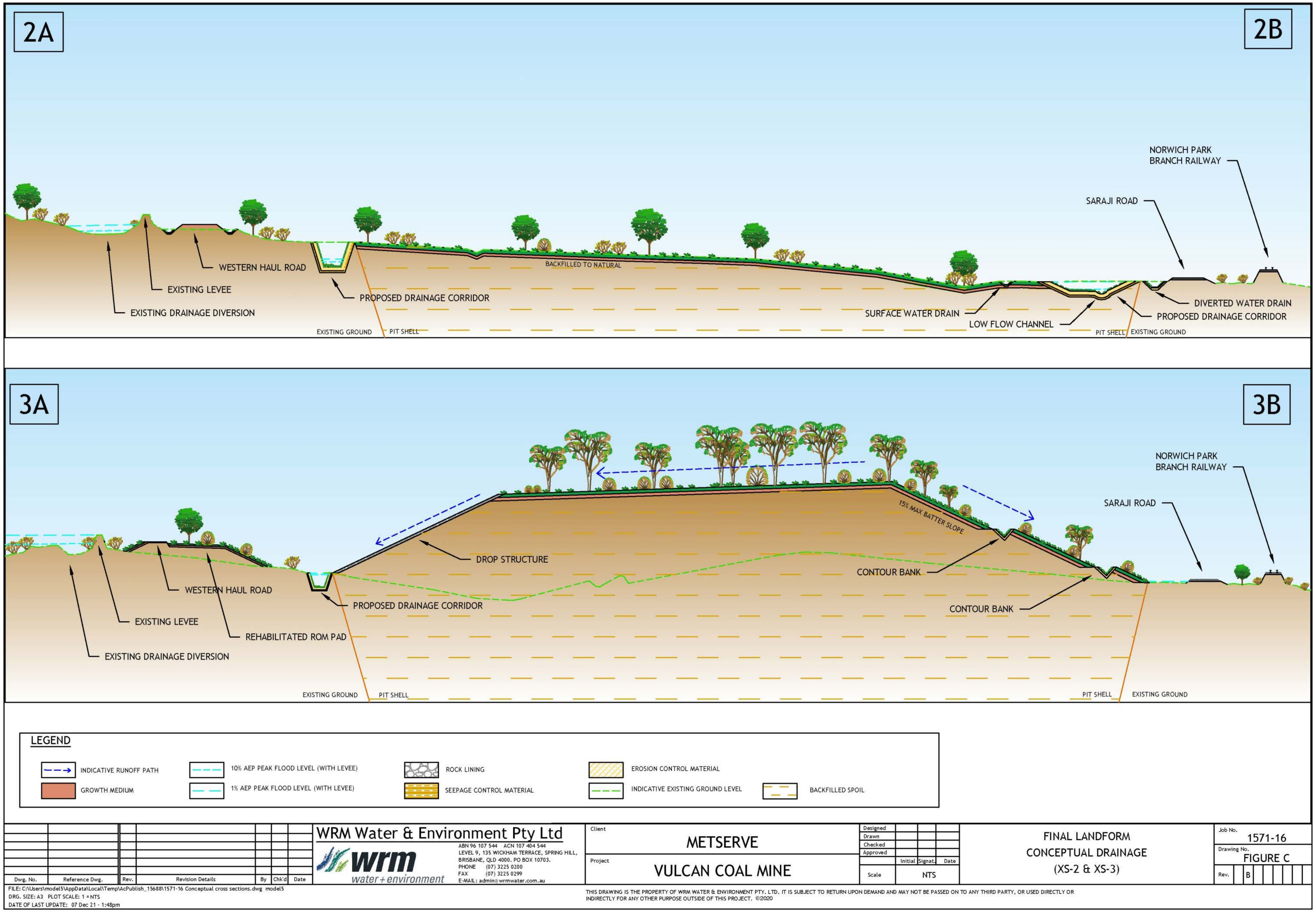
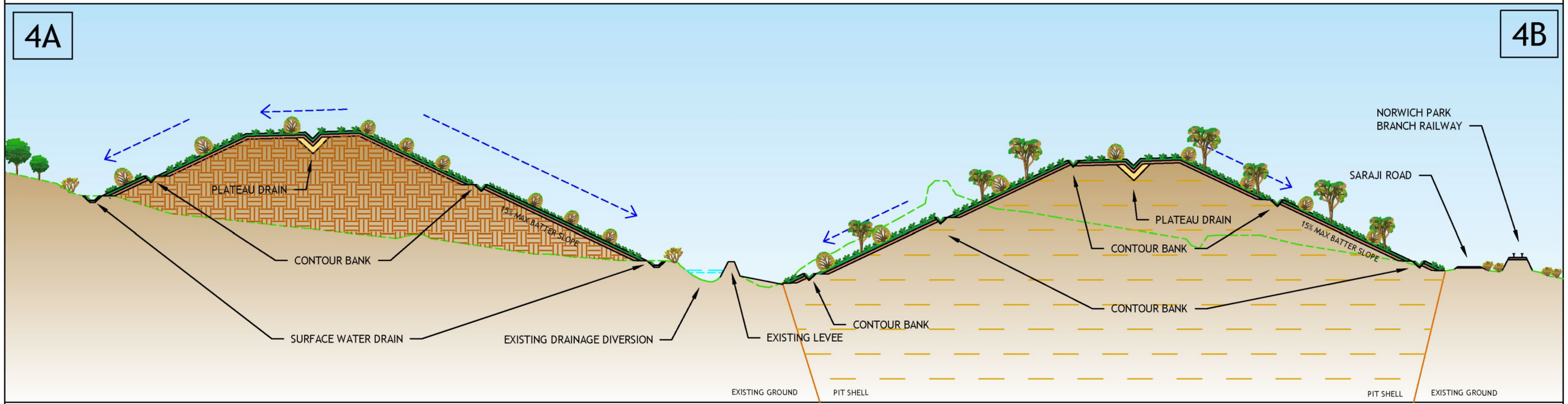


Figure 6-5 Final Landform Drainage XS-2 and XS-3



LEGEND

INDICATIVE RUNOFF PATH	10% AEP PEAK FLOOD LEVEL (WITH LEVEE)	EROSION CONTROL MATERIAL	SUITABLE OVERBURDEN MATERIAL
GROWTH MEDIUM	1% AEP PEAK FLOOD LEVEL (WITH LEVEE)	SEEPAGE CONTROL MATERIAL	INDICATIVE EXISTING GROUND LEVEL
			BACKFILLED SPOIL

Dwg. No.	Reference Dwg.	Rev.	Revision Details	By	Chk'd	Date

WRM Water & Environment Pty Ltd
wrm water + environment
ABN 96 107 544 ACN 107 404 544
LEVEL 9, 135 WICKHAM TERRACE, SPRING HILL, BRISBANE, QLD 4000. PO BOX 10703.
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Client: METSERVE
Project: VULCAN COAL MINE

	Initial	Signat.	Date
Designed			
Drawn			
Checked			
Approved			
Scale	NTS		

FINAL LANDFORM
CONCEPTUAL DRAINAGE
(XS-4)

Job No. 1571-16
Drawing No. FIGURE D
Rev. B

FILE: C:\Users\model5\AppData\Local\Temp\AcPublish_34780\1571-16 Conceptual cross sections.dwg model5
DRG. SIZE: A3 PLOT SCALE: 1 = NTS
DATE OF LAST UPDATE: 07 Dec 21 - 11:54am

Figure 6-6 Final Landform Drainage XS-4

All drainage channels and corridors are designed as free-flowing gravity drains.

The main drainage channel (Drainage Line 1) servicing the in-pit WRD commences near the south-western edge of the in-pit WRD, drains through SD11 and discharges into the drainage corridor. The drainage channel will collect runoff from the drop structures along the western side of the in-pit WRD, as well as runoff draining from the eastern side of the existing levee (includes the area containing the ROM pad). Cross sections of the drainage channel are shown in XS-2 and XS-3 (**Figure 6-5**).

The drainage corridor allowing water to travel around the northern edge of the in-pit WRD flows eastward through the backfilled spoil of the in-pit WRD. The corridor discharges through the existing culverts under the Norwich Park Branch Railway to the east. The drainage corridor is to be approximately 1 km in length.

WRM (2021) has produced hydrologic and hydraulic models of flood plains within the ML and surrounding areas to inform the Mine surface water assessment. A flood plain is defined as the same height, or lower than, the water level modelled with a 0.1% annual exceedance probability for a relevant watercourse under the guideline, *Australian Rainfall and Runoff* (Ball *et al.* 2019). When flood models undertaken by WRM (2021) for the pre-mining landscape were repeated for the final landform, these indicated that (**Figure 6-9**):

- within the Mine area during a 1% AEP event, peak velocities increase within the existing drainage diversion upstream of the rail loop embankments by up to 3 m/s where the channel is diverted around the embankment;
- overflows at the ROM pad would be captured by the existing drainage corridor;
- the drainage corridor has sufficient capacity to convey flood events up to the 0.1% AEP.
- similar to the existing Saraji Road, the realigned Saraji Road is inundated as the culverts have insufficient capacity to convey the 0.1% AEP event flows and floodwaters are impounded behind the constructed Norwich Park Branch Railway embankment.there are negligible increases in peak water levels and velocities at the Norwich Park Branch Railway culverts in 0.1% AEP flood events.
- the water drainage corridor around the northern end of the in-pit WRD could experience peak inundation of 1–3 m, with 4 m depth expected immediately upstream of the culvert under Saraji Road.
- the modified landforms (waste rock dumps, raised ROM pad) will remain largely unaffected by extreme flood events, although their toes could experience flooding (in most locations, up to 1–2 m).
- the impact of the Mine on the hydraulic characteristics of Boomerang Creek and its tributaries do not affect the existing conditions significantly. It is expected that the channel and floodplain will undergo little, if any, adjustment to the altered hydraulic conditions upstream or downstream of the Mine as a result of mining activities.

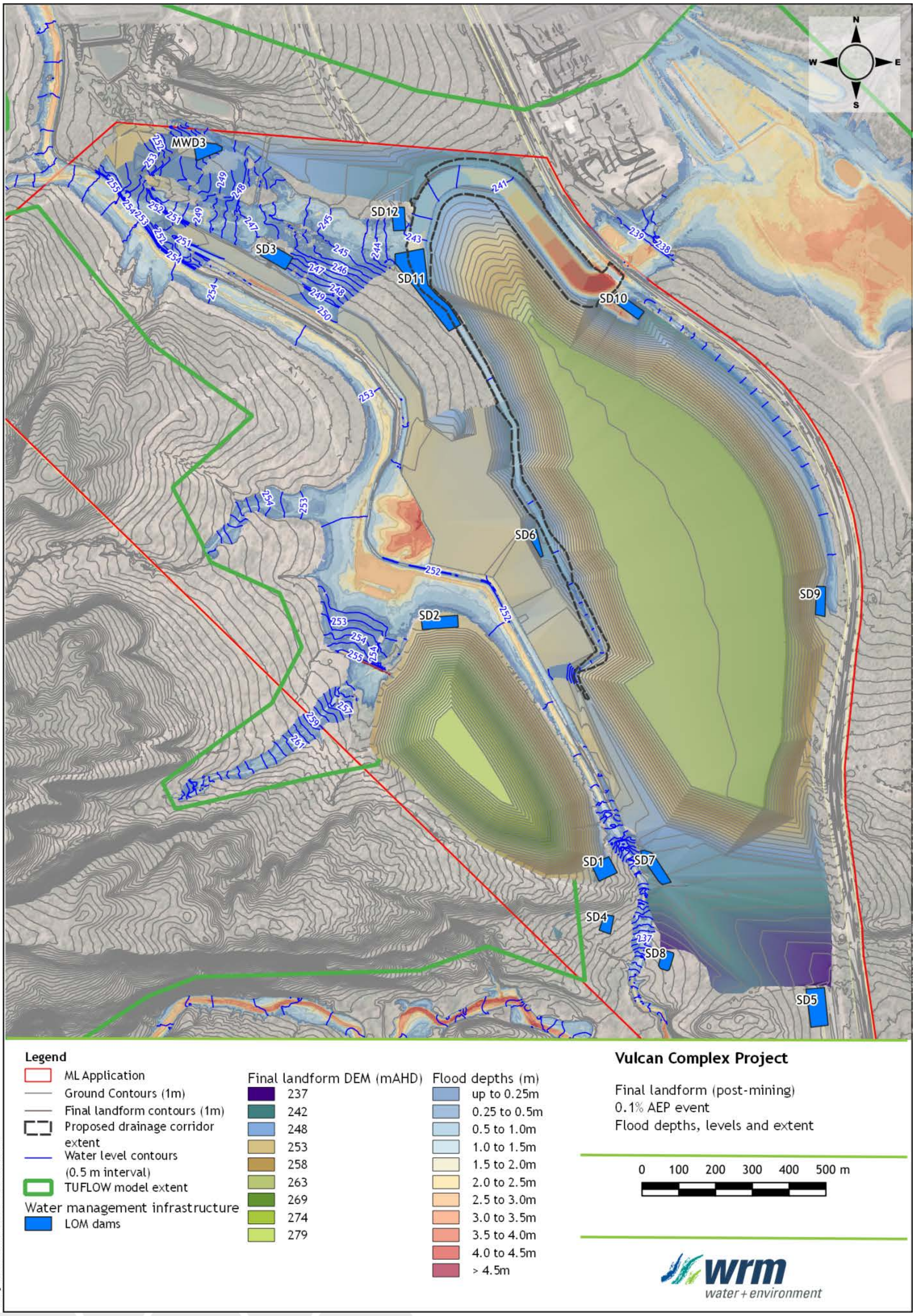


Figure 6-7 Final landform 0.1% AEP flood event

Considering the peak velocities and flood heights, erosion and scour protection will be required along the corridor structure and for the northern toe of the final landform. Erosion control measures will be carefully considered at the inlet and outlet of the drainage corridor, as well as the downstream culvert crossings. Suitable erosion and sediment control measures will be determined during detailed design. Possible erosion controls include:

- topsoiling and revegetating the drainage corridor;
- rock lining the corridor and landform toe;
- operating DD1 until all erosion controls have been implemented in the channel and/or revegetation is established;
- implementing seepage minimisation measures (such as the addition of a liner along the base of the diversions) to minimise seepage from the corridor to the underlying spoil; and
- routine monitoring of erosion and sedimentation along the drainage corridor to ensure the diversion is stable during natural flow events.

When the drainage corridor is rehabilitated, DD1 will be decommissioned. DD1 will remain until this time to allow in-stream vegetation to establish before receiving upstream catchment flows.

The size and configuration of the drainage channel and corridor will be confirmed during detailed design; however, it is expected that it will be designed to convey at least 0.1% AEP flow event.

The conceptual cross sections in **Figure 6-4** to **Figure 6-6** show the intended profile of the final landform, including across the in-pit and ex-pit WRDs. The conceptual landform surfaces have been developed using the finished level of the dumps supplied from Vitrinite Pty Ltd and have been shaped in order to evenly shed water down the landform in order to minimise erosion.

The key features of the final landform profile are described below:

- cross section XS-1 shows a profile across the in-pit WRD (**Figure 6-4**). As shown, the final landform is intended to be shaped to direct runoff towards the plateau drains situated along the surface. This sloping will ensure that runoff generated along the surface will be collected and controlled through the drainage structures along the surface and minimise uncontrolled flows down the landform batters.
- the surface of the final landform will be topsoiled and will be vegetated consistent with final rehabilitation plans.
- batter slopes (shown in **Figure 6-4** to **Figure 6-6**) will be graded at a maximum of 15% and therefore, will be well below the angle of repose.
- cross section XS-2, XS-3 and XS-4 (shown in **Figure 6-5** and **Figure 6-6**) show a profile across the ex-pit and in-pit WRDs. The dumps are intended to be shaped to grade runoff to planned drainage structures.
- contour banks and plateau drains along the final landform surface are intended to be lightly vegetated and lined with a suitable erosion control material (as shown on **Figure 6-4** to **Figure 6-6**).
- no final voids are proposed. All open cut pits will be backfilled with overburden material.
- when sediment dam catchments are completely rehabilitated, and water quality monitoring of the runoff has established that it is consistent with natural background conditions, the sediment dam and associated drainage infrastructure will be decommissioned.

The materials used in the construction of levees and final landforms will be considered at the time of detailed design.

Impacts on downstream water quality

Preliminary baseline monitoring indicates that water quality in the surrounding environment is of poor quality. Notwithstanding, the water balance modelling indicates that no mine-affected spills are predicted from mining operations. In addition, modelling predicts that spills from the sediment dams will possess electrical conductivity below the 720 µS/cm Water Quality Objective (WQO) for low flows. Baseline salinity exceeds the WQO for high flows.

In consideration of the already-heavily disturbed nature of the surrounding catchment, it is unlikely that Mine releases will have a measurable impact on receiving water quality or environmental values.

Receiving Environment Monitoring Program (REMP)

A Receiving Environment Monitoring Program (REMP) has been developed that specifies the monitoring program for the local receiving waters. The REMP will incorporate the historical and monitoring as described in **Section 9.1.8** of this PRC Plan.

The main objective of the REMP is to report against WQOs for local waterways potentially affected by discharge from the Mine and assists in assessing general aquatic ecosystem health.

A set of initial proposed receiving water contaminant triggers levels have been developed, based on conditions at nearby operating coal mines and preliminary baseline results. These trigger levels (see **Table 5-2**) are to be measured at the upstream and downstream water monitoring locations (i.e. VSW1, VSW2, VSW3 and VSW8). Monitoring at these locations will allow for an accurate evaluation of the impact of any releases from the Mine and allow for identification of any upstream influences that are not associated with the Mine.

Contaminant Sources, Pathways and Receptors

As outlined in **Section 6.1.4**, the waste rock dumps and final landforms will be relatively benign landforms, with no potential for acid mine drainage or seepage to groundwater. The overburden and interburden at the site was found to have a universally low sulphide content and high acid-neutralising capacity due to high pH. All material assessed was non-acid-forming and considered essentially barren for oxidisable sulphur. All carbonaceous interburden samples for the site were classified as non-acid-forming and, as a bulk material, carbonaceous interburden is considered to be non-acid-forming (RGS 2020).

As such, the primary source of contaminant during rehabilitation works and the post-rehabilitation period of the site will be potential increases in sediment load and turbidity of surface water flows. The pathway of any potential elevated sediment load will be the surface water flows across the final landform as outlined in **Section 6.1.6** and **Figure 6-3**. The potential receptors are the downstream catchments and receiving environment, as described in detail in **Section 1.2.4.**

The controls for potential elevated sediment loads and turbidity include revegetation and rock mulch (**Section 6.2**), and water management structures such as contour banks, sediment dams, and plateau drains as detailed in **Section 6.1.6.**

Release contaminant trigger investigation levels

The WQOs for the Mine (**Table 5-2**) will be used as release contaminant trigger investigation levels. Should surface water monitoring show that a release from the Mine are above the WQOs, an investigation will be undertaken into the release. Reporting of the spill will be undertaken in accordance with the EA.

6.1.7 Hydrogeology

Hydrogeologist.com.au (2020) has developed a numerical hydrogeological model of all relevant aquifers within the ML and broader region to predict the effects of the Mine on local groundwater levels. This was based on a range of data sources, including an on-site groundwater monitoring network, groundwater assessments from nearby mines, and the Queensland Groundwater Database (DNRME 2019).

An adaptive management strategy is proposed to assist with the management and mitigation of any potential drawdown and water quality impacts on the site. The overall framework for the adaptive management strategy is to undertake a number of ongoing monitoring programs of groundwater level and water quality, and the development of site-specific groundwater trigger levels and contaminant limits.

Drawdown Monitoring

Ongoing monitoring of groundwater levels within the monitoring network will enable natural groundwater level fluctuations (such as responses to rainfall recharge) to be distinguished from potential groundwater level impacts (drawdown) due to dewatering/depressurisation resulting from mining activities. Automatic data loggers are currently installed in the groundwater monitoring network and record daily measurements. These data loggers will be downloaded quarterly to coincide with groundwater quality sampling.

The groundwater monitoring network established by hydrogeologist.com.au (2020) is considered fit for purpose for this assessment, and will form the basis for ongoing drawdown monitoring and management through the life of the Mine.

Predicted drawdown due to mining operations is limited to generally less than 2 km from the open cut pit (that is the lateral distance from the pit to the 1 m drawdown contour). Predicted drawdown is also limited in magnitude (up to 10 m) (hydrogeologist.com.au 2020). This limited drawdown propagation is mainly due to the limited extent of saturation in the Mine area, the low hydraulic conductivities and low storage coefficients. The predicted drawdown extends towards the east, toward Saraji Mine.

Any effects of drawdown will cease soon after the cessation of mining, with no expected residual drawdown post closure (hydrogeologist.com.au 2020). No surface expression of groundwater will occur once the final landform is constructed. Due to this negligible risk, no measures are required or proposed to limit groundwater discharge to the surface (hydrogeologist.com.au 2020). Following recharge, minor groundwater interaction with placed waste material within the former pit is expected. However, based on assessments of the waste material and the current quality of groundwater, this is anticipated to be of limited consequence.

There are no third-party groundwater users within the predicted extent of drawdown and hence impacts on existing users are considered very unlikely. The nearest third party bore (to any of the mine pits) is 700 m from the 1 m predicted drawdown contour line. An uncertainty analysis undertaken by hydrogeologist.com.au (2020) also shows that the maximum probable drawdown does not extend to the nearest third party bore, and that impact to the bore is very unlikely. This is a substantial buffer, and together with the groundwater monitoring program, will ensure that third-party bores are not put at undue risk by the Mine.

Surface- Groundwater interaction

An assessment of the mechanism of recharge from surface water systems in the Mine area was undertaken (Hydrobiology 2020). It was concluded that there was no significant surface-groundwater interaction in the Mine area. It was also determined that impacts on surface waters from groundwater interaction are considered extremely unlikely.

Site-specific Groundwater Quality Parameters

All groundwater sampled to date in or near the ML is brackish to highly saline, being sodic waters of marine origin. Electrical conductivity of groundwater on site ranges between 2.7 to 11.7 dS/m, with a mean value of 6.1 dS/m (hydrogeologist.com.au 2020). For context, sea water has an electrical conductivity of approximately 50 dS/m, while drinking water has 0.05–0.5 dS/m. The pH of groundwater on site is generally close to neutral (hydrogeologist.com.au 2020).

Quarterly groundwater quality monitoring and sampling of the groundwater monitoring network will continue in order to provide longer term baseline data for the formulation of site-specific triggers. The groundwater quality parameters to be monitored will be developed in consideration of the DES (2017) Guideline: Model mining conditions. The monitoring and sampling will be carried out in consideration of the methodology outlined in DES (2018).

Interim trigger values have been developed using water quality data from the groundwater monitoring network over the first 18 months of monitoring (**Table 5-3**). Poor aquifer connectivity results in widespread variation in water quality even between bores within the same aquifer. Bores within different aquifers are even less similar. For these reasons, comparison between compliance and reference bores is not considered worthwhile. Instead, the recommended compliance approach outlined in DES (2021) was followed by deriving individual intra-bore control limits for each bore. Trigger values are based on 80th percentiles recorded in each bore pre-mining, with the exception of pH, which applies the 5th and 95th percentiles as trigger values. In line with the DES (2021) guidelines, where metalloid analytes have consistently returned values below the limit of reporting (LOR), the ANZG (2018) guideline values for the 95% level of species protection have been applied. For Total Petroleum Hydrocarbons (both C6-C9 and C10-C32), the LOR has been applied as the proposed trigger value, due to the ANZG (2018) guideline value (7 µg/L) being significantly lower than can currently be detected. It is recommended that once enough results above the LOR have been collected for mercury, molybdenum, selenium and Total Petroleum Hydrocarbons, site specific trigger values can be calculated. Interim groundwater quality trigger values are listed in Table E2 of the EA.

Once 24 months of groundwater quality data is available from the groundwater monitoring network, the interim guidelines will be replaced with a series of groundwater trigger levels and contaminant limits. These groundwater trigger levels and contaminant limits will be developed in consideration of DSITI (2017). The methodology and overall approach to determining site-specific groundwater trigger levels and contaminant limits has been developed to present the most accurate measure of effect on water quality, particularly in the context of the short life of the Mine, the relatively low groundwater values, and the minimal potential for groundwater impacts for the Mine. Given the impact on groundwater quality in the regional context from the many surrounding established, large-scale, long-term operations, monitoring for similar impacts from the relatively small and short-lived mining operation in the same regional context, would likely yield little meaningful result.

6.1.8 Predicted Stability

An extensive review of literature was undertaken to assess the local landscape, extent of protective cover of natural slopes, and previous studies on slope stability in the region (METServe 2020). The result of this review concludes that the final landform is expected to be stable under a post-mining land use of low-intensity cattle grazing.

The following are the main lines of evidence for this:

- the final landform is similar to the topography of surrounding areas; the maximum slope in the final landform is 15%, and 45% of the local landscape comprises grazed slopes that are naturally steeper than this;
- a 30% cover of rock applied to 10-15% gradients will maintain stability until vegetation establishes;
- studies conducted at other mines across the Bowen Basin have found that 15% gradients with only a moderate groundcover of 30-40% have very low erosion rates;
- other Bowen Basin mine sites regularly achieve vegetative cover of 30 to 100% on rehabilitated waste rock, which is more than adequate for maintaining the stability of 15% gradients; and
- even after considering the removal of vegetation expected from cattle grazing, a sufficient cover is expected to be maintained on rehabilitated sites in the long-term.

Further discussion is provided in the subsections below.

The Mine is located on the eastern foothills of the Harrow Range, sandstone ridges and escarpments that rise 100-170 m above the surrounding plains. This range and much of the neighbouring plains support remnant vegetation (open eucalypt forests) that is currently used for low-intensity cattle grazing. The Mine itself is located on cleared pasture and regrowth on relatively low slopes 1 km east of the Harrow Range. Most of the soils on site are sandy and originate from colluvial deposits from the neighbouring range.

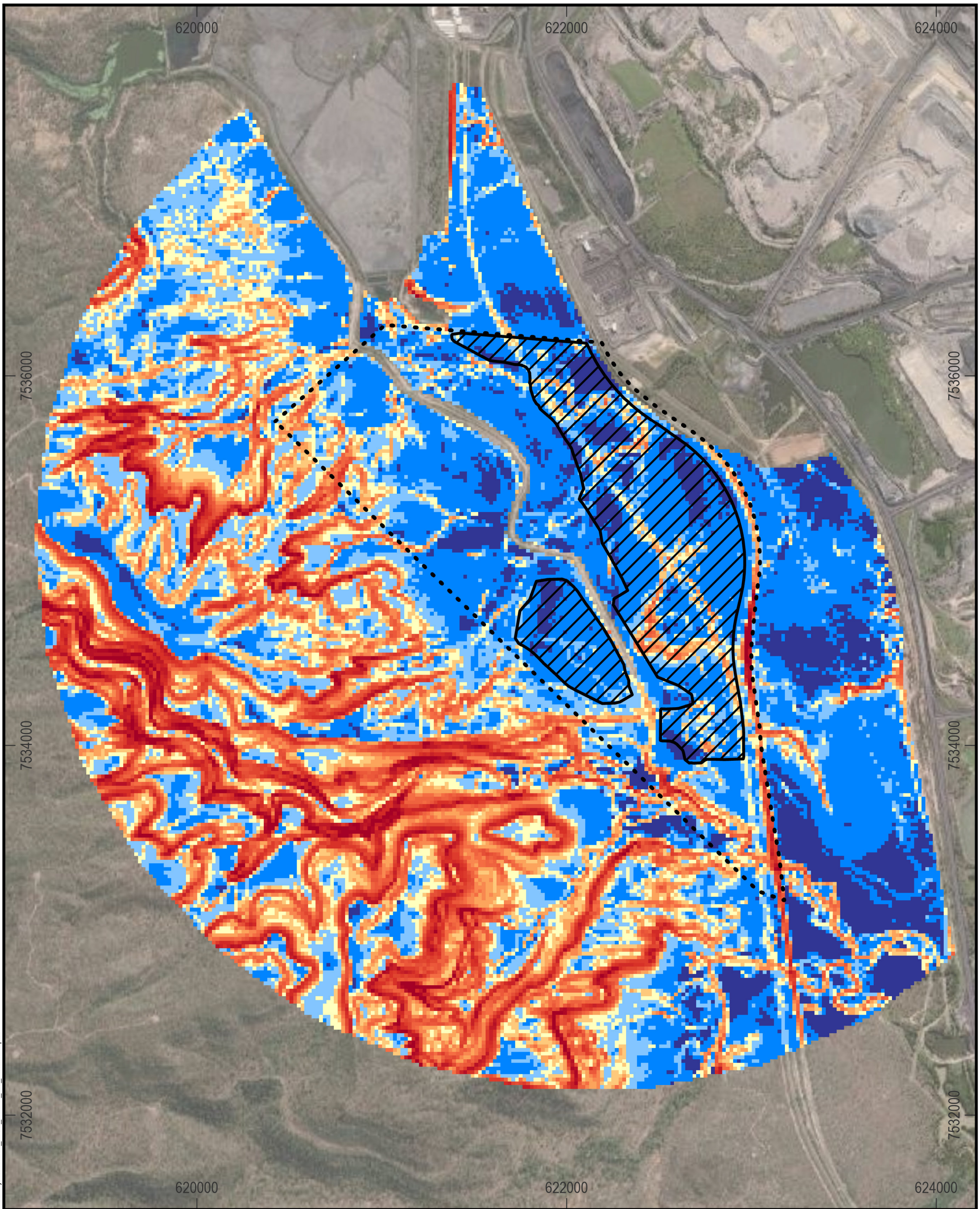
The topography of the region is shown in **Figure 6-8** and the range of natural slopes present within 3 km of the Mine is summarised in **Figure 6-9**. As can be seen from these figures, the final landform has slopes comparable to the existing natural topography, which is stable under low-intensity grazing. In summary, 45.2% of the natural landscape within a 3 km radius of the Mine is steeper than the maximum slope for the final landform.

Extent of Protective Cover on Natural Slopes

Many naturally steep slopes in the local region maintain low erodibility via a high cover of rock, vegetation and leaf litter. Ecology surveys undertaken across the area surrounding and including the Mine, measured groundcover and slope across 50 sites. All sites were maintaining stability under low-intensity grazing. This data is plotted in **Figure 6-10** and identifies that when slopes were less than 20% there was no relationship between slope and percentage groundcover. These shallow slopes ranged widely in groundcover, from 40% to 95% (average = 70%). This implies that erosion is not an important force on these shallow slopes. Once slopes have a gradient exceeding 20%, increasing groundcover is required to maintain stability, and all natural sites with a slope greater than 40% had a groundcover exceeding 95%.

This data supports the notion that a final landform with slopes ≤15% will not be at risk of erosion, provided a moderate cover of rock, vegetation and leaf litter can be established and maintained. An approximate 30% cover of rock mulch is to be applied to gradients of 10-15%. Rock is effective protection against erosion of waste slopes on newly rehabilitated mine sites (Williams 2001; Erskine & Fletcher 2013).

Rock will constitute approximately half of the protective cover required for maintaining long-term stability (based on the natural variation in cover observed in the region), while the remainder will be supplied by developing vegetation.



Legend

- ML700060
- Waste rock dump

Slope Classification

≤5%	25-30%	65-70%
5-10%	30-35%	70-75%
10-15%	35-40%	75-80%
15-20%	40-45%	80-85%
20-25%	45-50%	85-90%
	50-55%	90-95%
	55-60%	≥95%
	60-65%	

Source: Mipela GeoSolutions 2020; Vitrinite 2020, 2021; Maxar.

Vulcan Coal Mine

Natural Topography of the Local Region

0 0.5 1
Kilometers
Scale: 1:30,000 (A4)

6/12/2021

Datum: GDA94
Projection: MGA55

FIGURE 6-8

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI010_Vulcan_Complex_Project_Jupiter_section\ARCGIS\Projects\VI010_RAIL_LOOP_EA_AMEND.aprx

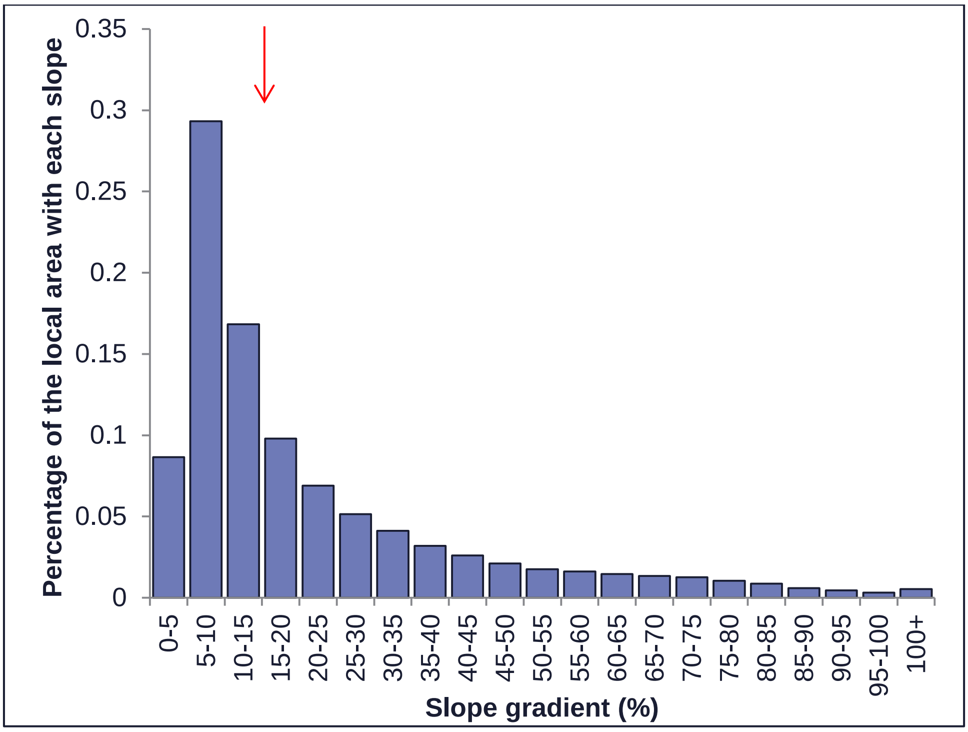


Figure 6-9 *Natural slopes within 3 km of the Vulcan Coal Mine*

The red arrow indicates the maximum slopes for the final landform of the Vulcan Coal Mine.

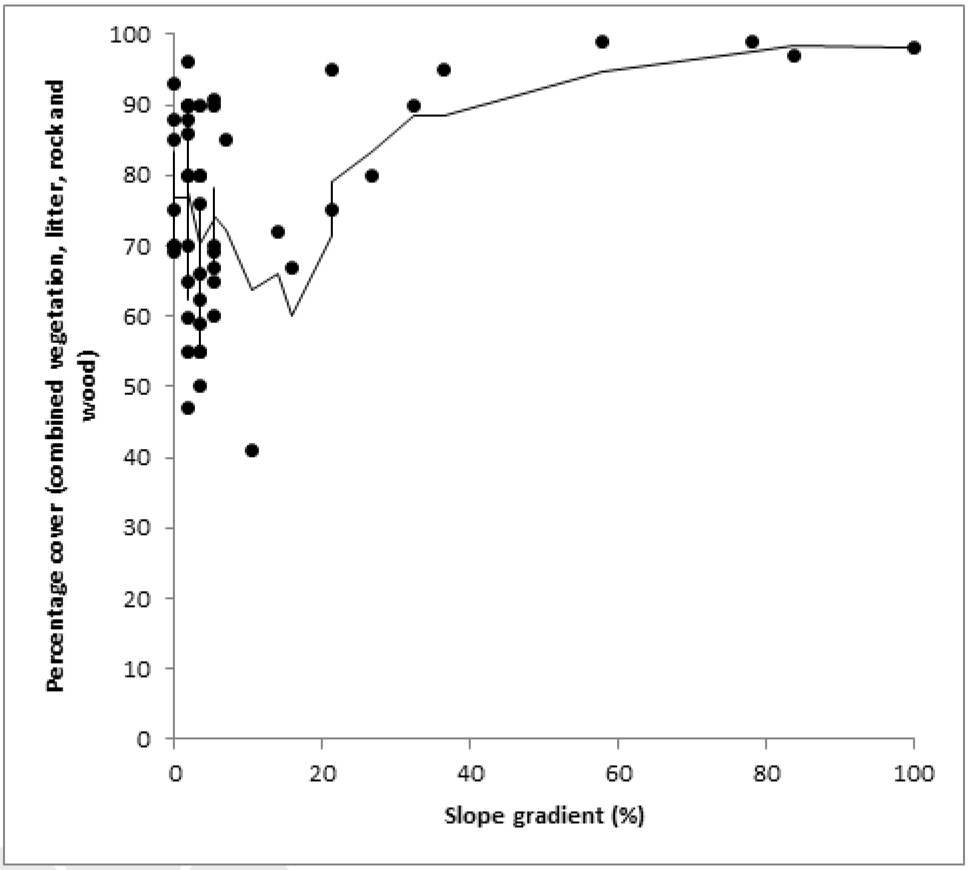


Figure 6-10 *Ground cover and slope relationship at natural vegetation sites assessed across the VCM area*

Previous Studies – Slope Stability

Other studies in central Queensland and elsewhere have investigated the stability of varying slopes on mine waste rock stockpiles and dumps. These are broadly consistent with the inferences about slope stability gained from investigating natural variation in slope and groundcover on the site.

Studies in Queensland demonstrated that any gradient exceeding 3.5%, if not protected by some sort of cover, will erode under average rainfall conditions, and extreme rainfall can erode bare slopes greater than 0.35% (Williams 2001). However, rock or vegetation cover drastically reduces erosion rates (**Figure 6-13**).

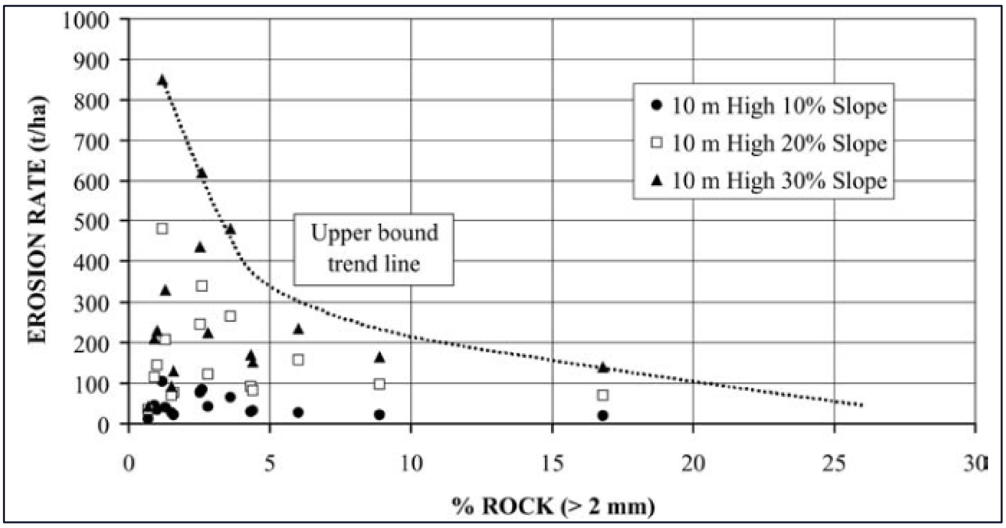


Figure 6-11 Erosion rate versus percentage rock for Bowen Basin soil materials (figure from Williams 2001)

The amount of cover required to protect slopes of various gradients from erosion has been investigated in numerous trials across Central Queensland. Carroll and Tucker (2000) found negligible differences in soil erosion for 10%, 20% and 30% slope gradients once vegetation established (**Figure 6-14**). Both Carroll *et al*. (2010) and Waters (2000) found that maintaining ground cover at 40-60% was sufficient in reducing erosion to negligible levels (<0.5 t/ha), regardless of slope. Likewise, a trial undertaken at Tarong, which simulated a heavy rainfall event on a 15% slope, found that 30-40% ground cover was sufficient to protect against erosion (Loch 2000: **Figure 6-15**).

In light of published data, the approximately 30% rock cover for slope gradients of 10-15% will provide sufficient protection for these slopes during periods of low vegetation cover (e.g., initial phase of rehabilitation, or following fire or drought). An additional vegetation cover of 10-20% (total groundcover of 40-50%) is expected to provide a highly stable landform in the long-term.

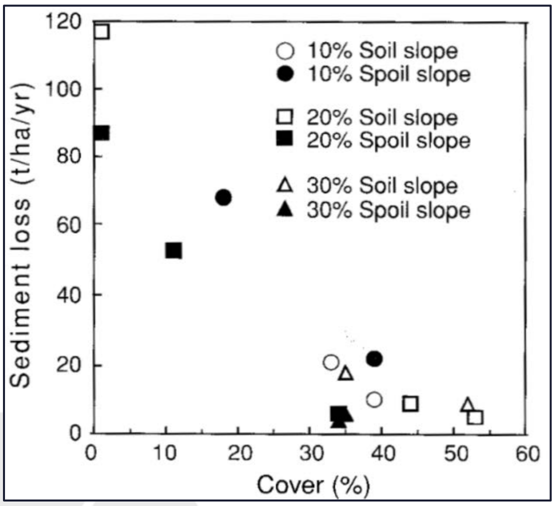


Figure 6-12 Annual sediment loss versus pasture cover on soil and spoil stockpiles at Oaky Creek (Figure from Carroll and Tucker 2000).

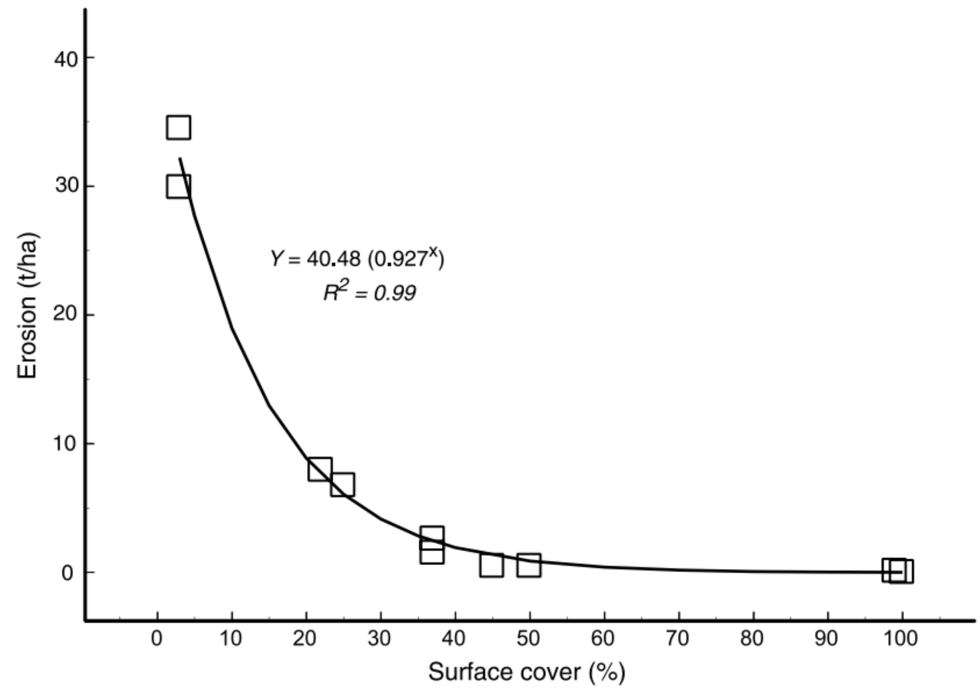


Fig. 5. Effects of surface cover on erosion from 12-m-long plots under simulated rain, King 1 area, Meandu Mine, Tarong.

Figure 6-13 Effect of surface cover on erosion (12-m plots, 15% slope, simulated rain) at Tarong (Figure from Loch 2000).

Previous Studies - Stability of Grazed Slopes

The above review of available data presents a coherent case for the selected final landform designs, having low erodibility provided they have a moderate vegetation cover of 10-20% (in addition to 30% rock cover). However, in order for the landforms to have long-term stability, they must also support the prescribed post-mine land use of low-intensity grazing. Livestock affect landform stability by removing a portion of the vegetation cover and damaging soil surface structure via trampling (Blackburn 1983). For this reason, a review of published data concerning stability of slopes under grazing was undertaken.

Comparisons between adjacent grazed and ungrazed pastures at Charters Towers found that grazing regimes prevalent at the time reduced protective cover (vegetation and leaf litter) by 0–88% (mean of 41%), depending on seasonal conditions (Scanlan *et al*. 1996). Ludwig and Tongway (2002) found this reduction in cover to be less severe; grazing led to an 11% reduction in perennial grass cover and a 29% reduction in canopy cover of trees (correlated with leaf litter cover). Taken together, this data predicts that grazing in central Queensland removes, on average, approximately 1/3 of the vegetative groundcover. When this is taken into account, a target vegetative cover (grass, herbs and leaf litter) of 15-30%, in addition to the 30% rock cover to be added to slopes, will be required in an ungrazed rehabilitated landscape to achieve a target cover of 40-50% once grazing is introduced. Given that other Bowen Basin mine sites regularly achieve vegetative cover of 30 to 100% (Carroll and Tucker 2000; Erskine and Fletcher 2013), a pre-grazing target of 15-30% vegetative cover is highly likely to be achieved at the Mine.

As summarised above, cattle currently graze natural slopes with gradients well in excess of 15% without compromising the stability of these slopes. However, the steepest slopes are somewhat protected from grazing because cattle prefer not to graze such areas (Mueggler 1965; Ganskopp & Vavra 1987). Nevertheless, gradients of 15% are well within the range of slopes utilised by cattle for grazing (Ganskopp & Vavra 1987), and the landform for the Vulcan Coal Mine is consistent with low-intensity grazing.

Geotechnical Assessment

Limit equilibrium analyses were performed by Blackrock Mining Solutions (2020) to determine the overall slope stability in terms of a Factor of Safety (FoS), which is a commonly employed measure in slope stability analysis to determine the likelihood of slope failure. The FoS is generally a measure of driving forces versus resisting forces in a system. FoS values > 1 are indicative that a system is likely to be stable, while an FoS value of 1.5 is considered to be the generally accepted value for long-term slope design.

The following methodology and criteria were used for the assessment:

- circular failure analyses using the auto-refine search algorithm and the general limit equilibrium method for spoil failures; and
- a basal saturated spoil layer of approximately 5 m thickness was assumed for final landform slope stability assessment.

Limit equilibrium analyses were assessed in terms of a circular failure mechanism acting through the unsaturated, and saturated Category 2.5 spoil material, for in-pit and ex-pit WRD final landforms, respectively.

Initial analyses returned critical Factor of Safety (FoS) values of 3.88 and 5.10 for the in-pit WRD and ex-pit WRD final landforms, respectively. It was concluded from the limit equilibrium analyses that the final landform design exceeds the minimum FoS of 1.5 for long-term stability, and is therefore acceptable from a geotechnical perspective. Minor amendment of the height and volume of the ex-pit WRD has since occurred, however the final landform has been assessed as having an insignificant influence on the FoS value, as the slope design has not been altered. Similalrly the reconfiguration of the ex-pit WRD is anticipated to be insignificant and the slope angles and slope lengths have not changed, due to the berm and batter configuration. As such, Vitrinite is confident that the FoS value for the in-pit and ex-pit WRD landforms remains in excess of the minimum value of 1.5 required for long term landform stability.

Erosion Assessment

While the above literature review suggests that the final landform is highly likely to be stable, no trials have been undertaken on the specific soil units to be used for rehabilitation at the VCM. Given the sandy texture and dispersive subsoils, a soil erosion assessment was undertaken by AARC (2021) to investigate the likely erosion rates to be expected on the final landform, in relation to background rates in the local region. The key results of this assessment are described in detail below.

The erosion assessment applied the Revised Universal Soil Loss Equation (RUSLE) to estimate the average annual soil loss caused by hillslope and rill erosion, based on the physical characteristics of the soil, slope and cover. This equation is:

$$A = R \times K \times LS \times C \times P$$

Where:

- A is the predicted rate of soil loss in tonnes per hectare per year;
- R is the rainfall erositivity factor, based on the total erosive power of storms during an average eyar and is dependent on local weather conditions;
- K is the soil erodibility factor, which has been specifically derived for the Crocodile, Limpopo and Zambezi soil management units;
- LS is the slope length-gradient factor, which describes the combined effect of slope length and gradient on soil loss;
- C is the cover and management factor, which compares the protective effect of vegetation and other soil covers to a standard fallow plot; and
- P is the conservation or support practice factor, which reflects the effects of management practices such as contouring or strip cropping, compared to straight-row farming up-and-down slope.

The K factor was calculated according to the methodology described by Lu *et al.* (2001), which uses the equation:

$$K = 2.77(100\ P_{125})^{1.14}(10^{-7})\ (12\text{-}20C) + (3.29 \times 10^{-3})\ (PP\text{-}3)$$

Where:

- P_{125} is the percentage of soil clay, silt and sand particles less than 0.125 mm diameter;
- OC is the organic carbon content; and
- PP is the soil profile permeability class.

An R factor of 1,729.45 MJ/mm per ha/h/y was chosen, based on imput R factor datasets available for use in the RUSLE data, available from the Queensland Spatial Catalogue. A P factor of 0.8 has been adopted, based on undisturbed loose soil to a depth of 0.3 m. Slope characteristics for the pre-mining landscape within each soil management unit were investigated with LiDAR imagery. The 10th percentile, median and 90th percentile slopes, and the corresponding slope lengths were used to determine the LS factor for each soil unit. The C factor was based on field-collected estimates of vegetative, rock and wood debris cover within each soil unit.

Due to the many assumptions and inputs for each of the factors, the erosion estimates are best used for comparative purposes (e.g., comparing different management measures or cover options), rather than for providing absolute estimates of erosion. Likewise, the equation predicts long-term annual soil loss, and erosion rates measures over shorter time scales may vary drastically from the estimates.

The estimated background (pre-mining) erosion rates for the three local soil management units within 3 km of the Vulcan Coal Mine are presented in **Table 6-3.**

Table 6-3 Estimated background erosion rates

Soil Unit (slope percentile)	C	Gradient (%)	A (t/ha.y)
Crocodile: 10th percentile	0.015	4	0.4
Crocodile: median	0.015	12	1.7
Crocodile: 90th percentile	0.015	39	7.2
Limpopo: 10th percentile	0.075	1	0.6
Limpopo: median	0.075	3	1.8
Limpopo: 90th percentile	0.075	14	11.2
Zambezi: 10th percentile	0.005	2	0.2
Zambezi: median	0.005	8	1.2
Zambezi: 90th percentile	0.005	38	9.7

These background erosion rates are lower than those calculated by Lu *et al.* (2003), who found erosion rates of 10-50 t/ha.y for the vicinity of the Mine. Lu acknowledges that their full erosion potential may not be realised for some areas of Queensland and northern Australia because of the high percentage of rock cover and shallow soil depths. As the estimates presented in **Table 6-3** incorporate rock cover as part of the C factor, these are probably more representative than those of Lu.

A similar approach was then applied to the post-mining landform, in order to determine whether the erosion rates are comparable to background levels. K and R factors remained the same as for the background assessments. The P factor was 0.9, based on contour ripping of the slopes. A slope length of 100 m was used for the calculations of LS, and a range of gradients were applied.

The resulting erosion estimates are presented in **Table 6-4**. This reveals that most surfaces of the final landform (gradient ≤ 5%) will have erosion rates resembling background levels provided these possess 50% or more vegetative cover. Batters of the waste rock dumps (with 10-15% gradients) will have erosion rates resembling the 90th percentile of background rates when these have 50% grass cover in addition to 30% rock cover.

When the grass cover increases to 70% (combined with rock cover), erosion rates are expected to be close to, but slightly above, median background levels. Given that these batters will comprise the steepest 15% of the total ML, comparison with the 90th percentiles of the pre-mining slopes is appropriate. Overall, this erosion assessment confirmed that, provided rehabilitation milestone criteria are achieved, the final landform is expected to erode at a similar rate to the surrounding landscape.

Table 6-4 Predicted soil erosion rates of the Limpopo soil management unit as a factor of slope and cover

Management	C	Gradient (%)	A (t/ha.y)
Bare ground (pre-vegetation)	1	1	10.27
Bare ground (pre-vegetation)	1	5	69.34
Bare ground (pre-vegetation)	1	10	167.96
30% rock mulch (pre-vegetation)	0.325	10	54.59
30% rock mulch (pre-vegetation)	0.325	15	99.58
30% grass cover	0.325	1	3.34
30% grass cover	0.325	5	22.54
30% grass cover	0.325	10	54.59
30% rock mulch with 30% grass cover	0.1	10	16.8
30% rock mulch with 30% grass cover	0.1	15	30.64
50% grass cover	0.15	1	1.54
50% grass cover	0.15	5	10.4
50% grass cover	0.15	10	25.19
30% rock mulch with 50% grass cover	0.05	10	8.4
30% rock mulch with 50% grass cover	0.05	15	15.32
70% grass cover	0.05	1	0.51
70% grass cover	0.05	5	3.47
70% grass cover	0.05	10	8.4
30% rock mulch with 70% grass cover	0.018	10	3.02
30% rock mulch with 70% grass cover	0.018	15	5.52

Rows shaded dark grey possess slopes and covers that meet rehabilitation targets defined by this PRC Plan

Quality Assurance and Control

The final landform will be surveyed following its completion and as-constructed plans drawn, to check compliance with the design plan. These surveys constitute a rehabilitation milestone (**Section 9.1.3**).

Monitoring of the final landform will be integral to the early detection of erosion and will allow for early intervention. **Section 9.1.8** details how erosion and land stability will be monitored.

6.1.9 Infrastructure to be Retained

Vitrinite has entered into an agreement with BMA to hand back to BMA most of the infrastructure within the northern infrastructure area of the Mine. Infrastructure contained within this area, which is to be retained for BMA includes:

- field offices;
- workshop;
- warehouse;
- communications tower;
- car parks; and
- access roads.

In addition, one sediment dam, one mine water dam and associated topsoil stockpiles will be retained, because these service the infrastructure to be retained (dams) or provide a valuable resource for potential future rehabilitation of retained infrastructure areas (topsoil stockpiles).

Due to the differing post-mining land use for this northern infrastructure area, compared to the rest of the Mine, it has been assigned its own rehabilitation area (RA6).

Likewise, the following are infrastructure that existed on site prior to the Mine that will remain unaffected by the Mine:

- flood management infrastructure for neighbouring mining operations (levee wall and adjacent farm dam); and
- the railway line along the eastern edge of the ML.

These have only been included within the Mine disturbance footprint to allow for maintenance works, if required. As these will not be rehabilitated, they have not been assigned their own rehabilitation area.

6.2 Revegetation

6.2.1 Revegetation Objectives

The following are the revegetation objectives for the site, consistent with the PMLUs:

- to ensure rapid establishment of vegetation on exposed soil in order to limit erosion over the early stages of rehabilitation;
- to establish a pasture with native and exotic grass species that is sufficiently dense in the long term to protect the soil surface from erosion and support low-intensity grazing;
- to establish a moderate density of locally native trees and shrubs that provide shade for livestock and sufficient cover for the vulnerable Squatter Pigeon;
- to establish a moderate density of Koala food trees; and
- to limit invasion by declared weed species to levels that are similar to those on site prior to mining or representative of adjacent areas.

All the above objectives apply to rehabilitation areas RA2 (the In-pit WRD), RA3 (infrastructure areas) and RA4 (dams and sediment ponds). However, due to limited subsoil availability, no trees are proposed for RA1 (the ex-pit WRD). As a result, the rehabilitation of Squatter Pigeon and Koala habitat is not an objective for rehabilitation area RA1. No revegetation is to take place in rehabilitation areas RA5 (Saraji Road) or RA6 (infrastructure to be retained).

6.2.2 Key Flora Species

The flora species to be planted in disturbed areas vary depending on the topsoil type used at each site. The flora species selected represent the majority of dominant species in regional ecosystems that grow naturally on each soil management unit (**Table 6-5**). The Crocodile Soil Management Unit won't be disturbed as part of the Mine; however, the dominant species that grow on it have been considered for rehabilitation activities on other soil units, where species are known to tolerate alternative soil conditions.

Of the species listed, approximately half are currently commercially available from suppliers such as Nindethana Seed Service and Seed World Australia. It is therefore expected that much of the seed used for rehabilitation efforts on site will require local collection by contractors. This will also have the effect of ensuring a good degree of local provenance of seed stock is utilised in revegetation works.

Table 6-5 Key flora species found pre-mining on each soil management unit

SMU	Reference RE	Dominant Trees	Dominant Midstorey	Dominant Grasses
Crocodile	11.10.3, 11.10.13.	*Acacia shirleyi, Corymbia aureola, Corymbia citriodora, Corymbia trachyphloia, Eucalyptus crebra.*	*Acacia bancroftiorum, Acacia burdekensis, Acacia flavescens, Alphitonia excelsa, Erythroxylum australe.*	*Alloteropsis cimicina, Cleistochloa subjuncea, Cymbopogon refractus, Digitaria diminuta, Eriachne obtusa, Melinis repens**, Paspalidium caespitosum, Themeda triandra, Urochloa piligera.*
Limpopo	11.5.9, 11.5.3, 11.10.7.	*Corymbia clarksoniana, Eucalyptus crebra, Eucalyptus melanophloia, Eucalyptus populnea,*	*Acacia burdekensis, Acacia flavescens, Alphitonia excelsa, Cassia brewsteri, Erythroxylum australe, Grevillea parallela, Grevillea striata, Melaleuca nervosa, Petalostigma pubescens.*	*Alloteropsis cimicina, Aristida calycina, Bothriochloa bladhii, Bothriochloa pertusa**, Cenchrus ciliaris**, Chrysopogon fallax, Eragrostis sororia, Eriochloa crebra, Heteropogon contortus, Perotis rara, Setaria surgens.*
Zambezi	11.3.2, 11.3.7, 11.3.25.	*Corymbia clarksoniana, Corymbia tessellaris, Eucalyptus camaldulensis, Eucalyptus crebra, Eucalyptus populnea, Melaleuca leucadendra.*	*Alphitonia excelsa, Bauhinia hookeri, Cassia brewsteri, Ficus opposita.*	*Bothriochloa ewartiana, Bothriochloa pertusa**, Cenchrus ciliaris**, Megathyrsus maximus**, Urochloa mosambicensis**.*

*Exotic pasture plants common on each soil prior to mining.

6.2.3 Species of Conservation Significance

Where this is consistent with a PMLU, habitat for threatened fauna inhabiting the Mine area is to be incorporated into the landscape. The following subsections detail how this will be achieved for each species of conservation significance potentially impacted by the Mine.

Koala

Habitat for Koalas can be incorporated into the PMLU of "low-intensity cattle grazing". This will be achieved by ensuring that trees established to provide shade for livestock are also food trees for Koalas. The tree species to be planted (via inclusion in the seed mix) vary by soil type, as shown in **Table 6-6**.

Table 6-6 List of Koala food trees suitable for planting on each soil management unit

Soil Management Unit	Suitable Food Trees
Limpopo	*Eucalyptus populnea, Eucalyptus crebra.*
Zambezi	*Eucalyptus camaldulensis* (on creek banks), *Eucalyptus populnea, Eucalyptus crebra.*

Squatter Pigeon

Habitat for Squatter Pigeons can be incorporated into the PMLU of "low-intensity cattle grazing" on all soil types contained within the ML, with the exception of the Crocodile soil management unit (rocky, sandstone-derived soils provide unfavourable foraging substrates).

Squatter Pigeons have two chief habitat needs that require restoration in rehabilitation sites: (1) a diversity of native and introduced pasture grasses and herbs (on which to feed) in the understorey; and (2) a minimum tree cover that generates a Normalised Differential Vegetation Index of at least 0.125 (measured across a 1-ha cell in the late dry season). As these habitat features are generally co-located in productive pastures (related to understorey productivity and diversity) and sites with Koala habitat (a moderate tree cover), a PMLU of "low-intensity grazing", with a low-moderate tree cover for livestock shade and Koala habitat is likely to provide habitat for Squatter Pigeons with no additional management inputs.

Short-beaked Echidna

Short-beaked Echidnas are habitat generalists that are likely to recolonise rehabilitated mine sites provided these contain (1) sufficient vegetation cover (e.g. pasture, woody vegetation) for protection; and (2) populations of termites and ants. It is expected that these habitat needs will be met by any rehabilitated sites that have a suitably dense and productive pasture cover to fulfil completion criteria pertaining to sustaining a PMLU of "low-intensity grazing". Consequently, no additional management inputs are required to facilitate recolonisation of rehabilitated sites by the Short-beaked Echidna.

6.2.4 Top-Soil Management

Topsoil is the most valuable soil horizon for post-mining rehabilitation. Topsoil contains a seed bank, micro-organisms and nutrients necessary for plant growth. In contrast, many of the subsoils on site are sodic and prone to dispersion if not managed correctly (AARC 2021). The soil characteristics of each soil management units present on site (see **Section 1.2.6**) were examined to determine the maximum depth to which suitable topsoil material should be stripped for stockpiling and/or rehabilitation, and to determine soil management requirements, in order to conserve an optimal growth medium for plants **Table 6-7**).

Table 6-7 Maximum topsoil stripping depths for each soil management unit

Soil Management Unit	Stripping Depth (m)*	Qualities
Crocodile	0.1	The Crocodile SMU is limited in its suitability as a topsoil medium where an improved pasture postmining land use is to be implemented. The land within this SMU has uneven rocky terrain which may introduce accessibility challenges for earth-moving machinery. Given this, the total volume of topsoil able to be sourced from this SMU may be reduced. The soil is very strongly acidic at the surface (pH 5.4) remaining so with depth. pH values such as these have potential to limit soil nutrient content and thus plant growth.
Limpopo	0.3	Topsoil is favourable for plant growth. Topsoil has a low nutrient-holding capacity and will be improved with fertiliser when planting. These sandy soils may be also be prone to erosion and will not be used on slopes exceeding 3% without appropriate measures to manage stability. Subsoils are susceptible to dispersion.
Zambezi	0.3	The Zambezi SMU is suitable for most rehabilitation purposes to a depth of 0.3 m. This surface layer has suitable pH, low salinity and is not sodic. Below this depth, the soil becomes strongly sodic with an ESP of 18.5% and is therefore at high risk of dispersion and subsequent erosion.

*Recommendations from AARC (2021).

Topsoils and subsoils are to be stored separately. Likewise, soils from different soil management units are to be managed separately. Where practicable soils should be directly placed in prepared rehabilitation areas rather than stockpiled. This conserves a viable seedbank, promotes revegetation and limits rehandling.

Topsoil Stockpiling

Where stockpiling of topsoil is required, the following measures for soil management will be implemented where relevant and practicable, to reduce the risk of soil degradation and improve the chances of rehabilitation success:

- topsoil stockpiles are to be less than 2 m high and be contoured and positioned in a manner that encourages water drainage and discourages erosion. Grass and herbaceous plants germinating from the soil seed bank are to be maintained as a protective cover for stockpiles;
- if stockpiles fail to develop a natural grass cover, they are to be seeded with a fast-growing, non-invasive, commercially available sterile grass species. Recommended species are listed in Appendix 4 of the *Soil Conservation Guidelines for Queensland* (DSITI 2015)*;*
- if there is a risk of a grass cover not establishing voluntarily, stockpiles will need to be ripped and seeded with a quick establishment pasture. Topsoil should ideally be stockpiled for the minimum time. Studies have shown that most deterioration occurs within the first year (Keipert *et al*. 2005);
- topsoil should be stockpiled for the minimum time practicable. Studies in the Hunter Valley have shown that the majority of deterioration occurs within the first year (Keipert *et al.* 2005);

- stockpiles are to be monitored annually for weeds and control measures implemented to prevent weed colonisation on the stockpiles;
- where soil must be stockpiled for extended periods (>2 years), soil testing will be considered before use for rehabilitation purposes; and
- topsoil stockpiles are to be located in areas fenced to exclude livestock.

Topsoil Placement

The disturbance area within the Mine area suggests that the topsoil resource will be sourced predominantly from the Limpopo SMU. The Limpopo SMU is characterised as having moderate organic matter content and a high sand content and may therefore be at risk of erosion-induced movement (AARC 2021). For this SMU, establishing a sufficient vegetative cover to mitigate erosion risk is important, particularly as rehabilitated slopes increase. To create a favourable environment for vegetation growth, topsoil from the Limpopo SMU will require application of one or more of the amelioration measures outlined in the following sub-sections.

Where possible, placement of topsoil at a minimum thickness of 0.25 m will be undertaken for rehabilitation areas to create a growth medium of sufficient depth to hold water and support revegetation.

For all rehabilitated areas, contour ripping and/or ploughing of the landform after topsoil placement will be undertaken to key the topsoil and subsoil layers together, and to improve seed germination conditions.

Placement of armour rock or mulch cover to assist in stabilising the landform and reducing topsoil loss should be considered for slopes above 10%.

Topsoil amelioration

Organic matter application

Sandy soils such as the Limpopo SMU, usually have poor soil structure, low moisture retention and low available nutrient concentrations. The addition of organic matter to such soils helps to bind soil aggregates together and resist physical breakdown, improving soil structure; in turn increasing soil moisture retention and re-incorporating nutrients back into the soil. Where possible, topsoil should be stripped with its existing ground cover vegetation and, if subject to stockpiling, relocated with its cover crop vegetation.

Depending on availability, additional organic matter (such as mulches, manures, or compost), may be incorporated into the topsoil. Organic materials incorporated into the topsoil will increase organic carbon levels, providing more exchange sites for necessary cations, increase water holding capacity, and ensure less organic matter is oxidised into carbon dioxide and nitrous oxide or reduced into methane (Smith *et. al*. 2018).

Application rates will vary depending on mulch type. Straw mulch should be applied at a rate of 5 t/ha (NSW Government 2015). Note that fresh mulch should not be used in acidic soils. Manure should be incorporated at rates of 5-30 t/ha (depending on the type of manure) (MLA n.d.). If available, compost can be applied at 70-150 t/ha (Kelly 2006).

Fertiliser application

Fertilisers may be utilised to increase nutrient concentrations in soil. As the Limpopo SMU is moderately acidic (pH of 5.5) care must be taken when fertilising, as some fertilisers (such as ammonium-based fertilisers) can have an acidifying effect on the soil. Were this to occur, lime applications would be required to mitigate the fertiliser's acidifying effects.

A calcium nitrate-based fertiliser such as calcium ammonium nitrate (15 to 27% N) is suitable for this application as it has near neutral effect on soil pH and can be used to increase both nitrogen and calcium levels in the soil. An application rate of 25-50 kg N/ha should be sufficient for successful vegetation establishment (CRDC 2020). This could be complemented with an application of sulphate of potash (41 % K) to increase potassium levels in the soil. This fertiliser would also increase sulphur and can be drilled with seeds (unlike other potassium fertilisers such as muriate of potash which can damage seed germination). Typical application rates of potassium for pastures in light soils are of around 20 kg K/ha (Department of Primary Industries n.d.).

Alternatively, urea (46.7% N) may be applied as a nitrogen fertiliser (usually the most economical nitrogen fertiliser), but this would need to be applied in combination with lime (calcium carbonate), to overcome the acidifying effects of urea. A rate of 150 kg/ha of urea is recommended for soils in low rainfall areas where soil nitrate content is below 3 mg/kg. Limestone application rates should be around 1 t/ha of lime.

It is expected that 1 t/ha of lime (incorporated in the first 10 cm of soil) will increase the pH of sandy soils by 0.57 units (Department of Primary Industries n.d.). Follow up pH testing will be undertaken to evaluate the need to add more lime – lime would be added initially at small doses and then at gradually increasing application rates as necessary.

Phosphorus application rates would be carefully determined, as many Australian native species are adapted to low phosphorus concentrations in the soil. Application rates of 10-20 kg P/ha have been suggested for grazing pastures (Victoria Government 2013) and mine restoration (Daws *et al.* 2013). To achieve this, single superphosphate (8.8% P) could be applied, which would also supply sulphate. Note this fertiliser should not be blended with urea.

After application, soil ameliorants will be incorporated into the soil to approximately 0.3 m (for example by using a scarifier or ripper tynes) so they are not lost by wind or washed away by rainfall. Ideally, after vegetation establishment (after 6 to 12 months since sowing) soils will be re-tested to determine if any follow-up application of ameliorants is required.

Besides using fertilisers, incorporating native leguminous forbs such as *Rhynchosia minima* (Rhynchosia) and *Glycine tomentella* (Hairy Glycine) to the seed mix is a natural method of increasing soil nitrogen levels due to the nitrogen fixing capabilities of legume species. This could establish natural nitrogen cycling within the topsoil resulting in long-term improvements in soil fertility and self-sustaining vegetation.

6.2.5 Subsoil Management

Most subsoils within the Mine area (with the exception of the Crocodile SMU) are dispersive and must be managed carefully to reduce the risk of erosion and sedimentation of downstream waterways. Most of these subsoils do not provide a favourable substrate for plant establishment, excluding the use of grass covers as an erosion protection measure. Instead, the following actions, where practicable, are to be taken to manage the storage of subsoils:

- subsoil to be directly placed into its final position rather than stockpiled as a priority;
- subsoil stockpiles to be contained, to ensure that any eroded material is retained within the pit and not released into waterways;
- Subsoil stockpiles should not to be placed on slopes greater than 3%, and the stockpile surface should be levelled to reduce the speed of any run-off; and
- Sediment control infrastructure is to be constructed around any stockpile areas.

Where dispersive subsoil material is to be utilised in rehabilitation works, it will be tested and, if required, treated with gypsum (calcium sulphate) prior to sowing/planting.

Dispersive soils generally have low porosity, low air movement and therefore low oxygen availability for plants. They also have slow water infiltration, which can lead to waterlogging. Gypsum application rates for moderately to severely dispersive soils usually range from 2.5 to 5 t/ha depending on site-specific characteristics (DPIRD 2020).

Given the high exchangeable sodium percentage (21.5%) and low pH present in the Limpopo subsoil, an application of 5 t/ha of gypsum is recommended (AARC 2021). Gypsum will cause soil particles to flocculate, thereby improving soil structure, increasing water and plant root penetration into the soil. Irrigation will also be important where required. These soils should be well irrigated so that sodium is leached down the soil profile. In contrast, low amounts of water in the soil can result in sodium moving up the soil profile by evaporation.

Outside of the Mine area, the subsoil characteristics of the Crocodile and Kei SMUs do represent an opportunity for use as a soil resource, given their non-sodic nature throughout the depth profile.

If available as a soil resource, consideration will be given to incorporating ameliorants to address the pH limitations of these materials and improve their potential to support a rapid and successful rehabilitation outcome.

6.2.6 Revegetation Approach

Soil Spreading

A growing medium of approximately 250 mm of topsoil will be placed over the deposited and shaped subsoil/waste-rock (see **Section 6.1.3**). Organic material harvested from the mine footprint will be incorporated into the topsoil, where practicable.

Following the spreading of topsoil, rehabilitated areas are to be ripped to a depth of 0.4 to 0.5 m. Ripping reduces compaction from heavy machinery, encourages the infiltration of water and reduces the risk of erosion.

Spread and ripped soil should have a rough surface with abundant troughs and banks, which help to resist erosion, improve infiltration and retain leaf litter. In accordance with the results of trials elsewhere in the Bowen Basin (Williams 2001), a rock cover (sourced from waste rock) is to be placed upon topsoil on slopes greater than 10% (equivalent to 6°). This rock is to constitute approximately 30% of the soil cover, to convey optimal erosion protection during the initial stages of vegetation establishment (Williams 2001). Further detail on the use of rock cover and establishment of grass cover is outlined in **Section 6.1.8**.

Where practicable, topsoil placement will occur in October-November, shortly before the commencement of the wet season. Soil operations are to be undertaken when the soil is dry or damp, but not saturated. Manual handling of wet soils is logistically difficult, damages the soil’s structure and leads to compaction.

Fertiliser and Soil Amelioration

Most of the topsoils within the Mine area are nutrient-deficient, and the addition of an initial fertiliser application at the time of planting will facilitate plant establishment and growth. A controlled-release fertiliser with the following nutrient concentrations is to be applied at the time of seeding as required:

- Nitrogen: 7.0-25.0%;
- Phosphorus: 0.3-2.0%; and
- Potassium: 4.0-15.0%.

Application rates should follow the manufacturer’s guidelines, but are expected to be 100-500 kg/ha, depending on nutrient concentrations. Further detail on specific application rates of fertilisers if required for amelioration of different anticipated conditions is also outlined above.

Seeding

Seeding operations shall not take place until the prepared area has been constructed in accordance with the specified requirements. Ideally, sowing should take place within one week of topsoil placement and ripping. Rainfall between cultivation and sowing results in the partial collapse of furrows and crusting of the soil surface. Sites may need to be re-ripped prior to sowing if rain occurs following the initial treatment. Seeding operations are not to be undertaken on days:

- when wind speeds exceed 15 km/h;
- where the surface is fully saturated;
- when temperatures exceed 37°C; and
- during or after heavy rain, or when heavy rain is forecast.

The seed mix to be applied varies by soil management unit (**Section 6.2.7**). However, all seed mixes are to include a combination of sterile grass varieties (e.g., Silk Sorghum *Sorghum* spp. and/or Japanese Millet *Echinochloa esculenta*)—which act as cover crops—native species and pasture species.

A fast-establishing sterile annual cover crop is recommended to be included in the seed mix. This will help to rapidly establish ground cover and minimise topsoil loss. This approach will also help to supress weeds and assist in restarting biological processes in the soil, creating a favourable micro-environment for the germination and emergence of the native seeds.

Considering the sandy nature of the Limpopo topsoil, it is recommended that a cover crop is sown at a high seed density, of approximately 30 kg/ha. This should provide a rapid ground cover and assist in achieving soil stabilisation. The seed mix is to be uniformly blended with a bulking agent such as dry sand or dry, fine sawdust at a rate of 1 part seed to 5 parts bulking agent by volume. This mix is then combined with fertiliser on the day of planting and distributed evenly across the planting area. Seed may be pre-mixed and stored with the bulking agent for several months; however, fertiliser should not be stored with seed for longer than necessary.

Hydromulching

Where deemed appropriate on the steepest banks that are more disposed to potential erosion, Hydromulching will be implemented. Hydromulching will be undertaken with a slurry of water, seed, fertiliser, mulch and a binder to contribute to ideal growing conditions and rapid vegetation through the stabilisation of the landform, incorporation of organic matter and nutrient addition.

Planting of Container Stock

Some species of trees and shrubs (especially those with fleshy fruits, such as *Erythroxylum australe* and *Carissa ovata*) recolonise poorly from directly sown seed, and are best reared in a nursery environment and planted as one-year-old tube stock. Monitoring of previous years progressive rehabilitation on site (i.e. detecting the failure of certain species to germinate in situ) will inform which species should be prioritised for container stock in ongoing rehabilitation campaigns.

Container stock is to be hand-planted in clusters of 5-10 individuals, each seedling spaced approximately 2 m apart. The planting of container stock is to take place within five days of heavy rain (>40 mm over a 24 hr period), when soil moisture levels are high. The spacing between clusters will depend on the density of other species that successfully germinate, but planting densities of up to 100 trees per hectare may be required where seed germination is particularly poor.

All container stock is to be sun-hardened for at least one month prior to planting.

Planting holes are to be excavated to a minimum diameter equivalent to twice the diameter of the plant container and to a depth equivalent to the height of the plant container. The material at the bottom of the hole is to be broken up to a depth of 50 mm. The sides of the hole are to be roughened. The top of the plant's root ball is to be level with the surrounding ground. The topsoil is to be tamped down to create a slightly depressed basin surrounding the plant, without exposing the root system.

Fencing

Livestock-proof fencing is to be installed around all revegetated areas at or prior to the completion of seeding and planting. Rehabilitated areas are to be maintained free of livestock until these sites are sufficiently established for the commencement of grazing.

6.2.7 Seed Mix

Seed is to be sourced from a combination of local collections and commercial suppliers. Local seed collections will begin at least two years prior to the commencement of revegetation, to allow for the potential of unfavourable weather to cause the failure of seed production in any one year. Seed is to be stored for a maximum of five years prior to use, and regular collections/purchases will be required throughout the Mine.

The preliminary seed mixes that have been planned for each soil management unit are shown in **Table 6-8**. These have been developed based on the dominant species of trees, shrubs and grasses present within each soil management unit within the Mine area prior to mining. Adjustments to these seed mixes will be made, pending seed availability and the performance of the earliest rehabilitation efforts on site. It is expected that some of the species listed will display poor recruitment via direct seeding, and such species will be removed from the seed mixes and planted as container stock instead.

The value of Buffel Grass (*Cenchrus ciliaris*) for mine rehabilitation in Queensland is debated. This exotic pasture species is a rapid coloniser of disturbed ground and is effective for controlling erosion. Among earlier rehabilitation efforts in the Bowen Basin, Buffel Grass was the dominant pasture species planted (Grice *et al.* 2012). However, it is only moderately palatable to cattle and aggressively outcompetes other plant species, including more valuable pastures (Grice *et al.* 2012; Erskine and Fletcher 2013). Buffel Grass is considered the likely cause of a marked decline in species diversity over time at other mine rehabilitation areas within the Bowen Basin (Erskine and Fletcher 2013). This declining diversity jeopardises the stability and functionality of the rehabilitated landforms.

Due to the risks associated with Buffel Grass (*Cenchrus ciliaris*) and the likelihood that it will establish naturally, it is not included within seed mixes applied at the Mine, despite being dominant on some soil management units pre-mining. This approach aims to replicate the pastures occurring on site prior to mining and establish a diverse mix of native and exotic pasture species that have high pasture productivity and environmental value (i.e., can sustain the PMLUs).

Table 6-8 Seed mixes for each Soil Management Unit (SMU) for low-intensity grazing PLMU

SMU	Trees and shrubs	Rate (kg/ha)	Pasture grasses and legumes	Rate (kg/ha)	Sterile cover crop	Rate (kg/ha)	Total Rate (kg/ha)
Limpopo*	*Acacia burdekensis*	0.1	*Alloteropsis cimicina*	1	Japanese Millet - sterile	15	
	Acacia flavescens	0.05	*Aristida calycina*	1	Silk Sorghum	15	
	Alphitonia excelsa	0.1	*Bothriochloa bladhii*	1			
	Cassia brewsteri	0.05	*Bothriochloa pertusa*	1			
	Corymbia clarksoniana	0.2	*Chrysopogon fallax*	1			
	Eucalyptus crebra	0.15	*Eragrostis sororia*	0.5			
	Eucalyptus melanophloia	0.15	*Eriochloa crebra*	0.5			
	Eucalyptus populnea	0.15	*Heteropogon contortus*	1.5			
	Grevillea parallela	0.05	*Perotis rara*	0.3			
	Grevillea striata	0.05	*Setaria surgens*	1			
	Melaleuca nervosa	0.05	*Stylosanthes scabra*	0.5			
	Petalostigma pubescens	0.1	*Glycine tomentella*	0.2			
	TOTAL	**1.2**		**9.5**		**30**	**40.7**
Zambezi	*Alphitonia excelsa*	0.1	*Bothriochloa bladhii*	3	Japanese Millet - sterile	15	
	Bauhinia hookeri	0.2	*Bothriochloa ewartiana*	2	Silk Sorghum	15	
	Cassia brewsteri	0.1	*Bothriochloa pertusa*	0.3			
	Corymbia clarksoniana	0.3	*Megathyrsus maximus*	1			
	Corymbia tessellaris	0.3	*Urochloa mosambicensis*	1			
	Eucalyptus camaldulensis	0.5	*Stylosanthes scabra*	0.5			
	Eucalyptus crebra	0.4	*Glycine tomentella*	0.2			
	Eucalyptus populnea	0.4					
	Ficus opposita	0.1					
	Melaleuca leucadendra	0.2					
	TOTAL	**2.7**		**8**		**30**	**40.7**

*In the RA1 rehabilitation area, no trees and shrubs are to be included in the seed mix.

6.2.8 Rehabilitation Trials

In accordance with the *Progressive Rehabilitation and Closure Plans Guideline*, rehabilitation trials are not to result in the delay of rehabilitation. They should also take place in locations that have been or will be disturbed for other components of the Mine, so as to not unnecessarily enlarge the total disturbance footprint of the Mine.

The short duration of the life of Mine, the narrow window of time until the first rehabilitation commences and the lack of suitable locations to undertake trials precludes rehabilitation trials from being a useful tool for refining the rehabilitation methodology. Instead, the rehabilitation methodology has been informed by rehabilitation trials elsewhere in the Bowen Basin, as well as reference data gathered during ecological surveys of the site prior to mining. The rehabilitation methodology (e.g., seed mixes, relative contribution of tubestock, timing of planting, soil management and amelioration) will also be progressively refined following the early outcome of each year's progressive rehabilitation efforts.

The Geochemical Assessment of Waste Rock and Coal Reject Technical Report concludes that the "overwhelming majority of the waste rock materials have low sulphide content, excess acid neutralising capacity (ANC), and are classified as non acid forming (NAF) (Barren)" and that these materials "have a very low risk of acid generation and a high factor of safety with respect to potential for generation of acidity". However, it is a recommendation of the report that additional sampling be undertaken to confirm geochemistry and to aid in best management of materials during progressive rehabilitation.

To this end, a geochemical and geophysical sampling and resting trial will be undertaken to focus on collecting representative samples of waste rock (i.e. spoil) materials planned to be used at the surface of final landforms to supplement any existing subsoil and topsoil salvaged re-used in revegetation and rehabilitation activities. Testing will also include a suite of typical parameters including pH, EC, exchangeable cations, organic matter, total organic carbon, Emerson Aggregate, particle size distribution, and nutrients (including available K, P, S, as well as Nitrogen (N) species (TKN, TN, Nitrite and Nitrate).

Testing will also include geophysical kinetic tests of sandstone waste rock material, to assess long-term weathering characteristics and competency of waste rock material potentially to be used as rock mulch.

In the unlikely circumstance that the available sandstone material not be sufficient, either in available volume, or on the basis of its geophysical or geochemical characteristics, Vitrinite commits to obtaining a substitute material that achieves the landform stability requirements of the Mine.

Similarly, in the event that waste rock material is identified as having negative geophysical or geochemical characteristics (i.e. is more susceptible to dispersion or instability), appropriate amelioration techniques and selective handing processes will be applied to maintain the integrity of the final landform.

7 SURRENDER OF THE ENVIRONMENTAL AUTHORITY

A surrender application must comply with requirements contained in section 262 of the *Environmental Protection Act 1994*. This application must be accompanied by a final rehabilitation report, a post-mining management report and a compliance statement for the EA and PRC Plan schedule.

The final rehabilitation report is to contain an environmental risk assessment and information on any proposed costs related to residual risks remaining at the site. The environmental risk assessment must be completed using a methodology agreed to by the administering authority. The risk assessment is a key step before the calculation of any residual risk costs for the site. The calculation of costs could include consideration of the present value of the future costs of likely repairs, necessary monitoring and maintenance costs and the ongoing management costs of rehabilitated land.

There is a payment as a pre-condition of the surrender of an EA in order to allow the government to address residual risks associated with a site at surrender. Residual risks may include the possibility that rehabilitation works and engineered structures may fail or the ongoing costs of monitoring and maintenance after surrender.

The residual risk requirements do not remove or change the obligations of an EA holder to complete rehabilitation to required standards. The residual risk framework enables companies to relinquish the tenure and surrender an EA whilst ensuring the State understands any remaining risks on site and is resourced to manage the risks, including possible financial consequences of future environment harm.

8 RISK ASSESSMENT

In accordance with section 126C(1)(f) of the EP Act, **Table 8-2** assesses the risks of a stable PMLU not being achieved, and how these risks will be managed or minimised. Risks specific to each rehabilitation milestone are identified. Both inherent risks (in the absence of risk treatments) and residual risks (once controls are in place) are identified and assessed for each hazard. Risks are scored based on definitions in **Table 8-1**.

Table 8-1 Scoring system used to assess risks

			Likelihood				
			1 Rare	**2 Unlikely**	**3 Possible**	**4 Likely**	**5 Almost Certain**
			Unlikely to occur in a lifetime; or very unlikely to occur; or no known occurrences in broader worldwide community.	Could occur about once during a lifetime; or more likely not to occur than to occur; or has occurred at least once in the broader worldwide industry.	Could occur more than once during a lifetime; or as likely to occur as not to occur; or has occurred at least once in the mining/ commodities trading industry.	May occur about once per year; or more likely to occur than not occur; or has occurred at least once on a mine site in the Bowen Basin.	May occur several times per year; or expected to occur; or has occurred several times on a mine site in the Bowen Basin.
Consequence	**5 Catastrophic**	Unconfined and widespread environmental damage; impacts reaching into surrounding areas; major remediation measures required.	**15**	**19**	**22**	**24**	**25**
	4 Major	Long-term (2-10 years) impact; major remediation measures required.	**10**	**14**	**18**	**21**	**23**
	3 Moderate	Medium-term (<2 years) impact; requires moderate intervention.	**6**	**9**	**13**	**17**	**20**
	2 Minor	Short-term impact; requires minor remediation or intervention.	**3**	**5**	**8**	**12**	**16**
	1 Negligible	No lasting impact; requires minor or no remediation; minor management intervention mat be required.	**1**	**2**	**3**	**7**	**11**

Table 8-2 Risk assessment for rehabilitation of the Mine

Milestone	Hazard	Impact	Inherent Risk: Likelihood	Inherent Risk: Consequence	Inherent Risk: Risk Ranking	Rehabilitation actions	Justification of treatment option	Resource requirements	Performance measures	Reporting and monitoring	Residual Risk: Likelihood	Residual Risk: Consequence	Residual Risk: Risk Rating
1: Infrastructure decommissioning and removal.	Schedule for infrastructure decommissioning and removal inadequately communicated among management and work teams.	• Failure to remove all infrastructure in accordance with the PRC Plan Schedule. • Achievement of Milestone 1 delayed.	2	3	9	• Infrastructure decommission schedule to be incorporated into annual mine planning. • Monthly progress meetings are to take place between management (i.e., responsible personnel) and work crews regarding infrastructure decommissioning and removal. • A register of infrastructure is to track which structures exist in each rehabilitation area and which have been removed.	The actions will allow the early identification of potential deviations from the PRC Plan Schedule, affording ample opportunity to adjust work rates to ensure that scheduled works are completed by the reporting date of 10 December.	Adequate time allocated for planning and progress meetings.	Refer to **Section 5.1**	Refer to **Section 9.1.1**	1	3	6
	Infrastructure decommissioning and removal takes longer than planned.	• Achievement of Milestone 1 delayed.	2	2	5	• Monthly progress meetings are to take place between management (i.e., responsible personnel) and work crews regarding infrastructure decommissioning and removal. • Additional work team resourcing may be sought in the event that the completion of scheduled works is otherwise unlikely by the annual reporting date.	The actions will allow the early identification of potential deviations from the PRC Plan Schedule, affording ample opportunity to adjust work rates to ensure that scheduled works are completed by the reporting date of 10 December.	Adequate time allocated for planning and progress meetings; funding for supplementary contractors, if required.			1	2	3
2: Remediation of Contaminated Land	Previously unidentified contamination source discovered.	• Achievement of milestone 2 delayed. • Financial cost of remediation.	2	3	9	• Records are to be kept of all spills, leaks and other incidents occurring at the Mine that might result in contamination. These incidents are to be recorded in an Incident Register, and information about relevant incidents are to be provided to an approved auditor prior to their site visit/testing. • Employees and contractors are to be made aware of their reporting obligations through a Site Induction. • Initial consultation with an approved auditor to identify contamination targets for remediation or removal.	To be suitable for a PMLU of low-intensity grazing, contaminated land must be removed from the Contaminated Land Register or the Environmental Management Register, and declared suitable for any use. These works must be approved by a suitably qualified person and an approved auditor (under the *Environmental Protection Act 1999* Act).	Adequate time per shift for reporting; funding for audits.	Refer to **Section 5.1**	Refer to **Section 9.1.2**	1	3	6
	Remediation work not completed to schedule.	• Achievement of milestone 2 delayed, stalling later phrases of rehabilitation.	2	3	9	• Decontamination works are to be incorporated into annual mine planning. • Monthly progress meetings are to take place between management (i.e., responsible personnel) and work crews regarding de-contamination works. • Compliance with the PRC Plan schedule is to be overseen by responsible personnel.	Decontamination works must be completed to allow sufficient time for milestones 3 and 4 to be accomplished prior to the wet-season, or milestone 5 will be delayed by an additional year.	Adequate time allocated for planning and progress meetings.			1	3	6
	Waste rock is more reactive than anticipated.	• Potential for acid mine drainage, neutral metalliferous mine drainage or saline mine drainage to reduce water quality in groundwater and surface water. • High cost of remediation.	2	4	14	• Ongoing waste characterisation throughout operations. • Ongoing testing of mine-affected water throughout operations. • Should waste rock material with reactive chemistry be identified during operations: - Extraction is to cease until the situation can be resolved; and - Geochemical specialists are to be consulted to advise about appropriate handling and management of the material.	Ongoing testing of waste material and mine-affected water is a standard practice in QLD mining operations. It will provide an early detection system for mischaracterisation of rock. A response procedure will aim to prevent further removal of reactive material until appropriate infrastructure can be designed and constructed to manage the material.	Adequate budget for geochemical testing.			1	4	10
3: Landform Development and Reshaping/Reprofiling	Heavy rain prior to surface preparation and revegetation (milestones 4 and 5).	• Sedimentation of downstream waterways.	4	3	17	• Slope designed with shallow gradient. • Earthworks timed to coincide with dry-season. • Sediment management systems (drains and sediment dams) to be operational during construction of final landform.	The planned low slope gradient limits the capacity for water to carry material. Heavy downpours are unlikely between the months of June and October. Sediment management systems trap eroded material before it can enter local waterways. This system has been designed in accordance with the *Best Practice Erosion and Sediment Control* (IECA 2008) guidelines.	The sediment management system has been already designed for the planning and approval stages of the Mine. Appropriate time and personnel are required for construction of this system.	Refer to **Section 5.1**	Refer to **Section 9.1.3**	2	3	9
	Timing and design specifications for final landform not adequately implemented.	• Achievement of milestone 3 delayed. • Reduced safety and/or stability of final landform.	2	3	9	• Annual audits are to confirm agreement between as-constructed landforms and approved designs. • Monthly progress meetings are to take place between management (i.e., responsible personnel) and work crews regarding landform construction.	Early detection of inconsistencies between constructed landforms and approved designs will allow adequate opportunity for modifications to be completed by the reporting date of 10 December.	Adequate time allocated for planning and progress meetings; funding for auditors.			1	2	3
3: Landform Development and Reshaping/Reprofiling (cont.)	Mining schedule changes.	• The final landform is not achieved.	3	2	8	• Detailed mine planning based on robust resource model • Short term project – less susceptible to significant influencing factors • Ability to modify designs through PRC Plan amendment possible – although undesirable.	A larger landform is not possible without approval and PRC Plan amendments. As such this Hazard is associated with a smaller scale landform. Given the progressive backfill of the pit, it is unlikely that such a landform would result in significantly different environmental outcomes, albeit of a smaller scale.	Mine planning, scheduling, surveying.	Refer to **Section 5.1**	Refer to **Section 9.1.3**	2	2	5

Milestone	Hazard	Impact	Inherent Risk			Rehabilitation actions	Justification of treatment option	Resource requirements	Performance measures	Reporting and monitoring	Residual Risk		
			Likelihood	Consequence	Risk Ranking						Likelihood	Consequence	Risk Rating
	Predicted waste rock swell factor overestimates volume of material available for preparation of final landform.	• The final landform is not achieved.	3	2	8	• Detailed mine planning based on robust geological model of well understood geological features. • Early monitoring of blasting and mining activities will inform ongoing scheduling and planning.	Industry standard swell factors have been applied. Significant deviations from this are unlikely. Minor deviations are considered unlikely to affect ability to achieve PMLU's and if lower may result in better outcome (lower final in-pit WRD).	Mine planning, scheduling, surveying.			2	2	5
4: Surface preparation	Inappropriate topsoil and subsoil management whilst stockpiled.	• Reduced viability of topsoil, limiting plant establishment at rehabilitated sites. • Topsoil infested with weed propagules, which will invade rehabilitated sites.	4	4	21	• Spatial segregation of topsoil and subsoil, with signage installed at each stockpile to denote soil type. • Topsoil stockpiles to be managed in strict accordance with practices described in **Section 6.2.6.**	By minimising stockpile heights, preventing the mixing of subsoils and topsoil, maintaining a vegetative cover on stockpiles and controlling weed populations on stockpiles before they become dominant, soil health will be maintained.	Adequate signage, herbicides and personnel are required.	Refer to **Section 5.1**	Refer to **Section 9.1.4**	2	3	9
	Inadequate topsoil cover.	• Exposure of dispersive subsoils to rain. • Gully erosion. • Cost of repeating landform reshaping and surface preparation.	3	4	18	• A minimum of 25 cm of topsoil is to be placed on all exposed subsoil. • 30% rock cover applied to topsoil on slopes. • Subsoils are to be mixed with 25% rock. • Rapidly establishing grasses to be included in seed-mixes. • Sediment management systems (drains and sediment dams) to be operational during surface preparation and revegetation.	Dispersive subsoils across the local region often naturally have a cover of only 10-20 cm of stable topsoil, and 25 cm is considered sufficient to protect the subsoil from exposure to erosional forces. A review of studies elsewhere in the Bowen Basin (refer **Section 6.1**) indicates that the measures in place at the Mine will sufficiently limit the risk of erosion.	Adequate waste rock set aside for a protective cover; seed for pioneer grasses; appropriate time and personnel are required for construction of the sediment management system and final landform according to designs.			2	3	9
	Vehicles contaminated with weed seeds used for earthworks.	• Weeds invading rehabilitated sites, inhibiting the establishment of desirable species and preventing achievement of milestones 6, 7 and 8.	3	4	18	• Strict vehicle wash-down practices for vehicles entering the site from contaminated areas. • Annual weed monitoring program, to allow the early detection and treatment of new weed infestations.	Prevention of introduction and early treatment of new infestations are central to the successful and cost-effective management of weeds on site.	Adequate time and budget for wash-downs, monitoring and weed control.			2	3	9
	Heavy rainfall occurring prior to establishment of vegetative cover.	• Loss of topsoil from slopes. • Siltation of downstream waterways. • Failure of vegetation to establish on eroded surfaces. • Cost of reapplying topsoil to eroded surfaces.	4	3	17	• Low slope gradient in landform design to limit capacity for sediment loss. • Surface preparation immediately prior to seeding to limit time that bare slopes are exposed to rain events. • 30% rock cover applied to slopes. • Rapidly establishing grasses to be included in seed-mixes. • Sediment management systems (drains and sediment dams) to be operational during surface preparation and revegetation.	A review of studies elsewhere in the Bowen Basin (refer **Section 6.1**) indicates that the measures in place at the Mine will sufficiently limit the risk of erosion.	Adequate waste rock set aside for a protective cover; seed for pioneer grasses; appropriate time and personnel are required for construction of the sediment management system and final landform according to designs.			2	3	9
5: Revegetation	Seed unavailable.	• Lack of seed of certain species can lead to long-term effects on the composition of the eventual plant communities that establish.	4	3	17	• Seed collection and procurement is to commence at the start of the Mine , so that supplies are available when revegetation begins. • A store of seed is to be maintained on site. • Woody species unavailable at the time of sowing are to be added to rehabilitated sites as tubestock in the following wet season.	Approximately half of the species to be used are not currently stocked by commercial seed suppliers and therefore require local collection. Collecting over two years prior to revegetation allows for certain species to seed poorly in any one year.	Funding for seed collection/purchase must be available from the start of the Mine.	Refer to **Section 5.1**	Refer to **Section 9.1.5**	2	2	5
	Heavy rain immediately after sowing.	• Loss of topsoil from slopes. • Siltation of downstream waterways. • Failure of vegetation to establish on eroded surfaces. • Cost of reapplying topsoil to eroded surfaces.	4	3	17	• Low slope gradient in landform design to limit capacity for sediment loss. • Surface preparation and sowing is not to take place if heavy rain (>40 mm) is forecast over any one day within the next fortnight. • 30% rock cover applied to slopes during surface preparation. • Rapidly establishing grasses to be included in seed-mixes. • Sediment management systems (drains and sediment dams) to be operational during surface preparation and revegetation.	A review of studies elsewhere in the Bowen Basin (refer **Section 6.1**) indicates that the measures in place at the Mine will sufficiently limit the risk of erosion.	Adequate waste rock set aside for a protective cover; seed for pioneer grasses; appropriate time and personnel are required for construction of the sediment management system and final landform according to designs.			2	3	9
	Inappropriate quantity of grass seed used in the seed mix.	• Tree and shrub establishment inhibited by high grass cover. • Insufficient protective cover of grass increasing the risk of erosion.	3	3	13	• Seed mixes have been based on other mine sites across north-eastern Australia. • Grass seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • In sites with excessive grass densities, tubestock of trees and shrubs are to be planted within circles (1 m radius) of grass that have been killed using herbicide. • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth.	Studies elsewhere in the Bowen Basin indicate that dense grass can inhibit vegetation development (Erskine and Fletcher 2013). Early identification of issues and amendments of seed mixes will reduce overall costs associated with remediating over- or under-dense grass swards.	Adequate time for reviewing the revegetation methodology on an annual basis.			2	2	5

Milestone	Hazard	Impact	Inherent Risk			Rehabilitation actions	Justification of treatment option	Resource requirements	Performance measures	Reporting and monitoring	Residual Risk		
			Likelihood	Consequence	Risk Ranking						Likelihood	Consequence	Risk Rating
	Inappropriate quantity of tree and shrub seed used in the seed mix.	• Insufficient or excessive canopy cover can cause the eventual vegetative communities to fail to achieve milestones 6 and 7.	3	3	13	• Seed mixes have been based on other mine sites across north-eastern Australia. • Seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • Supplementary planting of tubestock or thinning of established seedlings may be required to correct for inappropriate tree densities.	A minimum tree and shrub density is required to achieve completion criteria pertaining to the Koala and Squatter Pigeon. However, excessive tree and shrub densities limit pasture development, jeopardising the achievement of the desired PMLU. Early identification of issues and amendments of seed mixes will reduce overall costs associated with remediating over- or under-dense grass swards.	Adequate time for reviewing the revegetation methodology on an annual basis.			2	2	5
	Drought over the first months after planting.	• Poor seedling survival and establishment.	3	3	13	• Planting is to take place in the early wet season, when probability of further rain during seedling establishment is high. • Supplementary planting (seed or tubestock) may be required following exceptionally dry years.	Long dry periods soon after germination can result in widespread mortality of seedlings. The actions reduce the risk of this occurring and propose remedial actions in the event it does occur.	Adequate time and budget allocated for planting in years following drought.			3	2	8
	Vehicles and/or footwear contaminated with weed seeds.	• Weeds invading rehabilitated sites, inhibiting the establishment of desirable species and preventing achievement of milestones 6 and 7.	3	4	18	• Strict vehicle wash-down practices for vehicles entering the site from contaminated areas. • Annual weed monitoring program, to allow the early detection and treatment of new weed infestations.	Prevention of introduction and early treatment of new infestations are central to the successful and cost-effective management of weeds on site.	Adequate time and budget for wash-downs, monitoring and weed control.			2	3	9
	Intruding livestock.	• Premature grazing could lead to poor seedling establishment.	4	3	17	• Cattle-proof fencing surrounding each rehabilitation area is to be installed prior to seeding. • Fences are to be inspected monthly, faults immediately repaired and livestock immediately removed.	Rehabilitated areas are to be maintained free of livestock until vegetation is adequately established (at least five years).	Fencing materials and personnel for construction and inspection.			1	1	1
6: Commencement of Grazing	Poor pasture development	• Insufficient pasture density to meet completion criteria. • Insufficient species richness of grasses to meet completion criteria. • Increased risk of erosion.	3	3	13	• Seed mixes have been based on other mine sites across north-eastern Australia. • Grass seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth.	Early identification of issues and amendments of seed mixes will reduce overall costs associated with remediating over- or under-dense grass swards.	Adequate time for reviewing the revegetation methodology on an annual basis; additional seed stocks and fertiliser, as required.	Refer to **Section 5.1**	Refer to **Section 9.1.6**	2	2	5
	Weeds	• Weeds invading rehabilitated sites, inhibiting the establishment of desirable species and preventing achievement of milestones 6, 7 and 8.	3	4	18	• Strict vehicle wash-down practices for vehicles entering the site from contaminated areas. • Annual weed monitoring program, to allow the early detection and treatment of new weed infestations.	Prevention of introduction and early treatment of new infestations are central to the successful and cost-effective management of weeds on site.	Adequate time and budget for wash-downs, monitoring and weed control.			2	3	9
	Excessive density of trees and shrubs	• Pasture species become shaded out. • Failure to achieve targets of rehabilitation completion criteria.	3	2	8	• Seed mixes have been based on other mine sites across north-eastern Australia. • Seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • Thinning of woody vegetation (using machinery or fire) may be required at sites with excessive shrub and tree densities.	Early refinements of the seed mixes will reduce the need for later interventions. Vegetation thinning is widely implemented in Queensland's pastoral landscapes to increase pasture production in densely forested situations.	Adequate time for reviewing the revegetation methodology on an annual basis; machinery to undertake thinning of trees and shrubs, if required.			1	2	3
7: Establishment of target vegetation type	Poor pasture development.	• Insufficient pasture density to meet completion criteria. • Insufficient species richness of grasses to meet completion criteria. • Increased risk of erosion.	3	3	13	• Seed mixes have been based on other mine sites across north-eastern Australia. • Grass seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth.	Early identification of issues and amendments of seed mixes will reduce overall costs associated with remediating over- or under-dense grass swards.	Adequate time for reviewing the revegetation methodology on an annual basis; additional seed stocks and fertiliser, as required.	Refer to **Section 5.1**	Refer to **Section 9.1.7**	2	2	5
	Poor development of Koala food trees.	• Insufficient density of food trees to allow use of rehabilitated areas by the Koala. • Failure to achieve targets of completion criteria.	2	4	14	• Seed mixes have been based on other mine sites across north-eastern Australia. • Seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • Regular monitoring aims for the early detection of sites with inadequate seedling establishment. • Sites with insufficient density of food trees developing over the first two years will undergo supplementary planting of tubestock.	Early refinements of the seed mixes will reduce the need for later interventions. Tubestock is a superior method for adding trees to existing pastures, as tree seeds often fail to germinate/establish among competitive understorey species.	Adequate time for reviewing the revegetation methodology on an annual basis; a nursery facility to rear tubestock OR contracts with commercial nurseries to rear stock.			2	2	5
	Excessive density of trees and shrubs.	• Pasture species become shaded out. • Habitat becomes unsuitable for the Squatter Pigeon. • Failure to achieve targets of rehabilitation completion criteria.	3	2	8	• Seed mixes have been based on other mine sites across north-eastern Australia. • Seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • Thinning of woody vegetation (using machinery or fire) may be required at sites with excessive shrub and tree densities.	Early refinements of the seed mixes will reduce the need for later interventions. Vegetation thinning is widely implemented in Queensland's pastoral landscapes to increase pasture production in densely forested situations.	Adequate time for reviewing the revegetation methodology on an annual basis; machinery to undertake thinning of trees and shrubs, if required.			1	2	3

Milestone	Hazard	Impact	Inherent Risk: Likelihood	Inherent Risk: Consequence	Inherent Risk: Risk Ranking	Rehabilitation actions	Justification of treatment option	Resource requirements	Performance measures	Reporting and monitoring	Residual Risk: Likelihood	Residual Risk: Consequence	Residual Risk: Risk Rating
	Insufficient density of trees and shrubs.	• Habitat is unsuitable for the Koala and Squatter Pigeon. • Failure to achieve targets of rehabilitation completion criteria.	3	4	18	• Seed mixes have been based on other mine sites across north-eastern Australia. • Seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • Regular monitoring aims for the early detection of sites with inadequate seedling establishment. • Sites with insufficient density of trees and shrubs developing over the first two years will undergo supplementary planting of tubestock.	Early refinements of the seed mixes will reduce the need for later interventions. Tubestock is a superior method for adding trees to existing pastures, as tree seeds often fail to germinate/establish among competitive understorey species.	Adequate time for reviewing the revegetation methodology on an annual basis; a nursery facility to rear tubestock OR contracts with commercial nurseries to rear stock.			2	2	5
	Weeds.	• Weeds could invade via wind, vehicles or footwear during vegetation development. • Weeds can inhibit the establishment of desirable species and preventing achievement of milestones 6, 7 and 8.	2	4	14	• Strict vehicle wash-down practices for vehicles entering the site from contaminated areas. • Annual weed monitoring program, to allow the early detection and treatment of new weed infestations.	Prevention of introduction and early treatment of new infestations are central to the successful and cost-effective management of weeds on site. Weed risk is highest during topsoil stockpiling, surface preparation and planting, rather than during the development of the vegetation communities post-planting. However, weed management practices are to remain in place throughout the duration of rehabilitation.	Adequate time and budget for wash-downs, monitoring and weed control.			2	3	9
7: Establishment of target vegetation type	Fire.	• A fire during early stages of vegetation establishment could kill developing trees and shrubs prior to their establishment, leading to a failure to achieve rehabilitation completion criteria pertaining to tree cover.	2	3	9	• A fire break will be maintained along the western boundary of the Mine, to minimise the risk of fires originating within bushland areas of the Harrow Range. • An Emergency Response Plan describes processes in place to control fires that originate on site.	Damaging fires are most likely to spread from the west, due to the large tracts of bushland present there and the hot, dry westerly winds typically associated with periods of high fire risk. Close proximity of the in-pit WRD to Saraji Road precludes the installation of fire breaks along the eastern boundary of rehabilitated land (maintaining a strip of bare ground on the foot-slopes of the in-pit WRD poses too high an erosion risk).	Personnel and machinery required to build and maintain fire breaks.	Refer to **Section 5.1**	Refer to **Section 9.1.7**	1	3	6
	Intruding livestock.	• Premature grazing could damage developing trees and shrubs and impair pasture development.	4	3	17	• Fences are to be inspected monthly, faults immediately repaired and livestock immediately removed.	Rehabilitated areas are to be maintained free of livestock until vegetation is adequately established (at least five years).	Personnel for inspections and repairs; tools and equipment for fencing.			1	1	1
8: Achievement of stable PMLU	Low pasture productivity.	• Failure to support economically viable cattle grazing.	2	3	9	• Seed mixes have been based on other mine sites across north-eastern Australia. • Grass seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth.	Early identification of issues and amendments of seed mixes will reduce overall costs associated with remediating inadequate grass cover.	Personnel/contractors required for regular monitoring; adequate time for reviewing the revegetation methodology on an annual basis; additional seed stocks and fertiliser, as required.	Refer to **Section 5.1**	Refer to **Section 9.1.8**	2	2	5
	Low pasture diversity.	• Over-dominance of one or few pasture species increases the vulnerability of the pasture to extreme environmental events (flood, fire, drought, insect plagues). • Low pasture diversity is associated with reduced nutrient cycling and ecosystem stability. • Failure to sustain cattle grazing in the long-term.	4	4	23	• A multitude of local pasture species are to be included in seed-mixes. • Non-native grasses known to suppress other species (e.g., Buffel Grass) are to be sown at very low rates. • Regular monitoring (every two years) of rehabilitated sites will track pasture diversity and allow for an early modification of seed mixes and/or other interventions.	Over-dominance of Buffel Grass limits rehabilitation success and stability at other Bowen Basin mines (Erskine and Fletcher 2013). It is important to allow less aggressive grass species time to establish prior to Buffel Grass becoming too dense. A diversity of grasses improves ecosystem stability and protects against fluctuations in environmental conditions.				2	4	14
	Poor landscape function.	• Failure of sites to develop adequate sediment and leaf litter capture by groundcover features. • Formation of a dysfunctional landscape that results in a loss of resources (nutrients, water, sediment) over the long term. • Failure to achieve rehabilitation completion criteria pertaining to landscape function.	2	3	9	• Low slope gradient in landform design to limit capacity for sediment loss. • 30% rock cover applied to slopes during surface preparation. • Inclusion of a diversity of grass, trees and shrubs in seed mixes. • Topsoil storage and handling are to be in accordance with practices described in **Section 6.2.6.**	Landscape function analysis is a widely implemented framework for managing and monitoring landscape stability. A review of studies elsewhere in the Bowen Basin (refer **Section 6.1**) indicates that the measures in place at the Mine will lead to a stable landform with low erodibility.				2	2	5

Milestone	Hazard	Impact	Inherent Risk			Rehabilitation actions	Justification of treatment option	Resource requirements	Performance measures	Reporting and monitoring	Residual Risk		
			Likelihood	Consequence	Risk Ranking						Likelihood	Consequence	Risk Rating
	Significant erosion of placed soils on final landform	• Failure to establish vegetative cover and therefore stable PMLU • Loss of topsoil • Loss of sediment control structure performance • Water quality impacts	4	3	17	• Low slope gradient in landform design to limit capacity for sediment loss. • Surface preparation and sowing is not to take place if heavy rain (>40 mm) is forecast over any one day within the next fortnight. • 30% rock cover applied to slopes during surface preparation. • Rapidly establishing grasses to be included in seed-mixes. • Sediment management systems (drains and sediment dams) to be operational during surface preparation and revegetation. • Amelioration measures to assist with soil retention, including addition of: o fertiliser; and o organic mulch.	A review of studies elsewhere in the Bowen Basin (refer **Section 6.1**) indicates that the measures in place at the Mine will sufficiently limit the risk of erosion. Further amelioration measures are provided to enhance early establishment of vegetation and to support a sustainable and productive vegetative cover.	Adequate waste rock set aside for a protective cover; seed for pioneer grasses; amelioration materials and labour; appropriate time and personnel are required for construction of the sediment management system and final landform according to designs.			2	3	9
9: Acceptance of Saraji Road by Isaac Regional Council	The Saraji Road realignment does not meet the requirements of IRC and will not be accepted.	• Cost of repairs • Delays to the commencement of mining at the VCM, due to the retention of the old road until the new one is accepted.	3	4	18	• Adherence to a legal agreement with IRC outlining the requirements and responsibilities of all parties to facilitate the construction, maintenance and eventual handover of the road realignment. • Road inspections at the direction of IRC. • Ability of IRC to direct Vitrinite to undertake remediation in a timely fashion. • Security held by IRC for the purpose of undertaking any remediation that Vitrinite fails to complete. • Requirement of a Certificate of Practical Completion prior to return of the Road to IRC. • A 12-month Defects Period during which Vitrinite remains responsible for any remediation that is required prior to IRC assuming maintenance responsibility.	As a functioning council road that is intended to remain in place in perpetuity, Saraji Road must meet regional council requirements in its construction and maintenance. The construction and maintenance of the Saraji Road Realignment is the only rehabilitation that is appropriate to this area as a piece of remaining infrastructure.	Provision of security and any associated management documents to IRC for approval prior to commencement. Resources appropriate to road maintance and all other aspects of the agreement with IRC until such time that the agreement is ended	Refer to **Section 5.1**	Refer to **Section 9.1.9**	2	3	9
10. Acceptance of retained infrastructure by BMA	The retained infrastructure does not meet the agreement between BMA and Vitrinite	• Cost of improvements to the condition of infrastructure or its removal; • Delays to the relinquishment of the ML	3	3	13	• Adherence to a legal agreement with BMA outlining the infrastructure to be retained and its condition at handover. • BMA to inspect remaining infrastructure at least six months prior to anticipating handover, to allow time for improvements/removals, if required.	Provided infrastructure meet the conditions if the signed agreement, there is little risk of completing this milestone.	Time allocated to inspections and liaising with BMA in the six months approaching handover.	Refer to **Section 5.1**	Refer to **Section 9.1.10**	2	2	5

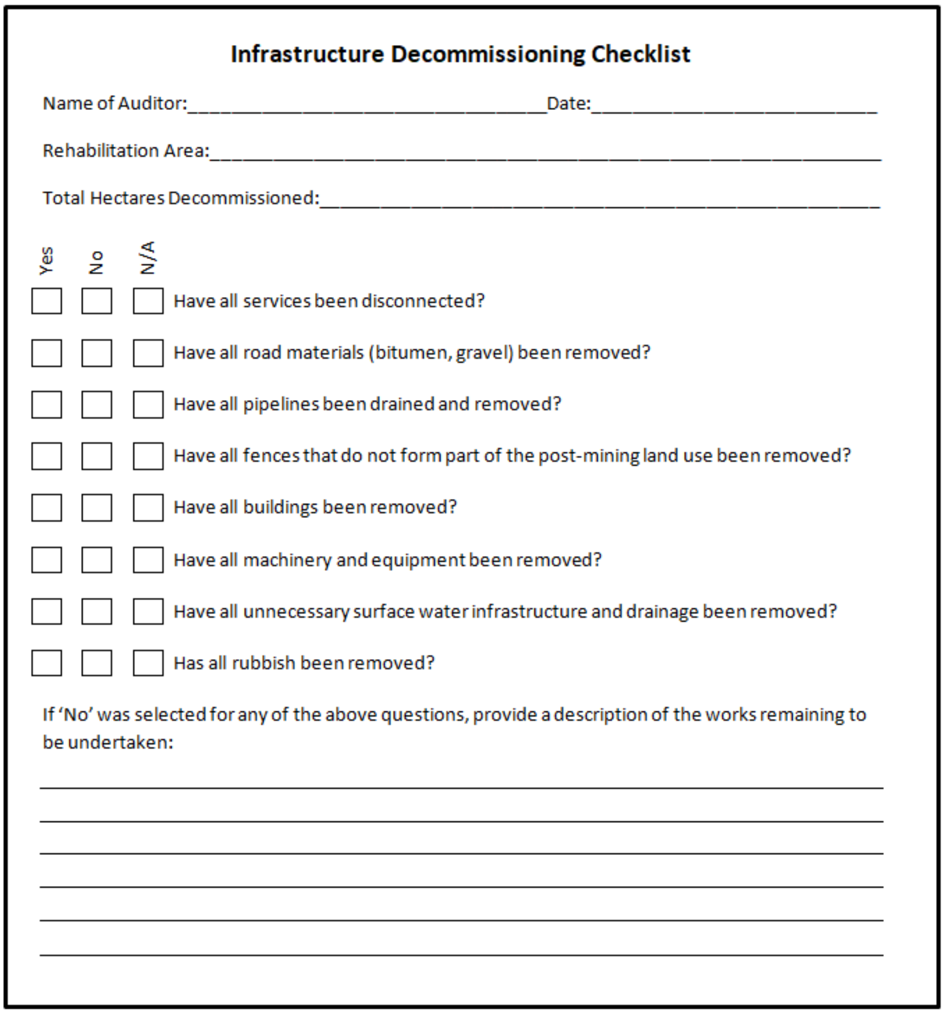
9 MONITORING

9.1 Milestone Monitoring

Ten rehabilitation milestones are described in **Section 10.3** (PRC Plan Schedule). A monitoring program has been developed to determine whether milestone criteria have been achieved. This program is described below, with respect to each of the rehabilitation milestones. Where milestones are only relevant to some rehabilitation areas, this is stated.

9.1.1 Rehabilitation Milestone 1: Infrastructure Decommissioning and Removal

Following the disconnection of services and removal of all buildings and mine infrastructure, an Infrastructure Decommissioning Checklist is to be completed. Failure of a site to meet all items on the checklist will trigger remedial works to remove outstanding infrastructure. This rehabilitation milestone monitoring is applicable to rehabilitation areas RA3 (CHPP, Rail loop, TLO, infrastructure, haul roads, stockpiles and ROM pad) and RA4 (dams and sediment ponds). An example checklist is provided below in **Figure 9-1.** Further detail on the milestone criteria set for the decommissioning and removal of infrastructure is provided in **Section 10.3.1** and **Table 10-3**. This includes a list identifying how infrastructure will be decommissioned.



Infrastructure Decommissioning Checklist

Name of Auditor:________________________________Date:_________________________

Rehabilitation Area:____

Total Hectares Decommissioned:____

Yes	No	N/A	
☐	☐	☐	Have all services been disconnected?
☐	☐	☐	Have all road materials (bitumen, gravel) been removed?
☐	☐	☐	Have all pipelines been drained and removed?
☐	☐	☐	Have all fences that do not form part of the post-mining land use been removed?
☐	☐	☐	Have all buildings been removed?
☐	☐	☐	Have all machinery and equipment been removed?
☐	☐	☐	Have all unnecessary surface water infrastructure and drainage been removed?
☐	☐	☐	Has all rubbish been removed?

If 'No' was selected for any of the above questions, provide a description of the works remaining to be undertaken:

nnnn

Figure 9-1 Example Infrastructure Decommissioning Checklist for each Rehabilitation Area

9.1.2 Rehabilitation Milestone 2: Remediation of Contaminated Land

A contaminated land investigation document is to be prepared by an approved auditor, which is to contain the following components:

- a site investigation report, scientifically assessing whether contamination exists;
- a validation report, describing works undertaken to remediate any contamination; and
- a site suitability statement, stating that land is not contaminated and is suitable for the relevant post-mining landuse.

Rehabilitation areas for which this milestone may be relevant include RA3 (CHPP, Rail loop, TLO, infrastructure, haul roads, stockpiles and run-of-mine pad), RA4 (dam and sediment ponds) and RA6 (infrastructure to be retained).

9.1.3 Rehabilitation Milestone 3: Landform Development and Reshaping/Reprofiling

Following landform development and reprofiling, survey, inspection and reporting is required to provide assurance that rehabilitation activities occurred in accordance with approved designs. Upon the completion of physical works, all landform works must have 'as-constructed' plans prepared. Deviations between design and construction are to be identified and highlighted. A database of design and 'as-constructed' plans for any engineering works associated with the mine rehabilitation is to be maintained.

Rehabilitation areas requiring landform development include RA1 (Ex-pit WRD, including the MIA), RA2 (In-pit WRD) and RA4 (dams and sediment ponds).

9.1.4 Rehabilitation Milestone 4: Surface Preparation

Soil assessments of stockpiled topsoil are to be undertaken within the six months prior to spreading. Soil is to be sampled at various depths of each stockpile. These tests are to be carried out by an appropriately qualified person to confirm that soil is suitable for target vegetation establishment.

As a record of milestone completion, GIS files should be kept that record:

- the boundaries of each area that had topsoil applied in each year (areas with different soil management units or topsoil spreading methodology are to be mapped separately);
- the date on which topsoil spreading occurred in each area;
- depth of topsoil applied in each area;
- the soil management unit of the topsoil applied in each area; and
- whether a rock mulch was applied.

These records are to be kept wherever topsoil is spread, including in rehabilitation areas RA1 (ex-pit WRD, including the MIA), RA2 (In-pit WRD), RA3 (CHPP, Rail loop, TLO, infrastructure, haul roads, stockpiles and ROM pad) and RA4 (dam and sediment ponds).

9.1.5 Rehabilitation Milestone 5: Revegetation

All areas in which seeding and planting have been carried out are to be entered into a GIS database that includes the following details:

- the boundaries of each area rehabilitated (areas with different soil management units, seed mixes or dates of planting are to be mapped separately);
- the soil management unit of the topsoil applied in each area;
- the seed mix applied to each area;
- the date the seed mix was applied to each area;
- the number and species of tubestock planted in each area; and
- the date tubestock was planted.

These records are to be kept wherever planting takes place, including in rehabilitation areas RA1 (ex-pit Dump, including the MIA), RA2 (In-pit WRD), RA3 (CHPP, Rail loop, TLO, infrastructure, haul roads, stockpiles and ROM pad) and RA4 (dams and sediment ponds). While this rehabilitation milestone applies to RA1 (ex-pit WRD, including the MIA), no tubestock will be planted there and the seed mix applied there will not contain trees.

9.1.6 Rehabilitation Milestone 6: Land Suitable for the Commencement of Grazing

Monitoring of milestone RM6 involves a combination of field surveys and satellite imagery analysis. Methodologies for each are described below.

Erosion

In-field erosion monitoring will be undertaken at permanent monitoring transects (50 m in length) established across the landform in conjunction with the Landscape Function Analysis (LFA) monitoring sites (**Section 9.1.8**), to provide a basis for temporal assessments.

Visual observations will be taken whilst traversing transects on foot and recording the number and average depth of any erosion features, rill lines or gullies. Visual assessments should identify any evidence of excessive sediment movement, including the formation of rills, removal of soil around the base of plants and accumulation of loose sediment at the base of slopes. In-field erosion monitoring will be accompanied by assessment of the water quality of run-off water released from the catchment of given rehabilitation areas (**Section 6.1.6**).

Rills are gullies are defined as "active" when (1) they have an average depth >15 cm, and (2) there is evidence of erosion during the most recent rain event (e.g., loose sediment is present, vegetation has not established within the rill/gully, and/or there has been an increase in depth or width of the rill/gully since the previous monitoring event).

Ground Cover

An accurate measurement is required to assess the rehabilitation completion criteria that "grazed land maintains a percentage ground cover of between 50% and 96%". While this criteria relates specifically to rehabilitation areas to which cattle have been introduced (at advanced stages of rehabilitation development), it is prudent to commence this monitoring prior to the introduction of cattle. This data can then be used to calculate the effect of grazing on percentage cover, and thereby predict the groundcover expected at ungrazed sites following cattle introduction. This in turn will be useful for adjusting stocking rates, if required.

Ground cover is to be calculated by running a 50 m measuring tape along the length of each vegetation monitoring transect. Observations of the type of cover (limited to the cover present below 1 m above ground level) are made at point intercepts along the centre line of the 50 m transect at 0.5 m intervals. Cover types include (a) vegetation (including all live vegetation and standing senescent vegetation that is still attached to the main plant and is not in intimate contact with the soil); (b) leaf litter and woody debris; (c) rock or (d) bare ground. The cover type that is intercepted directly below each point is recorded. The intercept point is to be assessed by viewing the ground through a small observation hole (in a piece of stiff card or plastic) or tube. Preferably, this should contain a cross hair, although this is not obligatory. A total of 100 observations are made per transect, and the sum of each cover type equates to its percentage cover.

Percentage cover is to be assessed at rehabilitation sites only (reference site data is not required). Monitoring is to be undertaken concurrently with assessments of landscape function and vegetation surveys in the late wet season.

Pasture Productivity

Pasture productivity within rehabilitated sites is to be equivalent to nearby unmined sites on the same soil types. Pasture productivity is to be assessed via one of two methods:

1) **Manual measurements of pasture mass at specific moments in time.** An electronic dry matter capacitance meter (e.g., Grassmaster Pro) can be used to estimate pasture dry mass (kg/ha) at points within rehabilitation areas. This technique is superior to traditional plate meters on stony ground, such as will be found on sloping rehabilitation areas. The exact number of replicate points required per rehabilitation area is dictated by the variation observed between points and the need to meet the conditions of the completion criteria, namely that pasture mass is not significantly different from unmined areas, with adequate sampling to detect ≥10% difference between groups. An appropriate sample size (n) is based on the following formula:

$$n = 15.68*\sigma^2 / d^2,$$

where σ^2 is the population variance, and d is the minimum difference required to be detected. This formula is based on a standard 95% confidence interval and 80% power. It is anticipated that several hundred point-readings are likely to be required per rehabilitation area and reference paddock. Data from the first 100 readings can be used to calculate n for a d value that represents 10% of the mean dry mass at the reference site. Reference and rehabilitation areas are to be assessed concurrently, under at least two seasonal conditions: 1) at the end of the growing season (February-May), and 2) at the end of prolonged dry weather (i.e., after at least three consecutive months with no more than 10 mm of rain falling per 24-hour period).

2) **Satellite estimation of pasture growth rate.** The CSIRO is in the process of developing their "Pastures from Space" website, which uses satellite imagery to provide real-time data on pasture growth rates at fine spatial scales. This technique has been optimised for temperate Australian pastures, but its applicability to the tropics and subtropics remains unclear. With further development and optimisation, this tool could provide a highly efficient method for comparing pasture productivity between rehabilitation and reference areas, without the need to undertake labour-intensive field studies. It is expected that this tool may be available by the time pasture productivity monitoring is to commence at the Mine (i.e., 2031, six years after the first planting).

Tree Height

In rehabilitation areas where tree cover is to be established (all but RA1), trees must be at least 4 m tall before cattle are first introduced. This is to prevent damage by browsing stock and to ensure that trees are sufficiently tall to begin being utilised by Koalas.

Tree height of the tallest ten trees within a 100 m × 100 m area is to be measured using a laser rangefinder. An average of one monitoring site is to be installed per 10 ha of rehabilitated land. The same monitoring locations are to be used as for groundcover assessments and landscape function analysis, although the size of the plot is larger for assessing tree height.

Land Suitability Assessment

Land suitability assessments are to be undertaken by a suitably qualified person in accordance with the *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI and DNRM 2015). Criteria and thresholds for the environmental limitations of grazing land are to be based on Table 2-2 of the Land Suitability Assessment Techniques, located in Part B of the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME 1995). Land suitability assessments, and the soil tests that inform these, are to be undertaken six and ten years after revegetation (rehabilitation milestone 5) is complete.

9.1.7 Rehabilitation Milestone 7: Establishment of Target Vegetation Type

Monitoring of milestone RM7 involves a combination of field surveys and satellite imagery analysis. Methodologies for each are described below.

Field Surveys

Field surveys are to monitor the following attributes of rehabilitation areas:

- Relative dominance of Koala food trees (all rehabilitation areas except for RA1);
- Percentage cover of declared weeds; and
- Species composition of the pasture.

These attributes are to be measured within a 10 m × 50 m belt transect installed within rehabilitation areas.

Basal area of woody vegetation is to be measured using a Bitterlich gauge. Each species of tree/shrub is to be measured separately. Each site is to be assessed using two 360° sweeps of the gauge (one at each end of the transect, 50 m apart), and the basal area of each woody species is the average from the two sweeps. The proportion of the total basal area of all woody vegetation that comprises Koala food trees (*Eucalyptus crebra, Eucalyptus populnea* and *Eucalyptus camaldulensis*) is used to assess the success of rehabilitation. As tree establishment is not a goal in RA1, basal area of woody vegetation is not monitored there.

The entire belt transect is to be searched, and all species of forbs and grasses contained within it are to be recorded. Percentage ground cover of each species is to be estimated to the nearest 0.1%, with 0.1% cover being equivalent to 0.5 m^2 total cover within the transect. From this data, milestone completion criteria pertaining to weed cover can be assessed.

Field surveys are to be undertaken in the late wet season (February-May), to coincide with maximum growth of grasses and forbs. Permanent monitoring sites are to be installed within all rehabilitation areas, and each end of each transect is to be marked with a star picket. An average of one monitoring site is to be installed per 10 ha of rehabilitated land.

NDVI

Rehabilitation areas for which the PMLU includes habitat for the Squatter Pigeon and Koala (i.e. RA2, RA3 and RA4) are to undergo monitoring of woody vegetation density six years and ten years after the revegetation milestone is achieved. Woody vegetation density is measured using the Normalised Difference Vegetation Index (NDVI). The following approach is to be adopted:

1) The entire rehabilitation area is divided into 1ha cells.
2) Landsat satellite imagery is to be downloaded from an appropriately dry time of year:
    - following at least two months in which no more than 10 mm of rain fell in a single 24-hour period; and
    - following at least one week with no rain.
3) Using mapping software, the mean NDVI value for each 1-ha cell is to be calculated.

By using imagery captured during dry periods, when grass is dry, the NDVI (an index of greenness) reflects the density of woody vegetation cover. The months of July-September are usually appropriate, but in unusually wet winters, other months may need to be considered.

All cells fully contained within the relevant rehabilitation area are to have NDVI values between 0.1240 and 0.1778 in order to satisfy the completion criteria for threatened fauna. One-hectare cells within parts of the ML in which no disturbance has occurred and in which woody vegetation density is likely to have remained relatively stable over time (e.g., remnant vegetation) are to be used as reference points for NDVI. NDVI values of reference cells within the focal year should closely resemble values of the same cells calculated from Landsat imagery collected in August 2018 (on which completion criteria were based). If this is not the case, imagery from a different time of year should be used or, if this is unavailable or yields a similar outcome, the completion criteria are to be adjusted to account for shifts in greenness that arise from measurement biases or the influence of pasture.

9.1.8 Rehabilitation Milestone 8: Achievement of a Stable PMLU

The achievement of a stable landscape that can support low-intensity cattle grazing is to be monitored through five field survey programs, described below.

Landscape Function Analysis

Monitoring of the stability of rehabilitated land is to be based on the “stability”, “infiltration/run-off” and “nutrient cycling” indices of Landscape Function Analysis (LFA) (Tongway and Hindley 2004). Methodology to be adopted is described in detail by Tongway and Hindley (2004). Permanent monitoring sites used for vegetation monitoring (see **Section 9.1.7**) are also to be monitored for soil stability.

Reference sites are to be installed in nearby undisturbed land used for grazing. Reference sites are to be of a similar soil type and slope to rehabilitated sites, and must have a vegetation density appropriate for Squatter Pigeons. Five reference sites are to be installed on flat land (gradients <6%) and five are to be installed on sloping land (gradient of 10-20%). Locations of proposed reference sites are listed in **Table 9-1** and shown in **Figure 9-2**. These reference sites were selected as (a) they meet the requirements for soil, slope and vegetation density and (b) they are evenly spaced, with at least 500 m between them. To avoid biases in the placement of these reference sites, their coordinates have been selected based on GIS information rather than through site visits. The baseline condition of reference sites therefore represents a random sample of analogous, nearby, unmined vegetation communities.

Reference sites are to be surveyed concurrently with every second rehabilitation area monitoring round. Reference sites must be monitored in the year rehabilitation success is expected. Vegetation development is to be assessed every two years until milestone criteria have been achieved.

Table 9-1 Proposed reference sites for LFA monitoring

Site	Slope	Latitude	Longitude
R1	Flat	-22.28313	148.16910
R2	Flat	-22.28582	148.17477
R3	Flat	-22.29014	148.18028
R4	Flat	-22.30203	148.19103
R5	Flat	-22.27888	148.17310
R6	Sloping	-22.27799	148.16634
R7	Sloping	-22.28109	148.16087
R8	Sloping	-22.28729	148.17035
R9	Sloping	-22.29139	148.17512
R10	Sloping	-22.29853	148.19032

Monitoring is to take place in the late wet season (February-May), to coincide with maximum plant growth. Sites are to be monitored at the time of planting and then every two years for ten years after planting. This time series of six intervals will generate a sigmoidal curve for the three indices. A stable PMLU will be achieved when the landscape function analysis scores for soil stability, infiltration/runoff and nutrient cycling have started to plateau, and the plateau values predicted from sigmoidal curves fitted to the data are equivalent to or exceed values at analogue sites (Tongway and Hindley 2004). If the curves do not plateau or exceed the target value within ten years, additional rounds of monitoring will take place every five years until the target is achieved.

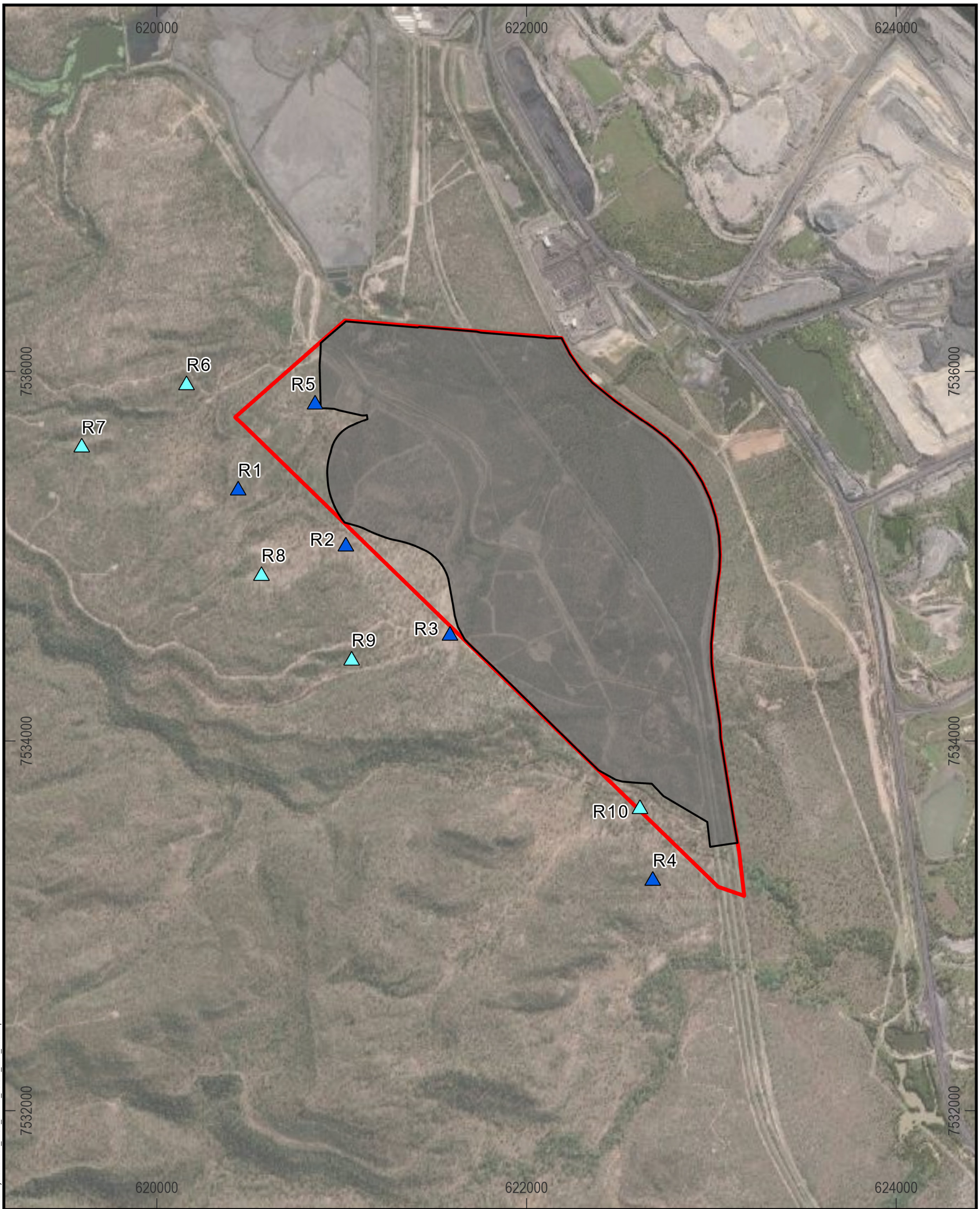
Erosion

In addition to the LFA monitoring to be undertaken for land stability (see above), additional erosion monitoring across the landform will also be undertaken for the early detection of erosion, to allow for early intervention.

In-field erosion monitoring will be undertaken at permanent monitoring transects, (50 m in length) established across the landform in conjunction with the LFA monitoring sites, to provide a basis for temporal assessments.

Visual observations will be taken whilst traversing transects on foot and recording the number and average depth of any erosion features, rill lines or gullies. Visual assessments should identify any evidence of excessive sediment movement, including the formation of rills, removal of soil around the base of plants and accumulation of loose sediment at the base of slopes. In-field erosion monitoring will be accompanied by assessment of the water quality of run-off water released from the catchment of given rehabilitation areas (**Section 6.1.6**).

Rills are gullies are defined as “active” when (1) they have an average depth >15 cm, and (2) there is evidence of erosion during the most recent rain event (e.g., loose sediment is present, vegetation has not established within the rill/gully, and/or there has been an increase in depth or width of the rill/gully since the previous monitoring event).



Legend

ML700060

Cadastral Boundary

VCM Revised Maximum Disturbance Footprint

Reference Sites

Flat

Slope

Source: State of Queensland (Department of Resources) 2021, Vitrinite 2021, METServe 2021, Maxar.

Vulcan Coal Mine

Proposed Reference Sites for Vegetation Monitoring

0 0.5 1

Kilometers

Scale: 1:30,000 (A4)

6/12/2021

Datum: GDA94
Projection: MGA55

FIGURE 9-2

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Ground Cover

Landscape Function Analysis, discussed above, involves an assessment of percentage ground cover as classes. A more accurate measurement is required to specifically assess the rehabilitation completion criteria that "grazed land maintains a percentage ground cover of between 50% and 96% on slopes up to 10% and between 70% and 96% on slopes between10-15%". While this criteria relates specifically to rehabilitation areas to which cattle have been introduced (at advanced stages of rehabilitation development), it is prudent to commence this monitoring prior to the introduction of cattle. This data can then be used to calculate the effect of grazing on percentage cover, and thereby predict the groundcover expected at ungrazed sites following cattle introduction. This in turn will be useful for adjusting stocking rates, if required.

Ground cover is to be calculated by running a 50 m measuring tape along the length of each vegetation monitoring transect. Observations of the type of cover (limited to the cover present below 1 m above ground level) are made at point intercepts along the centre line of the 50 m transect at 0.5 m intervals. Cover types include (a) vegetation (including all live vegetation and standing senescent vegetation that is still attached to the main plant and is not in intimate contact with the soil); (b) leaf litter and woody debris; (c) rock or (d) bare ground. The cover type that is intercepted directly below each point is recorded. The intercept point is to be assessed by viewing the ground through a small observation hole (in a piece of stiff card or plastic) or tube. Preferably, this should contain a cross hair, although this is not obligatory. A total of 100 observations are made per transect, and the sum of each cover type equates to its percentage cover.

Percentage cover is to be assessed at rehabilitation sites only (reference site data is not required). Monitoring is to be undertaken concurrently with assessments of landscape function and vegetation surveys in the late wet season.

Recruitment

The extent of natural recruitment of established woody species is to be assessed within each of the 10 m × 50 m belt transects used to assess weed cover (see **Section 9.1.7**). Percentage recruitment is simply the number of woody species present as seedlings or suckers <2 m tall divided by the the number of woody species >2 m tall that is found within the belt transect.

Pasture Productivity

Pasture productivity within rehabilitated sites is to be equivalent to nearby unmined sites on the same soil types. Pasture productivity is to be assessed via one of two methods:

1) Manual measurements of pasture mass at specific moments in time. An electronic dry matter capacitance meter (e.g., Grassmaster Pro) can be used to estimate pasture dry mass (kg/ha) at points within rehabilitation areas. This technique is superior to traditional plate meters on stony ground, such as will be found on sloping rehabilitation areas. The exact number of replicate points required per rehabilitation area is dictated by the variation observed between points and the need to meet the conditions of the completion criteria, namely that pasture mass is not significantly different from unmined areas, with adequate sampling to detect ≥10% difference between groups. An appropriate sample size (n) is based on the following formula:

$$n = 15.68*\sigma^2 / d^2,$$

where σ^2 is the population variance, and d is the minimum difference required to be detected. This formula is based on a standard 95% confidence interval and 80% power. It is anticipated that several hundred point-readings are likely to be required per rehabilitation area and reference paddock. Data from the first 100 readings can be used to calculate n for a d value that represents 10% of the mean dry mass at the reference site. Reference and rehabilitation areas are to be assessed concurrently, at the end of the growing season (April-May).

2) Satellite estimation of pasture growth rate. The CSIRO is in the process of developing their "Pastures from Space" website, which uses satellite imagery to provide real-time data on pasture growth rates at fine spatial scales. This technique has been optimised for temperate Australian pastures, but its applicability to the tropics and subtropics remains unclear. With further development and optimisation, this tool could provide a highly efficient method for comparing pasture productivity between rehabilitation and reference areas, without the need to undertake labour-intensive field studies. It is expected that this tool may be available by the time pasture productivity monitoring is to commence at the Mine (i.e. 2031, six years after the first planting).

Water Quality

The Mine will have a groundwater and surface water monitoring program operating throughout all phases of the Mine, including through rehabilitation and closure.

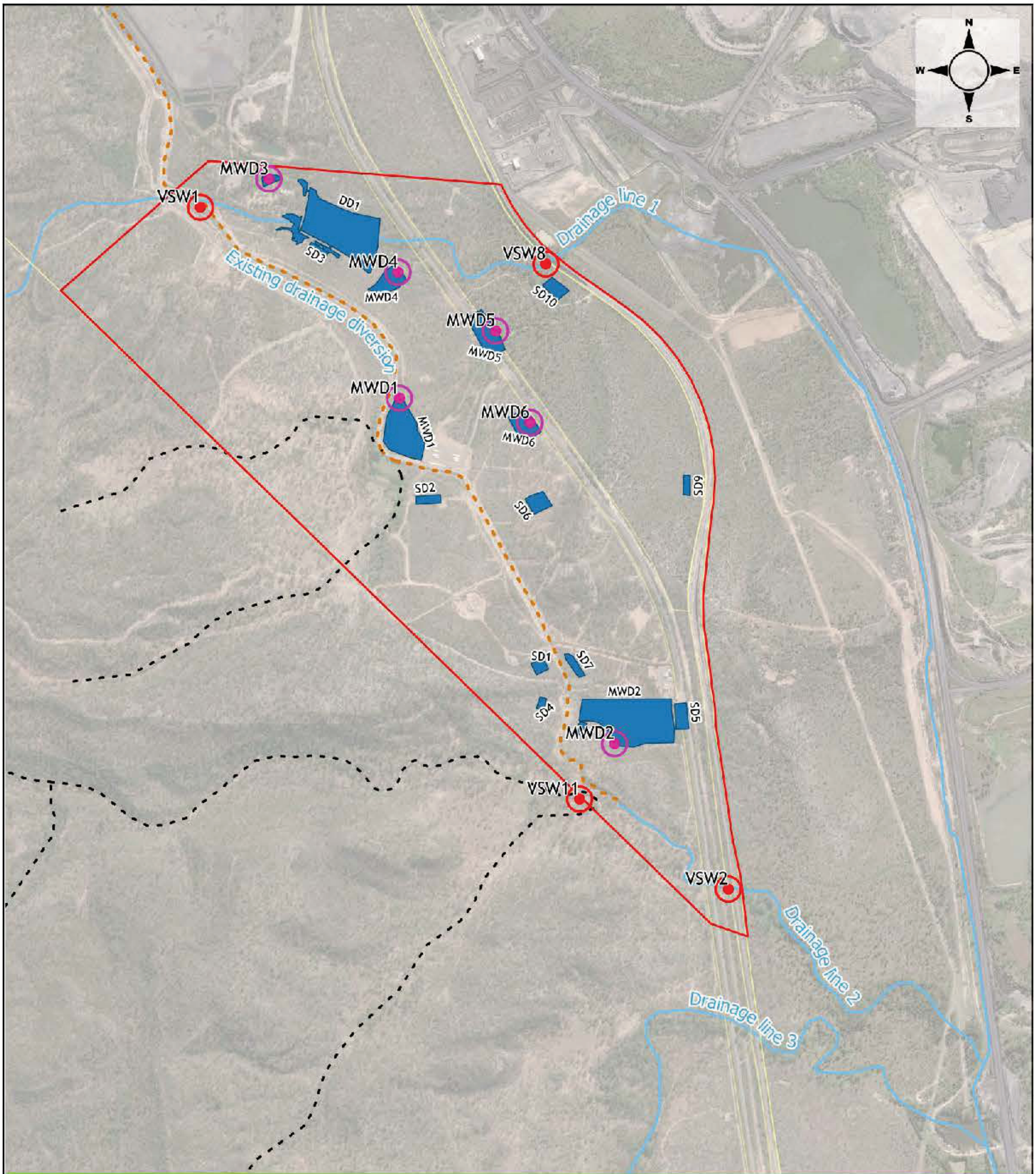
Surface water will be monitored at four locations listed in **Table 9-2** and shown on **Figure 9-3**. All four monitoring locations are highly ephemeral, and water sampling is to coincide with each flow event that occurs at each location.

Interim locally derived receiving waters trigger values have been proposed for the Mine using the 80th percentile of recorded reference site data in accordance with ANZG (2018). The 80th percentile values were compared against the Mine Water Quality Objective (WQO) default trigger values given in WRM (2021) and the Model Mine Conditions guideline (DES 2017). ANZG (2018) states that reference data can be used to derive site-specific guideline values for water quality when natural background concentrations of a toxicant exceed the Mine WQO default trigger value.

ANZG (2018) recommends that baseline data is collected over two years of monthly sampling (18 to 24 samples), to indicate ecosystem variability. The recommended number of samples at each location has not yet been collected and therefore the proposed interim receiving water site-specific guidelines values (see **Section 5.1, Table 5-2)** should be reviewed once sufficient monitoring data has been collected.

Table 9-2 Surface water monitoring locations

Station ID	Catchment	Latitude	Longitude	Description
Upstream Sites				
VSW1	Boomerang Ck	-22.276605	148.174505	Diversion bund approximately 3.1 km upstream of Drainage Line 2. Used as an upstream monitoring location for all site dams
VSW11	Boomerang Ck	-22.29796	148.18932	Minor drainage line, upstream of confluence of the existing drainage diversion and Drainage Line 2
Downstream sites (receiving waters)				
VSW2	Boomerang Ck	-23.301059	148.195230	Drainage Line 2 upstream of the railway. Used as a downstream monitoring location for SD1, SD2, SD4, SD5, SD7, SD8 and MWD2
VSW8	Boomerang Ck	-22.278613	148.187818	Drainage Line 1 upstream of the railway. Used as a downstream site for SD10, SD11, SD12, DD1, MWD3,SD3, MWD1 and MWD3.



Legend

- Cadastre
- Project ML
- Receiving water monitoring location
- Dam monitoring locations
- Sediment dams

Local Drainage Features

- Minor Drainage Feature
- Drainage Feature
- Drainage Diversion
- Watercourse

Vulcan Coal Mine
Surface Water Assessment

Surface water monitoring locations

0 0.5 1 km

wrm water+environment

FIGURE 9-3

Groundwater will be monitored at three locations listed in **Table 9-3** and shown in **Figure 9-4**. Daily water level measurements are to be collected by installed data loggers, while water quality is assessed by collecting water samples each month. Electrical conductivity and pH is measured in the field, and all other attributes are assessed at an approved laboratory.

Table 9-3 Groundwater monitoring bore locations

Monitoring Location	Latitude (GDA94)	Longitude (GDA94)	Surface RL (mAHD)	Depth (mbGL)	Aquifer	Monit. Unit*
MB04	-22.27597	148.18431	243.28	21.5	Moranbah Coal Measures	DLL coal seam
MB05	-22.28721	148.18392	252.70	40.9	Back Creek Group	MAT coal seam
MB13	-22.29849	148.19340	223.13	35	Back Creek Group	MAT coal seam

*DLL = Dysart Lower Lower; MAT = Matilda.

Note that two other bores (MB02 and MB03) were initially included in the monitoring program, but have been removed due to an absence of water during pre-mining baseline monitoring.

An additional three groundwater monitoring bores will be installed during operations, inaccordance with the general locations and timing presented in the EA. The specific locations will be determined once detailed design work has been completed.

Legend

ML 700060

Groundwater Monitoring Bores

- DLL seam
- MAT seam

Source: State of Queensland (Department of Resources) 2021, METServe 2021, Esri, Geoscience Australia, NASA, NGA, USGS.

Vulcan Coal Mine

Groundwater Monitoring Locations

0 250 500

Meters

Scale: 1:18,000 (A4)

6/12/2021

Datum: GDA94
Projection: MGA55

FIGURE 9-4

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Path: S:\Projects\VI010_Vulcan_Complex_Project_Jupiter_section\ARCGIS\Projects\VI010_RAIL_LOOP_PRCP_OtherFigures.aprx

9.1.9 Rehabilitation Milestone 9: Acceptance of Saraji Road by Isaac Regional Council

Vitrnite is signatory to a formal conpensation agreement with IRC for the realignment of Saraji Road. This agreement prescribes the terms and conditions for IRC's acceptance of responsibility for the management and maintenance of the realigned road.

Upon completion of the construction of the road realignment, Vitrinite is to provide IRC with a Certificate of Practical Completion. The receipt of this certificate denotes the start of a "Defects Period", during which Vitrinite will continue to be responsible for all maintenance costs associated with rectifying any identified defects in the realignment, and must do so at the direction of IRC if required.

The Defects Period will end on the later of a 12-month period after Vitrinite provides IRC with a Certificate of Practical Completion or the date that IRC notifies Vitrinite that the new road alignment is accepted "off maintenance". Rehabilitation milestone 9 is considered complete following this acceptance by IRC.

Inspections of road condition will be the responsibility of IRC, but Vitrinite will be responsible for undertaking traffic monitoring in accordance with the compensation agreement.

9.1.10 Rehabilitation Milestone 10: Transferral of Infrastructure to BMA

Any monitoring of infrastructure condition prior to transferral of ownership to BMA is to be in accordance with the conditions of the signed agreement with BMA.

9.1.11 Monitoring Report

Rehabilitation milestones RM6, RM7 and RM8 are generally to be assessed concurrently and, as these constitute the primary rehabilitation completion criteria for the Mine, they will be monitored over an extended period of at least ten years. The results of each round of monitoring (every two years for most attributes) are to be presented in a report that assesses progress of these three milestones. Each report is to contain details about how the methodology used is consistent with this PRC Plan. Each report is also to discuss how the results obtained indicate progression towards the fulfilment of milestone criteria. This monitoring report is to be completed by 1 October in the calendar year in which surveys are undertaken, to allow adequate time for Vitrinite to report on the findings by the state-wide reporting deadline of 10 December.

9.2 Audits

In accordance with section 285 of the *Environmental Protection Act 1994*, holders of a PRC Plan schedule must commission a rehabilitation auditor to undertake an audit of the PRC Plan schedule every three years. The first audit must be for the three-year period that commences from the day the schedule takes effect. Each subsequent audit period is for the three years commencing on the day after the previous audit period ended. Each audit report must be delivered to the administering authority within four months after the end of each audit period.

In accordance with section 286 of the *Environment Protection Act 1994*, each audit must include the following:

- a statement about whether the holder has complied with the schedule during the audit period;
- a description of actions the holder has taken with respect to rehabilitation milestones and management milestones;
- whether the holder has complied with conditions imposed on the schedule;
- a declaration stating the holder has not knowingly given false or misleading information;
- an assessment of whether the post-mining land use is likely to be achieved; and
- recommendations about actions the holder should take to ensure rehabilitation milestones and management milestones are achieved.

In addition to the mandatory three-yearly audits, the administering authority has the power (under section 322 of the *Environmental Protection Act 1994*) to issue an audit notice, which requires the holder of a PRC Plan schedule to commission an audit.

9.3 Annual Return

In addition to the annual return requirements that relate to EAs, in accordance with section 316IA of the *Environmental Protection Act 1994*, the annual return must also include an evaluation of the effectiveness of the PRC Plan schedule, including the environmental management carried out under the schedule, for the year to which the annual return relates. This evaluation must include:

- whether any milestones to be completed under the PRC Plan schedule during the year have been met; and
- whether the conditions imposed on the PRC Plan schedule have been complied with.

9.4 Progressive Rehabilitation Report

In the event that a particular rehabilitation area within the tenure of the Mine has been rehabilitated in accordance with all relevant requirements of the *Environmental Protection Act 1994*, the relevant environmental authority, the PRC Plan schedule and any relevant guidelines made under the *Environmental Protection Act 1994*, the holder of the EA can apply for progressive certification. In accordance with section 318ZD of the *Environmental Protection Act 1994*, the application for progressive certification must be accompanied by a progressive rehabilitation report. The requirements for a progressive rehabilitation report are listed in section 318ZF of the *Environmental Protection Act 1994.*

9.5 Final Rehabilitation Report

A final rehabilitation report is to be prepared when applying to surrender the EA. The purpose of this final rehabilitation report is to demonstrate that the conditions of the EA have been complied with, and that rehabilitation of disturbed land has been carried out satisfactorily. The requirements of this final rehabilitation report are listed in section 262 of the *Environmental Protection Act 1994.*

9.6 Post-mining Management Report

A post-mining management report is to be submitted as part of the surrender application for the EA. This report states the requirements for ongoing management of the land, and includes an environmental risk assessment. The requirements of this post-mining management report are listed in section 264A of the *Environmental Protection Act 1994.*

10 PRC PLAN SCHEDULE

This section has been prepared in accordance with section 126D(1) of the *Environmental Protection Act 1994*. It contains a description of each rehabilitation area, a schedule of land availability for rehabilitation and a detailed description of the rehabilitation milestones that apply to each rehabilitation area. This information has been used to develop a PRC Plan schedule that describes when each rehabilitation milestone is to be progressively achieved in each rehabilitation area.

10.1 Final Site Design

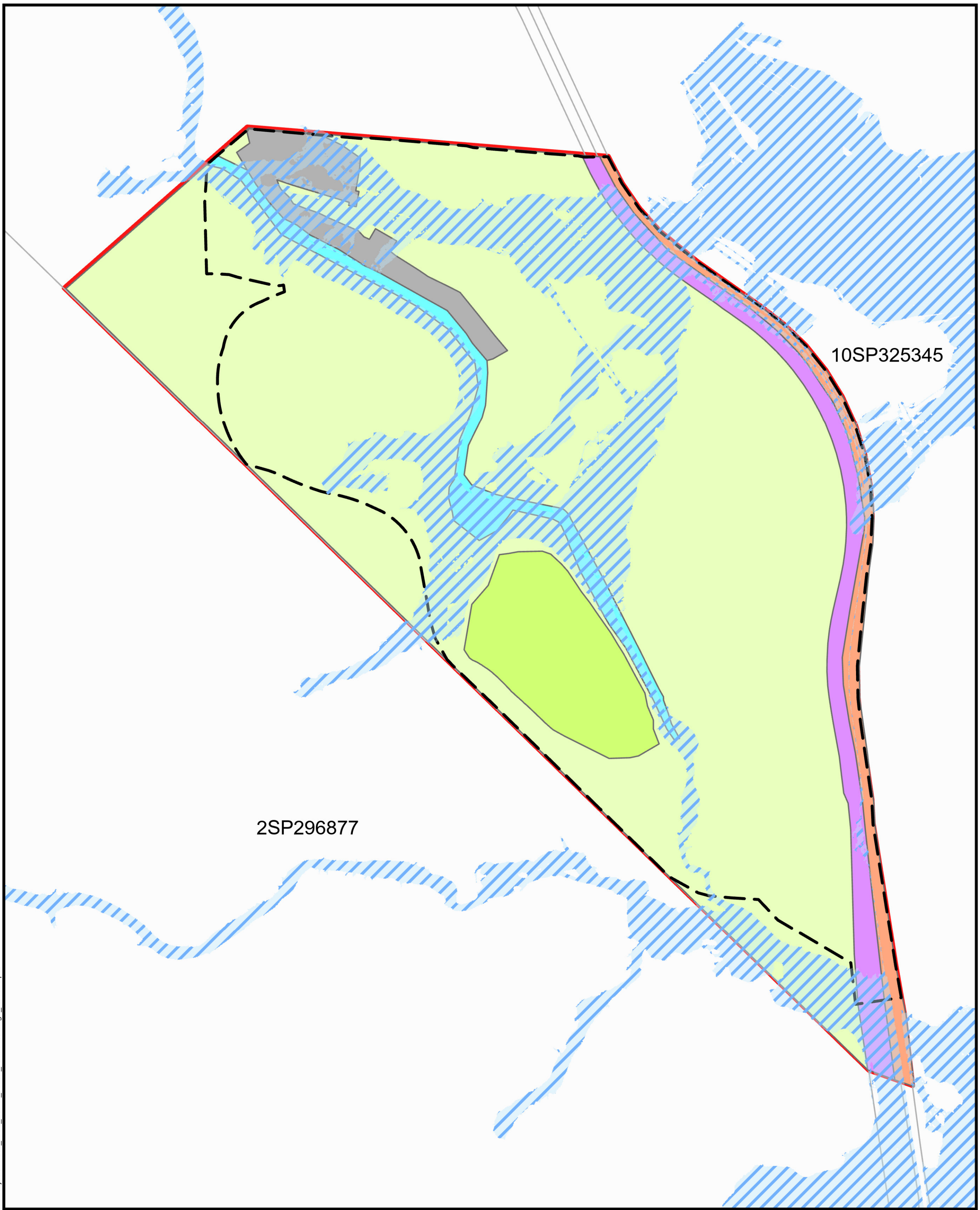
The final site design—showing the maximum disturbance footprint, the mining lease boundaries, the PMLUs for land within the mining lease, and flood plain extent—is shown in **Figure 10-1**.

10.1.1 Rehabilitation Areas

The disturbance footprint of the Mine has been divided into the following six rehabilitation areas with a common PMLU and rehabilitation methodology:

- RA1: Ex-pit WRD;
- RA2: In-pit WRD;
- RA3: CHPP, Rail loop, TLO, infrastructure, haul roads, stockpiles and run-of-mine pad;
- RA4: Dams and sediment ponds;
- RA5: Saraji Road; and
- RA6: Infrastructure to be retained for BMA.

The division of the disturbance footprint into rehabilitation areas is shown in **Figure 10-2**.



Legend

- ML700060 Boundary
- Cadastral Boundary
- VCM Revised Maximum Disturbance Footprint
- Flood Plain Extent

PMLU

- Cattle Grazing
- Cattle Grazing and Habitat for Threatened Fauna
- Flood Levee
- Mine-support Infrastructure
- Rail Corridor
- Saraji Road

Source: State of Queensland (Department of Resources) 2021, Vitrinite 2019-2021, METServe 2021.

Vulcan Coal Mine

Final Site Design

0 250 500

Meters

Scale: 1:18,000 (A4)

6/12/2021

Datum: GDA94
Projection: MGA55

FIGURE 10-1

VITRINITE BRIGHTER COAL

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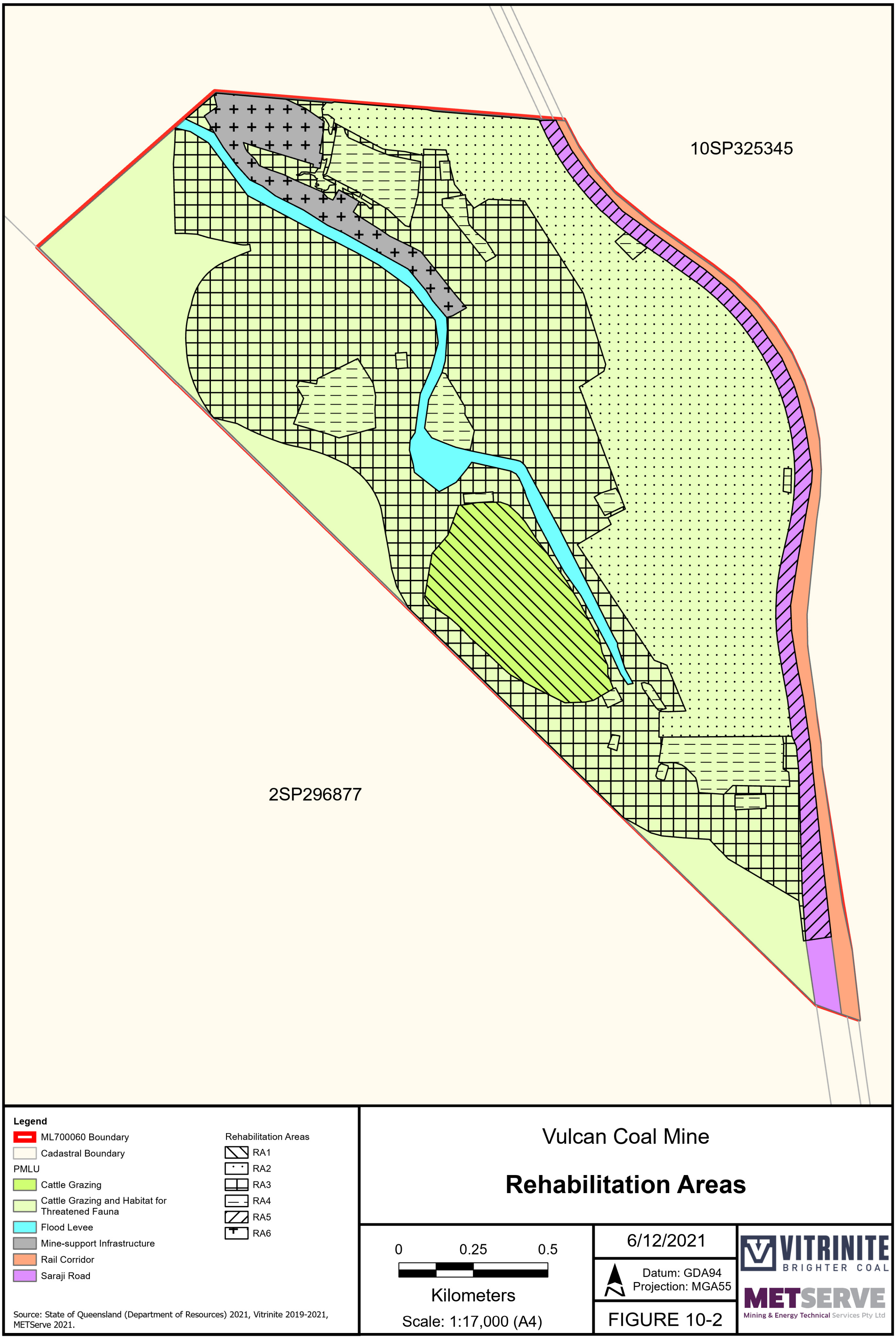
Path: S:\Projects\VI010_Vulcan_Complex_Project_Jupiter_section\ARCGIS\Projects\VI010_RAIL_LOOP_PRCP_FinalSiteDesign_Rehab.aprx


10SP325345
2SP296877
Legend
ML700060 Boundary
Cadastral Boundary
PMLU
Cattle Grazing
Cattle Grazing and Habitat for Threatened Fauna
Flood Levee
Mine-support Infrastructure
Rail Corridor
Saraji Road
Rehabilitation Areas
RA1
RA2
RA3
RA4
RA5
RA6
Source: State of Queensland (Department of Resources) 2021, Vitrinite 2019-2021, METServe 2021.
Vulcan Coal Mine
Rehabilitation Areas
0
0.25
0.5
Kilometers
Scale: 1:17,000 (A4)
6/12/2021
Datum: GDA94
Projection: MGA55
FIGURE 10-2
VITRINITE
BRIGHTER COAL
METSERVE
Mining & Energy Technical Services Pty Ltd

10.2 Schedule of Land Availability

Due to the gradual back-filling of the mined pit, land will become progressively available for rehabilitation throughout the four years of the Mine. Disturbed land is available for rehabilitation when:

1) the land is no longer being mined;
2) the land is no longer being used to dump further waste rock;
3) the land is no longer being used for operating infrastructure or machinery for mining; and
4) the land does not support permanent infrastructure (e.g. Saraji Road, northern Mine Infrastructure Area).

10.2.1 Timing Considerations

Mine plans, which include the schedule of land available for rehabilitation, have been developed for each 12 months starting at the commencement of the Mine. However, in accordance with the *Progressive Rehabilitation and Closure Plans Guideline*, annual reporting of rehabilitation works is to be based on the completion date of 10 December each calendar year. Consequently, the progression of the mine (and its rehabilitation) within any one calendar year is strongly dependent on the date the Mine commences. All calculations and predictions of land availability within each calendar year are based on the current forecast Mine commencement date of 1 February 2022. This date is subject to change, pending the government approval process and progression of the bulk sampling that precedes the Mine.

One rehabilitation milestone (revegetation) is strongly season-dependent, and is only to take place following the start of wet season rain. It is assumed that any land available for rehabilitation later than July in any one calendar year is unlikely to have sufficient time to undergo infrastructure removal, decontamination and final landform shaping in preparation for revegetation at the start of the wet season (November-January, depending on the year). Consequently, deferring the commencement of rehabilitation of such land until the following year will not delay the revegetation stage.

Land that is available for rehabilitation before July will commence rehabilitation in the same calendar year. It is expected that milestones RM1, RM2 and RM3 (see **Section 10.3**) will be completed in the year that land becomes available for rehabilitation. Milestones RM4 and RM5 may also be completed the same year (relative to the reporting date of 10 December), but only if the wet season commences early (e.g., November). As the start of the wet season is unpredictable, for the purposes of the schedule, it is assumed that milestones RM4 and RM5 will be completed early in the following year, and hence are attributed to the following years' progress in the schedule.

Based on tree growth rates and pasture development at other mines in central Queensland (Mulligan *et al.* 2006), it is expected that the target vegetation community will be established ten years after planting, and the land will be suitable for the commencement of grazing at this time. This is a conservative estimate to allow for opportunities for remedial planting in the event of initial failures; grazing has been successfully introduced to central Queensland pastures with trees that are as young as four years old (Donaghy *et al.* 2010).

10.2.2 Schedule of Availability

The schedule of land availability for rehabilitation in each rehabilitation area is shown in **Table 10-1**.

Table 10-1 Schedule of land availability for rehabilitation

Rehabilitation Area		Land available for rehabilitation in each year (ha)*						
		2022	2023	2024	2025	2026	2027	2028
RA1	Ex-pit WRD	14	0	10	0	0	0	0
RA2	In-pit WRD	0	19	42	44	0	0	0
RA3	CHPP, Rail loop, TLO, infrastructure, haul roads, soil stockpiles and run-of-mine pad	0	0	0	64	86	0	0
RA4	Dam and sediment ponds†	0	0	0	0	0	0	25
RA5	Saraji Road‡	0	0	0	0	17	0	0
RA6	Infrastructure to be retained	0	0	0	0	0	0	13
Total		**14**	**19**	**52**	**108**	**103**	**0**	**31**

*Land areas represent hectares of land that becomes available for the first time in that year (i.e., is not cumulative across years).

†Erosion control infrastructure is to remain in place until sufficient vegetative cover has developed on rehabilitated land. This is conservatively estimated to be three years post-mining, but may be sooner.

‡The realigned Saraji Road corridor will be constructed and operational within year 1; however, further rehabilitation works within the corridor fringes may be required following construction of the final in-pit WRD landform. Hence rehabilitation works are scheduled to occur after the landform is established.

10.3 Rehabilitation Milestones

Rehabilitation milestones relevant to the Mine area are listed in **Table 10-2**.

Table 10-2 Rehabilitation milestones

Code	Milestone	Description	Applicable Rehabilitation Areas
RM1	Infrastructure decommissioning and removal.	▪ Services such as water and electricity have been disconnected and terminated; ▪ Buildings (modular CHPP, TLO, administration, ablution block, workshops, warehouses, etc.) have been demolished and removed; ▪ Bitumen, blue metal, aggregate, etc., have been removed; ▪ Fencing has been removed; ▪ Rail tracks and balast have been removed; and ▪ Boreholes have been decommissioned.	RA1, RA3
RM2	Remediation of contaminated land.	▪ Contaminated land investigations have been carried out; ▪ Contaminated water (e.g. affected by hydrocarbons) has been treated on site or removed; ▪ Contaminated materials have been appropriately removed and disposed of; ▪ On-site remediation of hydrocarbon-contaminated soils has been completed; and ▪ Completion of validation testing to confirm that contaminated soils have been removed/remediated.	RA1, RA3, RA4
RM3	Landform development and reshaping/reprofiling.	▪ Bulk earthworks to achieve required landform and slopes have been completed; ▪ Placement of subsoils over waste rock has been completed; ▪ General reshaping to achieve final landform is complete; and ▪ Installation of erosion and sediment control systems is complete.	RA1, RA2, RA3, RA4
RM4	Surface preparation.	▪ Remediation any erosion or subsidence is complete; ▪ Growth media (topsoil) has been sourced, carted and spread; ▪ Ameliorants to improve or stabilise soils have been added; and ▪ Deep riping has been undertaken.	RA1, RA2, RA3, RA4
RM5	Revegetation.	▪ Direct seeding has been completed; ▪ Fertiliser has been applied; ▪ Tube stock (except RA1) has been planted; and ▪ Stock fencing to protect planting has been installed.	RA1, RA2, RA3, RA4
RM6	Land is suitable for the commencement of grazing.	▪ Pasture is sufficiently productive to support grazing and (where relevant) trees are sufficiently tall to avoid damage by cattle; ▪ Internal stock fencing, to separate land ready for grazing from that not yet developed sufficiently, has been installed; and ▪ Water sources for cattle have been installed.	RA1, RA2, RA3, RA4
RM7	Establishment of target vegetation type.	▪ Monitoring has determined that vegetation meets the completion criteria.	RA1, RA2, RA3, RA4
RM8	Achievement of post-mining land use to stable condition.	▪ Monitoring has determined that that the land is safe, structurally stable, does not cause environmental harm and is able to sustain the PMLU.	RA1, RA2, RA3, RA4
RM9	Fulfilment of all conditions of the agreement with Isaac Regional Council for the construction and commissioning of Saraji Road.	▪ The road has been constructedin accordance with all conditions agreed between Isaac Regional Council and Vitrinite Pty Ltd in the signed compensation agreement. ▪ A "Defects Period" of at least 12 months has passed following the completion of construction. ▪ Isaac Regional Council has notified Vitrinite that the new road alignment is accepted "off maintenance".	RA5

Code	Milestone	Description	Applicable Rehabilitation Areas
RM10	The infrastructure to be retained meets the conditions of the signed agreement with BMA.	▪ Monitoring has been undertaken in accordance with the signed agreement and all retained infrastructure is in accordance with the signed agreement. ▪ BMA accepts responsibility for the infrastructure.	RA6

10.3.1 Milestone Criteria

Milestone criteria pertaining to each of the rehabilitation milestones are listed in **Table 10-3**.

Table 10-3 Milestone criteria

Code	Milestone	Milestone criteria
RM1	Infrastructure decommissioning and removal.	▪ All services disconnected; ▪ All road materials (bitumen, gravel) removed; ▪ All pipelines drained and removed; ▪ All fencing that is not part of the PMLU removed; ▪ All buildings are demolished and removed; ▪ All machinery and equipment removed; ▪ All rail lines removed; ▪ All surface water drainage infrastructure not required in the PMLU has been removed; and ▪ All rubbish removed.
RM2	Remediation of contaminated land.	▪ All contamination is remediated or removed from site; ▪ Any contamination removed from site has been removed in accordance with relevant regulations; and ▪ A contaminated land investigation document has been prepared by an approved auditor, containing a site suitability statement that states that land is not contaminated and is suitable for the PMLU.
RM3	Landform development and reshaping/reprofiling.	▪ All earthworks except topsoil handling and placement are complete; ▪ Subsoil has been applied and spread to RA2 (the in-pit WRD); ▪ All erosion and sediment control systems have been installed; ▪ The final landform surveyed and certified by a suitably qualified person as per the construction designs; ▪ Batters have a maximum slope of 15%; ▪ Rehabilitation areas RA1, RA2 and RA4 have 'as-constructed' plans prepared; and ▪ The back-filled pit has been certified as geotechnically stable by a suitably qualified person.
RM4	Surface preparation.	▪ Any erosion or subsidence that occurs after the achievement of RM3 has been remediated prior to topsoil application; ▪ 250 mm of topsoil has been be placed over all surfaces following amelioration of subsoils in accordance with the recommendations of an appropriately qualified person; ▪ Slopes greater than 10% have an average rock mulch cover of 30%; ▪ No slopes greater than 10% have a rock mulch cover exceeding 50%, to facilitate the safe movement of cattle and production of pasture; ▪ Slopes less than 10% do not have a rock mulch cover added; ▪ An assessment of soil health and suitability has been completed by an appropriately qualified person to confirm soil is suitable for target vegetation establishment; ▪ Any fertilisers/ameliorants recommended as a result of the soil assessment have been applied at the rate recommended by the appropriately qualified person; and ▪ Contour ripping and/or ploughing (depth of 0.4-0.5 m) has been undertaken after topsoil placement.
RM5	Revegetation.	▪ Seeding has been completed at a rate of 40.7 kg/ha using seed mixes; ▪ Any species not establishing after seeding (as identified 12 months after seeding) have been planted as tubestock in RA2, RA3 and RA4 at a density of 20-100 seedlings/ha; and

Code	Milestone	Milestone criteria
		▪ Supplementary seeding and tubestock planting completed within one year of sites failing to achieve vegetation establishment on initial attempts.
RM6	Land is suitable for the commencement of grazing.	▪ Rehabilitated areas have a pasture biomass that is not >10% less than pasture biomass on unmined areas within the same soil management unit measured at the same time, as measured under both wet and dry conditions; ▪ All corrective actions recommended by suitably qualified persons in response to erosion or deficient vegetation cover have been implemented; ▪ Rehabilitated areas are to have a land suitability class for cattle grazing of 4 or lower; ▪ No active rill or gully erosion deeper than 15 cm present; ▪ Trees are, on average, at least 4 m tall; ▪ Water sources have been installed; and ▪ Stock fencing installation is complete.
RM7	Establishment of target vegetation type*.	▪ *Eucalyptus crebra* and/or *Eucalyptus populnea* constitute ≥21% of the total basal area of woody vegetation on sand plains AND *Eucalyptus camaldulensis* is to constitute ≥33% of the total basal area of woody vegetation along Ripstone Creek and Drainage Line 2 (not applicable to RA1); ▪ Rehabilitated areas have a mean NDVI between 0.1240 and 0.1778.
RM8	Achievement of post-mining land use to stable condition*.	▪ All corrective actions recommended by suitably qualified persons in response to erosion or deficient vegetation cover have been implemented; ▪ A suitably qualified person has certified that the final landform is geotechnically stable; ▪ The land suitability class of rehabilitated land is to be 4 or lower for cattle grazing; ▪ Rehabilitated areas have a pasture biomass that is not >10% less than pasture biomass on unmined areas with the same soil management unit measured at the same time, as measured under both wet and dry conditions; ▪ Landscape function analysis scores for soil stability, infiltration/runoff and nutrient cycling have started to plateau, and the plateau values predicted from sigmoidal curves fitted to the data are equivalent to or exceeed values at analogue sites; ▪ Erosion monitoring has been completed; ▪ No active rill or gully erosion deeper than 15 cm present; ▪ Grazed land maintains a percentage ground cover of between 50% and 96% on slopes up to 10% and between 70% and 96% on slopes between 10-15%; ▪ Rehabilitated areas have ≤0.2% cover of *Parthenium hysterophorus* AND ≤0.1% cover of *Harrisia martini*; ▪ Any other weeds listed under the *Biosecurity Act* are present in densities of <1 individual per hectare; ▪ Surface water in downstream monitoring locations remains within site-specific water quality monitoring limits detailed in environmental authority EA0002912 in Table F2: Interim contaminant trigger investigation levels; ▪ Groundwater in downstream monitoring locations remains within site-specific water quality monitoring limits detailed in environmental authority EA0002912 in Table E2: Groundwater quality limits; ▪ At least 50% of established species show natural recruitment; and ▪ Sites fulfil all other milestone criteria after having experienced at least one “drought” year (defined as having a total rainfall over a 12-month period that falls within the lowest decile recorded at the nearest weather station, Moranbah Airport).
RM9	Fulfilment of all requirements of the agreement with Isaac Regional Council for the construction and commissioning of Saraji Road.	▪ Isaac Regional Council (IRC) has notified Vitrinite that the new road alignment is accepted “off maintenance”, in accordance with processes prescribed by the signed compensation agreement between Vitrinite and IRC.
RM10	The infrastructure to be retained meets the conditions of the signed agreement with BMA.	▪ Monitoring has been undertaken in accordance with the signed agreement and all retained infrastructure is in accordance with the signed agreement; and ▪ BMA accepts responsibility for the infrastructure in accordance with a formal written agreement.

*For a more detailed description and justification of milestone criteria used for the final two rehabilitation milestones, refer to **Section 5.1**.
^For Erosion Monitoring Classifications, see Section 9.6.1 of the VCM Soils and Land Suitability Assessment (Appendix I of the EA Application Supporting Information document).

10.4 PRC Plan Schedule

The PRC Plan Schedule is provided in **Table 10-4**.

Table 10-4 PRC Plan Schedule

Rehabilitation area				RA1						
Relevant activities				Ex-pit waste rock dump						
Total size of rehabilitation area (ha)				24 ha						
Commencement of first milestone (RM3)				01 Aug 2022						
PMLU				Low-intensity cattle grazing						
Date area is available	31 Jul 2022		31 Jul 2024							
Cumulative area available (ha)	14		24							
	Milestone completed by									
	10 Dec 2022	10 Dec 2023	10 Dec 2024	10 Dec 2025	10 Dec 2033	10 Dec 2035				
Milestone code	**Cumulative area achieved (ha)**									
RM3	14	14	24							
RM4		14	14	24						
RM5		14	14	24						
RM6					14	24				
RM7					14	24				
RM8					14	24				
Rehabilitation area				RA2						
Relevant activities				Open-cut mining pit; In-pit waste rock dump						
Total size of rehabilitation area (ha)				105 ha						
Commencement of first milestone (RM3)				01 Aug 2023						
PMLU				Low-intensity cattle grazing with habitat for Koalas and Squatter Pigeons						
Date area is available	31 Jul 2023	31 Jul 2024	31 Jul 2025							
Cumulative area available (ha)	19	61	105							
	Milestone completed by									
	10 Dec 2023	10 Dec 2024	10 Dec 2025	10 Dec 2026	10 Dec 2034	10 Dec 2035	10 Dec 2036			
Milestone code	**Cumulative area achieved (ha)**									
RM3	19	61	105							
RM4		19	61	105						
RM5		19	61	105						
RM6					19	61	105			
RM7					19	61	105			
RM8					19	61	105			

Rehabilitation area	RA3									
Relevant activities	CHPP, Rail Loop, TLO, haul roads, internal tracks, soil stockpiles, run-of-mine pad, magazine									
Total size of rehabilitation area (ha)	150 ha									
Commencement of first milestone (RM1)	01 Aug 2025									
PMLU	Low-intensity cattle grazing with habitat for Koalas and Squatter Pigeons									
Date area is available	31 Jul 2025	31 Jul 2026								
Cumulative area available (ha)	64	150								
	Milestone completed by									
	10 Dec 2027	10 Dec 2028	10 Dec 2029	10 Dec 2038	10 Dec 2039					
Milestone code	**Cumulative area achieved (ha)**									
RM1	64	150								
RM2	64	150								
RM3	64	150								
RM4		64	150							
RM5		64	150							
RM6				64	150					
RM7				64	150					
RM8				64	150					

Rehabilitation area	RA4									
Relevant activities	Dams, sediment control drains and ponds									
Total size of rehabilitation area (ha)	24 ha									
Commencement of first milestone (RM1)	01 Aug 2028									
PMLU	Low-intensity cattle grazing with habitat for Koalas and Squatter Pigeons									
Date area is available	31 Jul 2028									
Cumulative area available (ha)	24									
	Milestone completed by									
	10 Dec 2028	10 Dec 2029	10 Dec 2039							
Milestone code	**Cumulative area achieved (ha)**									
RM1	24									
RM2	24									
RM3	24									
RM4		24								
RM5		24								
RM6			24							

RM7			18							
RM8			18							
Rehabilitation area				RA5						
Relevant activities				Saraji Road						
Total size of rehabilitation area (ha)				17 ha						
Commencement of first milestone (RM9)				30 Apr 2026						
PMLU				Road						
Date area is available	30 Apr 2026									
Cumulative area available (ha)	17									
	Milestone completed by									
	10 Dec 2027									
Milestone code	**Cumulative area achieved (ha)**									
RM9	17									
Rehabilitation area				RA6						
Relevant activities				Offices, workshops, warehouses, roads and associated water management infrastructure and topsoil stockpiles						
Total size of rehabilitation area (ha)				13 ha						
Commencement of first milestone (RM9)				31 Jul 2028						
PMLU				Mine-support infrastructure						
Date area is available	31 Jul 2028									
Cumulative area available (ha)	13									
	Milestone completed by									
	10 Dec 2028									
Milestone code	**Cumulative area achieved (ha)**									
RM10	13									

11 REVISION OF THE PRC PLAN

The holder of a PRC plan may, at any time, apply to the administering authority to amend their PRC Plan schedule (an amendment application). An application may be made to amend only the PRC Plan schedule, or as part of an amendment application for an EA. An amendment application must be submitted in the approved form and be accompanied by the relevant fee and an amended rehabilitation planning part for the holder's PRC plan that complies with section 126C of the EP Act. Due to the dependencies between an EA and the PRC Plan schedule, an applicant should always consider whether a proposed amendment to the PRC Plan schedule requires a concurrent amendment to the EA in order to ensure consistency between both instruments.

Once a PRC Plan schedule has been amended, the rehabilitation planning part of the PRC plan must be reviewed and revised to make any necessary or appropriate changes. The administering authority is to be provided with a copy of the amended PRC plan within 10 business days of receiving a copy of the amended PRC Plan schedule (or receiving written notice under section 211 of the EP Act), unless the administering authority agrees to a longer period.

12 SPATIAL INFORMATION

Shapefiles detailing the following spatial information were submitted to the administering authority accompanying the submission of this PRC plan.

- the location and maximum extent of the disturbance footprint for the mine life;
- the PMLU and NUMAs for the area within the resource tenures; and
- the rehabilitation areas within the resource tenures;
- the locations of sensitive receptors.

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