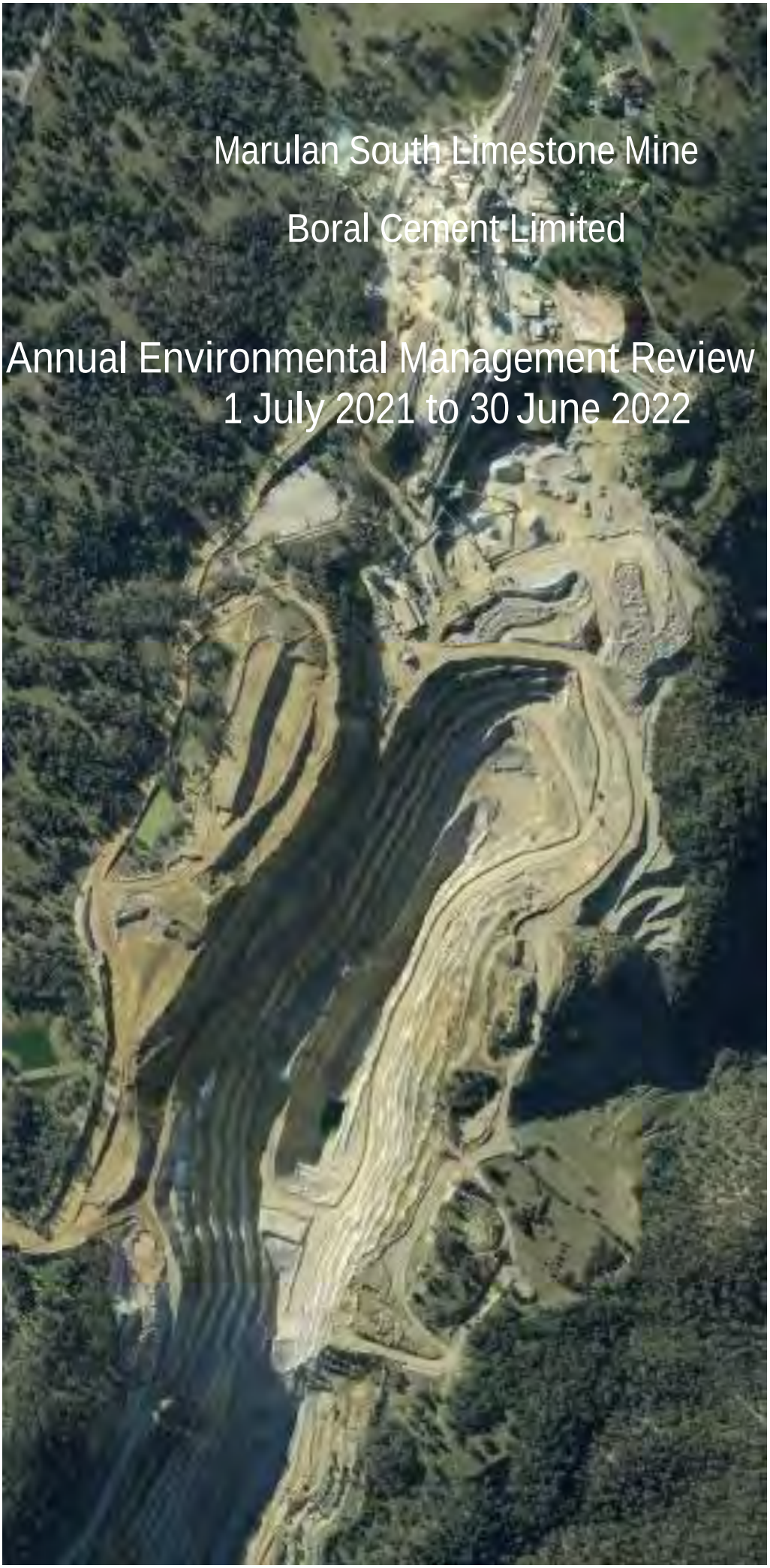

Marulan South Limestone Mine

Boral Cement Limited

Annual Environmental Management Review
1 July 2021 to 30 June 2022

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ANNUAL REVIEW INFORMATION

AEMR Authorisation

Name of Operation	Marulan South Limestone Mine
Name of Operator	Boral Limited
Development Consent No.	DA/0156/1112 DA No. 2802 DA No. 118/967
Name of holder of development consents	Boral Limited
AEMR start date	01 Jul 2021
AEMR end date	30 Jun 2022

I, Greg Johnson, certify that this audit report is a true and accurate record of the compliance status of the Marulan South Limestone Mine for the period 1 Jul 2021 to 30 June 2022 and that I am authorised to make this statement on behalf of Boral Cement Limited.

Note.

a) The AEMR is an 'environmental audit' for the purposes of section 122B(2) of the Environmental Planning and Assessment Act 1979. Section 122E provides that a person must not include false or misleading information (or provide information for inclusion in) an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual $250,000.

b) The Crimes Act 1900 contains other offences relating to false and misleading information: section 192G (intention to defraud by false or misleading statement – maximum penalty 5 years imprisonment); sections 307A, 307B and 307C (False or misleading applications/ information/ documents – maximum penalty 2 years imprisonment of $22,000, or both).

Name of authorised reporting officer	Greg Johnson
Title of authorising reporting officer	Environmental Sustainability Manager, Boral Cement
Signature of authorised reporting officer	
Date	30 August 2022

1. STATEMENT OF COMPLIANCE

This Annual Environmental Management Review (AEMR) summarises compliance with the following Mining Authorisations, Mining Operations Plan and EPL applicable to the Marulan South Limestone Mine:

- ML 1716;
- CML 16;
- Marulan South Limestone Mine 2018-2023 Mining Operations Plan; and
- Environment Protection Licence 944.

The site also holds State Significant Development Approval (SSD) 7009 which was granted by the NSW Department of Planning, Industry and Environment on 19 August 2021 however this approval has yet to be triggered. This report has been prepared in accordance with the *Post-approval requirements for State significant mining developments Annual Review Guideline* (2015) (the Guideline). Tables 1.1 to 1.3 detail the compliance status of Marulan South Limestone Mine during the 2021 to 2022 reporting period.

Table 1.1 – Compliance Summary

Were condition of the relevant approval(s) complied with?	
ML 1716	Conditions satisfied
CML 16	No
MOP 2018-2023	No
EPL 944	Conditions satisfied

Table 1.2 – Non-Compliance

Approval	Condition	Description	Compliance Status	Comment	Where addressed
MOP 2018-2023 CML 16	Section 2.3.4 Condition 14	Blast Limits	Non-compliant	Not all blast monitoring was completed	6.6

Table 1.3 Compliance Status Key

Risk Level	Code	Description
High	Non-compliant	Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence.
Medium	Non-compliant	Non-compliance with: ❒ potential for serious environmental consequences, but is unlikely to occur; or ❒ potential for moderate environmental consequences but is likely to occur.
Low	Non-compliant	Non-compliance with: ❒ potential for moderate environmental consequences, but is unlikely to occur; or ❒ potential for low environmental consequences but is likely to occur.
Administrative non-compliance	Non-compliant	Only to be applied where the non-compliance does not result in any risk of environmental harm (eg submitting a report to government later than required under approval conditions).

It is anticipated that the pre-commencement conditions associated with SSD 7009 will be satisfied in the coming reporting period allowing commencement of the new approval. Future reporting will be referred to as an Annual Report and will be prepared in accordance with Clause D11 of SSD 7009.

2. INTRODUCTION

2.1 Overview

Boral's Marulan South Limestone Mine has been operational since the 1860s, consisting of a limestone mine and processing plant. It is located directly to the north of Bungonia Gorge and approximately 35km east of Goulburn NSW, with lands covering 650 hectares of a significant limestone and granodiorite deposit. Resources over a total of 616.5 hectares of land are to be extracted under current approvals.

Under existing use rights, the mine is consented to produce up to 3.38 million tonnes of limestone per annum, which is used to supply the construction, agricultural and industrial markets across the state. Limestone is an essential ingredient in cement and steel manufacture while a component is further processed on site to produce Calcium Oxide and Hydrated Lime for various applications such as water purification, mining, asphalt production and soil stabilisation. Crushed Limestone is transported by rail direct to the Boral Cement Works at Berrima and Maldon, or to Bluescope Steel at Port Kembla. Limestone supplied to the Peppertree Quarry forms a key part of manufactured sand for concrete and Limestone and fine limestone are also widely used in the agricultural industry for neutralising soils and for animal feed. Lime products are distributed typically by road tanker to destinations throughout NSW or by container to Queensland and Victoria. A component of the mine production including clay shale and aggregates is transported directly by truck where rail facilities are not available. Marulan South Limestone Mine operates 24 hours per day, 7 days per week and employs approximately 95 full time personnel.

Boral received approval of the Marulan South Limestone Mine Continued Operations State Significant Development Application (SSDA) on the 19th August 2021 and is currently working through the implementation requirements of the consent. The approval provides modern planning consent consistent with current legislative requirements which covers a 30 year mine plan representing 120 Mt of limestone at an extraction rate of 4 Mtpa. Clay shale will also be extracted at up to 200,000 tpa. The new mine plan seeks to incorporate rehabilitation and final landform initiatives with overburden emplacement. Given that the SSDA approval has not yet been triggered, this report covers the prior approvals and operations under existing use rights.

The continued operations of the mine will provide an uninterrupted supply of construction materials to local and regional industries and state projects with an optimal use of regionally significant resources. The mining project is expected to provide economic benefits to the local community through the purchase of goods, local expenditure, and continued employment of almost 200 people, both directly and indirectly associated with the mining operations.

This Annual Environmental Management Review (AEMR) has been prepared to reflect the existing operations over the 2021-2022 reporting period whilst also taking into account the new SSD project and associated rehabilitation initiatives. In light of this, this report has been structured in accordance with the Department of Planning and Environment guidelines from the preparation of Annual Reviews.

2.2 Key Personnel

Details of the management personnel at Marulan South Limestone are provided in Table 2.1 below. Additional specialist advice is provided as required by a range of environmental consultants.

Table 2.1 –Mine Contacts

Role	Name	Contact
Marulan Limestone Statutory Quarry Manager	Les Longhurst	Ph: 0401 895 032 Email: les.longhurst@boral.com.au
Mine Technical Manager	Garth Nagle	Ph: (02) 4820 3048 Email: garth.nagle@boral.com.au
Environmental Sustainability Manager Boral Cement	Greg Johnson	Ph: (02) 9033 4916 Email: greg.johnson@boral.com.au
Environmental Coordinator	Therese Hadjia	Ph: (02) 4820 3007 Email: therese.hadjia@boral.com.au

3. APPROVALS

3.1 Consents, Authorisations and Licenses

Existing Consents, Authorisations and Licences as detailed in this section were subject to applications for amendment, revision or replacement in accordance with changes in statutory requirements. An Environmental Impact Statement for the continued operations of the mine was prepared and a State Significant Development Application (SSDA) was lodged with the Department of Planning Investment and Environment (DPIE) in 2018. The SSDA covers a 30 year period for the extraction of up to 4 million tonnes per annum (tpa) of limestone, extraction of up to 200,000 tpa of clay shale and the processing of the lime products (hydrated lime and quick lime) limestone aggregates and sand.

Approval of the SSDA was granted on the 19th August 2021 (SSD7009) but development under this consent is yet to commence and as such the below DAs and 'existing use rights' remain the key planning instrument governing the site during the reporting period.

3.1.1 Development Consents

The local government authority is Goulburn Mulwaree Council that administers the Goulburn Mulwaree Local Environmental Plan (LEP) 2009 and the current development consents issued for the mine.

Currently limestone mining and processing operations within Consolidated Mining Lease No.16 (refer to Section 3.1.2) and Mining Lease No. 1716 (refer to Section 3.1.3) are subject to five development consents:

- The Barbers Creek Disposal Area for which the development consent was given on 21 December 1972 to Southern Portland Cement Limited;
- Q8 Quarry and Main Gully Disposal Area to which development consent was given on 16 October 1974 to BCSC;
- DA/0156/1112 was approved by Goulburn Mulwaree Council on 1 March 2012 for a Limestone Sand Plant capable of producing up to 800,000 tpa of manufactured sand;
- DA No. 2802 granted 13 February 1995 for Proposed White Clay Extraction on lands described as Portion 83 and public road with Portion 83 in the Parish of Marulan;
- DA No. 546/0506/DA for a lime plant maintenance shed, approved by Goulburn Mulwaree Council on 20 June 2006; and
- DA No. 118/967 granted 22 May 1997 for Proposed Clay Shale Extraction within the Marulan South Limestone Quarry on lands described as Portions 81, 82, 132, 114, ML8, and ML 16 in the Parish of Marulan.

The remaining lease area is operated under 'continuing use rights', under section 109 of the EP&A Act as defined by the boundary of disturbance as at 1 August 2007 presented in the 2018/2023 MOP Plan 4. The above DAs and 'continuing use rights' will be required to be surrendered within 12 months of commencement of development under the SSD7009 consent.

In addition, the following development applications have previously been approved by Council:

- Application No.129/0405/OSMF for an on-site sewage management facility, approved by Goulburn Mulwaree Council on 8 September 2005 to upgrade septic facilities at the Lime Plant.
- Development Application Number 646/0405/DA approved by Goulburn Mulwaree Council for two – 200m^3 silos installed adjacent to the existing lime product storage and load out facility.

3.1.2 Consolidated Mining Lease No. 16

Consolidated Mining Lease No. 16 (CML16) was granted on the 23 April 2004 for the purpose of prospecting and mining for agricultural lime, clay/shale, iron minerals, limestone, marble, and structural clay. CML16 is the consolidation of 66 leases that allows mining operations at Marulan South Limestone Mine until 26 February 2023.

3.1.3 Mining Lease 1716

ML1716 was granted on the 4 September 2015 to remove a depth restriction on 12.04 hectares on the Eastern Batters within CML16. The lease was granted for a period of 21 years for mining clay/shale, iron minerals, limestone, marble, and structural clay.

3.1.4 Mining Authority Application

During the reporting period, an application for a new mining lease was lodged with Department of Regional NSW - Resource Operations, Mining, Exploration and Geoscience upon approval of the SSDA. This mining lease will cover the new mining and associated ancillary activity areas detailed in the SSDA that are not already covered by CML16. This application will likely result in the granting of one consolidated mining lease for the whole operation which will be detailed in the updated RMP. It is expected that the new mining lease will be granted early in the coming reporting period.

3.1.5 Environmental Protection Licence (EPL) 944

Boral Cement Limited is the licensee of EPL 944 for the "Marulan South Limestone Mine and Lime Plant". The EPL allow for between 100,000 and 250,000 tpa of cement or lime production and between 2 and 5 million tpa of minerals production by mining.

Commencement of development under of the SSD consent in the forthcoming reporting period will trigger a revision and variation of the EPL in order to align new consent conditions placed on the operation with those in the EPL as is normal practice following a new planning approval.

3.1.6 Mining Operations Plan / Rehabilitation Management Plan

The current Mining Operation Plan (MOP) covers the period 1 April 2018 to 26 February 2023 and is detailed in Plans 1A-5B. A Rehabilitation Management Plan (RMP) will be finalised following receipt of the new mining lease which will replace the MOP.

3.1.7 Other Licences

The following activities and items are licenced:

Table 3.1 - Site Licences

Description	Licence No	Licence Authority	Renewal
Mining Lease Agreement	CML16	DRG	31/03/2023
	ML1716	DRG	04/09/2036
Explosive Licence to Import	11-100005-004	Safe Work NSW	15/06/2024
Acknowledgement of Notification of Dangerous Goods on Premises	35/008099	Safe Work NSW	N/A
Revised Apparatus Licence	1203917 1958988 & 1958989 9922223	A.C.M.A.	21/07/2023 23/01/2023 22/02/2023
Radiation Management Licence	5061123	NSW EPA	21/08/2023
Motor Vehicles Repairers Licence	MVRL 36381	NSW Fair Trading	02/01/2024
Refrigerant Trading Authorisation Certificate	AU 04450	ARC	10/03/2024
Certificate of Plant Item Registration	MC 6-82896/05/0	Safe Work NSW	16/10/2022
Bore Licences (2 x Production Bores) Converted to Certificate W3M9-WS-6FLQ Ground water bore	(WAL24697) 12 ML 10WA116142 10AL116141 (WAL41976) 838ML/units 10AL122346 10CA122907 (for road construction /dust suppression)	NSW Department of Primary Industries Office of Water	10 Aug 2024 3 Dec 2028
Water Supply Works – two bores	10CA123795	NRAR	08 Apr 2030
Monitoring Bore Licences	10BL605442 10BL605443 10BL605444 10BL605445 10BL605449 10BL605450	NSW Department of Primary Industries Office of Water	Licence 10AL116141D Perpetuity
Surface Water Licence (1 x Overshot Dam & 2 Pumps)	Water supply works 10WA102352 pump to overshot dam (Shoalhaven River water source) Pumps 10AL102350 - WAL 25352 Stock and domestic (1ML Barbers Ck MGMT Zone) 10AL102351 - WAL25207 unregulated river (76ML Barbers Ck MGMT Zone)	NSW Department of Primary Industries Office of Water	30/06/2024
Surface Water Licence (1 x 38mm Centrifugal Pump)	10WA102377 10AL102376 WAL 25373	NSW Department of Primary Industries Office of Water	25/04/2026

Description	Licence No	Licence Authority	Renewal
Environmental Protection Licence (EPL) Marulan South Limestone Mine and Lime Plant	944	EPA	24/02/2025
EPL Annual Return Marulan	944	EPA	27/01/2023
Local Land Services ACT 2013 - Rate Notice	Ref: 110324316	NSW Government Office of Local Land Services	Feb/March 2023

4. OPERATIONS SUMMARY

4.1 Exploration

The Annual Exploration Reports for ML1716 and CML16 were prepared by GeoRes and submitted to EROL in September 2021 and April 2022 respectively. No exploration was undertaken within either title during the reporting period. Previous exploration work was used to develop the geological model and mine plan for the SSD process which has now been finalised and approved.

Future exploration work will be focused on supporting ongoing limestone extraction. This will include areas with insufficient geological data or as required to support limestone production.

4.2 Reserve and Resource Status

The Marulan South limestone resource is significant, with current estimates in the order of 640 million tonnes. SSD7009 has secured 120 million tonnes which will be extracted over a 30 year period once commenced.

4.3 Estimated Mine Life

Current studies undertaken as part of the SSDA demonstrated that the limestone resource is extensive and can support at least a 30 year mine plan at an extraction rate of 4 Mtpa. The resource will not be exhausted at this time and depending on market conditions at the time, further approvals may be sought to continue extraction.

4.4 Land Preparation

An area of approximately 2.1 hectares was developed for the purpose of a contractor compound adjacent to the eastern extent of the Western Overburden Emplacement Area. This land had previously been disturbed and no topsoil stripping was required for surface preparation of the laydown and storage areas and demountable site offices.

A pad comprising 0.2 ha was developed for the installation of a 500,000L water tank for use in dust suppression and plant water use located to the west of Dave Shepard Drive.

4.5 Construction

Minor construction projects are currently in progress or planned for the coming reporting period. These projects are required to support the ongoing operation and are not associated with SSD7009. Construction activities over the last 12 months include:

- Establishment of water control structures in association with surface water management plans;
- Ongoing replacement/upgrade of dust control systems;

- General maintenance of processing facilities. The existing facilities will continue to be used following approval of the SSDA;
- Establishment of a temporary refuelling station adjacent to Ring Road on the western side of the mining area and removal of the diesel tank in the north pit for refurbishment. The refuelling station is fully bunded and provides designated parking bays for vehicles;
- Installation of a 500,000L water tank and associated pad.

SSD 7009 provides approval for two major construction projects which have yet to commence. The first is the upgrading of Marulan South Road from the site to the Hume Highway interchange as well as realigning a section to accommodate the Western Overburden Emplacement extension. The upgrade will be to Austroads and relevant Council standards and specifications. The second project is the construction of a new in-stream water supply dam on Marulan Creek to supplement the water supply and will include associated infrastructure such as an overland pipeline and pump station. Work will commence on these construction projects following the commencement of SSD7009.

4.6 Mining

For the current reporting period and the previous 10 years, the following tonnages of Limestone, shales/clay and overburden/waste were mined and produced (Table 4.1).

Table 4.1 - Mine Production

Material	Limestone (Tonnes)	Shales/clay (Tonnes)	Overburden (tonnes)
2011/2012	2,858,120	81,448	1,748,240
2012/2013	2,768,890	80,115	1,864,720
2013/2014	2,863,200	98,923	1,664,320
2014/2015	3,107,325	121,340	1,518,080
2015/2016	3,212,015	123,873	1,944,800
2016/2017	3,298,098	128.267	1,794,020
2017/2018	3,380,000	142,939	1,479,865
2018/2019	3,169,811	254,266	1,979,420
2019/2020	2,720,000	200,000	2,550,000
2020/2021	2,607,968	211,254	2,193,875
2021/2022	2,328,242	217,538	4,457,176

Overburden removal of 4.5 million tonnes occurred during the 2021/2022 period resulted in a cumulative overburden removal of 23.3million tonnes for the 10 year period. The values increased in the reporting period due to contractor activities on site, and increased numbers are expected to remain for the next 3-5 years. Limestone and (overburden as required) is mined using drilling and blasting methods while clay shale is mined by excavator or front-end loader. Limestone, clay shale and overburden are transported to the primary crusher, stockpile areas and overburden emplacement areas using the load and haul fleet of front end loaders and trucks on site.

Additional mobile crushing and screening plant is hired as required to meet and trial special product specifications and during plant breakdown and maintenance periods. Limestone is selected from particular areas within the mine and blended together with shale when required at the face, within stockpiles and during the crushing and screening process. Limestone quality is monitored using laboratory analysis of drill hole cuttings and online using Geoscan technology.

Limestone extraction has focused on the northern end of North Pit over the previous three years, requiring the prior removal of previously dumped overburden as well as insitu shale and granite as the pit has developed. Stripping on the eastern side of North Pit and further development on the northwest side was undertaken during the reporting period to relocate the haul road to enable resource extraction. In-pit overburden emplacement continued in South Pit.

4.7 Mineral Processing

During the 2021/2022 reporting period the lime manufacturing plant produced the following tonnages of Quicklime, Hydrated Lime and Waste Lime in comparison with the previous nine years (Table 4.2).

Table 4.2 – Mineral Production

Material	Quicklime (Tonnes)	Hydrated Lime (Tonnes)	Waste Lime (tonnes)
2011/2012	89,418	35,044	3,210
2012/2013	88,408	45,590	2,571
2013/2014	84,745	42,735	1,343
2014/2015	83,165	43,133	2,496
2015/2016	84,132	43,506	2,056
2016/2017	73,565	59,308	1,679
2017/2018	85,129	58,468	365
2018/2019	80,471	49,890	10,078
2019/2020	84,000	52,000	1,400
2020/2021	68,479	47,928	1,077
2021/2022	78,204	46,839	3,237

4.8 Waste Management

Domestic and light industrial waste continues to be deposited in large dumpsters which are collected weekly by a licensed waste removal contractor.

All runoff from the workshop is channelled through an oil and grease separator. Recovered grease and oil material is collected and stored for removal by a licensed recycling contractor. Similarly, grease drums and oil filters are stored until collected and disposed of for recycling by a licensed contractor.

Reject lime continues to be placed in the designated area of the Middle Gully waste emplacement and investigations continue for reuse of this material to minimise on-site disposal.

4.9 Limestone and Lime Product Stockpiles

The limestone stockpiles nominal capability is currently 300,000 tonnes. The limestone bin capacity for rail dispatch is approximately 20,000 tonnes. Lime product storage capacity is 1,600 tonnes of quicklime and 700 tonnes of hydrated lime.

4.10 Hazardous Material Management

There are multiple hazardous chemical facilities at the mine with two diesel, two LPG, one compressed gas, and one distillate depot which are maintained in accordance with the Work Safe NSW Acknowledgement of Notification of Dangerous Goods on Premises Licence 35/008099. Explosives used for blasting are supplied by the contractor as necessary and not stored on site.

As required, all enclosures to fuel facilities are bunded to meet AS 1940 Storage and Handling of Flammable and Combustible Liquids, 2017 and hazardous materials and chemicals facilities are inspected at least annually by an external accredited inspector.

5. ACTIONS REQUIRED FROM PREVIOUS AEMR

No specific actions were required by the Resources Regulator following submission of the 2020/2021 AEMR. The Resources Regulator has however made global changes to the administration of mining leases within NSW. These changes have been implemented through the Mining Amendment (Standard Conditions of Mining Leases – Rehabilitation) Regulation 2021 which commenced on 2nd July 2021. The changes were subject to a transition period over the 2021/22 reporting period which ended on 2nd July 2022.

As Boral is seeking a new mining lease covering the 30 year mining extent, it will be issued under the new amendments. A new Rehabilitation Management Plan (RMP) is currently being prepared which will replace the existing Mining Operations Plan (MOP). Once the new RMP has been approved by the Resources Regulator, Boral will complete the new online Annual Rehabilitation Report requirements for future reporting periods. This will include the required rehabilitation objectives, rehabilitation completion criteria and final land form and rehabilitation plan in accordance with the published Form and Way.

Specific actions listed in the previous AEMR that have been completed during the 2021-22 reporting period are:

- Completed the review and signoff of the SSD approval conditions.
- Prepared the new set of management plans required under the SSD approval conditions. These represent pre-conditions that need to be approved in order to commence the development under SSD7009.
- Applied for a new mining lease to cover the SSD7009 footprint. Issue of the new mining lease is pending.
- Seeding and planting of the completed second bench on the southern slopes of the Western Overburden Emplacement.
- Infill planting of tubestock in rehabilitation trial areas on the southern slopes of the Western Overburden Emplacement in spring 2021.
- Continued use of external contractors for the weed spraying as per updated internal weed control plan. Aerial spraying of pampas grass was focused on South Pit benches and targeted spraying of blackberries was undertaken throughout the operation together with generalised weed spraying.
- Continued Ecosystem Function Analysis (EFA) as outlined in Section 8.4.
- Continued monitoring rehabilitation works on Bryce's Dump and reviewed the rehabilitation strategy as detailed in Section 8.3.2.2.

6. ENVIRONMENTAL PERFORMANCE

6.1 Environmental Risk Identification

The Marulan South Limestone Mine is operated by Boral Limited and managed in accordance with the 2018/2023 Mining Operations Plan (MOP) (including subsequent amendments) and supporting Review of Environmental Factors (REF documents 2010) for CML No. 16, together with the conditions of consents, leases and licences as detailed in Chapter 3. In addition, environmental issues and opportunities continue to be managed in accordance with Site Environmental Management/Improvement Plans.

Components of the Site Environmental Management/Improvement Plans include:

- The Boral Environmental Policy;
- Boral's "LEAN" approach to operational excellence;
- Site Environmental Audit Tool employed annually;
- Internal Environmental reporting performance indicators for hazards and incidents;
- Internal company monthly reporting of environmental protection actions/breaches;
- Environmental Awareness training;
- Ground disturbance toolbox; and
- Rehabilitation Risk Assessment for RMP and rehabilitation strategy as required by the Resources Regulator 2021 Rehabilitation Risk Assessment Guidelines.

The Marulan South Limestone Mine has also been recently subject to further environmental impact assessment as part of the SSDA and EIS process. Following approval of the SSDA in August 2021, a revised set of environmental management plans have been prepared but as at the date of this report, have yet to be approved. A new RMP is also in preparation and will be completed in the coming reporting period. These documents will include any necessary environmental risk identification and assessment.

6.2 Meteorological Monitoring

The Marulan South Meteorological Station records weather data on an hourly basis. This data is downloaded monthly and provided to environment staff at Marulan South and Peppertree. Weather station data is also recorded at 0900 hours for a "daily" temperature, relative humidity, wind speed, wind direction and rainfall recording. Data can be provided by the weather station on an as needed basis which assist with dust controls and on site activities.

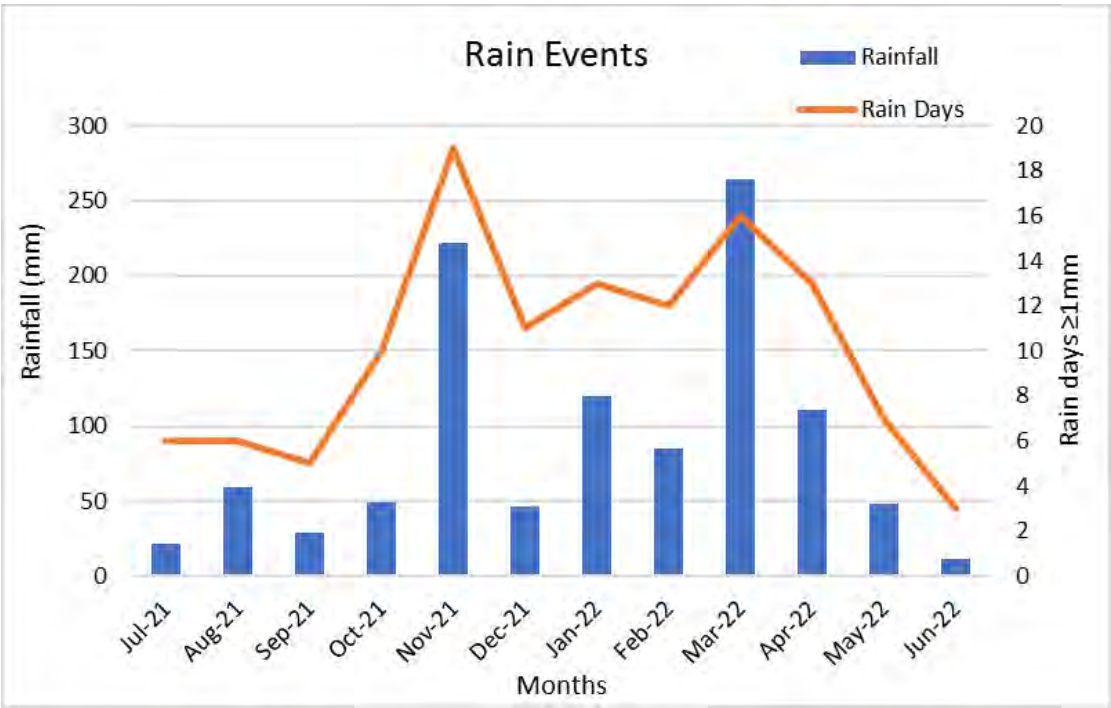
6.2.1 Rainfall

A total of 1065mm of rainfall with 121 rain days was recorded at the site weather station during the reporting period. This was similar to the previous reporting period that recorded 1063.5mm with 109 rain days. Rainfall was highest during March 2021 with 264mm and was

the lowest in June 2022 with 11mm (Graph 6.1). The number of rain days ranged from 3-19 days per month.

Table 6.1 – Total Monthly Rainfall (mm) (2021/22)

Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Tot
21.5	59.5	28.5	49.5	222	46	119.5	84.5	264	111	48	11	1065
Number of Rain Days (**≥1mm)**												
6	6	5	10	19	11	13	12	16	13	7	3	121



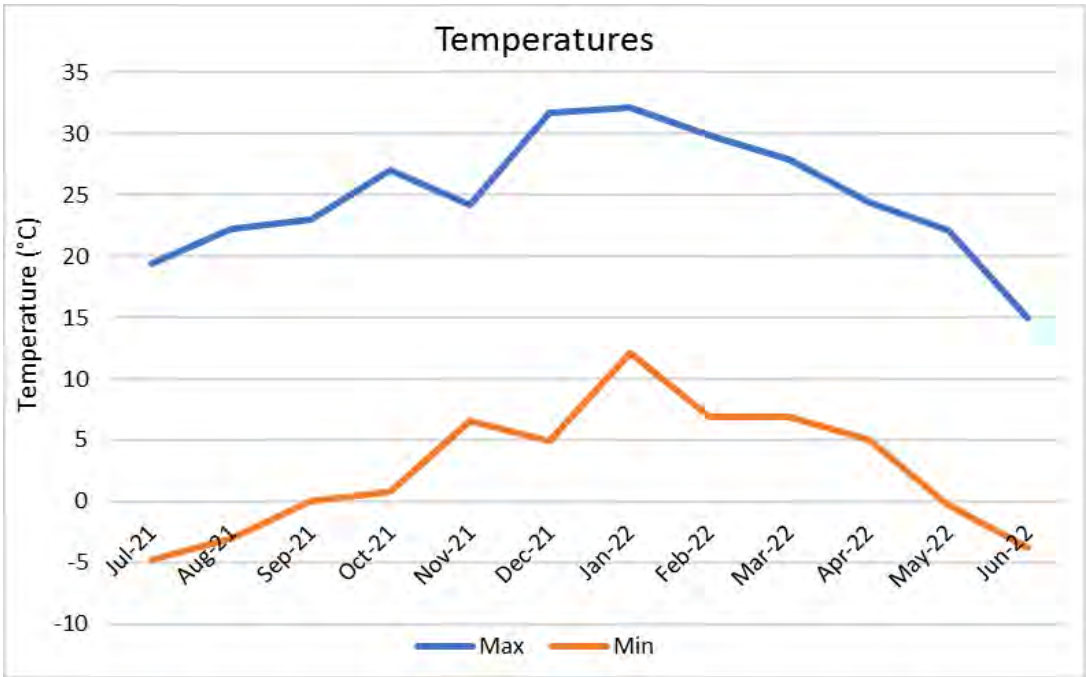
Graph 6.1 – Monthly rainfall and number of rain days

6.2.2 Temperature

Temperatures were hottest in summer months with the highest maximum of 32.2°C in January 2022 and were coldest during the winter months with a lowest minimum of -4.8°C in July 2021 (Graph 6.2). The average maximum and minimum temperatures for the reporting period were 24.9°C and 2.6°C respectively, which were lower maximums and higher minimums than recorded in the previous period.

Table 6.2 - Minimum and Maximum Monthly Temperatures (°C) (2021/22)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Min	-4.8	-3	-0.02	0.8	6.6	4.9	12.1	6.85	6.9	5	-0.3	-3.8
Max	19.4	22.2	23.04	27	24.2	31.7	32.2	29.9	27.9	24.4	22.1	14.95



Graph 6.2 – Monthly Minimum and Maximum Temperatures

6.3 Air Quality

Marulan South Mine operates under the site's *Marulan Dust Management Plan* (reviewed in August 2020), which documents control measures and management initiatives. The main objectives of the Dust Management Plan are to minimise the dust exposure to all persons working on site as well as to reduce the offsite dust impacts, to remain in compliance with stack emission limits and mitigate dust nuisance.

A revised Air Quality Management Plan (pending approval) has been prepared as required by the SSDA consent which provides a program detailing the assessment criteria, monitoring locations and procedures, reporting protocol and compliance checking procedures for air quality management at the Mine for the new 30 year project.

6.3.1 Air Quality Monitoring

Marulan South Limestone Mine operates an air quality monitoring program as required by EPL Licence 944. This program includes monitoring of ambient dust levels with deposited dust and PM10, as well as emissions of specific metals, particulates and both nitrogen and sulphur oxides from the kiln and hydrator stacks as detailed in Table 6.5. The NSW EPA air quality impact assessment criteria for dust emissions are presented in Table 6.3 below.

Table 6.3 – NSW EPA Air Quality Impact Assessment Criteria (dust)

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total	90 µg/cm^3
PM_{10}	Annual 24 hour	Total Total	25 µg/cm^3 50 µg/cm^3
$PM_{2.5}$	Annual 24 hour	Total Total	8 µg/cm^3 25 µg/cm^3
Deposited Dust	Annual	Incremental Total	2g/m^2/month 4g/m^2/month

The NSW EPA air quality impact assessment criteria for NO_2 and SO_2 emissions are presented in Table 6.4.

Table 6.4 - NSW EPA Air Quality Impact Assessment Criteria (NO_2 and SO_2)

Pollutant	Averaging Period	Criterion
NO_2	1 hour Annual	246 µg/cm^3 62 µg/cm^3
SO_2	10 minutes 1 hour 24 hour Annual	712 µg/cm^3 570 µg/cm^3 228 µg/cm^3 60 µg/cm^3

6.3.1.1 Kiln and Hydration Stack Monitoring

In accordance with EPA Licence 944 Condition L2, the actual load of an assessable pollutant discharged from the mine during the reporting period must not exceed the load limit specified for the assessable pollutant in table 6.5 below. Emissions of these pollutants are monitored annually, and the actual load of each pollutant is calculated in accordance with the relevant load calculation protocol provided by the EPA and reported in the Annual Return. The current and previous load limits are detailed in Table 6.5.

Table 6.5 - Assessable Pollutant

Assessable Pollutant - Air (Kg)	Coarse Particulates	Fine Particulates	Lead	Mercury	Nitrogen Oxides	Sulphur Oxides
Load Limit (current)	8,050	5,050	6.00	2.00	91,680	170
Load Limit (previous)	19,050	28,500	-	-	862,500	16,000
Load 18/19	12,084	4,724	1.6	0.2084	88,589	66
Load 19/20	6,413	9,522	0.7	0.1	96,430	27
Load 20/21	4,596	3,832	0.38	0.304	49,394	27.71
Load 21/22	2,075	2,080	0.568	0.378	87,031	39.676

Kiln stack and hydrator stack monitoring results from the previous and the current reporting periods are presented in Table 6.6. All stack monitoring results were below the 100th percentile for both existing concentration limits and for Group 5 emission standards.

Table 6.6 - Kiln Stack and Hydrator Stack Results

Pollutant	Kiln Stack (11)		Hydrator Stack (12)
Units: mg/m^3	Nitrogen Oxides	Solid Particles	Solid Particles
Sampling Method:	TM-11	TM-15	TM-15
Existing 100th percentile concentration limit	2,500	250.0	250.0
Group 5 100th percentile concentration limit	2,000	100	100
Result 2018/2019	260	50	<2
Result 2019/2020	470	86	9.7
Result 2020/2021	240	39	<2
Result 2021/2022	370	8.4	<2

Notes: Monitored results on a Dry Basis, corrected to 101.325kPa and 0^{0}C

6.3.1.2 Dust Deposition and PM_{10} Monitoring

Dust Deposition

Both deposited dust and PM10 are monitored as required by EPL 944 with two deposited dust gauges and one PM10 high volume air sampler (HVAS). The dust gauges are referred to as 'Nearest Residence' (EPL Point Number 1) located to the northwest of the mine and 'Store Paddock Hill' located to the northeast of the mine (EPL Point Number 16). The dust deposition gauges and the HVAS are monitored by mine personnel in association with Peppertree Quarry staff with samples being delivered to NATA-accredited Boral Laboratories for dust analyses.

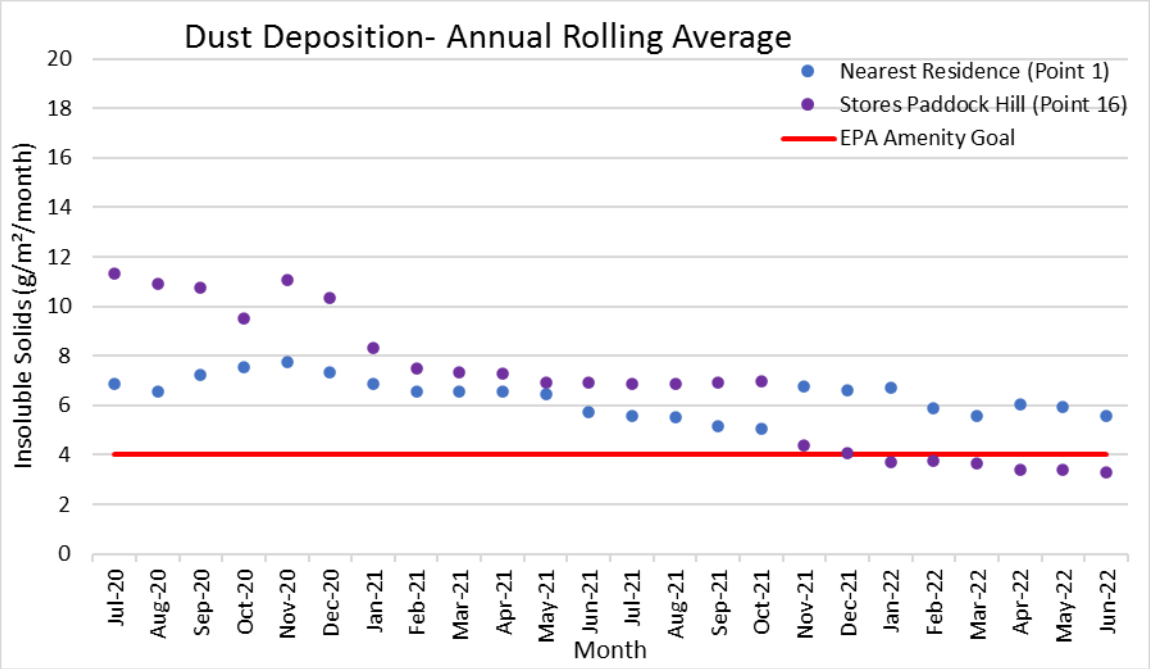
Results for dust deposition monitoring for the deposited dust monitoring sites are shown in Table 6.7 and Graph 6.3 below.

Table 6.7 **–** Deposited Dust (g/m^2/month Insoluble Solids)

Gauge	Nearest Residence EPA ID 1	Store Paddock Hill EPA ID 16
2019/2020 Annual Average	7.23	11.56
2020/2021 Annual Average	5.71	6.94
2021/2022 Annual Average	5.59	3.27

The annual average for the Store Paddock Hill Site 16 shows a decreasing trend over the previous reporting periods (Graph 6.3) with an annual rolling average of 3.27g/m2/month for the past 12 months. The previously high deposition levels were attributed to the Peppertree waste emplacement area which had progressed to within a 10m proximity of the gauge. The emplacement has been rehabilitated and dust emissions have decreased as a result.

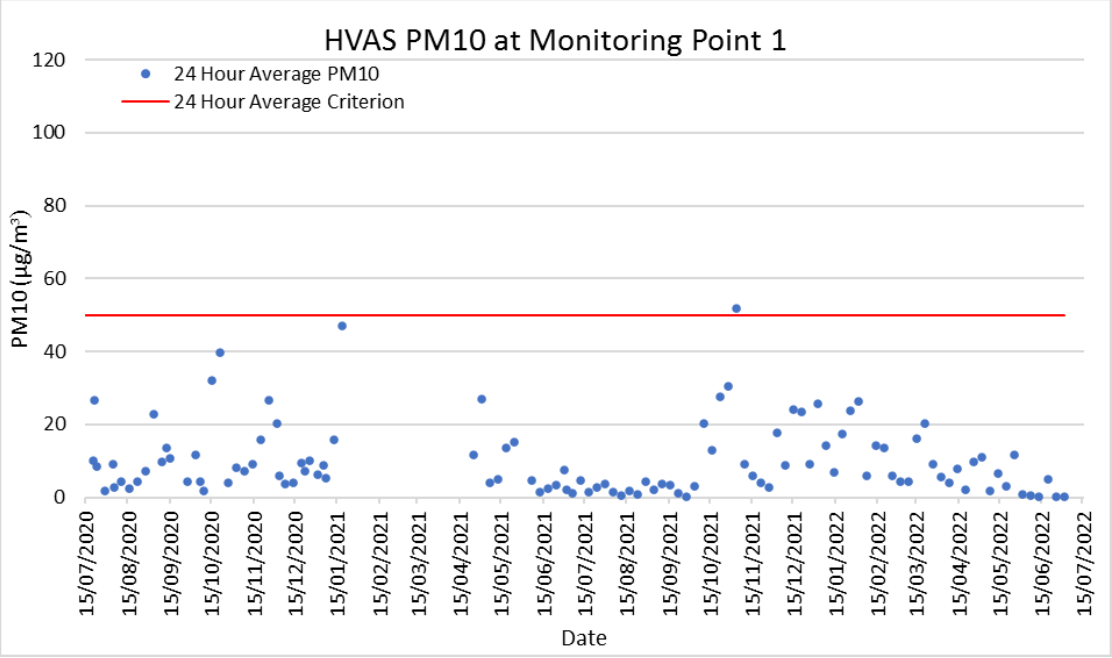
The rolling average level of insoluble solids at the Nearest Resident Site 1 fluctuated from 5.06g/m^2/month to 6.87g/m^2/month during the reporting period and dropped below the EPA amenity criteria guidelines in January 2022. Whilst this gauge is located on Boral-owned land the data is useful in determining the relative sources of dust which contribute to the levels experienced at the nearest non-company owned residences further from the mine. The distance to the nearest non-Boral owned residence is approximately 1.2km further to the northwest from the monitoring location. The data



Graph 6.3 - Rolling Average Dust Deposition at EPL Points 1 and 16

PM_{10}

The PM_{10} high volume air sampler (HVAS) is also referred to and located at the 'Nearest Resident' and identified as Monitoring Point 1 in the EPL. The monitoring results for the reporting period and the previous period are shown in Graph 6.4. The 24-hour average PM_{10} indicated a slight decline from the previous AEMR period with one exceedance of the 24 –hour average EPA amenity criteria on the 3rd November 2021 with a concentration of 51.97 µg/m³ and an annual average of 9.07 µg/m³ which is well below the annual criterion of 25 µg/m³.



Graph 6.4 - PM_{10} Monitoring Point 1 HVAS

6.3.1.3 $PM_{2.5}$ and TSP Monitoring

Until February 2021, $PM_{2.5}$ levels were not monitored in the vicinity of the mine, and therefore levels for the site were estimated from the site HVAS data and Wollongong AWS for the SSDA EIS air quality assessment. A criteria ratio approach was used, where the $PM_{2.5}$ is estimated to be 32% of the maximum ambient PM_{10} recorded at the HVAS. This approach conservatively estimated that the maximum 24-hour average $PM_{2.5}$ level would be 16.6 μg/cm^3 for the reporting period which is lower than the criterion of 25 μg/cm^3 presented in Table 6.3. Data obtained from the nearby Peppertree Quarry shows a 24-hour annual rolling average of 6.90 μg/cm^3 for the 2022 reporting period, which indicates that the modelled numbers are conservative.

Total Suspended Particulate (TSP) levels are also estimated from PM_{10} results recorded for the mine using a criterion ration approach. The TSP annual criterion is 90 μg/m^3 (Table 6.3) and the typical percentage of PM_{10} in a semi-rural environment (i.e. one where the airshed is not dominated by particulate from motor vehicles) lies in the range of 40-50%. Given this, compliance with the annual PM_{10} criterion of 30 μg/m^3 should therefore be seen to be satisfying the annual TSP criterion. The annual average TSP has been estimated from the monitoring results to be approximately 20.2 μg/m^3 which is well below the annual average criteria of 90 μg/m^3 for TSP. Data obtained from Peppertree Quarry showed an annual average TSP concentration of 23.13 μg/m^3 TSP recorded for the 2022 reporting period at the site which is slightly higher than the calculated concentration at the mine.

6.4 Contaminated Land

A Phase 1 and Phase 2 ESA was presented in August 2018 by ZOIC as part of the SSDA. The assessment included surface and subsurface investigations covering all key potential contamination sites. The outcome of this investigation is currently being incorporated into new environmental management plans for the mine.

6.5 Biodiversity

The consent SSD7009, requires the preparation and implementation of a number of management plans, strategies, protocols and procedures detailing environmental commitments, controls and performance objectives at the mine throughout its operational life. A Biodiversity Management Plan (BMP) is required in accordance with condition B54. The BMP was prepared in April 2022 and is awaiting final approval. The BMP covers vegetation clearing, management of remnant vegetation, establishes biodiversity performance indicators and rehabilitation completion criteria as well as ongoing biodiversity monitoring initiatives.

Separate to the BMP, Boral has successfully negotiated a Biobanking Agreement which includes two Stewardship Sites under the Biodiversity Assessment Method to provide in-perpetuity protection and management of biodiversity values. Short, medium and long term measures have been developed as part of the Biodiversity Stewardship Agreement (BSA) to manage the offset areas. These sites form the primary means of retiring the required ecosystem and species credit terms associated with the SSD7009. It is expected that the agreement will be executed and credits retired in the coming reporting period and the results and progress on biodiversity management will be reported in subsequent Annual Reviews.

6.6 Vibration and Air blasting

In accordance with Conditions 13 and 14 of the Schedule of Conditions attached to CML No. 16, mining operations are required to employ practices to limit the effects from blasting as follows:

Ground Vibration	-	Peak particle velocity not to exceed 10mm/sec
	-	Peak particle velocity not to exceed 5mm/sec in more than 5% of the total number of blasts over a period of 12 months
Blast Overpressure	-	Blast overpressure noise level not to exceed 120dB(lin) for any blast
	-	Blast overpressure noise level not to exceed 115dB(linear) in more than 5% of the total number of blasts over a period of 12 months

The following protocols are currently followed in regard to blasting:

- The use of explosives on the lease area is not permitted on Saturdays, Sundays and Public Holidays.
- Prior to blasting, warning sirens continue to be activated in accordance with safe blasting procedures.
- In accordance with Condition M7 of EPA Licence No. 944, Boral records each blast fired during rim removal or in the area shown on the Plan titled "*Blast Affecting Bungonia Gorge*", dated 30 October 1996. Records of such blasts are digitally recorded and submitted to the EPA at the end of the licence reporting period.

The continuous blast monitor failed in early September 2021 which resulted in a non-compliance with the blast monitoring requirements of the current MOP and CML16. In response, attended blast monitoring was conducted by Orica for a worst case scenario blast on 16th December at 3:30pm to assess the maximum predicted noise and vibration from the blasts that were not monitored during the reporting period. The attended monitoring was conducted at the Substation, which is located on Marulan South Road closer to the mine than the nearest residents. A nil trigger was recorded for this blast. The failure of the blast monitor does not result in a non-compliance with the EPL as there was no rim removal or blasts in the area that could affect Bungonia Gorge during the reporting period. In terms of blasting, the EPL only requires monitoring of blasts in those specific locations and does not contain noise and vibration limits for those blasts or any other blasts undertaken at the mine.

As part of the new Blast Management Plan (pending approval), additional precautions will be put in place to prevent the absence of monitoring data in the case of a monitor failure. Moving forward, Marulan South will have two compliance monitors and access to Peppertree's five live blast monitors as a management tool.

Table 6.8 details the Airblast Overpressure and the Ground Vibration level monitoring results for the 32 monitored blasts from the total 115 blasts undertaken at Marulan South during the reporting period. These blasts were monitored at the Boral owned residence on Marulan South Road to the northwest of the mine and Longpoint Road across the gorge to the east of the mine. There were no exceedances of the criteria and all blasting was undertaken within the approved time between 9:00am to 5:00pm Monday to Friday.

Table 6.8- Blast Monitoring Results

Date/time	Marulan South Road		Longpoint Road	
	Vibration (mm/s)	Overpressure (dB(A)	Vibration (mm/s)	Overpressure (dB(A)
1/7/21 14:05	No trigger	No trigger	No trigger	No trigger
5/7/21 12:35	No trigger	No trigger	No trigger	No trigger
12/7/21 13:00	No trigger	No trigger	No trigger	No trigger
16/7/21 13:05	No trigger	No trigger	No trigger	No trigger
20/7/21 15:15	No trigger	No trigger	No trigger	No trigger
22/7/21 13:05	No trigger	No trigger	No trigger	No trigger
26/7/21 15:25	No trigger	No trigger	No trigger	No trigger
28/7/21 15:15	No trigger	No trigger	No trigger	No trigger
29/7/21 15:21	No trigger	No trigger	No trigger	No trigger
2/8/21 15:30	No trigger	No trigger	No trigger	No trigger
4/8/21 15:25	0.10	114.3	No trigger	No trigger
5/8/21 09:35	0.05	113.1	No trigger	No trigger
11/8/21 12:08	No trigger	No trigger	No trigger	No trigger
12/8/21 15:20	No trigger	No trigger	No trigger	No trigger
16/8/21 15:00	0.05	114.3	No trigger	No trigger
17/8/21 15:00	No trigger	No trigger	No trigger	No trigger
18/8/21 15:25	No trigger	No trigger	No trigger	No trigger
19/8/21 15:25	No trigger	No trigger	No trigger	No trigger
20/8/21 09:50	No trigger	No trigger	No trigger	No trigger
23/8/21 13:10	No trigger	No trigger	No trigger	No trigger
25/8/21 15:10	No trigger	No trigger	No trigger	No trigger
2/9/21 12:15	No trigger	No trigger	No trigger	No trigger
6/9/21 15:22	No trigger	No trigger	No trigger	No trigger
8/9/21 10:08	No trigger	No trigger	No trigger	No trigger
9/9/21 10:08	No trigger	No trigger	No trigger	No trigger
15/9/21 12:35	No trigger	No trigger	No trigger	No trigger
16/9/21 11:00	No trigger	No trigger	No trigger	No trigger
20/9/21 10:09	No trigger	No trigger	No trigger	No trigger
22/9/21 15:30	No trigger	No trigger	No trigger	No trigger
23/9/21 11:21	No trigger	No trigger	No trigger	No trigger
24/9/21 11:08	No trigger	No trigger	No trigger	No trigger
27/9/21 15:22	No trigger	No trigger	No trigger	No trigger
29/9/21 15:20	No trigger	No trigger	No trigger	No trigger
30/9/21 11:45	No trigger	No trigger	No trigger	No trigger
27/5/22 10:45	No trigger	No trigger	No trigger	No trigger
30/5/22 15:25	No trigger	No trigger	No trigger	No trigger
2/6/22 15:16	No trigger	No trigger	No trigger	No trigger
6/6/22 15:24	No trigger	No trigger	No trigger	No trigger
9/6/22 15:18	No trigger	No trigger	No trigger	No trigger
15/6/22 15:25	No trigger	No trigger	No trigger	No trigger
20/6/22 15:35	No trigger	No trigger	No trigger	No trigger
22/6/22 15:20	0.14	96.5	0.18	92.6
23/6/22 15:42	No trigger	No trigger	No trigger	No trigger
27/6/22 15:28	No trigger	No trigger	No trigger	No trigger
30/6/22 15:18	0.28	98.0	No trigger	No trigger

6.7 Operational Noise

Wilkinson Murray conducted a noise assessment in March 2019 to predict the operating noise at four stages of the mine over the next 30 years following approval of the SSDA. During the reporting period, an updated Noise Management Plan (pending approval) was prepared which established noise criteria as defined by Section B1 of the SSD consent. These are provided in Table 6.9. The Noise Management Plan established a hierarchical approach to ensure that operations comply with the relevant conditions of the consent:

- Mine operations will be managed to meet the criteria presented in Table 6.9 and EPL noise criteria, through operational practices and the implementation of reasonable and feasible noise controls.
- Where noise levels exceed noise criteria or verified noise complaints are received, ensure all noise controls are in place or determine the need to reduce operations and point of source noise.
- Liaise with the local community regarding scheduled works which are predicted to have increased noise impacts.

Table 6.9 – Operational Noise Criteria

Receivers	Project Noise Trigger Level (dBA)		
	Day	Evening	Night
R9	40	36	36
All other residents	40	35	35

Note: Daytime 7:00am-7:00pm; Evening 7:00pm-10:00pm; Night 10:00pm-7:00am

Current mitigation measures will continue to be followed to avoid the likelihood of exceedances in the future. This will entail a quarterly noise monitoring program based on attended noise monitoring. To supplement quarterly attended noise monitoring, a continuous unattended noise monitoring station will be established between the western overburden emplacement and the nearest potentially affected receiver location identified as R9. The results of the future noise monitoring program will be detailed and reported in subsequent Annual Reviews.

6.8 Aboriginal Heritage

An Historic Heritage Management Plan (HHMP) was prepared in December 2021 (pending approval) in accordance with Condition B63 of SSD 7009. The plan provides guidance on

- management procedures for historic heritage values within, and adjacent to, the mine during pre-construction and construction phases;
- protocols and procedures for new cultural finds and human remains;
- protocols for undertaking activities in areas that have not been previously assessed;
- administrative requirements, including post-project management of historical finds and recovered material, ongoing compliance, regular review and update of the HHMP to ensure its functionality is maintained through the mine life; and
- includes a strategy for the care, control and storage of heritage relics salvaged from the site.

The implementation of the new Aboriginal Heritage Management Plan and activities undertaken as required will be reported in future Annual Reviews.

6.9 Combustion Risk and Management

The storage of coal used as a supplementary fuel for the calcination of limestone in the lime kilns is the only activity previously identified on site with the potential for spontaneous combustion. The primary use of natural gas as kiln fuel has reduced the potential risk of spontaneous combustion.

The risk of spontaneous combustion is minimized by CO monitoring, alarming and a triggered, stored CO_2 discharge system sized to extinguish combustion. This system is serviced by Wormald, a division of Tyco Australia Pty Ltd. These services are carried on a planned preventative maintenance schedule held within BCL's MAXIMO maintenance management system.

6.10 Bushfire

Bushfire response and management is an ongoing site program both from a safety and environmental aspect. The Marulan South Operations Bushfire Management Plan seeks to maintain and monitor bushfire prone areas and equipment; minimise the risk of bushfires spreading from the project site; and establish responses and controls to fires.

An annual bushfire risk assessment is undertaken at the commencement of each bushfire season in October. The bushfire management plan addresses associated risks and lays out requirements for very high risk days relating to things such as hot work, vehicles driving on vegetation etc. Boral is aware of the risks of bushfire and has implemented the following safeguards:

- Fire fighting equipment is on hand during hot work activities at all times;
- Safe Work Method Statements are required for all activities on site and the risks of bushfire are considered;
- Fire extinguishers are installed in mobile machinery;
- Cleared asset protection zones have been created around all buildings and infrastructure;
- Water storages on site are available for use in firefighting as necessary; and
- One of the two water carts on site must remain full at all times to be available on site for emergencies.

The Bushfire Management Plan was reviewed in February 2020 following the Morton Bushfires. Specific measures for evacuation were updated to include refuge in the pit as a secondary option to evacuation via Marulan South Road as it was demonstrated that the fire threat could be more widespread than previously mitigated against. Three levels of threat

were identified based on RFS categorisation and associated response measures incorporated into the management plan.

During the reporting period, bushfire risk has been low given the higher rainfall and lower fuel loads. Long range forecasts suggest that bushfire risk will remain low for the coming reporting period as well.

6.11 Geotechnical Stability

Open pit and waste emplacement slope stability is an aspect of limestone mining activities with the potential for both safety and environmental impacts particularly as the depth of mining increases. The use of improved blasting techniques, the development of procedures for managing slope stability issues and training instruction for site inspections have previously been implemented and continue.

Geotechnical investigations have been undertaken since December 2002 and have been continued on a regular basis by rock, soil and water engineering consultants Pells Sullivan Meynink Pty Ltd (PSM).

The annual geotechnical report for the Marulan Limestone Mine was undertaken by PSM in March 2022 and attached as Appendix B. The assessment focused on:

- West wall of North Pit;
- The far norther end of North Pit;
- East Wall;
- South Wall; and
- Cutback development in West Wall at the junction of North and South pits.

The inspections covered the current exposures to provide an overview of the potential long term performance of the pit walls in limestone and which will need to remain to allow production to continue under the new SSD approval. Known areas of instability were also covered in the 2022 assessment. The assessment made a number of recommendations which are summarised as follows:

- Surface water control will be a critical factor for long term pit development and allowing water to cascade of pit walls should be avoided.
- Surface water ponding above walls or surface water flow over the face should be avoided.
- Surface water from the road above the re-mined backfill in the northeast should be appropriately managed to avoid ponding and with no cut throughs allowed in the windrow which would allow gullying to quickly develop.
- For the failure at the northern end of east wall, PSM recommended that the windrow at the toe of the area be slightly raised to limit the risk of future rock falls.
- The future sump for the High Dump in the South Pit should be maintained against the east wall and to the north so tipping from the high dump proceeds onto a flat dumped surface that is not comprised of any ponded water or mud.

6.12 Hydrocarbon Contamination

Hydrocarbons used on site include fuels (diesel and petrol), oils and greases. The 95,000L diesel tank was removed from the diesel storage facility in North Pit to be refurbished and relocated to a temporary refuelling station to the south of Ring Road. In the interim one 40,000L tanks and one 20,000 tank is being utilised in this temporary facility. The area is fully bunded where any potential spills can be adequately contained and managed in accordance with emergency response procedures and classified and disposed of in accordance with relevant waste legislation. The underground 12,000L petrol tank located at the store (approximately 800m from the site boundary) was decommissioned during the reporting period..

The potential for hydrocarbon contamination resulting from leakages and spills continues to be minimised by the implementation of documented hydrocarbon spill procedures and the use of biological oil spill kits located across site operational areas. These spill kits are maintained and serviced by approved contractor services and checked by BCL.

Oils are stored within bulk storage tanks within a roofed storage facility at the mine. A maximum of 10,000L of hydraulic oil, engine oil, and torque fluids respectively are stored within these storage tanks. Small quantities of greases are required for maintenance of plant and equipment. Storage, handling, containment and disposal of workshop hydrocarbons is managed in accordance with AS 1940:2004.

Review of procedures, equipment and training for hydrocarbon management and spill response is an ongoing commitment. Testing of the management system and responses is undertaken generally every 12 months.

6.13 Public safety

Public safety risks may arise in Bungonia Gorge at times of blasting in the south pit and where members of the public can access the site un-authorised. Warning sirens sound prior to blasting as a safety procedure, and historically additional measures were followed prior to blasts in the south pit that may have affected the public areas declared as “Blast Affecting Bungonia Gorge”. No blasts were undertaken in the south pit during the reporting period and are unlikely to occur in the foreseeable future.

The security plan has been fully operational since 2006 and was upgraded with the new access requirements between Peppertree and the mine. This plan is reviewed annually.

Features of the security plan and system include the following:

- A 3 metre tall automated sliding security gate at the exit of the Sand Plant Road.
- A 3 metre tall sliding gate located at the Main office, connected to chain mesh fencing for appropriate scrutiny of all site visitors.
- A pedestrian gate near the visitor’s car park for office access to ensure visitor sign in.
- Two swing gates located on the Lime Kiln Road prior to the main weighbridge and associated chain mesh fencing.

- Chain mesh fencing of the mine site perimeter and around the main entry areas to limit points of entry and exit to the control points (gates).
- Signage for both the new and existing mine perimeter fencing.

All visitors report to the “off lease” Site Administration and Training Main Office to sign in prior to gaining entry to Mining Lease CML 16.

Review and upgrade of the Site’s Induction system for visitors, contractors and employees is an on-going commitment as part of the Site Safety Management System.

7. WATER MANAGEMENT

An updated site Water Management Plan (WMP) was completed in April 2022 but is awaiting approval. The updated WMP covers the Stage 1 and 2 expansions of the mine but will need to be updated again prior to the commencement of Stage 3. Once the new management plans are approved, the mine will transition to the new SSD approval. Until this occurs, the mine will continue to operate under the existing WMP.

7.1 Erosion and Sediment Management

Current methods of erosion control including the use of clean water diversions to limit run off over disturbed areas, contour banks on the exposed batters of waste emplacements, rock and concrete lined drainage structures, sediment ponds and the re-establishment of vegetation continue to be effective means of reducing erosion on exposed areas. Periodic inspections on drainage are performed to ensure water runs to either the North pit or South pit voids.

Use of a daily water balance model within the surface water assessment concluded that the water management system is extremely robust and is secure for the mining operations. Overflow from storage dams and runoff can be estimated at 580ML per annum, which is expected to evaporate or seep into groundwater. Clean water and "mine supply water" storages are detailed in Table 7.2 - Stored Water Volumes.

The erosion and sediment control system is managed through control plans which have been progressively updated to meet changes as the project develops. The new WMP will continue this process in order to meet the obligations and commitments identified in the SSD approval. The existing surface water management system provides measures to divert runoff from the overburden emplacements to sediment basins designed in accordance with current guidelines. Rehabilitated landforms are designed to shed water without causing excessive erosion and downstream pollution. During rehabilitation, topsoil is prioritised for the high-risk erosion areas on the overburden emplacement slopes, and alternative media for vegetation growth is used on lower slopes and flat areas.

During the reporting period, a 6 ML catchment dam (referred to as W2) was constructed to capture runoff from the Western Overburden Emplacement. This was constructed as part of the existing WMP. Rock lined drains were also installed to direct runoff into the new dam. In the North Pit, runoff diversion drains were installed to direct runoff away from the quarry face in accordance with PSM geotechnical assessment. The South Pit sump was also relocated in accordance with PSM recommendations.

Maintenance of dams and drainage lines continued where possible following high rainfall events which occurred during the reporting period.

7.1.1 Sewerage Waste Management

No changes to sewerage waste management have occurred during the reporting period. The Marulan South Limestone Mine continues to operate five sewerage treatment facilities:

- Main envirocycle unit that receives effluent from main offices, laboratory, bathrooms, store and conference room. This aerated water treatment system was refitted with new pumps and upgraded during the reporting period to maintain compliance with Council requirements.
- Two Lime plant envirocycle units servicing the kiln control room, hydration, dispatch and workshop areas.
- Two Septic tanks, one located at the "machine shop"/primary crusher the other adjacent to the "Fettlers' shed".

Another septic system services the former "Club" facility, north of the main office and located "off-lease".

To ensure no overflow occurs from the "machine shop"/primary crusher septic tank, this unit continues to be inspected and pumped out weekly by an accredited waste disposal contractor. The "Fettler's shed" and "Club" units are adequately serviced by adsorption trenches.

7.2 Surface Water Management

7.2.1 Pollution Control Strategies

The Marulan South Limestone Mine continues to operate under the Environment Protection Licence (EPL) No. 944 and is required to prevent pollution of waters. The existing water management system involving three major catchments, (northern, southern and western emplacement areas) and associated infrastructure continued to operate during the 2021/2022 reporting period. The performance measures for the pollution control system are as follows:

- Maintain separation between clean, dirty (i.e. sediment laden) and mine water management systems.
- Minimise the use of clean and potable water on the site.
- Maximise water recycling, reuse and sharing opportunities.
- Minimise the use of make-up water from external sources.
- Design, install, operate and maintain water management systems in a proper and efficient manner.
- Minimise risks to the receiving environment and downstream water users.

The surface water management system is an integrated network of pipelines, drains, dams and sediment basins that provide dual purposes of water supply for on-site use and erosion and sediment control functions for runoff generated from disturbed areas. The water management system will be progressively developed over the life of the mine. A site water balance has also been developed to assess the performance of the water management system.

As the mine transitions to the new SSD approval, the eastern emplacement batters will be progressively rehabilitated which will significantly reduce the sediment load leaving the site. This work is nearing completion which will allow all future runoff from the Eastern Emplacement to be fully contained with the South Pit. Over the next three years, overburden will be used to:

- Backfill the South Pit and subsequently extend the emplacement of overburden to the west to create a single Southern Overburden Emplacement (SOE).
- Extend the existing Western Overburden Emplacement to the north.

- Construct a Northern Overburden Emplacement, also referred to as Peppertree Quarry Southwestern Overburden Emplacement.
- except for the section of the SOE that drains directly to the South Pit, overburden and haul road drainage will be directed to a series of new sediment basins that have been appropriately sized.
- runoff collected in the sediment basins would either be pumped to one of the mine water dams for reuse in limestone processing or dust suppression or would drain to the mine pit.

An overview of the current water management plan is provided in Plate 1.

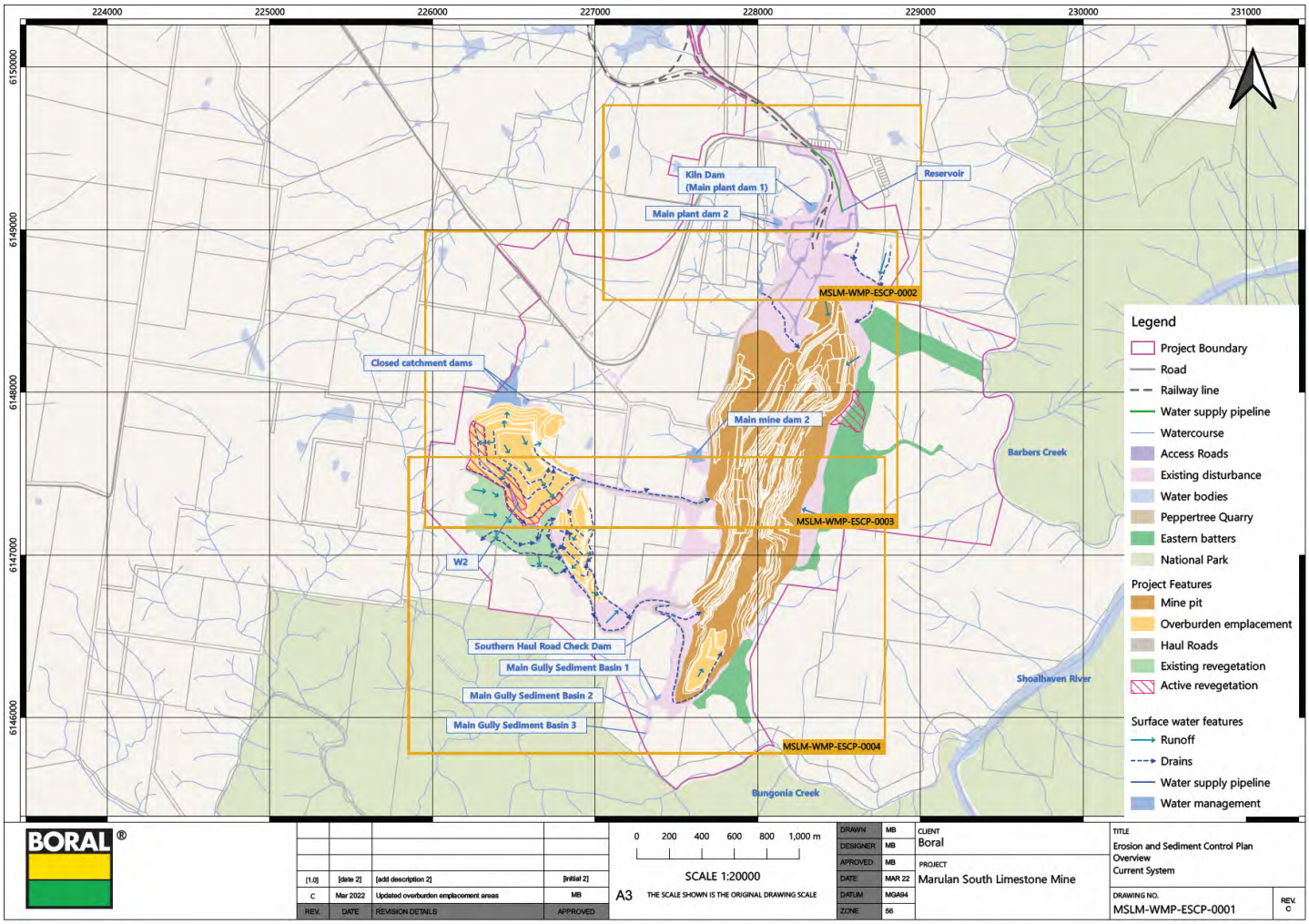


Plate 1 – Existing Surface Water Management System

7.2.2 Pollution Control Storages

A description of the current pollution control dams is provided in Table 7.1 while the estimated volumes stored within the pollution control structures is provided in Table 7.2.

Table 7.1 - Dam Descriptions

Dam name	Description
Clean Water Dam 1	Clean water diversion dam constructed in late 2007 above Main Plant Dam 2
Clean Water Dam 2	Clean water diversion dam constructed as above but not previously recorded
Minor Farm Dam 1	"Off-lease" farm dam upstream of Main Mine Dam 1
Minor Farm Dam 2	Farm dam upstream of Main Mine Dam 1
Minor Farm Dam 3	Potential New Clean Water Dam added as per MOP Plan 4-1

Dam name	Description
Minor Mine Dam 1	Clean water dam North of Main Gully waste emplacement
Minor Mine Dam 2	Clean water dam North-East of Main Gully waste emplacement
Minor Mine Dam 3	Clean water dam, East of North Pit
Main Plant Dam 1	"Off-lease" dam north of lime plant. Holds Tallong water and some plant area run-off
Main Plant Dam 2	Main lime plant water re-cycling dam on lease boundary
Main Mine Dam 1	See Note 3
Main Mine Dam 2	Mine water supply dam to west of shale road on boundary
North Pit Void	Water retained in small sump at 431.5m May 2014 Water retained in small sump at 433.9m May 2015
Plant Sediment Dam	Small sediment pond upstream from Main Plant Dam 2
South Pit Void	See Note 4
Southern Haul Road	Pre-treatment sediment check dam in roadside drainage
Check Dam	Near Main Gully diversion of southern haul road prior to entry to South Pit
Sediment Dams 1-3	Main Gully control and monitoring dams

Table 7.2 - Stored Water Volumes Locations

	Volumes held – ML		
	At start of Jul 2021	At end of Jun 2022	Estimated Storage Capacity
Clean Water (Non-Mine Supply)			
North Catchment			
Clean Water Diversion Dam 1**	0.4	0.6	0.6
Clean Water Diversion Dam 2	0.4	0.6	0.6
Minor Farm Dam 1	0.28	0.3	0.3
Minor Farm Dam 2	1.0	1.0	1.0
Potential Clean Water Dam	3.6	4.0	4.0
Minor Mine Dam 1	2.5	4.0	4.0
Minor Mine Dam 2	nr	0.5	0.5
Minor Mine Dam 3	10.0	14.3	15.3
Total Clean Water (Non-Mine supply)	18.2	25	26
Mine Supply Water			
North Catchment			
Main Plant Dam 1	23	24	25
Main Plant Dam 2#	0.5	14	15
South & West Catchments			
Main Mine Dam 1##	0	0	0
Main Mine Dam 2	20	43	43
Total Mine Supply Water Dams	43.5	81	83
Sediment Water			
North Catchment			
North Pit Void	7.5	na	na
Plant Sediment Dam	0.3	0.3	0.3
South & West Catchments			
Western Batters Sump	0	11	11
South Pit Void	0	na	na
Southern Haul Road Check Dam	0	na	na
Sediment Dam 1	4.5	5.8	5.8
Sediment Dam 2	0.1	0.2	0.2
Sediment Dam 3	0.5	0.8	0.8
Total Sediment Water Dams	12.9	18.1	7.1

Notes:

**Estimated from aerial survey data July 2021 for End of reporting period*

 # Estimated capacity subject to cleaning of sediment.

Mine Dam 1 has been covered by the advance of the west emplacement.

7.2.3 Monitoring and Reporting

The surface water monitoring program is outlined in the EIS for the SSDA with the intention of finalising the program within a Water Management Plan following approval. The water management plan will incorporate any specific conditions of the approval taking into account the ongoing potential impacts of the developing mine. The approval process will likely modify the current program.

At present, an automatic water sampler is located in the lower section of Main Gully which is triggered automatically when the water levels rise during a significant storm event. Overflow events occurred during January 2022 and March 2022 following heavy rainfall. Results for January 2022 and March 2022 are presented in Table 7.3 and Table 7.4 respectively.

In the five days to January 8th, 53mm of rainfall was recorded at the site weather station which exceeded the 95% 5 day rain event for Marulan of 52.8mm. This intense event followed on from 110mm of rainfall received in December and caused movement of sediments in all local catchments and resulted in a short discharge event from the Main Gully dam recorded on 8th January.

Between the 2nd and 3rd March 101mm of rainfall was recorded with a further 107mm of rainfall over the next five days again exceeding the 95% 5 day rain event for Marulan. The total rainfall recorded for the month was 264mm. Solids loading was lower in the March event and showed progressive reduction over time. This indicates that the material moved within the catchment was not feed by continually eroding surfaces but rather represented the existing sediment deposits within the drainage line.

Both of the January and March events were caused by a persistent off shore low pressure system resulting in widespread flooding.

Table 7.3- Main Gully Overflow Water Quality Monitoring Results January 2022

Date	pH Units	EC (µS/cm)	Suspended Solids (mg/L)	Turbidity (NTU)	Oil and Grease
8/1/2022*	-	-	3380	6760	<5

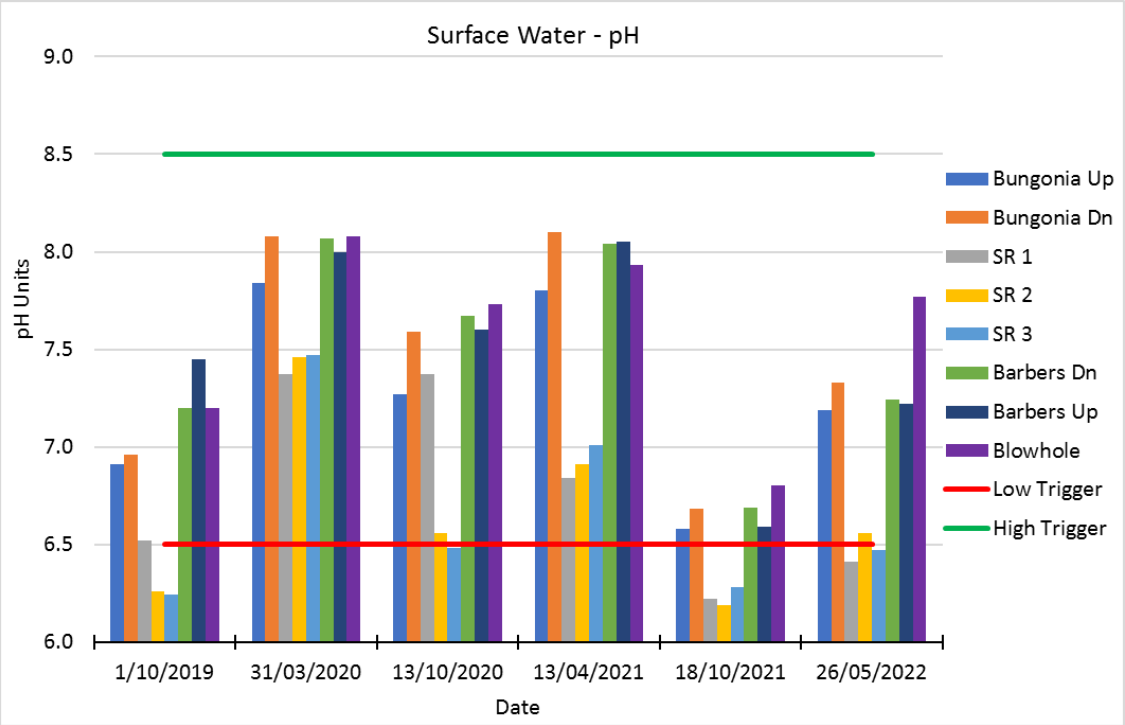
*These samples were taken by an automatic sampling unit and it is believed that the result is erroneous and not representative of the actual release event.

Table 7.4- Main Gully Overflow Water Quality Monitoring Results March 2022

Date	pH Units	EC (µS/cm)	Suspended Solids (mg/L)	Turbidity (NTU)	Oil and Grease
2/03/2022	7.98	447	145	214	<5
3/03/2022	7.74	500	22	34.8	<5
4/03/2022	8.07	508	29	44	<5
5/03/2022	8.05	529	18	42.4	<5
6/03/2022	8.15	469	423	865	<5
7/03/2022	8.17	566	64	141	<5
8/03/2022	8.22	641	30	50.9	<5
9/03/2022	8.22	669	10	13.4	<5
10/03/2022	8.23	686	13	11	<5
11/03/2022	8.24	703	5	10.7	<5
12/03/2022	8.25	657	<5	6.7	<5
13/03/2022	8.26	701	22	33.6	<5

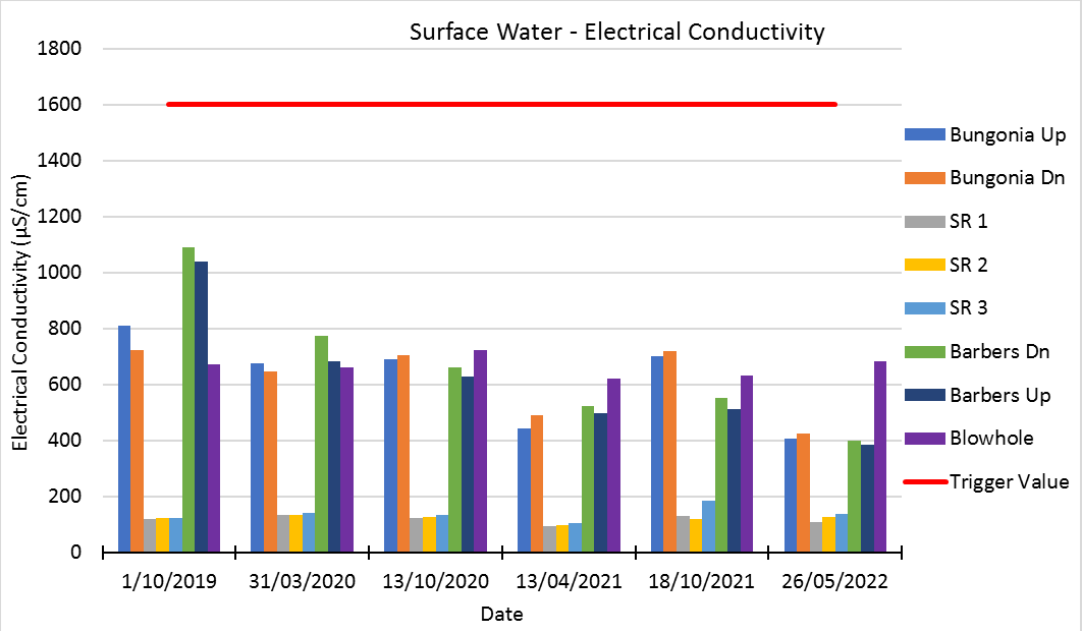
An extended ambient surface water quality monitoring program is also in place as envisaged in the EIS. This currently includes biannual measurements taken from sites upstream and downstream of the mine on Bungonia Creek and Barbers Creek, at three sites along the Shoalhaven River (SR) and at the Main Gully Sample Point located downhill of the Spring (Blowhole).

Water quality 'trigger values' for Bungonia Creek and Barbers Creek will be included in the Water Management Plan which is being prepared as a condition of the SSDA approval however anticipated values are noted in Graphs 7.1 - 7.6 below. The purpose of the trigger values is to provide indicators of whether the mine is having an influence on the receiving water quality. Graphs 7.1 - 7.6 present the water quality parameters over the last two reporting periods.



Graph 7.1 – Ambient Surface Water Quality – pH

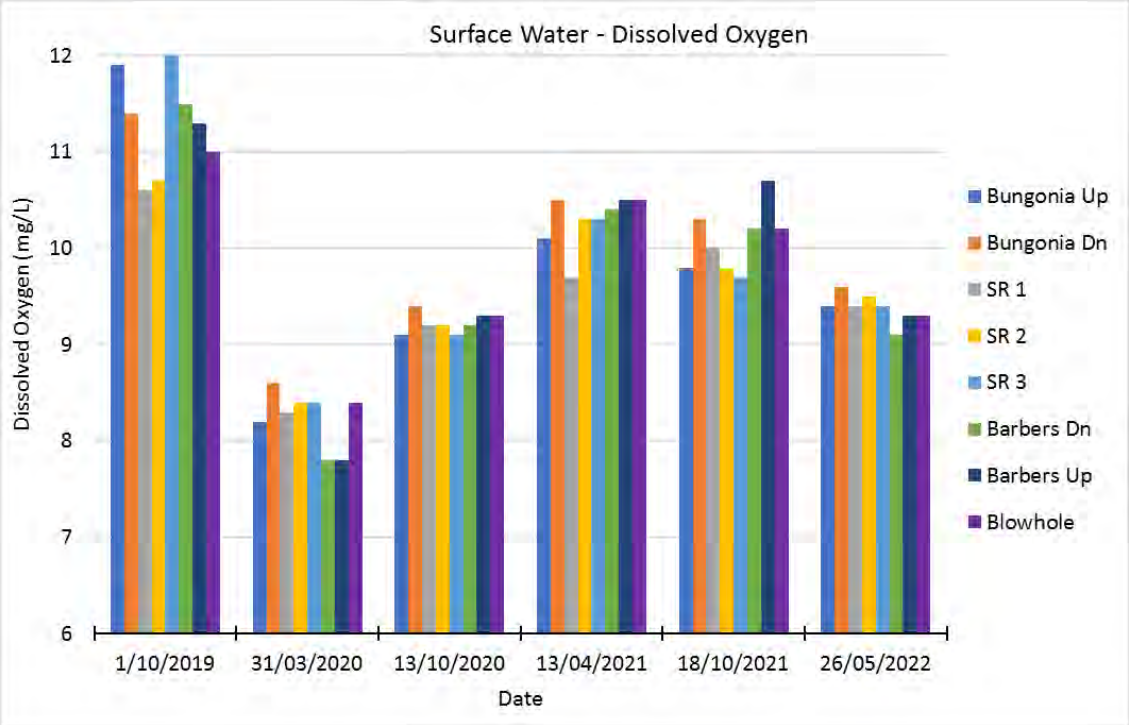
Graph 7.1 shows the pH values of the eight sample sites over the past three reporting periods. Bungonia Creek and Barbers Creek are well within the upper and lower trigger values, with averages of 7.36 pH and 7.49 pH respectively over the past three years. Levels at the Bungonia downstream site are approximately 0.2 pH higher than the upstream sample site, and both sites on Barbers creek are relatively equal. The pH levels in the Shoalhaven River are consistently lower than both Bungonia Creek and Barbers Creek, with pH levels ranging from 6.19 pH units to 7.47 pH over the three sampling locations. The Blowhole three-year average is 7.59 pH. The pH is governed by geological influences, particularly the large limestone deposit. Given the limestone's marine origin, salt level is also largely controlled by geological influences.



Graph 7.2 – Ambient Surface Water Quality – Electrical Conductivity

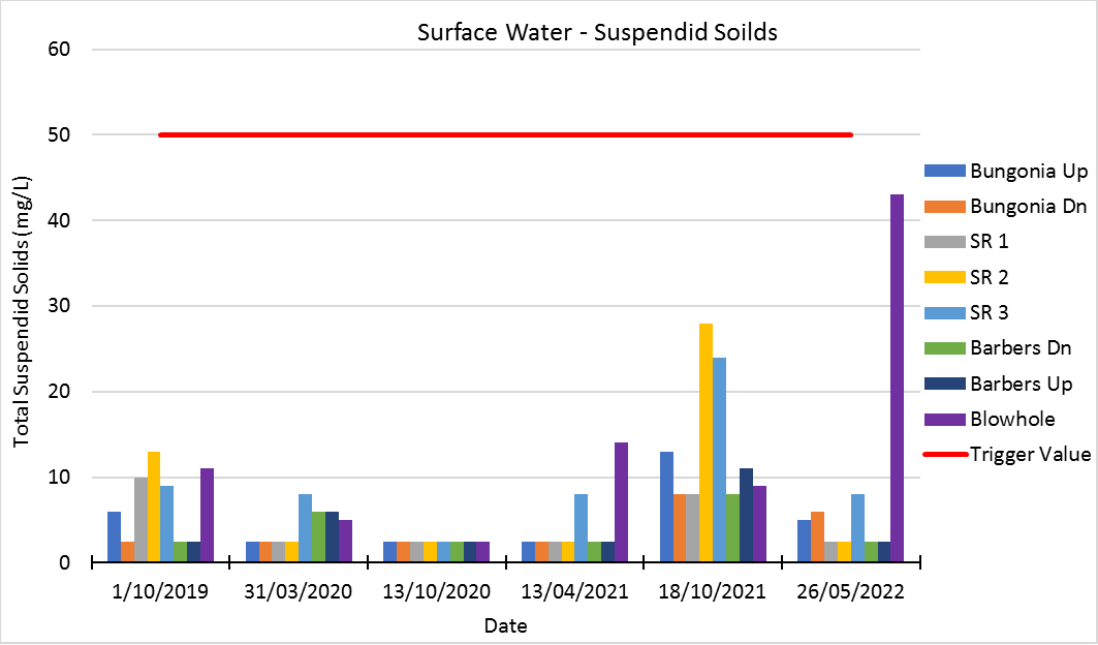
The electrical conductivity is significantly lower in the Shoalhaven River than all other sampling sites with a three-year average of 125 µS/cm (Graph 7.2). Bungonia and Barbers Creek three-year averages of 618 µS/cm and 645 µS/cm respectively lie significantly lower than the trigger value of 1600 µS/cm, and show levels representative of the surrounding limestone aquifer. The average electrical conductivity at the Blowhole recorded over a three-year period is 665 µS/cm. Levels of electrical conductivity have dropped slightly during the reporting period, and remain in a healthy and stable state over the past three reporting periods.

The variation in pH and conductivity, which is a measure of salt, is considered natural and caused by surrounding marine based geological strata. The physical and chemical properties of Shoalhaven River will naturally vary as it passes through different geological strata and land uses. The variations would occur in mineral content, nutrients, pH and dissolved solids.



Graph 7.3 – Ambient Surface Water Quality – Dissolved Oxygen

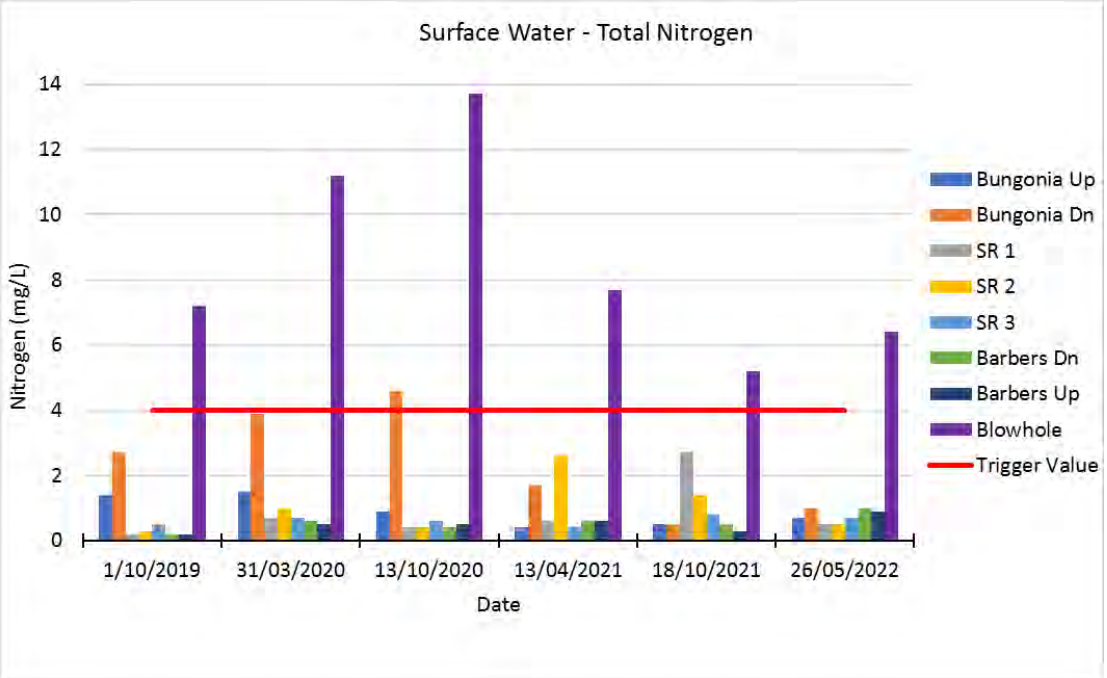
The dissolved oxygen levels range from 7.8 mg/L to 12.0 mg/L with an average of 9.75 mg/L over a three-year period across all ambient surface water monitoring sites (Graph 7.3). Results show that the waterways have sufficient dissolved oxygen levels to support a healthy aquatic environment including fish populations.



Graph 7.4 – Ambient Surface Water Quality – Total Suspended Particles

Suspended solid concentrations remained below the trigger level at all sites over the three years shown in Graph 7.4. The levels were often under detection limits of 5 mg/L (recorded as half of the limit value: 2.5 mg/L). The higher than average concentration at the Blowhole in May 2022

is likely due to the prolonged rainfall flushing out the sediment contained in the karst system over time.



Graph 7.5 – Ambient Surface Water Quality – Total Nitrogen

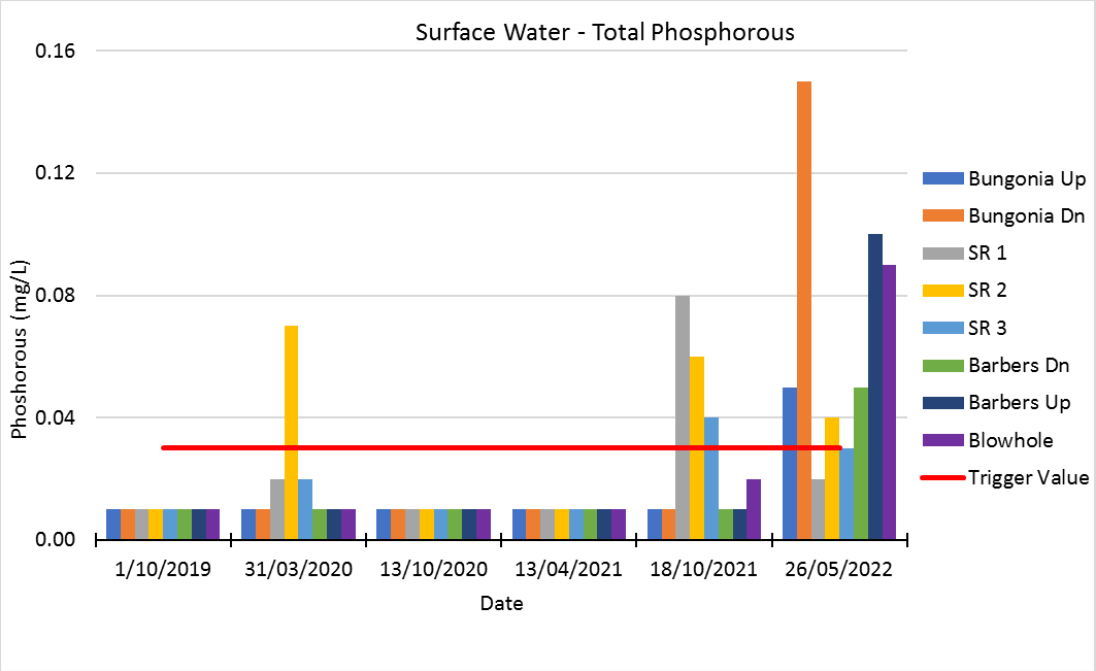
Total Nitrogen levels were the highest at the Blowhole with a three-year average of 8.6 mg/L (Graph 7.5). Concentrations at Bungonia and Barbers Creeks usually remained below the trigger level of 4 mg/L with respective averages of 1.65 mg/L and 0.52 mg/L. A sample at Bungonia Creek down exceeded the trigger level on one occasion in October 2020, with a value of 4.6 mg/L. Nitrogen levels in the Shoalhaven River recorded an average of 0.83 mg/L and did not exceed 3.0 mg/L.

Total Nitrogen is the combined value of both Nitrite (NH2-) and Nitrate (NO3-) in the natural environment, Nitrite readily oxidises to Nitrate. Laboratory results are presented as Nitrate+Nitrite-N which is their respective Nitrogen contents. The conversion for both are as follows:

- 1mg/L nitrate-N = 4.43mg/L nitrate
- 1mg/L nitrite-N = 3.29mg/L nitrite

The nominated trigger value of 4mg/L of Nitrogen is conservative. ANZECC 2000 guidelines state that Nitrate concentrations less than 400mg/L in livestock drinking water should not be harmful to animal health. The Australian Drinking Water Guidelines (2011) stipulate 50mg/L of Nitrate as an appropriate long term health criteria in drinking water.

Nitrogen and Phosphorous occur naturally but are also caused by agricultural fertilisers. Although Nitrogen levels at the Blowhole are uncharacteristically high, it does not pose a hazard to either humans or animals. However, the cause of the elevated Nitrogen is unknown.



Graph 7.6 – Ambient Surface Water Quality – Total Phosphorous

As shown in Graph 7.6, Phosphorous was above the trigger levels within the Shoalhaven River in October 2021, whilst all other sites remained low, whereas all monitoring locations in May 2022 were at or above the trigger values with the exception of the uppermost sampling location in the Shoalhaven. It is thought that the elevated concentrations during the reporting period are a result of runoff from saturated soils in agricultural areas within the catchment following over a year of above-average rainfall and storm events. The concentration of nutrients will continue to be monitored and investigations into the cause of the elevated nitrogen will be reported in the next Annual Review. It should also be noted that the actual concentrations are very low and would not cause adverse algal growth within the receiving waters.

7.2.4 Future Improvements

Surface water management procedures will be amended and updated as mining operations move forward in the upcoming reporting period. In particular, the specific surface water management controls to be implemented as part of the proposed Marulan Creek Dam and Marulan South Road alignment operations are to be aligned with the SSDA approval.

7.3 Groundwater Management

The quality and quantity of ground water may be impacted by sediments, dissolved salts, sewage effluent, hydrocarbons and chemicals generated or associated with surface water run-off from limestone mining and lime processing operations at the Marulan South Limestone Mine.

7.3.1 Pollution Control Strategies

It has been assumed and reported in previous AEMRs that sediment laden surface waters re-directed into the North and South pits do not significantly impact on groundwater. Water containing both fine and coarse sediments are effectively filtered as it percolates through the limestone bed under the North and South pits. This effectiveness is currently evident from dry

pit floors even after a day or two of rain and also by the quantity of sediment trapped on the surface of the pit floors.

Water quality impacts of concern to groundwater from site related activities include oil, grease and total suspended solids. Whilst the diversion of surface water from the mine area into the North and South pits will control the risk of sediment laden water overflowing off site, the monitoring of oil and grease at these locations will need to be carried out to enable any contamination to be detected and rapid action to be taken to prevent any further contamination entering the groundwater.

7.3.2 Monitoring and Reporting

There are three groundwater sources located on site, including a shallow unconsolidated aquifer within the weathered zone where groundwater exists between pores and deeper consolidated bedrock aquifer located between rock fractures.

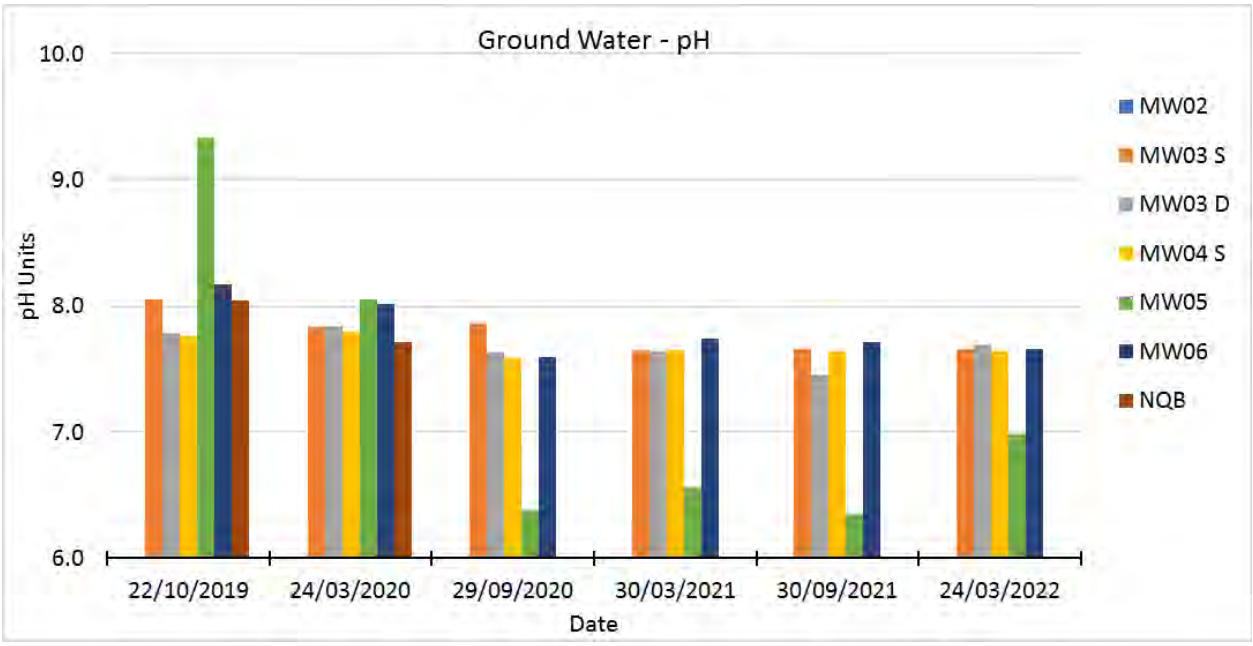
A total of eight monitoring bores were installed in 2014 within and adjacent to the pit area to determine the baseline groundwater levels and quality for the SSD project groundwater assessment. Monitoring bores MW01 and MW02 were located in the north pit and south pit respectively, and were removed as bench development progressed in 2017 and 2018. Bore MW04D was damaged and subsequently water quality analysis was not possible during the reporting period. The remainder of the bores continue to be monitored twice-yearly. Screened formations of the bores include limestone, sandstone, weathered regolith and volcanics such as dacite, tuffs and andesite.

Monitoring Point 13 on EPL 944 requires monitoring of groundwater for oil and grease and suspended solids on a quarterly basis. Monitoring Point 13 related to the North Quarry Bore however this bore was required to be removed for pit development during the reporting period. The EPL was modified in December 2020 to relocate Monitoring Point 13 to the groundwater bore MW05. Table 7.5 shows the results of monitoring as required by the EPL for the past two reporting periods whilst pH and conductivity are presented in Graphs 7.7 and 7.8 below.

Table 7.5 – EPL Monitoring Point 13

Date	Oil and Grease (mg/L)	TSP (mg/L)
29/09/2020	<5	<5
09/12/2020	<5	11
30/03/2021	<5	<5
15/06/2021	<5	14
30/09/2021	<5	11
13/12/2021	<5	15
24/03/2022	<5	11
8/06/2022	<5	14

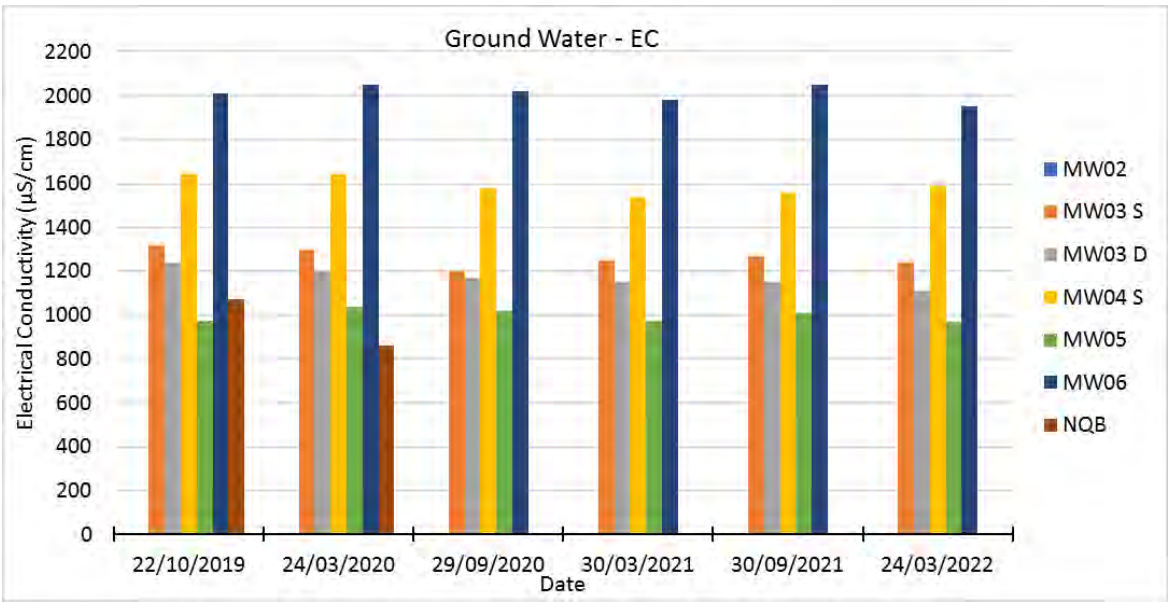
All the results for the reporting period are below the detection limits for Oil and Grease. TSS ranges from 11 to 15 mg/L at the licenced monitoring point (Table 7.3).



Graph 7.7 – Monitoring Bore Ground Water - pH

Bores MW03S, MW03D, MW04S and MW06 all sit at a level at neutral to slightly alkaline, within a 1 pH unit range (Graph 7.7). In the past, differences in pH levels have resulted from variability in host rock geology, although no such trends have been observed in the past two reporting periods.

The pH of MW05 dropped from a long term average of 9.5 to an average of 6.5 pH over the past two reporting periods. There is a positive correlation between pH and alkalinity, so as total alkalinity (CaCO3) falls the natural buffering capacity of the water decreases as does its ability to neutralise acid, and pH decreases. It is believed that a decrease in water level has reduced the aquifer's exposure to the baked limestone in the proximity of the bore, which in turn has reduced its inherent carbonate concentration and buffering capacity, allowing the pH to fall. This is discussed further in Section 7.3.3.



Graph 7.8 – Monitoring Bore Ground Water - Electrical Conductivity

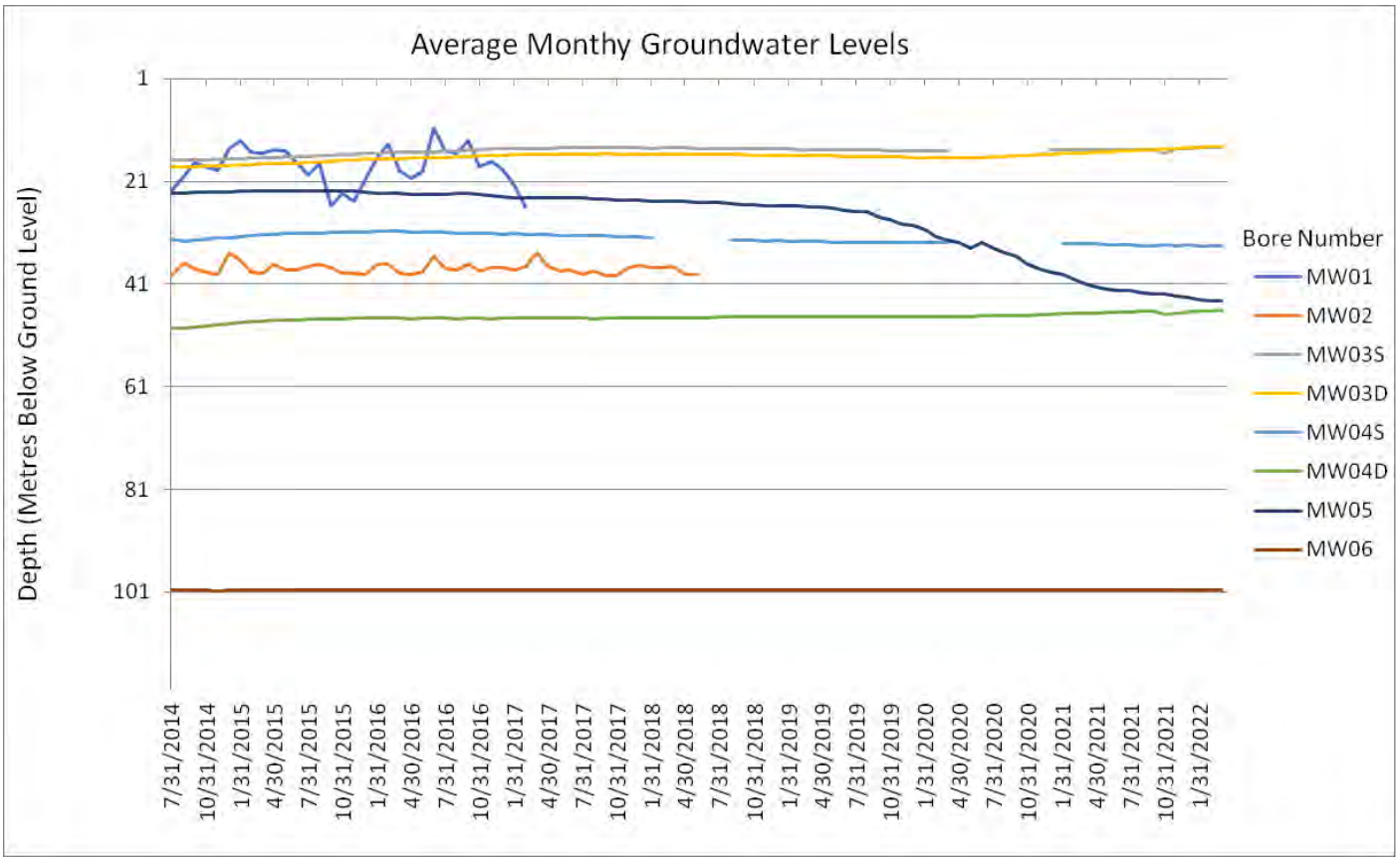
Graph 7.8 above shows variability among monitoring bore conductivity levels over the past three reporting periods. Host geology significantly influences conductivity of the bores, with limestone bores such MW05 with the lowest salinity ranging from 971 to 1040 μS/cm, and bores hosted in volcanics with conductivity levels as high as 2050 μS/cm at MW06. This fresh to slightly brackish water is defined as 'marginal' for drinking water use, but suitable for stock water and aquatic ecosystems.

7.3.3 Groundwater Levels

Groundwater levels are recorded daily from monitoring bores using pressure transduced piezometers. The piezometers are downloaded twice-yearly in correspondence with water quality sampling and the recordings are cross checked with manual water level measurements.

Historical water levels of bores in the pit contrast strongly with those located outside pit. Bores located in the pit such as MW01 and MW02 (both of which are now discontinued) had rapid responses to rainfall and runoff that seeps directly through the limestone. As an alternative, bores remainder of the bores outside of the pit do not show variation associated with rain events because such fluctuation is buffered by the regolith situated above the groundwater level. The standing water level in these bores has either been fairly static or increased slightly since 2014.

The standing water level in monitoring bore MW05 presents a gradual decline from March 2017 until May 2019, then a much more rapid decrease from June 2019 to June 2021. The decrease in standing water level observed at MW05 was expected based on groundwater modelling predictions of pit development. It is believed that the rapid decline was a result of the removal of the cross-cutting dolerite dyke in the North Pit which appeared to be 'damming' groundwater up-dip. Because the water level of this bore is artificially high (perched) it is also not reflective of the impact the quarry is having on regional groundwater levels. MW03 and MW04 are more accurate representations of the surrounding granite groundwater systems which have not as yet been impacted by the limestone removal within the mine. Graph 7.9 below shows that bore levels as monitored since 2014.



Graph 7.9 – Average Monthly Groundwater Levels from Monitoring Bores

The groundwater impact assessment conducted for the SSDA by AGE in 2019 does not predict any private bores will be impacted by drawdown greater than 1 metre during the 30 year SSD7009 consent period for the mine.

7.3.4 Future Improvements

The potential impact of the SSD7009 approved 30-year mining plan on groundwater was assessed by a numerical groundwater flow model which was prepared in accordance with the Aquifer Interference Policy. The assessment identified that two risk areas. The first is the potential impacts on the quality and volume of groundwater flowing between the western mining area and the eastern Bungonia gorge system. The second is the potential risk to the water level at private bores located on the plateau to the west of the mine.

A model predicted that there will be only a minimal change in groundwater resources outside the limestone bodies following the mining project. The dolerite dyke running through the current north section of the northern pit is the only barrier identified to potentially prevent drainage in the future. The assessment also found that assuming no changes to the pit fractures, there will be a slight increase in recharge into the limestone from a larger overall mine pit area and increased flow into Bungonia Creek.

There are no specific groundwater mitigation measures required however Table, Condition B43 of SSD7009 provides performance indicators applicable to groundwater. In order to verify the impact predictions made in the EIS and to confirm adherence to the performance indicators, the existing groundwater monitoring program will be enhanced. This will include the installation of

additional monitoring bores to supplement the existing monitoring network. These will be installed in the 12 months proceeding the commencement of the development under SSD7009.

A Trigger Action Response Plan has been developed and once approved will form the basis for ongoing assessment of potential groundwater impacts. The following key actions and responses will be undertaken if a trigger threshold is exceeded.

- The re-confirmed exceedances will prompt an investigation, conducted by suitably qualified personnel, to determine the reasons for the exceedance, which could include but not be due to the influence of climatic conditions, agriculture abstraction or mining activities.
- In the case exceedances are attributed to mining activities, changes in groundwater conditions, such as a decrease in water level or increase in salinity, will be compared to performance measures to evaluate the significance of any impacts on the groundwater system.
- Furthermore, the response and action to trigger exceedances in the TARP should determine if the trigger event resulted in an incident.

The results of the trigger investigations will be reported in each Annual Review. If it is clear each year that the groundwater baseline is changing in response to factors not related to mining such as climate or other land uses then the trigger thresholds will be recalculated. If this occurs the Ground Water Management Plan will be updated.

8. REHABILITATION STRATEGY

Site rehabilitation strategy is covered in the 2018-23 Mining Operations Plan. The strategy has developed from the Final Marulan South Limestone Mine – Rehabilitation Strategy dated July 2010 and a Soils, Land Resources and Rehabilitation Assessment undertaken in 2018 as part of the SSDA. A new Rehabilitation Management Plan (RMP) is currently being prepared and will be finalised following approval of the new Mining Lease. The RMP will further refine the rehabilitation strategy in future years.

8.1 Rehabilitation Objectives

The current rehabilitation strategy encompasses the following landform objectives:

- The rehabilitated site will be geotechnically stable and will not be of a greater safety hazard than the surrounding land to land-users, public, livestock and native fauna;
- The land capability will be returned to a class similar to that existing prior to project commencement;
- Excluding the mine void itself, mine land will be visually compatible with the surrounding natural landscape;
- Rehabilitated landforms will be designed to shed water without causing excessive erosion or downstream pollution; and
- Rehabilitated landforms will not negatively impact the visual amenity for nearby residents and users of reserves.

8.2 Site Domains

The site has been divided into primary domains which are operation based such as infrastructure areas and overburden emplacements, and secondary domains indicating post-mining land use objectives. The domains are shown in Plan 2 and outlined in Tables 8.1 and 8.2 below:

Table 8.1 – Primary Rehabilitation Domains

No.	Domain	Description	Area (Ha)
1	Infrastructure Area	Includes processing facilities, workshops, buildings, roads and rail, dams, pipelines and hard stand. Will remain operational until the end of the project life.	106.2
2	Waste Lime Storage/ Emplacement Area	Located in western overburden emplacement area for placement and capping of waste lime materials.	2.0
3	Water Management Areas	Sediment basins and water supply dams including the proposed Marulan Creek dam infrastructure.	30.0
4	Overburden Emplacement Areas	Existing overburden emplacement west and south of the open cut pit.	246.3

No.	Domain	Description	Area (Ha)
5	Stockpiled Material Area	Designated areas for management of raw, processed and product materials. (Incorporated into Domain 1).	0
6	Open Cut Mine Void	The open cut mine void will expand toward the west pit during development.	155.5
7	Rehabilitation Areas	Rehabilitated overburden emplacement areas, currently consists of rehabilitated areas of the western overburden emplacement, Bryce's Gully Emplacement, Barbers Emplacement and Eastern batters (south).	58
Total			598

Table 8.2 – Secondary Rehabilitation Domains

No.	Domain	Description	Area (Ha)
A	Native Woodland Areas	Former overburden emplacements and infrastructure areas rehabilitated to native woodland communities.	326.8
B	Trees over Grass-Landform Stability	Mix of tree, shrub and groundcover vegetation established on the eastern batters to promote long term erosion control and landform stability.	37.1
C	Final Mine Void	Post mining, the residual void will be approximately 240-270m deep, up to 900m wide (east to west) and 2000m long (north to south) with steeply sloping 'benched' walls and a generally level floor. This domain also includes approximately 8.9ha of the Southern overburden emplacement.	106.3
D	Visual Screening	Tree and shrub vegetation established around the void perimeter and upper slopes/ benches to promote visual screening and landform stability.	29.7
E	Water Management	Drainage control and water supply structures.	23.4
F	Infrastructure	Individual infrastructure items (mainly roads) incorporated into other domains to support post mining land use.	74.6
Total			598

8.3 Rehabilitation of Disturbed Land

8.3.1 Seed Sources and Application

Seed spray trials conducted at the south-western end of the Western Overburden Emplacement during 2020 showed best results with Flexterra FGM with ryegrass and couch cover seed mix.

This therefore has been selected from the trials and will be used to rehabilitate the remainder of the Western Overburden Emplacement area.

8.3.2 Rehabilitation Activities

During the reporting period, overburden continued to be emplaced in the existing Western Overburden Emplacement, with approximately 5 metres in height remaining on the highest batter until final height is reached. No rehabilitation was undertaken in the South Pit and rehabilitation activities are detailed in the following sections.

8.3.2.1 Western Overburden Emplacement

Rehabilitation works during the reporting period have focused on the second highest bench of the Western Overburden Emplacement (WOE). Flexterra FGM with ryegrass and couch cover seed mix (Table 8.3) was selected from the previous hydro-seeding trials to rehabilitate 3.9ha of the Western Overburden Emplacement during Autumn 2022 (See Plate 1 below). The hydro-seeding conducted in Autumn was deemed to be extremely successful, with close to complete groundcover by the end of May 2022. It is likely that this was due to the seed mix which was high in clover which had a high success rate, combined with the improved environmental conditions and high rainfall experienced in the first half of 2022. An additional 5.1ha along the uppermost bench will be hydro-mulched in the upcoming spring of 2022 (Plate 2).

Plate 1 Western Overburden Emplacement Rehabilitation May 2022

Due to a lack of native shrub and tree species emerging in the 2020-2021 rehabilitation areas, Infill planting of tube stock including *Eucalypts* along this bench was undertaken in the reporting period to increase species diversity.

Table 8.3 Ryegrass and Couch Cover Seed Mix

Seed Type	Species Name	Amount (Weight)
Grasses	Austrodanthonia spp	2kg
	Microlaena stipoides	2kg
	Chloris spp	2kg
	Themeda australis	2kg
Shrubs	Acacia falcata	0.3kg

Seed Type	Species Name	Amount (Weight)
	Acacia decora	0.5kg
	Acacia decurrens	0.5kg
	Acacia mearnsii	2kg
	Acacia rubida	1kg
	Acacia ulicifolia	0.3kg
	Dodonaea viscosa	1kg
	Hardenbergia violacea	0.5kg
	Indigofera australis	2kg
	Leptospermum obovatum	0.1kg
	Kunzea parvifolium	0.1kg
	Daviesia ulicifolia	0.2kg
Trees	Eucalyptus blakelyii	0.3kg
	Eucalyptus melliodora	0.3kg
	Eucalyptus mannifera	0.3kg
	Eucalyptus viminalis	0.3kg
	Allocasuarina littoralis	0.3kg

It is proposed that 1000 tubestock will be planted over the last years hydro-mulched area (B in Plate 2- shaded green), and infill planting of 500 tubestock will occur within the previous years rehabilitation to replace unsuccessful plants (C in Plate 2- shaded red). All tubestock will be sourced from current species lists.

Plate 2 Western Overburden Emplacement Rehabilitation to be conducted Spring 2022

8.3.2.2 Bryce's Gully

The site specific Bryce's Gully Rehabilitation Strategy was implemented in 2019. The general objectives for rehabilitation of the gully are to construct a geotechnically stable landform which does not present a greater safety hazard than the surrounding land; create land to be visually compatible with the surrounding natural landscape and to not negatively impact the visual amenity of the gully. The rehabilitation progression is monitored annually using EFA (See Section 8.4).

As required by the strategy, tube stock was planted in nominated locations along the benches and drainage lines in the upper part of the gully and along steep sections adjacent to erosion channels in the southern part of the gully. These areas were fenced to prevent loss of tube stock due to grazing. Weed control measures were performed involving hand spot-spraying of tussock in targeted areas to ensure persistence of vegetation on the banks and to prevent erosion. Hand weeding was conducted inside the fenced areas, and plants were watered and fertilised using the irrigation system where required. Maintenance activities involved the application of fertiliser and water via an irrigation system which has been installed on the slope.

Inspections during December 2021 showed that regeneration is going well on the upper benches with the tube stock becoming more established. Low levels of loss were recorded, and thus replacement of tube stock has not yet been required. Further down the slope in the

narrower sections of the gully there has been less success with the species planted due to wetter conditions and less light and alternate replacement species such as sandpaper fig will be investigated in the coming period.

Work planned for the upcoming 2022/2023 reporting period includes additional planting of tube stock within new rehabilitation enclosures on the lower section of the gully (See Plate 4), spot spraying and replacing of tube stock if necessary.

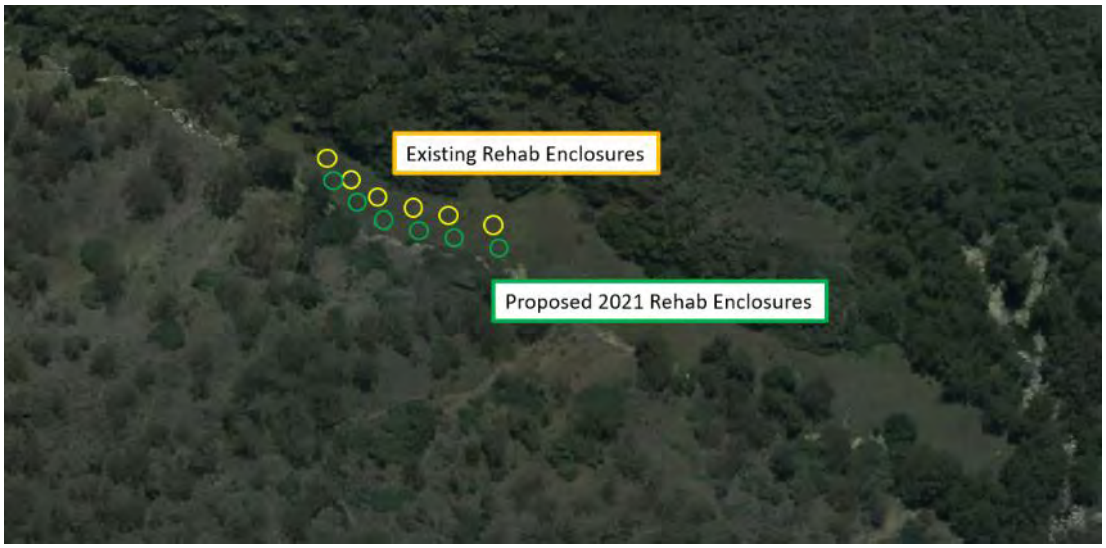


Plate 4 Proposed Rehabilitation for Upcoming Reporting Period


Plate 5 Current status of Bryces Gully bench 2 (EFA site 4)

8.3.3 Feral Animal Control

There has been much habitat disturbance on the project site associated with feral animals including rabbits, brown hares, foxes, goats and more recently deer. During the reporting period goats located on site were captured by a rural contractor, taken off site and sold. Additionally aerial culling was undertaken by the National Parks and Wildlife Services in the vicinity of the mine.

8.3.4 Weed Management

Schedule 4 Class 4 noxious weeds recorded on site include Blackberry, Pampas grass, Paterson's curse, Serrated tussock, and Sweet Briar. In accordance with the Noxious Weeds Act 1993, "the growth and spread of the plant (Class 4 weeds) must be controlled according to the measures specified in a management plan published by the local control authority".

During the 2021-2022 reporting period weed control was done as per the Marulan South Limestone Mine Weed Management Plan. Hand weeding was conducted within the rehabilitation enclosures on Bryce's Gully, as well as hand spraying of blackberry in the narrow sections of the gorge and on other areas surrounding the mine. Pampas Grass was aerially sprayed with the use of a helicopter on the benches and in rocky areas adjacent to the South Pit.

8.4 Rehabilitation Monitoring

8.4.1 Rehabilitation Monitoring - Ecosystem Function Analysis

An Ecosystem Function Analysis (EFA) developed by Tongway and Hindley (2004) is being utilised to assess the rehabilitation progression at the mine. The EFA monitors transects to measure the landscape function, vegetation dynamics, habitat complexity and disturbance. These measures are converted into indices for comparisons of rehabilitation over time and to undisturbed reference sites. The methodology used does not replace the traditional methods of monitoring vegetation and fauna but adds a functional interpretation to link vegetation structure and organisation more closely with soil function and the development of habitat for native fauna.

The site is surrounded by National Park and State Conservation Area bushland to the South and East, and farmlands to the North and West. The end result of the rehabilitation process is a return of the site to natural woodland where possible, or as sustainable grazing pasture where appropriate.

Monitoring surveys are scheduled to occur on a biannual basis, with monitoring undertaken in December 2021 and May 2022. Generally, surveys will occur in Autumn and Spring to record seasonal differences in floristic structure and composition in the reference areas, to identify seasonally occurring plant species, and to note the effects of seasonal conditions on plant germination on exposed rehabilitation sites.

A total of five transects, including one reference site were surveyed, as described in Table 8.4 below.

Table 8.4- Transect Description

Transect	Landscape Position	Comments
Reference 1 (R1)	South-West of the WOE	Has not been disturbed by mining activities
T1	Located at the northern end of the WOE, Domain 4.1w in the 2018-2023 MOP	Monoculture of *acacia* species with juvenile *Eucalypts*. Rehabilitated in 2005 and 2008. Discontinued due to expansion of the west overburden emplacement.
T2	South of the active area within the WOE, Domain 7.1w in the 2018-2023 MOP	Flat ground with groundcover of weed species and older monoculture of *Acacia*. Rehabilitated in 2005.
T3	Far south of the WOE Domain 7.1w in the 2018-2023 MOP	Rehabilitation occurred in 2017. Many *Acacia* with juvenile *Eucalyptus* and *Allocasuarina.* Many weeds present.
T4	Second bench of Bryces Dump Domain 7.3e in the 2018-2023 MOP	Stable slope, high vegetation cover is mostly weeds, moss and dying serrated tussock. Rehabilitated in 2019/2020
T5	WOE - first bench, Domain 4.1w in the 2018-2023 MOP	Transect established April 2021. Rehabilitation trial conducted January 2019. High grass and broadleaf weed density with increased *Acacias* down low.

A summary of the May 2022 EFA results are presented below, while the complete report is provided as Appendix C.

Field surveys involved the collection of patch/interpatch and soil surface condition data for each transect. This data is used to calculate the landscape organisation, soil stability, infiltration and nutrient cycling indices. The landscape organisation and soil surface assessments are most useful when compared over time, during subsequent monitoring surveys.

Table 8.5 contains the Landscape Function Analysis (LFA) and Soil Surface Assessment (SSA) results for May 2022. There was an improvement in the stability rating across all sites, with increased patches of grass, moss and weeds presenting the highest soil stability index. Since infiltration scores were similar to, or higher than the reference site, no further infiltration improvements are necessary. Nutrient cycling improved substantially at Site 3 over the last 6 months due to the increased weed cover and juvenile Acacias filling out. A slight improvement of nutrient cycling is still required for Site 3, which would involve increased vegetation, litter and biological cover. Brush-matting can be recommended to achieve this.

Table 8.5- Landscape Function Analysis and Soil Surface Assessment Results

Index	T2	T3	T4	T5	Reference
Landscape Organisation	100	73	100	90	96
Stability	73.5	57.6	72	62	73.5
Infiltration	67.8	58.9	56.5	59.3	55.3
Nutrient Cycling	59	47.4	72.4	59.4	57.4

Vegetation Composition is measured by species richness at three strata levels and by cover percentages (Table 8.7). The canopy is split into middle (1-3m tall) and upper canopy (>3m). Stem count is used as a measure of vegetation density. An inventory of all species recorded is provided in Table 8.8.

Species Richness is fairly consistent across the sites, except for lower shrub richness in the rehabilitated areas compared to the reference site. Species Richness of Revegetated Areas remains well below the Species Richness of the Reference Transect. It is natural for species richness to be low in newly colonised and regenerating areas, with complexity increasing with time. The groundcover richness ranges from 16 to 30 species per transect, although a significant proportion of groundcover species are weeds (see Table 8.8). Groundcover richness increased significantly at T4 and T5.

Percent covers varied considerably among all five transects. There is a large percent of bare ground in transect T3 which can have negative impacts on soil stability and nutrient cycling, although this percent dropped from 72% to 50% in the past 6 months. T4 has a high groundcover percentage, although is lacking a middle and upper storey level. Seeding and tube stock planting has occurred in this area and will seek to address this issue over time.

The rehabilitated sites T2 and T5 in particular, have a considerably high density of mature acacia species, which is not representative of the reference site. Care must be taken when conducting rehabilitation that species mixes reflect the surrounding native vegetation.

Table 8.6- Vegetation Composition Results

Species Richness	T2	T3	T4	T5	Reference
Groundcover	25	16	30	29	23
Shrub	1	1	2	1	4
Canopy	4	7	1	2	7
Average Cover (%)					
Groundcover	60.5	29	85	70	12
Shrub Cover	0	21	2	1	0
Leaf Litter	24	21	12	11	80
Bare Ground	16	50	1	19	9
Canopy Cover	56	0	0	0	21
Total Stem Density Count					
1-3m	0	7	2	7	1
3m+	2	0	0	2	2

Table 8.7- Transect Species List

Transect 2	Transect 3	Transect 4	Transect 5	Reference
Weed species				
Sonchus asper	*Plantain lanceolata*	*Verbena brasiliensis*	*Hirschfeldia incana*	*Euphorbia maculata*
Plantago lanceolata	*Medicago minima*	*Stachys byzantina*	*Sonchus arvensis*	*Euphorbia peplus*
Erigeron bonariensis	*Hirschfeldia incana*	*Erigeron canadensis*	*Sinapis arvensis*	*Gamochaeta sp*
Centaurea Melitensis	*Euphorbia peplus*	*Solanum nigrum*	*Plantago lanceolata*	*Hypochaeris glabra*
Lactuca serriola	*Hypochaeris glabra*	*Cirsium vulgare*	*Dittrichia graveolens*	*Asclepias fascicularis*
Cirsium vulgare	*Geranium molle*	*Sonchus asper*	*Erigeron bonariensis*	*Nassella trichotoma*
Hirschfeldia incana	*Atractylis cancellata*	*Marrubium vulgare*	*Sonchus Asper*	*Daucus carota*
Silybum marianum	*Modiola caroliniana*	*Dittrichia graveolens*	*Hypochaeris glabra*	*Erigeron bonariensis*
Rumex acetosella	*Erigeron bonariensis*	*Geranium dissectum*	*Lythrum salicaria*	*Portulaca oleracea*
Hypochaeris glabra	*Erigeron canadaensis*	*Erigeron sumatrensis*	*Cirsium vulgare*	*Euchiton japonicus*
Erodium moschatum	*Sonchus Asper*	*Helminthotheca echioides*	*Helminthotheca echioides*	*Solanum nigrum*
Erigeron canadaensis	*Dodonaea viscosa*	*Sonchus oleraceus*	*Erigeron canadensis*	*Dichondra repens*
Erigeron sumatrensis	*Centaurea Melitensis*	*Plantain lanceolata*	*Dichondra repens*	*Verbena bonariensis*
Sonchus oleraceus	*Lactuca serriola*	*Machaeranthera tanacetifolia*	*Euchiton japonicus*	
Gamochaeta coarctata	*Cirsium vulgare*	*Scorzoneroides*	*Lythrum salicaria*	
Verbena brasiliensis		*Leontodon saxatilis*	*Erigeron canadensis*	
Dichondra repens		*Tetraneuris scaposa*	*Conyza bonariensis*	
Solanum nigrum		*Modiola caroliniana*	*Onopordum acanthium*	
Portulaca oleracea		*Andropogon virginicus*	*Anagallis arvensis*	
Oxalis dillenii		*Hypochaeris glabra*		
Ageratina adenophora		*Anagallis arvensis*		
Tagetes minuta		*Hirschfeldia incana*		
Improved Pasture Species				
Trifolium repens	*Trifolium repens*	*Trifolium repens*	*Trifolium repens*	*Poaceae sp.*
Phallaris sp.	*Phallaris sp.*	*Heteropogon contortus*	*Dactylis glomerata*	*Poa sieberiana*

Transect 2	Transect 3	Transect 4	Transect 5	Reference
	Lolium sp.	*Paspalum dilatatum*	*Cynodon dactylon*	*Cyperaceae sp.*
	Cenchrus Clandestinus	*Cynodon dactylon*	*Phallaris minor*	*Microlena spp*
	Cynodon dactylon	*Chloris gayana*	*Chloris gayana*	
			Poa pratensis	
			Lolium	
			Festuca arundinacea	
Native Understorey Species				
		Lomandra Longifolia	*Chrysocephalum apiculatum*	*Goodenia pinnatifida*
			Unknown groundcover	*Patersonia occidentalis*
			Hardenbergia violacea	*Chrysocephalum apiculatum*
				Indigofera australis
				Hardenbergia violacea
				Vicia tetrasperma
				Vittadinia muelleri
Mid to Upper Storey Species				
Acacia decurrens	*Acacia parramattensis*	*Pittosporum multiflorum*	*Dodonaea sp*	*Hakea sp.*
Acacia mearnsii	*Acacia falciformis*	*Pittosporum undulatum*	*Acacia decurrens*	*Eucalyptus eugenioides*
Eucalyptus cinerea	*Acacia mearnsii*		*Acacia mearnsii*	*Acacia sp. (juvenile)*
Eucalyptus macrorhyncha	*Acacia longifolia*			*Eucalyptus mannifera*
	Acacia decurrens			*Eucalyptus bosistoana*
	Allocasuarina littoralis			*Ozothamnus diosmifolius*
	Eucalyptus cinerea			*Olearia viscidula*
	Acacia parramattensis			*Eucalyptus cinerea.*
	Gleditsia triacanthos			*Acacia decurrens*
				Casuarina sp. (juvenile)

The Habitat Complexity is scored from 0 to 3 on the following five features to survey the extent of available niches for vertebrate fauna (Table 8.8). The index shows that all rehabilitated transects have lower habitat complexity levels than the reference transect. Transects T2, T3 and T4 have improved Habitat Complexity Scores from the previous reporting period.

Table 8.8- Habitat Complexity Scores

Transect	Tree Canopy %	Shrub Canopy %	Ground Herb %	Litter %	Water Availability	Habitat Complexity Index
2	3	1	3	2	1	10
3	0	2	1	1	0	4
4	0	1	3	1	1	6
5	1	1	3	1	0	6
Reference	2	1	1	3	2	9

The EFA monitoring program is primarily designed to track rehabilitation progression and success through time. These results can be used as a baseline for the future.

8.4.2 Progressive Rehabilitation Strategy

In accordance with the rehabilitation strategies developed in the 2018-2023 MOP, a commitment to prepare a program for ongoing rehabilitation for implementation during each future AEMR period was made.

The Marulan South Limestone Mine's progressive rehabilitation strategy is also currently being reviewed which considers the continued 30 year SSDA mine operation. Following approval of the SSDA, rehabilitation strategies will be updated as required to satisfy the consent conditions.

The rehabilitation activities planned for 2022-2023 reporting period will include:

- Use of soil ameliorants to prepare soil for seeding;
- A total of 1000 tubestock will be planted over the last years hydro-mulched area on the second highest completed bench in Spring 2022 of the southern slopes of the WOE;
- Also in Spring 2022, infill planting of 500 tubestock will occur within the previous years rehabilitation to replace unsuccessful plants on the third highest completed bench of the southern slopes of the WOE;
- Cross-ripping followed by hydro-mulching and seeding of a total of 5.1ha on the uppermost completed bench in the WOE area;
- Thinning out the Acacia species located in the 2014 rehabilitation area with a density reduction of approximately 20%, located on the south-west lower bench of the WOE;
- Replacement of removed Acacias with 250 tubestock of Eucalypt and other native mid-upper storey species on the south-west lower bench of the WOE;
- Completion of the uppermost, final bench within the WOE with 5 metres in height remaining;
- The planting out the new rehabilitation enclosures on the lower sections of Bryce's Gully and ongoing fertilisation and watering via the irrigation system as required; and
- Monitoring and maintenance Bryce's Gully including weed control measures when required.

The following actions may need to be taken as per recommendations from the LFA/EFA rehabilitation monitoring program:

- ❒ Controlling weeds within rehabilitation areas;
- ❒ Management and control of feral animals as required;
- ❒ Management and control of erosion;
- ❒ Revisiting rehabilitation methodologies in areas that may have failed;
- ❒ Infilling tube stock to improve species richness or in areas with failed plantings.
- ❒ General maintenance including irrigation and fertilising; and
- ❒ Repairing fences, access tracks and other land management activities.

Table 8.9 Rehabilitation Summary

Mine Area type	Total Area (ha) Start of AEMR 01/07/2021	Total Area (ha) End AEMR 30/06/2022	Total Area (ha) Next AEMR 30/06/2023
A. Total Mine Footprint	616.5	617.5	617.5
B. Total Active Disturbance			
Infrastructure Areas	114.0	114.2	114.2
Active Mining Areas	108.7	108.7	108.7
Waste Emplacements	27.9	27.9	27.9
Tailings Emplacements	2.0	2.0	2.0
Shaped Waste Emplacements	31.2	35.1	35.1
C. Land Prepared for Rehabilitation	46.7	50.7	50.7
D. Land Under Active Rehabilitation	49.9	49.9	53.7
E. Completed Rehabilitation	56.6	56.6	60.6

Table 8.10 Maintenance activities on Rehabilitated Land

	Area Treated (Ha)		
Nature Of Treatment	Report period 21/22	Next Period 22/23	Comment/control strategies/ treatment detail
Additional erosion control works (drains re-contouring, rock protection)	2.5	2.5	Construction of W2 Dam and associated rock drains on the southern slopes of the WOE.
Re-covering (further topsoil, subsoil sealing etc.)	2.1ha	4	Topspoil covering old contractor laydown area to the North of Lime Dump Road. Further establishment of the final batter in the WOE in FY23
Soil treatment (fertiliser, lime, gypsum etc.)	3.9ha	5.1ha	To be undertaken based on Marulan South Limestone Mine Progressive Rehabilitation Strategy. Hydro-mulching of final landform of the southern slopes of the WOE continues.
Treatment/Management (grazing, cropping, slashing etc.)	minor	minor	Areas leased to local farmers for grazing generally in surrounding buffer zone land owned by BCL and Boral Resources (NSW) Pty Ltd.
Re-seeding/Replanting (species density, season etc.)	4ha	12 ha	Seeding and tubestock planting was undertaken on the WOE during the period and is continued for FY23. Tubestock planting lower on Bryces Gully is scheduled for FY23.
Adversely Affected by Weeds (type and treatment)	Refer to Section 8.3.4	Refer to Section 8.3.4	During the reporting period contractors were engaged for spot spraying and hand removal of Blackberry on Bryce's Dump in conjunction with the rehabilitation and stabilisation works. Aerial spraying was conducted across the site targeting Pampas Grass and Blackberries.
Feral animal control (additional fencing, trapping, baiting etc.)	Refer to Section 8.3.3	Refer to Section 8.3.3	Feral Goat control was undertaken onsite where animals were caught and removed from site.

8.5 Further Development of the Final Rehabilitation Plan

A Final Rehabilitation Plan was developed as part of the SSDA. This involves rehabilitation of all out-of-pit overburden emplacement and a final void. Partial in-pit placement of overburden in the south pit will reduce the final void size as well as provide some visual screening of the extraction area. The revegetation of the emplacement area will include a mixture of native trees, shrubs and grasses representative of regionally occurring woodland. The completion criteria specified in the SSDA commitments include a minimum of 70% vegetation cover, 50% if rocks, logs or other features of cover are present and no areas of weed infestation.

The final rehabilitation plan will be further developed with approval of the new Mining Lease and finalisation of a new RMP to cover the 30 year mine plan.

8.6 Targeted Assessment Program

A crucial part of the Resource Regulator's compliance and enforcement strategy involves implementing Targeted Assessment Program (TAP) for mines. The TAPs comprise inspections across the mine sites in NSW to ensure measures have been identified and implemented to facilitate sustainable rehabilitation outcomes.

The TAPs proactively assesses how effectively a mine is controlling risks and managing compliance with the preventative and mitigating controls that are critical in planning for and implementing mine site rehabilitation.

In June 2021 the Resource Regulator undertook a Landform Establishment TAP site inspection at the mine. As an outcome of this inspection an improved final landform signoff process has been prepared and has been incorporated into the management plans currently awaiting approval from DPE.

9. COMMUNITY RELATIONS

The Marulan South Limestone Mine has been owned and operated previously by BCSC and now Boral Cement Limited (BCL) since 1987 and continues to provide direct employment currently for approximately 95 local people who travel from the towns of Goulburn (35kms), Marulan (12kms), Berrima (60kms) and surrounding areas.

Services provided by BCL include a contracted bus service for employees travelling from Goulburn. In addition, a helicopter landing station is maintained in support of emergency responses, which may occur on site or in the adjoining Bungonia National Park and State Conservation Area.

During the reporting period, the Marulan South Community Consultative Committee was established and combined merged with the Peppertree CCC to form the Marulan South Operations CCC. The CCC advertised for new committee members and the first meeting was held on the 27th July 2022. Meetings are held on a three-monthly basis and committee members are emailed an update including the monitoring data from the previous quarter.

9.1 Environmental Complaints and Enquiries

Two complaints were received from the public during the reporting period. These have been detailed below in Table 9.1.

Table 9.1 Complaints register

Date and time	Complaint received from	Nature of complaint	Outcome of Investigation
9/1/22	Public (via DPIE)	The Department has received a complaint in relation to Bungonia Creek pollution incident, observed on 9 January 2022. It is alleged the pollution incident may have been as a result of sediment discharge from the Marulan South Limestone Mine Continued Operations Project. Below photos were taken from the Lookdown platform, just out from the edge of the escarpment.	The image of the 'muddy waterfall', appears to be groundwater being released via a natural feature known as the "Blow Hole" (also known as B68). The Main Gully discharge point takes surface water from a small area of the mine that is not directed into the pit, other than retention drainage, our records indicate there was no overflow from the quarry on 9 January 2022. This event is similar to the January 2016 event. Subsequent investigation by Boral concluded that the discolouration identified was not caused by surface runoff from any disturbed areas that drain to Main Gully. The discolouration was attributed to an overflow event from the 'Blow Hole' cave (fed by groundwater)

Date and time	Complaint received from	Nature of complaint	Outcome of Investigation
			It is noted from the 2016 report and previous correspondence between the EPA and Boral, that links between high sediment loads in Bungonia Creek and the operations at the mine remain inconclusive, but could be attributed to the intricacies of the limestone karst system and overflows from within this system.
28/5/22 7:30	Public	Squealing metal/an unoiled rotating implement sound coming from the quarries	Immediate Response: Ben Williams responded to the text on Monday asking for further information so that investigation could be undertaken. Investigation: Operations and weather conditions assessed for the period of time leading up to and after the notification. Conveyor screw was the identified issue and operations turned off the conveyor during temperature inversion events. Outcome: Screw was replaced as part of maintenance program.

9.2 Community Liaison

Boral conducted a specific community liaison program as part of the SSDA in addition to its normal ongoing community engagement activities. The additional liaison provided information on community attitudes and concerns which assisted in the development of the ongoing mine operation strategic planning and environmental mitigation strategies.

The current engagement activities include:

- Regular community newsletters;
- Active participation in local events;
- Arranging site inspections and one on one consultation;
- Active engagement with key government and non-government organisations; and
- Maintenance of an environmental and community complaints register and actively managing and resolving community issues as they arise.

9.3 Community Involvement

Boral is engaged in local community events and has been involved in two of the most significant events since 2011. Boral is a proud major sponsor of the Marulan Spring Festival, (formally known as the Marulan Kite Festival) each September - October and the Tallong Apple Day Festival held annually in May. Unfortunately due to Covid-19 restrictions, the Marulan Spring Festival was cancelled again in 2021.

The Marulan South Operations Community Plan was acknowledged at the 2017 NSW/ACT Cement Concrete Aggregates Australia (CCAA) Innovation Awards with a win in that year's Community Leadership category. The Marulan South sites also won the category at the 2019 Awards for their Youth Leadership and Development initiative.

10. INDEPENDENT AUDIT

There were no independent audits required during the reporting period. The SSDA approval will require an Independent Environmental Audit to be undertaken within one year of commencement of development under the consent and every three years thereafter. As development has not yet commenced, the first of these audits will not be required to be undertaken until at least during the 2023/2024 reporting period.

11. INCIDENTS AND NON-COMPLIANCES

No reportable incidents occurred during the 2021-2022 reporting period as confirmed by this review. One non-compliance with CML16 was identified in relation to blast monitoring as detailed in Section 6.6.

12. ACTIVITIES PROPOSED FOR NEXT AEMR PERIOD

Activities for the coming reporting period primarily centre around the requirements of SSD post-approval process. The approval required the preparation of a number of environmental management plans to support the approved mine plan. These plans have been prepared and are currently awaiting comment from DPE.

12.1 Environmental Risk Management

The SSDA approval will initiate a new Broad Brush Risk Assessment as well as individual risk assessments covering specific environmental aspects of the operation.

12.2 SSDA Approval Requirements

Actions required to be undertaken include:

- Finalisation of management plans and strategies following comment from DPE.
- Review existing environmental monitoring activities for adequacy.
- Prepare an EPL licence variation to align with the SSDA approval.
- Surrendering of CML16 and ML1716 following receipt of the New Mining Lease.
- Prepare a new RMP to take into account the approved mine plan and any specific conditions of the approval and conditions of the new Mining Lease.
- Relinquishment of previous DA approvals and continuing use rights coinciding with commencing development under SSDA consent in the coming period.
- Execution of the Biodiversity Stewardship Agreement and retiring of credits.

The DPIE will be notified of the date of commencement of development, construction and mining under the development consent.

12.3 Management Plans and Strategies

The SSDA development consent required the preparation of a number of plans and strategies including the following:

- Noise Management Plan.
- Blast Management Plan.
- Air Quality and Greenhouse Gas Management Plan.
- Water Management Plan (including Site Water Balance, Erosion and Sediment Control Plan, Surface Water Management Plan, Marulan Creek Dam Management Plan, and Groundwater Management Plan).
- Biodiversity Management Plan.
- Aboriginal Cultural Heritage Management Plan.

- Historic Heritage Management Plan.
- Bushfire Management Plan
- Rehabilitation Strategy.
- Rehabilitation Management Plan.
- Traffic Management Plan.
- Environmental Management Strategy.

These plans have been prepared in accordance with relevant guidelines and in consultation with DPE and relevant government agencies. The plans provide details on statutory requirements, relevant limits or performance criteria and performance indicators, as well as a description of the measures to be implemented to comply with these requirements. The plans also detail monitoring programs to assess the environmental performance of the development and the effectiveness of the management measures. Protocols for managing and reporting any incidents, non-compliance or exceedances of impact assessment criteria are also included. These plans and have been submitted to DPE for approval and will be implemented in the coming reporting.

12.4 MOP / RMP / Rehabilitation Strategy

The Marulan South Limestone Mine's progressive rehabilitation strategy is also currently being reviewed which considers the continued 30 year SSDA mine operation. Following approval of the SSDA, rehabilitation strategies will be updated as required to satisfy the consent conditions.

The rehabilitation activities planned for 2022-2023 reporting period will include:

- Use of soil ameliorants to prepare soil for seeding;
- A total of 1000 tubestock will be planted over the last years hydro-mulched area on the second highest completed bench in Spring 2022 of the southern slopes of the WOE;
- Also in Spring 2022, infill planting of 500 tubestock will occur within the previous years rehabilitation to replace unsuccessful plants on the third highest completed bench of the southern slopes of the WOE;
- Cross-ripping followed by hydro-mulching and seeding of a total of 5.1ha on the uppermost completed bench in the WOE area;
- Thinning out the Acacia species located in the 2014 rehabilitation area with a density reduction of approximately 20%, located on the south-west lower bench of the WOE;
- Replacement of removed Acacias with 250 tubestock of Eucalypt and other native mid-upper storey species on the south-west lower bench of the WOE;
- Completion of the uppermost, final bench within the WOE with 5 metres in height remaining;
- The planting out the new rehabilitation enclosures on the lower sections of Bryce's Gully and ongoing fertilisation and watering via the irrigation system as required; and
- Monitoring and maintenance Bryce's Gully including weed control measures when required.

12.5 Mining Operations

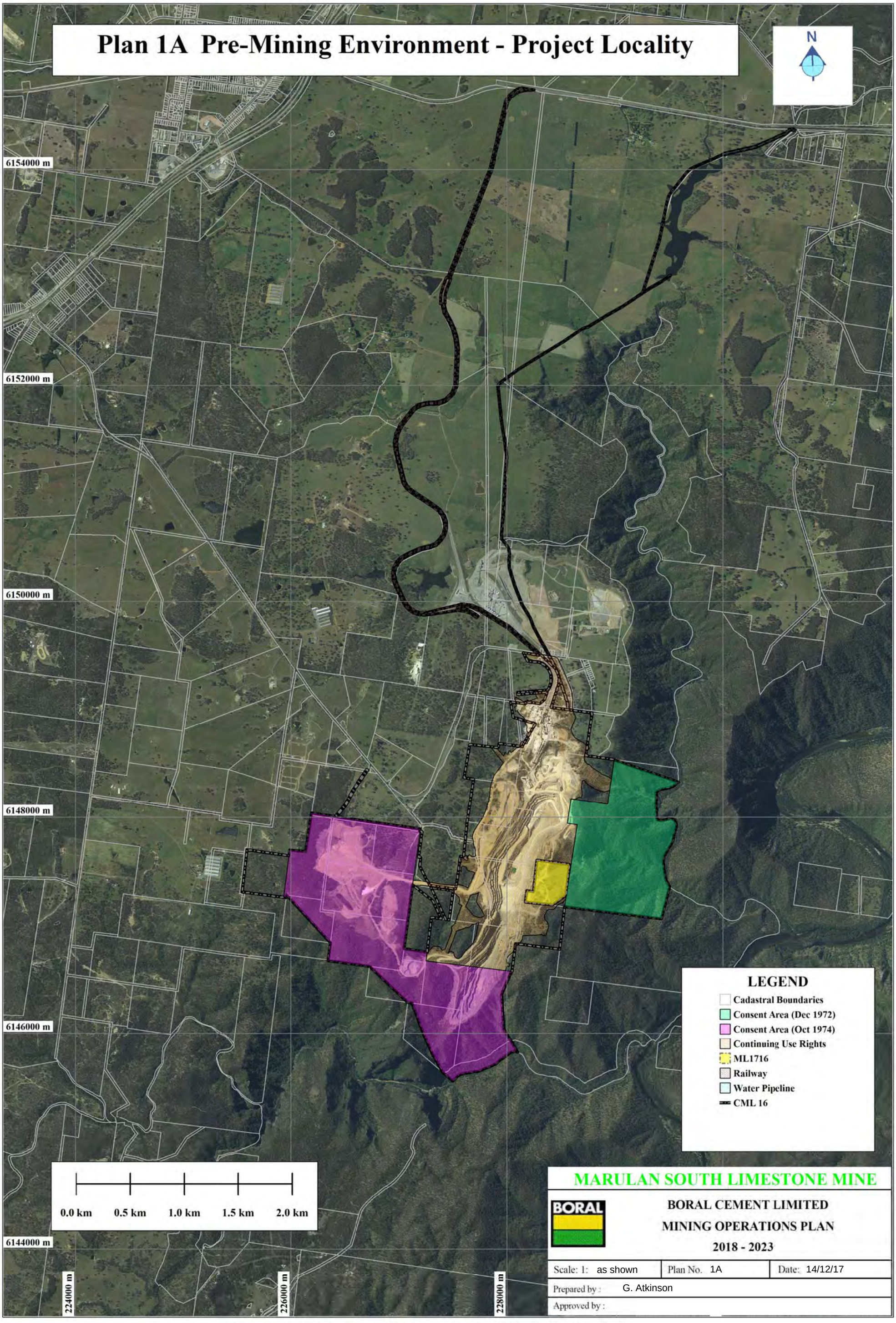
The EIS for the SSDA indicated that current mining operations could continue for a period of up to three years following approval of the SSDA and therefore it is anticipated that the coming reporting period will involve:

- pre-stripping of topsoil in approved mine expansion and emplacement areas;
- overburden removal and emplacement;
- drill and blast activities;
- extraction of limestone and clay shale;
- Clay shale will continue to be mined by excavator or front-end loader;
- hauling of overburden and extracted resource;
- crushing, screening and stockpiling operations;
- product despatch predominantly by rail but also by road;
- maintenance and rehabilitation activities; and
- environmental and rehabilitation monitoring.

Further exploration will be undertaken to further develop the geological model and assist with future mine planning.

Plans

Plan 1A Pre-Mining Environment - Project Locality



Aerial Photography by Photomapping Services - 2 Nov 2014 (MGA Zone 56 / GDA94)

Plan 1B Pre mining environment - Natural Environment

N

6150000 m

6148000 m

6146000 m

226000 m

228000 m

125 m 375 m 625 m 875 m

LEGEND

- ML1716
- Niche Ecological Communities 2014
- Revegetation (progressive)
- Active Mine MOP footprint
- CML 16
- Drainage
- Project Approval Area
- 5m contours

MARULAN SOUTH LIMESTONE MINE

BORAL

BORAL CEMENT LIMITED

MINING OPERATIONS PLAN

2018 - 2023

Scale: 1: as shown	Plan No. 1B	Date: 14/12/17

Prepared by : G. Atkinson

Approved by :

Aerial Photography by Photomapping Services - 28 April 2017 (MGA Zone 56 / GDA94)

Plan 1C Pre mining environment - Built Environment

N

6149000 m

6148000 m

6147000 m

6146000 m

226000 m

227000 m

125 m 375 m 625 m

LEGEND

- ML1716
- Water Management Areas
- 2 Landform Establishment
- 3 Growth Medium Development
- 4 Ecosystem and Land Use Establishment
- Active Mine MOP footprint
- CML 16
- Project Approval Areas

MARULAN SOUTH LIMESTONE MINE

BORAL

BORAL CEMENT LIMITED

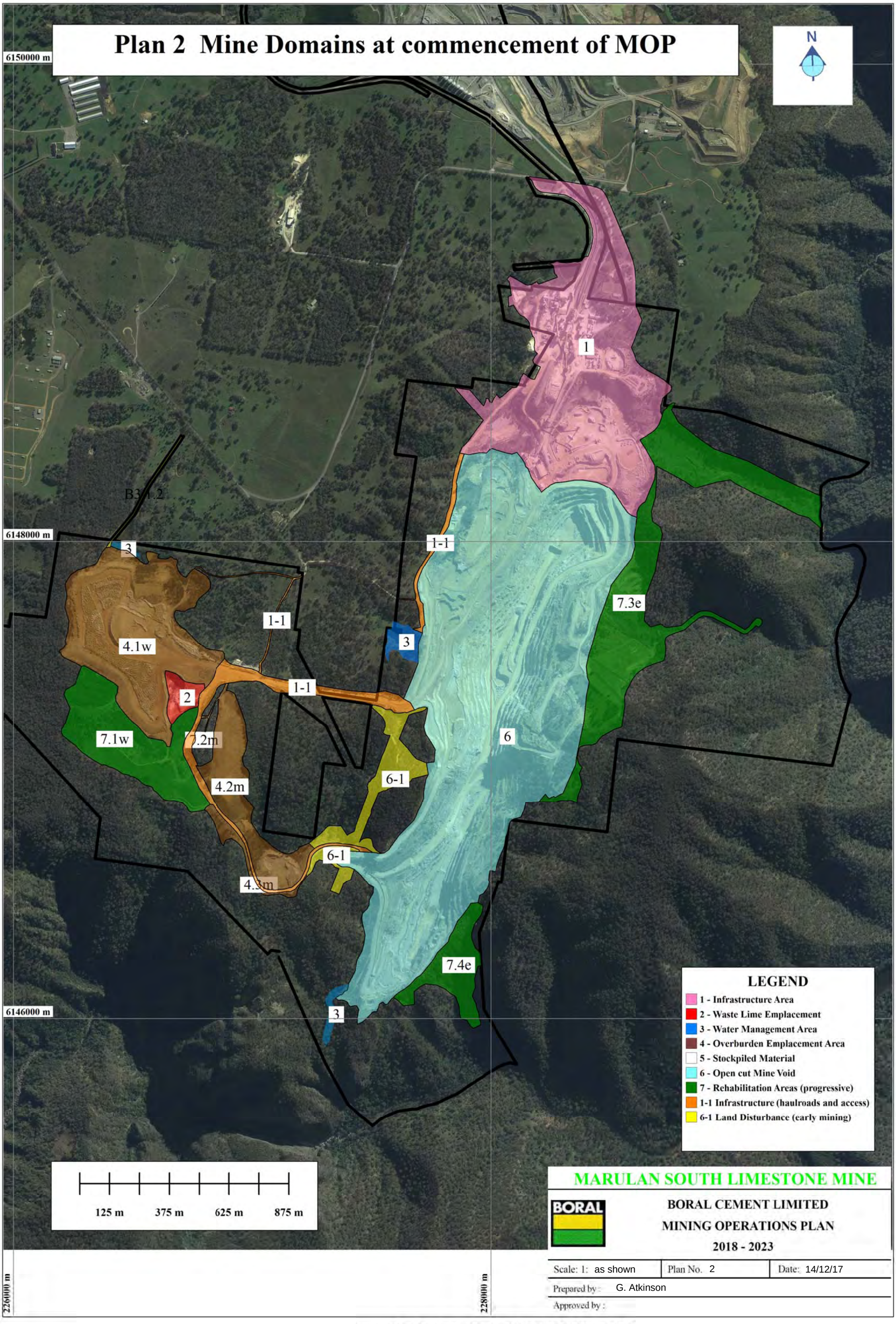
MINING OPERATIONS PLAN

2018 - 2023

Scale: 1: as shown	Plan No. 1C	Date: 14/12/17
Prepared by : G. Atkinson		
Approved by :		

Aerial Photography by Photomapping Services - 28 April 2017 (MGA Zone 56 / GDA94)

Plan 2 Mine Domains at commencement of MOP



MARULAN SOUTH LIMESTONE MINE

BORAL CEMENT LIMITED

MINING OPERATIONS PLAN

2018 - 2023

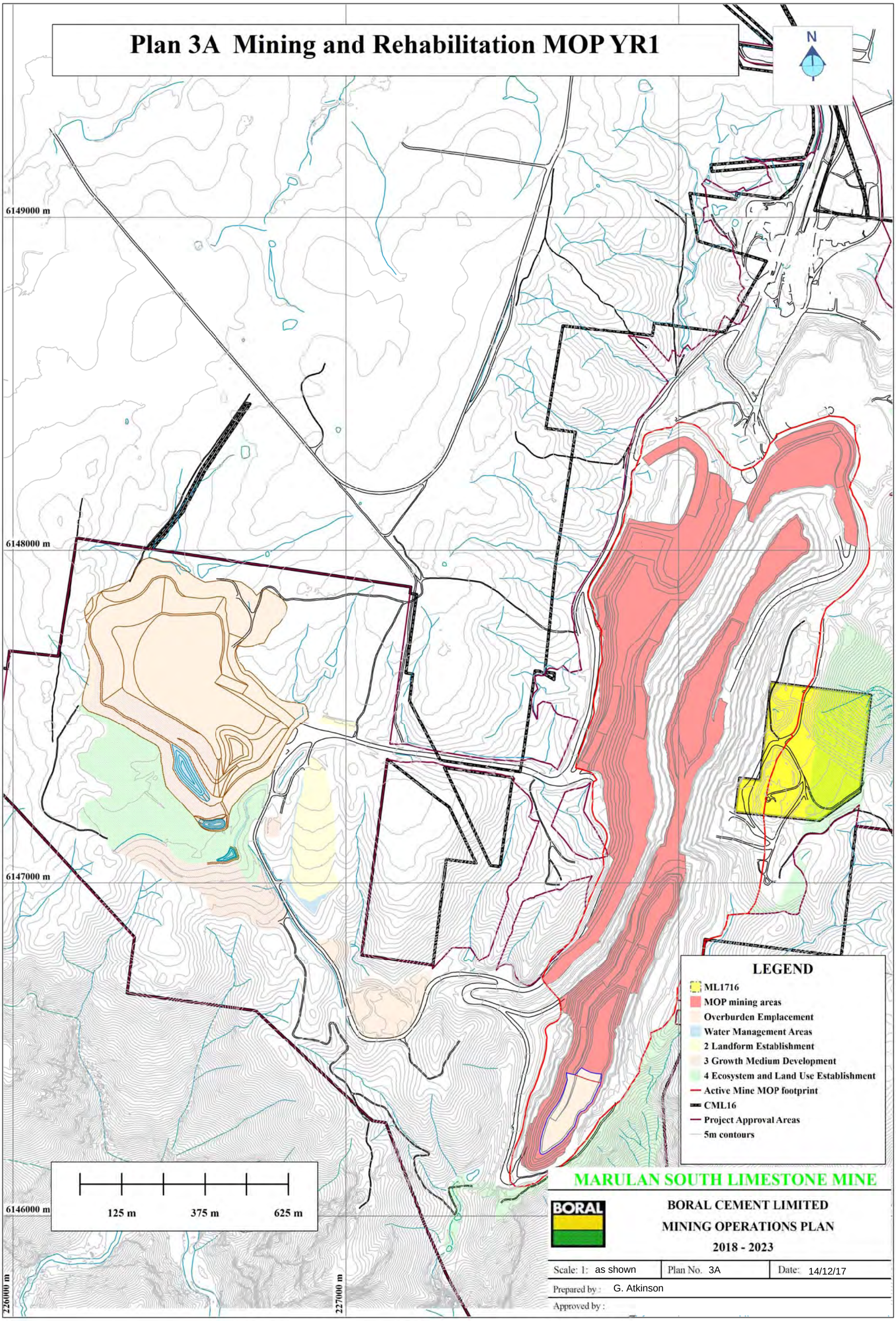
Scale: 1: as shown	Plan No. 2	Date: 14/12/17

Prepared by : G. Atkinson

Approved by :

Aerial Photography by Photomapping Services - 28 April 2017 (MGA Zone 56 / GDA94)

Plan 3A Mining and Rehabilitation MOP YR1



Aerial Photography by Photomapping Services - 28 April 2017 (MGA Zone 56 / GDA94)

Plan 3B Mining and Rehabilitation MOP YR2

N

6149000 m

6148000 m

6147000 m

6146000 m

226000 m

227000 m

125 m 375 m 625 m

LEGEND

- ML1716
- MOP mining areas
- MOP_YR2
- Overburden Emplacement
- Water Management Areas
- 3 Growth Medium Development
- 4 Ecosystem and Land Use Establishment
- Active Mine MOP footprint
- CML16
- Project Approval Areas
- 5m contours

MARULAN SOUTH LIMESTONE MINE

BORAL

BORAL CEMENT LIMITED

MINING OPERATIONS PLAN

2018 - 2023

Scale: 1: as shown	Plan No. 3B	Date: 14/12/17
Prepared by : G. Atkinson		
Approved by :		

Aerial Photography by Photomapping Services - 28 April 2017 (MGA Zone 56 / GDA94)

MOP Amendment A
Plan 3C/3D Mining and Rehabilitation MOP YR3 & YR4

N

6150000 m

6149000 m

6148000

6147000 m

6146000 m

D

A1

Bryce's Gully

227000 m

228000 m

125 m 375 m 625 m 875 m

LEGEND

- haulroad EB
- ML1716
- MOP mining areas
- Water Management Areas
- 2 Landform Establishment
- 3 Growth Medium Development
- 4 Ecosystem and Land Use Establishment
- Active Mine MOP footprint
- Active OB Emplecement Area
- CML16
- Project Approval Areas
- Overburden Emplacement
- A1 Mine Area Amendment A (2.4ha)
- D New Stockpile / Reclaim Area (2.6ha)

MARULAN SOUTH LIMESTONE MINE

BORAL

BORAL CEMENT LIMITED

MINING OPERATIONS PLAN
AMENDMENT A
2019 - 2023

Scale: as shown	Plan No. 3C/3D	Date: 13-Aug-19
Prepared by : Gordon Atkinson & Associates Pty Ltd		
Approved by : BCL		Amendment Date: 24-Sep-20

Aerial Photography by Photomapping Services - 27 April 2019 (MGA Zone 56 / GDA94, AHD)

225000mE
226000mE
227000mE
228000mE
229000mE
6151000mN
6150000mN
6149000mN
6148000mN
6147000mN
6146000mN
Water pipeline easement
Rail Spur
Marulan 10km
Main Access Road
Marulan South Road
Mine Entrance
Borlers
80 year conceptual mine void
Shoalhaven River
LEGEND:
CML No.16
Water course
Dam
Residence / sensitive receptor location
Power line
Extent of mining
Conceptual areas of final waste emplacement rehabilitation
N
W
E
S
0 100 200 300 400 500m
Note: Contour Interval is 5m; Grid: MGA Zone 56

Plan 4 Final Rehabilitation and Post Mining Land Use

BORAL
MARULAN SOUTH LIMESTONE MINE - Mining Operations Plan
Boral Cement Limited

Final Rehabilitation for Lease Relinquishment

Date: 8-12-10	Scale: 1 : 10000 (A1 size)	Plan No.: 6
Prepared by: GSS Environmental Pty Ltd / Gordon Atkinson & Associates Pty Ltd		

226000mE
227000mE
228000mE
229000mE
230000mE
6151000mN
6150000mN
6149000mN
6148000mN
6147000mN
6146000mN
6145000mN
Water pipeline easement
Rail Spur
Marulan 10km
Main Access Road
Marulan South Road
A
A'
B
B'
C
C'
D
D'

Plan 5 Rehabilitation and Post Mining Land Use Cross Sections

N
W
E
S
0 100 200 300 400 500m

Note: Grid: MGA Zone 56

BORAL

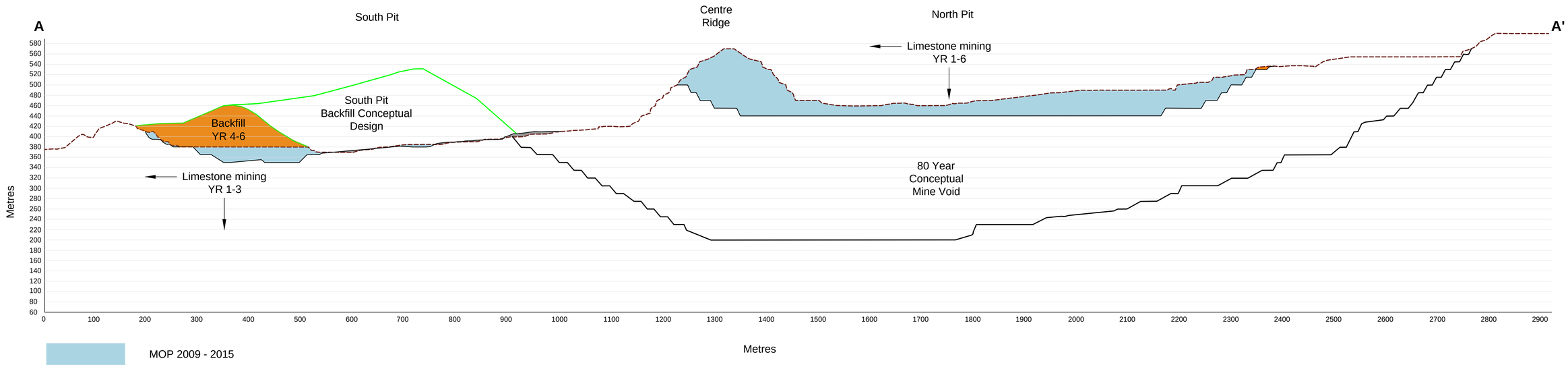
MARULAN SOUTH LIMESTONE MINE - Mining Operations Plan

Boral Cement Limited

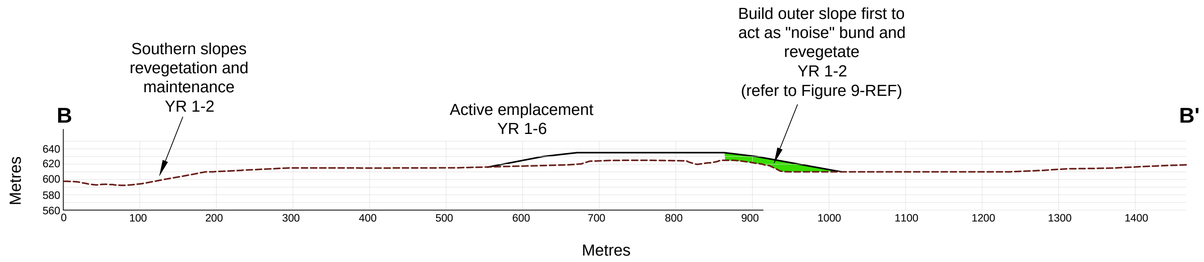
Mine Longitudinal and Additional Section Locations

Date:	Scale:	Plan No.:
9-12-10	1 : 20000 (A1 size)	7

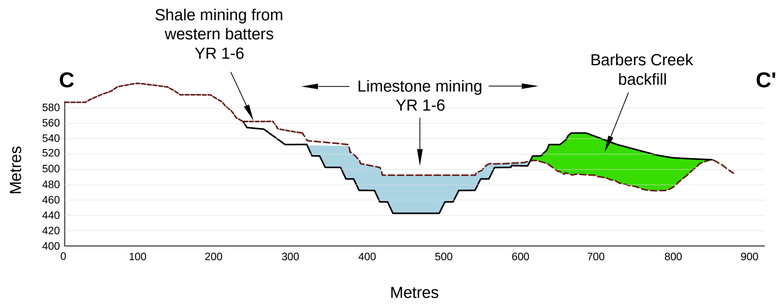
Prepared by: GSS Environmental Pty Ltd / Gordon Atkinson & Associates Pty Ltd

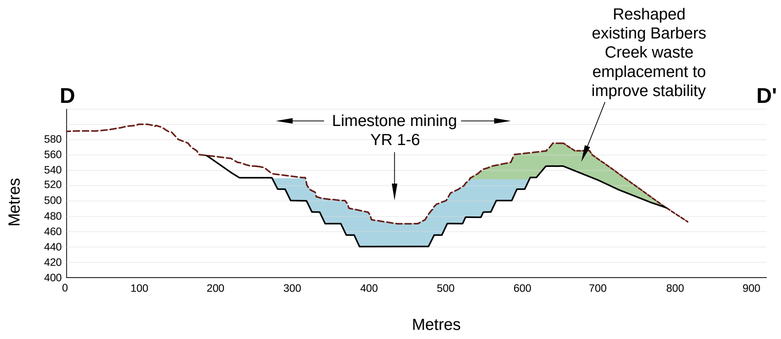


MINE LONGITUDINAL



WESTERN WASTE EMPLACEMENT





NORTH PIT AND BARBERS CREEK EMPLACEMENT

0 100 200 300 400 500m
Vertical Scale: 1 : 4000 (A1)

0 100 200 300 400 500m
Horizontal Scale: 1 : 4000 (A1)

BORAL

MARULAN SOUTH LIMESTONE MINE - Mining Operations Plan

Boral Cement Limited

Mine Longitudinal and Additional Sections

Date: 8-12-10	Scale: 1 : 20000 (A1 size)	Plan No.: 7-1
Prepared by: GSS Environmental Pty Ltd / Gordon Atkinson & Associates Pty Ltd		

APPENDIX A - EPA Licence

Environment Protection Licence

Licence - 944

Licence Details	
Number:	944
Anniversary Date:	28-January

Licensee

BORAL CEMENT LIMITED

PO BOX 6041

NORTH RYDE NSW 2113

Premises

MARULAN SOUTH LIMESTONE MINE AND LIME PLANT

HUME STREET

MARULAN SOUTH NSW 2579

Scheduled Activity

Cement or lime works

Mining for minerals

Fee Based Activity	Scale
Cement or lime production	> 100000-250000 T annual production capacity
Mining for minerals	> 2000000-5000000 T annual production capacity

Region

Regional South - Queanbeyan

11 Farrer Place

QUEANBEYAN NSW 2620

Phone: (02) 6229 7002

Fax: (02) 6229 7006

PO Box 622

QUEANBEYAN NSW 2620

Environment Protection Licence

Licence - 944

Environment Protection Licence

Environment Protection Licence

Licence - 944

Information about this licence

Dictionary

A definition of terms used in the licence can be found in the dictionary at the end of this licence.

Responsibilities of licensee

Separate to the requirements of this licence, general obligations of licensees are set out in the Protection of the Environment Operations Act 1997 ("the Act") and the Regulations made under the Act. These include obligations to:

- ensure persons associated with you comply with this licence, as set out in section 64 of the Act;
- control the pollution of waters and the pollution of air (see for example sections 120 - 132 of the Act);
- report incidents causing or threatening material environmental harm to the environment, as set out in Part 5.7 of the Act.

Variation of licence conditions

The licence holder can apply to vary the conditions of this licence. An application form for this purpose is available from the EPA.

The EPA may also vary the conditions of the licence at any time by written notice without an application being made.

Where a licence has been granted in relation to development which was assessed under the Environmental Planning and Assessment Act 1979 in accordance with the procedures applying to integrated development, the EPA may not impose conditions which are inconsistent with the development consent conditions until the licence is first reviewed under Part 3.6 of the Act.

Duration of licence

This licence will remain in force until the licence is surrendered by the licence holder or until it is suspended or revoked by the EPA or the Minister. A licence may only be surrendered with the written approval of the EPA.

Licence review

The Act requires that the EPA review your licence at least every 5 years after the issue of the licence, as set out in Part 3.6 and Schedule 5 of the Act. You will receive advance notice of the licence review.

Fees and annual return to be sent to the EPA

For each licence fee period you must pay:

- an administrative fee; and
- a load-based fee (if applicable).

Environment Protection Licence

The EPA publication “A Guide to Licensing” contains information about how to calculate your licence fees. The licence requires that an Annual Return, comprising a Statement of Compliance and a summary of any monitoring required by the licence (including the recording of complaints), be submitted to the EPA. The Annual Return must be submitted within 60 days after the end of each reporting period. See condition R1 regarding the Annual Return reporting requirements.

Usually the licence fee period is the same as the reporting period.

Transfer of licence

The licence holder can apply to transfer the licence to another person. An application form for this purpose is available from the EPA.

Public register and access to monitoring data

Part 9.5 of the Act requires the EPA to keep a public register of details and decisions of the EPA in relation to, for example:

- licence applications;
- licence conditions and variations;
- statements of compliance;
- load based licensing information; and
- load reduction agreements.

Under s320 of the Act application can be made to the EPA for access to monitoring data which has been submitted to the EPA by licensees.

This licence is issued to:

BORAL CEMENT LIMITED
PO BOX 6041
NORTH RYDE NSW 2113

subject to the conditions which follow.

Environment Protection Licence

Licence - 944

1 Administrative Conditions

A1 What the licence authorises and regulates

A1.1 This licence authorises the carrying out of the scheduled activities listed below at the premises specified in A2. The activities are listed according to their scheduled activity classification, fee-based activity classification and the scale of the operation.

Unless otherwise further restricted by a condition of this licence, the scale at which the activity is carried out must not exceed the maximum scale specified in this condition.

Scheduled Activity	Fee Based Activity	Scale
Cement or lime works	Cement or lime production	> 100000 - 250000 T annual production capacity
Mining for minerals	Mining for minerals	> 2000000 - 5000000 T annual production capacity

A2 Premises or plant to which this licence applies

A2.1 The licence applies to the following premises:

Premises Details
MARULAN SOUTH LIMESTONE MINE AND LIME PLANT
HUME STREET
MARULAN SOUTH
NSW 2579
SHIRE OF MULWAREE, PARISH OF MARULAN, COUNTY OF ARGYLE

A2.2 Additional Premises Description:

Lot 1 DP 23030; Lot 130 A/C 15310-179; Lot 186 A/C 15310-179; Lot 189 A/C 15310-179; Lot 193 A/C 15310-179; Lot 4 DP 216767; Lot 82 DP 750029; Lot 114 DP 750029; Lot 115 DP 50029; Lot 131 DP 750029; Lot 132 DP 750029; Lot 154 DP 750029; Lot 156 DP 750029; Lot 165 DP 750029; Lot 197 DP 750029; Lot 196 DP 750029; Lot 6 DP 111641; Lot 7 DP 111641; Lot 1 DP 527500; Lot 2 DP 527500; Lot 3 DP 527500; Lot 1701 DP 610507; Lot 1702 DP 610507; Lot 1 DP 617992; Lot 3 DP 617992; Lot 14 DP 111641; Lot 15 DP 111641; Lot 16 DP 111641; Lot 9 DP 111645; Lot 1 DP 371167; Lot 113 DP 830458; Lot 1 DP 860561; Lot 2 DP 860561; Lot A DP 368922; Lot B DP 368922; Lot 2 DP 536838; Lot 22 DP 867667.

A3 Information supplied to the EPA

A3.1 Works and activities must be carried out in accordance with the proposal contained in the licence

application, except as expressly provided by a condition of this licence.

In this condition the reference to "the licence application" includes a reference to:
a) the applications for any licences (including former pollution control approvals) which this licence replaces under the Protection of the Environment Operations (Savings and Transitional) Regulation 1998; and
b) the licence information form provided by the licensee to the EPA to assist the EPA in connection with the issuing of this licence.

2 Discharges to Air and Water and Applications to Land

P1 Location of monitoring/discharge points and areas

P1.1 The following points referred to in the table below are identified in this licence for the purposes of monitoring and/or the setting of limits for the emission of pollutants to the air from the point.

Air

EPA identification no.	Type of Monitoring Point	Type of Discharge Point	Location Description
1	Dust monitoring		Dust Deposition Gauge and High Volume Air Sampler labelled as "HVAS & Dust Gauge - Nearest Residence" on map entitled 'EPL 944 Sampling Points - May 2012" (DOC12/23175)
11	Discharge to air; Air emissions monitoring	Discharge to air; Air emissions monitoring	Kiln Stack labelled as "Kiln Stack" on map entitled 'EPL 944 Sampling Points - May 2012" (DOC12/23175).
12	Discharge to air; Air emissions monitoring	Discharge to air; Air emissions monitoring	Lime Hydration Plant Stack labelled as "Lime Hydration Plant Stack" on map entitled 'EPL 944 Sampling Points - May 2012" (DOC12/23175).
16	Dust Monitoring		Dust Deposition Gauge labelled as "Dust Guage - Store Paddock Hill" on map entitled 'EPL 944 Sampling Points - May 2012" (DOC12/23175)

P1.2 The following utilisation areas referred to in the table below are identified in this licence for the purposes of the monitoring and/or the setting of limits for any application of solids or liquids to the utilisation area.

P1.3 The following points referred to in the table are identified in this licence for the purposes of the monitoring and/or the setting of limits for discharges of pollutants to water from the point.

Water and land

EPA Identification no.	Type of Monitoring Point	Type of Discharge Point	Location Description

13	Groundwater Monitoring	Groundwater Monitoring Point labelled as "MW05" on map entitled 'EPL 944 Groundwater Monitoring Point Location Change- December 2020" (DOC20/1014984)

3 Limit Conditions

L1 Pollution of waters

L1.1 Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.

L2 Load limits

L2.1 The actual load of an assessable pollutant discharged from the premises during the reporting period must not exceed the load limit specified for the assessable pollutant in the table below.

L2.2 The actual load of an assessable pollutant must be calculated in accordance with the relevant load calculation protocol.

Assessable Pollutant	Load limit (kg)
Coarse Particulates (Air)	8050.00
Fine Particulates (Air)	5050.00
Lead (Air)	6.00
Mercury (Air)	2.00
Nitrogen Oxides (Air)	91680.00
Sulfur Oxides (Air)	170.00

Note: An assessable pollutant is a pollutant which affects the licence fee payable for the licence.

Note: Lead and Mercury load limits were derived from 5 years of annual returns and discussion with the licensee. Load limits are to be reviewed in 2025.

L3 Concentration limits

L3.1 For each monitoring/discharge point or utilisation area specified in the table\s below (by a point number), the concentration of a pollutant discharged at that point, or applied to that area, must not exceed the concentration limits specified for that pollutant in the table.

L3.2 Air Concentration Limits

Environment Protection Licence

POINT 11

Pollutant	Units of measure	100 percentile concentration limit	Reference conditions	Oxygen correction	Averaging period
Solid Particles	milligrams per cubic metre	100			
Nitrogen Oxides	milligrams per cubic metre	2000			

POINT 12

Pollutant	Units of measure	100 percentile concentration limit	Reference conditions	Oxygen correction	Averaging period
Solid Particles	milligrams per cubic metre	100			

4 Operating Conditions

O1 Activities must be carried out in a competent manner

O1.1 Licensed activities must be carried out in a competent manner.
This includes:
a) the processing, handling, movement and storage of materials and substances used to carry out the activity; and
b) the treatment, storage, processing, reprocessing, transport and disposal of waste generated by the activity.

O2 Maintenance of plant and equipment

O2.1 All plant and equipment installed at the premises or used in connection with the licensed activity:
a) must be maintained in a proper and efficient condition; and
b) must be operated in a proper and efficient manner.

O3 Dust

O3.1 All operations and activities occurring at the premises must be carried out in a manner that will prevent and or minimise the emission of air pollutants, including dust, from the premises.

O3.2 Trucks transporting materials from the premises must be covered as soon as practicable after loading prior to leaving the premises.

5 Monitoring and Recording Conditions

Environment Protection Licence

Licence - 944

M1 Monitoring records

M1.1 The results of any monitoring required to be conducted by this licence or a load calculation protocol must be recorded and retained as set out in this condition.

M1.2 All records required to be kept by this licence must be:
a) in a legible form, or in a form that can readily be reduced to a legible form;
b) kept for at least 4 years after the monitoring or event to which they relate took place; and
c) produced in a legible form to any authorised officer of the EPA who asks to see them.

M1.3 The following records must be kept in respect of any samples required to be collected for the purposes of this licence:
a) the date(s) on which the sample was taken;
b) the time(s) at which the sample was collected;
c) the point at which the sample was taken; and
d) the name of the person who collected the sample.

M2 Requirement to monitor concentration of pollutants discharged

M2.1 For each monitoring/discharge point or utilisation area specified below (by a point number), the licensee must monitor (by sampling and obtaining results by analysis) the concentration of each pollutant specified in Column 1. The licensee must use the sampling method, units of measure, and sample at the frequency, specified opposite in the other columns:

M2.2 Air Monitoring Requirements

POINT 1

Pollutant	Units of measure	Frequency	Sampling Method
Particulates - Deposited Matter	grams per square metre per month	Monthly	AM-19
PM10	milligrams per cubic metre	Special Frequency 2	AM-18

POINT 11

Pollutant	Units of measure	Frequency	Sampling Method
Nitrogen Oxides	grams per cubic metre	Yearly	TM-11
Solid Particles	milligrams per cubic metre	Yearly	TM-15

POINT 12

Pollutant	Units of measure	Frequency	Sampling Method
Solid Particles	milligrams per cubic metre	Yearly	TM-15

POINT 16

Environment Protection Licence

Pollutant	Units of measure	Frequency	Sampling Method
Particulates - Deposited Matter	grams per square metre per month	Monthly	AM-19

Note: For the purposes of the table(s) above:

Special Frequency 2 means the collection of samples on a one day in six cycle using HVAS fitted with size selective inlet for PM10.

M2.3 Water and/ or Land Monitoring Requirements

POINT 13

Pollutant	Units of measure	Frequency	Sampling Method
Oil and Grease	milligrams per litre	Quarterly	Grab sample
Total suspended solids	milligrams per litre	Quarterly	Grab sample

M3 Testing methods - concentration limits

M3.1 Monitoring for the concentration of a pollutant emitted to the air required to be conducted by this licence must be done in accordance with:
a) any methodology which is required by or under the Act to be used for the testing of the concentration of the pollutant; or
b) if no such requirement is imposed by or under the Act, any methodology which a condition of this licence requires to be used for that testing; or
c) if no such requirement is imposed by or under the Act or by a condition of this licence, any methodology approved in writing by the EPA for the purposes of that testing prior to the testing taking place.

M3.2 Subject to any express provision to the contrary in this licence, monitoring for the concentration of a pollutant discharged to waters or applied to a utilisation area must be done in accordance with the Approved Methods Publication unless another method has been approved by the EPA in writing before any tests are conducted.

Note: The *Protection of the Environment Operations (Clean Air) Regulation 2010* requires testing for certain purposes to be conducted in accordance with test methods contained in the publication "Approved Methods for the Sampling and Analysis of Air Pollutants in NSW".

M4 Testing methods - load limits

Note: Division 3 of the *Protection of the Environment Operations (General) Regulation 2009* requires that

monitoring of actual loads of assessable pollutants listed in L2.2 must be carried out in accordance with the relevant load calculation protocol set out for the fee-based activity classification listed in the Administrative Conditions of this licence.

M5 Recording of pollution complaints

M5.1 The licensee must keep a legible record of all complaints made to the licensee or any employee or agent of the licensee in relation to pollution arising from any activity to which this licence applies.

M5.2 The record must include details of the following:
a) the date and time of the complaint;
b) the method by which the complaint was made;
c) any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
d) the nature of the complaint;
e) the action taken by the licensee in relation to the complaint, including any follow-up contact with the complainant; and
f) if no action was taken by the licensee, the reasons why no action was taken.

M5.3 The record of a complaint must be kept for at least 4 years after the complaint was made.

M5.4 The record must be produced to any authorised officer of the EPA who asks to see them.

M6 Telephone complaints line

M6.1 The licensee must operate during its operating hours a telephone complaints line for the purpose of receiving any complaints from members of the public in relation to activities conducted at the premises or by the vehicle or mobile plant, unless otherwise specified in the licence.

M6.2 The licensee must notify the public of the complaints line telephone number and the fact that it is a complaints line so that the impacted community knows how to make a complaint.

M6.3 The preceding two conditions do not apply until 3 months after: the date of the issue of this licence.

M7 Blasting

M7.1 The licensee must record each blast fired during either rim removal or in the area shown on the plan titled "Blast Afftecting Bungonia Gorge", dated 30 october 1996. Records of each blast must be digitally recorded.

6 Reporting Conditions

R1 Annual return documents

R1.1 The licensee must complete and supply to the EPA an Annual Return in the approved form comprising:

1. a Statement of Compliance,
2. a Monitoring and Complaints Summary,
3. a Statement of Compliance - Licence Conditions,
4. a Statement of Compliance - Load based Fee,
5. a Statement of Compliance - Requirement to Prepare Pollution Incident Response Management Plan,
6. a Statement of Compliance - Requirement to Publish Pollution Monitoring Data; and
7. a Statement of Compliance - Environmental Management Systems and Practices.

At the end of each reporting period, the EPA will provide to the licensee notification that the Annual Return is due.

R1.2 An Annual Return must be prepared in respect of each reporting period, except as provided below.

R1.3 Where this licence is transferred from the licensee to a new licensee:
a) the transferring licensee must prepare an Annual Return for the period commencing on the first day of the reporting period and ending on the date the application for the transfer of the licence to the new licensee is granted; and
b) the new licensee must prepare an Annual Return for the period commencing on the date the application for the transfer of the licence is granted and ending on the last day of the reporting period.

R1.4 Where this licence is surrendered by the licensee or revoked by the EPA or Minister, the licensee must prepare an Annual Return in respect of the period commencing on the first day of the reporting period and ending on:
a) in relation to the surrender of a licence - the date when notice in writing of approval of the surrender is given; or
b) in relation to the revocation of the licence - the date from which notice revoking the licence operates.

R1.5 The Annual Return for the reporting period must be supplied to the EPA via eConnect *EPA* or by registered post not later than 60 days after the end of each reporting period or in the case of a transferring licence not later than 60 days after the date the transfer was granted (the 'due date').

R1.6 Where the licensee is unable to complete a part of the Annual Return by the due date because the licensee was unable to calculate the actual load of a pollutant due to circumstances beyond the licensee's control, the licensee must notify the EPA in writing as soon as practicable, and in any event not later than the due date. The notification must specify:
a) the assessable pollutants for which the actual load could not be calculated; and
b) the relevant circumstances that were beyond the control of the licensee.

R1.7 The licensee must retain a copy of the Annual Return supplied to the EPA for a period of at least 4 years after the Annual Return was due to be supplied to the EPA.

R1.8 Within the Annual Return, the Statements of Compliance must be certified and the Monitoring and Complaints Summary must be signed by:
a) the licence holder; or
b) by a person approved in writing by the EPA to sign on behalf of the licence holder.

R1.9 The results of the blast monitoring required by condition M7.1 must be submitted to the EPA at the end of each reporting period.

Note: The term "reporting period" is defined in the dictionary at the end of this licence. Do not complete the

Annual Return until after the end of the reporting period.

Note: An application to transfer a licence must be made in the approved form for this purpose.

R2 Notification of environmental harm

R2.1 Notifications must be made by telephoning the Environment Line service on 131 555.

R2.2 The licensee must provide written details of the notification to the EPA within 7 days of the date on which the incident occurred.

Note: The licensee or its employees must notify all relevant authorities of incidents causing or threatening material harm to the environment immediately after the person becomes aware of the incident in accordance with the requirements of Part 5.7 of the Act.

R3 Written report

R3.1 Where an authorised officer of the EPA suspects on reasonable grounds that:
a) where this licence applies to premises, an event has occurred at the premises; or
b) where this licence applies to vehicles or mobile plant, an event has occurred in connection with the carrying out of the activities authorised by this licence,
and the event has caused, is causing or is likely to cause material harm to the environment (whether the harm occurs on or off premises to which the licence applies), the authorised officer may request a written report of the event.

R3.2 The licensee must make all reasonable inquiries in relation to the event and supply the report to the EPA within such time as may be specified in the request.

R3.3 The request may require a report which includes any or all of the following information:
a) the cause, time and duration of the event;
b) the type, volume and concentration of every pollutant discharged as a result of the event;
c) the name, address and business hours telephone number of employees or agents of the licensee, or a specified class of them, who witnessed the event;
d) the name, address and business hours telephone number of every other person (of whom the licensee is aware) who witnessed the event, unless the licensee has been unable to obtain that information after making reasonable effort;
e) action taken by the licensee in relation to the event, including any follow-up contact with any complainants;
f) details of any measure taken or proposed to be taken to prevent or mitigate against a recurrence of such an event; and
g) any other relevant matters.

R3.4 The EPA may make a written request for further details in relation to any of the above matters if it is not satisfied with the report provided by the licensee. The licensee must provide such further details to the EPA within the time specified in the request.

Environment Protection Licence

R4 Other reporting conditions

R4.1 The results of the blast monitoring required by condition M7.1 must be submitted to the EPA at the end of each reporting period.

7 General Conditions

G1 Copy of licence kept at the premises or plant

G1.1 A copy of this licence must be kept at the premises to which the licence applies.

G1.2 The licence must be produced to any authorised officer of the EPA who asks to see it.

G1.3 The licence must be available for inspection by any employee or agent of the licensee working at the premises.

Environment Protection Licence

Licence - 944

Dictionary

General Dictionary

3DGM [in relation to a concentration limit]	Means the three day geometric mean, which is calculated by multiplying the results of the analysis of three samples collected on consecutive days and then taking the cubed root of that amount. Where one or more of the samples is zero or below the detection limit for the analysis, then 1 or the detection limit respectively should be used in place of those samples
Act	Means the Protection of the Environment Operations Act 1997
activity	Means a scheduled or non-scheduled activity within the meaning of the Protection of the Environment Operations Act 1997
actual load	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
AM	Together with a number, means an ambient air monitoring method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*.
AMG	Australian Map Grid
anniversary date	The anniversary date is the anniversary each year of the date of issue of the licence. In the case of a licence continued in force by the Protection of the Environment Operations Act 1997, the date of issue of the licence is the first anniversary of the date of issue or last renewal of the licence following the commencement of the Act.
annual return	Is defined in R1.1
Approved Methods Publication	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
assessable pollutants	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
BOD	Means biochemical oxygen demand
CEM	Together with a number, means a continuous emission monitoring method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*.
COD	Means chemical oxygen demand
composite sample	Unless otherwise specifically approved in writing by the EPA, a sample consisting of 24 individual samples collected at hourly intervals and each having an equivalent volume.
cond.	Means conductivity
environment	Has the same meaning as in the Protection of the Environment Operations Act 1997
environment protection legislation	Has the same meaning as in the Protection of the Environment Administration Act 1991
EPA	Means Environment Protection Authority of New South Wales.
fee-based activity classification	Means the numbered short descriptions in Schedule 1 of the Protection of the Environment Operations (General) Regulation 2009.
general solid waste (non-putrescible)	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997

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flow weighted composite sample	Means a sample whose composites are sized in proportion to the flow at each composites time of collection.
general solid waste (putrescible)	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environmen t Operations Act 1997
grab sample	Means a single sample taken at a point at a single time
hazardous waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
licensee	Means the licence holder described at the front of this licence
load calculation protocol	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
local authority	Has the same meaning as in the Protection of the Environment Operations Act 1997
material harm	Has the same meaning as in section 147 Protection of the Environment Operations Act 1997
MBAS	Means methylene blue active substances
Minister	Means the Minister administering the Protection of the Environment Operations Act 1997
mobile plant	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
motor vehicle	Has the same meaning as in the Protection of the Environment Operations Act 1997
O&G	Means oil and grease
percentile [in relation to a concentration limit of a sample]	Means that percentage [eg.50%] of the number of samples taken that must meet the concentration limit specified in the licence for that pollutant over a specified period of time. In this licence, the specified period of time is the Reporting Period unless otherwise stated in this licence.
plant	Includes all plant within the meaning of the Protection of the Environment Operations Act 1997 as well as motor vehicles.
pollution of waters [or water pollution]	Has the same meaning as in the Protection of the Environment Operations Act 1997
premises	Means the premises described in condition A2.1
public authority	Has the same meaning as in the Protection of the Environment Operations Act 1997
regional office	Means the relevant EPA office referred to in the Contacting the EPA document accompanying this licence
reporting period	For the purposes of this licence, the reporting period means the period of 12 months after the issue of the licence, and each subsequent period of 12 mo nths. In the case of a licence continued in force by the Protection of the Environment Operations Act 1997, the date of issue of the licence is the first anniversary of the date of issue or last renewal of the licence following the commencement of the Act.
restricted solid waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
scheduled activity	Means an activity listed in Schedule 1 of the Protection of the Environment Operations Act 1997
special waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
TM	Together with a number, means a test method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*.

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TSP	Means total suspended particles
TSS	Means total suspended solids
Type 1 substance	Means the elements antimony, arsenic, cadmium, lead or mercury or any compound containing one or more of those elements
Type 2 substance	Means the elements beryllium, chromium, cobalt, manganese, nickel, selenium, tin or vanadium or any compound containing one or more of those elements
utilisation area	Means any area shown as a utilisation area on a map submitted with the application for this licence
waste	Has the same meaning as in the Protection of the Environment Operations Act 1997
waste type	Means liquid, restricted solid waste, general solid waste (putrescible), general solid waste (non-putrescible), special waste or hazardous waste

Ms Debbie Maddison

Environment Protection Authority

(By Delegation)

Date of this edition: 25-August-2000

Environment Protection Licence

Licence - 944

End Notes

1	Licence varied by notice 1002259, issued on 18-Oct-2000, which came into effect on 12-Nov-2000.
2	Licence varied by change to Common Name field, issued on 31-May-2001, which came into effect on 31-May-2001.
3	Licence transferred through application 140465, approved on 15-Jun-2001, which came into effect on 15-Jun-2001.
4	Licence varied by notice 1008757, issued on 27-Nov-2001, which came into effect on 22-Dec-2001.
5	Licence varied by notice 1017662, issued on 21-Jun-2002, which came into effect on 16-Jul-2002.
6	Licence varied by notice 1026529, issued on 30-Apr-2003, which came into effect on 25-May-2003.
7	Licence varied by notice 1030085, issued on 21-Aug-2003, which came into effect on 15-Sep-2003.
8	Licence varied by notice 1038040, issued on 14-Jul-2004, which came into effect on 08-Aug-2004.
9	Licence varied by change to record due to LGA amalagamatio, issued on 01-Dec-2004, which came into effect on 01-Dec-2004.
10	Licence varied by notice 1044343, issued on 15-Mar-2005, which came into effect on 09-Apr-2005.
11	Licence varied by notice 1054428, issued on 24-Feb-2006, which came into effect on 21-Mar-2006.
12	Licence varied by notice 1057796, issued on 03-Apr-2006, which came into effect on 28-Apr-2006.
13	Licence varied by correction to DEC File number, issued on 07-Mar-2007, which came into effect on 07-Mar-2007.
14	Condition A1.3 Not applicable varied by notice issued on <issue date> which came into effect on <effective date>
15	Licence varied by notice 1095801, issued on 09-Feb-2009, which came into effect on 09-Feb-2009.
16	Licence varied by notice 1502865 issued on 06-Dec-2011
17	Licence varied by notice 1506039 issued on 29-Jun-2012
18	Licence varied by notice 1521469 issued on 07-Aug-2014
19	Licence varied by notice 1603582 issued on 24-Dec-2020

APPENDIX B - Geotechnical Assessment

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Our Ref: PSM645-043L

17 March 2022

Marulan Limestone Technical Manager
Boral Cement Limited
Marulan South Limestone Mine
Hume Street
MARULAN SOUTH NSW 2579

garth.nagle@boral.com.au

Attention: Garth Nagle

Dear Garth

RE: 2022 MARCH GEOTECHNICAL SITE VISIT – MARULAN SOUTH LIMESTONE MINE

1. Introduction

At the request of Boral Cement Limited (BCL), Mr Alex Duran of Pells Sullivan Meynink (PSM) carried out a geotechnical annual review of the Marulan South Limestone Mine on 10 March 2022.

The site visit was utilised to address the following aspects:

- Inspection of pit exposures
- Inspect historic Barbers Creek dump
- Discuss the High Dump procedure
- Discuss requirement for a GCMP.

The previous geotechnical annual review of the mine was carried out on 21 January 2021 and reported in PSM645-036L dated 29 January 2021.

Photos 1 to 27 provide an overview of the areas inspected during this site visit.

2. Pit Exposures

2.1 Overview

Photos 1 to 20 present areas inspected in the pit and which largely focused on the North pit. Areas inspected and discussed below included:

- West wall of North pit, Photos 1 to 3 and 12 to 17
- The far northern end of North pit, Photos 3 and 6 to 11
- East wall, Photos 4 and 5
- South Pit, Photo 18
- Cutback development in west wall at junction of North and South pits, Photos 19 and 20.

2.2 Lower Part of West Wall North Pit

Photos 1 to 3 provide an overview of the lower part of the west wall in the North pit, largely developed in Limestone, and with no mining having been carried out of these walls for several years.

The current exposures provide an overview of the potential long-term performance of the pit walls in Limestone and which are worthy of note as BCL have indicated the Marulan mine will continue production for potentially a further 40 years. Of note in Photos 1 to 3 are areas where:

- Erosion of benches in the contact zone between sediments and Limestone (Photos 1 to 3)
- Bench scale failures (central part of Photo 1)
- Erosion of dykes (Photo 2) and which in the longer term may provide localised stability issues
- Narrow or absent berms (lower part of Photo 2).

PSM consider that each of these factors provide localised bench scale issues and are unlikely to impact of ongoing operations below where these may occur. The only exception to the above, are areas where surface water is allowed to focus and resulting in deposition of debris fans that overfill berms (such as evident in the lowest bench in Photo 2). The concern being an ongoing higher rock fall risk to operations below where such fans are developed. This highlights that surface water control will be a critical factor for long term pit development.

2.3 Northern end of North Pit

Inspection of the exposures in the northern end of the North encountered the following three issues:

- Poor conditions in selected benches on the west wall
- Occurrence of a zone Granodiorite in the northeast
- Several benches in re-minded backfill south of the Granodiorite.

Whilst there had been concern during initial development in the far north of wedges at the batter scale, the most recent bench appears to be less affected, Photo 7. This is not uncommon at Marulan and where the structural pattern can vary from bench to bench.

Photos 8 and 9 highlight the zones where poor conditions are present in the batters of the west wall. For the area in Photo 9 there is an overhang and it is understood an additional row of holes will be drilled behind the crest in the near future and develop the wall to the west. This will largely remove the issue. For the area in Photo 8, the poor rock mass extends through both batters and it is likely the issue will remain in the final wall. PSM recommend good attention to scaling of this area and that surface water management avoid ponding above or surface water flow over the face.

Whilst no detailed photo is provided in this reporting of the area of Granodiorite, PSM highlight the extent of Granodiorite is minor and although the rock is moderately weathered there was a distinct lack of structural pattern that would indicate concern to stability.

The area of re-mined backfill, Photos 3, 6, 10, 11 and 12 was discussed with BCL. It is understood the backfill extends to nominally RL400 and through a gulley in the original topography. As such the backfill which was largely tipped towards the east, has been cut with batters facing to the west. The batter development, largely cross cutting any layering introduced in the initial placement and therefore is favourable. The critical control in such slopes is avoiding erosion formed by water flowing over the batters. PSM note there is a wide berm through the backfill, Photos 11 and 12, and with limited evidence of ponding which is favourable. However, it is critical that surface water from the road above be appropriately managed to avoid ponding and with no-cut throughs allowed in the windrow which would allow gulleying to quickly develop.

2.4 East Wall North Pit

Photos 4 and 5 provide an overview of the east wall in the North pit. Of note has been the remobilisation of an existing failure at the northern end, Photo 5, and which had been initially recognised in 2008. It is understood the recent significant rainfall events contributed to triggering the failure, albeit the recent failure was gradual. PSM recommend the windrow at the toe of the area be slightly raised to limit the risk of future rock falls reporting to the haulroad.

2.5 Upper Part of West Wall North Pit

Photos 12 to 16 provide an overview of batters developed in the sediments in the upper part of the west wall. Of note is that whilst the sediments are typically moderately to steeply dipping to the west throughout most of the exposures, Photos 13 to 16, there appears to be some flattening in the far north, Photo 12.

The predominant issue in the sediments, owing to the moderate to steep dip to the west and into the slope, is formation of a toppling mechanism. Photo 14 indicates the initial signs that are typically seen in a toppling style mechanism and developing towards the southern end of the North pit. Further to the north, there are several bench scale instabilities that have occurred, Photos 15 and16, and with cracking noted behind the batter crest during the inspection. PSM highlight that the recommended design for the west wall sediment comprises 50° batters and which have been proposed to mitigate toppling both at the bench and inter-ramp scales. PSM note the areas of instability appear to have utilised slightly steeper batters and PSM infer the combination of locally deeper weathering and steep batters (based on the batter in slightly fresher material in Photo 15 being somewhat steeper than 50°) have contributed to the instabilities. BCL indicated that scaling back of the instabilities would be undertaken in the near future. PSM recommend that a maximum batter angle of 50° be utilised to mitigate the risk of further instability.

PSM note that whilst the slopes to date in sediments have been in largely highly weathered materials, recent exposures indicate the sediments are becoming fresher. The occurrence of fresher material may make battering of the slopes to 50° more difficult. Hence BCL should anticipate bench scale toppling failures where the 50° batter angle is difficult to emplace.

Photo 17 highlight an area in the upper part of the west wall and developed to mine the Middle Limestone. This area had significant ponded water and which was actively being pumped away by BCL. This approach is commended by PSM to actively reduce pore pressures which may impact on the lower part of the west wall.

2.6 South Pit

The only activity in the South pit is ongoing backfilling of the void, Photo 18. PSM note that backfilling is from north to south and leaving a void at the southern end to act as a sump. This latter aspect is of note if backfilling from the crest and developing a High Dump proceeds. If the latter proceeds, PSM recommend the future sump be maintained against the east wall, and to the north, so tipping from the High Dump proceeds onto a flat dumped surface and that is not comprised by any ponded water or mud.

2.7 West wall Cutback

Photos 19 and 20 provide an overview of the west wall cutback. PSM note the operation was proceeding well and following the appropriate controls as outlined in PSM645-038L dated 29 April 2021.

3. Barbers Creek Dump

Photos 21 to 27 provide an overview of the historic dump at Barbers Creek.

Of particular note recent rainfall has triggered the following:

- Development of fresh shallow scarps in the dump face, Photos 21 and 22.
- Erosion towards the toe of the dump, Photo 23.
- Inducing settlement of the dump owing to wetting of material internally and evidence by formation of minor cracks at lips/steps formed historically, Photos 24 to 27.

Whilst the above aspects indicate there is ongoing movement of the dump at Barbers Creek, such movements would be expected from such a high dump placed with a top-down construction (i.e. end tipped over full height). However, none of the noted phenomena are indicative of developing large scale instability.

Comments provided by PSM in regard to long term monitoring options, PSM645-038L, remain appropriate.

4. High Dump procedure

During the site visit the High Dump procedure was discussed. The BCL procedure has utilised an existing template from another site (which PSM had provided to BCL). PSM had not appreciated the existing template did not convey adequately the initial stages of High Dump development and specifically:

- Initial tipping from the pit crest and
- Extent the dump crest needs to progress horizontally before chamfering of the dump is carried out.

In essence, the existing template largely focuses on the steps and procedures once the dump has been developed to the stage where the chamfer is developed.

The discussion with BCL was utilised to clarify some of these aspects and BCL will update the procedure as appropriate. PSM would be pleased to review and sign-off once the document has been updated by BCL.

5. GCMP

BCL have indicated that a Ground Control Management Plan (GCMP) of the Principal Hazard relating to slope failure is required at Marulan. As part of the site visit, PSM provided examples developed at other quarries. Of note the Boral GCMP developed for the Montrose quarry in Victoria was provided and which has been reviewed by PSM for Montrose.

PSM would be glad to assist in either developing the GCMP for BCL or providing review as required. A proposal setting out cost estimates to assist will be provided shortly.

6. Recommendations

The following provides key recommendations as part of this review:

- Surface water control will be a critical factor for long term pit development and allowing water to cascade over pit walls should be avoided where practical.
- For the area in Photo 8, it is likely the issue will remain in the final wall and PSM recommend good attention to scaling of this area and that surface water management avoid ponding above or surface water flow over the face.
- For the re-mined backfill in the northeast, it is critical that surface water from the road above be appropriately managed to avoid ponding and with no-cut throughs allowed in the windrow which would allow gulleying to quickly develop.
- For the failure at the northern end of east wall, PSM recommend the windrow at the toe of the area be slightly raised to limit the risk of future rock falls reporting to the haulroad.
- For the bench scale instabilities in the west wall sediments, which will be scaled back in the near future PSM recommend that a maximum batter angle of 50° be utilised.
- For the proposed High dump in the South pit, PSM recommend the future sump be maintained against the east wall, and to the north, so tipping from the high dump proceeds onto a flat dumped surface and that is not comprised by any ponded water or mud.
- For the High dump procedure, PSM would be pleased to review and sign-off once the document has been updated by BCL
- PSM would be glad to assist in either developing the GCMP for BCL or providing review as required. A proposal setting out cost estimates to assist will be provided shortly.

7. Closure

We trust the above meets your immediate requirements and please contact the undersigned if you have any queries in relation to any aspect.

Yours Sincerely

ALEX DURAN
PRINCIPAL

AusIMM
"GEOTECHNICAL"
ALEX DURAN

Encl. Photos 1 to 27

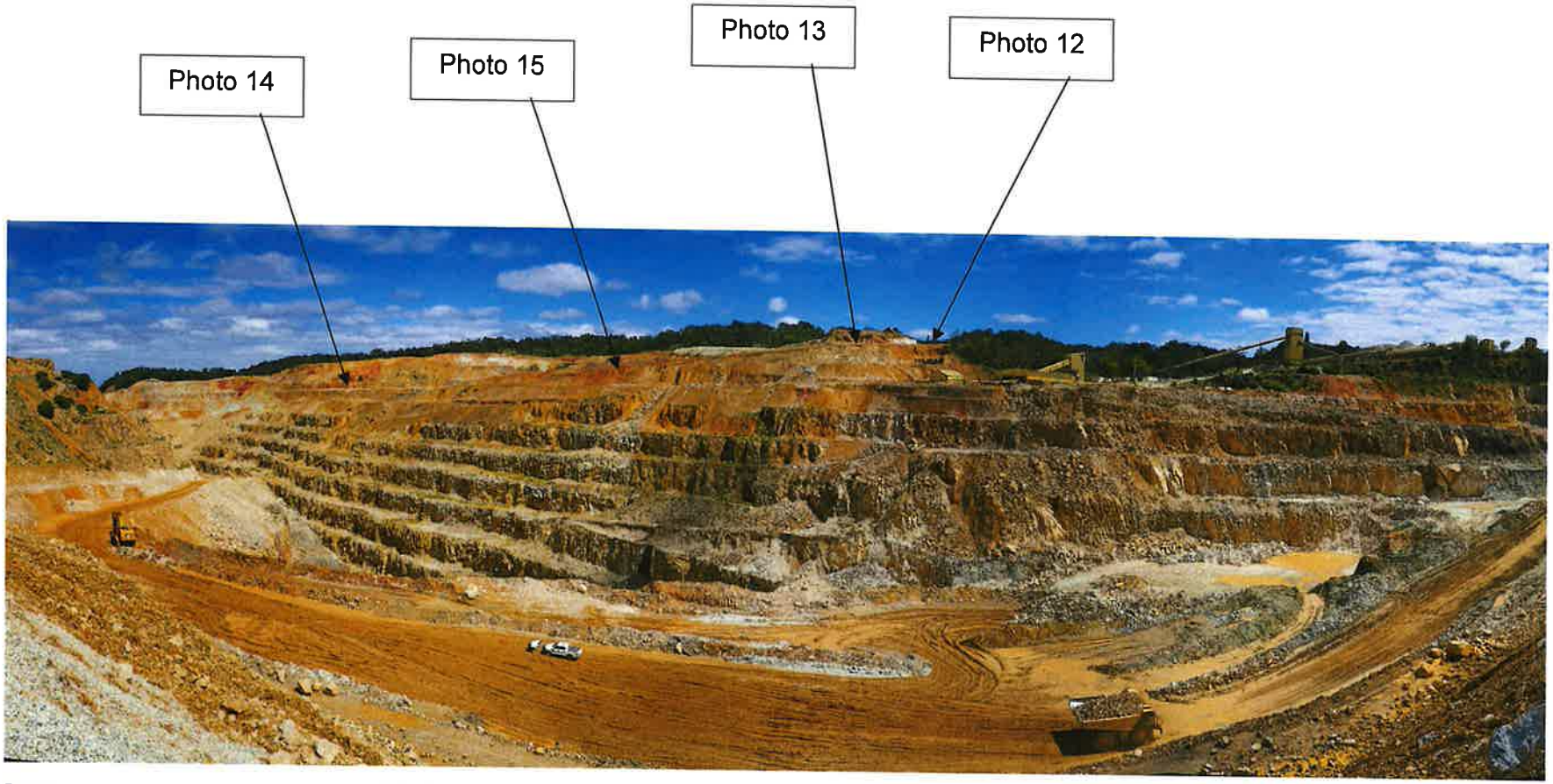

Photo 1: **Overview of western wall in North pit and which has been largely inactive. Photo locations as appropriate annotated.**

Photo 2: **Overview of northern end of west wall in North pit.**

Photo 3: **Overview of northern end of North pit. The upper northeast wall is largely in "re-mined" backfill and with boundary nominally annotated.**

Photo 4: **Overview of east wall in North pit.**

Photo 5: **Northern end of east wall in North pit and with recent mobilisation of historic instability dating back to 2008.**

Photo 6: **Northern end of North Pit. Note transition in east wall from Limestone to Granodiorite and then to re-mined backfill.**

Photo 7: **Northern end of North pit, predominantly limestone. Dyke at right has a highly irregular contact and suggests infilling of cavities.**

Photo 8: **West wall in the northern end of North pit and highlighting zone of limestone of poor rock mass quality.**

Photo 9: **West wall in the northern end of North pit and highlighting variable conditions in wall with both overhang and areas of loose rocks in the face.**

Photo 10: View from road on east wall and looking into northern end of North pit. The nominal extent of backfill annotated. Berm present is wide and in good condition in view of recent rainfall.

PSM645-043L

Photo 12: **West wall in North pit, immediately south of plant site and with rotation of bedding in sediments, note the strata dips to the south at north. See Photo 1 for location.**

Photo 13: **West wall in North pit, south of Photo 12, see Photo 1 for nominal location, and with bedding dipping shallowly to the west.**

Photo 14: **West wall at southern end of North pit, see Photo 1 for nominal location, and with bedding dipping steeply to the west. There are several dilated bedding feature indicating the slope is showing toppling style mechanism and at limit of stability.**

Photo 15: **West wall in central part of North pit, see Photo 1 for nominal location. Sediments are variably weathered and PSM infer the bench scale instabilities that have occurred are bench scale toppling in the areas of deeper weathering. If BCL chose to scale these areas, a maximum batter angle of 50° should be utilised.**

Photo 16: **South of Photo 15 and with similar comments applicable.**

Photo 17: **Upper west wall in North pit, with mining of Middle limestone. Area has ponded during recent rainfall and is actively being pumped dry to limit pressures developed on lower part of west wall.**

Photo 18: **View of South pit, looking south, with backfilling of two lowest benches nearing completion.**

Photo 19: **West wall in transition area between North and South pits and with cutback of upper slopes of west wall in progress.**

Photo 20: **West wall cutback and with winning of material from pit floor.**

Photo 21: Overview of Barbers Creek dump and with development of a fresh scarp in face of dump.

Photo 22: **Barbers Creek dump and focusing on fresh scarps in face of dump.**

Photo 23: Barbers Creek dump and focusing on toe area with gulley developed.

Photo 24: **Barbers Creek dump and highlighting recent crack development near crest. Note the pronounced lip is as a result of historic movements.**

Photo 25: Barbers Creek dump and highlighting lip from historic movements.

Photo 26: **Barbers Creek dump crest area, looking to the west and with two lips highlighting historic movements.**

Photo 27: **Same view as Photo 26 and note cracking on lower lip indicating recent movement.**

APPENDIX C – Ecosystem Function Analysis

Marulan South Limestone Mine

Ecosystem Function Analysis
Rehabilitation Monitoring

May 2022

Prepared By:
International Environmental Consultants Pty Limited
"Longmead"
700 Wombeyan Caves Road
High Range NSW 2575

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1. INTRODUCTION

1.1 Background

Boral's Marulan South Limestone Mine (the Mine) has been operational since the 1830s, consisting of a limestone mine and processing plant. It is located directly to the north of Bungonia Gorge and approximately 35km east of Goulburn NSW, with lands covering 650 hectares of a significant limestone and granodiorite deposit. Resources over a total of 616.5 hectares of land are to be extracted under current approvals.

In accordance with the 2018-2023 Mining Operations Plan (MOP) the Mine has committed to progressive rehabilitation of identified disturbed land as part of the Progressive Rehabilitation Strategy. The strategy centres on completed slopes of the waste emplacements and external batters of the mining area. These are shaped according to the final landform design, top dressed, contour ripped and sown. Soil testing and characterisation is undertaken to determine any amelioration needed while sowing time is generally governed by available soil moisture.

International Environmental Consultants has been engaged by Boral to undertake a rehabilitation monitoring program at the Mine based on the CSIRO developed Ecosystem Function Analysis (EFA) method (Tongway & Hindley, 2004). The method assesses a variety of soil and vegetation-based parameters which are assigned numeric values that are converted into percentages indicating ecosystem functionality. Over time, these percentages can be compared to indicate if the rehabilitation is progressing toward a self-sustaining ecosystem.

1.2 Objectives

1.2.1 Rehabilitation Strategy

The key rehabilitation goal discussed in the Rehabilitation Strategy is to "re-establish vegetation on the disturbed areas (excluding the voids) to as closely as practical to represent the pre-mining vegetation communities". The three main rehabilitation objectives of the strategy are:

- Achievement of acceptable post-disturbance land use suitability: to create a stable landform with land use capability and/or suitability similar to that prior to disturbance, unless other beneficial land uses are pre-determined and agreed. This is achieved by setting clear rehabilitation success criteria and outlining the monitoring requirements that assess whether or not these criteria are being accomplished.
- Creation of stable post-disturbance landform: disturbed land will be rehabilitated to a condition that is self-sustaining or one where maintenance requirements are consistent with the agreed post-mining land use(s).
- Preservation of downstream water quality: surface and groundwater that leave the mining leases are not degraded to a significant extent. Current and future water quality will be maintained at levels that are acceptable for users downstream of the site.

Rehabilitation progression at the Mine is identified in Domain 4 and in Domain 7 as detailed in the 2018-2023 MOP and comprise the southern slopes of the western overburden emplacement and the eastern batter areas including the former Bryce's Gully to the north, Barber's Creek (central) and the south-eastern batters of the southern pit.

The majority of the Marulan South Limestone Mine is an active mining and mineral processing site with associated infrastructure and mine related disturbance. Rehabilitation and rehabilitation maintenance activities will continue within Domains 4 and 7 progressing in the overburden emplacement domain, Domain 4 from landform establishment through to ecosystem and land use establishment.

1.2.2 Ecosystem Function Analysis

An EFA survey will be conducted bi-annually to monitor rehabilitation progression at the South Marulan Mine to achieve the required rehabilitation objectives. Accurate and detailed site records incorporating EFA will be maintained for future reference and to provide a benchmark for evaluating the success of the rehabilitation works. EFA methods will provide the necessary records and assessment of the vegetation community health, structure, natural succession and species diversity. The objectives of this monitoring program are to:

- Track the progress of rehabilitation works using measurable ecosystem function scores to identify trends and identify success and failures;
- Identify rehabilitation programs or areas that are failing or under-achieving at an early stage, so that prompt remedial actions can be undertaken, and to provide information to guide subsequent rehabilitation works within the site; and
- Predict when rehabilitated land has become stable with self-sustaining ecosystems, such that ongoing management can cease.

The progressive indicator measurements are compared against a Rehabilitation Success Criteria to ascertain if rehabilitation objectives are being met. The nominated success criteria for the rehabilitation areas on the site have been determined based on the proposed final land use of woodland and grassland ecosystems, as presented in Table 1 below.

1.2.3 Success Criteria

The progressive indicator measurements are compared against the success criteria to ascertain if rehabilitation objectives are being met. The Project Site's success criteria (or closure criteria) for the rehabilitation areas on the site have been determined based on the proposed final land use of woodland / grassland mosaic. These have been re-produced in Table 1.1.

Table 1.1- Rehabilitation Success Criteria

Rehabilitation Element	Indicator	Criteria
Topsoil	Nutrient Cycling	Nutrient accumulation and recycling processes are occurring showing the presence of a litter layer, mycorrhizae and/or other microsymbionts. Adequate macro and micro-nutrients are present.
Vegetation	Land Use	Area remains as healthy native woodland or a sustainable grazing pasture.
	Surface Cover	Minimum of 70% vegetative cover is present (or 50% if rocks, logs or other features of cover are present). No bare surfaces >20 m2 in area or >10 m in length down slope.
	Species Composition	Subject to proposed land use, comprise a mixture of native trees, shrubs and grasses representative of regionally occurring woodland where possible OR palatable, nutritious pasture grass species are present.
	Resilience to Disturbance	Established species survive and/or regenerate after disturbance. Weeds do not dominate native species after disturbance or after rain. Pests do not occur in substantial numbers or visibly affect the development of native plant species.
	Sustainability	Species are capable of flowering and setting viable seed. Evidence of second-generation shrub and understorey species. Vegetation develops and maintains a litter layer as a consistent mass and depth of litter over subsequent seasons. More than 75% of shrubs and/or trees are healthy when ranked healthy, sick or dead.

2. ECOSYSTEM FUNCTION ANALYSIS (EFA)

2.1 Overview

The Ecosystem Function Analysis method is a quick visual field assessment of a range of indicators (such as litter cover, bare ground, vegetative cover, vegetation height, floristic diversity, etc) to assess the biogeochemical functioning of landscapes. These features reflect the ability of the ecosystem to uptake, retain and recycle nutrient resources, which indicates the functionality of the ecosystem.

The EFA is based on numerical ratings and percentages which is a robust method to be used for statistical comparisons, allowing the function of the site to be tracked over time. This also enables the site to be compared to a reference site of an extant ecosystem. Comparisons can indicate if rehabilitation works are satisfactorily progressing an area towards becoming a self-sustaining ecosystem. It will also be possible to predict when an ecosystem has achieved sufficient functionality to become sustainable in the long term.

Analysis of EFA data will inform decisions about ongoing management and maintenance of rehabilitation areas and will identify problem or 'under-performing' areas at an early stage.

The Ecosystem Function Analysis is separated into the following three components which are designed for joint implementation:

- Landscape Function Analysis (LFA) is the original core procedure.
- Vegetation Dynamics – The functional role of vegetation structure and composition.
- Habitat Complexity – An assessment of the development of vertebrate habitat.

2.2 Reference Sites

Assessment of a 'Reference' ecosystem can be used as a useful tool as part of the monitoring program. Normally a reference site is located nearby in a fully functioning ecosystem to represent as close as possible the slope, aspect, soils, and proposed vegetation characteristics of the rehabilitation areas. Unfortunately, the vegetation surrounding the mine site has also suffered from a history of agricultural disturbance and is not truly representative of the original vegetation community that would have been present prior to European settlement.

The reference site chosen has a relatively sparse understory of native plants and a shortage of old growth canopy trees. There is a thick layer of leaf litter on the soil surface and a moderate canopy predominantly of Eucalyptus species. The midstorey is open, with a scatter of native shrubs which are dominated by *Olearia viscidula*. This site has been assessed as being Brittle Gum Stringybark Forest.

The reference site provides helpful data for the LFA component of this study, although improved vegetation dynamics would be expected for the rehabilitated sites.

2.3 Landscape Function Analysis (LFA)

Landscape function refers to the ability of the biophysical landscape to capture and retain resources such as soil, water and nutrients. Landscapes with a higher functional value can capture and conserve resources to be used within the system.

2.3.1 Landscape Organisation Index

The landscape organisation index (LOI) records data for a site along a 50m long transect running directly downslope in the direction of water flow, which is used as a representative of the site. The transect is marked with stakes and the same line is used on each monitoring occasion.

A continuous record of the patch and interpatch lengths, widths and types is recorded along the transect. A patch can be defined as a long-lived feature in which resources tend to accumulate. Patch types can include grass swards, rocks > 10 cm, or tree branches in contact with the soil. The term interpatch refers to the bare ground between patches, where the resources flow more freely and can be lost.

The Landscape Organisation index is then recorded by dividing the length of patches by the length of the transect (50m).

2.3.2 Soil Surface Assessment (SSA)

The quality of patch and interpatch types are measured by a Soil Surface Assessment. The following eleven soil surface assessment indicators are tested at each patch/ interpatch type:

1. Rain splash Protection- is an assessment of the amount of physical surface and plant cover to prevent the effect of raindrops impacting the soil. This indicator relates to the Stability Index.
2. Perennial Vegetation Cover- is an estimation of the basal cover of perennial grass and canopy cover of shrubs and trees. This indicates the below-ground biomass and its contribution to nutrient cycling and water infiltration.
3. Litter Cover- The percent of cover litter and depth (when 100% cover) is assessed and relates to the nutrient cycling index. The origin of the litter is then classed as local or transported, and the degree of decomposition/incorporation is classed as nil, slight, moderate or extensive.
4. Cryptogram Cover- refers to the percentage cover of algae, fungi, lichen, moss and liverworts. This indicator relates to both soil stability and nutrient cycling.
5. Crust brokenness- is ranked as a class 0 to 4. A broken crust is more available for erosion.
6. Soil Erosion Type and Severity- is a measure of the type and severity of recent soil loss. Erosion present can be classed as rills/gullies, terracettes, sheeting, scalding or pedestalling.
7. Deposited Materials- is a measure of the amount and type of recently transported material deposited. This can include litter, soil and gravel and is an indicator of soil stability.

8. Soil Surface Roughness- allows for the soil to capture and retain resources such as water, propagules, topsoil and organic matter which is linked to infiltration and nutrient cycling.
9. Surface Resistance to Disturbance– measured by mechanically disturbing the soil to observe the ease of disturbance. This shows the ease of release of erodible material.
10. Slake Test- assesses the stability of soil fragments to rapid wetting. Stable soil fragments will maintain cohesion when wet.
11. Soil Texture- is classified as a combination of silt, clay and loam which is related to permeability and thus infiltration.

A detailed methodology of the soil surface assessment indicators is provided in the LFA Manual (Tongway and Hindley, 2004). The soil surface indicators are all classed as ranks, which are used to calculate the three key landscape function indices, being stability, infiltration and nutrient cycling.

2.4 Vegetation Composition and Dynamics

Vegetation is crucial for habitat, food and shelter for native fauna, and plays a functional role in the control and cycling of resources. Similar to the LFA, the vegetation dynamics is assessed using numerical values, often percentages, for ease of comparison and statistical analyses.

Vegetation data is recorded using the same transects as the LFA. A grid is formed by spacing 2m each side of the transect at 5m intervals, making a total of ten 4x5m quadrants. Within each quadrant, a $1m^2$ grid is used in the top left and bottom right corner to calculate the following:

- % cover of combined lower stratum vegetation (all plants with height < 0.5m);
- % cover of combined lower stratum vegetation (all plants with height 0.5m-1.0m);
- % cover of litter; and
- % cover of bare ground.

2.4.1 Lower Stratum

The lower stratum is defined as 0 to 1m from ground level. Within each quadrant, the following lower stratum data is recorded:

- Inventory of all species;
- List key species; and
- Growth type (annual/perennial) of all species.

2.4.2 Middle and Upper Strata

The middle stratum is defined as 1 to 3m from ground level, and the upper stratum is defined as above 3m. These two vegetation levels will be combined during the EFA. The following parameters is recorded in each quadrant to provide an estimate of the canopy cover, height and composition of the transect:

- Record of all species present;
- Count stem densities per species;
- Canopy cover presence/absence, and if present
  - Species contribution; and
  - Mid or upper stratum.

2.5 Habitat Complexity

The Habitat Complexity module surveys the extent of available niches (habitat and shelter) for various vertebrate fauna. The greater the diversity, or complexity of habitat, the greater the range of fauna species likely to utilise the habitat, and the greater the robustness of the ecosystem. Habitat complexity is scored from 0 to 3 on the following five features:

- Canopy Cover;
- Shrub Cover;
- Ground Vegetation Cover;
- Amount of litter, fallen logs, rocks; and
- Free water availability

The area assessed is 10 to 20m in radius based on sight distance, centred at the middle of the 50m transect used for the LFA and Vegetation Dynamics. The total score of the five features indicates the final Habitat Complexity Score which can be compared across sites and time.

3. PHOTOGRAPHIC MONITORING

Photographic monitoring is recorded during each survey at the beginning of each transect. The photo is taken from the same position, with the camera leaning on the top of the star picket looking down the transect at a ground to sky ratio of 5:1. This enables visual comparisons to be made across survey periods. Photos of each patch-interpatch type is also be recorded to allow for consistency of descriptions over time.

The photographic record for each site is provided below.

3.1 Photographic Record Site 1

July 2020

Monitoring of Site 1 was discontinued in April 2021 due to the proposed expansion of the Western Overburden Emplacement.

3.2 Photographic Record Site 2

July 2020

April 2021

December 2021

May 2022

3.3 Photographic Record Site 3

July 2020

April 2021

December 2021

May 2022

3.4 Photographic Record Site 4

July 2020

April 2021

December 2021

May 2022

3.5 Photographic Record Site 5

April 2021

December 2021

May 2022

3.6 Photographic Record Reference Site

July 2020

April 2021

December 2021

May 2022

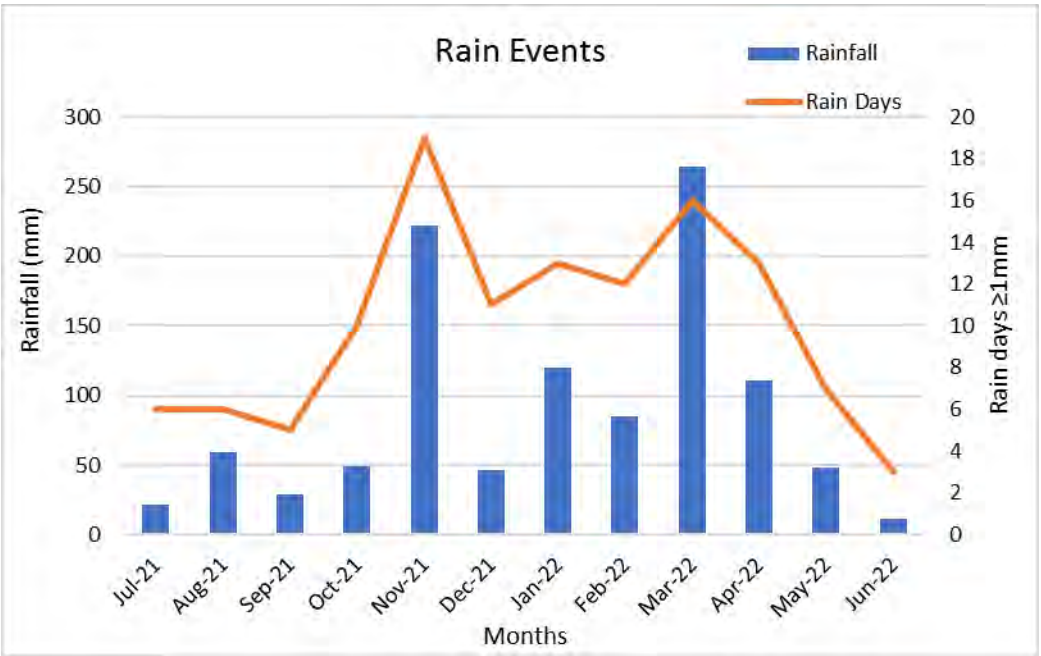
4. RESULTS AND DATA ANALYSIS

4.1 Geographic Setting

The Marulan South Limestone Mine has been operational since the 1830s, consisting of a limestone mine and processing plant. It is located directly to the north of Bungonia Gorge and approximately 35km east of Goulburn NSW, with lands covering 650 hectares of a significant limestone and granodiorite deposit. The site is characterised into two key vegetation communities namely, native Brittle Gum Stringybark Forest located to the west, and Coastal Grey Box Forest Red Gum Woodland situated to the east.

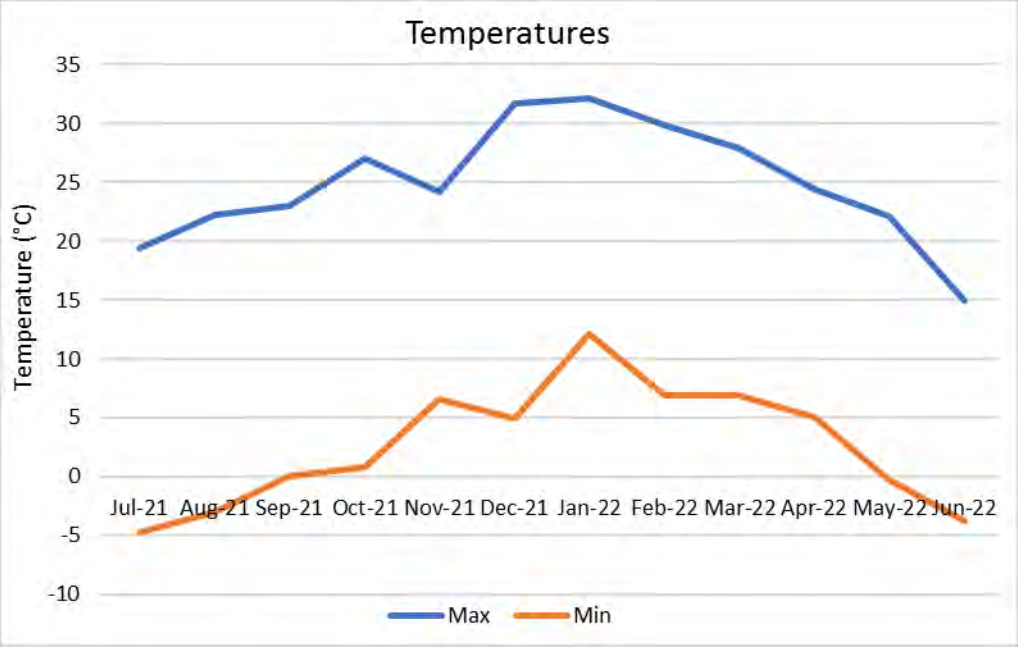
4.2 Weather

Weather data is obtained from the Marulan South Meteorological Station. Annual rainfall data is presented in Graph 1. The site is located in Australia's cool, temperate climatic region. The site received total of 1065mm of rain over the 12-month period with 121 rain days. The total rainfall was similar to that received in the previous 2020-2021 period with 12 additional rain days. Rainfall was highest during March 2021 with 264mm of rain and was the lowest in June 2022 with 11mm over 3 rain days. The number of rain days ranged from 3-19 days per month.



Graph 1- Monthly rainfall and number of rain days

Temperatures were hottest in Summer months with the highest maximum of 32.2°C in January 2021 and were coldest during the winter months with a lowest minimum of -4.8°C in July 2021 (Graph 2). The average maximum and minimum temperatures for the reporting period were 24.9°C and 2.6°C respectively, which were lower maximums and higher minimums than recorded in the previous period.



Graph 2– Monthly Minimum and Maximum Temperatures

4.3 Rehabilitation Monitoring Sites

Below in Table 4.1 is a description of the monitoring locations which are shown in Plan 1.

Table 4.1- Transect Description

Transect	Landscape Position	Comments
Reference 1 (R1)	South-West of the WOE	Has not been disturbed by mining activities
T1	Located at the northern end of the WOE, Domain 4.1w in the 2018-2023 MOP	Monoculture of *acacia* species with juvenile *Eucalypts*. Rehabilitated in 2005 and 2008. Discontinued due to expansion of the west overburden emplacement.
T2	South of the active area within the WOE, Domain 7.1w in the 2018-2023 MOP	Flat ground with groundcover of weed species and older monoculture of *Acacia*. Rehabilitated in 2005.
T3	Far south of the WOE Domain 7.1w in the 2018-2023 MOP	Rehabilitation occurred in 2017. Many *Acacia* with juvenile *Eucalyptus* and *Allocasuarina.* Many weeds present.
T4	Second bench of Bryces Dump Domain 7.3e in the 2018-2023 MOP	Stable slope, high vegetation cover is mostly weeds, moss and dying serrated tussock. Rehabilitated in 2019/2020
T5	WOE - first bench, Domain 4.1w in the 2018-2023 MOP	Transect established April 2021. Rehabilitation trial conducted January 2019. High grass and broadleaf weed density with increased *Acacias* down low.

4.3.1 Site 1

Monitoring of Site 1 was discontinued in April 2021 due to the proposed expansion of the WOE.

4.3.2 Site 2

The transect at Site 2 (T2) is located immediately to the south of the WOE and is directly below the active rehabilitation areas. The site is mainly comprised of very gently inclined to gently inclined land (3-10%) with a stable soil surface and no visible erosion. This rehabilitated zone is approximately 0.85 ha and the transect is positioned in the centre of the area in a NW to SE direction. Rehabilitation was conducted in 2005, in which the area was sprayed to control weeds and deep ripped prior to direct tree seeding. The seed mix was treated with heat, scarified, dried and mixed with fertiliser before use. The vegetation can now be described as a monoculture of *Acacia mearnsii* which appear to be heading toward the end of their lifespan. Groundcover is dominated by a dense layer of broadleaf weeds and grasses, particularly *Echium plantagineum* (Paterson's Curse), *Hypericum perforatum* (St John's-Wort) and *Plantago lanceolata* (Ribwort Plantain) with no native grasses and very few native herbs.

4.3.3 Site 3

The transect at site 3 (T3) is positioned on a bank at the far south of the WOE, adjacent to the native woodlands. The transect spans from the dirt road at the top of the bank to the edge of the native woodlands at the bottom. This transect is representative of the rehabilitation conducted on the western overburden emplacement in February 2017. Revegetation was done by direct seeding. This involved hydroseeding using the following mix:

- Mulch Wood fibre cellulose 2 tonnes/ha
- Seed
  - Cover Crop of Rye corn / Jap Millet 35kg/ha
  - Acacia species 7kg/ha
  - Eucalyptus Species 3kg/ha
- Fertilizer Dynamic lifter 250kg/ha
- Binder Envirotack 40kg/ha

Bundles of large fallen logs, bark and other organic material were positioned on the slope to improve habitat complexity. This area is comprised mostly of *A. decurrens* with a scatter of other acacia species, juvenile eucalypts and allocasuarina species. The lower half of the transect down-slope is dominated by weed species, particularly *Hirschfeldia incana* (Shortpod Mustard). Bare patches are quite prevalent and a small amount of rilling is present on the lower half of the site although no sediment problems are evident.

4.3.4 Site 4

This site is the only site currently located on the eastern side of the mining area, and therefore will be rehabilitated to a native Coastal Grey Box Forest Red Gum Woodland community. Transect 4 (T4) is located on the first bench of Bryce's Gully in a NE to SW direction. This site is exceptionally steep, with an average incline of 56 to 100% (classed steep to very steep) and benches with a slope range of 32-56% (moderately inclined to steep). The embankments are stable with little sedimentation evident from runoff and clear drainage lines. Rehabilitation was conducted during the 2019-2020 reporting period. Activities included weed spraying with a focus on *Nassella trichotoma* (Serrated Tussock), direct seeding and tubestock planting on the benches. Tubestock were fenced to prevent grazing and are watered using an irrigation system. So far approximately 50% of the tubestock have survived although show signs of

disease or possible stress from too much water or nutrient deficient. There is good vegetation cover at this site with lots of annual weeds holding the soil together, limited perennial weeds and some native ground covers emerging.

Manual seeding focussed on the drainage lines and gullies in which a mix of the following pasture species were used:

- Japanese Millet
- Ryecorn/Oats
- Rhodes grass
- Couch Grass
- Wimmera Ryegrass
- White Clover
- Lucerne
- Sub Clover

The tubestock species planted included:

- *Lomandra longifolia*
- *Eucalyptus Viminalis*
- *Eucalyptus macrochyncha*
- *Eucalyptus Eugenoides*
- *Eucalyptus melliodora*
- *Eucalyptus bosistoana*
- *Allocasuarina littoralis*

4.3.5 Site 5

The Transect at Site 5 (T5) was established in April 2021 and is situated on the next completed bench to the northwest of Site 2 on the southern side of the WOE. This area was ripped and hydro sprayed with a hydro-mulch standard fibre spray media including sterile ryegrass and couch cover seed mix (see Table 2) to improve the soil conditions and enhance the microclimate. No additional topsoil was spread on this area, although a small amount of topsoil may exist from when the site had previously been subject to unsuccessful revegetation efforts. These rehabilitation works were commenced in January 2019. Currently, the top half of the transect has a dense cover of grass and weed species. The predominant species are Rhodes Grass and Couch Grass, and the dominant weeds include *Hirschfeldia incana* and *Plantain lanceolata*. Further downslope in the southern direction, dense *Acacia mearsii* are growing up to approximately 3 metres tall. More rehabilitation work is planned for this site, including planting of native tubestock of a range of Eucalypt and Casuarina species.

A total of three rehabilitation trials have been conducted along this bench, with two additional trials conducted to the west of T5. Work at these two sites was more recently conducted during mid-2020. These sites may be included in the monitoring program once the rehabilitation work progresses in these trials.

The trial site (5b) directly to the west of T5 was ripped in Spring 2020 and treated with a hydro-mulch using *proganics dual* with ryegrass and couch cover seed mix as per Table 2

below. The majority of this area was spread with topsoil some time before the trial, although there is a smaller area to the west where there was no topsoil added.

The furthest trial site (5c) along the bench in a north-west direction was sprayed with hydro-mulch using Flexterra FGM with ryegrass and couch cover seed mix (see Table 4.2) in August 2020. No ripping or topsoil was added to this area. At present, a dense layer of grass and weed cover is maintaining a stable bench to prevent loss of organic matter and moisture.

Table 4.2 Ryegrass and Couch Cover Seed Mix

Seed Type	Species Name	Amount (Weight)
Grasses	Austrodanthonia spp	2kg
	Microlaena stipoides	2kg
	Chloris spp	2kg
	Themeda australis	2kg
Shrubs	Acacia falcata	0.3kg
	Acacia decora	0.5kg
	Acacia decurrens	0.5kg
	Acacia mearnsii	2kg
	Acacia rubida	1kg
	Acacia ulicifolia	0.3kg
	Dodonaea viscosa	1kg
	Hardenbergia violacea	0.5kg
	Indigofera australis	2kg
	Leptospermum obovatum	0.1kg
	Kunzea parvifolium	0.1kg
	Daviesia ulicifolia	0.2kg
Trees	Eucalyptus blakelyii	0.3kg
	Eucalyptus melliodora	0.3kg
	Eucalyptus mannifera	0.3kg
	Eucalyptus viminalis	0.3kg
	Allocasuarina littoralis	0.3kg

4.3.6 Reference Site

The Reference site is situated to the South-West of the WOE. The transect is situated in an ESE to WNW direction. This area has not been disturbed by mining activities, however the quality of this vegetation community has been compromised by an assumed history of disturbance which occurred approximately 25 years ago. This has led to a relatively sparse understory of native plants and a lack of old growth canopy trees. There is a thick layer of leaf litter on the soil surface and a moderate canopy predominantly of Eucalyptus species. The midstorey is open, with a scatter of native shrubs, predominantly *Olearia viscidula*. This site has been assessed as being Brittle Gum Stringybark Forest. The site is characteristic of a closed woodland with a sparse shrub layer and dominated by *Eucalypt obliqua.* The site contains a complete layer of litter and provides good ground habitat with logs, branches and very little weeds present. The soil is stable with full organic matter and humic in nature with good ground biology including ants, termites, mushrooms and liches. There is previous evidence of a cooler burning fire on tree bark and evidence of regrowth in the shrub layer. Older large trees are present with hollows suitable for habitat of larger birds and arboreal mammals. No erosion is evident whatsoever at the reference site.

4.4 Landscape Function Analysis

4.4.1 Patch/interpatch Types and Descriptions

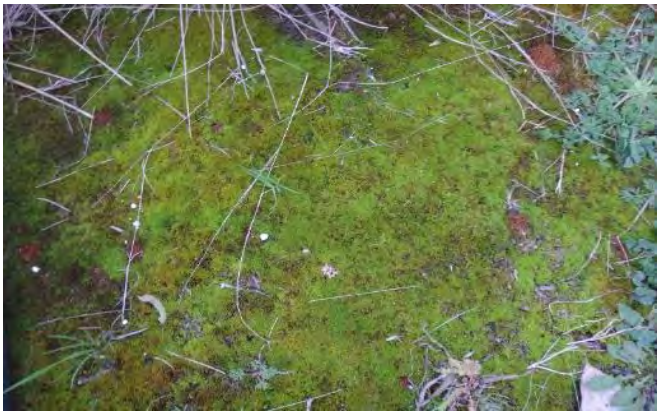
Shrub (S) patches ranged up to 1.5m in height and were characteristic of native plant growth. This category also includes native juvenile tubestock.

Weed (W) comprised individual and thickets of exotic species which were not planted during rehabilitation.

Niche (N) patches included fallen logs, piles of bark and debris which can enhance habitat structure.

A Log (L) patch differs from a Niche, as it includes a single log, often partially buried in the soil which has not accumulated additional debris, as in T5.

Leaf litter (LL) varied from Acacia leaves, Eucalypt leaves, small branches and dead and decomposing tussock grass in T4.



Patches of moss (M) were present in T2, T4 and the reference site.

Grass patches (G) were observed at all rehabilitated sites. These patches were often reflective of improved pasture species which had been sown as a cover crop.

Bare ground (BG) is an interpatch type which consists of overburden material. A high composition of rocks is evident and hydro-mulching material has been added to the surface to improve soil structure at some sites.

4.5 Landscape Function Analysis (LFA) Results

Field surveys involved the collection of patch/interpatch and soil surface condition data for each transect. This data is used to calculate the landscape organisation, soil stability, infiltration and nutrient cycling indices. The landscape organisation and soil surface assessments are most useful when compared over time, during subsequent monitoring surveys.

4.5.1 Landscape Organisation Index (LOI)

The summary statistics for the LOI method are presented in Table 4.3. Not every patch type was present in each selected transect site. For example, niche patches were present in Transect 3, although moss and grass were not. Niche patches were only present in Transect 3 and the reference site. The reference site had the greatest variety including 6 different patch types in total.

Transect 5 had the largest patch area and patch area index. This is because the areas of grass cover spanned for increased widths, over 10 metres in some cases. The breaking of the drought has resulted in more consistent rainfall and favourable conditions for weed growth. This explains the complete removal of interpatches which were reduced to 0% at Transect 2 and 4. The percentage of weed patches did not increase over the past 6 months, but instead there was an improvement in grass patches and native shrubs which accounted for 25% and 68% at T2 and T4 respectively which have overgrown the remaining proportion of bare patches. Since patches are known to retain resources, a high total patch area (m^2) can indicate that there are large areas within a site which are capable of conserving water, nutrients and soil. Such patches can be called 'fertile zones'.

The highest LOI were calculated for rehabilitated Sites 2 and 4, suggesting that these sites represent highly functional landscapes. Both transects are composed of a higher proportion of weed cover and grasses which minimises the proportion of bare ground to produce a high index. Such herbaceous ground cover weeds are not considered concerning as they will not compete with the growth of native plant species, they will add to the organic biomass following their death, and they protect the soil from erosive forces. Increased weed cover has grown following the high rainfall over the past twelve months, further improving the LOI for these sites in May 2022.

The average interpatch length is an important calculation as it represents the distance of unobstructed resource transport as runoff. The average interpatch length declined considerably at all rehabilitated sites over the past six months due to improved herbaceous weed and grass growth. The average interpatch length was lower than the reference transect at all rehabilitated sites, except for T3. The average interpatch length at the reference site was 0.55 and distances lower than this would imply that the momentum of overland flow is low, and resources will not be transported far out of the site. Shorter interpatches suggests that there are more patches available to capture resources. The shorter interpatch lengths would prevent increased erosive forces.

Table 4.3- Summary of LOI Results

July 2020	T1	T2	T3	T4		Reference
Patch Zones (number/10m)	12.2	11.6	3.2	8.6		9.0
Number Patch Types	6	3	4	6		6

July 2020	T1	T2	T3	T4		Reference
Total Patch Area (m²)	236.4	45.4	149.3	42.4		176.8
Patch Area Index	0.47	0.09	0.3	0.08		0.35
Mean Interpatch Length (m)	0.97	1.04	2.29	0.83		0.63
Interpatch Range (m)	0.1-7.7	0.1-5.0	0.5-7.0	0.5-1.5		0.3-1.3
Landscape Organisation Index	0.5	0.85	0.36	0.9		0.772
April 2021		T2	T3	T4	T5	Reference
Patch Zones (number/10m)		5.6	3.2	11.4	6.0	6.4
Number Patch Types		3	4	6	3	6
Total Patch Area (m²)		116.3	295.9	27.9	97.2	198.2
Patch Area Index		0.24	0.59	0.06	0.19	0.4
Mean Interpatch Length (m)		0.60	2.78	1.10	1.08	0.82
Interpatch Range (m)		0.1-3.0	0.4-7.6	0.3-2.5	0.2-5.0	0.1-1.8
Landscape Organisation Index		0.93	0.33	0.87	0.66	0.92
December 2021		T2	T3	T4	T5	Reference
Patch Zones (number/10m)		6.4	3.6	13.8	8.4	6.4
Number Patch Types		4	4	5	4	6
Total Patch Area (m²)		258.9	242.8	54.3	131.1	182.9
Patch Area Index		0.52	0.49	0.11	0.26	0.37
Mean Interpatch Length (m)		0.10	2.13	0.42	0.78	0.80
Interpatch Range (m)		0.4-7.5	0.7-5.0	0.2-0.6	0.2-2.2	0.5-1.0
Landscape Organisation Index		1.0	0.45	0.96	0.78	0.92
May 2022		T2	T3	T4	T5	Reference
Patch Zones (number/10m)		8.0	6.6	10.4	7.4	7.0
Number Patch Types		5	4	5	5	6
Total Patch Area (m²)		69.4	121.1	59.4	174.1	179.2
Patch Area Index		0.14	0.24	0.12	0.35	0.35
Mean Interpatch Length (m)		0	0.90	0	0.52	0.78
Interpatch Range (m)		0	0.2-2.5	0	0.1-1.1	0.1-1.5
Landscape Organisation Index		1.00	0.73	1.00	0.90	0.96

4.5.2 Soil Surface Assessment (SSA)

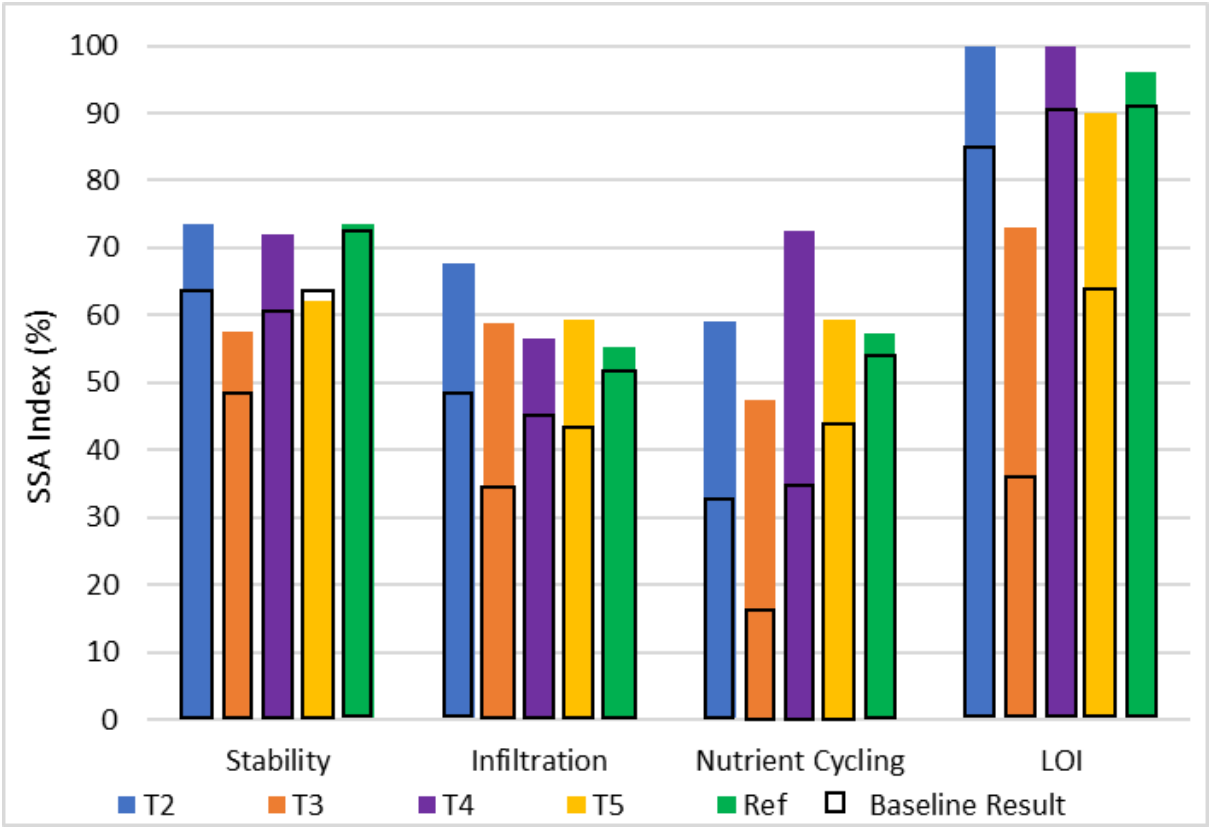
Patches of grass, moss and weeds presented the highest soil stability index. They act as obstructions for slowing down and capturing overland flow, providing soils with physical stability and thus preventing subsequent erosion. Bare ground patches had the lowest stability index predominantly due to the absence of rain splash protection. The stability indices of each site were strongly associated with the proportion of different patch types. Site 2 had the highest stability index (Graph 3), characterised by an extensive, localised layer of litter, high rain splash protection and a high presence of vegetative and biological cover. Site 3 had a lower stability rating of 57.6% due to the lack of cover (vegetation, litter and biological) and evidence of erosion, however this rating did improve by 4% over the past 6 months.

A high infiltration index was predominantly characterised by litter cover and decomposition, basal vegetation cover and physical soil attributes (texture, slake, dry coherence). Naturally, vegetation and litter patches contributed to the highest scores. Infiltration scores improved considerably at Site 3, reaching 58.9% due to acacias filling out in the first half and increased density of weeds in the second half of the transect in May 2022. Since scores across all Sites

were similar to, or higher than the reference site, no further infiltration improvements are necessary.

The highest nutrient cycling SSA indices were achieved by vegetated patches including grasses, shrubs, weeds, moss and litter, which will contribute to soil surface nutrients when broken down. Localised litter cover with a high decomposition improved the score because nutrients are effectively being returned to the soil. Low basal cover including bare ground and rock allows for resources to be lost in contrary to being filtered into the substrate. Nutrient cycling indices rose considerably during December 2021 and rose slightly higher in May 2022, with scores ranging from 47.4% at Site 3 (a 12% increase) to 72.4% at Site 4 (Graph 3).

The LOI is a good indication of vegetation cover and is related to the SSA parameters. It is recommended that the LOI is improved at Sites 3 and 5 to reach a similar score to the reference site (Graph 3). This can be done by minimising the proportion of bare ground on the site by increasing vegetation cover through planting and seeding methods.



Graph 3- Soil Surface Assessment Index (%) Baseline result= July 2020 (April 21 for T5)

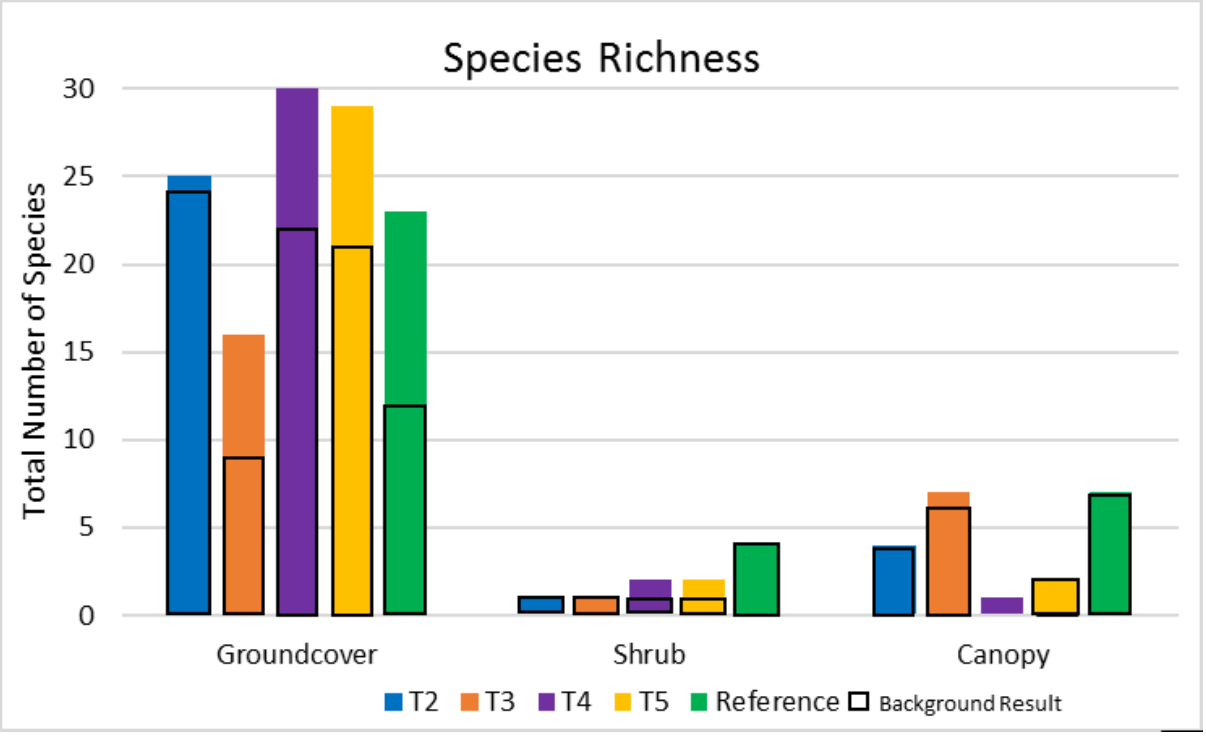
4.6 Vegetation Composition and Dynamics

The number of groundcover species was the highest strata level for each site, with species numbers ranging from 16 to 30 groundcover species per transect (Graph 4). The majority of groundcover plant species (57% to 95%) were weeds as shown on Table 3 below. Across all sites, the most common weed species were *Hirschfeldia incana, Plantago lanceolate, Hypochaeris glabra* and *Cirsium vulgare.* Common pasture species included *Trifolium* sp, *Cynodon* sp, *Phallaris* sp and *Lomandra*. As expected, the reference site had the highest number of native groundcover species, including *Pomax umbellate, Patersonia occidentalis,*

and *Vicia tetrasperma*. Site 4 had the highest diversity of groundcover, with a total of 30 species. Species richness has also improved at Site 3 over the past year. As previously discussed, herbaceous weed species will not have detrimental effects on the ecosystem.

The reference site shows that the native vegetation resembles an open woodlands ecosystem where mid-storey cover is sparse. Only four middle storey species were present in the reference transect, while one or two species were present in each of the rehabilitated transects. The middle storey of the reference transect was dominated by *Olearia viscidula.* Species richness of the reference site did not entirely represent a Brittle Gum Stringybark Forest as the middle and lower stories were disturbed. The reference site provides helpful data for the LFA component of this study, although improved vegetation dynamics would be expected for the rehabilitated sites.

The upper canopy at the reference site is characterised by mature *Eucalyptus mannifera* and *E. bosistoana* with the emergence of few juvenile *Acacia* and *Casuarina*. Meanwhile, Site 2 is comprised of a dense canopy of *A. decurrens* and *A. mearsii,* with the emergence of *E. cinerea.* Transect 3 and 5 are comprised of the same species, however rehabilitation work in these sites was more recent and all species are still at a juvenile stage. The dense monoculture of *Acacia* trees does not reflect the natural reference site, and more care should be taken with species selection. It could be suggested that planting of Eucalypt tubestock in these areas would improve diversity and species richness of canopy species to represent the reference site.

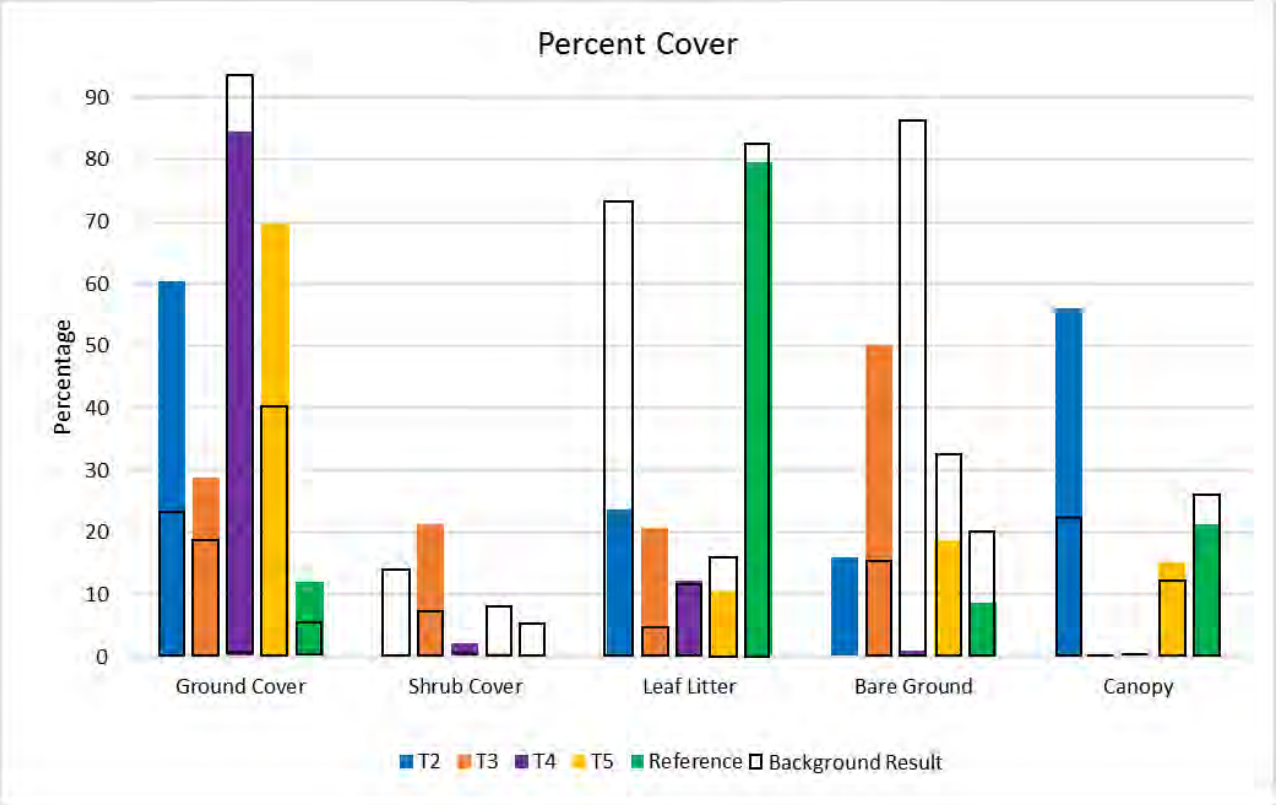


Graph 4- Species Richness at three levels of vegetation strata Baseline result= July 2020 (April 21 for T5)

Percent cover is important for several reasons as it covers both ecological systems and physical protection. This category does not distinguish between weed cover and native vegetation as it is not necessarily a factor in protecting soil from erosion. Organic matter is important in the development of soil structure and fertility, and it is not necessarily relevant

whether this material comes from native or non-native species. It also doesn't distinguish between species diversity and structure, however for long term sustainability the structural components should still match the reference vegetation community.

As shown on Graph 5, the reference site has a high canopy cover, but less ground and shrub cover and includes a significant proportion of leaf litter. Site 4 however, is predominantly ground cover, with vegetation increasing into the shrub layer, and has minimal tree layer at this stage. Over time as trees emerge, the groundcover will reduce, and the leaf litter layer will increase. Conversely, Site 3 is in the early stage of rehabilitation and shows little ground cover and leaf litter cover. Site 2 is an older rehabilitated area and has a higher canopy and leaf litter approaching the proportions observed in the reference site. It is evident that the timing of rehabilitation of Site 5 lies between Site 3 and Site 2, with a fair amount of bare ground gradually being covered by lower storey species and litter, while the middle and upper storeys are still somewhat lacking. It appears that over the past 6 months there has been a reduction in bare ground across all the rehabilitated sites, as ground cover species emerge and the leaf litter layer develops further.



Graph 5- Average ground, shrub, litter and bare cover percentages Baseline result= July 2020 (April 21 for T5)

Table 4.4- Transect Species List

Transect 2	Transect 3	Transect 4	Transect 5	Reference
Weed species				
Sonchus asper	*Plantain lanceolata*	*Verbena brasiliensis*	*Hirschfeldia incana*	*Euphorbia maculata*
Plantago lanceolata	*Medicago minima*	*Stachys byzantina*	*Sonchus arvensis*	*Euphorbia peplus*
Erigeron bonariensis	*Hirschfeldia incana*	*Erigeron canadensis*	*Sinapis arvensis*	*Gamochaeta sp*
Centaurea Melitensis	*Euphorbia peplus*	*Solanum nigrum*	*Plantago lanceolata*	*Hypochaeris glabra*
Lactuca serriola	*Hypochaeris glabra*	*Cirsium vulgare*	*Dittrichia graveolens*	*Asclepias fascicularis*
Cirsium vulgare	*Geranium molle*	*Sonchus asper*	*Erigeron bonariensis*	*Nassella trichotoma*
Hirschfeldia incana	*Atractylis cancellata*	*Marrubium vulgare*	*Sonchus Asper*	*Daucus carota*
Silybum marianum	*Modiola caroliniana*	*Dittrichia graveolens*	*Hypochaeris glabra*	*Erigeron bonariensis*
Rumex acetosella	*Erigeron bonariensis*	*Geranium dissectum*	*Lythrum salicaria*	*Portulaca oleracea*
Hypochaeris glabra	*Erigeron canadaensis*	*Erigeron sumatrensis*	*Cirsium vulgare*	*Euchiton japonicus*
Erodium moschatum	*Sonchus Asper*	*Helminthotheca echioides*	*Helminthotheca echioides*	*Solanum nigrum*
Erigeron canadaensis	*Dodonaea viscosa*	*Sonchus oleraceus*	*Erigeron canadensis*	*Dichondra repens*
Erigeron sumatrensis	*Centaurea Melitensis*	*Plantain lanceolata*	*Dichondra repens*	*Verbena bonariensis*
Sonchus oleraceus	*Lactuca serriola*	*Machaeranthera tanacetifolia*	*Euchiton japonicus*	
Gamochaeta coarctata	*Cirsium vulgare*	*Scorzoneroides*	*Lythrum salicaria*	
Verbena brasiliensis		*Leontodon saxatilis*	*Erigeron canadensis*	
Dichondra repens		*Tetraneuris scaposa*	*Conyza bonariensis*	
Solanum nigrum		*Modiola caroliniana*	*Onopordum acanthium*	
Portulaca oleracea		*Andropogon virginicus*	*Anagallis arvensis*	
Oxalis dillenii		*Hypochaeris glabra*		
Ageratina adenophora		*Anagallis arvensis*		
Tagetes minuta		*Hirschfeldia incana*		
Improved Pasture Species				
Trifolium repens	*Trifolium repens*	*Trifolium repens*	*Trifolium repens*	*Poaceae sp.*
Phallaris sp.	*Phallaris sp.*	*Heteropogon contortus*	*Dactylis glomerata*	*Poa sieberiana*
	Lolium sp.	*Paspalum dilatatum*	*Cynodon dactylon*	*Cyperaceae sp.*

Transect 2	Transect 3	Transect 4	Transect 5	Reference
	Cenchrus Clandestinus	*Cynodon dactylon*	*Phallaris minor*	*Microlena spp*
	Cynodon dactylon	*Chloris gayana*	*Chloris gayana*	
			Poa pratensis	
			Lolium	
			Festuca arundinacea	
Native Understorey Species				
		Lomandra Longifolia	*Chrysocephalum apiculatum*	*Goodenia pinnatifida*
			Unknown groundcover	*Patersonia occidentalis*
			Hardenbergia violacea	*Chrysocephalum apiculatum*
				Indigofera australis
				Hardenbergia violacea
				Vicia tetrasperma
				Vittadinia muelleri
Mid to Upper Storey Species				
Acacia decurrens	*Acacia parramattensis*	*Pittosporum multiflorum*	*Dodonaea sp*	*Hakea sp.*
Acacia mearnsii	*Acacia falciformis*	*Pittosporum undulatum*	*Acacia decurrens*	*Eucalyptus eugenioides*
Eucalyptus cinerea	*Acacia mearnsii*		*Acacia mearnsii*	*Acacia sp. (juvenile)*
Eucalyptus macrorhyncha	*Acacia longifolia*			*Eucalyptus mannifera*
	Acacia decurrens			*Eucalyptus bosistoana*
	Allocasuarina littoralis			*Ozothamnus diosmifolius*
	Eucalyptus cinerea			*Olearia viscidula*
	Acacia parramattensis			*Eucalyptus cinerea.*
	Gleditsia triacanthos			*Acacia decurrens*
				Casuarina sp. (juvenile)

4.7 Habitat Complexity

Habitat complexity examines the extent of environmental niches, shelter and food resources available for vertebrate fauna. The reference site has a high habitat complexity index with a score of 9 (Table 4.5). This was comprised of a tree canopy of 30-70%, shrub canopy <30%, sparse ground herbs <0.5m, litter >70% and a permanent water body adjacent.

The habitat complexity scores of Site 2 and Site 3 saw no changes over the past 6 months. The score at Site 5 declined from 7 to 6. This was due to a reduction of the shrub layer, as the previous weed species that were evident had died off during the cooler months.

Site 4 has seen an improvement in habitat complexity, with a score rising from 5 to 6. This is due to the shrub canopy increasing from 0% to <30% with the extended growth of tubestock, however minimal shrub cover is still evident at this site. The serrated tussock that had been sprayed in spring 2021 has now died off, thus increasing litter to 30% - 70% cover.

The entire lower and mid strata assemblage of all sites requires active rehabilitation. The vertical vegetation structure of an ecosystem plays a significant role in many positive feedback processes including stratum diversity providing increased habitat niches for a greater diversity of vertebrate species. As for the vegetation structure observed within Sites 2 and 5, although *Acacia* species can be used for successional development in a disturbed ecosystem, other components such as a seed bank must also be provided to enable to target succession to occur.

Habitat complexity can be easily improved in rehabilitation areas by the inclusion of brush matting such as logs, branches and debris. There is evidence of this having originally occurred in some of the rehabilitation areas, and this should improve over time.

Table 4.5- Habitat Complexity Woodland Scores

July 2020	1	2	3	4	5	Reference
Tree Canopy %	2	1	0	0		2
Shrub Canopy %	0	1	2	0		1
Ground Herb %	0	0	0	2		0
Litter %	2	2	1	0		2
Water	0	1	0	0		2
Habitat Complexity Index	4	5	3	2		7
April 2021	1	2	3	4	5	Reference
Tree Canopy %		2	0	0	1	2
Shrub Canopy %		1	2	1	1	1
Ground Herb %		2	0	2	3	1
Litter %		2	1	1	1	3
Water		1	0	0	0	2
Habitat Complexity Index		8	3	4	6	9
December 2021	1	2	3	4	5	Reference
Tree Canopy %		3	0	0	1	2
Shrub Canopy %		1	2	0	2	1
Ground Herb %		3	1	3	3	1
Litter %		2	1	1	1	3

Water		1	0	1	0	2
Habitat Complexity Index		10	4	5	7	9
May 2022	1	2	3	4	5	Reference
Tree Canopy %		3	0	0	1	2
Shrub Canopy %		1	2	1	1	1
Ground Herb %		3	1	3	3	1
Litter %		2	1	1	1	3
Water		1	0	1	0	2
Habitat Complexity Index		10	4	6	6	9

5. DISCUSSION AND RECOMMENDATIONS

5.1 General

This was the fourth EFA monitoring round for Marulan South Limestone Mine under the 2018-2023 MOP period. It covered both older revegetation areas, newly rehabilitated areas and the reference site which was characteristic of the surrounding native vegetation communities. During April 2021 Site 1 was discontinued and an additional Site 5 was included into the program. The mine is undertaking progressive rehabilitation in accordance with the 2018-2023 Mining Operations Plan which will be updated and enhanced as part of the State Significant Development approval process for the life of mine development project.

This EFA study found that overall rehabilitation activities have been successful but has identified areas of improvement and corrective action which should be considered over time. The study has also found the surrounding native vegetation communities are highly disturbed and not necessarily representative of the target ecosystem quality that should be sought in the rehabilitation areas. Further discussion and recommendations of the EFA findings can be found in the sections below.

5.2 Rehabilitation Success Criteria

The EFA program is used in accordance with the Rehabilitation Strategy to collect information of the rehabilitated sites which can be matched against the success of rehabilitation objectives and completion criteria. Table 6 below shows that more work is required before any of the sites will meet the success criteria.

Table 5- Rehabilitation Success Summary

Hierarchy of Ecosystem Succession	Targeted Ecosystem Components	Key Performance Indicators	Units	Satisfaction of the Criteria			
				Site 2	Site 3	Site 4	Site 5
Landform Establishment	Landform Function	LFA Stability	%	✓	x	x	x
		LFA Infiltration	%	✓	✓	✓	✓
		LFA Nutrient Cycling	%	✓	x	x	✓
Growth Medium Development	Active Erosion	Surface Area	m^2	✓	✓	x	✓
	Soil chemical/ Physical properties	pH	pH (6.5)	-	x	-	✓
		Organic Carbon	% (>4.5)	-	x	-	x
		Nitrate	ppm (>12.5)	-	✓	-	x
		Total Phosphorous	ppm	-	x	-	x
Ecosystem Establishment	Vegetation Density	Tree Density	Stems/area	x	x	x	x
		Shrub Density	Stems/area	x	x	x	x
	Vegetation Diversity	Native Understorey Diversity	> Species / m^2	x	x	x	x
		Exotic Understorey Diversity	< Species / m^2	✓	x	✓	✓
Ecosystem Development	Groundcover Components	Perennial Plant Cover (<0.5m)	%	✓	x	✓	✓
		Total Ground Cover	%	✓	x	✓	✓
		4-6m height class	% Cover	x	x	x	x

Hierarchy of Ecosystem Succession	Targeted Ecosystem Components	Key Performance Indicators	Units	Satisfaction of the Criteria			
				Site 2	Site 3	Site 4	Site 5
	Floristic Diversity	Native Species Diversity	> no. / area	x	x	x	x
		Exotic Species Diversity	> no. / area	✓	x	✓	✓
Ecological Stability	Ecosystem Health	Healthy Trees	% Population	x	x	x	✓
	Ecosystem Recruitment	Shrub / Recruitment 0-0.5m	no. / area	x	x	x	x
	Ecosystem Composition	Trees	no. / area	x	x	x	x
		Shrubs	no. / area	x	x	x	x

5.3 Site 1

Rehabilitated Site 1 is characterised as a steep bank previously used as an overburden waste emplacement. It has a low LOI (50.0) with moderate to high stability (54.6), nutrient cycling (40.6) and infiltration (50.1). The bank is quite steep and erosion rills are present in the lower half. The lower stratum is comprised of herbaceous weed species, up to 40% left litter and 60% bare ground. Canopy cover is present which is provided by the dense monoculture of *Acacia.* The middle storey is lacking in shrub species and a scatter of juvenile eucalypts are emerging among the ground stratum. Site 1 had a habitat complexity score of 4, due to improved litter and tree canopy percentages (both 30-70%).

The high density of *Acacia* species may be suppressing the growth of other plant species due to the allelopathic effects, particularly during previous dry conditions. These effects are mainly caused by high densities which outcompetes other natives for space and light and build-up of *Acacia* seed within the soil profile which exclude the germination of other native species. Under normal ecological conditions within a healthy forest community, *Acacias* act as colonisers in areas of natural disturbance. As a successional species that is generally short lived, *Acacias* for an important factor in soil stability and habitat development while the forest community recovers from disturbance. However, at site 1, there is a monoculture of *Acacias* which will successfully out-compete other successional species which inhibits ultimate species diversity and may not produce a sustainable native vegetation community.

This site was not monitored during April 2021 and has been discontinued as the new emplacement area will be expanded into this location. No recommendations are required for this area.

5.4 Site 2

This site had a high LOI of 100. The ground cover was comprised of grass and weed species, litter and moss, with no bare ground patches remaining. This area had high stability (73.5) and moderate infiltration and nutrient cycling (67.8 and 59.0 respectively). The soil surface indices have improved slightly over the past six months due to increased rainfall favouring herbaceous understorey growth. The shrub stratum predominantly included juvenile *Eucalyptus* species, particularly *Eucalyptus cinerea*. Canopy cover is present which is provided by the ageing *Acacia.* Site 2 had the highest habitat complexity index of all the

rehabilitated sites, with a score of 10. This site has a stable soil surface with no visible erosion. There are no native grasses in the understory vegetation and very few native herbs.

Although the *Acacias* in this Site are progressing towards the end of their lifespan, thinning out these trees and supplementing with *Eucalypts* tubestock would aid improvement of the species diversity. Some of the weeds present including *Tagetes minuta* are persistent perennials, and do need to be managed by spot spraying.

5.5 Site 3

Site 3 had the lowest LOI of all the rehabilitated sites of 73, however this index has improved significantly due to the *acacias* filling out in the upper half of the transect and the increased density of weeds in the second half. This site had comparatively low stability, infiltration and nutrient cycling indices of 57.6, 58.9 and 47.7 respectively, however the soil surface indices have also improved over the past 6 months. A significant amount of bare ground is observed at this site at 50%, with the lowest number of species at all stratum levels over all transects. Additionally, no canopy is present at this site, but over time the juvenile natives present are expected to fill the upper storey. Habitat complexity is also relatively low, with a score of 4. There are no sediment problems at this site and the soil surface is quite stable. A positive action undertaken at this site is that piles of logs and sticks have been clustered among the groundcover to create micro-niches to enhance shelter for smaller animals.

This site represents more recent rehabilitation work and currently consists of juvenile *Acacias* and Eucalypts but with extensive weed infestation on the lower bank. The density of Eucalypts would indicate that a monoculture of *Acacias* is unlikely, however this would require ongoing monitoring and assessment. The development of weed growth is not a concern at this stage as they do provide stability for the bank, however it is important that the weed mass does not become an inhibitor to the ultimate development of a native forest community. Weed spraying in this area should be avoided at this stage, since this would also have the effect of suppressing Eucalypt seedlings.

5.6 Site 4

Site 4, known as Bryce's gully, is a difficult area to rehabilitate. It represents a steep slope on the eastern side of the mine with poor access. Despite being one of the older rehabilitation sites at the mine, it has generally only been able to support herbaceous weeds and tussock. The site is heavily grazed by both native and introduced species because historically is has been a source of food. This in turn has made it more difficult to develop native species.

During 2020, native tree and shrub species were planted along the benches and protected in fully enclosed wire cages, each with an irrigation water supply. The cages will be removed after the plants have matured to a point where grazing pressure is no longer a concern. The irrigation system is likely to remain until root systems have developed sufficiently to ensure sustainable growth. Serrated tussock which dominated the understorey was sprayed during 2021 and has been deemed successful, with decomposition of the majority of tussocks. This decomposition has contributed to a large proportion of the leaf litter. The site has a high LOI of 100 with no bare patches remaining and moderate to high soil surface indices. The groundcover at this site is excellent, and the herbaceous weeds are gradually being

outcompeted by pasture grasses. The embankments are very stable due to the high vegetation cover, and therefore there is little sedimentation evident from runoff and the drainage lines are clear. The middle and upper canopy layers are currently absent, but over time the tube stock are expected to fill these areas. The habitat complexity index is still low, but has increased to a score of 6 in May 2022.

This site requires active management in order to achieve the approved objective of a stable native woodland ecosystem compatible with surrounding vegetation communities. The results of this EFA study have found that the foundations of the land use goal have been established with good groundcover and SSA indices. Adequate tree and shrub development are however in the early phase and will take some time to achieve sustainability. These foundations could be improved with brush matting and further native planting. The success rate of tubestock planted in enclosures is currently approximately 50% and some of these plants are showing signs of disease or stress. Replacement tubestock should be used to in fill where previous plats have not survived. The addition of tree pellets to provide slow release fertiliser should be used when planting.

5.7 Site 5

Site 5 is located on the second completed bench on the southern side of the Western Overburden Emplacement and represented an area of the most recent rehabilitation undertaken at the Mine. This site LOI increased by 12% to 90 in the past 6 months. Site 5 had a relatively high stability (62), level of infiltration (59.3) and nutrient cycling index (59.4) which were similar to, or higher than the reference site. A fair amount of bare ground is still visible, although it is gradually being covered by lower storey species and litter, while the middle and upper storeys are still somewhat lacking. Improvement of the shrub and tree canopy layer will result in an increased habitat complexity index (currently 6) at this site. This is expected to occur over time as species observed in juvenile stages in 2022 become established. As observed at sites 2 and 3, the *acacia* is dominating the upper storeys. Improving biodiversity by infilling with *eucalypts* and removing excess *acacias* as required would reflect a better representation of the reference site. A small patch of *Cortaderia selloana* is located just below the transect line which should be treated.

5.8 Reference Site

The reference site used in this study was located within a community identified as Brittle Gum Stringybark Forest. This site is characteristic of a closed woodland, dominated by stringybark with not a great deal of shrubs. It has a complete layer of litter, good ground habitat with an abundance of logs and branches, and very little weeds. The soil is stable with full organic matter and humic in nature with no erosion evident whatsoever. There is positive ground biology including ants, termites, mushrooms and lichen. There is previous evidence of a cooler burning fire in the tree bark. Older large trees are present with hollows perfect for bird and arboreal mammal habitat and nesting.

This site is a successful indicator of landscape organisation and soil surface levels required by the rehabilitated sites, although the vegetation dynamics and habitat complexity showed previous disturbance. It is expected that the rehabilitated sites should exceed this reference site in terms of flora density and richness, particularly in the lower stratum levels. A habitat complexity score beyond that of the reference site is also required for a healthy, sustainable

rehabilitated vegetation community. It is proposed that a second reference site located within the Coastal Grey Box Forest Red Gum Woodland also present on site will be established.

This ecosystem function analysis monitoring program has shown that Marulan South Limestone Mine has clear rehabilitation objectives and has selected indicators to measure rehabilitation success against a criterion. The monitoring of such indicators has highlighted that more rehabilitation work is required in the areas discussed above in order to reach a successful completion criterion.

Plan 1- EFA Monitoring Plan

APPENDIX A – LFA Raw Data December 2021

Transect 2			Transect 3			Transect 4			Transect 5			Reference		
Distance (m)	Width (cm)	Patch Type	Distance (m)	Width (cm)	Patch Type	Distance (m)	Width (cm)	Patch Type	Distance (m)	Width (cm)	Patch Type	Distance (m)	Width (cm)	Patch Type
0	-	-	0	-	-	0	-	-	0	-	-	0	-	-
2.7	400	W	0.7	130	B	1.3	150	G	0.6	2000	G	0.5	100	L
3.1	20	M	1	20	S	1.4	10	W	1.2	100	B	0.6	30	B
5.9	150	W	2	500	B	2.2	150	G	5	2000	G	2	100	W
6.6	20	W	2.6	100	W	2.6	100	M	5.1	10	B	2.3	50	L
6.9	20	N	3.4	20	S	5.5	50	G	6.8	250	G	3	50	W
8.5	150	W	3.7	100	W	5.9	10	M	6.9	50	N	4	50	L
8.7	100	N	4.6	200	S	6.5	20	W	8	1500	G	4.5	100	W
13.1	120	W	5.3	120	B	6.8	30	M	9.1	100	N	6.3	60	S
13.2	10	M	6.6	200	S	8.8	150	G	9.2	150	B	6.8	10	B
13.4	20	N	7	80	B	9.3	50	S	9.5	50	W	7.7	50	L
14.9	200	W	7.1	20	N	9.8	50	W	10.2	150	B	8.5	50	S
15.6	10	L	7.4	100	S	13.5	20	G	11.3	200	B	10.2	200	L
16.9	150	W	9.9	100	B	13.6	10	M	15.3	150	N	10.8	40	S
17.7	30	N	10.2	500	W	15.9	200	G	16	50	W	11.2	30	W
18.4	110	W	12.7	800	S	16	10	M	16.3	150	G	11.4	400	N
18.8	250	M	13.3	600	B	17.8	100	G	16.5	150	W	12.6	150	L
20	50	N	14.9	400	S	18	200	M	16.9	20	B	16.6	200	S
24	80	M	16	500	L	19	100	G	17.1	20	G	16.7	200	N
26.1	200	W	18	20	B	19.2	20	W	19.3	130	G	17.9	80	S
27.3	20	N	18.4	400	W	20	50	S	19.5	100	W	18	10	M
29.1	200	W	19.4	130	B	20.5	50	W	20.9	200	G	21.8	500	L
29.5	10	M	20.6	130	N	21.3	20	L	21.5	150	B	22	30	S
31.9	300	W	20.7	10	W	22.1	20	W	22.2	120	W	24.3	20	W

Transect 2			Transect 3			Transect 4			Transect 5			Reference		
Distance (m)	**Width (cm)**	**Patch Type**	**Distance (m)**	**Width (cm)**	**Patch Type**	**Distance (m)**	**Width (cm)**	**Patch Type**	**Distance (m)**	**Width (cm)**	**Patch Type**	**Distance (m)**	**Width (cm)**	**Patch Type**
32.8	200	G	21.9	250	S	22.6	300	G	23.1	200	G	27	150	L
34.5	150	L	23	200	B	23.4	100	S	23.5	30	W	27.1	10	S
38.2	600	W	23.6	50	S	24.2	50	W	25.1	200	G	28.6	250	L
39.4	100	N	24	20	W	25.5	150	G	26.3	150	N	28.8	10	S
40.1	150	L	24.8	50	B	26.2	40	W	26.8	150	W	32	500	L
40.4	80	N	25.2	10	W	26.9	100	G	27.1	10	B	34	150	S
41.1	50	G	26.2	50	B	28	80	W	29.2	200	G	36	50	L
41.6	20	N	27	10	W	28.2	50	S	29.4	20	W	40	30	S
42.1	80	G	27.8	20	L	29.8	400	G	30.9	150	G	41.2	200	L
43.6	120	W	28.2	30	B	30.3	50	W	32.3	250	W	41.5	30	B
45.5	50	N	29.7	700	W	30.5	30	L	33.1	150	N	43	100	L
45.7	50	W	30.2	50	B	33.4	150	S	33.6	20	B	44	20	S
47	50	N	32.5	600	W	33.7	30	W	34.4	110	N	46	150	L
47.5	120	L	33.5	200	N	34.2	30	G	35.7	150	G	47.8	50	B
48.2	50	W	35	1000	W	37.2	50	W	37.1	200	N	47.9	1	G
49	100	L	40.5	10	S	38.1	50	L	37.9	10	B	50	100	S
50	150	G	41.4	200	W	38.3	80	W	38.8	150	G			
			44.5	200	W	39.1	50	S	39.5	150	N			
			45.1	20	B	39.7	100	W	41	250	G			
			45.9	10	S	43	300	G	42.2	150	N			
			47.3	200	W	43.5	300	W	49.3	80	G			
			47.5	10	B	44.4	20	M	50	400	N			
			49.1	200	W	45.5	150	G						
			49.6	10	S	46	30	S						
			50	150	W	46.8	100	G						
						47	20	W						
						47.8	50	S						
						49	200	G						

Transect 2			Transect 3			Transect 4			Transect 5			Reference		
Distance (m)	**Width (cm)**	**Patch Type**	**Distance (m)**	**Width (cm)**	**Patch Type**	**Distance (m)**	**Width (cm)**	**Patch Type**	**Distance (m)**	**Width (cm)**	**Patch Type**	**Distance (m)**	**Width (cm)**	**Patch Type**
						50	300	W						

KEY:
B= Bare
G= Grass
L= Litter
W= Weed
N= Niche (Fallen logs, wombat hole)
M= Moss
S= Shrub (native shrub)

APPENDIX B – SSA Raw Data December 2021

Soil Surface Assessment of individual zones

Transect 2			
Zone	Stability	Infiltration	Nutrients
Weed	78.8	68.9	57.7
Litter	62.5	72.0	57.7
Native	58.3	61.6	61.5
Moss	77.5	68.9	61.5
Grass	80.0	68.9	61.5

Transect 3			
Zone	Stability	Infiltration	Nutrients
Weed	60.5	68.5	58.1
Shrub	61.8	66.5	60.3
Litter	57.5	60.4	53.8
Niche	63.2	64.6	54.7
Bare	48.1	37.0	17.1

Transect 4			
Zone	Stability	Infiltration	Nutrients
Grass	73.3	56.7	72.4
Moss	65.8	56.7	84.6
Weed	70.6	56.7	69.8
Litter	72.6	58.5	73.5
Shrub	70.8	54.8	72.2
Bare	52.6	30.2	23.3

Transect 5			
Zone	Stability	Infiltration	Nutrients
Grass	68.0	61.3	65.6
Weed	64.5	61.6	67.0
Shrub	58.3	61.6	61.5
Litter	58.3	62.2	61.5
Bare	47.2	51.1	38.5
Niche	47.2	51.1	38.5

Reference			
Zone	Stability	Infiltration	Nutrients
Shrub	76.6	56.1	59.0
Litter	75.2	56.1	59.0
Niche	83.5	53.4	53.8
Moss	73.8	35.2	39.6
Weed	60.4	60.1	61.5
Grass	60.4	57.9	57.7
Bare	55.8	27.9	19.6

Soil Surface Assessment Individual zones contribution to the whole landscape

Transect 2			
Zone	Stability	Infiltration	Nutrients
Weed	42.5	37.2	31.2
Litter	8.5	9.8	7.8
Grass	15.0	13.0	11.6
Moss	10.4	9.2	8.2
Total	76.5	69.2	58.8

Transect 3			
Zone	Stability	Infiltration	Nutrients
Weed	15.7	17.8	15.1
Shrub	7.8	8.4	7.6
Litter	1.2	1.2	1.1
Niche	2.5	2.6	2.2
Bare	26.6	20.5	9.5
Total	53.8	50.5	35.4

Transect 4			
Zone	Stability	Infiltration	Nutrients
Grass	33.3	25.7	32.9
Moss	4.7	4.1	6.1
Weed	17.7	14.2	17.5
Litter	7.3	5.9	7.4
Shrub	5.8	4.5	5.9
Bare	2.2	1.3	1.0
Total	71.0	55.6	70.6

Transect 5			
Zone	Stability	Infiltration	Nutrients
Grass	38.5	34.7	37.1
Weed	7.1	6.8	7.4
Shrub	3.2	3.3	3.3
Litter	3.0	3.2	3.2
Bare	10.3	11.1	8.4
Total	62.0	59.2	59.4

Reference			
Zone	Stability	Infiltration	Nutrients
Shrub	18.7	13.7	14.4
Litter	39.2	29.3	30.8
Niche	6.2	4.0	4.0
Moss	0.7	0.4	0.4
Weed	0.2	0.2	0.2
Grass	4.0	3.8	3.8
Bare	4.5	2.2	1.6
Total	73.5	53.6	55.2